Texas Water Development Board

2014 Biennial Report on Seawater Desalination

The Future of Desalination in Texas

2014 Biennial Report on Seawater Desalination

December 1, 2014

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2014 Biennial Report on Seawater Desalination

Carlos Rubinstein, Chairman
Bech Bruun, Board Member
Kathleen Jackson, Board Member

Kevin Patteson, Executive Administrator

Section 16.060 of the Texas Water Code directs the Texas Water Development Board to undertake or participate in research, feasibility and facility planning studies, investigations, and surveys as it considers necessary to further the development of cost-effective water supplies from seawater desalination in the state. The Texas Water Development Board is required to prepare a biennial progress report on the implementation of seawater desalination activities in the state and shall submit it to the Governor, the Lieutenant Governor, and the Speaker of the House of Representatives not later than December 1 of each even-numbered year.

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Texas Water Development Board

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December 1, 2014

To: The Honorable Rick Perry, Governor of Texas
The Honorable David Dewhurst, Lieutenant Governor of Texas
The Honorable Joe Straus, Speaker of the Texas House of Representatives

The Texas Water Development Board is pleased to present the 2014 Biennial Report on Seawater Desalination, submitted to you in compliance with Texas Water Code §16.060. This report examines progress toward the goal of creating water supplies in Texas through seawater desalination.

We present updates on seawater desalination activities in the state including information on new projects that are presently taking shape. We also identify areas where the State can help advance seawater desalination. These include facilitating meetings between water providers and regulatory agencies for permits, providing financing through existing programs to entities interested in pursuing seawater desalination, and working with private and public partners to advance the implementation of seawater desalination in the state.

On behalf of the citizens of Texas, the Texas Water Development Board respectfully submits to the Governor, the Lieutenant Governor, and the Speaker of the House this report, providing a status update on seawater desalination in Texas.

Carlos Rubinstein
Chairman

Kevin Patteson
Executive Administrator

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Executive Summary

In 2002, Governor Rick Perry charged the Texas Water Development Board (TWDB) with developing a proposal to build the first seawater desalination plant in Texas. Immediately thereafter, the TWDB began an initiative to identify suitable locations for a seawater desalination plant by publishing a request for statements of interest from the public. Of the 13 project proposals received, three projects were selected and recommended for implementation. In the next few years, the TWDB completed three feasibility studies, two pilot-plant studies, and several environmental reports. These studies resulted in two proposals to build two seawater desalination facilities: one at the Brownsville Ship Channel by the Brownsville Public Utilities Board, and the other on South Padre Island by the Laguna Madre Water District. Meanwhile, recent events reaffirm the continued need to develop drought-proof water supplies for the state such as seawater desalination. In 2011, Texas experienced its worst one-year drought in recorded history. The drought of 2011 persists today and is likely to continue. Furthermore, the 2012 State Water Plan notes that existing water supplies cannot meet future demands during drought-of-record conditions.

The 2014 Biennial Report on Seawater Desalination is the sixth report in the series and marks the completion of 12 years of work to advance seawater desalination in Texas.

Results of Studies and Activities

During the reporting biennium, lack of funding slowed the state's role in advancing seawater desalination in Texas. In 2010, the TWDB exhausted the remainder of $2.5 million appropriated by the 79th Texas Legislature for desalination demonstration activities. Since then, no additional seawater desalination studies have been funded. During the past biennium, the TWDB staff kept abreast of seawater desalination activities in the state by monitoring the regional water planning groups that have identified seawater desalination as a water management strategy, getting updates from entities that had conducted feasibility or pilot-plant studies, and following the activities of other entities that have plans for or are actively pursuing seawater desalination. The TWDB Board and staff members also provided testimony at hearings held in June 2014 by the Joint Committee to Study Water Desalination.

Impediments to Implementation

The relatively high cost of seawater desalination compared to less expensive conventional water supplies is the greatest challenge to implementing a large-scale seawater desalination facility in Texas. Desalinating seawater is more costly for various reasons but mainly because seawater's higher salinity (about 35,000 milligrams per liter) requires more pressure in the treatment process, which increases energy costs. Other factors that affect cost include location of intake and outfall structures, pretreatment process, brine disposal method, length of distribution pipelines, and permitting.

Desalination technology continues to improve. Because of this, the pilot-plant studies completed during the past decade are now dated. Therefore, there is a need to conduct more pilot-plant studies to test the most recent modern technologies. Updated studies on potential environmental impacts will also be needed.

The Role of the State

Efforts initiated in 2002 began paving the path to the goal of implementing a large-scale seawater desalination facility in Texas. The role of the State is to continue providing leadership and support to advance seawater desalination in Texas. Fulfilling this role during the upcoming biennium would require the following considerations:

- Facilitate an efficient permitting process: The permitting process can be challenging for entities pursuing seawater desalination for the first time. By participating in and facilitating meetings between water providers or municipalities and regulatory agencies, the State can assist in the permitting process. The Texas Commission on Environmental Quality is the state agency that has regulatory authority over water quality and the level of treatment required. It also issues permits for water diversions and waste discharges.

- Keeping the public informed about existing financing opportunities: Political subdivisions such as cities, counties, utility districts, and authorities will be eligible for the TWDB's loan and grant programs. The low-interest loans provide funding for water supply projects including seawater desalination. The State should keep the public informed of these and other funding opportunities.

- Seeking partnership opportunities with the private sector: Public-private partnerships are a common means of implementing large-scale seawater desalination projects around the world. Recent legislative changes in Texas have made it easier for the private sector to develop public infrastructure, including water production facilities. The TWDB could provide programmatic support to facilitate private sector participation in the development of seawater desalination facilities.

Appropriations

No further state appropriations are being requested for seawater desalination activities during the next biennium. The TWDB believes that it can continue monitoring activities with current resources and finance the construction of seawater desalination plants using current financing programs. The TWDB staff will continue to look for partnering opportunities with public and private entities to advance seawater desalination in the state.

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Introduction

The 2014 Biennial Report on Seawater Desalination provides a status update on the activities to date on seawater desalination in Texas.

Background

The Texas Water Code (TWC) §16.060 requires the Texas Water Development Board (TWDB) to undertake necessary steps to further the development of cost-effective water supplies from seawater desalination in the state and report the results of its studies and activities relative to seawater desalination not later than December 1 of each even-numbered year. The report includes:

(1) the results of the board's studies and activities related to seawater desalination during the preceding biennium;
(2) an identification and evaluation of research, regulatory, technical, and financial impediments to implementing seawater desalination projects;
(3) an evaluation of the role the State should play in furthering the development of large-scale seawater desalination projects in the state; and
(4) an anticipation of appropriation from general revenues necessary to continue investigating water desalination activities in the state during the next biennium.

The 2014 Biennial Report on Seawater Desalination is the sixth report in the series and marks the completion of 12 years of activities toward advancing seawater desalination in Texas. The initiative began in 2002 with the identification of sites for a seawater desalination demonstration project. In 2003, the TWDB selected three locations for feasibility studies (Cities of Corpus Christi, Brownsville, and Freeport). These studies were completed in 2004. Between 2006 and 2008, two pilot-plant studies were conducted: one at the Brownsville Ship Channel by the Brownsville Public Utilities Board, and the second on South Padre Island by the Laguna Madre Water District. In 2009 and 2010, the TWDB funded research studies on environmental permitting requirements to implement seawater desalination along the Texas Gulf Coast.

Despite these efforts, Texas does not yet have a seawater desalination plant.

Current State of Seawater Desalination

According to the International Desalination Association, desalination is being used in 150 countries around the world to produce fresh water supplies (International Desalination Association, 2014). In 2013, the total number of desalination plants worldwide was approximately 17,000, equivalent to a total installed capacity of 21.1 billion gallons per day (International Desalination Association, 2014). The global installed seawater desalination capacity was about 12.7 billion gallons per day, which is 60 percent of the total installed desalination capacity.

Currently, there is one operational seawater desalination facility in the United States: the Tampa Bay Seawater Desalination Plant located in Tampa Bay, Florida. A second seawater desalination plant is being built in Carlsbad, California, and is scheduled to become operational in late 2015. The Tampa Bay Seawater Desalination Plant was built under a public-private partnership, and the Carlsbad plant is privately funded.

The Tampa Bay Seawater Desalination plant, which first became fully operational in 2007, has a design capacity of 25 million gallons per day. It is co-located with and uses electricity generated from Tampa Electric's Big Bend Power Station. For source water, the seawater desalination plant uses approximately 44 million gallons per day of warm water that has passed through the co-located power plant's cooling tower (Tampa Bay Water, n.d.). The treatment process includes pre-treatment, reverse osmosis, and post-treatment. The concentration of total dissolved solids in the raw water averages 26,000 milligrams per day but can range from 10,000 to 30,000 milligrams per day.

The desalinated water produced at the Tampa Bay Seawater Desalination Plant is piped to a regional water facility located 14 miles away and blended with treated surface water at a rate based on demand. Water from the desalination plant currently provides up to 10 percent of the region's needs (Tampa Bay Water, n.d.). The 19 million gallons per day of concentrate resulting from the reverse osmosis process is returned to the Big Bend Power Station and blended with the cooling water stream. It is then discharged to a canal where it blends with seawater and eventually reaches the Tampa Bay.

The 50-million gallon per day Carlsbad Desalination Project, located in Carlsbad, California, is under construction and scheduled to become operational in late 2015 (City of Carlsbad, 2014). When completed, it will be the biggest seawater desalination plant in the United States. In 2020, seawater desalination will account for approximately seven percent of the San Diego region's water supply and about one-third of all locally generated water in San Diego County (San Diego County Water Authority, 2014). The planning phase of this project took 12 years, with the permitting process taking an additional six years. The concentration of total dissolved solids in the seawater is approximately 33,500 milligrams per day (Poseidon Water, 2014).

Section 1 - Results of the Texas Water Development Board's Studies and Activities Relative to Seawater Desalination during the Preceding Biennium

Studies

Since 2002, the TWDB has funded $3.1 million in studies related to seawater desalination, including three feasibility studies, two pilot-plant projects, and several guidance and research studies (Table 1). By 2010, the $2.5 million appropriated by the 79th Texas Legislature for desalination demonstration activities had been spent. Since then, the TWDB has not funded additional seawater desalination studies.

Table 1. Texas Water Development Board-funded reports on seawater desalination studies.

Report title	Study location	Study type
Lower Rio Grande Valley, Brownsville Seawater Desalination Demonstration Project *(Brownsville Public Utilities Board, 2004)*	City of Brownsville	Feasibility study
Large Scale Demonstration Desalination Feasibility Study *(City of Corpus Christi, 2004)*	City of Corpus Christi	Feasibility study
Freeport Seawater Desalination Project *(Brazos River Authority, 2004)*	City of Freeport	Feasibility study
Pilot Study Report, Texas Seawater Desalination Demonstration Project *(Brownsville Public Utilities Board, 2008)*	City of Brownsville	Pilot-plant study
Feasibility and Pilot Study, South Padre Island Seawater Desalination Project *(Laguna Madre Water District, 2010)*	South Padre Island	Pilot-plant study
Guidance Manual for Permitting Requirements in Texas for Desalination Facilities Using Reverse Osmosis Processes *(R.W. Beck, Inc., 2004)*	Not applicable	Guidance document
Lessons Learned from the Brownsville Seawater Pilot Study *(Reiss Engineering Inc., 2009)*	City of Brownsville	Guidance document
Texas Desal Project (*Brownsville Public Utilities Board, 2011*)	City of Brownsville	Guidance document

Further information on the current status of the three feasibility studies, the two pilot-plant projects for which TWDB provided funding, and any additional work being done by other entities on implementing seawater desalination is included on pages 7 to 15.

Brownsville Feasibility and Pilot-Plant Studies

From 2004 to 2011, the TWDB and the Brownsville Public Utilities Board conducted feasibility and pilot-plant studies and completed scoping of permitting issues and conceptual layout and cost estimate for a full-scale seawater desalination production facility. Implementing a seawater desalination plant at the Brownsville Ship Channel would make effective use of those studies and deliver on the goal of this program. It would enhance the drought reliability of the region's water supply and offer a valuable reference for other potential projects with similar profiles located along the Texas Gulf Coast.

The Brownsville Public Utilities Board has explored an increasingly smaller project to reduce the financial impact to its ratepayers and the State. In the 2010 and 2012 biennial seawater desalination reports, the TWDB reported that the plant capacity was reduced from an original 25 million gallons per day to 2.5 million gallons per day with an estimated cost of $22.5 million. The amount of financial assistance (grant) requested from the 82nd Texas Legislature for this project was $9.5 million (TWDB, 2012). The project is currently on hold, pending procurement of funds by the Brownsville Public Utilities Board.

South Padre Island Feasibility and Pilot-Plant Studies

Although South Padre Island was not one of the three original sites selected for a feasibility study as part of the Seawater Desalination Initiative (TWDB, 2002), the Laguna Madre Water District completed a feasibility and pilot-plant study and was part of the environmental scoping study for seawater desalination (Brownsville Public Utilities Board, 2011). The amount of financial assistance (grant) requested from the 82st Texas Legislature for this project was $5 million (TWDB, 2012).

In May 2011, Texas voters approved two propositions. Proposition I was for the issuance of bonds in the amount of $23,750,000 for system improvements and the levy of taxes in payment of the bonds. Proposition II authorized the Laguna Madre Water District to issue bonds in the amount of $15,655,000 to finance construction of a seawater desalination facility and the levy of taxes in payment of the bonds.

In May 2014, the Laguna Madre Water District replaced dual media filters with microfiltration membranes to the existing surface water treatment plant No. 2 to add two million gallons per day to the existing plant capacity. These changes increased the total production capacity to seven million gallons per day. While this additional capacity strengthens the water supply system, because the original water source is the Rio Grande, a surface-water source, it lacks the reliability that seawater desalination would provide. The next step in the seawater desalination project would be land acquisition for the facility, but Laguna Madre Water District has not yet purchased the land. Currently, the seawater desalination project is on hold while the district pursues direct potable reuse (Laguna Madre Water District, 2014).

The Laguna Madre Water District is conducting a feasibility study for a water reclamation and reuse facility that was completed in November 2014. For the water reuse project, the district is considering a reclamation plant at either Port Isabel or Laguna Vista to treat wastewater effluent from the Port Isabel Wastewater Treatment Plant for augmenting surface water in their Reservoir 3. The district is also examining other alternatives including a regional approach that involves receiving effluent from both Laguna Vista and Port Isabel wastewater treatment plants and treating the effluent at a single water reclamation and reuse facility. Once the feasibility study is completed, the district foresees completing a design for the reclamation plant within 12 months and construction within 18 months. The resulting supply from the Port Isabel Wastewater Treatment Plant is estimated to fulfill the need of the water district for approximately the next 10 years. The additional supply from Laguna Vista Wastewater Treatment Plant is projected to meet the water demand until 2040.

Corpus Christi Feasibility Study

In 2004, the TWDB and City of Corpus Christi completed a feasibility that identified two sites, Barney Davis Power Plant and DuPont-OxyChem, as potential sites for a seawater desalination plant. Until recently, no additional work had been conducted. In 2013, the City of Corpus Christi contracted with an engineering consulting firm to design, construct, and operate a demonstration seawater desalination plant (City of Corpus Christi, 2014b). On April 22, 2014, the City of Corpus Christi approved approximately $1.1 million to fund the desalination demonstration project.

The selection of the preliminary sites for the demonstration plant and the technology being tested are estimated to be completed in the first quarter of 2015 (City of Corpus Christi, 2014a). Water quality sampling would be conducted at up to five locations. An 18-month-long pilot study for a 200,000 gallon-per-day plant at the final selected site is expected to begin in the second quarter of 2015. Testing of various desalination technologies will be also conducted. The TWDB is participating in this project as a partner.

For the demonstration project, the City of Corpus Christi has obtained, in addition to its own internal funding, a $400,000 grant from the U.S. Bureau of Reclamation through the Desalination and Water Purification Research program for the piloting component of the project.

Freeport Feasibility Study

The City of Freeport reports that no additional work has been conducted since the TWDB-funded feasibility study was completed in 2004 (City of Freeport, 2014).

Regional Water Plans

The 2012 State Water Plan recommends seawater desalination as a water management strategy to meet projected shortages in three regional water planning areas (Region H, Region L - South Central Texas, and Region M - Rio Grande). If implemented, collectively these projects would

produce an estimated 125,514 acre-feet per year of new water supplies by 2060 (Table 2). Collectively, seawater desalination water management strategies constitute about 1.4 percent of new water supplies in the state.

Additionally, the Coastal Bend (Region N) Regional Water Planning Group included seawater desalination as an alternative strategy in its regional water plan. If implemented, this alternative strategy would produce 28,000 acre-feet per year of new water supplies by 2060. On August 28, 2014, the Coastal Bend (Region N) Regional Water Planning Group submitted a request to the TWDB Executive Administrator to approve a minor amendment to change the seawater desalination strategy from alternative to recommended. On September 18, 2014, the TWDB approved adopting the minor amendment to the 2011 Coastal Bend (Region N) Regional Water Plan and authorized the TWDB staff to develop the corresponding amendments to the 2012 State Water Plan and post notice for a public hearing as appropriate per 31 Texas Administrative Code (TAC) §357.51(f). A public hearing was held on November 14, 2014, and no public comments were received. On November 20, 2014, the TWDB approved an amendment to the 2012 State Water Plan to adopt seawater desalination as a recommended water management strategy, in accordance with 31 TAC §358.4(a).

Table 2. Seawater desalination water management strategies in the 2012 State Water Plan.

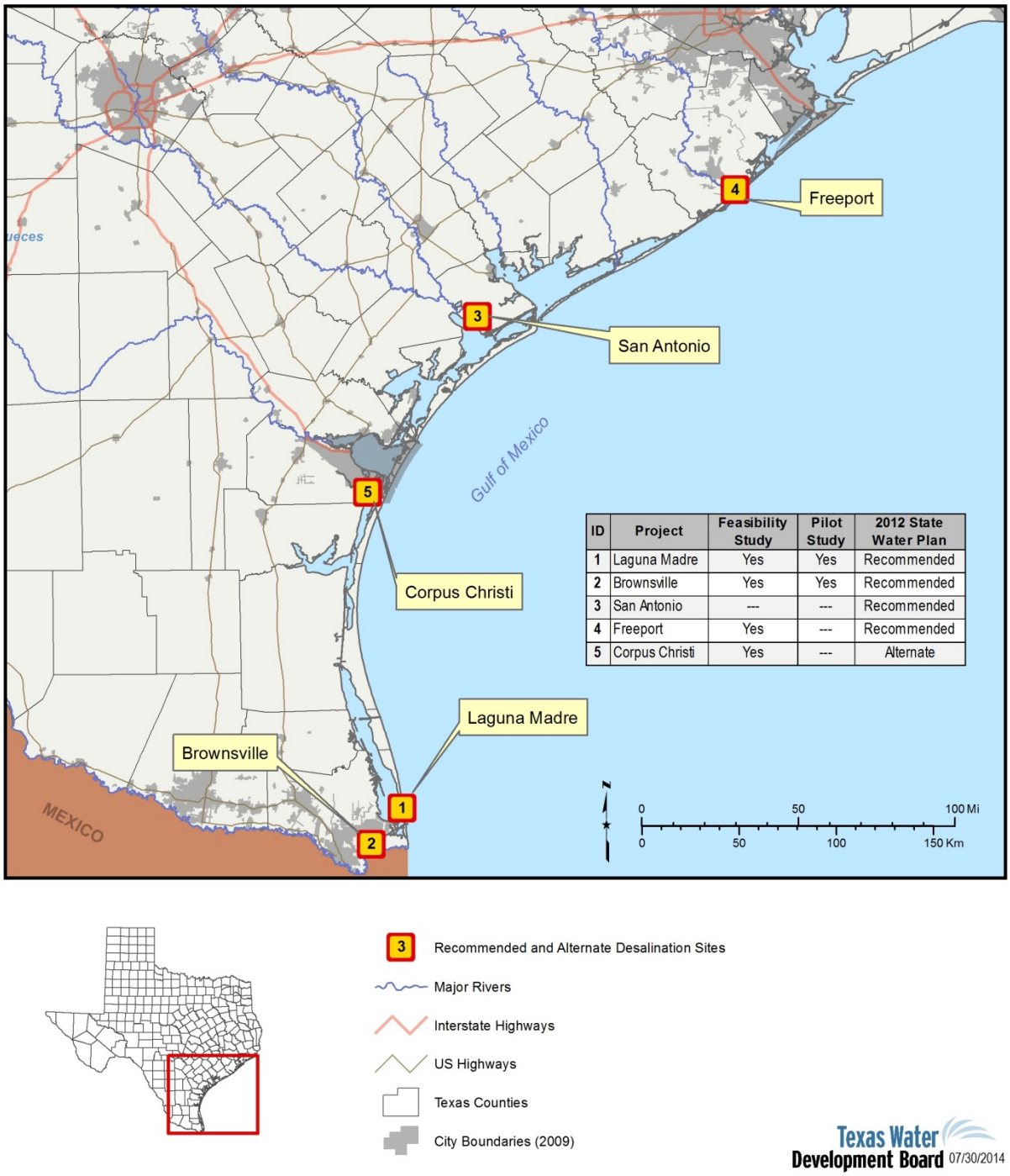
Region	Project	2010	2020	2030	2040	2050	2060
		Volume of water in acre-feet per year					
H	Freeport	---	---	---	---	33,600	33,600
L	San Antonio	---	---	---	---	---	84,012
M	Brownsville	---	---	---	5,600	5,600	7,013
M	South Padre Island	125	125	143	449	821	889
N	Corpus Christi (Alternative)	---	---	---	---	---	28,000

Source: All information derived from 2011 approved regional water plans and Brownsville Large-Scale Seawater Desalination Pilot-plant Study, 2008 (Region M)

Region H Regional Water Planning Area

Seawater desalination is recommended as a water management strategy in the 2011 Region H water plan to meet manufacturing demands in Brazoria County in decade 2050. A seawater desalination plant with an initial capacity of 11,200 acre-feet per year (10 million gallons per day) is proposed at the Dow Chemical Company complex in the City of Freeport. The facility would use an existing intake and discharge outfall which would reduce construction costs and environmental impacts. The wholesale water providers near the recommended desalination plant are the Brazos River Authority and the Gulf Coast Water Authority.

The Brazos River Authority and City of Freeport reaffirmed that no additional work has been completed on seawater desalination after the Freeport feasibility study was completed in 2004 (Brazos River Authority, 2014; City of Freeport, 2014).



ID	Project	Feasibility Study	Pilot Study	2012 State Water Plan
1	Laguna Madre	Yes	Yes	Recommended
2	Brownsville	Yes	Yes	Recommended
3	San Antonio	---	---	Recommended
4	Freeport	Yes	---	Recommended
5	Corpus Christi	Yes	---	Alternate

Figure 1. **Location of recommended seawater desalination water management strategies in the 2012 State Water Plan and the TWDB-funded feasibility studies.**

South Central Texas (Region L) Regional Water Planning Area

The 2011 South Central Texas (Region L) water plan includes a seawater desalination plant located adjacent to San Antonio Bay near the City of Seadrift that would produce 28,000 to 112,000 acre-feet per year (25 to 100 million gallons per day). The treated water would be delivered to a location in southern Bexar County near the Twin Oaks Aquifer Storage and Recovery facility.

The San Antonio Water System lists seawater desalination as a conceptual solution for long-term projects for the 2040 to 2070 time period (San Antonio Water System, 2012). The water system's 2012 Water Management Plan lists five conceptual solutions and states that each would be investigated and evaluated to prepare a solid foundation to build these future water supplies (San Antonio Water System, 2012). Staff from San Antonio Water System's water resources department reaffirmed that the seawater desalination project is in the initial conceptual stages and current focus is on other planned projects for the 2012 to 2020 time period including a brackish groundwater desalination project (San Antonio Water System, 2014).

In September 2014, the Guadalupe-Blanco River Authority submitted a request to the Texas Water Development Board to adopt a minor amendment to the 2011 regional water plan. The minor amendment would add a seawater desalination project known as the Integrated Water-Power Project as a recommended water management strategy to the regional plan (Guadalupe-Blanco River Authority, 2014). The projected decade of need is 2030 and the project is estimated to yield 100,000 acre-feet per year (50,000 acre-feet per year for Calhoun County and 50,000 acre-feet per year for Gonzales County).

Rio Grande (Region M) Regional Water Planning Area

The Rio Grande (Region M) Regional Water Planning Area included seawater desalination as a recommended water management strategy in its 2011 regional water plan. Because the Laguna Madre Water District is the water provider for South Padre Island, Laguna Vista, and Port Isabel, the water yield of 889 acre-feet per year in Table 2 is total yield. The individual water yields for South Padre Island and Laguna Vista in the decade 2060 is 864 acre-feet per year and 25 acre-feet per year, respectively.

The proposed seawater desalination plants would be located in the Port of Brownsville at the ship channel and on South Padre Island. A facility at the Brownsville Ship Channel would have an initial capacity of 5 million gallons per day (5,600 acre-feet per year) and might be sponsored by the Southmost Regional Water Authority. The treated water would initially serve customers in southeast Cameron County and later be extended to customers in Cameron and Hidalgo counties. A 1 million-gallon-per-day (1,120 acre-feet-per-year) seawater desalination plant in South Padre Island was also recommended by the Laguna Madre Water District.

The status of the Brownsville and South Padre Island projects is described in the Studies subsection of Section 1on pages 7 and 8.

Coastal Bend (Region N) Regional Water Planning Area

The 2011 Coastal Bend (Region N) Regional Water Plan recommends a seawater desalination plant with an initial capacity of 25 million gallons per day (28,000 acre-feet per year) of treated water co-located with the Barney M. Davis Power Station in Corpus Christi. The desalination facility would use the existing intake from the power station that diverts water from Laguna Madre and the concentrate would be piped and discharged through a new outfall into the Gulf of Mexico.

In May 2014, the Coastal Bend (Region N) Water Planning Group adopted a minor amendment to change the seawater desalination water management strategy from an alternative strategy in the 2012 State Water Plan to a recommended strategy. The request to amend the regional water plan, and in turn the 2012 State Water Plan, was submitted to the TWDB on August 28, 2014. On September 18, 2014, the TWDB approved adopting the minor amendment to the 2011 Coastal Bend (Region N) Regional Water Plan and authorized TWDB staff to develop the corresponding amendments to the 2012 State Water Plan and post notice for a public hearing as appropriate per 31 TAC §357.51(f). A public hearing was held on November 14, 2014, and no public comments were received. On November 20, 2014, the TWDB approved an amendment to the 2012 State Water Plan to adopt seawater desalination as a recommended water management strategy, in accordance with 31 TAC §358.4(a).

Other Activities

Guadalupe-Blanco River Authority

The Guadalupe-Blanco River Authority is currently conducting a feasibility study for the Integrated Water-Power Project along the Texas Gulf Coast. The project would include a seawater desalination plant co-located with a power plant. This project is proposed as a regional solution that would create a new source of water supply for the Coastal Bend (Region N), South Central (Region L), and (potentially) Central Texas (Region K) regional water planning areas. The river authority has obtained a $450,000 grant from the U.S. Bureau of Reclamation through the Title XVI Water Reclamation and Reuse Program to cover part of the cost for the feasibility study. The study is expected to be completed in the second quarter of 2015.

The proposed seawater desalination plant would have a capacity ranging from 25 to 250 million gallons per day (28,000 to 280,000 acre-feet per year) with a 500 to 3,000 megawatt co-located power plant (Guadalupe-Blanco River Authority, 2014). The study area for the project extends from Freeport to Corpus Christi along the Gulf Coast. Representative site locations have been identified in San Patricio, Calhoun, Matagorda, and Brazos counties. The Guadalupe-Blanco River Authority envisions an interested entity using the preliminary design for one of these four

project sites and developing and implementing a full-scale seawater desalination plant. The river authority anticipates that the permitting and design phases will be completed in 2018 and the construction phase in 2020. The seawater desalination plant is planned to become operational by 2020.The per-unit construction cost for the seawater desalination plant is currently estimated to range from $1,700 to $2,550 per acre-foot.

M&G Resins USA, LLC

M&G Resins USA, LLC (M&G Resins), an Italian chemical company, is one of the leading producers of polyethylene terephthalate in the world. M&G Resins is a subsidiary of M&G Chemical and part of Gruppo M&G. Polyethylene terephthalate is used in making plastic packaging such as bottles and containers. In 2012, M&G Resins announced plans to build the world's largest polyethylene terephthalate plant along with an integrated terephthalic acid plant in Corpus Christi. That same year it purchased about 412 acres of land in Corpus Christi from the Driscoll Foundation. The new polyethylene terephthalate plant is expected to have a production capacity of 1 million metric tons per year, and the terephthalic acid plant is expected to have a capacity of 1.2 million metric tons per year. The plants will be located at a site between Nueces Bay and the Viola Channel (Figures 2 and 3).

Source: Gruppo Mossi & Ghisolfi (M&G) Polymers

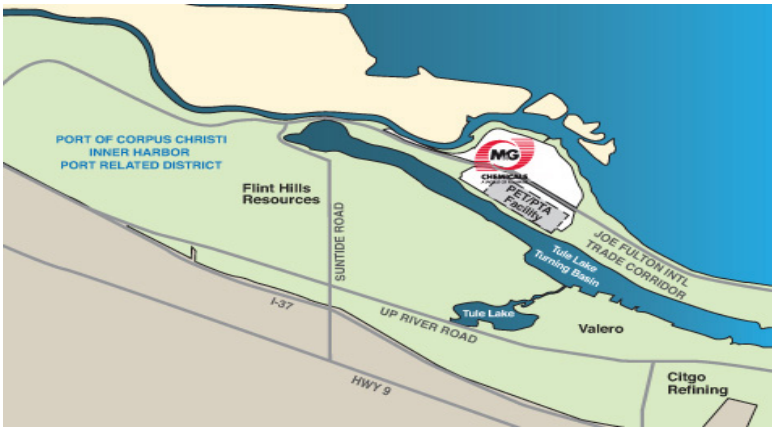
Figure 2. **Artist's rendering of the polyethylene terephthalate and terephthalic acid plant in the Port of Corpus Christi Inner Harbor. Viola Channel is in the foreground and Nueces Bay in the background.**

The two chemical plants require about eight million gallons per day of water for the manufacturing process (M&G Resins USA, LLC, 2014). To meet this requirement, the chemical company plans to build a seawater desalination plant onsite to supply six million gallons per day of water and recover two million gallons per day of water from their internal process. The desalination plant will ensure that a reliable, drought-proof source of water is always available for use at the plants. Additionally, by locating a desalination plant onsite, the quality of water produced can be controlled to meet the requirements of the chemical plants.

The planned seawater desalination plant is expected to require about 15 million gallons per day of raw seawater from the Viola Channel. About 9 million gallons per day of brine produced during the desalination process will be discharged back into the channel.

M&G Resins has conducted studies to model the impact of salinity mixing from discharge of brine into the channel. The studies were conducted to ensure that recirculation would not be an issue. The results of the simulation indicate that in a worst-case scenario, the total dissolved solids concentration in the water of the channel would increase by one percent. Thus, the total dissolved solids concentration is expected to increase the salinity gradient from top to bottom in the channel. Currently, the Texas Commission on Environmental Quality does not have rules limiting the maximum and minimum concentrations of total dissolved solids in marine water.

The seawater desalination plant is being designed for a maximum capacity of 22 million gallons per day. The desalination plant will be initially designed to suit M&G Resins' needs but can be expanded up to the maximum capacity in the future. The distance between the intake and the outfall will be approximately 800 to 900 feet. The outfall will be an above-surface diffuser. A submerged diffuser was considered but not selected because of potential clogging problems. Two factors that affect the channel intake is the silt that returns after dredging and the algae found at the bottom of the channel. To minimize these sedimentation effects, the seawater will be flocculated.



Source: Gruppo Mossi & Ghisolfi (M&G) Polymers

Figure 3. Location of the polyethylene terephthalate and terephthalic acid plant in Port of Corpus Christi Inner Harbor.

The seawater desalination plant will consist of two filters, twelve ultrafiltration trains, and seven reverse osmosis trains. The design also includes a flotation system that will remove oil in emulsion and control turbidity. Approximately 80 percent of the water consumption in the manufacturing plant is for cooling purposes. The manufacturing process can be a closed loop system because water is a byproduct of the polyethylene terephthalate and terephthalic acid process. The byproduct water can be treated and reused internally.

Archeological and geo-archeological investigations at the plant site were completed in March 2014 (Owens & Frederick, 2014). In February 2013 the company filed for a water permit with the Texas Commission on Environmental Quality to divert approximately 28,000 acre-feet of water per year (23 million gallons per day) from the Viola Channel. The water and wastewater discharge permits were granted on September 2014 (M&G Resins, USA, LLC, 2014). It is expected that construction of the desalination plant will begin in 2015 and the plant will become operational in the first quarter of 2016.

Joint Interim Committee to Study Water Desalination

The Joint Interim Committee to Study Water Desalination was created in 2013 to examine the status of seawater and groundwater desalination in Texas and explore ways to expand the use of desalinated water to help meet water needs in the state. On March 28, 2014, the Speaker of the Texas House of Representatives appointed House members to the committee. The committee is co-chaired by Representative Todd Hunter (Corpus Christi) and Senator Craig Estes (Wichita Falls). The committee consists of five members from the senate: Senator Troy Fraser (Marble Falls), Senator Glenn Hegar (Katy), Senator Juan Hinojosa (McAllen), and Senator Eddie Lucio, Junior (Brownsville). The committee also includes seven members from the house: Representative Terry Canales (Edinburg), Representative Ryan Guillen (Rio Grande City), Representative Phil King (Weatherford), Representative Tim Kleinschmidt (Lexington), Representative Lyle Larson (San Antonio), and Representative Marisa Marquez (El Paso).

The committee conducted three hearings in June 2014. The first hearing was held in Austin on June 16, 2014, and focused on general desalination. The second hearing was in Corpus Christi on June 23, 2014, and focused on ocean and saltwater desalination. The third hearing was in Wichita Falls on June 30, 2014, and focused on brackish groundwater desalination.

TWDB Board members and staff were invited to provide testimony at all three hearings.

Section 2 - Identification and Evaluation of Research, Regulatory, Technical, and Financial Impediments to the Implementation of Seawater Desalination Projects

Seawater desalination and desalination projects in general are driven by site-specific conditions. Permitting requirements, construction and operation costs, and source water quality are all dependent on local site conditions. Thus, identifying the specific technical, regulatory, and financial components of projects for evaluation prior to site selection is challenging.

Research

A list of research topics specific to Texas was identified in studies done by the TWDB (Brownsville Public Utilities Board, 2011; TWDB, 2010). These research topics remain relevant today and include:

- characterizing benthic fauna in areas that will be affected by concentrate discharges;
- determining the salinity tolerance of key aquatic species along the Texas Gulf Coast that may potentially be affected by desalination concentrate discharges;
- modeling currents and tides to determine impact on concentrate dispersion;
- improving thin-layer mixing models as part of far-field plume modeling;
- integrating desalinated seawater into existing drinking water distribution networks; and
- revising regulatory bacteria and virus removal credits for reverse-osmosis membranes.

There is also a research need to update the permit-decision model or roadmap developed by the TWDB in 2004 along with a corresponding guidance document for use by entities interested in pursuing seawater desalination.

Recent seawater desalination studies funded by the WateReuse Foundation include an investigation of the following (WateReuse Foundation, 2014):

- impingement mortality and entrainment-reduction guidance document for existing seawater intakes;
- consideration of the co-siting of desalination facilities with municipal and industrial facilities;
- pilot-testing preformed chloramines as a means of controlling bio-fouling in seawater desalination ; and
- characterization of seawater in the United States and development of standardized protocols for evaluating foulants in seawater reverse osmosis desalination.

In May 2014 the U.S. Environmental Protection Agency passed regulations that require minimizing environmental impacts at cooling water intake structures of existing facilities and new facilities (U.S. Environmental Protection Agency, 2014b). The agency passed the

requirements under Section 316(b) of the Clean Water Act, which regulates the design and operation of intake structures. The requirements will be implemented when entities apply for a National Pollutant Discharge Elimination System permit. The regulations apply to facilities such as electric-generating plants, chemical-manufacturing plants, petroleum refineries, and other factories. The regulations require existing facilities with a design capacity of withdrawing two million gallons per day of cooling water to reduce fish impingement (U.S. Environmental Protection Agency, 2014a). Regulations also require existing facilities with a design capacity of withdrawing 125 million gallons per day to conduct environmental studies to reduce aquatic entrainment. Additionally, existing facilities that add new units are required to reduce aquatic impingement and entrainment. This recent rule-approval raises two key questions (1) how this national rule will be implemented in Texas and (2) how the rule affects seawater desalination. Accordingly, areas for further research related to intake structures (Carollo Engineers, 2014) include:

- studying subsurface intakes, including subsurface infiltration galleries, for entrainment data;
- quantifying construction impacts of subsurface intakes;
- quantifying differences in energy use and greenhouse gas emissions between open and subsurface intakes; and
- determining mitigation for impacts due to intake structures.

Regulatory

In general, the number of permits required and the length of the permitting processes will always be site-specific. The exact requirements from the Texas Commission on Environmental Quality and other agencies will not be known until a few permitting cycles have been completed. A 2011 TWDB-funded study determined that a total of approximately 26 potential federal and state permits may be required to implement a seawater desalination project along the Gulf Coast (Brownsville Public Utilities Board, 2011). The study prepared two separate reports that identified the environmental permits and compliance documents required to build a seawater desalination plant on South Padre Island (1 million gallons per day) and at the Port of Brownsville (2.5 million gallons per day) (Brownsville Public Utilities Board, 2011). The report also included information about the timeframe and cost associated with each permit and the regulatory agency responsible for the permits.

A 2004 TWDB-funded study developed a permit-decision model for identifying major requirements through a decision tree analysis (R.W. Beck, Inc., 2004). The model can be applied to either a seawater or brackish water desalination facility that uses a reverse osmosis system. The model is divided into three main categories: (1) raw water source, (2) facility, and (3) concentrate disposal. The study also provides an example of how to apply the permit-decision model to a seawater desalination plant co-located with a power plant.

The seawater desalination plant currently being built by M&G Resins USA, LLC in Corpus Christi will provide an opportunity to gather data on and become knowledgeable about the permitting process for an industrial seawater desalination facility. However, a seawater desalination facility built to produce drinking water will likely have different permitting requirements. As listed in the research category on page 16, updating the permit decision model along with a corresponding guidance document is a research need.

Technical

The Brownsville and the South Padre Island pilot-plant studies conducted between 2008 and 2010 tested treatment technologies that are now four to six years old. Recent desalination technological advances make the results of these pilot-plant studies dated. Consequently, additional piloting may be needed at these facilities if the Brownsville Public Utilities Board and the Laguna Madre Water District plan to pursue and implement seawater desalination.

Financial

Despite the improvements to reverse osmosis membranes and the increased cost-competitiveness of desalination, creating a new water supply from seawater is still relatively more expensive than developing supplies from existing fresh sources, if available. Desalinating seawater is more costly for a number of reasons but predominately because of the salinity of seawater (about 35,000 milligrams per day). Higher-salinity water requires more pressure in the treatment process which increases the energy costs. Other factors that affect cost include the location of intake and outfall structures, the pre-treatment process, the brine disposal method, and the length of distribution pipelines. Additionally, permitting can increase the cost by requiring environmental studies and permits for brine disposal, wastewater discharges, and air emissions.

In 2013, a TWDB-funded study developed the Unified Costing Model for the 16 regional water planning groups to use when preparing their cost estimates for projects (TWDB, 2013). The purpose of the costing model was to bring uniformity to the cost estimates developed by the regional water planning groups. Additionally, by providing entities an automated costing tool, human error could be reduced. The Unified Costing Model allows the user to indicate the level of the water treatment plant. There are six levels to choose from, labeled zero to five, with level five being seawater desalination. The cost for the treatment is for a general process, additional costs may be incurred if pre-treatment for solids removal is required. Overall, the costing model standardizes cost estimates used for planning across the state.

The greatest challenge to implementing a large-scale seawater desalination facility in Texas is the relatively higher cost of seawater desalination compared to less expensive conventional supplies. Therefore, sponsoring entities need financial assistance to implement seawater desalination projects. For the recommended 2.5 million-gallon-per-day seawater desalination plant in Brownsville, the TWDB requested a $9.5 million financial grant from the 83rd Texas Legislature (TWDB, 2012). Additionally, the first projects that would be implemented will face greater risks and thus higher implementation costs due to uncertainties.

Section 3 - Evaluation of the Role the State Should Play in Furthering the Development of Large-Scale Seawater Desalination Projects in the State

The purpose of the Seawater Desalination Initiative is to accelerate the development of cost-effective seawater desalination supplies in Texas. Since the initiative's inception in May 2002, the ultimate goal has been to install a seawater desalination plant to demonstrate the potential of seawater as a new water source in Texas.

The role of the State is to continue providing leadership and support to advance seawater desalination in Texas. The State has begun creating a pathway for entities to implement seawater desalination by identifying and addressing past and current challenges to seawater desalination. Fulfilling this role during the upcoming biennium would require consideration of the following:

- Facilitating an efficient permitting process
  The permitting process can be challenging for entities pursuing seawater desalination for the first time. By participating in and facilitating meetings between water providers or municipalities and regulatory agencies, the State can assist in the permitting process. The Texas Commission on Environmental Quality is the state agency that has regulatory authority over water quality and the level of treatment required. It also issues permits for water diversions and waste discharge. Documenting the permitting process for the seawater desalination plant being built in Corpus Christi by M&G Resins USA, LLC will be useful for entities, especially industrial entities.

- Informing the public of funding opportunities
  Political subdivisions such as cities, counties, utility districts, and authorities will be eligible for TWDB loan and grant programs. The low-interest loans provide funding for water supply projects including seawater desalination projects. The state should keep the public informed of these and other funding opportunities.

- Seeking partnering opportunities with the private sector
  Public-private partnerships are a common means of implementing large-scale seawater desalination projects around the world. Recent legislative changes in Texas have made it easier for the private sector to develop public infrastructure, including water-production facilities. The TWDB can provide support to entities pursuing these partnerships in the development of seawater desalination facilities. Existing TWDB funding programs can accommodate public-private partnerships as long as the project meets eligibility requirements. However, the TWDB can only provide funding to a political subdivision in the partnership.

Section 4 - Anticipated Appropriation from General Revenues Necessary to Continue Investigating Water Desalination Activities in the State during the Next Biennium

The Texas Water Development Board is not requesting further state appropriations for seawater desalination activities during the next biennium. The TWDB believes it can continue monitoring activities with current resources and that its current financing programs are available to finance the construction of seawater desalination plants. TWDB staff will continue to look for partnering opportunities with public and private entities to advance seawater desalination in the state.

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