Large-Scale Demonstration
Seawater Desalination in Texas

Report of Recommendations
For the Office of Governor Rick Perry

Prepared by

Texas Water Development Board

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Index

Executive Summary..... 3

Introduction 9

Advances in Desalination Technology..... 10

Process and Methodology for Developing Recommendations 12

Summary of Statements of Interest 16

Recommended Projects 19

Financial Considerations 20

Conclusions 25

Figure 1, Desalination Statements of Interest, Proposed Plant Sites and Recommended Proposals..... 8

Appendices

1. Texas Water Development Board Demonstration Seawater-Desalination Project—Request for Statements of Interest 26

2. Recent Desalination Research Studies Funded by the Texas Water Development Board 31

Large-Scale Demonstration Seawater Desalination in Texas

Executive Summary

On April 29, 2002, Governor Perry charged the Texas Water Development Board (TWDB)[1] with the task of developing a recommendation for a large-scale demonstration seawater desalination project. In response to the Governor's charge, TWDB developed a process for identifying and screening potential demonstration seawater desalination projects. This document reports the results of that process, as well as the financial and legislative recommendations that could help implement seawater desalination projects.

To prepare these project recommendations, TWDB relied on submitted Statements of Interest[2] (SOI), existing desalination research, and planning reports[3] and information developed during the regional water planning process. The sites of projects proposed in the SOI and the sites of the TWDB recommended projects are illustrated in Figure 1.

The SOI were evaluated on the basis of screening criteria contained in the SOI request. The criteria, developed with input from the Regional Water Planning Groups (Planning Groups), are based on, in order of importance, the following parameters: (1) need/potential benefit, (2) demonstration value of the proposed project, (3) siting advantages/benefits, (4) State/regional/local support for the project, and (5) project cost.

Project Recommendations

The Governor's primary charge was for TWDB to develop a recommendation for a large-scale demonstration seawater desalination project. TWDB considered a total of 10 SOI and 3 in-house project proposals. After applying the screening criteria contained in the request for SOI, TWDB selected three potential projects. The three selected projects are recommended to proceed toward implementation.

Freeport project: This project proposes development by Poseidon Resources of a privately funded seawater desalination treatment facility at the Dow Chemical complex in Freeport and the subsequent distribution of product water to wholesale customers of the Brazos River Authority (BRA). It is anticipated that the BRA will

[1] Governor Rick Perry, Press release, Announcement in San Antonio on Securing Abundant Water Supplies for Texas' Future Needs, april 29, 2002.
[2] Appendix 1, TWDB Demonstration Seawater-Desalination Project—Request for Statements of Interest, published in the Texas Register on October 4, 2002.
[3] Appendix 2, Recent Desalination Research Studies Funded by the TWDB.

require State financial assistance [Fiscal Years (FY) 05–06] to cover the cost of treated-water conveyance.

Of the three selected projects, the Freeport project appears to be the most feasible at this time on which to begin permitting and design activities. Poseidon Resources estimates project construction to begin in calendar year 2005, with an initial water delivery of 25 million gallons per day (MGD)[4] beginning by the end of 2006.

Regarding the Freeport project, TWDB recommends that

1. A detailed raw-water-quality study be developed to best determine pretreatment requirements for the proposed site;
2. A regional water-facility plan, inclusive of a full financial analysis, be prepared to accurately assess the cost of the project, the benefits that may be derived from its implementation, and the need and type of subsidy that may be required to ensure the project's economic viability; and
3. The project developers initiate the process of securing the necessary permits for the project.

Corpus Christi and Lower Rio Grande Valley projects: TWDB received several SOI for potentially feasible projects in the Corpus Christi (4 SOI) and Lower Rio Grande Valley (2 SOI) areas. Of these, TWDB recommends conducting feasibility studies for projects proposed by the City of Corpus Christi and the Port of Brownsville.

TWDB recommends that the feasibility studies for these projects be of a regional water-supply nature. TWDB further recommends that these studies address the following enhancements to the original proposals:

1. Assessment of combined uses of seawater and brackish groundwater sources as a means of enhancing the cost-competitiveness of a desalination project;
2. Identification and assessment of regional partnerships inclusive of local entities experienced in desalination research;
3. Identification and assessment of water transfers resulting from net new water created by a desalination project that could enhance the benefits of the project to other large water users/municipalities in the Coastal, Lower Rio Grande, South Central and Lower Colorado planning regions, including approaches to structuring such transfers and draft agreements that would be required to secure their implementation;
4. Identification and assessment of likely power sources and expected cost over the life of the project and, if from a co-located facility, description of

[4] 1 MGD= 3.1 acre-feet (AF)/day or 1,126 acre-feet per year (AFY)

the impact of current and proposed regulations on use of this source, plus costs; and

5. Assessment of project funding and development alternatives.

Research Recommendations

In order to increase the potential long-term benefits of desalination technologies throughout the State of Texas, TWDB asked that the SOI include and address relevant research activities to be developed in association with the proposed projects. The Freeport proposal includes a Membrane Research Center of Excellence, which would work with State agencies and academic institutions on desalination research, development, demonstration, and technology transfer. Research goals could include identifying new and efficient techniques for producing desalinated water, conducting pilot testing and evaluation, developing techniques to minimize environmental concerns, and adapting membrane technology to include inland brackish-water treatment applications.

The Texas Water Resources Institute (TWRI) at Texas A&M University and the Center for Research in Water Resources (CRWR) at The University of Texas at Austin submitted a SOI describing a research partnership focusing on desalination. The TWRI/CRWR proposal represents the types of research and interests that may be addressed at the proposed Membrane Research Center of Excellence. Currently recognized topics requiring disciplined research are issues of pretreatment alternatives when utilizing seawater, pathogen protection, and removal of low-molecular-weight constituents.[5]

TWDB recommends that a steering committee be formed, consisting of representatives from TWDB, TCEQ, TPWD, TWRI, CRWR, the proposed project developers, Planning Groups, membrane manufacturers, and the U.S. Department of Interior, Bureau of Reclamation (Bureau), to identify and guide research and development at the Freeport site.

Funding Recommendations

Projects have been recommended on the basis of available information. Additional feasibility and regional water facility planning and design work are necessary to ensure the success of these projects. TWDB therefore recommends that the Legislature appropriate $1,500,000 to the Research and Planning Fund so that TWDB may issue grants for preparing regional water-facility planning and feasibility studies for these three proposed seawater desalination projects.

Additionally, of the three projects, the Freeport project appears to be the more developmentally advanced project and, therefore, potentially closer to

[5] Reiss Environmental, Evaluation of Desalination Waters under the Influence of Surface Water Runoff for Pretreatment, Water Quality and Pathogen Removal Performance, June 24, 2002.

implementation. Although its proponents, rather than requesting financial assistance for constructing treatment facilities, suggest that State participation would only be sought for conveyance facilities, there are opportunities for State participation to enhance the viability of this project. According to TWDB cost estimates of the Freeport project, water delivered to BRA wholesale customers costs $3.74/1,000 gal.[6] To the extent that tax-exempt funding (Private Activity Bonds) can be used for the privately owned portion of the project, approximately $0.15/1,000 gal could be saved. Existing TWDB funding programs, Texas Water Development Fund or the State Participation Program, may be used to provide financial assistance (loans) for the water conveyance component of the project, estimated to be $71,000,000. State funds for constructing conveyance lines would be needed in FY 05–06.

The TWDB has identified the potential to provide funding for the desalination project through existing State financial assistance programs and through the issuance and use of private activity bonds. Currently, two options exist for private activity bond proceeds to be used to finance large-scale water projects: (1) TWDB may apply to the Bond Review Board for a portion of the State Cap through the "State Voted Issues" category (subceiling #2) and (2) political subdivisions of the State may apply to the Bond Review Board through the "All Other Issues" category (subceiling #6). If TWDB applies for an allocation of the State Cap through subceiling #2, a $50 million maximum is imposed. Applications through subceiling #6 are further restricted to a maximum of $25 million per project. Neither of these amounts would be sufficient to provide the financing necessary for a large-scale water project. Current statutes also require that the Bond Review Board award allocations of the State Cap on the basis of a lottery system. This requirement can create difficulties for implementing large-scale water projects in which the need for predictable financing spans multiple years. Therefore, TWDB recommends that the Legislature consider the following:

- Increase the maximum application amount for TWDB under subceiling #2 to $150 million;
- Increase the maximum amount per project for applicants to subceiling #6 for projects that propose the development of water from $25 million to $125 million; and
- Eliminate the lottery system for applications that propose large-scale water projects in subceiling #6.
- Provide statutory authority to delay the closing date on bonds to at least 180 days from the reservation date.
- Give the Bond Review Board the authority to delay reservation dates for any private activity applications in the State-Voted Issues Subceiling.

[6] Cost estimates developed assuming $.04/Kw-hr and interest on capital of 8% for the treatment plant and 6.25% for water conveyance facilities.

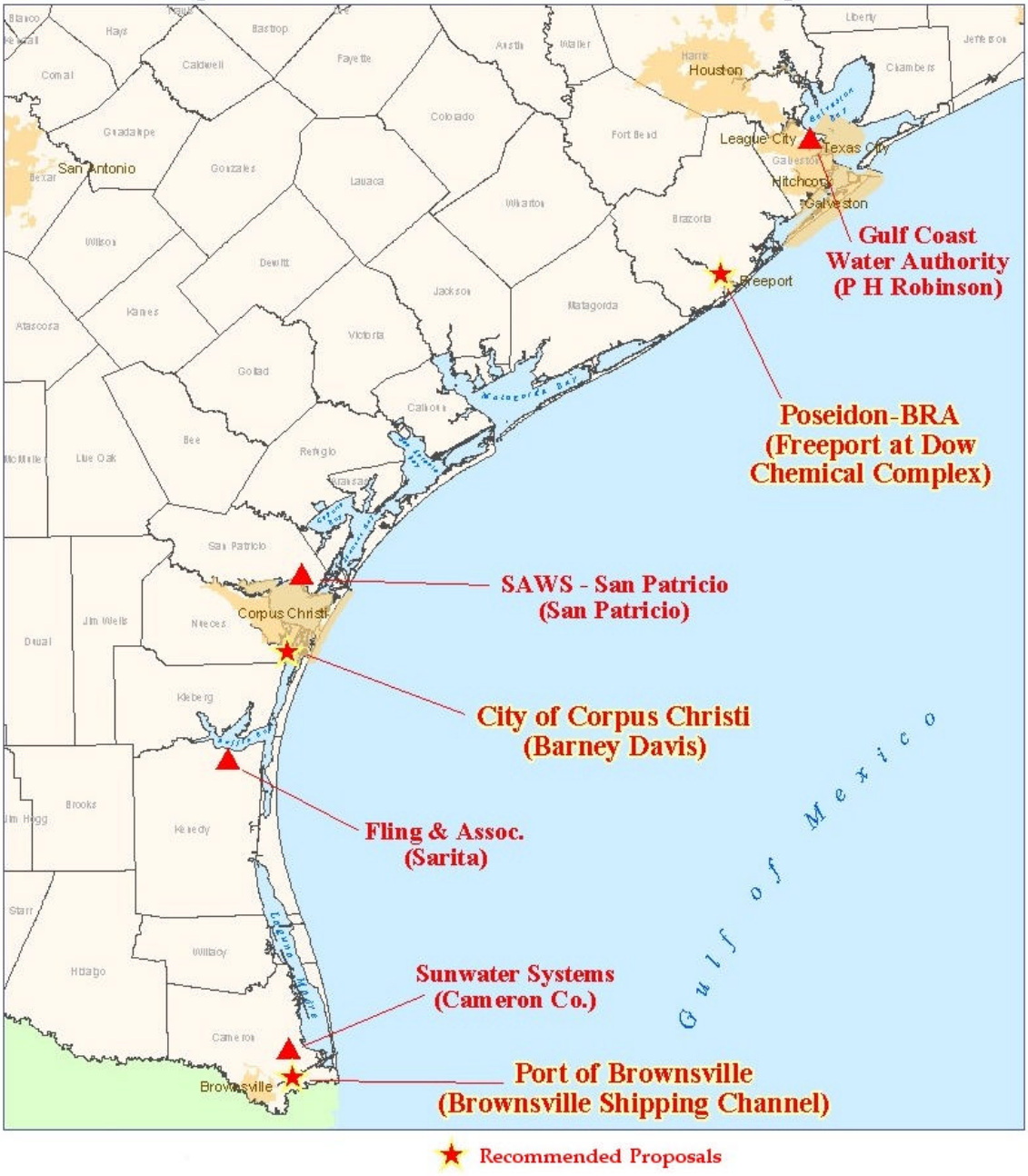
Combined, these recommendations will provide the State with the flexibility needed for timing the issuance and closing of the bonds in a manner that best fits the financing needs.

Opportunities for Federal assistance need to be explored as well. TWDB recommends that the Legislature provide the support necessary to pursue Federal resources for seawater desalination projects in Texas.

Permitting Recommendations

The permits for a seawater desalination project, although not insignificant, do not appear to place unreasonable requirements on such a project. The first seawater desalination project to go through the permit phase shall nevertheless be closely monitored to identify specific areas in which permitting processes might need to be adjusted to facilitate future seawater desalination projects in Texas.

Figure 1 Desalination Statements of Interest
- Proposed Plant Sites and Recommended Proposals -



Introduction

The State of Texas relies on Regional Water Plans to identify water management strategies for meeting the water needs of users in times of drought. Because the regional water planning process is ongoing and dynamic, Regional Water Plans are revised every 5 years and may be amended at any time in response to changing conditions.

The regional water planning process mandates that all potentially feasible water management strategies to meet identified needs be considered. Several of the Regional Water Plans have considered seawater desalination. The South Central Texas Planning Group adopted seawater desalination as the means to meet regional water needs in 2040. Because the general perception has historically been that seawater desalination is too costly and complex, there has been a significant reluctance for it to be considered or included as a water-supply tool.

The Texas Gulf Coast, with approximately 367 miles of coastline, is particularly suited to seawater desalination. Recent improvements in membrane technology have also lowered desalination production costs. These facts, along with the large population growth in areas relatively close to the ocean, as well as the growing scarcity and/or cost of developing new conventional water sources, have compelled the State to take a closer look at seawater desalination.

Additionally, from an environmental perspective, there are potential benefits in operating a large-scale seawater desalination plant in Texas, especially considering the potential reduction in demand for traditional surface and groundwater resources. Desalination not only mitigates the impacts of traditional water supply projects, such as reservoirs and groundwater wells, it also has the potential of providing an environmentally positive and drought-proof water supply.

Florida and California, like Texas, are coastal states with rapidly increasing populations. Currently Tampa Bay Water, Florida, and the Metropolitan Water District (MWD) of Southern California are both pursuing major desalination projects. The Tampa Bay seawater desalination plant, which will produce 25 MGD, will most likely be operational by 2003. MWD has received proposals from five of its member agencies for building seawater desalination plants and is in the process of preparing principles and terms for subsidy contracts. MWD recognizes the dependability of desalination and is thus prepared to provide a performance-based subsidy for desalination of water of as much as $250/AF for delivered water.[7]

[7] Metropolitan Water District, Press Release, August 21, 2001.

Building on Regional and State Water Plans, Governor Rick Perry charged the TWDB "*in concert with regional water planning groups and the private sector, to develop a proposal for building Texas' very first large-scale coastal desalination plant to produce drinking water using the latest technology.*"[8] In order to meet this charge, TWDB held a workshop on August 21, 2002, with representatives of the 16 Planning Groups and approximately 200 representatives from interested parties, requesting their input on how to develop the recommendations included in this report, as well as the screening criteria to be used in reviewing potential demonstration projects.

In response to feedback received at the August 21 workshop, TWDB issued a request for SOI and asked that responses be filed by November 1, 2002. TWDB received 10 responses to this request, one of which is limited to the research component of the request. Additionally, TWDB staff developed three *in-house* proposals generally based on information contained in the Regional Water Plans. The in-house proposals were developed prior to the SOI being filed and were used in the process for comparison purposes.

The following sections of the report include a description of current desalination technology, relevant aspects of the review of SOI, a description of the proposals, a more detailed description of recommended projects, and a discussion of financial issues related to development of seawater desalination projects.

Advances in Desalination Technology

This section covers major desalination technologies that have been used in the past and newer technologies that are being used currently. Information is also provided on desalination capacity globally, in the United States, and in Texas. Past Federal efforts to promote desalination are discussed, and topics still in need of focused research are presented.

There are two major categories of desalination technologies that currently exist in the world: thermal and membrane based.

Thermal technologies include processes such as multistage flash distillation, multiple-effect distillation, and vapor compression. The technology of distilling water at reduced pressures for desalination purposes is at least 50 years old. Thermal technologies are usually more energy-intensive processes than reverse osmosis. They are common in areas such as the Middle East, where abundant supplies of fossil fuels are available.

[8] Governor Rick Perry, Press release, April 29th 2002.

Membrane-based technologies are more recent developments. They can be either reverse osmosis (RO) systems or electrodialysis reversal (EDR) systems. Membrane technologies are also energy-intensive processes, which utilize semi-permeable membranes to produce desalinated water. The RO process utilizes pressure as the driving force to separate brackish water or seawater into desalinated product water and a brine concentrate. The EDR process utilizes opposing electrodes to separate out positive and negative ions of the dissolved salts from a saline water supply. EDR systems may be used with water containing low amounts of total dissolved solids (TDS). When TDS levels exceed 3,000 milligrams per liter (mg/L), RO systems are typically the preferred choice for desalination.

During the past 20 years, membrane technology has advanced significantly, resulting in more efficient and relatively lower cost membranes. Globally, desalination capacity has been increasing at approximately 12 percent a year and currently is estimated to be about 7 billion gallons per day (BGD).[9] There are more than 8,600 desalination plants installed globally, approximately 20 percent of which are in the U.S.A.[10] No seawater desalination plants are currently operating in this country, although Tampa, Florida, is in the process of completing a large-scale seawater desalination plant having a 25-MGD capacity, and San Diego, California, is pursuing the development of a 50-MGD seawater RO plant.

Texas currently has more than 100 desalination plants, with an installed capacity of approximately 40 MGD. However, all desalination plants in the State currently use either brackish surface water or groundwater as their raw-water source. Municipal desalination accounts for 23 MGD, whereas industrial desalination is approximately 17 MGD. Texas is fortunate to have the Gulf Coast available, which can provide almost limitless seawater for desalination. Because the costs of membrane elements have decreased about 75 percent in the last 30 years[11] and other associated costs have also declined, the time is ripe for considering development of seawater desalination plants to meet future water needs in Texas. RO membrane systems, if effectively maintained, are capable of not only lowering TDS to meet drinking-water standards, but also removing bacteria, viruses, and protozoa from the water supply.

The Bureau has a long record in desalination activities. Federal funding of desalination research began exactly 50 years ago (in 1952), and $1+ billion has

[9] U.S. Department of the Interior, Bureau of Reclamation,Technical Service Center. Desalting Handbook for Planners, 3rd Edition, 2002.
[10] Ibid.
[11] HDR, Guidance Document, Desalination for Texas Water Supply, Part B: Economic Importance of Siting Factors for Seawater Desalination, August 2000.

been spent on research, development, and demonstration projects[12]. One of the earliest major projects, the Yuma, Arizona, desalting plant, which has a Water Quality Improvement Center associated with it, is used for research, technology transfer, and training. The Bureau is currently operating joint projects with several private and public entities to perform research on desalination technologies and to develop improved cost-effective desalination technologies. The Federal Water Desalination Act of 1996, currently due to be reauthorized by Congress, allows for research studies and development and demonstration programs for desalination, as well as cooperative agreements with state and local agencies and water utilities for technology development.

Aspects of desalination requiring continued research and development include membrane design and the associated energy requirements for desalination, as well as the management and/or disposal of concentrates. Although recently developed membranes are more efficient than those used earlier, pretreatment and energy requirements for RO processes are still high. Research is needed for improving membranes that could operate efficiently at lower pressures, thereby reducing energy costs and total operating costs. The management of concentrates, through deep-well injection or by disposal to the sea, is another significant issue that needs continued funding and evaluation. If alternative uses are found for the brine concentrate, permitting requirements and capital and operating costs could be reduced.

Process and Methodology for Developing Recommendations

Screening of Statements of Interest

TWDB commissioned a team of six TWDB staff members and a representative from the Bureau to evaluate the submitted SOI. The review team applied screening criteria contained in the request for SOI, as well as the relative weight of each:

1. Need/potential benefit, 25 points;
2. Siting advantages/benefits, 20 points;
3. State/regional/local support for the project, 15 points;
4. Project cost, 15 points; and
5. Demonstration value of the proposed project, 25 points.

Additionally, TWDB staff undertook independent cost analysis and preliminary environmental-impact assessments of all SOI. This cost and environmental-review information was provided to the reviewers for consideration in the screening of SOI.

[12] U.S. Department of Interior, 2002. Ibid.

The review team reviewed each SOI, carefully considering information provided therein, and selected a score for each screening category. The relative project ranking reached by each review team member was determined by comparing the total score for all SOI. The top three SOI were among the top four rankings, as determined by all review team members. This final ranking agreed closely with individual rankings reached by each member. Review team members determined that the three top-ranked projects are suitable for site-specific feasibility studies and/or regional water facility planning studies:

1. Freeport at Dow Chemical, submitted by Poseidon Resources and Brazos River Authority;

2. Corpus Christi, submitted by the City of Corpus Christi; and

3. Lower Rio Grande Valley, submitted by the Port of Brownsville and the Brownsville Public Utilities Board.

Proposal Costing Methodology

TWDB staff developed standardized, planning-level cost estimates in order to evaluate the proposals at a preliminary planning level using a common cost basis for comparison of all SOI.[13] As much as possible, costs directly associated with the desalination plants were estimated using available cost models and handbooks specifically developed by the Bureau for estimating desalination plant costs. The primary plant costing tools used in this process were WaTER and WTCost©. These are cost models based on software developed jointly by the Bureau and the National Institute of Standards and Technology. The cost-development approach used WTCost for estimating all pre- and postdesalination water-treatment process costs. Subsequently, WaTER was used to estimate desalination process and pumping costs. TWDB staff noticed errors in both models while developing cost estimates and worked with Bureau representatives to correct and update the models as much as possible. These models are still in development and may continue to be updated. Additional costs that could not be estimated within these costing models (e.g., pipelines) were developed using various reports and indices.[14]

[13] Cost evaluations were developed for equitable cost-comparison purposes. These estimates should not be used as the basis for allocating financial resources.

[14] Cost estimates for ancillary infrastructure (e.g., delivery pipelines) were developed using related reports and previous cost estimates. The primary sources of additional cost data include the TWDB, 2002 State Water Plan, January 2002; TWDB's 2007 State Water Plan, Attachment B Guidance Document; HDR, ibid; South Central Texas Regional Water Plan, 2001, Region C Regional Water Plan, 2001; and Turner Collie & Braden Inc., Investigation of Joslin Steam Electric Station for Co-Location of a Desalination Plant, September 2000. The base year for calculating and comparing all costs was 2002. The indices used to update cost estimates and run costing models were Engineering News Record (ENR) Sept 2, 2002, values.

Cost estimates of capital outlays and annual costs were developed to make comparisons. Capital outlays were primarily a combination of direct construction costs and indirect development costs, such as permitting. Annual costs consisted of mostly debt service (based on the capital outlays), power costs, and annual operating and maintenance costs. Cost comparisons were based primarily on a lifetime, discounted-present-value unit cost of water calculated for each plant.[15] This approach allowed for equitable comparisons between projects having varying capacities and cost-escalation rates. The cost analyses relied on some simplified, standard, financial, and schedule assumptions.[16]

In order to avoid speculation regarding the potential for design-build-operate (DBO) savings at this early stage, TWDB staff did not assume any reduction in cost estimates for DBO/design-build-own-operate or design-build-own-operate-transfer projects.[17] These types of arrangements are intricate because they depend on a variety of complex and difficult-to-predict circumstances and agreements that were unknown at this preliminary planning stage. Although potential cost savings attributed to DBO could be as high as 30%,[18] the complexities of the approach may also result in cost increases.[19]

A more detailed cost analysis focused on the top three proposals and sought to compare the estimated unit costs of water for the selected seawater desalination projects. The following table summarizes this comparative analysis:

Estimated Costs, Seawater-Desalination Proposals
Total Capital Cost and Unit Cost[20]

Proposal/Capital Cost	$/1,000 ga	$/AF
Corpus Christi -$150 million	$3.10	$1,011
Freeport -$206 million	$3.74	$1,219
Lower Rio Grande Valley -$226 millio	$3.74	$1,219

[15] Discounting reflects the time value of money. The dollar value of a cost that is incurred farther in the future is worth less in present terms than a cost incurred sooner. Thus, discounting allows a valid comparison of different projects where costs are incurred over different periods of time.
[16] Based on 30-year project life at 6.25% financing with a 2006 startup date, 2.5 years for construction, $0.04/Kw-hr for power cost.
[17] Turner Collie & Braden Inc., ibid, p. I-2.
[18] Jeff Clunie, RW Beck, Tampa Bay Water's project costing consultant, phone conversation 10/07/02.
[19] Turner Collie & Braden Inc, ibid.
[20] Based on TWDB cost estimates.

Environmental Considerations

The environmental assessment of SOI involved four major issues, (1) water quality, (2) hydrodynamic issues, (3) biological issues, and (4) wildlife preserves or protected areas. Each of these issues was evaluated in detail, using all readily available information for each site, including information on salinity, flow characteristics of bays and estuaries, proximity of discharges to seagrass beds and oyster reefs, occurrence of threatened and endangered species (including their critical habitats), location of wildlife preserves and refuges, and presence of toxic compounds. This level of review was a preliminary assessment for site-screening feasibility. A greater level of environmental assessment will be required as each project moves toward possible implementation.

The sites corresponding to proposals recommended by the review team (Freeport, Corpus Christi, and Lower Rio Grande Valley) were evaluated further to determine the impact of salinity changes in bays where brine concentrate is proposed for discharge. TWDB staff developed a steady-state, salinity-loading model to estimate increases in salinity during normal and dry conditions. Input data included intake salinity; receiving-bay salinity; water volume of discharge and receiving bay, tidal, and freshwater inflow; and brine concentration. The model was used to determine whether expected salinity loading during normal and dry conditions would result in changes that could cause environmental impacts on biological resources.

These preliminary assessments for each of the recommended desalination sites indicate that for normal flow conditions, ambient salinity levels would increase from 12,800 mg/L to 13,280 mg/L at Freeport, and 32,700 mg/L to 34,500 mg/L at Oso Bay (potential discharge site for the Corpus Christi project). These levels would not significantly impact the fishery or important habitats of resident fish or wildlife species. For flows equivalent to a drought-of-record scenario, ambient salinity levels in the receiving bodies of water would increase from 12,800 mg/L to 13,730 mg/L at Freeport and 35,400 mg/L to 39,300 mg/L at Oso Bay. The estimated drought-of-record salinity levels at Oso Bay are considered hypersaline and will require more detailed environmental analysis during the feasibility study phase. The Brownsville SOI described three brine disposal options, including deep-well injection, surface discharge into the Gulf of Mexico, and a zero-discharge scenario. Therefore, the most appropriate discharge process for this project will need to be determined during feasibility studies.

Summary of Statements of Interest

Following are a list and brief description of the proposals TWDB received in response to the request for SOI for the Demonstration Seawater Desalination Project.

Recommended Proposals

Submitted by	Proposed Project
Brazos River Authority and Poseidon Resources (Freeport Project)	? A 25- to 50-MGD reverse-osmosis facility located near Freeport at the Dow Chemical complex.
▪ The project could provide water to customers located in Brazoria, Fort Bend, and Harris Counties. Also, by making new water available at locations closer to the coast, the project could potentially free up currently committed surface-water sources for use by customers located upstream.	
City of Corpus Christi (Corpus Christi Project)	A 25-MGD reverse-osmosis plant potentially co-located with the Barney Davis Power Plant in Corpus Christi, Nueces County.
▪ The project would provide water to the city and its wholesale customers. Additionally, the project would allow alternate use of existing water sources for the potential benefit of other water users, such as LCRA, SARA, SAWS, GBRA, Laredo, or the Lower Rio Grande Valley.	
Port of Brownsville and others (Lower Rio Grande Valley Project)	? A 25-MGD reverse-osmosis plant co-located with a new (proposed) power-generation facility at the Port of Brownsville
▪ The primary customers of this project would be the City of Brownsville and other entities located in Cameron County. ▪ The project would have the potential to expand benefits to other water users in the region by means of water-rights transfers.	

Other Proposals

Submitted by	Proposed Project
?—Gulf Coast Water Authority	A 20-MGD reverse-osmosis facility co-located with the P. H. Robinson Steam Generating Station, near Bacliff, Galveston County.
▪ The project would serve customers of the Gulf Coast Water Authority (GCWA) in Galveston, Fort Bend, and Brazoria Counties. The project could potentially free up Brazos River water for use within the GCWA's service area.	
?—Ionics, Inc., and others	A 25-MGD reverse-osmosis plant co-located with the Barney Davis Power Plant in Corpus Christi, Nueces County.
▪ The Ionics proposal would supply water to the City of Corpus Christi Water Department, a regional provider.	
Public Project Management (PPM) and others	A 25-MGD reverse-osmosis plant co-located with the Barney Davis Power Plant in Corpus Christi, Nueces County.
▪ The PPM proposal would serve a geographic area reaching into Rio Grande, South Central Texas, Lavaca-Navidad, and Coastal Bend Regional Water Planning Areas.	
San Antonio Water System and others	A phased project starting at 8 MGD and expanding to 75 MGD in year 2040
▪ The project would consist of a brackish groundwater (Gulf Coast aquifer) treatment facility and an ocean water desalination plant. Both plants would be located at the San Patricio Municipal Water District (SPMWD) complex in San Patricio County. The initial service area would be the SPMWD system, expanding at a later phase to serve San Antonio, the San Antonio River Authority, and the Guadalupe-Blanco River Authority.	
Fling & Associates, Inc., and others	A 40-MGD plant located near Sarita, Kenedy County, at Laguna Madre; 5 MGD of the capacity would be used by the proposed power plant.
▪ The project features distillation and reverse-osmosis processes co-located with a new gas-fired power plant and mariculture project (proposed). The proposed service area is San Antonio and other cities located along the transmission route from Sarita to San Antonio.	
Sun Water Systems	A .11MGD solar distillation plant, potentially expandable to 1 MGD, located near Laguna Vista, Cameron County.
▪ The process involves use of solar panels, windmills, and moderr greenhouses to distill brackish groundwater.	
▪ The proposed project location allows access to water-distribution networks of East Rio Hondo WSC and South Padre Island.	

Research-Only Proposal

A research proposal was submitted by the Center for Research in Water Resources at The University of Texas at Austin and the Texas Water Resources Institute at Texas A&M University. Recommended focus areas of research are:

1. Optimization of water sources and pretreatment;
2. Improved desalination technologies;
3. Efficient concentrate management;
4. Socioeconomic, environmental, permitting, and legal limitations;
5. Next-generation desalination systems;
6. Conveyance of process water to municipalities; and
7. Service area and project beneficiaries.

The proposal calls for formation of a research advisory committee.

Recommended Projects

Freeport Project

The Freeport Desalination Project, proposed by Poseidon Resources and the Brazos River Authority (BRA), to be located at Dow Chemical Company complex in Freeport, consists of a proposed 25- to 50-MGD seawater reverse-osmosis desalination facility. The project would be located within the extraterritorial jurisdiction of the City of Freeport on property leased by Poseidon Resources from Dow Chemical Company. The output of the project would be developed in increments according to needs in the lower and central Brazos river basin, with an initial output of 25 MGD expandable to 50 MGD. Additionally, depending on water quality and dispersion analyses for the concentrate discharge permit and water market conditions, final build-out may result in a 100-MGD facility. Project product water would be conveyed via a proposed pipeline for users in Brazoria and southern Fort Bend Counties. Product water could also be delivered via water transfers for BRA customers in the upper Brazos River basin.

TWDB recommendations regarding the Freeport project are that

1. A detailed raw-water-quality study be developed to best determine pretreatment requirements for the proposed site;
2. A regional-water-facility plan, inclusive of a full financial analysis, be prepared to accurately assess cost of the project, benefits that may be derived from its implementation, and need and type of subsidy that may be required to ensure the project's economic viability; and
3. The project developers initiate the process of securing necessary permits for the project.

Corpus Christi Project

The City of Corpus Christi proposes a 25-MGD plant in the Corpus Christi area. The SOI is inconclusive regarding access and/or use of the Barney Davis Power Plant or the location of concentrate disposal. The TWDB recommendation to conduct a site-specific feasibility-level study would address these issues. TWDB also recommends that the feasibility study address

1. Assessment of combined uses of seawater and brackish groundwater sources as a means to enhance the cost-competitiveness of a desalination project;
2. Identification and assessment of regional partnerships inclusive of local entities experienced in desalination research;
3. Identification and assessment of water transfers resulting from net new water created by the desalination project that could enhance benefits of the project to other large water users/municipalities in the Coastal, Lower Rio Grande Valley, South Central and Lower Colorado planning regions,

including approaches to structuring such transfers and draft agreements that would be required to secure their implementation;
4. Identification and assessment of likely power sources and expected cost over the life of the project—if from a co-located facility, description of the impact of regulations on use of this source and costs; and
5. Assessment of project funding and development alternatives.

Lower Rio Grande Valley Project

The Lower Rio Grande Valley Project is generally based on the SOI submitted by the Port of Brownsville, Brownsville PUB, and the Southmost Regional Water Authority. TWDB recommends that this project include the consideration of a larger regional service area than that described in the SOI. The project consists of a 25-MGD seawater-desalination plant combined with a 500-megawatt (MW) cogeneration plant (also proposed) and possible plans to utilize the brine concentrate as raw material for chemical production. The development of the 500-MW plant is not discussed in the SOI. The proposed "zero-discharge site" is one of various alternatives described and is of particular interest to researchers, although insufficient information is available at this time to determine whether this option would indeed be chosen.

In addition to the four topics described for the Corpus Christi Project, the feasibility study for the Lower Rio Grande Valley Project should fully address plant site and concentrate-disposal alternatives suggested in the SOI. Because of the potential for a larger service area than the one originally described in the SOI, it is strongly recommended that the feasibility study be inclusive of a larger service area and possible partnerships among potential water users in the Lower Rio Grande Valley area.

Financial Considerations

Several resources may be considered as potential means of financing a desalination project, including private financing, local contributions, State appropriations, and Federal resources. The Freeport SOI indicates that capital for the project will be a combination of long-term institutional fixed-rate debt and private equity. The financing will be nonrecourse to the BRA, will be secured by the assets of the project, and is anticipated to be investment-grade rated. To the extent that private activity tax-exempt bond allocation is available, the tax-exempt bonds will be substituted for the institutional debt with a corresponding cost reduction.

Following the conclusion of the 77th Texas Legislature, the Lieutenant Governor and Speaker of the House of Representatives formed the Joint Interim Committee on Private Activity Bonds (Committee). One of the Committee's

charges was to determine the effectiveness of the current Private Activity Bond Program in meeting public policy objectives. Although water was not specifically mentioned in the Committee's charges, the Committee's report includes recommendations related to increasing the availability of private activity bonds to fund large-scale water projects, such as desalination projects. Although the Committee does not specifically recommend a set-aside for water projects, its recommendations make it clear that private activity bond financing of water projects should be a priority for the State and the amount of financing should be predictable and consistently available each year when the State volume cap is allocated. In addition, the Committee's report envisions TWDB playing a key role in the financing of large-scale water projects.

TWDB has identified the potential to provide funding for the desalination project through existing State financial assistance programs and through the issuance and use of private activity bonds. Currently two options exist for private activity bond proceeds to be used to finance large-scale water projects: (1) TWDB may apply to the Bond Review Board for a portion of the State Cap through the "State Voted Issues" category (subceiling #2) and (2) political subdivisions of the State may apply to the Bond Review Board through the "All Other Issues" category (subceiling #6). If TWDB applies for an allocation of the State Cap through subceiling #2, a $50 million maximum is imposed. Applications through subceiling #6 are further restricted to a maximum of $25 million per project. Neither of these amounts would be sufficient to provide the financing necessary for a large-scale water project. Current statutes also require that the Bond Review Board award allocations of the State Cap on the basis of a lottery system. This requirement could create difficulties for implementing large-scale water projects in which the need for predictable financing spans multiple years. Therefore, TWDB recommends that the Legislature consider the following:

- Increase the maximum application amount for TWDB under subceiling #2 to $150 million;
- Increase the maximum amount per project (of those that propose the development of water) for applicants to subceiling #6, from $25 million to $125 million;
- Eliminate the lottery system for applications that propose large-scale water projects in subceiling #6;
- Provide statutory authority to delay the closing date on the bonds to at least 180 days from the reservation date; and
- Give the Bond Review Board the authority to delay reservation dates for any private-activity applications in the State-Voted Issues Subceiling.

Combined, these recommendations will provide the State with the flexibility needed to time the issuance and closing of the bonds in a manner that best fits financing needs.

Available TWDB Programs

Political subdivisions of the State conducting design and construction of water supply projects, including seawater desalination projects, may apply for financial assistance from one of two programs: the State Participation Program and the Texas Water Development Fund (TWDF).

Generally the State Participation Program enables TWDB to assume a temporary ownership interest in a regional project when local sponsors are unable to assume debt for the optimally sized facility. TWDB may require ownership interests in the water rights or a co-ownership interest of the property and treatment infrastructure. The main advantage of this program is that loan repayments during the early years of the project are deferred on a sliding-scale basis. Ultimately, however, cost of the funding is repaid on the basis of purchase payments, which allow TWDB to recover its principal and interest costs and issuance expenses, but on a deferred timetable.

The intent of this program is to optimize regional projects through limited State participation. Benefits must be able to be documented, however, and the projects in question would have to be otherwise unaffordable without State participation. The goal is to allow for the "right sizing" of projects in consideration of future growth.

Benefits to the participant are threefold. First, payments are deferred until the customer base grows into the added capacity facilitated, which will augment the applicant's ability to make the loan payments. Second, TWDB will not accrue interest on the deferred interest portion, thereby reducing overall carrying costs of the facility for the applicant. Third, optimizing regional projects will reduce the need (and expense) for local governments to build new structures or replace undersized structures in the future.

These funds are limited in availability, not only as to the total approved by the Legislature each biennium and but also by limitations to participation in individual projects. Furthermore, the project cannot be reasonably financed without State participation assistance, nor can optimal regional development of the project be reasonably financed without State participation.

The TWDF provides financing (loans) for the planning, design, and construction of water supply, wastewater, and flood control projects. To apply for State financial assistance through the TWDF, the applicant must be a political

subdivision of the State or a nonprofit water supply corporation. The interest rate on a TWDF loan varies according to market conditions. The lending-rate scales are set 0.35 percent above the TWDB borrowing cost and are intended to provide reasonable rates for its customers while covering TWDB's cost of funds and risk exposures. A typical tax-exempt loan would have an average rate of 5.48 percent using current rate scales; typical loans subject to taxation, i.e., loans made to water supply corporations, would have an average rate of 6.9 percent.

Federal Assistance Opportunities

To make a preliminary determination of each agency's ability to provide either technical assistance or funding for development of a desalination project, from planning and design through construction, TWDB considered the authority of three Federal agencies.

Army Corps of Engineers

The Water Supply Act of 1958 (Public Law 85-500) and the Water Resources Development Act of 1986 (Public Law 99-662) prescribe the Army Corps of Engineers' (Corps) authority related to water-supply initiatives. These acts authorize the Corps to cooperate with State governments and local entities to develop water supplies as part of multiple-purpose projects. Desalination plants typically are not considered multiple-purpose projects; therefore, the Corps does not have the authority to participate in planning or construction of desalination projects.

The Corps is currently participating in a desalination project in El Paso, Texas. The Corps' involvement in the El Paso project is unique, however. Because the desalination plant will help meet water-supply needs of Ft. Bliss, the Corps may participate in the project as part of its mission to support the military base.

U. S. Department of Interior, Bureau of Reclamation

The Bureau is involved in certain desalination initiatives under the authority of the Reclamation Wastewater and Groundwater Study and Facilities Act of 1992 (Public Law 102-575, Title XVI). For example, the Bureau is involved in a desalination initiative in Long Beach, California, and a cooperative study at the San Patricio Municipal Water District in Texas.

Under Title XVI of P.L. 102-575, the Bureau is authorized to investigate and identify opportunities for reclamation and reuse of municipal, industrial, domestic, and agricultural wastewater, as well as naturally impaired ground and surface waters, for the design and construction of demonstration and permanent facilities to reclaim and reuse wastewater and for conducting research, including desalination, for the reclamation of wastewater and naturally impaired ground and

surface waters. The Bureau may cost share as much as 50% of a project. According to the Bureau's *Guidelines for Preparing, Reviewing, and Processing Water Reclamation and Reuse Project Proposals Under Title XVI of the Public Law 102-575, As Amended,* a demonstration project is defined as one that is sized appropriately to demonstrate practicality and that also promotes application of innovative technologies, promotes nontraditional application of current technology as yet unproven, or establishes the feasibility of recycling water to local institutions when an unproven technology is employed. Application of a known technology that merely demonstrates feasibility in a different site or geographic region or modification of an already successfully applied technology would not qualify as a demonstration project.

The Bureau could undertake a full-scale desalination project if Congress were to grant specific authority. Title XVI of P.L. 102-575 has been amended previously to include authority for specific reclamation and reuse studies and construction projects.

The Bureau is also responsible for implementing the Desalination and Water Purification Research and Development Program, although the program authority expired and the program has not yet been reauthorized.

Environmental Protection Agency

The U.S. Environmental Protection Agency (EPA) has provided funding for desalination projects as authorized under the National Assistance Program for Water Infrastructure and Watersheds. Under the program, EPA may provide technical and financial assistance in the form of grants for the construction, rehabilitation, and improvement of water-supply systems. Typically the allocation of funding under this program is specified in the committee report that accompanies EPA's appropriations.

Conclusions

- TWDB staff published a Request for Statements of Interest in the *Texas Register* on October 4, 2002, for a demonstration seawater desalination project (See Appendix 1). Pursuant to that request, 10 statements of interest were received and reviewed. TWDB staff screened the SOI that contained project proposals (9 of them) and screened them on the basis of the Screening Criteria contained in the TWDB Request for Statements of Interest.

- Three proposed projects, the Freeport Project, the Corpus Christi Desalination Project, and the Lower Rio Grande Valley Project, are recommended to proceed toward implementation.

- All three of the proposed projects will require some type of financial assistance in order for the objectives of the Governor's initiative to be fully achieved. Partial funding may be available from both State and Federal sources.

Appendix 1: Texas Water Development Board Demonstration Seawater-Desalination Project—Request for Statements of Interest

The Texas Water Development Board (TWDB) is soliciting Statements of Interest for the development of a large-scale Demonstration Seawater Desalination Project. Interested parties are invited to provide a Statement of Interest to the TWDB no later than close of business on Friday, November 1, 2002.

Background:

On April 29, 2002, Governor Perry tasked the TWDB with developing a recommendation for a large-scale demonstration seawater desalination project.

The goals of the Seawater Desalination Initiative are to demonstrate:

- The State's resolve to add large-scale seawater desalination to the mix of water supply sources to meet long-term water needs in the State with a drought-proof source;
- That large-scale seawater desalination technologies can be feasibly implemented in Texas; and
- That large-scale seawater desalination projects are a cost-effective and environmentally sensitive means to meet water supply needs in the State.

A key feature of the demonstration project will be the opportunity it will offer for on-going research on alternative desalination technologies and their potential applications. The TWDB welcomes the participation of universities or other research organizations as team members in the preparation and submission of statements of interest.

To meet this charge, TWDB will prepare a project recommendation report that will be delivered to the Governor and the Texas Legislature in January 2003. TWDB will seek to identify a project proposal that has a strong potential for implementation.

TWDB anticipates that, in order to facilitate legislative action on the recommendation, it will need to include sufficient detail addressing location of the desalination plant, treatment methodology and plant capacity, concentrate disposal method and location, possible project owner(s) and operator(s), targeted water users (cities, industry, etc.), additional infrastructure needs, financing alternatives, identification of estimated potential subsidy requirements, regulatory recommendations regarding any legislative issues that may need to be addressed, possible project time line and any other information or endorsements provided by the regional water planning groups.

TWDB will primarily consider information contained in the 2001 Regional Water Plans and 2002 State Water Plan, Water for Texas, to identify potential demonstration seawater desalination projects. Additionally, as per guidance received from the regional water planning groups to expand the pool of potential projects, TWDB invites public and private entities to submit statements of interest for consideration under the Demonstration Seawater Desalination Project initiative. The responses to this request will be considered in the development of a recommendation for a demonstration seawater desalination project.

Statement of Interest Requirements:

Ten complete copies and one electronic reproducible copy of the statements of interest are due no later than close of business on Friday, November 1, 2002. Please mail them to:

Jorge Arroyo
Texas Water Development Board
1700 North Congress Avenue
Austin, Texas 78711-3231

Responses should be limited to no more than five 8-½X11 inches pages and should address the items listed below. Responses to the request for statements of interest may include appendices; however, supplemental information provided in addition to the five pages will only be considered at TWDB's discretion.

1. Project proponent(s)
   Identify the project proponent(s) and describe all partnerships or other type of arrangements affiliated with the proposal. Provide a summary of the project proponent(s) relevant qualifications.

2. Project description
   Describe the proposed demonstration project, with emphasis on how it will address the goals for the seawater desalination initiative. Identify any relevant factors that increase the likelihood that the proposed project will be implemented.

3. Proposed project location
   Provide a map showing the location of the proposed project's treatment facilities, intake and discharge facilities, and transmission lines to deliver the water to the intended users. If applicable, identify existing facilities, whether in use or abandoned, that are part of the proposed project. Discuss availability and accessibility of land for siting a desalination treatment plant and if available, any infrastructure upgrades that are

anticipated to be necessary to support plant operation or product water delivery.

4. Water treatment process
   Describe the proposed treatment processes, the plant treatment capacity and its potential to expand. Discuss the plant's finished water quality and provide an assessment of any stability issues in the proposed receiving distribution systems. Identify any specific technology demonstration features or technology research capabilities that may be part of the project concept. Discuss whether the project involves mixing with other non-saline or less saline sources and the impact such action has on the project's feasibility.

5. Concentrate disposal method
   Describe the proposed method for disposing of the treatment process concentrate. Discuss any anticipated environmental considerations and solutions associated with the permitting of the proposed disposal method.

6. Service area and project beneficiaries
   Describe the geographic area that would be served by the proposed project. Identify all potential customers of the proposed project. Identify any project benefits to other regions and/or water users, and/or relief to existing water sources that may result from implementation of the proposed project.

7. Support for the project
   Describe endorsement obtained or expected for the proposed project from Regional Water Planning Group(s) and potential project beneficiaries.

8. Estimated cost of water delivered to receiving distribution networks
   Provide a preliminary estimate of the cost of the facility's product water in dollars per acre-foot and of the transmission costs to deliver the water to the receiving distribution systems. Provide a comparative assessment of the current and projected cost of water to the potential project beneficiaries with and without the proposed project.

9. Funding
   Describe the proposed financing structure for the proposed project. Describe financial capabilities and arrangements of all entities participating in the proposal. Identify expected level of state funding necessary to successfully implement the project. Discuss whether the project financing would require any legislative changes and whether it would require an

increase in the private activity bond cap. Clarify whether the proposed ownership is private, non-profit or governmental.

10. Environmental and permitting considerations
    Discuss any potential environmental impact that could result from the proposed project. Identify by statutory/regulatory reference federal and state permitting requirements applicable to the proposed project and the estimated timelines to satisfy those requirements.

11. Project schedule
    Provide the proposed project implementation schedule.

12. Contact information
    Identify the name, company, title and contact details for the person representing the proposed project's proponent.

Demonstration Seawater Desalination Project - Screening Criteria:

TWDB will rely primarily on the following criteria to screen potential demonstration seawater desalination projects. Top ranked proposals resulting from the screening will be subjected to additional evaluation on the merits of the individual proposals.

Screening Criteria

Item		
A. Need/Potential Benefits		**25**
▪ Projected target population		
▪ Relative need for additional water supplies by year 2020 under drought-of-record basis.		
▪ Relative cost of water to potential project customers [With project vs. w-out project]		
▪ Impact to other water resources of the State		
▪ Other benefits, including environmental, site-specific, direct and indirect benefits to other water users in the State.		
B. Siting advantages/benefits		**20**
▪ Proximity of treatment plant to place of need		
▪ Use of existing intake/discharge facilities		
▪ Raw water quality		
▪ Concentrate disposal		
▪ Environmental considerations		
C. State/Regional/local support for the project		**15**
▪ Consistency with Regional Water Plans		
▪ Endorsement from Regional Water Planning Groups		
▪ Endorsement from targeted water users		
D. Project Cost [To be developed by TWDB staff]		**15**
▪ Total project cost		
▪ Capital cost to the State		
▪ Operation & Maintenance cost		
E. Demonstration value of the proposed project		**25**
▪ Research and technology transfer features of the proposed project		
▪ Ability of the project's proponent to implement the project within the next four years		
		100

Appendix 2: Recent Desalination Research Studies Funded by the Texas Water Development Board

Contract #	Contractor Name	Description	Commitment Amount	Date Completed
93-483-373	Kleber Denny, Inc.	Evaluate Utilization of Geopressured/Geothermal Resources for Additional Water Supply in the Lower Rio Grande Valley	$75,000	3/7/1994
95-483-141	Brownsville, City of	Regional Water Supply Plan	$130,000	11/18/1997
95-483-142	Stonewall County	Evaluation of Economic and Reliable Methods of Brine Management	$42,000	12/27/1999
97-483-202	Laguna Madre Water District	Regional Water Supply Plan for the City of Port Isabel, South Padre Island, and Laguna Vista	$63,750	3/29/1999
99-483-280	Nueces River Authority	Assessment of Current Membrane Desalination Technology and Cost Treatment of Brackish and Saline Waters in Texas	$50,000	11/20/2000
99-483-297	Lavaca-Navidad River Authority	Investigation of Joslin Steam Electric Station for Co-Location of a Desalination Facility	$374,104	6/11/2001
2000-483-328	Nueces River Authority	Review of Factors Impacting Siting Decisions of Seawater Desalination Facilities for the Texas Coast	$50,000	11/20/2000
2001-483-395	LBG Guyton and Associates	Identification of Brackish Groundwater Sources for Future Potable Use and Their Estimated Desalinization Costs	$99,940	Not yet completed