Lower Rio Grande Valley Brownsville Seawater Desalination Demonstration Project

FEASIBILITY STUDY

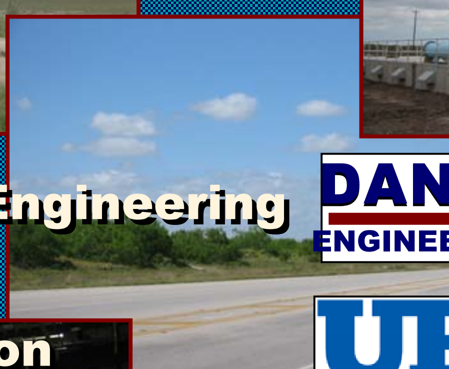
Prepared for:

Brownsville Public Utilities Board

BROWNSVILLE PUBLIC UTILITIES BOARD

Port of Brownsville

PORT OF BROWNSVILLE
HOME PORT TO NAFTA



Prepared by:

Dannenbaum Engineering Corporation

DANNENBAUM
ENGINEERING CORPORATION

URS Corporation

URS

November 2004

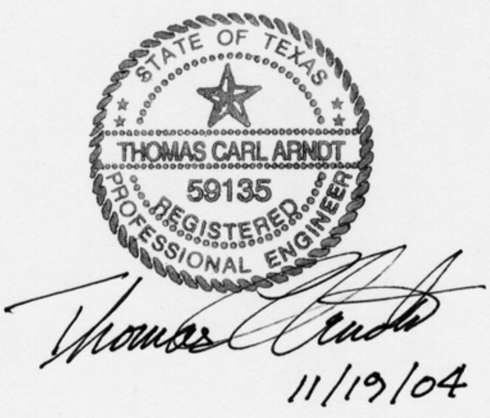
LOWER RIO GRANDE VALLEY
BROWNSVILLE SEAWATER DESALINATION DEMONSTRATION PROJECT

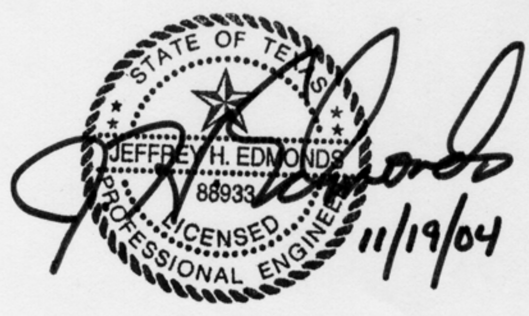
BROWNSVILLE PUBLIC UTILITIES BOARD
PORT OF BROWNSVILLE

FEASIBILITY STUDY

DANNENBAUM ENGINEERING CORPORATION
URS CORPORATION

Estrada Hinojosa & Co.





November 2004

BROWNSVILLE
PUBLIC UTILITIES BOARD

November 4, 2004

Mr. Jorge Arroyo
Texas Water Development Board
Steven F. Austin Building
1700 North Congress
Austin, Texas 78521

RE: **Lower Rio Grande Valley**
Brownsville Seawater Desalination Demonstration Project
Draft Feasibility Study

Subject: **Response to Comments**

Dear Mr. Arroyo:

This letter is to inform you that the responses to your comments on behalf of the Brownsville Public Utilities Board (BPUB) and the Port of Brownsville were submitted to the Texas Water Development Board (TWDB) on October 29, 2004, by Dannenbaum Engineering Corporation.

The BPUB staff had the opportunity to review the comments made by TWDB on the draft document and assisted Dannenbaum Corporation in preparing the responses prior to being submitted to the TWDB.

I hope the information submitted fulfilled your concerns and please contact me regarding any questions at (956) 983-6277 or Mr. Tom Arndt with Dannenbaum Engineering Corporation at (512) 345-8505. The BPUB looks forward to continue working with the TWDB on the successful completion of this Feasibility Study.

Sincerely,

John S. Bruciak
General Manager & CEO

c: Tom Arndt
Maribel Hinjosa
File

P.O. Box 3270 Brownsville, TX 78523-3270
(956) 983-6100 Fax: (956) 983-6289

October 29, 2004

Mr. Jorge Arroyo
Texas Water Development Board
Steven F. Austin Building
1700 North Congress
Austin, Texas, 78711

RE: Lower Rio Grande Valley
Brownsville Seawater Desalination Demonstration Project
Draft Feasibility Study

Subject: Response to Comments

Dear Mr. Arroyo:

In response to the comments from the Texas Water Development Board and others, we are providing the enclosed responses. We have also taken this opportunity to revise the operating costs for Phase I to more accurately reflect the current cost of energy. This discussion can be found in Attachment A, Revised Response to Initial Comments. We have also revised the enclosed Executive Summary to include the increased operating costs associated with power.

The sequence of our responses to the comments is as follows:

1. Attachment A – Revised Response to Initial Comments
2. Tables A-1, A-2, A-3 and A-4
3. Attachment B – Texas Water Development Board Staff Review Comments
4. Attachment C – Comments from the Texas Parks and Wildlife Department
5. Attachment D – Comments from the Water Treatment Engineering and Research Group of the United States Bureau of Reclamation
6. Tables A-5 and A-6
7. Figure A-1
8. Appendix A
9. Revised Executive Summary

We look forward to continuing our relationship with you on this project. If you have any questions or comments, please call me at (512) 345-8505.

Sincerely,

DANNENBAUM ENGINEERING CORPORATION

Thomas C. Arndt, P.E.
Project Manager

Attachments

C: John Bruciak, General Manager & CEO, Brownsville Public Utilities Board
Maribel Hinojosa, Brownsville Public Utilities Board
Jim Dannenbaum, Dannenbaum Engineering Corporation
Craig Pedersen, URS Corporation
Jeff Edmonds, URS Corporation

Attachment A

REVISED RESPONSE TO INITIAL COMMENTS

1. Access to a reliable source of low cost power is a critical cost factor for reverse-osmosis water treatment. The draft feasibility report uses a power cost basis of 3.5 cents per kilowatt/hour, which although consistent with the current utility tariff, is considered low. Brownsville Public Utilities Board's (B-PUB) situation as a provider of both water and electric utility service is unique. Please comment on the B-PUB's capacity to meet the power needs of the proposed project, in all of its different phases, and on its ability to maintain competitive power rates in the long run.

   Response:

   Maintaining of Competitive Power Costs and Capabilities
   Brownsville Public Utilities Board (BPUB) utility's goal is to provide the lowest possible cost to its customers. It achieves a highly competitive posture because it is a nonprofit, municipally owned utility. BPUB does not pay dividends to shareholders; instead, BPUB provides a cash transfer to the City of Brownsville and in kind utility service under the municipal tariff. BPUB is willing to provide power to the Desalination facility under the municipal tariff that creates an energy savings to the project versus commercial rates. BPUB facilities and City of Brownsville facilities are charged for energy consumption utilizing this rate. This rate is offered only to municipally owned facilities. This rate is determined to cover BPUB's cost only. The rate will fluctuate over time as changes in energy costs occur (as has been the case recently). The current rates are higher than those cited in the draft report. BPUB has represented that it can provide a low cost relative to the open market for this project because of its historically low rates (with a good mix of power sources) and its ongoing pursuit of low cost future fuel supplies. Alternative plans could result in a potential reduction in the fuel component cost with a potential blended rate that may include wind generation at the Port of Brownsville and the acquisition of additional coal-fired generation.

   BPUB has power generation plants across the state providing an equal balance of diversified energy resources including coal and natural gas. These include:

- Calpine Hidalgo Energy Center
  BPUB's investments in new facilities include clean-burning natural gas with advanced environmental control technology such as the Calpine Hidalgo Energy Center.

- Oklaunion
  Coal-fired plant. The operation of the Oklaunion facility is BPUB's most economical fuel consuming resource available at this time. Currently, they are in the process of purchasing additional generation from this facility that will increase the portfolio mix to approximately 35% coal-fired generation.

- Purchase Power
  - On a daily basis, BPUB calculates its own generation cost versus purchase power cost for energy off of the market and selects the most economical source of energy for its customers.

- Silas Ray
  - Peaking units located in Brownsville, Texas.
  - If the market prices are higher than the generation cost at the Silas Ray facility, BPUB will run the units at this plant.

Because energy costs are such a significant part of any desalination project's financial picture, cost estimates can only realistically reflect a snapshot in time, and due to the ongoing, significant volatility in national and world energy markets, it is recommended that energy costs be evaluated on an ongoing basis for all projects being considered under the Governor's Seawater Desalination Demonstration Project initiative.

Due to the increase in fuel costs for energy, we have taken this opportunity to revise our calculations to reflect the average cost of energy for the last 12 months. BPUB has determined that the **Municipal Rate** for this facility based on the last 12 months would be 5.45 cents per kilowatt/hour rather than the 3.5 cents per kilowatt/hour utilized in the feasibility study. This increased operating cost is reflected in the attached Tables A-1, A-2, A-3 and A-4.

2. Task 4A requires establishing the local and regional need for the project. In ES #2 and in Section 1.3.2, Current and Projected Water Supply Needs, the draft report recognizes that even with the implementation of other currently proposed water management strategies, the region may experience water supply deficits. Please comment on how the study considered the potential benefits of a seawater desalination facility in light of the currently proposed strategies, such as the Brownsville Weir, and other factors such as, for example: irrigation districts with strong conservation programs and canal lining projects (Hidalgo County) that may provide cheaper conserved water to adjacent customers; current long-term contract commitments for surface water supplies; regional brackish groundwater desalination centers; the continued availability of less expensive water that is easily transferable in the closed water market under the Rio Grande Watermaster's service area; and, terms and conditions associated with some B-PUB's water rights permits that might limit their sale to upstream users.

Response: Table A-1 (attached) identifies the costs associated with the various water management strategies contained within the Region M plan. We have also included the Southmost Brackish Desalination Plant in this analysis. Seawater desalination is $216/acre-foot more expensive or $58,267,334 over the life of the project. We, and BPUB, and BPUB's water availability consultant are not aware of any terms or conditions that would preclude the lease of water rights to upstream users.

3. For comparative consistency between the three proposed projects we are seeking the following: for the service area targeted for the first phase of the proposed project, please provide the total cost difference between implementing the currently approved water management strategies and seawater desalination.

   a. Provide the net present value of this cost differential over the life of the first phase of the project.
   b. Identify and consider any offsetting income resulting from sales related to surplus water rights.
   c. Identify and consider any other costs that would have to be addressed if the seawater desalination project is implemented; such as debt on existing facilities that may become redundant as a result of the desalination project.
   d. Calculate and report the corresponding cost differential as dollars per acre-foot.

   Response: These costs are broken out in the attached Table A-1. The existing Brownsville Water Treatment Plant debt of $173/acre foot ($0.53/1000 gal) was included in the financial analysis.

4. Please provide a breakdown of the water desalination production and transmission costs over the life of the project (net present value) on dollars per acre-ft, as follows:

   a. Treatment
      i. Debt service
      ii. Operations and maintenance costs
         - Chemical
         - Membrane replacement
         - Power costs
         - Miscellaneous
         - Labor
   b. Transmission
      i. Debt service
      ii. Operations and maintenance costs

   Response: These costs are broken out in the attached Table A-2.

5. It is not clear from reading the report whether a subsidy is required as a condition for the B-PUB to implement this project. Please comment. If a subsidy is required, please indicate what the recommended amount is and the form the subsidy should take, such as number of years over which it would be required, and what would be the equivalent amount on dollars per acre-foot when considered over the life of the first phase of the project.

   Response: A subsidy will be required for this project. As per Table A-2, an annual subsidy of $13,830,319 is required for the first phase of the project. This includes $9,181,000 in SRF excess capacity loans. Also depicted in Table R-2, an initial subsidy of $186,903,457would be required for this project.

TABLE A-1
BROWNSVILLE SEAWATER DESALINATION
CURRENT PROPOSED WATER MANAGEMENT STRATEGIES (WMS)

	Interest	Term (years)
Inflation Rate (from 1997)	4.00%	7
Bonds	4.98%	23

	Acre Feet/Year	Cost/ Acre-Foot (1997 4th Qtr)	TOTAL
Conservation:	0	$1,112	$0
Non Potable Reuse:	2,000	$360	$720,000
Potable Reuse:	0	$646	$0
Acquisition of Additional Rio Grande Water:	34	$430	$14,620
Brownsville Weir:	20,643	$438	$9,041,634
Brackish Groundwater (2004 Cost) (Southmost 7.5 MGD)	8,406	$571	$4,797,188
TOTALS:	**31,083**	**$469**	**$14,573,442**
WMS ANNUAL COST/YEAR (2004): (Brackish Cost Not Inflated)	**31,083**	**$568**	**$17,662,071**
2016 SEAWATER DESALINATION ANNUAL COST/YEAR (2004 $'s, with O&M):	**28,021**	**$784**	**$21,973,386**
DIFFERENCE/YEAR:	**3,062**	**($216)**	**($4,311,315)**

WMS PRESENT VALUE:	**$238,685,905**
SEAWATER DESALINATION (with O&M) - PRESENT VALUE:	**$296,949,184**
DIFFERENCE:	**($58,263,279)**

TABLE A-2
BROWNSVILLE SEAWATER DESALINATION
COST SUMMARY & SUBSIDY CALCULATION
2004 DOLLARS

	Interest	Term (years)
Bonds	4.98%	23
SPP	5.73%	32

Phase I: Treatment Plant		**Annual Cost**	**$/1000 gal**	**$/acre foot**
Capital Cost:	$107,591,000			
Bond Debt (Less SPP) * 1.1	$106,680,600	$8,683,464	$0.95	$310
2016 SPP	$910,400	$46,400	$0.01	$2
Total Capital Debt	**$107,591,000**	**$8,729,864**	**$0.96**	**$312**
O&M:				
Chemical	$1,866,000		$0.20	$67
Membrane Replacement	$1,300,000		$0.14	$46
Power	$6,943,000		$0.76	$248
Miscellaneous	$397,000		$0.04	$14
Labor	$1,270,000		$0.14	$45
Total	**$11,776,000**		**$1.29**	**$420**
TOTAL			**$2.25**	**$732**
Phase I: Transmission & Brine		**Annual Cost**	$/1000 gal	$/acre foot
Capital Cost:	$43,797,000			
Bond Debt (Less SPP) * 1.1	$37,362,600	$3,041,197	$0.33	$109
2016 SPP	$6,434,400	$374,450	$0.04	$13
Total Capital Debt	**$43,797,000**	**$3,415,647**	**$0.37**	**$122**
O&M:	**$426,000**		**$0.05**	**$15**
TOTAL			**$0.42**	**$137**
Phase I: Totals		**Annual Cost**	$/1000 gal	$/acre foot
Capital Cost:	$151,388,000			
Bond Debt (Less SPP) * 1.1	$144,043,200	$11,724,661	$1.28	$418
2016 SPP	$7,344,800	$420,850	$0.05	$15
Total Capital Debt	**$151,388,000**	**$12,145,511**	**$1.33**	**$433**
O&M:	**$12,202,000**		**$1.34**	**$435**
TOTAL		**$12,145,511**	**$2.67**	**$869**
Less Water Rights Credit			**-$0.26**	**($85)**
NET COST			**$2.41**	**$784.18**
SUBSIDY/YEAR		**$13,830,319**	**$1.51**	**$494**
SUBSIDY - PRESENT VALUE	**$186,903,457**			

TABLE A-3 WATER PRODUCTION COST FOR NEW FACILITY - PHASE I

	Initial Construction & Ramp-Up			Phase I Operation									
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Projected O&M Expenses[1]													
Operating Expenses													
Labor/Subcontractors				1,394,000	1,394,000	1,394,000	1,394,000	1,394,000	1,394,000	1,394,000	1,394,000	1,394,000	1,394,000
Power [7]				6,943,300	6,943,300	6,943,300	6,943,300	6,943,300	6,943,300	6,943,300	6,943,300	6,943,300	6,943,300
Chemicals				$1,866,000	1,866,000	1,866,000	1,866,000	1,866,000	1,866,000	1,866,000	1,866,000	1,866,000	1,866,000
Site Lease				$179,000	179,000	179,000	179,000	179,000	179,000	179,000	179,000	179,000	179,000
Phase Start-Up Expenses[2]													
Labor/Subcontractors			174,250										
Power			867,913										
Chemicals			233,250										
Site Lease[3]		$179,000	$179,000										
Maintenance Reserve				1,820,000	1,820,000	1,820,000	1,820,000	1,820,000	1,820,000	1,820,000	1,820,000	1,820,000	1,820,000
Total Projected O&M Exp	$ -	$ 179,000	$ 1,454,413	$ 12,202,300	$ 12,202,300	$ 12,202,300	$ 12,202,300	$ 12,202,300	$ 12,202,300	$ 12,202,300	$ 12,202,300	$ 12,202,300	$ 12,202,300
Projected Debt Service[4]													
Phase I-A (Series 2007)[5]	541,575	1,590,202	1,588,684	1,585,920	1,586,787	1,586,160	1,588,915	1,589,926	1,589,195	1,586,720	1,587,378	1,586,044	1,587,594
Phase I-B (Series 2008)		3,052,865	8,953,021	8,953,870	8,952,125	8,952,411	8,954,232	8,952,213	8,950,981	8,954,913	8,953,512	8,951,404	8,952,967
Phase I State Participation Loan[6]			84,171	84,171	126,257	168,343	231,471	294,600	357,728	420,857	420,857	420,857	769,567
Phase I State Participation Fee	18,852	18,852	18,852										
Total Projected Debt Service	$ 560,427	$ 4,661,918	$ 10,644,728	$ 10,623,961	$ 10,665,169	$ 10,706,914	$ 10,774,617	$ 10,836,738	$ 10,897,903	$ 10,962,490	$ 10,961,747	$ 10,958,305	$ 11,310,127
Required Revenues													
Total Exp O&M Expenses		179,000	1,454,413	12,202,300	12,202,300	12,202,300	12,202,300	12,202,300	12,202,300	12,202,300	12,202,300	12,202,300	12,202,300
Debt Service X 1.10	616,469	5,128,110	11,709,200	11,686,358	11,731,685	11,777,605	11,852,079	11,920,412	11,987,694	12,058,739	12,057,922	12,054,136	12,441,140
Total Required Revenues	616,469	5,307,110	13,163,613	23,888,658	23,933,985	23,979,905	24,054,379	24,122,712	24,189,994	24,261,039	24,260,222	24,256,436	24,643,440
Less Revenue from Water Leases				(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)
Net Total Required Revenues	$ 616,469	$ 5,307,110	$ 13,163,613	$ 21,520,468	$ 21,565,796	$ 21,611,716	$ 21,686,190	$ 21,754,523	$ 21,821,805	$ 21,892,850	$ 21,892,033	$ 21,888,246	$ 22,275,251
O&M Cost per 1000 Gallons				$1.34	$1.34	$1.34	$1.34	$1.34	$1.34	$1.34	$1.34	$1.34	$1.34
Debt Service Cost per 1000 Gallons				$1.28	$1.28	$1.29	$1.30	$1.31	$1.31	$1.32	$1.32	$1.32	$1.36
Water Rights Credit per 1000 Gallons				-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26
Net Cost per 1000 Gallons				$2.36	$2.36	$2.37	$2.37	$2.38	$2.39	$2.40	$2.40	$2.40	$2.44

(1) Does not include City of Brownsville transfers.

(2) Phase start-up expenses are 45-days of O&M expenses.

(3) Phase start-up assumes two years of site lease expenses during construction period.

(4) Debt service extends through 2030, 2031 and 2040 for Series 2007, Series 2008 and State Participation Loan respectively.

(5) Interest rate used for bond borrowing assumed to be 4.98%

(6) Interest rate used for State Participation loans was 5.73%.

(7) Energy prices subject to changes

TABLE A-4 User rates Impact Analysis

	Brownsville[1]		Harlingen[2]		Pharr[3]		McAllen[4]	
	Current	2010	Current	2020	Current	2030	Current	2040
Water Expenses								
Water Production[5]	$2,585,461		$2,045,494		$845,879		$2,858,163	
Net Remaining O&M Expenses	$3,233,418		$2,558,126		$1,057,869		$3,574,463	
Debt Service	$3,647,936		$1,162,310		$883,337		$2,024,634	
Capital Outlay and Other	$3,447,437		$1,945,274		$347,807		$4,172,920	
Transfers	$1,062,095		$0		$0		$0	
Total Expenses	$13,976,347		$7,711,203		$3,134,892		$12,630,180	
Capacity of Plant(s) (MGD)	40.0		13.3		8.5		42.2	
Capacity in 1,000 of Gallons	14,610,000		4,857,825		3,104,625		15,413,550	
Total Usage (1000's of Gallons)	6,871,000		4,387,990		1,817,494		6,572,523	
Cost per 1000 Gallons								
… on Water Production	$0.38	$2.36	$0.47	$2.42	$0.47	$2.50	$0.43	$2.02
… on Net Remaining O&M Exp	$0.47	$0.47	$0.58	$0.58	$0.58	$0.58	$0.54	$0.54
… on Debt Service	$0.53	$0.53	$0.26	$0.26	$0.49	$0.49	$0.31	$0.31
… on Capital Outlay and Other	$0.50	$0.50	$0.44	$0.44	$0.19	$0.19	$0.63	$0.63
… on Transfers[6]	$0.15	$0.15	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Cost per 1000 Gallons	$2.03	$4.01	$1.76	$3.71	$1.72	$3.76	$1.92	$3.51
Assistance Required (all per 1000 Gallons)								
Target Max Total Cost[7]		$2.50		$2.20		$2.16		$2.40
Expected Water Production Cost		$2.36		$2.42		$2.50		$2.02
Max Water Prod. Cost to Reach Target		$0.84		$0.91		$0.90		$0.92
Difference		$1.51		$1.51		$1.60		$1.11
Annual Assistance Required To Meet Target		**$13,830,319**		**$13,785,445**		**$14,641,968**		**$10,114,973**

(1) From the Brownsville PUB 2003-2004 budget.

(2) From the City of Harlingen Waterworks System continuing disclosure submitted 3/30/04 for the fiscal year ending 9/30/03.

(3) From the City of Pharr continuing disclosure submitted 3/31/04 for the fiscal year ending 9/30/03.

(4) From the City of McAllen CAFR for the fiscal year ending 9/30/03.

(1) The new plant will replace the "Water Production" component of the water rate.

(2) Brownsville transfer is shown based on the absolute value of the current amount.

(3) Target is $2.50 for Brownsville and a 25% increase for Harlingen, Pharr and McAllen.

Attachment B
Texas Water Development Board Staff Review Comments

The following comments are those of TWDB staff. They are broken down by category (contract compliance and technical) and represent the formal comments of the TWDB and should be addressed by the contractor before producing a finished product. Additionally and without any performance obligation, there are some suggestions that the contractor may want to consider. These are listed separately and are meant to help provide a more thorough or readable product.

CONTRACT COMPLIANCE COMMENTS:

1. ***Task 6A (the tasks referenced are those identified in the contract's Scope of Work attachment) requires a description of blended water characteristics if two or more source waters are being considered. This may help identify any cost savings related to raw water sources. These characteristics were not found in the draft report.***

Response: A preliminary evaluation of available brackish groundwater supplies in the local area was considered during the alternatives analysis. The project team apologies for not including the results from that evaluation in the Feasibility Study report, and has included the relevant information below for your consideration.

For a blended water supply solution considering two or more sources to be technically and financially attractive and feasible, the following criteria are considered essential:

- **Quantity of Alternative Water Supply** – A firm water supply from each alternative source of a sufficient magnitude would be required to maintain a lower composite TDS concentration after blending. This approach could theoretically improve overall project economics by reducing power consumption associated with the desalination process. The key two factors associated with this criterion are (1) a sufficient quantity to ensure a certain degree of TDS reduction and (2) a firm quantity that can be guaranteed through time.

- **Quality of Alternative Water Supply** – The overall quality of the alternative water supply source(s) would need to be such as to eliminate or at least minimize the requirement for any additional water treatment processes and operations at the desalination facility. Iron, manganese, and amorphous forms of silica could all have a negative impact on a blending solution by necessitating additional unit treatment processes and operations. While additional water treatment processes/operations to address problematic water quality constituents could be considered, the capital cost and operational expenses associated with additional treatment units would reduce the apparent cost effectiveness associated with a blended water solution to effect reductions in operational costs for TDS reduction.

- **Resulting Capital & Operational Expenses** – The location of alternative water supply sources would be another critical aspect to successfully support a blending solution. If brackish groundwater sources were to be used, the capital investment and operational expenses needed to acquire and route groundwater to the desalination facility would need to less than the cost savings associated with the off-set in treatment requirements and/or power reduction for the desalination process itself.

Although a comprehensive hydrogeological investigation was not conducted as part of the initial feasibility study, sufficient information was obtained to confirm that each criterion listed above would be negatively impacted by some degree. Specifically, the following issues were identified that would substantially reduce cost savings associated with a blended water solution for this particular project:

- **Available Yield** – Based on a review of historical reports, firm brackish groundwater yields remain highly questionable in the nearby area. For only a 10 percent TDS reduction in the blended water supply, a total groundwater quantity of approximately 4 to 6 MGD (corresponding to a TDS range of 500 to 10,000 mg/L) would be needed for the initial 25 MGD plant capacity. If a larger TDS reduction is needed to support cost savings for a blended water solution, even larger quantities of brackish groundwater would be needed. While it may be possible to locate brackish groundwater quantities of this magnitude and greater, a more extensive hydrogeological investigation would be required to confirm what the available and long-term yield would be from local brackish groundwater aquifers.

- **Firm Yield** – Without additional hydrogeological information and testing, a firm yield for a brackish groundwater supply of a suitable quality could not be fully established during the initial feasibility study. To maintain a proper and consistent blending solution for this project, additional brackish groundwater quantities of similar quality would be needed as the desalination facility is hydraulically expanded from 25 MGD to 100 MGD. Thus, the initial 4 to 6 MGD groundwater supply estimated above for the 25 MGD plant capacity to effect a 10 percent reduction in TDS may have to increase to 16 to 24 MGD for the build-out capacity. Thus, a firm yield of at least 16 MGD, and perhaps greater, throughout the 50 year life-time of the project would need to be available from nearby groundwater sources to maintain a reasonable reduction in the blended water TDS content of a blended supply.

  Proceeding with a blended water solution at this phase of the project without confirming this very important criterion could potentially skew the conceptual design and configuration of the desalination facility. The project team could not reasonably substantiate that there would be a sufficient firm capacity from local brackish groundwater sources to support a blended water solution for this project. The proposed design configuration of the desalination facility is based on a firm supply capacity that would be available from the Brownsville Ship Channel of a known quality to better ensure the project's financial estimates and resulting unit cost of water. If a firm groundwater yield were estimated during conceptual planning and proves not to be available during the lifetime of the project, the blended water quality could not be maintained and operational costs would likely increase.

- **Suitable Water Quality** – Based on a review of the available hydrogeological information for the immediate area, groundwater contains varying degrees of problematic constituents such as iron, manganese, sulfates, silica, etc. If groundwater containing these constituents were considered for the project, it is likely that additional water treatment processes and operations would be needed to reduce and/or manage the concentration of these constituents prior to membrane treatment. If not properly managed, these water quality constituents could result in catalytic degradation and/or irreversible scaling of the SWRO membranes.

  Potential treatment strategies that may be required to manage these constituents could include an oxidation and clarification system for the precipitation of iron and manganese, at a minimum. Other treatment processes such as lime precipitation and/or pH adjustment may be needed to reduce relatively high levels of sulfate. Furthermore, sludge production would increase as a consequence of exploring water treatment infrastructure to address these problematic constituents. The resulting costs associated with the additional treatment works would negatively impact (reduce) potential cost savings associated with reducing the TDS content of the blended water supply.

- **Additional Capital Investment and Operational Expenses** – In order to establish an adequate water delivery system for a brackish groundwater supply source, multiple wells, deep well pumping systems, and one or more transmission mains would be needed. Without additional site specific hydrogeological testing in the Brownsville area, it would be difficult to establish the exact location and depth of groundwater production wells. While assumptions could be made to configure a groundwater production and transmission system, the degree of uncertainty introduced by the assumptions could result in inaccurate (high or low) cost estimates for this additional infrastructure work. Regardless of whether or not an accurate cost estimate could be developed for a dedicated groundwater supply system, it is anticipated that the cost of this system would be substantial compared to the potential cost savings associated with a blended water supply solution.

The reader must take all of the foregoing considerations into account before making a decision to include a brackish groundwater supply for this project. Without additional information related to local groundwater sources, there is reduced ability to (1) confirm groundwater yields, (2) establish the need for additional treatment units to address problematic groundwater constituents, and (3) accurately configure a groundwater production and transmission system. Due to this reduced ability, additional capital and operational costs associated specifically with the infrastructure to route and treat groundwater prior to blending can not be accurately established. And an accurate set of cost estimates would be necessary to confirm if this would result in a reduction in the project's overall cost to treat water.

Due to the degree of uncertainty associated with the brackish groundwater component, this solution was not considered viable at this time to include as part of the conceptual design of the desalination facility. If so desired by the TWDB, an additional and more detailed evaluation of a blended water solution could be considered and included in the Special Studies phase of the project, which would follow this conceptual-level study phase. Results from a more detailed and expansive groundwater study would provide better ability to properly assess potential cost savings related to a blending solution. If results from such a study positively addresses each of the criteria listed above, a groundwater supply system could be easily added to the conceptual configuration of this project in order to capitalize on any related cost savings.

2. ***Task 6C requires a data review and analysis capable of supporting a preliminary hydro-geologic assessment to determine deep well injection zones and locations. While there is a reference to data in Appendix "F", it is not possible for a reader to make a direct association or to verify the supporting data.***

Response: Readily available hydrogeological information and data for the local area was obtained and reviewed. Source documents for the available hydrogeological information were documented in Section 3.1.3 of the report. This information was used to evaluate (1) potential brackish groundwater supplies that could be explored as part of a blended water supply solution for the project and (2) possible injection zones for the disposal of concentrated brine. While the available information proved useful to assess issues associated with the above two goals, additional hydrogeological information would be needed to develop an adequate design for an Underground Injection Control (UIC) system.

In leiu of sufficient information and data to fully support a conceptual-level UIC system design for brine disposal, various assumptions were made in order to develop an initial cost estimate for this type of system. The following considerations and assumptions were made as the basis for the conceptual-level design of a UIC system for this project:

- Underground injection of brine should be restricted to a depth where it cannot upwell and contaminant shallow sources of brackish groundwater that could potentially be used for a potable water supply. Below the documented brackish water zones that could be used for potable supplies, lie the lower portions of the Evangeline and Jasper Aquifers, which are located at approximate depths of 1,500 to 7,000 feet. It was concluded in Section 3.1.3 that the exploration of this deeper zone is considered impractical as a reliable potable water supply source due to relatively high levels of TDS and other undesirable water quality constituents. However, this zone could potentially be used to inject and dispose of concentrated brine.

- Since groundwater at depths above 1,500 feet could potentially be used as drinking water sources, injection wells should be installed below this depth by a sufficient margin. The capital cost estimates presented in Section 3.9.2 assumed that the injection wells would be installed to a depth of approximately 5,000 feet BLS. This depth should adequately protect the shallower groundwater supplies, while allowing a sufficient zone of dilution around the zone of injection. The actual depth for the injection interval would need to be established through site-specific hydrogeological testing during a subsequent project phase.

- At least five injection wells per 25 MGD plant capacity were estimated for the total quantity of brine that may require disposal. A sixth well was included for purposes or redundancy and added reliability. Each injection well would be located within a 2 mile radius of the plant site. All wells would be at least 8-inch in diameter and equipped with one or more surface casings to prevent cross contamination of the shallower geologic units. Each well would be manifolded into a common transmission main to minimize piping costs.

- An injection pressure of 100 psig was assumed as the basis to estimate pumping costs. No information could be found in the literature regarding what the injection pressure may actually be for the proposed injection zone. However, a literature search conducted for similar types of injection wells in similar lithologies suggests that injection pressures could range widely from as low as 50 psig to 200 psig and greater. A reasonable median value of 100 psig was used. Site-specific hydrogeological testing during a subsequent project phase would need to be performed to assess actual injection pressures.

Based on the above assumptions, both capital and annual O&M costs were estimated and used to conduct an initial life-cycle cost analysis of brine disposal via underground injection. Life-cycle results of underground injection were compared to the ocean outfall option. As documented in Table 3-52, the ocean outfall option is more cost effective at all discharge rates. However, as additional brine volumes are produced as a consequence of plant expansion events, the cost effectiveness of the ocean outfall increases from just a few $1M to nearly $40M as expressed on a life-cycle cost basis. This single result is significant since it confirms the consequences of disposing greater brine volumes underground; e.g., additional capital costs associated with installing more deep wells and additional energy costs due to additional pumping requirements. This particular conclusion is a strong factor that would influence which brine disposal option would be more cost effective in the long term.

Another important consideration when comparing an ocean outfall to an underground injection option is one of overall reliability. Injection wells can be prone to a relatively high failure rate. Before they fail completely, there may be a long period of time in which the performance of the well decreases. During this time, additional pumping energy is required to maintain a similar disposal rate. Eventually, the well may need to be taken off-line for rehabilitation. Sometimes rehabilitation is possible, while other times the well must be abandoned and replaced with a new well, which is a very expensive proposition. This does not mean that there are not potential maintenance problems associated with an ocean outfall. A large anchor or other object could damage the brine transmission main or its associated diffuser array. However, the ability to access and effect repairs on the infrastructure needed for an ocean outfall is generally much easier and less expensive than repairing and/or replacing one or more injection wells.

3. ***Task 7A requires a description of the various existing water treatment facilities in the potential service area, including such parameters as their relative locations, potential build-out capacities, primary water sources, the quality of their finished water, as well as the impact of the proposed desalination facility on such existing facilities. Such a description was not found in the draft report.***

Response: The project team apologizes for not including the information concerning the two existing Brownsville Public Utilities Board's surface water treatment plants in the Feasibility Study report. We have included the relevant information below for your consideration.

Both water treatment plants (WTP) are conventional treatment systems with the raw water source being the Rio Grande River. The relative locations of the plants are depicted in the enclosed Figure A-1. Both of these plants are 20 MGD facilities with no future expansions proposed at this time. With the proposed first phase of the desalination plant, the total capacity of the existing plants will not be required, and it would be our recommendation that WTP 1, which is the oldest plant, would be decommissioned. This would save BPUB the future cost of upgrading and renovating this older plant. In Section 8 of the report, we have included the existing debt for the plants in our financial analysis. Tables A-5 and A-6 summarize the water quality data for WTP 1 and 2. The existing water treatment plants are treating poor quality water from the Rio Grande River, not far from where the River discharges into the Gulf of Mexico and the existing plants are not designed to reduce the hardness in the raw water. The water from the proposed desalination plant, blended with the treated river water, will reduce the hardness and improve the quality of the water delivered to the citizens of Brownsville.

4. ***Task 9A requires supporting data for the preliminary cost categories and estimates (for example, labor, site development and primary treatment systems) that help justify the estimates. Please provide the supporting data or other information used to calculate these cost estimates.***

Response: Please refer to Appendix A, which contains a series of quantity take-offs and unit costing data for the various project components. For each of the primary project components, a spreadsheet is provided to summarize the various work associated with constructing each component. The total cost estimated for each component was previously reported in Chapter 7 of the report along with the basis for the unit cost estimates.

5. ***Task 11 discusses a public participation component involving a kick off meeting and opportunity by the public to provide comments. The draft does not contain any information regarding this effort nor when it would occur. Please provide information on the status of this task.***

Response: Two public meetings have been held concerning this project:

1. The kick-off meeting/workshop was held on January 23, 2004 at the city of Brownsville Public Library. Brownsville Public Utilities Board (BPUB) invited potential stakeholders to this meeting. BPUB and the project team made a presentation and fielded questions. The overall response was positive, with the main concern being air quality from the proposed coal fired power plant.

2. A public hearing was held on January 28, 2004 at the McAllen Miller International Airport. This hearing was advertised by BPUB and a presentation was made by BPUB and the project team. Two speakers signed up to speak. Again, The overall response was positive, with the main concern being environmental issues.

In addition, a presentation was made to the Zapata County Commissioner's Court at their regular meeting on June 14, 2004.

<u>TECHNICAL COMMENTS:</u>

1. ***Task 9A requires supporting data for cost estimates. Table 3-18 ("Estimated Capital and Annual O&M Expenses for BFC System with Single-Stage Filtration") lists a $2.1 million dollar installation cost associated with a $5.26 million dollar filtration system. TWDB staff believes this to be an unusually high ratio. Please address this concern.***

Response: During the conceptual-level design and costing effort, specific multipliers were applied to the capital cost estimated for each project component. Usually, a conservative multiplier is used during conceptual-level planning to ensure that there will be sufficient budget to address all field-related work including proper storage and security, installation and field fabrication work, functional testing, initial operational testing, etc.

A 40 percent factor was applied to the capital cost estimates for each primary component to cover all field-related work associated with each component. As part of the cost verification process, information was obtained from specific vendors regarding actual installation costs for similar work constructed for other projects. The vendor feedback was used as a "sanity check" to qualify installation costs developed for the conceptual facility. It should be qualified that the 40 percent installation factor is conservative in nature and that actual field-installation work may indeed be lower than that presented in the Feasibility Study report. However, through this approach, better assurance can be given that the resulting unit cost of water for the project will not be higher that that estimated, thereby better supporting project feasibility.

2. ***Section 3.9.1.3 ("Surface Water Discharge to the Brownsville Ship Channel") dismisses this alternative for brine disposal because it may degrade water quality and/or impact the channel's aquatic environment, increasing salinity. This is stated without reference to supporting data or models. TWDB staff ran a Stella Model of such a disposal scenario that indicates no stressful salinity levels would result from well-mixed waters entering the channel from Brazos Santiago Pass. Since the study's conclusion directly impacts both environmental and cost considerations discussed in Sections 6 ("Potential Environmental Impacts") and 7 ("Opinion of Probable Costs"), a more detailed explanation should be included before dismissal of this alternative.***

Response: Advanced and site-specific numerical modeling would need to be conducted to confirm the resulting impact of increased salinity levels due to a discharge directly within the Brownsville Shipping Channel from the project. The ability to conduct such an extensive modeling effort, which would require a considerable amount of field work and data, was beyond the scope of the initial work effort associated with the conceptual-level design of the facility. However, the above comment indicates that "*…no stressful salinity levels would result from well-mixed waters entering the channel from Brazos Santiago Pass.*" The primary working assumption in this statement is one of well-mixed waters; a condition that cannot be guaranteed at this time with any level of certainty for this specific project. The project site is located approximately 8 miles inland from the Gulf of Mexico. Given the fact that the Gulf of Mexico is the only principal source of replacement water for the channel due to normal tidal influences, there would be limited ability for brine discharges into the channel (at a TDS concentration of approximately 90 ppm) to be properly mixed without causing increased salinity levels. Previous numerical models that URS has developed for similar brine discharge scenarios within a confirmed open water channel have, in fact, demonstrated a significant increase in salinity levels in the vicinity of the discharge.

The project team doubts at this time that the salinity level directly adjacent to and/or nearby the proposed plant site would not increase given (1) the site specific geometry of the ship channel and (2) the lack of fresh water feed sources for the channel. Even a subtle increase in salinity could adversely affect local ecosystems that are present within the channel. Larger salinity increases could directly and significantly impact the project by increasing energy costs associated with the desalination process.

In order to support project permitting, a detailed hydraulic numerical model would be developed to confirm the resulting impact to water quality as a consequence of water withdrawals associated with the project's intake system. At that time, it would be relatively easy to model a brine discharge at various locations along the Brownsville Ship Channel to confirm the resulting impact on salinity levels in the channel. If results from that analysis prove favorable, the project team could possibly reconsider the proposed brine disposal system as it could substantially reduce project costs. However, similar to the exploration of a brackish groundwater blending solution as discussed above, it would be difficult to defend a brine discharge into the shipping channel at this phase of the project.

3. ***Task 6 et seq. requires an analysis of available information regarding environmental effects. Section 6.6.5 ("Potential Environmental Impacts") appears to be incomplete because it deals only with resident birds and their habitats without a similar analysis of the diverse migratory birds associated with this area.***

Response: These issues will be further discussed through agency consultation once this project moves out of the feasibility stage. A baseline study of endangered and threatened species would be conducted to confirm the presence of or supporting habitat for species of concern at that time.

4. ***Task 3A requires an analysis of funding options. Section 8.2.2 ("Regional Project Service Configuration") and Table 8-3 ("Water Lease Rights") suggest principal and customer cities would help fund the project using freed-up surplus water rights that would be leased for at least the term of any bonds, thereby reducing the total required revenue. The assumed value of those leased rights is presented as $2,000 per acre-foot. This number appears to be close to an outright purchase amount. Please elaborate on the reasonableness of that value and explain what factors may impact the "lease" amount.***

Response: For purposes of simplicity, the $2000 per acre-foot was amortized over the 23 year debt service for Phase I. It is our belief that the value of water in the Rio Grande basin will only continue to increase in value.

SUGGESTIONS:

1. ***Correct Figure E-1 (in the Executive Summary) to include the cost increments identified on the Y-axis of its scale.***

Response: This figure has been revised in the attached Executive Summary, which has been updated.

2. ***Include a full discussion of the pilot testing required for this project.***

Response: A pilot-scale program will certainly be required before final design plans are prepared and construction of the desalination facility can occur. For a facility of the size proposed (25 to 100 MGD), it would be imperative to pilot for an extended period of time, such as one year or more. This duration for the testing program is recommended in order to capture a larger range of potential raw water quality variation in terms of TDS, seasonal foulants, and temperature.

The pilot program itself would consist of multiple components, a summary of which is provided below:

- **Pilot-Scale Testing Plan** – A plan would be prepared that would summarize all testing activities that would be performed. These activities would include continuous and intermittent water quality analyses of the raw water supply, pilot-scale testing for potential pretreatment units, different RO membranes types and configurations, and post-treatment conditioning steps. The size of individual pilot units would be confirmed by the plan to ensure to the degree practical that data obtained from pilot testing could be scaled upward and used to support design efforts for the full scale desalination facility. Other aspects of the pilot-scale testing program that would be detailed in the plant include (1) a series of pre-pilot studies to prescreen specific membrane elements, (2) detailed testing protocols, (3) sampling schedule, (4) data collection schedule, (5) seasonal verification testing, and (6) schedule of activities for the testing program. Activities that would be included in the schedule would include an equipment procurement and set-up period, starting and ending dates for pilot-scale testing activities, and post-testing data review, analysis, and reporting.

- **Pilot-Scale Equipment Set-up** – Upon plan approval, all equipment specified in the testing plan would be procured, delivered to the site, and installed. It is anticipated that a small construction contract would be executed to facilitate the installation and set-up of the pilot-scale system. The construction contract would provide a means to collect water from the Brownsville Ship Channel and route it to the pilot-scale system, equipment staging area, chemical stocks, proper power supply, waste disposal facilities, and all other requisite infrastructure that would be needed to support the pilot-scale system.

- **Pilot-Scale Testing** – Pilot-scale testing activities would commence as soon as all equipment was installed and readied for operation. The testing program would be composed of multiple, individual tests to assess various types of treatment components and physiochemical test conditions. As confirmed in other responses within this document, different pretreatment alternatives would be evaluated and rated with respect to their ability to reduce suspended solids and organic content of the raw water supply. Different RO membrane types of configurations would be evaluated to assess which membrane would be the most suitable for the specific source water. The overall goal of the testing program itself will be to establish the most appropriate, efficient, and cost effective combination of treatment components for this project.

- **Data Reduction and Analysis** – During and after to pilot-scale testing, raw data will be compiled into a database for subsequent reduction and analysis. Data will be trended to assess various aspects of the pretreatment, membrane treatment, and post-treatment strategies including, but not limited to: (1) ability to address fluctuations in various raw water quality parameters, (2) increased fouling potential of the membranes through time, (3) chemical demands and usage rates, and (4) other pertinent considerations. Using data collected from pilot-scale testing, potential long-term membrane performance over time would evaluated through numerical modeling including but not limited to a productivity model and a water quality model.

- **Pilot-Scale Report** – Upon completion of data analysis, a report would be prepared to document and summarize the results from the pilot-scale testing activities. Using data from the testing program, specific design parameters would be established for the full-scale desalination facility. The report would be used to support the development of a formal Preliminary Engineering Report (PER) for the project. The PER would serve as the basis of design for the project from which detailed construction drawings and technical specifications would be prepared. In addition, both capital and annual O&M cost estimates could be further refined to provide a more accurate assessment of total project costs.

3. ***Appendix D ("Preliminary Brine Dilution Modeling and Conceptual Design of Diffuser Array") presents different diffuser array results using three and 12 mile scenarios based on shallow and deep water dispersal. In Section 3.9.1.2 ("Ocean Outfall Within the Gulf of Mexico"), the conceptual design costs are based on the three mile scenario because both sets of dilutions are so similar. The feasibility costs may benefit from a discussion of even shorter array scenarios if there is no apparent need to go further of the coast.***

Response: The specific location, or locations, where a brine diffuser array could be constructed would need to be verified during the Special Studies phase of the project. The two locations considered during the preliminary modeling effort were used to evaluate potential dilutions at two possible boundary locations in the Gulf. The 3-mile site was selected since it would ensure sufficient depth of the diffuser array to safe guard against damage due to shipping traffic to the degree practical. The 12-mile site was selected as a possible worse case location to address potential environmental concerns that may exist at locations closer to the Texas coastline.

The project team agrees that another location, even one closer than the 3-mile site, is highly possible and will be properly and fully evaluated during Special Studies. However, in an attempt to establish reasonable and somewhat conservative estimates for the capital costs associated with the conceptual-level facility, the 3-mile site was selected as the basis for the project's financial analysis. If a closer site can be confirmed and permitted during the subsequent phase, a lower unit cost of water could be potentially realized by reducing infrastructure, thereby reducing the amount of subsidy that may be required to implement the project.

Attachment C
Comments from the Texas Parks and Wildlife Department

<u>General Comments Regarding Seawater Desalination Plants</u>

Cooling Water Intake Structure rules, adopted under the Clean Water Act Section 316(b), already exist for power plants, and are anticipated for all other large facilities in the future. These rules will require certain facilities to use technology to minimize impingement and entrainment of larval and juvenile fish. These rules will be implemented in the TPDES permitting process.

Response: The project team acknowledges that the CWA requirements pertaining to screening must be fully addressed during the TPDES permitting process. To support this pending process, the intake screens for the desalination facility were conceptually selected and sized to maintain a maximum approach velocity of 0.5 feet per second (fps), which complies with Section 316(b) of the Clean Water Act. It should be noted that this approach velocity would exist directly along the face of the screen assemblies and would decrease to 0.1 fps as water is routed into the side intake channels.

Each of the facilities would have a pretreatment waste stream of relatively low volume, compared to a 25 MGD brine discharge. Having a low volume, this waste stream could go to a local wastewater treatment plant, or it could be commingled with the brine.

Response: The options mentioned in this comment are viable means to manage and address the low volume waste stream generated by the pretreatment system. For the Brownsville Desalination Facility, approximately 1.0 MGD of unthickened sludge would be generated by the BFC system. In addition, 0.18 to 0.88 MGD of backwash wastewater would be generated by the dual media filters. If an initial effort to minimize waste disposal volumes, while maximizing water recovery, the project team proposed that the wastewater streams generated by the pretreatment system should be treated on-site through a dedicated solids handling system. The following advantages are realized through this approach:

- The majority of water can be recovered and returned to the desalination facility. This would allow residual pretreatment chemicals to also be recovered, thereby reducing the overall quantities of chemicals needed.

- Generation of wastewater by the pretreatment system would be essentially eliminated, thereby eliminating effluent disposal issues and costs. This would result in more independence for the desalination facility, by reducing reliance on using a regional or local wastewater treatment facility to manage this waste stream.

- Low concentrations of various constituents could affect the ability to properly dispose of wastewater from the pretreatment system via the brine disposal system. Since metal salts, polymers, and other chemical additives will be used in the pretreatment system, the presence of these chemicals even in trace amounts could adversely affect the brine discharge in terms of biotoxicity. Since bioassays would likely be required on a routine basis for the brine discharge as part of an NPDES permit, it will be extremely important to avoid adding any constituent that could cause a test failure and noncompliance.

The project team would re-evaluate the management of wastewater generated by the pretreatment system during the detailed design phase of the project to ensure that the most reliable and cost effective approach is selected and implemented for the project. However, the conceptual approach described and illustrated in the Feasibility Study would be appropriate to pursue for the reasons outlined above and is considered the more conservative approach to adopt at this phase of the project.

Facilities operating water pipelines typically periodically use some sort of antifouling chemicals to clean their lines. As part of the TPDES application process for brine disposal, the facilities would have to specify what they plan to use, to ensure that TCEQ can properly regulate to prevent environmental harm.

Response: Specific chemical additives that may be needed from time to time to address pipeline fouling would be considered and included during final engineering design and project permitting. However, until additional information is available from bench-scale and pilot-scale testing activities, the exact means to address antifouling cannot be adequately established during the conceptual-level planning effort.

Specifics of Gulf disposal of brine, relevant to Brownsville and Corpus Christi, would have to be worked out. This would focus, from a water quality perspective, on outfall location and depth, prevailing currents, and design of a diffuser system.

Response: The project team concurs that a significant work effort will be required to fully evaluate and implement a suitable brine disposal solution for the subject project. A detailed engineering evaluation, complete with advanced numerical and hydraulic modeling, would be performed to site and design a proper brine diffuser. This activity would be coordinated with the various environmental studies that would be needed to confirm suitable sites for a brine diffuser array. It is anticipated that a detailed plan will be prepared to outline specific activities that will be performed for the design of a brine disposal array. This plan would take into account those items included in the above comment along with many other considerations.

<u>Brownsville Proposal</u>

The Executive Summary states that the Rio Grande River environment could also be enhanced by dedicating some of the surface water currently used for municipal purposes, which could remain in the river due to the water made available by this project. TPWD is cautiously optimistic that this goal could be realized but recognizes that additional steps will be needed. Brownsville has selected a Gulf disposal option for brine disposal, which is consistent with discussion at a multi-environmental-agency meeting in Brownsville earlier this year.

Response: We acknowledge this statement.

The intake is proposed for side channels of the Brownsville ship channel. It is not clear how the intake from the ship channel may affect flow of the ship channel. There is potential for the intake to set up a consistent "upstream" flow pattern, which could affect the ship channel's ability to assimilate other wastewater discharges in the area, should those exist.

Response: A detailed hydrologic engineering evaluation would be performed during the detailed engineering design phase of the project to support the final design configuration of the intake system. But to address this comment to the degree practical at this time, the project team conducted a cursory analysis to assess the potential velocity change that would occur within the Brownsville Ship Channel as a result of withdrawing seawater for the desalination facility. The following excerpt from Section 3.0 of the Feasibility Study report that addresses the potential velocity impact of the water withdrawal from the channel is provided below:

> *The initial finished water production capacity of the desalination plant will be 25 MGD, while the potential build-out capacity may reach 100 MGD. Assuming a conservative recovery factor of 50 percent for seawater membrane systems, the potential withdrawal rate for the initial plant capacity could be as high as 50 MGD. For the build-out capacity using the same recovery factor, up to 200 MGD may be required. Using an average cross sectional area of the Brownsville Shipping Channel of approximately 18,000 square feet, the velocity associated with the withdrawal of 200 MGD would be approximately 0.017 feet/second. The impact of normal tidal fluctuations within the shipping channel would be considerably larger than the withdrawal of the water for the desalination facility. Thus, from a capacity perspective, the shipping channel has more than sufficient capacity to support the desalination plant up to and exceeding its potential build-out capacity.*

Based on the foregoing initial assessment of the maximum water withdrawal capacity, the change in the ship channel's velocity profile would be fairly nominal and should remain below the anticipated tidal velocities that the channel would normally experience. This relatively small change in velocity within the ship channel should mitigate changes in waste assimilation within the channel. Although there may be issues associated with the channel's ability to assimilate other waste discharges in the nearby area, these issues would need to be addressed during the Special Studies and Permitting phase of the project.

Section 4

Page 36 - The report states that the onshore alignment for the brine disposal main appears to be primarily with in property owned either by the Port of Brownsville or the USFWS. Coordination with USFWS needs to happen.

Response: Page 6-21, third paragraph under Onshore Biological Resources, specifically states that activities in this area will be "closely coordinated with USFWS to minimize the impact of construction" on the habitat.

No mention is made of archeological sites known in the area for instance the proposed alignment takes the brine discharge pipeline through or very near a newly discovered historical ship wreck from the early to mid-1800's. Other known and historical ship wreck sites also exist in this area. Coordination with the Texas Historical Commission and/or Nautical Archaeological Program at Texas A&M.

Response: This study was conducted at the planning level and is not meant to be an in-depth analysis at the EA or EIS level at this time. The SHPO and other concerned historic preservation agencies will be fully consulted at the time the project moves beyond the feasibility stage to determine the presence of any cultural artifacts in both the marine and terrestrial environment.

Section 6

Page 1 - The statement in paragraph 3 regarding brine disposal pipeline right-of-ways (ROW) that "Since these ROWs have already undergone significant disturbance as a result of construction and maintenance, additional construction will not affect any sensitive biological populations, archeological sites, recreational areas, or other sensitive receptors." is incorrect. Such ROWs will affect USFWS undeveloped lands, Gulf beach recreational areas, seaturtle nesting areas, shrimp habitat, commercial shrimp fishing areas, recreational fishing areas and potentially archeological sites.

Response: The sentence refers to existing ROW along roads and other existing linear features. In areas not previously impacted, the above-statement is true and is addressed by use of non-intrusive methods described here and in more depth later in the section.

The statement in paragraph 4, "The brine discharge pipeline outfall has been located approximately 3 miles offshore in a minimum water depth of 25 feet." while correct contains a large discrepancy. The 25 ft contour in the area of the proposed discharge pipeline is approximately 1 statute mile from shore. The water depth at 3 statute miles from shore is 48-50 ft deep. Of note regarding this discrepancy is that currents can be substantially different between these distances from shore and may affect the brine dispersion modeling.

Response: Three different current speeds were used for the initial modeling effort. These current speeds were selected to represent that range of current speeds that could be reasonably expected at the discharge location. The current speeds were determined using data from two different sources, NOAA Buoy 4204, which is located in deep water, and the Texas Automated Buoy System buoy D in shallow water off Corpus Christi. Therefore, the impact of placing the discharge in a water depth slightly different than those modeled should not significantly affect the current speeds selected for the modeling.

The actual depth for the diffuser array will be established during the Special Studies and Detailed Design phases for this project. The 25 foot depth used for the initial modeling effort was based on information obtained from the bathemetry map presented in Appendix D of the Feasibility Study and represents the minimum depth below the water surface for a diffuser to protect it from shipping traffic.

Page 6 - Screened Intake Assemblies - This approach velocity and screen will entrain and impinge many eggs and larval organisms.

Response: The project team carefully evaluated and considered entrainment and impingement when developing the conceptual design of the intake system for this project. The project team believes that sufficient design provisions were accounted for at the conceptual level to address these issues. However, it is also acknowledged that additional and/or modified infrastructure may be required during the project's detailed design phase. Key design aspects that address this concern at this time are listed below:

- **Approach Channels** – The geometry of the approach channels was configured to reduce the approach velocity to the side inlets of 0.1 feet per second (fps) or less. At this very low approach velocity, there is reduced potential to entrain sensitive species that may be present on the floor of the ship channel.

- **Screened Assemblies** – These units consist of a wire mesh screen of 1/8-inch openings. The units were sized to maintain a velocity below 0.5 fps, which is consistent with the design provisions as specified in 316(b) of the CWA.

- **Air Burst System** – To address any impingement that may occur along the face of the screens, the assemblies would be equipped with an automatic air burst system. This system would periodically provide a gentle burst of clean, compressed air along the entire screen assembly, which would dislodge any accumulated larval eggs or species.

While no system can ensure zero mortality, the conceptual system proposed in the Feasiblity Study report should be sufficient to demonstrate that adequate provisions will be taken to minimize mortality.

Page 19 - Section 6.6.3, paragraph 4 - Same issue with coordinating with USFWS on ROW over their land.

Response: Page 6-21, third paragraph under Onshore Biological Resources, specifically states that activities in this area will be "closely coordinated with USFWS to minimize the impact of construction" on the habitat.

Page 22 - Paragraph 2 states that "a general lack of vegetative cover with in the area traversed by the proposed brine disposal main, precludes the presence of many terrestrial species." This is a relative statement about the concentrations of terrestrial wildlife and does not reflect the purpose goals of the USFWS or TPWD in efforts to preserve and protect areas mostly covered by the Lower Rio Grande National Wildlife Refuge, Brazos Island State Park and the nearby South Bay Coastal Preserve. The last sentence about the unlikeliness that coyote or other predators are abundant is incorrect.

Response: These issues will be further discussed with USFWS and TPWD once this project moves out of the feasibility stage. A baseline study of endangered and threatened species would be conducted to confirm the presence of or supporting habitat for species of concern at that time.

Paragraph 3 states that it is unlikely that many raptors would be present with in the area due to a general lack of prey species. This area is frequented by osprey, migrating raptors and is one of the more likely places to find peregrine and possibly aplamado falcons.

Response: These issues will be further discussed through agency consultation once this project moves out of the feasibility stage. A baseline study of endangered and threatened species would be conducted to confirm the presence of or supporting habitat for species of concern at that time.

Paragraph 5 states that an analysis of habitat requirements associated with state and federally listed threatened and endangered species indicates that it is unlikely that any threatened or endangered species or other species of concern would be found along the proposed project alignment. This is incorrect for several species. Species not addressed as potentially impacted are all of the sea turtles.

Response: These issues will be further discussed with USFWS and TPWD once this project moves out of the feasibility stage. A baseline study of endangered and threatened species would be conducted to confirm the presence of or supporting habitat for species of concern at that time.

The report states that the additional environmental assessment will need to include (but will not be limited to) potential impacts to vegetative communities and wildlife. The report also includes a list of the State and Federally listed species for this area and states that a field reconnaissance has not been performed to identify vegetation and wildlife resources within the area and habitat that potentially could support these species. They will evidently be evaluating potential T&E species/habitat impacts in the near future.

Response: Threatened and endangered species will be evaluated in future studies, when authorized.

Attachment D

Comments from the Water Treatment Engineering and Research Group of the United States Bureau of Reclamation

The need for additional water supplies in the future is clearly demonstrated. It appears from the graph on Page 2-18 that, while the text says that desalination is the only new water supply source, the planned incremental production is not sufficient to meet net regional needs. Thus desalination is not a complete solution.

Response: This project is not the total solution but would be a major contributor to the regional needs.

Good engineering design suggests that if a project cannot pay for itself, using reasonable costing and product evaluation procedures, it is a very questionable project. Some fairly strong justification for the subsidies proposed should be provided.

Response: The Governor's Office, the State Legislature, the Texas Water Development Board, the Project Sponsors: Brownsville Public Utilities Board and the Port of Brownsville, all recognize the need for a new drought-proof water supply for Texas. The three feasibility studies authorized by the Texas Water Development Board all will require a subsidy in order to maintain reasonable water rates. The entities cited above all understand that these subsidies will be required and are particularly interested in their magnitude. We know of no seawater desalination project that operates in the U.S. without some form of significant government subsidy.

Having real data on the composition of the proposed water source, as presented in Table 3-2, is absolutely necessary for desalination plant design. The maximum TDS of 49,000 is worrisome. It is annoying that the sodium concentration is not presented except in the supplemental data column. The average dissolved oxygen (D.O.) of 6.6 mg/L suggests that some sewage or other material that consumes dissolved oxygen gets into the ship channel routinely.

Response: Each of the noted water quality issues is addressed in the following bullets:

- **<u>TDS</u>** – The 49,000 ppm TDS value in the data set is considered suspect since three other TDS values documented on the same date were relatively close to the average TDS level of 36,100 ppm. As such, this and other data outliers were removed from the data set. Upon re-examining the remaining data, it was confirmed that there is a fluctuation in TDS concentrations throughout the year. Chapter 3 of the report confirms that the TDS concentration ranges from 29,400 to 41,400 ppm with an average value of 36,100 ppm. The average value is comparable to typical seawater. It is believed that the lower TDS values occur during and after heavy rain events, when there is a substantial amount of fresh water input to the ship channel. The higher TDS values could be due to forced evaporation effects during the dry season, when humidity levels remain low and temperature levels are moderate to high.

Treating seawater with the lower TDS values should not present a problem to the desalination facility and may actually reduce operational costs. However, the project team concurs that operational modifications will need to be considered and made to address periods when TDS levels are elevated. However, the higher TDS levels can be properly treated by the proposed desalination processes. Increasing pumping rates would allow the desalination facility to maintain its overall finished water production capacity. If increased pumping alone does not ensure adequate finished water production capacity, each membrane train could be equipped with a spare membrane vessel to reduce flux rates and guarantee proper finished water production capacity is available at all times. Through exploration of the above solutions, the project team would like to convey that there are feasible options available that can be easily implemented to address temporary increases in source water TDS levels.

- **Sodium** – The project team apologizes that a more comprehensive water quality profile is not available for the Brownsville Ship Channel at this time. However, this conceptual-level design effort was initiated at the beginning of 2004, at which time all available water quality data for the Brownsville Ship Channel was collected and reviewed. Based on the initial data review, it was established that there was no analytical data for sodium, among other water quality constituents. In an attempt to report on all important water quality parameters, the project team collected a set of water samples in March and April 2004 from the ship channel for laboratory analysis. The results from the laboratory analysis were summarized in the supplemental column of Table 3-2 of Section 3.0 of the report. Given the time constraints associated with the execution of the conceptual-level feasibility study, the data set presented is what is possible at this time. Additional raw water quality data would be obtained during pilot-testing to confirm the variation in sodium concentrations as well as other constituents.

- **Dissolved Oxygen** – Dissolved oxygen (DO) concentrations could be depressed as a consequence of organic waste loads that occur along the ship channel. Alternatively, lower DO readings may coincide during periods of the year when temperature levels are highly elevated. The pending pilot-scale testing program, as described in further detail above, will assess organic waste loads and variations in DO levels within the ship channel to ensure that unit treatment processes and operations are properly selected and specified for the facility.

The consequence of higher TDS levels, lower DO levels potentially due to waste loadings within the ship channel, and potential issues associated with other water quality constituents and/or the variation of these constituents in the source water would be thoroughly evaluated during pilot-scale testing before developing final design plans. The amount of historical data available at this time is sufficient, however, to support the conceptual-level design of the facility for the purposes of this reporting effort.

There are a couple of curious factors in the data in Table 3-2. It appears very unlikely that the total dissolved solids could vary by a factor of more than four and the calcium and magnesium could stay constant to three significant figures. If there were only one value measured for

calcium and magnesium in the data set, then that value would be the minimum maximum and average, but it would not be a very good representation of reality.

Response: All historical water quality data was reported in its original form. The project team concurs that some of the historical data may not accurately capture the full, potential range for each parameter. However, this data is the only data available to support the conceptual-level design effort at this time. As stated previously, a more comprehensive evaluation of the raw seawater quality within the ship channel will occur during the Special Studies phase of the project. Water samples from the channel will be drawn on a frequent basis and analyzed for all of the water quality parameters of concern and interest. Sampling work will likely coincide with the pilot-testing activities that will be conducted. Details regarding the schedule for raw water samples will be provided in the pilot-scale testing plan.

The method used to arrive at a plant design (i.e., taking each subsystem separately and comparing alternatives for that part) has a deficiency when the output of the alternatives is not the same. The system used works well if the outputs are the same or nearly so; otherwise it tends toward selecting the minimum cost for that subsystem, not necessarily for the system as a whole. The most troubling example of this is in the pretreatment selection. BSF is "shown" to be superior to MF. A Reclamation study, run only a few miles from the proposed plant indicated clearly that the excess cost of MF was paid for by improved membrane performance and reduction in cleaning frequency. Unfortunately, the final report was not available during the period of the Brownsville study. This selection should be revisited if a plant is to be built.

Response: The project team clearly understands that the selection of one component in the facility could have a profound effect on other components. Perhaps the most important example of this is the selection of a pretreatment system for the project. The Tampa Bay Desal project is a recent example of this important concept as it applies to pretreatment design and selection.

In the alternatives analysis that was conducted for the pretreatment system, it was acknowledged that a system should be considered and selected that could offer more reliable and effective treatment to better protect the downstream membrane system. Three alternatives were retained and considered in the alternatives analysis for the pretreatment system. These include a dual-stage filtration system, a ballasted flocculation-clarification (BFC) system, and an ultrafiltration (UF) system. In reality, until pilot-testing is conducted, the most appropriate of these three options cannot be established with certainty. To justify the selection of the most suitable pretreatment system for the purposes of the conceptual-level design effort, the scoring criterion for treatment efficiency and reliability was increased, while the cost effectiveness criterion was decreased. In other words, the project team acknowledged that a more expensive pretreatment system may be needed since it could have a direct effect on and reduce operational and maintenance costs associated with downstream membrane system. As a consequence of adjusting the scoring criteria, the BFC system received the highest overall composite score and was subsequently selected for the conceptual configuration of the desalination facility.

As a matter of record, all possible pretreatment alternatives evaluated during the conceptual level design effort would be included during the pilot-scale testing phase of the project (e.g., conventional sand media filtration, BFC, and UF). During that phase, a much better and thorough evaluation could be performed to establish the most suitable pretreatment system for the project. However, at this time, there is not sufficient justification to support a UF system over a BFC system. An extended pilot-testing program would prove which pretreatment system would be the most appropriate system to condition the raw seawater supply prior to membrane treatment.

The recovery is stated as 60% on p.4-22 without further explanation or justification. This is high compared to conventional practice. It would be a matter of concern even if one did not have to worry about the wide variation of feed concentration. This high recovery will, admittedly, lower costs of pretreatment and feed supply, but it increases operating pressure, probably to undesirable levels and makes problems of concentrate disposal considerably more severe. Interestingly, it is states as 50% on page 3-5. Typical plant recoveries are between 40% and 50%. This assumption should be revisited.

Response: SWRO recovery is a function of water chemistry, temperature and pressure. Theoretically, from the viewpoint of chemistry, the limit of recovery for standard seawater in SWRO is about 70%. However, at this level, the applied pressure would be extremely high, beyond the capabilities of current membranes, and the permeate quality would require that a full second pass be used to achieve potable water quality product. Thus, this theoretically high recovery factor is not achievable or would it prove to be cost effective.

In this application (Brownsville), the average water quality appears to be in the range of 36,000 ppm TDS, slightly above standard seawater TDS. By using feedwater preheating to a temperature of about 80 degrees, 60% recovery, with a second pass is achievable at acceptable pressure. Recycle of the second pass concentrate to the feed tends to dilute the seawater feed to the first pass, further assisting in controlling the average osmotic pressure in the first pass system. The use of an interstage boost also increases the efficiency of the second stage of the first pass system.

It is possible that there may be times when the conditions are not favorable for operation at a higher recovery, and therefore the plant should be designed with sufficient flexibility to operate at a more conservative recovery of 50%, as stated on page 3-5. Clearly the ability to operate at higher recovery, by maintaining a reasonably high feedwater temperature will result in significant energy savings. It is not proposed that the plant be designed for 60% recovery, but that the process be configured in such a way as to allow a range of operating recoveries, with 60% being the upper limit. Thus, a lower recovery factor of 50% was used to assess other aspects of the project, one of which was the potential water withdrawal capacity from the Brownsville Ship Channel.

As a final noteworthy point, the potential range in TDS levels in the source water may not be as high as indicated in a previous comment. The maximum TDS concentration may only be 41,000 to 42,000 ppm versus 49,000 ppm as discussed previously. Thus, by preheating the feed water supply, the minimum anticipated recovery for this application is estimated at 50%. The range in actual recovery factors will be further assessed and documented during pilot scale testing. Consequently, the final design of the facility would be based on the documented range of possible recovery factors along with sufficient safety factors to ensure a firm finished water production capacity is achievable at all times.

The ship canal, from the description provided appears to be an almost stagnant pond, warm, with high insolation. If there were any possibility of locating this plant where there was some real tidal flush, I would move it. Do not even consider building this plant without a pilot test of the processes to be used located at the intended plant site, preferable one long enough to encompass the expected seasonal variation.

Response: An extended pilot-scale testing program (one year minimum) would be performed prior to finalizing the design of this project. The testing program would be designed to evaluate the concerns raised in the above comment. Unless results from pilot-scale testing reveal that it would be impossible to maintain a finished water production capacity of 25 MGD, it would be unlikely that a different site would be used for the desalination facility.

The assumption that there must be subsidies, p 4 of the Summary, suggests that consumers do not understand that water is valuable and that a reliable source of water is even more valuable. "Why do you expect me to pay for water that you use?" is a question that must be asked and a good answer is necessary. Without a good answer, the assumption is not good.

Response: The Governor's Office, the State Legislature, the Texas Water Development Board, the Project Sponsors: Brownsville Public Utilities Board and the Port of Brownsville, all recognize the need for a new drought-proof water supply for Texas. The three feasibility studies authorized by the Texas Water Development Board all will require a subsidy in order to maintain reasonable water rates. The entities cited above all understand that these subsidies will be required and are particularly interested in their magnitude. We know of no seawater desalination project that operates in the U.S. without some form of significant government subsidy.

Seawater retention is over 99% in SWRO, instead of 95%, on page 3-31.

Response: This was a typographical error in the report and is noted accordingly.

During final design the comparison of Pelton Wheel vs. alternative energy recovery devices (p. 3-37) should be revisited.

Response: Acknowledged. The project team would further evaluate all viable energy recovery devices before finalizing the design of the project.

Heating the feedwater with an electric heater (p.35-5) is not conventional practice. I did not see any site-specific cause why this would be justified here and not elsewhere.

Response: An electric heater was not proposed in the feasibility report. Rather, the in-line heater would use steam energy available from the co-located power plant to maintain a certain feed water temperature (90 degrees F) prior to the membrane units. This provision would reduce energy costs associated with the high-pressure RO pumping system through a large portion of the year. Any and all possible synergies that could be associated with the co-located power plant were explored and considered for this project. Since steam energy would be readily available from the co-located facility, it only makes sense to consider using it to defray energy costs associated with the desalination process. By including an in-line steam heater, an annual energy savings of nearly $400,000 could be realized for the project. This annual, recurring cost savings would quickly off-set additional capital expense associated with providing in-line steam heaters.

Reclamation's experience with on-site hypochlorite generation (p.3-43) has not been favorable.

Response: Before completing the design process for the project's disinfection system, the type and configuration of this system would be confirmed by the operator of the plant; in this case, the Brownsville PUB. The on-site hypochlorite system will be compared in more detail during the engineering design phase with other disinfection systems to establish which system would be the most appropriate and cost effective to use.

It should be considered that older, first generation on-site hypochlorite systems were more prone to inadequate performance and excessive system maintenance due to various reasons. These reasons include both engineering design factors associated with specific units as well as the use of below-grade, non-spec salt stocks and feed water quality. More recent designs for on-site hypochlorite systems have resulted in better overall operation, while reducing maintenance requirements. Proper and consistent use of specified salt stocks and deionized water minimizes maintenance issues and costs associated with these systems.

Table A-5

Monthly Chemical Analysis Average

Brownsville Public Utilities Board
Water Treatment Plant No.1

	Treated Water					***Raw Water***					
Month	Turbidity	Alkalinity	P.H.	Hardness	Chlorides	Turbidity			Alkalinity	P.H.	Hardness
						Reservoir	River	Average			
Sep-03	0.116	103	7.8	256	3.40	28.4	31.0	29.7	115	7.7	272
Oct-03	0.120	109	7.7	252	3.29	59.9	147.6	103.8	126	7.6	281
Nov-03	0.105	116	7.8	336	3.63	37.0	46.3	41.7	137	7.9	365
Dec-03	0.128	155	7.8	418	3.99	26.3	12.3	19.3	175	22.1	444
Jan-04	0.142	145	7.8	340	3.78	28.1	15.8	22.0	161	7.8	364
Feb-04	0.119	149	7.9	375	3.27	27.5	18.0	22.7	171	7.9	410
Mar-04	0.102	145	7.9	381	3.64	44.2	40.3	42.2	167	7.9	409
Apr-04	0.082	135	7.9	340	3.85	53.2	88.4	70.8	146	8.1	355
May-04	0.092	118	8.0	306	3.92	65.6	155.1	110.4	135	8.1	326
Jun-04	0.091	123	8.0	300	3.80	57.2	82.9	70.0	143	8.3	324
Jul-04	0.075	122	7.9	275	3.89	45.6	50.1	47.9	142	8.3	299
Aug-04	0.066	143	7.9	268	3.70	50.1	44.2	47.2	158	8.3	296
Sep-04	0.073	123	7.9	258	3.66	48.7	104.3	76.5	136	8.0	276
Ave.	0.101	130	7.9	316	3.68	44.0	64.3	54.2	147	9.1	340
Max.	0.142	155	8.0	418	3.99	65.6	155.1	110.4	175	22.1	444
Min.	0.066	103	7.7	252	3.27	26.3	12.3	19.3	115	7.6	272

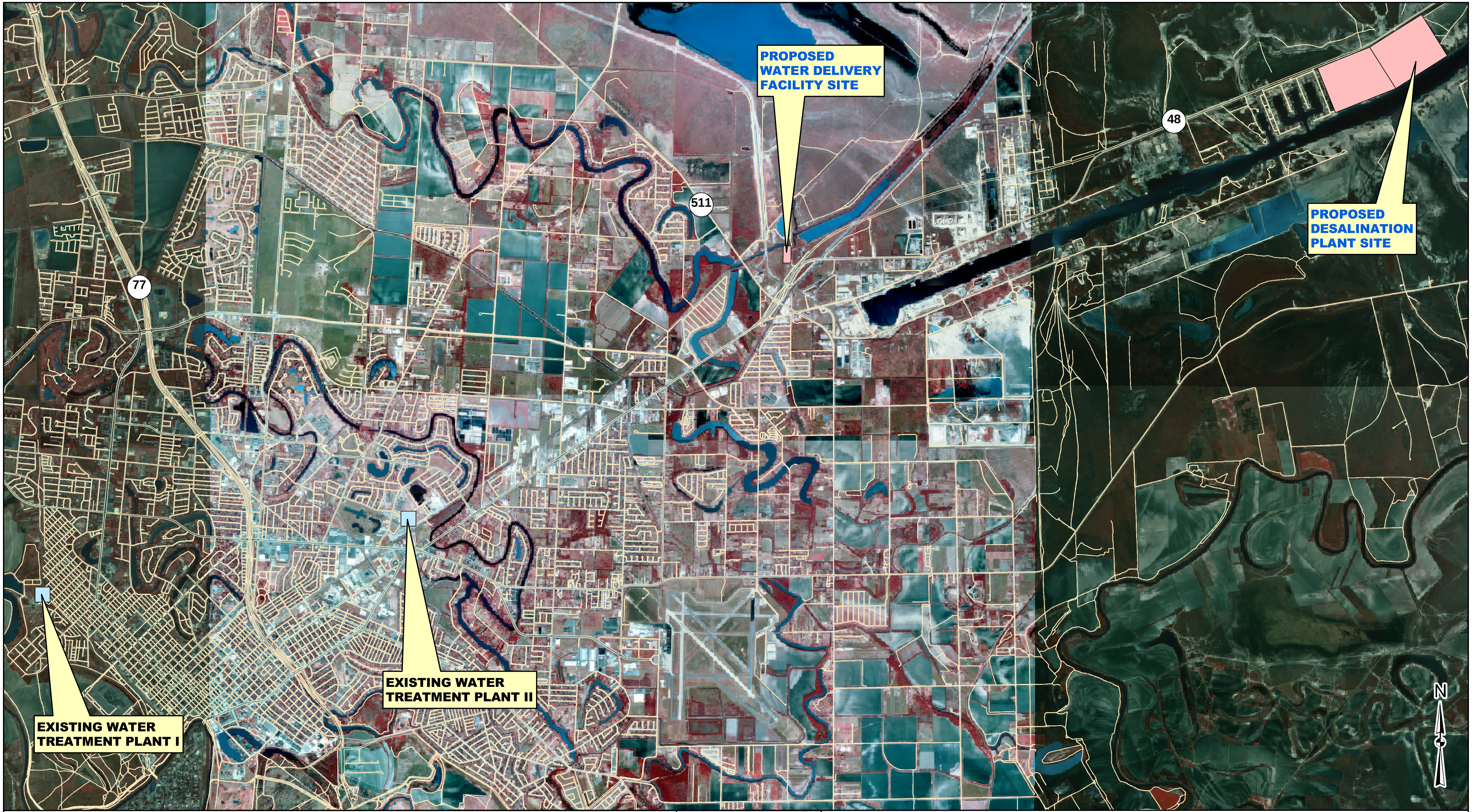
Table A-6

Monthly Chemical Analysis Average

Brownsville Public Utilities Board

Water Treatment Plant No.2

	Treated Water					***Raw Water***			
Month	Turbidity	Alkalinity	P.H.	Hardness	Chlorides	Turbidity	Alkalinity	P.H.	Hardness
						Raw Water			
Sep-03	0.097	116	8.0	261	4.11	17.7	109	7.9	267
Oct-03	0.111	122	8.0	284	3.89	30.3	124	7.7	349
Nov-03	0.108	129	8.0	327	4.03	24.3	144	7.8	345
Dec-03	0.163	155	8.0	405	4.26	22.1	154	7.9	385
Jan-04	0.161	159	8.0	391	3.95	32.4	165	8.0	404
Feb-04	0.131	158	8.0	379	4.21	48.9	159	8.0	395
Mar-04	0.104	148	8.0	386	4.11	46.4	143	8.1	375
Apr-04	0.092	135	7.9	342	4.21	40.2	137	7.8	346
May-04	0.094	117	7.9	296	4.05	32.9	122	7.5	296
Jun-04	0.086	119	7.9	283	4.05	18.9	126	7.7	272
Jul-04	0.084	118	7.9	279	3.89	13.1	123	7.9	285
Aug-04	0.075	126	7.9	269	3.86	16.2	123	7.7	275
Sep-04	0.102	123	7.9	256	4.04	15.6	125	7.7	254
Ave.	0.108	133	7.9	320	4.05	27.6	135	7.8	327
Max.	0.163	159	8.0	405	4.26	48.9	165	8.1	404
Min.	0.075	116	7.9	256	3.86	13.1	109	7.5	254



"If we could ever competitively, at a cheap rate, get freshwater from saltwater, that would be in the long-range interest of humanity and would dwarf any other scientific accomplishments."
- Pres. John F. Kennedy April 12, 1961

DANNENBAUM ENGINEERING CORPORATION

URS

"I have an obligation to look at the big picture and help develop new water resources for the future of all Texans"
- Gov. Rick Perry April 29, 2002

BROWNSVILLE PUBLIC UTILITIES BOARD

BROWNSVILLE WATER TREATMENT FACILITIES

FIGURE A-1

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA

APPENDIX A

Preliminary Cost Estimate for Brownsville 25 MGD Desalination Facility

Capital Construction Costs			
Item	**Description**	**Total Cost**	**% of Total Capital Cost**
1	Site Development	$9,722,000	12.0%
2	Seawater Intake System	$4,984,000	6.2%
3	Pretreatment System	$10,619,000	13.1%
4	Primary Treatment System	$32,699,000	40.5%
5	Post Treatment System	$3,645,000	4.5%
6	Solids Handling System	$3,921,000	4.9%
7	Yard Piping	$2,000,000	2.5%
8	Support Facilities	$7,702,000	9.5%
9	Electrical and Instrumentation	$5,500,000	6.8%
10	**Subtotal**	$80,792,000	100.0%
11	**Effective Contingency**	$9,972,000	12.3%
12	**Total Capital Construction Cost**	**$90,764,000**	-----

Project Implementation Costs			
Item	**Description**	**Total Cost**	**% of Total Implement. Cost**
1	Special Studies	$2,723,000	3%
2	Engineering Design	$4,538,000	5%
3	NEPA Document/Permitting	$1,815,000	2%
4	Construction Support Services	$3,631,000	4%
5	Startup Support Services	$908,000	1%
6	**Total Project Implementation Cost**	**$13,615,000**	15%
7	**Total Desalination Facility Cost**	**$104,379,000**	-----

Notes:

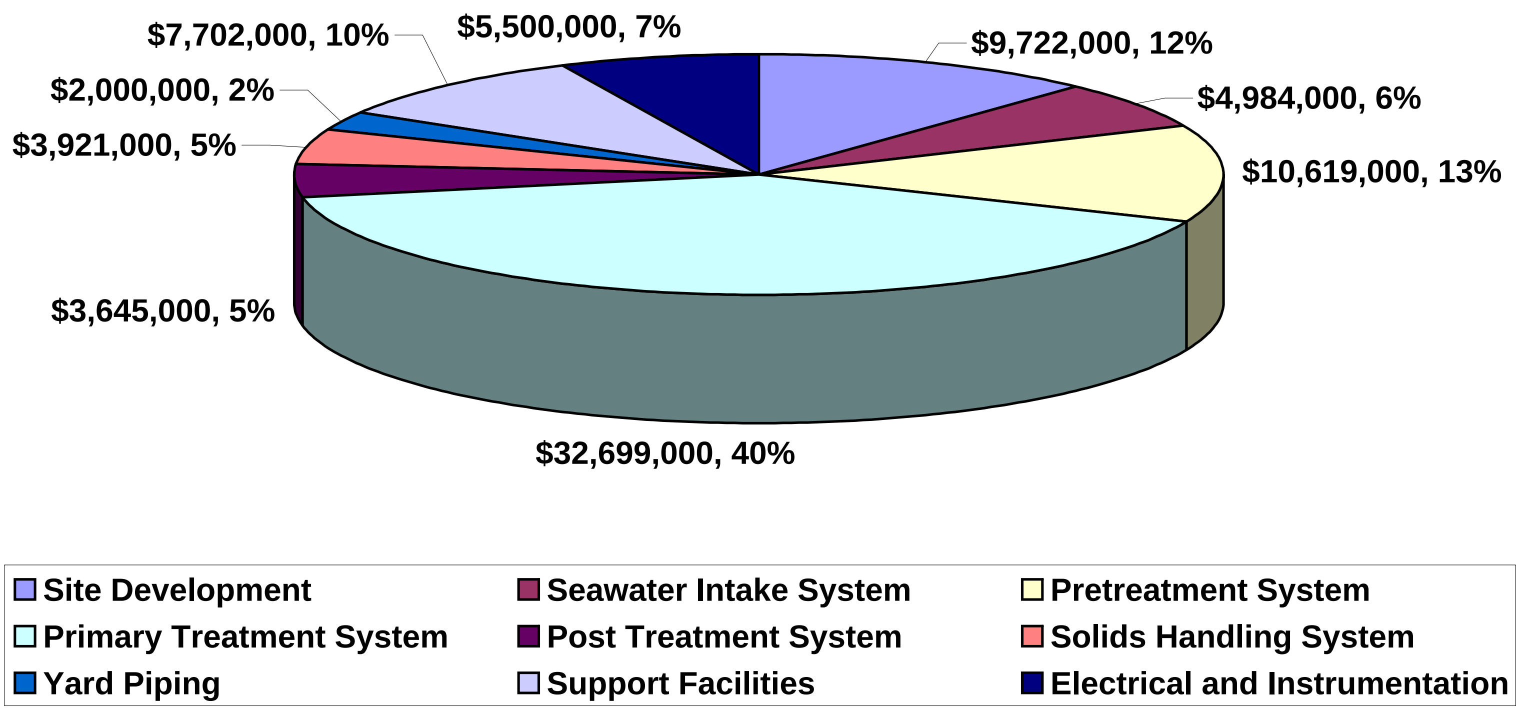
(1) Effective contingency considers a 5 percent contingency for mechanical components where a budgetary quote was solicited and obtained from a qualified equipment vendor and a 25 percent contingency for all other project related components and/or work.

(2) Legal services, capitalized interest, construction insurance, financing fees, and miscellaneous local and state permitting costs are not included in the cost estimate.

(3) Cost estimate does not include the brine discharge system (transfer pump station, tranmission main, ocean outfall), nor the finished water system (pump station, transmission main, storage tanks, etc.).

(4) All costs are expressed in current, 2004 US dollars and were rounded to the nearest $1,000.

Distribution of Capital Construction Costs



Preliminary Cost Estimate for Brownsville Desalination Demonstration Project Build-Out
Site Development

Installation Factor 40%
Contingency 25%

Phase I Construction								
Line ID	Component Description	Field Construction Costs				Equipment Installation Costs		Total
		Unit Basis	Unit Cost	Quantity	Extension	Equipment	Installation	
1	Clearing and Grubbing	AC	$1,500	42	$63,000	$0	$0	$63,000
2	Site Grading & Compaction	SF	$0.30	1,808,480	$542,544	$0	$0	$542,544
3	Excavation for Fill Material	CY	$3.50	205,000	$717,500	$0	$0	$717,500
4	Piles (35' deep)	EA	$750	4,000	$3,000,000	$0	$0	$3,000,000
7	Asphalt Roadway/Parking	SF	$2.65	215,000	$569,750	$0	$0	$569,750
8	8' Chain Link Fence	LF	$30	6,106	$183,180	$0	$0	$183,180
9	Mitigation Allocation	LS	$1,000,000	1	$1,000,000	$0	$0	$1,000,000
10	Landscaping	LS	$300,000	1	$300,000	$0	$0	$300,000
11	Seed & Mulch	SF	$0.20	900,000	$180,000	$0	$0	$180,000
12	Seawall Along Channel (without Side Inlets)	LF	$3,000	922	$2,766,000	$0	$0	$2,766,000
13	Extended Seawall Flanking Side Inlets	LF	$5,000	80	$400,000	$0	$0	$400,000
14	**Subtotal:**	---	---	---	**$9,721,974**	**$0**	**$0**	**$9,721,974**
15	**Contingency:**	---	---	---	$0	$0	$0	$2,430,494
16	**Total:**	---	---	---	**$9,721,974**	**$0**	**$0**	**$12,152,468**

Notes:

Phase II Expansion Event								
Line ID	Component Description	Field Construction Costs				Equipment Installation Costs		Total
		Unit Basis	Unit Cost	Quantity	Extension	Equipment	Installation	
1	Clearing and Grubbing	AC	$1,500	25	$37,500	$0	$0	$37,500
2	Site Grading & Compaction	SF	$0.30	1,095,075	$328,523	$0	$0	$328,523
3	Excavation for Fill Material	CY	$3.50	102,500	$358,750	$0	$0	$358,750
4	Piles (35' deep)	EA	$750	4,000	$3,000,000	$0	$0	$3,000,000
5	Asphalt Roadway/Parking	SF	$2.65	215,000	$569,750	$0	$0	$569,750
6	8' Chain Link Fence - Relocate	LF	$10	4,500	$45,000	$0	$0	$45,000
6	8' Chain Link Fence - New	LF	$30	344	$10,320	$0	$0	$10,320
7	Mitigation Allocation	LS	$1,000,000	1	$1,000,000	$0	$0	$1,000,000
8	Landscaping	LS	$300,000	1	$300,000	$0	$0	$300,000
9	Seed & Mulch	SF	$0.20	900,000	$180,000	$0	$0	$180,000
10	Seawall Along Channel (without Side Inlets)	LF	$3,000	0	$0	$0	$0	$0
11	Extended Seawall Flanking Side Inlets	LF	$5,000	0	$0	$0	$0	$0
12	**Subtotal:**	---	---	---	**$5,829,843**	**$0**	**$0**	**$5,829,843**
13	**Contingency:**	---	---	---	$0	$0	$0	$1,457,461
14	**Total:**	---	---	---	**$5,829,843**	**$0**	**$0**	**$7,287,303**

Notes:

Phase III & IV Expansion Events									
Line ID	**Component Description**	**Field Construction Costs**				**Equipment Installation Costs**		**Total**
		Unit Basis	**Unit Cost**	**Quantity**	**Extension**	**Equipment**	**Installation**	
1	Clearing and Grubbing	AC	$1,500	6	$9,000	$0	$0	$9,000
2	Site Grading & Compaction	SF	$0.30	275,000	$82,500	$0	$0	$82,500
3	Excavation for Fill Material	CY	$3.50	102,500	$358,750	$0	$0	$358,750
4	Piles (35' deep)	EA	$750	4,000	$3,000,000	$0	$0	$3,000,000
5	Asphalt Roadway/Parking	SF	$2.65	215,000	$569,750	$0	$0	$569,750
6	8' Chain Link Fence - Relocate	LF	$10	1,100	$11,000	$0	$0	$11,000
7	8' Chain Link Fence - New	LF	$30	4,500	$135,000	$0	$0	$135,000
8	Mitigation Allocation	LS	$1,000,000	1	$1,000,000	$0	$0	$1,000,000
9	Landscaping	LS	$300,000	1	$300,000	$0	$0	$300,000
10	Seed & Mulch	SF	$0.20	900,000	$180,000	$0	$0	$180,000
11	Seawall Along Channel (without Side Inlets)	LF	$3,000	500	$1,500,000	$0	$0	$1,500,000
12	Extended Seawall Flanking Side Inlets	LF	$5,000	40	$200,000	$0	$0	$200,000
13	**Subtotal:**	---	---	---	**$7,346,000**	**$0**	**$0**	**$7,346,000**
14	**Contingency:**	---	---	---	$0	$0	$0	$1,836,500
15	**Total:**	---	---	---	**$7,346,000**	**$0**	**$0**	**$9,182,500**

Notes:

Preliminary Cost Estimate for Brownsville Desalination Demonstration Project Build-Out
Seawater Intake System

Installation Factor	40%
Contingency	25%
Equipment Contingency	5%

Phase I Construction

Line ID	Component Description	Field Construction Costs				Equipment Installation Costs		Total
		Unit Basis	Unit Cost	Quantity	Extension	Equipment	Installation	
1	Dredge Intake Channels within Shipping Channel	CY	$25	35,000	$875,000	$0	$0	$875,000
2	Inlet Basin Seawall	LF	$5,000.00	200	$1,000,000	$0	$0	$1,000,000
3	Box Culvert Between Side Inlets	LF	$1,000.00	300	$300,000	$0	$0	$300,000
4	Barrier Wall	LF	$2,000.00	120	$240,000	$0	$0	$240,000
5	Barrier Wall Support Piers	LS	$5,000.00	4	$20,000	$0	$0	$20,000
6	2 foot Diameter Concrete Protective Barriers	EA	$5,000	22	$110,000	$0	$0	$110,000
7	Water Intake Screens with Airburst System	LS	---	---	$0	$235,000	$94,000	$329,000
8	Seawater Intake Pumping Station w\Valving & Appurtenances	LS	---	---	$0	$1,500,000	$600,000	$2,100,000
9	Structure for Airburst System	LS	$10,000	1	$10,000	$0	$0	$10,000
10	**Subtotal:**	---	---	---	**$2,555,000**	**$1,735,000**	**$694,000**	**$4,984,000**
11	**Contingency:**	---	---	---	**$638,750**	**$86,750**	**$34,700**	**$760,200**
12	**Total:**	---	---	---	**$3,193,750**	**$1,821,750**	**$728,700**	**$5,744,200**

Notes: Blended Contingency = **15.3%**

Phase II Expansion Event

Line ID	Component Description	Field Construction Costs				Equipment Installation Costs		Total
		Unit Basis	Unit Cost	Quantity	Extension	Equipment	Installation	
1	Dredge Intake Channels within Shipping Channel	CY	$25	0	$0	$0	$0	$0
2	Inlet Basin Seawall	LF	$5,000.00	0	$0	$0	$0	$0
3	Box Culvert Between Side Inlets	LF	$1,000.00	0	$0	$0	$0	$0
4	Barrier Wall	LF	$2,000.00	0	$0	$0	$0	$0
5	Barrier Wall Support Piers	LS	$5,000.00	0	$0	$0	$0	$0
6	2 foot Diameter Concrete Protective Barriers	EA	$5,000	0	$0	$0	$0	$0
7	Water Intake Screens with Airburst System	LS	---	---	$0	$235,000	$94,000	$329,000
8	Seawater Intake Pumping Station w\Valving & Appurtenances	LS	---	---	$0	$1,500,000	$600,000	$2,100,000
9	Structure for Airburst System	LS	$10,000	1	$10,000	$0	$0	$10,000
10	**Subtotal:**	---	---	---	**$10,000**	**$1,735,000**	**$694,000**	**$2,439,000**
11	**Contingency:**	---	---	---	**$2,500**	**$86,750**	**$34,700**	**$123,950**
12	**Total:**	---	---	---	**$12,500**	**$1,821,750**	**$728,700**	**$2,562,950**

Notes: Blended Contingency = **5.1%**

Phase III & IV Expansion Events								
Line ID	**Component Description**	**Field Construction Costs**				**Equipment Installation Costs**		**Total**
		Unit Basis	**Unit Cost**	**Quantity**	**Extension**	**Equipment**	**Installation**	
1	Dredge Intake Channels within Shipping Channel	CY	$25	17,500	$437,500	$0	$0	$437,500
2	Inlet Basin Seawall	LF	$5,000.00	100	$500,000	$0	$0	$500,000
3	Box Culvert Between Side Inlets	LF	$1,000.00	0	$0	$0	$0	$0
4	Barrier Wall	LF	$2,000.00	60	$120,000	$0	$0	$120,000
5	Barrier Wall Support Piers	LS	$5,000.00	2	$10,000	$0	$0	$10,000
6	2 foot Diameter Concrete Protective Barriers	EA	$5,000	11	$55,000	$0	$0	$55,000
7	Water Intake Screens with Airburst System	LS	---	---	$0	$235,000	$94,000	$329,000
8	Seawater Intake Pumping Station w\Valving & Appurtenances	LS	---	---	$0	$1,500,000	$600,000	$2,100,000
9	Structure for Airburst System	LS	$10,000	1	$10,000	$0	$0	$10,000
10	**Subtotal:**	---	---	---	**$1,132,500**	**$1,735,000**	**$694,000**	**$3,561,500**
11	**Contingency:**	---	---	---	**$283,125**	**$86,750**	**$34,700**	**$404,575**
12	**Total:**	---	---	---	**$1,415,625**	**$1,821,750**	**$728,700**	**$3,966,075**

Notes: Blended Contingency = **11.4%**

Preliminary Cost Estimate for Brownsville 25 MGD Desalination Demonstration Project
Pretreatment System

Installation Factor	40%
Contingency	25%
Equipment Contingency	5%

Line ID	Component Description	Field Construction Costs				Equipment/Materials Costs		Total
		Unit Basis	Unit Cost	Quantity	Extension	Equip./Mater.	Installation	
1	BFC System	LS	$0	0	$0	$3,350,000	$1,340,000	$4,690,000
2	Reinforced Concrete Structure for BFC System	CY	$350	350	$122,500	$0	$0	$122,500
3	Dual Medial Filters	LS	$0	0	$0	$1,350,000	$540,000	$1,890,000
4	Reinforced Concrete Structure for Dual Media Filters	CY	$350	1,250	$437,500	$0	$0	$437,500
5	Clearwell Transfer Pumps	LS	$0	0	$0	$1,500,000	$600,000	$2,100,000
6	Cartridge Filtration System	LS	$0	0	$0	$325,000	$130,000	$455,000
7	In-Line Steam Injectors (6)	LS	$0	0	$0	$660,000	$264,000	$924,000
8	**Subtotal:**	---	---	---	**$560,000**	**$7,185,000**	**$2,874,000**	**$10,619,000**
9	**Contingency:**	---	---	---	**$140,000**	**$359,250**	**$143,700**	**$642,950**
10	**Total:**	---	---	---	**$700,000**	**$7,544,250**	**$3,017,700**	**$11,261,950**

Preliminary Cost Estimate for Brownsville 25 MGD Desalination Demonstration Project
Primary Treatment System

Installation Factor	40%
Contingency	5%
Pumps' Installation Factor	5%

Line ID	Component Description	Field Construction Costs				Equipment/Materials Costs		Total
		Unit Basis	Unit Cost	Quantity	Extension	Equip./Mater.	Installation	
1	RO Membranes, Booster Pumps, Piping, & Cleaning System	LS	---	---	$0	$17,675,000	$7,070,000	$24,745,000
2	High Pressure RO Feed Pumps w/Variable Frequency Drives	LS			$0	$4,950,000	$247,500	$5,197,500
3	Wastewater Pump Station No. 1	LS			$0	$125,000	$6,250	$131,250
4	Energy Recovery System	LS			$0	$2,500,000	$125,000	$2,625,000
5	**Subtotal:**	---	---	---	**$0**	**$25,250,000**	**$7,448,750**	**$32,698,750**
6	**Contingency:**	---	---	---	**$0**	**$1,262,500**	**$372,438**	**$1,634,938**
7	**Total:**	---	---	---	**$0**	**$26,512,500**	**$7,821,188**	**$34,333,688**

Preliminary Cost Estimate for Brownsville 25 MGD Desalination Demonstration Project
Post Treatment System

Installation Factor	40%
Contingency	25%
Equipment Contingency	5%

Line ID	Component Description	Field Construction Costs				Equipment Installation Costs		Total
		Unit Basis	Unit Cost	Quantity	Extension	Equipment	Installation	
1	Pebble Lime Stabilization System (2)	LS	---	---	$0	$600,000	$240,000	$840,000
2	Sodium Hypochlorite Disinfection System, Complete	LS	---	---	$0	$1,300,000	$520,000	$1,820,000
3	1.2 MG Prestressed Concrete Tank with Baffle Curtains	LS	$935,000	1	$985,000	$0	$0	$985,000
4	**Subtotal:**	---	---	---	**$985,000**	**$1,900,000**	**$760,000**	**$3,645,000**
5	**Contingency:**	---	---	---	**$246,250**	**$95,000**	**$38,000**	**$379,250**
6	**Total:**	---	---	---	**$1,231,250**	**$1,995,000**	**$798,000**	**$4,024,250**

Preliminary Cost Estimate for Villalba Water Treatment Plant
Solids Handling System

Installation Factor	40%
Contingency	25%
Equipment Contingency	5%

Line ID	Component Description	Field Construction Costs				Equipment/Materials Costs		Total
		Unit Basis	Unit Cost	Quantity	Extension	Equip./Mater.	Installation	
1	Equalization Basin Reinforced Concrete Structure	CY	$350	445	$155,750	$0	$0	$155,750
2	Sludge Scraper for Equalization Basin	LS	$0	0	$0	$100,000	$40,000	$140,000
3	Thickener Feed Pumps (2)	LS	$20,000	1	$20,000	$0	$0	$20,000
4	Flocculation Basins Reinforced Concrete Structure	CY	$350	170	$59,500	$0	$0	$59,500
5	Flocculation Basin Axial Flow Turbine Mixers	LS	$0	0	$0	$50,000	$20,000	$70,000
6	Thickener Tanks' Reinforced Concrete Structure	CY	$350	445	$155,750	$0	$0	$155,750
7	Thickener Mechanical Components	LS	$0	0	$0	$340,000	$136,000	$476,000
8	Thickener Lamella Modules	LS	$0	0	$0	$675,000	$270,000	$945,000
9	Return Pump Station	LS	$150,000	1	$150,000	$0	$0	$150,000
10	Solids Dewatering Feed Pumps (3)	LS	$0	0	$0	$100,000	$40,000	$140,000
11	Wastewater Pump Station No. 2	LS	$0	0	$0	$175,000	$70,000	$245,000
12	Belt Filter Presses (3)	LS	$0	0	$0	$810,000	$324,000	$1,134,000
13	Polymer System	LS	$0	0	$0	$25,000	$10,000	$35,000
14	Discharge Conveyor	LS	$0	0	$0	$67,500	$27,000	$94,500
15	Ancillary Items	LS	$100,000	1	$100,000	$0	$0	$100,000
16	**Subtotal:**	---	---	---	**$641,000**	**$2,342,500**	**$937,000**	**$3,920,500**
17	**Contingency:**	---	---	---	**$160,250**	**$117,125**	**$46,850**	**$324,225**
18	**Total:**	---	---	---	**$801,250**	**$2,459,625**	**$983,850**	**$4,244,725**

Preliminary Cost Estimate for Brownsville 25 MGD Desalination Demonstration Project
Yard Piping

Installation Factor 40%
Contingency 25%

Line ID	Component Description	Field Construction Costs				Equipment/Materials Costs		Total
		Unit Basis	Unit Cost	Quantity	Extension	Equip./Mater.	Installation	
1	Yard Piping, Misc Valves and Appurtentances	LS	$2,000,000	1	$2,000,000	$0	$0	$2,000,000
2	**Total:**	---	---	---	**$2,000,000**	**$0**	**$0**	**$2,000,000**
3	**Contingency:**	---	---	---				**$500,000**
4	**Total:**	---	---	---				**$2,500,000**

Preliminary Cost Estimate for Brownsville Desalination Demonstration Project Build-Out
Support Facilities

Installation Factor 40%
Contingency 25%

Phase I Construction								
Line ID	Component Description	Field Construction Costs				Equipment Installation Costs		Total
		Unit Basis	Unit Cost	Quantity	Extension	Equipment	Installation	
1	Chemical Building	SF	$65	3,200	$208,000	$0	$0	$208,000
2	Membrane Building	SF	$150	30,000	$4,500,000	$0	$0	$4,500,000
3	Aministration Building	SF	$200	5,000	$1,000,000	$0	$0	$1,000,000
4	Solids Dewatering Building	SF	$90	5,000	$450,000	$0	$0	$450,000
5	Storage Building	SF	$65	1,250	$81,250	$0	$0	$81,250
6	Maintenance Building	SF	$65	2,500	$162,500	$0	$0	$162,500
7	0.5 MG Plant Service Water Tanks	LS	$400,000	2	$800,000	$0	$0	$800,000
8	Laboratory Equipment	LS	$100,000	1	$100,000	$0	$0	$100,000
9	Maintenance Equipment (2 Trucks, Car, Forklift & Tools	LS	$300,000	1	$300,000	$0	$0	$300,000
10	Administration/Operations Building Furnishings & Supplies	LS	$100,000	1	$100,000	$0	$0	$100,000
11	**Subtotal:**	---	---	---	**$7,701,750**	**$0**	**$0**	**$7,701,750**
12	**Contingency:**	---	---	---	**$1,925,437.50**	**$0**	**$0**	**$1,925,438**
13	**Total:**	---	---	---	**$9,627,188**	**$0**	**$0**	**$9,627,188**

Notes: Blended Contingency = **25.0%**

Phase II Expansion Event								
Line ID	Component Description	Field Construction Costs				Equipment Installation Costs		Total
		Unit Basis	Unit Cost	Quantity	Extension	Equipment	Installation	
1	Chemical Building	SF	$65	6,400	$416,000	$0	$0	$416,000
2	Membrane Building	SF	$150	30,000	$4,500,000	$0	$0	$4,500,000
3	Administration Building	SF	$200	0	$0	$0	$0	$0
4	Solids Dewatering Building	SF	$90	5,000	$450,000	$0	$0	$450,000
5	Storage Building	SF	$65	1,250	$81,250	$0	$0	$81,250
6	Maintenance Building	SF	$65	2,500	$162,500	$0	$0	$162,500
7	0.5 MG Plant Service Water Tanks	LS	$400,000	2	$800,000	$0	$0	$800,000
8	Laboratory Equipment	LS	$100,000	1	$100,000	$0	$0	$100,000
9	Maintenance Equipment (2 Trucks, Car, Forklift & Tools	LS	$300,000	1	$300,000	$0	$0	$300,000
10	Administration/Operations Building Furnishings & Supplies	LS	$100,000	1	$100,000	$0	$0	$100,000
11	**Subtotal:**	---	---	---	**$6,909,750**	**$0**	**$0**	**$6,909,750**
12	**Contingency:**	---	---	---	**$1,727,437.50**	**$0**	**$0**	**$1,727,438**
13	**Total:**	---	---	---	**$8,637,188**	**$0**	**$0**	**$8,637,188**

Notes: Blended Contingency = **25.0%**

Phase III Expansion Event								
Line ID	Component Description	Field Construction Costs				Equipment Installation Costs		Total
		Unit Basis	Unit Cost	Quantity	Extension	Equipment	Installation	
1	Chemical Building	SF	$65	6,400	$416,000	$0	$0	$416,000
2	Membrane Building	SF	$150	30,000	$4,500,000	$0	$0	$4,500,000
3	Administration Building	SF	$200	0	$0	$0	$0	$0
4	Solids Dewatering Building	SF	$90	5,000	$450,000	$0	$0	$450,000
5	Storage Building	SF	$65	1,250	$81,250	$0	$0	$81,250
6	Maintenance Building	SF	$65	2,500	$162,500	$0	$0	$162,500
7	0.5 MG Plant Service Water Tanks	LS	$400,000	2	$800,000	$0	$0	$800,000
8	Laboratory Equipment	LS	$100,000	1	$100,000	$0	$0	$100,000
9	Maintenance Equipment (2 Trucks, Car, Forklift & Tools	LS	$300,000	1	$300,000	$0	$0	$300,000
10	Administration/Operations Building Furnishings & Supplies	LS	$100,000	1	$100,000	$0	$0	$100,000
11	**Subtotal:**	---	---	---	**$6,909,750**	**$0**	**$0**	**$6,909,750**
12	**Contingency:**	---	---	---	**$1,727,437.50**	**$0**	**$0**	**$1,727,438**
13	**Total:**	---	---	---	**$8,637,188**	**$0**	**$0**	**$8,637,188**

Notes: Blended Contingency = **25.0%**

Phase IV Expansion Event								
Line ID	Component Description	Field Construction Costs				Equipment Installation Costs		Total
		Unit Basis	Unit Cost	Quantity	Extension	Equipment	Installation	
1	Chemical Building	SF	$65	0	$0	$0	$0	$0
2	Membrane Building	SF	$150	30,000	$4,500,000	$0	$0	$4,500,000
3	Operations Building	SF	$200	5,000	$1,000,000	$0	$0	$1,000,000
4	Solids Dewatering Building	SF	$90	5,000	$450,000	$0	$0	$450,000
5	Storage Building	SF	$65	1,250	$81,250	$0	$0	$81,250
6	Maintenance Building	SF	$65	2,500	$162,500	$0	$0	$162,500
7	0.5 MG Plant Service Water Tanks	LS	$400,000	2	$800,000	$0	$0	$800,000
8	Laboratory Equipment	LS	$100,000	1	$100,000	$0	$0	$100,000
9	Maintenance Equipment (2 Trucks, Car, Forklift & Tools	LS	$300,000	1	$300,000	$0	$0	$300,000
10	Administration/Operations Building Furnishings & Supplies	LS	$100,000	1	$100,000	$0	$0	$100,000
11	**Subtotal:**	---	---	---	**$7,493,750**	**$0**	**$0**	**$7,493,750**
12	**Contingency:**	---	---	---	**$1,873,437.50**	**$0**	**$0**	**$1,873,438**
13	**Total:**	---	---	---	**$9,367,188**	**$0**	**$0**	**$9,367,188**

Notes: Blended Contingency = **25.0%**

Preliminary Cost Estimate for Brownsville 25 MGD Desalination Demonstration Project
Electrical and Instrumentation

Installation Factor 40%
Contingency 25%

Line ID	Component Description	Field Construction Costs				Equipment/Materials Costs		Total
		Unit Basis	Unit Cost	Quantity	Extension	Equip./Mater.	Installation	
1	Electrical System Components	LS	$3,200,000	1	$3,200,000	$0	$0	$3,200,000
2	Instrumentation System Components	LS	$2,300,000	1	$2,300,000	$0	$0	$2,300,000
3	**Total:**	---	---	---	**$5,500,000**	**$0**	**$0**	**$5,500,000**
4	**Contingency:**	---	---	---	**$1,375,000**	**$0**	**$0**	**$1,375,000**
5	**Total:**	---	---	---	**$6,875,000**	**$0**	**$0**	**$6,875,000**

EXECUTIVE SUMMARY
Brownsville Demonstration Seawater Desalination Project

1. Introduction

No region of Texas has as great a need for additional water supplies or is as limited with regard to new supply options as the Texas-Mexico border. No region in Texas has the international, environmental, demographic or the economic challenges that this area possesses. It is a high growth area with an already overcommitted central water supply (the Rio Grande) that has been placed at further risk by international treaty compliance issues. It is a region struggling to retain existing jobs, including those in the agricultural sector, and to expand its economic base to include new economic activity. Its environmental challenges are complicated by the lack of water available for water uses traditionally identified with the natural environment and its needs.

- ***Because of the Lower Rio Grande geographic location, the only viable and dependable major source of new water to sustain, continue growth in the region is the Gulf of Mexico.***

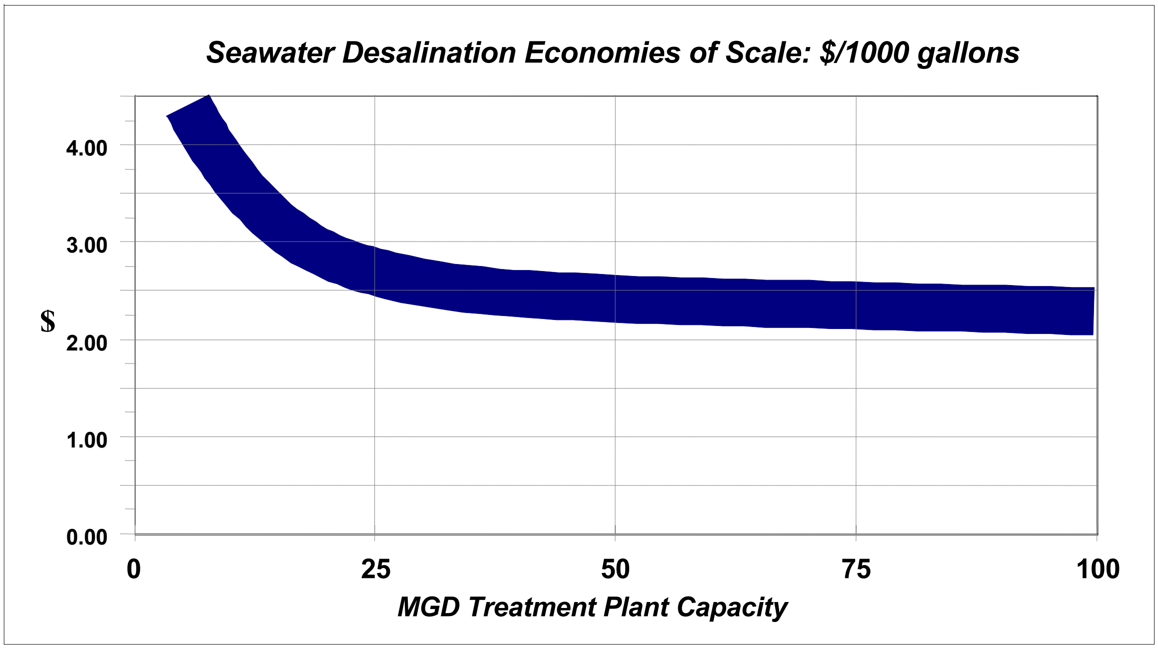
- ***Furthermore, the quality of water available to many water users continues to degrade, increasing the cost of treatment and making desalination of seawater more feasible.***

All of these challenges could be eased by securing a new, drought proof, high quality water supply and by the right public policies and actions (including financial assistance) associated with this supply source. **This water supply could be desalinated seawater.**

The Lower Rio Grande area is better positioned to take advantage of this new supply than any other area of the state by virtue of its needs and its ability to find direct and indirect markets for this water. Water rights management in the Amistad-Falcon Reservoir system serving this area allows for enhanced ability to provide water supplies in ways unique to this part of Texas. **No other region has the ability to internally "market" water made available from such a project.**

There is also the **possibility to provide water to Mexican cities** with even greater needs, should the right financial, political and institutional arrangements be reached. Providing such service **could create an indirect subsidy for U.S. water users by creating larger economies of scale, thereby reducing the unit cost of water for this project**. Mexican governmental entities should bear the full cost of desalinated water service should they be allowed to participate in the project. As **Figure E-1** shows, all users gain by economies of scale. As the scale of the project is increased, the unit cost to produce water is reduced. All users benefit from increased participation whether these users are other regional entities in the Texas portion of the region or some combination of Texas and Mexican communities.

Figure E-1 Unit Cost Relative to Project Size



2. Regional Needs/Options

The recently completed Rio Grande Water Availability Model (WAM) identified available firm supplies in drought of record conditions and current treaty compliance circumstances as approximately half of the demand for water. While municipalities are given priority for the delivery of water in the Lower Rio Grande, the consequences of this shortfall are reduced availability to irrigators, industry and the environment. Some municipalities, however, could also see their supply impacted since many municipal users secure their water through delivery arrangements with irrigators. Often, the "push water" needed to fill canals and allow for the transportation of municipal water is provided by irrigation water, which typically is the much greater volume being transported in the canal systems. **If there are insufficient volumes of irrigation water being transported in the canals, the ability to deliver water to many municipal users may be compromised.**

The current water deficit in the Lower Rio Grande Water Supply Planning Region (Region M) exceeds 1,000,000 acre-feet per year. Even with all identified water management strategies implemented, Region M will continue to have a water deficit for the foreseeable future. Further, **the existing water supply from the Rio Grande in Region M is projected to decline over 25% in the next 50 years.**

In the current regional water plan, the primary option for securing additional new water for municipal, industrial and steam electric purposes in the area of the Lower Rio Grande Regional Planning Group is the transfer of water rights from irrigated agriculture. This transfer would further exacerbate the deficit for agriculture identified above, and further reduce the economic viability of that important economic sector.

New, local water supply options are limited and imported water supplies are subject to intense competition from other needy municipal users outside the Lower Rio Grande region. Imported water also suffers from the associated high cost of delivery. Locally available brackish groundwater is one option to bridge this gap but is, by definition, a finite resource and its extent not fully known. Supplies of brackish groundwater are still being characterized within the region.

New surface water supplies identified from within the region are limited to the proposed Brownsville Weir, which, while technically viable, requires bi-national approval to proceed to implementation. The prospects of bi-national approval for the weir project are far from certain. New supplies from outside the region are distant and coveted by other potential users. Potentially available new surface water supplies in the Guadalupe and Colorado Basins are largely earmarked for Bexar County or in-basin users. Potential seawater desalination projects in Corpus Christi and Freeport are even farther from potential users than the proposed project of this study.

The only major new water supply source for the Rio Grande Basin that will satisfy the identified needs, have certain availability and provide a drought-proof supply is desalinated seawater. Desalination can be easily viewed as the most feasible technology to satisfy the growing industrial and domestic water demands while maintaining current supplies for agriculture in the region. This proven technology will provide the region with a drought independent source that can contribute to the growing and existing needs.

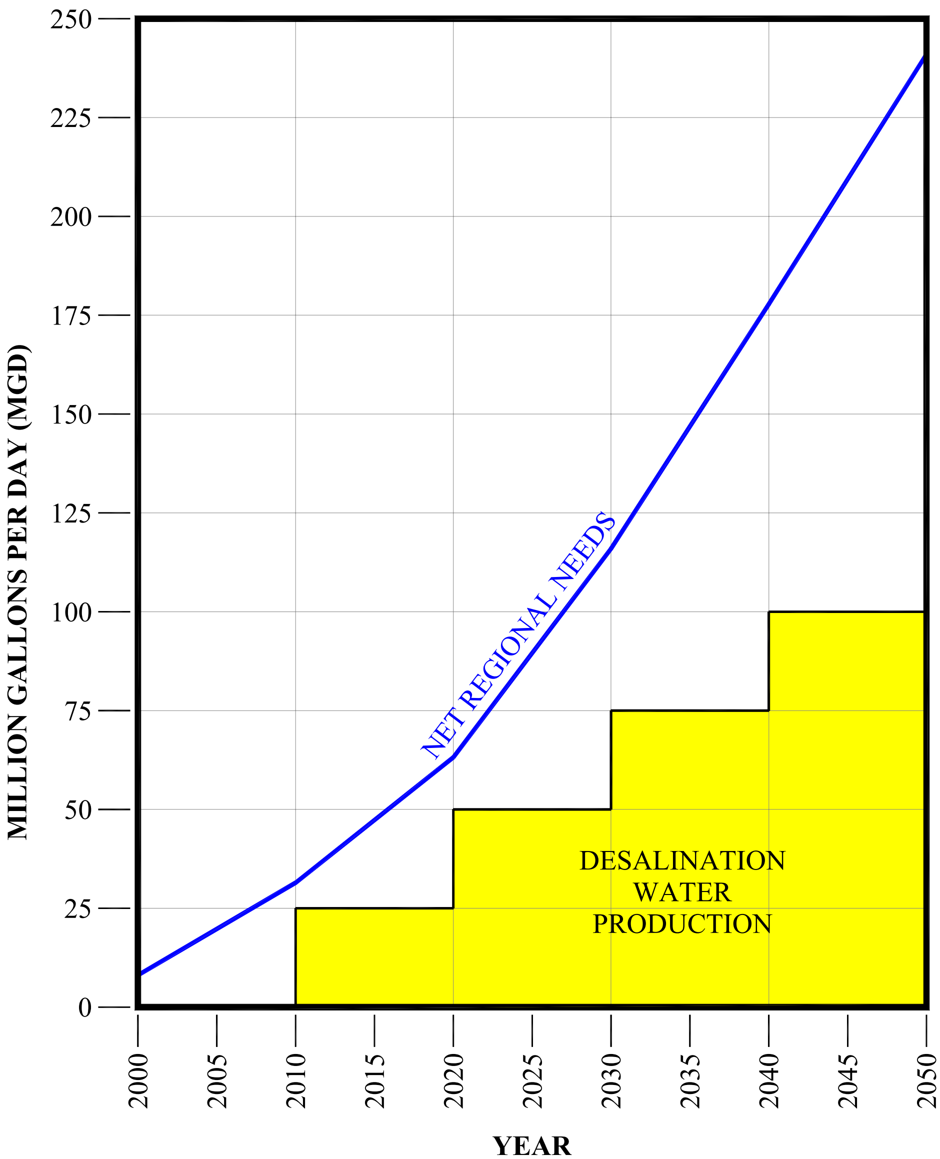
The major water user types that could *directly* benefit from a seawater desalination project include municipal, industrial and steam electric users. **The regional demand for new water supplies for these sectors is approximately 200mgd or some 184,000 acre-feet per year by 2050**. **No other identified supply source can satisfy this demand for new water**.

Local demand in the Brownsville system makes up a major portion of the need in the early years of the project and is a key foundation for project viability. However, in the long term the majority of the project demand is from the rest of the region. (See **Figure E-2**.) This is truly a regional project with the potential to address regional needs.

In addition to the new supplies to regional municipal and industrial users, **positive impacts to agricultural users and environmental flows** are indirectly benefited by the return flows of desalinated water, if so dedicated. The Rio Grande River environment could also be enhanced by dedicating some of the surface water currently used for municipal purposes, which could remain in the river due to the water made available by this project.

Such an undertaking can benefit the whole region's industry, agriculture and domestic use and provide for increased environmental flows. Even though the project will not meet the total Net Regional needs over the next 50 years, the project will be a fundamental element in an overall strategy to satisfy the region's future water demands.

Figure E-2 Net Regional Needs



Note:

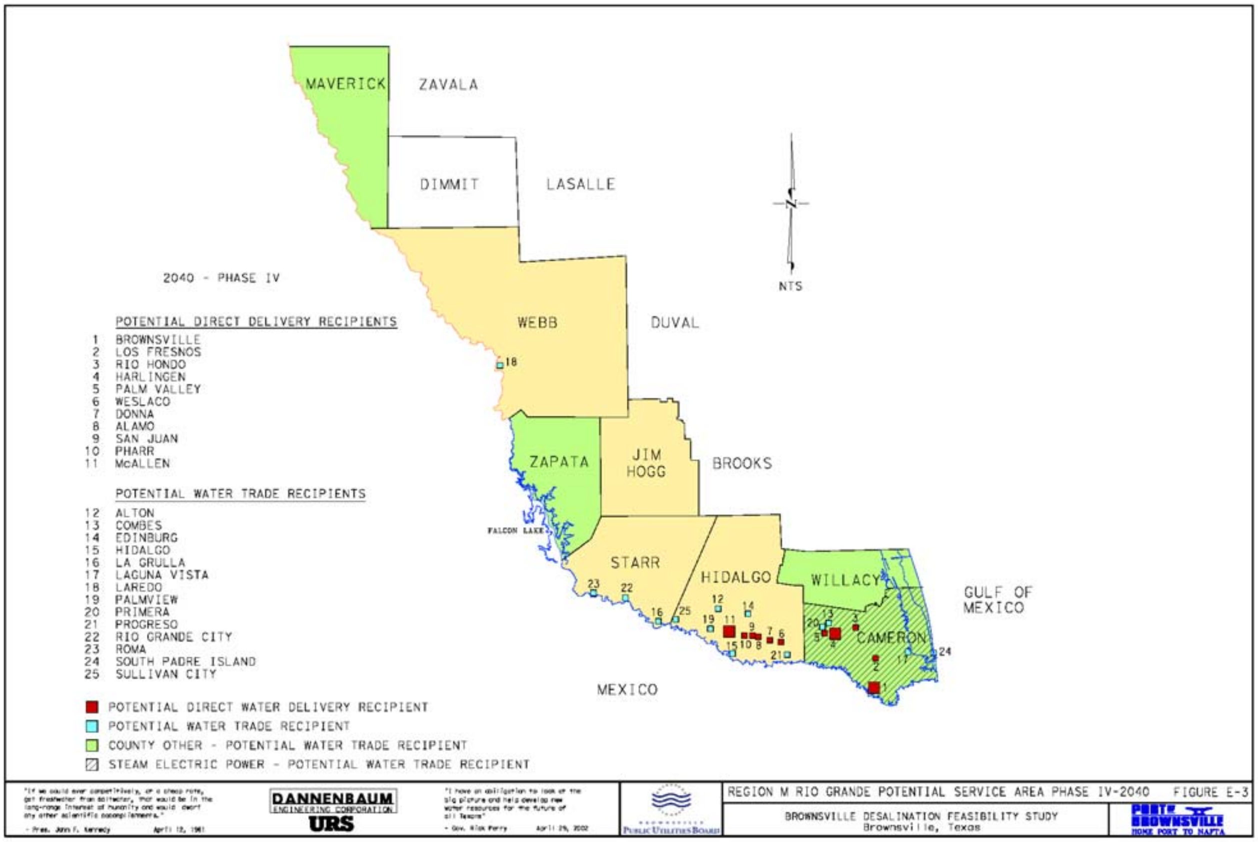
Net Regional Needs are the Sum of Municipal and Steam Electric Power Water User Deficits from the Region M Water Plan.

3. Regional Partnerships

The major stumbling block to implementation of a seawater desalination project is ultimate delivery cost. Given the present water rate structure, subsidies are required for *any* seawater desalination project in Texas and throughout the United States. The Lower Rio Grande project proposed by Brownsville has **key competitive advantages** over other regions that will help limit the subsidy requirement. As described above, the pronounced water supply deficit, associated economies of scale and the presence of efficient and effective delivery mechanisms will facilitate the project's implementation.

Securing additional regional partnerships is critical to the project's success. Some forty-eight communities within the region have supported the desalination project in concept. Some of these communities—like Brownsville—could be served directly with water from the desalination plant. Other communities as far away from the project as Eagle Pass or Laredo could receive indirect benefits from the project by securing water freed up from use by project "direct delivery customers." Again, this management tool is available to the region because of the unique system, hydrology and legal characteristics of water supplies in the Lower Rio Grande.

Figure E-3 Lower Rio Grande Valley Water Planning (Region M) Potential Service Area



4. Description of Project

The project consists of the water desalination plant initially scaled to 25 MGD, the finished water transmission line and offsite storage, which integrates into the Brownsville PUB system, and the brine disposal system that safely discharges concentrate into the Gulf of Mexico. As additional customer cities are added into the project, treatment plant size, associated intake structures, additional pipeline capacities and other infrastructure will be expanded.

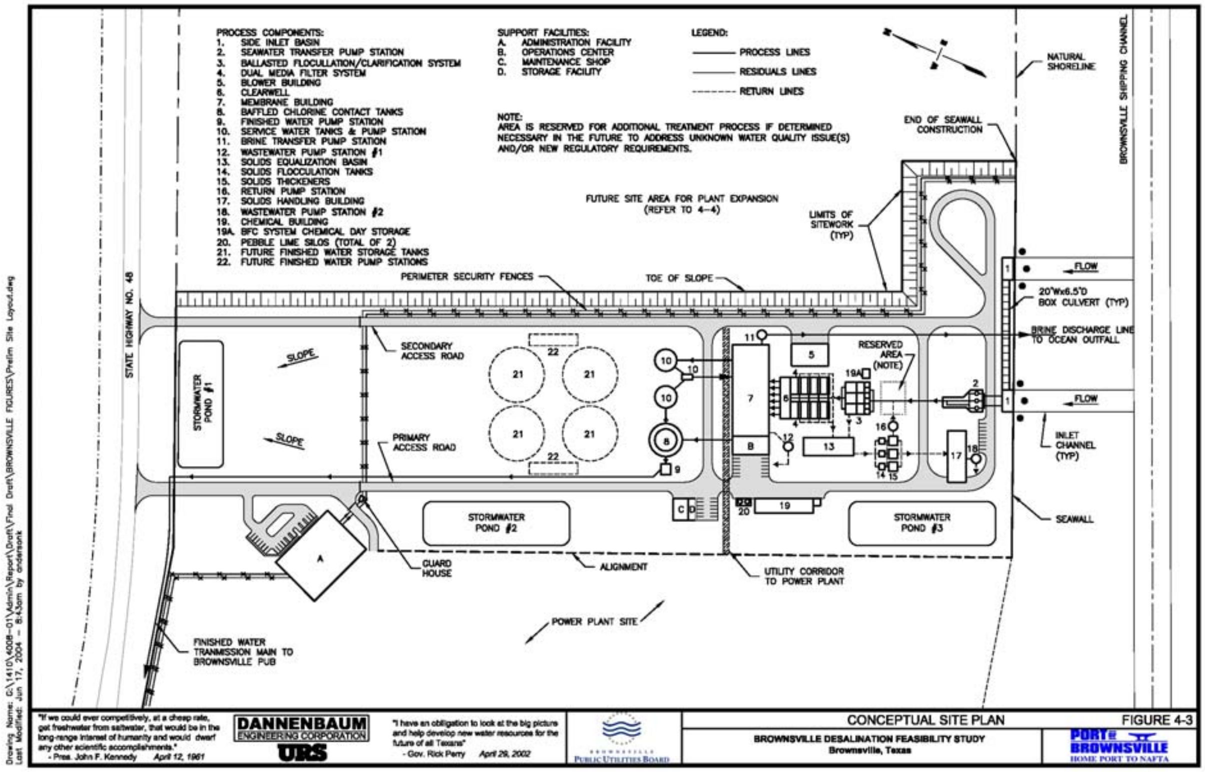
Figure E-4 Project Layout

Water Treatment: A detailed alternatives analysis was conducted for all major treatment processes and plant components. (Please refer to **Section 3** of the report for a full discussion of the alternative analysis, the methodology used to conduct the analysis, and individual alternatives considered by the analysis.) In summary, the alternative analysis used weighted evaluation criteria for each alternative. Viable options were identified and a score assigned for each evaluation criteria. The option receiving the highest total weighted score was then selected as the recommended alternative. Based on the alternatives analysis, the following systems were selected for the conceptual design:

- Seawater Intake - Side channels from the Brownsville Ship Channel with screened intake assemblies;
- Pretreatment System - Ballasted flocculation, dual media filtration, cartridge filtration;
- Primary Treatment - High pressure reverse osmosis with energy recovery;
- Post-Treatment - Pebble lime stabilization, on-site generated sodium hypochlorite disinfection;
- Solid Handling - Flocculation basins, gravity thickeners, belt filter presses;

The above described system would reliably provide a high quality potable water complying with all current and anticipated standards for drinking water quality. It is also believed that permits could be obtained for the plant and concentrate disposal with appropriate study and permit applications.

Figure E-5 Conceptual Site Plan



Finished Water Transmission: The finished water transmission main will leave the pump station located at the treatment plant site and cross State Highway 48 (SH 48) to the north. It will then parallel SH 48 and run westerly to the proposed offsite storage near FM 511. From this point, the finished water will be pumped into the Brownsville system and in future phases, to other municipalities.

Brine Disposal: Several brine disposal alternatives were considered including industrial water reuse, ocean outfall into the Gulf of Mexico, discharge to the Brownsville Ship Channel, evaporation ponds, and deep well injection. Due to extreme logistical, environmental, and/or cost feasibility reasons, the viable options that could potentially be used for brine disposal for this project would be limited to an ocean outfall or a deep well injection solution. While both of these options can be considered in further detail in subsequent phases, conceptual level costing has indicated that an ocean outfall would be the most cost-effective approach for the management of this stream, especially as plant capacity is expanded through time. It should be noted that it is a foregone conclusion that additional studies and evaluations will be needed to properly support any disposal option. For the purpose of this initial conceptual-level study, the ocean outfall was adopted in order to address this important project component. The safety and reliability of offshore pipelines has been documented from the long history and the experience of the engineering community.

Power Generation: At the Statement of Interest and scoping phase of the project, it was believed by the project team that significant synergies could be realized from co-locating a power generation facility with the desalination plant. Since it was believed that a need existed for new generation capacity in the region, it made sense to consider locating these facilities adjacent to one another. It was believed that locating the power plant adjacent to the water plant would offer lower cost power for the water treatment plant and help ease the concentrate disposal problem by providing water for dilution.

Once the study was underway, it became clear that co-locating the power and water plants would neither reduce the power rate to the water treatment plant nor assist with the concentrate disposal, both previously assumed to offer significant synergies. There are still some synergies to be gained from co-locating the two plants, such as pre-heating the feedwater for the water treatment plant and demineralized make-up water for the power plant. These synergies, however, are small compared to what was originally anticipated.

Since there are limited synergies between the power and water facilities, the projects should largely be viewed independently. Should there be demand for both projects, there are arguments in favor of co-locating the facilities; however, neither one of these projects depends on the other for viability.

5. Regional Partnership Opportunities

The implementation of the proposed seawater desalination demonstration project should be phased so as to reduce operating costs and take advantage of existing supplies of lower priced water (like brackish groundwater) while they are available. **The following phasing concept is proposed only for demonstration purposes** and no communities have made firm commitments to such a proposal. However, it demonstrates a feasible series of options to address critical regional concerns. (**It is hoped that as a result of this study, further discussions with other potential regional teaming partners could progress.**) Preliminary concepts for phasing would appear to be as follows:

- Phase I (2010-2020)—direct delivery within the Brownsville system with water supply trades to other communities within the region. Desal use and available water for trade would be further phased in over time, as demand grows. Water trades could help offset some of the costs of providing desalinated seawater. Environmental enhancements from unused river water, high quality wastewater return flows or some combination of the two sources could be dedicated to maintaining a base level of instream flows for environmental health considerations in the Rio Grande. This project could serve additional users and free up some 12,600 ac-ft of water supply for trades elsewhere in the region.

- Phase II (2020-2030)—expanded direct deliver and associated expanded water trades. The PUB would not need all of the water from Phase II capacity of the Desalination Plant. A transmission pipeline to Harlingen could deliver water to five additional communities that will need additional water in 2020. In concept this delivery could be a pipeline from the treatment plant to customers along US Highway 77 to Harlingen.

- Phase III (2040-2050). The need for the construction of Phase III would be the water demands in Hildalgo County. A transmission pipeline to Pharr could deliver water to seven communities that will need additional water in 2030.

- The need for the construction of Phase IV would be the water demands in McAllen. A transmission pipeline to McAllen could deliver water to that community which will need additional water in 2040.

In addition to the desalinated seawater supplied directly through the project, a net of nearly 50,000 acre-feet of additional Rio Grande surface water could be traded to communities for which direct desalinated seawater is not a viable option (primarily because of the distance from the source).

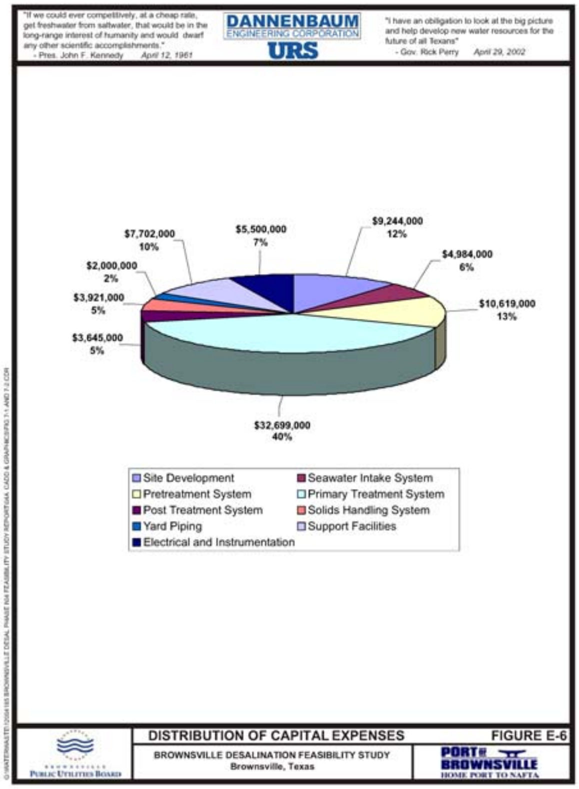
Greater specificity of phasing opportunities, partnerships and timelines will need to be developed as the project moves into subsequent stages of the implementation process and as communities consider both their own internal needs and project costs and subsidy levels.

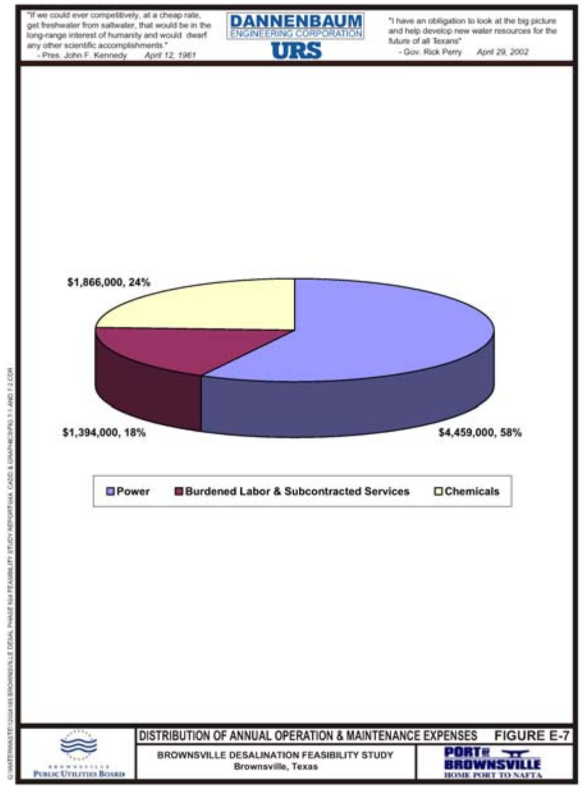
6. Financial Analysis/Financial Mechanism Recommendations

Implementing any new technology provides both opportunities and challenges. The desalination demonstration project is no exception. The opportunity is clear: a viable supply of new water that is a cost-effective alternative to other new regional supply options. The challenge is that like all viable new supplies, the cost will exceed the average cost that the region *currently* pays; though not what the region *must* pay if it wants to expand the supply available to it.

Like all of the demonstration desalination projects this project will likely require an external funding source in addition to revenues provided by local ratepayers to achieve financial viability. The exact amounts, timing and overall manner of that support cannot be precisely ascertained without further analysis to optimize the project's configuration, production levels and timing of phasing. Firm agreements with regional partners (which can only be made after all financial information is available) will determine the phasing of implementation and unit cost of water produced.

Table E-1 Total Project Costs	
Phase I - 25 MGD	
Desalination Plant	**$90,167,000**
Concentrate Discharge System	**$30,583,000**
Finished Water Transmission System	**$9,232,000**
Project Implementation Costs	**$21,406,000**
Total Capital Costs	**$151,388,000**





However, given these caveats, it should be noted that the costs for water from this project are highly competitive with other new sources and with other seawater desalination projects from around the U.S. The cost per 1000 gallons **without external subsidy** is anticipated to be in the **$2.36 to $2.44 range during the first project phase**. These numbers should be viewed as preliminary for the reasons noted above.

Further reducing costs through subsidies is necessary to make the project affordable. Such subsidies would have to come from government entities. It is highly unlikely that private water companies could provide such subsidies, thereby limiting their ability to implement such a project on their own. We know of no seawater desalination project that operates in the U.S. without some form of significant government subsidy.

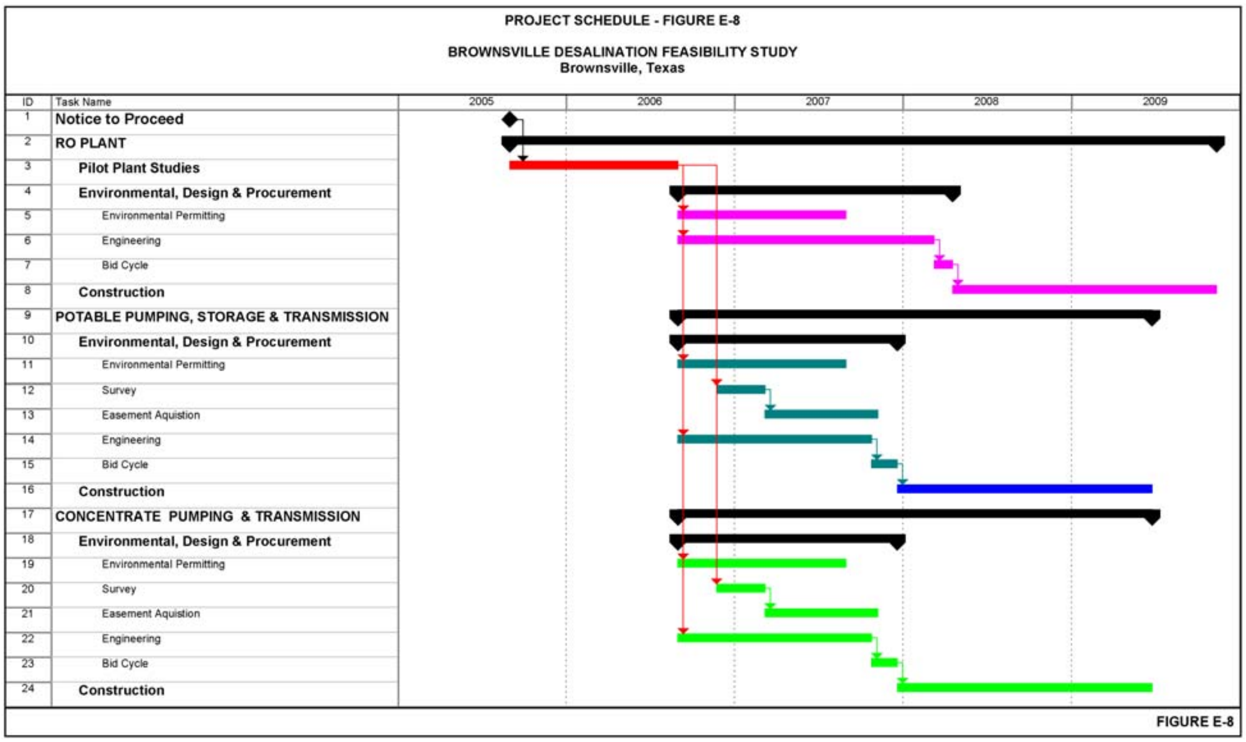
Subsidies may come in several forms: direct grants to offset capital or operating costs, low interest loans and deferred payment of capital costs by project owners and customers (until the project's customer base is sufficient to contribute all or part of the deferred payment over time). Some direct grant subsidy will likely be needed to move the unit cost for water for this project more in line with current average regional water costs (though the amount will depend on assumptions for the cost of new or replacement supplies). The exact magnitude of this direct subsidy will depend on other factors such as customer base, actual construction costs, etc.

The primary grant and subsidized loan mechanisms would be from bi-national institutions (the BECC or NADBank), from federal agencies (Bureau of Reclamation, U.S. Corp of Engineers, etc.) or the State of Texas through the Texas Water Development Board.

Further, less costly (to the government) is deferral of payments. These would have to be coupled with subsidies, but could reduce the near-term and long-term amounts of direct grant subsidies if properly structured to reflect ultimate customer bases for the project.

7. Schedule

The schedule below identifies the earliest possible completion of the Phase I project. This schedule anticipates beginning the project in the fall of 2005. Several factors could affect the schedule including environmental permitting, and timing and amount of financing.



8. Summary

The Lower Rio Grande Regional Seawater Desalination project offers the unique opportunity to assist all regional users with their water supply challenges. The project is the only major new water supply identified that can bring the volumes of new supplies to impact all water users in the region. Its costs are highly competitive with other potential supplies from outside of the region and with other desalination projects in the U.S. The region also possesses advantages over other desalination demonstration projects under Governor Rick Perry's Seawater Desalination initiative. It's unique regional needs, lack of practical alternatives, hydrology, and institutional arrangements that allow for water trading throughout the region, afford it an opportunity to succeed not possessed by the other demonstration projects.

The successful implementation of this project will be a function of State and/or Federal governmental financial subsidies that will have to be secured. There are no desalination plants within the United States that currently operate without significant government subsidies.

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Acronym	**Definition**
acfm	Actual cubic feet per minute
AMSL	Above mean sea level
BACT	Best Available Control Technology
BECC	Border Environment Cooperation Commission
BEIF	Border Environment Infrastructure Fund
BFC	Ballasted flocculation/clarification
BGS	Below ground surface
BMP	Best management practice
BWRO	Brackish water reverse osmosis
CA	Cellulose acetate
$CaSO_3$	Calcium sulfite
$CaSO_4$	Calcium sulfate
CDA	Cellulose diacetate
CEMS	Continuous Emission Monitoring System
CFR	Code of Federal Regulations
CO	Carbon monoxide
CO_2	Carbon dioxide
CWA	Clean Water Act
CT	Concentration time
DBP	Disinfection byproducts
EA	Environmental assessment
ED	Electrodialysis
EDR	Electrodialysis reversal
EFH	Essential fish habitat
EIS	Environmental Impact Statement
ELMR	Estuarine Living Marine Resources
EQ	Equalization
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
Floc	Flocculated organic particles
FONSI	Finding of no significant impact
FPS	Feet per second/Foot per second
ft^2	Square feet
g/L	Grams per liter
GLO	Texas General Land Office
gpm	Gallons per minute
H_2S	Hydrogen sulfide
HAP	Hazardous air pollutants
HDD	Horizontal directional drilling
HDPE	High density polyethylene
HP	Horsepower

IBWC	International Boundary and Water Commission
kV	Kilovolt
kW-hr	Kilowatts per hour
lbs/day	Pounds per day
lbs/hr	Pounds per hour
LNAPL	Light Non-Aqueous Phase Liquid
MACT	Maximum Available Control Technology
MCL	Maximum concentration limits
MED	Multi-effect distillation
mg/L	Milligrams per liter
MGD	Million gallons per day
mL	Milliliter
MM Btu/hr	Million British thermal units per hour
mm	Millimeter
MSF	Multi-stage flash
MVC	Mechanical vapor compression
MW	Megawatt
NAAQS	National Ambient Air Quality Standards
NADB	North American Development Bank
NEPA	National Environmental Policy Act
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NF	Nanofiltration
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NO_x	Nitrous Oxide
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NSPS	New Source Performance Standards
NSF	National Sanitation Foundation
NTU	Nephelometric Turbidity Unit
O&M	Operation and maintenance
ºC	Degrees Centigrade
ºF	Degrees Fahrenheit
OSHA	Occupational Health and Safety Administration
PA	Polyamide
PCIS	Process Control and Instrumentation System
PLC	Programmable logic controllers
PM	Particulate matter
POTW	Publicly owned treatment works
ppm	Parts per million
ppmv	Parts per million by volume
ppt	Parts per trillion
PSD	Prevention of significant deterioration
psi	Pounds per square inch
psig	Pounds per square inch, gauge
PTE	Potential to emit

PUB	Public Utility Board
RCP	Reinforced-concrete pipe
RCT	Railroad Commission of Texas
RMP	Risk Management Plan
RO	Reverse osmosis
ROW	Right of way
SDI	Silt density index
SH4	State Highway 4
SH48	State Highway 48
SNCR	Selective non-catalytic reduction
SU	Standard unit
SWPPP	Storm Water Pollution Prevention Plans
SWRO	Seawater reverse osmosis
TABS	Texas Automated Buoy System
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TDS	Total dissolved solids
TFC	Thin-film composite
TNRCC	Texas Natural Resource Conservation Commission
TOC	Total organic carbon
TPDES	Texas Pollution Discharge Elimination System
TPH	Tons per hour
TPWD	Texas Parks and Wildlife Department
TPY	Tons per year
TSHPO	Texas State Historical Preservation Office
TSP	Total suspended particulates
TSS	Total suspended solids
TWC	Texas Water Code
TWDB	Texas Water Development Board
TXDOT	Texas Department of Transportation
UF	Ultrafiltration
UPS	Uninterrupted power supplies
uS/CM	Micro Siemen/centimeter
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USDOE	United States Department of Energy
USDW	Underground sources of drinking water
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UV	Ultraviolet
V	Volt
VOC	Volatile organic compounds
WAM	Water availability model
WAN	Wide area network
yd^3	Cubic yards

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE OF STUDY

The Governor's Office, the State Legislature, the Texas Water Development Board, the Project Sponsors: Brownsville Public Utilities Board and the Port of Brownsville, all recognize the need for a new drought-proof water supply for Texas. Seawater desalination can serve an important role for Texas water users in the future. For the Lower Rio Grande Valley (LRGV), that future is now. Region M water planners and state officials, including the Governor, recognize the importance of desalination technology for the LRGV's water future. Water continues to be a key state and local issue for the ongoing economic development in Texas, and if unaddressed, it will impact the future development of the state and the Lower Rio Grande Region. The availability of water and the manner in which the resource is provided will help define opportunities for economic growth and quality of life issues in Texas for years to come. Some parts of the state, like the LRGV, have few new supply alternatives. This fact coupled with supply uncertainties caused by treaty compliance issues with Mexico further magnifies the region's challenges. Desalination of seawater is already a serious long-term water supply option. If studied and implemented correctly, and if the right local partnerships and financing are made available, desalination can provide an economically viable technological solution to redefine availability while limiting the impacts to the environment.

This conceptual-level study consisted of the following five activities:

1. Water supply planning;
2. Analysis of desalination alternatives;
3. Evaluation of the power component;
4. Development of cost estimates; and
5. A preliminary financial analysis.

1.2 BACKGROUND

In April 2002, the Governor charged the Texas Water Development Board (TWDB) with the task of developing recommendations for a large-scale seawater desalination project. Statements of Interest (SOI) were solicited by TWDB and in October 2002, TWDB received ten SOI's and three in-house proposals.

In January 2003, TWDB made recommendations to the Governor for three projects. The Brownsville Desalination Demonstration Project was one of three potential pilot projects selected by the TWDB for further study. In August 2003, a Regional Water Supply Planning Application was submitted to TWDB for project funding. In December 2003, contracts were executed for the Brownsville Desalination Demonstration Project, Feasibility Study Report.

1.2.1 Description of Area

The minimum geographic area that would be served by the proposed project is within Cameron County, consisting primarily of the Brownsville PUB, the Southmost Regional Water Authority, and independent water suppliers who may need additional supply. Current Southmost Regional Water Authority customers include the City of Brownsville, Rancho Viejo, Indian Lake, Los Fresnos, and the Port of Brownsville. However, a key goal of the feasibility phase of the project is to identify other potential partners for this project throughout the Rio Grande Valley.

As outreach efforts in the feasibility phase show results, the project could be expanded to directly serve Los Fresnos, Rio Hondo, Harlingen, McAllen, Palm Valley, Weslaco, Donna, Alamo, San Juan, Pharr, water supply corporations such as Military Highway WSC, North East Alamo, and industry. The agricultural community would be an indirect beneficiary by lessening the demands from municipal users on agricultural rights and supplies.

Ultimately, additional project benefits would accrue to other water users not directly connected to the proposed facility. The opportunity would exist to lease existing municipal water rights or water from water rights holders to other water users, including distant users such as Roma and Eagle Pass. This could provide significant relief on existing water demands, both in the lower valley and upstream (for all sectors, including agriculture), by creating a net increase in the available water supply to the region. This area could potentially encompass the entire Lower Rio Grande Regional Planning Group (Region M).

1.3 WATER SUPPLY PLANNING

The water supply planning for Region M has not identified adequate water sources to serve the current and projected future needs of the region. A new water supply based on seawater desalination will have a significant market in which to sell water. The Brownsville PUB alone has a current deficit in water supply that by 2050 will increase to approximately 20,000 acre-feet per year, which is equal to approximately 18 million gallons per day (MGD), the state designated water supply planning entity. This Region includes eight Counties. (See Figure2-1)

Without desalination, municipal users will have to acquire all of the additional water sources as outlined in the Region M plan. These sources will have to come from conservation, wastewater reuse, and the acquisition of additional water rights from other users. While conservation and reuse help to mitigate the problem, they do not address the magnitude of the demand in Region M. Therefore, these municipalities will have to acquire additional water rights through either urbanization or the purchase of rights from other users. Most notably, the irrigation users will most likely be affected, which can have a significant economic impact on the agricultural community.

It must be noted that the potential surface rights from current irrigation users can and do have significant water quality problems. Wastewater discharges into the supply and high salinity (averaging 10,000 ppm in the Morillo Drain Diversion Canal) impact the cost of treating this water for municipal consumption.

1.3.1 Historical Water Supply Conditions

The Rio Grande River has been the primary source of water within the valley area. There is some groundwater available in the region, but the Rio Grande River will continue to be the major source for water. Much of the available water has historically been used for agricultural purposes. As the total population within the region has grown, there has been a tremendous demand placed on the Rio Grande River system. As a result of this demand, coupled with drought and treaty compliance issues, the river water has not reached its outfall at the Gulf of Mexico during periods of drought, which has been the condition during the past 10 or more years. The need for a new supply of water independent of the Rio Grande River is critical due to the rapid population growth in the Rio Grande Valley.

1.3.2 Current and Projected Water Supply Needs

The population growth in the Rio Grande Region has already exceeded the available supply of water currently allocated for municipal uses. This has been documented in the Region M Regional Water Plan. Additional supplies of water are badly needed. Traditional sources have been exhausted and one brackish ground water desalination plant has already been constructed. The need for additional water sources is critical as the population continues to grow at a very fast rate.

The current water deficit in Region M exceeds 1,000,000 acre-feet per year. Even with all the water management strategies implemented, Region M will continue to have a water deficit for the long-term future. Further, the existing water supply in Region M is projected to decline over 25% in the next 50 years. Table 1-1 identifies the Water Demands for Region M.

Table 1-1 Region M Water Plan - 2006 Water Demand Projections

WUG Name		2010		2020		2030		2040		2050	
		AC-FT	MGD	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD
Alamo		2,319	2.07	3,022	2.70	3,808	3.40	4,675	4.17	5,667	5.06
Alton		3,346	2.99	4,153	3.71	5,061	4.52	6,056	5.41	7,135	6.37
Brownsville		43,655	38.98	52,038	46.46	60,475	54.00	69,270	61.85	77,985	69.63
Combes		208	0.19	229	0.20	256	0.23	281	0.25	309	0.28
County-Other	Cameron Co.	6,970	6.22	7,812	6.98	8,709	7.78	9,572	8.55	10,485	9.36
County-Other	Hidalgo Co.	9,886	8.83	13,072	11.67	16,626	14.84	20,536	18.34	24,981	22.30
County-Other	Jim Hogg Co.	153	0.14	159	0.14	164	0.15	167	0.15	165	0.15
County-Other	Maverick Co.	2,727	2.43	3,249	2.90	3,742	3.34	4,183	3.73	4,573	4.08
County-Other	Starr Co.	6,228	5.56	7,663	6.84	9,141	8.16	10,663	9.52	12,141	10.84
County-Other	Webb Co.	1,388	1.24	1,575	1.41	1,786	1.59	2,025	1.81	2,296	2.05
County-Other	Willacy Co.	215	0.19	213	0.19	212	0.19	211	0.19	210	0.19
County-Other	Zapata Co.	1,232	1.10	1,514	1.35	1,792	1.60	2,048	1.83	2,293	2.05
Donna		2,309	2.06	2,565	2.29	2,842	2.54	3,156	2.82	3,521	3.14
Eagle Pass		4,932	4.40	5,123	4.57	5,314	4.74	5,460	4.88	5,644	5.04
East Rio Hondo Wsc		2,408	2.15	3,107	2.77	3,862	3.45	4,555	4.07	5,323	4.75
Edcouch		499	0.45	547	0.49	604	0.54	668	0.60	744	0.66
Edinburg		8,274	7.39	10,428	9.31	12,967	11.58	15,528	13.86	18,583	16.59
El Cenizo		671	0.60	968	0.86	1,302	1.16	1,664	1.49	2,074	1.85
El Indio Wsc		1,253	1.12	1,567	1.40	1,855	1.66	2,108	1.88	2,335	2.08
El Jardin		1,910	1.71	2,332	2.08	2,771	2.47	3,216	2.87	3,656	3.26
Elsa		1,099	0.98	1,134	1.01	1,182	1.06	1,232	1.10	1,303	1.16
Harlingen		11,374	10.16	12,780	11.41	14,175	12.66	15,604	13.93	17,109	15.28
Hebbronville (Cdp)		731	0.65	759	0.68	780	0.70	792	0.71	778	0.69

Table 1-1 Region M Water Plan - 2006 Water Demand Projections

WUG Name	2010		2020		2030		2040		2050	
	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD
Hidalgo	1,058	0.94	1,444	1.29	1,859	1.66	2,316	2.07	2,841	2.54
Hidalgo County Mud #1	1,703	1.52	2,387	2.13	3,161	2.82	3,994	3.57	4,915	4.39
Indian Lake	49	0.04	57	0.05	66	0.06	76	0.07	85	0.08
La Feria	855	0.76	1,031	0.92	1,214	1.08	1,403	1.25	1,587	1.42
La Grulla	639	0.57	635	0.57	631	0.56	627	0.56	624	0.56
La Joya	408	0.36	471	0.42	538	0.48	613	0.55	700	0.63
La Villa	234	0.21	230	0.21	225	0.20	221	0.20	218	0.19
Laguna Madre Wd	2,310	2.06	3,386	3.02	4,516	4.03	5,622	5.02	6,744	6.02
Laguna Vista	268	0.24	323	0.29	382	0.34	444	0.40	503	0.45
Laredo	51,467	45.95	65,032	58.06	80,548	71.92	97,846	87.36	116,596	104.10
Los Fresnos	767	0.68	1,008	0.90	1,247	1.11	1,490	1.33	1,745	1.56
Los Indios	230	0.21	271	0.24	311	0.28	354	0.32	396	0.35
Lyford	297	0.27	307	0.27	313	0.28	317	0.28	322	0.29
Mcallen	28,697	25.62	33,551	29.96	39,226	35.02	45,267	40.42	52,032	46.46
Mercedes	1,890	1.69	1,956	1.75	2,048	1.83	2,142	1.91	2,285	2.04
Military Highway Wsc	1,486	1.33	1,780	1.59	2,066	1.84	2,378	2.12	2,683	2.40
Military Highway Wsc	1,346	1.20	1,540	1.38	1,748	1.56	2,000	1.79	2,271	2.03
Mission	9,864	8.81	12,564	11.22	15,594	13.92	18,792	16.78	22,529	20.12
North Alamo Wsc Hidalgo Co.	11,675	10.42	15,158	13.53	19,046	17.01	23,352	20.85	28,297	25.27
North Alamo Wsc Willacy Co.	733	0.65	853	0.76	961	0.86	1,052	0.94	1,122	1.00
Olmito Wsc	952	0.85	1,314	1.17	1,691	1.51	2,060	1.84	2,444	2.18
Palm Valley	413	0.37	440	0.39	468	0.42	494	0.44	525	0.47
Palm Valley Estates Ud	85	0.08	108	0.10	132	0.12	155	0.14	180	0.16
Palmhurst	1,157	1.03	1,789	1.60	2,497	2.23	3,263	2.91	4,099	3.66
Palmview	869	0.78	1,199	1.07	1,570	1.40	1,967	1.76	2,414	2.16
Penitas	149	0.13	150	0.13	150	0.13	151	0.13	155	0.14
Pharr	8,474	7.57	10,370	9.26	12,511	11.17	14,887	13.29	17,448	15.58
Port Isabel	2,645	2.36	2,846	2.54	3,052	2.73	3,254	2.91	3,470	3.10
Primera	525	0.47	628	0.56	730	0.65	838	0.75	945	0.84
Progreso	576	0.51	717	0.64	867	0.77	1,037	0.93	1,234	1.10
Rancho Viejo	373	0.33	496	0.44	627	0.56	755	0.67	888	0.79
Raymondville	1,681	1.50	1,701	1.52	1,715	1.53	1,717	1.53	1,730	1.54
Rio Bravo	1,090	0.97	1,490	1.33	1,924	1.72	2,409	2.15	2,958	2.64
Rio Grande City	2,575	2.30	2,751	2.46	2,957	2.64	3,141	2.80	3,353	2.99
Rio Hondo	404	0.36	428	0.38	453	0.40	475	0.42	503	0.45
Rio Wsc	484	0.43	624	0.56	772	0.69	913	0.82	1,063	0.95
Roma City	2,722	2.43	3,053	2.73	3,397	3.03	3,751	3.35	4,112	3.67
San Benito	4,916	4.39	5,484	4.90	6,050	5.40	6,630	5.92	7,241	6.47
San Juan	3,501	3.13	4,665	4.17	5,956	5.32	7,384	6.59	9,031	8.06
San Perlita	105	0.09	112	0.10	117	0.10	120	0.11	124	0.11
Santa Rosa	331	0.30	376	0.34	429	0.38	478	0.43	531	0.47
Sebastian Mud	256	0.23	297	0.27	333	0.30	362	0.32	382	0.34
Sharyland Wsc	4,893	4.37	5,469	4.88	6,095	5.44	6,747	6.02	7,492	6.69
South Padre Island	2,504	2.24	3,136	2.80	3,789	3.38	4,443	3.97	5,095	4.55

Table 1-1 Region M Water Plan - 2006 Water Demand Projections											
		2010		2020		2030		2040		2050	
WUG Name		AC-FT	MGD	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD
Steam Electric	Cameron Co.	1,616	1.44	1,523	1.36	1,780	1.59	2,094	1.87	2,477	2.21
Steam Electric	Hidalgo Co.	10,355	9.25	14,151	12.63	16,545	14.77	19,462	17.38	23,018	20.55
Steam Electric	Webb Co.	1,492	1.33	1,190	1.06	1,391	1.24	1,636	1.46	1,935	1.73
Sullivan City		526	0.47	672	0.60	845	0.75	1,016	0.91	1,226	1.09
Valley Mud #2		858	0.77	854	0.76	850	0.76	846	0.76	843	0.75
Webb County Water Utility		239	0.21	336	0.30	441	0.39	559	0.50	690	0.62
Weslaco		5,534	4.94	6,201	5.54	6,966	6.22	7,819	6.98	8,792	7.85
Zapata (Cdp)		1,033	0.92	1,017	0.91	1,001	0.89	985	0.88	974	0.87
Total For Region M		**293,096**	**261.69**	**355,580**	**317.48**	**423,227**	**377.88**	**495,824**	**442.70**	**575,177**	**513.55**

1.4 ALTERNATIVES ANALYSES

The alternatives analyses included a comprehensive evaluation and selection of all systems and subsystems needed for a desalination plant including seawater collection, pretreatment, primary treatment (the system where the water supply is desalted), post-treatment, solids handling, and brine disposal. All methodologies adopted and used for this study are based on sound engineering experience, practices, and professional engineering judgment. Each of the study project activities is described in more detail below.

A central focus of the feasibility study is the desalination plant itself. A typical desalination plant is composed of various systems and subsystems that must properly convert seawater into fresh potable water and convey it from the point of collection to the point(s) of delivery. Many of the more important systems could affect both treatment reliability and project costs. A screening and subsequent analysis of viable options for these systems are necessary to ensure that an appropriate and cost-effective solution is selected. **Table 1-2** summarizes the principal systems of the desalination plant for which various alternatives were considered.

Table 1-2. Summary of Alternatives Evaluated for Desalination Plant	
System Description	**Alternatives Evaluated**
Seawater Intake Screening	T-Shaped Water Intake Screens Engineered Aquatic Filter Barrier System
Pretreatment System	Two-Stage Dual-Media Filtration System Ballasted Flocculation/Clarification with Single-Stage Dual-Media Filtration Submerged Ultrafiltration (UF) Membrane System
Primary Treatment System	Membrane Configurations Thermal Solutions
Energy Reduction System	Positive Displacement Work Exchanger Pelton Wheel Turbine Steam-Powered Feedwater Heater
Stabilization System	Pebble Lime Calcite Filters
Disinfection System	Gas Chlorine On-Site Sodium Hypochlorite Generation Commercial Bleach
Solids Dewatering System	Belt Filter Presses Centrifuges Solids Drying Beds Steam-Powered Sludge Drying System

*Note: Refer to **Section 3** for the results of the alternatives analyses for the components listed above.*

The overall analysis and the conceptual design of the desalination plant was based on analyzing alternatives for specific components listed in **Table 1-2**. A consistent methodology was used to perform the alternatives analysis for each project component. This three-step process is summarized below.

1. **Research and Inventory Potential Options** – Various options for a particular project component were researched and inventoried for further consideration. Information on each option was collected, reviewed, and summarized. Where possible, references for existing plants that use a particular treatment technology were contacted and interviewed to obtain supplemental feedback regarding the technology. If available, an additional layer of information was added on the basis of in-house knowledge and experience regarding the technology.

2. **Screening Evaluation** – A screening evaluation was used to eliminate solutions that were inappropriate, non-viable, or non-applicable from a technical perspective and/or would not be cost-effective to explore in further detail. This step reduced the total number of options to be evaluated in more detail, thereby allowing a more focused analysis of the most suitable alternatives.

3. **Alternative Analysis** – Options retained from the screening evaluation were analyzed in more detail using specific criteria and applying a weighted scoring system. The criteria included efficiency, unit reliability, how easily an option might be permitted, and overall ability to install and/or construct. In addition, both capital and annual operation & maintenance (O&M) costs were compiled and/or estimated to assess the overall cost-effectiveness of the option. Each criterion was assigned a weight based on the relative importance of each screening criteria, as summarized below in **Table 1-3**.

   Once weights were established for each evaluation criterion, scores were assigned. Scores ranging from 1 (representing 10%) through 10 (representing 100%) were used, with 1 being the least attractive or suitable score and 10 being the greatest for each criterion. Specific scores were applied to each weighted criterion based on a comprehensive review of the information collected in the first step. Scores for the various criteria were summed to arrive at a composite score for each alternative. The alternative receiving the highest composite score is recommended as the preferred option for the plant component under consideration.

Table 1-3. Summary of Screening Criteria and Weighting Factors Used in the Alternatives Analysis

Screening Criteria	Relative Weighting Factor	Range of Possible Scores	
		Lowest (10%)	Highest (100%)
Technical/Treatment Efficiency	40	4.0	40
Unit Reliability	35	3.5	35
Permitability	25	2.5	25
Constructability	30	3.0	30
Cost-Effectiveness	50	5.0	50
Total Base and Adjusted Scores	180	18	180

Within this framework, comparative advantages and disadvantages associated with each alternative were considered to identify the most appropriate and cost-effective option for the project.

It should be noted that the relative weighting factors summarized in **Table 1-3** could be adjusted for a particular analysis if conditions dictated a different set of weights. For instance, weighting factors were adjusted for the pretreatment system component of the project (as described in more detail in **Section 3.3**) as well as for the brine disposal solutions presented in **Section 3.9**.

For the balance of the required components needed for the desalination plant (e.g., transfer pumping systems, chemical storage and feed systems), a rigorous alternative analysis was not necessary at the conceptual-level planning phase. Instead, appropriate components were tentatively selected, sized, described, and included in the conceptual layout and associated cost estimate for the plant. To minimize energy costs, all mechanical components (e.g., pumps and blowers) were selected with the highest possible operating efficiencies.

1.4.1 Development of Capital and Annual O&M Cost Estimates

To support a life-cycle cost estimate for the desalination plant from which a unit cost of water for the project could be estimated, both capital and annual O&M costs for the individual project components were estimated. This section describes the methods used to estimate costs and any important assumptions or conditions that would govern the results of the cost estimates.

Capital Costs

Capital cost estimates were developed using current (2004 United States dollars) unit pricing for each component. Unit costs for recently constructed civil works projects were used to estimate the majority of costs for the various project components, such as roads, buildings, pipelines, etc. For the various treatment components described in this report (e.g., the membrane system, the pretreatment system, and all other primary treatment systems), budgetary quotes were obtained from equipment vendors. For special construction works (e.g., a directional bore [drilling] under the Brownsville Ship Channel for the brine disposal main), budgetary quotes were obtained from a qualified contractor to confirm the costs.

All capital costs were assembled and organized into a master spreadsheet so that they could be easily reviewed and verified. A marginal contingency factor of 5% was applied to any major equipment component for which a budgetary quote was obtained from a qualified vendor since that quote should already be conservative. A 25% contingency factor was applied to the capital cost estimates for the remaining project components to cover any uncertainties or changed conditions that may occur between the conceptual and final configurations of the project. The overall result from using the two different contingency factors was a blended contingency, which is discussed in more detail in **Section 7**.

Annual O&M Expenses

Annual O&M expenses for the project were estimated using feedback from equipment vendors and operators at similar water treatment plants and supplemented with engineering judgment and experience. Primary operational expenses include labor to operate and maintain the plant; energy to run pumps, blowers, and other mechanical equipment; and chemicals needed to properly condition the water supply. Primary maintenance costs include labor and materials needed to periodically rehabilitate specific components in the plant, such as pumps, gear drives, etc. Of considerable importance is the periodic replacement of membrane elements, which represents a significant cost impact to the project.

Similar to the capital cost estimate for the project, all annual O&M expenses were assembled and organized in a master spreadsheet. Annual O&M expenses were summarized under the following three categories:

1. **Labor** – All costs associated with a particular employee were taken into account including his/her salary, fringe benefits, payroll taxes, etc. Labor rates established by the **Brownsville Public Utility Board (PUB)** were used as the basis for the various types and levels of staff recommended for the operation and maintenance of this project. Due to the relative size and complexity of the desalination facility, it is assumed that it would be staffed 24 hours/day, 7 days/week. Any subcontracted work that may be needed to supplement the fixed labor pool for the project was taken into account and added to the labor cost category (e.g., sludge hauling, chemical deliveries, electrical).

2. **Power** –To accurately estimate power costs, each principal project component was inventoried along with its power ratings and/or amperage draws. Since it was assumed that the desalination facility would consistently produce 25 million gallons per day (MGD), appropriate run times were selected for the individual equipment components. Thus, a 24 hours/day, 7 days/week operating schedule was used for all primary water treatment components. For process-related plant components that would not require full-time operation (e.g., solids dewatering), a suitable runtime was selected. A unit power cost of $0.035 per kilowatt-hour (kW) was used to estimate annual power costs, consistent with current Brownsville PUB pricing for municipal wholesale customers.

3. **Chemicals** – Various chemical stocks will be needed to support the normal operations of the desalination facility. Chemical types and use rates were estimated based on the conceptual configuration and design of the facility that were developed and described in **Section 4**. Typical unit cost data for the types of chemicals needed for this facility were used as the basis for this cost component. Quantities of chemicals were estimated based on the total process flow streams associated with the facility, from which total chemical costs were derived, including delivery fees as applicable.

4. **Site Lease** – The site proposed for the desalination facility is located along the Brownsville Ship Channel approximately 11 miles northeast of Brownsville. The site is bounded on the north by State Highway 48 (SH48), to the south by the Brownsville Ship Channel, and to the west by an existing fishing harbor. This property is owned and

controlled by the Port of Brownsville. A lease cost of $3600 per acre per year was used in the analysis.

A 10% contingency factor was applied to the total electrical (excluding the electrical load associated with the high-pressure seawater reverse osmosis [SWRO] pumps) and chemical costs estimated for these O&M components. This contingency would cover any uncertainties or changed conditions that may occur between the conceptual and final configurations of the project. Since proper staffing can be better quantified and justified for the proposed facility, no contingency factor on labor was included in the cost estimate.

In addition to the recurring annual O&M expenses every year, other maintenance events would occur during the lifetime of the project. These events include the replacement or major refurbishment of the various mechanical systems associated with the project. For instance, one of the most significant maintenance events that must be taken into account is the replacement of the membrane elements approximately once every five years. This event will have a significant cost impact and cannot be excluded from the overall financial analysis. In addition, maintenance events for other equipment components, such as pumps, blowers, and process unit refurbishment, are also taken into account and inventoried in the cost estimate presented in **Section 7**.

1.5 FINANCIAL ANALYSIS

As part of the overall study, a financial analysis was performed and a financial model was developed. The financial analysis initially focused on ensuring that all costs were estimated as accurately as possible and that all reasonably expected costs were included in the model. Issues analyzed include construction costs; financing options; borrowing rates; debt service coverage; operating costs; maintenance requirements; phasing of the project; and required grants and subsidies. Many of these issues were documented and are discussed throughout **Section 7 and 8**.

From the financial analysis, a financial model was developed. This model includes many of the costs discovered during the analysis phase and ultimately seeks to answer several questions including 1) how much will the plant cost to build; 2) what will the debt service costs be including coverage; 3) how much will it cost to operate the plant; 4) how will the plant affect the rates users pay for their water; 4) what grants and subsidies will be required; and finally, 5) is the project economically viable.

2.0 REGIONAL PARTNERSHIPS AND OWNERSHIP ANALYSIS

2.1 POTENTIAL WATER SUPPLY INVESTORS AND CUSTOMERS

The Lower Rio Grande Valley (LRGV) Region has significant water supply needs relative to supplies and few traditional water supply solutions to address those needs. It is unique among the regions of Texas in this regard. Counties within LRGV traditionally rank among the highest growth counties in the nation and its water challenges are well documented, particularly the international treaty issues on the Rio Grande.

The vast majority of the water used in the region comes from the Rio Grande and the Amistad/Falcon reservoir system. The strain on this resource has been documented for a number of years. The recently completed Water Availability Model (WAM) developed for the Texas Commission on Environmental Quality (TCEQ) quantifies this strain. Water demand on the river and its reservoirs is approximately 2,000,000 acre-feet per year. Available firm yield supply is estimated at no more than (and likely less than) 1,050,000 acre-feet per year. The actual availability is likely to be less than this amount because the drought of record conditions that form the basis of firm yield calculations extended beyond the period examined in the WAM process. Simply stated, approximately one-half of the demands in the Rio Grande system in Texas cannot be met under drought of record conditions (presentation by Dr. R.J. Brandes to the Region M Planning Group, May 26, 2004).

The 2001 Regional Water Plan and 2002 Texas State Water Plan note that most of the incremental supplies of water to be provided for the growing municipal, industrial and steam electric demand will come directly from water currently allocated to irrigated agricultural uses. This will place more pressure on already-constrained agricultural users. Only with new supplies or significant investments in conservation (ideally with both) will the basic equation of system operation be altered in a positive way.

Significant supply alternatives for the Rio Grande's local users appear to be brackish groundwater and desalinated seawater. The former is a limited resource; the latter, unlimited, for all practical purposes.

Desalinated seawater offers significant attraction to potential users in the region. Among these attractions are the following:

- In a drought-prone region (that relies on a long river system which moves through long stretches of desert county), desalinated seawater is a **drought-proof** source of water.
- Desalinated seawater is a **reliable** source, not subject to the vagaries of international treaty issues nor is it tied to agricultural deliveries which require additional "push water" to fill canals upon which many communities rely.
- It is the most **sustainable** of resources. The oceans represent a nearly endless supply of water.
- It is a **cost-effective** new supply. Other supply options, except as noted above, require significant capital investments (dams and pipelines) with which to impound and move water, require long movements, compete with other water needs (San Antonio, for

example) and create third party and environmental impacts. Desalinated seawater is available in the region, competitive with other new sources, does not limit the water available to other communities and can have a positive environmental impact.

- It is a high **quality** of water that can meet all drinking water standards. Currently, the Rio Grande, because of low flows and high demand, often has impaired quality.
- Desalinated seawater used as a municipal and industrial supply can take the pressure off of agricultural users. In the absence of a new supply, the loss of water from agriculture is the major new supply to these other users. Agriculture is a major employer in the region and a major industry. Maintaining its viability is a state and national interest. Desalination offers the hope of **maintaining the water currently used by agriculture** for food and fiber production.
- A desalinated seawater project can provide the new water necessary to enhance **environmental flows** in the Lower Rio Grande Valley. The Valley is a highly productive and important region for wildlife and the environmental and economic benefits derived from it (it is a national birding center, for example). An investment by the state or federal government in water flows made available from the desalination project can allow substitution for some current river water to remain as a base flow for the environment.

Many of the above-mentioned issues are key reasons for Brownsville PUB's interest in pursuing a regional desalination project. The PUB has a substantial need (starting now) for new water because of growing population and demand (some 20,000 acre-feet per year over the planning horizon). PUB is also very concerned about whether the water rights it actually owns will, in fact, be delivered in drought conditions give the it's intakes are at "the end of the line" in the region. PUB also has concerns about the quality of the water it receives. Often, the total dissolved solids (TDS) in its intake water exceed secondary drinking water standards. These needs, taken together, form a compelling justification for a new water supply investment.

While challenges for the region are significant, the region does offer water planners a major strategic advantage: municipal water rights in the Amistad/Falcon system are interchangeable and, as such, can be traded to others with access to Amistad/Falcon Reservoir water. This fact affords an opportunity to produce new water supplies and either directly or indirectly share water throughout much of the region. One such method for indirect sharing could be through the production of desalinated seawater in the Port of Brownsville area, offsetting the need to use existing water rights by those who would receive direct delivery of that desalinated seawater, and trading unused water rights or leasing water to upstream users.

2.1.1 Local and Regional Municipal Water Authorities

As noted in **Section 1**, municipal needs represent a major growth area for regional water demands. Further, these growing demands occur throughout the region. Also as noted above, the regional delivery and management structure of the Amistad/Falcon system coupled with state water rights mechanisms make the direct and indirect regional delivery of water associated with a seawater desalination project a real possibility. Linking the concepts of local water demand and cost-effective delivery of supply is the focus of this section.

Over 60 entities received a letter from the Brownsville Public Utilities Board requesting support for the regional desalination project. Of these entities, many were subsequently contacted either in person or by telephone for follow-up conversations. At this time, forty-nine have indicated their support by either submitting a resolution from the governing body or a letter of support. **Appendix E** provides a copy of the letters of support and resolutions. **Table 2-1** identifies the list of entities contacted and the status.

Table 2-1 Local and Regional Municipal Water Authorities
Brownsville Demonstration Seawater Desalination Project

Entity	Letters of Support	Resolution	Date	Comment
1 . Brownsville EDC	X	X	05/19/2004	
2 . Cameron County		X	04/29/2004	
3 . Cameron County Irrig. Dist. #2	X		05/05/2004	
4 . City of Alamo	X	X	05/19/2004	
5 . City of Alton	X	X	05/04/2004	
6 . City of Brownsville		X	05/04/2004	
7 . City of Donna	X	X	05/04/2004	
8 . City of Eagle Pass	X		04/21/2004	
9 . City of Edinburg	X	X	05/07/2004	
10 . City of Elsa				6/7 Agenda
11 . City of Harlingen	X	X	05/11/2004	
12 . City of Hidalgo		X	05/11/2004	
13 . City of La Grulla		X	05/04/2004	
14 . City of La Joya		X	05/12/2004	
15 . City of La Villa				No response to date
16 . City of Laredo		X	07/06/2004	
17 . City of Los Fresnos		X	05/03/2004	
18 . City of Los Indios	X	X	05/07/2004	
19 . City of Lyford	X	X	05/10/2004	
20 . City of McAllen		X	04/26/2004	
21 . City of Mercedes				Tabled
22 . City of Mission				No response to date
23 . City of Palm Valley	X	X	05/19/2004	
24 . City of Palmview		X	05/18/2004	
25 . City of Penitas		X	05/05/2004	
26 . City of Pharr	X		05/13/2004	
27 . City of Port Isabel				No response to date
28 . City of Primera	X	X	05/27/2004	
29 . City of Progreso		X	04/29/2004	
30 . City of Raymondville				No response to date
31 . City of Rio Hondo		X	05/11/2004	
32 . City of Roma		X		
33 . City of San Benito				No response to date
34 City of San Juan		X	05/11/2004	
35 . City of Weslaco		X	05/04/2004	
36 . El Jardin Water Supply Corp.	X		05/05/2004	
37 . Harlingen Consolidated ISD	X		04/22/2004	

Table 2-1 Local and Regional Municipal Water Authorities
Brownsville Demonstration Seawater Desalination Project

Entity	Letters of Support	Resolution	Date	Comment
38 . Hidalgo County				No response to date
39 . Hidalgo M.U.D. # 1	X		05/13/2004	
40 . LRGDC	X	X	05/11/2004	
41 . Matamoros, Mexico				No response to date
42 . Maverick County	X	X	04/29/2004	
43 . McAllen EDC	X		04/27/2004	
44 . McAllen PUB		X	05/11/2004	
45 . McAllen ISD		X	05/13/2004	
46 . Military Highway Water Supply	X		04/26/2004	
47 . North Alamo Water Supply	X		05/03/2004	
48 . Olmito WSC	X	X	05/20/2004	
49 . Pharr-San Juan-Alamo ISD	X		04/27/2004	
50 . Port Mansfield	X		04/28/2004	
51 . Region M				6/17 Agenda
52 . Reynosa, Mexico				No response to date
53 . Rio Grande City		X	05/12/2004	
54 . San Benito Consolidated ISD	X	X	05/18/2004	
55 . San Benito Irrigation District				No response to date
56 . Sullivan City		X	04/27/2004	
57 . Town of Combes	X	X	05/11/2004	
58 Town of Indian Lake		X	05/11/2004	
59 Town of Laguna Vista		X	05/11/2004	
60 Town of S. Padre Island	X	X	05/19/2004	
61 Webb County				Other Alternatives
62 Willacy County		X	06/01/2004	
63 . Zapata County				6/14 Presentation

Following is a brief description of the major water providers contacted.

Cameron County

Major water providers in Cameron County include: Brownsville, Harlingen, San Benito, Port Isabel, and South Padre Island. These water providers were contacted, and several have supported the desalination project in concept. Harlingen, Port Isabel, and South Padre Island have major water supply needs for the future and could benefit from direct or indirect project water delivery (water rights or "wet" water being freed up from current users and sold or leased to them).

- **Brownsville** − The City of Brownsville has provided a resolution signed by the mayor in support of the project.

- **Harlingen** − The City of Harlingen has provided a resolution signed by the mayor in support of the project

- **Los Fresnos** − The City of Los Fresnos has provided a resolution signed by the mayor in support of the project.

- **Palm Valley** − The City of Palm Valley has provided a letter of support and resolution signed by the mayor in support of the project.

- **South Padre Island** − The Town of South Padre Island has provided resolution signed by the major in support of the project.

Hidalgo County

Major water providers in Hidalgo County include: McAllen, Mission, Edinburg, Weslaco, Pharr, San Juan, Donna, Mercedes, Alamo, Elsa, Alton and Hidalgo. These water providers were contacted, and most supported the desalination project in concept. Most have major water supply needs for the future and could benefit from direct or indirect project water delivery.

- **McAllen** − Roy Rodriguez, Utilities Manager, McAllen PUB, has provided a resolution signed by the Mayor in support of the project.

- **Mission** - Contacted the office of Isauro Trevino, City Manager and requested letter of support from the Mayor.

- **Edinburg** – Received a letter of support from Ricardo Rodriguez, Jr., Councilmember Place 4 and a resolution signed by the Mayor in support of the project.

- **Weslaco** – Mrs. Elizondo, City Secretary, was contacted and has provided a resolution signed by the Mayor in support of the project

- **Pharr** - Benito Lopez, City Manager was contacted and has provided a letter of support signed by the Mayor.

- **San Juan** - Jorge Arcaute, City Manager, was contacted and has provided a resolution signed by the Mayor in support of the project.

- **Donna** - Juan Ortiz, City Manager was contacted and has provided a letter of support and a resolution signed by the Mayor.

- **Mercedes** - Richard Garcia, City Manager was visited in his office. The item was placed in the agenda but City council tabled the item.

- **Alamo** - Luciano Ozuna, City Manager was contacted and has provided a resolution signed by the Mayor in support of the project.

- **Elsa** - Eddie Gonzalez, City Manager, was contacted and a resolution is to be placed on the council agenda for the second week in June.

- **Alton** – In response to the letter from Brownsville Public Utilities Board, the City of Alton provided a letter of support and a resolution signed by the Mayor.
- **Hidalgo** - Joe Vera, City Manager was contacted and has provided a resolution signed by the Mayor in support of the project.

Willacy County

Layla Patina, assistant to County Judge was contacted concerning this project. A resolution was to be placed on June 4, 2004 Commissioners Court agenda. Willacy County water users could benefit greatly from indirect project water delivery

Starr County

Major water providers in Starr County include: Roma/Los Saenz, La Grulla, and Rio Grande City. These three water providers were contacted, and each has supported the desalination project in concept. All three have major water supply needs for the future and could benefit from indirect project water.

- **Roma** − Chris Salinas, City Administrator, has provided a resolution signed by the city council in support of the project.

- **La Grulla** − Clarita Cardenas, City Secretary, indicated that a resolution has been passed by the city in support of the project and sent to Mr. Bruciak.

- **Rio Grande City** − Leo Olivares, City Administrator, has also been contacted and has provided a resolution of the city in support of the regional desalination project. [Note: check status with PUB staff.]

Zapata County

Zapata County has also gone on record supporting the desalination project. Ms. Laura Guerro with the County Judge's Office indicated support by the county for the project in a May 17, 2004 telephone conversation. A presentation was made to Zapata County Commissioner's Court on June 14, 2004. The Court was supportive and the Judge indicated that a resolution would be placed on the agenda at a future date. Zapata County water users could also benefit greatly from indirect project water delivery.

Webb County

The major water providers in Webb County are the City of Laredo and Webb County itself. The city has among the greatest future water demands in the region.

The project team has communicated with both organizations. Several discussions were held in April and May 2004 with Mayor Betty Flores, City Manager Larry Davilla, Utility Director Pablo Martinez, and Water Supply Planning Director Adrian Montemayor regarding the possibility of Laredo participating in the regional seawater desalination project. Meetings were thought provoking and in-depth but inconclusive. Laredo has a relationship with Corpus Christi, and they may not actively support the Lower Rio Grande project out of deference to their relationship with Corpus Christi. They view that option as a potential supply for the long term, if it is also linked to a San Antonio-supported pipeline for cost-effectiveness. Laredo's position is as follows:

- They desire a diversified resource that does not rely on the Rio Grande (directly or indirectly);
- They want to be partners in a project, not merely customers; and
- Once committed, they want to be in "to the end."

Webb County's position, as articulated in an April 15, 2004 conversation with Tomas Rodriguez, the County Engineer, is similar to Laredo's in that the county also desires to diversify its water supply away from the Rio Grande, pending further research on available options and cost. The county has in the past and is currently investigating groundwater supplies as a preferred alternative. Depending on the outcome of these evaluations, the county may at some future date consider trading for water supplies freed up by the creation of a new supply through desalination.

Maverick County

Eagle Pass is the major water provider in Maverick County. It is a high-growth area making considerable investment in water and wastewater infrastructure. The city has become the de facto regional utility provider for most of the county.

Discussions regarding the project have been held with the city's water utility director, Robert Gonzalez, on several occasions. The city has submitted a letter (resolution?) in support of the project (telephone conversation with Robert Gonzalez, Utility Director for Eagle Pass–April 15, 2004). Follow-up conversations were held in Eagle Pass on May 25-26 with Robert Gonzalez, Direct of Water Utilities and other interested parties.

Rio Grande Authority

As of the writing of this document, gubernatorial appointments have not been made, and the Authority is not yet up and running. However, initial conversations with individuals involved with the Authority's creation suggest that the authority could be a viable mechanism available to the region to support regional infrastructure associated with elements of the project (e.g., transmission line to deliver water to non-Public Utility Board (PUB) system customers, should such options be pursued).

Lower Rio Grande Development Council

The Development Council has also supported the project concept through resolution and facilitated the communication of project information letters to member communities throughout the region.

Valley Water Summit

A major water meeting was held in Harlingen on February 17, 2004. A number of project team members attended, and Brownsville PUB was a major sponsor.

Various water management strategies for the region were discussed and evaluated. Preferences were articulated and characterized. Among the strategies that were mentioned as priorities for regional water "solutions" was the desalination of seawater. This strategy was ranked high among the options evaluated by breakout groups that met throughout the day (personal observations by Craig Pedersen and Jeff Edmonds, URS representatives and meeting participants, February 17, 2004).

Regional Facilities Interconnections

The Texas Water Development Board (TWDB) financed a series of water supply interconnect projects in the Lower Rio Grande Region in response to concerns raised during the drought of the 1990s. The issue was that a number of communities' municipal water supplies were received through irrigation systems whose supply was uncertain under significant drought conditions. Physical interconnections with more reliable systems were financed by the state through the TWDB and constructed by local service providers. Many of these communities are in Cameron County or in nearby adjacent county locations that could theoretically be connected to a desalinated seawater plant in Brownsville. These communities represent a potential demand for project water.

Information regarding four interconnect projects was secured from the TWDB and reviewed for its potential to facilitate the transfer of project water. The TWDB-funded interconnections were mainly direct lines or canal linings to serve specific point-to-point water deliveries. These interconnects do not appear to present a realistic opportunity to more broadly deliver water regionally but could provide limited direct delivery of treated water, in some cases. Whether this would be cost-effective is questionable at this time, pending further analyses not included in our scope of work.

2.1.2 Water Supply Corporations and Private Utilities

There are numerous water supply corporations and private utilities within Region M. A few of them were among the suppliers that were contacted. They are generally included in the county totals in the Region M Water Plan. The County totals are very large water deficits, which indicate a significant number of small water systems and irrigation deficits, most dependent on the Rio Grande River for their water supply.

2.1.3 Bulk Wholesale Entities (Matamoros, Mexico)

The major community of Matamoros, Mexico, located directly across the Rio Grande River from Brownsville, has a need for additional water. Resolving the international water treaty and release issues will be needed if water is to be sold to Matamoros.

2.1.4 Summary of Water Supply Needs by Entity

The summary of water supply needs is shown in **Table 2-2.** This summary is taken from the Region M Water Plan. This summary shows that the initial regional municipal water deficits are less than 25 MGD but that by 2020 the municipal deficits will have exceeded 25 MGD and by 2030 the municipal deficits will exceed 100 MGD, with most of the increases coming in Hidalgo County.

TABLE 2-2 SUMMARY OF WATER SUPPLY NEED PER REGION M WATER PLAN										
	2010		2020		2030		2040		2050	
CITY	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD
Alamo	(629)	(0.56)	(824)	(0.74)	(1,137)	(1.02)	(1,297)	(1.16)	(1,524)	(1.36)
Alton										
Brownsville (Nueces-Rio Grande)	(5,065)	(4.52)	(8,945)	(7.99)	(15,104)	(13.49)	(17,162)	(15.32)	(19,611)	(17.51)
Brownsville (Rio Grande)	(11)	(0.01)	(16)	(0.01)	(23)	(0.02)	(26)	(0.02)	(30)	(0.03)
Combes	31	0.03	19	0.02	(4)	(0.00)	(2)	(0.00)	(17)	(0.02)
County Other-Cameron (Nueces-Rio Grande)	9,737	8.69	7,410	6.62	6,145	5.49	2,604	2.33	1,512	1.35
County Other-Cameron (Rio Grande)	(97)	(0.09)	(132)	(0.12)	(151)	(0.13)	(205)	(0.18)	(222)	(0.20)
County Other-Hildago (Nueces-Rio Grande)	6,593	5.89	(751)	(0.67)	(11,668)	(10.42)	(20,049)	(17.90)	(27,960)	(24.96)
County Other-Hildago (Rio Grande)	254	0.23	21	0.02	(308)	(0.28)	(537)	(0.48)	(736)	(0.66)
County Other-Jim Hogg (Nueces-Rio Grande)	214	0.19	199	0.18	187	0.17	181	0.16	171	0.15
County Other-Maverick (Nueces)	382	0.34	379	0.34	319	0.28	313	0.28	302	0.27
County Other-Maverick (Rio Grande)	(758)	(0.68)	(910)	(0.81)	(1,073)	(0.96)	(1,328)	(1.19)	(1,782)	(1.59)
County Other-Starr (Nueces-Rio Grande)	1,613	1.44	1,492	1.33	1,370	1.22	1,263	1.13	1,226	1.09
County Other-Starr (Rio Grande)	(2,497)	(2.23)	(3,681)	(3.29)	(4,871)	(4.35)	(5,911)	(5.28)	(6,273)	(5.60)
County Other-Webb (Nueces)	(6)	(0.01)	(88)	(0.08)	(202)	(0.18)	(227)	(0.20)	(384)	(0.34)
County Other-Webb (Nueces-Rio Grande)	457	0.41	259	0.23	(17)	(0.02)	(79)	(0.07)	(461)	(0.41)
County Other-Webb (Rio Grande)	(3,959)	(3.53)	(5,455)	(4.87)	(7,548)	(6.74)	(8,017)	(7.16)	(10,899)	(9.73)
County Other-Willacy (Nueces-Rio Grande)	(61)	(0.05)	(70)	(0.06)	(70)	(0.06)	(48)	(0.04)	(25)	(0.02)
County Other-Zapata (Rio Grande)	15	0.01	(237)	(0.21)	(680)	(0.61)	(1,309)	(1.17)	(2,320)	(2.07)
Donna	(997)	(0.89)	(1,840)	(1.64)	(3,032)	(2.71)	(4,090)	(3.65)	(5,353)	(4.78)
Eagle Pass	2,320	2.07	1,867	1.67	1,415	1.26	754	0.67	(40)	(0.04)
Edcouch	524	0.47	478	0.43	370	0.33	265	0.24	136	0.12
Edinburg	(2,658)	(2.37)	(4,230)	(3.78)	(6,499)	(5.80)	(8,529)	(7.62)	(10,987)	(9.81)
El Cenizo	221	0.20	173	0.15	97	0.09	108	0.10	119	0.11
Elsa	(98)	(0.09)	(225)	(0.20)	(475)	(0.42)	(731)	(0.65)	(1,032)	(0.92)
Harlingen	3,960	3.54	2,782	2.48	414	0.37	(324)	(0.29)	(1,223)	(1.09)
Hebronville	1,685	1.50	1,613	1.44	1,544	1.38	1,503	1.34	1,447	1.29
Hidalgo	539	0.48	303	0.27	(3)	(0.00)	(269)	(0.24)	(615)	(0.55)

TABLE 2-2 SUMMARY OF WATER SUPPLY NEED PER REGION M WATER PLAN										
	2010		2020		2030		2040		2050	
CITY	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD
La Feria	933	0.83	832	0.74	700	0.63	517	0.46	283	0.25
La Grulla	(511)	(0.46)	(831)	(0.74)	(1,377)	(1.23)	(1,654)	(1.48)	(1,986)	(1.77)
La Joya	(219)	(0.20)	(380)	(0.34)	(544)	(0.49)	(663)	(0.59)	(817)	(0.73)
La Villa	(26)	(0.02)	(117)	(0.10)	(241)	(0.22)	(350)	(0.31)	(462)	(0.41)
Laguna Vista	106	0.09	100	0.09	82	0.07	66	0.06	48	0.04
Laredo	(9,391)	(8.38)	(22,354)	(19.96)	(40,998)	(36.61)	(44,766)	(39.97)	(48,910)	(43.67)
Los Fresnos	(16)	(0.01)	10	0.01	(153)	(0.14)	(332)	(0.30)	(528)	(0.47)
Lyford	292	0.26	250	0.22	217	0.19	186	0.17	151	0.13
Mcallen	2,167	1.93	1,060	0.95	(1,965)	(1.75)	(6,742)	(6.02)	(12,701)	(11.34)
Mercedes	326	0.29	(37)	(0.03)	(619)	(0.55)	(1,162)	(1.04)	(1,817)	(1.62)
Mission	(2,438)	(2.18)	(6,490)	(5.79)	(9,908)	(8.85)	(12,804)	(11.43)	(16,331)	(14.58)
Palm Valley	23	0.02	(12)	(0.01)	(70)	(0.06)	(115)	(0.10)	(144)	(0.13)
Palmview	(310)	(0.28)	(404)	(0.36)	(550)	(0.49)	(679)	(0.61)	(844)	(0.75)
Pharr	576	0.51	(928)	(0.83)	(2,908)	(2.60)	(4,705)	(4.20)	(6,925)	(6.18)
Port Isabel	1,045	0.93	761	0.68	248	0.22	69	0.06	(129)	(0.12)
Primera	283	0.25	229	0.20	145	0.13	68	0.06	(27)	(0.02)
Progreso	(105)	(0.09)	(115)	(0.10)	(136)	(0.12)	(157)	(0.14)	(194)	(0.17)
Rancho Viejo	278	0.25	273	0.24	266	0.24	264	0.24	260	0.23
Raymondville	1,120	1.00	957	0.85	780	0.70	695	0.62	539	0.48
Rio Grande City	(974)	(0.87)	(2,038)	(1.82)	(3,862)	(3.45)	(4,806)	(4.29)	(5,891)	(5.26)
Rio Hondo	382	0.34	329	0.29	255	0.23	200	0.18	163	0.15
Roma-Los Saenz	584	0.52	(84)	(0.08)	(1,267)	(1.13)	(1,832)	(1.64)	(2,566)	(2.29)
San Benito	(407)	(0.36)	(841)	(0.75)	(1,789)	(1.60)	(2,078)	(1.86)	(2,436)	(2.18)
San Juan	(2,874)	(2.57)	(3,193)	(2.85)	(3,675)	(3.28)	(4,018)	(3.59)	(4,440)	(3.96)
San Perlita	(16)	(0.01)	(31)	(0.03)	(48)	(0.04)	(63)	(0.06)	(80)	(0.07)
Santa Rosa	430	0.38	344	0.31	338	0.30	330	0.29	298	0.27
Sebastian	122	0.11	120	0.11	113	0.10	107	0.10	105	0.09
South Padre Island	691	0.62	415	0.37	11	0.01	(297)	(0.27)	(653)	(0.58)

TABLE 2-2 SUMMARY OF WATER SUPPLY NEED PER REGION M WATER PLAN										
	2010		2020		2030		2040		2050	
CITY	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD
Steam Electric Power-Cameron	400	0.36	400	0.36	(9,200)	(8.21)	(9,200)	(8.21)	(9,200)	(8.21)
Steam Electric Power-Hidalgo	11,789	10.53	11,289	10.08	11,289	10.08	10,289	9.19	10,289	9.19
Steam Electric Power-Webb	(1,705)	(1.52)	(1,705)	(1.52)	(3,605)	(3.22)	(3,605)	(3.22)	(3,605)	(3.22)
Sullivan City	(618)	(0.55)	(645)	(0.58)	(688)	(0.61)	(739)	(0.66)	(804)	(0.72)
Weslaco	(92)	(0.08)	(1,308)	(1.17)	(3,014)	(2.69)	(4,563)	(4.07)	(6,406)	(5.72)
Zapata	(1,321)	(1.18)	(2,374)	(2.12)	(3,653)	(3.26)	(5,484)	(4.90)	(8,036)	(7.18)
Total For Region M	**12,233**	**10.92**	**(36,927)**	**(32.97)**	**(116,830)**	**(104.31)**	**(161,172)**	**(143.90)**	**(210,377)**	**(187.84)**

NEGATIVE NUMBERS INDICATE AN UNMET NEED, POSITIVE NUMBERS INDICATE A SURPLUS

According to the State Water Plan, Region M has a large water deficit, which grows larger every year. The Brownsville Desalination Project will make new water available to many communities by either direct delivery of water or by obtaining water rights from communities that take water and have water rights to lease or sell to offset their cost for the new water. One potential option for direct delivery and water trades is discussed below.

The service area for the Brownsville Desalination Project will grow as the plant is expanded over the next 40 years. This expansion of the service area is shown in **Figures 2-1, 2-2, 2-3** and **2-4,** which shows the communities that are potential direct water delivery recipients or potential water trade recipients.

As the Brownsville Desalination Plant is expanded, the direct delivery of new water could expand beyond the Brownsville PUB service into other areas in Cameron County and later into Hildalgo County.

The entire flow of water from Phase I of the Seawater Desalination Plant would be utilized in the PUB service area. The new water would replace most of the water currently taken from the Rio Grande River. This would allow the PUB to lease or sell some of its water rights to other entities that need additional water rights from the Rio Grande River. See **Table 2-3.** This would avoid the need for long transmission pipeline in Phase I. **Table 2-3** identifies the potential direct delivery and water trade entities for all four Phases.

The PUB would not need all of the water from Phase II capacity of the Desalination Plant. A transmission pipeline to Harlingen could deliver water to five additional communities that will need additional water in 2020. See **Table 2-3.** This will require a transmission pipeline as shown in **Figure 2-5. Figure 2-5** identifies the possible transmission pipeline for Phases II, III and IV.

The need for the construction of Phase III will be the water demands in Hildalgo County. A transmission pipeline to Pharr will deliver water to seven communities that will need additional water in 2030.

The need for the construction of Phase IV will be the water demands in McAllen. A transmission pipeline to McAllen will deliver water to that community which will need additional water in 2040.

The potential water trades made available from the desalination project and potential value of the water rights leased or sold are shown in **Table 2-4.** The values of these water rights are significant and could be applied to the cost of the seawater desalination project.

There are numerous communities that need additional water that are too far from Brownsville for an economical direct delivery of water. These entities are shown in **Table 2-5** and are potential purchasers of water rights that will be made available by the seawater desalination plant.

Table 2-3 Potential Desalination Direct Delivery Option Based on Region M Water Plan 2006 Water Demand Projections

	2010		2020		2030		2040		2050	
CITY	**AC-FT**	**MGD**	**AC-FT**	**MGD**	**AC-FT**	**MGD**	**AC-FT**	**MGD**	**AC-FT**	**MGD**
Brownsville System - PHASE I	**43,655**	**38.98**	**52,038**	**46.46**	**60,475**	**54.00**	**62,270**	**55.60**	**77,985**	**69.63**
Less Brackish DESAL	6,720	6.00	10,080	9.00	10,080	9.00	10,080	9.00	10,080	9.00
Brownsville Net Demand	**36,935**	**32.98**	**41,958**	**37.46**	**50,395**	**45.00**	**52,190**	**46.60**	**67,905**	**60.63**
Pipeline to Harlingen - Phase II										
Los Fresnos			1,008	0.90	1,247	1.11	1,490	1.33	1,745	1.56
Rio Hondo			428	0.38	453	0.40	475	0.42	503	0.45
Harlingen			12,780	11.41	14,175	12.66	15,604	13.93	17,109	15.28
Total			**14,216**	**12.69**	**15,875**	**14.17**	**17,569**	**15.69**	**19,357**	**17.28**
Pipeline to Pharr - Phase III										
Palm Valley					468	0.42	494	0.44	525	0.47
Weslaco					6,966	6.22	7,819	6.98	8,792	7.85
Donna					2,842	2.54	3,156	2.82	3,521	3.14
Alamo					3,808	3.40	4,675	4.17	5,667	5.06
San Juan					5,956	5.32	7,384	6.59	9,031	8.06
Pharr					12,511	11.17	14,887	13.29	17,448	15.58
Total					**32,551**	**29.06**	**38,415**	**34.30**	**44,984**	**40.16**
Pipeline to McAllen - Phase IV										
McAllen							45,267	40.42	52,032	46.46
Total							**45,267**	**40.42**	**52,032**	**46.46**
Total Desalination Demand	**36,935**	**32.98**	**56,174**	**50.16**	**98,821**	**88.23**	**153,441**	**137.00**	**184,278**	**164.53**
Plant Capacity	**28,000**	**25.00**	**56,000**	**50.00**	**84,000**	**75.00**	**112,000**	**100.00**	**112,000**	**100.00**
Less Power Plant Make-Up Water	2,240	2.00	2,240	2.00	2,240	2.00	2,240	2.00	2,240	2.00
Net Plant Capacity	**25,760**	**23.00**	**53,760**	**48.00**	**81,760**	**73.00**	**109,760**	**98.00**	**109,760**	**98.00**

Table 2-4 Potential Water Trades Made Available From Desalination Direct Delivery Option Base on 2001 Region M Water Plan - Supply Availability Analysis

	2010		2020		2030		2040		2050	
CITY	**AC-FT**	**MGD**	**AC-FT**	**MGD**	**AC-FT**	**MGD**	**AC-FT**	**MGD**	**AC-FT**	**MGD**
Brownsville System - PHASE I	**28,000**	**25.00**	**28,000**	**25.00**	**28,000**	**25.00**	**28,000**	**25.00**	**28,000**	**25.00**
Less Resaca Rights	4,223	3.77	4,223	3.77	4,223	3.77	4,223	3.77	4,223	3.77
Brownsville Net Transfer	**23,777**	**21.23**	**23,777**	**21.23**	**23,777**	**21.23**	**23,777**	**21.23**	**23,777**	**21.23**
Pipeline to Harlingen - Phase II										
Los Fresnos			850	0.76	850	0.76	850	0.76	850	0.76
Rio Hondo			890	0.79	890	0.79	890	0.79	890	0.79
Harlingen			18,385	16.42	18,385	16.42	18,385	16.42	18,385	16.42
Total			**20,125**	**17.97**	**20,125**	**17.97**	**20,125**	**17.97**	**20,125**	**17.97**
Pipeline to Pharr - Phase III										
Palm Valley					406	0.36	406	0.36	406	0.36
Weslaco					7,976	7.12	7,976	7.12	7,976	7.12
Donna					4,190	3.74	4,190	3.74	4,190	3.74
Alamo					1,203	1.07	1,203	1.07	1,203	1.07
San Juan					2,346	2.09	2,346	2.09	2,346	2.09
Pharr					7,341	6.55	7,341	6.55	7,341	6.55
Total					**23,462**	**20.95**	**23,462**	**20.95**	**23,462**	**20.95**
Pipeline to McAllen - Phase IV										
McAllen							33,549	29.95	33,549	29.95
Total							**33,549**	**29.95**	**33,549**	**29.95**
Potential Total Water Trades Available	**23,777**	**21.23**	**20,125**	**39.20**	**23,462**	**60.15**	**33,549**	**90.10**	**23,777**	**90.10**
Less Unmet Desal Need	11,175	9.98	2,414	2.16	17,061	15.23	43,681	39.00	74,518	66.53
Water Trades Available Less Desalination Water	**12,602**	**11.25**	**17,711**	**15.81**	**6,401**	**5.72**	**-10,132**	**-9.05**	**-50,741**	**-45.30**
Less Previously Traded Water			12,602	11.25	17,711	15.81	17,711	15.81	17,711	15.81
Net Water Trades Available	**12,602**	**11.25**	**5,109**	**4.56**	**-11,310**	**-10.10**	**-27,843**	**-24.86**	**-68,452**	**-61.12**
Potential Value	**$25,204,000**		**$10,218,000**							

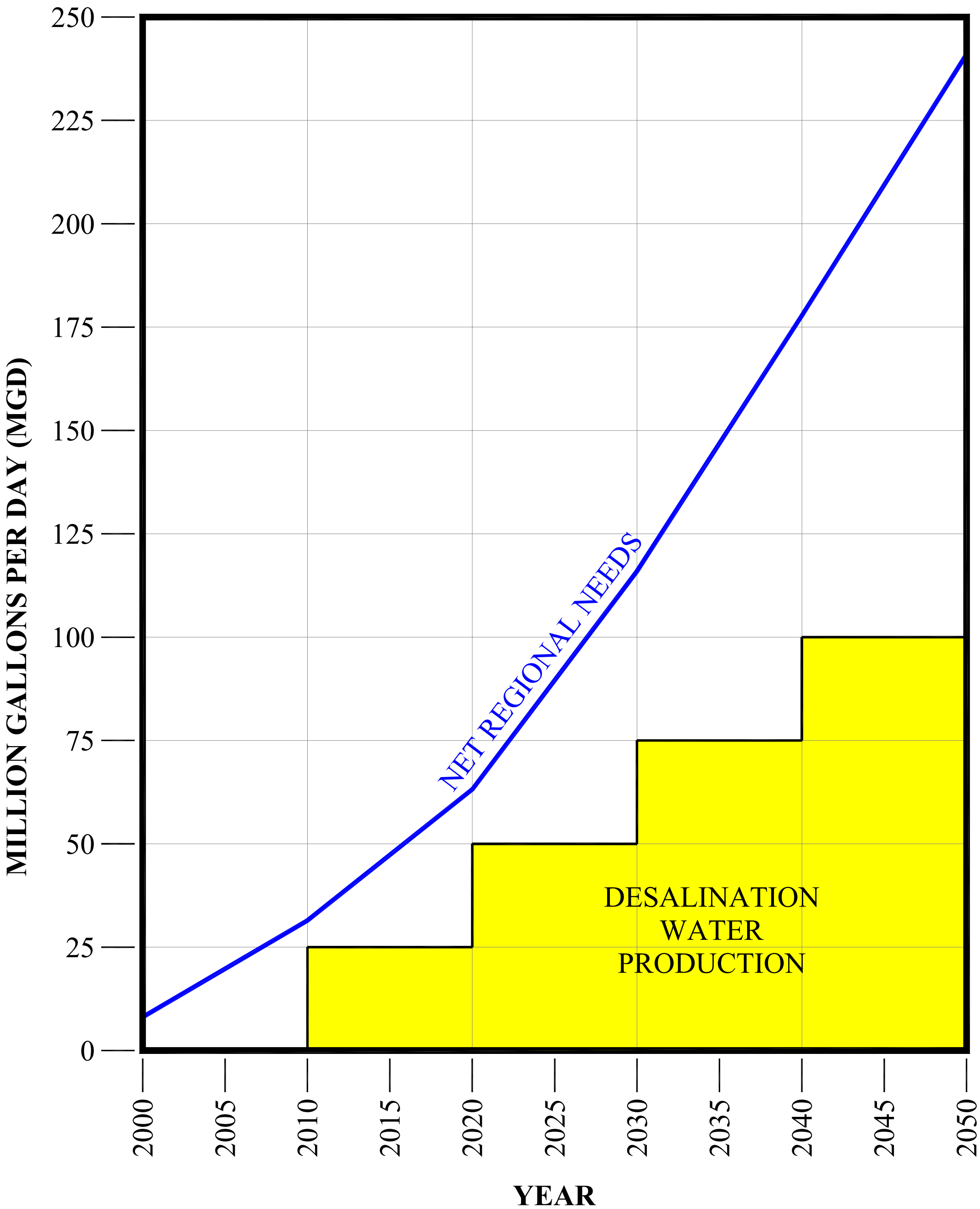
Trades Could be Direct Sale or Lease of Water Rights

Table 2-5 Potential Water Trade Recipients from Desalination Direct Delivery Option
Based on 2001 Region M Water Source Supply & 2006 Water Demand Projections

POTENTIAL TRADE RECIPIENTS	2000		2010		2020		2030		2040		2050	
	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD
Alamo			-666	-0.59	-1,369	-1.22	-2,155	-1.92	-3,022	-2.70	-4,014	-3.58
Alton			-2,116	-1.89	-2,807	-2.51	3,556	3.18	-4,443	-3.97	-5,375	-4.80
Brownsville	-2,412	-2.15	-15,227	-13.60	-23,610	-21.08	-32,047	-28.61	-40,842	-36.47	-49,557	-44.25
Combes							-26	-0.02	-51	-0.05	-79	-0.07
County Other - Cameron									-1,873	-1.67	-5,387	-4.81
County Other - Hildago							-7,759	-6.93	-18,098	-16.16	-29,803	-26.61
County Other - Maverick	-259	-0.23	-1,048	-0.94	-1,884	-1.68	-2,665	-2.38	-3,359	-3.00	-3,976	-3.55
County Other - Willacy							-97	-0.09	187	0.17	-46	-0.04
County Other - Zapata	-91	-0.08	-322	-0.29	-604	-0.54	-882	-0.79	-1,138	-1.02	-1,383	-1.23
Edinburg			-293	-0.26	-2,447	-2.18	-4,986	-4.45	-7,547	-6.74	-10,602	-9.47
Harlingen											-258	-0.23
Hidalgo							-153	-0.14	-610	-0.54	-1,135	-1.01
La Grulla	-176	-0.16	-172	-0.15	-168	-0.15	-164	-0.15	-160	-0.14	-157	-0.14
Laguna Vista							-48	-0.04	-110	-0.10	-169	-0.15
La Joya											-31	-0.03
Laredo	-4,015	-3.58	-7,894	-7.05	-21,459	-19.16	-36,975	-33.01	-54,273	-48.46	-73,023	-65.20
Los Fresnos					-158	-0.14	-397	-0.35	-640	-0.57	-895	-0.80
McAllen					-2	0.00	-5,677	-5.07	-11,718	-10.46	-18,483	-16.50
Palm Valley			-7	-0.01	-34	-0.03	-62	-0.06	-88	-0.08	-119	-0.11
Palmview	-276	-0.25	-556	-0.50	-886	-0.79	-1,257	-1.12	-1,654	-1.48	-2,101	-1.88
Pharr					-1,839	-1.64	-3,980	-3.55	-6,356	-5.68	-8,917	-7.96
Primera									-21	-0.02	-128	-0.11
Progresso	-189	-0.17	-309	-0.28	-450	-0.40	-600	-0.54	-770	-0.69	-967	-0.86
Rio Grande City			-107	-0.10	-238	-0.21	-489	-0.44	-673	-0.60	-885	-0.79
Roma					-211	-0.19	-555	-0.50	-909	-0.81	-1,270	-1.13
San Juan	-151	-0.13	-1,155	-1.03	-2,319	-2.07	-3,610	-3.22	-5,038	-4.50	-6,685	-5.97
South Padre Island					-137	-0.12	-790	-0.71	-1,444	-1.29	-2,096	-1.87
Steam Electric Power - Cameron Co. [a]							-9,200	-8.21	-9,200	-8.21	-9,200	-8.21
Sullivan City	-390	-0.35	-513	-0.46	-659	-0.59	-832	-0.74	-1,003	-0.90	-1,213	-1.08
Weslaco											-816	-0.73
Subtotal	-7,959	-7.11	-30,385	-27.13	-61,281	-54.72	-111,850	-99.87	-174,853	-156.12	-238,770	-213.19

Table 2-5 Potential Water Trade Recipients from Desalination Direct Delivery Option												
Based on 2001 Region M Water Source Supply & 2006 Water Demand Projections												
POTENTIAL TRADE RECIPIENTS	**2000**		**2010**		**2020**		**2030**		**2040**		**2050**	
	AC-FT	**MGD**	**AC-FT**	**MGD**	**AC-FT**	**MGD**	**AC-FT**	**MGD**	**AC-FT**	**MGD**	**AC-FT**	**MGD**
Other Communities with Deficits												
County Other - Starr	-1,094	-0.98	-2,589	-2.31	-4,164	-3.72	-5,790	-5.17	-7,453	-6.65	-9,081	-8.11
El Cenizo			-164	-0.15	-461	-0.41	-795	-0.71	-1,157	-1.03	-1,567	-1.40
Mission					-2,275	-2.03	-5,305	-4.74	-8,503	-7.59	-12,240	-10.93
Rancho Viejo					-16	-0.01	-147	-0.13	-275	-0.25	-408	-0.36
San Benito							-550	-0.49	-1,130	-1.01	-1,741	-1.55
Sebastian							-33	-0.03	-62	-0.06	-82	-0.07
Steam Electric Power - Webb Co.			-1,705	-1.52	-1,705	-1.52	-3,605	-3.22	-3,605	-3.22	-3,605	-3.22
			-407	-0.36	-841	-0.75	-1,789	-1.60	-2,078	-1.86	-2,436	-2.18
Subtotal	-1,094	-0.98	-4,865	-4.34	-9,462	-8.45	-18,014	-16.08	-24,263	-21.66	-31,160	-27.82
Total Potential Trades	**-9,053**	**-8.08**	**-35,250**	**-31.47**	**-70,743**	**-63.16**	**-129,864**	**-115.95**	**-199,116**	**-177.78**	**-269,930**	**-241.01**
Potential Water Trades Available from Direct Delivery Option			**12,602**	**11.25**	**5,109**	**4.56**	**-11,310**	**-10.10**	**-27,843**	**-24.86**	**-68,452**	**-61.12**
Net Need with Seawater Desalination	**-9,053**	**-8.08**	**-22,648**	**-20.22**	**-65,634**	**-58.60**	**-141,174**	**-126.05**	**-226,959**	**-202.64**	**-338,382**	**-302.13**

The following chart depicts the deficits from Region M Municipal and Steam Electric Power water users as identified in **Table 2-5**. As can be seen from this chart, seawater desalination would make a significant contribution to reducing the overall deficit for water users.



Note: Net Regional Needs are the Sum of Municipal and Steam Electric Power Water User Deficits from the Region M Water Plan.

2.2 POTENTIAL SERVICE BOUNDARIES AND OWNERSHIP AUTHORITY

Potential service boundaries are directly linked to the locations of those entities in need of water and the cost of providing that water service. Ownership authority should follow service delivery and service area boundary considerations for maximum effectiveness and conceptual simplicity.

Service could be provided in one of three ways:

1. Direct delivery into the existing Brownsville PUB system;

2. Delivery through a newly constructed pipeline directly from the PUB system to one or more users; or

3. "Indirect delivery" of water through the Rio Grande (Amistad/Falcon system) from unused water rights freed up through direct delivery of desalinated seawater from the project.

The first and third options described above would lend themselves to the existing Brownsville PUB system configuration (though a new water authority organization of the system could be created if that were the desire of the project owners). This would appear to be the simplest and most straightforward manner in which to manage the legal and physical infrastructure issues associated with water delivery under these scenarios. For Phase I existing ownership authority by PUB makes the most sense for direct delivery though the PUB system since that is the status quo. Sale or lease of water rights or water supplies could be handled as direct seller to buyer exchanges and would not require additional ownership authority considerations.

For Phase II, III, and IV construction and development of a new conveyance facility and associated appurtenances (pump stations, storage tanks, etc.) could lead to a variety of service and ownership issues. Service "boundaries" per se, would not necessarily have to be negotiated under this scenario. Ownership considerations, however, could be highly variable. A wide range of feasible options exists, and models for these can be found among water suppliers around the state. Service could be extended from Brownsville PUB through a pipeline it owned and operated. A buyer or group of buyers could form a regional delivery entity through a shared ownership interest (either with or without PUB). Another option is to contract through a separate entity, like the Rio Grande Authority, which could issue project debt, own the project, and operate it. A variety of ownership models for the pipeline are feasible. Any final decision could be as much driven by the preferences of working relationships; considerations of which entity would hold the debt; or other similar factors not directly related to the physical delivery of water.

3.0 ALTERNATIVES ANALYSES

The Brownsville Desalination Demonstration Project must include various unit treatment operations and processes to efficiently and cost-effectively convert seawater into potable water, satisfying all requisite local, state, and federal regulations. An evaluation of potential water treatment strategies and an analysis of viable alternatives is required. The following section provides a detailed, preliminary evaluation of viable alternative technologies that were considered.

Alternatives analyses were conducted for the most significant unit treatment operations and processes for which various competing technologies exist. To assess treatment reliability and costs, an initial screening and subsequent analysis of viable alternatives were conducted to ensure that an appropriate and cost-effective solution is selected. During the initial screening process, potential treatment technologies and various configurations of technologies were inventoried and considered for this project. **Appendix C** contains a complete summary of the initial screening of alternatives and includes an inventory of the alternatives that were eliminated from further consideration. Many of the alternatives considered during the initial screening process were eliminated if they were not suitable from a treatment efficiency, technical applicability, or cost-effective perspective.

Viable alternatives retained from the initial screening process were considered in further detail through a formal alternatives analysis. This section presents the analysis that was used to develop a conceptual configuration for the Desalination Facility. **Table 3-1** summarizes alternatives that were retained from the initial screening for further analysis.

The methodology for analyzing desalination alternatives as described in **Section 1.3.3** was followed. Each of the alternatives evaluated was briefly described; its advantages and disadvantages listed; the capital and annual operation and maintenance (O&M) costs estimated; the present worth of the alternative estimated; and the alternative compared with other viable alternatives though the use of a weighted scoring system. Finally, using the results of the scoring system, an alternative was recommended for the Desalination Facility.

Table 3-1. Summary of Alternatives Evaluated for Brownsville Desalination Demonstration Project

System Description	Alternatives Evaluated
Raw Water Supply Sources	Brownsville Ship Channel Gulf of Mexico Brackish Groundwater Supplies
Seawater Intake Screening	T-Shaped Water Intake Screens Engineered Aquatic Filter Barrier System
Pretreatment System	Two-Stage Dual-Media Filtration System Ballasted Flocculation/Clarification (BFC) with Single-Stage Dual-Media Filtration Submerged Ultrafiltration Membrane System Steam-Powered Feedwater Heater
Primary Treatment System	Membrane Types and Configurations Thermal Solutions

Table 3-1. Summary of Alternatives Evaluated for Brownsville Desalination Demonstration Project (Continued)

System Description	Alternatives Evaluated
Energy Recovery System	Positive Displacement Work Exchanger Pelton Wheel Turbine
Stabilization System	Pebble Lime Calcite Filters
Disinfection System	Gas Chlorine On-Site Sodium Hypochlorite Generation Commercial Bleach
Solids Dewatering System	Belt Filter Presses Centrifuges Solids Drying Beds Steam-Powered Sludge Drying System

For the initial economic analysis of the alternatives, the following assumptions, conditions, and qualifications apply:

- Cost data in the form of budgetary quotes for major equipment components and systems were obtained from vendors. Current unit construction cost data was compiled to estimate other costs such as site development, pipelines, structures, and other supporting infrastructure.

- Installation, electrical, and instrumentation costs were estimated as a relative percentage of the equipment cost based on the complexity of each system.

- Annual O&M costs were estimated based on labor, power, maintenance, and replacement costs and subsequently amortized over a 20-year life at an annual interest rate of 7.5% to yield the present worth. The present worth of the annual O&M expenses was then added to the capital cost estimated for the alternative to yield a complete present worth value for that alternative. This value was used to assess the cost-effectiveness of each alternative compared to one another.

- The economic factors and assumptions used for the initial alternative analyses may differ from the final factors used in **Section 7** (Preliminary Cost Estimates) for the complete cost estimate prepared for the full, conceptual configuration of the Desalination Facility. Any differences between the economic factors used in this section and those in **Section 7** are a result of developing a complete conceptual level evaluation and subsequent reporting within a relatively short time frame. However, since all alternatives are compared on a consistent economic basis using identical cost factors, the results of the initial economic screening are normalized and, as such, are valid for the purposes of proper comparison to the other alternatives under consideration.

3.1 ALTERNATIVE WATER SUPPLY SOURCES

One of the most important factors in designing a desalination facility is the availability of accurate data for the source water quality as well as the quantity of water available throughout the anticipated life of the project. For this project, three water supply sources were considered: the Brownsville Ship Channel, the Gulf of Mexico, and local aquifers containing brackish groundwater. Following is a detailed alternative analysis of these sources.

3.1.1 Brownsville Ship Channel

The Brownsville Ship Channel is a 17-mile long, man-made channel that is connected to the Gulf of Mexico. The width of the channel averages approximately 1,200 feet. The deepest portion of the channel is approximately 45 feet and slopes upward to meet the existing banks on either side of the channel. **Figure 3-1** illustrates a vicinity map for the Brownsville Ship Channel. The Brownsville Port Authority plans to deepen the central portion of the channel from 45 to 57 feet in the near future. The channel is not directly fed by any constant freshwater source (e.g., river, stream). However, storm water runoff from the land directly adjacent to the channel can contribute a certain amount of water during storm events, depending on the duration and intensity of the events. During and immediately after significant rain events, a substantial quantity of storm water runoff into the channel may result in significant dilution of seawater within the channel. Conversely, during relatively dry periods, the salinity level within the channel may become elevated.

Water quality data for the Brownsville Ship Channel was obtained from the Texas Commission on Environmental Quality's (TCEQ) website database. Data was available from January 13, 1993 to September 25, 2003 and was downloaded directly from the database. The data was subsequently reduced, and the water quality constituents were summarized. Additional water quality data was obtained and/or confirmed from recent testing conducted by the Brownsville Public Utility Board (PUB) Analytical Laboratory in support of this feasibility study. The following water quality parameters were obtained:

- Temperature and pH;
- Conductivity;
- Turbidity;
- Total Alkalinity;
- Total Hardness;
- Chlorides;
- Total Suspended Solids (TSS);
- Total Dissolved Solids (TDS);
- Calcium; and
- Total Organic Carbon (TOC).

In addition, a series of water samples were recently collected from the Ship Channel and forwarded to a United States Environmental Protection Agency (USEPA) certified laboratory (Severn Trent Laboratories, Inc.) for analytical testing. This sampling effort was conducted to confirm some of the more important and critical water quality parameters for which historical data were available as well as to obtain supplemental data for other parameters for which no historical data were found. Water samples were collected and analyzed for the following supplemental water quality parameters:

- Boron;
- Iron;
- Manganese ;
- Potassium;
- Sodium; and
- Bromide.

The combined results for the Brownsville Ship Channel water quality are summarized in **Table 3-2**. The average, minimum, and maximum columns represent a summary of the data from the TCEQ, whereas the supplemental column contains data obtained from the Brownsville PUB Analytical Laboratory and/or Severn Trent Laboratories, as indicated.

Table 3-2. Summary of Raw Water Quality Data for the Brownsville Ship Channel

Parameter	Average	Minimum	Maximum	Supplemental
pH (SU)	8.1	7.3	11.0	8.17 [a]
Conductivity (uS/cm)	50,255	26,760	60,000	35,800 [a]
Temperature (^oC)	23.9	7.9	31.1	21.6 [a]
Barium (mg/L)	0.062	0.023	0.100	-
Boron (mg/L)	-	-	-	4.1 [b]
Bromide (mg/L)		-	-	46.0 [b]
Calcium (mg/L)	390	390	390	337 [a]
Total Hardness (as $CaCO_3$)	-	-	-	2,462 [a]
Iron (mg/L)	0.109	0.003	0.215	0.19 [b]
Magnesium (mg/L)	1,310	1,310	1,310	
Manganese (mg/L)	0.025	0.001	0.049	BDL [b]
Potassium (mg/L)	-	-	-	350 [b]
Total Alkalinity (mg/L)	126	100	147	121 [a]
Chlorides (mg/L)	18,684	9,100	29,000	15,140 [a]
Fluoride (mg/L)	1.10	0.69	1.66	-
Nitrate –N (mg/L)	0.33	0.01	0.75	-
o-Phosphate (mg/L)	0.04	0.06	1.5	-
Sulfate (mg/L)	2,564	252	3,420	-
TOC (mg/L)	1.1	1.0	2.0	3.4 [a]
TDS (mg/L)	36,122	11,700	49,000	27,890 [a]
Turbidity (NTU)	-	-	-	4.76 [a]
Sodium (mg/L)	-	-	-	8,800 [b]
Salinity (ppt)	32.1	16.3	40.2	-
TSS (mg/L)	35.6	6.0	153.0	7.9 [a]
Dissolved Oxygen (mg/L)	6.6	1.3	11.4	-
Fecal Coliform (#/100 mL)	25	1	780	-

[a] *Data obtained from Brownsville PUB Analytical Laboratory on March 26, 2004.*
[b] *Data obtained from Severn Trent Analytical Labs, Inc. on April 14, 2004.*
SU = Standard Unit *mg/L =milligrams per Liter*
NTU = Nephelometric Turbidity Unit *ppt = parts per thousand*
uS/cm = microSiemen/centimeter *°C = degrees Centigrade*
mL = milliliter

The results from the data summary indicate that the water quality of the Ship Channel is, on average, very similar to "typical" seawater, with the exception of elevated suspended solids from time to time. The TSS in the Ship Channel is approximately 36 mg/L and has been as high as 153 mg/L. A review of the historical data from the TCEQ indicates that the Ship Channel is affected by tropical storm events that increase the amount of suspended solids in the channel for periods of up to two days. Although the solids content in the Ship Channel is higher than "typical" seawater, a relatively robust seawater reverse osmosis (SWRO) pretreatment system will be incorporated into the desalination facility's design to allow for a high-quality SWRO feedwater stream containing minimal solids.

Similar to the wide variations in suspended solids within the Ship Channel, a relatively wide range of TDS within the Ship Channel was revealed by a review of the data. Further examination of the data indicates that the TDS content ranges from approximately 11,700 parts per million (ppm) to 49,000 ppm, with an arithmetic average of approximately 36,100 ppm. Since the lowest and highest recorded TDS values occurred on dates when at least three data points were relatively close to the average TDS of 36,100 ppm, the extremely low and high TDS values from the data set were eliminated. With these outliers removed, the resulting TDS concentrations range from 29,400 ppm to 41,400 ppm. Since the Ship Channel experiences minimal tidal flushing, the lower TDS concentrations may be caused by extreme rainfall/storm water runoff events. The higher TDS range may be a result of extended dry periods and/or natural evaporation effects that may occur within the Ship Channel.

A formal and complete hydraulic analysis and associated environmental impact study for the Ship Channel as a result of the withdrawal of seawater for the desalination plant has not been conducted to date. A complete analysis to fully address these important considerations would need to be performed to support the development of a formal Environmental Impact Statement (EIS) for the project. However, to address potential water withdrawal capacity requirements associated with this project, the following quantitative and qualitative aspects are outlined for further consideration to support the possible selection of this alternative:

- The initial finished water production capacity of the desalination plant will be 25 million gallons per day (MGD), while the potential build-out capacity may reach 100 MGD. Assuming a conservative recovery factor of 50% for seawater membrane systems, the potential withdrawal rate for the initial plant capacity could be as high as 50 MGD. For the build-out capacity using the same recovery factor, up to 200 MGD may be required. Using an average cross-sectional area of the Brownsville Ship Channel of approximately 18,000 square feet (ft^2), the velocity associated with the withdrawal of 200 MGD would be approximately 0.017 foot per second (FPS). The impact of normal tidal fluctuations within the Ship Channel would be considerably larger than the withdrawal of the water for the desalination facility. Thus, from a capacity perspective, the Ship Channel has more than sufficient capacity to support the desalination plant up to and exceeding its potential build-out capacity.

- While all potential impacts to the local marine environment cannot be confirmed at this time, the case could be made that the quantity of water extracted from the Ship Channel would have a minimal adverse affect on ecosystems within the Ship Channel. The approach channel that would be used to collect seawater can be configured to limit the approach velocity within it, thereby minimizing impacts to existing marine species in the area. The configuration, sizing, and selection of components that will be explored for the seawater screening system should adequately protect fish, larvae, and other species by minimizing mortality caused by impingement and entrainment. Since the Ship Channel can be prone to the development of stagnant water during low flow/tidal periods, the extraction of seawater from the channel may actually improve water quality by inducing additional flow within the channel and in turn potentially enhance local ecosystems.

An initial economic analysis was conducted to evaluate costs associated with developing a seawater intake system within the Brownsville Ship Channel. The seawater intake would be located on the site selected for the desalination facility and directly along or adjacent to the existing northern bank of the Ship Channel. This location would minimize, to the degree practical, infrastructure costs associated with the intake system, while improving overall control and security of the intake system. The following important considerations were taken into account when estimating the potential capital and annual O&M costs associated with this water intake alternative:

- A dedicated set of collection channels within the Ship Channel would be needed to reduce and limit the approach velocity of water into the intake structure to minimize the collection of solids and marine aquatic life. At least two intakes are recommended for purposes of reliability and redundancy.

- Sufficient provisions must be made to protect the project's intake system from large and small floating debris as well as to safeguard it against the collection of and/or exposure to oils or other petroleum products, which could be present due to local shipping traffic within the channel. A proper barrier system to address this critical issue should be provided.

- Proper screening of seawater should be provided to meet the requirements of Section 316(b) of the Clean Water Act (CWA). The screening system must be suitable for seawater environments (i.e., non-corrosive); properly sized to collect the potential quantity of water required for the project; and capable of being easily cleaned to maintain proper water supply to the project. The screening components should be properly protected from potential damage by minimizing their exposure to the open environment.

Preliminary sizes and configurations for the seawater intake system to meet these primary considerations were developed to serve as a basis for the costs estimated for this water supply alternative. **Table 3-3** presents the estimated capital and annual O&M cost for the Brownsville Ship Channel water supply alternative.

Table 3-3. Estimated Capital and Annual O&M Costs for the Brownsville Ship Channel Water Supply Alternative

Estimated Capital Costs	
Item Description	**Capital Cost**
Construction of Collection Channel	$1,000,000
Seawall along Side Inlets	$1,000,000
Construction of Protective Barrier System	$250,000

Table 3-3. Estimated Capital and Annual O&M Costs for the Brownsville Ship Channel Water Supply Alternative	
Estimated Capital Costs	
Item Description	**Capital Cost**
Water Intake Screening	$350,000
Allocation for Environmental Mitigation	$500,000
Subtotal	$3,100,000
Contingency @ 25%	$775,000
Total Capital Cost	**$3,875,000**
Estimated Annual O&M Costs	
Annual Inspection and Manual Cleaning Events for Intake Screens	$5,000
Maintenance Dredging of Collection Channel (Annualized Cost)	$30,000
Replacement of Intake Screens (Annualized Cost)	$25,000
Total O&M Costs	**$60,000**

Table 3-4 illustrates some of the main advantages and disadvantages associated with the use of the Brownsville Ship Channel as a seawater supply source.

Table 3-4. Advantages and Disadvantages of Brownsville Ship Channel for the Seawater Supply Source

Advantages	Disadvantages
▪ Sufficient hydraulic capacity to support both the initial and build-out finished water production capacity of the project. ▪ Directly adjacent to project site with a relatively low capital cost to construct intake system (i.e., eliminate the need for raw water transmission system). ▪ Relatively low maintenance requirements and minimal associated maintenance costs. ▪ Security of source water supply enhanced by being adjacent to project site rather than located at a remote site. ▪ Easy maintenance for intake devices.	▪ High potential TSS concentrations from time to time, requiring a robust SWRO pretreatment system. ▪ Relatively high variability in TSS and TDS concentrations, which may require periodic adjustments to the desalination facility's operating and/or recovery factors. ▪ Channel dredging occurs every two to three years; facility may need to reduce finished water capacity while dredging occurs in vicinity of proposed desalination site.

3.1.2 Gulf of Mexico

The option of using the Gulf of Mexico as a seawater supply source was explored since the Gulf contains a virtually unlimited supply of seawater for potential use as a drinking water source. It is important to note that the proposed Brownsville Desalination Demonstration Project site is located approximately 11 miles inland from the Gulf as measured along the Brownsville Ship Channel. The use of the Gulf as a seawater supply requires the installation of a relatively large-diameter (54-inch) pipeline that would need to be routed through several environmentally sensitive areas before reaching the Gulf. Since the plant may need to be hydraulically expanded to greater capacities in the future, a larger utility corridor would be needed for the installation of additional raw water supply mains, thereby increasing land acquisition and set-back requirements.

While the quality of the water supply would be, on average, slightly better and perhaps more consistent than the water supply available in the Brownsville Ship Channel, the costs and permitting issues associated with the use of the Gulf as a supply source would be significant. Moreover, if constructed, the intake structure within the Gulf would be more exposed to the natural environment and would be more vulnerable. The intake system would likely require frequent maintenance to remove accumulated marine growth, debris, and/or sand from the inlet pipes.

An initial capital cost estimate was developed for the construction of an intake structure within the Gulf and the associated transmission main. The following important considerations were taken into account when estimating the potential capital and annual O&M costs associated with this water intake alternative:

- A set of dedicated seawater intake structures would be needed to properly collect the quantity of seawater required for the project, while reducing and limiting the approach velocity of water to minimize the collection of solids and marine aquatic life. At least two separate structures would be recommended for purposes of redundancy and because this critical project component would be remotely located and more exposed to the environment and potential damage when compared with an intake located directly at the plant site.

- Proper screening of seawater is required by Section 316(b) of the CWA. The screening system must be suitable for seawater environments (i.e., non-corrosive); properly sized to collect the potential quantity of water required for the project; and capable of being easily cleaned to maintain proper water supply to the project. The screening components should be properly protected from damage by minimizing their exposure to the open environment.

- A pipeline of sufficient capacity would need to be installed from the intake structures to the plant site, which is approximately 12 miles in length, assuming the intake structures are sited 1 mile offshore in the Gulf. It is estimated that the pipeline would be 54 inches in diameter to provide a sufficient quantity of water for the initial plant capacity of 25 MGD.

- A suitable point of collection for seawater that is transferred to the site by the pipeline would be needed. A reinforced wet well structure of suitable diameter and depth is assumed for this component.

For purposes of reference, the following provides a summary of “typical” seawater quality that would be anticipated for a Gulf intake. It should be noted that the relative quality of seawater obtained directly from the Gulf should be more consistent than that obtained from the Brownsville Ship Channel, since the water quality within the Ship Channel can experience both extreme dilution events during rain events (due to large inputs of stormwater runoff into the channel) and evaporation effects creating elevated salinity conditions from time to time.

Summary of Typical Ambient Seawater Quality	
Parameter	Average Ambient Seawater
Conductivity (uS/cm)	50,255
Temperature (°C)	23.94
Barium (mg/L)	0.0615
Calcium (mg/L)	390
Iron (mg/L)	0.109
Magnesium (mg/L)	1,310
Manganese (mg/L)	0.025
Alkalinity (mg/L)	126
Chloride (mg/L)	18,684
Fluoride (mg/L)	1.1
Nitrate – N (mg/L)	0.328
o-Phosphate (mg/L)	0.04
Sulfate (mg/L)	2,564
TOC (mg/L)	1.07
TDS (mg/L)	36,122
Salinity (g/L)	32.1

Preliminary sizes and configurations for the primary considerations listed above were developed to serve as a basis for the costs estimated for this water supply alternative. **Table 3-5** presents the estimated capital and annual O&M cost for the Brownsville Ship Channel water supply alternative.

Table 3-5. Estimated Capital and Annual O&M Costs for the Gulf of Mexico Water Supply Alternative	
Item Description	**Cost**
Estimated Capital Costs	
Construction of Intake Structures (Total of 2)	$1,000,000
Construction of 54-inch Seawater Transmission Main	$30,000,000
Seawater Collection Wetwell	$1,000,000
Allocation for Environmental Mitigation	$5,000,000
Subtotal	$37,000,000
Contingency @ 25%	$9,250,000
Total Capital Cost	**$46,250,000**
Estimated Annual O&M Costs	
Seawater Intake Structure Maintenance	$100,000
Total Annual O&M Costs	**$100,000**

Table 3-6 illustrates some of the main advantages and disadvantages associated with the use of the Gulf of Mexico as the seawater supply source for this project.

Table 3-6. Advantages and Disadvantages of the Gulf of Mexico for the Seawater Supply Source

Advantages	Disadvantages
▪ Sufficient hydraulic capacity to support both the initial and build-out finished water production capacity of the project. ▪ Better and more consistent water quality than the other supply source alternatives.	▪ Extremely high capital cost associated with the installation of a Gulf intake and transmission system to the plant site. Additional pipelines would be needed for plant expansion events. ▪ Significant environmental impacts and additional environmental mitigation required to address areas disturbed during the installation of the intake structure and transmission main. ▪ Potential permitting issues associated with a Gulf intake structure and the associated transmission main. ▪ Potential maintenance issues associated with the intake structure resulting in higher maintenance costs. Reduced access to the remotely located intake structure to address potential problems. ▪ Remotely located intake structure more vulnerable to failure.

3.1.3 Brackish Groundwater Sources

The option of using groundwater as a source of low TDS water for the desalination plant or for blending with seawater to reduce the costs of treating seawater (by lowering its TDS content) was evaluated as part of this study. Details of this evaluation are presented below.

3.1.3.1 Hydrogeologic Setting of Area

In the Brownsville area, water-bearing zones, which are part of the Gulf Coast Aquifer, can provide slightly to very saline groundwater. The Gulf Coast Aquifer in this area is divided into the shallow Gravel Zone, an Intermediate Zone, and the Lower Zone. The Gravel Zone and Intermediate Zone are equivalent to the Chicot Aquifer. The Lower Zone straddles the lower portion of the Chicot Aquifer and the Evangeline Aquifer. The geologic strata are composed of complexly interbedded sedimentary deposits of gravel, sand, silt, and clay of fluvial and deltaic origin, which make prediction of suitable well locations difficult. **Figure 3-2** illustrates a general cross section of the various shallow (<1,500 feet depth) stratigraphic horizons in the Brownsville area. A brief description and discussion of each zone follows.

- <u>Gravel Zone</u> – The Gravel Zone occurs between depths of approximately 150 to 225 feet below ground surface (BGS) and consists of unconsolidated gravels and interbedded sands. Thicknesses of sand and/or gravel strata within this zone can vary from zero to approximately 50 feet. An interpretation of available data for the Brownsville area indicates that the zone thickness can be quite variable, and its suitability (thickness and lateral extent) to provide a sufficient quantity of water to support a well field is limited. Additionally, the zone thickness may decrease toward the Gulf of Mexico with a trend of fining of grain size, which further limits the practical use of this zone.

- Intermediate Zone – The Intermediate Zone is generally composed of interbedded sands, silts, and clays with some gravel horizons. The zone starts just below the Gravel Zone (approximately 225 feet BGS) with depths to approximately 400 feet BGS. The zone can have tens of feet up to 150 feet of sands, but the variability can be considerable over short distances. Test drilling in and around Brownsville indicates that clays and silty clays present in this horizon may reduce the potential for this zone to provide an adequate water supply capacity for the purposes of the subject project.

- Lower Zone – The Lower Zone is composed of interbedded sand, silt, and clay. Certain zones within this interval consist of thick clay horizons with thinner layers of sand and silt. Deeper zones are known to have considerable sand thickness, with individual layers being typically 30 to 70 feet thick.

Additional water-bearing zones within the Gulf Coast Aquifer that are found at greater depths (i.e., lower portions of the Evangeline Aquifer and the Jasper Aquifer) could provide substantial sources of groundwater. These deeper units are found at approximate depths of 1,500 feet to 7,000 feet BGS (Chowdhury and Mace, 2003). The TDS concentration within these units, although variable, is generally higher than shallower horizons (Baker, 1979; LBG-Guyton, 2003). Due to the relatively high TDS concentrations within these lower geologic units, coupled with drilling and operational costs to produce water, exploration of these deeper units for a suitable water supply for this project is considered impractical.

3.1.3.2 Water Quality and Availability

The groundwater quality in the Brownsville area varies widely in chemical composition both vertically and horizontally. In general, there is an increase in mineralization from west to east toward the Gulf and away from the Rio Grande, and from shallower to deeper horizons. The southwestern portions of Cameron County have the best groundwater quality in the Rio Grande Alluvium with TDS concentrations less than 1,000 mg/L. However, in the eastern portion of Cameron County where the proposed desalination project is located, water quality characteristics of the Lower Aquifer are very poor.

Table 3-7 presents three typical water quality analyses in the Brownsville area. Wells 89-05-404 and F.F. are located in the east and west sides of Brownsville, respectively, and represent water quality characteristics of the Gravel and Intermediate Zones (upper Chicot). Well 88-59-411 is located approximately 20 miles west of Brownsville and is considered to be representative of the Lower Zone (lower Chicot and Evangeline Aquifers). **Figure 3-3** depicts the approximate location of these wells in relation to the proposed site for the desalination facility. As shown on **Table 3-7**, all area aquifers have relatively high concentrations of chloride, sodium, and sulfate. This water quality is not a substantial improvement over what can be found in the open seawater supplies, which are more readily available than the local groundwater aquifers.

Table 3-7. Representative Groundwater Water Quality in the Brownsville Area [a]

Well/Site Designation	89-05-404	F.F.	88-59-411
Zone	**Gravel**	**Intermediate**	**Lower**
Screened Interval (ft BGS)	**165-225**	**316-336**	**932-952**
Parameter	**Values**		
pH (SU)	7.4	7.3	7.7
Conductivity (uS/cm)	10,540	16,000	53,760
Boron (mg/L)	3.6	------	------
Calcium (mg/L)	369	580	1,048
Hardness (mg/L, $CaCO_3$)	1,990	------	4,347
Iron (mg/L)	3.74	3.6	------
Magnesium (mg/L)	258	260	420
Manganese (mg/L)	<0.05	0.54	------
Potassium (mg/L)	16	40	34
Alkalinity (mg/L, $CaCO_3$)	246	190	95
Chlorides (mg/L)	3,680	4,000	11,904
Fluoride (mg/L)	1.7	0.90	0.9
Nitrate (mg/L, NO_3)	<0.4	<0.22	0.04
Sulfate (mg/L)	1,610	1,600	4,855
TDS (mg/L)	8,400	9,900	26,277
Sodium (mg/L)	2,260	3,200	7,946
Silica (mg/L	19	54	12
Bicarbonate (mg/L)	300	190	116

[a] *Data obtained from "Development of Brackish Ground Water Resources in the Brownsville Area," TWDB Contract No. 95-483-141, Issued November 1996.*
----- = *No data.*

A handful of brackish groundwater reverse osmosis (BWRO) systems have been built or designed in the area and typically taps the Gravel Zone. These systems, with designs from 1.0 to 10.5 MGD capacity, are generally located north and northwest of Brownsville and represent water quality conditions likely to be significantly better than those near the proposed location for the desalination plant. Modeling studies have shown that, even if a well field is located in an area with favorable water quality, the quality will gradually deteriorate over time (NRS, 1996). The Lower Zone is likely more uniform in terms of well-yield capacities than the Gravel and Intermediate Zones because of its greater thickness. It has been estimated that to adequately produce 10 MGD from a local well field would require approximately 26 wells (average 280 gallons per minute [gpm] per well), if completed in the Gravel and Intermediate Zones. Although it is estimated that only five wells may be required if completed in the Lower Zone, the water quality significantly deteriorates with depth while construction costs increase.

3.1.3.3 Suitability of Brackish Groundwater

The brackish groundwater supply found in the Brownsville area is not considered a suitable water supply source for this desalination project. The reasons have been described above and are summarized in **Table 3-8**.

Although the brackish groundwater supply could provide a certain amount of moderately low TDS water, the high variability of the TDS content, the probable limited life of the source well field, and the high costs associated with installation and O&M of a well field make this option impractical for further consideration.

Table 3-8. Advantages and Disadvantages of a Brackish Groundwater Supply Source

Advantages	Disadvantages
▪ Wells could potentially be sited directly at and/or adjacent to the project site (i.e., eliminate the need for a substantial water transmission system).	▪ High capital cost associated with the installation of relatively deep wells. Costly long-term operation and maintenance costs associated with groundwater pumping. ▪ Deterioration of water quality and high potential for decline in well performance through time. ▪ Relatively high variability in TDS content between different locations and depths. Significant increase in mineralization with depth and towards the coast.

3.1.4 Comparison of Water Supply Source Alternatives

An economic analysis was performed to compare the costs associated with identifying a suitable intake system for the Brownsville Ship Channel and the Gulf of Mexico supply sources. A cost estimate for the brackish groundwater supply alternative was not developed since it was established that this water supply source would not be viable for this project due to capacity limitations. A comparison of the capital and annual O&M costs for the two water supply alternatives is presented in **Table 3-9.**

Table 3-9. Comparison of Capital and Annual Operation & Maintenance Costs for the Water Supply Source Alternatives

Cost Item	Intake Screening Alternative	
	Brownsville Ship Channel	Gulf of Mexico
Estimated Capital Cost	$2,920,000	$46,250,000
Estimated Annual O&M Costs	$60,000	$100,000
Present Worth	$3,530,000	$47,270,000

The alternative water supply sources were scored and ranked to select the most viable and cost-effective option for the project. A summary of screening criteria and weighted scores for the various water supply source alternatives is presented in **Table 3-10**.

Table 3-10. Summary of Screening Criteria and Weighted Scores for Water Supply Source Alternatives

Screening Criteria	Score	Weighting Factor	Weighted Score
Brownsville Ship Channel			
Technical/Treatment Efficiency	8	40	32.0
Source Reliability	7	35	24.5
Permitability	5	25	12.5
Constructability	8	30	24.0
Cost-Effectiveness	9	50	45.0
		Total Weighted Score	**138.0**
Gulf of Mexico			
Technical/Treatment Efficiency	6	40	24.0
Source Reliability	9	35	31.5
Permitability	6	25	15.0
Constructability	3	30	9.0
Cost-Effectiveness	2	50	10.0
		Total Weighted Score	**89.5**
Brackish Groundwater Sources			
Technical/Treatment Efficiency	5	40	20.0
Source Reliability	1	35	3.5
Brackish Groundwater Sources			
Screening Criteria	**Score**	**Weighting Factor**	**Weighted Score**
Permitability	8	25	20.0
Constructability	6	30	18.0
Cost-Effectiveness	2	50	10.0
		Total Weighted Score	**71.5**

3.1.5 Selection of Preferred Water Supply Source

Based on the previously described evaluation of the available water supply source alternatives, the Brownsville Ship Channel was selected as the most viable and cost-effective option for this project. This alternative has sufficient water supply capacity for both the initial and build-out production capacity of the desalination plant; the water quality is similar to that of typical seawater; and minimal adverse environmental impacts are anticipated as a consequence of using this supply source.

3.2 ALTERNATIVE SEAWATER INTAKE SCREENING SYSTEMS

The USEPA's CWA Section 316(b) regulates and reduces the amount of fish kill caused by impingement and entrainment. Impingement occurs when fish and other aquatic life are trapped against water intake screens. Entrainment occurs when aquatic organisms, eggs, and larvae are drawn into an intake system through some type of process and then are transferred back to the source water. The new USEPA guidelines require the reduction in impingement mortality by 80 to 95 percent.

Two alternatives were evaluated for the screening of aquatic life for the seawater intake system. These alternatives included an engineered aquatic filter barrier system and a series of T-shaped water intake screens. Both alternatives are designed to limit the maximum approach velocity to 0.5 FPS, which is required to reduce entrainment and impingement of marine life. A detailed evaluation of both alternatives is presented in the following sections.

3.2.1 Water Intake Screens

An engineered screen assembly manufactured by Hendrick Screen is a viable alternative retained from the initial screening process. A 72-inch Tee Intake Screen would be a suitable selection for this plant component.

The water intake screens would admit water at a maximum velocity of 0.5 FPS. Water would pass through the screens, while aquatic life and debris larger than 1/8-inch in diameter would be excluded. The water intake screens have no moving parts and thus are considered passive screening mechanisms. The screens can be placed away from the shoreline, which would result in better water quality and would provide more distance from high concentrations of debris and marine life. In addition, the screens can be mounted directly to a seawall or other similar fixed bulkhead, thereby facilitating their installation and overall structural support.

Installing intake screens at the proper depths, distances from the shoreline, and distances from each other is necessary to minimize screen clogging and obstruction. However, even when the screen assemblies are installed in an optimized configuration, the potential for debris accumulation on the surface of the screens remains high. As such, an adequate system should be provided for the periodic removal of accumulated debris from the surface of the screens to maintain the requisite intake flow for the desalination plant at all times. For the type of intake screens considered for this project, debris would be removed using an automated airburst system. With this system, a rapid release of compressed air through a manifold of nozzles located along the surface of the screens would dislodge debris from the screen surface.

Cone-shaped end plates allow the water intake screens to be protected from floating debris. Water intake screens can be subject to fouling or plugging by aquatic vegetation. However, the water intake screens would be constructed of a copper-nickel alloy to aid in minimizing the plugging problems. In bodies of water where debris accumulates on the screen body, either by gravity or in response to random ambient currents, screens can be cleaned with an airburst system when the pressure drop through the screens reaches a certain value (typical pressure losses through the water intake screens would be limited to approximately 2 pounds per square inch [psi]). Air, rather than water, is the preferred medium for cleaning intake screens because air moves with less head loss than water and allows for more effective cleaning of debris from the screens. The airburst system is generally comprised of the following components:

- **Accumulator** – A high-pressure air receiver tank, which would be supplied with air through the use of a 15 horsepower (HP) air compressor.

- **Distributor System** – Air piping that sends bursts of air to screen(s) in manifolded assemblies. Sequential bursts are usually sent to each screen with the accumulator recharged between bursts.

- **Control System** – Automatically operated when screen headloss exceeds a predetermined value.

Table 3-11 illustrates some of the main advantages and disadvantages associated with the use of the proposed water intake screens.

Table 3-11. Advantages and Disadvantages of Water Intake Screens

Advantages	Disadvantages
▪ Low capital cost. ▪ Relatively small space requirements. ▪ Relatively easy installation process. ▪ Low maintenance requirements and O&M costs. ▪ Material resistant to corrosion and damage during normal operating conditions. ▪ Connects directly in-line to the seawater intake pump suction piping. ▪ Consistent solids removal (based on slot opening dimension) efficiency not affected by variable influent solids concentration. ▪ Meets current CWA Section 316(b) provision of limiting the approach velocity to 0.5 FPS maximum.	▪ Slot openings relatively wide; does not allow for suspended solids removal less than 1/8-inch in diameter. ▪ Relatively high approach velocity (0.5 FPS) when compared to the Engineered Aquatic Filter Barrier System (0.1 FPS), the other screening alternative evaluated below. ▪ Airburst system requires installation of redundant unit to maintain intake flow during cleaning events. ▪ Ease of access to the screens is impeded due to their relative location and depth of submergence. Would require special maintenance event to inspect, repair, and replace a screen assembly.

3.2.2 Engineered Aquatic Filter Barrier System

Another viable alternative retained from the initial screening process is the Engineered Aquatic Filter Barrier System manufactured by Gunderboom, Inc. A floating boom approximately 350 feet in length and approximately 30 feet in depth, complete with an air scouring system would be a suitable selection for the project's seawater screening component.

The engineered aquatic filter barrier system is designed to reduce the impact on aquatic organisms by preventing entrainment and impingement, while protecting the seawater intake pumping system from marine life intrusion. The filter barrier system would also serve to keep fish eggs, larvae, and other aquatic organisms a safe distance away from the intake pumping system.

The system is comprised of a pocket formed by two layers of treated fabric with a water curtain that is either suspended by flotation billets and anchored in place or integrated into existing shoreline seawalls or bulkheads. While sealed against the sea floor and shoreline structures, the water-permeable barrier completely surrounds the intake pumping system, preventing planktonic and neustonic organisms from entering the system. The treated fabric is designed to accommodate a wide range of pore sizes, which can be used to adjust the approach velocity of the water and provide for a means of sedimentation.

The surface area of the water-permeable barrier is relatively large compared to the water intake screens evaluated above, resulting in an approach water velocity of approximately 0.1 FPS. This lower water velocity enables even small fish larvae to drift away from the boom. The system would include an automatic airburst cleaning system. Sediment and passively floating organisms drawn onto the fabric are freed when the airburst cleaning system routinely releases high-pressure air at the boom's base. Bursts of compressed air shake each fabric panel, releasing deposits and ensuring a steady flow of water through the curtain.

Design considerations that would need to be taken into account for this system include:

- Target species and stages of aquatic life;
- Facility water flow rates;
- Physical factors, including bathymetry, bottom conditions, configuration of the water body, and facility layout;
- Water body characteristics, including elevation changes, currents, wind-induced wave action, and suspended sediment concentrations;
- Seasonality of the problem and duration of deployment; and
- The potential for fouling along the face of the fabric that comprises the barrier.

Table 3-12 illustrates some of the main advantages and disadvantages associated with the use of an engineered aquatic filter barrier system.

Table 3-12. Advantages and Disadvantages of an Engineered Aquatic Filter Barrier System

Advantages	Disadvantages
▪ Low approach velocity; provides best possible assurance of minimizing entrainment and impingement. ▪ Small openings; provides for some removal of suspended solids. ▪ Consistent solids removal.	▪ High capital costs. ▪ Would require the construction of a dedicated intake structure for the seawater intake pumping system. ▪ Susceptible to damage from oil/fuel spills. ▪ Relatively complicated installation process and need for special maintenance events to inspect, repair, or replace.

3.2.3 Comparison of Intake Screening Alternatives

A summary of the results from the economic analysis for the intake screening systems under consideration is presented in **Table 3-13**.

Table 3-13. Comparison of Capital and Annual O&M Costs for the Intake Screening System Alternatives

Cost Item	Intake Screening Alternative	
	Water Intake Screens	Engineered Aquatic Filter Barrier System
Estimated Capital Cost	$232,500	$1,000,000
Estimated Annual O&M Costs	$50,000	$70,000
Present Worth	$740,000	$1,715,000

A summary of screening criteria and weighted scores for the water intake screening system alternatives is presented in **Table 3-14**.

Table 3-14. Summary of Screening Criteria and Weighted Scores for Water Intake Screening System Alternatives

Screening Criteria	Score	Weighting Factor	Weighted Score
T-Shaped Water Intake Screens			
Technical/Treatment Efficiency	5	40	20.0
Unit Reliability	9	35	31.5
Permitability	7	25	17.5
Constructability	8	30	24.0
Cost-Effectiveness	9	50	45.0
		Total Weighted Score	**138.0**
Engineered Aquatic Filter Barrier System			
Technical/Treatment Efficiency	9	40	36.0
Unit Reliability	4	35	14.0
Permitability	9	25	22.5
Constructability	35	30	9.0
Cost-Effectiveness	2	50	10.0
		Total Weighted Score	**91.5**

3.2.4 Selection of Preferred Intake Screening Alternative

The analysis of water intake screening alternatives revealed that the use of the T-shaped water intake screens would be the most cost-effective and most appropriate system for the Brownsville Desalination Demonstration Project. The water intake screens are durable and non-corrosive, and would comply with permit requirements for avoiding entrainment and impingement of marine life. In addition, the configuration of the water intake screens would allow the seawater intake pumping system to be directly connected to the screens, thus eliminating the need for a dedicated intake structure.

In **Section 4**, principal design considerations will be addressed to provide a reasonable assurance that the passive intake screens will be properly configured to collect the quantity of water required for the project, while minimizing and addressing debris collection to the degree practical. These considerations include the following:

- The screens' proximity to the water surface and seabed;
- The proximity of screens to one another;
- Additional structures required to protect the screen;
- Support of screens in the water;
- The location of the air connection;
- Piping configuration for multiple screen assemblies; and
- Siting and infrastructure support requirements for the airburst system.

3.3 ALTERNATIVE PRETREATMENT SYSTEMS

The proper evaluation, selection, and implementation of pretreatment operations and processes are imperative for SWRO. The importance of a desalination facility's pretreatment system cannot be overemphasized. For instance, the recently constructed 25 MGD Tampa Bay Desalination Facility has experienced premature cartridge filter and SWRO membrane fouling, reportedly caused by problems associated with that facility's pretreatment system. Thus, careful thought and consideration must be given to the evaluation of viable pretreatment solutions.

The weighting scale used for the pretreatment system alternatives analysis was adjusted so that the weighting factors for treatment efficiency and reliability of the system were increased, while the weighting factor for cost-effectiveness was accordingly decreased. It is still important to design a cost-effective SWRO pretreatment system. However, the efficiency and reliability of the pretreatment system is (within reason) more important than the cost-effectiveness of the system itself, since a reduction in pretreatment reliability could have a significant adverse affect on annual O&M expenses associated with the membrane system. By demanding higher efficiency and reliability from the pretreatment system, the system will maximize protection of the downstream SWRO membrane system to the degree practical, resulting in longer run times for individual membrane trains and longer life spans for the membrane elements themselves.

SWRO membranes may experience scaling, fouling, or a combination of these factors. A variety of pretreatment operations and processes available for municipal SWRO pretreatment should be evaluated for their ability to reduce or eliminate membrane scaling and fouling. Without a robust pretreatment system, SWRO membranes could experience reduced flux and shortened lifespan, resulting in higher O&M costs. For purposes of this report, pretreatment is defined as all unit operations and processes downstream of the seawater intake pumps through the final component before seawater is pressurized and treated via the membrane system itself; in this case, the cartridge filtration system. Since capital costs for SWRO pretreatment systems typically range from 20 to 25% of the total capital cost for a desalination facility, pretreatment selection is a very important design consideration.

The only quantitative measurement of SWRO feedwater quality that has been widely used to assess the potential for membrane fouling is the silt density index (SDI). However, the use of this index alone cannot always confirm the fouling potential of various seawater sources. Considerable interest and research is taking place in an attempt to find a better predictor of the membrane fouling potential for various source waters (i.e., the Modified Fouling Index, a combination of SDI with turbidity measurements, and the correlation of SDI with particle counting measurements).

A properly planned and executed pilot-scale study must be conducted to assess the potential for membrane fouling and to support the final system selected to pretreat the seawater supply for this project. However, the exact potential for membrane fouling cannot be accurately predicted at this time for the proposed source water that will be used to support this project. Therefore, the system selected for the project should be robust in nature and designed to: 1) eliminate the majority of all suspended solids present in the feedwater, and 2) reduce the fouling potential of the water source to the degree practical. The fouling potential could be reduced if the Total Organic Carbon (TOC) content of the water supply is reduced by a suitable degree.

The goal in selecting SWRO pretreatment equipment is to design a pretreatment system that will produce a continuous supply of SWRO feedwater with low fouling potential, regardless of the variability of the raw seawater supply. The pretreatment system design should be simple, reliable, durable, and cost-effective, while meeting all requirements to ensure a high-quality SWRO feedwater. The following SWRO pretreatment alternatives were evaluated in increasing order of overall complexity and costs:

- Two-stage dual-media filtration;
- Ballasted flocculation/clarification system with single-stage dual-media filtration; and
- Submerged ultrafiltration (UF) membrane system.

The various pretreatment processes must be evaluated to assess their suitability for the Brownsville Desalination Demonstration Project. The preferred pretreatment system should be cost-effective and must protect the SWRO membranes against premature fouling. Each alternative pretreatment process has specific advantages and disadvantages associated with it, as well as unique O&M requirements and capital costs. Various pretreatment vendors provided information detailing their approaches for the pretreatment system. In addition, in-house experience with all three of the alternative pretreatment system components was taken into account when scoring and ranking each alternative in the following analysis.

3.3.1 Two-Stage Dual-Media Filtration System

A two-stage dual-media filtration system was one option evaluated for use at the Brownsville Desalination Demonstration Project. Filtration has been used for SWRO pretreatment with varying levels of success. Potential solids loading rates on the filters are a critical consideration to take into account, since large loading rates can lead to frequent backwash cycles, which in turn could potentially result in inconsistent SWRO feedwater quality. In addition, excessive backwash cycles would escalate annual operational costs and result in additional maintenance costs over time. Thus, solids loading must be included in the analysis of this alternative and weighed accordingly.

For this project, raw water quality data indicate a maximum TSS level in the Ship Channel of approximately 150 ppm. The pretreatment filters could potentially experience this quantity of solids in the raw seawater supply. In addition, to reduce the fouling potential of the seawater supply, a chemical coagulant would be added to assist with the solids removal processes. Based on similar projects using similar seawater quality, a ferric salt would be used at a dose rate of approximately 15 mg/L. Taking into account both the maximum suspended solids concentration and the quantity of the ferric coagulant, a peak total solids loading rate of approximately 165 mg/L (corresponding to approximately 57,000 pounds per day of dry solids) could result. When suspended solids in the Ship Channel are at an average level, a total solids loading rate of approximately 36 mg/L (corresponding to approximately 17,000 pounds per day of dry solids) could result. Based on this potential range in solids loading rates, it is anticipated that the filters may need to be backwashed approximately once per day during average water quality conditions and more than six times per day during reduced water quality (high TSS) conditions.

Dual-media filters typically contain layers of sand and anthracite. Dual-media filters are recommended since the available pore space within the anthracite layer would accommodate the storage of larger quantities of suspended solids, thereby extending the period between backwash events. For this project, it is anticipated that the sand layer would be approximately 12 inches deep, whereas the anthracite layer would be approximately 48 inches deep. The sand layer would consist of sand particles approximately 0.5 millimeter (mm) in diameter, while the anthracite layer would consist of particles approximately 1.0 mm in diameter. Underlying the sand layer in the filter bed would be a layer of garnet or similar, inert support media, which would protect the filter system's underdrains.

Hydraulic loading rates for deep-bed media filtration are typically on the order of 3.0 to 6.0 gallons per minute per square foot (gpm/ft^2). Since a two-stage filtration system would be used, this analysis is based on an average hydraulic loading rate of 4.5 gpm/ft^2 (i.e., 3.0 gpm/ft^2 for the first stage and 6.0 gpm/ft^2 for the second stage). Each stage would consist of eight filters; seven filters would be on-line, while one unit would be off-line and/or in a backwash mode.

The treatment goals of the filtration pretreatment system would include:

- Limiting the SWRO feedwater SDI to 3.0;
- Limiting the filtered water turbidity to 0.2 NTU; and
- Limiting backwashing of filters to once per day.

Based on feedback from various filter manufacturers, the raw water quality for the facility may not be conducive to achieving the above goals. During periods of relatively high TSS concentrations in the Ship Channel (100 mg/L or more), the use of primary sedimentation/clarification tanks would most likely be required. Although this is a significant limitation and potential fatal flaw for this alternative in this particular application, the alternative is retained for comparison to the other alternatives.

Screened seawater would flow through the media in each filter cell of the first-stage filtration bank and through an underdrain system. The underdrain system would then collect water from each cell and route it to a common effluent chamber from which the primary filtered water stream would flow over an effluent weir and flow by gravity to the second-stage filter bank. The process would be repeated in the second-stage filtration bank, and the secondary filtered water stream would then be routed into a clearwell. Automatic control valves would be provided both before and after each filter cell to allow isolation of each cell for backwashing. Differential water levels above each filter cell, as well as automatic timers, would be used to trigger backwash cycles.

Table 3-15 lists some of the advantages and disadvantages of the two-stage dual-media filtration SWRO pretreatment system.

Table 3-15. Advantages and Disadvantages of the Two-Stage Dual-Media Filtration Pretreatment System	
Advantages	**Disadvantages**
▪ Relatively easy O&M of system due to the configuration of the system (gravity flow) and minimization of mechanical components. ▪ Relatively low capital cost as compared to the other pretreatment alternatives. ▪ Relatively low installation cost as compared to the other pretreatment alternatives.	▪ High coagulant dosages required – results in high solids generation rates and high solids loading rates on filter cells if a solids sedimentation step is not used prior to the filters. ▪ Filters may be subject to blinding during periods of high TSS concentrations in the raw seawater supply. ▪ Sedimentation/Clarification may be required upstream of the filters to ensure that cartridge filters and SWRO membranes are protected against premature fouling. ▪ Filters would need to be backwashed several times per day during periods of high TSS concentrations in the raw seawater supply which could result in reduced filtered water quality and generation of excessive quantities of spent backwash water.

Table 3-16 presents the estimated capital and annual O&M costs for the two-stage dual-media filtration SWRO pretreatment system.

Table 3-16. Two-Stage Dual-Media Filtration SWRO Pretreatment System Estimated Capital and Annual O&M Costs	
Item Description	**Cost**
Estimated Capital Costs	
Mechanical Equipment; Programmable Logic Controller (PLC) Based Control Panels; Process Instrumentation	$2,700,000
Concrete Tanks	$630,000
Subtotal	$3,330,000
Electrical and Instrumentation @ 15%	$500,000
Installation @ 40%	$1,330,000
Subtotal	$5,160,000
Contingency @ 25%	$1,290,000
Total Capital Cost	**$6,450,000**
Estimated Annual O&M Costs	
General Maintenance and Power	$270,000
Rehabilitation of Filter Underdrains and Troughs (Annualized Cost)	$65,000
Filter Media Replacement (Annualized Cost)	$5,000
Total	**$340,000**

3.3.2 Ballasted Flocculation/Clarification (BFC) System with Single-Stage Filtration

Based on the list of disadvantages associated with the previously described alternative, a bulk solids removal step before the filtration step should be considered. The following pretreatment system alternative is explored in lieu of a conventional coagulation-flocculation-sedimentation process, whereby solids are removed in a relatively large sedimentation basin, which is configured and sized based on unassisted gravity settling of flocculated particles. The following alternative resembles the conventional process in most ways, but process modifications associated with this alternative reduce the requisite settling area needed for the sedimentation process.

The BFC system is a relatively compact and advanced clarification system that uses micro-sand (60-120 µm in diameter) to enhance flocculation and settling, thus substantially reducing the amount of surface area and tankage required for the sedimentation process. The system consists of a series of tanks where coagulation, flocculation, and sedimentation take place as summarized below:

- The appropriate coagulant aid, such as a ferric salt, is added and mixed with the raw seawater before the coagulation tank to destabilize incoming solids. Coagulant addition would be automatically controlled using influent water quality data such as turbidity measurements to vary the rate of chemical addition.

- Coagulated water then passes into the injection tank, where micro-sand and a flocculation chemical (i.e., cationic polymer) are added and mixed to initiate flocculated organic particles (floc) formation.

- From the injection tank, water passes into the third tank, the maturation tank, where it is gently mixed to enhance the formation of the floc. This tank provides sufficient detention time to complete the flocculation process. The polymer serves as an adhesive agent between the micro-sand and the suspended floc.

- The fully formed ballasted flocs (micro-sand/sludge flocs) leave the maturation tank and pass to the settling tank. Laminar upflow through the settling zone provides for rapid and effective removal of the flocs.

- The settled flocs are collected and pumped out of the bottom of the tank by rubber-lined centrifugal slurry pumps and routed to a set of hydrocyclones. Here, sludge and micro-sand are separated through centrifugal forces created within the hydrocyclones. The recovered micro-sand is then recycled to the injection tank, while the separated sludge is routed onward to the solids handling system for further treatment before final disposal.

- The flow of water throughout the BFC system occurs via gravity. Pumping is only used to extract the sludge/micro-sand mixture for recycle within the system as described above.

Other constructed projects have demonstrated that a properly designed BFC system can reliably and consistently remove the majority of suspended solids present in the raw water supply fed to this system despite large fluctuations in the raw water suspended solids concentrations. The use of micro-sand ballast within the BFC system improves solids removal efficiencies associated with the process and is the primary reason why the system can produce a consistent water quality containing low suspended solids concentrations. This design consideration would yield a robust solution for the project's pretreatment system.

If the Brownsville Desalination Demonstration Project were to be designed around a BFC system, single-stage, dual-media filters would be installed downstream of the BFC system to remove the majority of the remaining suspended particles that may be carried over the effluent launders of the sedimentation tanks. Treated water from the BFC system would be routed by gravity through a dedicated main into the filters' inlet flume where the flow would be divided among the cells in operation. Water would flow downward through the media in each filter cell via gravity and through an underdrain system. The underdrain system would then collect water from each cell and route it to a common effluent chamber from which treated water would flow over an effluent weir and into the clear well. Any particles with diameters greater than five (5) microns that escape the BFC/filtration system would be removed by the cartridge filters, which serve as the final protective barrier to the SWRO membranes.

Automatic control valves are provided both before and after each filter cell to allow isolation of each cell for backwashing. The backwash system would consist of a series of backwash pumps rated to provide sufficient flow and pressure to fluidize the media in each filter cell, as well as a series of blowers that would provide an air scour of the filter media. Differential water levels above each filter cell, as well as automatic timers, would be used to trigger backwash cycles.

Table 3-17 lists some of the advantages and disadvantages of the BFC/filtration pretreatment system.

Table 3-17. Advantages and Disadvantages of the BFC/Filtration Pretreatment System

Advantages	Disadvantages
▪ Short startup time. ▪ Very good and consistent filtered water quality, regardless of large TSS variations within Brownsville Ship Channel. ▪ Compact footprint and therefore reduced site development and structural costs. ▪ Relatively stable and robust solids removal process. ▪ Proven treatment process and wide use in the water treatment industry.	▪ Portion of micro-sand is lost to the solids waste stream and needs to be frequently replenished. ▪ Loss of micro-sand from the process slightly increases sludge production quantities. ▪ High coagulant dosages required – results in high solids generation rates.

Table 3-18 presents the estimated capital and annual O&M cost for the BFC/Filtration pretreatment system.

Table 3-18. Estimated Capital and Annual O&M Expenses for BFC System with Single-Stage Filtration

Item Description	Cost
Estimated Capital Costs	
BFC Mechanical Equipment	$3,350,000
Filters' Mechanical Equipment; PLC Based Control Panels; Process Instrumentation	$1,350,000
Concrete Tanks	$560,000
Subtotal	$5,260,000
Electrical and Instrumentation @ 15%	$790,000
Installation @ 40%	$2,100,000

Table 3-18. Estimated Capital and Annual O&M Expenses for BFC System with Single-Stage Filtration	
Item Description	**Cost**
Estimated Capital Costs	
Subtotal	$8,150,000
Contingency @ 25%	$2,040,000
Total Capital Cost	**$10,190,000**
Estimated Annual O&M Costs	
General Maintenance and Power	$470,000
Rehabilitation of Filter Underdrains and Troughs (Annualized Cost)	$35,000
Filter Media Replacement (Annualized Cost)	$3,000
Refurbish BFC System (Annualized Cost)	$65,000
Total	**$573,000**

3.3.3 Submerged Ultrafiltration Membrane System

The membrane pretreatment system would use a process technology that produces high-quality treated water by drawing raw water through immersed membrane elements within a process tank. The hollow-fiber membranes have a nominal pore size of 0.02 µm and have been demonstrated to be capable of removing suspended solids, protozoa, bacteria, and some viruses. If chemical coagulation is practiced upstream of the UF membrane system, the membrane system would also remove a portion of the water's organic carbon content as well. Dissolved salts within the seawater supply would pass through the UF membrane elements because the pore size would permit the passage of the monovalent salts. The membranes would operate under a slight vacuum created within the hollow membrane fibers by a permeate pump. The system works by drawing the seawater through the membranes and into the hollow fibers, and subsequently routes it by the permeate pump to a clearwell. Separated solids retained within the process tank would be continually removed during the operation of the pretreatment system and routed onward to the solids handling system for further treatment. Solids would be removed from the process tanks either via gravity flow or pumping, depending on the exact physical configuration developed for the system.

The membrane pretreatment system would consistently produce high-quality SWRO feedwater, since the membranes would not be subjected to stress, pressurization, or rapid pressure fluctuations. The membranes would be periodically cleaned by backpulsing, which involves the reversal of the permeate flow through the fibers' lumen at low pressure. The backpressure during backpulsing would be relatively low due to the high permeability of the membranes. The small variations in operating pressure would occur smoothly over relatively long periods of time so that the membrane would not be stressed at any time. An air curtain would also be used to dislodge solids from the surface of the membrane elements, thereby extending the period of time between backpulse events. During system operation, air would be continuously introduced at the bottom of the membrane modules via fine bubble-diffused aerators to clean the outside of the membrane fibers. The aeration operation could also be designed to oxidize organic compounds that may be present within the seawater supply, resulting in an SWRO feedwater quality that may be better than that provided by UF alone.

Recovery rates for this system could be designed as high as 95%, which would considerably reduce sizing requirements for the solids handling system. However, due to the potential solids flux rates during high raw water turbidity events, a lower recovery factor may be needed to maintain proper pretreatment while producing an equal quantity of water for the downstream treatment processes. Since the membranes would be immersed directly in the process tank with only a low vacuum applied to them, high suspended solids concentrations would not foul the membranes. The membranes would be cleaned daily by periodically reversing the permeate flow and backpulsing the fiber's lumen with permeate at a low pressure. In addition, periodic chemical cleanings (i.e., monthly or bi-weekly) would be conducted to remove organic and/or inorganic scales that may form on the surface of the membrane elements over time.

With Programmable Logic Controllers (PLC), the membrane pretreatment system would be designed so that it could be left unattended with only periodic monitoring and data logging required. The system also would have a number of membrane integrity diagnostic facilities to monitor the system integrity and provide continuous filtrate quality assurance.

A requirement for this particular pretreatment alternative would be the need to install a system of mechanical strainers upstream of the process tanks to house the membrane elements. Strainers are necessary to ensure proper removal of suspended solids. These strainers would be sized to remove the majority of particles that are 0.5 mm in diameter or greater. An adequate number of strainers arranged in a parallel configuration would be needed to ensure continuous operation of the membrane system. This conceptual design provision would maximize the resulting recovery factor that could be used for the submerged UF membrane system. However, additional testing would be needed to characterize the particle size distribution of suspended solids and confirm if strainers alone would be sufficient to support a higher membrane recovery factor.

Table 3-19 illustrates some of the main advantages and disadvantages associated with the submerged ultrafiltration membrane SWRO pretreatment system.

Table 3-19. Advantages and Disadvantages of a Submerged Ultrafiltration Pretreatment System

Advantages	Disadvantages
▪ Coagulant not required; reduces chemical costs and sludge production rates. ▪ Can achieve 6-log removal of Giardia cysts and Cryptosporidium oocysts; 2-log removal of viruses; much greater removal credits than provided by other evaluated pretreatment alternatives. ▪ Consistent solids removal efficiencies not affected by variable influent solids loading. ▪ Provides superior assurance that SWRO feedwater quality will be less than 0.1 NTU. ▪ Conventional filtration not required, thereby reducing large instantaneous backwash flows and eliminating the need for a solids equalization basin.	▪ Relatively high capital cost for equipment. ▪ Relatively high operating cost due to power and chemical usage. ▪ Membranes may need to be replaced once every 5 to 10 years. ▪ Membrane system would require the installation of mechanical strainers. ▪ Solids handling components would need to be designed for greater hydraulic capacity.

Table 3-20 presents the estimated capital and annual O&M cost for the submerged ultrafiltration system alternative.

Table 3-20. Submerged Ultrafiltration System Estimated Capital and Annual O&M Costs	
Item Description	**Cost**
Estimated Capital Costs	
Ultrafiltration System Mechanical Equipment; Process Instrumentation Concrete Tanks Mechanical Strainers	$11,325,000 $645,000 $400,000
Subtotal	$12,370,000
Electrical and Instrumentation @ 15% of Capital Cost Installation @ 40% of Capital Cost	$1,860,000 $4,950,000
Subtotal	$19,180,000
Contingency @ 25%	$4,795,000
Total Capital Cost	**$23,975,000**
Estimated Annual O&M Costs	
General maintenance, chemicals and membrane replacement	$325,000
Power	$250,000
Ultrafiltration system refurbishment (Annualized Cost)	$190,000
Total	**$765,000**

It should be noted that a pressurized UF or microfiltration modification of this particular treatment alternative is also available for consideration. While there may be different advantages and disadvantages associated with this modification of the same process technology, the results from the initial economic analysis would be similar. Thus, for the purposes of this feasibility study and alternative analysis, this process modification was not directly evaluated since it would receive a similar weighted score as the membrane alternative analyzed.

3.3.4 Comparison of Pretreatment System Alternatives

An economic analysis was performed for the alternative pretreatment systems considered in this study. **Table 3-21** presents a comparison of the capital costs, O&M costs, and present worth for the pretreatment system alternatives.

Table 3-21. Comparison of Estimated Capital Cost, O&M Cost, and Present Worth for Pretreatment System Alternatives				
SWRO Pretreatment System	**Initial Capital Cost**	**Annual O&M Cost**	**Annual O&M Present Worth**	**Total Present Worth**
Two-Stage Dual-Media Filtration	$6,450,000	$340,000	$3,470,000	$9,920,000
BFC System with Single-Stage Filtration	$10,190,000	$573,000	$5,850,000	$16,040,000
Submerged Ultrafiltration Membrane System	$23,975,000	$765,000	$7,810,000	$31,785,000

Although the two-stage dual-media filtration pretreatment system has the lowest present worth, other factors must be considered before a recommendation can be made. The robustness and reliability of the pretreatment system is extremely important. For this reason, the weighting factor for the technical/treatment efficiency and reliability criteria were increased, while the weighting factors for the cost criteria were decreased. A summary of screening criteria and weighted scores for SWRO pretreatment systems is presented in **Table 3-22**.

Table 3-22. Summary of Screening Criteria and Weighted Scores for SWRO Pretreatment Systems

Screening Criteria	Score	Weighting Factor	Weighted Score
Two-Stage Dual-Media Filtration			
Technical/Treatment Efficiency	2	50	10.0
Unit Reliability	5	40	20.0
Permitability	5	25	12.5
Constructability	6	30	18.0
Cost-Effectiveness	9	35	31.5
		Total Weighted Score	**92.0**
Ballasted Flocculation/Clarification System with Single-Stage Filtration			
Technical/Treatment Efficiency	8	50	40.0
Unit Reliability	5	40	20.0
Permitability	5	25	12.5
Constructability	5	30	15.0
Cost-Effectiveness	7	35	24.5
		Total Weighted Score	**112.0**
Submerged Ultrafiltration Membrane System			
Technical/Treatment Efficiency	9	50	45.0
Unit Reliability	5	40	20.0
Permitability	5	25	12.5
Constructability	4	30	12.0
Cost-Effectiveness	2	35	7.0
		Total Weighted Score	**96.5**

3.3.5 Selection of Preferred Pretreatment System Alternative

Although the analysis of SWRO pretreatment system alternatives reveals that a two-stage dual-media filtration system would be the lowest cost system, the weighted scores indicate that the BFC/filtration system would be the most appropriate SWRO pretreatment system for the proposed Brownsville Desalination Demonstration Project. This system produces filtered water of a consistent quality; is not subject to the potential blinding and excessive backwashing cycles that a two-stage dual-media filtration system may encounter; and is much more cost-effective than a submerged membrane-based pretreatment system. Based on the results of this analysis, the use of a BFC/filtration SWRO pretreatment system is recommended as the preferred alternative for this project.

3.4 ALTERNATIVE DESALINATION SYSTEMS

3.4.1 Potential Desalination Processes

Various treatment technologies are available for the desalination of seawater and brackish groundwater. Two general classes of desalination technologies are used throughout the world: membrane processes and thermal processes. For purposes of complete reporting, all available desalination alternatives are addressed in this report, with the exception of solar distillation, which would not be practical for this project due to capacity limitations associated with the process. Of the remaining desalination options, SWRO is the only alternative that is cost-effective and suitable for the type of water that needs to be treated, as detailed below. **Table 3-23** provides a summary of potential desalination processes that have been used in various applications throughout the world.

Table 3-23. Summary of Alternative Desalination Processes

Membrane Processes	Thermal Processes
▪ Seawater Reverse Osmosis (SWRO) ▪ Nanofiltration (NF) ▪ Electrodialysis (ED) ▪ Electrodialysis Reversal (EDR)	▪ Multi-Effect Distillation (MED) ▪ Multistage Flash (MSF) ▪ Mechanical Vapor Compression (MVC)

Each process varies with respect to equipment needs, chemical use, operator requirements, waste disposal, capital expenditure, and annual O&M expenses. Further, there are process variations for each alternative technology that could be explored. Brief descriptions of the two technologies that appear to offer the greatest advantages are provided below.

3.4.1.1 Membrane Processes

Membrane processes are capable of desalting; softening; removing trihalomethane precursors, viruses, and turbidity; and reducing the level of specific organics that may be present in the water supply, and are of concern from a regulatory- or health-based perspective. A membrane process is defined as any barrier to the flow of suspended, colloidal, or dissolved species in any solvent. Although membrane processes traditionally have been limited to treatment of extremely poor quality water, they are now commonly used to treat waters ranging in quality from fresh to brackish. A primary consideration related to the efficiency and cost-effectiveness of the membrane processes is the correlation between increasing salinity content and higher power requirements.

Membrane processes treat water by separating solids in the raw water from the finished water product, also referred to as permeate. Separation takes place when water flows through the pores of the membrane at a much higher rate than the solute of rejected species. The smaller the membrane pore, the smaller the rejected species and the more costly the membrane operation becomes as a consequence of the power required to drive water through the membrane elements. The three membrane processes for desalting applications are seawater reverse osmosis (SWRO), nanofiltration (NF), and electrodialysis (ED). Electrodialysis reversal (EDR) is another membrane process that is a patented variation of the ED process. Of these membrane solutions, only SWRO is typically used to desalt seawater supplies because the other processes are more suitable for brackish groundwater and/or surface water supplies.

Various issues must be considered when evaluating membrane processes. These include constituent type and size, membrane operation, membrane configuration, membrane materials, and pre-treatment requirements. Each of these factors has a significant effect on the ability of the process to economically produce satisfactory water quality. A brief discussion of each topic is provided below:

- **Constituent Size** − The principal mechanisms for separation of ions and contaminants by membrane processes are diffusion, charge repulsion, and size exclusion. Solute species are removed from the water stream via these three processes. The size of specie governs the removal process. Almost all solutes of concern for water can be classified into three approximate ranges: 1) an ionic range from 0.0001 to 0.01 micron; 2) a macromolecular size from 0.01 to 1 micron; and 3) a fine particle range from 1 to 100 microns.

- **Membrane Operation** − Depending on the direction of the influent flow relative to the membrane, filtration processes generally are divided into two types: normal and crossflow. Normal flow directs the influent water perpendicular to the membrane, which causes clogging and fouling of the surface. Crossflow filtration is the preferred method for membrane design where the influent is directed parallel to the membrane.
- **Membrane Configuration** − There are several types of membrane configurations. Hollow fiber and capillary membranes are manufactured in a shape of tiny tubes to maximize the surface area. Tubular membranes are similar to the capillary type, but have larger diameters, and therefore, low permeation and recovery rates. Spiral-wound and plate-and-frame are common configurations for membrane systems.

- **Membrane Materials** – Membrane materials are manufactured from a variety of materials such as cellulose acetate (CA), cellulose diacetate (CDA), cellulose triacetate, polyamide (PA), other aromatic polyamides, polyetheramides, polyetheramines, and polyetherurea. In CA membrane chemistry, the higher the acetyl content, the higher the scale rejection, and the lower the water flux. Cellulosic membranes are usually inexpensive and can tolerate some chlorine; however, there are several disadvantages. CA membranes are subject to biological attack and to hydrolysis that reverts CA to cellulose and acetic acid. This reversion occurs very rapidly at very low or high pH values. PA and thin-film composite (TFC) membranes may be degraded by oxidants (i.e., Cl_2), but they resist hydrolysis and are not susceptible to biological attack.

- **Pretreatment Requirements** – Membrane clogging and fouling can occur as a result of scale, colloidal deposition, silt, metal oxides, organics, silica, and other substances in the feedwater. Pretreatment may be required to prevent or at least minimize fouling effects. Pretreatment components contain all the necessary particulate-removal filtration units and the chemicals needed to prevent fouling and hydrolysis. For instance, cartridge filtration typically is provided to remove suspended solids before membrane treatment. Injections of acids or antiscalents also are commonly used to condition the raw water supply before treatment through the membrane system.

Four membrane applications were evaluated for this project. These applications include SWRO, NF, ED, and EDR. A brief description of each is provided below.

1. **SWRO** – This pressure-driven process retains more than 95% of sodium chloride and passes water through a semipermeable membrane. The process can properly treat brackish water and seawater containing a range of 1,500 to 50,000 ppm TDS. Through the SWRO process, a concentrated brine is generated, which requires appropriate disposal. SWRO is widely used to desalt seawater. Because of the small size of the pores, SWRO acts as an effective barrier to dissolved organic and inorganic constituents as well as to bacteria and viruses. The operating pressure depends largely on the salinity of the raw water supply. Processes involving waters with high salinity require higher operation pressure. Like all pressure-driven processes, SWRO requires relatively large quantities of energy and a certain degree of pre-treatment. However, the widespread use of SWRO for seawater desalination has resulted in decreased costs, which makes it a desirable alternative compared to other methods of treatment.

2. **NF** – This membrane operation is nearly identical to the one previously described for SWRO. The primary difference between the two lies in the porosity of the membranes used. Nanofilters are an excellent choice for removal of multi-valent ions such as calcium and other water quality constituents such as viruses, cysts, etc. NF is a suitable choice to apply to a groundwater supply, which must be softened, and/or to reduce the overall TDS content of the water supply by up to 40 to 60 percent. However, due to the relative size of the pores in a NF membrane, this process would not be appropriate to cost-effectively remove TDS from a seawater supply.

3. **ED** – This is an electro-chemical separation process in which ions are transported through semi-permeable-, anion-, or cation-selective membranes from a less concentrated to a more concentrated solution as a result of the flow of a direct current applied to the membranes. The water runs tangentially to the membrane and the ions move perpendicularly. Since a large portion of the current on the anion membrane is carried by hydroxide ions, an increase in pH and potential calcium carbonate precipitation on the surface of the membrane can occur. This concentration polarization causes undesirable conditions such as increased energy consumption and reduced polarization flux. ED is applicable for brackish groundwater or surface water supplies containing TDS concentrations less than 10,000 ppm.

4. **EDR** – This is a variation of the ED process in which the polarity is periodically reversed. Consequently, the ion movement changes direction. This direction change prevents the accumulation of scale-forming materials on the surface of the membranes, and therefore, minimizes the need for pre-treatment to prevent membrane fouling. Both ED and EDR are typically used for treating brackish water to meet drinking water standards; however, EDR is a patented process, and this particular technology is available only through a single source. Like ED, EDR is applicable for brackish groundwater or surface water supplies containing TDS concentrations less than 10,000 ppm.

3.4.1.2 Thermal Processes

At least three thermal processes could be used for desalination of seawater, assuming that there is a suitable and sufficient source of steam energy to drive the process. This single requirement of sufficient steam energy availability effectively eliminates all of the thermal processes from further consideration. Although a co-located power plant would be available based on the conceptual design presented in this report, the power plant's 100-megawatt (MW) capacity would not be large enough to support any of the thermal processes.

The three commonly used thermal processes are multi-effect distillation (MED), multi-stage flash (MSF), and mechanical vapor compression (MVC). Each of these methods distills and purifies water by boiling it, while concurrently reducing the vapor pressure within each unit and thereby minimizing the need for additional heat energy to carry out the process. A brief description of each process type is provided below.

1. **MED** – MED is an established process for seawater desalination. This type of distillation consists of a series of evaporation processes called "effects." In multiple-effect units, water is boiled on the outside of evaporation tubes. The water is applied in the form of a thin film to ease the evaporation process. The energy used for evaporation is the heat of condensation of the steam. The steam is condensed on the inner side of the evaporation tubes, and treated water produced by the process can be used as a potable drinking water supply. The capital cost of these new plants is also lower since they can be constructed from aluminum and other relatively low-cost materials.

2. **MSF** – This process was initially developed in the early part of the twentieth century and was further refined by the U.S. Navy in the early 1950s to eliminate the scaling problem occurring with MED. The incoming raw water is maintained under pressure and high temperature inside the evaporation tubes. After the water is heated to its highest temperature (not to exceed 100 degrees Celsius), it is passed through "flashing" stages. The vapor pressure is controlled in such a manner that the temperature and pressure in each stage is lower than the preceding one, which causes instantaneous boiling. The formed water vapor is condensed to form fresh water. The fresh water is passed in parallel with the forming brine through the stages. Since large quantities of brine are required to recirculate through the stages of the process to initiate flash boiling, 50 to 70% of the effluent brine is mixed with the feed water. The use of a "brine recycle" reduces the amount of water-conditioning chemicals required as well as pumping costs, which in turn greatly decreases the operating cost. Continuous runs of up to 90 days can be achieved without cleaning or the use of additives when using brine recycle. The principal disadvantage of brine recycling is the resulting high salinity of the product end of the brine. As the salinity increases, the boiling point of the feed water rises, and the danger of corrosion and scaling becomes greater.

3. **MVC** – The MVC process uses mechanical energy rather than direct heat. A vapor compressor is used to raise the temperature and pressure of the vapors from the boiling water supply. The heat of condensation is used to evaporate a thin film of saline water applied to the exterior of the tubes within the evaporation chambers. Vapor compression can be achieved by using a steam jet, also called a thermal compressor. The water vapor

is extracted through a venturi orifice at the steam jet. The vapor is then compressed to provide thermal energy for evaporation of the seawater on the outside of the tubes. Vapor compression units are usually built at resorts and industrial sites where drinking water is not readily available. The use of MVC technology typically is limited to smaller applications, such as those listed above, due to compressor capacity limitations.

3.4.2 Process Feasibility and Operational Considerations

Various feasibility and operational issues are associated with each of the desalination treatment technologies presented above. These issues include the following:

- Complexity of the treatment process;
- Chemical needs;
- Existing infrastructure available to support the implementation of a particular technology;
- Waste handling and disposal;
- Operator skill and level of involvement; and
- Maintenance requirements.

While both membrane and thermal desalination processes require energy to operate, thermal processes are extremely energy-intensive. Thermal processes require minimal pre-treatment compared to the membrane processes, thereby potentially reducing operation and maintenance requirements to a significant degree. Despite the latter advantage associated with thermal desalination systems, implementation of membrane systems has proliferated in recent years due to ongoing technological advances coupled with relatively inexpensive manufacturing and installation costs.

The primary feasibility and operational considerations of particular importance with respect to implementing these technologies for the Brownsville Desalination Demonstration Project are outlined and discussed below:

- **Suitability of Thermal Processes** – Where possible, thermal treatment systems that use MED and MSF technology are constructed in locations where they can use thermal energy previously generated by an existing industry, such as backpressure steam from turbines in a power production plant. If these types of industries are not present, MED and MSF systems would require a system of dedicated boilers to provide the necessary heat energy to drive the treatment process, thereby substantially increasing O&M requirements, space, and costs. As stated above, at the current size of 100 MW the proposed co-located power plant would not be large enough to generate sufficient quantities of steam energy to support any of the thermal desalination alternatives for this particular project. However, should circumstances change and the power plant capacity increase, this would be re-evaluated. In addition, there are no known industries within close proximity to the proposed site for the Desalination Facility that could provide suitable quantities of thermal energy for the MED and MSF processes. Without an existing source for the requisite steam energy, these thermal technologies are not cost-competitive with the MVC thermal process. Therefore, these two thermal alternatives were eliminated from further consideration.

The remaining thermal technology of MVC incorporates electric or diesel-driven steam compressors as the primary source of energy to minimize heat energy requirements. Capacity limitations associated with the compressors used in an MVC system eliminate this last thermal option from further consideration for this project.

- **Suitability of Membrane Processes** – All of the membrane processes previously discussed (SWRO, NF, ED, and EDR) were considered as potential candidates for treating the raw water supply from the Brownsville Ship Channel. Of the four technologies, SWRO has been implemented to a much larger extent than the other membrane technologies and is considered the most appropriate membrane technology for treatment of seawater. The NF, ED, and EDR processes are primarily used in the desalination of brackish water with TDS concentrations of 10,000 ppm or less. In addition, both the ED and EDR processes are typically used for treatment facilities with finished water capacities of 15 MGD or less. In instances where either the TDS concentrations or the treatment capacities exceed these typical values, the capital and O&M costs of these processes become prohibitively expensive. For these reasons, NF, ED, and EDR processes are eliminated as viable treatment solutions.

- **Operation and Maintenance Requirements** – The difference in O&M requirements between a membrane system and a thermal system are significant. The principal difference between the two is the virtual elimination of pre-treatment requirements for the thermal process. A thermal process has minimal pretreatment needs and is usually restricted to the application of an antiscalent. In contrast, an SWRO system would require a substantial degree of pretreatment. Thus, there is a significant difference between the two primary treatment options with regard to the amount of O&M needed for pretreatment. However, since the suitability of the thermal processes is not appropriate for this particular application (i.e., due to the lack of available steam power, the relative size of the project, etc.), the advantages associated with the reduction of pretreatment requirements for the thermal alternatives are negated.

- **Relative Power Requirements** – Without a separate entity or source from which to obtain steam or a preheated water stream for the thermal treatment process, electrical consumption for the thermal alternatives can be as high as 700% more than for an SWRO system. This significant difference between thermal and membrane systems would substantially affect annual operation costs to the point that thermal processes would not be cost-effective for the production of potable water. Based on this issue and those presented above, the thermal-based systems are eliminated from further consideration.

3.4.3 Selection of Preferred Desalination Alternative

Based on the operation considerations discussed above, the use of SWRO membranes is recommended for the Brownsville Desalination Demonstration Project. Refer to **Section 4** for a complete description of the primary treatment system for the desalination facility, which includes the SWRO membrane systems along with other components used to support this type of treatment process.

3.5 ENERGY REDUCTION ALTERNATIVES AND CONSIDERATIONS

Because of the large amount of power needed to operate the desalination components of the project, additional consideration of various energy reduction alternatives should be taken into account and explored. The following section assesses potential modifications and supplemental components that could be used to reduce the overall power required to operate the desalination facility.

3.5.1 In-Line Feedwater Heater Analysis

Installation of an in-line feedwater heater was evaluated to determine if its use would make the desalting process more economical. Since the desalination facility may be co-located with a new coal-fired, 100-MW power plant, potential synergies between the two facilities should be explored. One of these synergies is the use of excess steam energy that may be available from the power plant for any beneficial use in the desalination facility. The option of using an in-line heater that would use excess low-to-medium grade steam from the power facility is further investigated as detailed below. It is important to note that the relative quantity of steam needed to drive one of the previously described thermal desalination processes (MED, MFD, and MVC) is high compared to the quantity of steam needed to support an in-line feedwater heater.

As previously discussed, the temperature of the Brownsville Ship Channel water typically ranges from 60 degrees Fahrenheit (°F) to 95°F, with the annual average temperature of the water being 75°F. As the temperature of the feedwater increases, the pressure required for the SWRO intake pumps decreases, resulting in a tangible savings in pumping energy usage. The output pressure of the SWRO intake pumps generally can be reduced by approximately 1% for each 1°F temperature increase. Thus, if the feedwater were heated from 75°F to 90°F, the required output pressure of the SWRO intake pumps would be reduced by approximately 15 percent.

To further explore this issue, several SWRO membrane manufacturers were contacted to determine the “ideal” feedwater temperature. Although the results varied, it was determined that a temperature of 90°F would be a proper and manageable goal for the project. As such, manufacturers were contacted who could provide a means of injecting steam into the feedwater stream to heat it to approximately 90°F. It was determined that a 36-inch direct steam injection heater would be a suitable choice. On average, the heater would use approximately 11,700 pounds per hour (lbs/hr) of steam at 165 pounds per square inch, gauge (psig) to heat the feedwater from 75°F to 90°F. A temperature monitor would be installed directly downstream of the heater that would be tied to control logic that would allow the appropriate amount of steam to maintain an approximate temperature of 90°F in the feedwater stream.

By incorporating the feedwater heater into the design, the average discharge pressure of the SWRO intake pumps would be reduced by approximately 15% over the course of a year. Using an energy cost of $0.035/kilowatt per hour (kW-hr), and accounting for the cost of the steam from the power plant, the use of the feedwater heater would result in an annual energy savings of approximately $385,000. Based on this information, the use of a feedwater heater is recommended for the desalination facility.

3.5.2 Energy Recovery System Alternatives

During the expected life of a desalination facility, one of the most important present worth cost components of producing potable water is the energy used to drive the high-pressure SWRO intake pumps. For this project, each SWRO intake pump would require approximately 4,000 HP if an energy recovery system was not used. This, along with the relatively low capital and O&M costs of energy recovery systems, necessitates the use of such a system for the proposed facility to defray overall energy requirements.

Two types of energy recovery systems were considered for this project. These systems include positive displacement work exchangers and Pelton Wheel (impulse) turbines. A third and newer type of positive displacement device, which uses the pressure exchange principle, is also available and is much simpler in operation than the conventional work exchanger and Pelton Wheel turbines. However, these devices are only capable of handling approximately 200 gpm of flow per unit at the present time. The use of this latter type of system would require approximately 11 units along with the associated booster pumps and piping per seawater SWRO train. Thus, the use of these devices would substantially complicate the configuration of the transfer piping system, require additional mechanical equipment, and result in a more labor-intensive system to operate and maintain through time. For these reasons, this latter option is eliminated from further consideration.

3.5.2.1 Positive Displacement Work Exchange Energy Recovery System

Positive displacement work exchangers were analyzed for their use as a potential energy recovery system for the Brownsville Desalination Demonstration Project. These devices transfer the high-pressure brine energy directly onto the incoming seawater. This system can be very efficient, and virtually no energy is lost in the transfer from the high-pressure rejection stream to the high-pressure feedwater stream. The installation of these systems can be very complex, requiring numerous valves, flow meters, piping, booster pumps, etc. Typical efficiencies for work exchangers range from approximately 85 to 95 percent. **Table 3-24** illustrates some of the main advantages and disadvantages associated with positive displacement work exchangers.

Table 3-24. Advantages and Disadvantages of Positive Displacement Work Exchangers

Advantages	Disadvantages
▪ More efficient than Pelton wheel turbines for lower flow applications.	▪ Flow limited; multiple units need per seawater SWRO process train. ▪ Not as efficient as Pelton wheel turbines in higher flow applications. ▪ Additional pumps, valves and piping required. ▪ Installation is relatively complex.

3.5.2.2 Pelton Wheel Turbine Energy Recovery System

Pelton Wheel turbines are another alternative considered for a potential energy recovery system for the Brownsville Desalination Demonstration Project. Pelton Wheel turbines operate by using kinetic energy associated with the high pressure SWRO reject stream to spin a rotating shaft, which in turn transfers energy from the brine stream to the SWRO feed water stream. Pelton Wheels are typically used for applications where high-pressure heads are available. Typical efficiencies for Pelton Wheel turbines range from approximately 80 to 90 percent. Large seawater SWRO facilities that have recently been constructed in Spain, Trinidad, and Florida all use Pelton Wheel energy recovery devices. **Table 3-25** illustrates some of the main advantages and disadvantages associated with Pelton Wheel energy recovery systems.

Table 3-25. Advantages and Disadvantages of Pelton Wheel Energy Recovery Systems

Advantages	Disadvantages
▪ Proven technology with large-scale SWRO facilities. ▪ Generally more efficient than positive displacement devices in high pressure, high flow situations. ▪ Typically are skid-mounted by pump manufacturer; very little on-site installation is required. ▪ Small footprint and relatively simple piping arrangement required for installation; units connect directly to high-pressure SWRO intake pumps.	▪ Very high pressure head is required for cost-effectiveness. ▪ Not as efficient as positive displacement devices in lower flow applications. ▪ Does not allow for reduction in pumping capacity for high pressure SWRO intake pumps.

3.5.2.3 Comparison of Energy Recovery System Alternatives

An economic analysis was performed for the alternative energy recovery systems considered in this study. **Table 3-26** presents a comparison of the capital costs, operation and maintenance costs, and present worth for these alternatives.

Table 3-26. Comparison of Capital and Annual Operation & Maintenance Costs for the Energy Recovery System Alternatives

Cost Item	Pelton Wheel Turbine	Positive Displacement Work Exchanger
Estimated Capital Cost	$2,500,000	$4,500,000
Estimated Annual O&M Costs	$50,000	$50,000
Present Worth	$3,010,000	$5,010,000

Table 3-27 presents a summary of screening criteria and weighted scores for the energy recovery systems evaluated.

Table 3-27. Summary of Screening Criteria and Weighted Scores for the Energy Recovery System Alternatives

Screening Criteria	Score	Weighting Factor	Weighted Score
Positive Displacement Work Exchanger			
Technical/Treatment Efficiency	9	40	36.0
Unit Reliability	9	35	31.5
Permitability	5	25	12.5
Constructability	3	30	9.0
Cost-Effectiveness	7	50	35.0
		Total Weighted Score	**124.0**

Table 3-27. Summary of Screening Criteria and Weighted Scores for the Energy Recovery System Alternatives			
Screening Criteria	**Score**	**Weighting Factor**	**Weighted Score**
Positive Displacement Work Exchanger			
Pelton Wheel Turbine			
Technical/Treatment Efficiency	9	40	36.0
Unit Reliability	9	35	31.5
Permitability	5	25	12.5
Constructability	7	30	21.0
Cost-Effectiveness	9	50	45.0
		Total Weighted Score	**146.0**

3.5.2.4 Selection of Preferred Energy Recovery System Alternative

The analysis of the energy recovery system alternatives reveals that a Pelton Wheel turbine system would be the most cost-effective and most appropriate energy recovery system for the Brownsville Desalination Demonstration Project. The system would consist of one energy recovery turbine per seawater SWRO train, along with the requisite piping and appurtenances. The use of this system would reduce the power consumption of the high-pressure SWRO feed pumps by approximately 33 percent. Using a unit power cost of $0.035/kW-hr, this would correspond with an energy savings of approximately $3,835 per day or $1,400,000 per year. As a result, the facility would realize a reduction in the cost to produce potable water of approximately $0.153/1,000 gallons.

3.6 PERMEATE STABILIZATION SYSTEM ALTERNATIVES

Stabilization of the desalted water supply before distribution is necessary to protect the various components in the distribution system and plumbing works within buildings from corrosion caused by contact with the new water supply. Stabilized water typically has a quantity of calcium slightly in excess of its solubility limit, as well as bicarbonate alkalinity and a pH level between 7.0 (neutral) and 8.5 SU. By maintaining a proper concentration of these constituents and optimizing the pH level for the finished water supply, a thin coating of calcium carbonate ($CaCO_3$) film forms on the interior surfaces of the distribution system components, thereby reducing the leaching potential of metals into the water supply from piping and plumbing components.

The raw seawater has an average alkalinity value of 126 mg/L (as $CaCO_3$). At the normal pH level of the seawater supply, the majority of the alkalinity is in the form of bicarbonate (HCO_3^-), which is easily removed through SWRO membranes. However, if properly managed and preserved during pretreatment and primary treatment of the seawater supply, sufficient alkalinity would be available to address water stabilization in the post-treatment system. Preservation of bicarbonate alkalinity can be accomplished through pH reduction prior to membrane filtration. A reduction in pH would convert bicarbonate into carbonic acid, which would pass through the pores of the SWRO membrane elements. Only calcium and proper pH management subsequent to membrane treatment would be needed to ensure a properly stabilized water supply.

For the purposes of this study, it is assumed that supplemental alkalinity addition will not be needed to properly stabilize the finished water supply. This assumption is based on: 1) the quantity of alkalinity present in the water supply, and 2) the management and preservation of alkalinity within the pretreatment and primary treatment systems through pH adjustment (reduction).

Therefore, the stabilization system should be designed to add approximately 40 mg/L of calcium, as $CaCO_3$, to the permeate stream generated by the upstream desalination process, while increasing the pH level to result in a stable water supply. If a supplemental source of alkalinity is needed for the project, a carbon dioxide system or a soda ash system could be added to the process design. The alternative permeate stabilization systems evaluated for the Brownsville Desalination Demonstration Project include a conventional pebble lime system and a system using pressured calcite filters. Both of these alternatives will add calcium and increase the pH level of the water supply.

3.6.1 Calcite Filters Stabilization System

Calcite is a mineral consisting of calcium carbonate crystallized in hexagonal form. Calcite is found in common limestone, chalk, and marble and can be used cost-effectively to neutralize acidic or low pH water. Two sources of calcite are widely used and available in mesh sizes for filters. These two sources include crushed southern marble calcite and ground northern limestone calcite.

The design of a calcite filter should account for the contact time required for the chemical reaction to reach completion as well as the flow path of permeate through the filter. Calcite filters usually increase the pH of a water supply by approximately 1 to 2 SU. The reaction of the calcium carbonate with carbon dioxide (CO_2) that may be in the permeate stream results in a treated water containing calcium bicarbonate that increases the pH of the permeate. Calcite filters eliminate acid condition due to CO_2 or small amounts of mineral acids. The acid combines with the carbonates in the limestone to form relatively soluble bicarbonates. Limestone filters are easy to use and require relatively little maintenance.

As the media in the calcite filters becomes exhausted, the addition of more calcite is required. Filter manufacturers can accurately predict how often to regenerate and replace the media. For proper neutralization, it is critical that the service flow rate through the filters does not exceed the rate at which the chemical reactions can occur.

Table 3-28 illustrates some of the main advantages and disadvantages associated with the calcite filter permeate stabilization system.

Table 3-28, Advantages and Disadvantages of a Calcite Filter Permeate Stabilization System

Advantages	Disadvantages
▪ Relatively easy dosage control. ▪ Air permit not required.	▪ High capital costs. ▪ Large site footprint required. ▪ Relatively little track record for operation of these units in the U.S.

3.6.2 Pebble Lime Stabilization System

Based on initial stability calculations coupled with the projected hydraulic capacity for this plant, a pebble lime system was considered as a potential alternative to stabilize the water supply before distribution. A storage silo would be required to maintain a sufficient stock of pebble lime along with an appropriate solid feed and make-up system. Mechanical components in this system would include the following components: 1) a bin activator, 2) a rotary screw feeder and vibrator to route the solid chemical stock into a slaker equipped with a mechanical mixer and temperature transducer, 3) a grit classifier for the removal of unslaked solids, 4) a lime slurry tank equipped with a mechanical mixer, and 5) a water supply rotameter panel equipped with a series of water feed lines for the system. In addition, the storage silo for the pebble lime stock would be equipped with level sensors, a dust collector blower, and a dust collection sequencer. These components are needed to control (abate) potential dust emissions from this system during deliveries of the pebble lime stock. One set of slurry transfer pumps (total of two) would route the lime slurry to the desalted permeate supply, with the requisite detention time provided either in-line or in a dedicated contact tank.

Table 3-29 illustrates some of the main advantages and disadvantages associated with the pebble lime permeate stabilization system.

Table 3-29. Advantages and Disadvantages of a Pebble Lime Permeate Stabilization System

Advantages	Disadvantages
▪ Pebble lime is relatively inexpensive and readily available. ▪ Relatively inexpensive capital costs. ▪ Pebble lime systems have a proven track record, are well understood, and systems are pre-engineered with all necessary components.	▪ Air permit required for emissions. ▪ Potential for overdosing lime in the permeate stream that could result in a build-up of lime in potential storage facilities. ▪ Lime processing equipment prone to frequent maintenance. ▪ Off-dusting within the silo enclosure can result in a lime dust coating in and around all exposed equipment within the system. ▪ Semihazardous material, which is caustic in nature, and requires proper personal protection for operators working in the area.

3.6.3 Comparison of Stabilization System Alternatives

An economic analysis was performed for the alternative stabilization systems considered herein. **Table 3-30** presents a comparison of the capital costs, O&M costs, and present worth for these alternatives.

Table 3-30. Comparison of Capital and Annual O&M Costs for Permeate Stabilization

Cost Item	Permeate Stabilization Alternative	
	Pebble Lime System	Calcite Filters
Estimated Capital Cost	$300,000	$3,000,000
Estimated Annual O&M Costs	$50,000	$70,000
Present Worth	$740,000	$1,715,000

Table 3-31 presents a summary of screening criteria and weighted scores for the stabilization alternatives evaluated.

Table 3-31. Summary of Screening Criteria and Weighted Scores for the Permeate Stabilization System Alternatives

Screening Criteria	Score	Weighting Factor	Weighted Score
Pebble Lime System			
Technical/Treatment Efficiency	7	40	28.0
Unit Reliability	5	35	17.5
Permitability	7	25	17.5
Constructability	8	30	24.0
Cost-Effectiveness	9	45	40.5
		Total Weighted Score	**127.5**
Calcite Filters			
Technical/Treatment Efficiency	9	40	36.0
Unit Reliability	8	35	28.0
Permitability	8	25	20.0
Constructability	5	30	15.0
Cost-Effectiveness	2	50	10.0
		Total Weighted Score	**109.0**

3.6.4 Selection of Preferred Stabilization System Alternative

Based on the previously described evaluation of the two stabilization alternatives, the pebble lime system is the most viable and cost-effective solution for this project.

3.7 DISINFECTION SYSTEM ALTERNATIVES

Alternative disinfection systems evaluated for the Brownsville Desalination Demonstration Project include the following:

- Chlorine gas;
- Commercial hypochlorite; and
- On-site hypochlorite generation.

A detailed evaluation (including economic considerations) of each alternative is presented in the following sections.

3.7.1 Chlorine Gas

Chlorine gas disinfection systems have demonstrated reliability in thousands of installations across the U.S. and abroad for almost 100 years. Part of the historical preference for chlorine gas systems was based on the relatively inexpensive capital, O&M, and chemical costs, as well as their reliability and trouble-free operation. However, the cost advantage of chlorine gas systems over other forms of chlorine for disinfection has decreased substantially in recent years due primarily to increased costs resulting from the adoption of new regulations, i.e., Uniform Fire Code and Risk Management Program, and increased material costs. Although chlorine gas prices increased almost 200% between 1996 and 1998 in the U.S., chlorine gas is still a relatively inexpensive chemical.

Most of the concerns associated with the use of chlorine as a disinfectant result from recent discoveries of some of the disinfection byproducts (DBPs) formed by the use of chlorine in the presence of water containing DBP precursors. Some of the DBPs have since been identified as suspected carcinogens. The USEPA has since legislated means of controlling the maximum concentration limits (MCLs) for various DBPs in treated water.

Because of safety concerns related to potential accidental releases of chlorine gas during transport and storage, new and stricter federal regulations have been adopted. These regulations have resulted in a substantial increase in the cost of chlorine gas systems. The same quality that makes chlorine gas a good disinfectant also makes it extremely toxic to humans. Although new safety measures are currently in effect, there are still risks associated with the use and transportation of chlorine gas. For example, while scrubbers may help to protect communities surrounding the treatment plant in case of a chlorine leak, the immediate area around the chlorine cylinder would still be hazardous, potentially exposing plant personnel to chlorine gas.

There have been numerous accidental chlorine gas leaks since chlorine was first used as a disinfectant. Although recent improvements in containment have greatly reduced the risks associated with the use of chlorine gas, accidental leaks still occur, often causing serious injury or death. It is important to note that the transportation of chlorine gas is highly regulated and requires special transportation permits and licensing. The trend toward more regulations regarding the transportation and storage of chlorine gas may continue, resulting in increased costs and difficulties associated with its use.

3.7.2 Commercial Hypochlorite

Commercial sodium hypochlorite systems are also well established; however, their use in the past has been primarily restricted to small systems. Relatively high chemical costs make commercial sodium hypochlorite systems less practical for larger water supply systems. Commercial sodium hypochlorite systems are basic chemical feed systems with tanks and metering pumps that involve low capital costs. These systems are relatively easy to operate and maintain, and do not require substantial operator attendance.

Commercial sodium hypochlorite is generally available in strengths of 12 to 15% by weight. A significant issue related to its use is the rapid degradation and loss of available chlorine over short periods. The following factors result in a more rapid degradation of the solution: 1) high hypochlorite concentrations; 2) high temperatures; 3) presence of iron, copper, nickel, and cobalt; and 4) exposure to light. Sodium hypochlorite solutions are most stable at a pH of 11, when stored in the dark at temperatures less than 70°F, and with iron, copper, nickel, and cobalt concentrations less than 0.5 mg/L. Storage for less than 28 days is highly recommended, and 7 days is preferred. Weekly deliveries of sodium hypochlorite should be scheduled to reduce degradation problems. The need for frequent deliveries and limited storage capabilities increases the risk of interrupted supply. In addition, the delivered chemical will have been stored and transported under unknown conditions, and the degree of degradation that occurs before arrival will be unknown. Thus, receiving a product from week to week that is of consistent quality is not guaranteed when using commercially available hypochlorite. Maintaining the solution at 70°F requires either an air-conditioned building for the storage tanks or a recycle line that is processed through a cooling unit.

Commercial sodium hypochlorite is produced from caustic soda, water, and chlorine. The pH is generally greater than 11 and can be as high as 13. Scaling of equipment can be a problem due to the presence of caustic; appropriate maintenance and cleaning are required. In particular, feed points require frequent cleaning to ensure delivery of the chemical. Although commercial hypochlorite is safer than chlorine gas, it is highly corrosive, posing a threat to equipment and safety if a spill occurs. The USEPA requires that secondary containment be provided for hypochlorite concentrations greater than 1 percent.

In addition to operational and maintenance problems caused by scaling, commercial sodium hypochlorite also off-gases oxygen. These gases can cause binding in the chemical feed lines and metering pumps. Special design features are necessary to avoid these problems, including the use of peristaltic hose pumps rather than diaphragm pumps for chemical metering.

3.7.3 On-Site Hypochlorite Generation

On-site generation of sodium hypochlorite has been in use in the U.S. and Europe for more than 20 years. Although well established in other industrial processes, on-site systems are relatively new in the water treatment industry. The on-site system is more complex than the chlorine gas system, but the ability to use commercial sodium hypochlorite as backup when necessary provides an extra element of reliability for the system. On-site generation of sodium hypochlorite requires relatively large capital expenditures to purchase the electrolytic cells and rectifiers. However, the raw material required for the system, i.e., solar salt, is produced locally and is readily available at a low cost.

On-site generated sodium hypochlorite is produced on an as-needed basis by electrolysis systems using salt, electricity, and softened water. One equivalent pound of chlorine is produced from 15 gallons of softened water, 1.9 pounds of salt, and 1.8 KW-hr of electricity. Because of the low concentration (approximately 0.8% by weight) of sodium hypochlorite produced by on-site generated systems coupled with minimal storage times, the degradation problems of commercial sodium hypochlorite are significantly reduced. In addition, the recent technological advances in the generation of sodium hypochlorite allow for easier O&M. Typical maintenance would include cleaning the electrodes with a muriatic acid solution twice per year to remove minerals that have plated-out onto the cells.

On-site generation produces 0.8% sodium hypochlorite that is substantially less corrosive than commercial hypochlorite, thereby posing less threat to workers and equipment, and negating the need for secondary containment. Sodium hypochlorite generation produces a small quantity of hydrogen gas that needs to be vented. Because hydrogen gas is lighter than air, conditions where the hydrogen gas could collect in pockets should be avoided. Standard design of on-site generation systems includes venting the hydrogen from the storage tanks and equipment building to the atmosphere where it quickly disperses.

3.7.4 Comparison of Disinfection System Alternatives

An economic analysis was performed to compare the three chlorination systems under consideration. Prices for chlorine gas, commercial sodium hypochlorite, and solar salt were obtained from local suppliers. A Risk Management Plan (RMP) is only required for the gas chlorine system, and its cost was considered. A cost of $20,000 for an initial RMP fee was amortized, and an additional fee of $2,000 for an annual update was included. A summary of the results from the economic analysis for the various chlorination systems under consideration is presented in **Table 3-32.**

Table 3-32. Comparison of Capital and Annual O&M Costs for the Disinfection System Alternatives

Cost Item	Treatment Alternative		
	Chlorine Gas	Commercial Sodium Hypochlorite	On-Site Generated Sodium Hypochlorite
Estimated Capital Cost	$1,000,000	$500,000	$1,300,000
Estimated Annual O&M Costs	$151,250	$370,250	$85,195
Annualized Estimated Risk Management Expense	$4,000	N/A	N/A
Present Worth	$2,585,000	$4,280,000	$2,170,000

N/A = Not Available.

Table 3-33 presents a summary of screening criteria and weighted scores for the disinfection system alternatives.

Table 3-33. Summary of Screening Criteria and Weighted Scores For the Disinfection System Alternatives

Screening Criteria	Score	Weighting Factor	Weighted Score
Chlorine Gas			
Technical/Treatment Efficiency	7	40	28.0
Unit Reliability	7	35	24.5
Permitability	4	25	10.0
Constructability	5	30	15.0
Cost-Effectiveness	7	50	35.0
		Total Weighted Score	**112.5**
Commercial Sodium Hypochlorite			
Technical/Treatment Efficiency	7	40	28.0
Unit Reliability	7	35	24.5
Permitability	6	25	15.0
Constructability	6	30	18.0
Cost-Effectiveness	3	50	15.0
		Total Weighted Score	**100.5**
On-Site Generated Sodium Hypochlorite			
Technical/Treatment Efficiency	7	40	28.0
Unit Reliability	5	35	17.5
Permitability	8	25	20.0
Constructability	4	30	12.0
Cost-Effectiveness	9	50	45.0
		Total Weighted Score	**122.5**

3.7.5 Selection of Preferred Disinfection System Alternative

The analysis of disinfection alternatives reveals that an on-site sodium hypochlorite generation system would be the most cost-effective, safest, and most appropriate disinfection system for the Brownsville Desalination Demonstration Project. The process produces hypochlorite of consistent quality, is non-corrosive compared to the other chlorination options, and the product is not prone to significant degradation effects. In addition, in the event of the temporary failure of the sodium hypochlorite system, commercial bleach can be brought to the site and used for disinfection while repairs are made. Additionally, hypochlorite is the safest and easiest to handle of the three chlorine sources, with minimal regulatory requirements associated with it. Based on this information, the use of an on-site sodium hypochlorite generation system is recommended as the preferred alternative for this project.

3.8 SOLIDS HANDLING AND DEWATERING SYSTEMS

Solids-laden wastewater generated by the desalination facility generally consists of inorganic suspended solids and floc. This wastewater stream, also commonly referred to as sludge, is generated partially by the chemical coagulation process used in the pretreatment system. To select suitable components for properly managing this stream, the wastewater stream that could be generated by the pretreatment system should be evaluated, quantified, and qualified at the conceptual level. Typically, components in a well-engineered solids handling system are used to recover water that would otherwise be lost from the desalination facility, while minimizing the amount of solid waste generated, which must be disposed.

This section summarizes the evaluation of solids processing options for the Brownsville Desalination Demonstration Project. The configuration of the principal components within the solids handling system would be essentially the same, regardless of which type of pretreatment alternative is used. The system generally would consist of a clarification/thickening system, followed by a dewatering system along with all requisite transfer pumping and/or piping systems.

The solids handling system would produce three streams as further described below:

- **Supernatant** – Supernatant from the thickening system's tanks would be recovered and routed back into the pretreatment systems for recycle to minimize water loss and reduce waste discharges to the degree practical.

- **Filtrate** – Due to the potential for various, undesirable constituents within filtrate from the solids handling system's dewatering system (e.g., cryptosporidium, giardia), this relatively low-flow waste stream would be transferred to the Robindale Wastewater Treatment Plant for final treatment and disposal. (The Robindale plant is within the jurisdictional control of the Brownsville PUB; is located relatively close to the site proposed for the desalination facility; and can accept this waste stream which would be classified as an industrial wastewater.)

- **Residuals** – After the sludge stream generated by the pretreatment system has been thickened and dewatered, the remaining dewatered sludge, also commonly referred to as residuals, will require off-site disposal.

3.8.1 Solids Clarification/Thickening System Alternatives

An analysis was conducted to evaluate solids clarification/thickening system alternatives. The two types of systems that were evaluated include a gravity thickening system with a center-mounted reaction chamber and a lamella-type settling/thickening system.

3.8.1.1 Gravity Thickeners with Reaction Chamber

A gravity thickener/reaction-type clarification system was evaluated for use in the proposed Brownsville Desalination Demonstration Project. The system would consist of three 85-foot diameter concrete structures fitted with mechanical equipment to assist with the thickening and bulk separation of solids from the influent wastewater stream. These types of systems have a proven and reliable track record and are commonly used in many water treatment facilities around the world. There are two important factors with respect to the proposed Brownsville Desalination Demonstration Project's site that were considered as part of this facility's proposed thickening system evaluation and selection. These factors are:

- **Materials of Construction** – Due to the high concentrations of dissolved solids in the influent wastewater stream, the gravity thickeners would need to be fitted with appropriate mechanical components that would be resistant to the corrosive nature of the water. As these types of thickeners are relatively large, the capital costs of this equipment would be relatively high.

- **Soil Conditions** – As previously indicated, the load-bearing characteristics for the soils at the proposed project site would require that piles approximately 35 feet in depth and 10 feet on-center, be installed for all medium to large structures and for all water bearing structures. Due to the relatively large size of this type of thickening system, additional piles would need to be installed to support the large footprint area of a conventional thickener structure. This requirement would further escalate costs and further increase the potential risk of structural instability if one of the supporting piles were to fail for any reason.

Based on these factors, the use of conventional circular gravity thickeners was eliminated from further consideration.

3.8.1.2 Lamella-Type Settling/Thickening Tanks

Since conventional thickeners were eliminated as discussed above, alternative components and configurations were investigated for the initial sludge-thickening operation. Several equipment manufacturers were contacted to select a thickening system that would be as small as possible, while resulting in a suitable and reliable degree of thickening. Based on the results of the evaluation of alternative thickening systems, in conjunction with feedback from various qualified equipment vendors, the following alternative was considered technically feasible, constructible, and cost-effective for this project.

This system would consist of a series of flocculation basins followed by a settling tank equipped with lamella-type plates, which would compose a single process train. Mechanical mixers would be used to impart the necessary mixing energy for each stage in the flocculation basin. An anionic polymer, and possibly lime, would be added to the influent wastewater flow to aid in the thickening and subsequent dewatering systems. This unit operation is considered necessary to reduce the total quantity of sludge that must be dewatered and eventually disposed. Based on experience and professional judgment, the use of the proposed thickening system should produce a thickened sludge containing between 2 to 4% dry solids. Refer to **Section 4** for a complete description of this system.

Table 3-34 presents the estimated capital and annual O&M costs for this sludge thickening alternative.

Table 3-34. Sludge-Thickening System Estimated Capital and Annual O&M Costs

Item Description	Cost
Estimated Capital Costs	
Thickener Tanks	$155,000
Flocculation Tanks	$60,000
Thickener Mechanical Components	$340,000
Lamella Modules	$675,000
Mixers	$50,000
Subtotal	$1,280,000
Electrical and Instrumentation @ 15% of Capital Cost	$190,000
Installation @ 40% of Capital Cost	$510,000
Subtotal	$2,000,000
Contingency @ 25%	$500,000
Total Capital Cost	**$2,500,000**
Estimated Annual O&M Costs	
General Maintenance and Power	$105,000
Total	**$105,000**

3.8.2 Residuals Dewatering System Alternatives

Three residuals dewatering alternatives were evaluated and are described below. These alternatives are belt filter presses, centrifuges, and vacuum-assisted sludge drying beds.

3.8.2.1 Belt Filter Presses

Belt filter presses are widely used to dewater sludge, thereby reducing the volume of solid waste generated by the desalination facility. As their name implies, belt filter presses use moving belts to compress the incoming sludge, resulting in the separation of water (termed filtrate) from the solids stream. Typical belt filter press designs route the sludge through a series of dewatering zones within the press that are specifically designed to gradually apply pressure to remove water.

Three 2-meter-wide belt filter presses would be installed for this project. Two units would be designed to operate approximately 16 hours per day during peak solids loading events, and the third unit would serve as a redundant unit. Belt filter presses typically provide a dewatered residuals cake containing approximately 18 to 20% dry solids. **Table 3-35** shows some of the advantages and disadvantages of using belt filter presses.

Table 3-35. Advantages and Disadvantages of Belt Filter Press De-watering Systems

Advantages	Disadvantages
▪ Low power requirements. ▪ Low capital and operating costs. ▪ Minimal shutdown effort required. ▪ Reliable operation. ▪ Ability to handle highly abrasive sludges. ▪ Widely used for dewatering applications.	▪ Non-automated operation. ▪ Belts need to be replaced approximately once per year.

Table 3-36 presents the estimated capital and annual O&M costs for this sludge dewatering alternative.

Table 3-36. Belt Filter Press Estimated Capital and Annual O&M Costs

Item Description	Cost
Estimated Capital Costs	
Pre-Engineered Metal Building	$200,000
Sludge Transfer Pumps and Piping	$100,000
Polymer System	$25,000
Belt Filter Presses (3)	$810,000
Discharge Conveyor (50-Ft Length Assumed)	$67,500
Ancillary Items	$38,000
Subtotal	$1,240,000
Electrical and Instrumentation @ 15% of Capital Cost	$185,000
Installation @ 40% of Capital Cost	$495,000
Subtotal	$1,920,000
Contingency @ 25%	$480,000
Total Capital Cost	**$2,400,000**
Estimated Annual O&M Costs	
Power (18 HP, 16 hrs.\day)	$3,000
Polymer	$50,000
General Maintenance (390 hr/yr @ $35/hr)	$15,000
Total	**$68,000**

3.8.2.2 Centrifuges

A centrifugal dewatering process uses gravitational forces generated by rapid rotation of a cylindrical bowl to separate sludge solids from liquid. Sludge enters the centrifuge where it is forced against the bowl's interior walls and forms a pool. Density differences cause the sludge solids and liquid to separate into two different layers. Centrifugal force compacts the solids as they are plowed out of the pool and conveyed up to the discharge point. Dried solids exit through discharge ports, while clarified wastewater exits at the opposite end of the bowl. The centrifuge can produce a dewatered cake of approximately 20% dry solids. Centrifuges are easy to operate and require little operator attention since they are fully automated.

Similar to the operational description for the belt filter presses, three centrifuges would be installed. Two units would be designed to operate approximately 16 hours per day during peak solids loading events, and the third unit would serve as a redundant unit. **Table 3-37** provides some of the advantages and disadvantages associated with centrifuges.

Table 3-37. Advantages and Disadvantages of Centrifuges

Advantages	Disadvantages
▪ Capable of producing relatively dry cake. ▪ Relatively compact with reduced building size requirement. ▪ Automated operation. ▪ Minimal startup/shutdown effort required.	▪ Can produce significant noise levels in the local vicinity of the unit, necessitating hearing protection for workers. ▪ Wear tiles need to be replaced every 5 to 10 years. ▪ Relatively high power usage.

Table 3-38 presents the estimated capital and annual O&M costs for this residuals dewatering alternative.

Table 3-38. Centrifuge Estimated Capital and Annual O&M Costs

Item Description	Cost
Estimated Capital Costs	
Pre-Engineered Metal Building	$100,000
Sludge Transfer Pumps and Piping	$100,000
Polymer System	$25,000
Centrifuges (3)	$1,125,000
Discharge Conveyor (50-Ft Length Assumed)	$67,500
Subtotal	$1,420,000
Electrical and Instrumentation @ 15% of Capital Cost	$215,000
Installation @ 40% of Capital Cost	$570,000
Subtotal	$2,205,000
Contingency @ 25%	$880,000
Total Capital Cost	**$3,085,000**
Estimated Annual O&M Costs	
Power (100 HP, 16 hr\day)	$15,000
Polymer	$50,000
General Maintenance (160 hr/yr @ $35/hr)	$6,000
Total	**$71,000**

3.8.2.3 Vacuum-Assisted Drying Beds

Thickened residuals from the settling tanks would be pumped to the filter bed where they are applied to the surface of the filter media. Wastewater contained within the thickened residuals drains through the porous filter media, through the support plenum, and out of the bed structure, resulting in a filtrate stream. After the bed is filled with thickened residuals to its maximum operating level, the residuals feed line is closed and a vacuum pump begins operation. This pump creates a vacuum in the plenum underlying the media and in turn creates a uniform differential pressure between the top of the cake and the porous filter media. As residuals continue to consolidate and shrink, the resulting dewatered residuals cake starts to crack. A vacuum will be maintained until the bed is uniformly cracked, at which time vacuum will gradually be lost. As the plenum area loses vacuum, the vacuum pump shuts down, thereby terminating a complete dewatering cycle.

When ready, the plant operator removes a stop gate at one end of the vacuum bed to allow a front-end loader to remove dewatered residuals. The underlying media surface is subsequently washed down using high-pressure, low-volume water. Once cleanup is completed, the stop gates are placed back into position, and the bed is ready for another dewatering cycle. A complete dewatering cycle for a vacuum sludge drying bed is typically 24 hours.

A total of six vacuum drying beds would be used to provide enough dewatering capacity for the desalination facility. Vacuum drying beds typically provide a dewatered residuals cake containing approximately 18 to 20% dry solids. Advantages and disadvantages of vacuum sludge drying beds are listed in **Table 3-39**.

Table 3-39. Advantages and Disadvantages of Vacuum Sludge Drying Beds

Advantages	Disadvantages
▪ Low energy consumption. ▪ Low chemical consumption. ▪ Low sensitivity to sludge variability. ▪ Low operator skill required.	▪ Relatively large land requirements. ▪ Sludge removal is labor intensive. ▪ Beds must be thoroughly cleaned after sludge is removed. ▪ Sludge conditioning before application is desirable. ▪ Translucent roof required over beds' area.

Table 3-40 presents the estimated capital and annual O&M costs for this dewatering alternative.

Table 3-40. Vacuum-Assisted Drying Bed Estimated Capital and Annual O&M Costs

Item Description	Cost
Estimated Capital Costs	
Translucent Roof	$150,000
Transfer Pumps and Piping	$100,000
Polymer System	$25,000
Vacuum-Assisted Drying Beds (6)	$2,265,000
Subtotal	$2,540,000
Electrical and& Instrumentation @ 15% of Capital Cost	$380,000
Installation @ 40% of Capital Cost	$1,015,000
Subtotal	$3,935,000
Contingency @ 25%	$985,000
Total Capital Cost	**$4,920,000**
Estimated Annual O&M Costs	
Power	$10,000
Polymer	$7,000
General Maintenance and Labor	$50,000
Total	$67,000

3.8.2.4 Comparison of Residuals Dewatering System Alternatives

A comparison of the capital cost, O&M cost, and present worth value for the alternative residuals dewatering alternatives is presented in **Table 3-41**.

Table 3-41. Estimated Cost of Residuals Dewatering Alternatives

Alternative	Capital Cost	Annual O&M Cost	Annual O&M Present Worth	Total Present Worth
Belt Filter Presses	$2,400,000	$68,000	$695,000	$3,095,000
Centrifuges	$3,085,000	$71,000	$725,000	$3,810,000
Vacuum Assisted Sludge Drying Beds	$4,920,000	$67,000	$685,000	$5,605,000

Table 3-42 presents a summary of screening criteria and weighted scored for the above alternatives.

Table 3-42. Summary of Screening Criteria and Weighted Scores for Residuals Dewatering Alternatives

Screening Criteria	Score	Weighting Factor	Weighted Score
Belt Filter Presses			
Technical/Treatment Efficiency	8	40	32.0
Unit Reliability	7	35	24.5
Permitability	5	25	12.5
Constructability	6	30	18.0
Cost-Effectiveness	9	50	45.0
		Total Weighted Score	**132.0**
Centrifuges			
Technical/Treatment Efficiency	9	40	36.0
Unit Reliability	7	35	24.5
Permitability	5	25	12.5
Constructability	7	30	21.0
Cost-Effectiveness	7	50	35.0
		Total Weighted Score	**129.0**
Vacuum-Assisted Sludge Drying Beds			
Technical/Treatment Efficiency	8	40	32.0
Unit Reliability	9	35	31.5
Permitability	5	25	12.5
Constructability	5	30	15.0
Cost-Effectiveness	6	50	30.0
		Total Weighted Score	**121.0**

3.8.2.5 Selection of Preferred Residuals Dewatering System Alternative

The analysis of the dewatering alternatives reveals that belt filter presses would be the most cost-effective and most appropriate system for the Brownsville Desalination Demonstration Project. The presses produce a consistent residuals cake with relatively high solids content. For these reasons, it is recommended that belt filter presses be used for the Brownsville Desalination Demonstration Project. The presses would be designed and constructed of suitable materials to withstand the corrosive nature of residuals generated by the plant.

3.8.3 Residuals Drying System

Following the conventional dewatering system, a drying system using steam from the co-located power plant could be installed to increase the dry solids content of the sludge from 20% up to as much as 95%, if needed for further waste reduction. For this process, approximately 1,050,000 pounds per day of steam would be needed to attain the maximum potential solids content of 95% dry solids. This final conditioning step could result in an anticipated 5:1 maximum potential reduction in the volume of solids generated by the desalination plant, which would be hauled to an appropriate landfill for disposal. Thus, the use of a drying system could substantially reduce hauling cost and landfill tipping fees due to the reduced waste volume produced.

Approximately 20,000 pounds of dry solids per day could be generated from the facility's pretreatment system. Assuming that the dewatered residuals will be approximately 20% dry solids, approximately 12 yd^3 per day of residuals would need to be hauled off site for disposal. If a drying system were used, residual volumes would be reduced to approximately 2.5 yd^3 per day.

An economic comparison was conducted to compare the present worth of the drying system. **Table 3-43** presents the estimated capital and annual O&M costs for the residuals drying system.

Table 3-43. Residuals Drying System Estimated Capital and Annual O&M Costs

Item Description	Cost
Estimated Capital Costs	
Automatic Batch Sludge Drying System	$750,000
Subtotal	$750,000
Electrical and Instrumentation @ 15% of Capital Cost Installation @ 40% of Capital Cost	$115,000 $300,000
Subtotal	$1,165,000
Contingency @ 25%	$290,000
Total Capital Cost	**$1,455,000**
Estimated Annual O&M Costs	
Labor (2 hrs per day @ $35 per hour) Steam from Power Plant General Maintenance	$25,000 $215,000 $75,000
Total	**$290,000**

An economic comparison of using a drying system to further reduce the volume of residuals against the direct disposal of dewatered residuals, including capital cost, O&M costs, hauling costs, and present worth for the range of potential drying rates and percent solids, is presented in **Table 3-44.**

Table 3-44. Estimated Cost of Solids Handling System Alternatives

Percent Solids	Capital Cost	Annual O&M Cost	Annual Sludge Hauling and Disposal Fees [a]	Annual O&M Present Worth	Total Present Worth
No Residuals Drying System					
20%	$0	$0	$140,000	$1,430,000	$1,430,000
Drying System Installed					
95%	$1,455,000	$290,000	$30,000	$3,265,000	$4,720,000

[a] *Based on 12 yd^3 truck @ $195/truck plus $15/yd^3 tipping fees.*

Based on the foregoing financial analysis, there would be no economic advantage associated with drying dewatered residuals produced by the desalination facility. As such, a sludge drying system is not recommended for the facility.

3.9 ALTERNATIVE BRINE DISPOSAL SOLUTIONS

One of the most important aspects to consider for a new desalination facility is brine management and disposal. Brine, also commonly referred to as concentrate, is generated when the desalination plant separates salt from the seawater supply. Brine is a concentrated salt solution that is considered to be a unique wastewater for which there are few if any beneficial uses. Since a well-designed desalination process removes the majority of dissolved solids from seawater, the TDS concentrations of a typical SWRO brine stream can range from 60,000 to 100,000 ppm, depending on the TDS content of the seawater supply being desalinated and the recovery factor used for the desalination process.

Based on experience and general knowledge of proposals and plans for other desalination projects in the United States, the Caribbean, and other locations throughout the world, evaluation of suitable brine disposal options can impede the progress of implementing a desalination facility. In some cases, it can result in the cancellation of the project altogether. The principal issue of concern is potential adverse impacts to the local and surrounding environment as a consequence of the discharge of this salty waste stream. Thus, to successfully evaluate the feasibility and implement the Brownsville Desalination Demonstration Project, a thorough exploration of suitable brine disposal alternatives and their potential environmental impacts is required.

It is beyond the scope of this initial, conceptual-level feasibility study to explore in full all of the potential environmental impacts caused by brine disposal via different routes. A detailed environmental impact analysis must be conducted for those brine disposal alternatives that are considered to be the most technically feasible and cost-effective to support the desalination facility. The purpose and intent of the following alternatives analysis is to evaluate all potential brine disposal options to select one or more for a further detailed evaluation in a subsequent phase.

The following section provides a brief description of each brine disposal alternative considered, followed by the results of the initial evaluation of the alternatives. The evaluation of alternatives is composed of an initial fatal flaw analysis followed by a detailed feasibility analysis. Advantages and disadvantages were inventoried for comparison, and an initial economic analysis of the most viable brine disposal alternatives was conducted. The same weighted scoring system (using slightly modified criteria) was used to select the most technically feasible and cost-effective solution to consider and explore in more detail in the next phase of the project.

3.9.1 Brine Disposal Alternatives

Five brine disposal alternatives were considered for the Brownsville Desalination Demonstration Project:

1. Industrial water reuse;
2. Ocean outfall in the Gulf of Mexico;
3. Discharge to the Brownsville Ship Channel;
4. Evaporation ponds; and
5. Deep well underground injection.

Each of these is described below along with specific factors that should be considered during a subsequent analysis.

3.9.1.1 Industrial Water Reuse

The basic premise of this “zero discharge” option is that the concentrate generated during the desalination process has a potential beneficial industrial use as a new material. For industrial water reuse to be a viable, cost-effective option, the following criteria should be met:

- To keep transportation costs feasible, the industrial user should be located near the desalination plant.
- The industrial user should be able to use a significant portion of the desalination plant’s concentrate stream.
- The industrial user must be willing to commit to a specific amount of concentrate on a continuous basis. User downtime must be coordinated with the desalination facility.
- There should be minimum pretreatment necessary to meet the industrial user’s process quality requirements.
- The industrial user must be flexible in terms of delivery that converges with the desalination facility’s production schedule.

To date, Formosa Plastics Corporation has been identified as one potential industrial user. Formosa Plastics has conceptually indicated that they can use 3,000,000 gallons/day at their Point Comfort facilities, which are located approximately 200 miles from the Brownsville site. Formosa has tentative plans to construct another facility within Brownsville, but no definite construction start date has been established. Consequently, brine disposal to Formosa within the vicinity of the plant site cannot be considered at this time.

3.9.1.2 Ocean Outfall Within the Gulf of Mexico

This option involves piping the concentrate a predetermined distance into the Gulf of Mexico and dispersing it using a diffuser array. The benefits of using a diffuser array include better assurance that the appropriate mixing conditions and dilution requirements are met, and that spatial and temporal impacts to the environment are minimized.

A preliminary design of the diffuser array has been developed and is presented in the **Appendices**. For conceptual design purposes to support this alternatives analysis, the diffuser has been located 3 miles off the Texas coastline.

3.9.1.3 Surface Water Discharge to the Brownsville Ship Channel

For this alternative, concentrate would be directly discharged into the Brownsville Ship Channel at and/or near the proposed desalination plant location. Factors that may limit the applicability and effectiveness of this alternative include:

- The possibility that some or all of the concentrate will short-circuit and be collected by the desalination plant's seawater intake system;

- Insufficient tidal flushing of the channel could create a hypersaline condition within the channel, thereby degrading water quality; and

- The concentrate could adversely impact the channel's aquatic environment and associated ecosystems due to increased salinity content within the Ship Channel.

3.9.1.4 Evaporation Ponds

This option would use evaporation as a concentrate disposal method. This method is generally used for low discharge volumes (i.e., less than 0.01 MGD). Public supply facilities, such as the Brownsville Desalination Demonstration Project are usually too large and require an excessive amount of land for effective evaporation rates. The requirements for cost-effective disposal using evaporation ponds include (Mickley, M., etal, 2001):

- Sufficient land availability;
- High evaporation rates;
- Low precipitation rates;
- Low concentrate discharge volumes; and
- Adequate pond liner material.

3.9.1.5 Deep Well Underground Injection

The principle behind this option is to dispose of the concentrate in a geologic zone that contains lower quality water and is separated from potential potable water aquifers by a series of aquicludes. A typical injection well consists of concentric pipes that extend several thousand feet down from the surface level into highly saline, permeable injection zones that are confined vertically by impermeable strata. The concentric pipes serve as surface casings to prevent the cross-contamination of shallower aquifers containing better water quality from the deeper aquifer(s) where brine would be injected for final disposal. For the purposes of this study, the well depth will be set at approximately 5,000 feet. This depth was selected based on a cursory evaluation of viable injection zones for the brine. A more detailed evaluation would need to be conducted subsequent to this feasibility study to confirm viable injection zones and depths.

Factors that may limit the applicability and effectiveness of this alternative include (Mickley, M., etal, 2001):

- Potential seismic activity in the area;
- Compatibility of the concentrate with the mechanical components of the injection well system and the injection reservoir fluids; and
- Costly geologic and hydrogeologic site assessments required to determine site suitability.

3.9.2 Comparison of Disposal Alternatives

Each of the five disposal alternatives were evaluated and ranked with respect to technical feasibility, permitability, and cost-effectiveness. Since the Brownsville Desalination Demonstration Project may need to be hydraulically expanded in the future to serve additional water supply needs, a larger range of potential brine disposal rates was considered during this initial analysis.

The following evaluation is based on finished water production volumes of 25, 50, 75, and 100 MGD using a 60% recovery factor as the basis for the desalination facility. In addition, to provide a cost-effective means to address potential blowdowns from the co-located power plant, an additional capacity allocation of 2.5 MGD was considered in the analysis. Based on these water production volumes and recovery factor, **Table 3-45** summarizes the potential range in brine disposal rates.

Table 3-45. Summary of Brine Production and Blowdown Rates

Finished Water Production Capacity	**25 MGD**	**50 MGD**	**75 MGD**	**100 MGD**
Brine Production Rates	16.7	33.3	50	66.7
Blowdown Allocation for Power Plant	2.5	2.5	2.5	2.5
Total Potential Brine Disposal Rates	**19.2**	**35.8**	**52.5**	**69.2**

Note: All brine production rates from the desalination facility are based on a membrane recovery factor of 60%. Up to 2.5 MGD of potential blowdown from the co-located power plant was allocated for disposal.

The evaluation consisted of two steps. The first step was to identify any major limiting issues or "fatal flaws" that may be associated with the individual alternatives. The second step was to rank the technical feasibility, permitability, and cost-effectiveness of those alternatives without fatal flaws.

3.9.2.1 Fatal Flaw Analysis

The fatal flaw analysis was designed to identify those factors that would make implementing any of the five alternatives obviously infeasible or impractical from a design and/or regulatory perspective. The analysis was based on the two following questions:

1. **Design Perspective** – Is there some critical design element of the alternative that makes it infeasible or impractical to implement?

2. **Regulatory Perspective** – Is there any aspect of the alternative that would make acquiring the necessary permits unlikely?

These questions are addressed below in **Table 3-46** for each brine disposal alternative that was being considered.

Table 3-46. Fatal Flaw Analysis of Brine Disposal Alternatives

Brine Disposal Alternative	Design Perspective	Regulatory Perspective
	Is there a critical design element that makes the alternative infeasible or impractical to implement?	**Is there any aspect of the alternative that would make acquiring the necessary permits unlikely?**
Industrial Water Reuse	The one key element of this option that makes it impractical and cost-prohibitive is the fact that the facilities where the brine is to be used are located approximately 200 miles from the Brownsville site and could only accept about 3 MGD of brine. Although the idea of a "zero discharge" disposal is very attractive, there is no cost-efficient way to transport the concentrate 200 miles. This, coupled with the low brine use capacity of the facility, represents a fatal flaw. Without a proposed construction date for a new Formosa facility in Brownsville, there would be no secured discharge route. This is also a fatal flaw.	Under the present regulatory environment, this alternative should be permitable, assuming proper assurance can be provided that the brine can be reliably transferred and used in the industrial process under consideration. For this alternative to be acceptable from a regulatory perspective, the industrial entity must demonstrate and guarantee sufficient and consistent production capacity would occur indefinitely to accept the brine stream.
Ocean Outfall in the Gulf	A review of this option's design considerations found no "fatal" design elements; however, additional studies would be needed to confirm and inventory local ecosystems as well as hydraulic modeling to develop a proper and suitable configuration of the brine diffuser array to minimize adverse environmental impacts.	Ocean discharge is one of the most commonly used methods of concentrate disposal. Although the permitting process is extensive, there appears to be no "fatal" permitting issues associated with this alternative at this time.
Brownsville Ship Channel	There is one potentially fatal flaw element associated with this alternative. The principal	Initial feedback from Mr. Rusty Swafford of the NOAA National

Table 3-46. Fatal Flaw Analysis of Brine Disposal Alternatives

Brine Disposal Alternative	Design Perspective Is there a critical design element that makes the alternative infeasible or impractical to implement?	Regulatory Perspective Is there any aspect of the alternative that would make acquiring the necessary permits unlikely?
	concern is that the discharged concentrate might adversely impact the quality of raw intake water by raising its salinity, thus decrease the plant's overall efficiency. Advanced hydraulic and solute transport modeling would need to be conducted to confirm this potential flaw. Based on this potential flaw, coupled with the relatively large fluctuations in the saline content of this water supply source, this alternative is not considered practical and is considered fatally flawed.	Marine Fisheries Service has indicated that there is a major concern over the possibility that the concentrate will create a hyper-saline condition within the Ship Channel. This condition would have a detrimental impact on the aquatic life within the channel's waters. Due to these concerns, Mr. Swafford stated that it would be highly unlikely if not impossible for the agency to permit this alternative. This is a fatal flaw.
Evaporation Ponds	While estimating pond size requirements, it became clear that there was a potential major flaw with this alternative, namely its land requirements. Sizing the ponds was based on the "net evaporation" rate for the Brownsville area. This rate is the difference between the annual lake evaporation rate for the area and the annual rainfall for the area. A value of 62.16 inches per year was used for annual lake evaporation rate (Texas Water Development Board) and a value of 26.61 inches was used for the annual rainfall amount (Texas Weather Website). Using these values yields an average annual net evaporation rate of 35.53 inches. Based on this value, the sizes of the ponds necessary to evaporate the projected concentrate rates are as follows: ▪ 19.2 MGD – 7,252 acres ▪ 35.8 MGD – 13,559 acres ▪ 52.5 MGD – 19,865 acres ▪ 69.2 MGD – 26,171 acres If one increases the land requirements by 5% to address the issue of setbacks and buffer zones, the adjusted land areas become:	There is the regulatory issue of lining the ponds as required by the Texas Administrative Code Title 30, Part 1 Chapter 317 Rule 317.4. This rule requires that ponds have at a minimum a 20 mil membrane liner with an underdrain leak detection system. Using cost estimates provided by a vendor from Houston, Texas, the minimum and approximate cost per flow rate would be: ▪ 19.2 MGD – $132,683,640 ▪ 35.8 MGD – $248,063,727 ▪ 52.5 MGD – $363,443,815 ▪ 69.2 MGD – $478,823,902 This cost impact alone would make the evaporation ponds alternative economically infeasible. This is a fatal flaw.

Table 3-46. Fatal Flaw Analysis of Brine Disposal Alternatives		
Brine Disposal Alternative	**Design Perspective** **Is there a critical design element that makes the alternative infeasible or impractical to implement?**	**Regulatory Perspective** **Is there any aspect of the alternative that would make acquiring the necessary permits unlikely?**
Evaporation Ponds (Continued)	▪ 19.2 MGD – 7,615 acres ▪ 35.8 MGD –14,237 acres ▪ 52.5 MGD – 20,858 acres ▪ 69.2 MGD – 27,480 acres A preliminary assessment of the Brownsville area indicates that it is highly unlikely that there are enough large tracts of land available near the proposed site to make this a viable option. Even if the land were available, the cost of acquiring it would make this alternative economically unattractive. Using a unit cost of $5000/acre, the cost for land would be: ▪ 19.2 MGD – $38,074,966 ▪ 35.8 MGD – $71,184,495 ▪ 52.5 MGD – $104,294,024 ▪ 69.2 MGD – $137,403,553 These costs do not cover infrastructure required to transfer brine from the proposed plant site nor the cost for salt disposal. Thus, from a capital cost perspective, this option is fatally flawed.	
Deep Underground Injection	A review of preliminary design and related geologic information revealed no apparent "fatal flaws," with the potential exception of costs required to construct and operate this disposal solution. However, additional research and geologic studies would be necessary to confirm a suitable injection zone and depth.	Deep well injection is one of the commonly used methods of concentrate disposal, especially for desalination plants not located near the ocean. Although the permitting requirements associated with deep well injection are rigorous and comprehensive, there appears to be no "fatal" permitting issues associated with this alternative.

Summary of Fatal Flaw Analysis

Disposal Option	Fatal Design Element?	Fatal Permitting Issue?
Industrial Water Reuse	Yes	No
Ocean Outfall in the Gulf	**No**	**No**
Brownsville Ship Channel	Yes	Yes
Evaporation Ponds	Yes	Yes
Deep Underground Injection	**No**	**No**

On the basis of the analysis described above, fatal flaws were identified for three of the five potential brine disposal alternatives. Only the ocean outfall and deep well injection option passed the fatal flaw analysis and were retained for further evaluation and consideration.

3.9.2.2 Regulatory Considerations for Ocean Outfall in Gulf

Compliance with all federal and state regulations involving industrial wastewater disposal of concentrate into waters within the State of Texas can be accomplished by obtaining a Texas Pollution Discharge Elimination System (TPDES) permit. The TPDES program is the state program for issuing, amending, terminating, monitoring, and enforcing permits for point source discharges into waters of Texas. Please refer to the appendices for additional information related to permitting requirements associated with a surface water discharge.

In essence, this five-year permit translates the general requirements of the Clean Water Act (CWA), Code of Federal Regulations (CFR), Texas Water Code (TWC), and Texas Administrative Code (TAC) into specific provisions tailored to the operations of each facility discharging pollutants.

Federal and State Agencies Involved in Permitting

Under previous permitting systems, USEPA authorized discharges of pollutants into waters of the U.S. under Section 402 of the federal CWA. Likewise, the Texas Natural Resource Conservation Commission (TNRCC, now known as the Texas Commission on Environmental Quality [TCEQ]) authorized discharges of pollutants specifically into waters of Texas under Chapter 26 of the TWC. Until September 1998, all such discharges into waters in the State of Texas required separate permits from both the USEPA and TCEQ.

The National Pollutant Discharge Elimination System (NPDES) is the federal program used to control the point source discharge of pollutants into waters of the United States. On September 14, 1998, USEPA authorized TCEQ to implement the TPDES program, the state program now used to carry out the federal NPDES program within Texas. The Wastewater Permits Section of the Water Quality Division within TCEQ is responsible for administering, issuing, and enforcing pending and future industrial wastewater disposal permits and applications.

The USEPA's involvement with the TPDES permitting program is now limited to administrative oversight responsibilities within the permitting process. A copy of the application and draft permit may be sent to USEPA Region 6 for a 45-day comment period. If no comments are received and an additional 45-day extension is not requested, the permitting process continues. The decision to review a permit application or draft permit is determined on a case-by-case basis. A decision on whether to review a permit for concentrate discharge would be based on factors including geographic area, raw water quality, pretreatment procedures, process components, and predicted concentrate quality. If it were determined that any of these parameters posed an environmental and/or health risk, the USEPA would review the draft permit.

In addition to the primary oversight of USEPA, various other federal, state, and local agencies may review a draft permit by request. The following organizations may be sent permit applications and draft permits for surface water discharge of concentrate, depending on the nature and geographic location of the discharge:

- U.S. Fish and Wildlife Service;
- U.S. Army Corps of Engineers;

- Texas Water Development Board;
- Texas Coastal Coordination Council;
- Texas Parks and Wildlife Department;
- Texas Wetland Information Network;
- Texas Department of Health;
- Association of State Drinking Water Administrators;
- Rio Grande Assessment of Water Quality;
- Texas Groundwater Protection Committee;
- Water Control and Improvement District;
- Office of Compliance and Enforcement;
- Public Interest Council;
- Corpus Christi Bay National Estuary Program;
- Galveston Bay Estuary Program;
- Galveston County Pollution Control Department;
- Texas Environmental Awareness Network; and
- City and County Planning Commissions, City Councils, and Boards of Supervisors.

Although these organizations have no permitting authority, any agency can request a hearing to argue technical and/or administrative reasons for opposing a permit. Their input may have significant influence over TCEQ's decision to issue a permit.

Rules Commonly Considered in TPDES Permitting

Table 3-47 provides a breakdown of the federal and state rules typically incorporated into a TPDES permit, as well as specific technical issues and other regulatory considerations.

Table 3-47. Summary of Requirements and Considerations for TPDES Permitting

Regulation Source	**Inventory of Applicable Regulations**	
Title 40 Code of Federal Regulations (CFR)	Part	Description
	125	Technology-based Standards
	129	Toxic Pollutants Standards
	130	Water Quality Management Plans
	131	Water Quality Based Standards
	136	Test Procedures for Analysis of Pollutants
Title 30 Texas Administrative Code (TAC)	Chapter	Procedural Issues
	7	Memoranda of Understanding
	39	Public Notice
	50	Action on Application
	55	Request for Contested Case Hearings
	281	Applications Processing
	305	Consolidated Permits
Technical Issues	Chapter	Procedural Issues
	213	Edwards Aquifer
	307	Texas Surface Water Quality Standards
	308	Criteria and Standards for NPDES
	311	Watershed Protection
	314	Toxic Pollutant Effluent Standards
	315	General Pretreatment Regulations
	319	General Regulations Incorporated into Permits
Other Federal and State Regulatory	▪ USEPA Toxic criteria documents	

Table 3-47. Summary of Requirements and Considerations for TPDES Permitting	
Regulation Source	**Inventory of Applicable Regulations**
Considerations	▪ USEPA Permit Writer's Guide to Water Quality Based Permitting ▪ State of Texas Water Quality Inventory (305b Report) ▪ USEPA Technical Support Document for Water Quality-Based Toxins Control

3.9.2.3 Regulatory Considerations for Deep Well Underground Injection

A Class I Injection Well Permit must be obtained to comply with all state regulations involving the disposal of concentrate by means of deep well injection. The primary goal of a Class I Injection Well Permit is to ensure that various waste injection conditions are met to prevent the movement of fluids into or between USEPA classified Underground Sources of Drinking Water (USDWs). Incorporated into the permit are various procedural and technical regulations that can be found in Chapter 27 of the TWC, Chapter 361 of the Texas Health and Safety Code, and various chapters of the TAC. Please refer to the appendices for additional information related to permitting requirements associated with underground injection.

Federal and State Agencies Involved in Permitting

Class I Injection Well Permits for the construction, operation, and abandonment of Class I injection wells in the State of Texas are administered, issued, and enforced by TCEQ's Underground Injection Control and Radioactive Waste Section. In rare cases, USEPA may take on various administrative and technical oversight responsibilities if a proposed deep well injection site may involve increased elements of risk to any surrounding USDWs.

For a Class I Injection Well Permit to be issued, the Railroad Commission of Texas (RCT) must submit a letter to TCEQ stating that drilling the proposed well and injecting it with concentrate will not endanger any known gas or oil resources. The RCT will make these determinations based on information submitted by the applicant. This information should include general data from the application form; a discussion of the local geology and hydrogeology; local oil and gas production data; and any other information necessary for the RCT to make a determination.

The primary environmental risk of concentrate disposal by deep well injection is the possible migration of contaminants into USDWs. Therefore, an applicant should expect draft permit and application reviews by agencies involved with subsurface geologic surveying and groundwater protection. The following organizations may influence TCEQ's decision to issue a Class I Injection Well Permit:

- U.S. Environmental Protection Agency;
- U.S. Geologic Survey;
- U.S. Army Corps of Engineers;
- American Society for Testing Materials;
- Railroad Commission of Texas;
- Texas Groundwater Protection Committee;
- Texas Alliance of Groundwater Districts;
- Texas Soil and Water Conservation Board;

- Texas Department of Health;
- Edwards Aquifer Authority;
- Office of Compliance and Enforcement;
- Tribal Governments; and
- City and County Planning Commissions, City Councils, and Boards of Supervisors.

<u>Rules Commonly Considered for Permitting Injection Wells</u>

Table 3-48 provides a summary of procedural and technical regulations that should be considered to secure a Class I Injection Well Permit for brine disposal.

Table 3-48. Summary of Requirements and Considerations for Class I

Regulation Source	Inventory of Applicable Regulations	
	Chapter	Procedural Issues
Title 30 Texas Administrative Code (TAC)	7 39 50 55 281 305	Memoranda of Understanding Public Notice Action on Application Request for Contested Case Hearings Applications Processing Consolidated Permits
	Chapter	Description
Technical Issues	213 331	Edwards Aquifer Underground Injection Control

3.9.2.4 Feasibility Analysis and Results

The second part of the evaluation was performed for those alternatives that passed the fatal flaw analysis—the ocean outfall solution and the deep underground injection well solution. The following evaluation lists advantages and disadvantages associated with each alternative along with initial cost estimates and an economic evaluation to generate conceptual level present worth values for the alternatives. Using this information, a comparative evaluation and ranking will be presented for consideration from which a preferred brine disposal alternative is identified. A listing of key advantages and disadvantages is presented in **Table 3-49**.

Table 3-49. Summary of Advantages and Disadvantages for Alternative Brine Disposal Solutions

Disposal Alternative	Advantages	Disadvantages
Ocean Outfall	▪ Most reliable method of disposal. ▪ Can handle large volumes more cost-effectively than the deep well injection solution. ▪ Can limit potential environmental impacts and confine them to a relatively small zone through proper siting and diffuser design.	▪ Requires adequate depth and circulation. ▪ Extensive and extensive permitting and monitoring requirements to address potential environmental impacts. ▪ High up-front capital cost to implement.
Deep Well Underground Injection	▪ Low cost up front as compared to the ocean outfall alternative.	▪ Potential for maintenance issues. ▪ Extensive and expensive permitting and monitoring requirement

Table 3-49. Summary of Advantages and Disadvantages for Alternative Brine Disposal Solutions		
Disposal Alternative	**Advantages**	**Disadvantages**
	▪ Could be located on site or relatively close to the site, thereby reducing transmission requirements. ▪ If injected into a suitable and confined deep zone, minimal if any adverse environmental impacts would occur.	monitoring requirement. ▪ Very site-specific, requires extensive testing for design. ▪ Potential limitations on disposal volumes ▪ High operational costs due to the quantity and injection pressure required for continuous and reliable disposal.

An initial cost analysis to estimate both capital and annual O&M costs was performed for each of the two alternatives. It should be noted that the results of this initial analysis, along with the economic factors used to calculate the present worth of each alternative, may differ from the cost estimates and resulting financial analysis of the final, conceptual configuration of the brine disposal system presented later in this report. Initial assumptions regarding the materials of construction, exact route of the brine disposal main, etc. may be modified to optimize and reduce costs of either brine disposal alternative to the degree practical during the conceptual design process that follows this initial analysis of alternatives. To be conservative at this step in the selection process, very conservative unit cost data and factors were used. A summary of the results for the ocean outfall and deep well injection solutions are presented in **Tables 3-50** and **3-51**, respectively.

Table 3-50. Capital and Annual O&M Cost Estimate for the Ocean Outfall Solution				
Capacity and Size of Brine Disposal System				
Finished Water Flow (MGD)	25	50	75	100
Total Brine Flow (MGD)	19.2	35.8	52.5	69.2
Main Size (inches)	48	60	72	84
Capital Cost Estimates				
Mainland Pipe (11.5 miles)	$18,273,684	$26,424,130	$37,920,247	$49,040,508
Ocean Pipe (3.0 Miles)	$7,150,572	$10,339,877	$14,838,358	$19,189,764
Diffuser Array	$500,000	$1,000,000	$1,500,000	$2,000,000
Pump Station	$4,524,184	$7,258,742	$9,688,903	$11,934,384
Land for Pipeline	$278,788	$348,485	$348,485	$383,333
Subtotal	**$30,727,228**	**$45,371,233**	**$64,295,992**	**$82,547,990**
Permitting and Design	$3,072,723	$4,537,123	$6,429,599	$8,254,799
Environmental Mitigation [a]	$3,000,000	$3,000,000	$3,000,000	$3,000,000
Subtotal	**$36,799,950**	**$52,908,356**	**$73,725,592**	**$93,802,789**
25% Contingency	$9,199,988	$13,227,089	$18,431,398	$23,450,687
Total	**$45,999,938**	**$66,135,445**	**$92,156,989**	**$117,253,486**
Annual O&M Cost Estimates				
Pumping Power	$26,000	$53,000	$65,000	$68,000
Routine O&M [b]	$920,000	$1,323,000	$1,843,000	$2,345,000
Total	**$946,000**	**$1,376,000**	**$1,908,000**	**$2,413,000**

[a] *Mitigation cost are estimated to be $1,000,000/mile of ocean pipeline.*
[b] *Taken as 2% of the estimated capital cost.*

Table 3-51. Capital and Annual O&M Cost Estimate for the Deep Well Injection Solution				
Capacity and Size of Brine Disposal System				
Finished Water Flow (MGD)	25	50	75	100
Total Brine Flow (MGD)	19.2	35.8	52.5	69.2
Main Size (inches)	48	60	72	84
Number of Injection Wells	6	11	16	21
Capital Cost Estimates				
Injection Wells	$23,357,920	$42,822,853	$62,287,786	$81,752,719
Mobilization / Demobilization	$831,169	$831,169	$831,169	$831,169
Monitoring Well Cost	$841,558	$841,558	$841,558	$841,558
Pump Stations	$4,273,147	$6,843,537	$9,140,478	$11,262,548
Piping 2 Miles	$3,178,032	$4,595,501	$6,594,826	$8,528,784
Land Cost for Pipe Line	$49,624	$62,030	$62,030	$68,233
Land Cost for Well Field	$500,000	$500,000	$500,000	$500,000
Security Fencing for Wells	$150,000	$150,000	$150,000	$150,000
Subtotal	**$33,181,450**	**$56,646,648**	**$80,407,846**	**$103,935,501**
Permitting and Design	$3,318,145	$5,664,665	$8,040,785	$10,393,501
Subtotal	**$36,499,595**	**$62,311,313**	**$88,448,631**	**$114,328,512**
25% Contingency	$9,124,899	$15,577,828	$22,112,158	$28,582,128
Total	**$45,624,494**	**$77,889,141**	**$110,560,788**	**$142,910,640**
Annual O&M Cost Estimates				
Pumping Power	$214,000	$400,000	$585,000	$768,000
Routine O&M [a]	$912,000	$1,556,000	$2,211,000	$2,858,000
Total	**$1,126,000**	**$1,956,000**	**$2,796,000**	**$3,626,000**

[a] *Taken as 2% of the estimated capital cost.*

Using the cost estimates presented in the tables, an initial economic analysis was performed to compare the costs associated with the two alternative brine disposal solutions. A summary of the results from the economic analysis for the brine disposal alternatives is presented in **Table 3-52.**

Table 3-52. Economic Analysis Results of the Brine Disposal Alternatives		
Cost Item	**19.2 MGD**	
	Gulf of Mexico	**Deep Well Injection**
Estimated Capital Cost	$45,999,938	$45,624,494
Estimated Present Worth O&M Costs	$9,655,000	$11,492,000
Present Worth	**$55,655,000**	**$57,117,000**
Cost Item	**35.8 MGD**	
	Gulf of Mexico	**Deep Well Injection**
Estimated Capital Cost	$66,135,445	$77,889,141
Estimated Present Worth O&M Costs	$14,044,000	$19,996,000
Present Worth	**$80,179,000**	**$97,852,000**
Cost Item	**52.5 MGD**	
	Gulf of Mexico	**Deep Well Injection**
Estimated Capital Cost	$92,156,989	$110,560,788
Estimated Present Worth O&M Costs	$19,473,000	$28,536,000

Table 3-52. Economic Analysis Results of the Brine Disposal Alternatives		
Present Worth	**$111,630,000**	**$139,097,000**
Cost Item	**69.2 MGD**	
	Gulf of Mexico	**Deep Well Injection**
Estimated Capital Cost	$117,253,486	$142,910,640
Estimated Present Worth O&M Costs	$24,627,000	$37,007,000
Present Worth	**$141,881,000**	**$179,918,000**

The scoring and subsequent ranking of the alternative brine disposal alternatives was conducted to select the most viable and cost-effective option for the project that should be considered in further detail during the subsequent project phase. Due to the prominence of potential environmental impacts associated with this particular aspect of the project, an additional screening criterion was used in the analysis. This additional criterion was assigned a relative weight of 50, equal only to the criterion for cost-effectiveness. Due to additional layers and complexity associated with project permitting, the base weight of the permitability criterion was increased from 35 to 45. With these adjustments made to the screening criteria, the maximum possible score available for this analysis would be 270. A summary of screening criteria and weighted scores for the various water supply source alternatives is presented in **Table 3-53**.

Table 3-53. Summary of Screening Criteria and Weighted Scores for Brine Disposal Alternatives			
Screening Criteria	**Score**	**Weighting Factor**	**Weighted Score**
Ocean Outfall			
Potential Environmental Impacts	5	50	25.0
Reliability	8	40	32.0
Permitability	7	45	31.5
Constructability	6	25	15.0
Operation and Maintenance Requirements	7	30	21.0
Cost-Effectiveness	6	50	30.0
		Total Weighted Score	**154.5**
Deep Well Injection			
Potential Environmental Impacts	7	50	35.0
Reliability	4	40	16.0
Permitability	7	45	31.5
Constructability	6	25	15.0
Operation and Maintenance Requirements	4	30	12.0
Cost-Effectiveness	3	50	15.0
		Total Weighted Score	**124.5**

3.9.2.5 Selection of Preferred Brine Disposal Solution

On the basis of the previously described evaluation of the viable brine disposal alternatives, the ocean outfall solution appears to be the most appropriate and cost-effective solution to explore in further detail. Even though potential environmental impacts would be greater for the ocean outfall option, the composite scores developed for each alternative supports the selection of the ocean outfall. As such, this solution is adopted for the purposes of this feasibility study. A conceptual-level configuration and design to fully describe and illustrate the components associated with this solution was developed as further described in **Section 4**.

4.0 CONCEPTUAL DESIGN OF DESALINATION FACILITY

This section of the report describes the conceptual configuration for the proposed Brownsville Desalination Demonstration Project, including all anticipated site development requirements and features needed to support the plant and its operations. The following considerations were taken into account when developing the conceptual design of the desalination facility:

- Results from the alternatives analyses were incorporated into and used as the basis for the initial configuration of the facility's process components and associated structures;

- A preliminary engineering analysis was performed to size individual unit treatment processes and operations, thereby establishing footprints for all of the plant's process components;

- Additional buildings that would be required to support the operation of the desalination facility, such as administration, maintenance, storage, etc., were taken into account for the initial facility configuration;

- Sufficient space was allocated for the various plant structures and between the structures to facilitate access, O&M of individual components, and the routing of the various process and non-process yard piping for the plant; and

- Future expansion of the plant, if and when additional water production capacity would be needed to serve the local area.

The following conceptual design and description of the Brownsville Desalination Demonstration Project were prepared using sound engineering judgment and experience. Since the layout and associated description are conceptual in nature, only the principal components of the facility, such as structures, major yard piping, and certain site development features, are shown. Additional effort will be needed in a subsequent phase to ensure that the facility layout is fully optimized. In addition, pilot testing will be needed to confirm process selection and operating efficienices.

Additional planning and design efforts could potentially reduce the overall configuration of the plant. Furthermore, additional engineering evaluation of the project through both bench- and pilot-scale testing could yield results different from those presented here, which could affect the process design of the desalination facility. Through additional engineering design and testing, unit treatment processes and operations could be confirmed along with optimum chemical dosages and power ratings for the various equipment components such as pumps, blowers, mixers, etc. However, sufficient information was developed during this study to support a defensible conceptual-level cost estimate for the project, which is presented in **Section 7**.

4.1 SITE SELECTION AND DEVELOPMENT

Issues associated with site selection and development for the project are addressed and described in the following section. It should be noted that the site proposed for the desalination facility, as well as for the power plant that is described in detail in **Section 5**, would be provided by the Brownsville Port Authority as part of the partnership agreement for this demonstration project. In addition, some of the components associated with the seawater intake system for the desalination plant, which would be located within or directly along the Brownsville Ship Channel, would be within the jurisdictional limits of the Port Authority.

4.1.1 Site Location for Desalination Facility

The site proposed for the desalination facility (and potentially the adjacent power plant) is located along the Brownsville Ship Channel approximately 11 miles northeast of Brownsville. This site is approximately 11 miles southwest of the mouth of the ship channel in the Gulf of Mexico, which ends directly south of South Padre Island. The site is bounded on the north by State Highway 48 (SH48), to the south by the Brownsville Ship Channel, and to the west by an existing fishing harbor. Vacant property exists to the east of the site, which is owned and controlled by the Brownsville Port Authority. There are no known plans regarding the future use and/or development of this open parcel of land.

The center of the site is located at Latitude 25º58’45” North and Longitude 97º19’45” West. **Figure 4-1** is a site location map, which was prepared using the Palmito Hill United States Geological Survey (USGS) 7.5-minute quadrangle map. The total site area required for the initial 25 million gallon-per-day (MGD) capacity of the desalination facility is estimated at 35 acres; however, a total land area of 100 acres will be reserved to address potential future expansion of the facility.

4.1.2 Site Development Requirements

Various site development considerations necessary to support the permitting and construction of a new desalination plant are described in the following subsections. Important considerations related to site development that could affect the overall capital cost to implement the project also were taken into account to ensure a more complete overall project evaluation.

4.1.2.1 Site Grading Requirements

A review of current topographic data for the site selected for the desalination facility indicated that the grade of the existing site ranges from approximately 5 feet to 40 feet Above Mean Sea Level (AMSL). Dispersed at certain locations within the site are spoil piles created by past dredging of the Brownsville Ship Channel. These piles range in height from 25 to 40 feet.

Since the site is located near a major water body that is tidally influenced, The FEMA Flood Insurance Rate Maps date map (FIRMs) were reviewed to confirm the minimum grade needed to address potential flooding effects. The finished minimum grade is 12 feet AMSL, which is the grade proposed for site development. However, we are familiar with storm surge effects, which may exceed this 12-foot elevation and adequate protection for sensitive equipment may require higher finished floor elevations for selected buildings. Based on this information and by conducting preliminary cut-and-fill calculations, approximately 255,000 yd^3 of material will need to be cut, whereas approximately 50,000 yd^3 of material will need to be filled to result in a uniform grade over the entire site. This results in approximately 205,000 yd^3 of excess soil that may be used for this purpose.

It is important to note that the proposed power plant site is located directly west of the proposed desalination site. The power plant site is significantly lower than the site proposed for the desalination facility and could use a large portion of the excess material removed from the desalination facility site. Any remaining excess soil can be stockpiled and graded over the open tract of land to the east of the site to support future development for the desalination facility.

All existing spoil piles on the site would be graded out. The overall site would be cleared and grubbed to remove any undesirable or unusable materials. The site would be graded to 12 feet AMSL from the south along the edge of the Brownsville Ship Channel where a new seawall would be constructed (as described below) and to the north where a sloped transition would match the existing grade along the southern right-of-way (ROW) of SH48. The transitional slope between the southern ROW of SH48 and the finished grade of the site would be approximately 2%. Through grading of swales and stormwater detention ponds along the sloped transition near SH48, proper storm water management would be provided. This would protect the existing road and developed areas along this road from flooding as a consequence of development of the site. **Figure 4-2** is a conceptual cross-section of the developed site showing both the existing and proposed grade of the site along with the proposed seawall along the ship channel and the sloped transition to Highway 48.

4.1.2.2 Site Soil Conditions and Foundation Requirements

To establish potential foundation requirements for the various structures and other infrastructure for this project, it was necessary to assess site-specific soil conditions to the degree possible using any available information from historical reports and/or studies. A soils report, previously prepared for the Port of Brownsville Shipyards, Inc. to support the development of the fishing harbor located to the immediate west of the subject site, was reviewed. This report summarizes the results of various soil investigations, which included a series of soil borings ranging from 30 to 60 feet in depth and standard soil classification tests. A summary of key conclusions provided from the report are:

- Soil types present in the area included intermixed strata of sand, clayey sand, silty clay, and clayey silt to the limits of the soil borings (Classifications CL, ML, CH, SC, ML, and SM).

- Soils encountered from grade to 25 feet in depth generally ranged from firm to soft, beneath which soil consistency improves to a very stiff condition.

- Static groundwater levels ranged between 5 and 7 feet below existing grade.

- The soil-bearing capacity of soils in the upper 20 feet was characterized as poor. For structural foundations, the poor soil conditions coupled with high wind loading would not be suitable for shallow footing foundations. In addition, due to the relatively shallow groundwater table, the installation of under-ream piers to a stratum of significant soil-bearing capacity would be difficult if possible at all. Due to the above soil and groundwater limitations, piles or pier foundations with load-bearing capacities derived from side friction should be explored for proposed structures.

Adopting the recommendations presented in the report, it is assumed that piles will be required to support the majority of structures needed for the desalination plant. Pile tips should be founded at a depth of at least 35 feet below the proposed grade of 12 feet AMSL for the site. For the purposes of this conceptual level study, all piles installed to support large water-bearing structures and buildings will be spaced 10 feet on center and will be either 14-inch or 16-inch square in configuration. Estimated capacities for 14-inch and 16-inch piles installed at the proposed depth of 35 feet are 25 and 35 tons, respectively.

4.1.2.3 Supporting Utilities and Site Infrastructure

Utility systems and infrastructure needed to properly support the desalination plant were taken into account for the conceptual design of the facility. Important utility and infrastructure systems required to support the project include:

- **Stormwater Drainage and Management** – Stormwater drainage and management components are needed to properly collect, treat, and route stormwater through and off the site. This system would be composed of a series of stormwater culverts and reinforced-concrete pipe (RCP) along the various internal roads, as well as natural swales and ditches for unpaved areas of the site. All stormwater collected on site would be routed through either dedicated stormwater detention or retention ponds for proper management before being discharged off site. To the extent possible, stormwater would be routed southward across the site toward the Brownsville Ship Channel where it would be discharged via a permitted stormwater NPDES outfall.

- **Potable Water Supply System** – A potable water supply system would be provided for the desalination plant to support its staff and operations. This system would receive water from the desalination plant itself via the chlorine contact chamber. A dedicated pumping system would be used to transfer finished water to a 0.5-million-gallon storage tank. This tank was sized to provide a sufficient water volume for potential plant needs. A set of distribution pumps and a distribution piping system would be used to route water from the storage tank to various locations in the desalination plant. The distribution pumps and all internal water mains would be properly sized to convey the amount of water needed for each location at the plant site. Due to the relative size of the plant, all water distribution mains would be at least 6 inches in diameter to properly serve fire hydrants. Fire hydrants would be located at least every 500 feet along the primary roads within the site. Finally, properly selected and sized backflow preventers would be installed at all critical and potentially hazardous service areas to address cross-connection control requirements.

- **Sanitary Wastewater Collection System** – A sanitary wastewater collection system would be provided to collect all wastewater generated at the site. A series of gravity collection mains would be provided to properly route wastewater from each location where wastewater could be generated to transfer pump stations for subsequent routing. Each pump station would contain a duplex pumping system for purposes of redundancy and would be properly sized to handle the anticipated quantity of wastewater that could be generated at each location within the plant. The force mains from each pump station would be manifolded together and routed off site to the Robindale Wastewater Treatment Plant for final processing and disposal.

  Filtrate generated through the residuals dewatering system would be routed into the wastewater collection system and would represent one of the larger wastewater flows produced by the desalination facility. In addition, process waste streams, such as spent cleaning and flushing solutions used to maintain the membrane system, and spent sample volumes from on-line process analyzers, would also be routed into the wastewater collection system for disposal.

- **Electrical Supply and Distribution System** – An electrical supply and distribution system would be properly sized and configured to serve all components at the plant site. There would be two electrical feeds for the plant's internal electrical distribution system. One feed would be provided from the co-located power plant, while a secondary feed would be provided from the local electrical grid. Both feeds would be provided through a common 13.8 kilovolt (kV) bus. Normally, the power plant would provide electricity to the desalination plant through the 13.8 kV bus. However, in the event that the power plant could not supply electricity, an automatic switch gear would maintain power supply to the desalination plant from the local electrical grid. Refer to **Section 4.3.4** and **Section 5** for additional information regarding the conceptual electrical supply system.

- **PCIS Network and Communication System** – A Process Control and Instrumentation System (PCIS) would be used to provide centralized control and monitoring capability for the project. The PCIS will be composed of a series of process logic controllers (PLCs); computer interfaces, also commonly referred to as Human-Machine Interfaces (HMIs); and various control and monitoring elements (e.g., mechanical equipment components, process sensors). A network would be established throughout the plant site to allow for the efficient transfer and communication of information among the various elements and components that would comprise the PCIS. This network would most likely be composed of fiber optic cable that would connect the critical components between multiple locations within the plant site. Refer to **Section 4.3.5** for additional information.

4.1.2.4 Seawall Along Shipping Channel

To address both flood protection and the proposed site grade of 12 feet AMSL, a seawall is proposed along the existing bank of the Brownsville Shipping Channel at the site. The seawall would be constructed of reinforced concrete to provide adequate long-term protection for the site. The top of the wall would be established at an elevation of 16 feet AMSL, which is approximately 4 feet above the proposed grade of the site (12 feet AMSL). The wall extension above the 100-year flood elevation will serve to protect the site from wave crests during the 100-year storm, as well as to address Occupational Health and Safety Administration (OSHA) safety requirements. The elevation of the wall base would be set at approximately -10 feet AMSL.

A reinforced concrete cap would be poured on top of the concrete bulkhead, and both would be secured in place using a series of tie-backs and concrete deadmen. Based on the proposed site area required for the initial 25 MGD plant capacity, approximately 1,000 linear feet of seawall would be required for the site as measured along the existing channel bank of the site. Structural modifications of the wall would occur at the site's two seawater intake inlets, which are described in further detail in **Section 4.2.2.2**.

4.1.2.5 Site Access

Access to the desalination plant will be limited to restrict the flow of traffic into and off the site for purposes of overall control and security. It is proposed that a primary access road be constructed into the site from SH48, which would be used for access to both the desalination plant and the co-located power plant. The administration building for the facility would be located along the primary access road. A visitor greeting area would be located within this building to allow visitors to check in before being granted access to the site. All delivery trucks and other official and/or routine vehicular traffic would be processed through a manned guardhouse before gaining access to the site.

Aside from the primary access road, a secondary access road would be provided from the interior of the site to SH48. A secured gate would be provided at the entrance to the secondary access road, which would typically remain locked to prevent site access through this route. The purpose of the secondary access road would be to allow another means of ingress and egress for the site in the event access through the primary entrance road is blocked or otherwise unavailable for any reason.

4.1.2.6 Conceptual Configuration and Layout of Plant

A conceptual-level configuration and layout for the desalination plant was developed based on the results of the engineering evaluation and the alternatives analyses presented in **Section 3** of this report. **Figure 4-3** is a conceptual site layout drawing for the proposed 25 MGD desalination plant. A total land area of approximately 35 acres is required to accommodate the conceptual configuration of the plant as illustrated on **Figure 4-3**. The various structures and other plant components illustrated on this figure are described in more detail in **Section 4.2**. A general description and overview of the plant layout follows.

All seawater for the site would be collected directly from the Brownsville Ship Channel through a set of side inlet channels located along the southern-most portion of the site. Seawater would be routed into the interior of the site where the pretreatment, primary treatment, and post-treatment facilities would be located. Through these various water treatment systems, a stabilized, desalted water supply would be produced and routed to a set of dedicated chlorine contact tanks located to the north of the treatment facilities for subsequent transmission off site to the Brownsville Public Utility Board (PUB) distribution system. A solids waste stream generated from the pretreatment system would be routed to the plant's solids handling system, which would be located on the southern portion of the site. Similarly, a brine stream generated as a consequence of the primary treatment system will also be routed southward through a dedicated brine disposal system.

In this physical arrangement for the plant, all water treated by the desalination plant would be routed from the south to the north through the site, while all waste byproducts including sludge and brine streams created within the central portion of the site would be routed southward for proper management and disposal. By segregating, physically separating, and routing treated water streams away from the wastewater streams generated by specific operations within the plant site, these streams can be better managed.

Another important consideration taken into account was reserving space for the construction of additional water and residuals treatment processes. While the various unit treatment processes and operations proposed here should properly treat and condition the water to meet all current and pending water quality regulations, there is always the potential for new regulations. In addition, currently unknown water quality constituents in the water supply could affect the overall operational efficiency of one or more unit treatment processes selected for the initial plant configuration. For these reasons, space was reserved at strategic locations within the plant site for potential use in a future configuration of the plant. For instance, a relatively large open tract of land was reserved just to the south of the ballasted flocculation/clarification (BFC) system should another type of pretreatment system be needed to address any new water quality regulations and/or problematic water quality constituents. This important design consideration was properly addressed through the conceptual layout of the desalination plant.

4.1.2.7 Expansion Capability

Due to the nature of this project and the potential that additional quantities of water may be needed to support future growth and development in the local area, consideration was given to expanding the desalination plant's initial design configuration. Plant expansion capability should be carefully considered during conceptual planning so that the initial configuration of the plant can be expanded to easily accommodate future capacities. **Figure 4-4** illustrates possible future configurations for the desalination plant in 25 MGD capacity increments up to a potential build-out configuration of 100 MGD. Additional plant expansions beyond this are also possible; however, potential environmental limitations associated with larger withdrawals from the Brownsville Ship Channel would have to be carefully considered.

The following considerations were taken into account and/or are of note regarding the expansion of the 25 MGD desalination plant to larger production capacities:

- To have sufficient space for future plant expansions, additional land area east of the site would be reserved. Based on the conceptual plant expansion layout for 100 MGD as illustrated on **Figure 4-4**, a total additional land area of approximately 65 acres should be reserved. (This additional land requirement would bring the overall land area needed for the entire project to 100 acres.) As the plant is expanded, additional tracts of the reserved land area would be developed by grading it to 12 feet AMSL and expanding the eastern site boundary accordingly. In this manner, the initial configuration of the desalination plant could remain in operation, while reducing construction conflicts during future plant expansion.

- An important and primary consideration associated with plant expansion is to maintain the uniformity and consistency of the various components needed for each expansion event. Consequently some facilities needed to support the initial configuration of the plant may need to be eliminated and/or relocated to accommodate new facilities associated with the expanded plant. For instance, in the conceptual layout developed for the initial configuration, the chemical storage building would be abandoned and a newer, larger building would be constructed to support the larger desalination plant when an expansion event occurs. If needed, the building initially used for chemical storage could be converted and used as an additional support facility for the larger plant configuration. In addition, the secondary access road that lies on the eastern side of the initial plant configuration would need to be relocated to facilitate the expansion of the plant. Beyond these few components, the remaining components and structures developed for the initial plant configuration remain in place.

- Due to the sheer size of the desalination plant, considerable quantities of various chemicals will be needed to properly manage the water supply. As the capacity of the desalination plant is expanded from 25 MGD to larger capacities, it may be necessary or at least practical to alter the method used to deliver chemicals to the site. For the conceptual expansion from 25 to 50 MGD, a railroad spur into the site could be used to reduce the overall delivery cost of certain chemical stocks. The optional railroad spur illustrated on **Figure 4-4** could also be used to support plant expansions through 100 MGD if determined desirable or necessary.

4.2 DESCRIPTION OF DESALINATION PLANT

The desalination plant will be designed to treat seawater, which would be obtained directly from the Brownsville Ship Channel. The plant will meet all federal and state water quality requirements for potable consumption as regulated by the Safe Drinking Water Act and its various amendments. The appendices contain a summary of all current and pending federal, state, and local rules and regulations pertaining to drinking water quality criteria that may apply to this project. The following section provides a detailed description of the conceptual configuration of the plant and its various components.

4.2.1 Overview of Conceptual Process Design

The desalination plant was conceptually designed to produce an initial potable water supply of 25 MGD for the local population. However, as discussed above, the plant was conceptually configured to be expanded to produce up to 100 MGD of finished water in the future, if needed. As a consequence of the various treatment processes the plant will use to produce finished water, a concentrated brine stream will be generated that will require disposal. In addition, nonhazardous waste streams will be generated as a consequence of the plant's pretreatment processes; waste cleaning and flushing solutions from the membrane system; filtrate generated from dewatering solids; and domestic wastewater generated at the plant. A conceptual process flow diagram for the treatment process is shown in **Figure 4-5**.

A description of the plant's primary systems and the main components that comprise these systems is provided below. The following subsections provide additional details and information on each component listed in the table below.

Table 4-1. Summary of Principal Systems and Subsystems for Desalination Plant

System	System Description	Subsystem Description
1	Seawater Intake System	Intake Channels Side Inlets Intake Screen Assemblies Transfer Pumping System
2	Pretreatment System	Ballasted Flocculation Clarification System Single-Stage Dual-Media Filtration System Filter Clearwell and Transfer Pumping System Heat Exchange System Chemical Conditioning Cartridge Filtration
3	Primary Treatment System	High Pressure SWRO Pumping System First Pass SWRO Units Partial Second-Pass BWRO Units with Pressure Booster Pumps Energy Recovery Turbines Foam Reduction Chamber for Brine Stream
4	Post-Treatment System [a]	Pebble Lime Stabilization System with pH Control On-Site Sodium Hypochlorite Disinfection System
5	Solids Handling System	Solids Equalization Basin Thickener Feed Pumps Flocculation Basins Gravity Thickeners Solids Dewatering Feed Pumps Belt Filter Presses
6	Brine Disposal System	Brine Transfer Pump Station Brine Transmission Main Brine Outfall Diffuser Array
7	Finished Water Transmission and Distribution System	Finished Water Transmission Pump Station and Main Finished Water Storage Tanks [b] Finished Water Distribution Pumps [b]

[a] *Per feedback from the Brownsville PUB, fluoridation is not practiced and no corrosion inhibitors are used in the local service area. The need for additional treatment processes to address these post-treatment requirements for other entities will be established, as necessary, during final project implementation.*
[b] *These components will be remotely located from the site of the desalination facility.*

Based on the potential variation in seawater quality that may occur within the Brownsville Ship Channel as documented in **Section 3**, it is anticipated that certain operational adjustments to specific equipment components may be needed from time to time. For instance, when barge and ship traffic passes by the site, there may be an increase in suspended solids concentrations. The selected pretreatment strategy should effectively address and counter the potential range of suspended solids concentrations that could occur. With sufficient on-line monitoring equipment, proper and automatic adjustments can be made to the chemical feed rates and mechanical components within the pretreatment system to ensure proper treatment for the entire range of suspended solids. Regarding the variation in the source water TDS, the operating factor of the membrane system may need to be adjusted from time to time. During periods of high water demand when the recovery factor cannot be reduced, increased pumping power may be needed to maintain the aggregate finished water production capacity of the system. However, at this time, it is anticipated that any operational adjustments needed to ensure proper treatment of the source water can be easily accommodated through the conceptual configuration of the plant as described herein.

4.2.2 Intake System

A conceptual design was developed for a seawater intake system that will supply sufficient volumes of feedwater while minimizing the collection of suspended solids and protecting marine life. This system consists of a dedicated intake channel that will be located directly within the Brownsville Ship Channel; a set of side collection inlets that will be constructed within the site selected for the desalination plant; a set of screened intake assemblies; and a transfer pump station equipped with vertical turbine pumps and a flowmeter assembly. Each component is further described below.

Of particular importance is the need to provide redundancy for each component within the intake system for the desalination facility. Various events could potentially reduce or eliminate the water supply normally available via a single intake (e.g., periodic maintenance on the intake structure, structural collapse of the intake structure itself, potential acts of terrorism, etc.). To adequately ensure an uninterrupted water supply for the project, two seawater intakes are proposed for the initial 25 MGD configuration of the plant. With this design provision in place, seawater could always be collected for the plant, thereby improving the overall water supply reliability of this project. Two intake channels within the Brownsville Ship Channel and two side inlets are proposed for the initial configuration of the desalination facility as further described below. It should be noted that the second intake channel was properly sited to support the next 25 MGD plant expansion, when it occurs, thereby optimizing the location of the seawater intakes while minimizing site development and redevelopment costs accordingly. A box culvert would be used to hydraulically connect the two intake structures to one another for the initial plant configuration as illustrated on **Figure 4-3**.

4.2.2.1 Intake Channels

A dedicated set of intake channels will be needed to properly collect seawater for the project, while minimizing the collection of suspended solids and aquatic species found in the Brownsville Ship Channel. To properly and reliably address these critical design considerations, the intake system should limit the approach velocity to the degree practical. Section 316(b) of the United States Environmental Protection Agency's (USEPA) Clean Water Act (CWA) allows for a maximum intake velocity of 0.5 foot per second (FPS) at the point of collection. However, to anticipate and minimize potential mitigation requirements that could have a considerable financial impact during project implementation, an approach velocity of 0.1 FPS within the ship channel was selected to better mitigate potential adverse environmental impacts. The lower approach velocity will also aid in reducing suspended solids concentrations, thus reducing solids collection, management, and disposal within the desalination facility itself.

To achieve the proposed approach velocity of 0.1 FPS, dredging within the Ship Channel will be required to create the intake channels for the project's intake system. Each channel is conceptually configured with a trapezoidal cross-section that has side slopes of 2:1 (horizontal:vertical). These channels would begin at the deep, central section of the Brownsville Ship Channel and terminate at the northern bank of the Ship Channel at the entrance to the side inlets described below. Based on these dredging limits and the proposed geometry of the channels to achieve a 0.1 FPS approach velocity, the total volume of soils, sands, and other sediments that must be removed to create each channel is approximately 15,000 cubic yards (yd^3), and nearly 30,000 yd^3 for both channels. **Figure 4-6** illustrates the conceptual configuration and approximate location of the two intake channels within the Brownsville Ship Channel relative to the proposed desalination plant site.

A considerable quantity of dredged materials would be removed from the Brownsville Ship Channel during the construction of the intake channels. This material could be spread across the site, mixed with other site soils, and subsequently graded and used to develop the overall property reserved for the desalination plant. Alternatively, the excess dredged materials could be disposed of off site in a landfill. An allocation was assigned in the cost estimate for the disposal of excess dredged material from the ship channel.

4.2.2.2 Side Inlets

Upon evaluating and properly addressing the preferred approach velocity at the final point of seawater collection for the desalination plant, a properly designed water intake structure was developed. This structure would minimize the collection of various contaminants and other hazards that could threaten a continuous and reliable collection of seawater for the project. Potential engineering issues and potential hazards considered in developing a conceptual configuration for the seawater intake structure included the following:

- **Oil Spills and LNAPL Contaminants** – Due to the nature of the Brownsville Ship Channel and the amount of large and small ship traffic that frequently traverses the channel, oil and gasoline spills may occur within the source water. Thus, the potential is high for sheens of separate-phase petroleum products such as oil and gasoline, also generally referred to as Light Non-Aqueous Phase Liquids (LNAPLs), to be present at the plant's intake. If a relatively large oil spill were to occur near the project's seawater intake, substantial damage could occur to the upfront components in the desalination facility (e.g., screens, pumps, initial process tanks and associated equipment). Therefore, in general terms, proper intake design should minimize or eliminate altogether the collection of LNAPLs.

- **Large Floating Debris** – Another hazard that should be addressed through proper intake design is the exclusion of floatable debris that could damage the intake structure itself and/or reduce or prevent the seawater supply from being collected. Light floating debris such as plastics, paper, etc., could reduce or limit the amount of water that could be collected by occluding an intake screen or even damaging the impellers on the seawater supply pumps. Floating debris that has considerable mass (e.g., tree trunks, wooden plank boards) could damage a critical link in the seawater intake system, such as a static screen, which could cause a premature shutdown of the overall plant.

- **Protection of Sensitive Intake System Components** – The sensitive components of the intake system such as the screens and the downstream piping and equipment should be protected from potential damage due to either acts of God or terrorism. Proper engineering design is needed to protect the more sensitive components of the intake system from intentional and unintentional damage. If possible, at least two lines of defense should be provided to properly safeguard the intake system.

- **Proper Hydraulic Configuration of Intake Screens** – Proper positioning of the water intake screens is necessary to minimize the collection of solids as well as sensitive environmental species that may be present. The screens should be installed at an elevation relative to the tidally influenced water surface that would ensure the proper collection of water to support the desalination facility's maximum water production capacity at all times. In addition, due to wave energy created within the Brownsville Ship Channel, the intake structure should dampen the majority of any wave energy that could occur near the screen assemblies, thereby normalizing the tidal water level and improving intake hydraulics.

A set of side inlets is conceptually proposed to cost-effectively and reliably address the issues described above. As with the intake channels, two side inlets (one for each channel) are proposed for the initial plant configuration to provide sufficient redundancy for this critical plant component. **Figure 4-7** depicts the general configuration of each side inlet. Each inlet will be approximately 60 feet wide as measured along the Brownsville Ship Channel and 20 feet long (into the site). The inlets would have a total depth of 28 feet as measured from the proposed site grade of 12 feet AMSL, with an "entrance barrier wall" located at the mouth of the inlets to address the previously described issues. The entrance wall will be a reinforced, concrete structure of sufficient thickness to protect the interior portion of the side inlet from any floatable debris and/or LNAPLs. In addition, the entrance wall will also protect the intake screens that will be located behind the wall by limiting access to them. Finally, the entrance wall will dampen wave energy that approaches the side inlet, thereby normalizing and improving hydraulics at the final point of seawater collection for the project.

The top of the entrance barrier walls will match the top elevation of the seawall that will flank it on either side (16 feet AMSL). The base of the wall will extend down to an elevation of approximately -5 feet AMSL to span the entire potential tidal fluctuations that may occur. A set of piles (total of two per inlet) would be driven and installed directly below the entrance barrier walls to better support the overall wall span. Directly below the bottom of the entrance barrier wall would be the seawater intake inlet measuring 60 feet in width and 11 feet in height. At these dimensions, the approach velocity into the side inlets will be minimized to 0.1 FPS. A relatively tall seawall will be needed to support the construction of the side inlets. Based on the dimensions for the proposed intake depth, the interior walls of the side inlets will be approximately 37 feet deep, measuring from 16 to –21 feet AMSL. A portion of the seawall abutting the side inlets will also have to extend to this depth to properly span the side slopes of the dredged intake channels. **Figure 4-7** contains an elevation view illustrating the general configuration of the side inlet structure, including its entrance barrier wall.

The conceptual physical configuration of the seawater intake openings at each side inlet would facilitate the closure of the inlet area under the barrier wall when needed to conduct major maintenance events within the inlet. Major maintenance events would include the removal and replacement of the screen assemblies, and/or repairs and rehabilitation work that may be needed within the inlets from time to time.

4.2.2.3 Seawater Screening

At the interior end of each side inlet, a set of water intake screens constructed of a copper-nickel alloy will be installed. These screens will reduce entrainment and impingement of aquatic life by excluding planktonic eggs, larvae, swimming organisms, and other objects greater than 1/8-inch in diameter. The screens are sized to limit the maximum approach velocity at the face of the screens to 0.5 FPS. A total of two screen assemblies will be installed within each side inlet at a center line elevation of approximately –7 feet AMSL. At this elevation, the top of the screen assembly would be around –5 feet AMSL, thereby maintaining at least a 2-foot water freeboard above the top of the screens during mean low tide conditions (-3 feet AMSL). Each screen assembly can be isolated if necessary for maintenance, repair, and/or replacement while maintaining water supply to the plant via the remaining screen assembly. Each screen assembly would be mounted directly to mechanical yard piping that would be cast into the concrete side wall of the inlet.

A compressed air supply will be used to provide a periodic “air burst” along the face of the screens to keep them clear of solids. An air burst of the screen assemblies would occur when the differential pressure drop across the screens exceeds 2 psi. This air burst also may be used more periodically using an automated timer. A 15 horsepower (HP) air compressor will supply compressed air to each screen assembly through a high-pressure receiver tank and a manifolded air supply line leading to a series of nozzles located along the length of the screen assembly. **Figure 4-7** illustrates the configuration of the screen intake assemblies and its associated air burst system.

4.2.2.4 Transfer Pumping System

A set of vertical turbine pumps will collect seawater from the side channels via the intake screen assemblies and will route it to the pretreatment system in the desalination plant. Three pumps will be used to collect the quantity of seawater needed for the plant’s initial finished water production capacity of 25 MGD. One of the three pumps will be a redundant unit in the event that one of the other pumps fails for any reason. Each pump will be rated for a transfer flow of approximately 21 MGD (14,470 gallons per minute [gpm]) at 100 feet of discharge head and equipped with a 450 HP motor that would be controlled by a variable frequency drive. The pumping system will include all necessary valves and other mechanical appurtenances necessary for proper and optimized operation to maximize the service life of this system. In addition, a flowmeter assembly will be installed directly downstream of the transfer pumps, which will confirm influent flows to the desalination plant. **Figure 4-8** illustrates the configuration of the transfer pumping system.

4.2.3 Pretreatment System Components

The pretreatment system for this project will include a ballasted flocculation and sedimentation system, and a single-stage dual-media filtration system for the bulk removal of organics and other suspended solids. The partially pretreated water would be routed through a heat exchange system to preheat the reverse osmosis (RO) feed water to 90 degrees Fahrenheit (ºF); a series of chemicals to condition the water supply would be added prior to the membrane system. The pretreated water would then be processed through the cartridge filtration. In addition, the raw water supply will be shock-chlorinated periodically to reduce bacteria and other biological agents that may accumulate within the pretreatment system through time. Each of these components is described in more detail below.

4.2.3.1 Ballasted Flocculation and Clarification (BFC) System

A BFC system will be used for the bulk removal of organic and inorganic constituents that may be present in the seawater supply. A total of three BFC trains will be arranged in a parallel configuration. Each train will be hydraulically rated for a feed flow rate of 21 MGD. Two of the three trains would operate to support the full finished water production capacity of the plant, while the third would serve as a redundant train when repairs and/or maintenance must be performed on the other trains. **Figure 4-9** is a preliminary layout diagram for this system and its various components.

A chemical coagulant such as a ferric salt (ferric chloride or ferric sulfate) would be used to coagulate the water supply. In addition, the water supply may be acidified to improve the removal efficiency of some constituents, including color, if determined necessary. Pilot testing would establish whether the seawater supply should be acidified or not at this location in the overall water treatment process train as well as the most appropriate chemical coagulant and its optimal dosage. For the purposes of conceptual planning and design, it is assumed that the pH of the raw seawater supply will be reduced to near neutral conditions (6.9 to 7.1) to optimize the coagulation process. Concentrated sulfuric acid was selected for the conceptual process design and would be dosed to the raw seawater supply via an in-line static mixer on the inlet piping to each BFC train. Based on the average alkalinity of the seawater supply, an approximate sulfuric acid dose of 15 milligrams per Liter (mg/L) was estimated to reduce the pH level to 6.9. The reduction in pH will result in a loss of alkalinity of approximately 15 mg/L; however, sufficient alkalinity will remain within the water supply for post-treatment stabilization needs as further described below.

After acidification, a chemical coagulant would be added and flashed-mixed via another in-line static mixer on the inlet piping to a BFC train. It would then be routed into a coagulation basin to provide sufficient detention time for the coagulation process to occur. Mechanical mixers equipped with 15-HP variable speed drives would be used in the coagulation basins. For the conceptual design, a coagulant dose of approximately 15 mg/L would be added to the raw seawater supply. Both the rate of coagulant addition and the speed of the mechanical mixers would be automatically controlled using influent turbidity measurements. Because total suspended solids concentrations vary within the raw seawater supply, the dose of coagulant and the mixer speed would be varied proportionally to ensure proper and optimized pretreatment of the water supply at all times.

Upon exiting the coagulation basin, the water would be injected with micro-sand. This would improve the solids separation efficiency in the downstream sedimentation basins through the attachment of coagulated floc to the micro-sand, which serves as a ballast to floc particles. A polymer added to the micro-sand within the injection basins aids in the attachment of floc to sand. Mechanical mixers with 15 HP drives would also be used in the sand injection basins. Sand for this process would be stored in a distribution box located directly above or near the injection basin so that it could be gravity or slurry fed. Most of the sand that is fed to the process would be recycled from the downstream sedimentation tank, although a relatively minor quantity of makeup sand must be periodically added due to sand entrainment and loss within sludge generated by the BFC system. The plant operator periodically would add replacement sand as needed to maintain a consistent sand concentration within the BFC system. Replacement sand can be added manually to each process train or through a more automated slurry makeup operation, which could be configured either in batch or continuous mode.

After sand injection, water would be routed through a flocculation (maturation) chamber equipped with a 20-HP variable speed mechanical mixer where proper detention time would be provided to allow all coagulated particles to flocculate and attach to the micro-sand ballast. Subsequently, water would be routed into a dedicated sedimentation basin equipped with lamella setting plates. Clarified water would flow up through the settling plates, which would reduce and impede the upward migration of any residual flocs that may be contained within clarified water produced by the BFC system. Clarified (solids free) pretreated water would rise out of the settling plates and be collected in an overflow structure for subsequent routing to the downstream filtration system. Concurrently, separated solids and sludge generated by the BFC system would fall by gravity into a lower hopper section of the sedimentation basin where it would be extracted using dedicated sand recirculation pumps.

Since micro-sand will be present within the sludge produced by the sedimentation process, the sand-sludge mixture will be routed to a set of hydrocyclones used to separate sand from the sludge. Sand separated through the hydrocyclones would be returned to the injection tank for recycle, while sludge would be routed onward to the solids handling system for further treatment. This process is described in more detail in **Section 4.2.6**. Based on preliminary sizing calculations, each sand recirculation pump would have a rated capacity of 440 gpm and would be equipped with a 20-HP motor. Upon separation of sand from the sludge generated by the BFC system, a total average sludge flow of approximately 700 gpm containing approximately 0.1% to 0.5% solids would be routed to the solids handling system.

Removal of the majority of suspended solids as well as a substantial portion of the total organic carbon (TOC) through the BFC system will significantly improve the quality of the sea water supply. Reduction of TOC levels will reduce the fouling potential associated with the downstream components including multimedia filters, the cartridge filters, and, probably most importantly, the SWRO membranes. Anticipated quality of the seawater supply processed and produced by the BFC System as compared to the original seawater quality is summarized in **Table 4-2**.

Table 4-2. Comparison of Probable Water Quality Before and After BFC Treatment

Water Quality Parameter	Units	Raw Seawater Supply (Historical Range)	BFC Treated Supply (Probable Range)
Total Suspended Solids (TSS)	mg/L	6 – 153	< 1 – 10
Total Dissolved Solids (TDS)	mg/L	11,700 – 49,000	11,700 – 49,000
Total Organic Carbon (TOC)	mg/L	1.0 – 3.4	0.5 – 2.0
Likely Fouling Potential	--	Moderate to High	Low
Other Important Water Quality Parameters			
Iron	mg/L	0.003 – 0.215	BDL
Manganese	mg/L	0.001 – 0.049	BDL
Alkalinity [(a)]	mg/L (as $CaCO_3$)	100 – 147	75 – 110
pH [b]	Std. Units	8.1 Average	6.9 – 7.1
Temperature	^{o}C	7.9 – 31	7.9 – 31

Note:
All results must be confirmed during proper pilot testing and achieved through detailed engineering design.
Refer to Section 3 for a more complete discussion regarding historical water quality data.
BDL = Below Detection Limits.
[a] *Alkalinity is lost due to consumption during the chemical coagulation process and/or through acid addition.*
[b] *A pH shift would occur if the seawater stream is pre-acidified for BFC treatment process.*

4.2.3.2 Single-Stage Dual-Media Filtration System

Water from the upstream BFC process would be gravity fed to a series of dual-media filter cells arranged in a parallel configuration. These cells would be conventional gravity filters in which influent water would be loaded on the top of the various filter cells. It would then flow downward through the filter media and subsequently be collected within a series of underdrains for final routing out of the system. All water from the filtration system would gravity-flow to a dedicated set of clearwell structures. **Figure 4-10** illustrates the general configuration and physical layout of this system.

For the initial design capacity of the desalination facility, a total of eight filter cells, each measuring 20 feet by 44 feet in area with a total media depth of 5 feet, would be used. Seven of the eight cells would be available at any given time to ensure that the full design capacity of the plant could be maintained. The remaining cell is provided to allow for the daily filter media backwashing events as well as periodic filter maintenance events that will be needed from time to time.

As partially pretreated water flows by gravity from the upstream BFC system, it is routed through a common centrally located header relative to each filter cell. If the cell is in its normal filtration mode, the inlet valve is in the open position, and water enters the cell. Since all cells are constructed at a uniform grade, a uniform hydraulic level occurs over all of the in-service filter cells. For the purposes of conceptual design, the upper portion of the filter bed would contain anthracite, a preferred media due to the relatively large pore space available within it for the storage of solids removed from water. This design provision optimizes the filtration process by allowing longer filter run times between backwash events. Following the anthracite layer, water is filtered through a layer of silica sand for the removal of most remaining suspended solids that may be present in the water stream. The majority of suspended solids that may be present in the seawater supply would be removed at this point in the overall treatment process. The final polishing step should produce a filtered water containing minimal suspended solids with a turbidity reading of less than 0.1 NTU 95% of the time. It should be noted that the exact type of filter media that should be used would be confirmed during pilot testing.

Backwash Waste Generation

Individual filter cells would be periodically backwashed for the removal of accumulated solids, and all spent backwash water would be routed to the solids handling system for further treatment as described later in this section. During a backwash event of one or more of the filter cells, the inlet valve would be closed to isolate the cell(s) from the remaining cells that are in operation. A backwash event would be triggered by a high-water level condition above the filter media or due to an event timer, which would periodically trigger a backwash cycle after a certain filter run time. Once initiated, the following sequence of events would occur:

- The inlet and outlet valves to the filter cell are closed.

- The backwash water supply valve to the cell is opened, and operation of a backwash pump is initiated.

- Filtered process water is reverse routed through the filter cell’s underdrain system to fluidize the filter media and dislodge the majority of solids contained there. Two backwash rates are used during a full backwash cycle. An initial air-scour backwash will clean the filter media at a rate of approximately 5 gpm/ft^2 for the first three to five minutes of the overall backwash cycle. Following this initial backwash rate, a backwash rate of up to approximately 20 gpm/ft^2 will occur for an additional five minutes.

- Spent backwash water upflows through the filter cell and is collected in the backwash troughs for subsequent routing onward to the solids handling system.

- After the full backwash cycle is complete (8 to 10 minutes), operation of the backwash pumps and air supply blowers is terminated, the backwash and air supply valves are closed, and a filter-to-waste valve opens (or remains open) to collect backwash water remaining in the filter cell, which is also routed to the solids handling system.

- The inlet valve to the filter cell re-opens and an initial volume of water is routed into the filter for a certain period of time (15 minutes) to prepare it for another filtration cycle. During this time, all filtered water is routed to the solids handling system via the filter-to-waste valve. (The filter outlet valve remains closed.) This step in the overall backwash process is necessary to minimize the re-entrainment and collection of suspended solids in the filter effluent during subsequent reactivation of the cell.

- The filter-to-waste valve is closed and the filter cell's outlet valve is opened, thereby reactivating the cell for another cycle of operation.

Pumps and blowers for filter backwashing will be housed in a dedicated enclosure located adjacent to the filters as illustrated on **Figure 4-3.** The enclosure will serve two important functions: 1) protect the mechanical equipment for exposure to adverse environmental elements (sun, heat, rain); and 2) reduce and abate noise generated by the mechanical equipment, especially the blowers.

As a consequence of filter backwashing operations, a relatively dilute wastewater stream containing various suspended solids is generated. All spent backwash water is routed via gravity to an equalization basin (part of the solids handling system), which is located adjacent to the filter system. The total wastewater flowrate estimated for the single-stage, dual media filtration system was calculated using the potential backwash rates and durations. The following table (**Table 4-3**) provides a summary of the resulting wastewater flows based on the backwash rate and duration.

Table 4-3. Summary of Potential Range in Spent Backwash Flowrates

Backwash Flow (gpm/ft^2)	Filter Area (ft^2)	Backwash Rate (gpm)	Backwash Duration (minutes)	Backwash Volume (gallons)
5	880	4,400	4	17,600
20	880	17,600	5	88,000
			Total	**105,600**

4.2.3.3 Filter Clearwell and Transfer Pumping Subsystem

A set of vertical turbine transfer pumps will be mounted on top of the filter clearwell to route the pretreated water supply through the cartridge filters and to the high-pressure seawater reverse osmosis (SWRO) feed pumps. Since each train in the primary treatment system will be rated for a finished water production capacity of 5 MGD, each transfer pump will be sized to provide the requisite feedflow to each membrane train. Assuming that individual membrane trains can operate at a 60% recovery factor, a total feedflow of 8.33 MGD must be transferred from the clearwell to each train in the primary treatment system. Based on this division of flow to support the individual membrane trains in the primary treatment system, six transfer pumps will be provided at the clearwell, i.e., one for each membrane train.

The vertical turbine pumps will be installed in a parallel configuration along the top of the filters' clearwell. The geometry of the clearwell was conceptually developed to match the overall width of the upstream filter system to better facilitate construction and overall appearance of and access to the system. Since it will be necessary from time to time to conduct maintenance within the interior of the clearwell, the structure will have internal division walls to separate it into six chambers. Each chamber will house a vertical turbine pump, thereby allowing for periodic maintenance and/or repair of any portion of the clearwell while only losing the use of one train. The physical configuration of the clearwell and the six vertical turbine transfer pumps is illustrated on **Figure 4-11**.

Manways on the top deck of each chamber in the clearwell will allow access to the interior of each chamber if and when necessary. A common water header connected to each chamber in the clearwell will be used to route filtered water to the filter system's backwash pumps, which will be the source for the backwash water supply. While each vertical turbine pump will be located within the clearwell, the pump drive (motor) will be located on top of the clearwell deck along with the pump discharge headers and various appurtenances. In this arrangement, easy access to each unit would be available, thereby facilitating access during both initial pump installation and during subsequent maintenance events.

4.2.3.4 Heat Exchange Subsystem

Steam energy from the co-located power plant will be used to pre-heat the feedwater for the downstream membrane system. As previously presented in **Section 3**, the temperature of water in the Brownsville Ship Channel typically ranges from 60°F to 95°F, with the annual average temperature of the water being 75ºF. As the temperature of the feedwater increases, the pressure required for the SWRO intake pumps decreases, resulting in a tangible savings in pumping energy usage. The output pressure of the SWRO intake pumps generally can be reduced by approximately 1% for each one degree Fahrenheit temperature increase. Thus, if the feedwater were heated from 75ºF to 90ºF on average, the required output pressure of the SWRO intake pumps would be reduced by approximately 15%. Using a unit energy cost of $0.035/kilowatt-hour (kW-hr), and accounting for the cost of the steam from the power plant, the use of the feedwater heater could result in an energy savings of up to $385,000 per year.

A 36-inch, in-line steam heater for each feed stream (total of six) would be a suitable choice to increase the temperature of the pretreated water supply to 90°F. A dedicated steam transfer line from the power plant to the in-line steam heater would be installed to support this unit operation via a dedicated utility corridor established between the two plants. The in-line heaters are essentially piping tees, which are used to inject high-temperature steam directly into the pretreated water stream. On average, the heater would use approximately 11,700 pounds per hour (lbs/hr) of 165 psig steam to heat the feedwater from 75ºF to 90ºF. During colder temperature months, additional steam energy would be needed to maintain a 90ºF temperature for the feedwater. During the hotter summer months, no steam at all would be required. Temperature monitors would be installed directly downstream of the heaters to properly control the amount of steam required to maintain an approximate feedwater temperature of 90ºF. **Figure 4-12** shows the in-line heater and its conceptual location within the Membrane Building.

4.2.3.5 Chemical Additions

To further condition and pretreat the seawater supply to preserve bicarbonate alkalinity prior to the membrane separation process, the supply will be dosed with an acid, such as sulfuric acid, to reduce its pH level to approximately 6.5. (If the seawater supply were previously acidified for pretreatment optimization, only a supplemental quantity of acid would be added to achieve or

maintain a pH level of approximately 6.5, as necessary.) Assuming that the raw seawater supply is acidified prior to the BFC System, an additional 20 mg/L of concentrated sulfuric acid would be needed to further reduce the pH from 7.0 to 6.0. The reduction in pH will convert bicarbonate alkalinity into carbonic acid, which would pass through the membranes for subsequent recovery in the post-treatment system. As previously indicated, pilot testing will be required to more accurately estimate the actual pH level needed to preserve sufficient alkalinity for post-treatment stabilization of the water supply. Refer to **Section 4.2.7** for additional information pertaining to the sulfuric acid supply needed for this process.
Another additive that may be needed to properly manage certain types of potential fouling agents is a class of chemicals collectively referred to as anti-scalents. These chemicals are typically added to reduce the ability of foulants and supersaturated species to attach to the surface of the membranes. It should be noted that, even if the need for an anti-scalent is not supported based on bench- and/or pilot-scale testing, it is prudent engineering design to have specific provisions available within the plant to add this chemical stock and associated delivery system. As such, an allocation for this system was accounted for in this study. Refer to **Figure 4-11** for the approximate location where sulfuric acid and/or an anti-scalent would be added prior to the downstream cartridge filtration system.

4.2.3.6 Cartridge Filtration

The preheated, pretreated water stream will be routed through a bank of cartridge filters before the primary treatment system. The cartridge filters will be used as the last physical barrier to prevent the passage of suspended solids greater than 5 microns in diameter. In addition, the cartridge filters will improve mixing and dispersion of the chemicals added to the water supply upstream of the filters, thereby ensuring a more homogenized water supply prior to membrane treatment.

Each train will be equipped with one 48-inch diameter cartridge filter housing, which will contain approximately 230 cartridge filter elements, designed to capture any solids with effective diameters of 5 microns or greater. Each cartridge filter vessel has a rated hydraulic capacity of approximately 8.33 MGD (5,800 gpm) at a clean differential pressure drop of 5 psig. **Figure 4-12** illustrates the location of the cartridge filter housings in relation to the Primary Treatment System as further described below.

Cartridge filters will be replaced on a routine basis during the course of facility operations. It is anticipated that the useful lifetime of individual cartridge filters will be approximately three months. This assumption is based on the knowledge that a reliable and robust pretreatment system is provided upstream to protect and extend the useful life of the cartridge filter elements. As such, quarterly replacement of cartridge filters is anticipated for this facility. The frequency of cartridge filter replacements would be confirmed through pilot testing.
4.2.3.7 Periodic Shock Chlorination

Seawater will be periodically dosed with chlorine in the form of hypochlorite (OCl^-) within the pretreatment system to manage the accumulation of biological contaminants that could foul the membrane elements. The exact frequency of the shock chlorination would be established from pilot testing and during initial full-scale plant operations. For planning purposes, it is assumed that the seawater supply will be shock chlorinated once every month. Sodium hypochlorite, in the form of commercial bleach (12 to 18% OCl), would be used for the shock chlorination events. (Refer to **Section 4.2.7.3** for additional information pertaining to this chemical stock.) The use of commercial bleach versus the on-site hypochlorite generation system, which is described in further detail below, would provide greater operational flexibility for this periodic maintenance event. Various chemical feed points would be established and available for the metering of concentrated hypochlorite into the pretreatment system. Potential points of application include the following:

- Seawater Transfer Pumping Station;
- Influent Pipe to BFC System;
- Influent to Dual-Media Filter System; and
- Within the Filter Clearwells.

When shock chlorination is done in the pretreatment system, sodium bisulfite would be added prior to the downstream cartridge filters to dechlorinate the water supply to protect the membranes from oxidant attack. **Section 4.2.7.5** provides information regarding this chemical stock.

A proper evaluation of disinfection byproduct (DBP) formation should be conducted during the pilot-testing phase of this process to confirm the potential generation of total trihalomethanes, haloacetic acids, and other DBPs, which could potentially violate finished water quality standards. Most DBPs would not be removed in the downstream membrane system. Through proper pilot testing, engineering design, and development of an appropriate operational strategy for this particular process, adequate assurance could be provided to properly manage and mitigate DBP production as a consequence of conducting shock chlorination.

4.2.4 Primary Treatment System Components

The primary treatment system will consist of specific components needed to reliably ensure the efficient removal of salt from seawater. While various modifications could be explored and further evaluated for the heart of the desalination facility, the following configuration was developed based on collective knowledge regarding the design of many existing desalination plants throughout the world. In addition to the configuration of components in the primary treatment system, options are also available regarding the specific manufacturer of the SWRO and brackish water reverse osmosis (BWRO) membranes that could be used in the final design (e.g., Hydranautics, Koch, Filmtec).

The following section provides a general discussion regarding the overall configuration of the various components described below as well as the configuration of individual membrane elements, which could be provided by any number of qualified SWRO/BWRO membrane vendors. Pilot testing and additional studies are needed to support the final selection, configuration, and layout of appropriate SWRO membranes for this project.

The following are the principal components that would comprise the primary treatment system for this project:

- SWRO trains;

- Second-Pass BWRO trains;
- High-Pressure SWRO feed pumps;
- Energy recovery turbines;
- Second-Pass BWRO feed pumps;
- Membrane cleaning and flushing system; and
- Foam management system.

Figure 4-12 illustrates the conceptual layout and configuration of these components relative to one another. Each of these components is described in more detail below along with a discussion of the production of permeate, brine, and waste products generated by this system.

4.2.4.1 SWRO Trains

The SWRO trains will be arranged in a parallel configuration. There will be a total of six trains. Each train will be designed to produce 5 MGD of permeate (desalted water). To increase the overall product recovery to approximately 60%, reject staging will be used within the SWRO trains. Each SWRO train will include two stages, using six-element pressure vessels. Concentrate from the first stage will be used as feedwater for the second stage. (Refer to the process flow diagram on **Figure 4-5** for the configuration of the SWRO units). Permeate from the two stages will be combined, and a portion of this combined flow from each SWRO train (approximately 44%) will be further treated by the partial second pass BWRO trains described in further detail below.

Brine will be produced by each SWRO train at an approximate rate of 3.33 MGD, assuming a 60% recovery factor is maintained for the overall membrane system. Therefore, at a brine generation rate of 3.33 MGD per train, a total brine disposal rate of 16.67 MGD would result for the facility's initial 25 MGD finished water production rate. All waste brine generated by the individual trains in the primary treatment system will be routed to a common discharge header that will in turn lead to the brine transfer station, which will route brine to its final disposal location.

Five of the six trains will be needed to produce the initial plant capacity of 25 MGD. The sixth train is provided for purposes of redundancy, when another train must be taken out of service for maintenance and/or repair. The provision of the sixth train will strengthen the ability of the plant to better maintain a production capacity of 25 MGD, as needed, based on the variation of water demands placed on the plant through time.

Based on initial numerical model calculations for the SWRO membrane separation process, the following TDS concentrations reported in **Table 4-4** were predicted for the SWRO trains. These results were based on the Hydranautics Membrane Solutions Design Software, Version 8.5.

Table 4-4. Summary of Anticipated TDS Content in Permeate and Brine Streams from SWRO Trains

Stage	Permeate Stream	Brine Stream
First-Stage Discharge	260	81,900
Second-Stage Discharge	2,100	89,900
Blended Streams		**380**

Note: All values are expressed in parts per million (ppm).

Through SWRO treatment, the TDS content of the water supply is reduced on average from approximately 36,000 ppm to 380 ppm. Thus, the TDS removal efficiency of the conceptual SWRO system is approximately 99% (2-log).

4.2.4.2 Second Pass BWRO Trains

For the initial design capacity of 25 MGD, the facility's second-pass BWRO system will consist of two trains, one of which will serve as a redundant train to allow for periodic maintenance and cleaning of the other train. Each BRWO train will process up to 11.1 MGD of feedwater that would be routed to it from the upstream SWRO units. The BWRO trains will use the low-pressure, high-rejection brackish water membranes in a two-stage configuration, with seven-element pressure vessels. (Refer to the process flow diagram, **Figure 4-5**, for the configuration of the BWRO units.) The second-pass BWRO trains will operate at an anticipated recovery factor of 90%. Concentrate from the BWRO trains will be recycled upstream of the SWRO trains to maintain a composite recovery factor for the overall desalination facility of approximately 60%.

Based on initial numerical model calculations for the BWRO membrane separation process, the following TDS concentrations reported in **Table 4-5** were predicted for the BWRO trains as well as the final TDS concentration once the streams from the SWRO and BWRO units are blended. These results are based on a feedwater TDS content of 380 ppm using the Hydranautics Membrane Solutions Design Software, Version 8.5.

Table 4-5. Summary of Anticipated TDS Content in Permeate and Brine Streams from BWRO Trains

Stage	Permeate Stream	Brine Stream
First Stage Discharge	15	1,800
Second-Stage Discharge	230	3,500
Blended BWRO Streams	**40**	
Blended SWRO and BWRO Streams	**200**	

Note: All values are expressed in ppm.

The blended SWRO and BWRO streams represent the newly created fresh water supply for the project containing approximately 200 ppm TDS. Upon being routed through the various unit processes and operations within the upstream pretreatment system and the primary treatment system, the desalted water supply has been properly conditioned for potable consumption by reducing TDS and other water quality constituents. The fresh water supply only needs to be properly stabilized and disinfected for final transmission and distribution to the local population, which will be performed in the downstream post-treatment system as further described below.

The total flow produced by five operational trains will be 25 MGD. If the sixth train is available, an additional 5 MGD could potentially be produced during certain periods; however, periodic maintenance and membrane cleaning events on the other trains will limit the use of the sixth train on a continuous basis. Of all the water produced by the membrane trains, two side streams will be transferred to the co-located power plant to support that plant's demineralized and cooling water makeup supply needs. Based on the conceptual level design for the power plant, about 1,280 gpm (1.84 MGD) of water from the primary treatment system would be needed by the power plant as a source of makeup water for that plant's cooling water system. In addition, 110 gpm (0.16 MGD) of demineralized-grade water from second-pass BWRO trains would be needed by the power plant. Both of these water supplies would be routed to the power plant via a dedicated utility easement that would also contain the low-pressure steam supply line for the pretreatment system. Taking this flow contribution for the power plant into consideration, the net production capacity of the desalination plant would be about 23 MGD.

4.2.4.3 Support Systems and Components

The following systems and components are needed to properly support the short-term and long-term operation of the desalination facility. The following systems do not directly affect the quality of the finished water supply or that of the waste brine stream generated within the primary treatment system.

High-Pressure SWRO Feed Pumps

A high-pressure SWRO pump feed will be used to provide the required feedwater flow at a pressure of approximately 1,100 psig for the membrane separation process in each train. It is anticipated at this time that there will be a total of six high-pressure SWRO pumps, i.e., one for each SWRO train in the primary treatment system for the initial plant capacity of 25 MGD. The pumps will be equipped with 2,900-HP variable-speed electrical drives sized for 4,160V power, which will be supplied through high voltage lines from the co-located power plant. A mechanical connection to an energy recovery turbine installed on the brine discharge main from each train as described below will also contribute work energy for the SWRO pumps, thereby defraying operating costs.

Energy Recovery Turbines

Each high-pressure SWRO pump will be coupled to an energy recovery turbine to reduce the electrical demand required for each pump. The energy recovery turbine uses the high-pressure brine stream from the second-stage SWRO Banks to spin a turbine, which is coupled to the SWRO pumps. Energy obtained from the brine stream reduces the total amount of electrical energy needed to run the pumps by about 33%, thereby conserving a significant amount of electrical energy. Refer to **Section 3** for additional information regarding the energy recovery system.

BWRO Feed Pumps

The majority of pressure provided by the high-pressure SWRO pumps will be lost through the SWRO units. To re-pressurize the permeate stream to provide sufficient driving pressure for the downstream BWRO units and subsequent transfer to the downstream chlorine contact chamber, a set of horizontal split-case pumps will be installed to boost the intake pressure prior to the BWRO units to approximately 80 psig. There will be a total of two BWRO feed pumps, i.e., one for each BWRO train. Each BWRO feed pump will be equipped with a 300-HP variable speed drive and will have a flow rated capacity of approximately 11.1 MGD at the requisite feed pressure for the BWRO units.

Membrane Cleaning and Flushing System

A membrane cleaning and flushing system will be needed to periodically clean the various membrane elements to remove accumulated solids and to restore the membrane's available flux rate to the degree possible. There will be two types of events: 1) flushing of the membrane elements using only clean permeate (or possibly using brine from the BWRO units to conserve water), and 2) surfactant cleaning using a combination of a suitable surfactant and clean permeate. For planning purposes, it is assumed that each membrane unit would be flushed with clean permeate each time an SWRO unit terminates operation. This event may occur frequently, depending on the variation in water demand placed on the desalination facility through time. Surfactant cleaning events would be performed when the differential pressure across the membrane surface (i.e., the transmembrane pressure) and/or the normalized permeate flux through the membrane reaches predetermined values. Pilot testing would establish what transmembrane pressure and flux values should be used to trigger a surfactant cleaning event. These periodic surfactant cleaning events will remove, to the degree possible, precipitated solids that may accumulate and be deposited on the surface of membrane elements through time.

Both the spent flushing and cleaning solutions generated by the membrane cleaning system will be routed to a dedicated wetwell structure equipped with a duplex pumping system. The pumping system will extract spent solutions for subsequent routing to the local wastewater treatment plant for final treatment and disposal.

Foam Management System

A significant quantity of foam would be produced within the waste brine stream as a consequence of turbulent aeration within the energy recovery turbines. A proper system to manage the foam must be taken into account to avoid an excessive buildup of foam within the brine discharge header and the downstream wetwell. Anti-foam chemical agents are commonly and widely used to reduce foam production; however, their use can present problems when attempting to secure a surface water discharge permit as well as represent an ongoing operational expense for the plant.

Rather than using a chemical additive as the primary means to address foam management, an anti-foam chamber is conceptually proposed for the plant. This chamber would consist of a honeycomb-like latticework structure, which would effectively retard the expansion of foam and allow its own weight to collapse itself, thereby maintaining a manageable level without having to rely completely on a chemical additive. The lattice structure would be similar to that used in packed aeration towers. A low-flow high-pressure supply of non-chlorinated water or other secondary water supply could be applied to the top and at intermediate locations within the honeycomb structure to further reduce foam levels, if necessary. In addition, a provision was made in the conceptual design for an anti-foam chemical to ensure proper management of the waste brine stream. A schematic depicting the general configuration of the anti-foam chamber is presented in **Figure 4-13**.

4.2.5 Post-Treatment System Components

The post-treatment system will include two unit treatment processes for final stabilization and final disinfection. A description of both of these unit processes is provided below.

4.2.5.1 Final Stabilization System

A stabilization system is needed to properly condition the water supply before it is routed into the downstream transmission and distribution systems. Stabilization is the process whereby the corrosive permeate stream is chemically conditioned to make it non-corrosive. This would be accomplished through a two-step process.

- **Step 1** – The first step occurs upstream of the membrane system through the addition of acid to reduce the pH level to approximately 6.5, which converts bicarbonate alkalinity (HCO_3^-) into carbonic acid (H_2CO_3) which would subsequently pass through the SWRO membranes within the permeate stream.

- **Step 2** – In the second step, the pH level of the desalted permeate stream from the membrane system is increased through the addition of lime. Lime is a caustic chemical (high pH) containing calcium (Ca^{+2}) and hydroxide (OH^-) as its primary constituents. As lime is mixed with the permeate stream, the pH level rises and carbonic acid within the permeate is converted to bicarbonate. Bicarbonate in turn combines with calcium from the lime supply to form calcium bicarbonate.

Sufficient concentrations of calcium carbonate should be maintained within the finished water supply so that the finished water supply is saturated and even supersaturated to a slight degree with this chemical. Calcium carbonate in excess of its saturation value within the water supply precipitates out of solution and forms a thin protective coating on the interior of all water transmission and distribution mains, and connected plumbing. The protective coating formed by maintaining a proper calcium carbonate content within the finished water supply protects the supply by minimizing the dissolution of metals within the piping and plumbing systems served by the water supply.

It appears that sufficient bicarbonate alkalinity would be available in the product water stream for final stabilization of the finished water supply if bicarbonate alkalinity present in the raw seawater is properly preserved and recovered as described above. However, since calcium will be removed through the membrane separation process, an additional source of calcium must be added to the water supply to stabilize it. By recovering bicarbonate alkalinity and adding calcium into the water supply during post treatment, sufficient levels of calcium carbonate can be maintained to ensure a properly stabilized water supply at all times.

Based on the results of the alternatives analysis, a pebble lime system was selected to stabilize the finished water supply produced by the treatment plant. This system will consist of the following components: 1) a bin activator; 2) a rotary screw feeder and vibrator to route the solid chemical stock into a slaker equipped with a mechanical mixer; 3) a grit classifier for the removal of solids; 4) a lime slurry tank equipped with a mechanical mixer; and 5) a water supply system. Refer to **Figure 4-14** for the configuration of the pebble lime system. A set of slurry transfer pumps (total of two) will route the lime slurry directly into the permeate header directly upstream of the chlorine contact chamber.

The addition of lime to the water supply during post treatment will add both calcium and hydroxide, which will result in a pH shift from 6.4 to 7.5 or greater. As the pH level increases during post treatment, alkalinity within the permeate will be converted from carbonic acid into bicarbonate. Bicarbonate alkalinity will then combine with calcium to form calcium carbonate at a sufficient concentration to stabilize the water supply as described above. During the detailed design phase of the facility, piloting will be required to determine if a carbon dioxide system and/or an additional caustic stock will be required along with the pebble lime system to provide a sufficient quantity of alkalinity at a suitable pH level to properly stabilize the finished water supply.

4.2.5.2 Final Disinfection System

The final disinfection system will consist of on-site generated sodium hypochlorite, which is produced on an as-needed basis by an electrolysis system utilizing salt, electricity, and softened water. Refer to **Figure 4-15** for the configuration of the sodium hypochlorite generation system. One equivalent pound of chlorine is produced from 15 gallons of softened water (using first-stage permeate from the BWRO system), 1.9 pounds of salt, and 1.8 kW-hr of electricity. Because of the low concentration (approximately 0.8% by volume) of sodium hypochlorite produced by on-site generated systems coupled with minimal storage times, the degradation problems of commercial sodium hypochlorite are significantly reduced. Also, recent technological enhancements of the on-site hypochlorite generators allow for easier O&M than in the past. (Typical maintenance would include cleaning the electrodes with a muriatic acid solution twice per year or more to remove minerals that have precipitated onto the cells.)

On-site generation produces hypochlorite that is substantially less corrosive than commercial hypochlorite, thereby posing less threat to workers and equipment, and negating the need for secondary containment. Sodium hypochlorite generation produces a byproduct of hydrogen gas that is potentially explosive. The quantity produced, however, is insignificant and the hydrogen gas is easily vented from the equipment, buildings, and storage tanks using a properly designed ventilation system.

Hypochlorite generated at the site would be metered into the permeate produced by the primary treatment system at a static mixer located within the membrane building. Once dosed with hypochlorite, water would be routed via pipeline to a dedicated set of chlorine contact chambers. Two contact chambers are proposed in the conceptual configuration of the plant to ensure that the process can be remain in operation at all times, while allowing one of the chambers to be taken out of service from time to time for cleaning and/or maintenance.

Figure 4-16 illustrates a conceptual configuration of the contact chambers. Flow from the primary treatment system would be evenly split through the influent piping to the two contact chambers. Each chamber was configured with internal walls and baffles to maximize the hydraulic detention time by approximating a plug flow regime through each chamber. The chambers were sized to provide the requisite Concentration Time (CT) criteria for the final disinfection process, with a total of 1.2 million gallons per chamber. Outlet pipes from the chambers would allow for the removal of water via either the finished water pump station or the plant service water system.

4.2.6 Solids Handling System

The solids handling system will include four primary components: 1) a solids equalization basin; 2) a solids thickening subsystem; 3) a solids dewatering subsystem; and 4) a return pump station. Each component is described in further detail below.

4.2.6.1 Solids Equalization Basin

All wastewater generated by the pretreatment system will be routed by gravity flow to a solids equalization (EQ) basin. As the name implies, the function of this basin is to equalize large, instantaneous waste flows that are discharged from the pretreatment system so that the size of the remaining downstream components in the solids handling system can be minimized. The actual size of the solids EQ basin will be based on the specific types of unit processes and operations selected for the pretreatment system. However, at this time, peak instantaneous spent backwash flows generated by the dual-media filtration units in the pretreatment system, coupled with the frequency of backwash cycles, was used to size the EQ basin.

The EQ basin would be equipped with a set of submersible pumps located within a sump at one end of the basin that would be used to transfer wastewater to the downstream thickening subsystem described below. The transfer pumping system would be installed in a duplex configuration and would be rated for high solids duty. Each transfer pump would be equipped with a 10 HP drive and would be sized to convey the entire quantity of wastewater to the downstream solids thickening system at an approximate rate of 1.25 MGD (870 gpm). In the event that one of the transfer pumps fails for any reason, the second pump would ensure proper transfer of wastewater. A mechanical scrapper mechanism will also be installed at the base on the EQ basin, which will continually move all solids that settle out within the basin toward the lower sump area where the submersible pumps are located. **Figure 4-17** illustrates the general configuration and overall dimensions of the solids EQ basin.

4.2.6.2 Solids Thickening Subsystem

For the solids thickening subsystem, and the subsequent residuals dewatering subsystem, three identical trains would be arranged in a parallel configuration. Two of the trains would be on-line, while the third would serve as a redundant train during times of maintenance or repairs of one of the other trains in the system.

A two-stage flocculation basin followed by a lamella-type settling tank composes one train of the solids thickening subsystem. **Figure 4-18** depicts the conceptual layout for one train of the solids thickening subsystem. Each flocculation basin will measure approximately 16 feet x 16 feet and will provide a hydraulic detention time of 20 minutes before water is routed downstream to the settling tank. Each lamella-type settling tank would be 25 feet x 25 feet and 20 feet deep. Once transferred to the head of a train, wastewater would gravity flow through the two-stage flocculation basin and settling tank. Clarified water (supernatant) would overflow into collection troughs located at the top of the settling tanks from where it would be recycled to the head of the desalination plant via the return pump station described in more detail below. Solids separated within the settling tanks would fall to the bottom portion of the tanks, where it would gradually be compressed by gravitational forces, thereby thickening it to 1 to 2% solids. Periodically, the thickened sludge (residuals) would be extracted by a dedicated set of pumps and routed to the residuals dewatering system for further processing. The settling tanks were sized to allow for two to three days of sludge storage. Pilot testing would confirm the need to have a separate sludge holding tank to improve the consistency of the thickened residuals prior to the downstream solids dewatering units.

4.2.6.3 Solids Dewatering Subsystem

Thickened residuals from the previous system would be transferred to a set of belt filter presses for final conditioning to reduce the total volume of residuals that would require disposal off site. **Figure 4-19** illustrates the general configuration of residuals feed pumps and belt filter presses. The presses would be located in a dedicated building to protect the presses and dewatered residuals from entrainment with rain water.

A total of three feed pumps equipped with 5 HP drives would be arranged in a parallel configuration with each pump rated for 0.5 MGD (350 gpm). A common suction header between the upstream solids thickeners would be connected to the three feed pumps so that thickened residuals can be extracted from the bottom of any of the settling tanks by any of the feed pumps, when necessary. This piping arrangement improves the reliability of this transfer system. The discharge piping and associated appurtenances for the three residuals feed pumps would be configured to route thickened residuals to the three downstream belt filter presses, which would also be arranged in a parallel configuration.

A polymer storage and feed system will also be used in the residuals dewatering system. The polymer will be an anionic type and will be added to the thickened residuals stream as it is fed to one or more of the belt filter presses. The polymer will be fed at a concentration of approximately 1 mg/L. The polymer will aid in improving the dewatering process and will result in an improved sludge consistency.
Each belt filter press would be equipped with 2.0-meter wide belts and would be capable of handling up to 20,000 pounds of dry solids per day (16 hour shift). Dewatered residuals processed by each belt filter press will contain approximately 20% dry solids, which represents a typical sludge cake of suitable thickness for transportation offsite. The residuals will be transferred to contract hauling trucks using an inclined conveyor, which will route the dewatered residuals from the end of each press and into the hauling truck's bed.

All filtrate generated during the dewatering operation would gravity drain to a dedicated wastewater pump station for subsequent routing to the local POTW for final treatment and disposal. The quantity of filtrate produced by the dewatering operation will vary, depending on the percent solids of the thickened sludge routed to the presses as well as the actual dewatering efficiency of the presses themselves. However, assuming that solids will be thickened to 1 to 2% dry solids and the presses produce a filter cake consisting of 20% dry solids, the resulting filtrate flow would range between 0.12 to 0.24 MGD (83 to 166 gpm).

4.2.6.4 Return Pump Station

The return pump station would consist of a reinforced wetwell structure that would receive supernatant generated from the solids thickeners via gravity flow. A set of submersible pumps would be configured in a duplex arrangement within the wetwell structure. As supernatant is produced by the solids thickeners and routed to the wetwell, a rising liquid level within the wetwell would trigger the operation of the transfer pumps. The pumps in turn would transfer and return all supernatant to the head of the overall water treatment process. The force main carrying the supernatant stream would be manifolded into the main seawater supply header leading to the BFC system. Supernatant would be blended with the raw seawater supply before coagulant addition at the BFC system to satisfy the requirements of USEPA's Backwash Recycle Rule.

4.2.7 Chemical Supply Systems

Various chemicals will be needed to properly condition and treat both the seawater supply as well as residuals produced by the pretreatment system. All chemicals that will be used in the desalination facility will be NSF approved and /or compliant with the applicable federal and state regulations pertaining to drinking water supplies. The following chemical stocks and other process materials, at a minimum, will be needed to support the conceptual design of the desalination facility:

- Coagulant (Ferric Chloride/Ferric Sulfate);
- Concentrated Sulfuric Acid (98%);
- Pebble Lime;
- Concentrated Hypochlorite (Commercial Bleach);
- Sodium Bisulfite;
- Cationic Polymer;
- Anionic Polymer;
- Solar Salt for On-Site Hypochlorite System; and
- Micro-Sand Makeup Ballast.

Most of the chemicals will be stored in the chemical building at the plant site as illustrated on **Figure 4-3**. However, other chemical and material stocks will be placed in the locations most appropriate to support certain treatment processes and operations. **Table 4-6** summarizes the various types and estimated quantities of chemicals that may be required to properly support the various treatment operations for water and residuals. Sufficient storage capacity was provided to maintain a 30-day stock of each chemical, thereby reducing the frequency of chemical deliveries to the site as well as on-site truck traffic.

Table 4-6. Summary of Process Chemical Stocks and Storage Quantities				
Chemical	**Estimated Dosage (mg/L)**	**Process Flow (MGD)**	**Daily Average Quantity Used**	**Monthly Storage Volume Required[a]**
Coagulant [b]	15	41.66	210 gallons	6,300 gallons
Sulfuric Acid (98%)	35	41.66	790 gallons	23,700 gallons
Pebble Lime	32	25.00	6,700 pounds	100 tons
Conc. Hypochlorite (12%)	10	41.66	14 gallons	420 gallons
Sodium Bisulfite	5.0	41.66	5 gallons	150 gallons
Cationic Polymer	1.0	41.66	21 gallons	630 gallons
Anionic Polymer	2.0	0.70	<1 gallons	30 gallons
Solar Salt [c]	---	25.00	4,000 pounds	60 tons
Micro-Sand Ballast [d]	---	41.66	500 pounds	7.5 tons

Note: All chemical quantities and volumes are rounded values.
[a] *Monthly storage volume is based on a 30-day supply.*
[b] *Conceptually, a ferric salt such as ferric chloride or ferric sulfate is the proposed coagulant.*
[c] *Solar salt is used in the on-site hypochlorite generation system.*
[d] *Micro-sand ballast is used in the BFC System and is lost at an estimated rate of 0.4% per day.*

While some of the chemicals listed in the above table will be stored within the dedicated chemical building at the site, other chemicals will be stored elsewhere on the site. In general, all process chemicals that represent a potential health hazard will be located or adjacent to the chemical building, while other less hazardous process chemicals and/or materials will be stored at an appropriate location relative to their respective points of application. **Table 4-7** summarizes the proposed locations for all of the chemical stocks conceptually proposed for the desalination facility along with the number and type of storage vessels and the bulk storage capacity provided for each chemical stock.

Table 4-7. Location of Process Chemicals, Storage Provisions, and Bulk Storage Capacities				
Chemical	**Location**	**Vessel Type**	**Number of Vessels**	**Total Bulk Capacity**
Coagulant	Chemical Building	HDPE	2	7,000 gallons
Sulfuric Acid	Adjacent to Chemical Building	Glass Fused	3	25,500 gallons
Pebble Lime	Chemical Building	Coated Steel	2	100 tons
Conc. Hypochlorite	Chemical Building	HDPE	2	660
Sodium Bisulfite	Chemical Building	HDPE	1	330 gallons
Cationic Polymer	Near BFC System	FRP	2	660 gallons
Anionic Polymer	Solids Handling Building	FRP	1	55 gallons
Solar Salt	Chemical Building	HDPE	1	80 tons

Table 4-7. Location of Process Chemicals, Storage Provisions, and Bulk Storage Capacities				
Chemical	**Location**	**Vessel Type**	**Number of Vessels**	**Total Bulk Capacity**
Micro-Sand Ballast	Near BFC System	Super Tote	8	8 tons
Surfactant	Membrane Building	Totes	2	330 gallons

Note: A super tote consists of a 1-ton bag of sand.
HDPE = High Density Polyethylene; FRP = Fiberglass-reinforced plastic.

Figure 4-20 is a conceptual floor plan for the chemical building based on the proposed sizing of the various chemical storage tanks that will be located within or adjacent to this building. The chemical building is conceptually sited to allow easy access to truck traffic for the initial 25 MGD configuration of the plant. However, as illustrated on **Figure 4-4** for plant production capacities greater than 25 MGD, the location and configuration of the chemical building relative to the site may be different to better accommodate the delivery of certain chemical stocks via rail as well as by truck.

The physical, conceptual configuration developed for most of these chemical stocks includes bulk storage tanks, drums, or totes; a chemical metering system; and in some cases a chemical day tank for those chemicals of which large quantities would be used as a consequence of the specific treatment process and/or operation. At least two storage tanks would be provided for each chemical stock, with the exception of the polymer and surfactant stocks, which would be stored in the drums or totes in which they were delivered to the site. For any chemical stock delivered to the site in drums and/or totes, multiple vessels would be ordered, delivered, and stored until used. At least two storage vessels for each chemical stock are proposed to ensure both a sufficient chemical supply between chemical deliveries as well as to ensure that the specific unit treatment process can be maintained if one of the vessels must be taken out of service for any reason (e.g., replacement, repair, maintenance, etc.).

The solid process materials and chemicals proposed for the desalination facility include solar salt for the on-site hypochlorite generation system, pebble lime for the post-treatment stabilization system, and micro-sand makeup ballast for the pretreatment system's BFC system. Solar salt/brine and pebble lime stocks would be stored in dedicated storage silos located adjacent to the chemical building. Each pebble lime silo (total of two) would be equipped with a lower hopper section to allow the solid chemicals to be properly fed to a solution tank. Similarly, the micro-sand makeup ballast would be stored in another dedicated silo near the BFC System from which it would be slurried and routed into the BFC System. To supply water for proper preparation of the pebble lime and other chemical stocks requiring dilution, a dedicated service water supply will be provided for the solution tank. A 500,000-gallon service water storage tank and associated transfer pumping system are proposed for the service water supply system as illustrated on the conceptual site layout drawing (**Figure 4-3**) and the conceptual process flow diagram (**Figure 4-5**). The same service water supply system would also support slurry operations associated with the micro-sand makeup ballast for the BFC System.

To address the potential for chemical leaks and releases at the site, each bulk chemical stock would be stored within a dedicated and appropriately-sized secondary containment dike. Transfer pumps suitable for chemical duty would be selected and installed adjacent to each tank's containment dike. The transfer pumps and associated discharge piping would also be located within secondary containment to address the potential for a chemical release. The secondary containment structure for the transfer pumps would be configured in such a way that any chemical leaks from the transfer pump system would gravity drain back into the secondary containment structures at the chemical building where the chemical(s) could be temporarily stored until they could be removed.

The conceptual layout of the chemical building was configured to allow for additional chemicals than those listed above if it is determined for any reason in the future that different or additional chemical stocks are needed. For instance, while not initially proposed, it may be possible that an anti-scalent may be needed for the membrane system during full-scale plant operations. Other chemicals may be needed to meet future water quality regulations. Sufficient space within the chemical building is reserved for the stocking and metering of additional chemicals, if they are determined to be needed at some time in the future.

Due to the relative size of the proposed desalination facility and to provide a certain degree of independence between the various treatment trains in the desalination plant, each chemical transfer system would route its chemical stock to the appropriate location within the plant site where a day tank will receive and store the chemical stock. As the name implies, a day tank is used to store approximately one day's worth of volume for each chemical used at the plant. This design provision would allow the plant operator to confirm the daily use of chemical as well as to minimize the potential for larger chemical releases if a day tank were to rupture or be damaged in any way. Secondary containment piping would be installed between the chemical transfer pump systems in the chemical building and each day tank location. Each day tank would also be installed in an appropriately-sized secondary containment structure. In all cases, a duplex metering pump system including the metering pumps themselves, pulsation dampers, backpressure valves, and all other chemical metering appurtenances would be installed directly adjacent to the day tanks.

Each day tank would be located as close as possible to the point of chemical application to the particular unit treatment process to ensure proper control, metering, and monitoring of the application. **Table 4-8** provides a summary of the various chemicals that would be used in the conceptual design of the desalination plant, along with their respective points of application within the conceptual layout of the plant, where a day tank may be located.

Table 4-8. Summary of Chemical Application Points Within Desalination Facility

Chemical Stock	Desalination System	Chemical Application Points
Coagulant	Pretreatment	Influent Mains to BFC System (total of 3)
Concentrated Sulfuric Acid	Pretreatment	Influent Mains to BFC System (total of 3) Prior to Cartridge Filter in Train #1 Prior to Cartridge Filter in Train #2 Prior to Cartridge Filter in Train #3 Prior to Cartridge Filter in Train #4 Prior to Cartridge Filter in Train #5 Prior to Cartridge Filter in Train #6
Cationic Polymer	Pretreatment	Influent Mains to BFC System (total of 3)

Table 4-8. Summary of Chemical Application Points Within Desalination Facility		
Chemical Stock	**Desalination System**	**Chemical Application Points**
Concentrated Hypochlorite	Pretreatment	Influent Mains to BFC System (total of 3) Effluent Mains from BFC System Prior to Cartridge Filter in Train #1 Prior to Cartridge Filter in Train #2 Prior to Cartridge Filter in Train #3 Prior to Cartridge Filter in Train #4 Prior to Cartridge Filter in Train #5 Prior to Cartridge Filter in Train #6
Sodium Bisulfite	Pretreatment	Prior to Cartridge Filter in Train #1 Prior to Cartridge Filter in Train #2 Prior to Cartridge Filter in Train #3 Prior to Cartridge Filter in Train #4 Prior to Cartridge Filter in Train #5 Prior to Cartridge Filter in Train #6
Sodium Hypochlorite	Post-Treatment	Common Discharge Main from Membrane System Suction Header to Finished Water Pump Station
Anionic Polymer	Solids Handling	Influent Mains to BFC System (total of 3)

4.2.8 Brine Disposal System

4.2.8.1 Brine Quantity and Quality

Based on the previous description of facilities, brine generated by the primary treatment system will be routed from the membrane building to a dedicated brine transfer system as described in the following sections. **Table 4-9** summarizes both the quantity and quality of brine that will be generated for the initial capacity (25 MGD) of the desalination facility in 5 MGD increments.

Table 4-9. Summary of Brine Disposal Quantities and General Quality Parameters		
Finished Water Production Rate (MGD)	**Number of Operational Membrane Trains**	**Brine Generation Rate (MGD)**
5	1	3.33
10	2	6.67
15	3	10.00
20	4	13.33
25	5	16.67
Blowdown Allocation from Co-Located Power Plant		2.50
Total Potential Brine Disposal Rate [a]		**19.2**
Average Brine Quality		
Parameter	**Value**	**Unit**
TDS	89,900	ppm
Temperature	85 – 90	^{o}F
pH	6.5	Std. Units
Sodium	28,200	ppm
Chloride	49,800	ppm
Calcium	970	ppm

Table 4-9. Summary of Brine Disposal Quantities and General Quality Parameters		
Average Brine Quality		
Parameter	**Value**	**Unit**
Magnesium	3,300	ppm
Potassium	900	ppm
Sulfate	6,400	ppm
Other TDS Constituents	330	ppm

[a] *The total brine disposal rate is based on the initial finished water production capacity of the desalination plant of 25 MGD assuming a 60% recovery operating factor. The total brine disposal rate includes an allocation of 2.5 MGD for potential instantaneous blowdowns that may occur from the co-located power plant.*

4.2.8.2 Brine Transfer Pumping System

The brine transfer system will consist of a brine pump station and a brine line. **Figure 4-21** depicts the brine line route, which will cross under the Port of Brownsville shipping channel and proceed approximately 12 miles to the coastline. The line will then continue 3 miles offshore to where the water depth is approximately 25 feet deep where the brine will be diffused into the surrounding waters.

The brine pump station will have a concrete wet well to receive the brine from the SWRO units. Two vertical turbine pumps, each rated at 19.5 MGD, will discharge into the brine line. The wet well structure will be arranged to provide space for one future brine pump. The two proposed pumps provide redundancy, and the pumps will be made of materials resistant to the brine. The pumps will have 700 HP motors and be constant speed pumps. The pumps will require initial control valves for start up against an empty pipe.

4.2.8.3 Brine Disposal Main and Route

The brine disposal main will be 36 inches in diameter and was sized to provide a velocity of 5 feet per second. The 36-inch pipe requires a velocity of 4.4 feet per second at 19.5 MGD, and the initial pressure will be 80 psi. The brine disposal main will be HDPE or other pipe material resistant to the corrosive properties brine water. The anticipated design life is 50 years.

The brine disposal main will leave the desalinization plant site going south under the shipping channel, which is depicted in **Figure 4-22**. The channel crossing will be made using horizontal directional drilling technology. The crossing will be approximately 80 feet deep under the channel to provide the 25-foot clearance under the 55 feet deep channel requested by the Port of Brownsville. A permit for this crossing will need to be obtained from the Corps of Engineers (USACE). South of the shipping channel, the brine disposal main will be installed by open cut methods most of the way to the coast to just before the sand dunes, approximately 2000 feet west of the Gulf shoreline, providing a minimum of 4 feet of soil cover.

The brine disposal main will go south in a 40-foot wide easement to State Highway 4 (Boca Chico Road). The 40-foot wide easement is required for construction of the brine disposal main and space for two future brine disposal mains when the desalinization plant is expanded. The brine disposal main will turn east and continue parallel to State Highway 4 in a 40-foot wide easement along the north side of the highway ROW. The brine disposal main will cross under the highway near Richardson Road and continue east in a straight line to the back side of the dunes.

The onshore alignment for the brine disposal main appears to be primarily within property owned either by the Port of Brownville or the USFWS. There appears to be one private tract located along the north side of State Highway 4 west of Kingston Road. This site is labeled as a Mobile Park but there is one abandoned house and one under construction. They appear to be less than forty feet from the state highway ROW and will pose a problem with acquisition. Aligning the brine disposal main along the south side of State Highway 4 appears to involve more private property.

Since the sand dunes are environmentally sensitive, as mentioned previously, the open cut pipe installation will be stopped west of the dunes. At this point, the pipe will be directionally drilled 2000 feet to the shoreline and an additional 3000 feet into the Gulf, for a total of 5000 feet of directional drilling. The 3000-foot directional drill into the Gulf is required such that a water depth of 13 feet is reached, where barge mounted equipment can be utilized to install the remainder of the pipe and diffuser array.

The barge construction will install the HDPE pipe by jet trenching, providing 4 feet of cover. It is anticipated that the HDPE pipe will be butt-fusion welded at a port facility in 1000-foot lengths and barged to the installation site. The 1000-foot lengths will be butt-fusion welded and sunk into the trench with concrete weights added to resist floatation. The trench will then be backfilled by the jet procedure.

4.2.8.4 Gulf Outfall and Diffuser Array

A conceptual design for a diffuser array was developed to support the discharge of brine that would be generated by the desalination plant while minimizing environmental impacts within the local area surrounding the array. The following guidelines were used in developing a preliminary design of the diffuser for brine discharge.

- The brine flow is equally distributed across the various ports of the diffuser.
- The velocity in the diffuser should be sufficient to prevent deposition of solids carried with the flow, if any. Minimum flow velocities of approximately 2 to 3 FPS (0.6 to 0.9 meters per second) should be achieved for peak flows.
- The overall head losses should be kept as low as possible to minimize the level of pressure head at the upstream end of the line and dynamic pumping head required.
- All the ports should be fully occupied by brine, i.e., no seawater intrusion should occur. This can be achieved by assuring a Froude number greater than one for all ports.

The diffuser array will be sited and installed at the end of the brine transmission main and will consist of several ports equipped with 1-meter (3.3-foot) high risers oriented upward in a vertical position. The risers on the diffuser will help achieve higher discharge dilutions. Since the concentrated brine stream is heavier than the surrounding seawater, it will exit the ports along the array in an upward direction before falling toward the seabed. During its fall, concentrated brine will be diluted with ambient seawater. Thus, the upward orientation of the brine discharge enhances dilution while also minimizing head losses.

Preliminary dispersion modeling was conducted to develop and support an initial, conceptual configuration of the diffuser array for this project. Please refer to **Appendix D** for results of the dispersion modeling. At the proposed discharge location within the Gulf, the seabed floor is sloped, and the total fall between the head and tail of the diffuser array would be approximately 3 feet (1 meter). For the initial plant capacity of 25 MGD, the array would be approximately 330 feet long (100 meters), 54 inches in diameter, and would have a total of 50 ports spaced approximately 6.5 feet (2 meters) on center. Each port would be 0.5 inches (0.15 meters) in diameter. **Figure 4-23** is a conceptual configuration of the brine diffuser array.

Based on the previous description of the conceptual diffuser array, various brine dispersion patterns were evaluated using results obtained from a dispersion model. (Visual Plumes and UM3 were used to assess brine dispersion. UM3 is a Langrangian model that features the projected-area-entrainment hypothesis. This hypothesis quantifies forced entrainment, the rate at which mass is incorporated into the plume in the presence of an ocean current. The UM3 model is a three-dimensional plume model for simulating single- and multi-port submerged discharges.) Information downloaded from databases of the National Oceanic and Atmospheric Administration (NOAA) and the Texas Automated Buoy System (TABS) was used to assess local current conditions. Based on an interpretation of the data available from these databases, the current direction is expected to be parallel to the coastline with mild, average, and strong current magnitudes of 0.15, 0.32, and 0.50 meters per second (mps), respectively.

The brine dispersion modeling effort produced an initial set of results, including the degree of dilution provided by the conceptual diffuser array for the various current conditions assessed as well as the approximate lateral and areal extent of the resulting brine plume produced as a consequence of the conceptual diffuser configuration. **Table 4-10** summarizes the results of the brine discharge within the Gulf based on the conceptual diffuser design.

Table 4-10. Summary of Initial Model Results for Conceptual Brine Diffuser Array

Current Strength	Current Magnitude		Dilution Factor	Lateral Distance from Diffuser Header	
	FPS	MPS		Feet	Meters
Mild	0.49	0.15	41 to 43	6 – 10	2 – 3
Average	1.05	0.32	89 to 98	23	7
Strong	1.64	0.50	132 to 149	33 – 50	10 – 15

Based on the initial dispersion modeling results presented above, dilution factors of the brine discharge will range between 41 and 149. The lowest dilution value corresponds to the location where the brine hits the seabed floor. Using average ambient seawater quality data as a reference for dilution and the approximate quality of brine generated by the desalination facility, the approximate concentration of various water quality parameters were estimated for the lowest (worst-case) dilution factor predicted by the dispersion model. **Table 4-11** summarizes the resulting water quality data at a dilution factor of 41.

Table 4-11. Estimated Resulting Water Quality of Brine at Lowest Dilution Factor

Parameter	Ambient Seawater	Concentrated Brine	Plume Concentration
Conductivity (uS/cm)	50,255	125,637	52,094
Temperature (^oC)	23.94	23.9	23.94
Barium (mg/L)	0.0615	0.15	0.064
Calcium (mg/L)	390	975	404
Iron (mg/L)	0.109	0.27	0.113
Magnesium (mg/L)	1,310	3,275	1,357
Manganese (mg/L)	0.025	0.0625	0.026
Alkalinity (mg/L)	126	315	131
Chloride (mg/L)	18,684	46,710	19,368
Fluoride (mg/L)	1.1	2.75	1.14
Nitrate -N (mg/L)	0.328	0.82	0.34
o-Phosphate (mg/L)	0.04	0.1	0.041
Sulfate (mg/L)	2,564	6,410	2,658
TOC (mg/L)	1.07	2.675	1.11
TDS (mg/L)	36,122	90,305	37,444
Salinity (g/L)	32.1	80.25	33.3

Based on these results, minimal change with respect to the ambient seawater quality would occur at a maximum lateral distance of 10 feet (3 meters) on either side of the diffuser array during mild current conditions. During strong current conditions, brine would be transported greater distances from the diffuser array (up to 50 feet laterally from the diffuser header); however, the dilution rate would be much greater (3 to 4 times the minimum dilution rate). Therefore, based on these initial results of the conceptual diffuser array, potential environmental impacts may occur within an area directly surrounding the diffuser header during mild current conditions, over a total affected area of less than 7,000 ft^2.

To properly protect the diffuser array, an exclusion zone should be established around the array with a radius ranging between 100 feet to 0.5 nautical miles (3,000 feet). The actual location and areal extent of the exclusion zone would need to be established during project permitting with the applicable regulatory authorities. Properly placed marker buoys equipped with lights should be used to establish the perimeter of the exclusion zone.

4.2.9 Finished Water Storage and Transmission System

4.2.9.1 Finished Water Storage

The finished water storage will be located in the northern area of the desalination plant close to State Highway 48. A clear well or ground storage tank with a minimum volume of 1.25 million gallons is required by the TCEQ and provides both chlorine contact time and sufficient volume for the finished water pumps to draw from.

4.2.9.2 Finished Water Pumping and Transmission Systems

The finished water pump station, as depicted in **Figure 4-24**, will be located north of the Operation Center as shown in **Figure 4-3**. This building will be arranged to provide room for two 25 MGD pumps with pump control valves and space for a future 25 MGD pump and control valve. This will provide the ability to increase the pumping capacity to 50 MGD when needed. The building will also include a climate-controlled room to house the electrical equipment and control systems. The control system will include a variable frequency drive to allow either motor to operate as a variable speed driver to allow flows less than 25 MGD to be pumped. The second 25 MGD pump will provide a redundant pump to meet the firm pumping requirements set by the TCEQ.

The pump station will also be sited to allow the construction of a second finished water pump station when the desalination plant is expanded beyond 50 MGD. The piping will be arranged to allow interconnections so that all the finished water pumps and pipelines can be operated as one system or separate as required.

The finished water line is sized to transmit 25 MGD approximately about 6 miles from the desalination plant to the finished water delivery site. The line size was selected to maintain the maximum velocity in the pipe at below 6 feet per second. Modeling the line found that at 25 MGD a 36 inch pipe requires a maximum velocity of 5.5 feet per second and a 250 Hp pump. A 30 inch pipe will require a velocity of 8 feet per second and a 800 Hp pump.
The finished water line will be routed along the north side of State Highway 48. The finished water line will be constructed in a 40-foot wide easement immediately north of the state highway ROW. The 40-foot wide easement will provide room for construction and allow for the installation of future finished water lines when the desalination plant is enlarged. The space available allows for two more finished water lines.

The alignment is primarily located within property owned by the Port of Brownsville. There are two areas where the Port of Brownsville (POB) is not the owner and easements will be needed from the property owners.

Figure 4-26 shows the finished water line route, which will leave the desalination plant site going north, cross under State Highway 48, passing under the highway in a steel casing, and then turn west and lie parallel to State Highway 48. The finished water line will be buried with a minimum of four feet of soil cover for most of the way to the finished water delivery site. There are several points along the alignment where there will be crossings of gas pipelines, drainage ditches, overhead power lines and a road. Additionally, the alignment passes through an area that may have been part of a Union Carbide facility. Most of these type features will be better defined in a more detailed preliminary design phase.

A fiber optic cable will also be installed along this easement to provide control capability between the finished water delivery site and the desalination plant site.

The proposed site to deliver water to the Brownsville PUB system is the existing POB Loma Alta Water Treatment Plant located north of State Highway 48 and east of FM 511. This existing water plant was constructed in about 1977 but is not in use. The water plant includes a 1.0 million gallon ground storage tank.

The total recommended storage at this location is about 3 million gallons based on providing 100 gallons per connection as required by the TCEQ. A second 2 million gallon tank will be added at this site. The finished water delivery site will also provide a location to provide treatment or blending to insure the mixing of the water in the distribution system does not result in any precipitates. The existing water plant facilities may be able to provide facilities for this purpose. The finished water facility schematic is shown in **Figure 4-25**.

The water from these two tanks will be delivered into the Brownsville PUB water system by a high service pump station with a capacity based on the BPUB share of the water. The BPUB will provide this high service pump station and one or more transmission lines to connect it to their existing system or new water lines they may need to distribute the water into their system. Additionally, the BPUB will need to provide an additional 100 gallons per connection in elevated storage tanks or ground storage tanks at other locations. Depending on how this new water fits into the BPUB system, it may not be necessary to provide additional elevated or ground storage tanks.

The site can accommodate the construction of one or more high service pump stations designed to pump water to the other local participants in the water system. Water transmission lines will be routed from this site to the appropriate point of connection for each entity.
The site could also accommodate the construction of a high service pump station designed to pump water to the Matamoros, Mexico water system should that city desire water from this project and reach appropriate accommodations with BPUB. A water transmission line would be routed from this site to a point of connection at the border. The city of Matamoros would need to extend this line to connect to its water system at an appropriate location(s). The route for this line must pass through the City of Brownsville and it may be possible to use a portion of the BPUB water system to bring the water to the border. The basic route would be west along State Highway 48(East 14th Street) to State Highway 4 to East 18th Street and crossing State Highway 77/83 and south along State Highway 77 (East 18th Street) to the border.

4.3 SUPPORT FACILITIES AND ANCILLARY CONSIDERATIONS

Various facilities will be needed to support the day-to-day operations of the desalination facility. In addition, ancillary considerations regarding various aspects of the Demonstration Project should be taken into account when preparing a complete and accurate conceptual, operational description of the plant. All facilities and considerations presented here would have a direct cost consequence for this or other similar projects and, if not taken into account, could skew results obtained from a formal financial analysis. A brief description follows of the various facilities and critical ancillary considerations that were taken into account for the conceptual configuration of the proposed desalination facility.

4.3.1 Support Facilities

Various support facilities are proposed for the initial configuration of the desalination facility. **Figure 4-27** depicts the location of all of the following facilities, which are shaded for clarity. Sufficient space for each facility was estimated based on the minimum needs of various support functions for the plant as well as the number of staff that would be needed to operate the plant. Many of the following facilities could be used to support both the operations of the desalination facility and the co-located power plant if needed. As such, the aggregate working area provided by some of the following facilities could result in a substantial cost savings when compared to developing the same number and type of buildings for each individual project at different locations.

4.3.1.1 Administration Facility

An Administration Facility is proposed to support various functions of the desalination plant (and potentially the co-located power plant). Periodic reporting to regulatory agencies, financial accounting, record keeping, and other routine administrative functions could be efficiently conducted at this facility. Its proximity to the plant(s) would result in efficient communication and the transfer of important data and information from the plant operators to administrative staff.

Since the facility would be constructed above the 100-year flood elevation and would be a publicly-owned facility, it could also double as a hurricane shelter for plant personnel as well as nearby communities, if desired. Additional financing options and subsidies may be available from other federal (Federal Emergency Management Agency [FEMA]) and state agencies, which could potentially help defray costs associated with the construction and operation of this facility.

A layout would be developed for the Administration Facility to support the functions described above as well as other functions as needed. For conceptual design and costing purposes, a total building footprint area of 3,000 ft^2 was allocated for this facility. At a minimum, the administration facility would have the following provisions:

- Visitor parking;
- Reception;
- Offices for Administrative Staff;
- Conference Room(s);
- Classroom(s) for Operator Training and Visitor Presentations;
- Files and Records Room; and
- Restroom Facilities.

Since the Brownsville Desalination Demonstration Project would be the first of its kind in Texas, as well as one of the largest desalination plants in the U.S., various organizations and individuals would be interested in it, including regulatory, scientific, and educational organizations. To properly receive, screen, and grant site access to visitors and important dignitaries, the administration facility would serve as the initial location where visitors would be met and greeted. Tours of the facility would commence at this facility, which would be located outside the perimeter security zone established for the plant.

4.3.1.2 Operations Center

A dedicated operations center would be needed to properly control and monitor the various unit treatment processes and operations of the desalination plant. This is one of the most important and critical support facilities that should be properly sited and designed to adequately and reliably maintain control of the plant and its various components at all times. For this project, the operations center is conceptually located on a second, partial floor level of the membrane building. **Figure 4-28** provides a conceptual layout for the operations center.

The operations center would be located directly above an equipment loading area, which is at the west end of the first floor of the membrane building. (Refer to **Figure 4-12** for the conceptual floor plan of the membrane building's first level in relation to the second level.) The eastern wall of the center would have multiple windows that would overlook the lower operating level of the membrane building where the various membrane trains and associated transfer pumping systems would be located. A series of rooms would be located along the overlook window including the operations room, an office for the shift operator, and an observation deck for visitors and other operational staff as needed and as further described below:

- **Operations Room** – The status and control of all critical plant functions could be verified within the operations room. This would be a continually staffed room where automated plant operations would be monitored and, if needed, manually controlled and monitored on an interim basis. This room would house the PLCs and the HMIs. The PLCs are industrial grade processors that have substantial reliability to maintain continuous electronic function and control over whatever components are attached to them. Each PLC would automatically control and monitor the various plant functions. The HMIs are essentially upper end personal computers that are electronically connected to the PLCs. Through this connection, the plant operators would be able to interface with the PLCs to obtain any critical or routine operating data that may be needed to confirm proper plant operations. Please refer to **Section 4.3.5** for a further description of this important project aspect.

- **Shift Operator Office** – The shift operator would use this office. The office is centrally located at the site and has an important vantage view of the operating level of the membrane building. From this central location, the staff operator could quickly reach any portion of the site, while providing an appropriate work environment to carry out the various operations and administrative tasks that would be required from day to day and from shift to shift.

- **Observation Deck** – This area would properly and adequately segregate visitors that may be at the site from the lower process level for purposes of security and overall protection of public health, while still allowing and providing an excellent, unobstructed view of the heart of the desalination facility. Sufficient space was allocated to accommodate large tour groups.

Other amenities that would be available at this location include a laboratory (as further described in the subsequent section), a break room, locker, and bathroom facilities. The conceptual layout of the operations center on **Figure 4-28** illustrates a possible configuration for all of the above rooms and amenities, for which an allocation of 5,000 ft^2 was provided.

4.3.1.3 Analytical Laboratory

An analytical laboratory is proposed for the desalination facility because of the proposed production capacity of this facility and the need to establish consistent sampling and analytical work to provide sufficient documentation regarding the operational efficiency of the plant. Typically, an on-site analytical laboratory is proposed for larger water treatment plants since a larger number of analyses are needed frequently to confirm proper water treatment. In addition, the cost associated with subcontracting analytical work to a third-party laboratory would result in additional operational expenditures. Thus, while there would be a capital investment for the various analytical equipment and labware needed to establish an on-site laboratory, operational costs associated with ongoing analytical work would be substantially reduced. Better quality control through consistent handling and overall site-specific knowledge of the various plant processes is an additional reason and justification for an on-site analytical laboratory.

For the conceptual design of this project component, it is assumed that the on-site laboratory would be outfitted with the basic lab equipment and supplies commonly used in similar laboratories (e.g., work benches, glassware, fume hood, chemical reagents, microscope, ovens and dryers, acetylene gas supply, personal protection, and safety equipment, etc.). In addition, a mass spectrometer is also proposed for the on-site laboratory, which would be used to confirm various water quality parameters. For more exotic water quality testing that is beyond the capability of the on-site laboratory, third-party contracting would be required. In addition, periodic or routine third-party testing could also be conducted as another quality control measure for the project, if determined necessary.

4.3.1.4 Maintenance Shop

A dedicated facility for various plant maintenance activities is proposed in the conceptual configuration of the desalination facility. The maintenance shop would be centrally located within the plant site and would house essential tools and equipment for the project for use when needed. The main functional room for the maintenance shop would have at least one exterior access door as well as one or more roll-up doors to facilitate the ingress and egress of large equipment. This room would have dedicated work benches; equipment and tool storage units; a compressed air supply; and other typical products necessary to properly maintain the desalination plant and its mechanical, electrical, and instrumentation components. Typical products that could potentially be stored at this location include oils and grease; industrial solvents; acid cleaning solutions needed for the on-site hypochlorite generation system; and spare parts for various equipment components. An overhead crane is proposed to allow large equipment components such as pumps and blowers to be easily placed within the shop during major maintenance events.

In addition to the main room described above, the maintenance shop would also have dedicated shower and washroom facilities as well as a break room for maintenance staff. A total building area of approximately 2,500 $ft^2$was allocated for this facility.

4.3.1.5 Storage Building

A dedicated facility for the storage of various plant components was taken into account and provided in the conceptual design of the desalination facility. The storage building would be located near the maintenance shop and would be used for the temporary storage of various items. These items could include bulky and/or relatively large spare parts that could not be stored elsewhere, large equipment components, and any other component for which proper storage to protect it from the environment would be required. A total building area of approximately 1,250 ft^2 was allocated for this structure.

4.3.2 Staffing Requirements

Staffing requirements were evaluated and established based on a review of plants with similar treatment operations and production capacities. Because of the overall size and complexity of this project, it is assumed that the facility would be staffed 24 hours a day, 7 days a week. The majority of the operating staff would be present during the first day shift, with a reduced number of staff present during the second (evening) and third (graveyard) shifts. All solids processing as well as routine maintenance work, chemical analyses, etc. would occur during the day shift and, if necessary, during the second shift at certain times.

Table 4-12 provides the proposed, conceptual staffing schedule for the initial 25 MGD plant configuration. As the plant is expanded to produce larger finished water supply capacities, additional staff would be required to ensure proper O&M of the additional plant infrastructure.

Table 4-12. Summary of Conceptual Staffing Levels for the Desalination Facility

Staff Group	Staff Description	Number of Staff
1	Plant General Manager	1
2	Class A Plant Operators	7
3	Instrumentation Specialists	2
4	Belt Filter Press Operator	1
5	General Maintenance Personnel	3
6	Chemist	1
	Total Staff Required	**15**

Note: Staffing is for the initial 25 MGD plant production capacity. Additional staff would be needed to support larger plant capacities.

All staff would be salaried personnel contracted directly through the Brownsville PUB. Their respective salaries, typical fringe benefits, and other typical employment costs as they affect the annual O&M cost estimate were taken into account using information from the Brownsville PUB. In addition to the conceptual-level staffing proposed above, an allocation for an electrical contractor is assumed to cover any electrical repairs, upgrades, etc. during the life of the project. There would be no dedicated electrical staff for the plant as a consequence of this contracting approach.

4.3.3 Security Provisions

Because of the size and overall importance of this critical water supply facility, proper security provisions are needed to protect the facility, and those within it, from acts of vandalism and terrorism. Specific security provisions were taken into account to address these concerns and to meet new regulatory requirements and guidance of the new Homeland Security Act. In addition, since the proposed security provisions described below could affect how the plant is physically configured and operated, the following considerations are important to consider since they could affect associated capital and annual O&M costs estimated for this project. In summary, the following security provisions were assumed or allocated for the conceptual plant design:

- **Dual-Perimeter Security Fence** – A dual-fence line is conceptually proposed to secure the perimeter of the desalination facility. The dual fence line would contain two, single chain link fence lines running parallel to one another around the site and physically separated with approximately 10 feet of open land. Barbed razor wire would be installed on the top of the outer fence to prevent the passage of intruders over the top of the perimeter fence. If necessary, an electronic beam could be established between the parallel fence lines to detect and sound an alarm if the outer fence line were breached, thereby preventing a breach of the inner fence line.
- **Restricted Site Access** – All authorized personnel associated with the desalination facility would be issued security badges and/or access codes, which would be used to gain access to the site. Any person(s) who does not have an authorized access card or code would not be able to gain access to the site without being first processed at the administration facility or the guard house, both of which are outside the perimeter security line.

- **Limited Site Ingress and Egress** – The conceptual site layout was developed to limit the number of routes into and out of the site. With this in mind, only two points of ingress and egress for the site were provided. One access route is the primary entrance road that enters the site from SH48. All traffic into and out of the site would be routed through this road to gain access to the site. In addition, in approaching the desalination facility on the primary entrance road, all traffic would have to pass by the administration facility and would be stopped at the guard house, which would be located at the perimeter fence line. A secondary site entrance road is also provided in the conceptual design; however, access to the site through this route would not normally occur. A secured gate on the secondary entrance road would remain locked. This secondary route of ingress and egress for the site is only provided in the event that access via the primary entrance road was blocked or not available for any reason. Site grading to 12 feet AMSL in conjunction with the seawall that would be constructed along the Brownsville Ship Channel would serve as a sufficient barrier to traffic from the south of the site.

- **Video Surveillance** – Surveillance cameras would strategically located at specific locations within and outside the desalination facility to provide continuous monitoring of the premises and adjacent areas. All video feeds could be managed by the PCIS and archived onto videotapes for subsequent review if needed. For the purposes of this conceptual study, video cameras are recommended at the following locations:

  - At the two side inlet channels to monitor the southern property line and any vessels that may approach the desalination facility from the Brownsville Ship Channel;

  - At the guard house near the north of the facility to monitor all traffic entering and leaving the site; and

  - At various locations within the plant site including the seawater intake transfer pump station, the pretreatment system, the membrane building, the finished water pumping station, the chemical building, and the solids handling building.

- **PCIS Security, Electronic Firewalls and Other Safeguards** – Various provisions related to the PCIS and its associated internal communications network should be adopted and/or provided for the desalination facility. These provisions include network security, electronic firewalls, uninterrupted power supplies, and other safeguards as detailed below.

  - Network Security – Network security would depend on the operating system chosen and would provide a minimum security level based on login accounts and passwords assigned to the various operating staff requiring access to the system. An administrator should be assigned to provide continued maintenance of accounts, access to the system, and time restrictions as applicable. Policies should be incorporated to provide guidelines for proper login/logout procedures to maintain maximum security and limited access to all critical and semi-critical systems.

  - Electronic Firewalls – A router and/or firewall should be provided for the protection of all computers accessing the system or that are on a network with access to the system. The implementation of a firewall, either hardware- or software-based and/or a router will provide added security and external protection from unauthorized intrusion where access to the Internet or project-related Wide Area Network (WAN) would be present. An owned or managed firewall and/or router would also be acceptable.

  - Uninterrupted Power Supplies (UPS) – All controlling computer systems and critical ancillary components should be protected from electrical surge and brown-out conditions through the use of a properly sized and sited UPS system(s).

The UPS system(s) should have sufficient capacity to handle all related equipment and computer systems, or individual smaller systems should be provided for each individual computer system. This is necessary to provide controlled voltage levels to the delicate computer systems and provide ample battery running times to allow for the plant operator(s) to conduct a controlled shutdown of all computer systems and related equipment.

- Other Safeguards – Virus protection should be installed on every computer on the network. Virus definition updates should be maintained either automatically via automated downloads or manually by a designated individual. Virus updates should be performed at least on a daily basis and verified by a designated responsible individual.

4.3.4 Primary and Secondary Power Supplies

Based on the conceptual configuration of the desalination facility, a total power load of approximately 17.6 megawatts (MW) will be required. Power will be supplied to the project through two sources. The primary source of electrical power will be from the co-located 100 MW power plant. A secondary power supply source would be obtained directly from the local electrical grid. Both supply sources would be routed through a common 13.8-kilovolt (kV) bus for the desalination facility's final power feed. Please refer to **Figure 5-2** in **Section 5** for additional details regarding the conceptual configuration of the power supply.

From the 13.8 supply bus, a set of step-down transformers would be used to reduce the voltage for the desalination facility. Both the power bus and the step-down transformers would be located at the co-located power plant. From this location, two voltage circuits would be provided for the desalination facility. One would be a 4,160 volt (V) circuit, while the second would be a 460 V circuit. The 4,160 V circuit would provide electrical power to the larger mechanical equipment components, such as the high-pressure SWRO pumps. The lower 460 V circuit would supply power to the remaining plant components, with smaller step-down transformers provided at strategic locations within the facility to accommodate various relatively minor electrical loads such as lighting, instrumentation components, etc. A dedicated utility corridor, as illustrated on **Figures 4-3** and **4-4** would be used to route the two power circuits from the power plant into the desalination plant. A properly configured power distribution network using the two power circuits from the utility corridor would be established throughout the desalination facility to properly support all components and power supply needs.

4.3.5 Process Control and Instrumentation System

A PCIS would be developed for the desalination facility, which would be used to maintain proper control and monitoring of the various plant components to ensure that sufficient quantities of water are produced and properly treated at all times to meet fluctuations in water demands of the local populations. As indicated in **Section 4.3.1.2**, the PCIS would include a series of PLCs, which would serve as the "electronic brain" of the overall desalination facility. Each PLC would be programmed to conduct automated control functions in response to various process operating data. For instance, when the water level in the finished water storage tank begins to drop, the

PLC program would detect the reduction in water levels and would initiate the operation of an upstream pump to recharge the tank with additional water. Through the PLCs, proper and automatic plant operations and monitoring capability would be provided at all times for the majority of the critical plant components.

Computer workstations, also referred to as HMIs, would be used by the plant operators to access the PLCs to obtain real-time operating data for the various plant components and processes. Manual control and override capability of the PLCs would also be available to the plant operators via the HMIs. Both the PLCs and the main HMIs for the project would be located within the Operations Center at the Membrane Building. In addition, remote access to the PCIS could be provided through strategically located HMIs throughout the plant site, such as at the Chemical Building, the Solids Handling Building, etc. By properly configuring the PCIS, superior control of the overall facility would be provided, thereby resulting in improved water supply reliability for the project.

The PCIS would process, analyze, and archive a considerable amount of operating data to support various regulatory requirements to allow periodic adjustments to various settings, thereby optimizing individual treatment processes and other specific needs for the project. For regulatory reporting, the PCIS could be used to analyze water quality data and even generate reports that could be submitted for review. These data could include the following parameters:

- Equipment run times;
- Transfer flow rates;
- Pressure levels;
- Tank water levels;
- Levels of stored chemical stocks;
- Raw and finished water quality parameters; and
- Various alarm conditions.

In addition to the various operating data and information that would be available from the PCIS, specific security provisions could be integrated into the PCIS. For instance, video records of critical locations within the plant could be made and archived; access to the site by authorized and unauthorized individuals could be confirmed, and automatic notification to the police, fire department, and other critical support lines could be made using the PCIS.

4.3.6 Materials of Construction

Because of the corrosive nature of the seawater supply for this project, specific attention and consideration must be given to proper materials of construction during conceptual level planning. If this specific consideration is not taken into account, the resulting capital cost estimated for the project would be too low. Special metal alloys, such as AL6XN and Zeron, or suitable plastics, such as HDPE, are needed for any mechanical or related process component between the point of collection of seawater at the Intake System and the fresh water permeate stream produced by the membrane units in the Primary Treatment System. These components would include the following at a minimum:

- Mechanical piping, valves, fittings, and other piping appurtenances;
- Transfer pumps, mechanical mixers, and other mechanical equipment;
- Certain components within the BFC System and Filter System including lamella settling plates, filter underdrains and backwash troughs, etc.; and
- Instrumentation components such as flowmeters, liquid level probes, etc.

HDPE was used as the preferred material of choice for yard piping between the intake system and the membrane building since it is impervious to the corrosive nature of seawater, coupled with its excellent material properties and low capital cost. However, where a mechanical fitting or piping appurtenance such as a valve is needed, a transition to one of the special metal alloy components is needed. In addition, most if not all above-grade piping would be constructed of one of the special metal alloys to properly protect against excessive corrosion due to contact with the seawater supply.

For all concrete process tanks that would be exposed to the corrosive seawater supply, a suitable engineered coating would be applied of a sufficient thickness to protect the concrete and its embedded structural steel from its exposure to seawater, thereby prolonging the useful life of all structural tanks. Tanks to be coated include those within the BFC system, the dual-media filter system, the filter clearwell, the solids equalization basin, the solids thickening units, and the floors of the membrane and solids handling buildings. In addition, suitable engineered coatings would also be applied at any location where exposure to corrosive chemicals, such as sulfuric acid, may occur.

Another consideration that must be given to the selection of proper and suitable materials of construction are those components associated with the various chemicals, which may be very corrosive in nature. Applicable chemicals for which special materials of construction would be needed include coagulant, sulfuric acid, sodium bisulfite, sodium hypochlorite, and pebble lime. Proper planning and selection of suitable materials of construction for these chemical stocks will ensure a suitable and extended life of the various chemical storage and supply infrastructure that would be needed for this project. Similar to exposure of components to seawater, if proper consideration is not given to materials of construction for the chemical supply systems, the resulting capital cost estimated for the project components would be too low.

4.3.7 Waste Production and Disposal

As a consequence of routine plant operations, the desalination facility will produce various solid and liquid wastes which will require disposal. **Table 4-13** summarizes both continuous and intermittent wastes that would be generated and must be properly disposed of through an acceptable and cost-effective method.

4.3.7.1 Wastewater Disposal

The Robindale WWTP is permitted under TPDES Permit No. 10397-005 and under the provisions of Section 402 of the Clean Water Act and Chapter 26 of the Texas Water Code. This WWTP has a permitted annual average effluent capacity of 10 MGD and a two-hour peak flow limit of 20,833gpm. According to feedback received from the Robindale WWTP, there is a sufficient amount of capacity that can be used to accept a relatively large quantity of wastewater from the Desalination Facility.

Per the information provided in **Table 4-13**, filtrate and sanitary wastes would be generated daily that would require disposal. The rate of filtrate generation will be dependent on the efficiency of the sludge dewatering system, which would range between 83 to 166 gpm (120,000 to 240,000 gpd). Based on the estimated staffing levels for the initial plant capacity, sanitary waste would be around 500 gpd. Regarding intermittent wastewater generation that would be routed to the POTW, membrane cleaning and flushing solutions would require disposal. The total quantity of this intermittent wastewater source would be dependent on the cleaning frequency established for each membrane train and cannot be easily quantified at this time. However, it is anticipated that the quantity of wastewater, if averaged over time, would be relatively small and would not represent a large volume. An equalization system would most likely be used to dampen large discharges of the spent cleaning solutions. All spent solutions would be properly neutralized before discharge to the POTW. Any requisite pretreatment for the cleaning solutions to meet the WWTP's pretreatment requirements would also be taken into account during the detailed design phase.

4.3.7.2 Sludge Hauling and Disposal

BFI has indicated that all sludge could be transported to the City of Brownsville Landfill. BFI would rent a 30-yard container truck to the project to handle the volume of sludge that would be generated. A rental rate of $195/truck at $4/day and $15/cubic yard was confirmed. This information was used in conjunction with the volume of sludge estimated for the project to estimate annual costs associated with sludge disposal. The treatment plant would generate a 20% sludge cake. This cake is of sufficient thickness to allow for transportation via truck and disposal via the landfill. As stated in this report, a total daily sludge production of 20,000 pounds per day based on an evaluation of the average raw water quality of the Ship Channel is anticipated. It should be noted that the daily sludge volume will vary depending on the variation of TSS and organic content of the source water through time.

4.3.7.3 Other Waste Products

Other waste products would be generated and are considered and described in **Table 4-13**. No fatal flaws were identified regarding these other wastes. Most solid wastes generated by the plant would be considered non-hazardous and could be disposed into the local landfill. Due to the use of some solvents, greases, and other products at the plant site, a small quantity of hazardous wastes may be generated from time to time. These would be properly addressed through a licensed hazardous waste disposal contract. Lastly, all brine would be segregated and routed through the dedicated brine disposal system, which would have its own permit.

Table 4-13. Inventory of Solid and Liquid Wastes Generated by Desalination Facility

Continuous Wastes	Intermittent Wastes
▪ **Concentrated Brine** – Up to 16.7 MGD of brine may be generated by the plant when operating at its maximum rated finished water production capacity of 25 MGD. All waste brine would be routed through the Brine Disposal System and discharged into the Gulf of Mexico. ▪ **Dewatered Residuals** – Commonly referred to as dewatered solids or sludge, this waste would be generated at the BFC system and dual-media filters and reduced in volume by the solids handling system. The semi-solid waste stream (at 20% solids) would be periodically collected and hauled off site to a Class I landfill for final disposal. Up to 20,000 lbs/day of dry solids may be generated at the plant's maximum rated finished water production capacity of 25 MGD. ▪ **Filtrate** – Water extracted from the dewatered residuals will be generated at an average rate of approximately 83 to 166gpm, depending on the actual operating efficiencies of the solids thickening and dewatering units. Since filtrate from the solids dewatering system could potentially contain high concentrations of problematic water quality constituents, such as Cryptosporidium oocysts and Giardia cysts, all filtrate should be routed out of the treatment plant for proper management and disposal. Filtrate generated by the solids dewatering system will be routed to a dedicated wastewater pump station, where it would be routed off-site to the local POTW. ▪ **Sanitary Wastewater** – An incidental waste stream generated by the desalination facility would be sanitary wastewater. Using a conceptual allocation of 30 gal/day/person for the staff levels proposed for this project, less than 500 gal/day would be generated each day on average.	▪ **Membrane Cleaning and Flushing Solutions** – Clean permeate would be flushed through each membrane unit as required to remove accumulated solids. Also, each membrane unit would be cleaned using a surfactant solution periodically to remove additional solids. All spent cleaning and flushing solutions would be routed to a dedicated wetwell structure. The spent cleaning solution would then be routed to the Robindale WWTP for treatment as an industrial wastewater. ▪ **Cartridge Filters** – It is anticipated that cartridge filter elements will be replaced once each quarter. Based on this replacement rate, a total of approximately 5,500 cartridge filters would require disposal each year. All spent cartridge filters would be classified as a nonhazardous waste and could be disposed of in a Class I landfill. ▪ **Membrane Elements** – It is anticipated that individual membrane elements would be replaced once every 5 years during the life of the project. All spent membrane elements would be classified as a non-hazardous waste and could be disposed of in a Class I landfill. ▪ **Miscellaneous Wastes** – Other miscellaneous solid and liquid wastes may be generated on a periodic basis. Through the adoption of Best Management Practices (BMPs), minimization and proper disposal of miscellaneous wastes would occur. All non-hazardous wastes would be segregated from semi-hazardous wastes, such as used oils, chemical sludges, etc.

4.4 DESIGN CHANGES DUE TO ELIMINATION OF POWER PLANT

A series of changes would result if the power plant is not co-located or is delayed for any reason. It should be noted and emphasized that, while specific changes in certain aspects of the conceptual process design would result that would also affect some of the components in the capital and annual O&M cost estimates, these changes would not significantly or adversely affect the feasibility of the desalination facility. A discussion of each potential design change due to the elimination of the power plant component and its potential impact on the desalination facility follows:

- **Pretreatment Changes** – Without an available source of low-cost steam for the desalination facility, the temperature of the pretreated feed stream could not be maintained at a consistent temperature prior to the primary treatment system. This alteration would result in additional power costs associated with the operation of the high-pressure SWRO pumping systems. During colder weather conditions, a lower flux rate would occur through the SWRO and BWRO process trains unless the feedwater pressure is increased. The feedwater pressure would be automatically monitored and adjusted as needed through the use of variable frequency drives that would control the pump motors' speeds. Please refer to **Section 7.2.5** for additional details related to the impact of this change on the capital and annual O&M cost estimates for the desalination facility.

- **Redundant Power Supply for Desalination Plant** – Without the co-located power plant, another source of redundant power would be needed to ensure uninterrupted operations of the desalination facility. There are various possible solutions that could be explored to address this particular issue. If full power redundancy would be required, one of two options could be explored. First, the most cost-effective option would be two electrical feeds physically separated from one another that could provide power to the project via the local electrical grid. This option would require two substations sited at appropriate locations at or near the project site. If redundant power were needed from another source altogether to address the potential loss of power from the local electrical grid, a dedicated transmission main would be needed to obtain power from another electrical source, such as a distribution station served by the regional electric authority.

Another option that could be considered for power redundancy is the use of on-site emergency generators. However, due to capacity and economic limitations associated with generators, only a fraction of the project's total power load could be supplied via a system of generators. For this latter option, generators could be used to maintain a partial power supply for an interim period of time until the primary feed from the local grid could be re-established. For this option, power would only be supplied to a portion of the plant to maintain partial operations. Please refer to **Section 7.5.2** for additional details related to the impact of an alternative redundant power supply source on the capital and annual O&M cost estimates for the desalination facility.

- **Elimination of Cooling Water and Demin Water Supplies** – The conceptual design of the desalination facility provides up to 110gpm of demineralized-grade water and 1,280gpm of cooling water makeup for the co-located power plant. The total water supply reserved for the power plant is equivalent to approximately 2 MGD, which would be available for distribution to the local population if the power plant were eliminated. Since all components within the post-treatment and finished water systems were hydraulically sized for the full plant production capacity of 25 MGD, no difference in cost would result as a consequence of this particular change.

- **Elimination of Power Plant Blowdowns to Brine Disposal System** – For the initial capacity of the co-located power plant of 100 MW, about 0.4 MGD of blowdown to the brine disposal system was estimated. In addition, a total potential blowdown rate of 2.5 MGD was taken into account when developing the conceptual level design for the brine disposal system to address the potential for expansion of the power plant in the future. If the power plant were eliminated, there would be a reduction in the total quantity of brine requiring disposal. While there would be a slight reduction in O&M costs associated with a lower brine disposal rate, the actual difference in costs would not be significant. As such, a separate analysis of the impacts of this change on the capital and annual O&M cost estimates presented for the project were not assessed.

5.0 POWER COMPONENT

5.1 INTRODUCTION

At the statement of interest phase of the feasibility study, there was mention of possibly co-locating the desalination plant with a 500-megawatt (MW) power generating station. There was interest in expanding power generating capacity in the Brownsville area, and it was believed that significant synergies could be realized by co-locating the facilities. During the course of developing the feasibility study, however, it became evident that the synergies of co-location are not as strong as the project team had originally envisioned.

The most significant benefit of co-location involved the dilution of the concentrate stream by combining it with once-through cooling water effluent. This practice is common in seawater desalination applications such as the Tampa Bay project. During the feasibility study, it was discovered that significant permitting obstacles exist for new once-through cooling applications. Most projects with this configuration in the United States, such as the Tampa Bay seawater desalination plant, were co-located with legacy power plants. In the current regulatory climate, it was concluded that permitting a new once-through cooling application would be nearly impossible. Therefore, the power generating station would not have any significant impact on the issue of concentrate disposal.

Another synergy that was originally anticipated was the availability of power for the desalination plant at a reduced cost. Since approximately 40 percent of the cost of desalinated water is derived from the cost of energy, it was hoped that significant energy savings could be realized by co-locating the desalination plant with a power generating station. Given the power load for the desalination plant, officials at the Brownsville Public Utility Board (PUB) concluded that it would qualify for their wholesale power rate of $0.035/kilowatt-hour (kW-hr). The PUB also indicated that this rate would apply regardless of whether the desalination plant was co-located with a generating station or simply buying power from the existing grid. Thus, the power cost is not affected by the co-location of the water and power plants.

Although some of the anticipated synergies from co-locating the two plants have not survived the feasibility study, there are still some arguments in favor of co-location if the need exists for both facilities. Some examples of remaining synergies are listed below:

- Steam from the power plant can be used to pre-heat feed water;
- The seawater reverse osmosis (SWRO) plant can provide demineralized makeup water for the power plant;
- There are some construction advantages by developing the projects jointly such as savings on site grading, fencing, etc.;
- Some facilities can be shared between the two sites; and
- Some staff, such as security and maintenance personnel, can be shared.

An analysis of the local power market resulted in the conclusion that a 500-MW plant could not be supported since the PUB's current peak demand is around 240 MW. Based on discussions with the Brownsville PUB, it became evident that a new generating station, if pursued, should be initially sized at 100 MW.

5.2 ALTERNATIVES ANALYSIS

Power generation alternatives for this application could be natural-gas-fired, coal-fired, or wind power electric generation. Wind power was dismissed as a sole supply due to the project's load and reliability requirements. Although the capital cost of a natural-gas-fired plant would be lower than for a coal-fired plant, the uncertainty of the cost and supply of natural gas offset the initial cost advantage. Colombian coal could be transported to the site via barge providing a reliable and economical fuel source.

The Brownsville PUB concurred with the recommendation for coal-fired capacity, which led to the selection of a circulating fluidized-bed boiler (CFB) with a nominal capacity of 100 MW for the purposes of this study. The Brownsville PUB's annual peak demand is reported to be 240 MW. A nominal 100-MW plant would help the utility satisfy the base load and would also support future expansion for industrial needs in the port area.

The CFB design allows for the use of various grades of fuel while providing the most cost-effective means of meeting strict environmental emissions requirements. The only significant drawback of the CFB design is limited load following capability and an ultimate capacity limited to the 200-MW range. A 100-MW base loaded unit would not be influenced by these constraints. The following sections provide a facilities description for a 100-MW, coal-fired power plant that could be accommodated on a tract adjacent to the proposed SWRO water treatment plant**.** **Figure 5-1** illustrates the layout for the proposed power generation facilities.

5.3 DOCKING FACILITIES

The docking facility must be designed to off load ocean service certified barges. The plan is to use 12,000-ton capacity barges with a draft of 26 ft. When the plant is operating at full capacity, there will be one barge unloaded per week.

The barge unloading facility will be composed of a clam shell bucket crane to unload the bulk of the material. A front end loader will be inserted into the barge to gather the remaining material for the bucket crane. The design unloading rate will empty a barge in two days at an average rate of 250 tons/hr.

5.4 COAL STORAGE YARD

The barge unloading crane will place the material in a feed hopper for the unloading conveyor that will transport the coal to the storage pile. The unloading conveyor will have material trippers that will discharge the coal along the pile. The unloading conveyor will have a maximum capacity of 500 tons/hr. Bulldozers and front-end loaders will maneuver and compact the coal in the storage pile. The storage pile will have a working capacity of 30 days of storage at full unit load. The pile will be approximately 30 ft high and 900 ft long by 110 ft wide.

The entire coal handling area and the power block will have an underdrain system to collect all rain water and contain it in the coal pile rain water runoff pond. Solids will settle in the pond, and then the water will flow to the water treatment pond. The effluent of this pond will be used for coal pile compaction and the dust suppression sprinkler system.

5.5 LIMESTONE STORAGE

The limestone handling system will unload the limestone from either trucks or rail cars. The limestone feed rate is approximately 120 tons/day. Two 600-ton silos will store ten days of limestone on site. The silos will be filled in three days alternating with the coal unloading to utilize the same crew for a full five-day work week. The limestone unloading must average 290 tons/day, which requires fifteen 20-ton-capacity trucks or six 50-ton-capacity rail cars.

The limestone feed rate to the unit is 5 tons/hr. Limestone will be drawn out the bottom of the storage silos into a grinding machine. The grinding machine will discharge properly sized limestone particles to the limestone day silos at the units. The day silos will contain 8 hours of material storage.

5.6 COAL TRANSPORT AND PREPARATION SYSTEM

Earth-moving machines will retrieve the coal from the pile and deposit the coal into a feed grater that will load the coal on the 75-tons/hr conveyors that will supply the coal grinding machine. The boiler feed rate will be 61 tons/hr. The grinding machine will discharge properly sized coal particles to the coal day silos at the units. The day silos will contain 8 hours of material storage.

5.7 POWER BLOCK

5.7.1 Boiler

Fluidized-bed combustion (FBC) technology has distinct advantages for burning solid fuels and recovering energy to produce steam. The process features a mixture of particles suspended in an upwardly moving gas stream, the combination of which exhibits fluid-like properties. Combustion takes place in the bed with high heat transfer to the furnace and low combustion temperatures. Key benefits of this process are fuel flexibility and reduced emissions.

The proposed boiler will be a CFB producing 640,000 pounds per hour (lbs/hr) of superheated steam at 2400 pounds per square inch, absolute (psia) and 1000 degrees Fahrenheit (°F). The boiler will have a superheater, single reheater, and economizer. Force draft fans will feed combustion air through an air preheater to the furnace wind box. The combustion air will flow up through the fluidized bed of coal and limestone. The fuel will burn at relatively low temperatures to avoid nitrous oxide (NO_x) formation, and the limestone will react with sulfur dioxide (SO_2) formed when burning the sulfur in the coal to form calcium sulfite ($CaSO_3$). Lighter unburned carbon, ash, limestone, and $CaSO_3$ particles will escape the furnace and be captured upstream of the superheater section and recirculated back to the fluidized bed. Heavier particles will eventually be extracted from the hoppers below the bed to waste disposal. The lighter ash particles will continue through the unit and be captured in a baghouse downstream of the air preheater.

The expected combined waste stream of the lighter fly ash and heavy ash, $CaSO_3$, and unreacted limestone is estimated to be 10 tons/hr. This material will be trucked to an off-site landfill.

5.7.2 Steam Turbines and Electric Generator

The steam turbine will be a multi-extraction condensing steam turbine. The generator will generate at 13,800 volts, three-phase 60 Hz and will be an air-cooled design. The superheated steam will be expanded through the high-pressure turbine and returned to the boiler for reheating. The re-heater will heat the steam back up to 1000°F at 600 psia. This steam will be expanded through the intermediate and low-pressure turbines. There will be seven extraction levels feeding two high-pressure feed water heaters, one deaerating open feed water heater, and four low-pressure feed water heaters.

The turbine exhaust steam will be condensed in a 420 million british thermal units per hour (MMBtu/hr) condenser operating at 1.5” Hg.

5.7.3 Cooling System

The condenser will be cooled with a closed-loop cooling tower system. The system will circulate 87,000 gallons per minute (gpm) of cooling water. The cooling tower will be an eight-cell, forced-draft, cross-flow design. It will require 1150 gpm of make-up water from the desalination plant. Assuming a 200-ppm total dissolved solids (TDS) make-up water and a 1200-ppm cooling tower concentration, the blowdown rate will be 215 gpm. The blowdown will be returned to the desalination plant pretreatment system and eventually recycled in the system.

5.7.4 Blowdown Management

The boiler blowdown will be flashed with the flash steam recovered in the system. The remaining 25 gpm of water will be returned to the desalination plant pretreatment system and eventually recycled in the system. The TDS concentration will be much lower than the brackish seawater used in the desalination plant. However, due to the metals in this blowdown stream, further evaluation is required to ensure the pretreatment and reverse osmosis (RO) system can successfully remove the metals.

The cooling tower blowdown will require similar evaluation depending on the types of water treatment chemicals that will be introduced to the tower for corrosion and bacterial control. Until these methods are identified, the reuse of this water is not certain.

However, these problems have been resolved for other plants, and there should be a workable solution once all the information is available. The alternate plan is to commingle the blowdown streams with the brine disposal effluent.

5.8 AIR EMISSION CONTROLS

This section describes the emission controls and continuous emission monitoring system (CEMS). The combustion and post-combustion emission control technologies presented below will optimize emission reductions consistent with normal operation practices.

5.8.1 NO_x Emissions

NO_x emissions are considered to come from two sources: oxidation of nitrogen in the air (thermal NO_x) and oxidation of nitrogen or nitrogen compounds in the fuel (fuel NO_x). The FBC operates at temperatures below the formation temperature of thermal NO_x (i.e., 1560 - 1650° F). In addition, a significant portion of the total air is introduced above the grate. Fuel is normally fed below these parts, creating a substoichiometric zone in the lower combustor with a resulting reducing atmosphere that lowers NO_x emissions.

The typical CFB boiler will achieve 120ppm NO_x emissions, and at a 90 percent load factor, this plant will produce approximately 790 tons/yr of NO_x. To achieve 9 ppm, a selective catalytic reduction (SCR) unit would have to be installed before the air preheater. The SCR would be of Ti/Si material and require an ammonia reagent system. This system would achieve the 9 ppm limit, resulting in 60 tons/yr with 10 ppm NH_3 slip.

5.8.2 SO_2 Emissions

SO_2 emissions are controlled within the combustor by the addition of sorbent material (i.e., limestone) so that a stack gas SO_2 scrubber is not required. The sulfur sorbent can also react with other fuel constituents such as vanadium, reducing downstream corrosion potential.

When sulfur-bearing fuels burn, most of the sulfur is oxidized to SO_2, which becomes a component of the flue gas. When limestone is added to the bed, it undergoes a transformation called calcination and reacts with the SO_2 in the flue gas to form calcium sulfate ($CaSO_4$). The calcining reaction is endothermic and is described by:

$$CaCO_3\ (s) + 766\ \text{Btu/lb (of } CaCO_3) \rightarrow CaO(s) + CO_2\ (g)$$

Once formed, solid CaO (lime) reacts with gaseous SO_2 and oxygen exothermically to form $CaSO_4$ according to the following reaction:

$$SO_2\ (g) + \tfrac{1}{2}\ O_2\ (g) + CaO(s) \rightarrow CaSO_4\ (s) + 6733\ \text{Btu/lb (of S)}$$

$CaSO_4$ is chemically stable at fluidized bed operating temperatures and is removed from the system as a solid for disposal.

SO_2 reductions of 90 percent are typically achieved in a circulating bed with calcium-to-sulfur (Ca/S) mole ratios of 2:2.5, depending on the sulfur content of the fuel and the reactivity of the limestone. The lower the sulfur concentration in the fuel, the greater the calcium-to-sulfur mole ratio must be for a given SO_2 removal level.

Assuming 1 percent sulfur coal, the SO_2 emissions from this plant would be approximately 950 tons/yr at the 90 percent load factor. For removal requirements greater than 90 percent, the amount of limestone needed increases rapidly, and alternative SO_2 removal methods, such as conventional pulverized coal-fired boilers with scrubbers, may become the economic choice.

5.8.3 Particulate Emissions

The ash contained in solid fuel is released during the combustion process. Some of this ash remains in the fluidized bed and is discharged by the bed material removal or drain system. This ash is normally larger than 140 mesh (105 microns) and is easy to handle and transport. The remaining ash leaves the boiler in the flue gas. This material is typically less than 325 mesh (44 microns) and requires a high-efficiency collection device. A fabric filter is used with atmospheric pressure fluidized-bed boilers because it is less sensitive to the ash properties, such as size, concentration, and resistivity.

Fly ash from the economizer/air heater hoppers and baghouse will be handled with a vacuum pneumatic system. Ash cooling is not necessary. The baghouse will have a removal efficiency of 99.9 percent. Assuming a 90 percent load factor, this plant will have produce approximately 43 tons/year of particulates which will be treated at the 99.9 percent level.

5.8.4 Continuous Emission Monitoring System (CEMS)

The project will install a CEMS, which will sample, analyze, and record the concentration of carbon monoxide, oxides of nitrogen, and oxygen/carbon dioxide in the flue gas. The system generates a log of emissions data and provides alarm signals to the control room when the level of emissions exceeds pre-selected limits. Continuous compliance with the NO_x emission limits will be demonstrated with the CEMS based on the applicable averaging time designation.

5.9 ELECTRICAL SUBSTATION AND TRANSMISSION LINES

5.9.1 Electrical Interconnection Facilities

The electrical interconnection facilities will connect the steam turbine generator to Brownsville PUB through a generator step-up unit transformer located in the site 138 kV switchyard.

5.9.2 Transmission Interconnection

The 138 kV switchyard will be connected into the Brownsville PUB grid through the existing 138kV transmission lines. The transmission lines are located adjacent to the proposed 138 kV switchyard.

5.9.3 Equipment

The switchyard will include but not be limited to the following outdoor equipment and materials:

- Power circuit breakers;
- Disconnect switches;
- Surge arrestors;
- Voltage transformers;
- Current transformers;
- Insulators;
- Lighting; and
- Perimeter Security Fence.

5.9.4 Bus Configuration

The switchyard will be connected to the transmission grid by a three-terminal bus. The existing 138 kV transmission line will be rerouted to enter and leave the proposed 138 kV switchyard. The configuration will protect the Brownsville PUB transmission line and provide power to the site from the public utility in the event of a turbine generator shutdown. **Figure 5-2** illustrates the bus configuration for the switchyard.

5.9.5 Control and Protection

The protective relay system will be designed to provide high reliability during all operating conditions. The protective relay system will be configured to protect equipment from damaging abnormal operating occurrences, limit damage to faulted equipment, minimize possibility of fire or explosion, and minimize hazard to personnel.

6.0 POTENTIAL ENVIRONMENTAL IMPACTS

6.1 SUMMARY OF ENVIRONMENTAL INFORMATION ANALYSIS

This section of the report addresses the potential environmental impacts associated with construction and operation of the Brownsville Desalination Demonstration Project. The facility is composed of five separate functional units:

1. Seawater intake system;
2. Brine disposal pipeline;
3. Desalination plant;
4. Power plant; and
5. Finished water transmission routes.

Each of these distinct areas of the project has its own unique potential impacts on the natural resources of the Brownsville area. Because of the nature of the information required for the feasibility study, only the impacts of the construction and operation of the preferred alternative have been addressed. Furthermore, this environmental analysis will only cover those potential impacts related to the surface water bodies, wetlands, offshore marine habitat, surface soils, and air quality. Although the qualitative assessment of current information concludes that there are no substantial impacts from the construction and operation of the Brownsville Desalination Demonstration Project, additional analyses will be required to quantitatively assess the full scope of the potential environmental impacts of this proposed project.

Environmental impacts of the proposed finished water transmission routing and brine disposal pipeline are minimized by selection of routes that primarily use existing rights-of-ways (ROWs) established for railroads, utility lines, drainage ditches, or roads. Since these ROWs have already undergone significant disturbance as a result of construction and maintenance, additional construction will not affect any sensitive biological populations, archeological sites, recreational areas, or other sensitive receptors. Disturbances to waterways and environmentally sensitive areas such as wetland and coastal dunes to be crossed by the finished water transmission line and brine disposal pipeline will be minimized by directionally drilling below the affected area and/or using construction methods that will minimize potential impacts.

The proposed seawater intake structure located on the Brownsville Ship Channel has been designed to minimize the impingement and entrainment of fish eggs and larvae by using an exceptionally low intake velocity across either a filtration-type or an exceedingly small mesh wedge-wire screen. The brine discharge pipeline outfall has been located approximately 3 miles offshore in a minimum water depth of 25 feet. However, a detailed environmental study has not been performed at this time for the brine outfall, but a comprehensive analysis will be performed in the preliminary design phase. The diffuser structure design allows for rapid mixing of the brine solution to facilitate the immediate diffusion of the concentrated saline discharge.

The proposed 100 million gallons per day (MGD) desalination plant and adjacent power plant located on the north side of the Brownville Ship Channel have been designed to minimize the potential plant footprint and impact to surrounding undeveloped property. The seawater intake structure will be located in a side channel cut into the plant site, and the brine discharge pipeline will be placed under the Brownsville Ship Channel to avoid impacts of future dredging projects in the channel on the plant facilities.

The proposed 100 megawatt (MW) coal-fired plant that may be co-located with the desalination plant would provide steam that could be used to preheat the seawater entering the reverse osmosis (RO) unit. This would maximize the efficiency of the process and also provide power for the operation of the desalination plant. The proposed plant would use the Best Available Control Technology (BACT) emission controls, as required, to minimize the impact of the plant on the local and regional air quality. Each of the project segments will be discussed in more detail in the following sections with regard to the affected environment, potential environmental impacts, and the potential permits and approvals that will be required for construction and operation of the Brownsville Desalination Demonstration Project.

6.2 APPLICABLE REGULATORY AGENCIES AND STAKEHOLDERS

The potential federal and state permitting and compliance requirements for the Brownsville Desalination Demonstration Project are summarized in **Table 6-1** at the end of this section. Some of the required federal and state approvals would be obtained through consultation with the appropriate agencies during the final project design phase. The primary federal, state, and local agencies that would be involved in the development and permitting of the proposed facility include:

- United States Army Corps of Engineers (USACE) – Galveston District;
- National Oceanic and Atmospheric Administration (NOAA);
- National Marine Fisheries Service (NMFS);
- United States Environmental Protection Agency (USEPA);
- United States Fish and Wildlife Service (USFWS);
- United States Coast Guard (USCG);
- Federal Aviation Administration (FAA);
- Texas Commission on Environmental Quality (TCEQ);
- Texas Parks and Wildlife Department (TPWD);
- Texas State Historic Preservation Office (TSHPO);
- Texas General Land Office (GLO);
- Texas Department of Transportation (TXDOT);
- Texas Water Development Board (TWDB);
- Cameron County;
- City of Brownsville;
- Port of Brownsville Authority;
- Brownsville Public Utility Board (PUB);
- Texas Shrimp Association; and
- International Boundary and Water Commission (IBWC).

The major permits that would be required are shown below.

USACE Section 404 and Section 10 Permitting

The USACE will have jurisdiction over temporary or permanent project activities that place fill materials into waters of the US, including wetlands (Section 404), or affect a navigable waterway (Section 10). Under Section 404 of the Clean Water Act (CWA), a permit would be required for activities such as crossing an intermittent or perennial stream or wetland with the brine or finished water transmission pipeline, access road, or the placement of temporary diversion structures in a waterway. This permit would also be required for the directional drilling of the brine disposal pipeline under the Brownsville Ship Channel and the construction of the side channel housing the seawater intake inlet structures.

Every attempt would be made to simplify the permitting process by working with the project engineers and USACE to qualify for nationwide permits for the project. However, the USACE does have discretionary authority to require an individual permit for all or portions of the project if there are significant environmental concerns. An individual permit may be needed for any major required harbor improvements.

The Galveston USACE District has specific permitting requirements and regional conditions that must be met because of the District's discretionary authority and state-specific conditions. It is advisable to meet with representatives of the District early in the project design phase. The pre-application consultation is valuable for establishing permitting requirements and mitigation measures, if needed, and for identifying critical issues that should be addressed.

TPDES Permit

The Brownsville Desalination Demonstration Project may have the following potential storm water and wastewater discharges:

- Storm water from the power plant and desalination plant both during construction and operation;
- Storm water during construction of the terrestrial portion of the finished water transmission and brine disposal pipelines;
- 50 MGD of brine from the proposed desalination plant;
- Sanitary wastewater from the proposed plant facilities; and
- Treated saltwater and freshwater potentially used for the hydrostatic testing of the pipelines.

The State of Texas is a delegated state under the National Pollutant Discharge Elimination System (NPDES) for the regulation of discharges of storm water and wastewater. As a result, the anticipated storm water and wastewater discharges associated with the project are regulated by TCEQ. As such, it is expected that Storm Water Pollution Prevention Plans (SWPPPs) will be required for both the plant facilities and construction phase of the terrestrial portion of the finished water and brine disposal pipelines.

The desalination plant will require a Texas Pollutant Discharge Elimination System (TPDES) permit for up to 70 MGD brine wastewater discharge (for maximum production of 100 MGD of finished water). It is expected that modeling of the flow from the diffuser and the saline plume in the Gulf of Mexico will be required as part of the permit application.

The sanitary discharge will be managed by one of the following three means:

1. Treatment in an on-site wastewater treatment plant with a discharge to surface water;

2. Treatment in a septic tank followed by discharge to a sub-surface sanitary system; or

3. Collection and transportation to an off-site facility for treatment and discharge, such as a Publicly Owned Treatment Works (POTW).

On-site treatment and discharge to surface water will require a TPDES permit from TCEQ. Discharge to an on-site subsurface sanitary system will require a permit from the Texas Department of Health and Cameron County. Transportation to an off-site facility may not require a permit. As a result, the applicable permitting requirements are undetermined at this time.

A TPDES permit is expected to be required for the discharge of wastewater generated by the potential hydrostatic testing of the finished water and brine disposal pipelines. However, the permitting requirements, which could include pretreatment of the discharge, cannot be determined at this time. The quality and quantity of the wastewater may vary depending on the materials and methods of pipeline construction and the nature of treatment chemicals, which have not been determined.

Air Quality Permitting

It is anticipated that the project will require TCEQ air permits to install and operate the proposed 100 MW coal-fired power plant. Air permits for this facility may include a Prevention of Significant Deterioration (PSD) new source review construction permit, Phase II Acid Rain permit, and a Title V operating permit. The USEPA has delegated implementation of its air permitting programs to the TCEQ. TCEQ implements the federal air permitting programs, as well as the Texas minor new source review permitting program, through Section 30 of the Texas Administrative Code (TAC) Chapters 116 and 120.

The project is located in an area classified as attainment for all pollutants. If the facility emits more than 100 tons per year (TPY) of any criteria pollutant (e.g., nitrous oxide [NO_x], carbon monoxide [CO], sulfur dioxide [SO_2], particulate matter ≤ μm [PM_{10}]), a BACT analysis will be required as part of the permit application.

6.3 SEAWATER INTAKE SYSTEM

6.3.1 Intake Structure Components

To properly collect seawater for this project, while minimizing the collection of suspended solids and protecting marine life, a conceptual design for the seawater intake system was developed. This system consists of a dedicated intake channel that will be located directly within the Brownsville Ship Channel; a set of side collection channels/pre-sedimentation basins that will be constructed within the site selected for the desalination plant; a set of screened intake assemblies; and a transfer pump station equipped with vertical turbine pumps. Each component is further described below:

Dedicated Intake Channel – A dedicated intake channel will be needed to properly collect seawater for the project. Dredging within the Brownsville Ship Channel will be required to create the dedicated intake channel for the desalination plant to minimize the velocity of water within the channel for the potential build-out capacity of the plant (i.e., 100 MGD). The channel is conceptually configured with a trapezoidal cross section. It would begin at the deep section of the Brownsville Ship Channel and would terminate at the northern bank of the ship channel at the entrance to the two side collection channels that are described below. A series of channel markers would be used to mark the sides of this channel to protect it from ship and boat traffic. An entrance barrier wall will be constructed at the mouth of the two side channels. The barrier wall will be configured to span the potential vertical variation in tide levels that may occur at that location. Based on information regarding potential tidal fluctuations, the barrier wall will start just above the Federal Emergency Management Agency (FEMA) 100-year flood elevation of 12 feet above mean sea level (AMSL)(FIRM Map, September, 1983) and will terminate at approximately 5 feet AMSL. The wall should properly span the entire potential range of tides that will occur at the intake structure. In addition, the manner in which the intake structure was designed will not cause any depression of the local tide level at any time, as a consequence of drawing in up to 167 MGD of seawater for the build-out capacity of the desalination plant. An estimated 30,000 cubic yards (yd^3) of soil/sediment will need to be dredged/excavated during construction of the intake channels.

Side Collection Channels/Pre-Sedimentation Basins – Two side channels will enter the site from the northern edge of Brownsville Ship Channel. An “entrance barrier wall” at the mouth of the two side channels will be constructed. The purpose of the entrance barrier wall is two-fold: 1) it will prevent any floatable contaminants, such as floating debris, separate-phase oils, etc. from entering the side channels; and 2) it will dampen the majority of all wave energy created with the Brownsville Ship Channel, thereby normalizing hydraulics within the interior of the side channels. Each side channel will serve as a pre-sedimentation basin for larger suspended particles and will be configured in such a manner to allow it to be periodically dredged for the removal of solids that may accumulate within it. Each side channel will be 30 feet long, 60 feet wide, and 30 feet deep. At these dimensions, the flow-through velocity within each side channel would be limited to less than 0.5 feet per second (FPS) at the potential build-out capacity of the plant of 100 MGD and at approximately 0.1 FPS for the initial plant capacity of 25 MGD. One channel can be taken out of service for maintenance (dredging) while maintaining use of the second channel. A concrete bulkhead (seawall) will be constructed along the Brownsville Ship

Channel and within the side channels to protect the site from flooding. The seawall will be constructed to 12 feet AMSL to match the FEMA 100-year flood elevation (FIRM Map, September, 1983).

Screened Intake Assemblies – At the interior end of each side channel, a set of water intake screens constructed of a copper-nickel alloy will be installed, which will reduce entrainment and impingement by preventing planktonic eggs, larvae, swimming organisms, and objects greater than 1/8-inch in diameter from entering the headworks of the desalination facility. The screens are sized to limit the maximum approach velocity to 0.5 FPS. A compressed air supply will be used to provide a periodic "air burst" along the face of the screens to keep them clear of solids. The screen assemblies in each side channel will be hydraulically connected through a concrete bulkhead to the seawater transfer pump station, which will consist of a series of vertical turbine transfer pumps.

Seawater Transfer Pump Station – A set of vertical turbine pumps will collect seawater from the side channels via the water intake screens and will route it to the pretreatment system in the desalination plant. Three pumps will be used to collect the quantity of seawater needed for the plant's initial finished water production capacity of 25 MGD.

Pumping rates at the intake channel will vary depending on the finished water capacity of the desalination plant. Based on current information, it appears that the desalination plant will have an initial finished water capacity of 25 MGD. Assuming that the primary treatment system will operate at a 60 percent recovery rate for the plant, the following table provides a summary of the requisite seawater intake rates.

Finished Water Capacity (MGD)	**25**	**50**	**75**	**100**
Intake Pumping Rates (MGD)	42	83	125	167

6.3.2 Potential Environmental Impacts

Baseline data does not exist to quantify the impingement and entrainment losses for estuarine species' fish eggs and larvae in the vicinity of the seawater intake structures located in the Brownsville Ship Channel. In previous discussion with the NMFS, it was determined that further studies may be required to determine what type of species would be impacted. The Brownville Ship Channel is directly hydraulically connected to Laguna Madre and the Gulf of Mexico.

In the database of Estuarine Living Marine Resources (ELMR), the NOAA NMFS provides the distribution and relative abundance of ecologically and economically important fishes and invertebrates in estuaries nationwide. The proposed site area is located adjacent to Laguna Madre, which has been identified as Essential Fish Habitat (EFH) for various life stages of red drum (Sciaenops ocellatus), penaeid shrimps (brown, Farfantepenaeus aztecus; white, Litopenaeus setiferus; pink, Farfantepenaeus duorarum), and juvenile Spanish mackerel (Scomberomoorus maculates). In addition to these federally managed species, the project area provides a nursery and forage habitat that supports an array of forage species and economically important fishery species.

The water intake structures have the potential to adversely impact fish stocks via mortality attributed to impingement and entrainment of fish eggs and larvae. The intake system is being designed to theoretically keep these losses to a minimum by using the exceptionally low intake velocity structures described above.

The material that is removed during the excavation and dredging of the intake channel structures will be used as fill in the site boundaries to bring the elevation of the site to a minimum of 12 feet AMSL, which is at the 100-year flood plain (FIRM Map, September, 1983). It is not anticipated that this excavated and dredged material will contain environmentally hazardous contaminants. The liberation of sediments into the water column in the ship channel will occur during the excavation and dredging operations. The movement of these sediments until re-deposited by gravity will rely directly on the tidal currents in the channel at the time of suspension.

6.4 DESALINATION PLANT

6.4.1 Desalination Facility Components

Pretreatment System – The pretreatment system for this project will include 1) coagulation and filtration for the bulk removal of organics and other suspended solids; 2) a heat exchange system to preheat the RO feed water to 90 degrees Fahrenheit [ºF]; 3) a series of chemical additions to condition the water supply prior to the membrane system; 4) cartridge filtration; and 5) periodic shock-chlorination of the raw water supply to reduce bacteria and other biological agents that may accumulate within the pretreatment system through time. Each of these components is described in more detail below.

- **Coagulation and Filtration Subsystem** – The preferred alternative currently being considered for the pretreatment system is a ballasted flocculation and clarification (BFC) system with single-stage dual-media filtration. The system would be used for the removal of organic and inorganic constituents that may be present in the seawater supply. A chemical coagulant such as a ferric salt (ferric chloride or ferric sulfate) would be used to coagulate the water supply. All residuals (sludge) produced by the pretreatment system would be transferred either by gravity or pumping to the plant’s solids handling system.

- **Heat Exchange Subsystem** – Excess heat energy that will be available from the co-located power plant will be used to preheat the feed water for the downstream membrane system. The feed water will be pre-heated to 90ºF using a system of heat exchangers, that will use low-pressure steam from the power plant. Condensate from the heat exchangers will be returned to the power plant via a closed loop for internal recycle and reuse. Using excess steam energy from the power plant to preheat the water supply will reduce the power usage of the high-pressure RO pumps by reducing their design operating pressure. In addition, the amount of heat that would otherwise be discharged directly to the environment from the power plant's cooling towers would be reduced as a consequence of utilizing the excess heat from the plant.

- **Chemical Additions** –To further condition the water supply prior to the membrane separation process, the water supply will be dosed with either an acid, such as sulfuric acid, or an anti-scalent. These chemicals are typically used in most RO applications to minimize membrane fouling and extend the useful life of the individual membrane elements. If sulfuric acid is selected for the pretreatment system, it would be bulk delivered to the site, and stored and routed using properly designed storage tanks and piping systems that include secondary containment.

- **Cartridge Filtration** – All pretreated water will be routed through a bank of cartridge filters before the primary treatment system. The cartridge filters will be used as the last physical barrier to prevent the passage of suspended solids greater than 5 microns in diameter. Cartridge filters will be replaced routinely, and spent cartridges will comprise one of the solid waste streams generated by this project. Spent cartridge filters are typically considered nonhazardous waste and can be disposed in a Class I solid waste landfill.

- **Periodic Shock Chlorination** – Seawater will be periodically dosed with chlorine prior to the downstream membrane treatment system to manage the accumulation of biological contaminants such as bacteria and virus that could damage the membrane elements. When shock chlorination is conducted in the pretreatment system, sodium bisulfite would be added prior to the cartridge filters to dechlorinate the water supply to protect the membranes from oxidant attack.

Primary Treatment System – The primary treatment system will consist of 1) a series of seawater reverse osmosis (SWRO) trains; 2) a set of high-pressure SWRO feed pumps; 3) a set of energy recovery turbines; 4) a set of second-pass Brackish Water Reverse Osmosis (BWRO) feed pumps; and 5) a series of second-pass BWRO trains. Each of these components is described in more detail below along with a discussion of the production of permeate, brine, and waste products generated by this system.

- **SWRO Trains** – The SWRO trains will be arranged in a parallel configuration, consisting of six trains. Each train will be designed to produce 5 MGD of permeate (desalted water). To increase the overall product recovery to approximately 60 percent, reject staging will be used within the SWRO trains. At the initial 25 MGD finished water capacity, the brine flow from each SWRO train will be 3.33 MGD. Five of the six trains will be needed to produce the initial plant capacity of 25 MGD. The sixth train is provided for purposes of redundancy, when a train must be taken out of service for maintenance and/or repair.

- **Second-Pass BWRO Trains** – For the initial design capacity of 25 MGD, the facility's second-pass BWRO System will consist of two trains, one of which will serve as a redundant train to allow periodic maintenance and cleaning. The BWRO trains will utilize low-pressure, high-rejection membranes in a two-stage configuration, with a total of seven-element pressure vessels. (Refer to attached process flow diagram for the configuration of the various RO units). The second-pass BWRO trains will operate at an anticipated recovery factor of 90 percent. Concentrate from the BWRO trains will be recycled upstream of the SWRO trains to maintain a composite recovery factor for the overall primary treatment system of approximately 60 percent.

- **Water Production** – The SWRO trains will remove the majority of dissolved solids from the pretreated seawater supply. A portion of permeate (desalted water) from the SWRO trains will be routed to the BWRO trains. Permeate from the BWRO trains as well as the balance of permeate from the SWRO trains will be combined and routed onward to the post-treatment system described below to be further treated to generate finished, potable-grade water for the project. A portion of the permeate generated from the BWRO trains (at a rate of 75 gallons per minute [gpm]) will be routed directly to the power plant to support that plant's demineralized water needs. Also, a portion of the combined permeate from the SWRO and BWRO trains (at a rate of 1,050 gpm) will be directly routed to the power plant to serve as makeup water for that plant's cooling water system.

- **Brine Production** – As indicated above, the high-pressure brine streams produced by the SWRO Trains will be routed through energy recovery turbines and then routed through baffled, anti-foam chambers, which will collapse and compress foam present in the brine stream. By using this chamber, the use of anti-foam agents and/or other chemical additives is eliminated. After the anti-foam chamber, brine will be routed to the brine wet well for subsequent transfer through the brine disposal system. As a consequence of the co-located power plant, daily blowdowns from the power plant's cooling water system will also be routed to the brine wet well where the two waste streams will be combined prior to disposal.

- **Waste Production** – Two types of waste products generated by the primary treatment system will require disposal. The first waste product will be spent flushing and cleaning solutions periodically generated as a consequence of monthly membrane cleaning events. For planning purposes, it is assumed that each membrane unit will be flushed (backwashed) with clean permeate water twice each month. Similarly, each membrane unit will be cleaned using a surfactant solution once each month. Both the spent flushing and cleaning solutions will be routed to a dedicated wastewater holding tank (scavenger tank) of 200,000-gallon capacity for temporary storage until they can be transferred via truck for disposal off site. The second waste product generated by the Primary Treatment System will be the membrane elements themselves once they have reached the end of their useful life, which is approximately five years. Spent membrane elements are typically classified as a nonhazardous type waste that can be disposed in a Class I solid waste landfill.

Post-Treatment System – The post-treatment system will include two unit treatment processes, including final stabilization and final disinfection. Descriptions of both of these unit processes are provided below.

- **Final Stabilization Subsystem** – The potential stabilization system currently being evaluated for the project is a conventional lime system consisting of one or more storage silos for a pebble lime stock, slaking equipment, and lime slurry tanks and transfer pumps. Due to the potential for this system to release lime dust, each storage silo would be equipped with a dust collection blower and filtration system. For a conventional lime system, deliveries of pebble lime would be required frequently, and a solid waste stream would be generated consisting of unslaked lime solids. Lime is caustic in nature (high pH) and proper secondary containment for this chemical stock will be provided.

- **Final Disinfection Subsystem** – Final disinfection will include the use of chlorine and a dedicated set of contact tanks to provide the requisite residence time for the final disinfection process. An on-site sodium hypochlorite generation system has been selected as the preferred alternative. Bulk deliveries of salt to the site may be required, or a portion of the brine stream from the SWRO process could be concentrated and potentially used as the salt stock. Few, if any, waste products would be generated as a consequence of the on-site hypochlorite generation process.

Solids Handling System – The solids handling system will have four primary components including 1) a solids equalization basin; 2) a solids thickening subsystem; 3) a solids dewatering subsystem; and 4) a solids drying subsystem. Each component is described in further detail below.

- **Solids Equalization Basin** – All wastewater generated by the pretreatment system will be routed to two 16-foot by 16-foot solids equalization basins. The basin would be equipped with a set of submersible pumps that would be used to transfer wastewater containing solids to the downstream thickening subsystem described below.

- **Solids Thickening Subsystem** – The solids thickening system will consist of two 25-foot by 25-foot lamella-type reactor-clarifiers and gravity thickener unit(s). This combination unit is used to thicken residuals generated by the pretreatment system. A coagulant and/or an anionic polymer would be dosed to the influent flow prior to the thickener units. Coagulated wastewater would exit the center reaction well into the gravity thickener portion of the unit where coagulated solids would settle to the bottom of the unit for subsequent collection and removal. Clarified water from the units would be recycled by gravity or pumping to the pretreatment system, thereby minimizing wastewater generated by the solids handling system and conserving the water supply obtained for the plant.

- **Solids Dewatering Subsystem** – The type of dewatering system currently being evaluated includes belt filter presses followed by drying beds. Thickened residuals from the gravity thickeners would be routed to these types of dewatering units to remove additional water and increase the solids content of residuals generated by the desalination plant. Filtrate (excess water) extracted by the dewatering system would be routed to the plant's drain pump station, where it will be transferred to a local wastewater treatment facility for additional treatment. If for any reason a suitable disposal route for this waste stream cannot be identified, an ultraviolet (UV) system may be proposed to treat the waste stream, thereby destroying and/or inactivating various biological contaminants for subsequent recycle back to the head of the plant.

- **Solids Drying Subsystem** – A set of dryers may be used to further consolidate solids generated by the desalination plant. Additional excess heat energy that will be available from the power plant would be applied to the dryers to evaporate additional water from the solids. Initial estimates for the total quantity of solids generated is around 20,000 pounds of dry solids per day. All solids (residuals) generated by the desalination plant would likely be classified as a nonhazardous waste that could be disposed of in a Class I landfill. Alternatively, it is becoming more and more common to use residuals from water treatment plants as soil amendments at land farms. For the latter option, no disposal costs aside from transportation costs would be incurred and the reuse of residuals could potentially represent a revenue stream for this project.

6.4.2 Potential Environmental Impacts

The proposed plant location is on an undeveloped piece of property owned by the Port of Brownsville in the immediate vicinity of Loma de los Lobos, east of the Brownsville Fishing Harbor. There will be no significant impacts from the operation of the desalination plant since all waste streams will be either disposed of in a Class I solid waste landfill for nonhazardous constituents (spent cartridges and membranes, dewatered solids); stored on site and transported to an approved total dissolved solids (TDS) facility (used flushing and cleaning solutions); or transported to an off-site water treatment plant (liquid generated during the solids dewatering process).

During the construction process there will be temporary impacts on air quality due to emissions from construction equipment, but the emissions generated during operation will be minimal. The limestone particulate generated by the post-treatment system lime pebble storage, handling, and crushing may also require an air emissions permit. The fugitive dust emissions will be minimized to the greatest extent possible through the use of engineering controls, such as wetting and a bag house for dust suppression, as necessary.

Construction of the facility will also result in the potential for soil erosion and runoff due to the movement and impaction of loose fill material. Mitigative methods such as silt fences for storm-water runoff management will be specified in an erosion control plan that will be finalized for the required TPDES permit to protect the migration of sediment off the property, particularly into the Brownsville Ship Channel.

6.5 POWER PLANT

6.5.1 Power Plant Conceptual Model

The proposed project includes the development of a 100-MW coal-fired power plant that will be located just to the west of the desalination plant. The plant will include the following elements:

Docking Facilities - The docking facility must be designed to off load ocean service-certified barges with 12,000 tons of capacity and a draft of 26 feet. When the plant is operating at full capacity, there will be one barge unloaded per week at an average rate of 250 tons per hour (TPH) using a diesel-powered clamshell bucket. Approximately 40,000 yd^3 of sediment will be excavated from the channel to deepen the coal barge docking facility.

Coal Storage Yard - The barge-unloading crane will place the material in a feed hopper for the unloading conveyor that will transport the coal to the storage pile. The unloading conveyor will have material trippers that will discharge the coal along the pile. The unloading conveyor will have a maximum capacity of 500 TPH. Diesel-powered bulldozers and front-end loaders will maneuver and compact the coal in the storage pile. The pile will be approximately 30 feet high by 900 feet long by 110 feet wide.

The entire coal handling area and the power block will have an under drain system to collect all rain water and contain it in the coal pile rainwater runoff pond. Solids will settle in the pond, and the water then will flow to the water treatment pond. The effluent of this pond will be used for coal pile compaction and the dust suppression sprinkler system.

Limestone Storage - The limestone handling system will unload the limestone from either trucks or rail cars. Two 600-ton silos will store 10 days of limestone on site. The limestone unloading must average 290 tons per day, which requires fifteen 20-ton capacity trucks or six 50-ton capacity rail cars. The limestone feed rate to the unit will be 5 TPH. Limestone will be drawn out the bottom of the storage silos into a grinding machine. The grinding machine will discharge properly sized limestone particles to the limestone day silos at the units.

Coal Transport and Preparation System - Earth-moving machines will retrieve the coal from the pile and deposit the coal into a feed grater that will load the coal on the 75 TPH conveyor that will supply the coal grinding machine. The boiler feed rate will be 61 TPH. The grinding machine will discharge properly-sized coal particles to the coal day silos at the units.

Power Block

Boiler - The proposed boiler will be a circulating, fluidized-bed boiler producing 640,000 pounds per hour (lbs/hour) of superheated steam at 2400 pounds per square inch, absolute (psia) and 1000°F. The boiler will have a super heater, single reheater, and economizer. Forced-draft fans will feed combustion air through an air preheater to the furnace wind box. The combustion air will flow up through the fluidized bed of coal and limestone. The fuel will burn at relatively low temperatures to avoid NO_x formation, and the limestone will react with sulfur dioxide (SO_2) formed when burning the sulfur in the coal to form calcium sulfite ($CaSO_3$).

Lighter unburned carbon, ash, limestone, and $CaSO_3$ particles will escape the furnace and be captured upstream of the superheater section and recirculated back to the fluidized bed. Heavier particles will eventually be extracted from the hoppers below the bed to waste disposal. The lighter ash particles will continue through the unit and be captured in a baghouse downstream of the air preheater. The expected combined waste streams of the lighter fly ash and the heavy ash,

$CaSO_3$, and unreacted limestone is estimated to be 10 TPH. This material will be trucked to an off-site landfill.

Steam Turbines and Electric Generator - The steam turbine will be a multi-extraction condensing steam turbine. The generator will be an air-cooled design. The superheated steam will be expanded through the high-pressure turbine and returned to the boiler for reheating. Some of the process steam will be diverted to the desalination plant and mixed with seawater to increase the temperature of the water being processed in the RO unit. The increased temperature will maximize the efficiency of the RO process.

Cooling System - The condenser will be cooled with a closed loop cooling tower system. The system will circulate 87,000 gpm of cooling water. The cooling tower will be an eight-cell forced draft cross-flow design and will require 1,150 gpm make up water from the desalination plant. Assuming 200 parts per million (ppm) TDS make-up water and a 1,200ppm TDS cooling tower concentration, the blowdown rate will be 215 gpm.

The blowdown will be returned to the desalination plant pretreatment system and eventually be recycled in the desalination system. The TDS concentration in this stream will be much lower than in the brackish seawater used in the desalination plant. However, because of the metals in the blowdown stream, further evaluation is required to ensure the pretreatment and RO system can successfully remove the metals and any treatment chemicals that will be used in system.

6.5.2 Potential Environmental Impacts

The USEPA classifies airsheds throughout the country as attainment areas or nonattainment areas with respect to the National Ambient Air Quality Standards (NAAQS). Brownsville, in Cameron County, is designated attainment for all criteria pollutants covered by the NAAQS.

The TCEQ will be the air quality regulatory authority for the proposed power plant. TCEQ's air regulations are contained in 30 TAC, Chapters 100-122. These regulations incorporate the federal regulatory program requirements listed in Section 40 of the Code of Federal Regulations (CFR) 50-99 and establish permit review procedures for all stationary facilities that may emit air pollutants. Any new facility that will emit air pollutants is required to obtain an air quality permit before to commencing construction.

New Source Review

PSD provisions apply to new major sources or major modifications in areas that attain the NAAQS. For purposes of PSD applicability, a major stationary source is defined as any source with the potential to emit (PTE):

- 100 TPY of any criteria pollutant if the facility category is listed in 40 CFR 52.21(b)(1)(i)(a); or

- 250 TPY of any criteria pollutant if the facility category is not listed in 40 CFR 52.21(b)(1)(i)(a).

Fossil-fuel boilers totaling more than 250 MMBtu/hour heat input are one of the listed categories in 40 CFR 52.21(b)(1)(i)(a). Therefore, the 100 TPY threshold applies and the proposed facility will be a major source subject to PSD permitting. The PSD permit must be applied for and obtained before the start of construction. USEPA has delegated authority to issue PSD permits to the TCEQ, and the permitting requirements are set forth in 30 TAC Chapter 116. TCEQ will require that the boiler have the BACT. A detailed BACT analysis will be necessary to determine what controls are required, especially for NO_x and SO_2.

Title V Operating Permit

The proposed power plant will be subject to the Title V Operating Permit Program (40 CFR Part 70), which requires major sources of air emissions to obtain an operating permit within one year of project startup. USEPA has delegated authority to issue Title V permits for projects in Texas to the TCEQ, and the Texas program is codified in 30 TAC Chapter 122. The major source thresholds triggering the Title V permit requirement are 100 TPY for any criteria pollutant, 10 TPY of any individual hazardous air pollutant (HAP), or 25 TPY of all HAPs combined.

Acid Rain Permit

The power plant will be required to obtain an acid rain permit. The acid rain permit program has been delegated to TCEQ; permit applications are required to be submitted at least 24 months before the affected unit commences operation. The acid rain program requires that SO_2 allowances be obtained for every ton of SO_2 to be emitted. Currently, these allowances cost $200-250 per ton per year. The rules also establish emission limits and monitoring, recordkeeping, and reporting requirements for SO_2, NO_x, carbon dioxide (CO_2), volumetric flow, and opacity.

New Source Performance Standards

40 CFR Part 60, New Source Performance Standards (NSPS) is incorporated by reference in TCEQ regulations. NSPS Subpart Da (Standards of Performance for Electric Utility Steam Generating Units) applies to fossil fuel-fired electric utility steam generating units with a heat input capacity greater than 73 MW (250 MMBtu/hr). The boiler will be subject to specific emission limits, recordkeeping, and reporting requirements of NSPS Subpart Da.

National Emission Standards for Hazardous Air Pollutants (HAPs)

National Emission Standards for Hazardous Air Pollutants (NESHAPs) and Maximum Available Control Technology (MACT) standards do not apply to the proposed power plant. NESHAPs and MACT standards are incorporated by reference in 30 TAC 113.55 and 30 TAC 113.100, respectively, and regulate HAP emissions either by substance or by industrial process. The power plant will not include sources or source categories subject to NESHAPs. MACT standards apply to major sources, i.e., those having the PTE an individual HAP in excess of 10 TPY or any combination of HAPs in excess of 25 TPY. The facility will not be a major source of HAPs; therefore, the MACT standards do not apply.

General Rules - The proposed power plant will be required to operate in compliance with TCEQ General Air Quality Rules, 30 TAC Chapter 101. These rules prohibit discharging air contaminants in amounts that constitute a nuisance or a traffic hazard, and require notification for emission events and maintenance activities, as well as sampling, sampling ports, emission inventory, compliance with USEPA standards, inspection fees, and emissions fees.

Visible Emission and Particulate Matter - The proposed power plant will be required to comply with TCEQ visible emission and particulate matter (PM) standards. 30 TAC §111.111 establishes an opacity limit of 20 percent for sources constructed after January 31, 1972. Section 111.151 limits total suspended particulate (TSP) emissions from non-agricultural processes based on the effluent flow rate in actual cubic feet per minute (acfm). Section 111.155 establishes maximum net ground-level PM concentration limits of 200 micrograms per cubic meter ($\mu g/m^3$) for a three-hour average and 400 $\mu g/m^3$ for a one-hour average. Limits on visible emissions are also established for motor vehicles (not longer than 10 consecutive seconds), ships (not to exceed 30 percent for any five-minute period, except during reasonable periods of engine startup), and other structures and sources (not to exceed 30 percent for any six-minute period).

Control of Emissions from Sulfur Compounds - The facilities will be required to comply with the emission limits for SO_2 and hydrogen sulfide (H_2S) contained in 30 TAC Chapter 112. Net ground-level concentrations of SO_2 are required not to exceed 0.4 parts per million by volume (ppmv) basis over any 30-minute period, as required by 30 TAC §112.3.

Net ground-level concentrations of H_2S are not to exceed 0.08 ppm, averaged over any 30-minute period if the downwind concentration affects a property used for residential, business, or commercial purposes, or 0.12 ppm averaged over any 30-minute period for other properties (such as industrial) and vacant tracts and range lands not normally occupied by people and will not exceed the limits in 30 TAC §112.31 and §112.32.

Construction

Activities during construction of the power plant that will result in the generation of air pollutant emissions include:

- Site preparation activities on land (earthmoving);
- Installation of component facilities;
- Dredging activities for barge docking facilities;
- Operation of vehicles and trucks during construction; and
- Worker commuting trips to and from the site.

Operation

The operational power plant will include several facilities and activities that will produce emissions of regulated air pollutants to the atmosphere. The primary emission sources are listed below:

- 1000 MMBtu/hour fluidized bed boiler;
- Coal handling/transfer and storage facilities;
- Limestone handling/transfer and storage facilities;
- Vessel emissions from coal transport and docking;
- Emergency diesel generator; and
- Truck and/or train emissions for handling of limestone.

Only the stationary sources of air emissions are subject to permitting; however, those emissions will be above the 250 TPY trigger for PSD permitting. As stated above, a BACT analysis will have to be conducted to determine the emission controls required, especially for SO_2 and dust suppression. There is a possibility that enclosure of the conveyor system will be required for particulate emissions.

NO_x Emissions - NO_x emissions are considered to come from two sources: 1) oxidation of nitrogen in the air (thermal NO_x); and 2) oxidation of nitrogen or nitrogen compounds in the fuel (fuel NO_x). The Fluidized Bed Combustor operates at temperatures below the formation temperature of thermal NO_x (i.e., 1560°F - 1650°F). In addition, a significant portion of the total air is introduced above the grate. Fuel is normally fed below these parts, creating a substoichiometric zone in the lower combustor with a resulting reducing atmosphere that lowers NO_x emissions.

It is expected that BACT for NO_x will be between 0.05 and 0.07 lb/MMBtu, probably requiring use of selective non-catalytic reduction (SNCR). A detailed BACT analysis will be needed to determine the exact control required. At 0.07 lb/MMBtu, NO_x emissions are estimated to be 276 TPY.

SO_2 Emissions - SO_2 emissions are controlled within the combustor by adding sorbent material (e.g., limestone) so that a stack gas SO_2 scrubber is not required. The sulfur sorbent can also react with other fuel constituents such as vanadium, reducing downstream corrosion potential.

When sulfur-bearing fuels burn, most of the sulfur is oxidized to SO_2, which becomes a component of the flue gas. When limestone is added to the bed it undergoes a transformation called calcination and then reacts with the SO_2 in the flue gas to form calcium sulfate ($CaSO_4$). Once formed, solid CaO (lime) reacts with gaseous SO_2 and oxygen exothermically to form Ca SO_4. $CaSO_4$ is chemically stable at fluidized bed operating temperatures and is removed from the system as a solid for disposal.

SO_2 reductions of 90 percent typically are achieved in a circulating bed with calcium to sulfur mole ratios of 2 to 2.5, depending on the sulfur content of the fuel and the reactivity of the limestone. The lower the sulfur concentration in the fuel, the greater the calcium to sulfur mole ratio that must be for a given SO_2 removal level. Assuming 1 percent sulfur coal, the SO_2 emissions from this plant would be approximately 950 TPY at the 90 percent load factor.

BACT for SO_2 may require the installation of a polishing scrubber. A detailed BACT analysis will be required.

Particulate Emissions - The ash contained in solid fuel is released during the combustion process. Some of this ash remains in the fluidized bed and is discharged by the bed material removal or drain system. This ash is normally larger than 140 mesh (105 microns) and is easy to handle and transport. The remaining ash leaves the boiler in the flue gas. This material is typically less than 325 mesh (44 microns) and requires a high efficiency collection device. A fabric filter is used with atmospheric pressure fluidized-bed boilers because it is less sensitive to the ash properties, such as size, concentration, and resistivity.

Fly ash from the economizer/air heater hoppers and baghouse will be handled with a vacuum pneumatic system. Ash cooling is not necessary. The baghouse will have a removal efficiency of 99.9 percent. Assuming a 90 percent load factor, this plant will have produced approximately 43 TPY of particulates.

Continuous Emission Monitoring System (CEMS) - CEMS will be installed to sample, analyze, and record the concentration of carbon monoxide, oxides of nitrogen, and oxygen/carbon dioxide in the flue gas. The system generates a log of emissions data and provides alarm signals to the control room when the level of emissions exceeds pre-selected limits. Continuous compliance with the NO_x emission limits will be demonstrated with the CEMS, based on the applicable averaging time designation.

Mitigation

During construction, measures will be employed as required to suppress dust emissions. Construction operations will be scheduled to avoid concurrent operations by larger emissions sources when feasible. Stationary equipment that will be used during operations will be subject to TCEQ permitting requirements and will be required to implement all emission controls and operating practices specified in the applicable TCEQ rules, including a demonstration that BACT is being installed.

Other Potential Impacts Not Related To Air Emissions

Dredging will be required to accommodate the draft required for docking coal transport vessels on the Brownsville Ship Channel in front of the power plant coal handling facility. The major effects would result from the temporary suspension of sediment in the water column. The extent of the impact will be directly related to the amount of material to be dredged and the current at the time dredging takes place. The facility will also be required to have a TPDES permit for construction and storm water runoff from the facility. Particular attention will be given to mitigation methods to prevent erosion and runoff into the ship channel, especially from the coal and fly ash storage and handling facilities.

The proposed stack height for the plant is estimated to be 150 feet. This will require lighting in accordance with FAA regulations. USFWS may also require mitigation due to potential bird strike hazards.

Limestone may be brought in via truck or rail. The additional truck traffic may require the upgrade of existing roads and will significantly increase the local traffic on State Highway 48 (SH48).

6.6 BRINE DISPOSAL SYSTEM

6.6.1 Brine Quantity and Quality

Discharge rates for the brine disposal system will vary depending on the finished water capacity of the desalination plant. As stated previously, it appears that the desalination plant will have an initial finished water capacity of 25 MGD. Assuming that the primary treatment system will operate at a 60 percent recovery rate for the plant, the following table provides a summary of the resulting brine disposal rates. In addition to brine generated by the desalination plant, approximately 2.5 MGD of blowdown from the power plant's cooling water system will be combined with brine from the desalination plant prior to disposal.

Finished Water Capacity (MGD)	**25**	**50**	**75**	**100**
Desalination Plant Brine Disposal Rate (MGD)	16.7	33.3	50.0	66.7
Blowdown from Power Plant (MGD)	2.5	2.5	2.5	2.5
Total Brine Disposal Rates (MGD)	19.2	35.8	52.5	69.2

Based on the conceptual configuration developed for the desalination plant to date, along with the average water quality data from the past 10 years, the following table provides a summary of the anticipated quality of brine discharged from the desalination plant.

Brine Quality Parameter	**Units**	**Value**
Salinity	ppt	79
Chlorides	mg/L	47,000
Sodium	mg/L	22,000
Temperature	ºC	Same as the ambient seawater temperature at diffuser array
TDS	mg/L	89,900

ppt = Parts per trillion.
mg/L = Milligrams per Liter.

6.6.2 Brine Transfer Pumping System

The brine transfer system will consist of a brine pump station and a brine line that crosses south under the Brownsville Ship Channel to the Boca Chica Highway and then parallels the highway eastward approximately 12 miles to the coastline. The brine disposal line then continues approximately 3 miles offshore into the Gulf of Mexico to a water depth of approximately 25 feet, where the brine discharge will be diffused into the surrounding waters.

The brine pump station will have a concrete wet well to receive the brine from the SWRO units. Two vertical turbine pumps, each rated at 19.5 MGD, will discharge processed seawater into the brine line.

6.6.3 Brine Disposal Line and Route

The brine disposal main will be 54-inch in diameter and is sized to provide a velocity of about 5 FPS. The 56-inch pipe requires a velocity of 4.4 FPS at 19.5 MGD and the initial pressure will be about 80 pounds per square inch (psi). The pumps will require 700 horsepower (HP) motors. The brine disposal main will be made of high density polyethylene (HDPE) or other pipe material resistant to corrosion from the brine. The anticipated design life should exceed 50 years.

The brine disposal main will leave the desalination plant site going south under the ship channel. The channel crossing will be made using horizontal directional drilling (HDD) technology. The crossing will be approximately 80 feet below land surface, where it passes under the channel to provide the requested 25-foot clearance under the predicted future 55-foot channel depth. A permit for this crossing will be part of the USACE permit application. The brine disposal main will be installed south of the ship channel by open-cut methods most of the way to the coast, providing a minimum of 4 feet of soil cover.

The brine disposal main will go south in a 40-foot wide ROW easement to State Highway 4 (SH4) (Boca Chica Road). The 40-foot wide ROW is required for construction of the brine disposal main and space for two future brine disposal mains when the desalination plant is expanded. The brine disposal main will turn east and continue parallel to SH4 in a 40-foot wide easement along the north side of the highway. The main will cross under the highway near Richardson Road and continue east in a straight line to the back side of the dunes on the Gulf of Mexico coast approximately 3,500 feet north of the mouth of the Rio Grande.

The onshore alignment for the brine disposal main appears to be primarily within property owned either by the Port of Brownville or the Lower Rio Grande Valley National Wildlife Refuge, under the management of USFWS. There appears to be one private tract located along the north side of SH4 west of Kingston Road. This site is labeled as a mobile park, but it has been visually determined that there is one abandoned house and one under construction at this location. They appear to be less than 40 feet from the SH4 ROW and may pose a problem with acquisition. Aligning the brine disposal main along the south side of SH4 appears to involve more private property.

6.6.4 Gulf Outfall and Diffuser Array

At a point behind the dunes, HDD methods will be used to construct the brine disposal main under the dunes, beach, and near the coast, subsequently connecting to the offshore line about 3,000 feet out in the Gulf where the water is about 13 feet deep. At that point, an offshore pipe-laying ship can begin constructing the remaining brine disposal main out to the point where the pipe lays in a minimum of 25 feet of water about 3 miles offshore. Diffusers installed on the pipe terminus will distribute the brine in a manner that will quickly blend it into the surrounding seawater. The offshore pipe will be buried at a minimum of 4 feet below the sea floor.

The diffuser array will be placed at the end of the discharge main and will consist of several ports equipped with 1-meter high risers oriented upwards. The risers on the diffuser will help achieve higher discharge dilutions since the brine is heavier than the surrounding seawater, and it will fall toward the seabed as it dilutes. The up-wards orientation of the discharge will also enhance dilution from ambient offshore current and minimize head losses.

Section 4 contained a full analysis of the modeling conducted in determining the best design for the diffuser array. The preliminary modeling made assumptions regarding brine discharge salinity, ambient seawater salinity at the array location, temperature, and current velocity. The modeling results demonstrated that, for a small current of 0.15 meters per second, the plume dispersed to the bottom approximately 2-3 meters away from the diffuser with a salinity of about 32 grams per liter (g/L). At a capacity of 25 MGD, the area of sea floor expected to experience elevated salinity during mild conditions is roughly 7,000 SF or 0.16 acres. This is based on an ambient salinity of 32 g/L for the seawater and a brine discharge concentration of about 80g/L.

6.6.5 Potential Environmental Impacts

The brine disposal main will require additional environmental assessment before construction to fully analyze the potential environmental impacts of both the onshore and offshore construction, and operation of the brine disposal line. The main potential impacts of the brine disposal line(s) will be on the natural resources (vegetation) and wildlife; cultural and historical resources (additional study will be required); land use; air emissions from onshore and offshore construction; soil and sediment disturbance of onshore and offshore construction; and impacts on water quality due to runoff and construction in/under water bodies and the discharge of concentrated brine solution offshore in the Gulf of Mexico.

The proposed route and construction methods will be selected to minimize the impacts to the affected environment and minimize the amount of potential mitigation and restoration to any potentially impacted resources. The most likely resource areas to be affected are described below.

Wetlands

There are a limited number of types of naturally occurring wetlands and aquatic features within this portion of the Rio Grande Valley. The only potential natural wetlands within the vicinity of the proposed alignment are the resacas (dry abandoned streambeds) and Coastal wetlands. These are now typically used as drainage features or as a supply of irrigation water. These features are "Special Aquatic Sites" as defined under provisions of the Clean Water Act and impacts to these features may be regulated under the USACE Section 404 regulatory program (33 CFR Parts 320 - 338). A wetland determination or delineation has not been performed on the potential pipeline route.

The Brownsville Ship Channel is defined as a navigable waterway and will also be subject to regulation under Section 10 of the Rivers and Harbors Appropriation Act of 1899. The proposed brine main alignment will pass beneath the ship channel and the depth of the installed pipeline must be coordinated with the USACE.

There are numerous wetlands located in drainage features along roadsides and ditches. All wetlands noted during this study result from manmade features. Natural wetlands that may have habitated this area appear to have been removed when the area was used for industrial development and mine tailing disposal. The proposed route passes through several areas of soils that are listed as hydric soils by the Natural Resources Conservation Service (NRCS, formerly the US Soil Conservation Service). These soil types consist typically of Benito clay and Lometa clay. Low areas near roadways and irrigation water canals may in some instances qualify as wetlands under the USACE's regulatory program.

Onshore Biological Resources

The Brownsville area is within the Rio Grande Plains vegetational area that is also known as the South Texas Plains or Tamaulipan Brushlands. The vegetational area encompasses a large portion of south Texas and lies immediately west of the Gulf Prairies and Marshes vegetational area. Due to its expansiveness, the area is actually comprised of several sub-regions that are reflected in differing compositions of grasses, forbs, and microhabitats that are associated with a variety of soil types and landforms.

The topography of the Rio Grande Plains is comprised of level to rolling elevation and is dissected by arroyos and streams, with elevations ranging from near sea level to approximately 1,000 feet AMSL. Soils within the area crossed by the proposed brine disposal main are described by the NRCS as nearly level to gently sloping, well drained and moderately well drained silty clay loams and silty clays.

The majority of the onshore portion of the brine disposal ROW will be on property managed by the USFWS, designated as the Lower Rio Grande Valley National Wildlife Refuge. The construction methods and schedule will be closely coordinated with the USFWS to minimize the impact of construction on a habitat that may support various migratory, breeding and nesting species during specific times of the year.

Vegetation Resources - The area is characterized as open prairies with dominant plant species consisting of mesquite (Prosopis laevigata), granjeno (Celtis pallida), a variety of cacti, clepe (Ziziphus obtusifolia), coyotillo (Karwinskia humboldtiana), guayacan (Porlieria angustifolia), white brush (Aloysia gratissima), brasil (Condalia hookeri), bisbirinda (Castela texana), cenizo (Leucophyllum spp.), huisache (Acacia farnesiana), catclaw acacia (A. greggii), black brush (A. rigidula), guajillo (A. Berlandieri), and other small trees and shrubs. Native palm (Sabal texana) is found in the extreme southern portion of the Brownsville area.

Climax grasses and successional plant communities are diverse within the Rio Grande Plains. Those common to soils that are found along the proposed alignment include silver bluestem (Bothriochloa saccharoides), Arizona cottontop (Trichachne californica), buffalo grass (Buchloe dactyloides), curly mesquite (Hilaria belangeri), and species of pappus grass (Pappophorum spp.), and grama (Bouteloua spp). Low saline areas are characterized by gulf cordgrass (Spartina spartinae), saltgrass (Distichlis spicata), and sacaton (Sporobolus wrightii). Shrubs, vines, and herbs that are common to Brownsville area include: David's milkberry (Chiococca alba), tropical heartseed (Cardiospermum corindum), Palmer's bloodleaf (Iresine palmeri), manzanita (Colubrina greggii), and vervain (Verbena cameronensis).

Wildlife Resources - A general lack of vegetative cover within the area traversed by the proposed brine disposal main, precludes the presence of many terrestrial species. Furthermore, the alignment has been selected to minimize the wetlands and water features that would provide habitat for aquatic species. Those water features that cannot be avoided would be crossed by directional boring, thus avoiding impacts to the resource. Mammalian species that may be within the project area are limited to Nine-banded Armadillo (Dasypus novemcinctus), Eastern Cottontail (Sylvilagus floridanus), Texas Pocket Gopher (Geomys personatus), Southern Plains Woodrat (Neotoma micropus), and Striped Skunk (Mephitis mephitis) (Davis and Schmidly, 1994). It is unlikely that coyote (Canis latrans) or other predator species are abundant within the area due to the lack of cover and prey base.

Avian species within the area would be limited to White-winged Dove (Zenaida asiatica), Mourning Dove (Z. macroura), Scissor-tailed Flycatcher (Tyrannus forticatus), European Starling (Sturnus vulgaris), Brown-headed Cowbird (Molothrus ater), and Red-winged Blackbird (Agelaius phoeniceus). Due to a general lack of prey species, it is unlikely that many raptors would be present within the area.

Threatened and Endangered Species - State and federal records of occurrence were checked for species of concern within Cameron County. Data received from the TPWD Endangered Resources Branch and from the USFWS indicate that a total of 75 species of concern have been reported in the county. A total of 19 federally-listed threatened or endangered species are known to occur in Cameron County. Federally-listed and state-listed species of concern are identified on **Table 6-2**.

An analysis of habitat requirements associated with state- and federally-listed species indicates that it is unlikely that any threatened or endangered species or other species of concern would be found along the proposed project alignment. Many federally-listed species are native to the marine environment or are associated with dense thickets and other native vegetation that was once present in the area. Habitat that once was present within the area has been eliminated or substantially modified as a result of industrial and agricultural activities. Federally-listed and state-listed animal species that may be within the area of the proposed pipeline are likely to be limited to incidental occurrences of migratory birds that winter along the Texas coast. However, the area lacks habitat that would be suitable to support nesting of any of the federally-listed avian species.

Species of concern that may be in the area are likely to be limited to the Jaguarundi (Felis yagouaroundi cocomitli), Ocelot (Felis pardalis), Texas Ayenia (Ayenia limitaris), and South Texas Ambrosia (Ambrosia cheiranthifolia) which are listed by the USFWS and TPWD as endangered. Although not afforded protection under the US Endangered Species Act, Runyon's

Water Willow (Justicia runyonii) which is listed by the USFWS and TPWD as a species of concern; and Vasey's adelia (Adelia vaseyi) which is only listed by TPWD as a species of concern, also may be present in the area.

A field reconnaissance has not been conducted to identify vegetation and wildlife resources within the area and habitat that potentially could support federally-listed threatened or endangered plant or animal species. Although not afforded protection under the Endangered Species Act, habitat requirements associated with state-listed species and other species of concern also need to be more fully evaluated. Threatened and endangered species and other species of concern that are listed by the USFWS and TPWD are provided on **Table 6-2**.

<u>Air Quality</u>

Air emissions will occur during construction of the brine disposal line. Air emissions associated with the construction of the pipeline include:

Exhaust emissions of CO, NO_x, volatile organic compounds (VOC), and PM from construction equipment (i.e., bulldozers, trenchers, trucks, lay barges); and Wind-blown dust emissions from disruption of the highly unconsolidated silty soils along the route.

Since construction of the pipeline will proceed at a rate of approximately 2,500 feet per day, all emissions associated with construction of the pipeline are short-term and temporary. The greatest impacts from construction will occur along those portions of the pipeline route where residences are adjacent to the pipeline. The exhaust emissions from the construction equipment would not result in a significant increase in CO, NO_X, VOC, and PM concentrations at the residences.

<u>Water Quality</u>

The impacts to water resources during the construction of the brine disposal line should be insignificant. To prevent disruptions to the Brownsville Ship Channel, crossing of this waterway will use HDD to bore beneath the grade of the waterway. Drilling will be done to a minimum depth of 10 feet (proposed design is 25 feet below future channel depth at 80 feet AMSL) below the anticipated future dredge depth of 55 in the ship channel. Boring or drilling below any other potential resacas, ditches, drains, and canals will prevent the delivery of sediment or other substances to the surface waters, and no damages to these waterways should result. The second proposed HDD under the coastal dunes will significantly minimize any potential impacts to the sensitive habitat along the beach and prevent the disturbance of the dune area.

The pipeline construction should not result in any discharges of storm water runoff. Over most of the construction route, soils are slightly permeable and, using the control measures outlined in the Stormwater Control Plan, the erosive effects of any rainwater falling during the course of construction should be minimized.

Throughout the route, trenching depths will usually go to an approximate depth of 9 feet, except at crossings of rivers, canals, railways, and paved roadways. At this depth, the excavations could encounter groundwater.

Wetlands, including jurisdictional wetlands regulated under the Clean Water Act, that would be potentially affected by this pipeline have not been delineated. Three types of aquatic features may be crossed by the pipeline ROWs - resacas, ditches (drainage and irrigation), and the coastal marsh. If these features are determined to be present, they will be crossed by directional drilling or by boring beneath them.

Marine Resources

During previous studies conducted for the US Department of Energy (USDOE) Strategic Petroleum Reserve (SPR) storage cavern brine disposal in the Gulf of Mexico, it has been determined that brine discharge can potentially impact the white shrimp populations in the shallow waters of the Gulf. White shrimp typically inhabit the Gulf of Mexico at depths of 60 feet or less, and can potentially be sensitive to brine discharges. The more resilient brown shrimp inhabits water depths of around 72 feet. The discharge main is proposed to extend approximately 3 miles off the Texas coastline, where the Gulf of Mexico attains a depth of 25 feet.

Exclusion zones for activities around the diffuser area are usually assigned by the local permitting agencies. Buoys and lights are usually placed to properly indicate the location of the diffuser. Exclusion zones can vary in size depending on the effluent discharged and the location of the diffuser, and can range between several yards to 0.5 nautical miles. Therefore, the project will have a potential impact to shrimp fishing and other sailing activities.

The impacts of the installation of the brine disposal line will be dependent on the method of laying the pipe, soil characteristics of the seabed, current, time of year and the potential presence of benthic colonies and seagrass beds along the proposed route. The construction methods of the pipeline will involve jetting of a trench using high pressure sea water to create a trench in which the pipeline into which the pipeline will be lowered. The jetting will suspend sediment in the water column. The turbidity in the water column will be primarily limited to the water column in the immediate area of the construction but may drift, depending on the prevailing ocean current. Mobile species such as shrimp and fish will not be significantly impacted because they can move away from the area. Immobile organisms such as seagrass and filter feeders may be more significantly impacted due to the deposition of the suspended sediment. It is not anticipated that any contaminated sediments would be present that could potentially be liberated into the water column during construction activities.

A sub-sea hazards survey will also be required along the proposed offshore brine disposal main corridor to identify any active or abandoned pipelines that could be impacted during the offshore line construction. This survey will also identify any other sub-sea anomalies that could represent historic shipwrecks or other barriers to construction.

6.7 FINISHED WATER STORAGE AND TRANSMISSION ROUTES

6.7.1 Finished Water Storage

The finished water storage facility will be located in the northern area of the desalination plant close to SH48. A clear well or ground storage tank with a minimum volume of 1.25 million gallons is required by the TCEQ and provides both chlorine contact time and sufficient volume for the finished water pumps to draw from.

6.7.2 Finished Water Pumping and Transmission Systems

The finished water pump station building will have a floor elevation above the 12 feet AMSL. This building will be arranged to provide room for two 25 MGD pumps with pump control valves and space for a future 25 MGD pump and control valve.

The finished water line is sized to transmit 25 MGD about six miles from the desalination plant to the finished water delivery site. The finished water line will be routed along the north side of SH48. The finished water line will be constructed in a 40 feet wide easement immediately north of the state highway ROW. The 40 feet wide easement will provide room for construction and allow for the installation of future finished water lines when the desalination plant is enlarged. The space available allows for two more finished water lines.

The alignment is primarily located within property owned by the Port of Brownsville. There are two areas where the Port of Brownsville is not the owner and easements will be needed from the property owners.

The finished water line will leave the desalination plant site going north, cross under SH48, passing under the highway in a steel casing, and then turn west and lie parallel to SH48. The finished water line will be buried with a minimum of four feet of soil cover for most of the way to the finished water delivery site. There are several points along the alignment where there will be crossings of gas pipelines, drainage ditches, overhead power lines and a road. Additionally, the alignment passes through an area that may have been part of a Union Carbide facility. Most of these features will be better defined in a more detailed preliminary design phase.

A fiber optic cable will also be installed along this easement to provide control capability between the finished water delivery site and the desalination plant site.

6.7.3 Brownsville PUB

The proposed site to deliver water to the PUB is the existing Port of Brownsville Loma Alta Water Treatment Plant located north of SH48 and east of FM 511. This existing water plant was constructed in about 1977 but has not been used. The water plant includes a 1.0 million gallon above ground storage tank.

The total recommended storage at this location is about 3 million gallons based on providing 100 gallons per connection as required by the TCEQ. A second, 2 million-gallon tank will be added at this site. The finished water delivery site will also provide a location to provide treatment or blending to insure the mixing of the water in the distribution system does not result in any precipitates. The existing water plant facilities may be able to provide these services.

The water from these two tanks will be delivered into the Brownsville PUB water system by a high service pump station with a capacity based on the Brownsville PUB share of the water. The Brownsville PUB will provide this high service pump station and one or more transmission lines to connect it to their existing system or new water lines they may need to distribute the water into their system. Additionally, the Brownsville PUB will need to provide an additional 100 gallons per connection in elevated storage tanks or ground storage tanks at other locations. Depending on how this new water fits into the Brownsville PUB system, it may not be necessary to provide additional elevated or ground storage tanks.

6.7.4 Other Local and Regional Entities

The site can accommodate the construction of one or more high service pump stations designed to pump water to the other local participants in the water system. Water transmission lines will be routed from this site to the appropriate point of connection for each entity, as necessary.

6.7.5 Matamoros, Mexico

The desalination plant site can accommodate the construction of a high service pump station designed to pump water to the Matamoros, Mexico, water system. A water transmission line would be routed from this site to a currently unspecified point of connection at the border with Mexico. The city of Matamoros will need to extend the line for connection to its water system at an appropriate location(s). The route for this line must pass through the City of Brownsville and it may be possible to use a portion of the Brownsville PUB water system to bring the water to the border. The basic route would be west along SH48 (East 14th Street) to State Highway 4 to East 18th Street and crossing State Highway 77/83 and south along State Highway 77 (East 18th Street) to the border.

6.7.6 Potential Environmental Impacts

The finished water transmission route will be primarily located in easements located in or adjacent to the ROW for existing roads and utility corridors. Because these areas have been previously developed, the impact to natural resources in the area will be minimal. The potential impacts will be similar to those previously described in **Section 6.6.5** for air emissions, water quality and potential wetland areas affected by construction of the finished water transmission system.

If the finished water transmission line is completed into Matamoros, Mexico, additional approvals may be required from US and Mexican authorities. An application to the US Department of State to request issuance of a "Presidential Permit" will be required. The

Presidential Permit must be granted pursuant to Executive Order 11423 before any pipelines may be constructed across the international boundary. The granting of this permit is subject to the National Environmental Policy Act of 1969 (NEPA). NEPA regulations (40 CFR 1500-1508 and the Department of State's NEPA implementing regulations at 22 CFR 161) require the Department of State to carry out an Environmental Assessment (EA) to determine the need for an Environmental Impact Statement (EIS) or a Finding of No Significant Impact (FONSI). Authorization may also be required from the IBWC.

Table 6-1. Preliminary List of Permits and Approvals		
Regulatory Agency	**Potentially Required Permit/Approval**	**Action Requiring Permit Approval or Review**
Federal		
U.S. Army Corps of Engineers (USACE)	Clean Water Act (CWA), Section 401/404 and Section 10 Permits	Facility construction impacting navigable waters (including dredge and fill operations, wetlands)
U.S. Fish and Wildlife Service (USFWS)	Endangered Species Act Consultation	Review for habitat, endangered and threatened species, including seasonal or migratory
National Marine Fisheries Service (NMFS)	Consultation on Marine Habitat	Essential Fish Habitat for Laguna Madre, GOM waters
U.S. Environmental Protection Agency (EPA)	SPCC Plan	On-site storage of fuel for plant facilities, construction equipment and pipeline ROW activities
EPA	Acid Rain Program Designated Representative	Assignment of a Designated Representative and Alternate for the Acid Rain Program
Advisory Council on Historic Preservation	Section 106 Compliance	Only required if SHPO mandates cultural survey, and if site is found to require mitigation.
EPA	Certification of Continuos Emission Monitoring System (CEMS)	Opération of CEMS System in compliance with Title IV of the Clean Air Act (CAA) – Acid Rain Program for power plant
Federal Aviation Administration	Determination of Obstruction Hazard	Construction of tall structures such as power plant stack
U.S. Department of Energy	Alternative Fuels Capability Certification	Construction and operation of base load power plants
Federal Energy Regulatory Commission	Qualifying Facility (QF) Certification	Cogeneration facilities
Federal Energy Regulatory Commission	Exempt Wholesale Generator (EWG)	Wholesale electricity sales
EPA	Risk Management Plan	Storage or use of hazardous air pollutants (such as ammonia)
State		
Texas Parks and Wildlife Service (TPWS)	Endangered Species Consultation	Facility construction impacting essential habitat for federally protected species
Texas State Historic Preservation Office (TSHPO)	NHPA, Section 106 Compliance	Project activities that will potentially affect cultural and/or historic resources subject to federal protection requirements
Texas General Land Office (GLO)	Coastal Use Permit (CUP), Coastal Zone Management Act	Project activities that will potentially impact navigable waters of the US in coastal zone Texas.
Texas Commission on Environmental Quality (TCEQ)	RCRA Small-Quantity Hazardous Waste Generator Identification Number	On-site presence of hazardous waste in quantities greater than threshold amounts.

Table 6-1. Preliminary List of Permits and Approvals (Continued)

Regulatory Agency	Potentially Required Permit/Approval	Action Requiring Permit Approval or Review
State (Continued)		
TCEQ, Water Permits and Resource Management Division, Wastewater Section	Texas Pollutant Discharge Elimination System (TPDES) Permit	Discharge of wastewater to surface waters
TCEQ, Water Permits and Resource Management Division, Wastewater Section	TPDES - Storm Water General Permit Operational Site	Industrial storm water runoff
TCEQ, Water Permits and Resource Management Division, Wastewater Section	Wastewater Facility Construction Approval	Construction of wastewater treatment equipment (oil separators, etc.)
TCEQ, Water Permits and Resource Management Division, Wastewater Section	TPDES – Construction Storm Water General Permit	Temporary storm water discharge during construction period and until revegetation
TCEQ, Water Permits and Resource Management Division, Wastewater Section	CWA, Section 401 Certification Consultation	Facility construction near rivers, streams, lakes (including deep waters), and wetlands
TCEQ, Air Permits Division	CAA – New Source Review and Title V Operating Permit	Operation of major source of air pollution, including facilities required to have an Acid Rain Permit
TCEQ, Water Permits and Resource Management Division, Wastewater Section	Well Drilling/Installation Permit	Installation of new groundwater wells used for non-public drinking water system
Texas Department of Transportation (TXDOT)	Highway Alteration Permit	Construction of access road connection to state highway
TCEQ, Air Permit Division, Operating Permit Section	Phase II Acid Rain Permit	Operation of an affected source under Phase II of the Acid Rain Program
TCEQ, Water Permits and Resource Management Division, Wastewater Section	Water Quality Certification	Issuance of COE 404 permit
TCEQ, Water Permits and Resource Management Division, Wastewater Section	Wetlands Alteration Review	Construction in a wetlands (in conjunction with USACE 404 permit)

Table 6-1. Preliminary List of Permits and Approvals (Continued)

Regulatory Agency	Potentially Required Permit/Approval	Action Requiring Permit Approval or Review
Cameron County and City of Brownsville, Texas		
County	County Zoning Permits	Contact to determine existence of zoning law and obtain permits, if warranted
TCEQ – County Authorized Agent	On-Site Sewage Facility Permit	Construction and operation of septic systems with inflow less than or equal to 5,000 gpd
County	Noise Requirements	Nuisance standard for noise
County	Conditional Use Permit / Zoning Changes	Construction of facilities not specifically allowed by local zoning ordinances
County Engineer	Building / Occupancy Permits	Construction of plant buildings
County and /or Township Highway Department	Local Road Construction Permit(s)	Construction of access road connection to local read
County Soil and Water Conservation District	Soil Erosion and Sediment Control Plan	General site development

Table 6-2. Species of Concern - Brownsville Desalination Demonstration Project		
*** AMPHIBIANS ***		
Black Spotted Newt (*Notophthalmus meridionalis*) - can be found in wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods; Gulf Coastal Plain south of the San Antonio River		T
Mexican Treefrog (*Smilisca baudinii*) – subtropical region of extreme southern Texas; breeds May-October coinciding with rainfall, eggs laid in temporary rain pools		T
Sheep Frog (*Hypopachus variolosus*) – predominantly grassland and savanna; moist sites in arid areas		T
South Texas Siren - large form (*Siren* sp. 1) – wet or sometimes wet areas, such as arroyos, canals, ditches, or even shallow depressions; aestivates in the ground during dry periods, but does require some moisture to remain; southern Texas south of Balcones Escarpment; breeds February-June		T
White-lipped Frog (*Leptodactylus labialis*) – grasslands, cultivated fields, roadside ditches, and a wide variety of other habitats; often hides under rocks or in burrows under clumps of grass; species requirements incompatible with widespread habitat alteration and pesticide use in south Texas		T
*** BIRDS ***		
American Peregrine Falcon (*Falco peregrinus anatum*) - potential migrant; nests in west Texas	DL	E
Arctic Peregrine Falcon (*Falco peregrinus tundrius*) - potential migrant	DL	T
Audubon's Oriole (*Icterus graduacauda audubonii*) - scrub, mesquite; nests in dense trees, or thickets, usually along water courses		
Brown Pelican (*Pelecanus occidentalis*) – largely coastal and near shore areas, where it roosts on islands and spoil banks	LE	E
Brownsville Common Yellowthroat (*Geothlypis trichas insperata*) - tall grasses and bushes near ponds, marshes, and swamps; breeding April to July		
Cactus Ferruginous Pygmy-owl (*Glaucidium brasilianum cactorum*) - riparian trees, brush, palm, and mesquite thickets; during day also roosts in small caves and recesses on slopes of low hills; breeding April to June		T
Common Black Hawk (*Buteogallus anthracinus*) - cottonwood-lined rivers and streams; willow tree groves on the lower Rio Grande floodplain; formerly bred in south Texas		T
Northern Aplomado Falcon (*Falco femoralis septentrionalis*) - open country, especially savanna and open woodland, and sometimes in very barren areas; grassy plains and valleys with scattered mesquite, yucca, and cactus; nests in old stick nests of other bird species	LE	E
Northern Beardless-tyrannulet (*Camptostoma imberbe*) - mesquite woodlands; near Rio Grande frequents cottonwood, willow, elm, and great leadtree; breeding April to July		T
Piping Plover (*Charadrius melodus*) – wintering migrant along the Texas Gulf Coast; beaches and bayside mud or salt flats	LT	T
Reddish Egret (*Egretta rufescens*) – resident of the Texas Gulf Coast; brackish marshes and shallow salt ponds and tidal flats; nests on ground or in trees or bushes, on dry coastal islands in brushy thickets of yucca and prickly pear		T
Rose-throated Becard (*Pachyramphus aglaiae*) - riparian trees, woodlands, open forest, scrub, and mangroves; breeding April to July		T
Sennett's Hooded Oriole (*Icterus cucullatus sennetti*) – often builds nests in and of Spanish moss (*Tillandsia unioides*); feeds on invertebrates, fruit, and nectar; breeding March to August		
Snowy Plover (*Charadrius alexandrinus*) – wintering migrant along the Texas Gulf Coast beaches and bayside mud or salt flats		
SOOTY TERN (*STERNA FUSCATA*) – PREDOMINATELY "ON THE WING"; DOES NOT DIVE, BUT SNATCHES SMALL FISH AND SQUID WITH BILL AS IT FLIES OR HOVERS OVER WATER; BREEDING APRIL-JULY		T

Table 6-2. Species of Concern - Brownsville Desalination Demonstration Project (Continued)		
*** BIRDS (Continued) ***		
Texas Botteri's Sparrow (*Aimophila botterii texana*) – grassland and short-grass plains with scattered bushes or shrubs, sagebrush, mesquite, or yucca; nests on ground of low clump of grasses		T
Tropical Parula (*Parula pitiayuma*) – dense or open woods, undergrowth, brush, and trees along edges of rivers and resacas; breeding April to July		T
White-faced Ibis (*Plegadis chihi*) – prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats		T
White-tailed Hawk (*Buteo albicaudatus*) – near coast it is found on prairies, cordgrass flats, and scrub-live oak; further inland on prairies, mesquite and oak savannas, and mixed savanna-chaparral; breeding March to May		T
Wood Stork (*Mycteria americana*) – forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960		T
Zone-tailed Hawk (*Buteo albonotatus*) – rough, deep, rocky canyons and streamsides in semiarid mesa, hill, and mountain terrain; breeding March to July		T
*** BIRDS-RELATED ***		
Colonial waterbird nesting areas - many rookeries active annually		
Migratory songbird fallout areas - oak mottes and other woods/thickets provide foraging/roosting sites for neotropical migratory songbirds		
*** FISHES ***		
River Goby (*Awaous tajasica*) - clear water with slow to moderate current, sandy or hard bottom, and little or no vegetation; also enters brackish and ocean waters		T
Blackfin Goby (*Gobionellus atripinnis*) – brackish and freshwater coastal streams		T
Opossum Pipefish (*Microphis brachyurus*) – brooding adults found in fresh or low salinity waters and young move or are carried into more saline waters after birth		T
*** INSECTS***		
Smyth's Tiger Beetle (*Cicindela chlorocephala smythi*) - most tiger beetles are active, usually brightly colored, and found in open, sunny areas; adult tiger beetles are predaceous and feed on a variety of small insects; larvae of tiger beetles are also predaceous and live in vertical burrows in soil of dry paths, fields, or sandy beaches		
*** MAMMALS ***		
Coues' Rice Rat (*Oryzomys couesi*) – cattail-bulrush marsh with shallower zone of aquatic grasses near the shoreline; shade trees around the shoreline are important features; prefers salt and freshwater, as well as grassy areas near water; breeds April-August		T
Jaguar (*Panthera onca*) (extirpated) – dense chaparral; no reliable TX sightings since 1952	LE	E
Jaguarundi (*Herpailurus yaguarondi*) – thick brushlands, near water favored; six month gestation, young born twice per year in March and August	LE	E
Ocelot (*Leopardus pardalis*) - dense chaparral thickets; mesquite-thorn scrub and live oak mottes; avoids open areas; breeds and raises young June-November	LE	E
Plains Spotted Skunk (*Spilogale putorius interrupta*) – catholic in habitat; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie		
Southern Yellow Bat (*Lasiurus ega*) – associated with trees, such as palm trees (*Sabal mexicana*) in Brownsville, which provide them with daytime roosts; insectivorous; breeding in late winter		*T*
West Indian Manatee (*Trichechus manatus*) – Gulf and bay system; opportunistic, aquatic herbivore	*LE*	*E*

Table 6-2. Species of Concern - Brownsville Desalination Demonstration Project (Continued)

***** MAMMALS (Continued) *****		
White-nosed Coati (*Nasua narica*) – woodlands, riparian corridors and canyons; most individuals in Texas probably transients from Mexico; diurnal and crepuscular; very sociable; forages on ground & in trees; omnivorous; may be susceptible to hunting, trapping, & pet trade		T
Yuma Myotis Bat (*Myotis yumanensis*) – desert regions; most commonly found in lowland habitats near open water, where forages; roosts in caves, abandoned mine tunnels, and buildings; season of partus is May to early July; usually only one young born to each female		
***** MOLLUSKS *****		
Texas Hornshell (*Popenaias popeii*) – Rio Grande drainage from the Pecos River to the Falcon Breaks	C1	
***** REPTILES *****		
Atlantic Hawksbill Sea Turtle *(Eretmochelys imbricata*) - Gulf and bay system	LE	E
Black-striped Snake (*Coniophanes imperialis*) - extreme south Texas; semi-arid coastal plain, warm, moist micro-habitats and sandy soils; proficient burrower; eggs laid April-June		T
Green Sea Turtle *(Chelonia mydas*) – Gulf and bay system	LT	T
Indigo Snake (*Drymarchon corais*) – thornbush-chaparral woodlands of south Texas, in particular dense riparian corridors; can do well in suburban and irrigated croplands if not molested or indirectly poisoned; requires moist microhabitats, such as rodent burrows, for shelter		T
Keeled Earless Lizard (*Holbrookia propinqua*) - coastal dunes, barrier islands, and other sandy areas; eats insects and likely other small invertebrates; lays clutches of 2-7 eggs March-September (most May-August) in soil/underground		
Kemp's Ridley Sea Turtle *(Lepidochelys kempii*) - Gulf and bay system	LE	E
Leatherback Sea Turtle *(Dermochelys coriacea*) - Gulf and bay system	LE	E
Loggerhead Sea Turtle *(Caretta caretta*) – Gulf and bay system	LT	T
Northern Cat-eyed Snake (*Leptodeira septentrionalis*) - Gulf Coastal Plain south of the Nueces River; thorn brush woodland; dense thickets bordering ponds and streams; semi-arboreal; nocturnal		T
Speckled Racer (*Drymobius margaritiferus*) - extreme south Texas; dense thickets near water, Texas palm groves, riparian woodlands; often in areas with much vegetation litter on ground; breeds April-August		T
Texas Horned Lizard (*Phrynosoma cornutum*) - open arid or semi-arid regions with sparse vegetation; grass, cactus, scattered brush or scrubby trees; burrows into soil, uses rodent burrows, or hides under surface cover		T
Texas Tortoise (*Gopherus berlandieri*) – open scrub woods, arid brush, lomas, grass-cactus association; open brush with grass understory preferred; uses shallow depressions at base of bush or cactus or underground burrow or hides under surface cover		T
***** VASCULAR PLANTS *****		
Bailey's ballmoss (*Tillandsia baileyi*) – epiphytic on various trees and shrubs; flowering February-May		
Green Island echeandia (*Echeandia texensis*) - associated with shrubs or in grassy openings in subtropical thornscrub plant communities on somewhat saline clay on lomas along the Gulf Coast near the mouth of the Rio Grande; known to flower in April, June, and November, and may also flower in other months		
Lila de los Llanos (*Echeandia chandleri*) – grasslands and openings in subtropical woodlands and brush on clay soils; common in windblown saline clay on lomas near mouth of Rio Grande; flowering (May?) September-December; fruiting October-December		

Table 6-2. Species of Concern - Brownsville Desalination Demonstration Project (Continued)		
*** VASCULAR PLANTS (Continued) ***		
Mexican mud-plantain (*Heteranthera mexicana*) - aquatic; ditches and ponds; flowering June-August		
Plains gumweed (*Grindelia oolepis*) – endemic; prairies and grasslands on black clay soils of the Gulf Coastal Bend; may occur along railroad rights-of-way and in urban areas; flowering May-December		
Runyon's cory cactus (*Coryphantha macromeris* var. *runyonii*) - endemic; low hills and flats on gravelly soils in Tamaulipan shrub communities along the Rio Grande		
Runyon's water willow (*Justicia runyonii*) - calcareous silt loam, silty clay, or clay in openings in subtropical woodlands on active or former floodplains; flowering (July-) September-November		
Shinner's rocket (*Thelypodiopsis shinnersii*) - mostly found along margins of Tamaulipan thornscrub on clay soils of the Rio Grande Delta, including lomas near the mouths of rivers; flowers mostly March and April		
South Texas ambrosia (*Ambrosia cheiranthifolia*) - open prairies and various shrublands on deep clay soils; flowering July-November	LE	E
St. Joseph's staff (*Manfreda longiflora*) – endemic; various soils (clays and loams with various concentrations of salt, caliche, sand, and gravel) in openings or amongst shrubs in thorny shrublands; on Catahoula and Frio formations, and also on Rio Grande floodplain alluvial deposits; flowering in September		
Star cactus (*Astrophytum asterias*) – gravelly saline clays or loams over the Catahoula and Frio formations, on gentle slopes and flats in grasslands or shrublands; flowering in May	LE	E
Texas ayenia (*Ayenia limitaris*) – woodlands on alluvial deposits on floodplains and terraces along the Rio Grande; flowering throughout the year with sufficient rainfall	LE	E
Vasey's adelia (*Adelia vaseyi*) – subtropical woodlands in Lower Rio Grande Valley; flowering January-June		

LE,LT = Federally Listed Endangered/Threatened.
PE,PT = Federally Proposed Endangered/Threatened.
E/SA,T/SA = Federally Endangered/Threatened by Similarity of Appearance.
C1 = Federal Candidate, Category 1; information supports proposing to list as endangered/threatened.
DL,PDL = Federally Delisted/Proposed Delisted.
E,T = State Endangered/Threatened.
"blank" = Rare, but with no regulatory listing status.

Species appearing on these lists do not all share the same probability of occurrence. Some species are migrants or wintering residents only, or may be historic or considered extirpated.

7.0 OPINION OF PROBABLE COSTS

This section of the report provides a summary of estimated costs associated with the implementation of the Brownsville Desalination Demonstration Project. The estimated costs include both capital investment to initially construct the project, and recurring operation & maintenance (O&M) expenses associated with the project throughout its estimated life. Estimates for ancillary expenses that are normally associated with final project implementation are also summarized and presented below. In addition, cost implications as a consequence of the elimination of the co-located power plant are also addressed in this section. The cost estimates provided here are used as the basis for the subsequent financial analysis of the project, which is presented in **Section 8**.

7.1 ESTIMATED CAPITAL COSTS

A complete capital cost estimate was developed for construction of the desalination plant including the various components previously described in **Section 4.** Various sources of information were used in developing this cost estimate:

- **Budgetary Quotes** – For all of the major equipment components needed to support the conceptual configuration of the desalination plant, one or more quotes were solicited and obtained from qualified equipment vendors. Components for which budgetary quotes were obtained include, but are not limited to, the membrane systems (both seawater reverse osmosis [SWRO] and brackish water reverse osmosis [BWRO]), pretreatment system components such as the ballasted flocculation/clarification [BFC] system, the filter system, large capacity mechanical units, and pre-stressed tanks. Since all quotes were budgetary in nature, they do not include any special discounts to contractors or other reductions that may otherwise be offered through special contracting and/or procurement methods. As such, quotes for the primary mechanical components are current (in 2004 United States [US] dollars) and valid.

- **Current Unit Cost Data** – Unit cost data are continually compiled, updated, and managed by collecting construction cost data available for similar civil works projects throughout the US. Average unit cost data were used to develop cost estimates for many aspects of the project including but not limited to typical site development work; civil works features such as clearing and grubbing the land; cut-and-fill operations; final grading; paving; major structures including their foundational elements such as buildings and the seawall along the Brownsville Ship Channel; and mechanical pipelines for all process and non-process related needs of the project, among others.

- **Contractor Quotes for Special Construction** – For special types of construction where typical and current unit cost data are not available, quotes were requested from qualified contractors who have performed the type of work required for this project. For example, quotes were solicited for the directional bore (drilling) of the brine transmission main under the Brownsville Ship Channel as well as at the beach head of the Gulf of Mexico.

The probable capital cost to construct the Brownsville Desalination Demonstration Project was developed based on specific components of the project as previously described in **Section 4**. Estimated capital costs were segregated into three principal components, which include the desalination facility itself, the brine disposal system, and the finished water transmission system. **Table 7-1** provides a summary of the estimated capital costs for these components. **Figure 7-1** is a pie chart that depicts the distribution of the capital costs as a percent of the estimated cost associated with the construction of the desalination plant.

Table 7-1. Estimated Capital Costs for Brownsville Desalination Demonstration Facility

Item	Description	Estimated Cost	% of Total
Desalination Plant			
1	Site Development	$9,244,000	11.5%
2	Seawater Intake System	$4,984,000	6.2%
3	Pretreatment System	$10,619,000	13.2%
4	Primary Treatment System	$32,699,000	40.7%
5	Post-Treatment System	$3,645,000	4.5%
6	Solids Handling System	$3,921,000	4.9%
7	Yard Piping	$2,000,000	2.5%
8	Support Facilities	$7,702,000	9.6%
9	Electrical and Instrumentation	$5,500,000	6.8%
10	**Subtotal**	$80,314,000	100.0%
11	Effective Contingency	$9,853,000	12.3%
12	**Total Estimated Capital Cost for Plant**	**$90,167,000**	69.4%
Brine Disposal System			
13	Brine Transfer Pump Station	$1,250,000	4.5%
14	Brine Disposal Main (Shipping Channel Directional Bore Installation)	$2,310,000	8.3%
15	Brine Disposal Main (Open Cut Land Installation)	$10,179,000	36.6%
16	Brine Disposal Main (Beach Head Directional Bore Installation)	$4,620,000	16.6%
17	Brine Disposal Main (Ocean Installation)	$6,864,000	24.7%
18	Diffuser Array	$2,000,000	7.2%
19	Easement Acquisition	$580,000	2.1%
20	**Subtotal**	**$27,803,000**	100%
21	Contingency	2,780,000	10%
22	**Total Estimated Capital Cost for Brine System**	**$30,503,000**	23.5%
Finished Water Transmission System			
23	Finished Water Pump Station	$2,100,000	25.0%
24	Finished Water Transmission System	$4,743,000	56.5%
25	Finished Water Storage Tank(s)	$1,250,000	14.9%
26	Easement Acquisition	$300,000	3.6%

Table 7-1. Estimated Capital Costs for Brownsville Desalination Demonstration Facility			
Item	**Description**	**Estimated Cost**	**% of Total**
27	**Subtotal**	**$8,393,000**	**100%**
28	Effective Contingency	$839,000	10%
29	**Total Estimated Capital Cost Finished Water System**	**$9,652,000**	**7.3%**
30	**Grand Total for Demonstration Project**	**$131,792,000**	**100%**

For any major equipment component for which a budgetary quote was obtained from a qualified vendor, only a marginal contingency factor of 5 percent was applied since the budgetary value should already be conservative in nature. A 25 percent contingency factor was applied to the capital cost estimates for the remaining project components to cover any uncertainties or changed conditions that may occur between the conceptual and final configurations of the project. The overall contingency resulting from using the two different contingency factors resulted in a blended contingency in the amount indicated in the table above.

7.2 ASSOCIATED IMPLEMENTATION EXPENSES

In addition to the capital costs needed for the construction of the Brownsville Desalination Demonstration Project, there will be specific tasks and associated costs to implement the project. A brief description of the implementation tasks associated with the project follows.

- **Special Studies** – Various studies will be required to support project implementation. These studies will include, but not limited to, those listed below. Of particular importance will be the need to conduct a competent pilot study of the overall water treatment process conceptually proposed in this report. The pilot study should be properly planned and executed to ensure that all unit treatment processes and operations are efficiently and cost-effectively designed for the project. In addition, the following various environmental studies, particularly those associated with the brine disposal system, will be needed to properly assess potential environmental impacts associated with the project:

  - Water Supply and Delivery Study,
  - Open Channel Hydraulic Analysis,
  - Benthic Studies of Local Ecosystems,
  - Geologic Surveys and Studies,
  - Water Quality Testing,
  - Bench-Scale Treatment Studies,
  - Pilot-Scale Treatment Studies and
  - Brine Dispersion Modeling.

- **Engineering Design** – Detailed engineering design services will be required to confirm the conceptual configuration and associated components of the desalination facility as described herein. Results from the various special studies described above, especially those obtained from the bench- and pilot-scale studies, would be used to refine the conceptual design of the plant to yield an optimal configuration, while reducing and/or minimizing capital and routine operational expenses as much as possible. From the engineering design phase, detailed construction documents, including plans and technical specifications, would be produced and used to bid the project to interested contractors if a conventional design-bid-build process is selected for final project implementation.

Alternatively, engineering design drawings of sufficient detail along with material and equipment specifications would be prepared to support alternative means of delivery for the project such as design-build or design-build-operate.

- **NEPA Permitting** – To secure regulatory approval from the federal, state, and local levels, a substantial work effort is anticipated to study and prepare sufficient documentation to meet the requirements associated with the National Environmental Policy Act (NEPA). An Environmental Impact Statement (EIS) would be prepared to address potential environmental impacts associated with project implementation. Additional documentation would be prepared as necessary to support other permits needed to secure approval from all applicable regulatory agencies and/or affected stakeholders.

- **Construction Support Services** – Technical and administrative services would be provided during the construction phase to ensure that the project is properly constructed, while remaining within budget and on schedule. Various personnel would be assigned construction oversight services including engineers qualified in civil, environmental, structural, geotechnical, electrical, and instrumentation work. In addition, one or more resident engineers would be present at the construction site throughout the entire construction phase to maintain proper communications, inspections of the work, and to address any conflicts and/or changed field conditions as they arise. During construction the resident engineer(s) would continually document the progress of construction and note any and all deviations from plan.

- **Startup Services** – Once the plant has been constructed, a series of operational and functional tests would be conducted to confirm proper operation of individual plant components as well as the initial operational efficiencies of the various unit treatment processes and operations. In addition, various support systems and their associated components, such as the Process Control and Implementation System (PCIS), would be tested to confirm proper installation and operation. Due to the relative complexity of this project, it is anticipated that an extended period of time (i.e., four to six months) would be needed to properly test all project components and bring the facility up to full-scale water production capacity.

The costs for the various implementation tasks described above were estimated based on a percentage of the total estimated capital cost of the project. **Table 7-2** summarizes the approximate costs estimated for the implementation tasks.

Table 7-2. Summary of Project Implementation Tasks and Associated Expenses

Item	Description	Estimated Cost	% of Capital Cost
Desalination Plant			
1	Special Studies	$2,705,000	3%
2	Engineering Design	$4,508,000	5%
3	NEPA Permitting	$1,803,000	2%
4	Construction Support Services	$3,607,000	4%

Table 7-2. Summary of Project Implementation Tasks and Associated Expenses			
Item	**Description**	**Estimated Cost**	**% of Capital Cost**
5	Startup Support Services	$902,000	1%
6	**Subtotal Associated Implementation Expenses**	**$13,525,000**	**15%**
Brine Disposal System			
7	Engineering Design	$1,529,000	5%
8	Permitting	$306,000	1%
9	Construction Support Services	$1,224,000	4%
10	**Subtotal Associated Implementation Expenses**	**$3,059,000**	**10%**
Finished Water Transmission System			
11	Engineering Design	$462,000	5%
12	Permitting	$92,000	1%
13	Construction Support Services	$369,000	4%
14	**Subtotal Associated Implementation Expenses**	**$923,000**	**10%**
15	**Legal/Bond Services**	**$3,899,000**	**3%**
16	**Grand Total Implementation Expenses**	**$21,406,000**	**16%**

Note: Implementation costs for each project component (desalination plant, brine disposal system, finished water transmission system) are based on the total estimated capital cost of the component as summarized in ***Table 7-1****.*

7.3 ESTIMATED ANNUAL OPERATION & MAINTENANCE COSTS

Annual O&M expenses for the project were estimated using feedback from equipment vendors and from operators at similar water treatment plants, supplemented with sound engineering judgment and experience. Primary operational expenses include labor to operate and maintain the plant; energy to run pumps, blowers, and other mechanical equipment; and chemicals needed to properly condition the water supply. Primary maintenance costs include labor and materials needed to periodically rehabilitate specific components in the plant, such as pumps, gear drives, etc. General and recurring annual O&M expenses were summarized under the following three categories:

1. **Labor** – All costs associated with a particular employee were taken into account including salary, fringe benefits, payroll taxes, etc. Labor rates established by the **Brownsville Public Utility Board (PUB)** were used as the cost basis for the various types and levels of staff recommended for the operation and maintenance of this project. Due to the relative size and complexity of the desalination facility, it is assumed that it would be staffed 24 hours/day, 7 days/week. Any subcontracted work that may be needed to supplement the fixed, labor pool for the project were taken into account and added to the labor cost category (e.g., sludge hauling, chemical deliveries, electrical).

2. **Power** –To accurately estimate power costs, each principal process and non-process component identified through the conceptual design of the project was inventoried along with its power ratings and/or amperage draws. Since it was assumed that the desalination facility would consistently produce 25 million gallons per day (MGD), appropriate run

times were selected for the individual equipment components. Thus, a 24 hours/day, 7 days/week operating schedule was used for all primary water treatment components. For process-related plant components that would not require full-time operation (i.e., solids dewatering), a suitable run time was selected for those components. Per the **Brownsville PUB**, which establishes electrical rates for the local area, a unit power cost of $0.035 per kilowatt-hour (kW) was used to estimate annual power costs.

3. **Chemicals** – Various chemical stocks will be needed to support the normal operations of the desalination facility. Chemical types and use rates were estimated based on the conceptual configuration and design of the facility that was developed and described in **Section 4**. Typical unit cost data for the types of chemicals needed for this facility were used as the basis for this cost component. Quantities of chemicals were estimated based on the total process flow streams associated with the facility, from which total chemical costs were derived, inclusive of delivery fees as applicable.

4. **Site Lease** – The site proposed for the desalination facility is located along the Brownsville Ship Channel approximately 11 miles northeast of Brownsville. The site is bounded on the north by State Highway 48 (SH48), to the south by the Brownsville Ship Channel, and to the west by an existing fishing harbor. This property is owned and controlled by the Port of Brownsville. A lease cost of $3600 per acre per year was used in the analysis.

As with the capital costs, a 10 percent contingency factor was applied to the total electrical (excluding the electrical load associated with the high pressure SWRO pumps) and chemical costs estimated for these O&M components to cover any uncertainties or changed conditions that may occur between the conceptual and final configurations of the project. Since proper staffing can be better quantified and justified for the proposed facility, no contingency factor on labor was included in the cost estimate. **Table 7-3** summarizes the estimated costs associated with the annual operation and maintenance of the Brownsville Desalination Demonstration Project.

Table 7-3. Estimated Annual O&M Expenses for Brownsville Desalination Demonstration Facility

Item	Description	Estimated Cost	% of Total
Desalination Plant			
1	Burdened Labor and Subcontracted Services	$1,270,000	16.1%
2	Power	$4,278,000	54.1%
3	Chemicals	$1,866,000	23.6%
4	Site Lease	$179,000	2.3%
5	**Subtotal Estimated Annual O&M Expenses**	**$7,898,000**	**96.1%**
Brine Disposal System			
6	Burdened Labor (Includes Different Array)	$87,000	1.1%
7	Power	$141,000	1.8%
8	**Subtotal Estimated Annual O&M Expenses**	**$228,000**	**2.9%**
Finished Water Transmission System			
9	Burdened Labor	$37,000	0.5%
10	Power	$40,000	0.5%

Table 7-3. Estimated Annual O&M Expenses for Brownsville Desalination Demonstration Facility			
Item	**Description**	**Estimated Cost**	**% of Total**
11	**Subtotal Estimated Annual O&M Expenses**	**$77,000**	**1.0%**
12	**Total Estimated Annual O&M Expenses**	**$7,898,000**	**100%**

7.4 ADDITIONAL SPECIAL MAINTENANCE COSTS

In addition to the recurring annual O&M expenses every year, other maintenance events would occur during the lifetime of the project. These events include the replacement or major refurbishment of the various mechanical systems associated with the project. For instance, one of the most significant maintenance events that will occur and must be taken into account is the replacement of the membrane elements approximately once every five years. This event will cost millions of dollars to address during the life of the project, and its cost impact cannot be excluded from the overall financial analysis, the results of which are presented in **Section 8**. In addition, maintenance events for other equipment components such as pumps, blowers, and process unit refurbishment are also taken into account and inventoried.

Table 7-4 summarizes each special maintenance event anticipated for the Brownsville Desalination Demonstration Project. For each special maintenance event, an estimated frequency is listed along with the estimated cost associated with the event. For instance, the water intake screens will likely need to be replaced in about 15 years due to their constant exposure to the corrosive seawater environment. Membrane replacement events are anticipated once every five years throughout the life of the project.

Table 7-4. Estimated Expenses for Special Maintenance Events			
Item	**Description**	**Frequency (Years)**	**Estimated Costs**
Seawater Intake System			
1	Replace Water Intake Screens	15	$400,000
2	Refurbish Seawater Transfer Pumps	10	$75,000
3	Dredge Intake Channels	5	$150,000
Pretreatment System			
4	Replace Filter Media	10	$50,000
5	Replace Filter Underdrain System and Troughs	15	$1,000,000
6	Refurbish BFC System	15	$1,000,000
7	Refurbish Clearwell Transfer Pumps	10	$150,000
Primary Treatment System			
8	Replace SWRO/BWRO Membranes	5	$6,500,000
9	Replace Cartridge Filters	0.25	$20,000
10	Refurbish SWRO Feed Pumps	10	$525,000
11	Refurbish BWRO Feed Pumps	10	$75,000
Post-Treatment System			

Table 7-4. Estimated Expenses for Special Maintenance Events			
Item	**Description**	**Frequency (Years)**	**Estimated Costs**
12	Refurbish Pebble Lime System	10	$100,000
13	Refurbish Sodium Hypochlorite Rectifiers	10	$100,000
14	Tank Cleaning (3 Tanks)	5	$60,000
Solids Handling System			
15	Filter Press Belt Replacement	1	$8,000
16	Refurbish Belt Filter Presses	10	$200,000
17	Refurbish Lamella-Type Thickeners	15	$750,000
18	Refurbish Thickener Feed Pumps	10	$50,000
19	Refurbish Solids Dewatering Feed Pumps	10	$125,000
Brine Disposal System			
20	Refurbish Brine Transfer Pumps	10	$100,000
Finished Water Transmission System			
21	Refurbish Furnished Water Pumps	10	$100,000
20	Tank Maintenance and Cleaning	5	$25,000

7.5 TOTAL PROJECT COSTS

Table 7-5 Summarizes the capital costs and annual operations costs for all four phases of the Desalination Project in 2004 dollars. The excess capacity costs for the intake structures, brine disposal system and potable transmission occur in Phases I and III. It is anticipated that these items will be sized for 50 MGD.

In Phase II, the direct delivery waterline from Brownsville to Harlingen is constructed and includes excess capacity costs for Phases III and IV. In Phase III, the direct delivery waterline from Harlingen to Pharr is constructed and includes excess capacity costs for Phase IV. Phase IV includes the construction of the direct delivery waterline to McAllen.

Table 7-5 Total Project Costs				
	PHASE I 25 MGD	**PHASE II 50 MGD**	**PHASE III 75 MGD**	**PHASE IV 100 MGD**
Desalination Plant -		-	-	-
Site Development	$9,244,000	$5,830,000	$7,346,000	$7,346,000
Seawater Intake Structure	$4,984,000	$2,439,000	$3,562,000	$3,562,000
Pretreatment System	$10,619,000	$10,619,000	$10,619,000	$10,619,000
Primary Treatment system	$32,699,000	$32,699,000	$32,699,000	$32,699,000
Post Treatment System	$3,645,000	$3,645,000	$3,645,000	$3,645,000
Solids Handling System	$3,921,000	$3,921,000	$3,921,000	$3,921,000
Yard Piping	$2,000,000	$2,000,000	$2,000,000	$2,000,000
Support Facilities	$7,702,000	$6,910,000	$6,910,000	$6,494,000
Electrical and Instrumentation	$5,500,000	$5,000,000	$5,500,000	$5,000,000
Subtotal	**$80,314,000**	**$73,063,000**	**$76,202,000**	**$75,286,000**

Table 7-5 Total Project Costs

	PHASE I 25 MGD	PHASE II 50 MGD	PHASE III 75 MGD	PHASE IV 100 MGD
Effective Contingency (12.3%)	$9,853,000	$8,963,000	$9,349,000	$9,236,000
Total Estimated Capital Cost	**$90,167,000**	**$82,026,000**	**$85,551,000**	**$84,522,000**
Eligible Intake Excess Capacity (SPP) [a]	***$1,138,000***			
Concentrate Discharge System		-	-	-
Concentrate Transfer Pump Station	$1,250,000	$350,000	$1,250,000	$350,000
Concentrate Discharge - Dir. Drill Main Channel Crossing	$2,310,000		$2,310,000	
Concentrate Discharge Main - Open Cut	$10,179,000		$10,179,000	
Concentrate Discharge - Dir. Drill Dunes & Gulf	$4,620,000		$4,620,000	
Concentrate Discharge Main - Offshore Installation	$6,864,000		$6,864,000	
Diffuser Array	$2,000,000		$2,000,000	
Easement Aquisition ($10,000/acre)	$580,000			
Subtotal	**$27,803,000**	**$350,000**	**$27,223,000**	**$350,000**
Effective Contingency (10%)	$2,780,000	$35,000	$2,722,000	$35,000
Total Estimated Capital Cost	**$30,583,000**	**$385,000**	**$29,945,000**	**$385,000**
Eligible Concentrate Discharge Main Excess Capacity (SPP) [a]	***$7,411,000***		***$7,411,000***	
Finished Water Transmission System		-	-	-
Plant Finished Water Pump Station	$2,100,000	$500,000	$2,100,000	$500,000
Finished Water Transmission Pipeline	$4,743,000		$4,743,000	
Finished Water Storage Tank(s)	$1,250,000			$1,250,000
Direct Transmission Pump Stations		$8,000,000	$7,500,000	
Direct Delivery Transmission Lines		$26,170,000	$26,339,000	$2,363,000
Easement Aquisition ($10,000/acre)	$300,000	$470,000	$360,000	$70,000
Subtotal	**$8,393,000**	**$35,140,000**	**$41,042,000**	**$4,183,000**
Effective Contingency (10%)	$839,000	$3,514,000	$4,104,000	$418,000
Total Estimated Capital Cost	**$9,232,000**	**$38,654,000**	**$45,146,000**	**$4,601,000**
Eligible Transmission Main(s) Excess Capacity (SPP) [a]	***$632,000***	***$7,406,000***	***$6,485,000***	
Project Implementation Costs		-	-	-
Legal/Bond Services (3%)	$3,899,000	$3,632,000	$4,819,000	$2,685,000
Special Studies	$2,705,000			
Engineering Design	$6,499,000	$5,876,000	$7,691,000	$4,453,000
NEPA Permitting	$2,201,000	$100,000	$100,000	$100,000
Construction Support Services	$5,200,000	$5,000,000	$5,000,000	$5,000,000
Startup Support Services	$902,000	$500,000	$500,000	$500,000
Total Estimated Implementation Cost	**$21,406,000**	**$11,476,000**	**$13,291,000**	**$10,053,000**
Total Capital Costs	**$151,388,000**	**$132,541,000**	**$173,933,000**	**$99,561,000**
Total Eligible Excess Capacity (SPP) [a]	***$9,181,000***	***$7,406,000***	***$13,896,000***	

Table 7-5 Total Project Costs

	PHASE I 25 MGD	PHASE II 50 MGD	PHASE III 75 MGD	PHASE IV 100 MGD
Annual O&M Costs -		-	-	-
Labor/Subcontract Services	$1,394,000	$1,869,000	$2,397,000	$2,739,000
Power	$4,459,000	$10,593,000	$16,192,000	$20,833,000
Chemicals	$1,866,000	$3,732,000	$5,598,000	$7,464,000
Site Lease ($3,600/acre)	179,000	292,000	419,000	541,000
Total Annual O&M Expenses	**$7,898,000**	**$16,986,000**	**$24,606,000**	**$31,577,000**
Annual Reserve for Maintenace Events		-	-	-
Replace Water Intake Screens	$26,667	$53,333	$80,000	$106,667
Refurbish Seawater Transfer Pumps	$7,500	$15,000	$22,500	$30,000
Dredge Intake Channels	$30,000	$60,000	$90,000	$120,000
Replace Filter Media	$5,000	$10,000	$15,000	$20,000
Replace Filter Underdrain System	$66,667	$133,333	$200,000	$266,667
Refurbish BFC System	$66,667	$133,333	$200,000	$266,667
Refurbish Clearwell Transfer Pumps	$15,000	$30,000	$45,000	$60,000
Replace SWRO/BWRO Membranes	$1,300,000	$2,600,000	$3,900,000	$5,200,000
Replace Cartridge Filters	$80,000	$160,000	$240,000	$320,000
Refurbish SWRO Feed Pumps	$52,500	$105,000	$157,500	$210,000
Refurbish BWRO Feed Pumps	$7,500	$15,000	$22,500	$30,000
Refurbish Pebble Lime System	$10,000	$20,000	$30,000	$40,000
Refurbish Sodium Hypochlorite Rectifiers	$10,000	$20,000	$30,000	$40,000
Tank Cleaning	$12,000	$24,000	$36,000	$48,000
Filter Press Belt Replacement	$8,000	$16,000	$24,000	$32,000
Refurbish Belt Filter Presses	$20,000	$40,000	$60,000	$80,000
Refurbish Lamella-Type Thickeners	$50,000	$100,000	$150,000	$200,000
Refurbish Thickener Feed Pumps	$5,000	$10,000	$15,000	$20,000
Refurbish Solids Dewatering Pumps	$12,500	$25,000	$37,500	$50,000
Refurbish Concentrate Transfer Pumps	$10,000	$20,000	$30,000	$40,000
Refurbish Plant Finished Water Pumps	$10,000	$20,000	$30,000	$40,000
Refurbish Potable Transmission Pumps	$10,000	$20,000	$30,000	$40,000
Refurbish Potable Direct Delivery Pumps		$30,000	$60,000	$60,000
Tank Maintenance and Cleaning	$5,000	$5,000	$5,000	$10,000
Total Annual Reserve for Maintenace Events	**$1,820,000**	**$3,665,000**	**$5,510,000**	**$7,330,000**
Total Annual Operating Costs	**$9,718,000**	**$20,151,000**	**$30,116,000**	**$38,907,000**

[a] *Assumes Excess Capacity will be subsidized 80% by the State Participation Program (SPP)*

7.6 COST IMPACTS DUE TO ELIMINATION OF CO-LOCATED POWER PLANT

In the event that implementation plans for the co-located power plant are delayed or cancelled altogether, some of the capital and annual O&M costs estimated and presented above would be affected. Two of the issues that were presented in **Section 4.4** would potentially impact the capital or annual O&M costs estimated and presented above. These issues and associated cost impacts are listed and addressed below.

7.6.1 Pretreatment Changes

Without a power plant available to provide an inexpensive source of heat energy, feedwater to the SWRO system could not be cost-effectively preheated. The capital and additional annual O&M costs associated with establishing a dedicated heating system for the desalination plant would not result in tangible savings, and would in turn cause a cost increase in the overall project. Thus, without a co-located power plant, the feedwater to the SWRO system would not be preheated.
Based on initial estimates, the elimination of the preheating system would reduce the initial capital cost of the desalination plant by an estimated $924,000. However, since additional pumping energy would be required to maintain a similar flux rate through the SWRO membranes, annual energy costs would increase by approximately $385,000.

7.6.2 Redundant Power Supply

Another potential cost impact associated with the elimination or unavailability of the co-located power plant would be the need for a secondary or redundant power supply for the desalination plant. There are various options that can be explored and further considered to address this critical issue. A significant criterion associated with this issue is the need to provide complete or partial power redundancy. Possible options that could be explored to address this particular criterion follow.

Complete Power Redundancy

One possible solution would be to provide two connections to the local electrical grid, which would be physically separated from one another. This solution would require the siting of two dedicated electrical substations at or near the site for the desalination plant. The estimated cost difference associated with providing two dedicated power feeds from the local electrical grid would need to be estimated.

If a completely separate source of power is required to address concerns related to the potential loss of power to the entire local electrical grid, a dedicated electrical transmission main from another electrical grid to the plant site would be required. This latter option would likely be expensive and probably cost-prohibitive due to the relative distance required to reach another grid. It has not been confirmed to date where another electrical grid is located relative to the site, for the purposes of preparing a cost estimate for this particular option.

Partial Power Redundancy

If power were lost from the local electrical grid, a system of on-site emergency generators could be considered to provide partial power for the desalination facility. The ability to permit the project without providing complete and full power redundancy for the desalination plant may be impeded or not possible, depending on the applicability of current laws and regulations related to this type of facility. Typically, full power redundancy is required for other water treatment facilities; however, due to the significant electrical consumption associated with a desalination plant, it is possible that a variance from normal regulations pertaining to 100 percent power redundancy could be sought and obtained.

If partial power redundancy were supported by the law through special or new legislation promulgated specifically for desalination facilities, the amount of redundant power for the desalination plant would have to be established. Two possible options could be further evaluated to provide partial backup power. First, a set of emergency generators could be sized and sited to provide backup power to one of the SWRO trains and other process equipment needed to collect and route seawater through the plant, as well as finished water produced by the one SWRO train. A second option would be to provide only a nominal amount of power to the site, which would be used for lighting; to maintain operation of the PCIS system so that the desalination plant could be quickly and efficiently restarted once main power becomes available; and to maintain security of the site. The difference in these two options could be significant. Preliminary estimates for emergency power generation for the first option results in a 4,000 kW system of generators and associated fuel storage system. To supply only a nominal amount of power associated with the second option would reduce the size of the emergency generators to approximately 250 kW. Based on these initial power ratings estimated for the emergency generation systems, capital costs associated with these options would need to be estimated.

7.7 SUMMARY OF COSTS ASSOCIATED WITH POWER PLANT

Table 7-6 summarizes the costs associated with the coal-fired, 110MW power plant as described previously in **Section 5.0**.

Table 7-6 Estimate Costs for the Brownsville 110 MW Power Generation Plant

Capital Construction Costs			
Item	**Description**	**Total Cost**	**% of Total Capital Construction Costs**
1	Site Work	$10,000,000	10.0%
2	Foundations	$8,000,000	8.0%
3	Buildings	$2,500,000	2.5%
4	Circulating Fluidized Bed Boiler - 650 K#/HR	$20,000,000	20.0%
5	Emmission Controls	$5,000,000	5.0%

Table 7-6 Estimate Costs for the Brownsville 110 MW Power Generation Plant

Capital Construction Costs			
Item	**Description**	**Total Cost**	**% of Total Capital Construction Costs**
6	Steam Turbine Generator - 110 MW	$15,000,000	15.0%
7	Condenser	$2,000,000	2.0%
8	Feedwater System	$6,000,000	6.0%
9	Make-Up Water System	$2,000,000	2.0%
10	Cooling Tower System - 510 MM BTU/HR	$4,500,000	4.5%
11	Fuel System	$250,000	0.3%
12	Service / Instrument Air	$50,000	0.1%
13	Unloading Dock	$3,000,000	3.0%
14	Material Handling	$12,000,000	12.0%
15	Portable Equipment	$1,200,000	1.2%
16	Emergency Generator - 500 Kw	$100,000	0.1%
17	Electrical Equipment & Switchgear	$6,000,000	6.0%
18	Control System	$2,400,000	2.4%
19	**Subtotal**	$100,000,000	100.0%
20	**Contingency**	$10,000,000	10.0%
21	**Total Capital Construction Cost**	**$110,000,000**	-----
1	Special Studies	$3,300,000	3%
2	Engineering Design	$6,600,000	6%
3	Permitting	$2,200,000	2%
4	Construction Support Services	$5,500,000	5%
5	Startup Support Services	$2,200,000	2%
6	**Total Project Implementation Cost**	**$19,800,000**	18%
7	**Total Power Generating Plant**	**$129,800,000**	-----

8.0 FINANCIAL ANALYSIS

Implementing any new technology provides both opportunities and challenges. The desalination demonstration project is no exception. The opportunity is clear: a viable supply of new water that is a cost-effective alternative to other regional supply options. The challenge is that like all viable new supplies, the cost will exceed the average cost the region *currently* pays; though not what the region *must* pay if it wants to expand the supply available to it.

This chapter integrates the capital and operating costs of the project and provides total and annual costs for the four conceptual phases of the regional project. The methodology used for calculating and presenting costs is that which was agreed to by the project participants and TWDB staff in the April 16, 2004 work session and with sound methodology as is traditionally used for financial analysis in Texas. Project costs are also represented in the context of rate impacts for the communities for which service is represented. Financial analysis is coupled with a summary of available funding sources that extend from utility rate revenues to state and bi-national loans, grants and payment deferral.

Like all of the desalination demonstration projects (as described by the project owners) this project will, in addition to the revenues provided by local ratepayers, likely require an external funding source to achieve local financial viability. The exact amounts, timing and overall manner of that support cannot be precisely ascertained until further analysis is done to optimize the project's configuration, production levels and timing of phasing. Firm agreements with regional partners (which can only be made after initial financial information is provided) will also drive costs and these other factors. Some preliminary judgments have been made about local financial support and represented in the rate analysis included in this chapter. These numbers should be viewed as preliminary for the reasons noted above.

8.1 POTENTIAL FUNDING SOURCES AND ELIGIBILITY ASSESSMENT

8.1.1 Bi-national Sources

The primary bi-national funding mechanism is a joint decision-making apparatus, which links the Border Environment Cooperation Commission (BECC) and the North American Development Bank (NADB, also referred to as NADBank).

Border Environment Cooperation Commission

The role of the BECC is primarily to certify projects for funding by the NADB. BECC funding is limited to relatively small amounts for technical assistance. The BECC certification function evaluates projects on technical and financial aspects. Considerations include "appropriate, proven, and non-polluting technology, with low operation and maintenance costs; and, a viable financial structure with limited impacts and a balance in sources of funding" (http://www.cocef.org/pprocess.htm).

The BECC's financial assistance is minor, related to technical assistance and not relevant to the construction financing aspects of this project, but may be considered for special studies (**Section 7.2**).

North American Development Bank

The NADB was established to finance environmentally-related projects along the United States (US)-Mexican border. This definition includes water supply projects. While the NADB offers half dozen or so financing programs, the ones most directly applicable to the desalination project are the low interest component of the Loan and Guarantee Program and the Border Environment Infrastructure Fund (BEIF). The Seawater Desalination project would appear to qualify for eligibility under both programs.

Loan and Guarantee Program is described by the NADB in the following manner:

> *"The NADB loan program provides direct financing for infrastructure projects with a demonstrable and reasonable assurance of repayment when private sector financing is not available on reasonable terms and conditions on a timely basis. In other words, NADB loans are intended to fill financing gaps not covered by other funding sources"* (http://www.nadbank.org/english/program_service/Loan/Loan2_main.htm).

The cost-effectiveness for the Brownsville Public Utility Board (PUB) project of the NADB's Loan and Guarantee Program funding is limited by the interest rates on loans provided under this program. Even its best rates are roughly comparable to those that could be received by the PUB if it went to market on its own, and its low interest financing is limited to $4 million. The likely subsidy needed for the desalination project to be cost-effective will be significantly higher than that amount—and it will need to be in the form of a grant or some other comparably deep subsidy (http://www.nadbank.org/english/program_service/Loan/Loan2_main.htm).
The bank also offers the BEIF assistance to both provide construction grants and other mechanisms to reduce debt service payments for local governments ("transition funds").

> *"In an effort to make projects affordable, especially for the smallest and poorest communities, the NADB established the Border Environment Infrastructure Fund (BEIF). This fund is designed to receive and administer grants from other institutions that can be combined with loans and guaranties to facilitate project financing."*

Further:

> *"BEIF funds are targeted at communities that could not otherwise afford to develop and execute necessary infrastructure. For each project, the NADB performs an analysis of the community's need for grant funds, its capacity to assume debt and, most importantly, the ability of its residents to afford the costs associated with the project and the system as a whole. Taking these factors into consideration, the NADB structures a financial package that ensures completion of a functional system at a cost affordable to the community. The amount of each award is based on this analysis and the availability of other sources of funding."*

The BEIF offers potentially large subsidies but limited to "covering constructions costs not covered by other sources." The program's greatest subsidies are in the form of pass-through funding from other entities—primarily the United States Environmental Protection Agency (USEPA) funding (from Congress). As a practical matter, the BEIF is limited to funds provided

through direct US Congressional appropriation. This program has not been funded for the current federal fiscal year.
(http://www.nadbank.org/english/program_service/beif/beif_main.htm)

The NADB is limited by a lack of funding available from the BEIF program outlined above. The program is highly over-subscribed ($17 million deficit) and federal appropriation to finance the grants has declined in recent years. However, this program is an eligible source of funding for the desalination project. NADB officials have expressed an interest in helping with this project if funds are available.

International Boundary and Water Commission (IBWC)

While no ongoing program with ready funding exists under which the desalination project could apply for funding with the IBWC, specific appropriation could be provided through the IBWC/State Department budget for such a project. It would presumably have to have benefit to both Mexico and the US for such funding to be justified. Specifically, the process is outlined below in quotation from the IBWC website:

> *"Implementation by the IBWC of the broad provisions of the treaties and other international agreements requires specific agreements by the IBWC for planning construction, operation and maintenance of joint works, manner of sharing the costs and other joint activities. Such agreements constituting decisions or recommendations, subject to the approval of the two Governments, are recorded in the form of Minutes done in the English and Spanish Languages, signed by each Commissioner and attested by the Secretaries. Copies thereof are forwarded to each Government within three days after being signed. Once approved by both Governments, the Minutes are binding obligations upon the two Governments.*
>
> *The United States performance of its part of each of the cooperative projects is subject to authorization and the appropriation of funds by the Congress. This authorization, usually obtained before conclusion of an IBWC Minute, takes the form of a legislative enactment. The United States Section justifies its requests for authorizations and appropriations as a part of the Congressional presentations by the Department of State after review by the Office of Management and Budget. The United States Commissioner presents the principal witness statements with the support of the Department of State before the appropriate Committees of the House of Representatives and the United States Senate"* (http://www.ibwc.state.gov/html/about_us.html).

8.1.2 Federal Sources

Bureau of Reclamation

The Bureau assists desalination projects in two ways: 1) research dollars, and 2) demonstration projects. Research projects, which are run out of the Bureau's Denver Office, are a matching program limited to $100,000. Demonstration projects typically can be a 25 percent Bureau match, but can go to 50 percent. They are limited to a practical extent to $1,000,000 per project. This amount may be able to be increased through Congressional Appropriation authority.

US Army Corp Of Engineers Financing Opportunities

The Corp (USACE) does not typically fund water supply projects, but can provide funding for projects that meet multiple goals in line with its overall mission. The Lower Rio Grande Project may meet these multiple goals that can include flood control and environmental restoration. Using the desal project to free up some water for increased flows may meet the restoration goal.

However, USACE projects generally require specific Congressional authorization to receive implementation funding. Adding the regional desal project to the pending USACE reathorization legislation (WRDA) could provide such funding. This would require a concerted effort on the part of local sponsors, the state and the Texas Congressional delegation. (William Fickel, USACE, Ft. Worth, Telephone Conversation, July 9, 2002).

Direct Congressional Appropriation

One alternative to be explored is the option of seeking a direct Congressional appropriation tied directly to this desalination project. Such "earmarks" are common features of federal appropriations bills and could be made directly to the Brownsville PUB, a state entity (such as the Texas Water Development Board [TWDB]) or to a federal agency. This appropriation could be made through an existing program (such as those above) or, potentially, set out in stand-alone fashion in the appropriation process.

Other Federal Assistance

Two bills are currently under consideration in Congress that might provide assistance to seawater desalination efforts such as the Lower Rio Grande Project. These bills are:

1. HR 3834, which would provide an energy subsidy of $0.62sp/per 1000 gallons to desal projects (http://thomas.loc.gov/cgi-bin/bdquery/D?d108:1:. /temp/~bdfLd9: @@@L&summ2 =m&|/bss/d108query.html|). Its bill summarizes it in the following manner:

   "To direct the Secretary of Energy to make incentive payments to the owners or operators of qualified desalination facilities to partially offset the cost of electrical energy required to operate such facilities, and for other purposes."

   It would provide a subsidy of 62 cents per thousand gallons for any desalination efforts on water with total dissolved solids (TDS) in excess of 1000 ppm.

2. HR 2828, "To authorize the Secretary of the Interior to implement water supply technology and infrastructure programs aimed at increasing and diversifying domestic water resources," which would provide grants to desalination projects. These would likely require a separate appropriation. The legislation further allows:

   "…a competitive grant program to: (1) investigate and identify opportunities for studying, planning, and designing water resources activities; and (2) construct

demonstration and permanent facilities or implement other programs, projects, and activities."

Neither bill is moving quickly through the federal process. HR 3834 has not had a hearing. HR 2828 has been heard and reported from one subcommittee of one of the two committees to which it has been referred (Thomas, Legislative Information on the Internet, 5/5/04.).

8.1.3 State and Local Sources

State Funding

The primary state vehicle for water infrastructure projects is the Texas Water Development Board (TWDB). The TWDB is a multi-billion dollar lending and granting institution with existing programs and relationships that could provide benefits to the project sponsor or other entities participating in the seawater desalination project.

The TWDB provides a wide range of financing program options for water infrastructure projects. The State Participation Program offers the best legal and financial opportunity for successful implementation, but will require new appropriation and flexibility in administration at the state agency end.

Program information on all major TWDB Programs is provided below, quoted directly from the TWDB website regarding financial assistance.

Clean Water State Revolving Fund Loan Program
Type: Loan.
Uses: Planning, acquisition and construction, wastewater treatment, stormwater and non-point source pollution control, and reclamation/reuse projects.
Applicants: Political Subdivisions. Individuals are eligible to apply for non-point source pollution control projects.
Availability: An annual priority rating process applies to projects.

Drinking Water State Revolving Fund Loan Program
Type: Loans and additional subsidies (subsidies are for disadvantaged communities only).
Uses: Planning, acquisition and construction of water related infrastructure, including water supply and Source Water protection.
Applicants: Community water system owners and Nonprofit Non-Community water system owners are eligible to apply for the funding. This includes political subdivisions of the state and private individuals.
Availability: An annual priority rating process applies to projects.

Rural Water Assistance Fund Program
Type: Loan.
Uses: Planning, acquisition, and construction of water supply related infrastructure, including water treatment, water distribution pipelines, reservoir construction, and storage acquisition.
Applicants: Political Subdivisions and Nonprofit Water Supply Corporations.
Availability: Not restricted.

State Participation in Regional Water and Wastewater Facilities Program
Type: Deferred interest loan (State has a temporary ownership interest in a facility. State's ownership is purchased by applicant as their customer base grows.)
Uses: Construction of regional water or wastewater construction project when the local sponsors are unable to assume debt for the optimally sized facility.
Applicant: Political Subdivisions of the State and Water Supply Corporations, which are sponsoring construction of a regional water or wastewater project can apply for funding.
Availability: Limited Funds.

Water and Wastewater Loan Program
Type: Loan.
Uses: Planning, acquisition, and construction of water related infrastructure, including water supply, wastewater treatment, storm-water and non-point source pollution control, flood control, reservoir construction, storage acquisition, and agricultural water conservation projects, and municipal solid waste facilities.
Applicants: Political Subdivisions and Nonprofit Water Supply Corporations.
Availability: Not restricted.

Economically Distressed Area Program for Water and Sewer Service
Type: Grant, loan, or a combination grant/loan.
Uses: To bring water and wastewater services to economically distressed areas (designated by TWDB) where the present water and wastewater facilities are inadequate to meet the minimal needs of residents. The program includes measures to prevent future substandard development.
Applicants: Political subdivisions, and nonprofit water supply corporations, provided they meet certain program requirements.
Availability: Limited Funds.
Source: TWDB Website (http://www.twdb.state.tx.us/assistance /financial /financial_main.asp#Public).

While the range of program types covers most foreseeable water-related needs, only three programs, the State Participation Program, the Water and Wastewater Loan Program, and the Economically Distressed Program, appear to offer potentially viable financial subsidies to the seawater desalination project. The nature and application of this assistance would appear to be limited, however.

The State Participation Program would appear to offer the desalination project the greatest opportunity for cost-saving state financial assistance—both from the states and the project sponsors.

> *"This program is designed to acquire a state interest in a project. Generally, the State Participation Program enables the Texas Water Development Board (TWDB) to assume a temporary ownership interest in a regional project when the local sponsors are unable to assume debt for the optimally sized facility. The TWDB may acquire ownership interest in the water rights or a co-ownership interest of the property and treatment works. The loan repayments that would have been required, if the assistance had been from a loan, are deferred. Ultimately, however, the cost of the funding is repaid to the*

TWDB based upon purchase payments, which allow the TWDB to recover its principal and interest costs and issuance expenses, etc., but on a deferred timetable.

Any political subdivision of the State and water supply corporations which is sponsoring construction of a regional water or wastewater project can apply to the TWDB for participation in the project. Although it is not required, the applicant usually acquires a loan from the TWDB for the community's immediate needs."
(Source: TWDB Website http://www.twdb.state.tx.us/assistance/financial /fin_infrastructure/StateParticipation.asp.)

Eligibility

The desalination project is clearly eligible for financing under this program. The Lower Rio Grande Seawater Desalination project is by its very nature and concept, as well as legal definition, a regional project. Brownsville PUB is a regional water supplier. The question is to what extent will the project be deemed eligible. Current rule and practice has been to limit eligibility to no more than 80 percent of "excess capacity" or "project oversizing." This practice is not, though, constrained by statute—merely TWDB rule. TWDB rules could be changed to accommodate this project, particularly in the face of expressions to do so in the form of appropriations language or state leadership guidance. The exact application of this program to the project would ultimately be dependent on the final project configuration, as different project elements (e.g., pipelines) may lend themselves to more cost-effective front-end "oversizing" than other elements.

The biggest limiting factor on the State Participation Program has been the need for appropriations to operate the program. Because debt service is being deferred on behalf of the borrower, the state is covering this cost. State appropriations equal to the debt service cost and small administrative costs are required to make the program work. The last Regular Session's budget crisis saw a cessation of new project assistance. A new appropriation allowing for this project to proceed would have to be made.

The Water and Wastewater Loan Program offers loans made from state General Obligation bonds. The project would be eligible for funding under this program, but its applicability would be limited. Because the Brownsville PUB is a high quality credit, it is unlikely that it could benefit from this program. However, if other communities associated with this regional project were self-financing elements of work tied to their portion of the project and their credit was not comparable, they might benefit from accessing this program.

The Economically Distressed Program presents another indirect benefit to help finance the project. Communities either within the Brownsville system that provide water to Economically Distressed Areas or communities through which service is otherwise provided that meet the statutory definition could be eligible for deep subsidies under this program. Up to a 100 percent grant could be provided, based on an eligibility to pay criteria. Economically Distressed, under state statute, are in this case, areas with inadequate water service with per capita income less than 25 percent below the state average and are in eligible counties. All border counties and many small cities and unincorporated areas in border counties are eligible.

Local Funding

Local project funding for project construction would be primarily limited to the issuance of debt in the public capital markets (Wall Street Investment Banks and other similar institutions) as is typically done for large capital projects. Debt would be serviced from project revenues. However, the interest rates and other financial criteria applied to such loans – even for a good quality credit like Brownsville PUB – would not appear to offer sufficient subsidy to make the project cost-effective. Grants or some other mechanism would appear to be necessary to achieve that later goal.

8.2 FINANCIAL MODEL AND PLAN

As part of the overall study, a financial analysis was performed and a financial model was developed. The financial analysis initially focused on ensuring that all costs were estimated as accurately as possible and that all reasonably expected costs were included in the model. Issues analyzed include construction costs; financing options; borrowing rates; debt service coverage; operating costs; maintenance requirements; phasing of the project; and required grants and subsidies. Many of these issues were documented and are discussed throughout **Sections 7 and 8**.

From the financial analysis, a financial model was developed. This model includes many of the costs discovered during the analysis phase and ultimately seeks to answer several questions including 1) how much will the plant cost to build; 2) what will the debt service costs be including coverage; 3) how much will it cost to operate the plant; 4) how will the plant affect the rates users pay for their water; 4) what grants and subsidies will be required; and finally, 5) is the project economically viable.

8.2.1 Alternative Financing Entities

Brownsville PUB

The Brownsville Desalination Demonstration project could be financed, in part, by the Brownsville PUB. Each type of security is issued pursuant to ordinances adopted by the City Commission, which establishes the terms and conditions of the securities, including the pledge, rate covenants, reserve fund requirements, and provisions governing the issuance of additional securities, among other matters. The ordinances also establish a flow of funds, which establishes, among other things, a transfer of residual revenues from the Brownsville PUB to the City of Brownsville.

Southmost Regional Water Authority

As an alternative, the Brownsville Desalination Demonstration project could be financed, in part, by a special district, such as the Southmost Regional Water Authority, which is a conservation and reclamation district organized pursuant to Article XVI, Section 59 of the Texas Constitution and a governmental agency and body politic and corporation of the State of Texas, created by Tex. Laws. 1981, 67th Legislature, Regular Session, Chapter 511. The Authority is comprised of all of the territory contained within Brownsville, Los Fresnos, the Town of Indian Lake, Brownsville Navigation District of Cameron County, Laguna Madre Water District, and Valley Municipal Utility District No. 2 of Cameron County (the "Participants").

The Bonds issued by the Authority are payable solely from (1) Pledged Revenues, including Pledged Contract Payments to be made by the Participants to the Authority, under individual Water Supply Contracts, (2) Pledged Funds, and (3) any and all property pledged as additional security. Although the Indenture does not require that the Pledged Revenues of the Project generate net earnings equal to more than 1.00 times the average annual principal and interest requirements for all outstanding Bonds, the Indenture does require that the Authority deposit an amount equal to the average annual principal and interest requirements of the Bonds into a Debt Service Reserve Fund. The Indenture does not require a transfer of residual revenues from the Authority to the City of Brownsville, and the payments from the Brownsville PUB to the Authority are removed from the calculation of the transfer of residual revenues from the Brownsville PUB to the City of Brownsville, as described above.

For this analysis, it was assumed that the Brownsville Desalination Demonstration project could be financed in part, by a special district, such as the Southmost Regional Water Authority. Additionally, we assume that the pledged revenues of the project will generate net revenues equal to 1.10 times the annual principal and interest requirements for all outstanding bonds, and we assume that there is no transfer of residual revenues from the Authority to the City of Brownsville.

8.2.2 Regional Project Service Configurations

The Brownsville Desalination Demonstration project is proposed in four phases, each illustrating 25 million gallons per day (MGD) of capacity. For illustrative purposes, the four phases are timed to occur in 2010, 2020, 2030, and 2040, respectively:

- Phase I satisfies a significant portion of the water supply requirements of the City of Brownsville,
- Phase II extends water supply northwest to the municipal users surrounding and including the City of Harlingen,
- Phase III extends water supply westward to the municipal users surrounding and including the City of Pharr, and
- Phase IV extends water supply westward to the municipal users surrounding and including the City of McAllen.

Capital costs reflect the costs of the desalination plant, the concentrate discharge system, the finished water transmission system, and the project implementation costs. Over-sizing for intake excess capacity, discharge main excess capacity, and transmission main excess capacity are reflected in Phases I, II, and III. Annual costs for operating expenses and maintenance reserves are also reflected. All costs are expressed in current dollars. **See Table 7-5.**

For each phase, two borrowings are assumed, including a sub-phase "A" bond issue to fund design, engineering, permitting and other upfront costs, and a sub-phase "B" bond issue to fund construction and related costs. All funds were assumed to be spent within three years of receipt. **Table 8-1** illustrates the principal and interest requirements of the proposed bond issues. The

Project Funds amount is the total amount of capital costs for that sub-phase (See **Table 7-5**) less any State Participation Funding discussed later in this section.

Principal was amortized over 23 years, representing a blending of average life of 20 years for plants and pumps and 30 years for pipes, with the exception of bond issues to fund costs eligible for State Participation. If principal could be amortized over a longer period of time, a project would require lower user charges and/or lower grant assistance. Interest was assumed at 4.98 percent for all bonds issues, which is the TWDB's current published rate for tax exempt bond borrowing.

Table 8-1 Bond Debt Amortization Schedule

	Phase I-A, Series 2007			**Phase I-B, Series 2008**			
	Dated Date:		**03/01/2007**	**Dated Date:**		**03/01/2008**	
	Par Amount:		**$21,750,000**	**Par Amount:**		**$ 122,605,000**	
	Project Funds:		**$21,406,000**	**Project Funds:**		**$ 120,801,000**	
FYE	**TIC(1):**		**4.98000%**	**TIC (1):**		**4.98000%**	
9/30	**Principal**	**Interest**	**Total**	**Principal**	**Interest**	**Total**	**Total**
2007	$ -	$ 541,575	$ 541,575				$ 541,575
2008	520,000	1,070,202	1,590,202	$ -	$ 3,052,865	$ 3,052,865	4,643,067
2009	545,000	1,043,684	1,588,684	2,920,000	6,033,021	8,953,021	10,541,705
2010	570,000	1,015,920	1,585,920	3,070,000	5,883,870	8,953,870	10,539,790
2011	600,000	986,787	1,586,787	3,225,000	5,727,125	8,952,125	10,538,912
2012	630,000	956,160	1,586,160	3,390,000	5,562,411	8,952,411	10,538,571
2013	665,000	923,915	1,588,915	3,565,000	5,389,232	8,954,232	10,543,146
2014	700,000	889,926	1,589,926	3,745,000	5,207,213	8,952,213	10,542,139
2015	735,000	854,195	1,589,195	3,935,000	5,015,981	8,950,981	10,540,175
2016	770,000	816,720	1,586,720	4,140,000	4,814,913	8,954,913	10,541,633
2017	810,000	777,378	1,587,378	4,350,000	4,603,512	8,953,512	10,540,890
2018	850,000	736,044	1,586,044	4,570,000	4,381,404	8,951,404	10,537,448
2019	895,000	692,594	1,587,594	4,805,000	4,147,967	8,952,967	10,540,560
2020	940,000	646,902	1,586,902	5,050,000	3,902,577	8,952,577	10,539,479
2021	990,000	598,845	1,588,845	5,310,000	3,644,613	8,954,613	10,543,458
2022	1,040,000	548,298	1,588,298	5,580,000	3,373,452	8,953,452	10,541,750
2023	1,095,000	495,137	1,590,137	5,865,000	3,088,472	8,953,472	10,543,608
2024	1,150,000	439,236	1,589,236	6,165,000	2,788,925	8,953,925	10,543,161
2025	1,210,000	380,472	1,590,472	6,480,000	2,474,064	8,954,064	10,544,536
2026	1,270,000	318,720	1,588,720	6,810,000	2,143,143	8,953,143	10,541,863
2027	1,335,000	253,856	1,588,856	7,155,000	1,795,415	8,950,415	10,539,270
2028	1,405,000	185,630	1,590,630	7,525,000	1,429,883	8,954,883	10,545,512
2029	1,475,000	113,918	1,588,918	7,905,000	1,045,676	8,950,676	10,539,593
2030	1,550,000	38,595	1,588,595	8,310,000	641,922	8,951,922	10,540,517
2031				8,735,000	217,502	8,952,502	8,952,502
Total	**$ 21,750,000**	**$ 15,324,705**	**$ 37,074,705**	**$ 122,605,000**	**$ 86,365,152**	**$ 208,970,152**	

(1) True Interest Cost

Table 8-1 Bond Debt Amortization Schedule							
	Phase II-A, Series 2017			**Phase II-B, Series 2018**			
	Dated Date:		**03/01/2017**	**Dated Date:**		**03/01/2018**	
	Par Amount:		**$11,655,000**	**Par Amount:**		**$115,360,000**	
	Project Funds:		**$11,476,000**	**Project Funds:**		**$113,659,000**	
FYE	**TIC(1):**		**4.98000%**	**TIC(1):**		**4.98000%**	
9/30	**Principal**	**Interest**	**Total**	**Principal**	**Interest**	**Total**	**Total**
2017	$ -	$ 290,210	$ 290,210				$ 290,210
2018	280,000	573,447	853,447	$ -	$ 2,872,464	$ 2,872,464	3,725,911
2019	290,000	559,254	849,254	2,745,000	5,676,578	8,421,578	9,270,832
2020	305,000	544,439	849,439	2,890,000	5,536,266	8,426,266	9,275,705
2021	320,000	528,876	848,876	3,035,000	5,388,734	8,423,734	9,272,610
2022	340,000	512,442	852,442	3,190,000	5,233,731	8,423,731	9,276,173
2023	355,000	495,137	850,137	3,355,000	5,070,761	8,425,761	9,275,897
2024	375,000	476,960	851,960	3,525,000	4,899,449	8,424,449	9,276,408
2025	395,000	457,787	852,787	3,705,000	4,719,422	8,424,422	9,277,208
2026	415,000	437,618	852,618	3,895,000	4,530,182	8,425,182	9,277,799
2027	435,000	416,453	851,453	4,090,000	4,331,355	8,421,355	9,272,808
2028	455,000	394,292	849,292	4,300,000	4,122,444	8,422,444	9,271,736
2029	480,000	371,010	851,010	4,520,000	3,902,826	8,422,826	9,273,836
2030	505,000	346,484	851,484	4,750,000	3,672,003	8,422,003	9,273,487
2031	530,000	320,712	850,712	4,995,000	3,429,353	8,424,353	9,275,065
2032	560,000	293,571	853,571	5,250,000	3,174,252	8,424,252	9,277,823
2033	585,000	265,061	850,061	5,520,000	2,906,079	8,426,079	9,276,140
2034	615,000	235,181	850,181	5,800,000	2,624,211	8,424,211	9,274,392
2035	650,000	203,682	853,682	6,095,000	2,328,026	8,423,026	9,276,708
2036	680,000	170,565	850,565	6,405,000	2,016,776	8,421,776	9,272,341
2037	715,000	135,830	850,830	6,735,000	1,689,590	8,424,590	9,275,419
2038	750,000	99,351	849,351	7,080,000	1,345,596	8,425,596	9,274,947
2039	790,000	61,005	851,005	7,440,000	984,048	8,424,048	9,275,053
2040	830,000	20,667	850,667	7,820,000	604,074	8,424,074	9,274,741
2041				8,220,000	204,678	8,424,678	8,424,678
Total	**$ 11,655,000**	**$ 8,210,028**	**$ 19,865,028**	**$ 115,360,000**	**$ 81,262,893**	**$ 196,622,893**	

(1) True Interest Cost

Table 8-1 Bond Debt Amortization Schedule							
	Phase III-A, Series 2027			Phase III-B, Series 2028			
	Dated Date:		03/01/2027	Dated Date:		03/01/2028	
	Par Amount:		$13,495,000	Par Amount:		$148,750,000	
	Project Funds:		$13,291,000	Project Funds:		$146,746,000	
FYE	TIC(1):		4.98000%	TIC(1):		4.98000%	
9/30	Principal	Interest	Total	Principal	Interest	Total	Total
2027	$ -	$ 336,026	$ 336,026				336,026
2028	320,000	664,083	984,083	$ -	$ 3,703,875	$ 3,703,875	4,687,958
2029	335,000	647,774	982,774	3,540,000	7,319,604	10,859,604	11,842,378
2030	355,000	630,593	985,593	3,725,000	7,138,706	10,863,706	11,849,298
2031	375,000	612,416	987,416	3,915,000	6,948,470	10,863,470	11,850,885
2032	390,000	593,367	983,367	4,115,000	6,748,523	10,863,523	11,846,890
2033	410,000	573,447	983,447	4,325,000	6,538,367	10,863,367	11,846,814
2034	435,000	552,407	987,407	4,545,000	6,317,504	10,862,504	11,849,910
2035	455,000	530,246	985,246	4,775,000	6,085,436	10,860,436	11,845,681
2036	480,000	506,964	986,964	5,020,000	5,841,540	10,861,540	11,848,504
2037	505,000	482,438	987,438	5,275,000	5,585,195	10,860,195	11,847,632
2038	530,000	456,666	986,666	5,545,000	5,315,777	10,860,777	11,847,443
2039	555,000	429,650	984,650	5,830,000	5,032,539	10,862,539	11,847,189
2040	585,000	401,264	986,264	6,125,000	4,734,860	10,859,860	11,846,123
2041	615,000	371,384	986,384	6,440,000	4,421,991	10,861,991	11,848,375
2042	645,000	340,010	985,010	6,770,000	4,093,062	10,863,062	11,848,072
2043	680,000	307,017	987,017	7,115,000	3,747,326	10,862,326	11,849,343
2044	715,000	272,282	987,282	7,480,000	3,383,910	10,863,910	11,851,192
2045	750,000	235,803	985,803	7,860,000	3,001,944	10,861,944	11,847,747
2046	785,000	197,582	982,582	8,260,000	2,600,556	10,860,556	11,843,138
2047	830,000	157,368	987,368	8,685,000	2,178,626	10,863,626	11,850,994
2048	870,000	115,038	985,038	9,125,000	1,735,157	10,860,157	11,845,195
2049	915,000	70,592	985,592	9,595,000	1,269,029	10,864,029	11,849,620
2050	960,000	23,904	983,904	10,085,000	778,997	10,863,997	11,847,901
2051				10,600,000	263,940	10,863,940	10,863,940
Total	**$ 13,495,000**	**$ 9,508,314**	**$ 23,003,314**	**$ 148,750,000**	**$ 104,784,927**	**$ 253,534,927**	

(1) True Interest Cost

Table 8-1 Bond Debt Amortization Schedule							
	Phase IV-A, Series 2037			Phase IV-B, Series 2038			
	Dated Date:		03/01/2037	Dated Date:		03/01/2038	
	Par Amount:		$10,215,000	Par Amount:		$ 90,810,000	
	Project Funds:		$10,053,000	Project Funds:		$ 89,508,000	
FYE	TIC(1):		4.98000%	TIC(1):		4.98000%	
9/30	Principal	Interest	Total	Principal	Interest	Total	Total
2037	$ -	$ 254,354	$ 254,354				254,354
2038	245,000	502,607	747,607	$ -	$ 2,261,169	$ 2,261,169	3,008,776
2039	255,000	490,157	745,157	2,165,000	4,468,430	6,633,430	7,378,586
2040	270,000	477,084	747,084	2,275,000	4,357,874	6,632,874	7,379,958
2041	285,000	463,265	748,265	2,390,000	4,241,715	6,631,715	7,379,980
2042	295,000	448,823	743,823	2,510,000	4,119,705	6,629,705	7,373,528
2043	310,000	433,758	743,758	2,640,000	3,991,470	6,631,470	7,375,228
2044	330,000	417,822	747,822	2,775,000	3,856,637	6,631,637	7,379,459
2045	345,000	401,015	746,015	2,915,000	3,714,956	6,629,956	7,375,970
2046	365,000	383,336	748,336	3,065,000	3,566,054	6,631,054	7,379,389
2047	380,000	364,785	744,785	3,220,000	3,409,557	6,629,557	7,374,342
2048	400,000	345,363	745,363	3,385,000	3,245,093	6,630,093	7,375,456
2049	420,000	324,945	744,945	3,560,000	3,072,162	6,632,162	7,377,107
2050	440,000	303,531	743,531	3,740,000	2,890,392	6,630,392	7,373,923
2051	465,000	280,997	745,997	3,930,000	2,699,409	6,629,409	7,375,406
2052	490,000	257,217	747,217	4,135,000	2,498,591	6,633,591	7,380,808
2053	515,000	232,193	747,193	4,345,000	2,287,439	6,632,439	7,379,631
2054	540,000	205,923	745,923	4,565,000	2,065,580	6,630,580	7,376,503
2055	565,000	178,409	743,409	4,800,000	1,832,391	6,632,391	7,375,800
2056	595,000	149,525	744,525	5,045,000	1,587,251	6,632,251	7,376,775
2057	625,000	119,147	744,147	5,300,000	1,329,660	6,629,660	7,373,807
2058	660,000	87,150	747,150	5,570,000	1,058,997	6,628,997	7,376,147
2059	690,000	53,535	743,535	5,855,000	774,515	6,629,515	7,373,050
2060	730,000	18,177	748,177	6,155,000	475,466	6,630,466	7,378,643
				6,470,000	161,103	6,631,103	6,631,103
Total	$ 10,215,000	$ 7,193,112	$ 17,408,112	$ 90,810,000	$ 63,965,610	$ 154,775,610	

(1) True Interest Cost

State Participation Program

The State Participation program enables the Texas Water Development Board (TWDB) to assume a temporary ownership interest in a regional project when the local sponsors are unable to assume debt for the optimally-sized facility. Currently, TWDB participation is limited to a maximum of 80 percent of costs of projects creating a new water supply. For this analysis, TWDB is assumed to participate in 80 percent of eligible costs as shown on **Table 7-5**. The interest rate for the State Participation program was assumed to be 5.73 percent.

In year one through year nine, the State Participation program requires the borrower to pay only a portion of the accrued interest and none of the principal. In year ten through year nineteen, the State Participation program requires the borrower to pay all of the accrued interest, as well as all of the deferred interest, and none of the principal. In year twenty through year thirty-four, the State Participation program requires the borrower to pay all of the accrued interest and to amortize all of the principal. **Table 8-2** illustrates the requirements of the State Participation program. Note that there is no State Participation currently assumed for Phase IV.

Table 8-2 State Participation Loans									
	Phase I State Participation			Phase II State Participation			Phase III State Participation		
	Eligible Ex Capacity:		$9,181,000	Eligible Ex Capacity:		$7,406,000	Eligible Ex Capacity:		$13,896,000
	Loan Amount[(1)]:		$7,344,800	Loan Amount:		$5,924,800	Loan Amount:		$11,116,800
FYE	Interest Rate:		5.73000%	Interest Rate:		5.73000%	Interest Rate:		5.73000%
9/30	Principal	Interest	Total	Principal	Interest	Total	Principal	Interest	Total
2007	$0	$0	$0						
2008	0	0	0						
2009	0	84,171	84,171						
2010	0	84,171	84,171						
2011	0	126,257	126,257						
2012	0	168,343	168,343						
2013	0	231,471	231,471						
2014	0	294,600	294,600						
2015	0	357,728	357,728						
2016	0	420,857	420,857						
2017	0	420,857	420,857	$0	$0	$0			
2018	0	420,857	420,857	0	0	0			
2019	0	769,567	769,567	0	67,898	67,898			
2020	0	769,567	769,567	0	67,898	67,898			
2021	0	769,567	769,567	0	101,847	101,847			
2022	0	769,567	769,567	0	135,796	135,796			
2023	0	769,567	769,567	0	186,720	186,720			
2024	0	769,567	769,567	0	237,644	237,644			
2025	0	769,567	769,567	0	288,567	288,567			
2026	322,099	420,857	742,956	0	339,491	339,491			
2027	340,556	402,401	742,956	0	339,491	339,491	$0	$0	$0
2028	360,069	382,887	742,956	0	339,491	339,491	0	0	0
2029	380,701	362,255	742,956	0	688,201	688,201	0	127,399	127,399
2030	402,516	340,441	742,956	0	688,201	688,201	0	127,399	127,399
2031	425,580	317,377	742,956	0	688,201	688,201	0	191,098	191,098
2032	449,966	292,991	742,956	0	688,201	688,201	0	254,797	254,797
2033	475,749	267,208	742,956	0	688,201	688,201	0	350,346	350,346
2034	503,009	239,947	742,956	0	688,201	688,201	0	445,895	445,895
2035	531,831	211,125	742,956	0	688,201	688,201	0	541,444	541,444
2036	562,305	180,651	742,956	259,827	339,491	599,318	0	636,993	636,993
2037	594,525	148,431	742,956	274,715	324,603	599,318	0	636,993	636,993
2038	628,592	114,365	742,956	290,456	308,862	599,318	0	636,993	636,993
2039	664,610	78,346	742,956	307,099	292,219	599,318	0	985,703	985,703
2040	702,692	40,264	742,956	324,696	274,622	599,318	0	985,703	985,703
2041				343,301	256,017	599,318	0	985,703	985,703
2042				362,972	236,346	599,318	0	985,703	985,703
2043				383,770	215,547	599,318	0	985,703	985,703
2044				405,760	193,557	599,318	0	985,703	985,703
2045				429,010	170,307	599,318	0	985,703	985,703
2046				453,593	145,725	599,318	487,517	636,993	1,124,510
2047				479,583	119,734	599,318	515,452	609,058	1,124,510
2048				507,063	92,254	599,318	544,987	579,523	1,124,510
2049				536,118	63,199	599,318	576,215	548,295	1,124,510
2050				566,838	32,480	599,318	609,232	515,278	1,124,510
2051							644,141	480,369	1,124,510
2052							681,050	443,459	1,124,510
2053							720,074	404,435	1,124,510
2054							761,334	363,175	1,124,510
2055							804,959	319,551	1,124,510
2056							851,083	273,426	1,124,510
2057							899,850	224,659	1,124,510
2058							951,412	173,098	1,124,510
2059							1,005,927	118,582	1,124,510
2060							1,063,567	60,942	1,124,510
	$7,344,800	$11,795,829	$19,140,629	$5,924,800	$9,987,217	$15,912,017	$11,116,800	$16,600,116	$27,716,916

(green) No principal paid. Accrued interest initially not paid then increasingly paid.
(blue) No principal paid. Annual accruing interest paid and all accumulated accrued interest paid in equal installments.
(yellow) All principal and accruing interest paid.

(1) Loan amount is 80% of the eligible excess capacity amount.

Recognizing that the new plant capacity would allow customer cities to release surplus water rights that are currently held to satisfy water supply needs, surplus water rights are assumed to be leased for at least the term of the bonds at the cost of capital of 4.98 percent. Water rights are assumed to be valued at $2,000 per acre-foot in the current market, and no appreciation or depreciation of this current value is assumed**.** **Table 8-3** illustrates the calculation of the revenues from the lease of surplus water rights. Revenues from these water rights are shown in **Table 8-4** and **Table 8-5** as reductions to total required revenues.

Table 8-3 Water Lease Rights

Area	Value at Lease Date	Lease Start Year	Annual Lease Payment
Brownsville	$47,554,000	2010	$2,368,189
Harlingen	$46,086,000	2020	$2,295,083
Pharr	$50,810,000	2030	$2,530,338
McAllen	$67,098,000	2040	$3,341,480
Cumulative Total Annual Lease Revenue in…		2010	$2,368,189
		2020	$4,663,272
		2030	$7,193,610
		2040	$10,535,090
Assumed water value =	$2,000 /acre-foot		
Lease interest rate =	4.98%		

For estimating operating expenses, it is assumed that the customer cities would not continue to operate existing water plants if the new desalination plant could satisfy the water supply needs. There are no revenues assumed in disposing of existing plants, and there are no costs assumed in decommissioning existing plants.

Water rates are assumed to be raised to meet construction period interest, so no capitalized interest is included in any of the bond issues. Water rates are also assumed to be raised to meet operating expenses that begin 45 days prior to initial plant operation. **Tables 8-4 and 8-5** illustrates the pro-forma revenues and expenses for Phase I and Phases I-IV respectively. Operating expenses are expressed in current dollars from **Table 7-5**.

Table 8-4 Water Production Cost For New Facility For Phase I

	Initial Construction & Ramp-Up			Phase I Operation									
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Projected O&M Expenses (1)													
Operating Expenses													
Labor/Subcontractors				1,394,000	1,394,000	1,394,000	1,394,000	1,394,000	1,394,000	1,394,000	1,394,000	1,394,000	1,394,000
Power				4,459,000	4,459,000	4,459,000	4,459,000	4,459,000	4,459,000	4,459,000	4,459,000	4,459,000	4,459,000
Chemicals				$1,866,000	1,866,000	1,866,000	1,866,000	1,866,000	1,866,000	1,866,000	1,866,000	1,866,000	1,866,000
Site Lease				$179,000	179,000	179,000	179,000	179,000	179,000	179,000	179,000	179,000	179,000
Phase Start-Up Expenses (2)													
Labor/Subcontractors			174,250										
Power			557,375										
Chemicals			233,250										
Site Lease (3)		$179,000	$179,000										
Maintenance Reserve				1,820,000	1,820,000	1,820,000	1,820,000	1,820,000	1,820,000	1,820,000	1,820,000	1,820,000	1,820,000
Total Projected O&M Exp	$ -	$ 179,000	$ 1,143,875	$ 9,718,000	$ 9,718,000	$ 9,718,000	$ 9,718,000	$ 9,718,000	$ 9,718,000	$ 9,718,000	$ 9,718,000	$ 9,718,000	$ 9,718,000
Projected Debt Service													
Phase I-A (Series 2007)(4)	541,575	1,590,202	1,588,684	1,585,920	1,586,787	1,586,160	1,588,915	1,589,926	1,589,195	1,586,720	1,587,378	1,586,044	1,587,594
Phase I-B (Series 2008)		3,052,865	8,953,021	8,953,870	8,952,125	8,952,411	8,954,232	8,952,213	8,950,981	8,954,913	8,953,512	8,951,404	8,952,967
Phase I State Participation Loan (5)	0	0	84,171	84,171	126,257	168,343	231,471	294,600	357,728	420,857	420,857	420,857	769,567
Phase I State Participation Fee	18,852	18,852	18,852										
Total Projected Debt Service	560,427	$4,661,918	$10,644,728	$10,623,961	$10,665,169	$10,706,914	$10,774,617	$10,836,738	$10,897,903	$10,962,490	$10,961,747	$10,958,305	$11,310,127
Required Revenues													
Total Exp O&M Expenses	0	179,000	1,143,875	9,718,000	9,718,000	9,718,000	9,718,000	9,718,000	9,718,000	9,718,000	9,718,000	9,718,000	9,718,000
Debt Service X 1.10	616,469	5,128,110	11,709,200	11,686,358	11,731,685	11,777,605	11,852,079	11,920,412	11,987,694	12,058,739	12,057,922	12,054,136	12,441,140
Total Required Revenues	616,469	5,307,110	12,853,075	21,404,358	21,449,685	21,495,605	21,570,079	21,638,412	21,705,694	21,776,739	21,775,922	21,772,136	22,159,140
Less Revenue from Water Leases				(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)
Net Total Required Revenues	$ 616,469	$5,307,110	$12,853,075	$19,036,168	$19,081,496	$19,127,416	$19,201,890	$19,270,223	$19,337,505	$19,408,550	$19,407,733	$19,403,946	$19,790,951
O&M Cost per 1000 Gallons				$1.06	$1.06	$1.06	$1.06	$1.06	$1.06	$1.06	$1.06	$1.06	$1.06
Debt Service Cost per 1000 Gallons				$1.28	$1.28	$1.29	$1.30	$1.31	$1.31	$1.32	$1.32	$1.32	$1.36
Water Rights Credit per 1000 Gallons				-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26
Net Cost per 1000 Gallons				$2.08	$2.09	$2.09	$2.10	$2.11	$2.12	$2.13	$2.13	$2.13	$2.17

(1) Does not include City of Brownsville transfers.
(2) Phase start-up expenses are 45-days of O&M expenses.
(3) Phase start-up assumes two years of site lease expenses during construction period.
(4) Interest rate used for bond borrowing assumed to be 4.98%
(5) Interest rate used for State Participation loans was 5.73%.

Table 8-5 Water Production Cost For New Facility By Phase

	Initial Construction & Ramp-Up			Phase I Operation									
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Projected O&M Expenses (1)													
Operating Expenses													
Labor/Subcontractors				1,394,000	1,394,000	1,394,000	1,394,000	1,394,000	1,394,000	1,394,000	1,394,000	1,394,000	1,394,000
Power				4,459,000	4,459,000	4,459,000	4,459,000	4,459,000	4,459,000	4,459,000	4,459,000	4,459,000	4,459,000
Chemicals				$1,866,000	1,866,000	1,866,000	1,866,000	1,866,000	1,866,000	1,866,000	1,866,000	1,866,000	1,866,000
Site Lease				$179,000	179,000	179,000	179,000	179,000	179,000	179,000	179,000	179,000	179,000
Phase Start-Up Expenses (2)													
Labor/Subcontractors			174,250										233,625
Power			557,375										1,324,125
Chemicals			233,250										466,500
Site Lease (3)		$179,000	$179,000									$292,000	$292,000
Maintenance Reserve				1,820,000	1,820,000	1,820,000	1,820,000	1,820,000	1,820,000	1,820,000	1,820,000	1,820,000	1,820,000
Total Projected O&M Exp	$ -	$ 179,000	$1,143,875	$ 9,718,000	$ 9,718,000	$ 9,718,000	$ 9,718,000	$ 9,718,000	$ 9,718,000	$ 9,718,000	$ 9,718,000	$ 10,010,000	$ 12,034,250
Projected Debt Service													
Phase I-A (Series 2007)(4)	541,575	1,590,202	1,588,684	1,585,920	1,586,787	1,586,160	1,588,915	1,589,926	1,589,195	1,586,720	1,587,378	1,586,044	1,587,594
Phase I-B (Series 2008)		3,052,865	8,953,021	8,953,870	8,952,125	8,952,411	8,954,232	8,952,213	8,950,981	8,954,913	8,953,512	8,951,404	8,952,967
Phase I State Participation Loan(5)	0	0	84,171	84,171	126,257	168,343	231,471	294,600	357,728	420,857	420,857	420,857	769,567
Phase I State Participation Fee	18,852	18,852	18,852										
Phase II-A (Series 2017)											290,210	853,447	849,254
Phase II-B (Series 2018)												2,872,464	8,421,578
Phase II State Participation Loan											0	0	67,898
Phase II State Participation Fee											15,207	15,207	15,207
Phase III-A (Series 2027)													
Phase III-B (Series 2028)													
Phase III State Participation Loan													
Phase III State Participation Fee													
Phase IV-A (Series 2037)													
Phase IV-B (Series 2038)													
Total Projected Debt Service	$ 560,427	$4,661,918	$10,644,728	$ 10,623,961	$ 10,665,169	$ 10,706,914	$ 10,774,617	$10,836,738	$ 10,897,903	$ 10,962,490	$ 11,267,164	$ 14,699,423	$ 20,664,064
Required Revenues													
Total Exp O&M Expenses	0	179,000	1,143,875	9,718,000	9,718,000	9,718,000	9,718,000	9,718,000	9,718,000	9,718,000	9,718,000	10,010,000	12,034,250
Debt Service X 1.10	616,469	5,128,110	11,709,200	11,686,358	11,731,685	11,777,605	11,852,079	11,920,412	11,987,694	12,058,739	12,393,880	16,169,365	22,730,470
Total Required Revenues	616,469	5,307,110	12,853,075	21,404,358	21,449,685	21,495,605	21,570,079	21,638,412	21,705,694	21,776,739	22,111,880	26,179,365	34,764,720
Less Revenue from Water Leases				(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)	(2,368,189)
Net Total Required Revenues	$ 616,469	$5,307,110	$12,853,075	$ 19,036,168	$ 19,081,496	$ 19,127,416	$ 19,201,890	$ 19,270,223	$ 19,337,505	$ 19,408,550	$ 19,743,691	$ 23,811,176	$32,396,531
O&M Cost per 1000 Gallons				$1.06	$1.06	$1.06	$1.06	$1.06	$1.06	$1.06	$1.06	$1.10	$1.32
Debt Service Cost per 1000 Gallons				$1.28	$1.28	$1.29	$1.30	$1.31	$1.31	$1.32	$1.36	$1.77	$2.49
Water Rights Credit per 1000 Gallons				-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26
Net Cost per 1000 Gallons				$2.08	$2.09	$2.09	$2.10	$2.11	$2.12	$2.13	$2.16	$2.61	$3.55

(1) Does not include City of Brownsville transfers.
(2) Phase start-up expenses are 45-days of O&M expenses.
(3) Phase start-up assumes two years of site lease expenses during construction period.
(4) Interest rate used for bond borrowing assumed to be 4.98%.
(5) Interest rate used for State Participation program was assumed to be 5.73%.

Table 8-5 Water Production Cost For New Facility By Phase

Phase II Operation

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Projected O&M Expenses [1]										
Operating Expenses										
Labor/Subcontractors	1,869,000	1,869,000	1,869,000	1,869,000	1,869,000	1,869,000	1,869,000	1,869,000	1,869,000	1,869,000
Power	10,593,000	10,593,000	10,593,000	10,593,000	10,593,000	10,593,000	10,593,000	10,593,000	10,593,000	10,593,000
Chemicals	3,732,000	3,732,000	3,732,000	3,732,000	3,732,000	3,732,000	3,732,000	3,732,000	3,732,000	3,732,000
Site Lease	292,000	292,000	292,000	292,000	292,000	292,000	292,000	292,000	292,000	292,000
Phase Start-Up Expenses [2]										
Labor/Subcontractors										299,625
Power										2,024,000
Chemicals										699,750
Site Lease [3]									$419,000	$419,000
Maintenance Reserve	3,665,000	3,665,000	3,665,000	3,665,000	3,665,000	3,665,000	3,665,000	3,665,000	3,665,000	3,665,000
Total Projected O&M Exp	$20,151,000	$20,151,000	$20,151,000	$20,151,000	$20,151,000	$20,151,000	$20,151,000	$20,151,000	$20,570,000	$23,593,375
Projected Debt Service										
Phase I-A (Series 2007)[4]	1,586,902	1,588,845	1,588,298	1,590,137	1,589,236	1,590,472	1,588,720	1,588,856	1,590,630	1,588,918
Phase I-B (Series 2008)	8,952,577	8,954,613	8,953,452	8,953,472	8,953,925	8,954,064	8,953,143	8,950,415	8,954,883	8,950,676
Phase I State Participation Loan [5]	769,567	769,567	769,567	769,567	769,567	769,567	742,956	742,956	742,956	742,956
Phase I State Participation Fee										
Phase II-A (Series 2017)	849,439	848,876	852,442	850,137	851,960	852,787	852,618	851,453	849,292	851,010
Phase II-B (Series 2018)	8,426,266	8,423,734	8,423,731	8,425,761	8,424,449	8,424,422	8,425,182	8,421,355	8,422,444	8,422,826
Phase II State Participation Loan	67,898	101,847	135,796	186,720	237,644	288,567	339,491	339,491	339,491	688,201
Phase II State Participation Fee										
Phase III-A (Series 2027)								336,026	984,083	982,774
Phase III-B (Series 2028)									3,703,875	10,859,604
Phase III State Participation Loan								0	0	127,399
Phase III State Participation Fee								28,533	28,533	28,533
Phase IV-A (Series 2037)										
Phase IV-B (Series 2038)										
Total Projected Debt Service	$20,652,649	$20,687,482	$20,723,287	$20,775,792	$20,826,779	$20,879,879	$20,902,109	$21,259,084	$25,616,186	$33,242,896
Required Revenues										
Total Exp O&M Expenses	20,151,000	20,151,000	20,151,000	20,151,000	20,151,000	20,151,000	20,151,000	20,151,000	20,570,000	23,593,375
Debt Service X 1.10	22,717,914	22,756,230	22,795,615	22,853,371	22,909,457	22,967,866	22,992,320	23,384,992	28,177,805	36,567,185
Total Required Revenues	42,868,914	42,907,230	42,946,615	43,004,371	43,060,457	43,118,866	43,143,320	43,535,992	48,747,805	60,160,560
Less Revenue from Water Leases	(4,663,272)	(4,663,272)	(4,663,272)	(4,663,272)	(4,663,272)	(4,663,272)	(4,663,272)	(4,663,272)	(4,663,272)	(4,663,272)
Net Total Required Revenues	$38,205,642	$38,243,958	$38,283,343	$38,341,099	$38,397,185	$38,455,594	$38,480,048	$38,872,720	$44,084,533	$55,497,288
O&M Cost per 1000 Gallons	$1.10	$1.10	$1.10	$1.10	$1.10	$1.10	$1.10	$1.10	$1.13	$1.29
Debt Service Cost per 1000 Gallons	$1.24	$1.25	$1.25	$1.25	$1.25	$1.26	$1.26	$1.28	$1.54	$2.00
Water Rights Credit per 1000 Gallons	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26
Cost per 1000 Gallons	$2.09	$2.09	$2.10	$2.10	$2.10	$2.11	$2.11	$2.13	$2.41	$3.04

(1) Does not include City of Brownsville transfers.
(2) Phase start-up expenses are 45-days of O&M expenses.
(3) Phase start-up assumes two years of site lease expenses during construction period.
(4) Interest rate used for bond borrowing assumed to be 4.98%
(5) Interest rate used for State Participation program was assumed to be 5.73%.

Table 8-5 Water Production Cost For New Facility By Phase

Phase III Operation

	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Projected O&M Expenses [(1)]										
Operating Expenses										
Labor/Subcontractors	2,397,000	2,397,000	2,397,000	2,397,000	2,397,000	2,397,000	2,397,000	2,397,000	2,397,000	2,397,000
Power	16,192,000	16,192,000	16,192,000	16,192,000	16,192,000	16,192,000	16,192,000	16,192,000	16,192,000	16,192,000
Chemicals	5,598,000	5,598,000	5,598,000	5,598,000	5,598,000	5,598,000	5,598,000	5,598,000	5,598,000	5,598,000
Site Lease										
Phase Start-Up Expenses [(2)]										
Labor/Subcontractors										342,375
Power										2,604,125
Chemicals										933,000
Site Lease [(3)]										
Maintenance Reserve	5,510,000	5,510,000	5,510,000	5,510,000	5,510,000	5,510,000	5,510,000	5,510,000	5,510,000	5,510,000
Total Projected O&M Exp	$ 29,697,000	$ 29,697,000	$ 29,697,000	$29,697,000	$29,697,000	$29,697,000	$29,697,000	$29,697,000	$29,697,000	$33,576,500
Projected Debt Service										
Phase I-A (Series 2007)[(4)]	1,588,595									
Phase I-B (Series 2008)	8,951,922	8,952,502								
Phase I State Participation Loan [(5)]	742,956	742,956	742,956	742,956	742,956	742,956	742,956	742,956	742,956	742,956
Phase I State Participation Fee										
Phase II-A (Series 2017)	851,484	850,712	853,571	850,061	850,181	853,682	850,565	850,830	849,351	851,005
Phase II-B (Series 2018)	8,422,003	8,424,353	8,424,252	8,426,079	8,424,211	8,423,026	8,421,776	8,424,590	8,425,596	8,424,048
Phase II State Participation Loan	688,201	688,201	688,201	688,201	688,201	688,201	599,318	599,318	599,318	599,318
Phase II State Participation Fee										
Phase III-A (Series 2027)	985,593	987,416	983,367	983,447	987,407	985,246	986,964	987,438	986,666	984,650
Phase III-B (Series 2028)	10,863,706	10,863,470	10,863,523	10,863,367	10,862,504	10,860,436	10,861,540	10,860,195	10,860,777	10,862,539
Phase III State Participation Loan	127,399	191,098	254,797	350,346	445,895	541,444	636,993	636,993	636,993	985,703
Phase III State Participation Fee										
Phase IV-A (Series 2037)								254,354	747,607	745,157
Phase IV-B (Series 2038)									2,261,169	6,633,430
Total Projected Debt Service	$33,221,858	$31,700,706	$22,810,667	$22,904,456	$23,001,354	$23,094,990	$23,100,111	$23,356,671	$26,110,432	$30,828,804
Required Revenues										
Total Exp O&M Expenses	30,116,000	30,116,000	30,116,000	30,116,000	30,116,000	30,116,000	30,116,000	30,116,000	30,657,000	34,536,500
Debt Service X 1.10	36,544,043	34,870,777	25,091,734	25,194,902	25,301,489	25,404,489	25,410,122	25,692,338	28,721,475	33,911,685
Total Required Revenues	66,660,043	64,986,777	55,207,734	55,310,902	55,417,489	55,520,489	55,526,122	55,808,338	59,378,475	68,448,185
Less Revenue from Water Leases	(7,193,610)	(7,193,610)	(7,193,610)	(7,193,610)	(7,193,610)	(7,193,610)	(7,193,610)	(7,193,610)	(7,193,610)	(7,193,610)
Net Total Required Revenues	$59,466,433	$57,793,167	$48,014,124	$48,117,292	$48,223,879	$48,326,879	$48,332,512	$48,614,728	$52,184,865	$61,254,575
O&M Cost per 1000 Gallons	$1.10	$1.10	$1.10	$1.10	$1.10	$1.10	$1.10	$1.10	$1.12	$1.26
Debt Service Cost per 1000 Gallons	$1.33	$1.27	$0.92	$0.92	$0.92	$0.93	$0.93	$0.94	$1.05	$1.24
Water Rights Credit per 1000 Gallons	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26	-$0.26
Cost per 1000 Gallons	$2.17	$2.11	$1.75	$1.76	$1.76	$1.76	$1.76	$1.77	$1.90	$2.24

(1) Does not include City of Brownsville transfers.

(2) Phase start-up expenses are 45-days of O&M expenses.

(3) Phase start-up assumes two years of site lease expenses during construction period.

(4) Interest rate used for bond borrowing assumed to be 4.98%

(5) Interest rate used for State Participation program was assumed to be 5.73%.

Table 8-5 Water Production Cost For New Facility By Phase

Phase IV Operation

	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
Projected O&M Expenses[(1)]										
Operating Expenses										
Labor/Subcontractors	2,739,000	2,739,000	2,739,000	2,739,000	2,739,000	2,739,000	2,739,000	2,739,000	2,739,000	2,739,000
Power	20,833,000	20,833,000	20,833,000	20,833,000	20,833,000	20,833,000	20,833,000	20,833,000	20,833,000	20,833,000
Chemicals	7,464,000	7,464,000	7,464,000	7,464,000	7,464,000	7,464,000	7,464,000	7,464,000	7,464,000	7,464,000
Site Lease	541,000	541,000	541,000	541,000	541,000	541,000	541,000	541,000	541,000	541,000
Phase Start-Up Expenses [(2)]										
Labor/Subcontractors										
Power										
Chemicals										
Site Lease [(3)]										
Maintenance Reserve	7,330,000	7,330,000	7,330,000	7,330,000	7,330,000	7,330,000	7,330,000	7,330,000	7,330,000	7,330,000
Total Projected O&M Exp	$38,907,000	$38,907,000	$38,907,000	$38,907,000	$38,907,000	$38,907,000	$38,907,000	$38,907,000	$38,907,000	$38,907,000
Projected Debt Service										
Phase I-A (Series 2007)[(4)]										
Phase I-B (Series 2008)										
Phase I State Participation Loan [(5)]	742,956									
Phase I State Participation Fee										
Phase II-A (Series 2017)	850,667									
Phase II-B (Series 2018)	8,424,074	8,424,678								
Phase II State Participation Loan	599,318	599,318	599,318	599,318	599,318	599,318	599,318	599,318	599,318	599,318
Phase II State Participation Fee										
Phase III-A (Series 2027)	986,264	986,384	985,010	987,017	987,282	985,803	982,582	987,368	985,038	985,592
Phase III-B (Series 2028)	10,859,860	10,861,991	10,863,062	10,862,326	10,863,910	10,861,944	10,860,556	10,863,626	10,860,157	10,864,029
Phase III State Participation Loan	985,703	985,703	985,703	985,703	985,703	985,703	1,124,510	1,124,510	1,124,510	1,124,510
Phase III State Participation Fee										
Phase IV-A (Series 2037)	747,084	748,265	743,823	743,758	747,822	746,015	748,336	744,785	745,363	744,945
Phase IV-B (Series 2038)	6,632,874	6,631,715	6,629,705	6,631,470	6,631,637	6,629,956	6,631,054	6,629,557	6,630,093	6,632,162
Total Projected Debt Service	$30,828,798	$29,238,052	$20,806,619	$20,809,591	$20,815,670	$20,808,737	$20,946,354	$20,949,163	$20,944,477	$20,950,554
Required Revenues										
Total Exp O&M Expenses	38,907,000	38,907,000	38,907,000	38,907,000	38,907,000	38,907,000	38,907,000	38,907,000	38,907,000	38,907,000
Debt Service X 1.10	33,911,678	32,161,858	22,887,281	22,890,550	22,897,237	22,889,611	23,040,989	23,044,079	23,038,925	23,045,610
Total Required Revenues	72,818,678	71,068,858	61,794,281	61,797,550	61,804,237	61,796,611	61,947,989	61,951,079	61,945,925	61,952,610
Less Revenue from Water Leases	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)
Net Total Required Revenues	62,283,588	60,533,767	51,259,191	$51,262,460	$51,269,147	$51,261,521	$51,412,899	$51,415,988	$51,410,834	$51,417,519
O&M Cost per 1000 Gallons	$1.07	$1.07	$1.07	$1.07	$1.07	$1.07	$1.07	$1.07	$1.07	$1.07
Debt Service Cost per 1000 Gallons	$0.93	$0.88	$0.63	$0.63	$0.63	$0.63	$0.63	$0.63	$0.63	$0.63
Water Rights Credit per 1000 Gallons	-$0.29	-$0.29	-$0.29	-$0.29	-$0.29	-$0.29	-$0.29	-$0.29	-$0.29	-$0.29
Cost per 1000 Gallons	$1.71	$1.66	$1.40	$1.40	$1.40	$1.40	$1.41	$1.41	$1.41	$1.41

(1) Does not include City of Brownsville transfers.
(2) Phase start-up expenses are 45-days of O&M expenses.
(3) Phase start-up assumes two years of site lease expenses during construction period.
(4) Interest rate used for bond borrowing assumed to be 4.98%
(5) Interest rate used for State Participation program was assumed to be 5.73%.

Table 8-5 Water Production Cost For New Facility By Phase

Continued Operation

	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063
Projected O&M Expenses [1]														
Operating Expenses														
Labor/Subcontractors	2,739,000	2,739,000	2,739,000	2,739,000	2,739,000	2,739,000	2,739,000	2,739,000	2,739,000	2,739,000	2,739,000	2,739,000	2,739,000	2,739,000
Power	20,833,000	20,833,000	20,833,000	20,833,000	20,833,000	20,833,000	20,833,000	20,833,000	20,833,000	20,833,000	20,833,000	20,833,000	20,833,000	20,833,000
Chemicals	7,464,000	7,464,000	7,464,000	7,464,000	7,464,000	7,464,000	7,464,000	7,464,000	7,464,000	7,464,000	7,464,000	7,464,000	7,464,000	7,464,000
Site Lease														
Phase Start-Up Expenses [2]														
Labor/Subcontractors														
Power														
Chemicals														
Site Lease [3]														
Maintenance Reserve	7,330,000	7,330,000	7,330,000	7,330,000	7,330,000	7,330,000	7,330,000	7,330,000	7,330,000	7,330,000	7,330,000	7,330,000	7,330,000	7,330,000
Total Projected O&M Exp	$38,907,000	$38,907,000	$38,907,000	$38,907,000	$38,907,000	$38,907,000	$38,907,000	$38,907,000	$38,907,000	$38,907,000	$38,907,000	$38,907,000	$38,907,000	$38,907,000
Projected Debt Service														
Phase I-A (Series 2007)[4]														
Phase I-B (Series 2008)														
Phase I State Participation Loan [5]														
Phase I State Participation Fee														
Phase II-A (Series 2017)														
Phase II-B (Series 2018)														
Phase II State Participation Loan	599,318													
Phase II State Participation Fee														
Phase III-A (Series 2027)	983,904													
Phase III-B (Series 2028)	10,863,997	10,863,940												
Phase III State Participation Loan	1,124,510	1,124,510	1,124,510	1,124,510	1,124,510	1,124,510	1,124,510	1,124,510	1,124,510	1,124,510	1,124,510			
Phase III State Participation Fee														
Phase IV-A (Series 2037)	743,531	745,997	747,217	747,193	745,923	743,409	744,525	744,147	747,150	743,535	748,177			
Phase IV-B (Series 2038)	6,630,392	6,629,409	6,633,591	6,632,439	6,630,580	6,632,391	6,632,251	6,629,660	6,628,997	6,629,515	6,630,466	6,631,103		
Total Projected Debt Service	$20,945,651	$19,363,855	$ 8,505,317	$ 8,504,141	$ 8,501,012	$ 8,500,309	$ 8,501,285	$ 8,498,316	$ 8,500,657	$ 8,497,559	$ 8,503,152	$ 6,631,103	$ -	$ -
Required Revenues														
Total Exp O&M Expenses	38,907,000	38,907,000	38,907,000	38,907,000	38,907,000	38,907,000	38,907,000	38,907,000	38,907,000	38,907,000	38,907,000	38,907,000	38,907,000	38,907,000
Debt Service X 1.10	23,040,216	21,300,241	9,355,849	9,354,555	9,351,113	9,350,340	9,351,413	9,348,148	9,350,722	9,347,315	9,353,467	7,294,213	-	-
Total Required Revenues	61,947,216	60,207,241	48,262,849	48,261,555	48,258,113	48,257,340	48,258,413	48,255,148	48,257,722	48,254,315	48,260,467	46,201,213	38,907,000	38,907,000
Less Revenue from Water Leases	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)	(10,535,090)
Net Total Required Revenues	$51,412,125	$49,672,150	$37,727,758	$37,726,464	$37,723,023	$37,722,250	$37,723,323	$37,720,057	$37,722,632	$37,719,225	$37,725,377	$35,666,123	$28,371,910	$28,371,910
O&M Cost per 1000 Gallons	$1.07	$1.07	$1.07	$1.07	$1.07	$1.07	$1.07	$1.07	$1.07	$1.07	$1.07	$1.07	$1.07	$1.07
Debt Service Cost per 1000 Gallons	$0.63	$0.58	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	$0.20	$0.00	$0.00
Water Rights Credit per 1000 Gallons	-$0.29	-$0.29	-$0.29	-$0.29	-$0.29	-$0.29	-$0.29	-$0.29	-$0.29	-$0.29	-$0.29	-$0.29	-$0.29	-$0.29
Cost per 1000 Gallons	$1.41	$1.36	$1.03	$1.03	$1.03	$1.03	$1.03	$1.03	$1.03	$1.03	$1.03	$0.98	$0.78	$0.78

(1) Does not include City of Brownsville transfers.
(2) Phase start-up expenses are 45-days of O&M expenses.
(3) Phase start-up assumes two years of site lease expenses during construction period.
(4) Interest rate used for bond borrowing assumed to be 4.98%
(5) Interest rate used for State Participation program was assumed to be 5.73%.

8.2.3 Summary of Project Costs and Subsidies

Based on the information contained in **Tables 8-4** and **8-5**, the following summary of project costs are presented. These numbers do not reflect any grants or operational subsidies beyond the State Participation numbers described earlier.

The costs for water production, transmission, and brine disposal for the first year of each phase are shown below in **Table 8-6**.

Table 8-6 Summary of First year Costs in dollars per 1000 gallons

	2010	2020	2030	2040
Capital (Debt Service)	1.28	1.24	1.33	0.93
O&M Expenses	1.06	1.10	1.10	1.07
Credit For Water Rights	-0.26	-0.26	-0.26	-0.29
Estimated Net Total Cost of Water Per 1000 gallons	2.08	2.09	2.17	1.71

Based upon projects being implemented throughout the U.S. and the world, these costs fall in the low to middle range. Therefore, we believe that this project is both technically and economically feasible. As described in **Section 8-1**, there are many means and sources available for capital subsidies and operating subsidies if required for this type of project.

8.2.4 Rate Analysis

A review of the current water utilities at Brownsville PUB and the Cities of Harlingen, Pharr, and McAllen was undertaken to determine the average or effective total costs and the component costs, expressed in dollars per 1,000 gallons, of providing existing water service. Because of the complexity of water rates (See **Table 8-14**), these costs are estimates only.

Table 8-7 Existing Water Costs

	Dollars per 1,000 Gallons			
Description	**Brownsville**	**Harlingen**	**Pharr**	**McAllen**
Water Production Expenses	$.38	$.47	$.47	$.43
Other Operating Expenses	$.47	$.58	$.58	$.54
Debt Service	$.53	$.26	$.49	$.31
Capital Outlay and Other	$.50	$.44	$.19	$.63
City Transfer	$.15	$.00	$.00	$.00
Total	**$2.03**	**$1.76**	**$1.72**	**$1.92**

In Phase I, it may be desirable for Brownsville PUB to cease to operate existing water plants if the new desalination plant could satisfy the water supply needs. The incremental costs of the Brownsville Desalination Demonstration project may replace the current Water Production Expenses and are assumed to be added to the other expenses.

Conversations with key staff at Brownsville PUB indicated that $2.00 per 1,000 gallons has historically been perceived as an upper limit on reasonable costs of water service, but that 25 percent increases in user charges are planned for the next five years. A 25 percent increase in user charges produces a total cost of approximately $2.50 per 1,000 gallons. Assuming that ratepayers in the Cities of Harlingen, Pharr, and McAllen can likewise afford a similar increase in user charges, a 25 percent increase in user charges produces a total cost of approximately $2.20, $2.16, and $2.40 per 1000 gallons respectively. Federal and/or state grants would be used to subsidize the remaining cost of providing water service so that the service does not exceed the Target Maximum Total Rate as discussed below.

Table 8-8 summarizes the rate goals for each of the four cities and the maximum water production expense component allowable to reach the goal.

Table 8-8 Target Rates

	Dollars per 1,000 Gallons			
Description	**Brownsville**	**Harlingen**	**Pharr**	**McAllen**
Target Maximum Total Rate	2.50	2.20	2.15	2.40
Less Non-Water Production Expenses	1.66	1.29	1.26	1.49
Maximum Water Production Expenses	0.84	.91	0.90	0.92

Table 8-9 illustrates the impact of the four phases of the project on the cost per 1,000 gallons of water for Brownsville PUB and the cities of Harlingen, Pharr, and McAllen.

Table 8-9 User Rates Impact Analysis

	Brownsville[(1)]		Harlingen[(2)]		Pharr[(3)]		McAllen[(4)]	
	Current	**2010**	**Current**	**2020**	**Current**	**2030**	**Current**	**2040**
Water Expenses								
Water Production [(5)]	$2,585,461		$2,045,494		$845,879		$2,858,163	
Net Remaining O&M Expenses	$3,233,418		$2,558,126		$1,057,869		$3,574,463	
Debt Service	$3,647,936		$1,162,310		$883,337		$2,024,634	
Capital Outlay and Other	$3,447,437		$1,945,274		$347,807		$4,174,920	
Transfers	$1,062,095		$0		$0		$0	
Total Expenses	$13,976,347		$7,711,203		$3,134,892		$12,630,180	
Capacity of Plant(s) (MGD)	40.0		13.3		8.5		42.2	
Capacity in 1000 of Gallons	14,610,000		4,857,825		3,104,625		15,413,550	
Total Usage (1000's of Gallons)	6,871,000		4,387,990		1,817,494		6,572,523	
Cost per 1000 Gallons								
… on Water Production	$0.38	$2.08	$0.47	$2.09	$0.47	$2.17	$0.43	$1.71
… on Net Remaining O&M Exp	$0.47	$0.47	$0.58	$0.58	$0.58	$0.58	$0.54	$0.54
… on Debt Service	$0.53	$0.53	$0.26	$0.26	$0.49	$0.49	$0.31	$0.31
… on Capital Outlay	$0.50	$0.50	$0.44	$0.44	$0.19	$0.19	$0.63	$0.63
… on Transfers[(6)]	$0.15	$0.15	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Cost per 1000 Gallons	$2.03	$3.74	$1.76	$3.38	$1.72	$3.43	$1.92	$3.19
Assistance Required (all per 1000 gallons)								
Target Max Total Cost [(7)]		$2.50		$2.20		$2.16		$2.40
Expected Water Production Cost		$2.08		$2.09		$2.17		$1.71
Max Water Production Cost to Reach Target		$0.84		$0.91		$0.90		$0.92
Difference		$1.24		$1.19		$1.27		$0.79
Annual Assistance Required To Meet Target		**$11,346,019**		**$10,834,538**		**$11,634,882**		**$7,213,234**

(1) From the Brownsville PUB 2003-2004 budget and continuing disclosure submitted 3/30/04 for the fiscal year ending 9/30/03.
(2) From the City of Harlingen Waterworks System continuing disclosure submitted 3/30/04 for the fiscal year ending 9/30/03.
(3) From the City of Pharr continuing disclosure submitted 3/31/04 for the fiscal year ending 9/30/03.
(4) From the City of McAllen CAFR for the fiscal year ending 9/30/03.
(5) The new plant will replace the "Water Production" component of the water rate.
(6) Brownsville transfer is shown based on the absolute value of the current amount.
(7) Target is $2.50 for Brownsville PUB and a 25 percent increase for the cities of Harlingen , Pharr and McAllen.

To the extent possible, it would be desirable to apply federal and State grants as construction grants, which reduce the size of the bond issues and the associated principal and interest requirements. However, it may also be necessary to apply federal and State grants as operating subsidies, which reduce the operating expenses borne by ratepayers on an annual basis.

A summary of Water Production Expenses with a variety of capital and operating subsidies is presented in **Tables 8-10, 8-11**, and **8-12**.

Table 8-10 Upfront Capital Subsidy				
Grant [(1)]	**Phase I**	**Phase II**	**Phase III**	**Phase IV**
$0	2.08	2.09	2.17	1.71
$25 mil.	1.86	1.87	1.95	1.54
$50 mil.	1.64	1.65	1.72	1.37
$75 mil.	1.42	1.42	1.50	1.20
$100 mil.	1.19	1.20	1.28	1.04

(1) Grant is per phase, therefore $25 million is $25 mil in each phase for a total of $100 million.

Table 8-11 Annual Operation Subsidy				
Subsidy [(1)]	**Phase I**	**Phase II**	**Phase III**	**Phase IV**
$0	2.08	2.09	2.17	1.71
$5 mil.	1.54	1.82	1.99	1.57
$10 mil.	0.99	1.54	1.81	1.43
$15 mil.	0.44	1.27	1.62	1.29
$20 mil.	-0.11	1.00	1.44	1.16

(1)Subsidy is per year, therefore $5 million is $5 million for 20 years for a total of $100 million.

There are a number of alternatives, which could help bridge the gap between expected Water Production Expenses and the maximum water production expenses desired. As discussed, these options include one time construction grants, annual operating subsidies and/or revision upwards of the Target Maximum Total Rate to the users. However, it is very likely that a final solution would entail all three measures. One possible scenario is described below.

1) Construction grants from various sources equal to $25 million per phase.
2) Use of a $0.62 per 1000 gallons federal subsidy currently under consideration as mentioned in **Section 8.1.2**.
3) Increasing the Target Maximum Total Rate goals.

Table 8-12 Possible Subsidy Alternatives				
Upfront Alternative	**Phase I**	**Phase II**	**Phase III**	**Phase IV**
1. Capital	$25 mil	$25 mil	$25 mil	$25 mil
O&M ($0.62subsidy per 1000 gal.)	$5,661,375	$11,322,750	$16,984,175	$22,645,500
Total Water Production Costs per 1000 gal.	$1.24	$1.25	$1.33	$0.92
Change From Target	$0.40	$0.34	$0.43	$(0.00)
Total Rate	$2.90	$2.54	$2.59	$2.41

Table 8-13 identifies the existing municipal water rates in the Rio Grande Valley. The rates vary from a low of $0.80/1000 gallons in Catarina WSC and Larga Vista to a high of $4.70/1000 gallons for the Hudspeth WCID #1. The average cost per 1000 gallons is $2.16.

Table 8-13 Brownsville Demonstration Seawater Desalination Project
Existing Water Rates

Entity	5,000 gal	10,000 gal	Avg. Water Bill	Base Cost	Base gal	Cost per 1000 gal less Base	Average Water Use gal	Average Cost per 1000 gal
Lower Valley								
Alton	$ 14.50	$ 20.50	$ 22.99	$ 10.00	3,000	$ 1.50	11,660	$ 1.97
Alamo	$ 11.40	$ 17.90	*$ 19.20*	$ 7.50	2,000	$ 1.30	*11,000*	$ 1.75
Border Waterworks (Big Five)	$ 9.40	$ 18.80	$ 22.30			$ 1.88	11,862	$ 1.88
Border Waterworks (Mile 17 1/2)	$ 11.90	$ 23.80	$ 26.11			$ 2.38	10,971	$ 2.38
Border Waterworks (Wisconsin Rd)	$ 11.50	$ 23.00	$ 26.11			$ 2.30	11,352	$ 2.30
Brownsville	$ 14.66	$ 26.77	$ 28.50	$ 9.47		$ 1.73	*11,000*	$ 2.59
Brownsville (Cameron Park)	$ 14.66	$ 19.51	$ 22.04	$ 9.81		$ 0.97	12,612	$ 1.75
Brownsville (Hacienda Gardens)	$ 14.66	$ 19.51	$ 18.54	$ 9.81		$ 0.97	9,000	$ 2.06
Combes	$ 12.00	$ 24.00	$ 22.65			$ 2.40	9,438	$ 2.40
Donna	$ 17.05	$ 29.58	*$ 32.32*	$ 9.20		$ 1.57/$2.74	*11,000*	$ 2.94
Edinburg	$ 12.35	$ 22.10	*$ 24.05*	$ 8.45	3,000	$ 1.95	*11,000*	$ 2.19
Edinburg (Faysville)	$ 9.60	$ 17.10	$ 20.25	$ 6.60	3,000	$ 1.50	12,100	$ 1.67
Edinburg (Lull)	$ 8.70	$ 15.45	$ 16.30	$ 6.00	3,000	$ 1.35	10,630	$ 1.53
Harlingen (ACE/Bishop)	$ 12.00	$ 24.00	$ 24.00			$ 2.40	10,000	$ 2.40
La Feria	$ 13.33	$ 26.65	$ 21.72			$ 2.67	8,150	$ 2.67
Harlingen	$ 6.50	$ 14.20	*$ 15.30*	$ 4.50	3,000	$1.00/$3.30/$1.10	*11,000*	$ 1.39
La Feria	$ 8.70	$ 15.45	$ 16.30	$ 6.00	3,000	$ 1.35	10,630	$ 1.53
Los Fresnos	$ 16.00	$ 23.50	*$ 25.00*	$ 13.00	3,000	$ 1.50	*11,000*	$ 2.27
McAllen	$ 10.00	$ 16.50	*$ 17.80*	$ 3.50		$ 1.30	*11,000*	$ 1.62
Mercedes	$ 10.92	$ 18.32	$ 17.32	$ 5.00	1,000	$ 1.48	9,325	$ 1.86
Mercedes (DeAnda & Saenz)	$ 10.92	$ 18.32	$ 17.32	$ 5.00	1,000	$ 1.48	9,325	$ 1.86
Military Highway WSC	$ 15.95	$ 31.89	$ 25.94			$ 3.19	8,132	$ 3.19
Mission	$ 13.70	$ 21.45	*$ 23.00*	$ 7.50	999	$ 1.55	*11,000*	$ 2.09
Mission (Madero and Granjeno)	$ 12.00	$ 18.50	$ 21.75	$ 5.50		$ 1.30	12,500	$ 1.74
Mission (North Mission)	$ 10.73	$ 21.45	$ 21.45			$ 2.15	10,000	$ 2.15
North Alamo WSC (Doolittle)	$ 10.00	$ 20.00	$ 21.98			$ 2.00	10,990	$ 2.00
North Alamo WSC (La Sara)	$ 10.00	$ 20.00	$ 20.46			$ 2.00	10,232	$ 2.00
North Alamo WSC (San Juan)	$ 10.00	$ 20.00	$ 25.32			$ 2.00	12,660	$ 2.00
North Alamo WSC (San Carlos)	$ 13.06	$ 26.11	$ 26.11			$ 2.61	10,000	$ 2.61
Olmito WSC	$ 21.00	$ 29.00	$ 29.00	$ 15.00	3,000	$ 2.00	10,000	$ 2.90
Palmview/La Joya (Eastern Half)	$ 14.74	$ 29.47	$ 26.38			$ 2.95	8,951	$ 2.95
Pharr	$ 14.45	$ 21.90	*$ 23.39*	$ 7.00		$ 1.49	*11,000*	$ 2.13
Pharr (Las Milpas)	$ 16.31	$ 25.51	$ 24.59	$ 7.11		$ 1.84	9,500	$ 2.59
Pharr (Las Milpas) II	$ 16.31	$ 25.51	$ 24.59	$ 7.11		$ 1.84	9,500	$ 2.59
Primera	$ 12.00	$ 24.00	$ 19.92			$ 2.40	8,300	$ 2.40
Rio Hondo	$ 15.00	$ 22.50	$ 33.51	$ 12.00	3,000	$ 1.50	17,340	$ 1.93
Roma	$ 10.65	$ 21.30	$ 23.52			$ 2.13	11,042	$ 2.13
San Benito	$ 13.12	$ 20.57	*$ 22.06*	$ 8.65	2,000	$ 1.49	*11,000*	$ 2.01
San Juan	$ 13.10	$ 19.10	*$ 20.30*	$ 9.50	2,000	$ 1.20	*11,000*	$ 1.85
Santa Rosa	$ 12.13	$ 24.25	$ 21.15			$ 2.43	8,722	$ 2.43
Siesta Shores WCID	$ 21.40	$ 28.36	$ 26.40	$ 18.70	3,000	$ 1.35	8,700	$ 3.03
Star Co. WCID #2 (Las Lomas)	$ 16.95	$ 26.95	$ 21.32			$ 2.70	7,912	$ 2.70
Weslaco	$ 14.00	$ 21.00	*$ 22.40*	$ 7.00		$ 1.40	*11,000*	$ 2.04
Average for Lower Valley	**$ 12.96**	**$ 22.18**	**$ 22.81**	**$ 8.42**	**1,500**	**$ 1.85**	**10,547**	**$ 2.20**
Middle Rio Grande								
Asherton (Dimmit Co)		$ 13.02	$ 13.02			$ 1.30	10,000	$ 1.30
Batesville WSC		$ 22.53	$ 22.53			$ 2.25	10,000	$ 2.25
Carrizo Hills WSC	$ 6.18	$ 12.35	$ 12.35	$		$ 1.24	10,000	$ 1.24
Catarina WSC	$ 21.60	$ 25.60	$ 25.60	$ 20.00	3,000	$ 0.80	10,000	$ 2.56
Crystal City		$ 16.80	$ 15.31			$ 1.68	9,113	$ 1.68
Del Rio (Cienegas Terrace)	$ 6.20	$ 9.40	$ 9.40	$ 4.92	3,000	$ 0.64	10,000	$ 0.94
Del Rio (Val Verde Park Estates)	$ 6.20	$ 9.40	$ 14.01	$ 4.92	3,000	$ 0.64	17,200	$ 0.81
Eagle Pass		$ 13.14	$ 15.84			$ 1.31	12,055	$ 1.31
Eagle pass (Eidson Road)	$ 5.23	$ 10.14	$ 13.01			$ 1.01	12,830	$ 1.01
Laredo (Mines Rd & 359)		$ 17.43	$ 17.43			$ 1.74	10,000	$ 1.74
Moore WSC		$ 34.00	$ 30.00			$ 3.40	8,824	$ 3.40

Table 8-13 Brownsville Demonstration Seawater Desalination Project
Existing Water Rates

Entity	5,000 gal	10,000 gal	Avg. Water Bill	Base Cost	Base gal	Cost per 1000 gal less Base	Average Water Use gal	Average Cost per 1000 gal
Spofford	$ 16.00	$ 21.00	$ 26.36	$ 14.00	3,000	$ 1.00	15,360	$ 1.72
Terrell Co. WCID #1 (Sanderson)		$ 23.25	$ 21.50			$ 2.33	9,247	$ 2.33
Uvalde Co. (Windmill WSC)		$ 21.00	$ 23.70			$ 2.10	11,286	$ 2.10
Webb County (El Cenizo & Rio Bravo)		$ 18.25	$ 18.42			$ 1.83	10,093	$ 1.83
Webb County (Larga Vista)	$ 11.00	$ 15.00	$ 18.86	$ 7.00		$ 0.80	14,831	$ 1.27
Zavala Co. WCID #1	$ 11.00	$ 15.35	$ 18.63			$ 1.54	12,137	$ 1.54
Average for Middle Rio Grande	**$ 12.98**	**$ 17.51**	**$ 18.59**	**$ 8.47**	**2,000**	**$ 1.51**	**11,352**	**$ 1.71**
Upper Rio Grande								
El Paso (Canutillo)		$ 19.61	$ 19.61			$ 1.96	10,000	$ 1.96
El Paso Co. (Eastside Montana)	$ 28.60	$ 35.30	$ 36.84	$ 28.60	5,000	$ 1.34	11,149	$ 3.30
Homesead MUD (Eastside Montana)	$ 14.20	$ 28.40	$ 28.40	$		$ 2.84	10,000	$ 2.84
Hudspeth WCID #1 (Sierra Blanca)	$ 18.80	$ 42.30	$ 31.02	$	1,000	$ 4.70	7,600	$ 4.08
LVWDA I	$ 16.02	$ 21.41	$ 26.36	$ 16.02	5,000	$ 1.08	14,594	$ 1.81
LVWDA II (Socorro)	$ 16.02	$ 21.41	$ 26.36	$ 16.02	5,000	$ 1.08	14,594	$ 1.81
LVWDA III	$ 16.02	$ 21.41	$ 26.36	$ 16.02	5,000	$ 1.08	14,594	$ 1.81
Pecos City		$ 19.41	$ 24.25			$ 1.94	12,494	$ 1.94
Tornillo WID		$ 26.10	$ 24.13			$ 2.61	9,245	$ 2.61
Westway I	$ 15.25	$ 30.50	$ 24.06	$ 12.20	4,000	$ 3.05	7,887	$ 3.05
Westway II	$ 15.25	$ 30.50	$ 24.06	$ 12.20	4,000	$ 3.05	7,887	$ 3.05
Average for Upper Rio Grande	**$ 13.91**	**$ 26.94**	**$ 26.50**	**$ 12.63**	**3,625**	**$ 2.25**	**10,913**	**$ 2.57**
Average	**$ 12.97**	**$ 22.21**	**$ 22.63**	**$ 9.84**	**2,375**	**$ 1.87**	**10,937**	**$ 2.16**

DATA FROM MUNICIPAL ADVISORY COUNCIL OF TEXAS
BROWNSVILLE DATA FROM BROWNSVILLE PUBLIC UTILITIES BOARD
ALL OTHER VALUES FROM TWDB

8.3 INTERLOCAL AGREEMENTS

Considering the expressions of interest and support received by the project team, a variety of transfer structures appear to be appropriate. The users who are closest to the existing system may be direct connect customers for the project. Other participants may acquire water rights from Brownsville PUB and other direct delivery customers in exchange for capital contributions. Interlocal agreements could provide for take-or-pay contracts with direct connect users or capital contributions to purchase a share in the plant coupled with prorata sharing of operating cost.

Other users may prefer to build their own surface water treatment plants based on water rights purchased. Their financing could be supported by NAD Bank, USDA or TWDB assistance, part of which could be traded to Brownsville PUB.

9.0 ALTERNATIVE PROJECT DELIVERY METHODS

9.1 INTRODUCTION

This section provides a brief description of project delivery methods. It has become increasingly common for owners to use alternatives to traditional project delivery methods for some capital projects. Reasons cited for utilizing alternative methods are that schedules can be accelerated and cost savings can be realized.

9.2 PROJECT DELIVERY METHODS

9.2.1 Traditional Project Delivery

The traditional method for delivering public capital projects is the Design-Bid-Build method. This method, evolved over a long period of time, is the most popular method for public project delivery. In this scenario, there is very clear separation between the responsibilities of the Architect/Engineer and the Contractor.

Under traditional project delivery, the Owner typically secures the services of an Architect/ Engineer based on their qualifications relative to the type of project that is contemplated. The Architect/Engineer endeavors to develop a set of drawings and specifications that satisfies all of the Owner's requirements as well as all applicable codes, rules, and laws. Once the design process is complete, a detailed set of contract documents is released to contractors. The General Contractor develops a competitive bid based on the contract documents.

The construction contract is typically awarded to the lowest responsible bidder. Financial instruments are normally required to ensure that the General Contractor will fulfill his obligations under the construction contract. In the traditional model, once construction is completed, the project is turned over to the Owner, and the facilities are operated by a public agency.

The traditional model of project delivery was based on a system of checks and balances. Many States required contract awards by this method to protect the public from malfeasance on the part of local governments and/or contractors. The design professionals are bound by codes of ethics and registration boards to ensure that they act professionally to promote the public interest.

9.2.2 Alternative Construction Delivery

There are quite a few variations on traditional construction project delivery that have become increasingly popular in recent years. Most of these involve some merging of roles of the Architect/Engineer and the General Contractor. The benefits claimed from alternative construction delivery include potential for an accelerated schedule and the potential for cost savings. Schedules can be accelerated because the contractor may proceed with material ordering and some phases of the work prior to completion of the design.

One thing that owners will need to be cognizant of is that the design professional's role is changed significantly in most alternative construction delivery methods. Under traditional project delivery, the Architect/Engineer works directly for the Owner. With alternative delivery, the Architect/Engineer has a different set of incentives that may not coincide perfectly with the Owner's interests. Owners will often contract with a third party or Construction Manager to ensure that their interests are protected when projects are procured with alternative delivery methods.

9.2.3 Accelerated Traditional Project Delivery

There are methods that can be used to accelerate projects that are procured under the traditional Design-Bid-Build method. A significant advantage offered by Alternative Project Delivery Methods is that schedules can be compressed by allowing certain activities to take place while the design is still under development. One way that a traditionally procured project can realize some of the schedule acceleration benefits of alternative methods is through the use of owner-furnished material and equipment. This is particularly useful if a project requires long-lead time items. Orders can be placed for the long-lead items as soon as the requirements are finalized. Contracts can then avoid costly downtime or slow-downs that often occur when waiting for orders to arrive.

Another method that can be used to accelerate a traditional project delivery is to phase construction so that project elements requiring less design time can be contracted independently ahead of elements requiring greater design effort. By subdividing the construction effort, a contractor can start construction long before a complete design is finalized. Since large projects are often delayed by some of the earliest elements of the design, a phased contracting approach can provide schedule compression benefits.

9.2.4 Contract Operations

Contract operations are where private entities enter into contracts for services traditionally provided by government workers. This is essentially a method whereby traditional government services are outsourced to a private firm. These arrangements are typically governed by very complex contracts stipulating a large number of performance criteria that the contractor must satisfy.

Contract operations will typically not include construction and financing of capital projects; however, they do typically include requirements for routine maintenance of plant and equipment. Examples would be contracting for solid waste collection or the operation of a water treatment plant.

A necessary component of contract operations is the oversight of performance. Since contract service provision creates incentives for contractors to cut corners that do not exist with public service provision, a responsible government agency must ensure that the public receives full value for the services they purchase. Government agencies will often enter into separate contracts for oversight and verification of the operator's compliance with the terms of the contract.

9.2.5 Public-Private Partnerships (PPPs)

This is a much-used but poorly defined term. In reality, these are not partnerships at all. They are, in fact, just a contractual relationship that merges alternative construction delivery, contract operations, and project financing. One fundamental difference is that, where construction delivery turns the project over to the owner at completion, a PPP often results in an arrangement where the contractor owns the facility for a stipulated period of time. An example might be where a contractor is hired not only to build a school, but also to staff and operate it for a 20-year period before turning the facility over to the school district.

Obviously there is a great deal of discussion and debate regarding PPPs. Some opponents maintain that PPP arrangements force government entities to cede control of service delivery to a contractor. Proponents counter that officials often have more control of quality and price with contracted service delivery than with a government bureaucracy providing services. Like most hotly debated issues, the truth probably lies somewhere in the middle.

It is important to remember that the PPP arrangements are ultimately just another contracting mechanism. They are much more complex and longer term than a traditional construction or service contract, but nonetheless, still a means for a government entity to obtain goods and services in the marketplace. PPP contracts need to be well constructed to ensure the best value and minimum risk for citizens and ratepayers. It is also ideal to structure a competitive procurement to ensure that citizens and ratepayers receive the best possible value.

9.3 CONCLUSIONS

It is impossible to discuss the Lower Rio Grande Valley Desalination Project without mentioning alternative project delivery methods. Unfortunately, there is no way to specify a correct method of project delivery. Ultimately, the project owners will have to determine which form of project delivery best meets the needs of their customers. There is a wide variety of delivery options that are available from traditional Design-Bid-Build to PPP, and there are arguments for and against each delivery method.

Each project delivery method has its track record of successes and failures, and no single delivery method has gained universal acceptance. Although there is a great deal of discussion over project delivery methods, most project managers will agree that the integrity and professionalism of the contracting parties has a far greater influence on the success of a capital project than the type of contractual relationship that exists.

Based on the experience of the BPUB with traditional project delivery, including the successful implementation of the Southmost Groundwater Desalination Project, it is recommended that a traditional project delivery be utilized.

10.0 PROJECT IMPLEMENTATION SCHEDULE

10.1 INTRODUCTION

Preliminary planning schedules were prepared for both a baseline and accelerated project schedule. The baseline schedule is illustrated in **Figure 10-1** and the accelerated schedule in **Figure 10-2**. The power plant component is illustrated on both schedules as well. No attempt was made to accelerate the power plant schedule since it has been determined to be largely independent of the SWRO project.

10.2 BASELINE SCHEDULE

The baseline schedule shown in **Figure 10-1**, illustrates a project delivery under the traditional project delivery approach. This is often referred to as a Design/Bid/Build approach. In this project delivery mechanism the design is taken to completion then the project is advertised for construction bids. A contract for construction is then awarded to the lowest responsive.

Once the contract is awarded, the contractor mobilizes his staff and equipment. After award, the contractor also begins his procurement of materials and equipment. The procurement, fabrication and delivery of materials and equipment is often a critical path activity in a construction project and is frequently the source of delays. This appears to be the case with the SWRO plant as well.

The baseline schedule for the SWRO plant illustrates a project duration that is 35 calendar months from the start of engineering until final acceptance. The project start date is shown for illustrative purposes only as the first business day of January 2005.

10.3 ACCELERATED TRADITIONAL PROJECT DELIVERY

There are methods that can be used to accelerate projects that are procured with the traditional Design-Bid-Build method. As mentioned in the previous section, traditionally procured projects can realize some of the schedule acceleration benefits of alternative methods through the use of owner-furnished material and equipment. This is particularly useful if a project requires long lead-time items.

When the owner supplies the materials and equipment, orders can be placed for the long-lead items as soon as the requirements are finalized. The SWRO plant is an example of a project that will have a substantial amount of long-lead equipment and materials. As a result, the schedule could be substantially compressed by using owner-furnished materials.

Another method that can successfully accelerate a traditional project delivery is to phase construction so that project elements requiring less design time can be contracted ahead of elements requiring greater study and design effort. By subdividing the construction effort, some phases of the construction can start long before the entire design is finalized.

Figure 10-2 illustrates a schedule where both of the aforementioned methods of project acceleration have been incorporated. The original 35-month schedule has been compressed to 22 months. This is a very significant reduction in project delivery time. There are some tradeoffs, however, that must be mentioned. These acceleration methods shift some of the management burden from the general contractor to the owner or engineer. The engineering and management tasks are also more complicated in an accelerated delivery approach.

The owner will need to be aware of the tradeoffs and make informed decisions on the level of schedule acceleration that is required by the project.

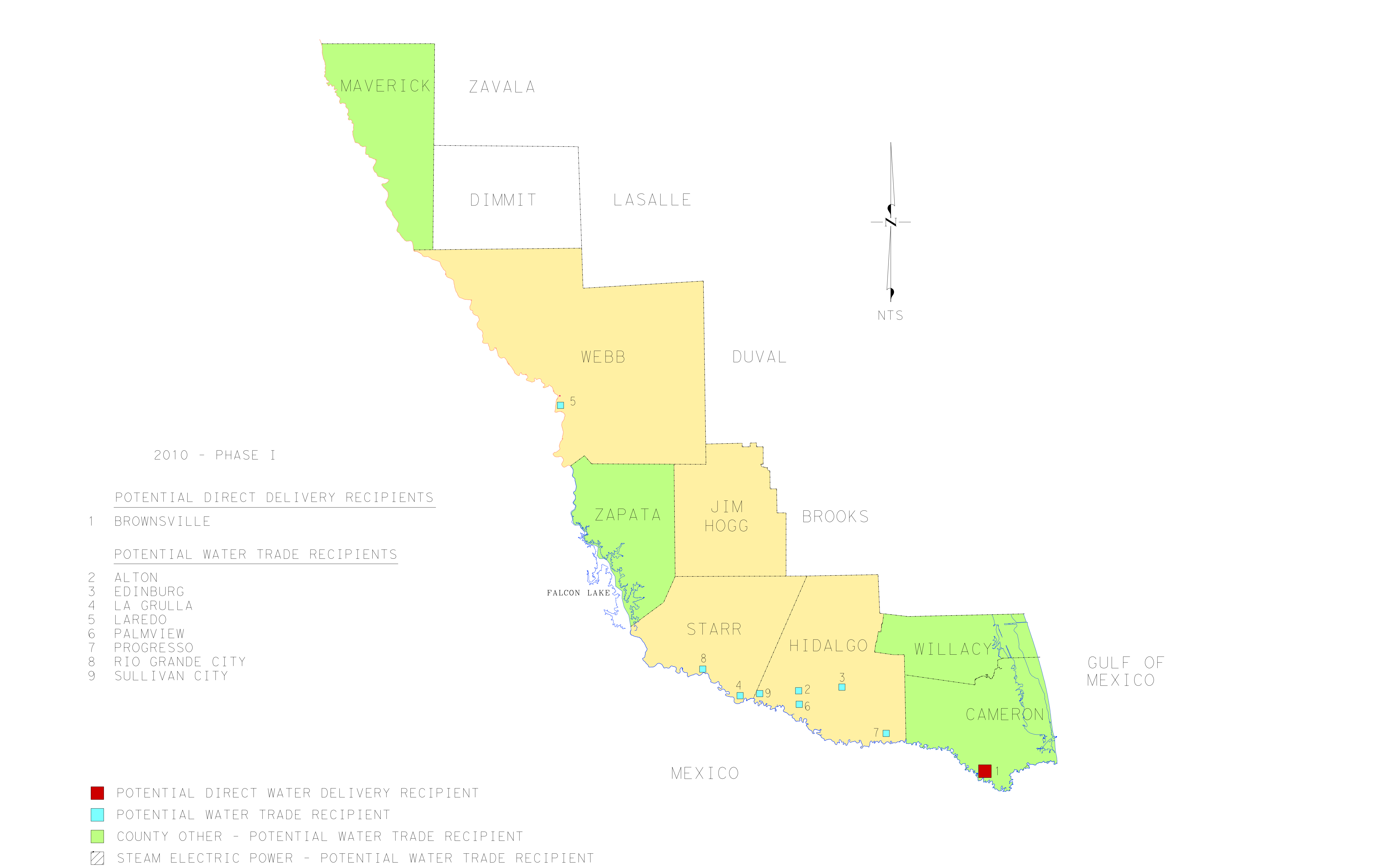
10.4 OTHER DELIVERY METHODS

The schedule benefits from alternative project delivery methods are essentially the same as those mentioned above but are managed by the contractor rather than the owner. An example would be a Build-Own-Operate-Transfer (BOOT) mechanism. The same type of acceleration methods may be used, however; since the owner has contracted much of his responsibility to the BOOT contractor, the owner does not participate directly in the schedule acceleration.

10.5 CONCLUSIONS

The preliminary schedule indicates that a seawater desalination project could be made operational within a three-year time frame using traditional project delivery methods. An accelerated traditional project delivery using owner-furnished materials and phased construction could reduce that timeframe to as little as two years. However, based upon the TWDB target date of January 2008, we recommend the more traditional and safe three-year schedule for implementation of this project be considered.

FIGURES



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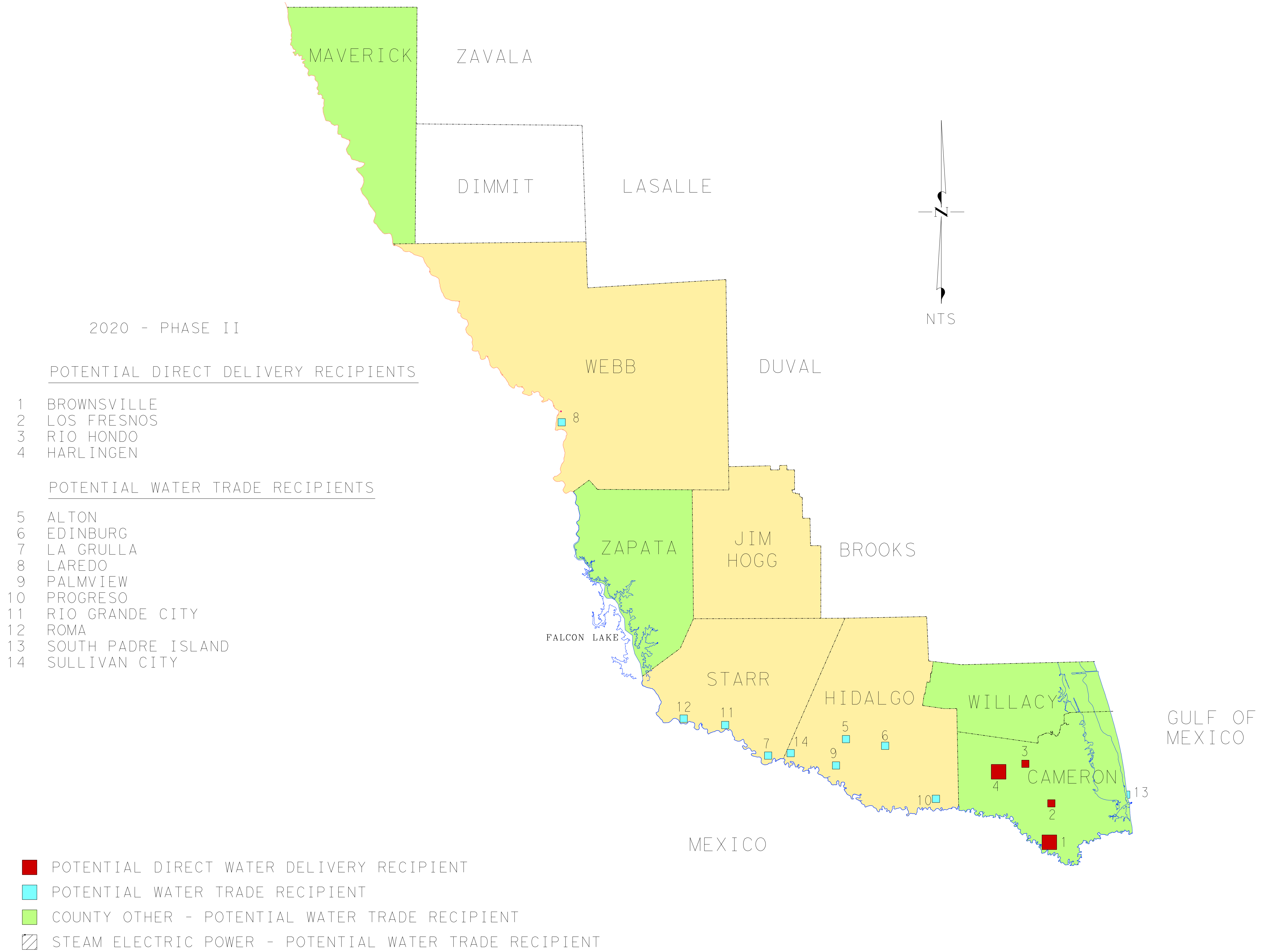
REGION M RIO GRANDE POTENTIAL SERVICE AREA PHASE I-2010 FIGURE 2-1

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA



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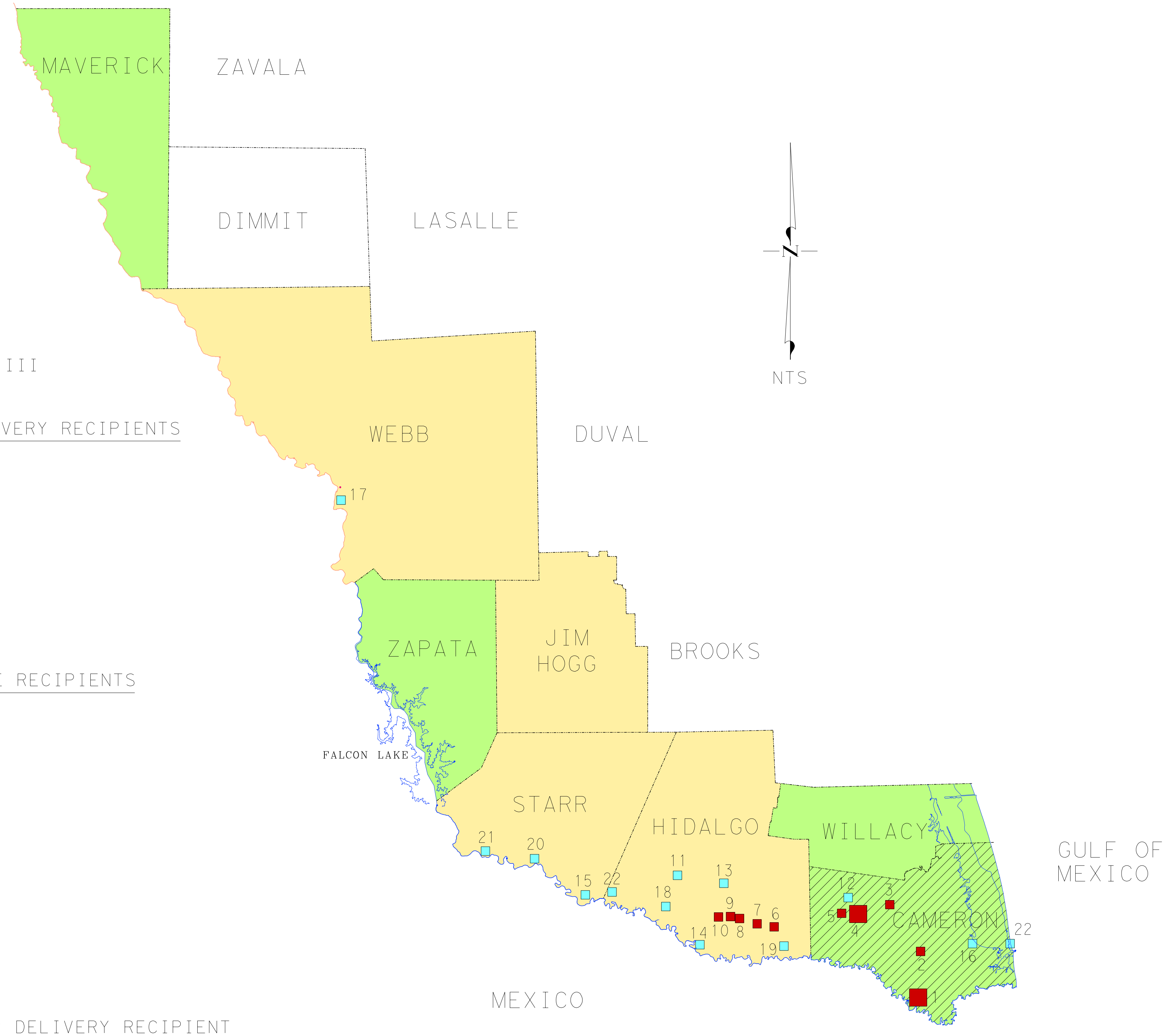
REGION M RIO GRANDE POTENTIAL SERVICE AREA PHASE II-2020

FIGURE 2-2

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA

2030 - PHASE III



POTENTIAL DIRECT DELIVERY RECIPIENTS

1 BROWNSVILLE
2 LOS FRESNOS
3 RIO HONDO
4 HARLINGEN
5 PALM VALLEY
6 WESLACO
7 DONNA
8 ALAMO
9 SAN JUAN
10 PHARR

POTENTIAL WATER TRADE RECIPIENTS

11 ALTON
12 COMBES
13 EDINBURG
14 HIDALGO
15 LA GRULLA
16 LAGUNA VISTA
17 LAREDO
18 PALMVIEW
19 PROGRESO
20 RIO GRANDE CITY
21 ROMA
22 SOUTH PADRE ISLAND
23 SULLIVAN CITY

■ POTENTIAL DIRECT WATER DELIVERY RECIPIENT
■ POTENTIAL WATER TRADE RECIPIENT
■ COUNTY OTHER - POTENTIAL WATER TRADE RECIPIENT
▨ STEAM ELECTRIC POWER - POTENTIAL WATER TRADE RECIPIENT

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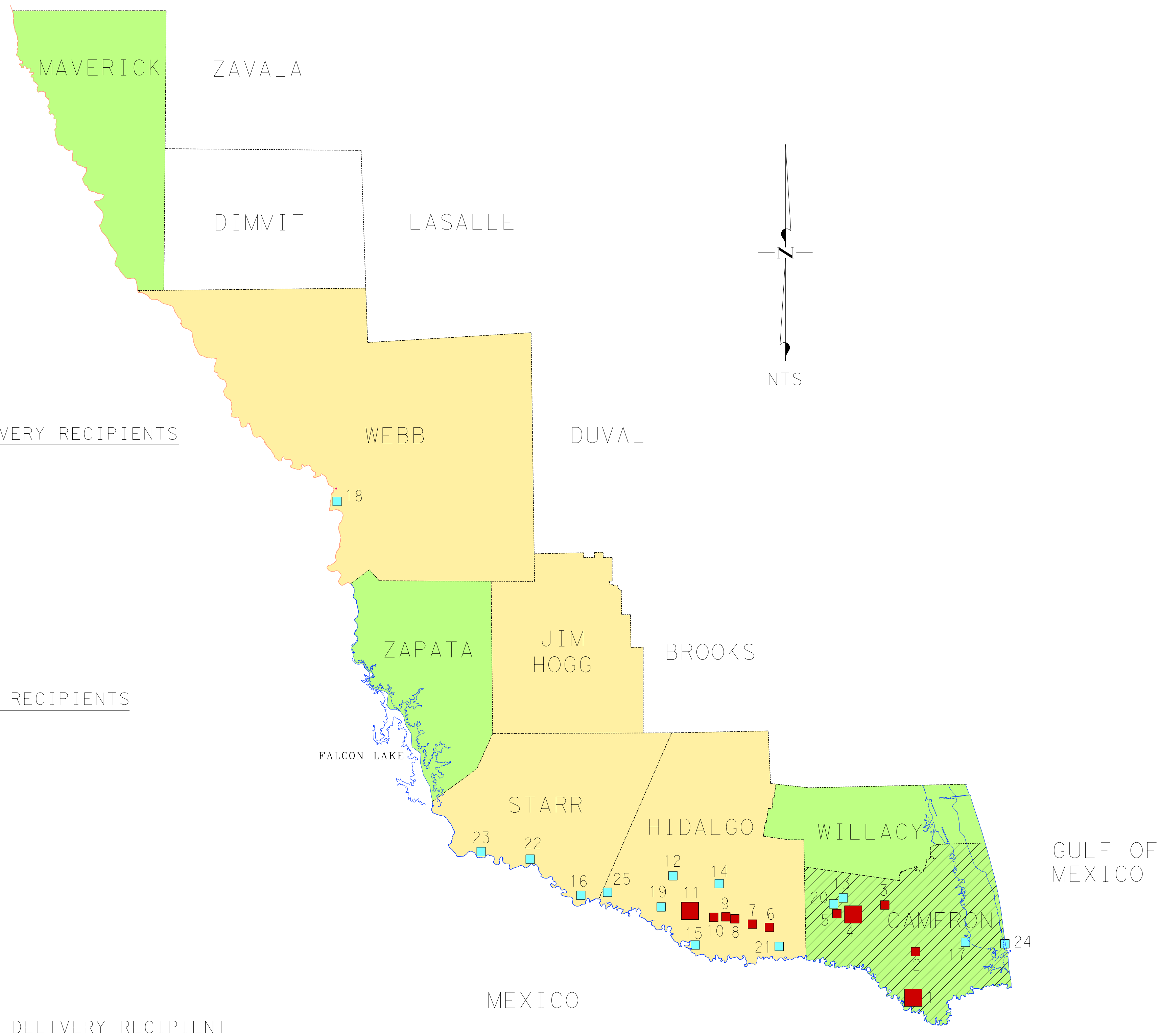
REGION M RIO GRANDE POTENTIAL SERVICE AREA PHASE III-2030 FIGURE 2-3

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA



2040 - PHASE IV

POTENTIAL DIRECT DELIVERY RECIPIENTS

1 BROWNSVILLE
2 LOS FRESNOS
3 RIO HONDO
4 HARLINGEN
5 PALM VALLEY
6 WESLACO
7 DONNA
8 ALAMO
9 SAN JUAN
10 PHARR
11 McALLEN

POTENTIAL WATER TRADE RECIPIENTS

12 ALTON
13 COMBES
14 EDINBURG
15 HIDALGO
16 LA GRULLA
17 LAGUNA VISTA
18 LAREDO
19 PALMVIEW
20 PRIMERA
21 PROGRESO
22 RIO GRANDE CITY
23 ROMA
24 SOUTH PADRE ISLAND
25 SULLIVAN CITY

POTENTIAL DIRECT WATER DELIVERY RECIPIENT

POTENTIAL WATER TRADE RECIPIENT

COUNTY OTHER - POTENTIAL WATER TRADE RECIPIENT

STEAM ELECTRIC POWER - POTENTIAL WATER TRADE RECIPIENT

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REGION M RIO GRANDE POTENTIAL SERVICE AREA PHASE IV-2040 FIGURE 2-4

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA

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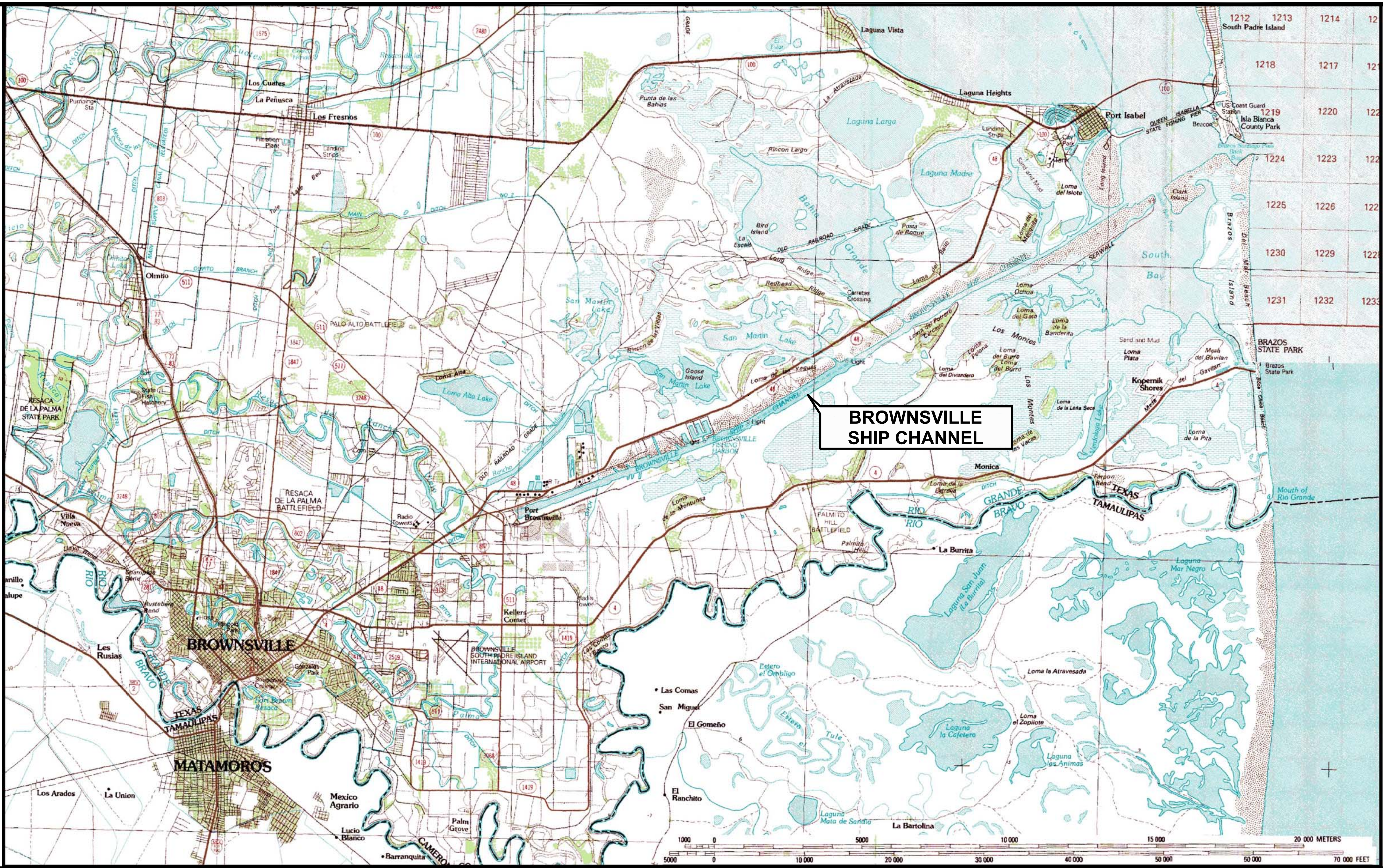
FUTURE WATER TRANSMISSION MAINS

FIGURE 2-5

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA



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BROWNSVILLE PUBLIC UTILITIES BOARD

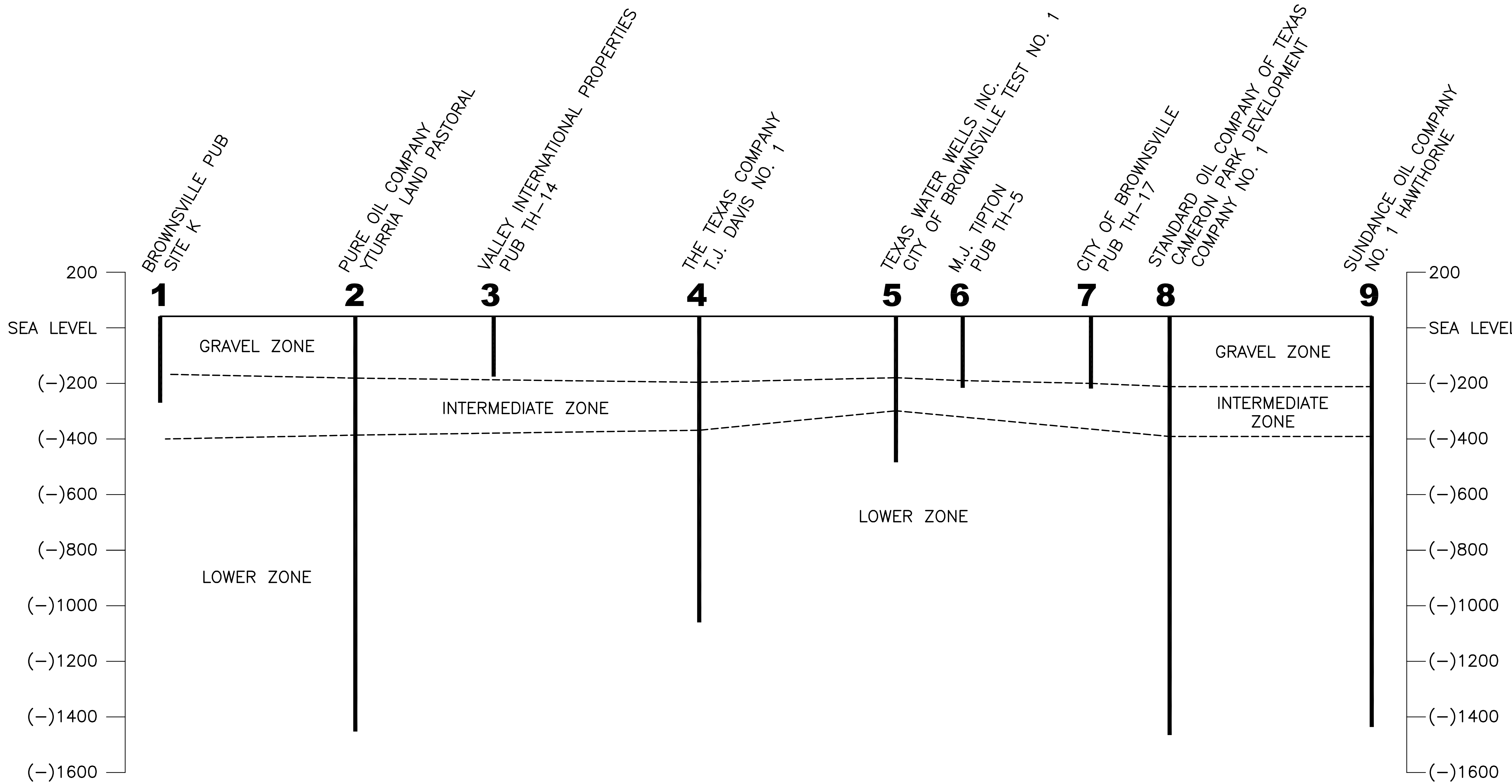
BROWNSVILLE SHIP CHANNEL

FIGURE 3-1

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA

Drawing Name: G:\1410\4008-01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\SITE LOCATIONS_2.dwg



SOURCE: NRS CONSULTING ENGINEERS, "DEVELOPMENT OF BRACKISH GROUNDWATER RESOURCES IN THE BROWNSVILLE AREA", TWDB CONTRACT NO. 95−483−141, NOVEMBER 1996, FIGURE 2.1

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BROWNSVILLE PUBLIC UTILITIES BOARD

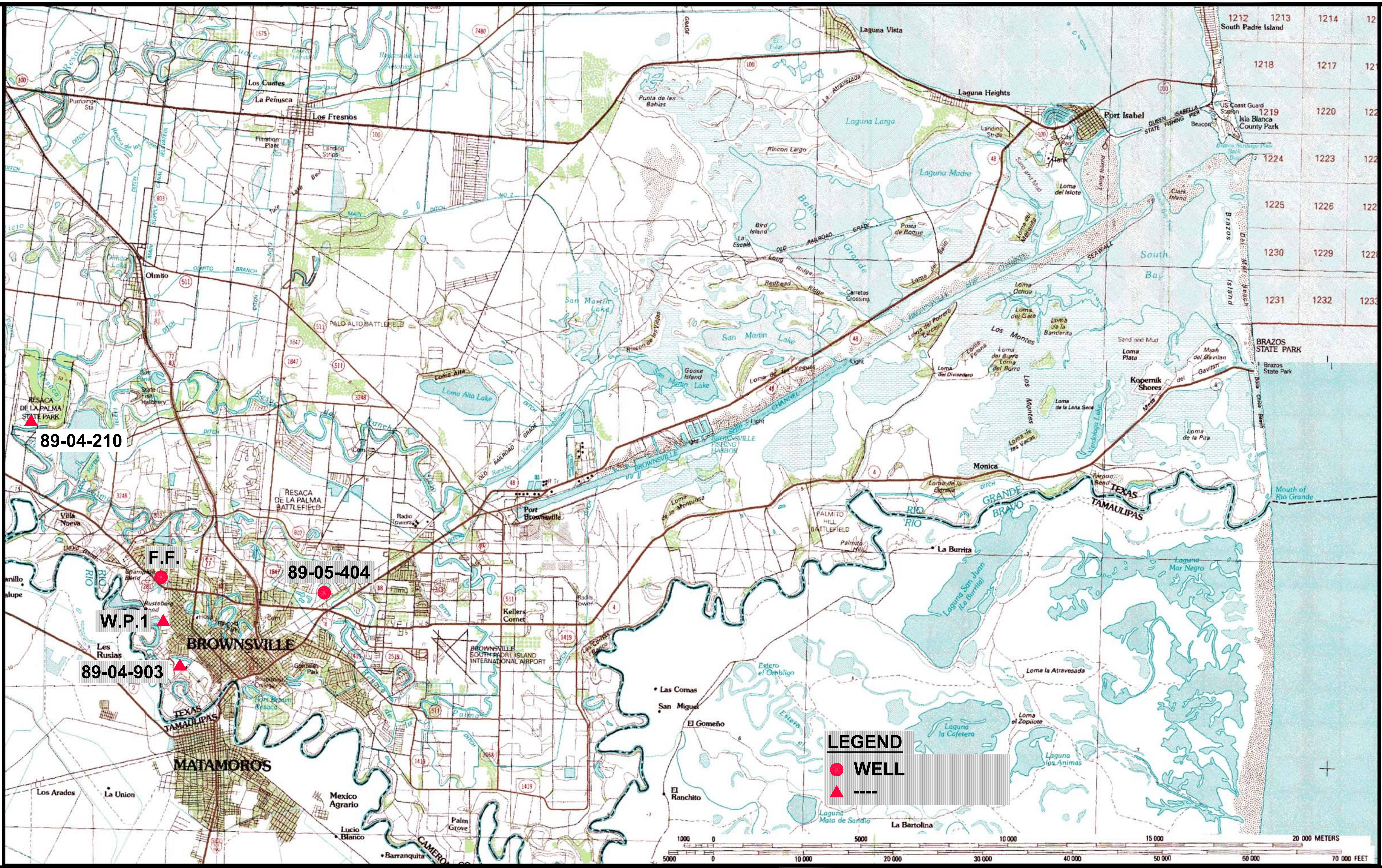
GEOLOGIC CROSS SECTION OF THE BROWNSVILLE AREA

FIGURE 3-2

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE HOME PORT TO NAFTA

Drawing Name: G:\1410\4008−01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\GEOLOGIC X−SECTION.dwg



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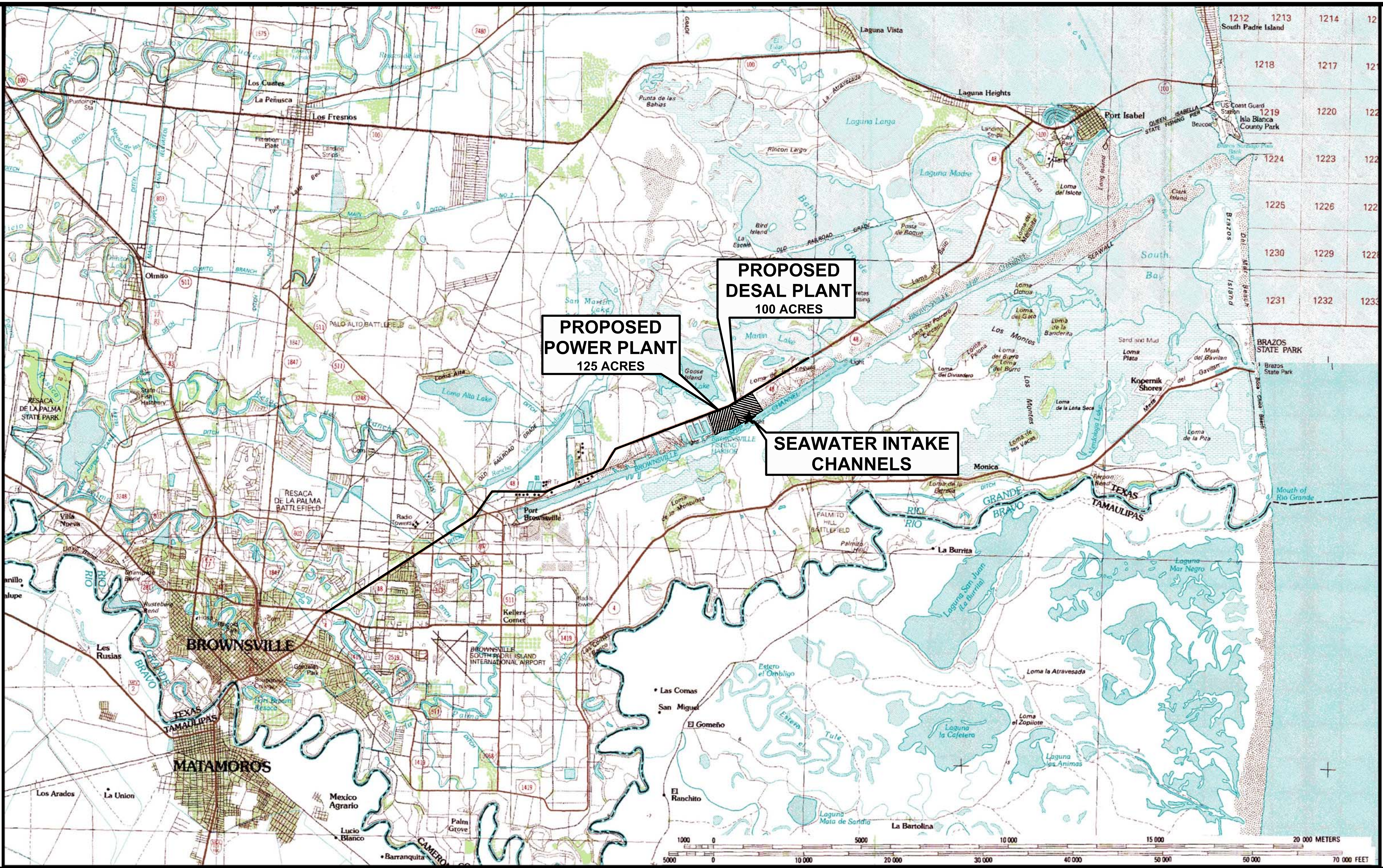
BROWNSVILLE PUBLIC UTILITIES BOARD

WELL LOCATION MAP

FIGURE 3-3

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA



Drawing Name: G:\1410\4008-01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\SITE LOCATIONS.dwg

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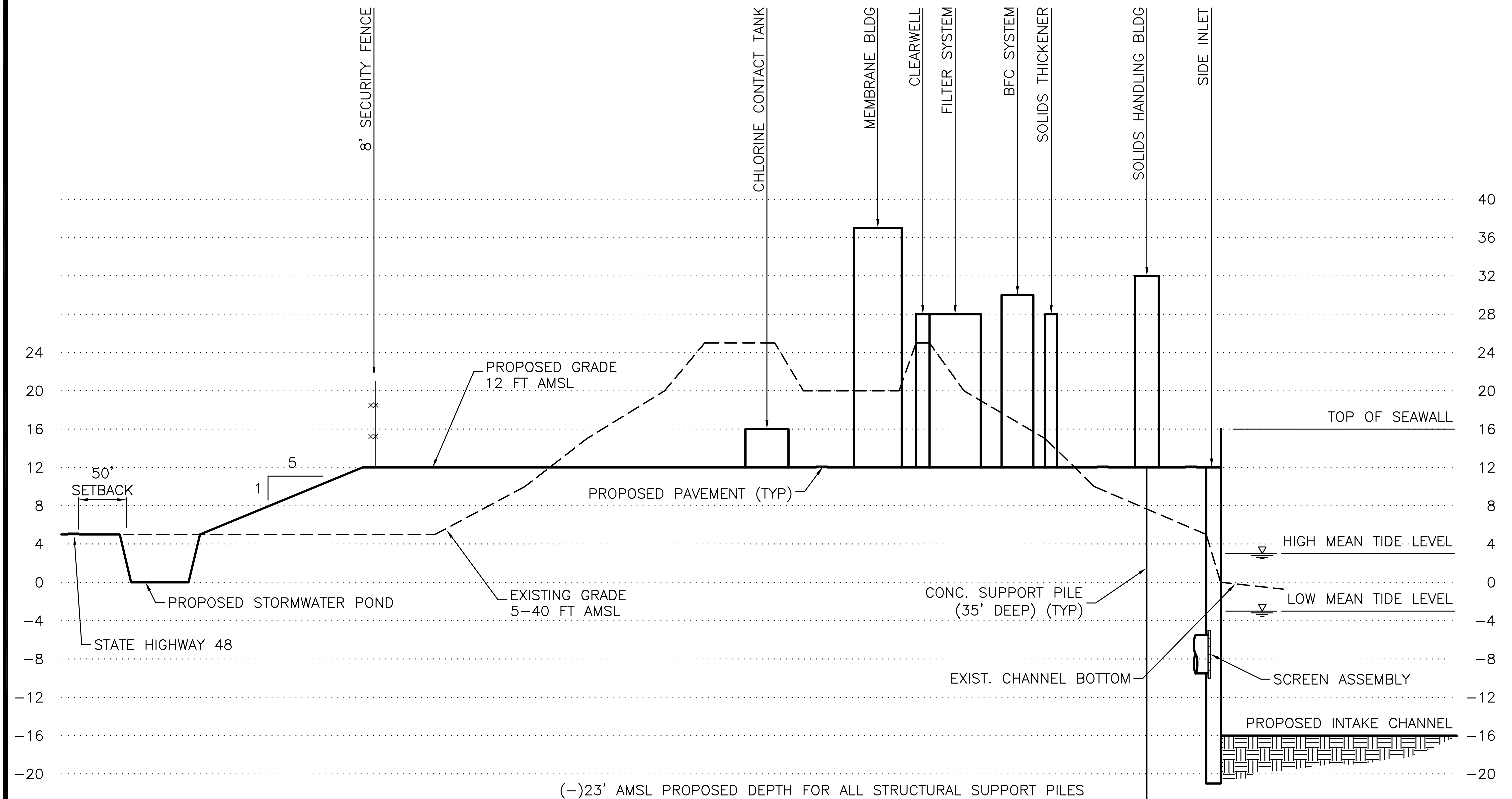
BROWNSVILLE PUBLIC UTILITIES BOARD

SITE LOCATION MAP

FIGURE 4-1

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA



NOTE: REFER TO FIGURE 4–3 FOR THE PLAN VIEW, FACILITIES AND SITE FEATURES

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BROWNSVILLE PUBLIC UTILITIES BOARD

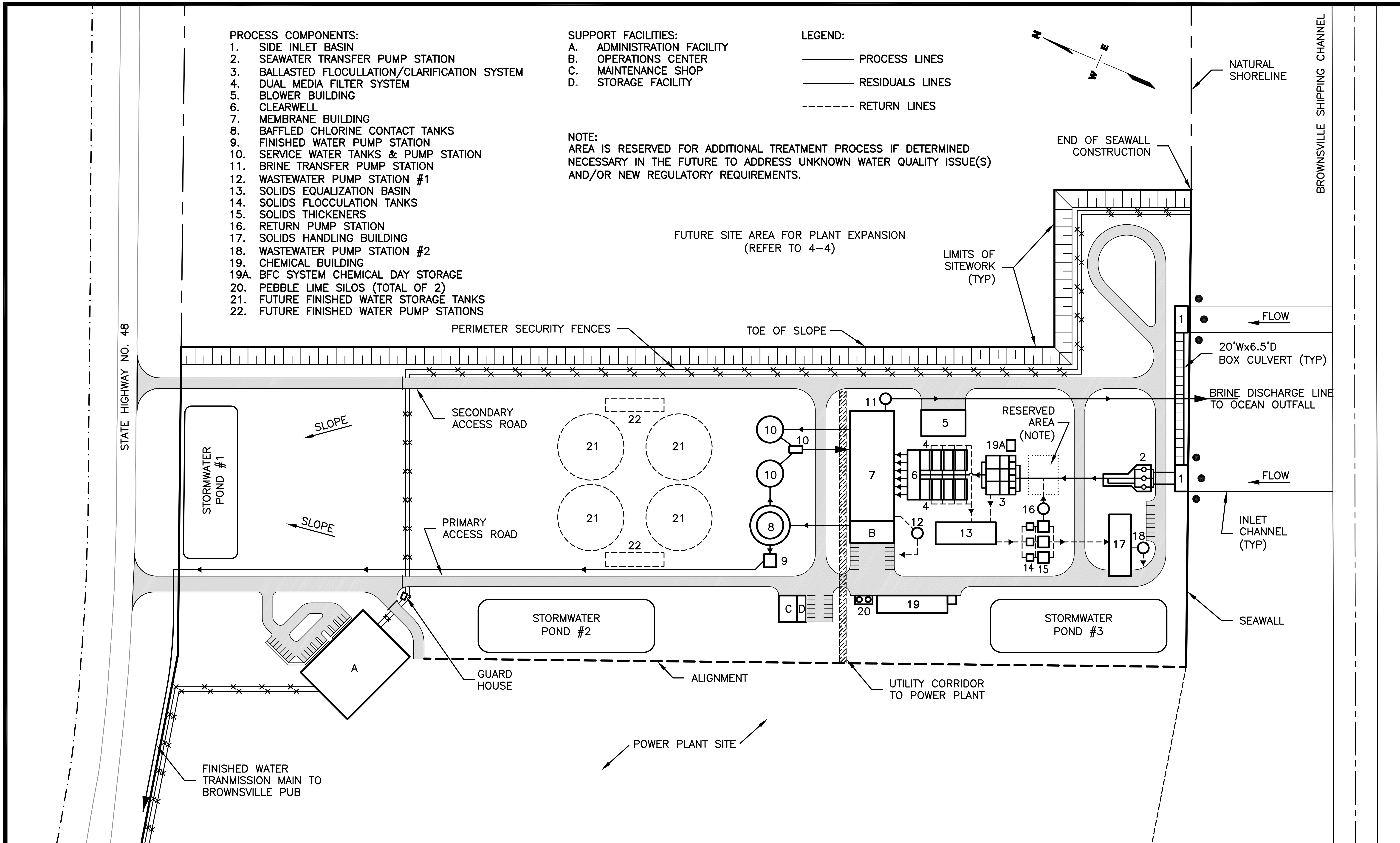
SITE DEVELOPMENT CROSS SECTION

FIGURE 4-2

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE HOME PORT TO NAFTA

Drawing Name: G:\1410\4008-01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\Site Development Cross Section.dwg



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BROWNSVILLE PUBLIC UTILITIES BOARD

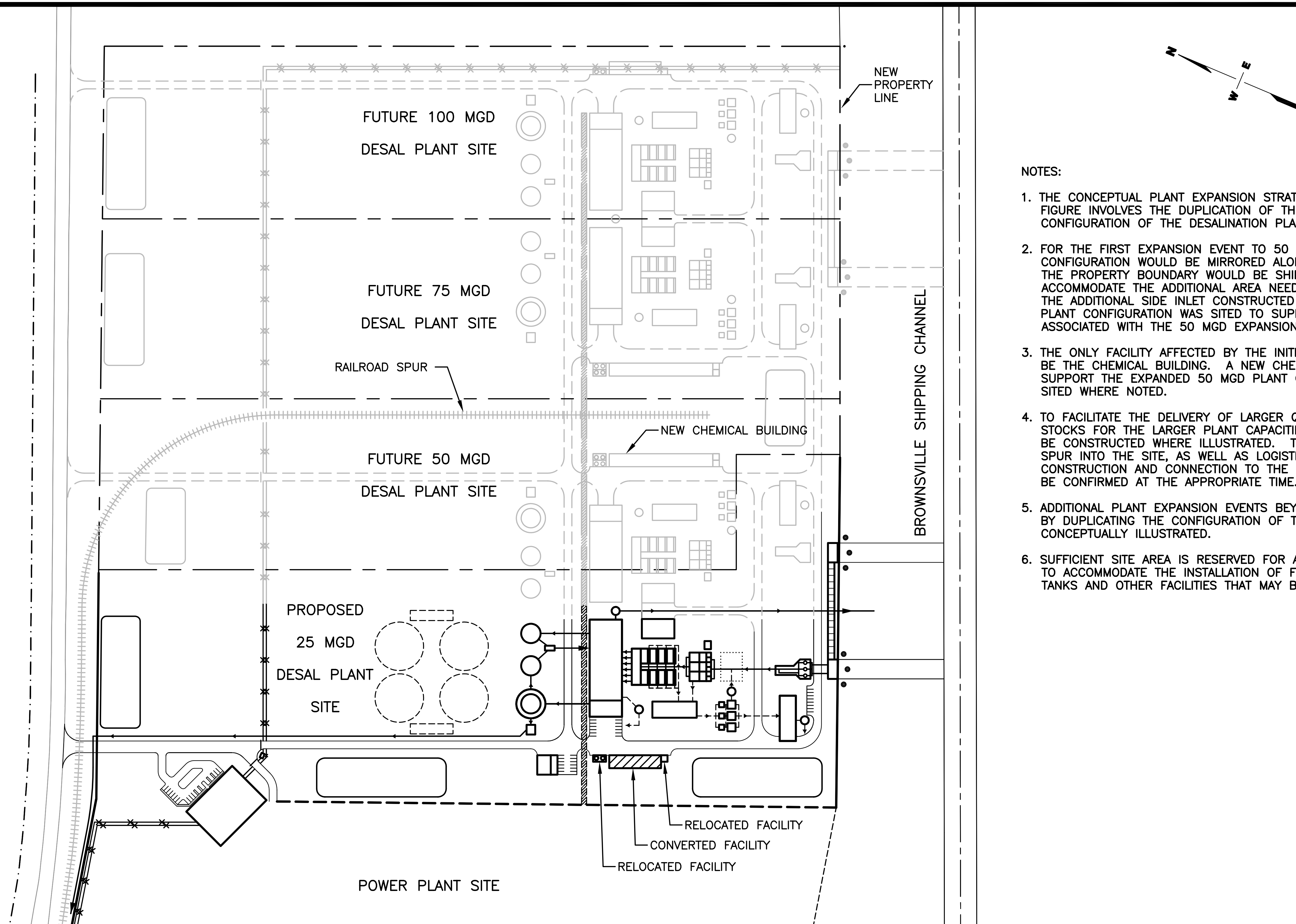
CONCEPTUAL SITE PLAN

FIGURE 4-3

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA

Drawing Name: G:\1410\4008-01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\Prelim Site Layout.dwg
Last Modified: Jun 17, 2004 – 8:43am by andersonk



NOTES:

1. THE CONCEPTUAL PLANT EXPANSION STRATEGY DEPICTED ON THIS FIGURE INVOLVES THE DUPLICATION OF THE INITIAL 25 MGD CONFIGURATION OF THE DESALINATION PLANT IN 25 MGD INCREMENTS.

2. FOR THE FIRST EXPANSION EVENT TO 50 MGD, THE INITIAL 25 MGD CONFIGURATION WOULD BE MIRRORED ALONG A HORIZONTAL AXIS AND THE PROPERTY BOUNDARY WOULD BE SHIFTED TO THE EAST TO ACCOMMODATE THE ADDITIONAL AREA NEEDED FOR THE EXPANSION. THE ADDITIONAL SIDE INLET CONSTRUCTED FOR THE INITIAL 25 MGD PLANT CONFIGURATION WAS SITED TO SUPPORT THE NEW FACILITIES ASSOCIATED WITH THE 50 MGD EXPANSION EVENT.

3. THE ONLY FACILITY AFFECTED BY THE INITIAL EXPANSION EVENT WOULD BE THE CHEMICAL BUILDING. A NEW CHEMICAL BUILDING THAT COULD SUPPORT THE EXPANDED 50 MGD PLANT CONFIGURATION WOULD BE SITED WHERE NOTED.

4. TO FACILITATE THE DELIVERY OF LARGER QUANTITIES OF CHEMICAL STOCKS FOR THE LARGER PLANT CAPACITIES, A RAILROAD SPUR COULD BE CONSTRUCTED WHERE ILLUSTRATED. THE NEED FOR A RAILROAD SPUR INTO THE SITE, AS WELL AS LOGISTICS ASSOCIATED WITH ITS CONSTRUCTION AND CONNECTION TO THE LOCAL RAILROAD SYSTEM MUST BE CONFIRMED AT THE APPROPRIATE TIME.

5. ADDITIONAL PLANT EXPANSION EVENTS BEYOND 50 MGD COULD OCCUR BY DUPLICATING THE CONFIGURATION OF THE 25 MGD PLANT SITE AS CONCEPTUALLY ILLUSTRATED.

6. SUFFICIENT SITE AREA IS RESERVED FOR ALL PLANT EXPANSION EVENTS TO ACCOMMODATE THE INSTALLATION OF FINISHED WATER STORAGE TANKS AND OTHER FACILITIES THAT MAY BE REQUIRED.

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BROWNSVILLE PUBLIC UTILITIES BOARD

CONCEPTUAL SITE PLAN FOR 100 MGD BUILD-OUT CONFIGURATION — FIGURE 4-4

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA

Drawing Name: G:\1410\4008-01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\Prelim Site Layout.dwg
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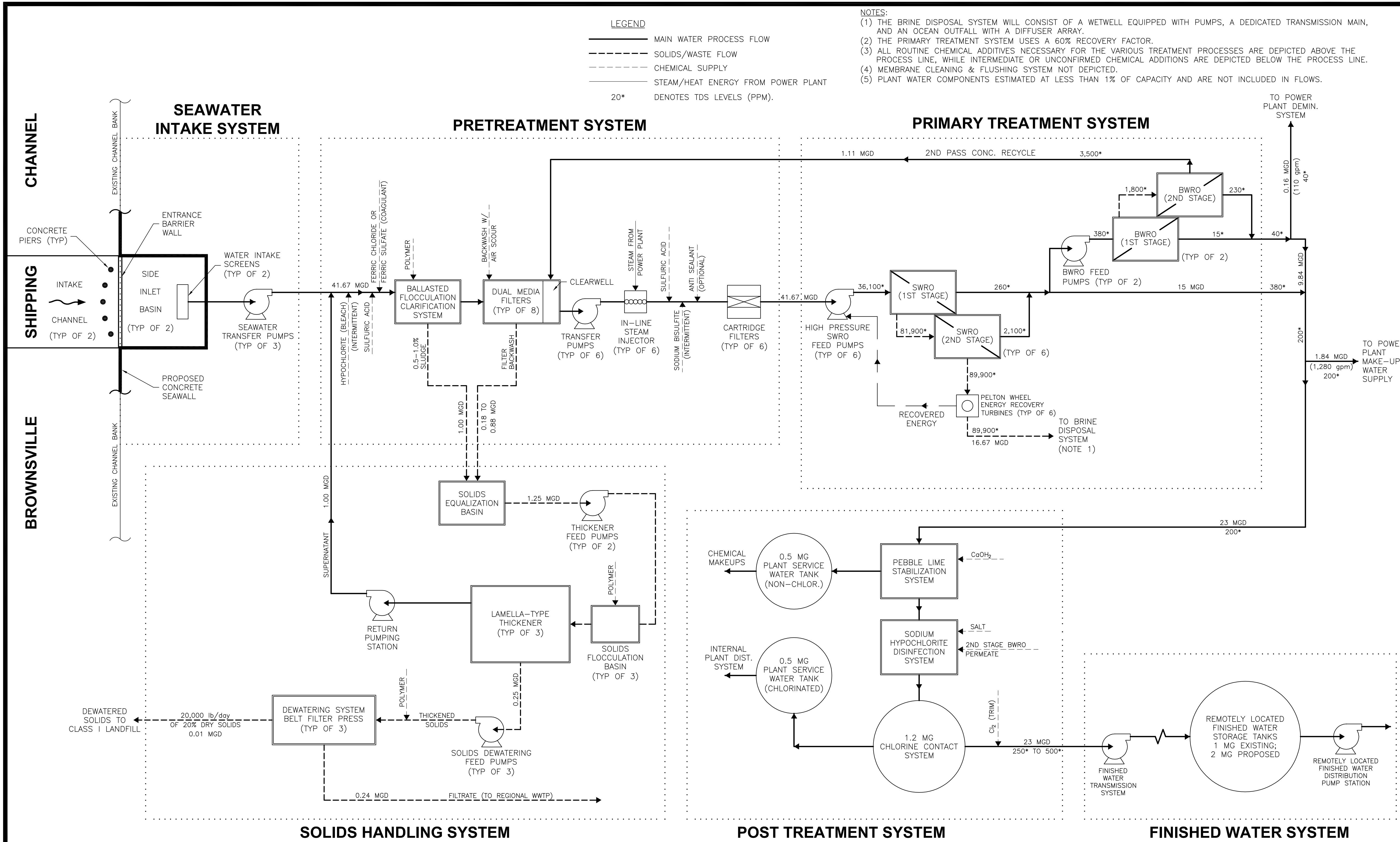

"If we could ever competitively, at a cheap rate, get freshwater from saltwater, that would be in the long-range interest of humanity and would dwarf any other scientific accomplishments."
- Pres. John F. Kennedy *April 12, 1961*

DANNENBAUM ENGINEERING CORPORATION

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- Gov. Rick Perry *April 29, 2002*

BROWNSVILLE PUBLIC UTILITIES BOARD

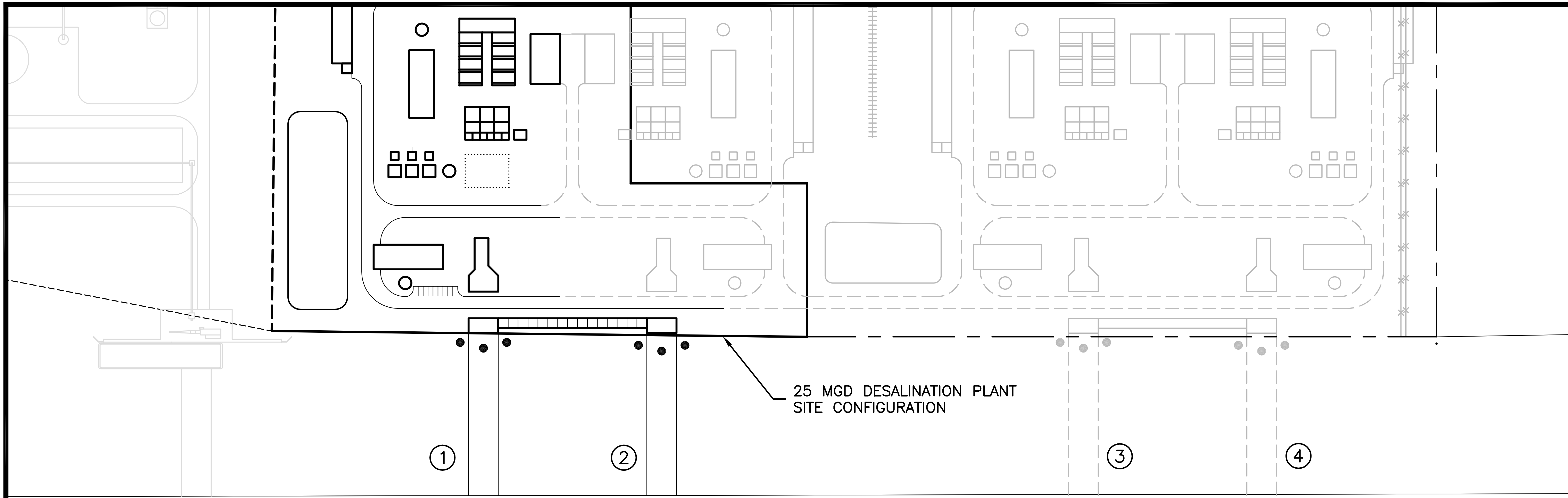
CONCEPTUAL PROCESS FLOW DIAGRAM

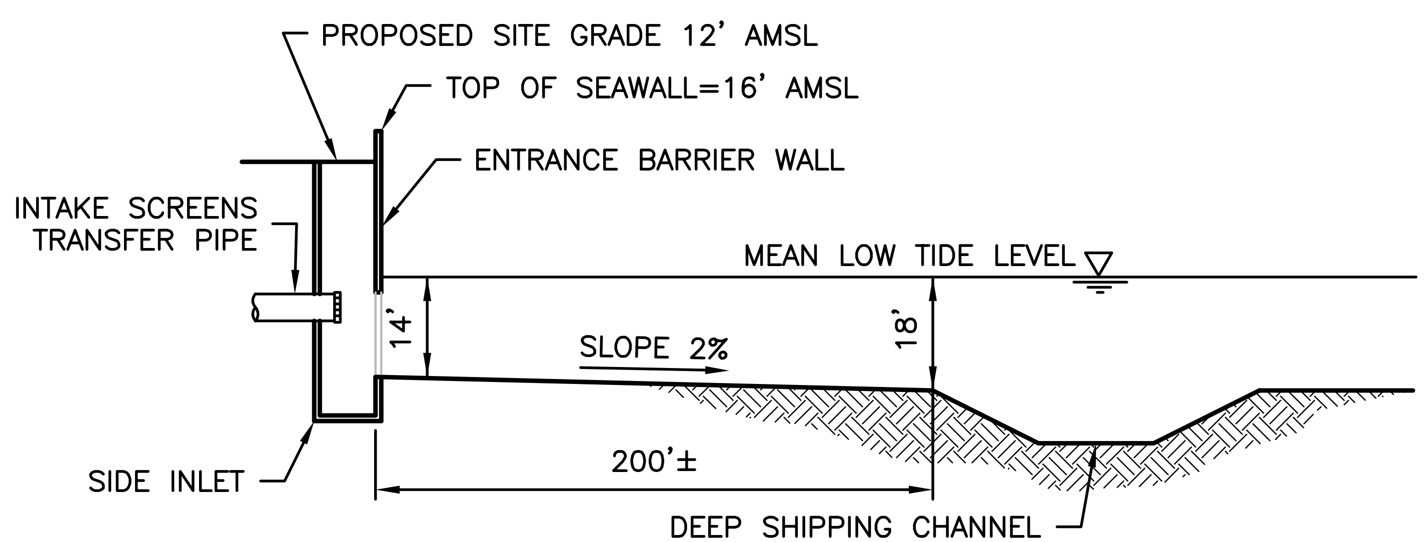
FIGURE 4-5

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA

Last Modified: Jun 22, 2004 – 9:15am by andersonk
Drawing Name: G:\1410\4008-01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\PFD.dwg





INTAKE CHANNEL PROFILE 'B–B'

CHANNEL GEOMETRY VERSUS DESAL PLANT CAPACITY (MGD)				
FINISHED WATER PRODUCTION CAPACITY (MGD)	25	50	75	100
CHANNEL INTAKE FLOW (MGD)	42	83	125	167
CHANNEL INTAKE FLOW (CFS)	64	129	193	258
NUMBER OF INTAKE CHANNELS	1	2	3	4

NOTES:
1) THE CHANNEL INTAKE FLOW IS BASED ON A SWRO 60% RECOVERY FACTOR.
2) APPROACH VELOCITIES FOR ALL FLOWS REMAIN AT 0.1 FPS OR LESS.

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- Gov. Rick Perry *April 29, 2002*

BROWNSVILLE PUBLIC UTILITIES BOARD

LOCATION AND CONFIGURATION OF INTAKE CHANNELS

FIGURE 4-6

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA

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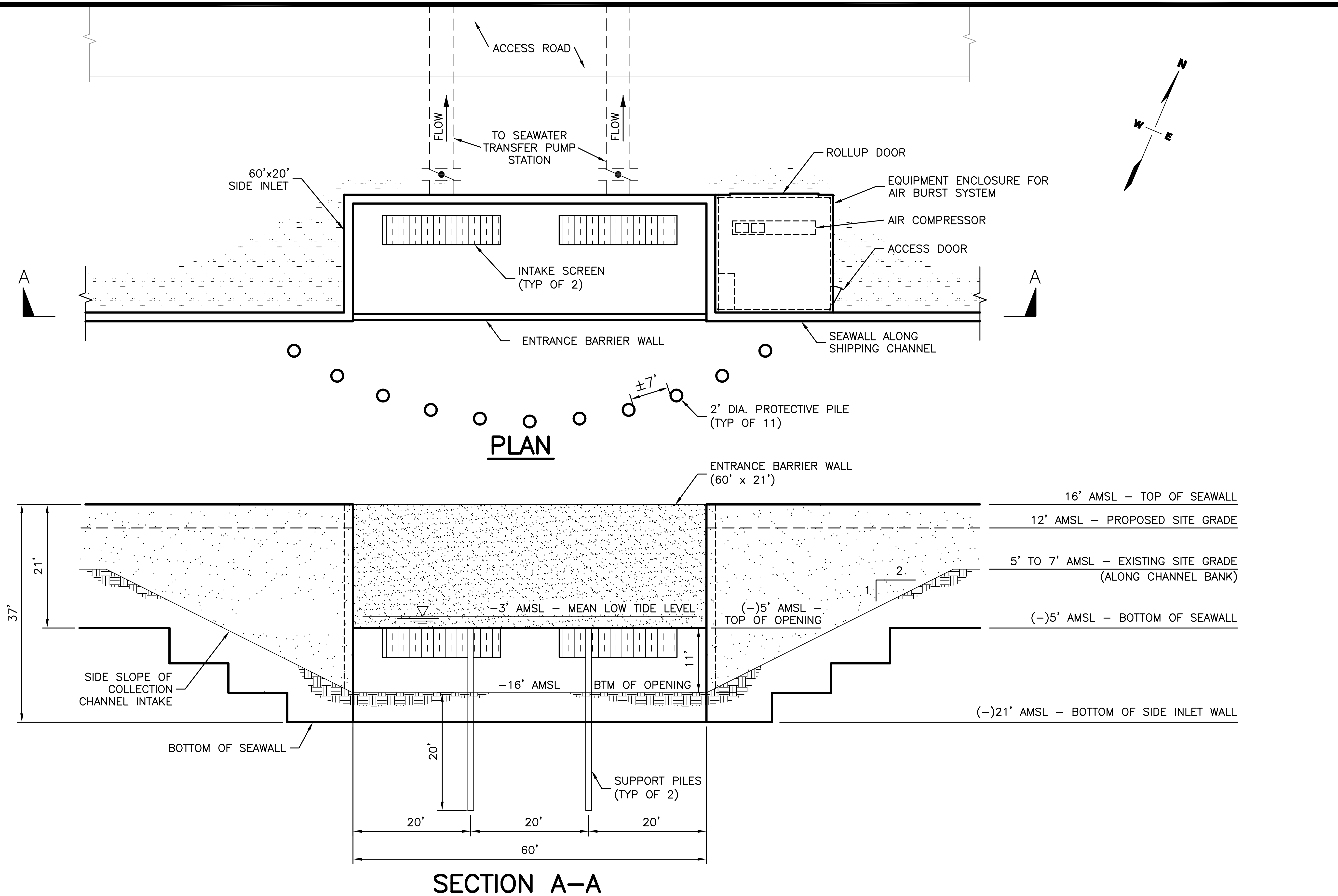
Last Modified: Jun 22, 2004 – 9:15am by andersonk



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- Gov. Rick Perry *April 29, 2002*

BROWNSVILLE PUBLIC UTILITIES BOARD

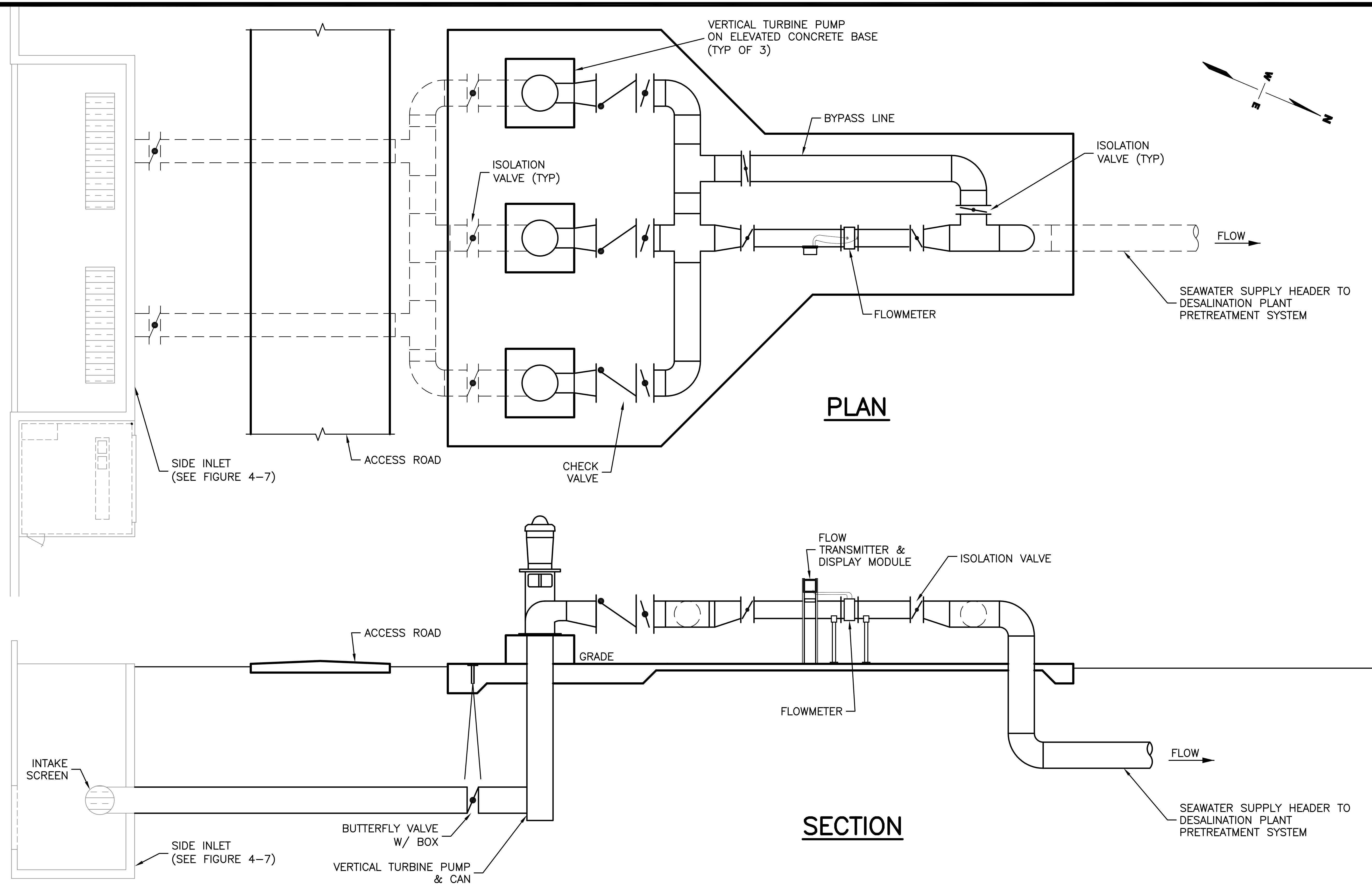
CONFIGURATION OF SIDE INLETS, ENTRANCE BARRIER WALL & SEAWATER COLLECTION SCREENS

FIGURE 4-7

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA

Drawing Name: G:\1410\4008-01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\SIDE INLET – ENTRANCE BARRIER.dwg



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- Gov. Rick Perry *April 29, 2002*

BROWNSVILLE PUBLIC UTILITIES BOARD

CONFIGURATION OF SEAWATER TRANSFER PUMPING SYSTEM

FIGURE 4-8

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA

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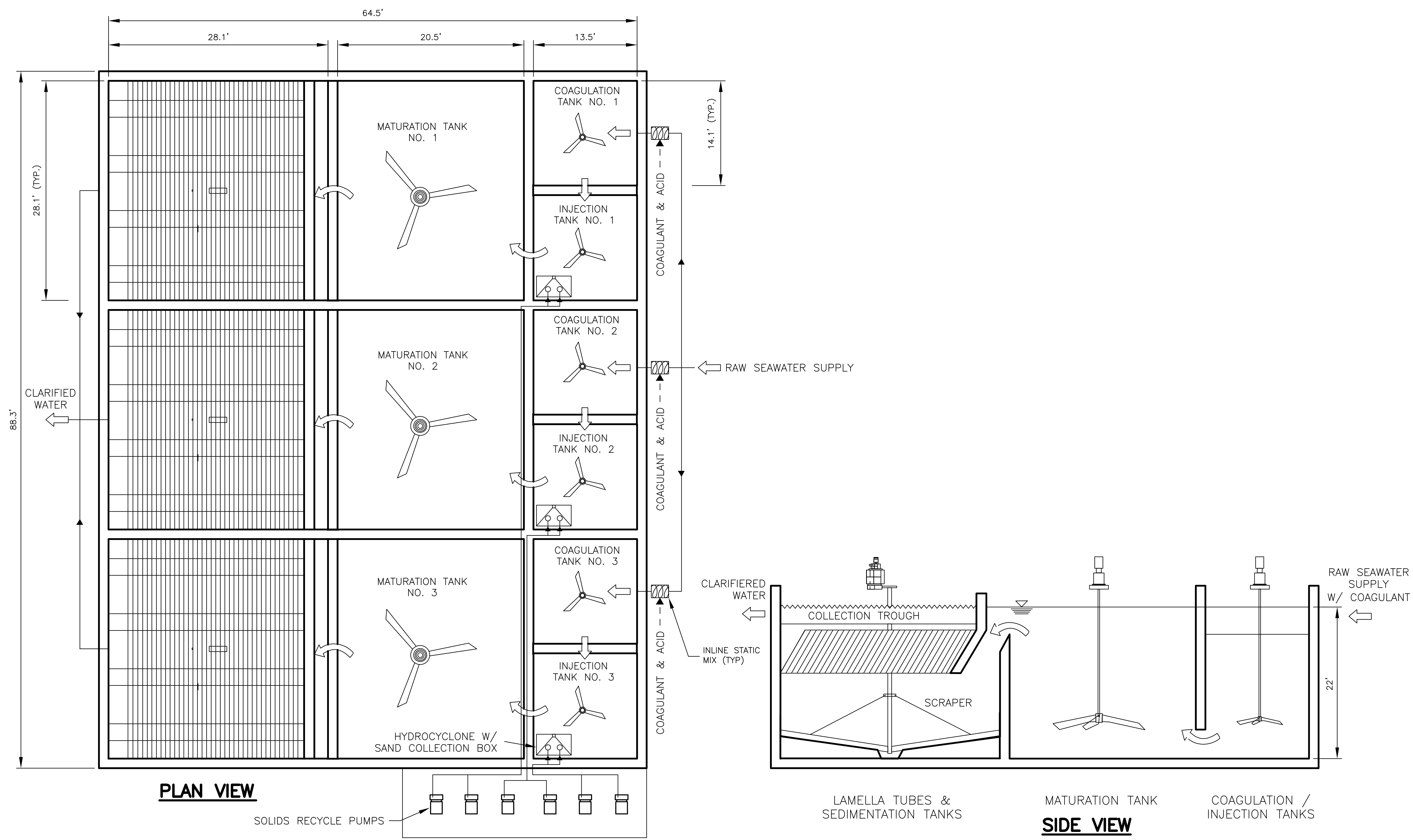

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- Gov. Rick Perry *April 29, 2002*

BROWNSVILLE PUBLIC UTILITIES BOARD

PRELIMINARY LAYOUT OF THE BALLASTED FLOCCULATION AND CLARIFICATION SYSTEM FIGURE 4-9

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE HOME PORT TO NAFTA

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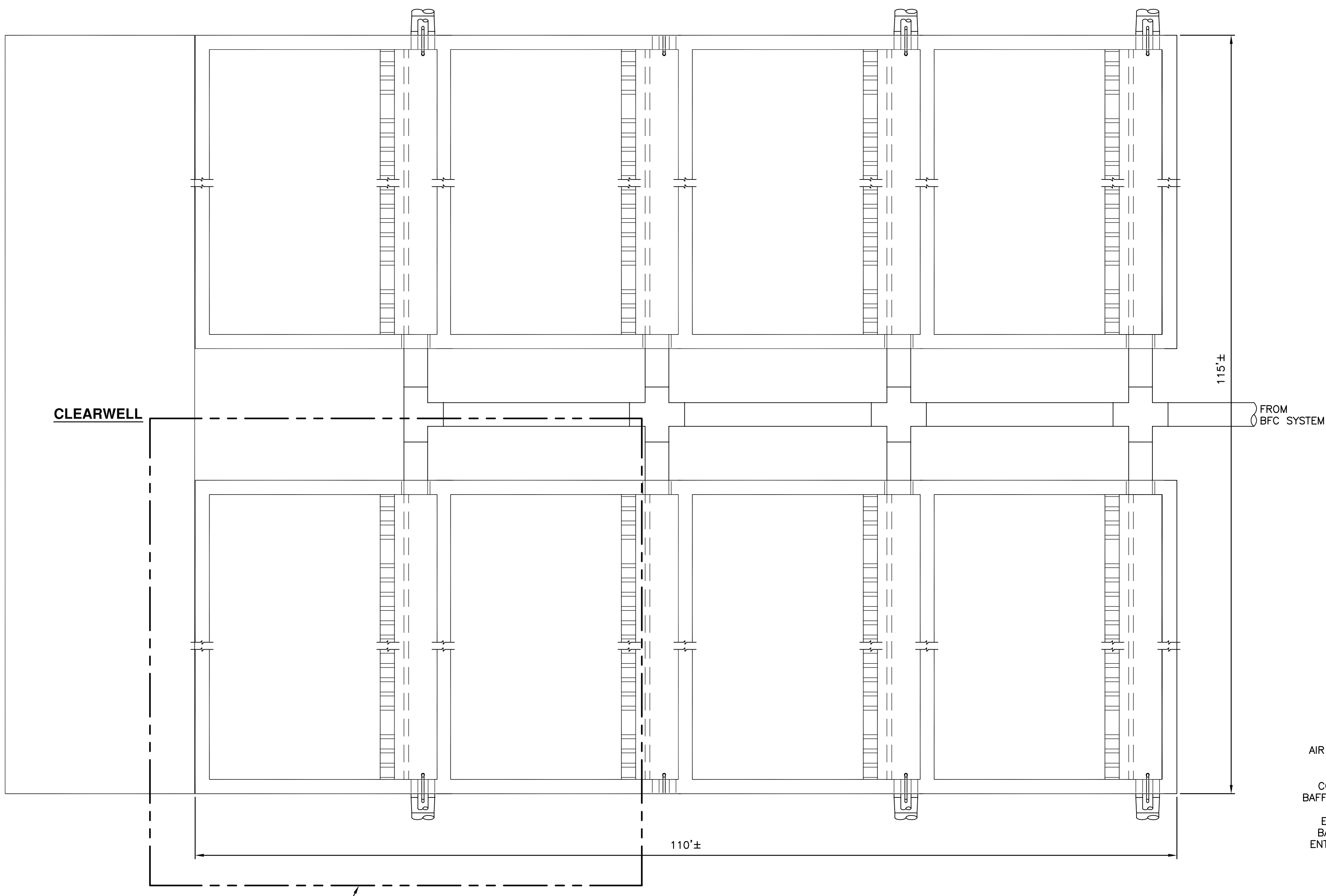
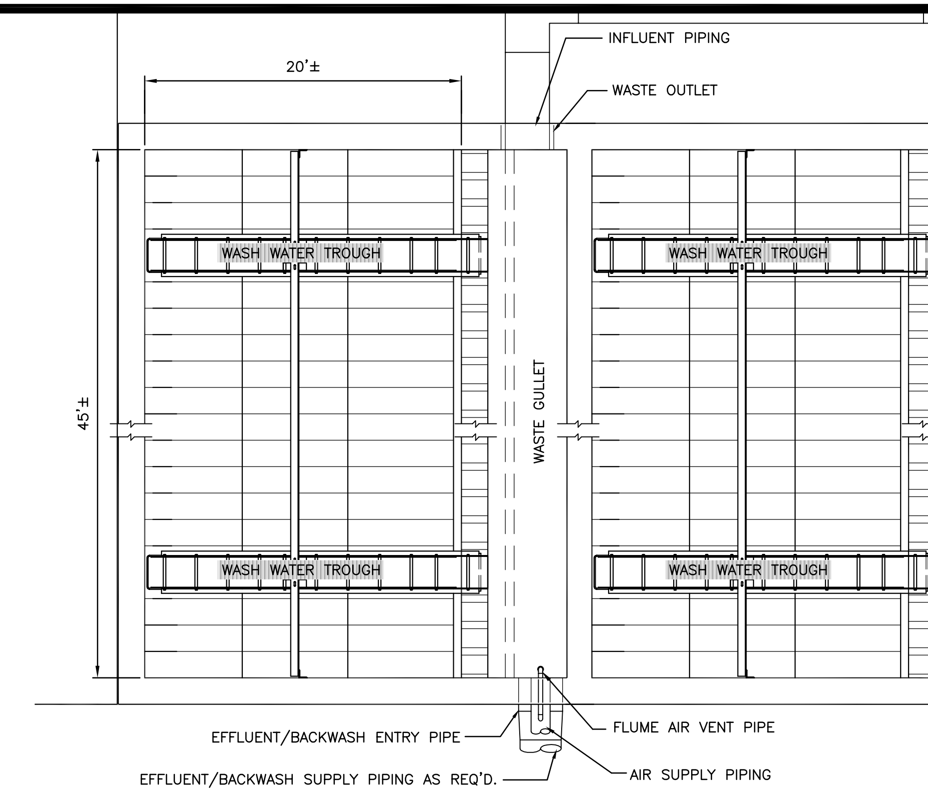
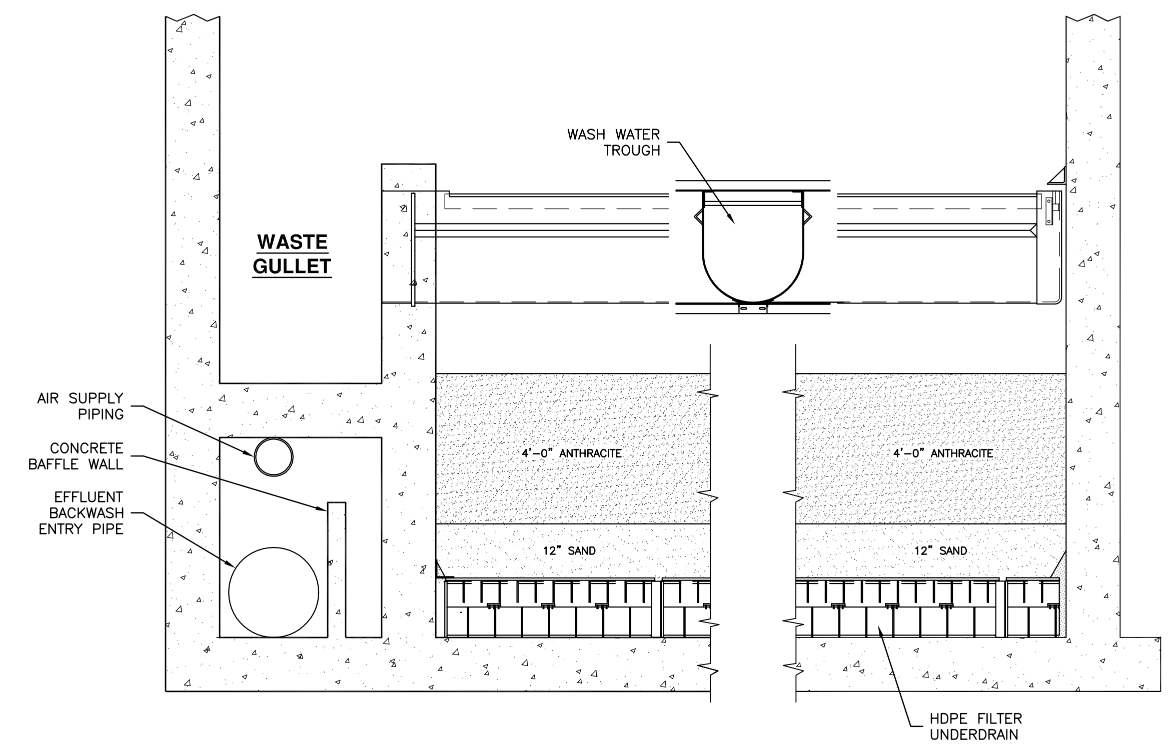


PLAN VIEW OF FILTER LAYOUT



DETAIL PLAN VIEW OF FILTER



TYPICAL FILTER SECTION

"If we could ever competitively, at a cheap rate, get freshwater from saltwater, that would be in the long-range interest of humanity and would dwarf any other scientific accomplishments."
- Pres. John F. Kennedy *April 12, 1961*

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- Gov. Rick Perry *April 29, 2002*

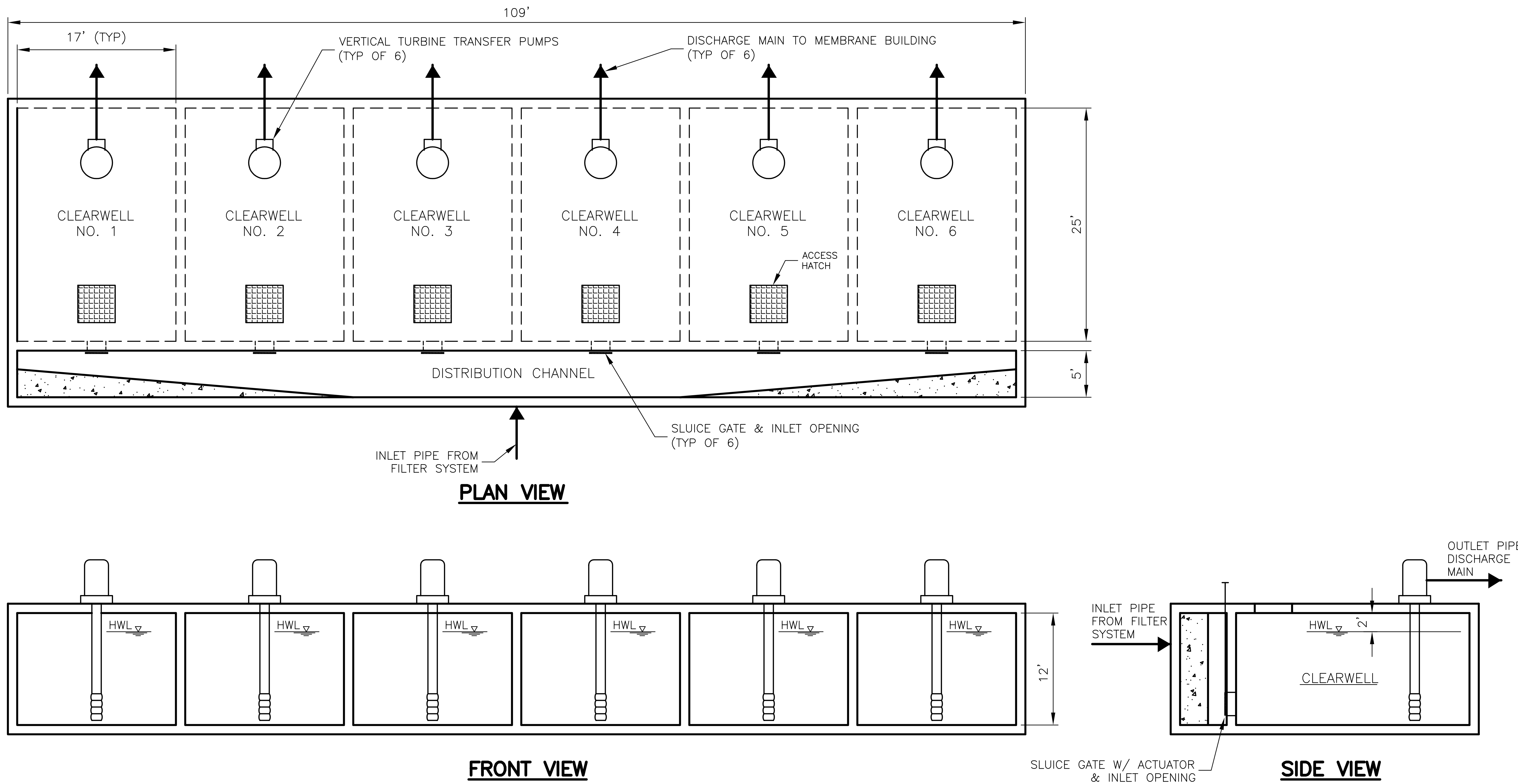
BROWNSVILLE PUBLIC UTILITIES BOARD

PRELIMINARY LAYOUT OF THE SINGLE-STAGE, DUAL-MEDIA FILTRATION SYSTEM FIGURE 4-10

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE HOME PORT TO NAFTA

Last Modified: Jun 17, 2004 – 8:15am by andersonk
Drawing Name: G:\1410\4008-01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\FILTRATION SYSTEM.dwg



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- Pres. John F. Kennedy *April 12, 1961*

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- Gov. Rick Perry *April 29, 2002*

BROWNSVILLE PUBLIC UTILITIES BOARD

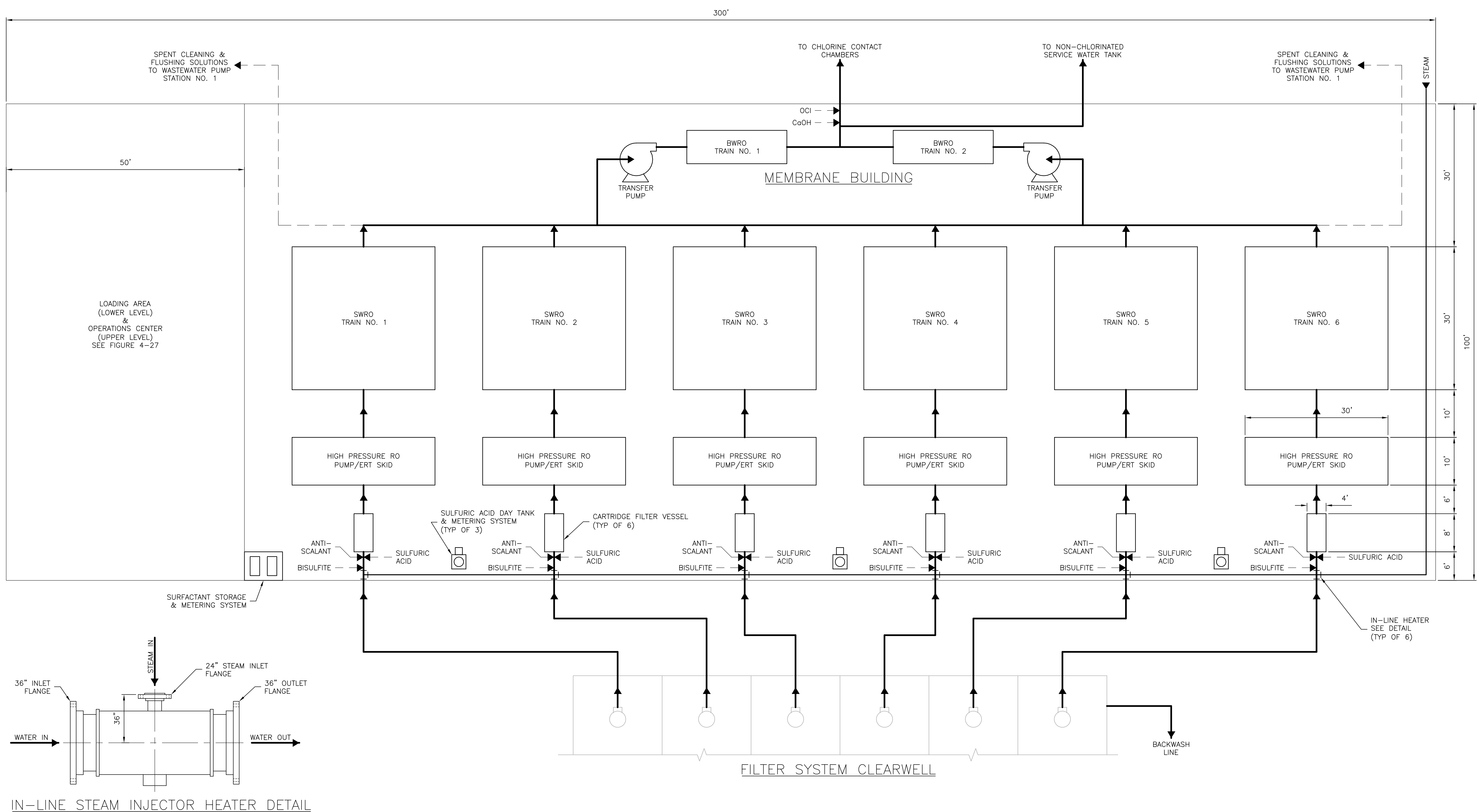
LAYOUT OF FILTER CLEARWELL & TRANSFER PUMPING SYSTEM

FIGURE 4-11

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE HOME PORT TO NAFTA

Drawing Name: G:\1410\4008-01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\CLEARWELL.dwg



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- Gov. Rick Perry *April 29, 2002*

BROWNSVILLE PUBLIC UTILITIES BOARD

CONCEPTUAL CONFIGURATION OF TREATMENT SYSTEM COMPONENTS IN MEMBRANE BUILDING

FIGURE 4-12

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE HOME PORT TO NAFTA

Last Modified: Jun 17, 2004 - 8:19am by andersonk
Drawing Name: G:\1410\4008-01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\MEMBRANE BLDG.dwg

"If we could ever competitively, at a cheap rate, get freshwater from saltwater, that would be in the long-range interest of humanity and would dwarf any other scientific accomplishments."
- Pres. John F. Kennedy *April 12, 1961*

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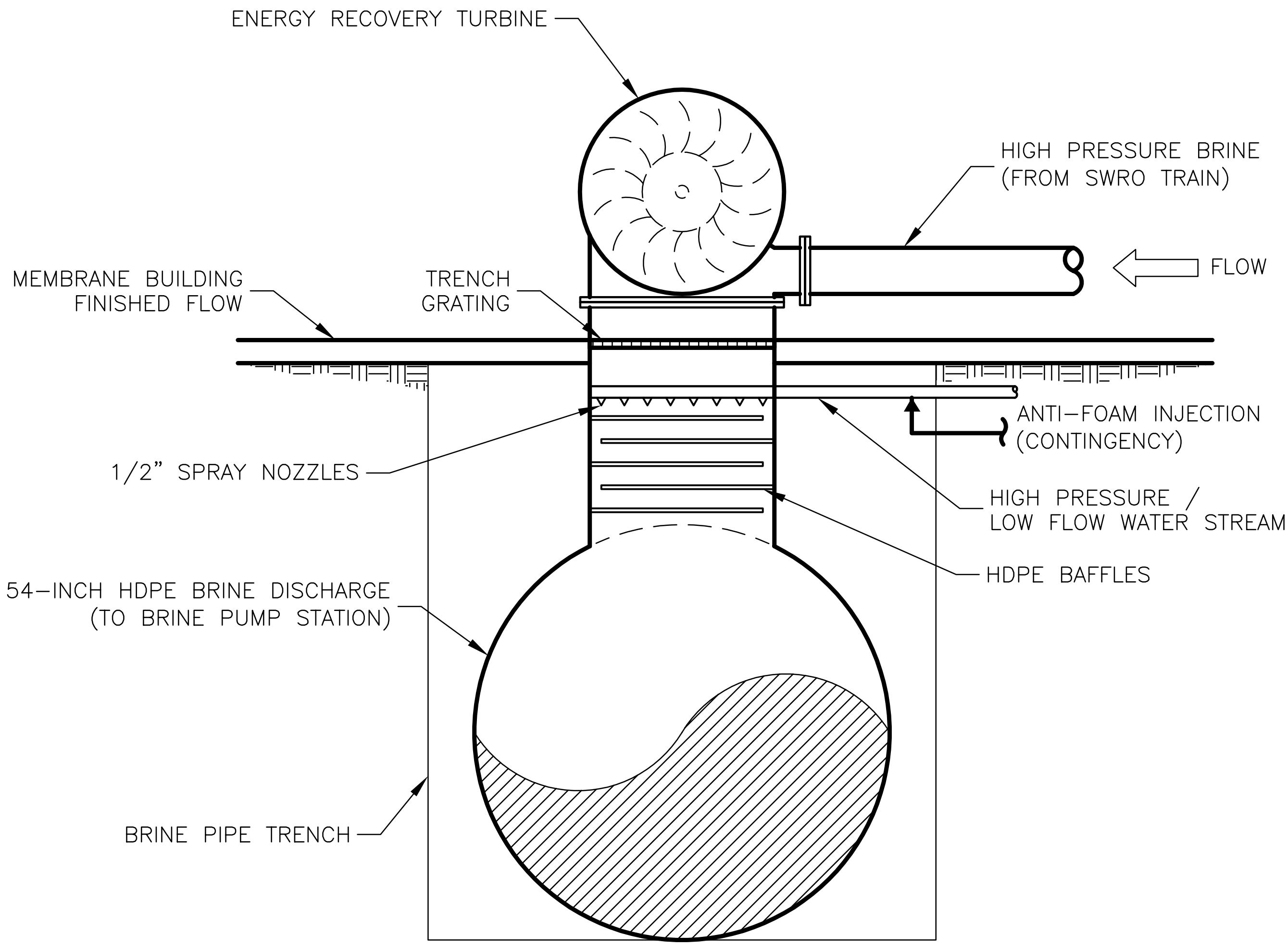
- Gov. Rick Perry *April 29, 2002*



Drawing Name: G:\1410\4008-01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\ANTI-FOAM.dwg

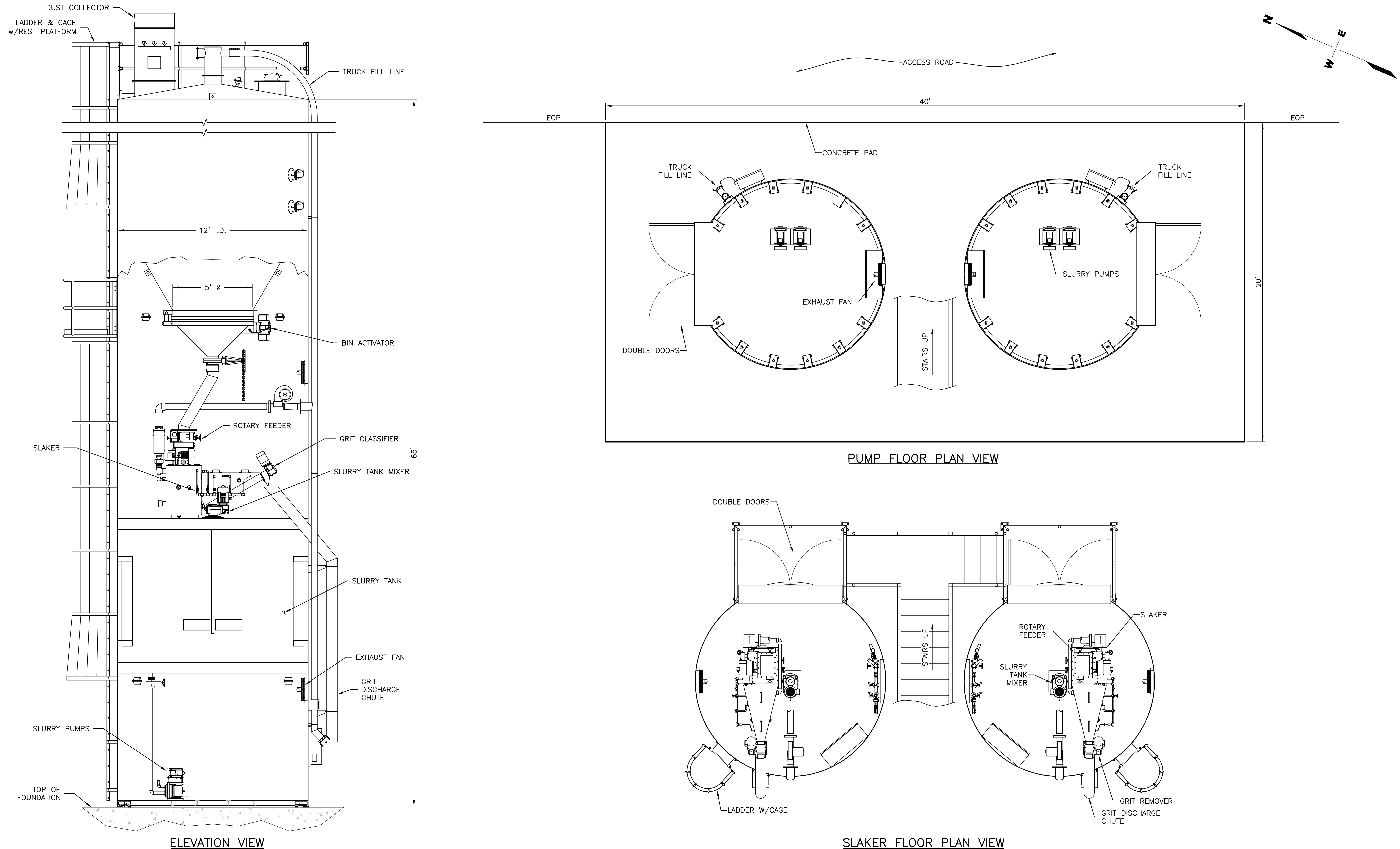
BROWNSVILLE PUBLIC UTILITIES BOARD

CONCEPTUAL SCHEMATIC FOR ANTI-FOAM CHAMBER

FIGURE 4-13

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA



"If we could ever competitively, at a cheap rate, get freshwater from saltwater, that would be in the long-range interest of humanity and would dwarf any other scientific accomplishments."
- Pres. John F. Kennedy *April 12, 1961*

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- Gov. Rick Perry *April 29, 2002*

BROWNSVILLE PUBLIC UTILITIES BOARD

CONCEPTUAL CONFIGURATION OF PEBBLE LIME SYSTEM

FIGURE 4-14

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE HOME PORT TO NAFTA

Last Modified: Jun 17, 2004 - 8:25am by andersonk
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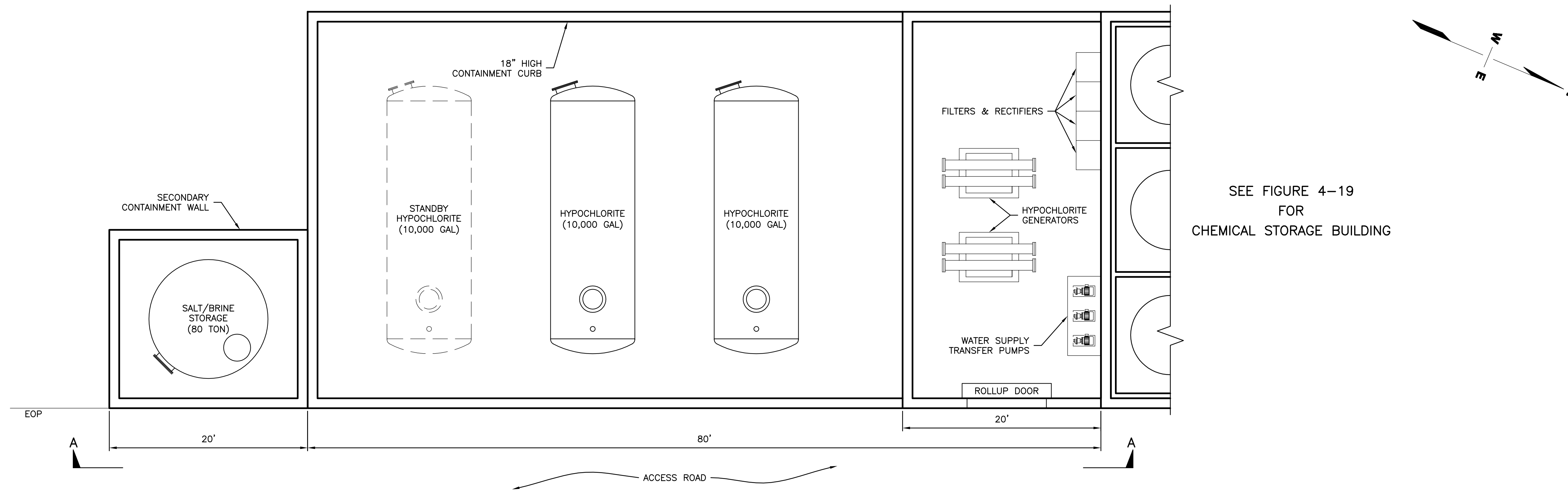
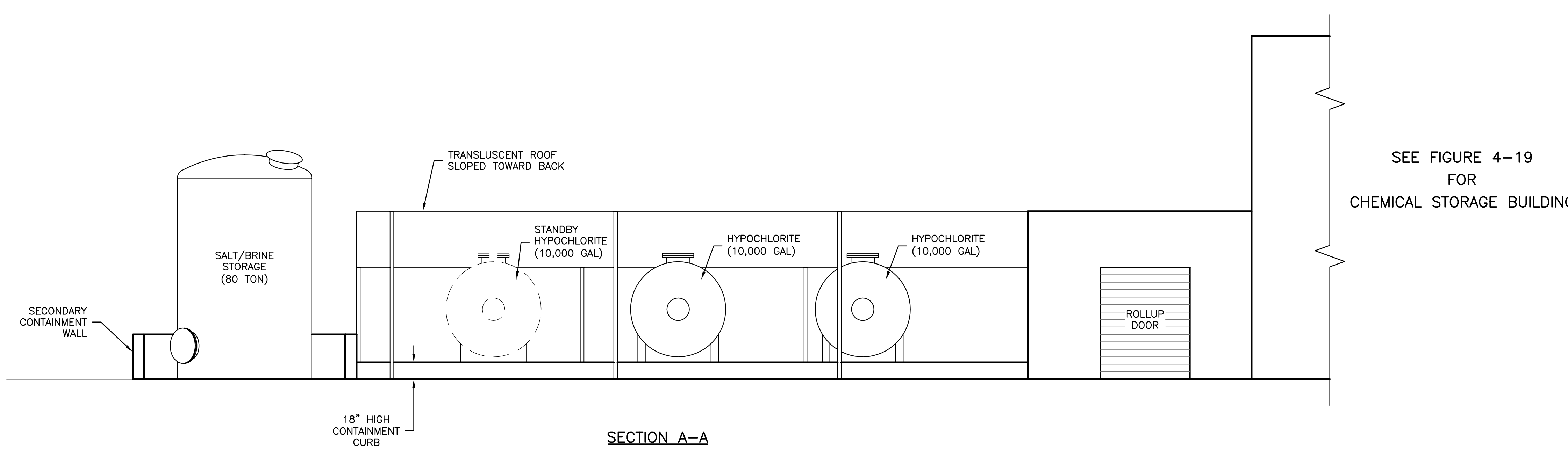


ON–SITE SODIUM HYPOCHLORITE
GENERATION SYSTEM



SECTION A–A

"If we could ever competitively, at a cheap rate, get freshwater from saltwater, that would be in the long-range interest of humanity and would dwarf any other scientific accomplishments."
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- Gov. Rick Perry *April 29, 2002*

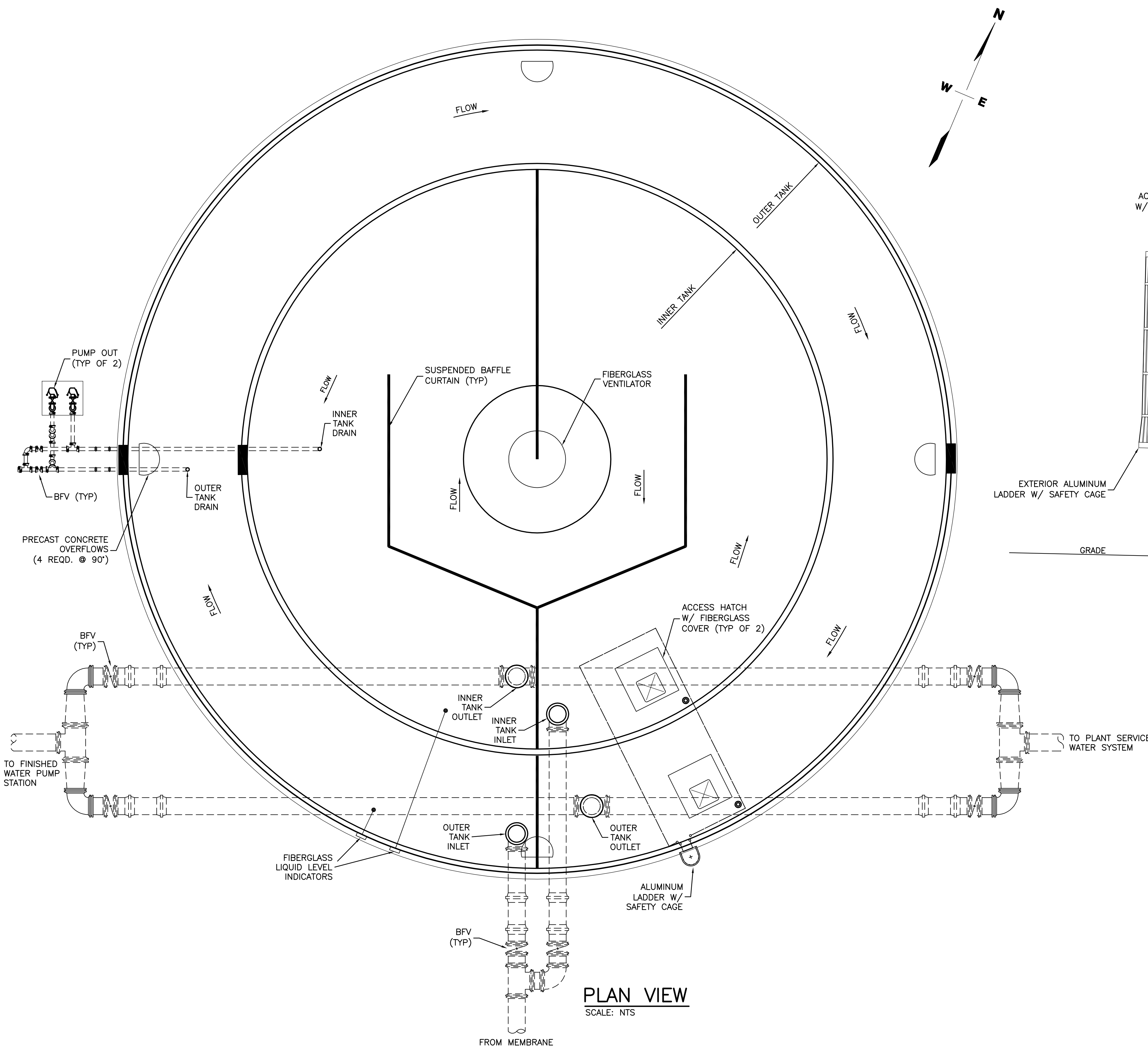
BROWNSVILLE PUBLIC UTILITIES BOARD

CONCEPTUAL CONFIGURATION OF ON-SITE HYPOCHLORITE GENERATION SYSTEM

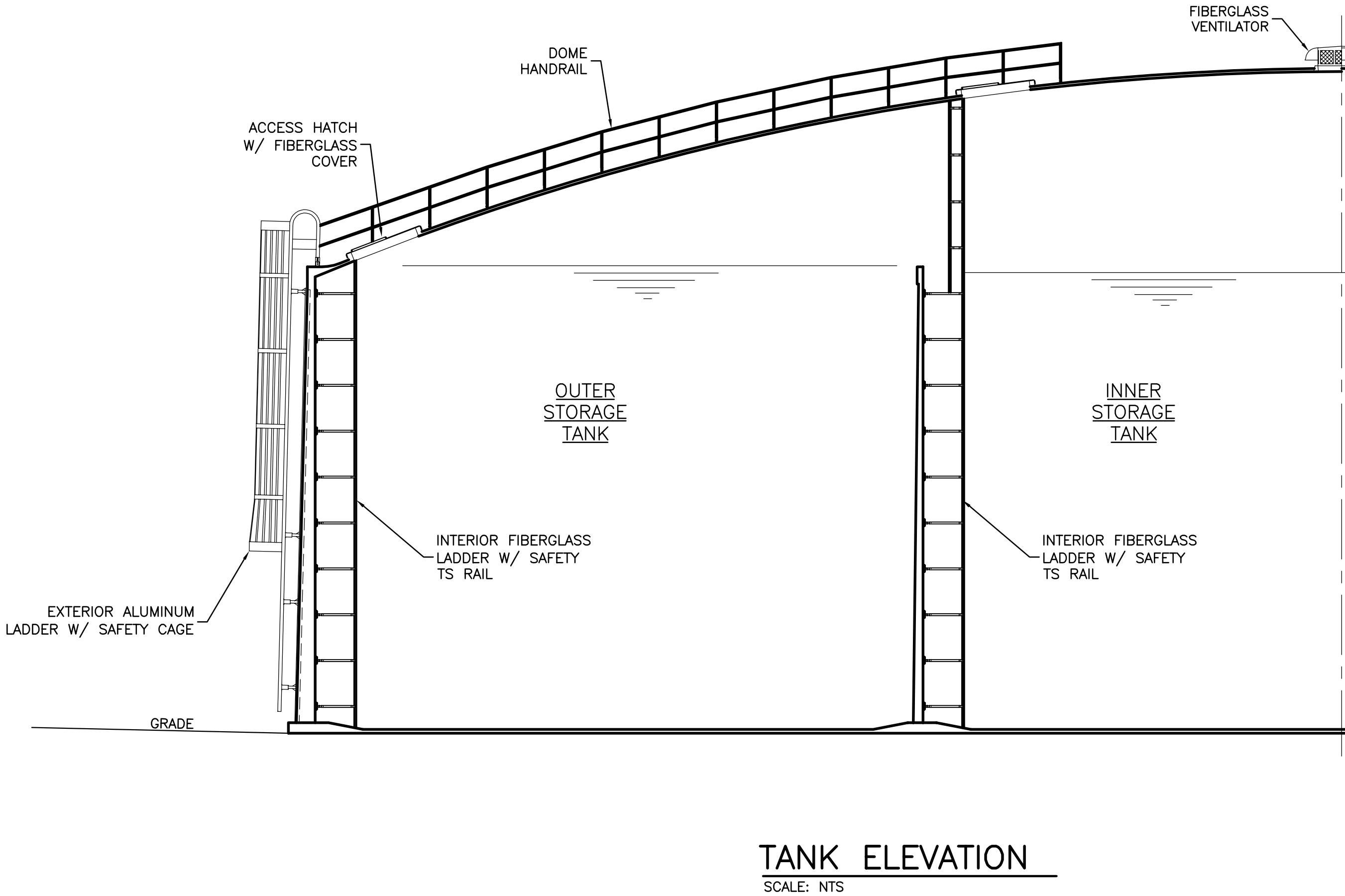
FIGURE 4-15

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA



PLAN VIEW
SCALE: NTS



TANK ELEVATION
SCALE: NTS

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- Gov. Rick Perry *April 29, 2002*

BROWNSVILLE PUBLIC UTILITIES BOARD

CONCEPTUAL CONFIGURATION OF CHLORINE CONTACT CHAMBERS

FIGURE 4-16

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA

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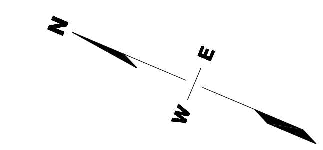
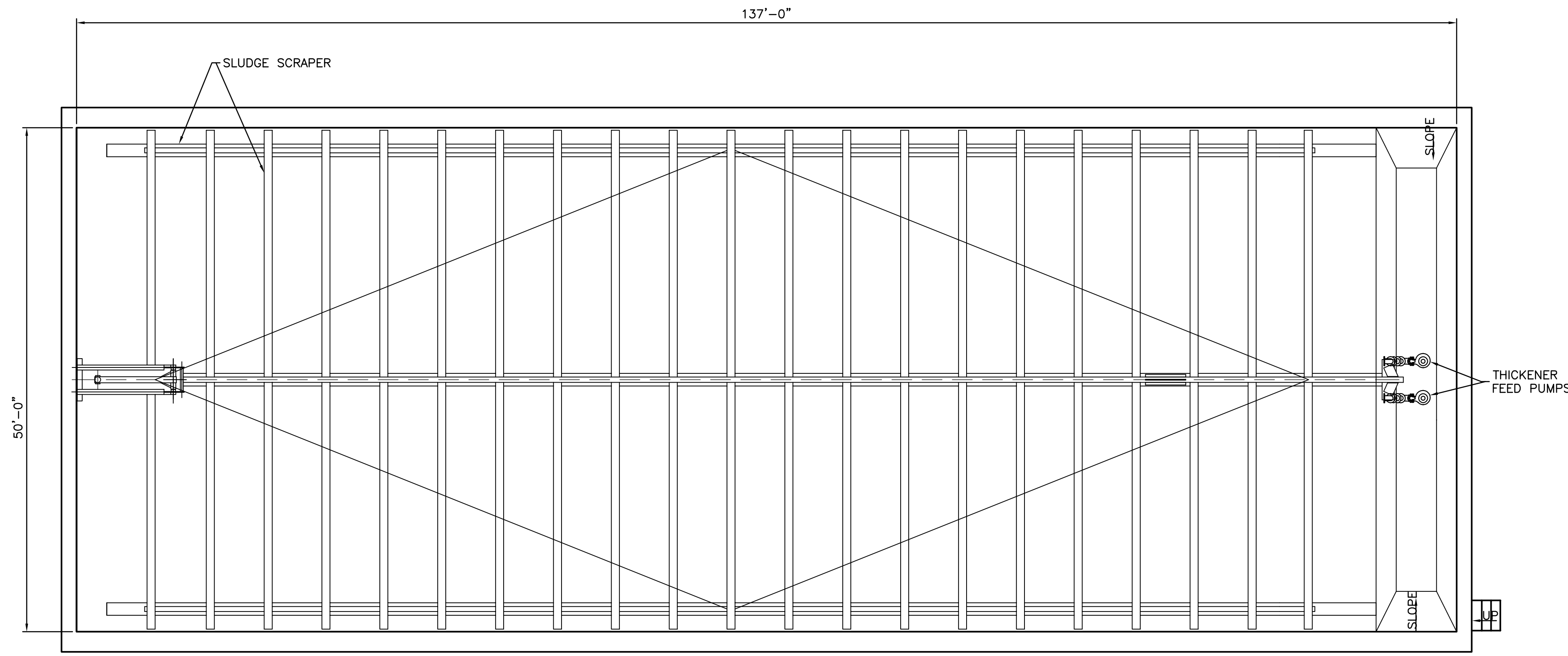
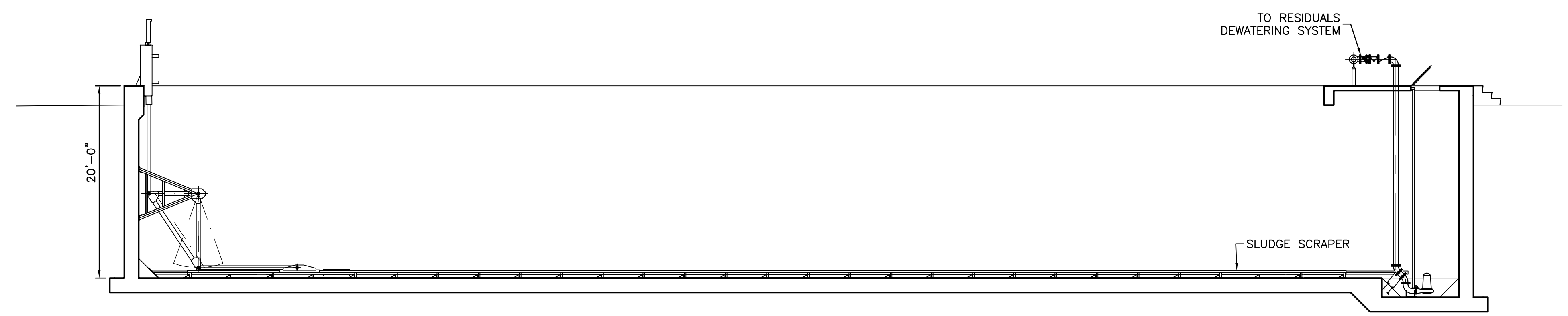




PLAN



SECTION A–A

"If we could ever competitively, at a cheap rate, get freshwater from saltwater, that would be in the long-range interest of humanity and would dwarf any other scientific accomplishments."
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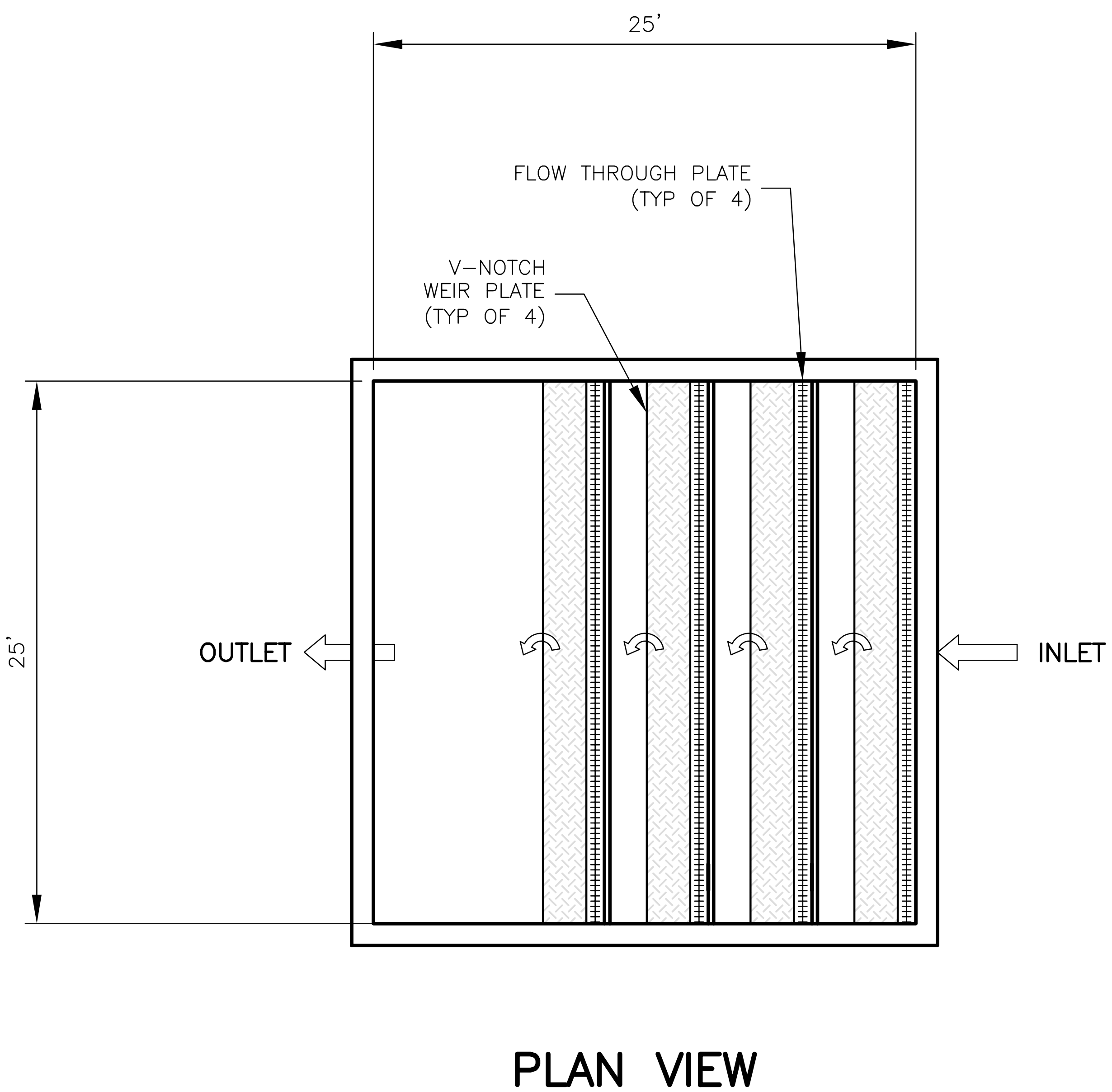
- Gov. Rick Perry *April 29, 2002*

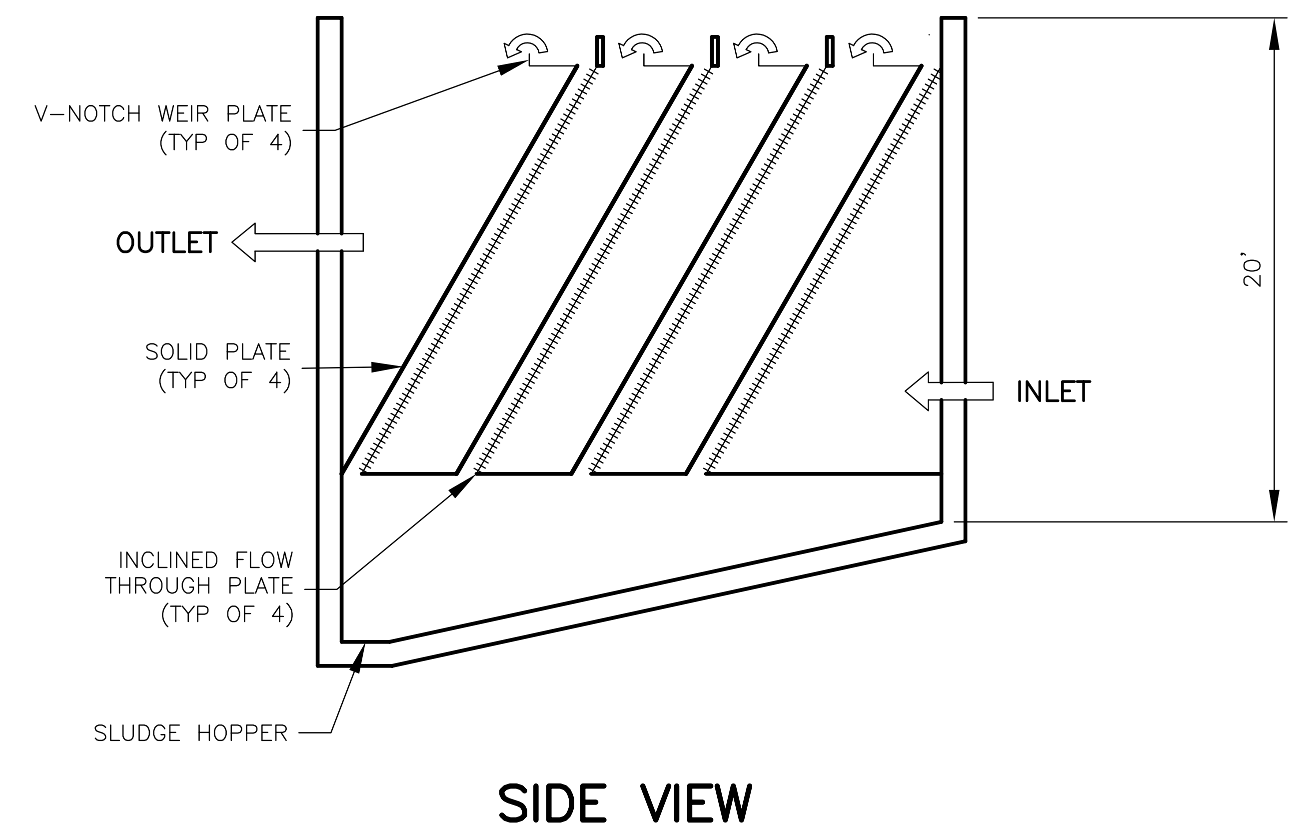
BROWNSVILLE
PUBLIC UTILITIES BOARD

CONCEPTUAL CONFIGURATION OF SOLIDS EQUALIZATION BASIN FIGURE 4-17

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA





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- Pres. John F. Kennedy *April 12, 1961*

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- Gov. Rick Perry *April 29, 2002*

BROWNSVILLE PUBLIC UTILITIES BOARD

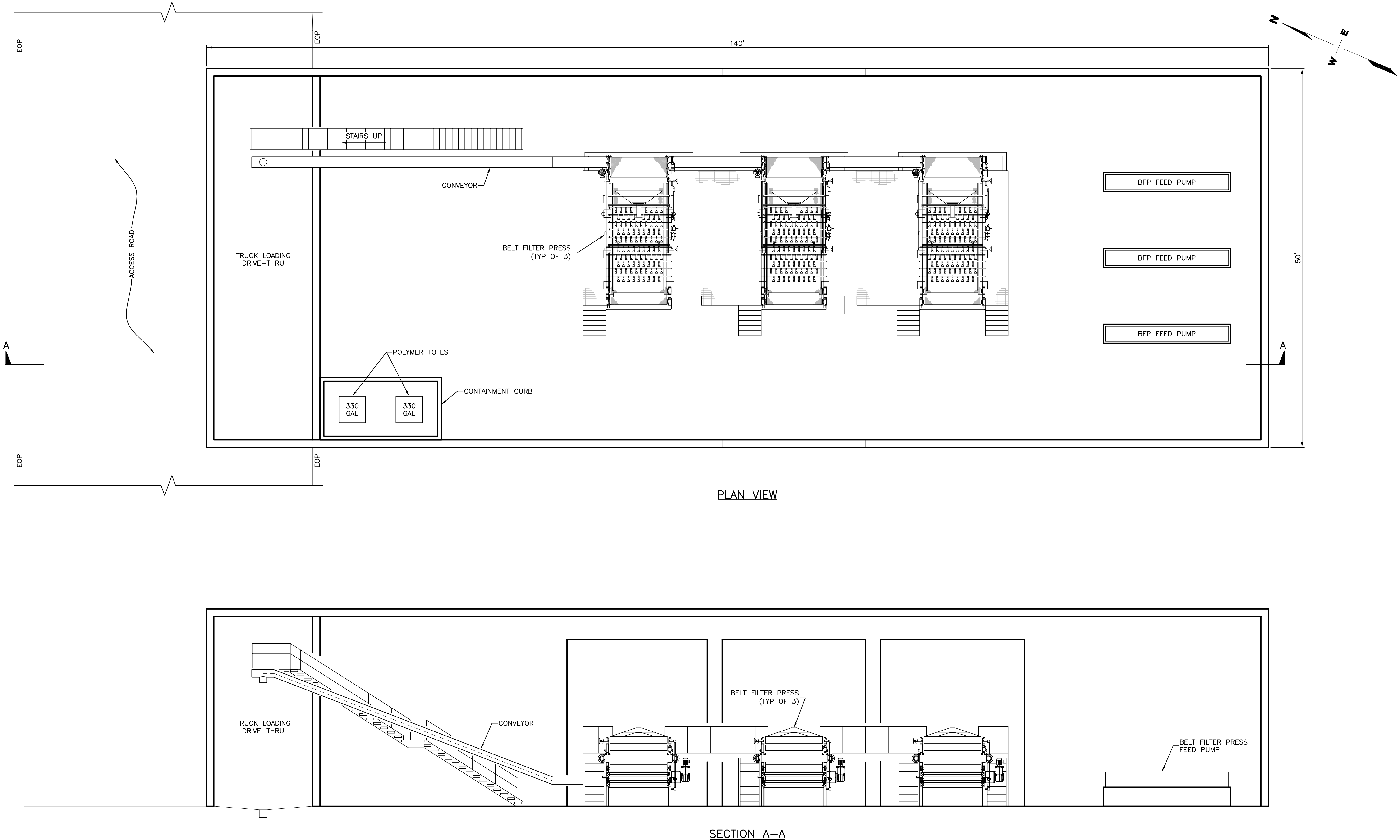
CONCEPTUAL CONFIGURATION OF SOLIDS THICKENING SYSTEM

FIGURE 4-18

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE HOME PORT TO NAFTA

Drawing Name: G:\1410\4008-01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\SOLIDS THICKENING.dwg



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- Gov. Rick Perry *April 29, 2002*

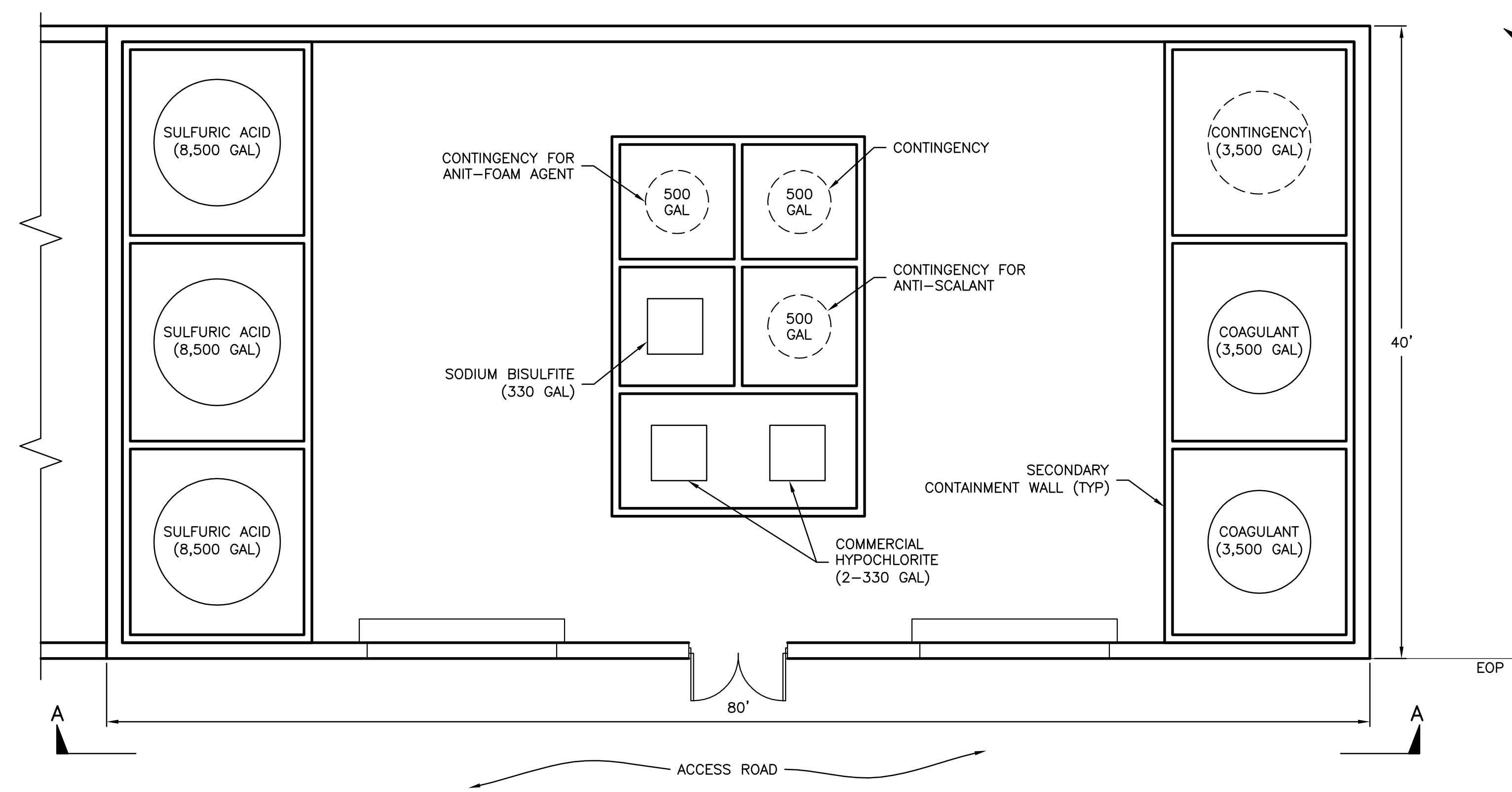
BROWNSVILLE PUBLIC UTILITIES BOARD

CONFIGURATION OF RESIDUALS DEWATERING SYSTEM

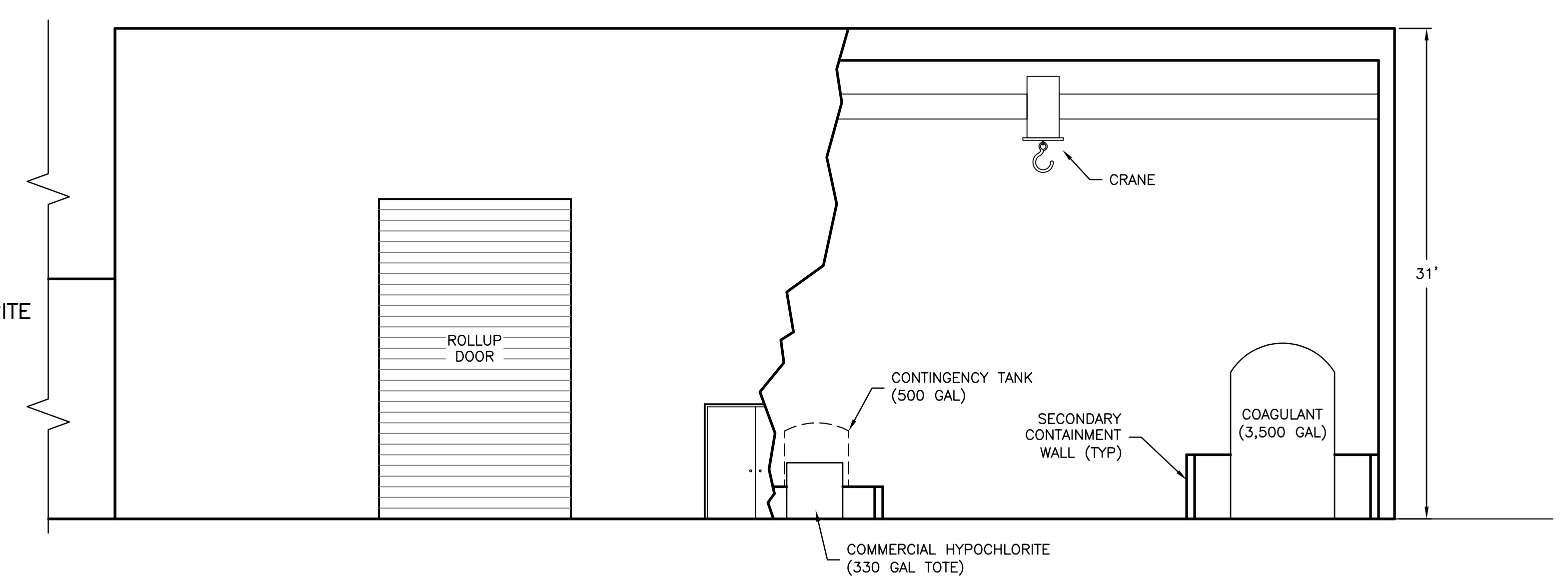
FIGURE 4-19

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE HOME PORT TO NAFTA



CHEMICAL STORAGE BUILDING



SECTION A–A

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- Gov. Rick Perry *April 29, 2002*

BROWNSVILLE PUBLIC UTILITIES BOARD

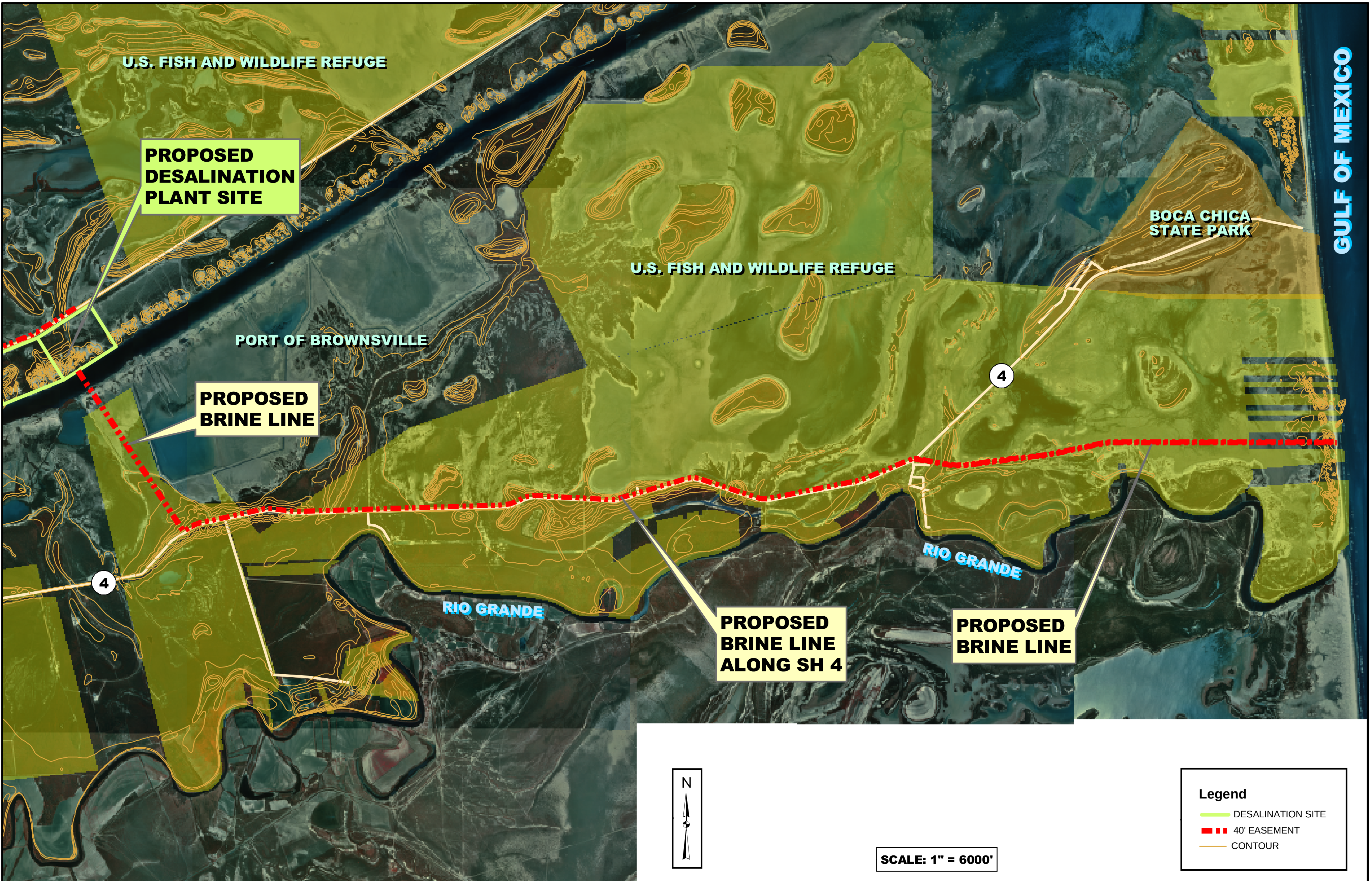
CONCEPTUAL LAYOUT OF CHEMICAL BUILDING

FIGURE 4-20

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA

Last Modified: Jun 17, 2004 – 8:39am by andersonk
Drawing Name: G:\1410\4008-01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\CHEM BLDG.dwg



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- Gov. Rick Perry April 29, 2002

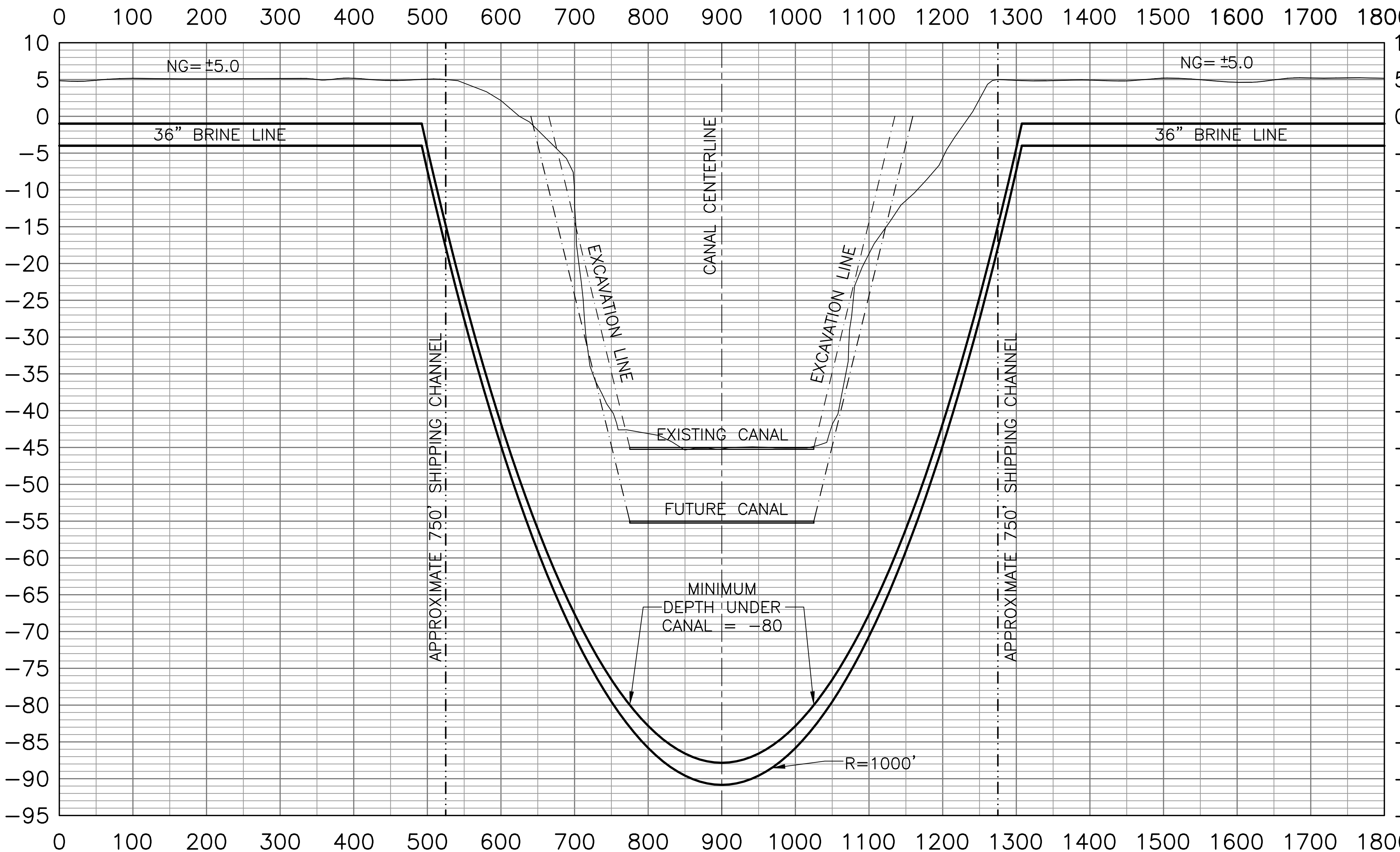
BROWNSVILLE PUBLIC UTILITIES BOARD

BRINE LINE TO THE GULF OF MEXICO

FIGURE 4-21

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA



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Last Modified: Jun 22, 2004 – 10:46am by andersonk

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- Pres. John F. Kennedy *April 12, 1961*

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- Gov. Rick Perry *April 29, 2002*

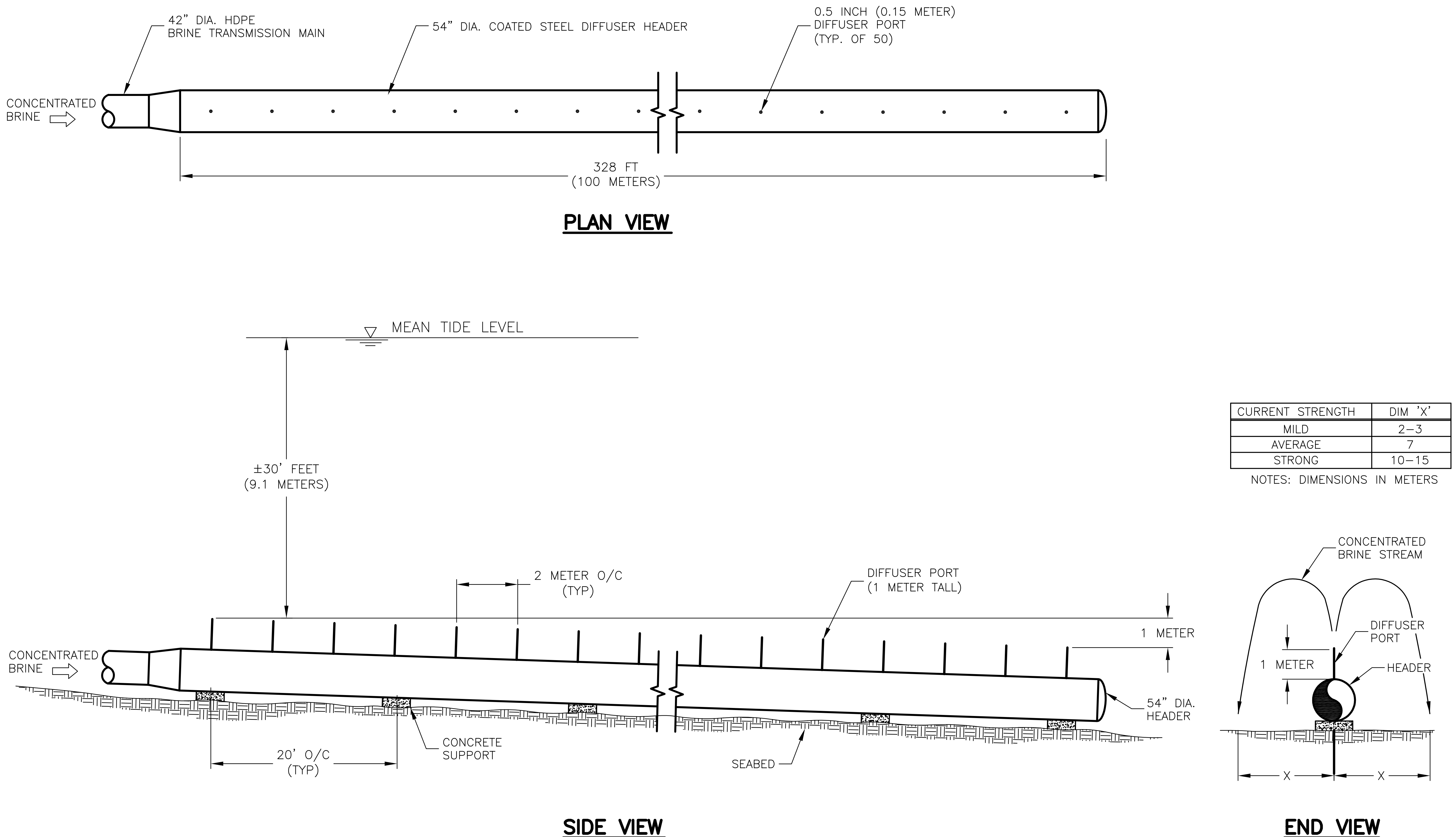
BROWNSVILLE PUBLIC UTILITIES BOARD

BROWNSVILLE SHIPPING CHANNEL CROSSING

FIGURE 4-22

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA



CURRENT STRENGTH	DIM 'X'
MILD	2–3
AVERAGE	7
STRONG	10–15

NOTES: DIMENSIONS IN METERS

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- Gov. Rick Perry *April 29, 2002*

BROWNSVILLE PUBLIC UTILITIES BOARD

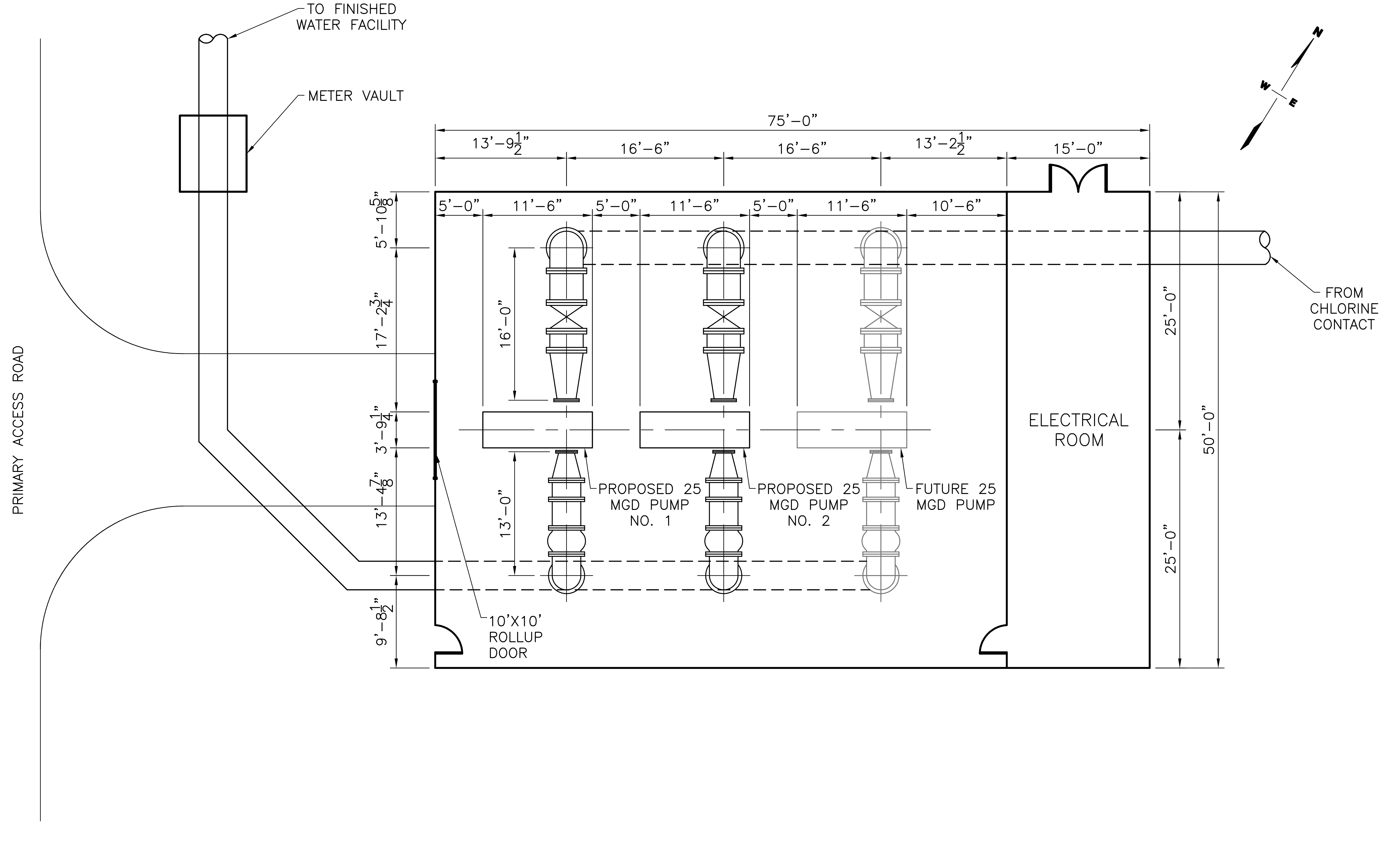
CONCEPTUAL CONFIGURATION OF BRINE DIFFUSER ARRAY

FIGURE 4-23

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA

Drawing Name: G:\1410\4008-01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\BRINE DIFFUSER.dwg



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- Gov. Rick Perry *April 29, 2002*

BROWNSVILLE PUBLIC UTILITIES BOARD

FINISHED WATER PUMP STATION LAYOUT

FIGURE 4-24

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE HOME PORT TO NAFTA

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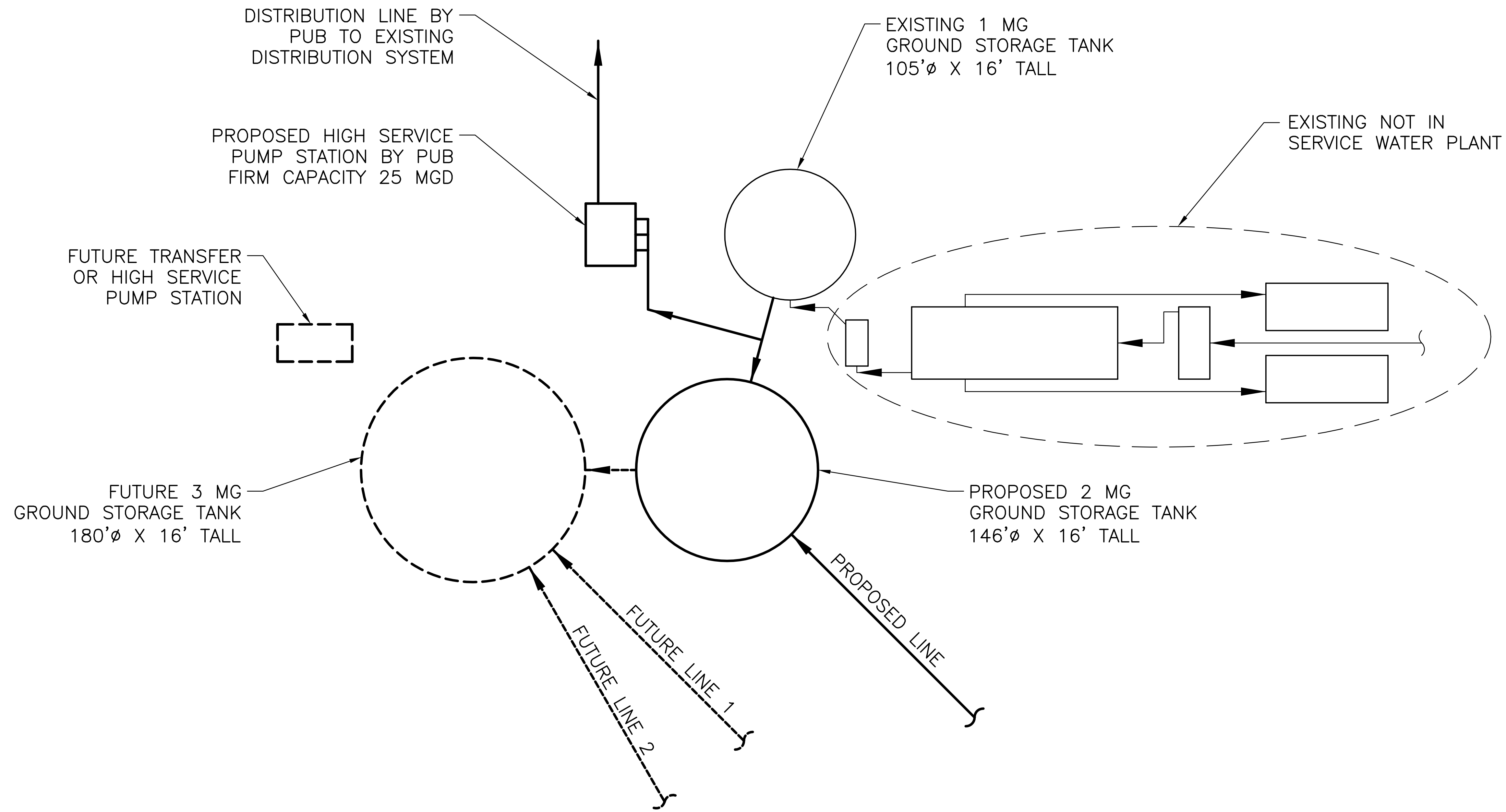

"If we could ever competitively, at a cheap rate, get freshwater from saltwater, that would be in the long-range interest of humanity and would dwarf any other scientific accomplishments."
- Pres. John F. Kennedy *April 12, 1961*

DANNENBAUM ENGINEERING CORPORATION

URS

"I have an obligation to look at the big picture and help develop new water resources for the future of all Texans"
- Gov. Rick Perry *April 29, 2002*

BROWNSVILLE PUBLIC UTILITIES BOARD

FINISHED WATER FACILITY SCHEMATIC

FIGURE 4-25

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE HOME PORT TO NAFTA

"If we could ever competitively, at a cheap rate, get freshwater from saltwater, that would be in the long-range interest of humanity and would dwarf any other scientific accomplishments."
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DANNENBAUM ENGINEERING CORPORATION
URS

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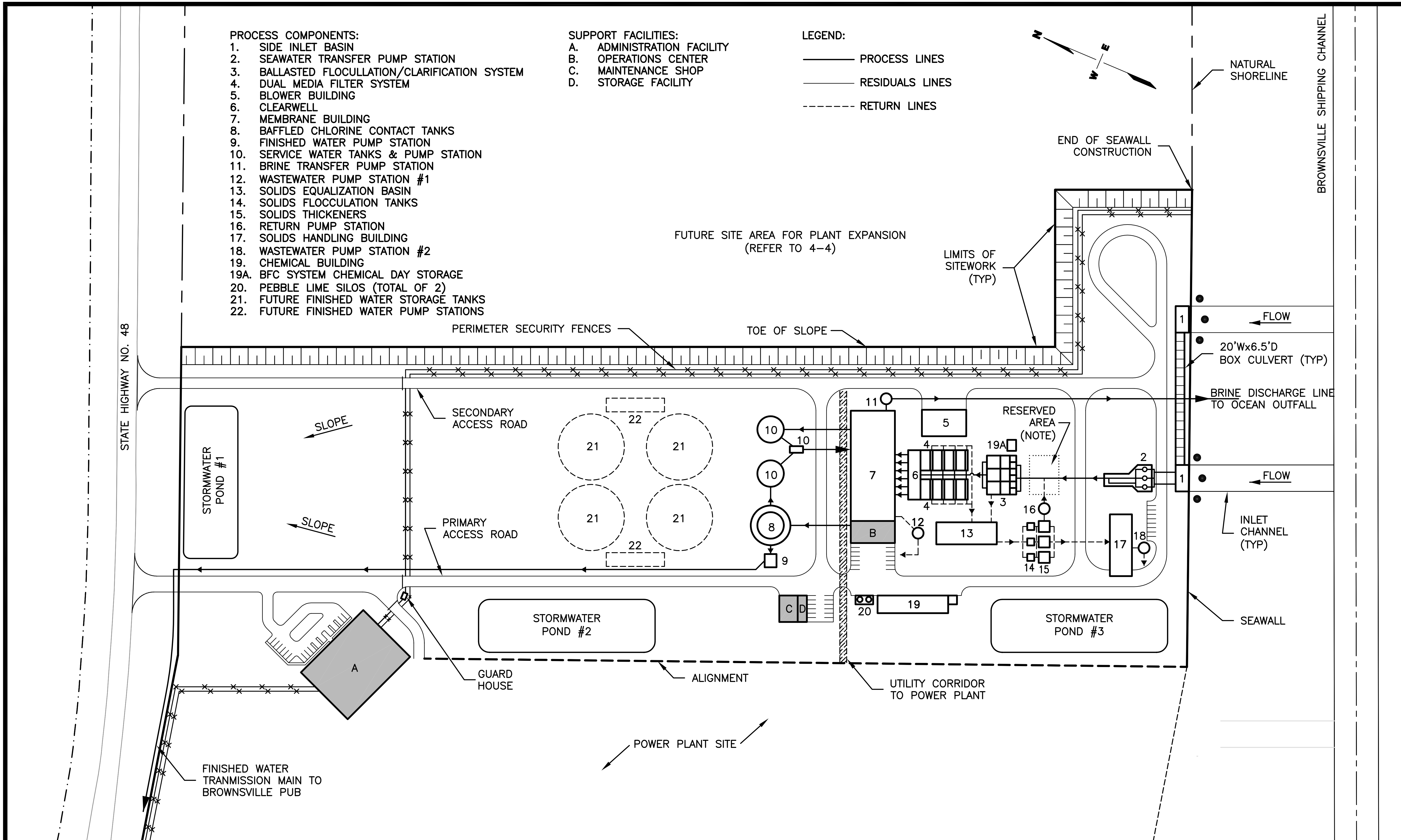
BROWNSVILLE PUBLIC UTILITIES BOARD

WATERLINE TO WATER DELIVERY FACILITY — FIGURE 4-26

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA



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BROWNSVILLE PUBLIC UTILITIES BOARD

LOCATION OF SUPPORT FACILITIES FOR DESALINATION PLANT — FIGURE 4-27

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA

Drawing Name: G:\1410\4008-01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\Prelim Site Layout.dwg
Last Modified: Jun 22, 2004 - 9:19am by andersonk

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DANNENBAUM ENGINEERING CORPORATION

URS

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BROWNSVILLE PUBLIC UTILITIES BOARD

CONCEPTUAL FLOOR PLAN FOR OPERATIONS CENTER

FIGURE 4-28

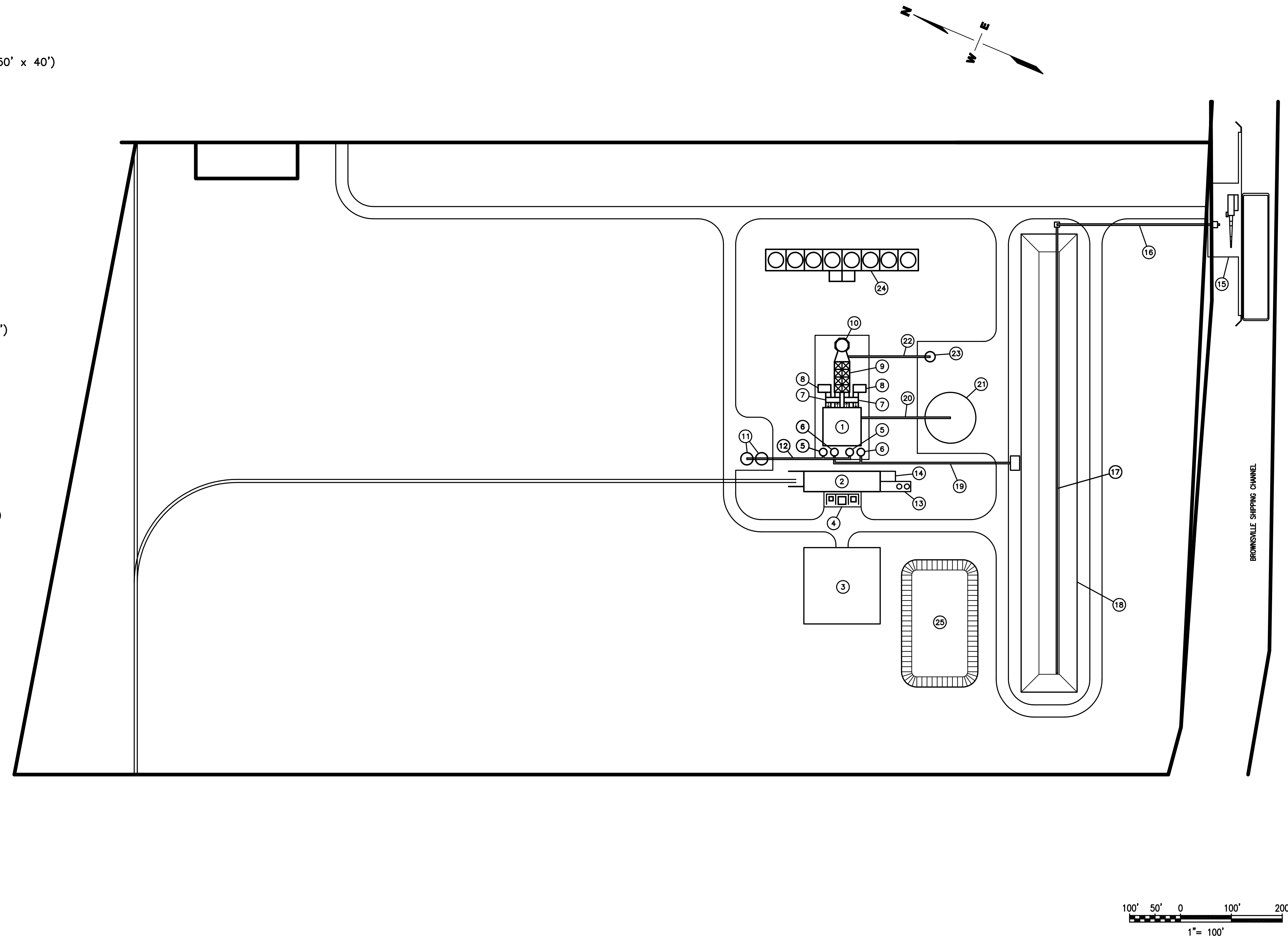
BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE HOME PORT TO NAFTA

Last Modified: Jun 17, 2004 - 8:48am by andersonk
Drawing Name: G:\1410\4008-01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\OPERATIONS CENTER.dwg

LEGEND

1. BOILER (75' x 75')
2. TURBINE / GENERATOR BUILDING (150' x 40')
3. SWITCHGEAR YARD (150' x 150')
4. TRANSFORMER PAD (73' x 30')
5. LIMESTONE SILO (15'ø)
6. COAL SILO (15'ø)
7. AIR PREHEATER
8. FORCE DRAFT FAN (25' x 15')
9. BAG HOUSE (30' x 60')
10. STACK (25'ø)
11. LIMESTONE SILO (24'ø)
12. LIMESTONE CONVEYOR
13. WATER TREATMENT AREA (60' x 30')
14. MAINTENANCE BUILDING (30' x 20')
15. COAL BARGE UNLOADING (240' x 45')
16. COAL UNLOADING CONVEYOR
17. TRAVELING TRIPPER CONVEYOR
18. COAL STORAGE (900' x 110')
19. COAL TRANSFER CONVEYOR
20. BOTTOM ASH CONVEYOR
21. BOTTOM ASH PILE (100'ø)
22. FLY ASH CONVEYOR
23. FLY ASH SILO (20'ø)
24. COOLING WATER TOWER (300' x 42')
25. WASTE POND (250' x 150')



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DANNENBAUM ENGINEERING CORPORATION

URS

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BROWNSVILLE PUBLIC UTILITIES BOARD

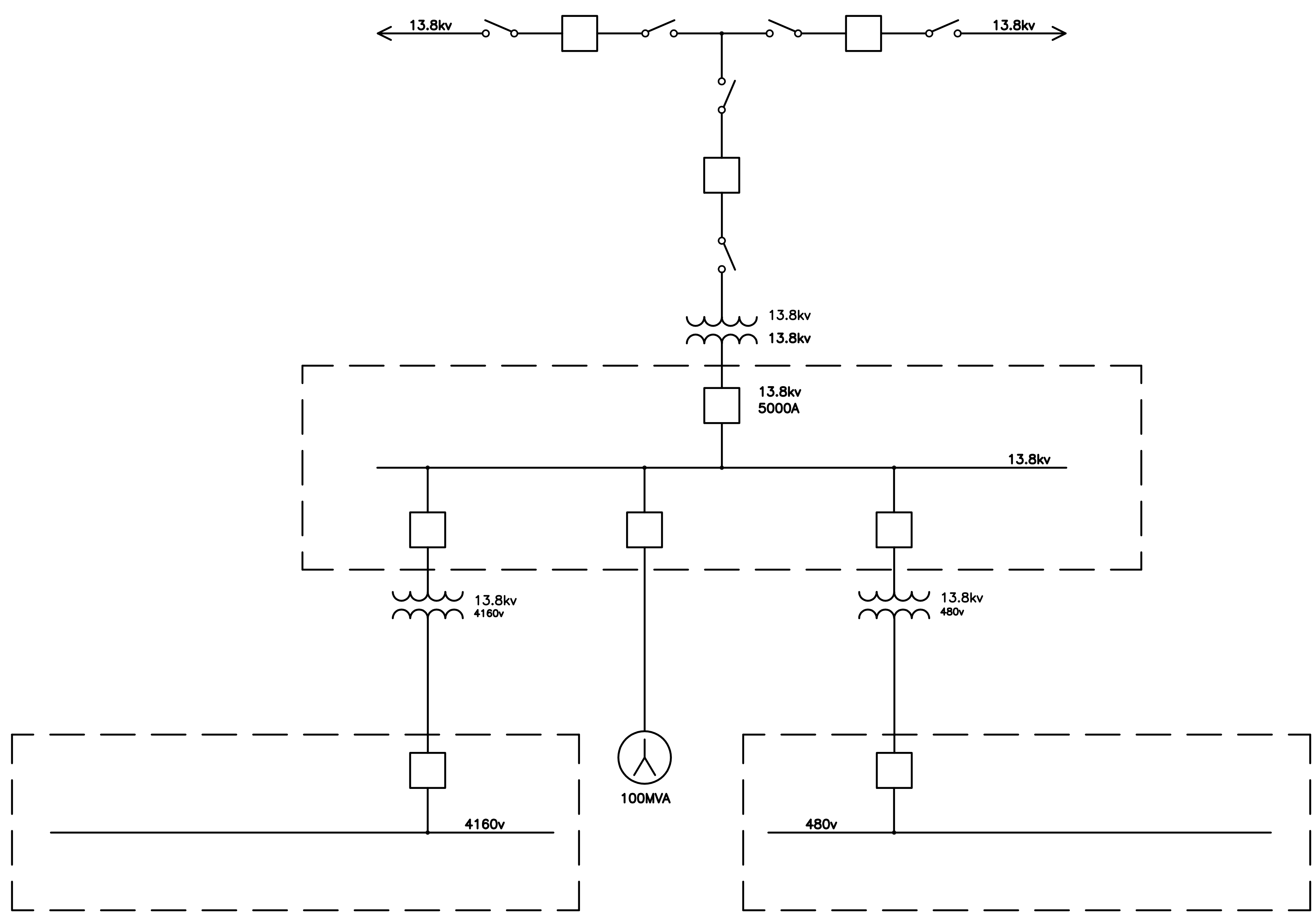
SITE PLAN 100 MW COAL FIRED POWER PLANT

FIGURE 5-1

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA

Drawing Name: G:\1410\4008-01\Admin\Report\Draft\Final Draft\BROWNSVILLE FIGURES\SITE PLAN 100 MW CFPP.dwg
Last Modified: Jun 17, 2004 - 2:27pm by andersonk



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DANNENBAUM ENGINEERING CORPORATION
URS

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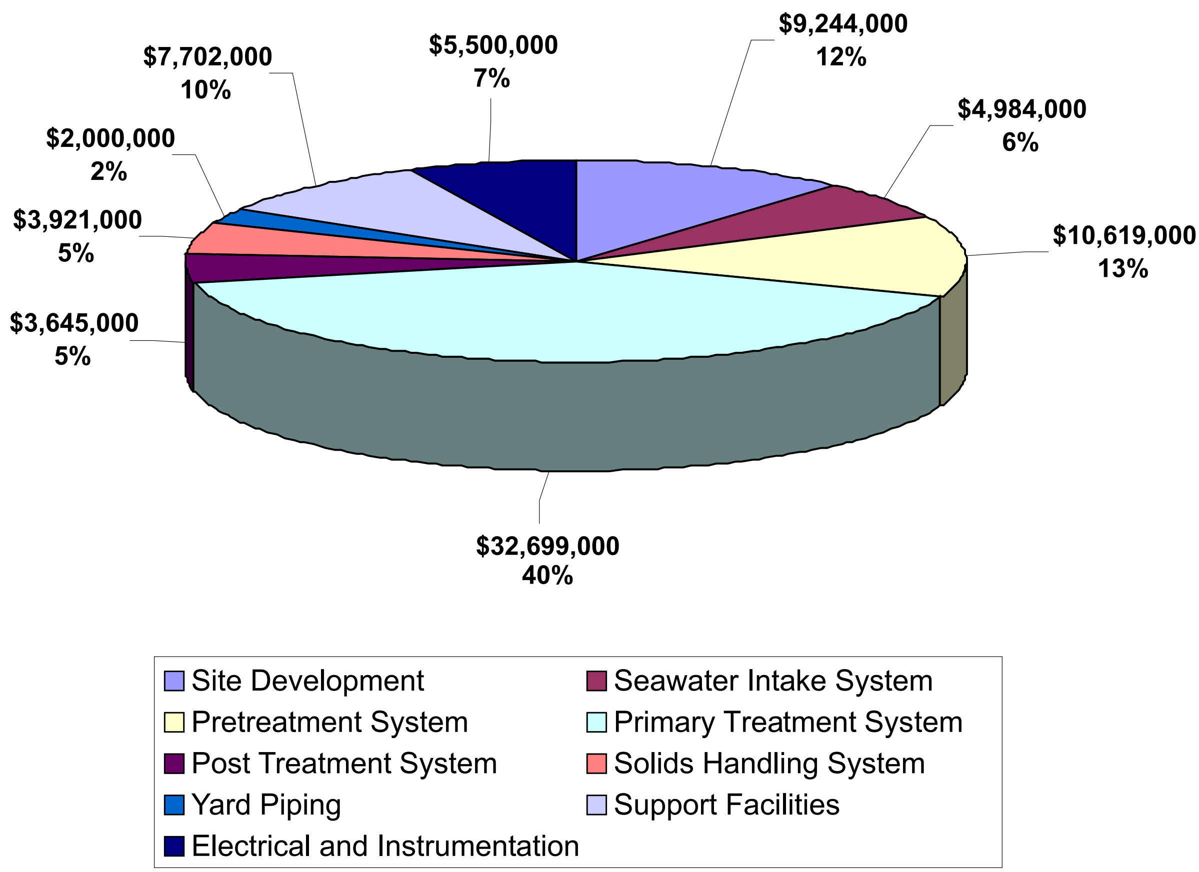
BROWNSVILLE PUBLIC UTILITIES BOARD

ONE-LINE SKETCH

FIGURE 5-2

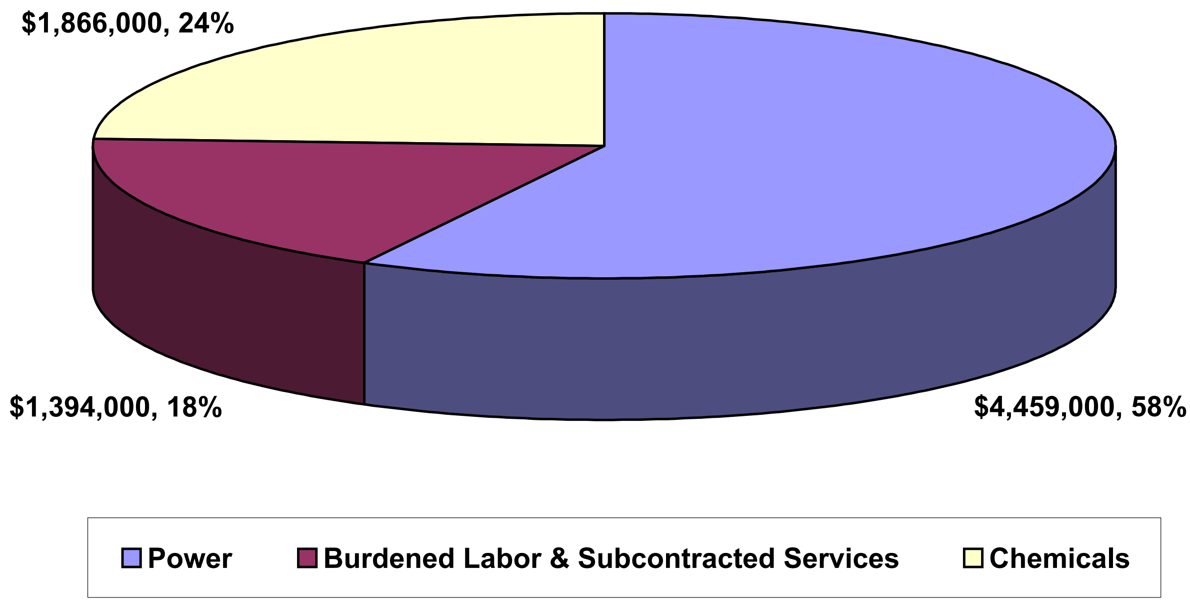
BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

PORT OF BROWNSVILLE
HOME PORT TO NAFTA



DISTRIBUTION OF CAPITAL EXPENSES

FIGURE 7-1



DISTRIBUTION OF ANNUAL OPERATION & MAINTENANCE EXPENSES FIGURE 7-2

PROJECT SCHEDULE - FIGURE 10-1

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

ID	Task Name	Duration	Start	Finish
1	**Notice to Proceed**	0 days	Mon 1/3/05	Mon 1/3/05
2	**RO PLANT**	**750 days**	**Mon 1/3/05**	**Fri 11/16/07**
3	**Environmental, Design & Procurement**	**330 days**	**Mon 1/3/05**	**Fri 4/7/06**
4	**Environmental Permitting**	**165 days**	**Mon 5/9/05**	**Fri 12/23/05**
5	Develop Environmental Permits	40 days	Mon 5/9/05	Fri 7/1/05
6	Issue Permit Applications to Regulatory Agencies	0 days	Fri 7/1/05	Fri 7/1/05
7	Review of Permit Applications	125 days	Mon 7/4/05	Fri 12/23/05
8	Permit Issuance	0 days	Fri 12/23/05	Fri 12/23/05
9	**Engineering**	**290 days**	**Mon 1/3/05**	**Fri 2/10/06**
10	Pilot Studies & Front End Engineering	90 days	Mon 1/3/05	Fri 5/6/05
11	Detailed Design	140 days	Mon 5/9/05	Fri 11/18/05
12	Balance of Plant Equipment	35 days	Mon 11/21/05	Fri 1/6/06
13	Long-Lead Equipment - Bid Specs	25 days	Mon 1/9/06	Fri 2/10/06
14	**Bid Cycle**	40 days	Mon 2/13/06	Fri 4/7/06
15	**Construction**	**420 days**	**Mon 4/10/06**	**Fri 11/16/07**
16	**Contractor Procurement**	**40 days**	**Mon 4/10/06**	**Fri 6/2/06**
17	Award Construction Contracts	40 days	Mon 4/10/06	Fri 6/2/06
18	**Site Work Construction**	65 days	Mon 6/5/06	Fri 9/1/06
19	**Foundation Construction**	**70 days**	**Mon 7/24/06**	**Fri 10/27/06**
20	Procure Materials	20 days	Mon 7/24/06	Fri 8/18/06
21	Mobilize	10 days	Mon 8/21/06	Fri 9/1/06
22	Install Foundations	40 days	Mon 9/4/06	Fri 10/27/06
23	**Long-Lead Equipment**	**265 days**	**Mon 4/10/06**	**Fri 4/13/07**
24	Procurement Cycle	25 days	Mon 4/10/06	Fri 5/12/06
25	Award Long-Lead Equipment	0 days	Fri 5/12/06	Fri 5/12/06
26	Vendor Data Development/Review Cycle	40 days	Mon 5/15/06	Fri 7/7/06
27	Fabrication	180 days	Mon 7/10/06	Fri 3/16/07
28	Delivery	20 days	Mon 3/19/07	Fri 4/13/07
29	**Structural/Mechanical Construction**	**135 days**	**Mon 1/8/07**	**Fri 7/13/07**
30	Procure Materials	60 days	Mon 1/8/07	Fri 3/30/07
31	Mobilize	10 days	Mon 4/2/07	Fri 4/13/07
32	Erect Structure & Install Equipment	65 days	Mon 4/16/07	Fri 7/13/07
33	**Instrumentation/Electrical Construction**	**75 days**	**Mon 6/4/07**	**Fri 9/14/07**
34	Procure Materials	20 days	Mon 6/4/07	Fri 6/29/07
35	Mobilize	10 days	Mon 7/2/07	Fri 7/13/07
36	Install Controls & Electrical	45 days	Mon 7/16/07	Fri 9/14/07
37	**Commissioning & Startup**	45 days	Mon 9/17/07	Fri 11/16/07
38	**Final Acceptance**	0 days	Fri 11/16/07	Fri 11/16/07
39	**POTABLE PUMPING, STORAGE & TRANSMISSION**	**750 days**	**Mon 1/3/05**	**Fri 11/16/07**
40	**Environmental, Design & Procurement**	**310 days**	**Mon 1/3/05**	**Fri 3/10/06**
41	**Environmental Permitting**	**165 days**	**Mon 5/9/05**	**Fri 12/23/05**
42	Develop Environmental Permits	40 days	Mon 5/9/05	Fri 7/1/05
43	Issue Permit Applications to Regulatory Agencies	0 days	Fri 7/1/05	Fri 7/1/05
44	Review of Permit Applications	125 days	Mon 7/4/05	Fri 12/23/05
45	Permit Issuance	0 days	Fri 12/23/05	Fri 12/23/05

FIGURE 10-1

PROJECT SCHEDULE - FIGURE 10-1

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

ID	Task Name	Duration	Start	Finish
46	**Survey**	**75 days**	**Mon 3/28/05**	**Fri 7/8/05**
47	Field Survey	60 days	Mon 3/28/05	Fri 6/17/05
48	Easment Documents	30 days	Mon 5/30/05	Fri 7/8/05
49	**Easement Aquistion**	175 days	Mon 7/11/05	Fri 3/10/06
50	**Engineering**	**230 days**	**Mon 1/3/05**	**Fri 11/18/05**
51	Studies & Front End Engineering	90 days	Mon 1/3/05	Fri 5/6/05
52	**Detailed Design**	**140 days**	**Mon 5/9/05**	**Fri 11/18/05**
53	Pump Station	140 days	Mon 5/9/05	Fri 11/18/05
54	Storage Tank	90 days	Mon 5/9/05	Fri 9/9/05
55	Pipeline	120 days	Mon 5/9/05	Fri 10/21/05
56	**Bid Cycle**	40 days	Mon 11/21/05	Fri 1/13/06
57	**Construction**	**480 days**	**Mon 1/16/06**	**Fri 11/16/07**
58	**Contractor Procurement**	**40 days**	**Mon 1/16/06**	**Fri 3/10/06**
59	Award Construction Contracts	40 days	Mon 1/16/06	Fri 3/10/06
60	**Pipeline Installation**	**160 days**	**Mon 3/13/06**	**Fri 10/20/06**
61	Procurement Cycle & Mobilization	60 days	Mon 3/13/06	Fri 6/2/06
62	Directional Drilling	30 days	Mon 6/5/06	Fri 7/14/06
63	Open Cut Installation	100 days	Mon 6/5/06	Fri 10/20/06
64	**Site Work Construction**	40 days	Mon 3/13/06	Fri 5/5/06
65	**Long-Lead Equipment**	**180 days**	**Mon 3/13/06**	**Fri 11/17/06**
66	Procurement Cycle	25 days	Mon 3/13/06	Fri 4/14/06
67	Award Long-Lead Equipment	0 days	Fri 4/14/06	Fri 4/14/06
68	Vendor Data Development/Review Cycle	30 days	Mon 4/17/06	Fri 5/26/06
69	Fabrication	125 days	Mon 5/29/06	Fri 11/17/06
70	Delivery	0 days	Fri 11/17/06	Fri 11/17/06
71	**Potable 2 MG Storage Tank**	**245 days**	**Mon 3/13/06**	**Fri 2/16/07**
72	Install Foundation	30 days	Mon 3/13/06	Fri 4/21/06
73	Erect Structure & Install Equipment	65 days	Mon 11/20/06	Fri 2/16/07
74	**Pump Station**	**320 days**	**Mon 3/13/06**	**Fri 6/1/07**
75	**Foundation Construction**	**70 days**	**Mon 3/13/06**	**Fri 6/16/06**
76	Procure Materials	15 days	Mon 3/13/06	Fri 3/31/06
77	Mobilize	10 days	Mon 4/3/06	Fri 4/14/06
78	Install Foundations	45 days	Mon 4/17/06	Fri 6/16/06
79	**Structural/Mechanical Construction**	**95 days**	**Mon 10/9/06**	**Fri 2/16/07**
80	Procure Materials	20 days	Mon 10/9/06	Fri 11/3/06
81	Mobilize	10 days	Mon 11/6/06	Fri 11/17/06
82	Erect Structure & Install Equipment	65 days	Mon 11/20/06	Fri 2/16/07
83	**Instrumentation/Electrical Construction**	**75 days**	**Mon 2/19/07**	**Fri 6/1/07**
84	Procure Materials	20 days	Mon 2/19/07	Fri 3/16/07
85	Mobilize	10 days	Mon 3/19/07	Fri 3/30/07
86	Install Controls & Electrical	45 days	Mon 4/2/07	Fri 6/1/07
87	**Commissioning & Startup**	45 days	Mon 9/17/07	Fri 11/16/07
88	**Final Acceptance**	0 days	Fri 11/16/07	Fri 11/16/07
89	**CONCENTRATE PUMPING & TRANSMISSION**	**750 days**	**Mon 1/3/05**	**Fri 11/16/07**
90	**Environmental, Design & Procurement**	**310 days**	**Mon 1/3/05**	**Fri 3/10/06**

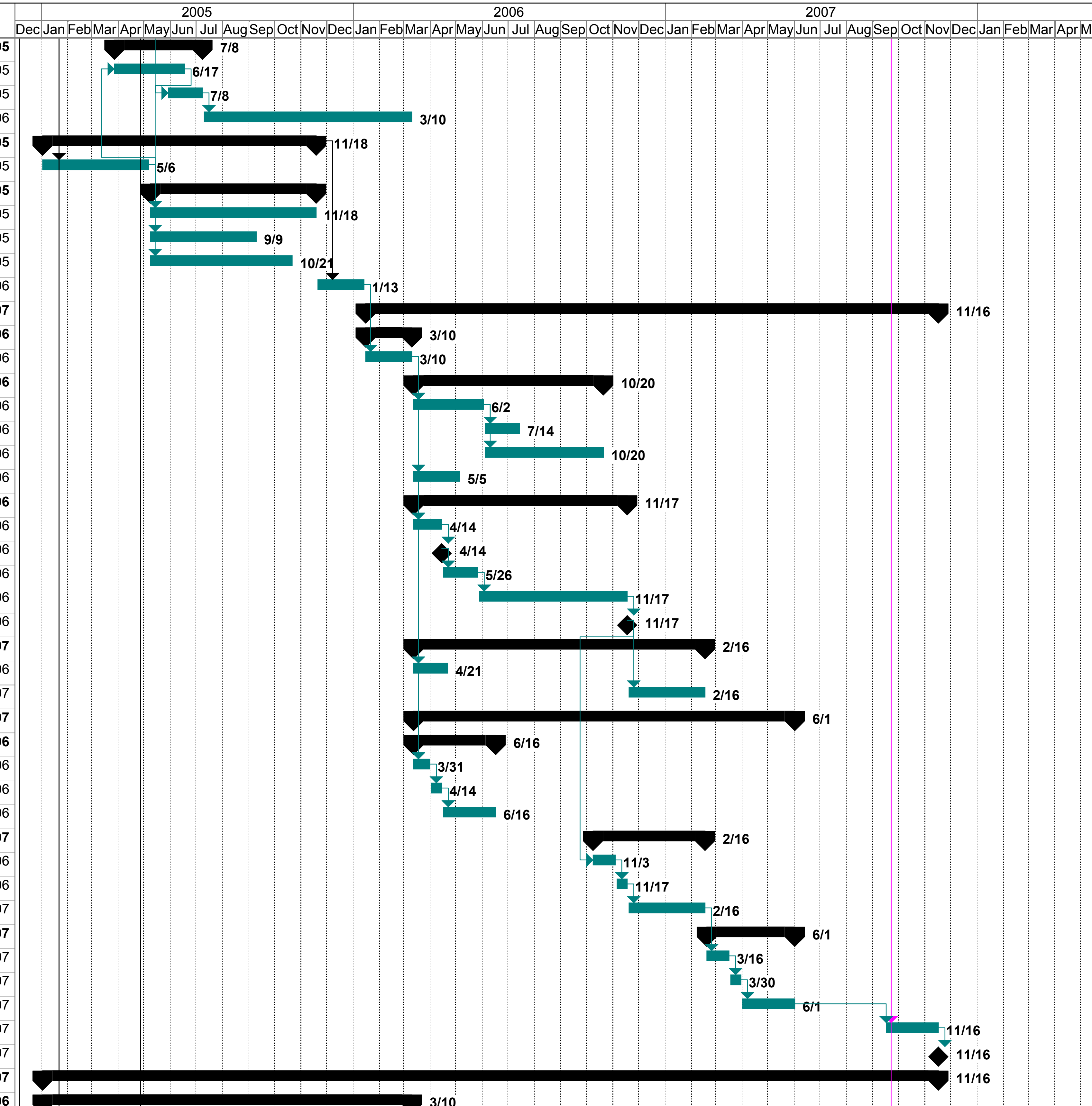


FIGURE 10-1

PROJECT SCHEDULE - FIGURE 10-1

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

ID	Task Name	Duration	Start	Finish
91	**Environmental Permitting**	**165 days**	**Mon 5/9/05**	**Fri 12/23/05**
92	Develop Environmental Permits	40 days	Mon 5/9/05	Fri 7/1/05
93	Issue Permit Applications to Regulatory Agencies	0 days	Fri 7/1/05	Fri 7/1/05
94	Review of Permit Applications	125 days	Mon 7/4/05	Fri 12/23/05
95	Permit Issuance	0 days	Fri 12/23/05	Fri 12/23/05
96	**Survey**	**75 days**	**Mon 3/28/05**	**Fri 7/8/05**
97	Field Survey	60 days	Mon 3/28/05	Fri 6/17/05
98	Easment Documents	30 days	Mon 5/30/05	Fri 7/8/05
99	**Easement Aquistion**	175 days	Mon 7/11/05	Fri 3/10/06
100	**Engineering**	**230 days**	**Mon 1/3/05**	**Fri 11/18/05**
101	Studies & Front End Engineering	90 days	Mon 1/3/05	Fri 5/6/05
102	**Detailed Design**	**140 days**	**Mon 5/9/05**	**Fri 11/18/05**
103	Pump Station	120 days	Mon 5/9/05	Fri 10/21/05
104	Pipeline	140 days	Mon 5/9/05	Fri 11/18/05
105	**Bid Cycle**	40 days	Mon 11/21/05	Fri 1/13/06
106	**Construction**	**480 days**	**Mon 1/16/06**	**Fri 11/16/07**
107	**Contractor Procurement**	**40 days**	**Mon 1/16/06**	**Fri 3/10/06**
108	Award Construction Contracts	40 days	Mon 1/16/06	Fri 3/10/06
109	**Pipeline Installation**	**220 days**	**Mon 3/13/06**	**Fri 1/12/07**
110	Procurement Cycle & Mobilization	60 days	Mon 3/13/06	Fri 6/2/06
111	Directional Drilling (Ship Channel)	40 days	Mon 6/5/06	Fri 7/28/06
112	Directional Drilling (Dunes & Offshore)	69 days	Mon 7/31/06	Thu 11/2/06
113	Open Cut Installation	160 days	Mon 6/5/06	Fri 1/12/07
114	Offshore Installation	30 days	Mon 6/5/06	Fri 7/14/06
115	Diffuser Installation	5 days	Mon 7/17/06	Fri 7/21/06
116	**Long-Lead Equipment**	**200 days**	**Mon 3/13/06**	**Fri 12/15/06**
117	Procurement Cycle	20 days	Mon 3/13/06	Fri 4/7/06
118	Award Long-Lead Equipment	0 days	Fri 4/7/06	Fri 4/7/06
119	Vendor Data Development/Review Cycle	30 days	Mon 4/10/06	Fri 5/19/06
120	Fabrication	130 days	Mon 5/22/06	Fri 11/17/06
121	Delivery	20 days	Mon 11/20/06	Fri 12/15/06
122	**Pump Station Construction**	**145 days**	**Mon 11/6/06**	**Fri 5/25/07**
123	**Mechanical Construction**	**95 days**	**Mon 11/6/06**	**Fri 3/16/07**
124	Procure Materials	20 days	Mon 11/6/06	Fri 12/1/06
125	Mobilize	10 days	Mon 12/4/06	Fri 12/15/06
126	Erect Structure & Install Equipment	65 days	Mon 12/18/06	Fri 3/16/07
127	**Instrumentation/Electrical Construction**	**50 days**	**Mon 3/19/07**	**Fri 5/25/07**
128	Procure Materials	20 days	Mon 3/19/07	Fri 4/13/07
129	Mobilize	10 days	Mon 4/16/07	Fri 4/27/07
130	Install Controls & Electrical	20 days	Mon 4/30/07	Fri 5/25/07
131	**Commissioning & Startup**	45 days	Mon 9/17/07	Fri 11/16/07
132	**Final Acceptance**	0 days	Fri 11/16/07	Fri 11/16/07
133	**POWER PLANT**	**855 days**	**Mon 1/3/05**	**Sun 3/30/08**
134	**Environmental, Design & Procurement**	**290 days**	**Mon 1/3/05**	**Fri 2/10/06**
135	**Environmental Permitting**	**165 days**	**Mon 5/9/05**	**Fri 12/23/05**

PROJECT SCHEDULE - FIGURE 10-1

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

ID	Task Name	Duration	Start	Finish
136	Develop Environmental Permits	40 days	Mon 5/9/05	Fri 7/1/05
137	Issue Permit Applications to Regulatory Agencies	0 days	Fri 7/1/05	Fri 7/1/05
138	Review of Permit Applications	125 days	Mon 7/4/05	Fri 12/23/05
139	Permit Issuance	0 days	Fri 12/23/05	Fri 12/23/05
140	**Engineering**	**290 days**	**Mon 1/3/05**	**Fri 2/10/06**
141	Studies & Front End Engineering	90 days	Mon 1/3/05	Fri 5/6/05
142	Detailed Design	140 days	Mon 5/9/05	Fri 11/18/05
143	Balance of Plant Equipment	35 days	Mon 11/21/05	Fri 1/6/06
144	Long-Lead Equipment - Bid Specs	25 days	Mon 1/9/06	Fri 2/10/06
145	Design IFC	0 days	Fri 11/18/05	Fri 11/18/05
146	**Bid Cycle**	30 days	Mon 11/21/05	Fri 12/30/05
147	**Construction**	**595 days**	**Mon 1/2/06**	**Sun 3/30/08**
148	**Contractor Procurement**	**20 days**	**Mon 1/2/06**	**Fri 1/27/06**
149	Award Construction Contracts	20 days	Mon 1/2/06	Fri 1/27/06
150	**Site Work Construction**	50 days	Mon 1/30/06	Fri 4/7/06
151	**Dock Facilities Construction**	**200 days**	**Mon 1/30/06**	**Fri 11/3/06**
152	Procure Materials	45 days	Mon 1/30/06	Fri 3/31/06
153	Mobilize	15 days	Mon 4/3/06	Fri 4/21/06
154	Erect Dock Facilities	140 days	Mon 4/24/06	Fri 11/3/06
155	**Foundation Construction**	**95 days**	**Mon 3/6/06**	**Fri 7/14/06**
156	Procure Materials	20 days	Mon 3/6/06	Fri 3/31/06
157	Mobilize	15 days	Mon 4/3/06	Fri 4/21/06
158	Install Foundations	60 days	Mon 4/24/06	Fri 7/14/06
159	**Long-Lead Equipment**	**335 days**	**Mon 1/30/06**	**Fri 5/11/07**
160	Procurement Cycle	25 days	Mon 1/30/06	Fri 3/3/06
161	Award Long-Lead Equipment	0 days	Fri 3/3/06	Fri 3/3/06
162	Vendor Data Development/Review Cycle	40 days	Mon 3/6/06	Fri 4/28/06
163	Fabrication	250 days	Mon 5/1/06	Fri 4/13/07
164	Delivery	20 days	Mon 4/16/07	Fri 5/11/07
165	**Boiler Erection**	**105 days**	**Mon 4/23/07**	**Fri 9/14/07**
166	Mobilize	15 days	Mon 4/23/07	Fri 5/11/07
167	Erect boiler	90 days	Mon 5/14/07	Fri 9/14/07
168	**Structural/Mechanical Construction**	**195 days**	**Mon 1/1/07**	**Fri 9/28/07**
169	Procure Materials	80 days	Mon 1/1/07	Fri 4/20/07
170	Mobilize	15 days	Mon 4/23/07	Fri 5/11/07
171	Erect Structure & Install Equipment	100 days	Mon 5/14/07	Fri 9/28/07
172	**Instrumentation/Electrical Construction**	**125 days**	**Mon 7/30/07**	**Fri 1/18/08**
173	Procure Materials	30 days	Mon 7/30/07	Fri 9/7/07
174	Mobilize	15 days	Mon 9/10/07	Fri 9/28/07
175	Install Controls & Electrical	80 days	Mon 10/1/07	Fri 1/18/08
176	**Commissioning & Startup**	60 days	Mon 1/21/08	Sun 3/30/08
177	**Final Acceptance**	0 days	Sun 3/30/08	Sun 3/30/08

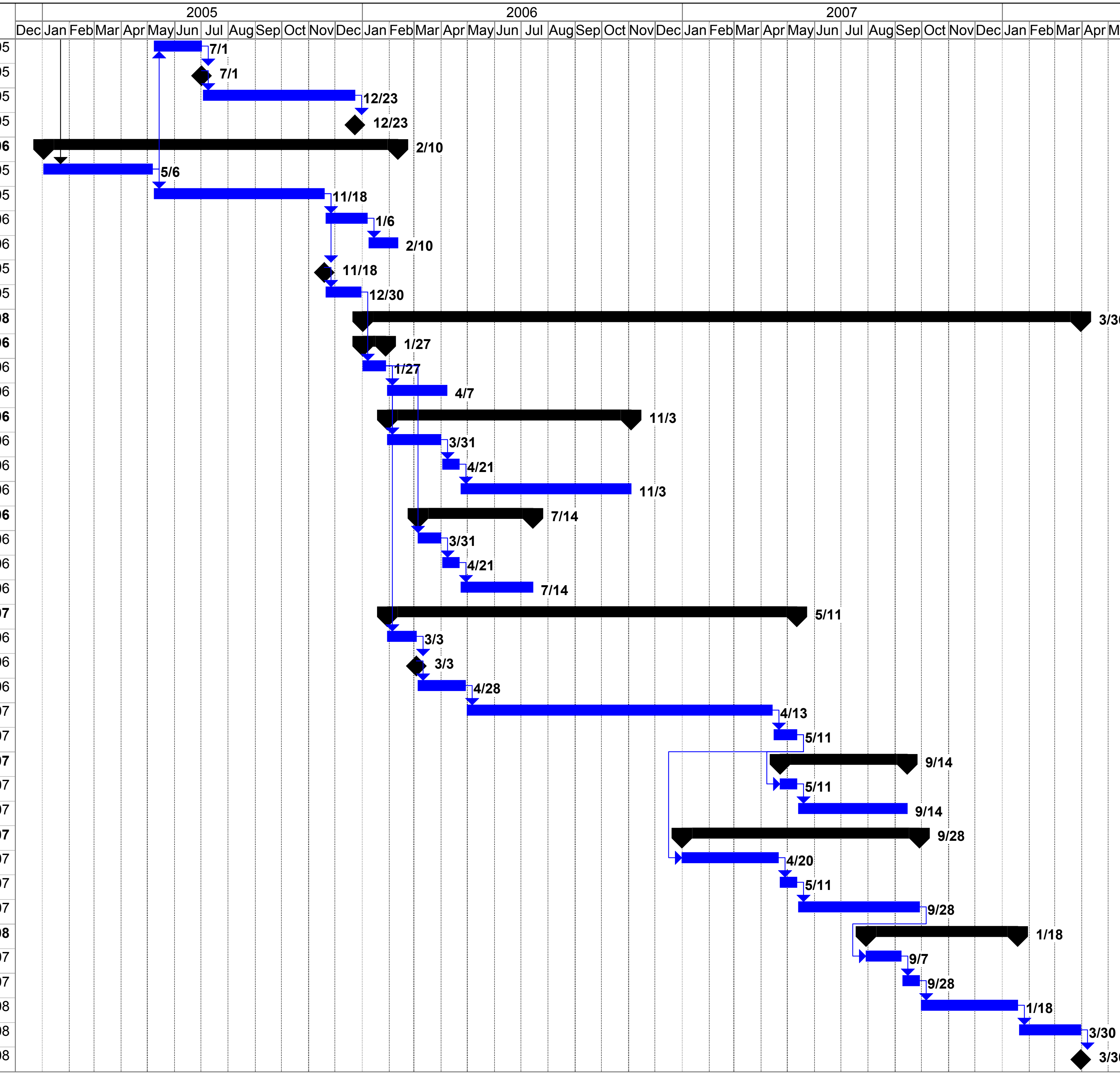


FIGURE 10-1

ACCELERATED PROJECT SCHEDULE - FIGURE 10-2

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

ID	Task Name	Duration	Start	Finish
1	Notice to Proceed	0 days	Mon 1/3/05	Mon 1/3/05
2	**RO PLANT**	**465 days**	**Mon 1/3/05**	**Fri 10/13/06**
3	**Environmental, Design & Procurement**	**375 days**	**Mon 1/3/05**	**Fri 6/9/06**
4	**Environmental Permitting**	**165 days**	**Mon 5/9/05**	**Fri 12/23/05**
5	Develop Environmental Permits	40 days	Mon 5/9/05	Fri 7/1/05
6	Issue Permit Applications to Regulatory Agencies	0 days	Fri 7/1/05	Fri 7/1/05
7	Review of Permit Applications	125 days	Mon 7/4/05	Fri 12/23/05
8	Permit Issuance	0 days	Fri 12/23/05	Fri 12/23/05
9	**Engineering**	**230 days**	**Mon 1/3/05**	**Fri 11/18/05**
10	Pilot Studies	90 days	Mon 1/3/05	Fri 5/6/05
11	Phase I Detailed Design	70 days	Mon 1/3/05	Fri 4/8/05
12	Long-Lead Equipment - Bid Specs	25 days	Mon 4/11/05	Fri 5/13/05
13	Phase II Detailed Design	140 days	Mon 5/9/05	Fri 11/18/05
14	Balance of Plant Equipment	35 days	Mon 5/9/05	Fri 6/24/05
15	**Owner Procurement of Long-Lead Equipment**	**245 days**	**Mon 5/16/05**	**Fri 4/21/06**
16	Procurement Cycle	25 days	Mon 5/16/05	Fri 6/17/05
17	Award Long-Lead Equipment	0 days	Fri 6/17/05	Fri 6/17/05
18	Vendor Data Development/Review Cycle	40 days	Mon 6/20/05	Fri 8/12/05
19	Fabrication	180 days	Mon 8/15/05	Fri 4/21/06
20	Delivery	0 days	Fri 4/21/06	Fri 4/21/06
21	**Balance of Plant Equipment**	**250 days**	**Mon 6/27/05**	**Fri 6/9/06**
22	Procurement Cycle	20 days	Mon 6/27/05	Fri 7/22/05
23	Award Long-Lead Equipment	0 days	Fri 7/22/05	Fri 7/22/05
24	Vendor Data Development/Review Cycle	30 days	Mon 7/25/05	Fri 9/2/05
25	Fabrication	180 days	Mon 9/5/05	Fri 5/12/06
26	Delivery	20 days	Mon 5/15/06	Fri 6/9/06
27	**Phase I Bid Cycle**	40 days	Mon 4/11/05	Fri 6/3/05
28	**Phase II Bid Cycle**	40 days	Mon 11/21/05	Fri 1/13/06
29	**Construction**	**355 days**	**Mon 6/6/05**	**Fri 10/13/06**
30	**Contractor Procurement**	**200 days**	**Mon 6/6/05**	**Fri 3/10/06**
31	Award Phase I Construction Contract	40 days	Mon 6/6/05	Fri 7/29/05
32	Award Phase II Construction Contract	40 days	Mon 1/16/06	Fri 3/10/06
33	**Site Work Construction**	65 days	Mon 8/1/05	Fri 10/28/05
34	**Foundation Construction**	**70 days**	**Mon 8/1/05**	**Fri 11/4/05**
35	Procure Materials	20 days	Mon 8/1/05	Fri 8/26/05
36	Mobilize	10 days	Mon 8/29/05	Fri 9/9/05
37	Install Foundations	40 days	Mon 9/12/05	Fri 11/4/05
38	**Structural**	**135 days**	**Mon 8/1/05**	**Fri 2/3/06**
39	Procure Materials	60 days	Mon 8/1/05	Fri 10/21/05
40	Mobilize	10 days	Mon 10/24/05	Fri 11/4/05
41	Erect Structure	65 days	Mon 11/7/05	Fri 2/3/06
42	**Mech./Instrumentation/Electrical Construction**	**110 days**	**Mon 3/13/06**	**Fri 8/11/06**
43	Procure Materials	20 days	Mon 3/13/06	Fri 4/7/06
44	Mobilize	10 days	Mon 5/29/06	Fri 6/9/06
45	Install Controls & Electrical	45 days	Mon 6/12/06	Fri 8/11/06
46	**Commissioning & Startup**	45 days	Mon 8/14/06	Fri 10/13/06
47	**Final Acceptance**	0 days	Fri 10/13/06	Fri 10/13/06
48	**POTABLE PUMPING, STORAGE & TRANSMISSION**	**550 days**	**Mon 1/3/05**	**Fri 2/9/07**
49	**Environmental, Design & Procurement**	**310 days**	**Mon 1/3/05**	**Fri 3/10/06**

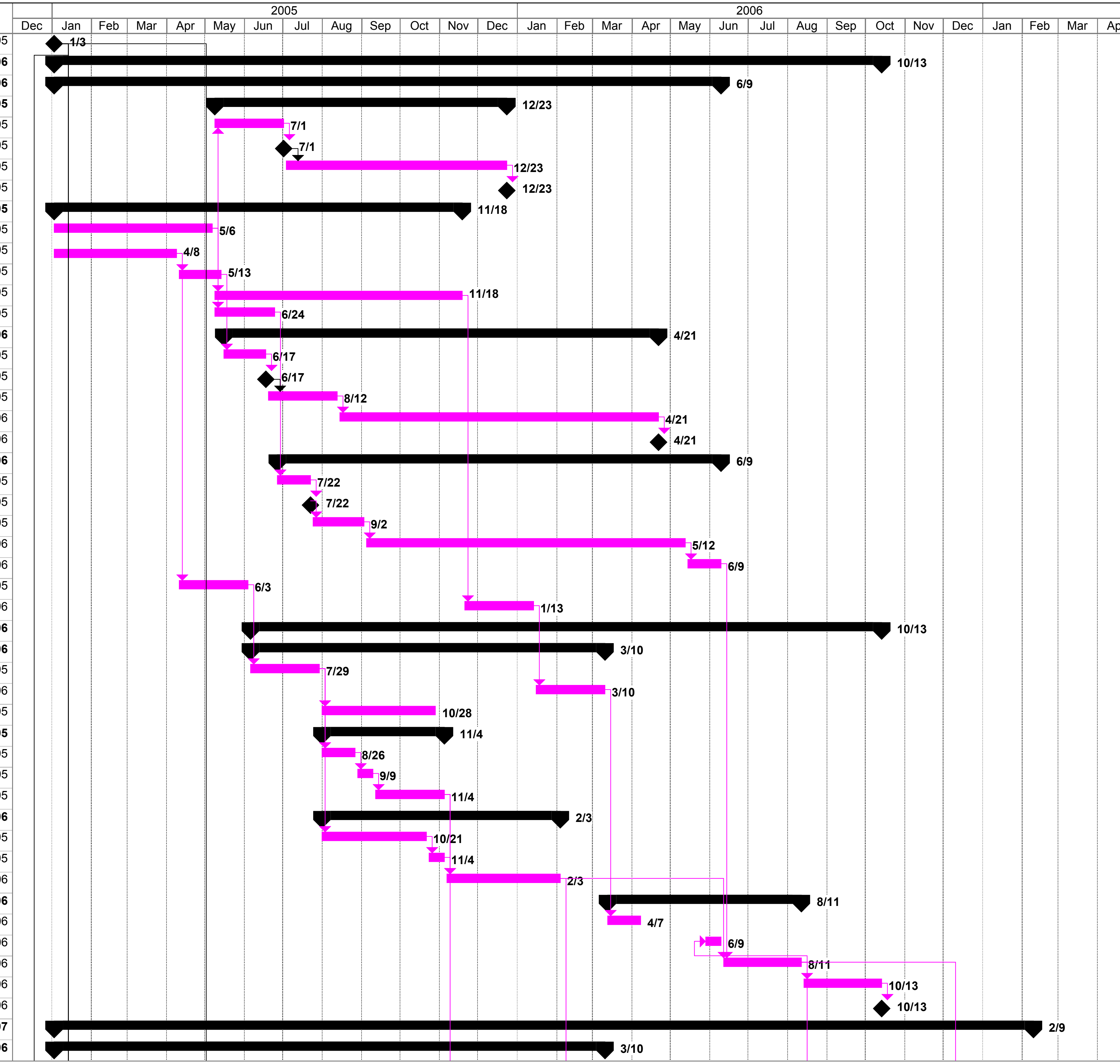


FIGURE 10-2

ACCELERATED PROJECT SCHEDULE - FIGURE 10-2

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

ID	Task Name	Duration	Start	Finish
50	**Environmental Permitting**	**165 days**	**Mon 5/9/05**	**Fri 12/23/05**
51	Develop Environmental Permits	40 days	Mon 5/9/05	Fri 7/1/05
52	Issue Permit Applications to Regulatory Agencies	0 days	Fri 7/1/05	Fri 7/1/05
53	Review of Permit Applications	125 days	Mon 7/4/05	Fri 12/23/05
54	Permit Issuance	0 days	Fri 12/23/05	Fri 12/23/05
55	**Survey**	**75 days**	**Mon 3/28/05**	**Fri 7/8/05**
56	Field Survey	60 days	Mon 3/28/05	Fri 6/17/05
57	Easment Documents	30 days	Mon 5/30/05	Fri 7/8/05
58	**Easement Aquistion**	175 days	Mon 7/11/05	Fri 3/10/06
59	**Engineering**	**230 days**	**Mon 1/3/05**	**Fri 11/18/05**
60	Studies & Front End Engineering	90 days	Mon 1/3/05	Fri 5/6/05
61	**Detailed Design**	**140 days**	**Mon 5/9/05**	**Fri 11/18/05**
62	Pump Station	140 days	Mon 5/9/05	Fri 11/18/05
63	Storage Tank	90 days	Mon 5/9/05	Fri 9/9/05
64	Pipeline	120 days	Mon 5/9/05	Fri 10/21/05
65	**Owner Procurement of Long-Lead Equipment**	**180 days**	**Mon 5/9/05**	**Fri 1/13/06**
66	Procurement Cycle	25 days	Mon 5/9/05	Fri 6/10/05
67	Award Long-Lead Equipment	0 days	Fri 6/10/05	Fri 6/10/05
68	Vendor Data Development/Review Cycle	30 days	Mon 6/13/05	Fri 7/22/05
69	Fabrication	125 days	Mon 7/25/05	Fri 1/13/06
70	Delivery	0 days	Fri 1/13/06	Fri 1/13/06
71	**Bid Cycle**	40 days	Mon 11/21/05	Fri 1/13/06
72	**Construction**	**300 days**	**Mon 12/19/05**	**Fri 2/9/07**
73	**Contractor Procurement**	**40 days**	**Mon 1/16/06**	**Fri 3/10/06**
74	Award Construction Contracts	40 days	Mon 1/16/06	Fri 3/10/06
75	**Pipeline Installation**	**170 days**	**Mon 12/19/05**	**Fri 8/11/06**
76	Owner Furnished Material	60 days	Mon 12/19/05	Fri 3/10/06
77	Contractor Mobilization	10 days	Mon 3/13/06	Fri 3/24/06
78	Directional Drilling	30 days	Mon 3/27/06	Fri 5/5/06
79	Open Cut Installation	100 days	Mon 3/27/06	Fri 8/11/06
80	**Site Work Construction**	40 days	Mon 3/13/06	Fri 5/5/06
81	**Potable 2 MG Storage Tank**	**95 days**	**Mon 5/8/06**	**Fri 9/15/06**
82	Install Foundation	30 days	Mon 5/8/06	Fri 6/16/06
83	Erect Structure & Install Equipment	65 days	Mon 6/19/06	Fri 9/15/06
84	**Pump Station**	**180 days**	**Mon 4/3/06**	**Fri 12/8/06**
85	**Foundation Construction**	**70 days**	**Mon 4/3/06**	**Fri 7/7/06**
86	Procure Materials	15 days	Mon 4/3/06	Fri 4/21/06
87	Mobilize	10 days	Mon 4/24/06	Fri 5/5/06
88	Install Foundations	45 days	Mon 5/8/06	Fri 7/7/06
89	**Structural/Mechanical Construction**	**95 days**	**Mon 5/29/06**	**Fri 10/6/06**
90	Procure Materials	20 days	Mon 5/29/06	Fri 6/23/06
91	Mobilize	10 days	Mon 6/26/06	Fri 7/7/06
92	Erect Structure & Install Equipment	65 days	Mon 7/10/06	Fri 10/6/06
93	**Instrumentation/Electrical Construction**	**75 days**	**Mon 8/28/06**	**Fri 12/8/06**
94	Procure Materials	20 days	Mon 8/28/06	Fri 9/22/06
95	Mobilize	10 days	Mon 9/25/06	Fri 10/6/06
96	Install Controls & Electrical	45 days	Mon 10/9/06	Fri 12/8/06
97	**Commissioning & Startup**	45 days	Mon 12/11/06	Fri 2/9/07
98	**Final Acceptance**	0 days	Fri 2/9/07	Fri 2/9/07

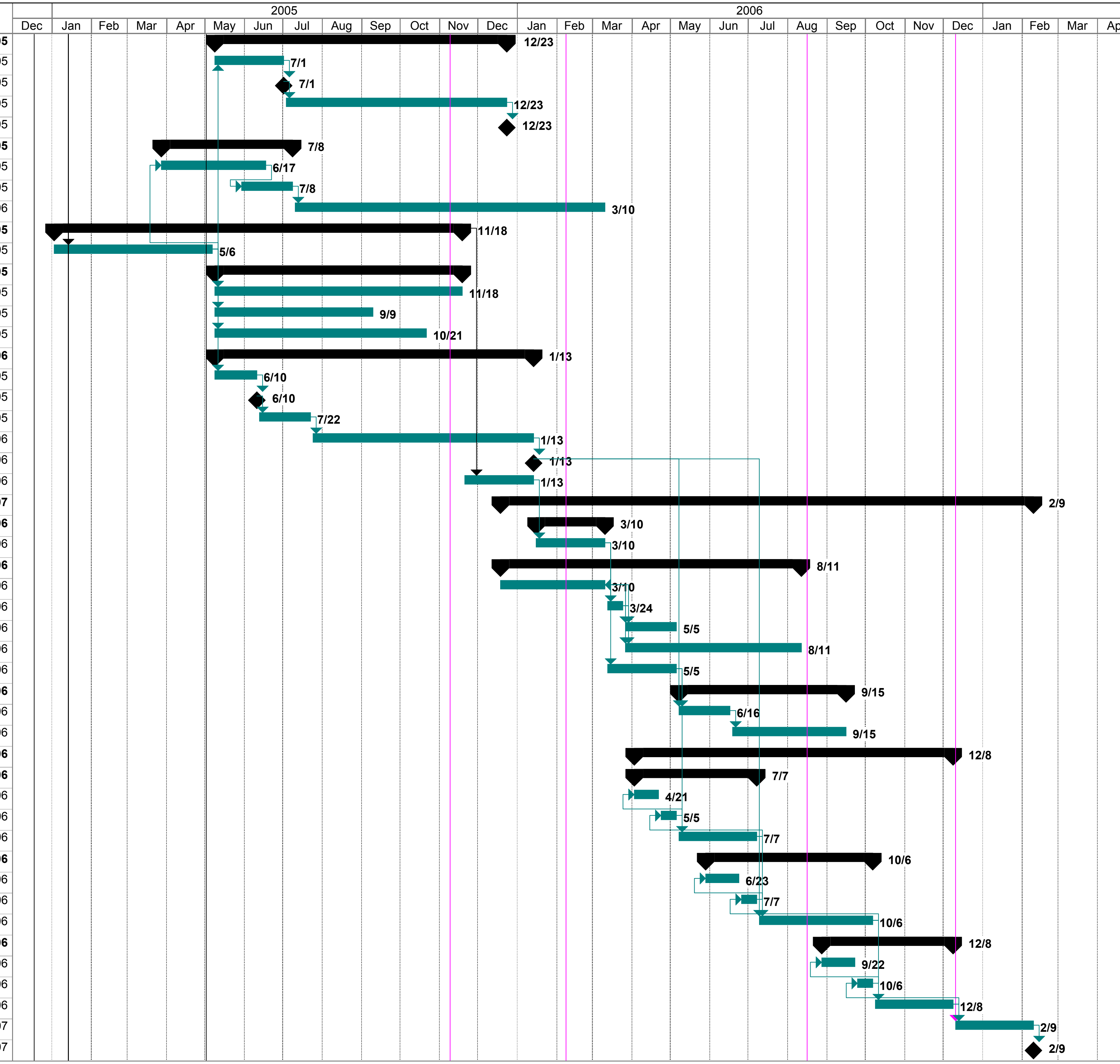


FIGURE 10-2

ACCELERATED PROJECT SCHEDULE - FIGURE 10-2

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

ID	Task Name	Duration	Start	Finish
99	**CONCENTRATE PUMPING & TRANSMISSION**	**480 days**	**Mon 1/3/05**	**Fri 11/3/06**
100	**Environmental, Design & Procurement**	**330 days**	**Mon 1/3/05**	**Fri 4/7/06**
101	**Environmental Permitting**	**165 days**	**Mon 5/9/05**	**Fri 12/23/05**
102	Develop Environmental Permits	40 days	Mon 5/9/05	Fri 7/1/05
103	Issue Permit Applications to Regulatory Agencies	0 days	Fri 7/1/05	Fri 7/1/05
104	Review of Permit Applications	125 days	Mon 7/4/05	Fri 12/23/05
105	Permit Issuance	0 days	Fri 12/23/05	Fri 12/23/05
106	**Survey**	**75 days**	**Mon 3/28/05**	**Fri 7/8/05**
107	Field Survey	60 days	Mon 3/28/05	Fri 6/17/05
108	Easment Documents	30 days	Mon 5/30/05	Fri 7/8/05
109	**Easement Aquistion**	175 days	Mon 7/11/05	Fri 3/10/06
110	**Engineering**	**230 days**	**Mon 1/3/05**	**Fri 11/18/05**
111	Studies & Front End Engineering	90 days	Mon 1/3/05	Fri 5/6/05
112	**Detailed Design**	**140 days**	**Mon 5/9/05**	**Fri 11/18/05**
113	Pump Station	120 days	Mon 5/9/05	Fri 10/21/05
114	Pipeline	140 days	Mon 5/9/05	Fri 11/18/05
115	**Long-Lead Equipment**	**200 days**	**Mon 7/4/05**	**Fri 4/7/06**
116	Procurement Cycle	20 days	Mon 7/4/05	Fri 7/29/05
117	Award Long-Lead Equipment	0 days	Fri 7/29/05	Fri 7/29/05
118	Vendor Data Development/Review Cycle	30 days	Mon 8/1/05	Fri 9/9/05
119	Fabrication	130 days	Mon 9/12/05	Fri 3/10/06
120	Delivery	20 days	Mon 3/13/06	Fri 4/7/06
121	**Bid Cycle**	40 days	Mon 11/21/05	Fri 1/13/06
122	**Construction**	**290 days**	**Mon 9/26/05**	**Fri 11/3/06**
123	**Contractor Procurement**	**40 days**	**Mon 1/16/06**	**Fri 3/10/06**
124	Award Construction Contracts	40 days	Mon 1/16/06	Fri 3/10/06
125	**Pipeline Installation**	**230 days**	**Mon 12/19/05**	**Fri 11/3/06**
126	Owner Furnished Material	60 days	Mon 12/19/05	Fri 3/10/06
127	Mobilization	10 days	Mon 3/13/06	Fri 3/24/06
128	Directional Drilling (Ship Channel)	40 days	Mon 3/27/06	Fri 5/19/06
129	Directional Drilling (Dunes & Offshore)	69 days	Mon 5/22/06	Thu 8/24/06
130	Open Cut Installation	160 days	Mon 3/27/06	Fri 11/3/06
131	Offshore Installation	30 days	Mon 3/27/06	Fri 5/5/06
132	Diffuser Installation	5 days	Mon 5/8/06	Fri 5/12/06
133	**Pump Station Construction**	**115 days**	**Mon 9/26/05**	**Fri 3/3/06**
134	**Mechanical Construction**	**95 days**	**Mon 9/26/05**	**Fri 2/3/06**
135	Procure Materials	20 days	Mon 9/26/05	Fri 10/21/05
136	Mobilize	10 days	Mon 10/24/05	Fri 11/4/05
137	Erect Structure & Install Equipment	65 days	Mon 11/7/05	Fri 2/3/06
138	**Instrumentation/Electrical Construction**	**50 days**	**Mon 12/26/05**	**Fri 3/3/06**
139	Procure Materials	20 days	Mon 12/26/05	Fri 1/20/06
140	Mobilize	10 days	Mon 1/23/06	Fri 2/3/06
141	Install Controls & Electrical	20 days	Mon 2/6/06	Fri 3/3/06
142	**Commissioning & Startup**	45 days	Mon 8/14/06	Fri 10/13/06
143	**Final Acceptance**	0 days	Fri 10/13/06	Fri 10/13/06
144	**POWER PLANT**	**585 days**	**Mon 1/3/05**	**Fri 3/30/07**
145	**Environmental, Design & Procurement**	**340 days**	**Mon 1/3/05**	**Fri 4/21/06**
146	**Environmental Permitting**	**165 days**	**Mon 5/9/05**	**Fri 12/23/05**
147	Develop Environmental Permits	40 days	Mon 5/9/05	Fri 7/1/05

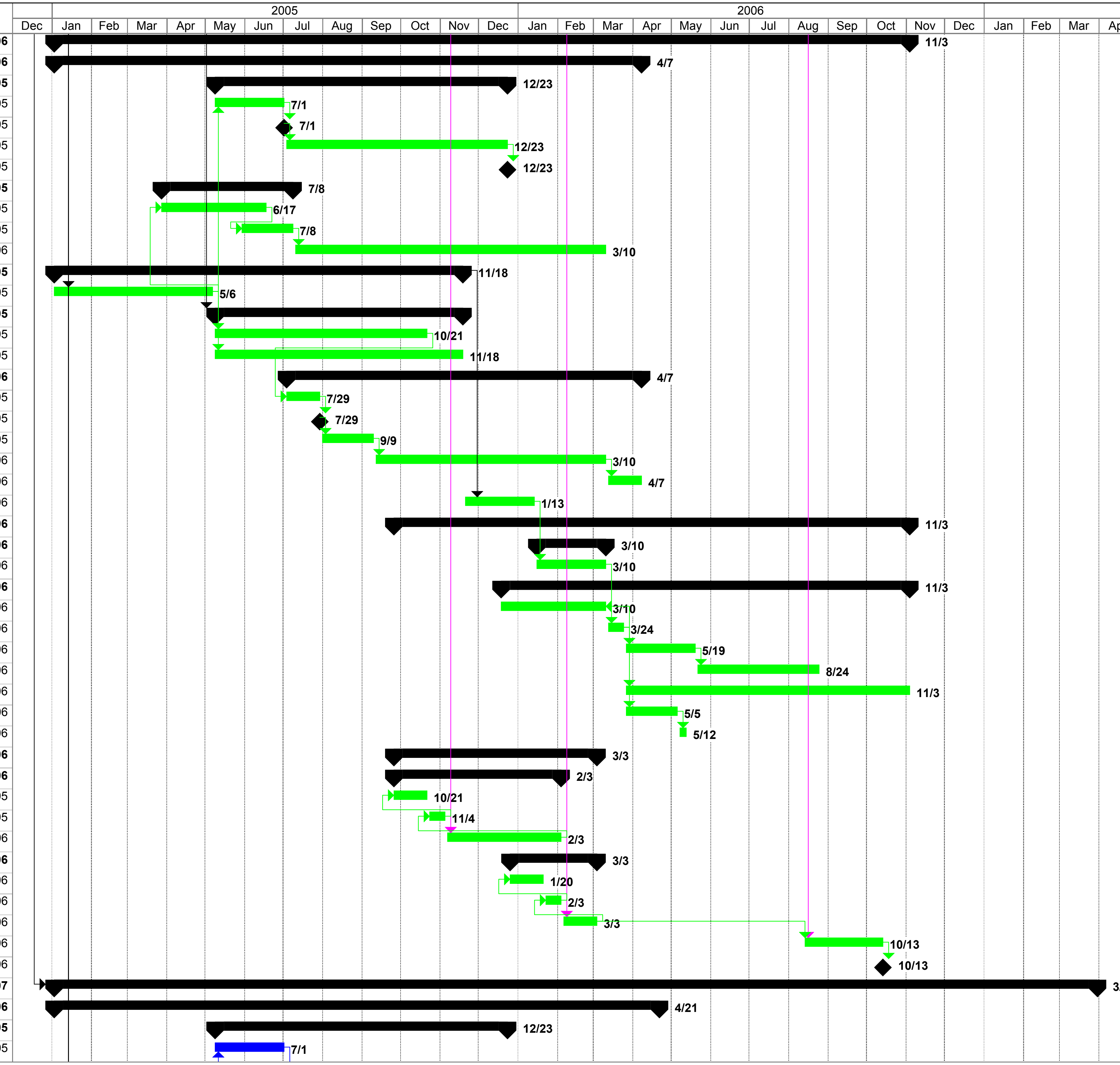


FIGURE 10-2

ACCELERATED PROJECT SCHEDULE - FIGURE 10-2

BROWNSVILLE DESALINATION FEASIBILITY STUDY
Brownsville, Texas

ID	Task Name	Duration	Start	Finish
148	Issue Permit Applications to Regulatory Agencies	0 days	Fri 7/1/05	Fri 7/1/05
149	Review of Permit Applications	125 days	Mon 7/4/05	Fri 12/23/05
150	Permit Issuance	0 days	Fri 12/23/05	Fri 12/23/05
151	**Engineering**	**230 days**	**Mon 1/3/05**	**Fri 11/18/05**
152	Studies & Front End Engineering	90 days	Mon 1/3/05	Fri 5/6/05
153	Long-Lead Equipment - Bid Specs	25 days	Mon 1/3/05	Fri 2/4/05
154	Detailed Design	140 days	Mon 5/9/05	Fri 11/18/05
155	Balance of Plant Equipment	35 days	Mon 5/9/05	Fri 6/24/05
156	Design IFC	0 days	Fri 11/18/05	Fri 11/18/05
157	**Long-Lead Equipment**	**315 days**	**Mon 2/7/05**	**Fri 4/21/06**
158	Procurement Cycle	25 days	Mon 2/7/05	Fri 3/11/05
159	Award Long-Lead Equipment	0 days	Fri 3/11/05	Fri 3/11/05
160	Vendor Data Development/Review Cycle	40 days	Mon 3/14/05	Fri 5/6/05
161	Fabrication	250 days	Mon 5/9/05	Fri 4/21/06
162	Delivery	0 days	Fri 4/21/06	Fri 4/21/06
163	**Balance of Plant Equipment**	**210 days**	**Mon 6/27/05**	**Fri 4/14/06**
164	Procurement Cycle	30 days	Mon 6/27/05	Fri 8/5/05
165	Award Long-Lead Equipment	0 days	Fri 8/5/05	Fri 8/5/05
166	Vendor Data Development/Review Cycle	40 days	Mon 8/8/05	Fri 9/30/05
167	Fabrication	140 days	Mon 10/3/05	Fri 4/14/06
168	Delivery	0 days	Fri 4/14/06	Fri 4/14/06
169	**Bid Cycle**	30 days	Mon 11/21/05	Fri 12/30/05
170	**Construction**	**325 days**	**Mon 1/2/06**	**Fri 3/30/07**
171	**Contractor Procurement**	**20 days**	**Mon 1/2/06**	**Fri 1/27/06**
172	Award Construction Contracts	20 days	Mon 1/2/06	Fri 1/27/06
173	**Site Work Construction**	50 days	Mon 1/30/06	Fri 4/7/06
174	**Dock Facilities Construction**	**200 days**	**Mon 1/30/06**	**Fri 11/3/06**
175	Procure Materials	45 days	Mon 1/30/06	Fri 3/31/06
176	Mobilize	15 days	Mon 4/3/06	Fri 4/21/06
177	Erect Dock Facilities	140 days	Mon 4/24/06	Fri 11/3/06
178	**Foundation Construction**	**95 days**	**Mon 3/6/06**	**Fri 7/14/06**
179	Procure Materials	20 days	Mon 3/6/06	Fri 3/31/06
180	Mobilize	15 days	Mon 4/3/06	Fri 4/21/06
181	Install Foundations	60 days	Mon 4/24/06	Fri 7/14/06
182	**Boiler Erection**	**105 days**	**Mon 6/26/06**	**Fri 11/17/06**
183	Mobilize	15 days	Mon 6/26/06	Fri 7/14/06
184	Erect boiler	90 days	Mon 7/17/06	Fri 11/17/06
185	**Structural/Mechanical Construction**	**195 days**	**Mon 4/10/06**	**Fri 1/5/07**
186	Procure Materials	80 days	Mon 4/10/06	Fri 7/28/06
187	Mobilize	15 days	Mon 7/31/06	Fri 8/18/06
188	Erect Structure & Install Equipment	100 days	Mon 8/21/06	Fri 1/5/07
189	**Instrumentation/Electrical Construction**	**125 days**	**Mon 9/18/06**	**Fri 3/9/07**
190	Procure Materials	30 days	Mon 9/18/06	Fri 10/27/06
191	Mobilize	15 days	Mon 10/30/06	Fri 11/17/06
192	Install Controls & Electrical	80 days	Mon 11/20/06	Fri 3/9/07
193	**Commissioning & Startup**	60 days	Mon 1/8/07	Fri 3/30/07
194	**Final Acceptance**	0 days	Fri 3/30/07	Fri 3/30/07

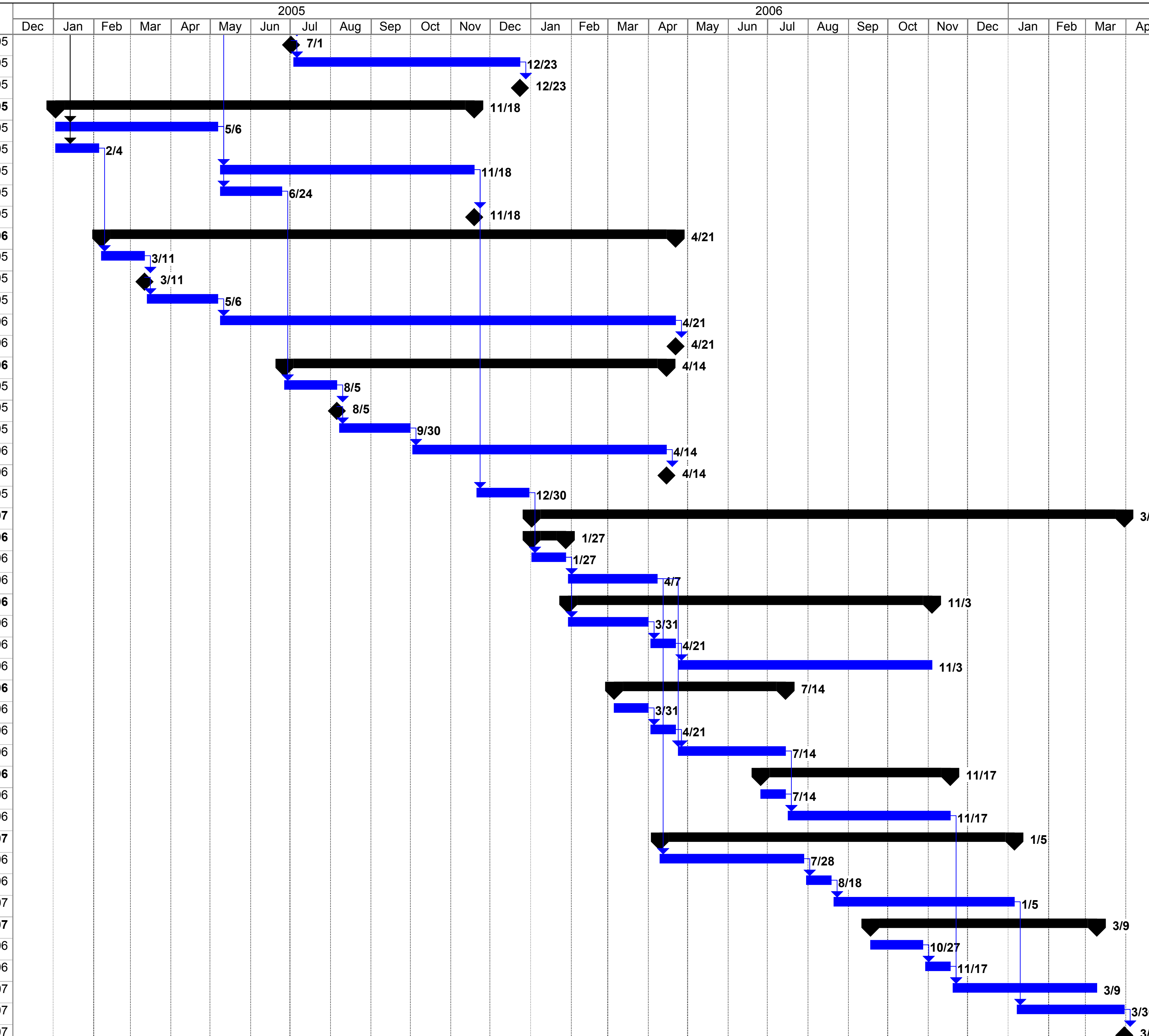


FIGURE 10-2

APPENDICES

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Feasibility Study Report
Brownsville Desalination Demonstration Project
Updated July 13, 2004

APPENDIX A

SCREENING OF ALTERNATIVE TREATMENT PROCESSES

Appendix A

Initial Screening of Potential Treatment Technologies
Brownsville Desalination Demonstration Project

General Methodology for Initial Technology Screening

1. An initial screening of potential alternatives was conducted for the major components associated with the desalination facility. These components were organized into the following categories:

   - Seawater Screening
   - Pretreatment
   - Desalination Technologies
   - Permeate Stabilization (for Corrosion Control)
   - Disinfection Options
   - Solids Dewatering Options

2. Potential options for each category described above were identified through a review of existing and proposed desalination facilities in the United States as well as in the world. A literature search was also conducted to identify other potential alternatives that should be considered in the feasibility study for this project. In addition, processes from other types of treatment facilities were considered if they could be used for the subject project (i.e., disinfection technologies, solids handling processes and operations, etc.).

3. Various screening criteria were used to assess the options identified for each plant component. These criteria include (1) technical applicability, (2) overall reliability, (3) permittability, (4) constructibility, (5) O&M requirements, and (6) cost effectiveness.

4. Numerical scores were assigned to each criterion for an option. Relative scores were selected for each screening criterion using sound engineering judgement and experience. For example, if one option were more costly than another, the first option would be given a lower score relative to the second option.

5. Once numerical scores were assigned to each criterion for each option, the individual scores were summed to derive a composite score for each option. The options receiving the highest scores were retained for a more detailed evaluation in the alternatives analyses.

6. Refer to the attached table for the initial technology screening matrix listing all alternatives considered for this project, the various screening criteria, and their numerical scores.

7. Refer to **Section 3** for a more detailed evaluation of those options retained from the initial screening process.

Important Notes Regarding Screening Process and Results

Refer to the attached technology screening matrix for the following notes regarding the selection and/or non-selection of specific alternatives. The following notes are arranged in order that they are referenced in the attached table.

A. Although course screens received a relatively high score in the initial screening step, this option was not retained due to other considerations taken into account regarding the design of the seawater intake system. An entrance barrier wall will be used to prevent large debris from entering the intake system, thereby eliminating the need for coarse screening. Refer to **Section 3** for a full discussion regarding this aspect of the project.

B. Although bank filtration can be an excellent option for the seawater screening system, the relative quantity of water that would need to be collected for the initial through build-out plant capacities would be costly to construct. Furthermore, due to the local geology, which contains varying proportions of clay, clayey sand, and sandy clay, as well as a high potential for organic colloidal sediment deposition along the bank of the Brownsville Shipping Channel, this option is not considered as applicable or as reliable as the other options under evaluation.

C. Both microfiltration (MF) and ultrafiltration (UF) received similar scores from the initial screening step. Either technology could potentially be used for the project's pretreatment system. However, since both options are very similar to one another in most respects, only one of the two was retained for further evaluation. MF was retained for further evaluation in the next step of the alternative analysis for this plant component. If this option proves to be the most appropriate for the desalination facility, a more detailed comparison of MF versus UF technology would be conducted to select the most viable membrane configuration for the pretreatment system.

D. Of all of the potential desalination alternatives considered in the initial screening process, only seawater reverse osmosis (SRWO) is a viable option for this project. The remaining membrane alternatives are more appropriate to desalt brackish surface water and groundwater supplies. The operating efficiencies and associated costs of the remaining membrane options eliminate them as viable candidates for this project. In addition, none of the thermal options are considered cost effective for this project due to large quantities of steam energy needed to support these options. A dedicated system of boilers along with a sufficient and continuous fuel source would be needed to drive any of the thermal options. The proposed 100 MW power plant that may be co-located with the desalination facility would not be large enough to support any of the thermal options. However, for purposes of complete reporting to the state of Texas, all of the potential desalination processes listed in the attached screening matrix were retained. Additional details regarding all potential desalination options are provided in **Section 3.** Some of the other options listed in the screening matrix could be explored for other locations within the state of Texas if needed and/or if applicable.

E. Any of the permeate stabilization alternatives could be used for proper corrosion control and potentially applied for the subject project. However, based on feedback from the Brownsville PUB, the finished water supply from the desalination plant will be blended with water obtained from other sources. Adjustment of the water quality with respect to pH, alkalinity, and calcium levels is the preferred approach to stabilize the water supply, while matching to the degree possible the water quality of finished water produced by the desalination plant to the water quality produced by other existing facilities in the local service area.

F. Hypochlorite was retained as a viable alternative from the initial screening step. There are two process modifications of this particular alternative that will be explored in more detail in the next step of the alternatives analysis: (1) bulk deliveries of commercial grade (12%+) hypochlorite and (2) on-site generation of hypochlorite.

G. None of these disinfection alternatives would result in a disinfectant residual that would be consistent with the type of residual present in the existing water supply system within the Brownsville service area. (Chlorine is currently used in the Brownsville service area.) Since it will be important to match the disinfectant residual as much as possible, only those options that would produce a chlorine residual were retained.

H. Ultraviolet (UV) light and ozone are effective and viable disinfection alternatives that could be used to disinfect the finished water supply. However, since an advanced membrane system will be used prior to the disinfection system, the need to rely on these alternative disinfection options is substantially reduced. Furthermore, neither of these options would provide a disinfectant residual after leaving the desalination facility.

I. Gravity thickening was retained from the initial screening step for solids dewatering. This is an efficient and reliable operation that can be used to substantially reduce sludge volumes, while recovering a large percentage of water wasted from the pretreatment system. This unit operation will be used in conjunction with the other options retained for solids dewatering to maximize the overall efficiency of this plant component.

Initial Technology Screening Matrix for the Brownsville Desalination Demonstration Project

Description of Alternative Process	Applicability	Reliability	Permit-ability	Construct-ability	O&M Requirements	Cost Effectiveness	Composite Score	Retain? (Y/N)
Seawater Screening								
Innovative Synthetic Permeable Filters	8	5	6	6	4	6	**35**	**Y**
Fine Screens	8	8	8	7	6	7	**44**	**Y**
Course Screens (Trash/Bar Racks) (A)	8	7	8	7	8	8	46	N
Bank Filtration (B)	6	5	5	5	3	5	29	N
Pretreatment								
Single Stage Direct Filtration	3	1	2	9	3	7	25	N
Two Stage Direct Filtration	5	6	7	8	6	8	**40**	**Y**
Conventional Coagulation, Flocculation, and Sedimentation with Filtration	6	5	7	7	4	4	33	N
Ballasted Flocculation Clarification with Filtration	8	7	7	8	6	8	**44**	**Y**
Dissolved Air Flotation with Filtration	4	5	6	7	5	5	32	N
Membrane Microfiltration (MF)	9	8	6	6	4	3	**36**	**Y**
Membrane Ultrafiltration (UF) (C)	9	7	6	6	4	3	35	N
Desalination Technologies (D)								
Seawater Reverse Osmosis (SWRO) Membranes	10	9	8	8	7	7	**49**	**Y**
Nanofiltration (NF) Membranes	2	1	2	5	7	2	19	N
Electrodialysis (ED) Membranes	2	1	2	5	7	2	19	N
Electrodialysis Reversal (EDR) Membranes	2	1	2	5	7	2	19	N
Multi-Effect Distillation (MED)	7	5	6	3	1	1	24	N
Multi-Stage Flash (MSF)	7	6	6	3	2	1	25	N
Mechanical Vapor Compression (MVC)	5	7	4	3	2	1	22	N
Permeate Stabilization for Corrosion Control (E)								
Water Quality Adjustment (Precipitation/Passivation)	9	8	8	7	4	8	**44**	**Y**
Polyphosphate (Cathodic Inhibitor)	7	6	5	7	6	5	36	N
Zinc Orthophosphate (Anodic Inhibitor)	7	6	5	7	6	5	36	N
Sodium Silicate (Anodic Inhibitor)	6	5	4	7	6	5	33	N

Initial Technology Screening Matrix for the Brownsville Desalination Demonstration Project

Description of Alternative Process	Applicability	Reliability	Permit-ability	Construct-ability	O&M Requirements	Cost Effectiveness	Composite Score	Retain? (Y/N)
Disinfection Options								
Gas Chlorine	9	9	8	6	8	8	**48**	**Y**
Sodium or Calcium Hypochlorite (F)	9	9	9	8	6	9	**50**	**Y**
Chlorine Dioxide (G)	8	6	5	8	6	7	40	N
Ultraviolet Light (G) (H)	5	8	5	9	7	6	40	N
Chloramines (G)	3	5	5	7	7	6	33	N
Ozone (G) (H)	5	8	5	5	5	3	31	N
Solids Dewatering Options								
Storage Lagoons	1	2	2	2	7	7	21	N
Gravity Thickening (I)	10	10	10	10	9	9	**58**	**Y**
Floatation Thickening	5	6	5	7	4	6	31	N
Gravity Dewatering Beds	5	8	7	6	4	5	35	N
Freeze-Assisted Sand Beds	2	4	4	4	2	4	20	N
Solar Drying Beds	3	3	3	3	3	3	18	N
Belt Filter Presses	9	9	9	8	6	7	**48**	**Y**
Centrifuges	9	9	8	9	8	8	**51**	**Y**
Vacuum-Assisted Drying Beds	9	9	7	7	7	6	**45**	**Y**

Notes:

1. *The principal components associated with the treatment plant were identified and used to organize possible alternatives for the initial screening evaluation. Potential options for each plant component were identified through a review of existing and proposed desalination facilities in the United States as well as the world. A literature search was also conducted to identify other potential alternatives that should be considered in the feasibility study for this project. Processes from other types of treatment facilities were also considered if they could be used for the subject project (i.e., solids handling processes and operations).*
2. *For each alternative, scores were assigned to each of the screening criteria. Scores range from 1 through 10 with 1 being the lowest or less desirable score and 10 being the greatest. Alternatives that receive larger relative composite scores compared to the other alternatives evaluated will be retained for a more detailed evaluation in the subsequent step in the alternatives analysis for each plant component.*
3. ***Bold print** is used to indicate which alternatives were retained for the next step of the alternatives analysis.*
4. *Refer to **Section 3** for a more thorough discussion and evaluation of the alternatives retained from the initial screening process.*
5. *Refer to the preceding pages for specific qualifications associated with those items in the table footnoted with letters.*

APPENDIX B

TEXAS PERMITTING REQUIREMENTS PERTAINING TO SURFACE WATER DISCHARGES

Appendix B

Texas Permitting Requirements Pertaining to Surface Water Discharges

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The most pertinent regulatory tool for guiding regulators through the technical aspects of the industrial wastewater permitting process is Chapter 307, Texas Surface Water Quality Standards (TSWQS). This section examines the specific regulatory issues and requirements described in the TSWQS that are commonly considered in permitting.

General Criteria

The general surface water criteria described in the TSWQS apply to all surface waters in the state of Texas unless otherwise exempted by site-specific water quality standards. The general parameters regulated in the TSWQS that are considered in a TPDES permit could include aesthetics, temperature, salinity, and toxicity.

It is required by TCEQ that all surface waters of Texas be maintained in an *"aesthetically attractive*" condition. This means that concentrate discharged into a water body must not interfere with the taste and odor of the receiving water along with the food fish and shellfish living in the water. Concentrate discharge must not cause persistent foaming or frothing, or alter ambient conditions of turbidity or color within the receiving water. Finally, a concentrate discharge must not result in the existence of suspended solids that may adversely effect aquatic life or settleable solids that may in any way alter the flow of receiving waters.

TCEQ requires that temperatures in all waters of the state be maintained*, "so as not to interfere with the reasonable use of such waters*". This means that concentrate discharges from a desalination plant must not alter the receiving water temperature in excess of established maximum temperature differentials. In gulf waters, bays, and tidal river reaches, this maximum differential has been set at 4 degrees Fahrenheit for the fall, winter, and spring. However, a more stringent maximum differential of 1.5 degrees Fahrenheit is required for the summer months of June, July, and August (30 TAC, Section 307.4).

Although proper salinity gradient maintenance is required to ensure healthy marine life populations, estuarine salinity criteria have yet to be established for surface waters of Texas. However, an absence of numerical salinity criteria does not necessarily mean lax regulation. Careful regulatory consideration will be given to all activities that may significantly effect coastal salinity levels and estuarine salinity gradients. Therefore, an applicant discharging desalination concentrate should expect the salt concentration of the discharge to be a defining issue in the permitting process.

Total Toxicity

Total toxicity, also referred to as whole-effluent toxicity, will be a key consideration in the permitting of a surface water concentrate discharge. An applicant must prove that the effluent from a proposed facility will be controlled so that acute and chronic toxicity indicated by the Texas Surface Water Quality Standards is not exceeded. The specific effluent tests and testing procedures to determine total toxicity will be discussed in Part V.

Total toxicity must be shown to fall below acute toxicity limits in receiving waters with the exception of small zones of initial dilution (ZID's) at points of discharge. Acute criteria may be exceeded in a ZID as long as the predicted effluent toxicity levels are not lethal to any aquatic organisms that may move through a ZID. A ZID may not extend more than 60 feet downstream and 20 feet upstream from a discharge point in a river. A ZID may not exceed a volume equal to a 50-foot radius in all directions from the discharge point in a bay, tidal river, or estuary (30 TAC, Section 307.4). ZID sizes for ocean disposal of concentrate are not specified and would be considered on a case specific basis by TCEQ.

Total toxicity must be shown to fall below chronic toxicity levels in receiving waters with the exception of mixing zones. Mixing zones encompass a larger area, and are subject to more stringent standards than ZID's. These zones are usually designated by TCEQ on a case-by-case basis. Factors considered in permitting mixing zones and determining mixing zone size limits include concentrate quality and receiving water characteristics.

The toxicity of some substances is defined as a function of pH and hardness. Appropriate pH or hardness standards are listed in the Texas Surface Water Quality Standards for each individual river basin. An applicant must show that these standards can be met unless data is available to derive site-specific pH and hardness criteria for the waters receiving the concentrate discharge.

Additional requirements must be met if effluent tests indicate that a proposed concentrate discharge will exceed toxicity levels established in the Texas Surface Water Quality Standards. If toxicity levels are exceeded, an applicant should expect to conduct a toxicity identification evaluation and a toxicity reduction evaluation. After assessing these evaluations, TCEQ may include additional conditions within the permit to ensure compliance with water quality standards. These conditions could include chemical specific limits and best management practices designed to reduce total toxicity levels.

Antidegradation Policy

Degradation is defined by TCEQ as a lowering of water quality to the extent that an existing use is impaired. Water quality must be maintained to a level that ensures the protection of existing uses. The baseline condition for determining degradation is defined as the highest water quality sustained since November 28, 1975 (30 TAC, Section 307.5).

The antidegradation policy of TCEQ is strictly enforced. However, a discharge of concentrate that causes degradation may be allowed if an applicant can show that the lowering of water quality is necessary for vital economic or social development. TCEQ deals with exemptions from the antidegradation policy on a case-by-case basis and requires significant evidence that degradation is necessary.

Required Reports Considered in TPDES Permitting

When applying for a TPDES permit for surface water disposal of concentrate, an applicant must complete both an Administrative Report for Permit Application and an Industrial Wastewater Permit Application Technical Report. The decision of TCEQ to issue an industrial wastewater permit depends heavily on the information submitted within these reports. The following is a breakdown of the general filing requirements, and regulatory issues considered within each report.

The information required to be submitted in the Administrative Report deals with general facility operations, disposal methods, ownership issues, and site characteristics. More specifically, these items include a description of the proposed project site and vicinity information adequate to determine whether the project complies with all relevant policies. Maps and photographs of the site area, disposal fallout points, and adjacent land and water bodies are required, as well as structural and schematic drawings for the proposed facility. The description of the development should also include any mitigation measures available that would substantially lessen any significant adverse impacts the development may have on the environment. Legal easements or lease agreements are required for proof of land ownership and land use authorization. Finally, extensive information involving adjacent landowners whose property may be adversely effected is an essential aspect of the Administrative Report.

After the Administrative Report is declared administratively complete, the Technical Report becomes open to a rigorous technical review process. The Technical Report deals with specific, technology-based information discussed in more detail in part V. It is encouraged that technical reports be prepared by either a Texas Registered Professional Engineer or by a qualified person who is competent and experienced in the field of desalination and concentrate disposal. TCEQ will then review the report and administer various simulated tests that will be used to develop appropriate permit limits and ensure that the proposed project will be in compliance with all relevant regulations. In essence, the decision of TCEQ to issue a permit is based primarily on the information submitted in the Technical Report.

Information Required for Regulatory Consideration in the Technical Report

Influent and Effluent Characterization

A list of all raw materials, major intermediates, maintenance chemicals, and products handled at the facility is to be submitted. Trade names for chemical compounds should be avoided. Proposed duration of discharge flow (hrs/day) is required along with the predicted daily average and maximum flows (MGD). All chemical constituents predicted to be present in the facilities discharge are to be indicated in the report. Average and maximum influent and effluent concentrations (mg/l) of indicated pollutants must be predicted and listed along with estimated pH levels. Note: It is required that all methods used for testing be sensitive enough to detect the constituents at the Minimum Analytical Levels (MAL) specified in the report.

Toxicity Testing

Since concentrated effluent may exert toxicity in receiving waters, a permittee should expect to perform whole effluent toxicity (WET) tests. Two types of toxicity tests using effluent produced from bench-scale or skid mounted pilot plant processes are required. Also known as biomonitoring, these tests include 100% end-of-pipe acute toxicity tests, and whole effluent tests based upon receiving water dilution. Permittees should consult the Water Quality Assessment Team of the Water Quality Division to for assistance regarding the characteristics of the proposed receiving water and the suitability of the marine test species. The following are examples of the whole effluent tests based upon receiving water dilution that are required:

- An acute 24-hour static toxicity test using Mysidosis bahia. It is required that a minimum of five (5) replicates with eight (8) organisms per each replicate be used.
- An additional acute 24-hour static toxicity test must be done also using a minimum of five (5) replicates with eight (8) organisms per each replicate. However, the second test should be carried out using Inland Silverside minnows (Menidia beryllina).

For both tests five effluent concentrations should be used including 6%, 13%, 25%, 50%, and 100%. An additional sample of 0% concentration must be used for a control. Each effluent sample should consist of a 24-hour composite sample. A 24-hour composite sample consists of a sample continuously collected proportional to flow over a 24-hour period, or at least twelve (12) effluent portions collected at equal time intervals and combined proportional to flow (30 TAC, Section 307.4). The dilution water used in the toxicity tests should consist of synthetic seawater.

When all tests are completed the applicant is required to submit a complete toxicity test report that includes the 24-hour LC50 and mean survival for each species at all effluent dilutions. The report should be prepared according *to "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fourth Edition*" (EPA 600/4-90/027F), Section 12, Report Preparation.

An applicant should note that a new study by the Florida Department of Environmental Protection (FDEP) has indicated that concentrate toxicity may result from conditions other than increased levels of one of more of the specific chemical constituents. During a study to determine the potential sources of toxicity, the FDEP found that in some cases toxicity might be caused solely by the imbalance of major seawater ions as opposed to elevated concentrations of certain elements (FDEP, 1995). Since an imbalance of major seawater ions would be corrected differently than an increased concentration of one or more individual ions, an applicant should take measurements to determine the exact source of toxicity. Determining the exact source of toxicity is key in planning the most effected means to reduce toxicity and comply with state and federal requirements.

<u>Receiving Water Characterization</u>

The applicant must submit an in-depth, physical description of the receiving waters indicating the following characteristics:

- Approximate surface area
- Average depth
- Approximate depth within a 500-foot radius
- Stream channel modifications (e.g. dammed, concrete lined, etc.)
- Basis of flow assessment
- Uses of water bodies (e.g. navigation, recreation, etc.)
- Upstream influences to discharge areas (e.g. agricultural or urban runoff, septic tanks, upstream discharges, etc.)
- Aesthetic characterization (e.g. wilderness, natural area, common setting, or offensive)

Original USGS quadrangle maps must also be submitted showing the location of the facility and proposed discharge points. Additional USGS quadrangle maps should be included showing the discharge paths three (3) miles from these discharge points. The applicant must indicate the existence of any domestic drinking water supplies and/or oyster beds downstream of the proposed discharge points. Approximate distances from each concentrate outfall must be indicated for any oyster bed, while any drinking water supplies must be located on a USGS 7.5-minute topographic map.

<u>Pollution Prevention Issues</u>

Along with the many technical issues considered in the report, the TCEQ also evaluates an applicant's proposed efforts toward pollution prevention. Facilities are encouraged to implement new and existing pollution prevention programs that will help to minimize the environmental impacts of a concentrate discharge. Within the Technical Report is a section intended to gather information pertaining to any initiated pollution prevention efforts of the applicant.

Determination of Appropriate Permit Limits

Technology based limits for USEPA classified categorical industries must be at least as stringent as Best Practical Control Technology, Best Available Technology Economically Achievable, and Best Conventional Pollutant Control Technology. However, the USEPA has not yet designated desalination as a categorical industry and so it is still considered a "New Source". Effluent limits for surface water discharge of concentrate from a desalination facility will therefore be subject to separate guidelines. These guidelines, referred to as New Source Performance Standards, will be much more stringent than the traditional technology based permit limits.

Once the Industrial Wastewater Permit Application Technical Report is reviewed and declared complete, the information is used to determine appropriate effluent limitations. The Technical Report is sent to the Toxicity Evaluation Team of Standards and Assessments Section where each proposed outfall will be plotted on maps to identify critical low flow conditions. Predicted effluent concentrations are evaluated along with critical low flow conditions to determine appropriate permit limits and monitoring requirements.

The Technical Report is then transferred to the Water Quality Standards Team where the receiving waters are evaluated to determine the use category. Uses are determined through a Receiving Water Assessment (RWA) consisting of measurements and observations at the discharge site. Habitat characteristics, flow characteristics, and aquatic species composition and abundance are key in designating uses.

This information is then sent to the Water Quality Modeling Team that will run water quality models. The purpose of these models will be to predict discharge impacts on the receiving waters and determine effluent limits that will secure protection of the designated uses. These limits will ensure compliance with the antidegradation policies described in the Texas Surface Water Quality Standards.

The application consisting of the complete Administrative Report for Permit Application, Industrial Wastewater Permit Application Technical Report, and all recommended effluent limitations are forwarded to a permit writer for the development of a draft permit.

Monitoring Requirements

Once appropriate limits are determined and a permit is issued, all holders of a TPDES permit are required to periodically report the status of their compliance with all relevant state and federal statutes. Based on recommendations from various permitting divisions involved in the technical evaluation, TCEQ determines what parameters must be monitored. These parameters are determined on a case-by-case basis and are designated in the TPDES permit. Also indicated in the permit are requirements for sampling points, testing methods, and minimum frequencies for each parameter at which tests must be made. Although each monitoring requirement discussed above is determined on a case-by-case basis.

APPENDIX C

TEXAS PERMITTING REQUIREMENTS PERTAINING TO UNDERGROUND INJECTION CONTROL

Appendix C

Texas Permitting Requirements Pertaining to Underground Injection Control

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The most pertinent regulatory tool for guiding regulators through the technical aspects of the Class I injection well permitting process is Chapter 331, Underground Injection Control. This section examines the specific regulatory issues and requirements described in Chapter 331 that are commonly considered in Class I injection well permitting.

General Criteria

Area of Review

A typical area of review should extend no less than 2.5 miles from the proposed wellbore site or 0.25 miles from any other existing or proposed injection wells (30 TAC, Section 331.42). The local hydrogeology along the population of the region and its dependence on ground water along are key factors when delineating an are of review.

Mechanical Integrity Standards

An injection well is considered by TCEQ to have mechanical integrity only if there is no migration of wastes through the casing, tubing, or packer. Furthermore, wastes must not be allowed to migrate through the vertical channels adjacent to the wellbore. Either of these occurrences could result in the movement of injection wastes into surrounding USDWs.

Corrective Action Standards

An applicant may be responsible for preventing the migration of wastes into USDWs due to other inadequately constructed, completed, plugged, or abandoned wells within the area of review. Corrective action plans must be submitted outlining the steps or modifications necessary to prevent such pollution from other existing wells. Factors considered when reviewing the adequacy of a proposed corrective action plan may include the history of injection operations in the area; completion and plugging records for existing wells; and/or abandonment procedures in effect at the time other wells were abandoned.

Approval for Construction

In order for TCEQ to consider approving the construction of an injection well various well data must be objectively reviewed for compliance with all standards and criteria listed in Chapter 331 of the Texas Administrative Code. An applicant must demonstrate that the construction design will ensure mechanical integrity based on the maximum proposed pressure and flow rate along with the waste compatibility. TCEQ will also review the calculated area of review and cone of influence to ensure that any corrective action plans for existing wells within these areas are adequate.

Construction Standards

All Class I injection wells must be designed with the purpose of preventing the movement of waste into surrounding USDWs. Well design must permit the use of testing devices for the continuous monitoring of the injection tubing, long string casing, and annulus. All materials should be designed to resist physical and chemical degradation from the injected waste. Surface casing must reach a minimum depth that extends past the confining bead below the lowest USDW. At least one string casing should extend all the way to the injection interval. Specific casing and cementing criteria will be set by TCEQ based on the proposed injection conditions and the local hydrogeology.

A class one injection well should be drilled in a way that minimizes problems that could compromise closure activities such as deviated holes and washouts. An injection hole should be drilled under laminar flow conditions with adequate fluid loss control so that hole washouts are minimized.

Using the pump and plug method, cementing may be accomplished by staging. The volume of cement pumped should equal 120% of the combined volume between the hole and casing and between the casing strings and surface of the ground. Deviation checks should be made at frequent intervals to ensure that no migration of waste will occur. Surface casing must be pressure tested at 1,000 psig while long string casing must be tested at 1,500 psig (30 TAC, Section 331.6). Both casings should be tested for at least thirty minutes. Core samples must be taken to determine porosity, bulk density, and permeability.

In accordance with the Texas Engineering Practice Act, a licensed professional engineer skilled in well construction operations must supervise all phases of well construction.

Operating Requirements

All chemical and physical characteristics must be maintained below permit limits to ensure protection of the injection well materials. To ensure that there is no migration of fluids into USDWs, monthly instantaneous rates and volumes of injected waste must fall within permit limits set by TCEQ.

Monitoring and Testing Requirements

An operator must develop and follow a waste analysis plan that illustrates the procedures used to carry out a chemical and physical analysis of the injected waste. The plan must include specified parameters for which the waste will be analyzed. Test methods and sampling procedures should be indicated along with the monitoring frequency for each parameter. Waste monitoring plans require approval from TCEQ.

Information Required for the Class I Injection Well Technical Report

Once the Administrative Report is reviewed, members of the Underground Injection Control Section permitting team will examine the Technical Report. The team will verify that all proposed construction, operation, and closure conditions comply with the criteria for underground injection listed in Chapter 331 of the Texas Administrative Code. TCEQ will decide to issue a Class I injection Well Permit if all proposed injection conditions are found to comply with the underground injection control criteria. The specific geologic and hydrogeologic information required in the Technical Report is discussed in this section.

An applicant must submit stratigraphy and hydrostratigraphy that depicts any major aquifers, USDWs, and/or fault lines that may exist as part of the local geology. A Class I Injection Well Permit cannot be issued unless it is demonstrated to TCEQ that each fault within a 2.5 mile radius of the well is not vertically or horizontally transmissive to an extent that contaminants may migrate from the injection zone. The confining zone, injection zone, injection interval, and lower confining strata must all be defined using structure and isopatch maps. TCEQ also requires a thorough description of the regional groundwater flow including its direction and discharge measurements.

An applicant must describe the configuration of the lowest USDW in terms of its base. The methods of this determination should be included. It must be demonstrated that the proposed confining zone is separated from the base of the lower most USDW by at least one other confining unit. Furthermore, it must be demonstrated that the potentiometric surface of the injection zone is less than the potentiometric surface of the lowermost USDW prior to injection.

Determination of Appropriate Permit Limits and Monitoring Requirements

Permit conditions such as effluent limitations, operational standards and monitoring requirements involving deep well injection are impossible to generalize as permitting is carried out strictly on a case-by-case basis. However, there are specific core requirements for all injection wells that applicants should consider when planning to dispose of concentrate by means of deep well injection.

Contrary to the effluent-based permit limitations of a surface water discharge, permit limits and monitoring requirements for deep well injection are established by TCEQ based on site-specific geologic and hydrogeology characteristics. Permit conditions are also heavily based on the engineering design, construction materials, and operating conditions of the injection well.

The primary goal of a Class I Injection Well Permit is to ensure that various waste injection conditions are met in order to prevent the movement of fluids into or between overlying USDWs. An applicant should site a well in an area where geologic and hydrogeologic conditions will best prevent any migration of concentrate from the injection reservoir into or between sources of drinking water. Furthermore, an applicant should use engineering design methods, materials, and operational conditions that will best prevent the leakage of concentrate. A proposed Class I injection well sited and designed with the above recommendations in mind will most likely be subject to a less time consuming permitting process while limitations and monitoring requirements will be less stringent

APPENDIX D

PRELIMINARY BRINE DILUTION MODELING AND CONCEPTUAL DESIGN OF DIFFUSER ARRAY

Appendix D

Preliminary Brine Dilution Modeling and Conceptual Design of Diffuser Array

Brownsville Desalination Demonstration Project

1.0 CONCEPTUAL-LEVEL DESIGN OF BRINE DIFFUSER ARRAY

1.1 Preliminary Considerations and Basis of Conceptual Design

The Brownsville desalination facility will use reverse osmosis (RO) technology and is anticipated to have an initial capacity of 25 MGD, but could be expanded to 100 MGD in 25 MGD increments. The plant will be designed for a 60% recovery rate and the produced brine will be discharged into the Gulf of Mexico through a diffuser array. Four different diffuser arrays will be considered in this study for plant capacities of 25, 50, 75, and 100 MGD, respectively.

It is our understanding that a discharge of concentrated brine into the Gulf could potentially impact the white shrimp populations that are present in the shallow waters of the Gulf of Mexico. White shrimp typically inhabit the Gulf at depths of up to 60 feet and can potentially be sensitive to brine discharges. The more resilient brown shrimp inhabits water depths of around 72 feet. Based on a review of bathymetric data for the Gulf, a depth of 70 feet occur at a distance of approximately 12 miles from the Texas coastline. This distance is extreme for the construction of a relatively large brine transmission main. Since the proposed site location of the desalination facility is approximately 11 miles inland from the coastline, a total brine transmission distance of up to 23 miles would be required to reach the lower depths where white shrimp are generally absent.

In order to provide a sufficient level of evaluation for the initial brine dispersion modeling effort that follows, two diffuser scenarios were evaluated. In the first scenarios, a deep diffuser was evaluated, whereby the brine transmission main is extended approximately 12 miles off the Texas coastline where a diffuser array would be located approximately 70 feet below the water surface. In the second scenario, a shallow diffuser was evaluated, which would be located only three (3) miles off the coast at a depth of 25 feet.

The following sections provides information regarding the design methodology used to model brine dispersion with the Gulf, provides details regarding the diffuser itself, and presents the input data and results of the preliminary brine dispersion modeling effort. It should be noted that additional and more advanced modeling work must be performed in a subsequent phase to support the final design of the diffuser array as well as confirm the best location for it.

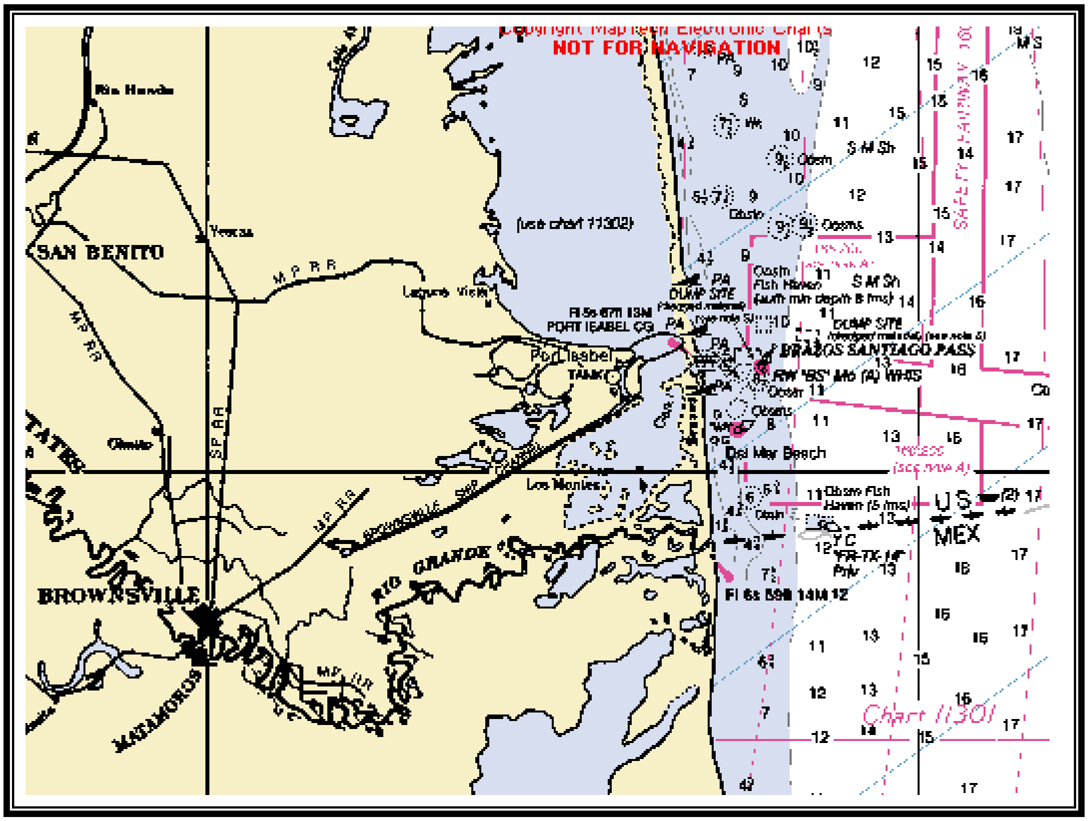

Figure 1 – Brownsville Coastline and Water Depths (in Fathoms)

1.2 Design Method

The following guidelines were used in developing a preliminary design of the diffuser for brine discharge (Grace,1978):

- The effluent flow is equally distributed across the various ports of the diffuser.
- The velocity in the diffuser should be sufficient to prevent deposition of solids carried with the flow. Minimum flow speeds of 0.6 to 0.9 m/s should be achieved at least for peak flows.
- The overall head losses should be kept as low as possible to minimize the level of pressure head at the upstream end of the line and the amount of pumping required.

- All the ports should be fully occupied by brine; i.e., no seawater intrusion should occur. This can be achieved by assuring that the Froude number exceeds one (1) for all ports.

The diffuser design should also be simple and functional to assure ease of construction and minimal maintenance problems.

An iterative methodology developed from the energy equation and fluid mechanics can yield the values of the hydraulic parameters of interest for the diffuser. These values can then be compared to the criteria mentioned above for properly designed diffusers. URS Oakland developed a spreadsheet that performs these calculations.

1.3 Diffuser Characteristics

The diffuser array will be placed at the end of the discharge main and will consist of several ports equipped with 1-meter high risers oriented upwards. The risers on the diffuser will help achieve higher discharge dilutions, since the brine is heavier than the surrounding seawater and it will fall towards the seabed as it dilutes with ambient seawater. The upwards orientation of the discharge will also enhance dilution and minimize head losses.

Two diffuser locations are considered. The first location considered is for a deep diffuser with a 12-mile transmision pipe as measured from the Texas coastline and at a depth of around 70 feet. The second location is for a shallow diffuser, which would be sited three(3) miles off the coast at a depth of approximately 25 feet.

Four diffusers designs were considerd at a conceptual level, corresponding to finished water plant production capacities of 25, 50, 75, and 100 MGD. The desalination plant will use an RO system operating at a recovery of 60 percent and will be co-located with a 100 MW power plant. In addition to the brine generated by the desalination plant, up to 2.5 MGD of blowdown from the co-located power plant may be combined with brine from the desalination plant prior to discharge. **Table 1** shows the effluent flows for the four diffusers designs.

Table 1 – Potential Range of Effluent Flows

Design	Finished Water Production Capacity	Resulting Brine Generation Rates	Blowdowns from Power Plant	Total Anticipated Effluent Flow
1	25	16.67	2.5	19.2
2	50	33.33	2.5	35.8
3	75	50.00	2.5	52.5
4	100	66.67	2.5	69.2

Note: All values are expressed in million gallons per day (MGD).

For the project's initial finished water production capacity of 25 MGD, a brine diffuser array measuring 300 meters (nearly 1000 feet) in length would be used to disperse brine into the Gulf. This array length would be duplicated in a parallel arrangement to provide additional disposal capacity for the remaining design increments. The seabed slope is very small at the proposed deep diffuser location. From **Figure 1**, the distance between a depth of 11 fathoms (66 feet) and a depth of 13 fathoms (78 feet) is approximately 5 miles. For a 300 meter long diffuser, the elevation difference between the start and end of the diffuser would only be between 10 and 20 cm. Therefore, the deep diffuser is considered to be horizontal. Shallower waters also present small slopes. However, the seabed slope is more pronounced at a depth of 30 feet than at a depth of 70 feet. It was assumed that for a 300-meter long diffuser at a depth of 30 feet the elevation difference between the start and the end of the diffuser is 1 meter. The features of the four proposed diffusers are summarized in **Table 2**.

Table 2 – Conceptual Design Features for Diffuser Designs

Design	Number of Ports	Port Diameter (m)	Main Pipe Diameter (m)	Diffuser Length (m)	Total Effluent Flow (MGD)
1	50	0.15	1.4	100	19.2
2	80	0.15	1.8	160	35.8
3	120	0.15	2.2	240	52.5
4	150	0.15	2.5	300	69.2

The hydraulic parameters of these four diffusers were calculated for an expected brine average salinity of 80 ppt, which corresponds to a brine density of 1,080 g/L. **Tables 3 and 4** summarize the hydraulic parameters for the deep and shallow diffusers, respectively.

Table 3 – Hydraulic Parameters for Deep Diffusers

Design	Head at Port #1 (m)[1]	Discharge Port Velocity (m/s)	Froude Number[2]
1	0.14	0.95	4.18
2	0.21	1.1	4.6
3	0.19	1.09	4.4
4	0.21	1.14	4.6

1. *The head at port number 1 (start of diffuser) is the head required to force flow through the diffuser.*
2. *The value is the Froude number provided by Visual Plumes, which should be larger than one to avoid seawater intrusion.*

Table 4 – Hydraulic Parameters for Shallow Diffusers

Design	Head at Port #1 (m)[1]	Discharge Port Velocity (m/s)	Froude Number[2]
1	0.04	From 0.87 to 0.97	From 3.8 to 4.6
2	0.05	From 1.02 to 1.13	From 4 to 5.2
3	0.04	From 0.99 to 1.1	From 3.7 to 5.1
4	0.04	From 1.05 to 1.15	From 3.8 to 5.4

1. *The head at port number 1 (start of diffuser) is the head required to force flow through the diffuser.*
2. *The value is the Froude number provided by Visual Plumes, which should larger than one to avoid seawater intrusion.*

The seabed slope at the shallow diffusers location results in different flows per port along the diffuser, and thus different discharge port velocities and Froude numbers. The ports located at the end of the diffuser will present higher flows than those at the beginning of the diffuser because the brine is denser than the surrounding seawater and tends to move down the sloped diffuser towards the deeper ports.

2.0 BRINE DILUTION MODELING

2.1 Visual Plumes Model

Visual Plumes (VP) is a Windows-based mixing zone modeling application. VP is USEPA approved and supports initial dilution models that simulate single and merging submerged plumes in arbitrarily stratified ambient flow. Predictions include dilution, plume diameter, plume elevation, and other plume variables.

The brine discharge was modeled using UM3, one of the models supported by VP. UM3 is a Lagrangian model that features the projected-area-entrainment hypothesis. This established hypothesis quantifies forced entrainment, the rate at which mass is incorporated into the plume in the presence of a current. The UM3 model is a three-dimensional plume model for simulating single and multi-port submerged discharges.

2.2 Input Parameters

Various parameters are needed to conduct the initial dilution modeling including diffuser parameters, effluent parameters, and ambient parameters. The following parameters were input to the model:

Diffuser Parameters

- Port Diameter: 0.15 m.
- Main Pipe Diameter: 1.4, 1.8, 2.2, 2.5 m.
- Port Elevation: Main pipe diameter plus 1-meter riser. Port elevations are 2.4, 2.8, 3.2, and 3.5 meters for the four diffusers considered in this analysis.
- Vertical Angle: 90 degrees (upwards).
- Horizontal Angle: 0 degrees (flow towards the East).
- Number of Ports: 50, 80, 120, or 150 ports.
- Port Spacing: 2 m.
- Port Depths: 21 meters (70 feet) for the deep diffuser and 9.1 meters (30 feet) for the shallow diffuser.

Effluent Parameters

- Flows: 19.2, 35.8, 52.5, or 69.2 MGD.
- Salinity: 80 g/L average brine salinity. Salinity varies between 40 and 100 g/L. Average salinity was calculated from the intake water salinity data and the 60% recovery factor for the plant. Considering that the brine gets mixed with 2.5 MGD fresh water from the power plant blowdown, the final salinities are as follows:

Table 5 – Salinities Used in the Model

Design	Brine Flow (MGD)	Total Flow (MGD)	Brine Salinity (g/L)	Final Salinity (g/L)
1	16.7	19.2	80	69.8
2	33.3	35.8	80	74.6
3	50.0	52.5	80	76.4
4	66.7	69.2	80	77.4

- Temperature: Ambient. The brine will be warmer than seawater temperature when leaving the RO plant and will travel 12 miles or 3 miles underwater before being discharged. The temperature of the brine at the point of discharge is expected to be similar to that of the surrounding seawater due to heat loss during transmission.

Ambient Parameters

- Current Speed: Data was downloaded from the NOAA web site for the closest available buoy to the Brownsville coastline. However, this buoy (buoy number 42041) is hundreds of miles away from the site and in deep water. Average bottom currents are 0.15 m/s and average currents at a depth of 85 feet are 0.32 m/s. The Texas Automated Buoy System (TABS) currently operates buoy J, which is very close to our site but appears to be out of service with no historical data archived. TABS also operates other buoys in shallow water (buoy D, off the shore of Corpus Christi) that usually report stronger currents than those offshore (see **Attachment A**).

- Current Direction: Expected to be parallel to the coastline.

- Ambient Salinity and Temperature: Measured at the shipping channel close to the site between 1993 and 2003. Average temperature is $24^{o}C$ and average salinity is 32 g/L. Ambient salinity varies between 16 and 40 g/L, and ambient temperature between 8 to 31 ^{o}C.

As explained above in **Section 1.3**, the seabed slope at the shallow diffusers location results in the flows per port being higher at the end of the diffuser than at the start of the diffuser. For these sloped diffusers the dense effluent tends to flow from the far end of the diffuser. VP considers horizontal diffusers and assumes equal flow velocities at all ports, which does not reflect what happens at the diffuser for the shallow location. To account for this effect, the diffusers were divided in two halves and a separate effluent flow was assigned to each half according to the diffuser hydraulics. This report presents the dilution results along the diffuser as a range, by combining the results from both halves.

2.3 Results

The model was run for the average conditions described above. A current speed of 0.15 m/s was considered to represent "small" currents, a value of 0.32 m/s was assumed to represent "average" currents, and a current speed of 0.5 m/s was considered as "strong" current conditions. **Table 6** shows the model results for the deep water diffusers.

Table 6 – Average Dilution at the Edge of the Mixing Zone for the Deep Water Diffuser				
Current Strengths	**Diffuser Design Number**			
	1	**2**	**3**	**4**
Small Currents (0.15 m/s)	42.4	45.8	52.2	55.4
Average Conditions (0.32 m/s)	94.2	98.5	114.3	119.9
Strong Currents (0.5 m/s)	142	147	170.3	182

Note: Edge of the mixing zone is the location where the plume hits the bottom.

For small currents, the plumes were found to hit the bottom between 2 and 3 meters away from the diffuser, while for average currents the plumes hit the bottom approximately 7 meters away from the discharge point. For strong currents the plume hits the bottom between 10 and 15 meters from the diffuser.

The shallow diffusers simulations resulted in two different dilution numbers for each diffuser design instead of a single dilution value, since each design was divided into two different problems to account for the seabed slope, as explained above. **Table 7** shows the dilution numbers from the model, which can be interpreted as the expected average dilution range at the shallow location.

Table 7 – Average Dilution at the Edge of the Mixing Zone for the Shallow Water Diffuser				
Current Strengths	**Diffuser Design Number**			
	1	**2**	**3**	**4**
Small Currents (0.15 m/s)	41 to 43	44 to 47	49 to 56	52 to 60
Average Conditions (0.32 m/s)	89 to 98	93 to 106	105 to 127	109 to 134
Strong Currents (0.5 m/s)	132 to 149	137 to 163	155 to 191	164 to 209

Note: Edge of the mixing zone is the location where the plume hits the bottom.

The dilutions found for the shallow diffuser are similar to those found for the deep diffuser. For every design, the first half of the diffuser discharges less effluent and achieves higher dilutions than the second half of the diffuser. The distances at which the shallow diffusers effluent plumes hit the bottom were also similar to those found in the deep diffuser analysis.

2.4 Conclusions and Recommendations

The dilutions varied from about 42 to 182 at the deep location and from 41 to 209 at the shallow location. **Table 8** shows the compositions of the ambient seawater, the brine before exiting the diffuser, and the plume at the point where it hits the bottom for a dilution of 41, the lowest dilution value found by the model.

Table 8 – Compositions for Lowest Dilution Factor			
Parameter	**Ambient Seawater**	**Brine**	**Lowest Brine Dilution**
Conductivity (uS/cm)	50,255	12,5637	52,094
Temperature (^oC)	23.94	23.9	23.94
Barium (mg/L)	0.0615	0.15	0.064
Calcium (mg/L)	390	975	404
Iron (mg/L)	0.109	0.27	0.113
Magnesium (mg/L)	1,310	3,275	1,357
Manganese (mg/L)	0.025	0.0625	0.026
Alkalinity (mg/L)	126	315	131
Chloride (mg/L)	18,684	46,710	19,368
Fluoride (mg/L)	1.1	2.75	1.14
Nitrate -N (mg/L)	0.328	0.82	0.34
o-Phosphate (mg/L)	0.04	0.1	0.041
Sulfate (mg/L)	2,564	6,410	2,658
TOC (mg/L)	1.07	2.675	1.11
TDS (mg/L)	36,122	90,305	37,444
Salininty (g/L)	32.1	80.25	33.3

Results summarized in the table above show that for the smallest dilution, the concentrations of the different components of the plume when they reach the bottom of the ocean are close to background ambient concentrations.

Several variable parameters will affect dilution, such as the brine salinity, ambient salinity and temperature, and currents. A more detailed study should be developed in order to understand the ambient and operational conditions that can result in the smallest dilutions, and to predict the the probabilities of such events.

There is no site-specific current speed and direction data available, and the installation of a current meter would be necessary in order to analyze the situation in more detail.

Exclusion zones for activities around the diffuser area are usually assigned by the local permitting agencies. Buoys and lights are usually placed to properly indicate the location of the diffuser. Exclusion zones can vary in size depending on the effluent discharged and the location of the diffuser, and can range between a few meters to 0.5 nautical miles. Therefore, the project will have a potential impact to shrimp fishing and other sailing activities.

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ATTACHMENT A

TEXAS AUTOMATED BUOY SYSTEM (TABS) DATA FOR BUOY D

From Proceedings of the Oceanology International 98 Exhibition and Conference, 10-13 March 1998, Brighton UK, Vol. 1, pp. 103-112. For information about the conference see www.spearhead.co.uk.

Texas Automated Buoy System (TABS): A Public Resource

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ABSTRACT

In August, 1994, The State of Texas General Land Office (GLO) directed the Geochemical and Environmental Research Group (GERG) of Texas A&M University to implement a program that provides real-time observations of surface currents and water temperature at selected locations along the Texas coast. The Texas Automated Buoy System (TABS) became operational in April 1995. Initially, the GLO funded five buoy sites: two off Galveston, two off Port Aransas, and one near Sabine Pass. In 1997 it authorized two additional TABS buoys for the region off Brownsville. TABS is a long-term operational system that the GLO considers absolutely critical to its ability to predict where spilled oil will go in Texas waters. Indeed, TABS data have proved pivotal during several recent spill responses. Beyond mandating this primary mission, the GLO has taken three steps to form TABS into an effective public resource: it insists that all TABS data be immediately disseminated through a user-friendly Internet webpage; it supports research to improve the reliability, operational range, and versatility of the TABS buoys; and it encourages other scientific research projects to build on the TABS resources.

TABS buoys take five-minute vector averages of current velocity and water temperature two meters below the surface every thirty minutes. A shore-based computer at GERG automatically acquires the data via cellular or satellite telephone four or more times per day, performs QA/QC functions, and adds the observations to the TABS database, which is publicly available through an interactive Web site http://www.gerg.tamu.edu/Tglo/. The buoys' observations are viewed hundreds of times each day by boaters, commercial fishing vessels, lightering operations, students, government agencies, and petroleum companies. The accessibility of TABS data and the GLO's long-term commitment to support the project have spawned new research projects and collaborations that build on the TABS core. An example of these is the Gulf of Mexico Ocean Monitoring Program, which is a National Ocean Partnership Program component, funded through the Office of Naval Research. The project's objective is to produce nowcasts and forecasts of surface and subsurface velocities for the entire Gulf of Mexico and distribute them publicly via an Internet Web page. This project and another one are funding the addition of four more buoys to the TABS system, bringing to eleven the total number in operation by spring 1998.

INTRODUCTION

Recognizing that oil spills threaten the economic and environmental well-being of the Texas Gulf Coast, the Texas Legislature passed the Oil Spill Prevention and Response Act of 1991, and it designated the Texas General Land Office (GLO) as the lead state agency for oil spills in Texas coastal waters. To support the additional GLO mission, the Legislature also created the Coastal Protection Fund through a two-cent-per-barrel fee on all crude-oil products moving through Texas ports. With this mandate and funding, the GLO has moved aggressively to develop its prevention program and response capabilities. (See: www.glo.state.tx.us/oilspill.)

Rapid, effective spill response can save substantial monies and greatly mitigate environmental impact. Therefore, the GLO maintains a computer workstation that continuously runs an oil-spill trajectory model. The model, Spillsym™, generates maps that are linked to an ArcInfo™ Geographic Information System to assess resources at risk. However, the accuracy and utility of any such model are almost entirely dependent on timely input of current and wind observations. The traditional use of historical or averaged seasonal data has proved ineffective for real-time operations, especially as a spill approaches the coast. In August 1994, the GLO directed the Geochemical and Environmental Research Group (GERG) at Texas A&M University (TAMU) to implement a program that would provide its computer with real-time observations of surface currents and water temperature and a synthesis of publicly available, real-time, marine weather data.

The Texas Automated Buoy System (TABS) became operational in April 1995 with the deployment of its first two buoys off Galveston, Texas. At the time of this writing, TABS has five buoys in operation, e.g., Buoy G, east of Sabine Pass, Buoys B and F off Galveston, and Buoys D and H off Corpus Christi (Figure 1). In 1997 the GLO authorized the purchase of two additional buoys for the South Padre Island region near Brownsville (Buoys J and K in Figure 1). Research projects external to TABS (see below), but cooperating and cost-sharing with it, are contributing four more buoys (Buoys I, L, M, and N in Figure 1). Thus, GERG will deploy the six new buoys during the spring of 1998, bringing to eleven the number of active TABS sites.

TABS has proved its worth during real spills, and realistic drills. During the *Buffalo Marine Barge 292* oil spill, for example, the National Oceanic and Atmospheric Administration HAZMAT modeling team and the GLO's trajectory modeling team used TABS data and computer simulations to forecast the movement of the oil to an unprecedented level of accuracy (Martin et al., 1997). The trajectory modelers did not have to begin their work with only educated guesses about the offshore currents. The currents were known within minutes of the spill and were continuously tracked for the next 24 days. Midway through the spill TABS data showed the direction of the coastal current switching from up-coast to down-coast. The benefit to cleanup and protection operations was that the Incident Command could make the decision to stand-down an alert to the Sabine Pass area and refocus efforts down-coast a full day earlier than would have been possible prior to TABS.

The primary mission of TABS is to provide real-time data when the spill alarm goes off. However, the GLO recognized from the project's inception that three factors would form TABS into an effective public resource as well. Thus, the GLO supports research to improve the reliability, operational range, and versatility of the TABS buoys; it insists that all TABS data be immediately disseminated though a user-friendly Internet Web site; and it encourages other scientific research projects to build on the TABS resources. We focus on the success of these aspects of the project in the following sections.

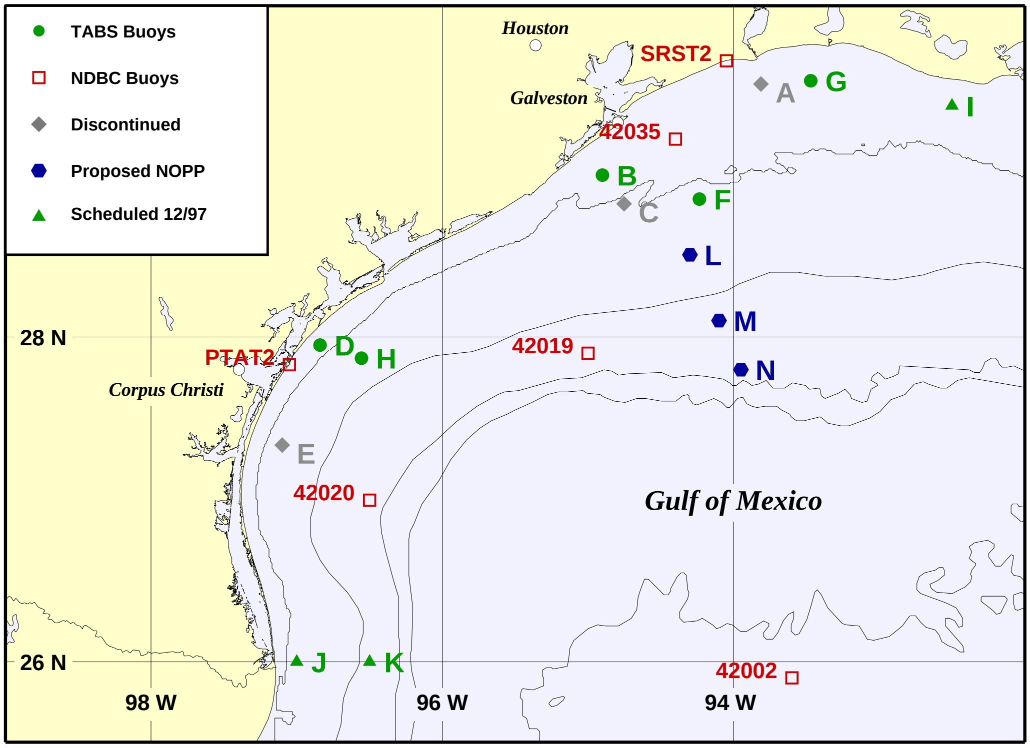

Figure 1. Map of current and future TABS buoy locations. Bathymetric contours shown for the following depths (meters): 20, 50, 200, 500, 2000, 3500.

TABS EQUIPMENT

TABS buoys take a five-minute vector average of current velocity and water temperature about two meters below the surface every thirty minutes. A shore-based PC computer running LINUX automatically acquires the data via either cellular or satellite telephone four times daily under normal conditions. Since the reporting link is fully two-way, GERG can switch to a more frequent schedule during spills. The data are automatically transferred to a UNIX workstation that performs QA/QC functions and adds the observations to the TABS database.

Two buoy models are now in operation. Both are schematically illustrated in Figure 2. The original TABS I model was designed for the nearshore coastal environment and intended to obtain just near-surface currents and water temperature. With this focus, the design could take advantage of the large offshore area that is covered by cellular telephone service (Chaplin and Kelly, 1995). By pulling already proven tools and technologies off the shelf and combining them

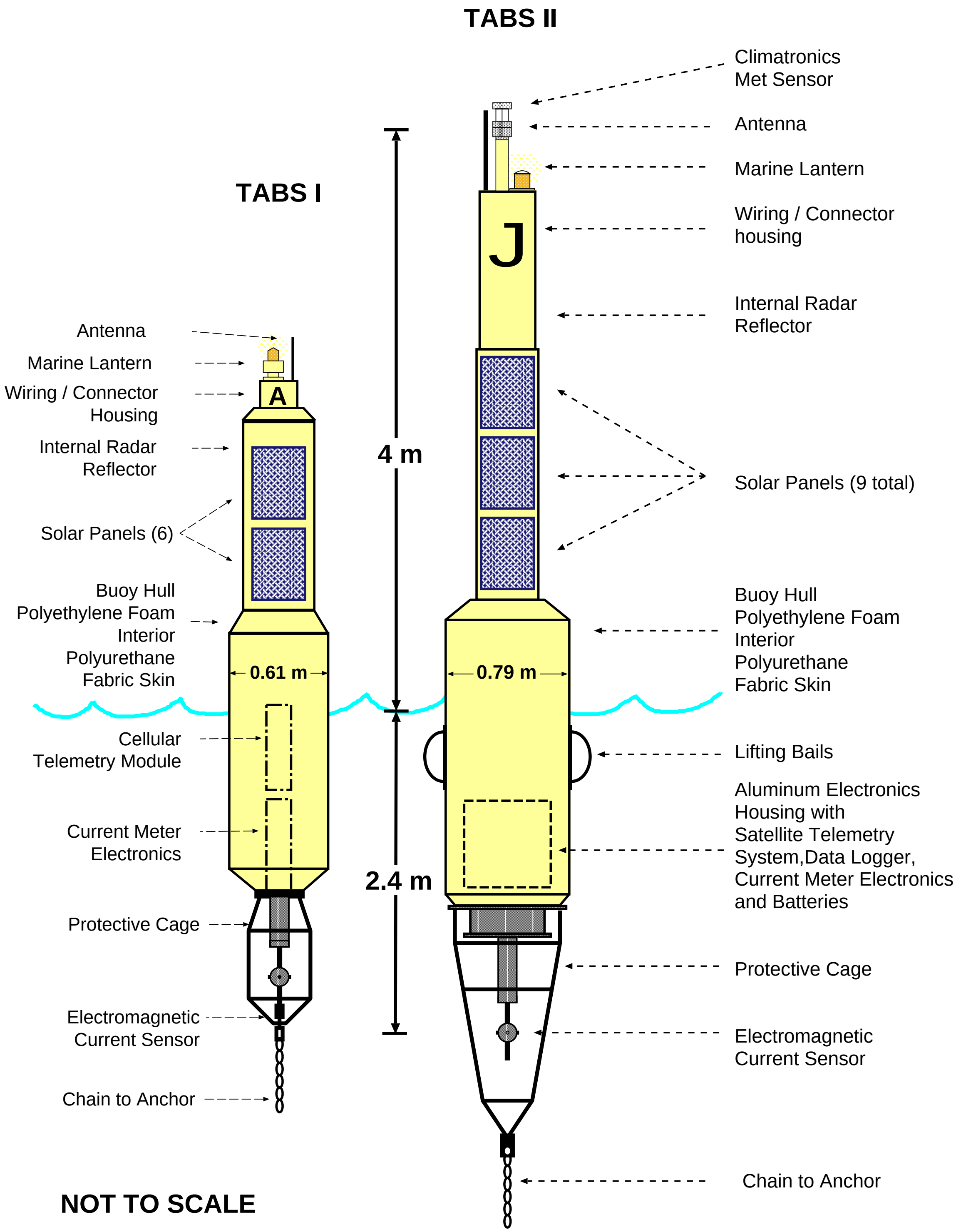

Figure 2. Schematic diagrams of the TABS I and TABS II buoy models.

in an innovative way, the length of the R&D phase was reduced, with the first deployment taking place just nine months from the project's inception.

Both buoys are a modified spar design with a flotation package constructed of closed-cell, cross-linked, polyethylene foam with a polyurethane fabric-reinforced skin. They have built-in radar reflectors, and central stainless steel or aluminum watertight housings for the current meter and communications electronics. A Marsh-McBirney electromagnetic 2-axis current sensor extends from the buoy bottom. Six or nine solar panels provide power through rechargeable batteries.

After a year-and-a-half of successful, operational, field experience with the TABS I model, during which several modifications and upgrades were accomplished, the GLO directed GERG to develop the "next generation" TABS buoy TABS II was developed in cooperation between GERG and Woods Hole Group/Advanced Coastal Environmental Systems (ACES), Inc. Magnell et al. (1998) describe the details of the new design. The four major design enhancements are 1) a new geostationary satellite telephone system, 2) an increased size of the flotation package, 3) an Argos satellite data transmission system that is automatically activated if the primary communications system fails, and 4) an electronic command and control system based on the ACES Remote System Monitor, which includes a powerful microprocessor and multiple analog and digital I/O ports. On January 20, 1998, GERG deployed the first TABS II buoy for test and evaluation next to Buoy B off Galveston. Initial results are excellent. The new model buoys will be deployed at Sites I through N (Figure 1). Selected buoys will incorporate the Climatronics TacMet meteorological package.

PUBLIC DATA DISSEMINATION

The data from the TABS buoys are available to the general public on the GERG Web server. Users are able to access the data in both graphical and tabular formats (Lee et al., 1996). The TABS Web page, shown in Figure 3, provides the user with access to a variety of oceanographic and meteorological data products. Users can select a TABS buoy location from the map or from text links for those without a graphical Web browser.

For each TABS station the user can choose to view either a graph of the past four days of data or the data in tabular format. The graph consists of a "stick plot" of the currents, cross shelf and along shelf components of the current and water temperature. These data are presented in both English and metric units. The graph can be downloaded as either a GIF image or a postscript file. TABS data are routinely updated every six hours but can be more frequently updated as needed in the event of an oil spill. Each buoy page also contains a link that allows the user to search the TABS database and retrieve data from a buoy for a user selectable time period. The user can access up to two months of data at a time. The results of each database search can be viewed in both graphical and tabular format. For example, Crout (1997) used the TABS database features to facilitate his study comparing currents calculated from satellite altimetry with those observed by the TABS buoys.

The TABS Web site also provides access to data from the National Data Buoy Center's (NBDC) buoy and coastal (CMAN) meteorological data. These data are obtained from the Global Telecommunications Stream (GTS) via the Internet. We include three offshore buoys and two CMAN stations, e.g., 42035 located southeast of Galveston, 42019 and 42020, which are east and southeast of Port Aransas, respectively, SRST2 near Sabine, and PTAT2 near

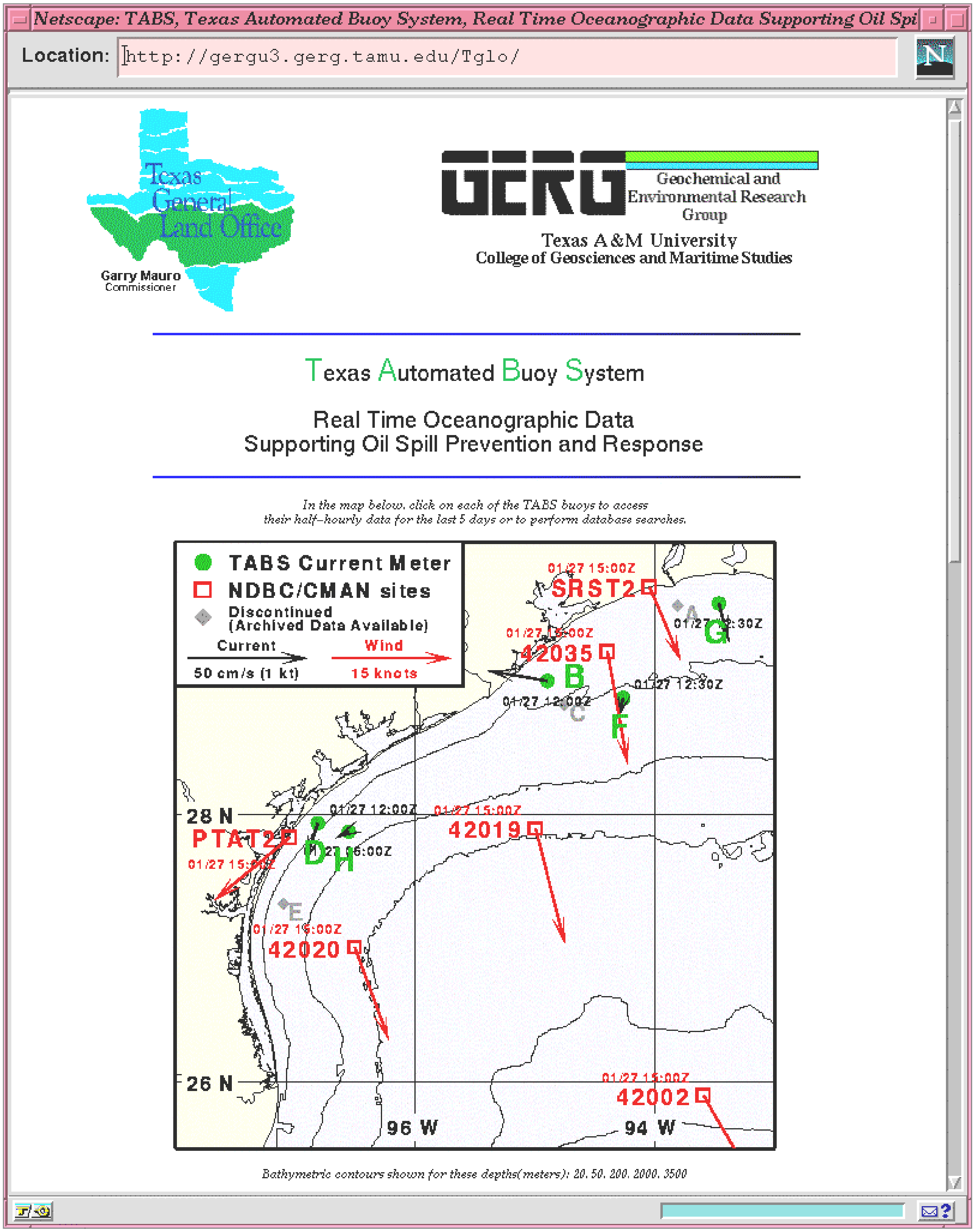

Figure 3. Example of TABS main Web page.

Port Aransas (Figure 1). These data are updated hourly and presented in both graphical and tabular formats.

There are several additional features of the TABS Web site that can assist in the utilization of the TABS data. A summary plot capability provides a stickplot for each buoy using a common time axis. A status table lists buoy latitude, longitude, lease block and water depth. The status table also indicates which of the buoys have successfully transmitted their data during the past twelve hours and contains other information regarding the operational status of each buoy. Links to National Weather Service coastal and offshore weather forecasts for the Gulf of Mexico are provided on the main TABS Web page. The Web site also contains a number of links to additional real-time oceanographic and meteorological data. There are links to the Houston/Galveston PORTS Web site, the Texas Coastal Ocean Observation Network (TCOON), Galveston Bay and Corpus Christi Bay Animated Hydrodynamic and Oil Spill Model output, Satellite Sea Surface Temperature Images from NOAA and Johns Hopkins University, Tampa Bay PORTS, and other relevant sites.

Analysis of the TABS Web server access logs show that utilization of the TABS Web site has been increasing since its inception. A graph of monthly access totals is shown in Figure 4. Peak usage of the TABS Web site generally occurs in mid-October and then tails off rather sharply. We see this as a reflection of the end of the recreational boating season and a decrease of usage by boaters. The three largest groups of TABS users come from the .com, .edu and .net Internet domains. The first represents commercial entities primarily from within the United States; the second represents educational institutions in the U.S. and the last are network service providers. However, since some of the major Internet service providers are in the .com domain, i.e., AOL, it would appear that the majority of the use of the TABS site is coming from the general public. There are several other noteworthy groups that access the TABS site. Some of these are users from the Texas State government and specifically the Texas General Land Office, users from the U.S. government, including users from NOAA, MMS, USGS and NASA. Usage by the offshore industry includes most of the major oil companies. In addition we have seen usage from sixty-nine foreign countries to date.

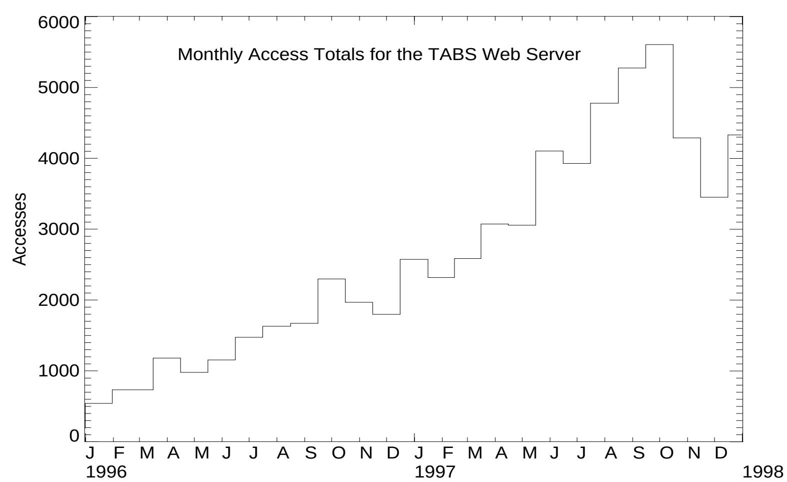

Figure 4. Monthly access totals for TABS Web site from January 1996 – January 1998.

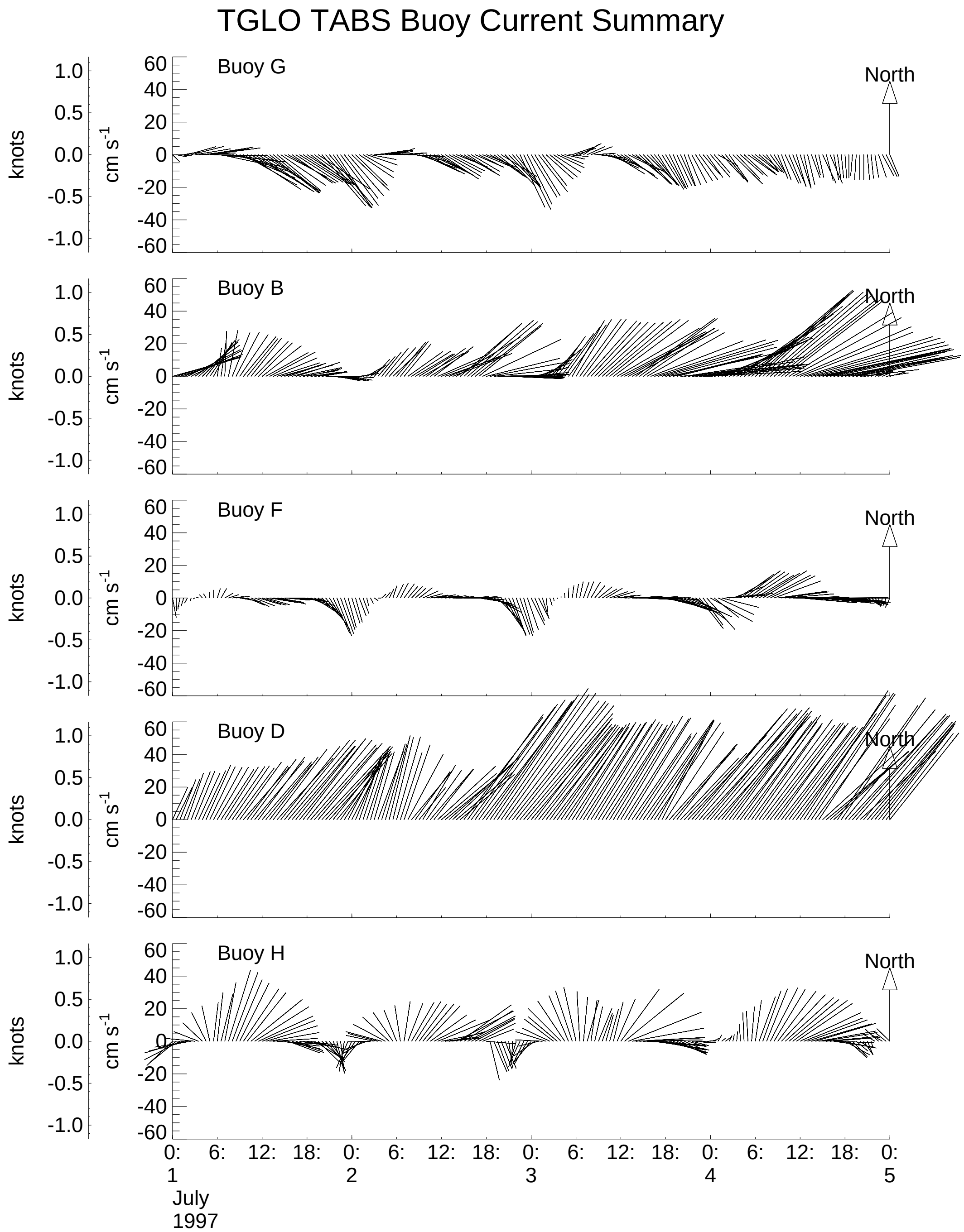

Figure 5. Stick vector plots of the current velocity measured half-hourly at five buoy locations during the first four days of July 1997. (A stick vector points in the direction the current is flowing, with True North at the top of the page. The length of the vector, from its base on the x-axis to its tip, is proportional to the speed; the y-axis serves as the scale.)

RESEARCH PROJECTS THAT BUILD ON TABS

Thus far, three research projects have been funded that take advantage of the resources of the TABS core program. The first of these is funded by the GLO itself and titled "Texas Automated Buoy System Modeling Effort." TABS buoys have proven highly successful at measuring currents at specific locations. However, the coastal ocean is often highly variable in both time and space. For example, Figure 5 shows "stick vector" plots of the current velocity measured half-hourly at five buoy locations during the first four days of July 1997. Note the strong, persistent, northeastward flow at Buoy D. A little farther offshore at Buoy H (Figure 1), however, the currents are rotating clockwise with a daily period. Currents at Buoy G, east of Sabine Pass, are frequently directed opposite to those off Galveston at Buoy B during this period. This new two-year modeling project will assimilate currents and wind measurements and provide estimates of currents all along the Texas Coast, thus extending the buoys' point measurements.

A second project, titled "An Observational and Predictive Study of Inner Shelf Currents over the Texas-Louisiana Shelf" is made possible by a combination of funding sources, including the U.S. Minerals Management Service, Louisiana State University, TAMU, Marine Industry Group-Gulf, and the GLO. It will add Buoy I, extending the TABS network into the coastal waters of western Louisiana. The project's goals are to analyze all the historical data collected by the TABS array, compare the field data with winds and water levels in an effort to understand better the dynamical balances present in the coastal waters of Louisiana and Texas, and develop a dynamically consistent nowcast/forecast of the coastal currents.

The third and most ambitious project, "Gulf of Mexico Ocean Modeling System" is one of the projects of the National Ocean Partnership Program. It is funded by the Office of Naval Research, with Dynalysis of Princeton, Inc., serving as the lead organization. The project's objective is to produce nowcasts and forecasts of surface and subsurface velocities for the entire Gulf of Mexico and distribute them publicly via an Internet Web site. The TABS contribution is to verify model generated velocities and to provide calibration data for currents derived from satellite altimetry along a line running across the Texas continental shelf, e.g., through Buoys B, F, L, M, and N, approximately, in Figure 1.

CONCLUSIONS

By adopting a farsighted policy toward the TABS program the GLO has transformed a tool critical to its oil spill response mission into a valuable public resource. The public and the scientific community are rapidly adopting it, finding new and innovative uses for its products, and adding to its capabilities. The new TABS II buoy is designed with expandability and flexibility in mind. It can accommodate a variety of additional sensors for meteorology, water optics, acoustics, and water chemistry. As the real-time observations are coupled with the computer models being developed by various research projects, our view and understanding of the waters offshore Texas will expand rapidly and profoundly.

ACKNOWLEDGEMENTS

The TABS project is funded by the Texas General Land Office, currently through Contract 98-067R. Additional TABS financial support has been provided by ARAMCO Services

Co., Marine Industry Group—Gulf (MIRG), and Mobil Co. The Marine Spill Response Corp. has provided ship support. Research projects that build on the TABS project are funded by the Texas General Land Office under Contract 98-153R, by the U.S. Minerals Management Service through Louisiana State University subcontract R148185, and by a National Ocean Partnership Program project funded by the Naval Research Laboratory through Dynalysis of Princeton subcontract 12/15/97. This paper does not necessarily reflect the views or policies of the Texas General Land Office or of any of the other agencies and companies providing financial and service support. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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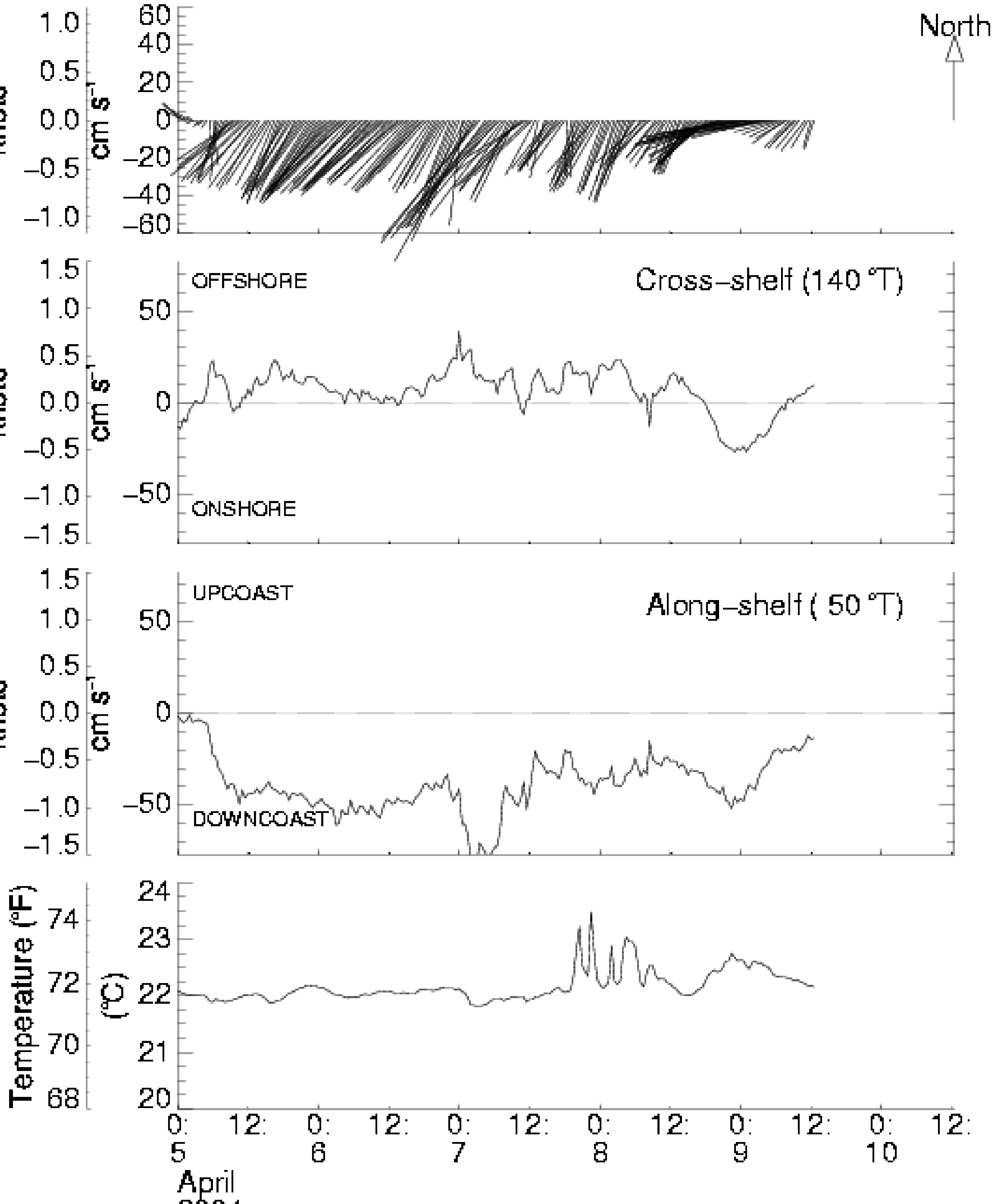
TGLO TABS Buoy D – 27 55.968N 96 48.498W



GERG Ocean Sciences –– Texas A&M University

GERG at Texas A&M University
Fri Apr 9 12:02:00 2004

APPENDIX E

LETTERS OF SUPPORT AND RESOLUTIONS

BROWNSVILLE ECONOMIC DEVELOPMENT COUNCIL
On the Border By the Sea

May 19, 2004

John Bruciak
General Manager and CEO
Brownsville Public Utilities Board
PO Box 3270
Brownsville, Texas 78523-3270

RE: Letter of Support

Dear Mr. Bruciak:

I am writing to you today in support of the Regional Seawater Desalination Project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the co-generation of a 100-megawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprised of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville PUB for this initiative and sincerely hope this project becomes a reality in the near future.

Sincerely,

Robert Swantner
BEDC Chairman

RESOLUTION OF SUPPORT FOR THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the Brownsville Economic Development Council desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley Region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination project, and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January, 2005; and

WHEREAS, the Brownsville Economic Development Council endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the Brownsville Economic Development Council supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, **THEREFORE BE IT RESOLVED**, that the Brownsville Economic Development Council has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

Done this 19th day of May, 2004.

Brownsville Economic Development Council

By: Robert Swantner

Robert Swantner, Chairman Board of Directors

ATTEST:

Jason Hilts
President & CEO

THE STATE OF TEXAS
COUNTY OF CAMERON

RESOLUTION

BE IT RESOLVED THAT ON THE 29th DAY OF APRIL, 2004, THE CAMERON COUNTY COMMISSIONERS' COURT CONVENED IN REGULAR SESSION, AND UPON THE REQUEST OF THE CAMERON COUNTY COMMISSIONERS, THE FOLLOWING ITEM WAS PLACED ON THE AGENDA OF THE SAID COURT FOR SUCH MEETING, PURSUANT TO GOVERNMENT CODE SECTION 551.041 *ET. SEQ.*, VERNON'S TEXAS CIVIL STATUTES (THE TEXAS OPEN MEETING ACT) TO BE CONSIDERED:

"CONSIDERATION AND ADOPTION OF A RESOLUTION REGARDING THE LOWER RIO GRANDE VALLEY SEAWATER DESALINIZATION PROJECT."

WHEREAS, DESPITE RECENT RAINS, THE RIO GRANDE VALLEY FACES A LONG TERM WATER SHORTAGE; AND

WHEREAS, DESALINIZATION, ALONG WITH INCREASED CONSERVATION, IMPROVED WATER DISTRIBUTION NETWORKS AND WATER USE REFORM, IS AN IMPORTANT PART OF THE REGIONAL WATER SUPPLY STRATEGY; AND

WHEREAS, AS PART OF A REGIONAL STRATEGY, DESALINIZATION PROMOTES STABILITY IN WATER SUPPLIES AND REDUCES DEPENDENCE ON UNRELIABLE DISTRIBUTION NETWORKS; AND

WHEREAS, STATE AND FEDERAL FUNDS SHOULD BE MADE AVAILABLE TO AID THE BROWNSVILLE PUBLIC UTILITIES BOARD AND ITS PARTNERS IN EXPLORING DESALINIZATION; AND

WHEREAS, THE CAMERON COUNTY COMMISSIONERS' BELIEVES THAT DESALINIZATION CAN BE AN IMPORTANT PART OF THE REGIONAL WATER SUPPLY STRATEGY AND WISHES TO ENCOURAGE FURTHER LOCAL, STATE AND FEDERAL INVESTMENT IN DESALINIZATION AND OTHER WATER INFRASTRUCTURE.

NOW THEREFORE, BE IT RESOLVED, THAT THE CAMERON COUNTY COMMISSIONERS' COURT SUPPORTS THE AIMS OF THE LOWER RIO GRANDE VALLEY SEAWATER DESALINIZATION PROJECT; AND

BE IT FURTHER RESOLVED, THAT THE CAMERON COUNTY COMMISSIONERS' COURT WISHES TO ENCOURAGE THE APPROPRIATION AND OR DESIGNATION OF STATE AND FEDERAL FUNDS FOR THE LOWER RIO GRANDE VALLEY SEAWATER DESALINIZATION PROJECT AND OTHER WATER INFRASTRUCTURE.

APPROVED THIS 29TH DAY OF APRIL 2004.

COMMISSIONERS' COURT OF CAMERON COUNTY, TEXAS

GILBERTO HINOJOSA
COUNTY JUDGE

PEDRO "PETE" BENAVIDES
COMMISSIONER PRECINCT 1

DAVID A. GARZA
COMMISSIONER PRECINCT 3

JOHN WOOD
COMMISSIONER PRECINCT 2

EDNA TAMAYO
COMMISSIONER PRECINCT 4

ATTEST:

COMMISSIONERS COURT
CAMERON COUNTY, TEXAS

JOE G. RIVERA
COUNTY CLERK

CAMERON COUNTY IRRIGATION DISTRICT NO. TWO

1301 FM 510 P.O. BOX 687 SAN BENITO, TEXAS 78586
Phone (956) 399-2484 Fax (956) 399-4721

Sonia Kaniger- General Manager

RECEIVED
MAY 11 2004

May 5, 2004

Mr. John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, TX 78523-3270

Dear Mr. Bruciak:

I am writing to you today in support of the Regional Seawater Desalination Project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the co-generation of a 100-megawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprised of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville Pub for this initiative and sincerely hope this project becomes a reality in the near future.

Sincerely,

Sonia Kaniger

Sonia Kaniger
General Manager
Cameron County Irrigation District No. 2

ALAMO
REFUGE TO THE VALLEY

May 19, 2004

Eddie Treviño, Jr.
Mayor of Brownsville
City of Brownsville/Market Square
P.O. Box 911
Brownsville, Texas 78522

Dear Honorable Mayor Treviño:

Enclosed is a certified copy of the resolution which was passed by the Board of Commissioners of the City of Alamo, in support for Lower Rio Grande Valley Seawater Desalination Project.

Should you need additional information please call me at (956) 787-0006.

Sincerely,

Rudy Villarreal
Mayor

MS:ms

Enclosure

RECEIVED

423 N. Tower Road • Alamo, Texas 78516
956.787.0006 • 956.787.1160 fax

RESOLUTION 02-04-04

RESOLUTION OF SUPPORT FOR LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the Board of Commissioners of the City of Alamo, Texas, desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination demonstration project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January 2005; and

WHEREAS, the City of Alamo, Texas endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the City of Alamo, Texas supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW THEREFORE, BE IT RESOLVED, that the Board of Director of the City of Alamo, Texas, has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

ADOPTED this the 20th day of April 2004, by the Board of Commissioners of the City of Alamo, Texas.

PASSED AND APPROVED on this the 20th day of April 2004.

Rudy Villarreal, Mayor

ATTEST:

Margot Saenz, City Secretary

CERTIFICATION

I hereby certify that this is a true and correct copy of Resolution 02-04-04 which was passed and approved by the Board of Commissioners of the City of Alamo on the 20th day of April 2004.

SEAL

Margot Saenz

Margot Saenz, City Secretary

5/19/04

Date

CITY OF ALTON

City On The Grow

Mayor Salvador Vela
Alderwoman Carla P. Garza
Alderman Ricardo Garza

City Administrator Israel Sagredo

Mayor Pro Tem Arturo R. Galvan, Jr.
Alderwoman Anita Lugo
Alderwoman Yolanda Sandoval

RECEIVED
MAY 14 2004

May 4, 2004

Mr. John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
PO Box 3270
Brownsville, TX 78523-3270

RE: LETTER OF SUPPORT

Dear Mr. Bruciak:

I am writing to you today in support of the Regional Seawater Desalination project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the cogeneration of a 100-megawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprised of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville PUB for this initiative and sincerely hope this project becomes a reality in the near future.

Sincerely,

Salvador Vela
Mayor City of Alton

CITY OF ALTON
P.O. Drawer 9004 • Alton, Texas 78574 • (956) 581-2733 • Fax (956) 581-2253

RESOLUTION 2004-17

RESOLUTION OF SUPPORT FOR THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the City of Alton desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley Region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination project; and

WHEREAS, The TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January, 2005; and

WHEREAS, the City of Alton endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the City of Alton Supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW THEREFORE BE IT RESOLVED, that the City of Alton has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project

CONSIDERED, PASSED, APPROVED and **SIGNED** this 4th day of May, 2004, at a regular meeting of the Board of Aldermen of the City of Alton, Texas, at which a quorum was present and which was held in accordance with Article 6252-17.

CITY OF ALTON

Salvador Vela, Mayor

ATTEST:

Anna Carrillo, City Secretary

RESOLUTION NO. 2004-026

THE STATE OF TEXAS §

COUNTY OF CAMERON §

CITY OF BROWNSVILLE §

A RESOLUTION OF THE CITY COMMISSION OF THE CITY OF BROWNSVILLE IN SUPPORT OF THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the City Commissioners of the City of Brownsville desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January 2005; and

WHEREAS, the City of Brownsville endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the City of Brownsville supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the City Commission of Brownsville, Commissioners has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

ADOPTED THIS 4th DAY OF May, 2004

Mayor Eddie Trevino, Jr.
City of Brownsville

ATTEST:

Inelda T. Garcia, City Secretary

CITY SECRETARY · STATE OF TEXAS · CITY OF BROWNSVILLE

City of
Donna
The Heart of the Valley

May 20, 2004

Mayor Eddie Treviño, Jr.
City of Brownsville
P.O. Box 911
Brownsville, TX 78522

Re: Letter of Support
Seawater Desalination Project

Dear Mayor Treviño:

This is in response to a letter sent to Mayor Morales requesting the city's support for the above-mentioned project.

On May 4, 2004, the Donna City Council approved a resolution and letter of support on the desalination project. Copies of the executed documents were mailed to Mr. John Bruciak of the Brownsville PUB. I have enclosed copies of the same documents for your information.

Please contact me at (956) 464-3314 if you have any questions or need further information.

Sincerely,

Martha Alvarado

Martha Alvarado
City Secretary

Enclosures

RECEIVED

City of Donna

The Heart of the Valley

May 4, 2004

Mr. John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, TX 78523-3270

RE: LETTER OF SUPPORT

Dear Mr. Bruciak:

I am writing to you today in support of the Regional Seawater Desalination project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the co-generation of a 100-megawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprised of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville PUB for this initiative and sincerely hope this project becomes a reality in the near future.

Sincerely,

Ricardo L. Morales
Mayor
City of Donna

307 S. 12th St. Donna, Texas 78537 (956) 464-3314 Fax (956) 464-9

City of Donna

The Heart of the Valley

RESOLUTION 2004-05-01
SUPPORTING
THE LOWER RIO GRANDE VALLEY
SEA WATER DESALINATION PROJECT

WHEREAS, the City Council of the City of Donna desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, The Governor of Texas has implemented a seawater desalination demonstration project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January 2005; and

WHEREAS, the City of Donna endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the City of Donna supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the Donna City Council has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

PASSED, APPROVED AND ADOPTED on this 4th day of May 2004.

CITY OF DONNA
DONNA, TEXAS

Ricardo L. Morales, Mayor
City of Donna

ATTEST:

Martha Alvarado, City Secretary

307 S. 12th St. Donna, Texas 78537
(956) 464-3314 Fax (956) 464-99

APR 23 2004

April 21, 2004

Mr. Bruciak
PO Box 3270
Brownsville, TX 78523-3270

Dear Mr. Bruciak:

I am writing regarding the regional seawater desalination project for which you are currently developing a feasibility study. You have asked those of us who operate water systems in the region about our potential interest in water provided either directly or indirectly from this project.

Eagle Pass definitely has a future water need. Water made available by the regional seawater desalination project could provide a source of water that will free up existing water supplies that, because of the nature of the Amistad-Falcon system, could indirectly serve Eagle Pass needs. I know that the ultimate amount of water produced and many other factors yet to be determined will impact the cost, and cost-effectiviness of this option. While too early in the process to make a firm commitment, I wanted to express our potential interest in the regional seawater desalination as a future source of water for our community. Eagle Pass wants to learn more about this option as cost and other feasibility factors are developed- -including project financing considerations- - before making firmer commitment.

Given that, we have experience a continued growth rate of 3.5 to 4% over the last five years, there is no question that Eagle Pass will need additional future water rights. We endorse and applaud your visionary efforts in preparing our region for future water demands.

Sincerely,

Robert Gonzalez, General Manager
City of Eagle Pass Water Works

CITY OF EAGLE PASS WATER WORKS SYSTEM • P.O. BOX 808 • EAGLE PASS, TEXAS 78853-0808 • (830) 773-2351

EDINBURG
A New Brand Of City

RECEIVED
MAY 11 2004

May 7, 2004

Mr. John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, TX 78523-3270

RE: LETTER OF SUPPORT

Dear Mr. Bruciak:

I am writing to you today in support of the Regional Seawater Desalination project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the co-generation of a 100-megawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprised of developments with the Region Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville PUB for this initiative and sincerely hope this project becomes a reality in the near future.

Sincerely,

Ricardo Rodriguez, Jr.
Councilmember Pl. 4
City of Edinburg

RRJ/mlag

210 W. McIntyre • P.O. Box 1079 • Edinburg, TX 78540
956-383-5661 • Fax 956-383-7111

BROWNSVILLE

On the Border By the Sea

All-America City 2001

May 12, 2004

The Honorable Richard H. Garcia
Mayor of Edinburg
P.O. Box 1079
Edinburg, Texas 78539

Dear Mayor Garcia:

It is probably not news to you that our region has water challenges. High growth in population and demand, uncertain water deliveries and a desire to promote economic opportunities for our people all signal the necessity for a constant, reliable supply of water.

I believe Governor Rick Perry's Desalinated Seawater Initiative is a viable, doable project that would serve our needs into the future. It would consist of a 25 million-gallon-per-day seawater desalinization plant which could be expanded as demand increases. Our area, however, is competing with Corpus Christi and Freeport for selection to proceed with such a project.

I believe, as you probably do, that the Lower Rio Grande Valley is the most deserving location in Texas for this project, based on immediacy and a lack of other, good water supply options.

If this project is to become a reality, I need your support. A letter of support or a resolution of support from your entity would be most welcome and most helpful. Please give this your every consideration.

Sincerely,

Eddie Trevino, Jr.
Mayor of Brownsville

RECEIVED
MAY 2 6 2004
City of Edinburg
City Secretary Department

EDINBURG

A New Brand Of City

May 26, 2004

The Honorable Eddie Trevino, Jr.
Mayor of Brownsville
P.O. 911
Brownsville, Texas 78522

Dear Mayor Trevino:

As per your request, enclosed please find a Resolution supporting the Desalinated Seawater Initiative project.

Sincerely,

Myra Garza
City Secretary

MG/mc

Enc.

RECEIVED
JUN - 3 2004
City of Brownsville
City Manager's Office

RESOLUTION NO. 04-1777

STATE OF TEXAS
COUNTY OF HIDALGO
CITY OF EDINBURG

A RESOLUTION SUPPORTING THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the City Council of the City of Edinburg desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination demonstration project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January 2005; and

WHEREAS, the City of Edinburg endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the City of Edinburg supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW THEREFORE BE IT RESOLVED that the City of Edinburg has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

READ, CONSIDERED, PASSED AND APPROVED at a regular meeting of the City Council of the City of Edinburg, Texas, at which a quorum was present and which was held in accordance with Tex. Government Code Ann. § 551.041 (Vernon 1994), on the 4th day of May 2004.

CITY OF EDINBURG

BY: ______________________
RICHARD H. GARCIA
MAYOR

ATTEST:

BY: ______________________
MYRA L. AYALA GARZA
CITY SECRETARY

APPROVED AS TO FORM:

BY: ______________________
DANIEL RIOS
CITY ATTORNEY

CITY OF
HARLINGEN
CAPITAL OF THE LOWER RIO GRANDE VALLEY
"WORKING AS A TEAM TO PROVIDE QUALITY SERVICE WITH RESPECT AND FAIRNESS TO ALL CITIZENS"

Office of the Mayor

RECEIVED
MAY 13 2004

May 11, 2004

Mr. John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, TX 78523-3270

RE: LETTER OF SUPPORT

Dear Mr. Bruciak:

I am writing to you today in support of the Regional Seawater Desalination Project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the co-generation of a 100-megawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprised of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville PUB for this initiative and sincerely hope this project becomes a reality in the near future.

Sincerely,

C. Connie de la Garza
Mayor

"Recipient Of Keep Texas Beautiful Governor's Achievement Award"
118 E. TYLER • P.O. BOX 2207 • HARLINGEN, TEXAS 78551 • (956) 427-8700

RESOLUTION NO. 04R-14

STATE OF TEXAS

COUNTY OF CAMERON

WHEREAS, the City of Harlingen desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley Region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January, 2005; and

WHEREAS, the City of Harlingen endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the City of Harlingen supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality

NOW, THEREFORE, BE IT RESOLVED BY THE CITY OF HARLINGEN

Has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project

CONSIDERED AND ADOPTED this 5th day of May, 2004 at a Regular Meeting of the Elective Commission of the City of Harlingen, Texas at which a quorum was present and which was held in accordance with the Texas Government Code.

City of Harlingen

By: ______________________
C. Connie de la Garza, Mayor

Attest:

____
Sylvia R. Trevino, City Secretary

STATE OF TEXAS §

COUNTY OF HIDALGO § RESOLUTION #2004-06

CITY OF HIDALGO §

WHEREAS, the Councilmembers of the City of Hidalgo desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination demonstration project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January 2005; and

WHEREAS, the City of Hidalgo endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the City of Hidalgo supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE, BE IT RESOLVED, that the CITY OF HIDALGO Councilmembers has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

PASSED, APPROVED AND ADOPTED THIS THE 11TH DAY OF MAY 2004.

CITY OF HIDALGO

John David Franz, Mayor

ATTEST:

Joe Vera III, Acting City Secretary

ALEJANDRO SOLIS
MAYOR

CLARITA S CARDENAS
CITY SECRETARY

CITY OF LA GRULLA

CITY HALL
P.O. BOX 197
LA GRULLA, TX 78548
PHONE: (956) 487-3341
FAX: (956) 487-5733

JOSE A VILLARREAL
MAYOR PROTEM

OSCAR V. GONZALEZ
COMMISSIONER

May 17, 2004

John S Bruciak
General Manager & CEO
Public Utilities Board of Brownsville
P.O. Box 3270
Brownsville, Texas 78523-3270

Re: Resolution No. 050404

Dear Mr. Bruciak,

The City of La Grulla supports the Lower Rio Grande Valley Seawater Desalination Project please find enclosed signed Resolution No. 050404.

If you have any questions regarding this matter please don't hesitate to call me at (956) 487-3341.

Thank you,

Clarita S Cardenas

Clarita S Cardenas
City Secretary
City of La Grulla

ALEJANDRO SOLIS
MAYOR

CLARITA S CARDENAS
CITY SECRETARY

CITY OF LA GRULLA

CITY HALL
P.O. BOX 197
LA GRULLA, TX 78548
PHONE: (956) 487-3341
FAX: (956) 487-5733

RECEIVED
MAY 21 2004

JOSE A VILLARREAL
MAYOR PROTEM

OSCAR V. GONZALEZ
COMMISSIONER

RESOLUTION NO. 050404

RESOLUTION OF SUPPORT FOR THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the Honorable City Council of La Grulla desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, The Governor of Texas has implemented a seawater desalination demonstration project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January 2005; and

WHEREAS, the Honorable City Council of La Grulla endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the Honorable City Council of La Grulla supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED that the Honorable City Council of La Grulla has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

PASSED AND APPROVED by the Honorable City Council of La Grulla, Texas on the 4th day of May 2004.

Alejandro Solis
Alejandro Solis/Mayor

Attest:
Clarita S. Cardenas
Clarita S. Cardenas/City Sec
City of La Grulla

"The City of La Grulla is an Equal Opportunity Employer and does not discriminate on the basis of race, color, national origin, sex, religion, age or disability in employment or the provision of services."

City of La Joya

"Jewel of the Valley"

Mayor: WILLIAM "Billy" LEO
Mayor Pro-Tem: ANGIE GARZA
Commissioner: MARI GONZALEZ

May 12. 2004

Brownsville Public Utilities Board
Attn: John S. Bruciak, General Manager
P.O. Box 3270
Brownsville, Texas 78523-3270

RE: RESOLUTION 2004-05

Dear Mr. Bruciak:

Enclosed a an original copy of the above mentioned reference for the support of seawater desalination project. The City of La Joya held its regular monthly on May 11, 2004 and approved this resolution.

If you should have any questions or concerns, please do not hesitate to contact our office at (956)581-7002. Thank you for your attention in this matter.

Sincerely,

Mike Alaniz, City Administrator

MA/jrs

cc: Mayor William "Billy" Leo
Mayor Pro-Tem, Angie Garza
Commissioner, Mari Gonzalez

CITY OF LA JOYA

RESOLUTION 2004-05

A RESOLUTION OF SUPPORT FOR THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT.

WHEREAS, the City of La Joya Council deseres

WHEREAS, the Rio Grande Valley region continue to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, The Governor of Texas has implemented a seawater desalination demonstration project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January 2005; and

WHEREAS, the City of La Joya endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the City of La Joya supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the City of La Joya Council has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

READ, CONSIDERED, PASSED AND ADOPTED ON THIS 11TH DAY OF MAY, 2004 AT A REGULAR CALLED MEETING IN WHICH A QUORUM WAS PRESENT.

ATTEST: **CITY OF LA JOYA**

Julianita R. Sabala

Julianita R. Sabala, City Secretary

Mayor William "Billy" Leo

LOS FRESNOS
Community with Opportunity

RECEIVED
MAY - 7 2004

May 3, 2004

Mr. John S. Bruciak
General Manager & CEO
Public Utilities Board
P. O. Box 3270
Brownsville, Tx. 78523-3270

Dear Mr. Bruciak:

Enclosed is a copy of the City of Los Fresnos Resolution 4-04 that was approved at their meeting on April 27, 2004 in support of the Seawater Desalination Project.

If you should need any additional information, please do not hesitate to contact me at (956) 233-5768.

Sincerely,

Pam Denny

Pam Denny
City Secretary

CITY OF LOS FRESNOS
RESOLUTION NO. 4-04

RESOLUTION OF SUPPORT FOR THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT.

WHEREAS, the Board of Aldermen of the City of Los Fresnos desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley region continues to experience water supply shortage; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, The Governor of Texas has implemented a seawater desalination demonstration project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January 2005; and

WHEREAS, the City of Los Fresnos endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the City of Los Fresnos supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the City of Los Fresnos Board of Aldermen has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

Approved this 27th day of April 2004.

Tom Jones, Mayor
City of Los Fresnos

ATTEST:

Pam Denny, City Secretary

CITY OF LOS FRESNOS
TEXAS

City of
LOS INDIOS

Podrawer 383
Los Indios, Tx 78567
Office: 9956) 399-4255
Fax: (956) 399-4582

GATEWAY TO THE FUTURE

May 7, 2003

Mr. John Bruciak, General manager and CEO
Brownsville Public Utilities Board
P. O. Box 3270
Brownsville, TX 78523-3270

RE: LETTER OF SUPPORT

Dear Mr. Bruciak:

I am writing to you today in support of the Regional Seawater Desalination project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the co-generation of a 100-megawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprised of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville PUB for this initiative and sincerely hope this project becomes a reality in the near future.

Sincerely,

Diamantina Bennett

Diamantina Bennett, Mayor
City of Los Indios

RESOLUTION #2004-R-004

RESOLUTION OF SUPPORT FOR THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the City of Los Indios desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley Region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January, 2005; and

WHEREAS, the City of Los Indios endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the City of Los Indios Supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the City of Los Indios has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

ADOPTED THIS 10TH DAY OF MAY, 2004.

Diamantina Bennett

Diamantina Bennett, Mayor
City of Los Indios

City of Lyford
P.O. Box 310 • 196 West Main
Lyford, Texas 78569
Phone: (956) 347-3512 • Fax: (956) 347-5434

RECEIVED
MAY 11 2004

May 3, 2004

Mr. John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, Texas 78523-3270

Re: Letter of Support

Dear Mr. Bruciak:

I am writing in support of the Regional Seawater Desalination project. As I understand, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the co-generation of a 100-megawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprised of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville PUB for this initiative and sincerely hope this project becomes a reality in the near future.

Sincerely,

Rodolfo S. Saldana
Mayor

RECEIVED
MAY 2 ? 2004

RESOLUTION OF SUPPORT
FOR THE
LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the City of Lyford desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley Region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January, 2005; and

WHEREAS, the City of Lyford endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the City of Lyford supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the City of Lyford has authorized the support of the Lower Rio Grande valley seawater Desalination Project.

ADOPTED THIS 10TH DAY OF MAY, 2004.

Rodolfo S. Saldana, Mayor

City of McAllen

April 28, 2004

John S. Bruciak
General Manager & CEO
Brownsville Public Utilities Board
PO Box 3270
Brownsville, Texas 78523-3270

RE: Resolution 2004-10 – Supporting the Lower Rio Grande Valley Seawater Desalination Project

Dear Mr. Bruciak:

Enclosed is a certified copy of the above referenced. Resolution No. 2004-10 was approved by the McAllen Board of Commissioners at their Regular Meeting held April 26, 2004.

If you should have any questions, please contact me at 972-7130.

Sincerely,

Leticia M. Vacek

Leticia M. Vacek, CMC
City Secretary

Enclosure (1)

LMV/pl

xc: Roel Rodriguez, McAllen Public Utilities Manager

APR 2 9 2004

City of McAllen

CERTIFICATION

STATE OF TEXAS
COUNTY OF HIDALGO
CITY OF MCALLEN

I, Leticia M. Vacek, City Secretary of the City of McAllen, do hereby certify that the following is a true and correct copy of Resolution 2004-10 which was approved by the McAllen Board of Commissioners at the Regular Meeting held April 26, 2004.

IN WITNESS WHEREOF, I have hereunto subscribed my signature and impressed the official seal of the City of McAllen, Texas, this 29th day of April, 2004.

SEAL
CITY OF McALLEN
McALLEN, TEXAS

Leticia M. Vacek, CMC
City Secretary

RESOLUTION NO. 2004-10

RESOLUTION OF SUPPORT
FOR
THE LOWER RIO GRANDE VALLEY
SEAWATER DESALINATION PROJECT

WHEREAS, The Board of Commissioners of the City of McAllen desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, The Rio Grande Valley region continues to experience water supply shortages; and

WHEREAS, The Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, The Governor of Texas has implemented a seawater desalination demonstration project; and

WHEREAS, The TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January 2005; and

WHEREAS, The Board of Commissioners of the City of McAllen endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, The Board of Commissioners of the City of McAllen supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the Board of Commissioners of the City of McAllen has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

Adopted this 26th day of April, 2004 by the City of McAllen.

CITY OF MCALLEN

By: ______________________
Leo Montalvo, Mayor

ATTEST:

____
Leticia M. Vacek, City Secretary

Approved as to Form:

____
James E. Darling, City Attorney

BROWNSVILLE
On the Border By the Sea

RECEIVED
MAY 21 2004
BY:

May 12, 2004

The Honorable James R. Matz
Mayor of Palm Valley
1313 Stuart Place Rd., Suite 100
Harlingen, Texas 78552

Dear Mayor Matz:

It is probably not news to you that our region has water challenges. High growth in population and demand, uncertain water deliveries and a desire to promote economic opportunities for our people all signal the necessity for a constant, reliable supply of water.

I believe Governor Rick Perry's Desalinated Seawater Initiative is a viable, doable project that would serve our needs into the future. It would consist of a 25 million-gallon-per-day seawater desalinization plant which could be expanded as demand increases. Our area, however, is competing with Corpus Christi and Freeport for selection to proceed with such a project.

I believe, as you probably do, that the Lower Rio Grande Valley is the most deserving location in Texas for this project, based on immediacy and a lack of other, good water supply options.

If this project is to become a reality, I need your support. A letter of support or a resolution of support from your entity would be most welcome and most helpful. Please give this your every consideration.

Sincerely,

Eddie Trevino, Jr.
Mayor of Brownsville

CITY OF PALM VALLEY

1313 Stuart Place Road, Ste 100
Palm Valley, Texas 78552
Telephone (956) 423-8384
Fax: (956) 423-6324

June 8, 2004

The Honorable Eddie Trevino, Jr.
Mayor of Brownsville
P.O. Box 911
Brownsville, Texas 78522

Dear ~~Mayor Trevino~~ Eddie:

Please pardon the belated reply to your letter of May 12, 2004 which requested support for Governor Perry's proposal to develop a sea water desalination plant in the Lower Rio Grande Valley.

Attached is a copy of a support letter and resolution on this support sent to John Bruciak, Brownsville Public Utilities Board, on May 19, 2004, just before I left town on vacation.

Please do not hesitate to let me know if there is anything else we can do.

Regards,

James

James R. Matz
Mayor

Cc: John Bruciak, GM &CEO
Brownsville Public Utilities Board

CITY OF PALM VALLEY

1313 Stuart Place Road, Ste 100
Palm Valley, Texas 78552
Telephone (956) 423-8384
Fax: (956) 423-6324

May 19, 2004

Mr. John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, TX 78523-3270

Re: Letter of Support

Dear Mr. Bruciak:

I am writing to you today in support of the Regional Seawater Desalination Project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the co-generation of a 100-megawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprised of developments with the Regional Desalination Project.

The City of Palm Valley congratulates the Brownsville PUB for this initiative and sincerely hopes this project becomes a reality in the near future. Attached is Resolution No. 2004-5 adopted by our City Council on May 17, 2004.

Sincerely,

James

James R. Matz
Mayor

RESOLUTION NO. 2004-5

RESOLUTION OF SUPPORT FOR THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the City of Palm Valley desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley Region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January, 2005; and

WHEREAS, the City of Palm Valley endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the City of Palm Valley supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE, BE IT RESOLVED that the City of Palm Valley has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

ADOPTED this 17th day of May 2004.

James K. Matz, Mayor

ATTEST:

Becky Grayson, City Secretary

RESOLUTION #2004-06
RESOLUTION OF SUPPORT FOR THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the City of Peñitas desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley Region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January, 2005; and

WHEREAS, the City of Peñitas endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region, and

WHEREAS, the City of Peñitas Supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the City of Peñitas has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

ADOPTED THIS 5th DAY OF MAY, 2004.

SERVANDO RAMIREZ, MAYOR

ATTEST:

CINDY HERNANDEZ, CITY SECRETARY

CITY OF PHARR
On the Rise!

MAYOR
Leo "Polo" Palacios, Jr.

COMMISSIONERS
Reynaldo Zuniga
Pablo Soto, Jr.
Raul Gonzalez
Victor Garcia
Carlos Villegas, Jr.
Irma Elizondo

CITY MANAGER
Benito Lopez

May 13, 2004

RECEIVED
MAY 17 2004

Mr. John Bruciak
General Manager and CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, TX 78523-3270

Responsible:

Dear Mr. Bruciak:

I am writing you today in support of the Regional Seawater Desalination project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the co-generation of a 100-megawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprized of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville PUB for this initiative and sincerely hope this project becomes a reality in the near future.

Sincerely,

Leo "Polo" Palacios
Mayor, City of Pharr

Telephone: (956) 702-5335 • Fax: (956) 702-5313 • P.O. Box B • Pharr, Texas 78577

CITY OF PRIMERA

ROUTE 1, BOX 176
PRIMERA, TEXAS 78552
(956) 423-9654
FAX (956) 423-2166

May 27, 2004

RECEIVED
JUN 17 2004

Mr. John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, TX 78523-3270

RE: LETTER OF SUPPORT

Dear Mr. Bruciak:

I am writing to you today in support of the Regional Seawater Desalination project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the cogeneration of a 100-megawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprised of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville PUB for this initiative and sincerely hope this project becomes a reality in the near future.

Sincerely,

John D. Osborne
Mayor
City of Primera

CITY OF PRIMERA
ROUTE 1, BOX 176
PRIMERA, TEXAS 78552
(956) 423-9654
FAX (956) 423-2166

RESOLUTION # 2004-09
SUPPORT FOR THE LOWER RIO GRANDE VALLEY
SEAWATER DESALINATION PROJECT

WHEREAS, the City of Primera desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley Region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January, 2005; and

WHEREAS, the City of Primera endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the City of Primera Supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the City of Primera has authorized that support of the Lower Rio Grande valley seawater Desalination Project.

ADOPTED THIS 27TH DAY OF MAY, 2004.

John David Osborne, Mayor
City of Primera

CITY OF PROGRESO

"MID-VALLEY GATEWAY TO THE SOUTH"

RECEIVED
MAY - 7 2004

May 3, 2004

Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, Texas 78523-3270
Attn: John S. Bruciak, General Manager & CEO

RE: Seawater Desalination

Mr. John S. Bruciak:

The Progreso City Commission has passed and approved the enclosed resolution supporting the Seawater Desalination.

If you have any questions please do not hesitate to call our office at (956) 565-0241.

Sincerely,

Alfredo Espinosa
City Administrator

AE/svc

Enclosed: as stated

P.O. BOX 699• PROGRESO, TEXAS 78579
e-mail address: progresocityhall@acnet.net
(956) 565-0241 • (956) 565-1332

RESOLUTION NO. 04-04-29-059

RESOLUTION OF SUPPORT FOR THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the Board of Directors/Commissioners/Councils of **The CITY OF PROGRESO** desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source fro additional water supplies; and

WHEREAS, The Governor of Texas has implemented a seawater desalination demonstration project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommended to the Legislature in January 2005; and

WHEREAS, the **CITY OF PROGRESO** endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the **CITY OF PROGRESO** supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the **CITY OF PROGRESO** Board of Directors/ Commissioners/Councils has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

PASSED, APPROVED AND ADOPTED THIS THE 29th **DAY APRIL 2004.**

CITY OF PROGRESO

[signature]

Omar Vela, Mayor

ATTEST:

[signature]

Sarah Castillo, City Secretary

RESOLUTION OF SUPPORT
FOR THE
LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the **City of Rio Hondo** desires to support the Lower Rio Grande Valley Seawater Desalination Project: and

WHEREAS, the Rio Grande Valley Region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January, 2005; and

WHEREAS, the **City of Rio Hondo** endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the **City of Rio Hondo** supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the **City of Rio Hondo** has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

ADOPTED THIS 11TH DAY OF MAY 2004.

CITY OF RIO HONDO, TEXAS

Santiago A. Saldana, Jr., Mayor

ATTEST:

Jose L. Lopez, City Secretary

STATE OF TEXAS ★ CITY OF ROMA ★

RESOLUTION NO. 2004-06

RESOLUTION OF SUPPORT FOR THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the Board of Commissioners of the City of Roma desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley region continues to experience water supply shortage; and

WHEREAS, the Texas Water Development Board's (TWDB) Approval Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination demonstration project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January 2005; and

WHEREAS, the City of Roma endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the City of Roma supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the City of Roma, Board of Commissioners has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

PASSED AND APPROVED THIS 9th DAY OF June 2004.

Fernando Peña, Mayor
City of Roma, Texas

Attest:

Josie Hinojosa, Clerk
City of Roma

P. O. BOX 947 ROMA, TEXAS 78584-0947 956-849-1411 FAX 956-849-3963

RECEIVED
MAY 21 2004

RESOLUTION NO. 04-016

RESOLUTION OF SUPPORT FOR THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, The Board of City Commissioner of San Juan desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, The Governor of Texas has implemented a seawater desalination demonstration project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January, 2005; and

WHEREAS, the City of San Juan endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

NOW, THEREFORE BE IT RESOLVED, that the Board of City Commissioners has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

PASSED, APPROVED and ADOPTED on this the 11th Day of May, 2004.

CITY OF SAN JUAN

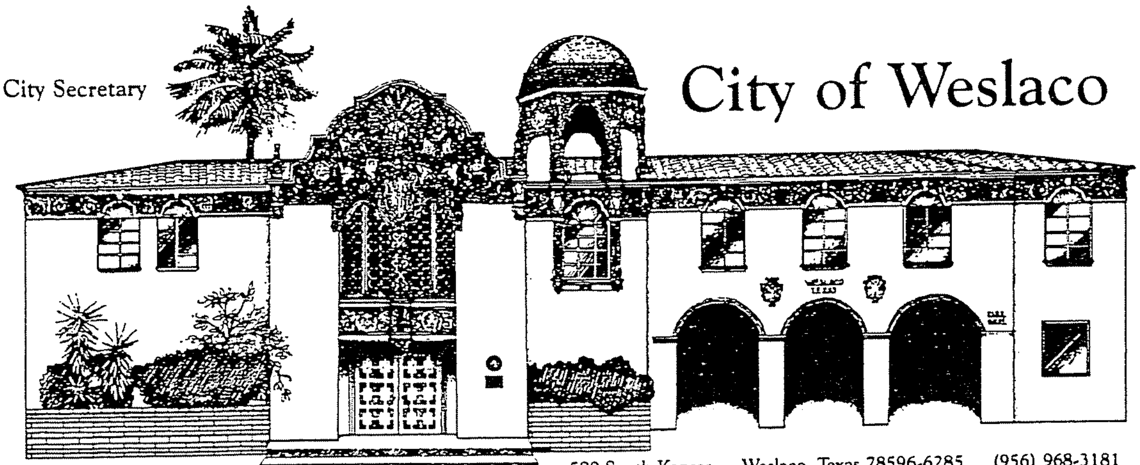
Roberto F. Loredo

ROBERTO F. LOREDO, MAYOR

ATTEST:
Vicki Ramirez
Vicki Ramirez, City Secretary

Office of the City Secretary

City of Weslaco



City Hall Building- 1928

500 South Kansas Weslaco, Texas 78596-6285 (956) 968-3181

May 6, 2004

RECEIVED
MAY - 7 2004

Mr. John S. Bruciak
General Manager & CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, Texas 78523-3270

Dear Mr. Bruciak:

At their regular meeting of May 4, 2004, the Weslaco City Commission approved Resolution 2004-14 to support the Lower Rio Grande Valley Seawater Desalination Project. Enclosed please find a copy of the resolution executed by Mayor Pro-Tem Oscar Rios.

Should you have any questions, please do not hesitate to contact my office at (956) 968-3181, Ext. 3102.

Sincerely,

Amanda C. Elizondo
City Secretary

ACE/jvb

Enclosure

Weslaco All-America City 2002

"The City on the Grow"

000086

RESOLUTION NO. 2004-14

STATE OF TEXAS	§	RESOLUTION OF SUPPORT FOR THE LOWER
COUNTY OF HIDALGO	§	RIO GRANDE VALLEY SEAWATER
CITY OF WESLACO	§	DESALINATION PROJECT.

WHEREAS, the City Commission of the City of Weslaco desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, The Governor of Texas has implemented a seawater desalination demonstration project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January 2005; and

WHEREAS, the City Commission of the City of Weslaco endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the City Commission of the City of Weslaco supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE, BE IT RESOLVED that the City Commission of the City of Weslaco has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

PASSED THIS this 4th day of May 2004.

CITY OF WESLACO

Oscar Rios

Oscar Rios, **MAYOR** PRO-TEM

ATTEST:

Amanda C. Elizondo

Amanda C. Elizondo, **CITY SECRETARY**

APPROVED AS TO FORM:

Ramon Vela

Ramon Vela, **CITY ATTORNEY**

Item VI (A)

El Jardin Water Supply Corporation

RECEIVED
MAY - 7 2004

May 5, 2004

Mr. John Bruciak, Gerneral Manager and CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, Texas 78523-3270

Re: Letter of Support

Dear Mr. Bruciak:

I am writing you today in support of the Regional Seawater Desalination Project on behalf of the Board of Directors, Management and members of El Jardin Water Supply Corporation. I understand the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded to keep pace with regional demand. Additionally, the co-generation of a 100-megawatt power plant will be considered to supply power for the desalination process as well as provide additional power for Brownsville PUB customers, the Region and other municipal power entities.

With the ever-increasing need for water and power, this project can serve an important role for the utility resources in the Rio Grande Region. As one of your largest customers for treated water, we would appreciate being apprised of developments with the Regional Desalination Project so that we may keep abreast of both demand and supply in planning to meet our customers' future needs.

We congratulate the Brownsville PUB for taking the initiative in making this project possible and look forward to the proposed project becoming a reality.

Sincerely yours,

Gale Armstrong, Jr.
General Manager

P.O. Box 3491 – 5250 Coffee Port Road, Suite D – Brownsville, Texas 78523-3491
Tel. (956) 831-9982 Fax . (956) 831-9983 E Mail address: ejwscorp@sc2000.net

HARLINGEN
Consolidated Independent School District

)9 E. Harrison Harlingen, Texas 78550 Telephone: (956) 427-3400 Fax: (956) 427-3589

RECEIVED
APR 23 2004

April 22, 2004

Mr. John Bruciak
General Manager and CEO
Brownsville Public Utilities Board
P. O. Box 3270
Brownsville, TX 78523-3270

Re: Letter of Support

Dear Mr. Bruciak:

I am writing to you today in support of the Regional Seawater Desalination project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the co-generation of a 100-megawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water resources, we would like to be kept apprised of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville PUB for this initiative and sincerely hope this project becomes a reality in the near future.

Sincerely,

Linda Wade

Linda Wade, Ph.D.
Superintendent

LW:sb

Hidalgo M.U.D. #1

7400 W. Exp. 83
Mission TX, 78572

Phone #: 956-585-2131
E-mail: hidalgomud1@
Yahoo.com

May 13, 2004

RECEIVED
MAY 14 2004

Mr. John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, TX 78523-3270

RE: LETTER OF SUPPORT

Dear Mr. Bruciak:

I am writing to you today in support of the Regional Seawater Desalination project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the co-generation of a 100-megawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprised of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville PUB for this initiative and sincerely hope this project becomes a reality in the near future.

Sincerely,

Jack Martin

Hidalgo M.U.D. #1
Jack Martin-Manager

Lower Rio Grande Valley Development Council

RECEIVED
MAY 21 2004

April 21, 2003

Hon. David Privett
Mayor, City of Laguna Vista
122 Fernandez Street
Laguna Vista, TX 78578

RE: REQUEST FOR LETTERS AND/OR RESOLUTIONS OF SUPPORT

Dear Mayor Privett:

At a recent Lower Rio Grande Valley Development Council (LRGVDC Board of Directors meeting, a presentation was heard from the Brownsville Public Utilities Board (PUB) regarding their proposed Regional Seawater Desalination Project. A project description is attached for your review.

The LRGVDC Board of Directors went on record as unanimously supporting this project as submitted for funding consideration under Governor Perry's Desalinated Seawater Initiative. The Board is also requesting of the LRGVDC membership to submit resolutions or letters of support for this important Project. For your convenience, a "Draft" Resolution and Sample Letter of support are attached for consideration. Please be advised that there is no financial commitment by supporting this Regional Seawater Desalination Project. Please address your support correspondence to the following:

Mr. John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, TX 78523-3270

COUNTY OF MAVERICK

Office of the County Judge

RECEIVED
JUN - 2 2004

May 28, 2004

Brownville Public Utilities Board
Post Office Box 3270
Brownsville, Texas 78523-3270

Attention: Mr. John S. Bruciak, General Manager & CEO

Dear Mr. Bruciak,

Thank you for the opportunity to partner and support the Brownsville initiative for the Lower Rio Grande Valley Seawater Desalination Project selected for study by the Texas Water Development Board.

We share your concern for the water challenges along the US – Mexico border. Our regional population growth and economic opportunity for the future are dependent on adequate water sources and infrastructure development. Governor Perry's Desalinated Seawater Initiative is an outstanding project to meet the present challenge and future regional water needs.

Maverick County Commissioners' Court and residents express their support through the enclosed Resolution of Support for the Lower Rio Grande Valley Seawater Desalination Project.

Sincerely,

José A. Aranda, Jr.
County Judge

1 enclosure, as stated

500 Quarry Street Suite 3 • Eagle Pass, Texas 78852 • Tel. (830) 773-3824 Facsimile: (830) 773-6450

RESOLUTION OF SUPPORT FOR THE LOWER RIO GRAND VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the Commissioners Court of Maverick County desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande River Basin continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, The Governor of Texas has implemented a seawater desalination demonstration project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January 2005; and

WHEREAS, Maverick County Commissioners Court endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, this project would allow the availability of more water rights to communities all along the Rio Grande; and

WHEREAS, the Commissioners Court of Maverick County supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the Commissioners Court of Maverick County has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

DULY ADOPTED BY VOTE OF MAVERICK COUNTY COMMISSIONERS' COURT SITTING IN SPECIAL SESSION IN THE COUNTY SEAT OF EAGLE PASS, TEXAS, ON THIS THE 29TH DAY OF APRIL, 2004.

ATTEST:

Sara Montemayor, County Clerk

José A. Aranda, Jr., County Judge

Johnny E. Martinez, Co. Comm. Pct. 1

Rudy Heredia, Co. Comm. Pct. 2

April 27, 2004

Mr. John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, TX 78523-3270

RE: LETTER OF SUPPORT

Dear Mr. Bruciak:

The McAllen Economic Development Corporation supports the Regional Seawater Desalination project. The proposed project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. In addition, a co-generation of a 100-megawatt power plant will be considered to supply the power for desalinations as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the increasing number of industrial, commercial and residential development, the proposed project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprised of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I support the Brownsville PUB for this initiative and sincerely hope the proposed project becomes a reality in the near future.

Sincerely,

Mike Allen
President & CEO

RECEIVED
APR 2004

McALLEN ECONOMIC DEVELOPMENT CORPORATION & FOREIGN TRADE ZONE
6401 S. 33rd St. • McAllen, Texas 78503 • 956 682-2875 • FAX 956 682-3077 • http://www.medc.org

RESOLUTION NO. 2004-02

RESOUTION OF SUPPORT
FOR
THE LOWER RIO GRANDE VALLEY
SEAWATER DESALINATION PROJECT

WHEREAS, The Public Utility Board of the McAllen Public Utilities desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, The Rio Grande Valley region continues to experience water supply shortages; and

WHEREAS, The Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, The Governor of Texas has implemented a seawater desalination demonstration project; and

WHEREAS, The TWDB will be preparing a sweater desalination project recommendation to the State Legislature in January 2005; and

WHEREAS, The Public Utility Board of the McAllen Public Utilities endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, The Public Utility Board of the McAllen Public Utilities support accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the Public Utility Board of the McAllen Public Utilities has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

Adopted this 11th day of May, 2004 by the McAllen Public Utilities.

MCALLEN PUBLIC UTILITIES

By: [signature]
Tony Aguirre, Chairman

ATTEST:
[signature]
Nyla L. Peña, Board Secretary

Approved as to Form:
[signature]
James E. Darling, City Attorney

RECEIVED

McALLEN
INDEPENDENT SCHOOL DISTRICT

CLYDE W. LYONS, JR.
Assistant Superintendent for Business

RECEIVED
MAY 17 2004

May 13, 2004

Mr. John Bruciak
General Manager and CEO
Brownsville Public Utilities Board
P O Box 3270
Brownsville, Texas 78523-3270

Dear Mr. Bruciak:

Enclosed please find an executed Resolution of Support for the Lower Rio Grande Valley Seawater Desalination Project from the McAllen Independent School District.

If you have any questions or need additional information, please advise.

Sincerely,

Clyde Lyons, Jr.
Asst. Supt./Business

CL:rp

Enclosure (1)

cc: Mrs. Yolanda Chapa

RESOLUTION OF SUPPORT
FOR THE
LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the McAllen Independent School District desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley Region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January, 2005; and

WHEREAS, the McAllen Independent School District endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the McAllen Independent School District supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the McAllen Independent School District has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

ADOPTED THIS 12th DAY OF MAY 2004.

[signature] 5·13·04

SIGNATURE, BOARD PRESIDENT

Alex Palacios

TYPED NAME

McAllen Independent School District

NAME OF ENTITY

MILITARY HIGHWAY
WATER SUPPLY CORP.
MHWSC

April 26, 2004

John Bruciak
General Manager
Brownsville Public Utilities Board
PO Box 3270
Brownsville, TX 78523-3270

RE: Letter of Support - Seawater Desalination Project

Dear Mr. Bruciak:

This correspondence is to express our support for the Brownsville PUB's Seawater Desalination Project. With an ever increasing need for water, this project can play an important role in the supply of water in the Rio Grande Valley area.

Because our corporation may have water supply issues in the future, we are very interested in the exploration of other water sources such as brackish and sea water.

I sincerely hope this project a reality and serves as an alternative to surface and groundwater utilization in the region.

Respectfully,

Amado E Salinas

Amado E. Salinas
General Manager
MHWSC

RECEIVED
APR 29 2004

PO Box 250 • Progreso, Texas 78579
Phone (956) 565-2491 • Fax (956) 565-9471

NORTH ALAMO WATER SUPPLY CORPORATION
3/8 MILE S OF SH 107 ON DOOLITTLE ROAD
420 S DOOLITTLE RD EDINBURG TX 78539-9078

TELEPHONE 956-383-1618
FAX 956-383-1372

RECEIVED
MAY - 7 2004

May 3, 2004

Mr. John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, TX 78523-3270

RE: LETTER OF SUPPORT

Dear Mr. Bruciak:

I am writing to you today in support of the Regional Seawater Desalination Project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the co-generation of a 100-megawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprised of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville PUB for this initiative and sincerely hope this project becomes a reality in the near future.

Sincerely,

Charles Browning

Charles Browning, General Manager
North Alamo Water Supply Corporation

Olmito Water Supply Corporation

May 20, 2004

Mr. John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
P. O. Box 3270
Brownsville, Texas 78523-3270

Re: Letter of Support

Dear Mr. Bruciak:

I am writing to you today in support of the Regional Seawater Desalination project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the cogeneration of a 100-meagawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprised of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville PUB for this initiative and sincerely hope this project becomes a reality in the near future.

Very truly yours,

Juan J. Lozano
President

An Equal Opportunity Employer

101 Clara Bennett Drive • P. O. Box 36 • Olmito, Texas 78575
Phone (956) 350-4099 Fax (956) 350-4480

RESOLUTION 05-20-04

RESOLUTION OF SUPPORT FOR THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the Olmito Water Supply Corporation desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley Region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January, 2005; and

WHEREAS, the Olmito Water Supply Corporation endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the Olmito Water Supply Corporation supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the Olmito Water Supply Corporation has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

ADOPTED THIS 20TH DAY OF MAY, 2004.

Juan J. Lozano
President

Attest:

Juan Mejia
Secretary-Treasurer

PHARR-SAN JUAN-ALAMO INDEPENDENT SCHOOL DISTRICT
P.O. Box Y * 804 E. Hwy. 83 * Pharr, Texas 78577 * (956) 702-5600 * Fax: (956) 702-5648

"Focused on Performance"

"Building Our Children's Future" "Opening Doors to the 21st Century"

MR. ARTURO GUAJARDO
Superintendent of Schools

April 27, 2004

Mr. John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, TX 78523-3270

Re: Letter of Support

Dear Mr. Bruciak:

On behalf of our School Board of Trustees, Pharr-San Juan-Alamo Independent School District, I would like to express our support of the Regional Seawater Desalination project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the co-generation of a 100-megawatt power plant will be considered to supply the power for desalination as well as provided additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprised of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville PUB for this initiative and sincerely hope this project becomes a reality in the near future.

Sincerely,

Arturo Guajardo

Arturo Guajardo
Superintendent of Schools

Port Mansfield

400 W. Hidalgo • Suite 200
RAYMONDVILLE, TEXAS 78580

TELEPHONE: (956) 689-3332
FAX: (956) 689-6165

MICHAEL G. WILSON
Port Director & General Manager

April 28, 2004

Mr John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
PO Box 3270
Brownsville, TX 78523-3270

Re: Letter of Support

Dear Mr. Bruciak

It is very exciting to hear about the Regional Seawater Desalination project in Brownsville. The Willacy County Navigation District strongly supports the Brownsville Public Utilities Board's efforts to turn salt water into municipal grade water. All Valley cities are dependant on the Rio Grand River for their water needs. Hopefully, your project will serve as the beginning of change for the Valley's future water needs.

Sincerely,

Michael G. Wilson
Port Director

San Benito Consolidated Independent School District

Office of Finance and Operations
240 N. Crockett • San Benito, TX 78586 • Phone: (956) 361-6168 • FAX: (956) 361-6166

May 18, 2004

Mr. John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, TX 78523-3270

RE: LETTER OF SUPPORT

Dear Mr. Bruciak:

I am writing to you today in support of the Regional Seawater Desalination project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the co-generation of a 100-megawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept appraised of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville PUB for this initiative and sincerely hope this project becomes a reality in the near future.

Sincerely,

Oscar De La Fuente,
President, Board of Trustees
San Benito Consolidated Independent School District

COPY

San Benito Consolidated Independent School District

Office of Finance and Operations
240 N. Crockett • San Benito, TX 78586 • Phone: (956) 361-6168 • FAX: (956) 361-6166

RESOLUTION OF SUPPORT
FOR THE
LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the San Benito Consolidated Independent School District desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley Region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January, 2005; and

WHEREAS, the San Benito Consolidated Independent School District endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the San Benito Consolidated Independent School District supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the San Benito Consolidated Independent School District has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

ADOPTED THIS 18TH DAY OF MAY, 2004.

Oscar de la Fuente
President, Board of Trustees

ATTEST:

Robert Tumberlinson
Secretary, Board of Trustees

RESOLUTION OF SUPPORT FOR THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PLANT

WHEREAS, the Sullivan City Commission desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination demonstration project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January 2005; and

WHEREAS, the Sullivan City Commission endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the Sullivan City Commission supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the Sullivan City Commission has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

ADOPTED THIS 27th DAY OF APRIL 2004.

[signature]

Gumaro "Maro" Flores, Mayor
City of Sullivan City

RECEIVED
MAY - 4 2004

Town of Combes
P.O. Box 280, 306 Templeton Street
Combes, Texas 78535
956/425-7131, fax 956/412-6795

RECEIVED
MAY 14 2004

May 11, 2004

Mr. John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, Texas 78523-3270

RE: LETTER OF SUPPORT

Dear Mr. Bruciak:

I am writing to you today in support of the Regional Seawater Desalination project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the co-generation of a 100-megawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprised of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville PUB for this initiative and sincerely hope this project becomes a reality in the near future.

Sincerely,

Silvestre Garcia, Mayor
Town of Combes

NO. 2004-7
RESOLUTION OF SUPPORT
FOR THE
LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the Town of Combes desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley Region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies, and

WHEREAS, the Governor of Texas has implemented a seawater desalination project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January, 2005; and

WHEREAS, the Town of Combes endorses the Lower Rio Grande Valley Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the Town of Combes Supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the Town of Combes has authorized the support of the Lower Rio Grande valley seawater Desalination Project.

ADOPTED THIS 10th DAY OF MAY, 2004.

Silvestre Garcia, Mayor
Town of Combes

Town of Indian Lake
62 South Aztec Cove Drive
Los Fresnos, TX 78566
(956) 233-4021 (956) 233-5140 Fax

RECEIVED
MAY 1 1 2004

May 11, 2004

John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
P. O. Box 3270
Brownsville, TX 78523-3270

Dear Mr. Bruciak:

At our meeting last night, our Council Members approved Resolution 2004-08 expressing support for the Lower Rio Grande Valley Seawater Desalination Project. A copy of the executed resolution is enclosed for your file.

Sincerely,

Jeanne Minton

Jeanne Minton
Town Secretary

Enc

RESOLUTION 2004-08

A RESOLUTION EXPRESSING SUPPORT FOR THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the Rio Grande Valley region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Texas Water Development Board will be preparing a Seawater Desalination Project recommendation for presentation to the Texas State Legislature in January 2005; and

WHEREAS, the Town Council of the Town of Indian Lake finds that the Lower Rio Grande Valley Seawater Desalination Project is a viable alternative to surface water utilization for the Lower Rio Grande Valley region and further, desires to express its support for the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Town Council of the Town of Indian Lake supports accessing to the maximum extent possible, all available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW THEREFORE, BE IT RESOLVED THAT THE TOWN COUNCIL OF THE TOWN OF INDIAN LAKE, TEXAS hereby expresses its full support for the Lower Rio Grande Valley Seawater Desalination Project.

PASSED AND APPROVED THIS 10th DAY OF MAY, 2004.

Stanley L. Greeley, Mayor

ATTEST:

Jeanne Minton, Town Secretary

RESOLUTION NUMBER 2004-09

A RESOLUTION OF SUPPORT FOR THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT.

WHEREAS, the Town of Laguna Vista desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

WHEREAS, the Rio Grande Valley Region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January 2005; and

WHEREAS, the Town of Laguna Vista endorse the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the Town of Laguna Vista supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the Town of Laguna Vista, Texas has authorized the support of the Lower Rio Grande Valley seawater Desalination Project.

PASSED AND APPROVED this 11th day of May 2004.

David Privett, Mayor
Town of Laguna Vista

Attest:

Alma Deckard, City Secretary

TOWN OF LAGUNA VISTA CORPORATE SEAL TEXAS

TOWN OF

South Padre
ISLAND, TEXAS®

ROBERT N. PINKERTON JR.
MAYOR OF SOUTH PADRE ISLAND
P.O. BOX 3410
SO. PADRE ISLAND, TEXAS 78597

(956) 761-6456
(956) 761-7561 FAX

RECEIVED
MAY 25 2004

May 19, 2004

Mr. John Bruciak, General Manager and CEO
Brownsville Public Utilities Board
P.O. Box 3270
Brownsville, Texas 78523-3270

Dear Mr. Bruciak:

I am writing to you today in support of the Regional Seawater Desalination Project. As I understand it, the initial phase of the project will consist of a 25 MGD capacity seawater desalination plant, which can be expanded as demand increases. Additionally, the co-generation of a 100-megawatt power plant will be considered to supply the power for desalination as well as provide additional power for Brownsville PUB customers, the Region, and other municipal power entities.

With the ever-increasing need for water, this project can serve an important role for the supply of water and power resources to the Rio Grande Valley Region. Because our communities may have water supply issues in the future and are interested in exploring more certain water sources, we would like to be kept apprised of developments with the Regional Desalination Project, so that we might determine if this source is a feasible water supply.

I congratulate the Brownsville PUB for this initiative and sincerely hope this project becomes a reality in the near future.

Sincerely,

Robert N. Pinkerton, Jr., Mayor
Town of South Padre Island, Texas
enclosure

RESOLUTION NO. 767

A RESOLUTION OF THE BOARD OF ALDERMEN OF THE TOWN OF SOUTH PADRE ISLAND, TEXAS, SUPPORTING THE LOWER RIO GRANDE VALLEY SEAWATER DESALINATION PROJECT

WHEREAS, the Board of Aldermen of the Town of South Padre Island desires to support the Lower Rio Grande Valley Desalination Project; and

WHEREAS, the Rio Grande Valley Region continues to experience water supply shortages; and

WHEREAS, the Texas Water Development Board's (TWDB) Approved Water Supply Plan for this region identifies desalination as a potential source for additional water supplies; and

WHEREAS, the Governor of Texas has implemented a seawater desalination project; and

WHEREAS, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January, 2005; and

WHEREAS, the Town of South Padre Island endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

WHEREAS, the Town of South Padre Island supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF ALDERMEN OF THE TOWN OF SOUTH PADRE ISLAND, TEXAS that the Town of South Padre Island has authorized the support of the Lower Rio Grande Valley seawater Desalination Project.

PASSED, ADOPTED AND APPROVED ON THIS THE 19TH DAY OF MAY, 2004.

Robert N. Pinkerton, Jr., Mayor

ATTEST:

Joyce Adams, City Secretary

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RESOLUTION
FOR THE LOWER RIO GRANDE VALLEY
SEAWATER DESALINATION PROJECT

Whereas, the Commissioners' Court of Willacy County desires to support the Lower Rio Grande Valley Seawater Desalination Project; and

Whereas, the Rio Grande Valley region continues to experience water supply shortages; and

Whereas, the Texas Water Development Board's (TWDB) approved Water Supply Plan for this region identifies as a potential source for additional water supplies; and

Whereas, The Governor of Texas has implemented a seawater desalination demonstration project ; and

Whereas, the TWDB will be preparing a seawater desalination project recommendation to the State Legislature in January 2005; and

Whereas, the Willacy County Commissioners' Court endorses the Lower Rio Grande Valley Seawater Desalination Project as an alternative to surface water utilization for this region; and

Whereas, the Willacy County Commissioners' Court supports accessing to the maximum extent possible available Federal and State resources to ensure that the Lower Rio Grande Valley Seawater Desalination Project becomes a reality.

NOW, THEREFORE BE IT RESOLVED, that the Willacy County Commissioners' Court has authorized the support of the Lower Rio Grande Valley Seawater Desalination Project.

ADOPTED THIS 01st DAY OF JUNE, 2004.

Fred Serrato

Fred Serrato, Commissioner Pct. #3
and Presiding Officer

COMMISSIONERS COURT
WILLACY COUNTY
TEXAS

Attest:

Terry Flores

Terry Flores, County Clerk

By: Susana Garza
Deputy

APPENDIX F

REFERENCES

Appendix F

REFERENCES

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