The Future of Desalination in Texas

2024 Biennial Report on Seawater and Brackish Groundwater Desalination in Texas

89th Texas Legislative Session

TEXAS WATER DEVELOPMENT BOARD

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2024 Biennial Report on Seawater and Brackish Groundwater Desalination in Texas

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Executive summary

Desalination is the process of removing dissolved solids and other minerals from saline water sources, which can include seawater and brackish groundwater. This important technology is used all around the world to produce new water supplies. As of 2023, desalination plants worldwide (seawater and brackish water), had a cumulative water production capacity of 26.4 billion gallons per day, which is 29.6 million acre-feet per year (Global Water Intelligence, 2024).

In the past decade, seawater desalination has become more prevalent in the U.S. On the east and west coasts of the country, there are two large (capacity >25 million gallons per day or >28,000 acre-feet per year) operational seawater desalination facilities for municipal use: the Claude "Bud" Lewis Carlsbad Desalination Plant located in Carlsbad, California, and the Tampa Bay Seawater Desalination Plant located in Tampa Bay, Florida. While Texas does not have an operational seawater desalination facility, the City of Corpus Christi and Port of Corpus Christi Authority have applied for permits from the Texas Commission on Environmental Quality.

Brackish groundwater is also an important water source that can provide new water supplies and help reduce the demand on freshwater supplies. For this report, brackish groundwater is considered groundwater with a total dissolved solid concentration ranging from 1,000 to 10,000 milligrams per liter. There are 406 municipal brackish groundwater desalination plants in the U.S. with the majority located in Florida (40 percent), California (14 percent), and Texas (13 percent) (Mickley, 2018). In 2003, Texas was estimated to have more than 815 trillion gallons (2.5 billion acre-feet) of brackish groundwater available (LBG-Guyton Associates, 2003). As of 2024, completed brackish aquifer studies indicate a total in-place brackish groundwater storage volume of 1,000 trillion gallons (3.2 billion acre-feet) in 12 of the 31 major and minor aquifers. The key differences between these volume calculation methods are detailed in Section 4.5.

The Texas Water Development Board (TWDB) updated the desalination plant database that tracks the growth of desalination across the state and, as of August 2024, Texas now has 60 municipal desalination plants that treat brackish groundwater, surface water, or reclaimed water and have a combined design capacity of approximately 172 million gallons per day (192,665 acre-feet per year). Of these 60 facilities, 43 desalinate brackish groundwater and have a combined design capacity of 98 million gallons per day (109,774 acre-feet per year).

While the *2024 Biennial Report on Seawater and Brackish Groundwater Desalination* is the 11th report in the series, marking the completion of 22 years of advancing seawater desalination in Texas, it is the fifth report with an expanded scope. Since 2016, the report has included progress made in furthering brackish groundwater desalination and in identifying and designating brackish groundwater production zones that meet the statutory requirements and exclusion criteria.

Primary updates of the report are as follows:

1. Desalination continues to be a vital strategy to meet future water needs. Ten regional water planning groups recommended desalination (including seawater, brackish groundwater, and surface water desalination) in the 2022 State Water Plan. If all recommended strategies are implemented, desalination would produce about 412,000 acre-feet per year of additional water supplies by 2070. This constitutes about 5.4 percent of all recommended water management strategies in the state water plan.
    - Seawater desalination would produce 192,000 acre-feet per year (2.5 percent).
    - Brackish groundwater desalination would produce 157,000 acre-feet per year (2.1 percent).
    - Surface water desalination would produce 63,000 acre-feet (0.8 percent).
2. From August 2022 to August 2024, the TWDB provided $545 million in financial assistance for two proposed seawater desalination projects: $535 million to the City of Corpus Christi and $10 million to the Laguna Madre Water District. During this same period, the TWDB also provided $14 million in financial assistance for three new brackish groundwater desalination projects: $1 million to Mullin Independent School District, $6 million to the City of Seagraves, and $7 million to the City of Alice.
3. In 2023, the 88th Texas Legislature passed Senate Bill 28 and Senate Joint Resolution 75 to create the Texas Water Fund. The Texas Legislature also passed Senate Bill 30 to authorize a one-time payment of $1 billion from general revenue to the Texas Water Fund contingent on voter approval. The Senate Bill 28 also created the New Water Supply for Texas Fund and appropriated $250 million to the fund, which can be used to finance new brackish groundwater and seawater desalination projects.
4. There is no seawater desalination plant in Texas, but the City of Corpus Christi and the Port of Corpus Christi Authority both continue to pursue water rights and discharge permits for seawater desalination plants.
    - The City of Corpus Christi obtained a water rights permit from the Texas Commission on Environmental Quality for the proposed Inner Harbor and La Quinta channel seawater desalination plants. Applications for the discharge permits for both proposed facilities are currently under review.
    - The Port of Corpus Christi Authority obtained a wastewater discharge permit from the Texas Commission on Environmental Quality for the Harbor Island seawater desalination plant.
5. The TWDB conducted 16 brackish aquifer studies, eight completed by TWDB staff and the other eight completed by contractors, and three more studies are in progress. There are six future aquifer studies that will be completed by December 1, 2032. After 2032, the 12 aquifers that are not eligible for brackish groundwater production zones will also be characterized.
6. To date, the TWDB has designated a total of 31 brackish groundwater production zones in the state with moderate to high availability and productivity of brackish groundwater. In the future, the TWDB will evaluate 15 aquifers or portions of aquifers and apply statutory requirements and exclusion criteria for the analysis of potential brackish groundwater production zones. These future zone analyses include three aquifers with studies

completed prior to the legislative directive to designate brackish groundwater production zones, three studies completed since August 2020, three ongoing aquifer studies, and six future aquifer studies.

7. In May 2023, the TWDB published guidance to request amendments to designated brackish groundwater production zones after engaging with stakeholders for their input on the zone amendment process. The TWDB continues to improve brackish groundwater mapping and modeling efforts with the expansion of existing groundwater availability models to incorporate the brackish portions of the aquifers and internal redesign of a tool to model wastewater injection wells.
8. The 88th Texas Legislature appropriated $840,723 in fiscal year 2024 and $840,723 in fiscal year 2025 to the TWDB to conduct studies regarding the designation of brackish groundwater production zones in aquifers of the state, excluding the Dockum Aquifer. In September 2023, the TWDB approved using appropriations for five research and outreach contracts totaling $1.6 million. These contracts are for three aquifers studies, a brackish groundwater exploratory project, a GIS story map, and log digitization services.

Results of the TWDB's studies and activities in desalination

The TWDB has a standalone Desalination Program under the Innovative Water Technologies Department. The program was initially created in 2002 to cover activities related to seawater desalination and added brackish groundwater desalination activities two years later.

The Texas Legislature last appropriated funding for seawater desalination in 2005 and for brackish groundwater desalination in 2009. Between 2003 and 2006, the TWDB funded $3.2 million for seawater desalination studies through the Desalination Program, including three feasibility studies, two pilot plant projects, and several guidance and research studies. Between 2004 and 2010, the TWDB funded 11 brackish groundwater desalination projects and studies totaling $2.1 million through the Desalination Program, which included implementing demonstration projects, preparing guidance manuals, and completing research studies.

Through the agency's financial assistance programs, the TWDB provided $545 million from August 2022 to August 2024 for two proposed seawater desalination projects and $14 million for three proposed brackish groundwater desalination projects. For seawater desalination, the TWDB provided a $535 million loan to the City of Corpus Christi for a 20-million-gallon-per-day (22,400-acre-foot-per-year) seawater desalination plant located in Inner Harbor and a $10 million loan to the Laguna Madre Water District for a 5-million-gallon-per-day (5,600-acre-foot-per-year) seawater desalination plant. For brackish groundwater desalination, the TWDB provided a $1 million loan to Mullin Independent School District to construct a brackish groundwater desalination plant to treat elevated nitrate levels in their groundwater from an existing well; a $6 million loan to the City of Seagraves to modify its existing reverse osmosis system to treat exceeding maximum contaminant levels of arsenic and fluoride; and a $7 million loan to the City of Alice to drill two new brackish groundwater wells and construct a reverse osmosis treatment plant that will be funded through a public-private partnership.

Other desalination activities include TWDB staff serving on the boards of the South Central Membrane Association and the Multi-State Salinity Coalition to stay informed and aware of ongoing national and local desalination activities.

Designation of brackish groundwater production zones

The Brackish Resources Aquifer Characterization System (BRACS) Program was created in 2009 to map and characterize in detail the brackish aquifers of the state. The program relies on funding appropriated by the Texas Legislature to complete internal studies and to contract work to support brackish aquifer studies and brackish groundwater production zone designations.

To date, the TWDB has designated a total of 31 brackish groundwater production zones in the state with moderate to high availability and productivity of brackish groundwater that meet statutory requirements and exclusion criteria. In October 2016, the TWDB designated eight brackish groundwater production zones: one zone in the Carrizo-Wilcox Aquifer south of the Colorado River, four zones in the Gulf Coast Aquifer and bordering sediments, and three zones in the Rustler Aquifer. No zones were identified in the Blaine Aquifer. In March 2019, the TWDB designated an additional 23 brackish groundwater production zones: 3 zones in the Blossom Aquifer, 5 zones in the Nacatoch Aquifer, and 15 zones in the northern portion of the Trinity Aquifer. No zones were identified in the Lipan Aquifer.

The TWDB has 15 remaining studies (6 completed studies, 3 current studies, and 6 future studies) to evaluate for brackish groundwater production zone designation. The TWDB continues to encounter four key challenges in conducting brackish aquifer studies and designating brackish groundwater production zones: data gaps, limited water well and injection data availability (no single database for wells in Texas), groundwater model accessibility, and injection well buffer applicability. The TWDB has focused agency resources on addressing these challenges to continue improving mapping, characterization, and assessment of the extent and availability of brackish groundwater resources in Texas.

Research, regulatory, technical, and financial impediments to implementation

The Texas Legislature last appropriated funds to the TWDB to advance seawater and brackish groundwater desalination research and pilot-scale studies in 2009. The regulatory impediment for seawater desalination is that, while the permitting requirements are in place, they will not be refined by practice until a few seawater desalination plants have undergone the required permitting cycles. The City of Corpus Christi and the Port of Corpus Christi Authority are the first to initiate the permitting process and will provide a learning opportunity for Texas. Another factor that can affect seawater desalination permitting is public opposition due to environmental concerns, as currently being encountered in the Corpus Christi area. The relatively high cost and site specificity of desalination compared to the cost of developing conventional freshwater supplies continue to be technical and financial impediments to advancing desalination in Texas. To help entities implement desalination projects, the TWDB administers such financial assistance programs as the State Water Implementation Fund for Texas, Drinking Water State

Revolving Fund, Water Development Fund, and several others. Furthermore, the New Water Supply for Texas Fund is a new source of funding for desalination projects. Other factors that affect the cost of desalination include permitting, treatment, concentrate/brine disposal, and transmission pipelines. In general, the feasibility of desalination projects depends on site-specific conditions, so each project requires unique treatment and brine disposal analyses.

The role of the State in furthering the development of desalination projects

The State's role is to continue technical efforts and provide leadership and support to further the development of cost-effective water supplies from seawater or brackish groundwater in Texas. The TWDB identified opportunities for continued State involvement that include: (1) supporting the advancement of seawater and brackish groundwater desalination studies, (2) directing water providers or municipalities to the appropriate regulatory or planning agencies to assist with the financial and permitting processes, and (3) providing financing through existing TWDB financial assistance programs, including the new Texas Water Fund, to entities interested in pursuing seawater and brackish groundwater desalination.

Anticipated appropriation from general revenues

The TWDB's baseline budget request for Fisal Year 2026-2027 included $1.68 million for the Brackish Resources Aquifer Characterization System Program to continue progress toward meeting statutory requirements for designating brackish groundwater production zones by the legislative deadline of December 1, 2032.

At present, one staff member covers the Desalination Program in the Innovative Water Technologies Department in addition to other job duties.

1 Introduction

In 2002, Governor Rick Perry announced his vision of meeting future water supply needs through seawater desalination and directed the TWDB to recommend a large-scale seawater desalination demonstration project. Thus, TWDB desalination efforts began with the identification of sites for a seawater desalination demonstration project. The first step was to issue a request for statements of interest to develop large-scale seawater desalination. In 2003, the TWDB selected three locations (cities of Corpus Christi, Brownsville, and Freeport) for feasibility studies. The 78th Texas Legislature subsequently appropriated $1.5 million to fund these studies. In 2005, the 79th Texas Legislature appropriated $2.5 million for seawater desalination pilot testing. Between 2006 and 2008, the TWDB contracted two pilot plant studies: 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.

To build on the governor's desalination initiative, the TWDB established the brackish groundwater desalination initiative in 2004. The goal was to demonstrate the use of innovative and cost-effective desalination technologies and to offer practical solutions to key challenges like concentrate management and energy optimization. In 2005, the 79th Texas Legislature appropriated funds to support the first round of demonstration projects. In 2007, the Texas Legislature appropriated funds to support five new studies and, in 2009, allocated additional funding to support four new demonstration projects. Texas legislative appropriations for the Desalination Program ended in 2009.

In 2003, the 78th Texas Legislature passed House Bill 1370 directing the TWDB to pursue seawater desalination and to report progress in a biennial report due December 1 of each even-numbered year. In 2015, the 84th Texas Legislature passed House Bill 30, directing the TWDB to also provide status updates on brackish groundwater desalination and designation of brackish groundwater production zones. Overall, Texas Water Code § 16.060 requires the TWDB to undertake necessary steps to further the development of cost-effective water supplies from seawater or brackish groundwater desalination in the state and to report the results of its studies and activities to the governor, lieutenant governor, and house speaker. The report includes

1. the results of the TWDB's studies and activities related to seawater and brackish groundwater desalination during the preceding biennium;
2. identification and evaluation of research, regulatory, technical, and financial impediments to implementing seawater or brackish groundwater desalination projects;
3. evaluation of the role the State should play in furthering the development of large-scale seawater or brackish groundwater desalination projects in Texas;
4. the anticipated appropriation from general revenue necessary to continue investigating water desalination activities in the state during the next biennium; and

5. identification and designation of local or regional brackish groundwater production zones in areas of the state with moderate to high availability and productivity of brackish groundwater that could be used to reduce the use of fresh groundwater.

The 2024 biennial report is the 11th report in the series to report on seawater desalination activities and marks the completion of 22 years of activities toward advancing seawater desalination in Texas. It is the 10th report in the series to report on brackish groundwater desalination activities and marks the completion of 20 years of activities furthering brackish groundwater desalination in Texas. It is the 5th report in the series to include designation of local or regional brackish groundwater production zones.

2 Current state of desalination

Desalination is an important strategy that has created new water supplies around the world. The desalination process removes dissolved solids and other minerals from saline water sources, including seawater and brackish groundwater. Membranes are generally used to physically separate the dissolved solids from water. The most widely used commercial membrane technology is reverse osmosis, which uses high pressure to push water through the membranes.

The treatment process in a desalination plant typically consists of pretreatment, reverse osmosis, and post treatment. The raw (untreated) water enters the plant and goes through a series of filtration or membrane processes (such as strainers, cartridge filters, and microfiltration) to remove sand and suspended solids. Operators dose the water with antiscalant and acid to avoid clogging the membranes. The operator then pumps the feed water to the reverse osmosis system, which results in two streams: (1) the permeate (desalinated water) and (2) the concentrate or brine (where the salts are accumulated). In post treatment, operators add chemicals to the permeate or blend the permeate with raw water to add minerals and make it less corrosive. For seawater desalination, the brine is typically discharged back to the ocean through a permitted outfall. With the required permits, the concentrate from brackish desalination can be discharged to an appropriate water body, sanitary sewer, injection well, or evaporation pond. A reverse osmosis system generally operates with a 50 percent recovery rate for seawater desalination (i.e., every 100 gallons of raw water desalinated produces 50 gallons of fresh water) and a 75 to 85 percent recovery rate for brackish desalination. Desalination systems with higher recovery rates and higher total dissolved solids in the raw water require more energy and incur higher costs.

There are 406 municipal desalination plants in the U.S. with a capacity 0.025 million gallons per day or greater located across 35 states (Mickley, 2018). Most municipal desalination plants are located in three states: 167 plants in Florida (40 percent), 58 in California (14 percent), and 52 in Texas (13 percent) (Mickley, 2018). Most municipal desalination plants in the nation employ reverse osmosis treatment technology: 295 plants treat brackish water using reverse osmosis (72 percent), 13 plants treat seawater using reverse osmosis (3 percent), 19 plants use reverse osmosis in combination with microfiltration or ultrafiltration membranes (4.6 percent), and the remaining plants use other technologies. The concentrate disposal methods used by the municipal desalination plants include surface water discharge (45 percent), sewer discharge (25 percent), deep well injection (17 percent), land application (7 percent), evaporation ponds (4 percent), and recycling (1 percent). Mickley & Associates, LLC were recently awarded funding from the Bureau of Reclamation to conduct an update to the 2018 survey on municipal desalination plants constructed in the U.S. from 2017 through 2024 (U.S. Bureau of Reclamation, 2024). The updated survey will include information on an estimated 50 to 70 additional desalination plants (Congressional Research Service, 2024).

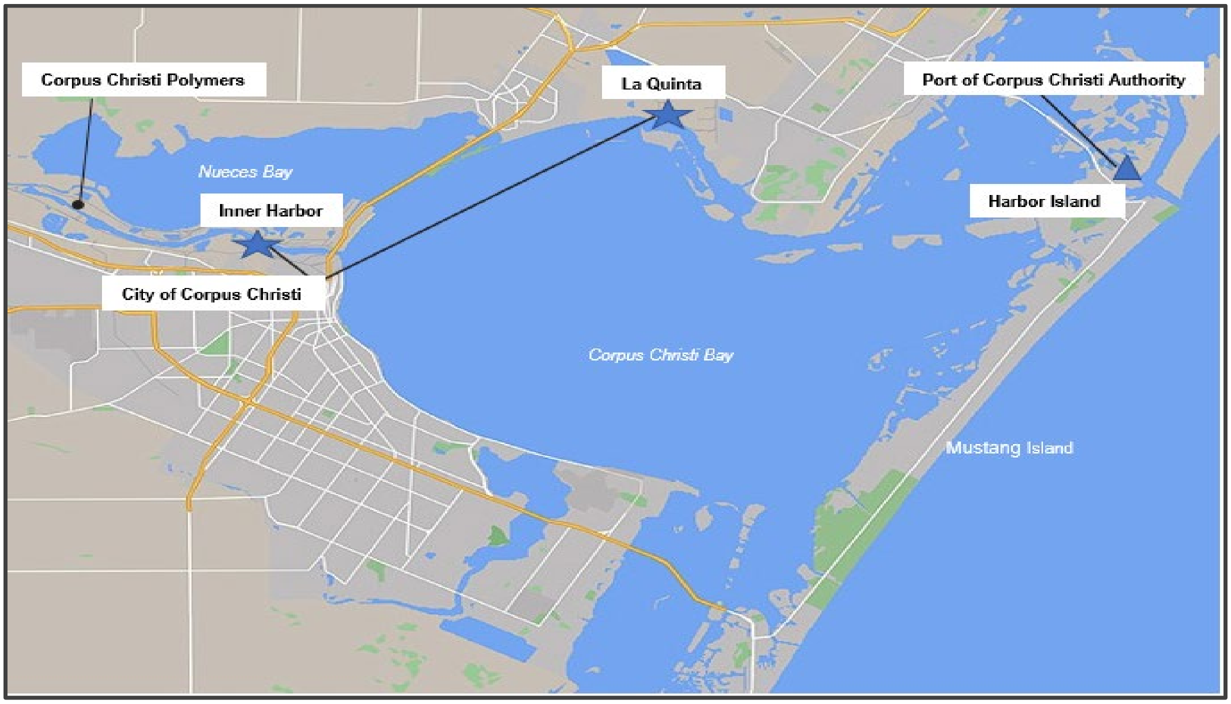
2.1 Seawater desalination

Various countries around the world use seawater desalination to produce freshwater supplies, and this technology has gained momentum in the U.S. in the past decade. Seawater has a total dissolved solid concentration of about 35,000 milligrams per liter or greater.

In the U.S., there are two large operational seawater desalination facilities for municipal use with a design capacity greater than 25 million gallons per day (28,000 acre-feet per year), both of which were financed through public-private partnerships. The first large plant is the Tampa Bay Seawater Desalination plant in Tampa, Florida, that began operating in December 2007 and has a design capacity of 25 million gallons per day (28,000 acre-feet per year). Florida also has two smaller seawater desalination plants operated by the Florida Keys Aqueduct Authority, which serve as emergency supplies to the Lower and Middle Keys (Florida Keys Aqueduct Authority, 2020). They are the Kermit H. Lewin and Marathon desalination plants, which have capacities of 4 million gallons per day and 1 million gallons per day respectively (Construction Journal, 2022; City of Marathon, 2022). The second large plant is the Claude "Bud" Lewis Carlsbad Desalination Plant located in Carlsbad, California, which became operational on December 14, 2015, and has a design capacity of 50 million gallons per day (56,000 acre-feet per year). Additionally, there are seven smaller active seawater desalination facilities on the California Coast and one newly approved facility (California Water Boards, 2024).

Texas does not have an operational seawater desalination facility but has made progress toward this goal in recent years. While there are seven recommended water management strategy projects for seawater desalination in the 2022 State Water Plan located along the Gulf Coast, recent activities have been concentrated in the Corpus Christi area (Figure 1). The City of Corpus Christi has been the most active entity and has advanced from planning to the permitting phase of a seawater desalination plant. Other entities that are or were pursuing seawater desalination include the Port of Corpus Christi Authority, Corpus Christi Polymers (formerly known as M&G Resins USA, LLC), Laguna Madre Water District, and Invenergy (Pankratz, 2024a; Pankratz, 2024b).

Figure 1. **Seawater desalination activities within the Corpus Christi area**



Initial investigations into seawater desalination in this area date back to 2004, when the TWDB and the City of Corpus Christi completed a feasibility study that identified two sites, Barney Davis Power Plant and DuPont-OxyChem, as potential locations for a seawater desalination plant. No additional work was conducted until 2013, when the City of Corpus Christi and the U.S. Bureau of Reclamation funded a 30-month variable salinity desalination study to pilot and demonstrate desalination treatment approaches for sources with dissimilar salinity. The City, however, decided not to move forward with the 12-month-long pilot testing.

In 2015, the City of Corpus Christi partially funded and participated in a feasibility study on seawater desalination for industrial purposes alongside 14 other stakeholders consisting of industries, water providers, and regional authorities. The study considered developing seawater desalination as potential new water supplies to ensure service continuity in the event of extreme drought. The study concluded that a phased approach of two seawater desalination plants, each with an initial capacity of 10 million gallons per day (11,200 acre-feet per year) and a total expanded capacity of 70 million gallons per day (78,400 acre-feet per year). One plant could be located in Corpus Christi on the Inner Harbor Ship Channel and the other in Ingleside on the La Quinta Channel. Building on the results of the feasibility study, the City recognized the need for additional planning to define, site, permit, and procure implementation of seawater desalination supplies for the Coastal Bend Region.

In July 2017, the City of Corpus Christi received a $2.75 million loan from the TWDB for planning tasks and to submit necessary permits for the two proposed locations, which it has since completed. In August 2018, the City also considered other alternative water supplies when it issued a request for information for projects that could produce 10 million gallons per day

(11,200 acre-feet per day) of potable water over a 30-year period. In July 2020, the TWDB granted a $222 million loan to the City to obtain permits for two sites and design and build a seawater desalination plant with a maximum capacity of 30 million gallons per day (33,600 acre-feet per year) for municipal use at one of the two sites. The desalination plant would initially have a capacity of 20 million gallons per day (22,400 acre-feet per year) and expand to full capacity in the future. On September 29, 2020, the City invited some entities to present on their alternative water supply projects submitted in response to the request for information.

In January 2020, the City of Corpus Christi submitted two water rights permits and discharge applications to the Texas Commission on Environmental Quality for the proposed Inner Harbor and La Quinta desalination plants (City of Corpus Christi, 2020a, 2020b, 2020c, 2020d). The Texas Commission on Environmental Quality approved the water rights permits for both proposed projects; it is currently reviewing the applications for the draft discharge permits for both proposed facilities (Crow, 2024a; Hami, 2024) The permit application packages and public meeting formal comments can be accessed at www.desal.cctexas.com/project-details. The public expressed opposition to the seawater desalination projects and requested that the Texas Commission on Environmental Quality grant a contested case hearing or deny the permits (Crow, 2024a). Public concern centered on potential environmental impacts to the Corpus Christi Bay's aquatic life and consequently to tourism, as well as the potential for using desalinated water for industrial demands rather than municipal demands.

In July 2024, the TWDB approved the City of Corpus Christi's application for a $535.1 million loan from the State Water Implementation Fund for Texas (SWIFT). The funds are for land acquisition, planning, construction, and design of the proposed Inner Harbor desalination plant (TWDB, 2024a). These funds are in addition to a $222.5 million loan and a $2.75 million loan from the SWIFT program that the TWDB approved for seawater desalination projects for the City of Corpus Christi in 2020 and 2017, respectively (TWDB, 2017; TWDB, 2020). Furthermore, the City of Corpus Christi has invited three firms to submit proposals to design and build the Inner Harbor desalination plant with plans to award the contract to the winning bidder in December 2024 (Pankratz, 2024b).

In March 2018, the Port of Corpus Christi Authority submitted a discharge permit application for a 50-million-gallon-per-day (56,000 acre-foot-per-year) seawater desalination plant located on Harbor Island. The discharge permit application and brine discharge modeling report can be accessed at portofcc.com/capabilities/real-estate/harbor-island/. On July 9, 2020, the State Office of Administrative Hearings held a contested case hearing on the draft discharge permit application, and the administrative law judges recommended that the Texas Commission on Environmental Quality deny the permit. In September 2021, the Environmental Protection Agency requested that the Texas Commission on Environmental Quality turn over the review of the permit. In January of 2023, the Environmental Protection Agency stated that it continued to view this permit as a draft permit stating that the Texas Commission on Environmental Quality did not address the Environmental Protection Agency's Interim Objection from December 2021. As a result, the discharge permit issued by the Texas Commission on Environmental Quality is not effective for compliance with the Clean Water Act (Clow, 2023a). In June 2023, the U.S. Army Corps of Engineers denied the Port of Corpus Christi's application for a Nationwide Permit

7, a water rights permit, for the proposed Harbor Island project citing the Environmental Protection Agency's objections as reasons for denial. The U.S. Army Corps of Engineers notified them that they must address these objections and resubmit their application for a Nationwide Permit 7 (Clow, 2023b). In August of 2024, the Port of Corpus Christi announced that it would apply for a new discharge water rights permit from the Texas Commission on Environmental Quality for the proposed Harbor Island facility that would increase its water production capacity to 100 million gallons per day. The new discharge permit proposes relocating the intake and discharge points into the Gulf of Mexico instead of the ship channel (Crow, 2024b).

On August 29, 2019, the Port of Corpus Christi Authority submitted a water rights permit application for a 30-million-gallon-per-day seawater desalination plant on the La Quinta Channel. The application can be accessed at portofcc.com/images/pccpdfs/events/Water_Rights_Permit_Application_final.pdf. Resident Encarnacion 'Chon' Serna and Ingleside on the Bay Coastal Watch Association submitted a request for a contested case hearing, and the Texas Commission on Environmental Quality granted the hearing in July 2022 (Ingleside on the Bay Coastal Watch Association, 2022). On July 16, 2024, the Texas Commission on Environmental Quality approved the draft water rights permit for this proposed project (Texas Commission on Environmental Quality, 2024). On August 22, 2024, the Port of Corpus Christi announced that it would no longer pursue the La Quinta seawater desalination project and would instead only pursue the proposed Harbor Island project (Beam & Hofmann, 2024).

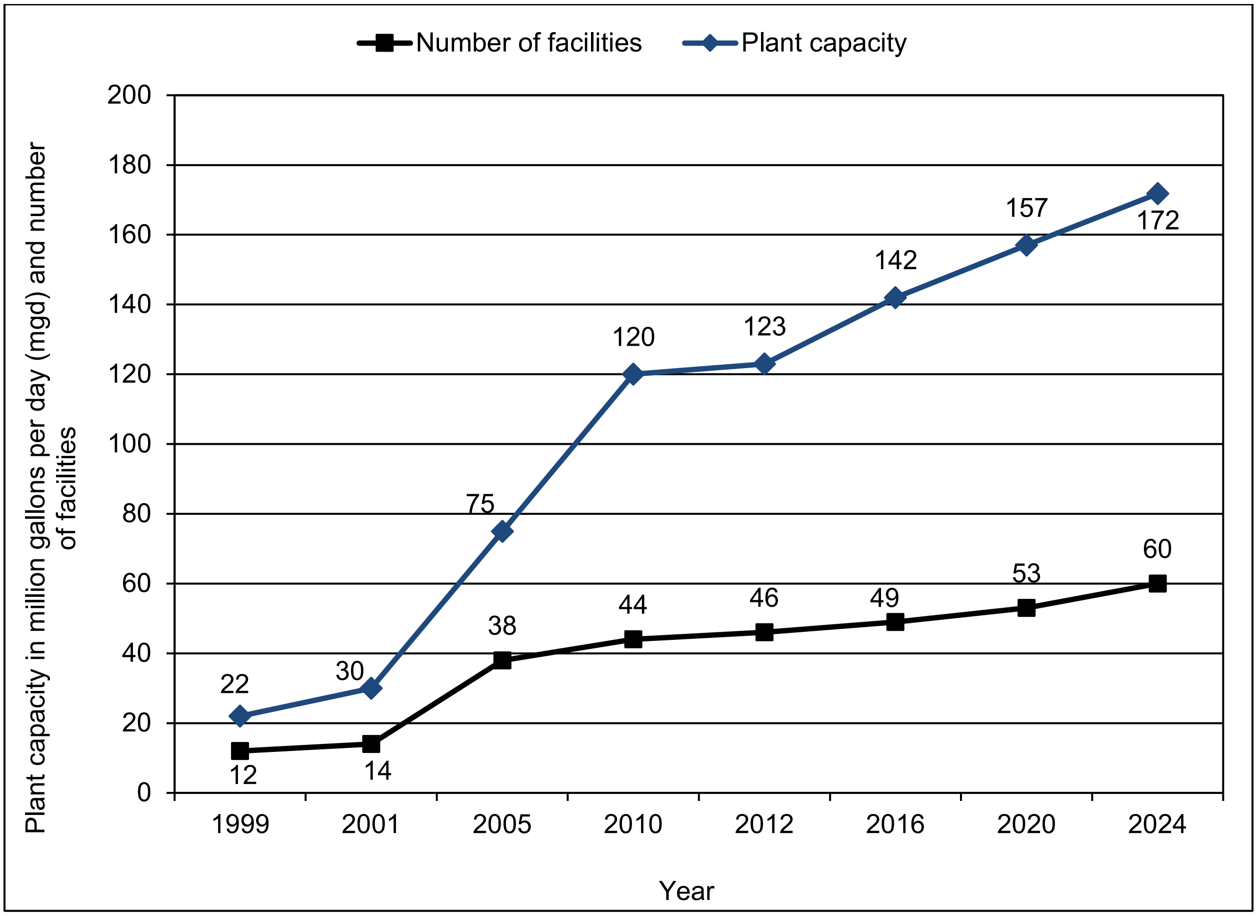
2.2 Brackish water desalination

Brackish water from surface water, groundwater, or reclaimed water sources is an important water source that can help reduce demand on freshwater sources. For this report, brackish water is considered water that contains a total dissolved solid concentration ranging from 1,000 to 10,000 milligrams per liter.

In the U.S., most municipal desalination plants are inland (Mickley, 2018). In South Florida alone, there are 38 brackish groundwater desalination plants with a total capacity of 287 million gallons per day (321,481 acre-feet per year) (South Florida Water Management District, 2023a; 2023b). In California, there are 35 brackish groundwater desalination plants with a total capacity of 95 million gallons per day (106,000 acre-feet per year) (California Department of Water Resources, 2024).

Brackish groundwater is an important water supply source in Texas. Based on the 16 completed aquifer studies to date, the state is estimated to have approximately 1,000 trillion gallons (3.2 billion acre-feet) of brackish groundwater in storage (TWDB, 2024b). In the last 25 years, municipal brackish desalination capacity in Texas has increased steadily (Figure 2).

Figure 2. **The growth of municipal desalination facilities and installed design capacity in Texas, 1999 through 2024**



In 2005, the TWDB funded a project to develop an initial desalination plant database to track the growth of desalination across the state (Nicot and others, 2005). In 2010, 2016, 2020, and 2024, TWDB staff updated the information by sending self-reported surveys to existing desalination plants in the database and to new desalination plants identified by staff. For entities that responded to the survey, their information was either updated or added to the database, which is available online at www2.twdb.texas.gov/apps/waterdatainteractive/GroundwaterDataViewer/?map=desal. Since the desalination plant database relies on utilities to submit self-reported surveys, it may not capture every plant in operation or plants constructed after August 2024.

As of August 2024, there were 60 desalination plants for municipal use with a per-facility capacity greater than 25,000 gallons per day (Table 1). Of these facilities, 16 treat brackish surface water, 43 treat brackish groundwater, and one treats reclaimed water (Figure 3). In total, Texas has a desalination production capacity of approximately 172 million gallons per day (192,665 acre-feet per year) for municipal use. More specifically, the state has a production capacity of 98 million gallons per day (109,774 acre-feet per year) for brackish groundwater desalination, 71 million gallons per day (79,530 acre-feet per year) for brackish surface water desalination, and 2.5 million gallons per day (2,800 acre-feet per year) for advanced treated reclaimed water. Fifty-seven facilities use reverse osmosis to desalinate water while three facilities use electrodialysis reversal. The largest inland desalination plant in the state and nation is the Kay Bailey Hutchison Desalination Plant located in El Paso with a production capacity of 27.5 million gallons per day (30,804 acre-feet per year).

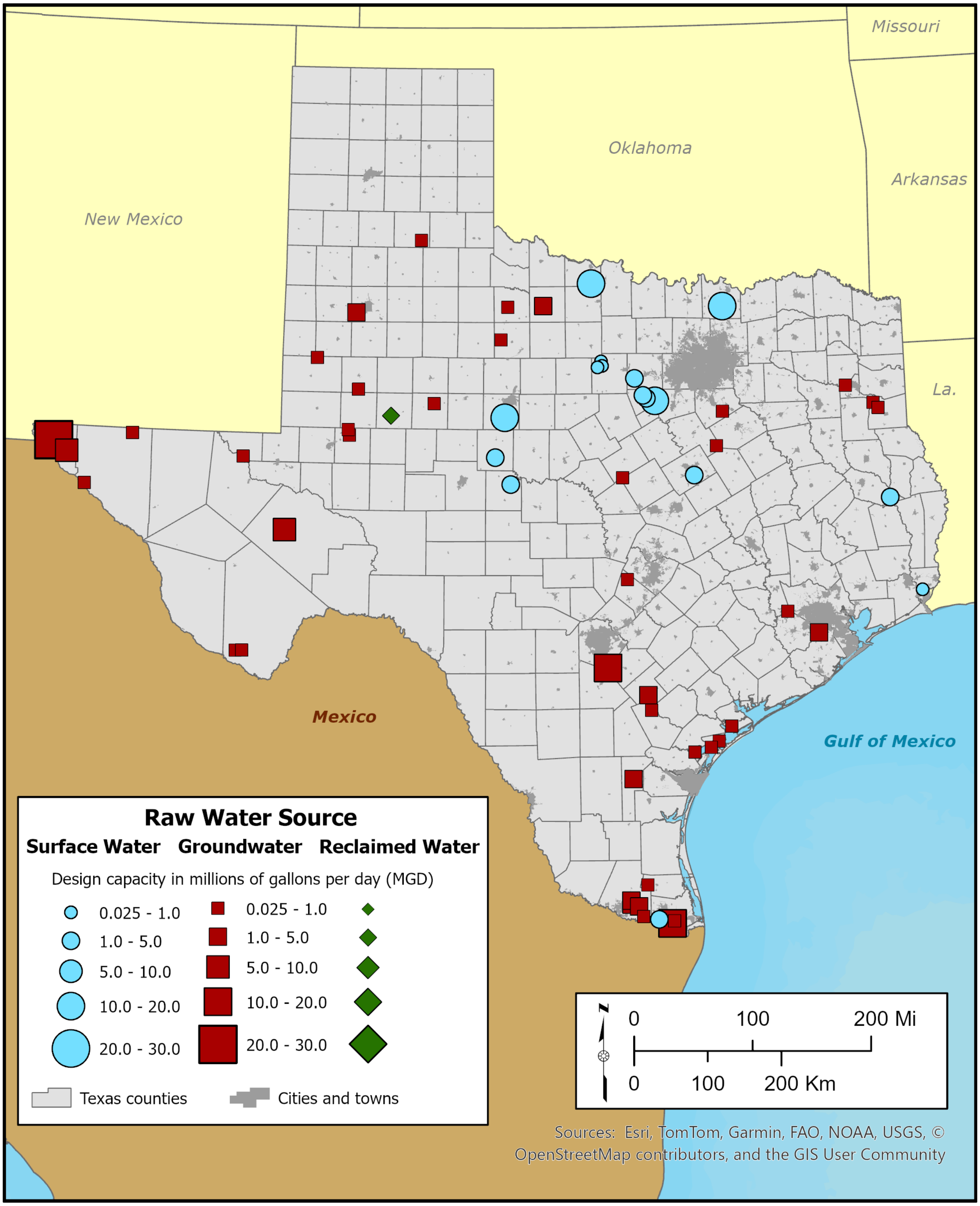
Table 1. Municipal brackish desalination facilities in Texas with a capacity greater than 0.025 million gallons per day in the database as of August 2024

Facility name	City	Water source	Facility startup year	Facility design capacity[1] (mgd)
Aransas County Municipal Utility District #1	Rockport	Groundwater	2011	0.110
Big Bend Motor Inn	Terlingua	Groundwater	1989	0.057
Bob Elder Water Treatment Plant	Milsap	Surface water	2014	2.000
Brazoria County Municipal Utility District 21	Rosharon	Groundwater	2018	2.572
Brazos Regional Public Utility Agency/Surface Water Advanced Treatment System	Granbury	Surface water	1989	15.000
City of Abilene (Hargesheimer Treatment Plant)	Tuscola	Surface water	2003	12.000
City of Alice	Alice	Groundwater	2024	2.775
City of Ballinger	Ballinger	Surface water	2005	2.000
City of Bardwell	Bardwell	Groundwater	1980	0.252
City of Bayside	Bayside	Groundwater	1990	0.045
City of Beckville	Beckville	Groundwater	2004	0.216
City of Benjamin	Benjamin	Groundwater	2012	0.065
City of Brady	Brady	Surface water	2005	3.000
City of Clarksville City	White Oak	Groundwater	2006	0.288
City of Evant	Evant	Groundwater	2010	0.100
City of Fort Stockton Osmosis/Desalination Facility	Fort Stockton	Groundwater	1996	7.000
City of Granbury	Granbury	Surface water	2007[2]	5.000
City of Hubbard	Hubbard	Groundwater	2002	0.648
City of Kenedy	Kenedy	Groundwater	1995	2.858
City of Robinson Reverse Osmosis Surface Water Treatment Plant	Waco	Surface water	1994	2.400
City of Rule	Rule	Groundwater	2015	0.086
City of Seadrift	Seadrift	Groundwater	1998	0.610
City of Seagraves	Seagraves	Groundwater	2016	0.288
City of Seymour	Seymour	Groundwater	1940	3.000
City of Sherman	Sherman	Surface water	1993	11.000
City of Tatum	Tatum	Groundwater	1999	0.324
City of Wolfforth	Wolfforth	Groundwater	2016	3.000
Cypress Water Treatment Plant	Wichita Falls	Surface water	2008	12.000
Dell City	Dell City	Groundwater	1968	0.100
DS Waters of America, LP	Katy	Groundwater	1997	0.090
Fort Hancock Reverse Osmosis (RO) Plant No. 1	Fort Hancock	Groundwater	2012	0.430

Facility name	City	Water source	Facility startup year	Facility design capacity[1] (mgd)
Greenwood Water System	Midland	Groundwater	2024	0.432
H2Oaks Center	Elmendorf	Groundwater	2016	12.000
Holiday Beach Water Supply Corporation	Fulton	Groundwater	1960	0.420
Horizon Regional Municipal Utility District	Horizon City	Groundwater	2001	8.000
Kay Bailey Hutchison Desalination Plant	El Paso	Groundwater	2007	27.500
Klondike ISD	Lamesa	Groundwater	2018	0.430
Loving County Water Treatment Plant	Mentone	Groundwater	2019	0.346
Military Highway Water Supply Corporation – Progreso	Progreso	Groundwater	2010	1.000
Military Highway Water Supply Corporation – Las Rusias	Los Indios	Surface water	2014	2.100
Midland Country Club	Midland	Groundwater	2004	0.023
Millersview-Doole	Millersview	Surface water	2012	1.530
Mitchell County Desalination Plant	Colorado City	Groundwater	2017	0.025
North Alamo Water Supply Corporation (Donna)	Donna	Groundwater	2012	2.000
North Alamo Water Supply Corporation (Doolittle)	San Juan	Groundwater	2008	3.000
North Alamo Water Supply Corporation (Lasara)	Edinburg	Groundwater	2005	1.000
North Alamo Water Supply Corporation (Owassa)	Raymondville	Groundwater	2008	3.000
North Cameron/Hidalgo Water Authority	Rio Hondo	Groundwater	2006	2.340
Oak Trail Shores	Granbury	Surface water	1985	1.584
Pettus MUD	Pettus	Groundwater	2014	0.025
Possum Kingdom Water Supply Corporation	Graford	Surface water	2003	1.000
Raw Water Production Facility	Big Spring	Reclaimed	2013	2.500
River Oaks Ranch	Pflugerville	Groundwater	1985[3]	0.115
Southmost Regional Water Authority	Brownsville	Groundwater	2004	10.000
Sportsman’s World Municipal Utility District	Strawn	Surface water	1984	0.083
Study Butte Terlingua Water System	Terlingua	Groundwater	2000	0.317
Texas Park and Wildlife Department – Caprock Canyons	Quitaque	Groundwater	2012	0.061
The Cliffs	Graford	Surface water	1991	0.381
Valley Municipal Utility District No. 2	Olmito	Groundwater	2000	1.000
Veolia Water Treatment Plant	Port Arthur	Surface water	1992	0.245
			Total	**171.770**

Notes: mgd = million gallons per day
[1]Plant design capacity includes blending
[2]Plant constructed in 1984; reverse osmosis implemented in 2007
[3]Plant rehabilitated in 2011

Figure 3. Distribution, size, and source water of municipal brackish desalination facilities in Texas with a design capacity of more than 0.025 million gallons per day, 2024



3 Results of the TWDB's desalination studies and activities

The Texas Legislature has directed the TWDB to engage in research, feasibility and facility planning studies, investigations, and surveys to further desalinated seawater supply development and to report on brackish groundwater desalination in the state. This chapter describes desalination activities (1) funded through the Desalination Program, (2) in the 2022 State Water Plan, and (3) funded through other TWDB grant and loan programs.

3.1 Desalination Program

The TWDB created the Desalination Program in 2002 in response to Governor Rick Perry announcing his seawater initiative and the 78th Texas Legislature passing House Bill 1370 that directed the TWDB to pursue seawater desalination studies and to report progress in a biennial report. Initially, the program covered activities for seawater desalination and added brackish groundwater desalination in 2004. The legislature last appropriated funding for seawater desalination studies in 2005 and brackish groundwater desalination studies in 2009.

3.1.1 Seawater desalination studies

Since 2002, the TWDB has funded $3.2 million in studies related to seawater desalination, including three feasibility studies, two pilot plant projects, and several guidance and research studies (Table 2). In 2005, the 79th Texas Legislature made its last appropriation of $2.5 million for seawater desalination demonstration activities, which was spent by 2010.

Table 2. TWDB-funded studies on seawater desalination

Report title	Study location	Study type
Lower Rio Grande Valley, Brownsville Seawater Desalination Demonstration Project	City of Brownsville	Feasibility study
Large-Scale Demonstration Desalination Feasibility Study	City of Corpus Christi	Feasibility study
Freeport Seawater Desalination Project	City of Freeport	Feasibility study
Guidance Manual for Permitting Requirements in Texas for Desalination Facilities Using Reverse Osmosis Processes	Not applicable	Guidance document
Pilot Study Report, Texas Seawater Desalination Demonstration Project	City of Brownsville	Pilot plant study
Lessons Learned from the Brownsville Seawater Pilot Study	City of Brownsville	Guidance document
Feasibility and Pilot Study, South Padre Island Seawater Desalination Project	South Padre Island	Pilot plant study
Texas Desal Project	City of Brownsville	Guidance document

3.1.2 Brackish groundwater desalination studies

Since 2004, the TWDB has funded $2.1 million for 11 studies related to brackish groundwater desalination, which include implementing demonstration projects, preparing guidance manuals, and completing research studies (Table 3).

Table 3. Brackish groundwater desalination studies funded through the Desalination Program

Report title	Contractor	Description	Study type	Year funded	Grant amount
Guidance Manual for Brackish Groundwater Desalination in Texas	North Cameron Regional Water Supply Corporation	The project prepared a brackish groundwater desalination guidance manual using a desalination plant in Cameron County as an example.	Demonstration	2006	$150,000
Demonstration of Efficiencies Gained by Utilizing Improved Reverse Osmosis Technologies	City of Kenedy/San Antonio River Authority	The project demonstrated the efficiencies gained by installing a new reverse osmosis system in an existing brackish groundwater desalination plant.	Demonstration	2006	$150,000
Assessment of the Whitehorse Aquifer as a Potential Source of Water Supply for the City of San Angelo	City of San Angelo/Upper Colorado River Authority	The project assessed the feasibility of the Whitehorse Aquifer in Irion County as a source of brackish water for the City of San Angelo.	Demonstration	2006	$300,000
Evaluation of Concentrate Management and Assessment of the Vibratory Shear Enhanced Process	San Antonio Water System	The project conducted a pilot test to assess the cost and technical feasibility of the Vibratory Shear Enhanced Process as a tool for reducing the volume of desalination concentrate.	Demonstration	2007	$205,000
Improving Recovery: A Concentrate Management Strategy for Inland Desalination	The University of Texas at Austin	The study investigated anti-scalant precipitation and electrodialysis to increase recovery in desalination of brackish groundwater.	Demonstration	2007	$238,500
Pilot Study to Demonstrate Volume Reduction of Reverse Osmosis Concentrate	El Paso Public Utilities Board	The study evaluated silica reduction in reverse osmosis concentrate through the addition of lime and application of the vibratory shear enhanced process. A second phase of the project tested the use of seawater reverse osmosis membranes to increase water recovery.	Demonstration	2007	$228,557
An Integrated Wind-Water Desalination Demonstration Project for an Inland Municipality	City of Seminole	The City of Seminole conducted pilot testing using wind energy to desalinate brackish groundwater.	Demonstration	2008	$300,000
Permitting Guidance Manual to Dispose Desalination Concentrate into a Class II Injection Well	CDM Smith, Inc.	The study developed an instruction manual and road map for permitting a Class II well for dual Class I-Class II purposes.	Demonstration	2010	$130,000
Upflow Calcite Contractor Design	Carollo Engineers, Inc.	The study developed design criteria for the post-treatment of permeate water using an upflow calcite contactor.	Demonstration	2010	$188,403

Report title	Contractor	Description	Study type	Year funded	Grant amount
Demonstration of Fiberglass Well Casings in Brackish Groundwater Wells	North Alamo Water Supply Corporation	The project demonstrated the viability of using fiberglass well casing in water wells installed in brackish aquifers.	Demonstration	2010	$100,000
Demonstration of a High Recovery and Energy Efficient Reverse Osmosis System for Small-Scale Brackish Water Desalination	Texas Tech University	The study demonstrated the use of a reverse osmosis system with parallel elements for small-scale desalination with high recovery and energy efficiency.	Demonstration	2010	$101,597

3.2 2022 State Water Plan

The TWDB develops the state water plan every five years through a locally driven planning process guided by 16 regional water planning groups. Each planning group assesses existing water supplies and future needs. If there are anticipated water shortages, the planning group identifies both recommended and alternative water management strategies and/or projects to create new water supplies or manage existing supplies. The difference between a water management strategy and a project is that a strategy is a plan to meet a water need and the project is the infrastructure required to implement the strategy. Projects would develop, deliver, or treat additional water supply volumes at a specified capital cost. One project may be associated with multiple water management strategies.

This section describes seawater, brackish groundwater, and brackish surface water desalination water management strategies and projects in the 2022 State Water Plan (TWDB, 2021).

3.2.1 Seawater desalination

Three regional water planning groups (regions H, M, and N) proposed seawater desalination as strategies in the 2022 State Water Plan. If implemented, these strategies would produce an estimated 192,000 acre-feet of new water supply by 2070. This constitutes about 2.5 percent of all recommended water management strategies in the state water plan.

The Rio Grande Regional Water Planning Group (Region M) included seawater desalination as an alternative water management strategy, which can replace a recommended strategy in the regional water plan and consequently the state water plan if the original recommended strategy cannot be achieved (Texas Administrative Code § 357.10(1)).

To implement recommended or alternative water management strategies, water user groups may need to execute projects to obtain the new water supplies. Regional water planning groups identified seven recommended projects (Table 4) and two alternative projects for seawater desalination.

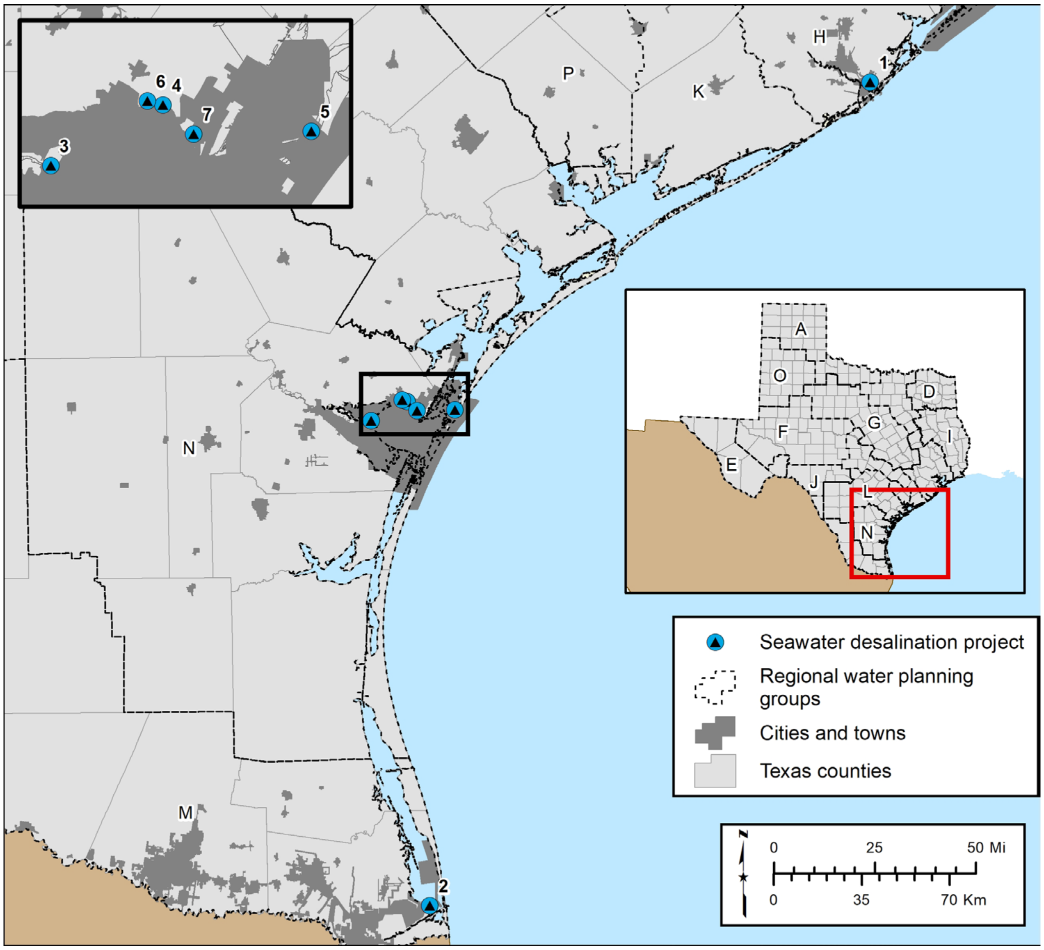
The statewide weighted-average[1] seawater desalination unit cost of recommended projects is $1,371 per acre-foot ($4.20 per thousand gallons). The projects are distributed along the Gulf Coast (Figure 4). For a few projects, sponsors have completed feasibility or pilot studies with the assistance of TWDB research funds.

Table 4. Recommended seawater desalination projects in the 2022 State Water Plan

ID	Region	Project sponsor	Project name/description	Online decade	Capital cost
1	H	DOW Inc.	Freeport seawater desalination	2040	$155,877,822
2	M	Laguna Madre Water District	Laguna Madre seawater desalination plant	2050	$40,290,000
3	N	Corpus Christi	Seawater desalination (Inner Harbor)	2030	$236,693,000
4	N	Corpus Christi	Seawater desalination (La Quinta)	2030	$420,372,000
5	N	Port Of Corpus Christi Authority	Seawater desalination - Harbor Island	2030	$802,807,000
6	N	Port Of Corpus Christi Authority	Seawater desalination - La Quinta Channel	2030	$457,732,000
7	N	Poseidon Water	Poseidon regional seawater desalination project at Ingleside	2030	$724,984,000

[1] The weighted average is the average of values scaled by the relative volume of each strategy.

Figure 4. Location of recommended seawater desalination projects in the 2022 State Water Plan (numbers refer to projects in Table 4)



3.2.1.1 Region H Regional Water Planning Area

Seawater desalination is recommended to meet demands of wholesale water providers in Brazoria County by 2040 (Freese and Nichols and others, 2020b). The proposed seawater desalination plant would have an initial capacity of 10 million gallons per day (11,200 acre-feet per year) and be located at the Dow Chemical Company complex in the City of Freeport. The facility would use an existing intake and discharge outfall and existing withdrawal and discharge permits, which would reduce construction costs and environmental impacts.

3.2.1.2 Rio Grande (Region M) Regional Water Planning Area

The Laguna Madre Water District relies on surface water from the Rio Grande and needs to diversify its water portfolio. In 1996, the TWDB funded a seawater desalination pilot study that concluded seawater desalination was not cost-effective (NRS Consulting Engineers and others, 1997). Interest in desalination increased due to the drought that followed the 1997 study. In 2006, the TWDB funded a demonstration project that included a feasibility study and 12-month pilot study (NRS Consulting Engineers, Inc., 2010). The feasibility study concluded it would be better to use seawater from the Gulf Coast with a 35,000 mg/L total dissolved solids than the Lower Laguna Madre Bay. The pilot study conducted testing using a 1-million-gallon-per-day (1,120-acre-foot-per-day) demonstration plant at the Andy Bowie County Park located on the north side of South Padre Island, which is the area experiencing the largest growth.

The Laguna Madre Water District proposal includes a 1-million-gallon-per-day (1,120-acre-foot-per-day) desalination plant with a 50 percent recovery and a finished product water with 500 mg/L total dissolved solids (Black & Veatch, 2020). The District will have the ability to expand up to 2 million gallons per day (2,240 acre-feet per day).

3.2.1.3 Coastal Bend (Region N) Regional Water Planning Area

The City of Corpus Christi proposes two seawater desalination plants with a 45 to 50 percent recovery (HDR Engineering, Inc., 2020). The 10- to 30-million-gallon-per-day (11,200- to 33,600-acre-foot-per-day) plant at the Inner Harbor in Nueces County would produce potable water for municipal use. The 20- to 40-million-gallon-per-day (22,400- to 44,800-acre-feet-per-day) plant would be located at the La Quinta Channel in San Patricio County, which would produce potable water for San Patricio Municipal Water District to use in manufacturing for industrial use.

The City of Ingleside and Poseidon Water propose to build a 50-million-gallon-per-day (56,000 acre-foot-per-year) desalination facility with a 50 percent recovery with the ability to expand in the future up to 100 million gallons per day (112,000 acre-feet per year) (HDR Engineering, Inc., 2020). The plant would be located northeast of the Corpus Christi Bay within city limits to produce water for manufacturing for industrial use but can be expanded to drinking water for municipal use.

The Port of Corpus Christi Authority proposes two seawater desalination plants (HDR Engineering, Inc., 2020). The Authority plans to construct a 50-million-gallon-per-day (56,000 acre-foot-per-year) desalination facility at Harbor Island near the Corpus Christi Ship Channel near Port Aransas. The second project includes a 30-million-gallon-per-day (33,600-acre-foot-per-year) desalination plant at La Quinta Ship Channel in San Patricio County.

3.2.2 Brackish groundwater desalination

In the 2022 State Water Plan, nine regional water planning groups (regions E, F, G, H, J, K, L, M, and N) recommended brackish groundwater desalination. If these recommended strategies are implemented, brackish groundwater desalination would produce about 157,000 acre-feet per year of additional water supplies by 2070. This would constitute about 2.1 percent of all recommended water management strategies in the state water plan.

Two planning groups (regions E and K) included groundwater desalination as an alternative water management strategy. Additionally, more groundwater desalination may occur as a result of implementing “groundwater wells and other” recommended water management strategies and projects. Although planning groups labeled these projects “groundwater wells and other,” the project name or project component indicates desalination may be involved.

Regional water planning groups propose implementing 37 brackish groundwater desalination projects (Table 5). The proposed projects are concentrated in the western, central, and southern parts of Texas (Figure 5). The statewide weighted-average[2] unit cost of recommended groundwater desalination projects is about $1,080 per acre-foot ($3.31 per 1,000 gallons). Project components may include pipelines, wells, new desalination plants, and expansions of existing plants. Implementing the recommended water management strategies may lead to developing or expanding 27 desalination plants (27 projects have a new water treatment plant or water treatment plant expansion component).

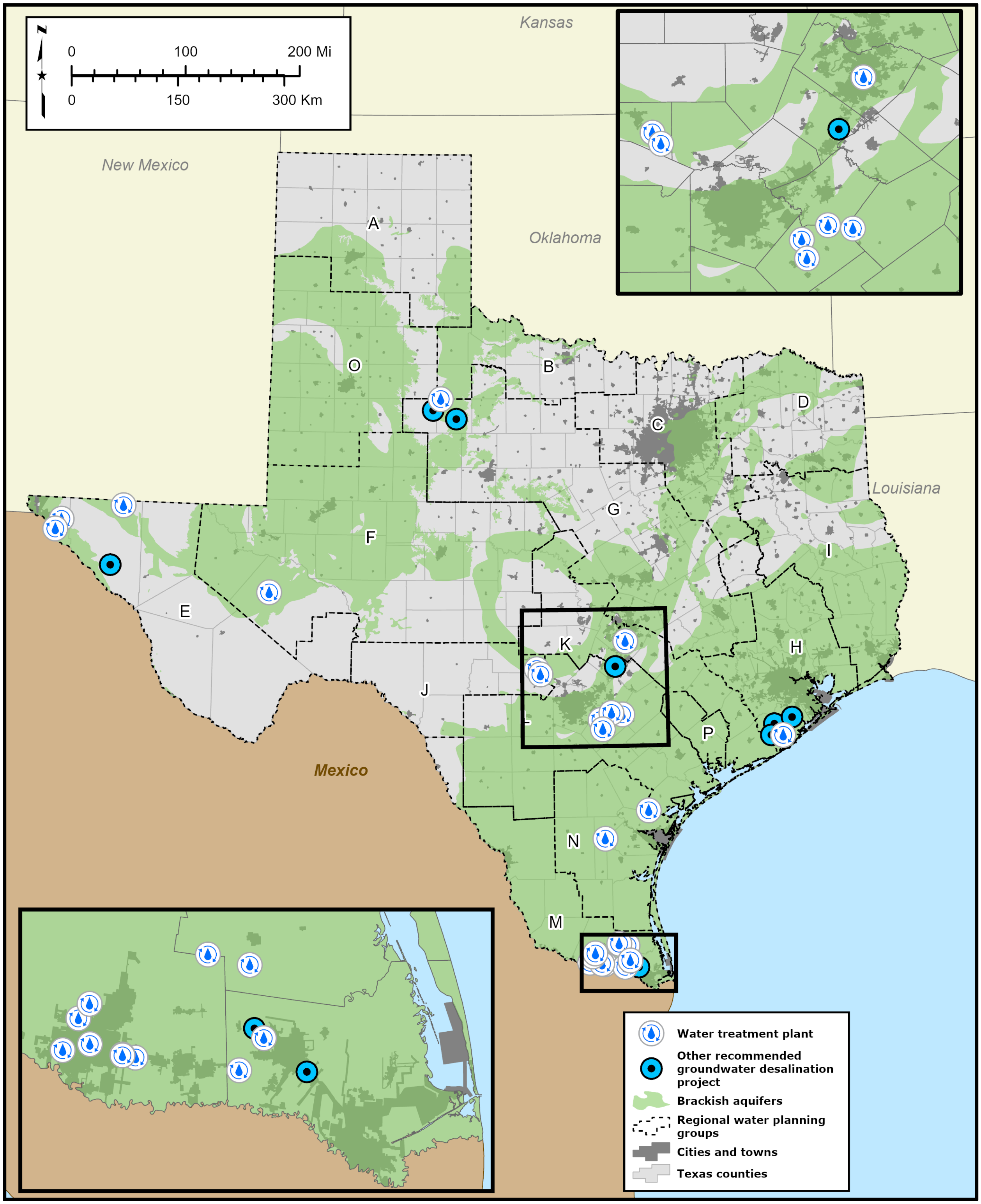
Table 5. Recommended brackish groundwater desalination projects in the 2022 State Water Plan

ID	Region	Project sponsor	Project name/description	Online decade	Capital cost
1	E	Horizon Regional Municipal Utility District	Additional wells and expansion of desal plant	2020	$71,809,000
2	E	Hudspeth County - other	Dell City brackish groundwater desalination facility	2030	$1,636,000
3	E	Hudspeth County - mining	Additional groundwater well	2020	$306,000
4	E	Lower Valley Water District	Groundwater from proposed well field - Hueco Bolson Aquifer	2030	$36,110,000
5	E	Lower Valley Water District	Groundwater from proposed well field - Rio Grande Alluvium Aquifer	2030	$39,236,000
6	F	San Angelo; Abilene; Midland	West Texas water partnership	2030	$549,093,000
7	G	Salt Fork Water Quality Corporation	Upper basin chloride control project	2030	$106,537,000
8	G	Jayton	Upper basin chloride control project supply	2030	$2,115,000
9	G	Aspermont	Upper basin chloride control project supply	2030	$8,254,000
10	H	Brazosport Water Authority	Brackish groundwater development	2030	$33,246,167
11	H	Brazoria County-other	Infrastructure Expansion - County-Other	2070	$10,088,460
12	H	Brazoria County-other	Infrastructure Expansion - County-Other	2030	$10,941,462
13	H	Brazosport Water Authority	Transmission expansion	2030	$77,755,692
14	H	Brazoria County-other	Infrastructure expansion	2030	$12,931,975
15	J	Kerr county-other	Construction of desalination plant	2030	$21,126,000
16	J	Kerrl county-other	Construction of wellfield for dense, rural areas	2030	$8,367,000
17	K	Austin	Brackish groundwater desalination	2070	$167,689,000
18	L	S S WSC	Brackish Wilcox groundwater	2060	$20,384,000
19	L	Schertz-Seguin Local Government Corporation	Brackish Wilcox groundwater	2040	$31,941,000
20	L	County Line Specialty Utility District	Brackish Edwards project	2050	$13,602,000
21	L	Canyon Regional Water Authority	Brackish Wilcox groundwater	2030	$177,944,000
22	L	San Antonio Water System	Expanded Brackish Wilcox project	2040	$819,805,000
23	M	Alamo	Brackish groundwater desalination plant	2030	$16,845,000

[2] The weighted average is the average of values scaled by the relative volume of each strategy.

ID	Region	Project sponsor	Project name	Online decade	Capital cost
24	M	La Feria	Water well with reverse osmosis unit	2030	$7,413,000
25	M	Lyford	Brackish groundwater well and desalination	2030	$5,753,000
26	M	McAllen	Brackish groundwater desalination plant	2030	$41,344,000
27	M	Mission	Brackish groundwater desalination plant	2030	$41,344,000
28	M	North Alamo Water Supply Corporation	Delta Area brackish groundwater desalination plant	2030	$28,374,000
29	M	East Rio Hondo and North Alamo Water Supply Corporation	North Cameron Regional Water Treatment Plant Wellfield Expansion	2030	$10,699,000
30	M	Primera	–Reverse Osmosis water treatment plant with groundwater well	2030	$10,804,000
31	M	San Benito	New groundwater supply	2030	$2,214,000
32	M	San Juan	Brackish groundwater well	2030	$8,594,000
33	M	San Juan	Water treatment plant 1 upgrade, expansion, and brackish groundwater development	2030	$11,784,000
34	M	Sharyland Water Supply Corporation	Well and reverse osmosis unit at water treatment plant t 2	2030	$19,805,000
35	M	Sharyland Water Supply Corporation	Well and reverse osmosis unit at water treatment plant 3	2030	$19,805,000
36	N	Alice	Brackish groundwater desalination	2020	$23,983,000
37	N	Corpus Christi; San Patricio Municipal Water District	Evangeline/Laguna treated groundwater project	2030	$157,550,000

Figure 5. Location of recommended brackish groundwater desalination projects in the 2022 State Water Plan



3.2.2.1 Far West Texas (Region E) Regional Water Planning Area

The Far West Texas (Region E) Regional Water Planning Group's desalination projects include developing new wells, constructing new desalination plants, and expanding existing facilities (WSP USA Inc. and Freese and Nichols, 2021).

Dell City plans to expand its existing plant by replacing the electrodialysis reversal system with a reverse osmosis system to produce 0.10 million gallons per day (111 acre-feet per year). The plant treats brackish groundwater from the Bone Spring-Victorio Peak Aquifer. The TWDB loaned the City $244,450 from the Drinking Water State Revolving Fund for the project.

The Horizon Municipal Utility District plans to expand its existing desalination plant from 6.0 to 21.4 million gallons per day (6,720 to 23,968 acre-feet per year). Expansion would include developing nine new wells, where five wells would produce from the Rio Grande Alluvium Aquifer and four from the Hueco Bolson Aquifer.

The Lower Valley Water District proposes to develop a 10-million-gallon-per-day (11,200-acre-foot-per-year) desalination plant along with a water storage tank, an injection well, and seven new wells. The District would be producing groundwater that is 150 feet below the surface from the Rio Grande Alluvium Aquifer. The District also proposes a similar project with the same size desalination plant but would instead drill six 650-foot-deep wells to produce groundwater from the Hueco Bolson Aquifer.

3.2.2.2 Region F Regional Water Planning Area

The West Texas Water Partnership, which includes the cities of Abilene, Midland, and San Angelo, was created to pursue drought-resilient water supplies (Freese and Nichols, Inc. and WSP USA Inc., 2020). The project would consist of constructing a 15.2-million-gallon-per-day (17,040-acre-foot-per-year) desalination facility and drilling 12 wells that produce groundwater from the Edwards-Trinity (Plateau) Aquifer in Pecos County. Disposal of the concentrate would be in evaporation ponds.

3.2.2.3 Brazos (Region G) Regional Water Planning Area

The Salt Fork Water Quality Corporation (includes Stonewall, Garza, and Kent counties), Jayton, and Aspermont are proposing a project to reduce the natural salt load from gypsum and other salts in the Brazos River (HDR Engineering, Inc. and others, 2020). The proposed project includes 10 brine recovery wells, a brine conveyance pipeline, a Brine Utilization and Management Complex (BUMC), and three water supply pipelines. The complex (BUMC) would include a Dynamic Vapor Recompression plant by Salttech and remineralization plant. The evaporative desalination plant would produce desalinated water and salts; the desalinated water would be remineralized at the facility and used for potable water, and the salts would be converted to sodium chloride and sold to interested buyers.

3.2.2.4 Region H Regional Water Planning Area

The Brazosport Water Authority is considering brackish groundwater desalination to supplement and mitigate shortages of surface water (Freese and Nichols and others, 2020b). Phase I of the proposed project includes drilling three groundwater wells and building a 6-million-gallon-per-day (6,720 acre-foot-per-year) desalination plant to treat the brackish groundwater from the Gulf Coast Aquifer. Phase II of the project involves drilling two additional wells and expanding the capacity of the plant to 10 million gallons per day (11,200 acre-feet per year). The concentrate would be discharged to a segment of the Brazos River below State Highway 332 where there are no salinity limitations.

3.2.2.5 Plateau (Region J) Regional Water Planning Area

The Kerr County Commissioners Court and Upper Guadalupe River Authority are pursuing regional and reliable water supplies, such as desalination, due to the growth in eastern Kerr County (WSP USA Inc. and Carollo Engineers, 2021). They propose to build a 1.2-million-gallon-per-day (1,344-acre-foot-per-year) desalination facility and dispose of the concentrate via evaporation ponds. This project also includes developing a wellfield by drilling four wells and producing water from 530 feet below the surface from the Trinity Aquifer.

3.2.2.6 Lower Colorado (Region K) Regional Water Planning Area

The City of Austin is considering diversifying its water supplies with desalination in the future (AECOM Technical Services, Inc. and others, 2020). The City proposes to build a 4.4-million-gallon-per-day (5,000-acre-foot-per-year) desalination plant and dispose of the concentrate via evaporation ponds. It proposes two wellfields: one producing brackish groundwater from the lower Trinity Aquifer and another producing from the saline Edwards Aquifer.

3.2.2.7 South Central Texas (Region L) Regional Water Planning Area

The Canyon Regional Water Authority's proposed project includes a 17.1-million-per-gallon-per-day (19,264-acre-foot-per-year) desalination plant. This project includes two new well fields that will produce brackish groundwater from the Carrizo-Wilcox Aquifer in Guadalupe and Wilson counties and five injection wells to dispose of the concentrate (Black & Veatch and others, 2020).

The S S Water Supply Corporation plans to pump brackish groundwater from the Carrizo-Wilcox Aquifer in Wilson County and treat it at a 2-million-gallon-per-day (2,240-acre-foot-per-year) desalination plant. The Corporation plans to dispose of concentrate via a deep injection well.

The Schertz-Seguin Local Government Corporation plans to drill seven wells and produce brackish groundwater between 1,800 and 2,400 feet below the surface from the Wilcox Aquifer in Gonzales County and treat it at a 5-million-gallon-per-day (5,600-acre-foot-per-year) desalination facility. The concentrate would be disposed via a deep injection well.

The San Antonio Water System proposes a multiphase project for developing four new wellfields, expanding its existing desalination plant, and drilling deep injection wells to dispose of the concentrate. This project would expand the capacity of the desalination plant to approximately 62 million gallons per day (70,160 acre-feet per year). The expansion of the plant includes a 12-million-gallon-per-day (13,440-acre-foot-per-year) expansion in the second phase, a 6-million-gallon-per-day (6,720-acre-foot-per-year) expansion in the third phase, a 28.5-million-gallon-per-day (32,000-acre-foot-per-year) expansion in the fourth phase, and a 16-million-gallon-per-day (18,000 acre-foot-per-year) expansion in the fifth phase. Wellfields will be developed in western Wilson County in the second and third phase, in eastern Wilson County in the fourth phase, and in central Wilson County in the fifth phase. These new wells will be about 2,300 feet deep and produce brackish groundwater from the Carrizo-Wilcox Aquifer. The concentrate would be disposed via a deep injection well.

The County Line Specialty Utility District plans to desalinate brackish groundwater from the saline Edwards Aquifer. The 1.3-million-gallon-per-day (1,500-acre-foot-per-day) desalination plant would be located east of Interstate Highway 35 in the City of Kyle in Hays County. The project will be completed in three phases: two wells will be drilled in the first phase, one well in the second phase, and one well in the third phase.

3.2.2.8 Rio Grande (Region M) Regional Water Planning Area

The Rio Grande Regional Water Planning Area has several brackish groundwater desalination projects, including producing brackish groundwater from the Gulf Coast Aquifer, constructing new desalination plants with 80 percent efficiency, and expanding existing facilities to provide new water supplies for the region (Black & Veatch, 2020).

The City of Alamo plans to build a new 1-million-gallon-per-day (1,120 acre-foot-per-year) desalination plant and discharge the concentrate to a surface water body. The City of La Feria plans to build a new desalination plant with a capacity of 1.25 million gallons per day (1,400 acre-feet per year). The City of Lyford plans to drill a 1,000-foot-deep well in the Gulf Coast Aquifer and treat the brackish groundwater at a new 0.5-million-gallon-per-day (560-acre-foot-per-year) desalination plant.

The City of McAllen plans to drill four new wells in the Gulf Coast Aquifer and build a 3-million-gallon-per-day (3,360 acre-foot-per-year) desalination plant to treat the brackish groundwater. The City of Mission plans to drill three new wells in the Gulf Coast Aquifer and build a 3-million-gallon-per-day (3,360 acre-foot-per-year) desalination plant. The City of Primera plans to drill a new well in the Gulf Coast Aquifer and build a 1-million-gallon-per day (1,120-acre-foot-per-day) desalination plant.

The North Alamo Water Supply Corporation plans to develop a well field that produces from the Gulf Coast Aquifer in Willacy County and build a 2-million-gallon-per-day (2,240-acre-foot-per-year) desalination facility to treat the brackish groundwater. Additionally, the North Alamo Water Supply, in conjunction with the East Rio Hondo Water Supply Corporation, plans to increase the capacity of the North Cameron Regional Water Supply Corporation desalination plant from 1.15 to 2.30 million gallons per day (1,288 to 2,576 acre-feet per year) with the addition of a supply well from the Gulf Coast Aquifer.

The City of San Juan plans to drill a 1,000-foot-deep well in the Gulf Coast Aquifer and build a 1-million-gallon-per day (1,120-acre-foot-per-day) desalination plant. San Juan also plans to expand and upgrade an existing water treatment plant by drilling three new wells in the Gulf Coast Aquifer and building a 1.6-million-gallon-per-day (1,792-acre-foot-per-year) desalination plant. It plans to discharge the concentrate to a surface water body.

The Sharyland Water Supply Corporation plans to drill a new well in the Gulf Coast Aquifer and build a 1-million-gallon-per day (1,120-acre-foot-per-day) desalination plant to treat the brackish groundwater and supplement its Water Treatment Plant No. 2. Similarly, the Corporation also plans to drill one well at 800-foot depth in the Gulf Coast Aquifer, build a 1-million-gallon-per day (1,120-acre-foot-per-day) desalination plant to treat the brackish groundwater, and supplement its Water Treatment Plant No. 3.

3.2.2.9 Coastal Bend (Region N) Regional Water Planning Area

The Coastal Bend Regional Water Planning Group recommends brackish groundwater desalination to create new water supplies for municipal and industrial use (HDR Engineering, Inc., 2020). The City of Alice proposes building a 3-million-gallon per-day (3,360-acre-foot-per-year) desalination facility and drilling two new wells to a 1,700-foot depth that would pump groundwater from the Jasper Formation. The concentrate would be piped and discharged to San Diego Creek, which ultimately flows into San Fernando Creek. On September 1, 2022, the TWDB approved financial assistance in the amount of $7 million to the City of Alice to drill two new brackish groundwater wells and construct a reverse osmosis treatment plant that will be funded through a public-private partnership.

The San Patricio Municipal Water District and City of Corpus Christi propose building a 25-million-gallon-per-day (28,000-acre-foot-per-day) desalination plant. The project will be completed in two phases: 13 wells will be drilled to a depth of 1,000 feet in the Gulf Coast Aquifer for the first phase and five wells will be drilled in the second phase. The concentrate will be discharged to Chiltipin Creek.

3.2.3 Surface water desalination

In the 2022 State Water Plan, two regional water planning groups (regions C and H) recommended surface water desalination. If implemented, these recommended strategies would produce an estimated 63,000 acre-feet of new water supply by 2070. This constitutes about 0.8 percent of all recommended water management strategies in the state water plan. Surface water desalination is reported in the state water plan under “other strategies” along with brush control, rainwater harvesting, and weather modification.

The Region C planning group also included surface water desalination as alternative water management strategies. Additionally, there is more surface water desalination occurring in Region C where the group labeled a few strategies and projects as “other surface water” with a strategy description of transfer/transaction instead of desalination.

Regional water planning groups identified seven recommended projects (Table 6) and two alternative projects for surface water desalination. In addition, there are three recommended projects labeled “other surface water” strategy type with a transfer/transaction description (Table 7). The state water plan does not specifically report the statewide weighted-average cost for surface water desalination since it is grouped with other strategies. The projects are distributed in the north and along the Gulf Coast (Figure 4). All recommended projects include either a new water treatment plant or a water treatment plant expansion component.

Table 6. Recommended surface water desalination projects in the 2022 State Water Plan

ID	Region	Project sponsor	Project name/description	Online decade	Capital cost
1	C	Greater Texoma Utility Authority	Regional water system phase I	2020	$243,986,000
2	C	Greater Texoma Utility Authority	Regional water system phase II	2030	$224,083,000
3	C	City of Sherman	10 MGD WTP expansion desalination-1	2020	$82,213,000
4	C	City of Sherman	10 MGD WTP expansion (desalination-2	2050	$82,213,000
5	C	City of Sherman	10 MGD WTP expansion desalination-3	2060	$82,213,000
6	C	City of Sherman	20 MGD WTP expansion desalination	2070	$149,002,000
7	H	NRG, Energy, Inc.	Cedar Bayou desalination	2030	$34,2840,391

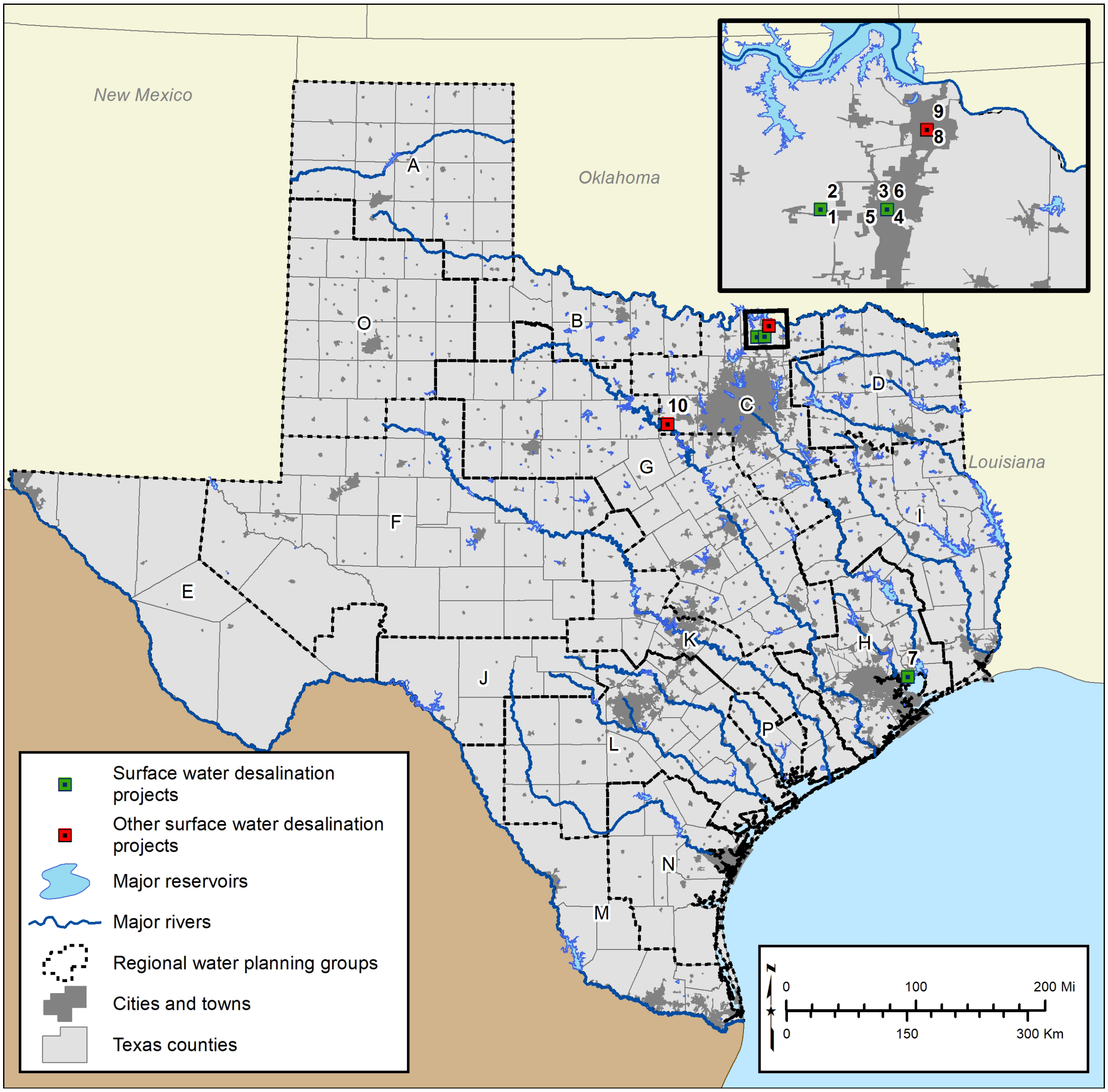
Notes: MGD = million gallons per day; WTP = water treatment plant

Table 7. Recommended other surface water projects with a desalination description in the 2022 State Water Plan

ID	Region	Project sponsor	Project name/description	Online decade	Capital cost
8	C	Denison	New desalination WTP	2030	$36,137,000
9	C	Denison	Desalination WTP expansion	2050	$82,213,000
10	C	Parker County Specialty Utility District	WTP desalination expansion-Brazos River Authority Supply	2030	$32,308,000

Notes: WTP = water treatment plant

Figure 6. **Location of recommended brackish surface water desalination projects in the 2022 State Water Plan (numbers refer to projects in Table 6 and Table 7)**



3.2.3.1 Region C Regional Water Planning Area

The Greater Texoma Utility Authority plans to desalinate brackish surface water from Lake Texoma at the existing Sherman Water Treatment Plant (Freese and Nichols and others, 2020a). This regional project would provide 35,872 acre-feet per year of new water supplies to four counties and be implemented in two phases.

The City of Sherman plans to expand its existing 20-million-gallon-per-day (22,400 acre-foot-per-year) desalination plant that desalinates brackish surface water from Lake Texoma. The City will expand the desalination plant in four phases, adding 10 million gallons per day (11,200 acre-feet per year) of capacity in each of the first three phases and 20 million gallons per day (22,400 acre-feet per year) of capacity in the final phase.

The City of Denison is a wholesale provider that supplies drinking water to four entities within Grayson County and raw water for manufacturing. The City of Denison plans to construct a 4-million-gallon-per-day (4,480-acre-foot-per-day) plant to desalinate surface water from Lake Texoma. It also plans to expand the new plant in the future and increase the capacity to 10 million gallons per day (11,200 acre-feet per day).

The Parker County Specialty Utility District is experiencing increasing water demands and membrane fouling at its existing 1-million-gallon-per-day (1,120-acre-foot-per-day) desalination plant that treats surface water from the Brazos River. The District plans to increase the plant's capacity to 3.5 million gallons per day (4,480 acre-feet per day).

3.2.3.2 Region H Regional Water Planning Area

NRG Energy generates electricity for several nearby industrial facilities. The proposed 20-million-gallon-per-day (22,400 acre-foot-per-year) desalination plant would be located at the NRG Cedar Bayou Electric Generating Station near the City of Baytown (Freese and Nichols and others, 2020b). NRG Energy would divert saline surface water from Cedar Bayou using existing intake and discharge outfall at the electric station.

3.2.3.3 Lavaca (Region P) Regional Water Planning Area

The Lavaca-Navidad River Authority is considering desalination of brackish groundwater in Jackson County and surface water from the Lavaca River downstream of Lake Texana to meet future water demands of Formosa Plastics and other industries (AECOM Technical Services, Inc., 2020). The proposed desalination plant would treat both saline sources, have an average capacity of 5.8 million gallons per day (6,496 acre-feet per year), and be located on property owned by Formosa Plastics or the Authority.

This recommended water management strategy project is not allocated to serve a specific water user group during the 50-year planning period. For this reason, it is not reflected in the table or on the map.

3.3 Grant programs

Internal grant programs that have funded desalination research include the Regional Facility Planning Grant Program and the Research and Planning Fund. The last two projects funded by the Regional Facility Planning Grant Program were the Barton Springs/Edwards Aquifer Conservation District's feasibility study to treat saline groundwater from the Edwards Aquifer at a desalination facility and store the desalinated water in an aquifer storage and recovery system (Carollo Engineers, 2018) and the Rio Grande Regional Water Authority's plan to evaluate alternative water supplies for the Lower Rio Grande Valley (Blandford and Jenkins, 2016). Table 8 is a non-exhaustive list of other projects funded by these grant programs.

Table 8. Brackish groundwater desalination projects funded through the Research and Planning Fund

Report title	Contractor	Description	Study type	Year funded	Grant amount
Brackish Groundwater Manual for Texas Regional Water Planning Groups	LBG-Guyton Associates	The study identified potential brackish groundwater sources in Texas for future potable use.	Research	2003	$99,940
A Desalination Database for Texas	Bureau of Economic Geology at The University of Texas at Austin	The study developed a desalination database for Texas.	Research	2004	$75,000
Self-Sealing Evaporation Ponds for Desalination Facilities in Texas	Bureau of Economic Geology at The University of Texas at Austin	The study investigated regulatory requirements for developing a self-sealing evaporation pond.	Research	2005	$49,928
Assessment of Osmotic Mechanisms Pairing Desalination Concentrate and Wastewater Treatment	CH2M Hill	The study investigated the use of reverse osmosis concentrate as a draw solution in a forward osmosis process for recovering water from wastewater.	Research	2008	$90,000
Energy Optimization of Brackish Groundwater Reverse Osmosis Desalination	Affordable Desalination Collaboration	This study assessed and demonstrated energy optimization strategies for brackish groundwater desalination by reverse osmosis.	Research	2009	$496,783
Alternative to Pilot Plant Studies for Membrane Technologies	Carollo Engineers, Inc.	The project evaluated alternatives to the current regulatory requirements for pilot testing membranes.	Research	2011	$150,000

3.4 Financial assistance programs

The TWDB's financial assistance programs are available to public entities to fund the planning, design, and construction phases of seawater and brackish groundwater desalination plants. Since 1989, the TWDB has financed 52 desalination projects (Table 9) with a total value of approximately $1.18 billion. Desalination projects are eligible for financing from various agency programs, including the Drinking Water State Revolving Fund, the State Participation Program, and the Texas Water Development Fund. Desalination projects in the state water plan are also eligible to benefit from the State Water Implementation Fund for Texas (SWIFT). The New Water Supply for Texas Fund provides loans to entities to finance the development and acquisition of new water sources for the state, including desalination with seawater or brackish groundwater (TWDB, 2024c; Perry, 2024).

Through the SWIFT program, the TWDB has funded four seawater desalination projects (two for Corpus Christi, one for the Guadalupe-Blanco River Authority, and one for the Laguna Madre

Water District) and one brackish groundwater desalination project (Brazosport Water Authority). The Guadalupe-Blanco River Authority canceled its seawater desalination feasibility study to focus on near-term projects.

From August 2022 to August 2024, the TWDB approved a $545 million loan for two seawater desalination projects and $14 million loan for three brackish groundwater desalination projects. For seawater desalination, the TWDB provided a $535 million loan to the City of Corpus Christi for a 20-million-gallon-per-day (22,400-acre-foot-per-year) seawater desalination plant located in Inner Harbor and a $10 million loan to the Laguna Madre Water District for a 5-million-gallon-per-day (5,600-acre-foot-per-year) seawater desalination plant.

For brackish groundwater desalination, the TWDB provided a $1 million loan to Mullin Independent School District to construct a brackish groundwater desalination plant to treat elevated nitrate levels in their groundwater from an existing well and $6 million loan to the City of Seagraves to modify its existing reverse osmosis system to treat exceeding maximum contaminant levels of arsenic and fluoride. Additionally, the TWDB provided a $7 million loan to the City of Alice to drill two new brackish groundwater wells and construct a reverse osmosis treatment plant that will be funded through a public-private partnership.

Table 9. Desalination projects funded through TWDB financial programs as of July 2024

No.	Entity	Funding program	Funding amount*	Funding date	Project name
1	Harlingen	WAF	$2,000,000	04/20/1989	Wastewater treatment plant No. 2 expansion
2	Haciendas del Norte Water Improvement District	WDF	$1,725,000	08/20/1997	East Montana transmission and reverse osmosis unit
3	Lorena	WDF	$3,335,000	10/16/1997	Robinson transmission line
4	Possum Kingdom Water Supply Corporation	DWSRF	$4,700,000	12/17/1998	Regional water system
5	Palmer	DWSRF	$1,405,000	07/14/1999	Reverse osmosis plant
6	Brady	DWSRF	$9,405,000	03/09/2000	New surface water treatment plant and storage tank
7	Harlingen	CWSRF	$1,845,000	04/19/2000	Wastewater treatment plant No. 2 sludge process
8	Holiday Beach Water Supply Corporation	WDF	$470,000	11/15/2000	Reverse osmosis water plant
9	Burleson Co Municipal Utility District No. 1	DWSRF	$1,560,000	09/19/2001	Reverse osmosis treatment facility
10	Horizon Regional Municipal Utility District	WDF	$7,780,000	11/14/2001	Reverse osmosis treatment plant
11	El Paso	WAF; SAAP	$1,240,000	03/20/2002	Eastside desalination plan
12	Ballinger	DWSRF	$3,865,000	06/16/2004	Lake Ballinger water line
13	Clarksville City	WDF	$1,530,000	02/15/2005	George Richey Road water wells
14	East Rio Hondo Water Supply Corporation	RWAF	$4,150,000	11/15/2005	North reverse osmosis plant transmission line
15	Possum Kingdom Water Supply Corporation	DWSRF	$1,625,000	07/18/2006	Water treatment plant expansion
16	Greater Texoma Utility Authority	WIF	$835,000	12/15/2008	Northwest Grayson County Water Improvement Control

No.	Entity	Funding program	Funding amount*	Funding date	Project name
					District No. 1 surface water treatment plant
17	San Antonio Water System	WIF	$109,550,000	07/16/2009	Brackish groundwater desalination
18	Millersview-Doole Water Supply Corporation	DWSRF	$10,857,148	10/15/2009	Surface water treatment plant and distribution lines
19	Fort Griffin Special Utility District	DWSRF	$2,355,000	10/15/2009	Throckmorton County water lines
20	Fort Hancock Water Improvement Control District	EDAP	$3,012,990	04/22/2010	Water well and reverse osmosis treatment facility
21	Stephens Regional Special Utility District	DWSRF; WDF	$5,800,000	01/20/2011	Water treatment plant and transmission lines
22	Roscoe	DWSRF	$1,765,000	05/04/2011	Reverse osmosis water treatment plant
23	Montgomery County Municipal Utility District No. 8 and No. 9	WDF	$5,450,000	09/22/2011	Walden conjunctive use water treatment plant design
24	Dell City	DWSRF	$244,450	05/16/2013	Reverse osmosis treatment plant
25	Raymondville	DWSRF	$3,800,000	09/19/2013	Well and reverse osmosis system
26	San Antonio Water System	DWSRF	$75,920,000	11/06/2014	Water resources integration pipeline
27	Baylor Water Supply Corporation	DWSRF	$500,000	02/25/2015	Urgent need - Bufkin well field development
28	Granbury	DWSRF	$16,430,000	03/26/2015	City of Granbury water treatment plant
29	Guadalupe-Blanco River Authority	SWIFT	$2,000,000	07/23/2015	Integrated water and power plant project
30	Brazosport Water Authority	SWIFT	$28,300,000	07/23/2015	Brackish groundwater reverse osmosis water treatment plant and water wells
31	Loop Water Supply Corporation	DWSRF	$170,000	12/14/2015	Water treatment plant improvements
32	Seymour	DWSRF	$4,140,476	04/11/2016	Water system improvements
33	Wellman	DWSRF	$1,122,654	05/05/2016	Nitrate and fluoride removal
34	Commodore Cove Improvement District	DWSRF	$200,000	12/15/2016	Reverse osmosis treatment
35	Corpus Christi	SWIFT	$2,750,000	7/20/2017	Seawater desalination
36	Holiday Beach Water Supply Corporation	DWSRF	$700,000	1/22/2018	Urgent need request: Hurricane Harvey
37	Elmendorf	DWSRF; WDF	$10,770,000	5/3/2018	Water supply project
38	Stephens Regional Special Utility District	DWSRF	$900,000	11/12/2018	Stephens Regional Special Utility District treatment improvements
39	Granbury	DWSRF	$13,810,000	11/12/2018	2018 DWSRF water treatment plant phase II expansion
40	Shallowater	DWSRF; WDF	$2,500,000	12/13/2018	Water and wastewater improvements
41	Parker County Special Utility District	DWSRF	15,080,000	3/28/2019	Phase I water system improvements
42	Ropesville	DWSRF	$1,268,750	6/4/2019	Fluoride removal water treatment project
43	Alice	DWSRF	$5,499,000	7/22/2019	Supplemental water resource

No.	Entity	Funding program	Funding amount*	Funding date	Project name
44	North Alamo Water Supply Corporation	DWSRF	$17,406,373	3/12/2020	Energy-efficient brackish groundwater desalination project
45	Corpus Christi	SWIFT	$222,475,000	7/23/2020	Seawater desalination
46	Brazosport Water Authority	GRG	$200,000	NA	Brackish groundwater reverse osmosis water treatment plant and water wells
47	Port O'Connor Improvement District	DWSRF	$6,000,000	11/5/2020	New water wells & reverse osmosis development
48	Seagraves	WDF/WIIN	$6,084,000	12/17/2020	Water system improvements
49	City of Alice	DWSRF	$7,000,000	9/1/2022	New water wells & reverse osmosis development
50	Mullin Independent School District	DWSRF	$998,000	10/5/2022	Greenfield water treatment plant and distribution
51	Laguna Madre Water District	SWIFT	$10,000,000	7/23/2024	Seawater desalination
52	Corpus Christi	SWIFT	$535,110,000	7/23/2024	Seawater desalination

Note:*Funding amount = final funded amount after all withdrawals and alterations
CWSRF = Clean Water State Revolving Fund
DWSRF = Drinking Water State Revolving Fund
EDAP = Economically Distressed Areas Program
GRG = General Revenue Grant
RWAF = Rural Water Assistance Fund
SWIFT = State Water Implementation Fund for Texas
WAF = Water Assistance Fund
WIF = Water Infrastructure Fund
WIIN = Water Infrastructure Improvements for the Nation Act
WDF = Water Development Fund

4 Brackish groundwater production zone designations

The Brackish Resources Aquifer Characterization (BRACS) Program maps and characterizes the brackish portions of the aquifers in Texas to designate brackish groundwater production zones and to provide useful data to regional water planning groups and other entities interested in developing and desalinating brackish groundwater as a new water supply. As of 2024, completed brackish aquifer studies indicate a total in-place brackish groundwater storage volume of 1,000 trillion gallons (3.2 billion acre-feet).

This chapter describes the BRACS Program; completed, current, and future aquifer studies; the requirements of Texas Water Code § 16.060; the status of zone designations; key challenges; and the permitting framework for zones.

4.1 Brackish Resources Aquifer Characterization System Program

Documented mapping of saline water resources in Texas began in 1956. The U.S. Geological Survey, in collaboration with other agencies within the U.S. Department of the Interior, "outlined the occurrence, quantity, and quality of saline groundwater and surface water available in Texas" for the Department of Interior's Saline Water Conversion Program (Winslow and Kister, 1956). In 1970, the TWDB funded a study "to make a reconnaissance and inventory of the principal saline aquifers in Texas that discussed the salinity, the productivity, and the geology of the aquifers" (Core Laboratories, 1972).

In 2003, the TWDB funded a study to map the brackish aquifers of the state and calculate the volume of brackish (1,000 to 10,000 milligrams per liter total dissolved solids) groundwater available in these aquifers (LBG-Guyton Associates, 2003). The study was done to support the regional water planning process and to help identify alternative sources to meet water demands. This study estimated there are 815 trillion gallons (2.5 billion acre-feet) of brackish groundwater in the state's aquifers. While the study demonstrated that brackish groundwater is a significant resource, it also highlighted the need for detailed aquifer studies, which led to the creation of the BRACS Program.

The BRACS Program was established in 2009 and uses legislative appropriations to complete internal studies and fund contracted work to support brackish aquifer studies and brackish groundwater production zone designations. The BRACS Program also has a role in providing technical reviews of permits received by groundwater conservation districts for production in brackish groundwater production zones.

In 2015, the 84th Texas Legislature directed the TWDB to identify and designate brackish groundwater production zones in the state (Texas Water Code § 16.060). Additionally, the TWDB funded seven contracted studies for eight aquifers or portions of aquifers to expedite the selected aquifer studies, totaling just under $1.7 million.

In 2019, the 86th Texas Legislature created a permitting framework for groundwater conservation districts to establish brackish rules for producing brackish groundwater from TWDB-designated production zones (Texas Water Code § 36.1015). A production permit application located within a brackish groundwater production zone is submitted to the TWDB by a groundwater conservation district for review. The legislature appropriated funding for one full-time equivalent staff member to support technical reviews associated with brackish groundwater production zone permits.

In 2023, the 88th Texas Legislature appropriated $840,723 each fiscal year to the TWDB for fiscal years 2024 and 2025 to conduct studies regarding the designation of brackish groundwater production zones in aquifers of the state, excluding the Dockum Aquifer. Additionally, the General Appropriations Act from the 88th Texas Legislature requires the TWDB to provide a report on its progress relating to aquifer studies and brackish groundwater no later than December 1 of each odd-numbered year. Examples of contracted work in BRACS Program history include brackish aquifer studies, identifying potential production areas, acquiring and reprocessing 2D seismic data to map brackish aquifers, calibrating geophysical well logs, testing and analyzing cores to determine key aquifer properties, and simulating well logs to determine key geophysical log properties relevant for calculating salinity.

In September 2023, the TWDB approved using appropriations for five research and outreach contracts totaling $1.6 million. These contracts are for complete brackish aquifer studies for the Ellenburger-San Saba, Hickory, and Yegua-Jackson aquifers; an exploratory brackish groundwater project; an online interactive webpage (like an ArcGIS StoryMap) highlighting a brackish aquifer study with designated production zones; and log digitization services.

Between 2010 and 2023, 28 contracts totaling $6,432,730 have been funded for brackish groundwater research, data collection, and outreach, as summarized in Table 10.

Table 10. TWDB-funded projects to support brackish aquifer studies and brackish groundwater production zone designations

Report title	Description	Contractor	Study type	Year funded	Contract amount
Geophysical Well Log Data Collection Project	Geophysical well logs from brackish aquifers in the state were collected from multiple sources, digitized, and entered in a database.	Bureau of Economic Geology at The University of Texas at Austin	Research	2010	$300,000
Brackish Groundwater Bibliography Project	The project developed a comprehensive bibliography of Texas brackish aquifers.	INTERA, Inc.	Research	2010	$99,500
An Assessment of Modeling Approaches to Brackish Aquifers in Texas	The study assessed groundwater modeling approaches for brackish aquifers.	INTERA, Inc.	Research	2010	$50,000

Report title	Description	Contractor	Study type	Year funded	Contract amount
Identification of Potential Brackish Groundwater Production Areas – Carrizo-Wilcox, Queen City, and Sparta aquifers	The project mapped and characterized the aquifer and evaluated it for potential production areas. This was one intra-agency contract that covered two aquifer projects.	Bureau of Economic Geology at The University of Texas at Austin	Research	2016	$181,446
Identification of Potential Brackish Groundwater Production Areas – Gulf Coast Aquifer	The project mapped and characterized the aquifer and evaluated it for potential production areas.	INTERA, Inc.	Research	2016	$500,000
Brackish Groundwater in the Blaine Aquifer System, North Central Texas	The project mapped and characterized the aquifer and evaluated it for potential production areas.	Daniel B. Stephens & Associates, Inc.	Research	2016	$200,000
Identification of Potential Brackish Groundwater Production Areas – Rustler Aquifer	The project mapped and characterized the aquifer and evaluated it for potential production areas.	INTERA, Inc.	Research	2016	$200,000
Identification of Potential Brackish Groundwater Production Areas – Blossom Aquifer	The project mapped and characterized the aquifer and evaluated it for potential production areas.	LBG-Guyton	Research	2016	$50,000
Identification of Potential Brackish Groundwater Production Areas – Nacatoch Aquifer	The project mapped and characterized the aquifer and evaluated it for potential production areas.	LBG-Guyton	Research	2016	$150,000
Identification of Potential Brackish Groundwater Production Areas – Trinity Aquifer	The project mapped and characterized the aquifer and evaluated it for potential production areas.	Southwest Research Institute	Research	2016	$400,000
Upper Coastal Plain East Aquifer Data Entry for the Brackish Resources Aquifer Characterization System Database	The project assessed approximately 19,000 geophysical well logs and conducted data entry for new logs into the BRACS database.	Allan R. Standen, LLC	Data entry	2020	$226,000
Core Testing for Hill Country Trinity Aquifer	The project described, sampled, and analyzed well core from the Bureau of Economic Geology's core library to determine key aquifer properties.	Allan R. Standen, LLC	Research and data collection	2020	$219,710
Drilling and Logging the Ideal Exploratory Brackish Groundwater Well	The project prepared a resource document detailing how to drill and log the ideal exploratory brackish groundwater well and additionally provided cost estimates.	Daniel B. Stephens & Associates, Inc.	Research	2020	$135,000

Report title	**Description**	**Contractor**	**Study type**	**Year funded**	**Contract amount**
Brackish Groundwater Comingling	The project identified what qualifies as comingling and assessed the risk of brackish groundwater comingling in the state's aquifers.	INTERA, Inc.	Research	2020	$137,700
Seismic Interpretation	The project investigated the application and suitability of using existing 2D seismic data to map brackish aquifers.	INTERA, Inc.	Research	2020	$150,000
Sampling of High Salinity Groundwater in Texas	The project sampled and logged several brackish groundwater wells.	U.S. Geological Survey	Data collection	2020	$288,200
Develop Procedures and Tools to Delineate Areas Designated or Used for Class II Well Wastewater Injectate	The project researched scientifically defensible methods to map injectate and developed a tool for TWDB staff to use to map injectate.	WSP USA	Research	2020	$500,000
Numeric Well Log Simulations and Core Testing for the Edwards-Trinity (Plateau) Aquifer	The project analyzed core samples and conducted numerical well log simulations to determine key aquifer properties.	The University of Texas at Austin, Hildebrand Department of Petroleum and Geosystems Engineering	Research and data collection	2021	$90,736
Core testing for Upper Coastal Plains and Llano Uplift aquifers	The project analyzed core samples and conducted numerical well log simulations to determine key aquifer properties.	The University of Texas at Austin, Hildebrand Department of Petroleum and Geosystems Engineering	Research and data collection	2022	$130,000
Core testing for the Woodbine and Maverick Basin aquifers	Lab analysis of cores in brackish aquifers for mineralogy, porosity, permeability, and cementation properties.	LRE Water, LLC	Research and data collection	2022	$175,000
Seismic data for the Edwards-Trinity (Plateau) Aquifer	Seismic data quality ranking, purchase, and post-processing for BRACS aquifer study areas of interest.	INTERA, Inc.	Research and data collection	2022	$374,777
Maverick Basin report	Prepare a resource document that details what is known about the Maverick Basin aquifer.	INTERA, Inc.	Research	2022	$49,698
Seismic data for Upper Coastal Plain System Aquifers in East Texas	Seismic data quality ranking, purchase, and post-processing for BRACS aquifer study areas of interest.	Collier Consulting, Inc.	Research and data collection	2022	$374,963
Brackish groundwater exploratory project	Survey of potential brackish groundwater exploratory projects,	Envision, LLC	Outreach and data collection	2023	$400,000

Report title	Description	Contractor	Study type	Year funded	Contract amount
Ellenburger-San Saba and Hickory Aquifers BRACS study	The project will map and characterize the aquifers and evaluate potential production areas.	LRE Water, LLC	Research	2023	$400,000
Yegua-Jackson Aquifer BRACS study	The project will map and characterize the aquifer and evaluate potential production areas.	INTERA, Inc.	Research	2023	$400,000
GIS story map	GIS story map to highlight the findings of a selected BRADCS study with designated BGPZs.	TBD	Outreach	2023	$150,000
Log digitization	Digitization of geophysical logs for future studies	TBD	Data opti-mization	2023	$100,000

4.2 Brackish aquifer studies

For each brackish aquifer study, the TWDB collects as much geological, geophysical, and water-well data as possible that is available in the public domain and uses the information to map and characterize both the vertical and horizontal extents of the aquifers in detail. Groundwater is classified into five salinity classes based on total dissolved solids: fresh (0 to 999 milligrams per liter), slightly saline (>1,000 to 2,999 milligrams per liter), moderately saline (>3,000 to 9,999 milligrams per liter), very saline (>10,000 to 35,000 milligrams per liter), or brine (>35,000 milligrams per liter) (Winslow and Kister, 1956). The volume of groundwater in each salinity class is estimated based on three-dimensional mapping of the salinity zones.

The project deliverables, including both the data and report, are available to the public on the BRACS website. All project data is compiled into the BRACS Database, which is in Microsoft Access format and described in a detailed data dictionary (Meyer, 2020). Digital geophysical well logs used for the studies may be downloaded from the Groundwater Data Viewer or are available upon request. GIS datasets house interpreted results and processed data, such as lithology, simplified lithologic descriptions, stratigraphic picks, aquifer water chemistry, and salinity analysis.

Overall, the TWDB has completed 16 brackish aquifer studies (Figure 7) and has three current ongoing studies (Figure 8). Of the completed studies, the TWDB completed nine internal studies and contractors completed seven.

In 2003, Texas was estimated to have more than 815 trillion gallons (2.5 billion acre-feet) of brackish groundwater available in 26 of its major and minor aquifers (LBG-Guyton Associates, 2003). Since then, the 16 completed brackish aquifer studies have refined the estimated volume, indicating a total in-place brackish groundwater storage of 1,000 trillion gallons (3.2 billion acre-feet).

The key differences between the volume calculation method use in 2003 and the methodology in the TWDB brackish aquifer studies are:

1) The 2003 study used an average aquifer thickness, whereas the brackish aquifer studies use thicknesses derived from detailed stratigraphic surfaces along with net sand or percent sand where applicable.
2) The 2003 study used an assumed average drawdown (conservative), whereas the brackish aquifer studies typically assume full saturation in the confined brackish portions of the aquifers, due to lack of water level data in the brackish portions of the aquifers.
3) The 2003 study included volumes attributed to both confined (in-place) storage within the aquifer and storage above the top of the confined aquifer, whereas the brackish aquifer studies do not include storage above the top of aquifer formation in a confined aquifer.

Figure 7. **Completed brackish aquifer studies**

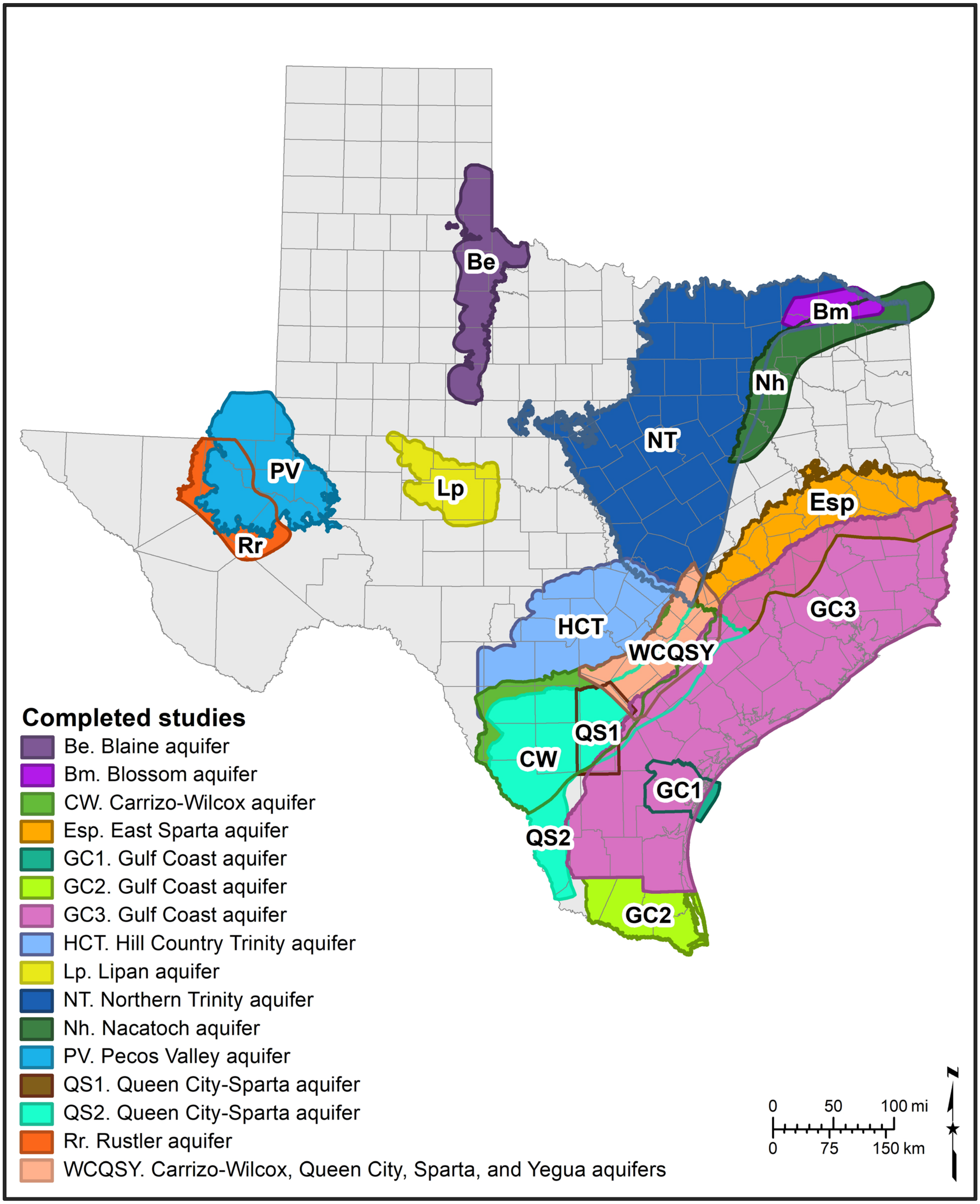
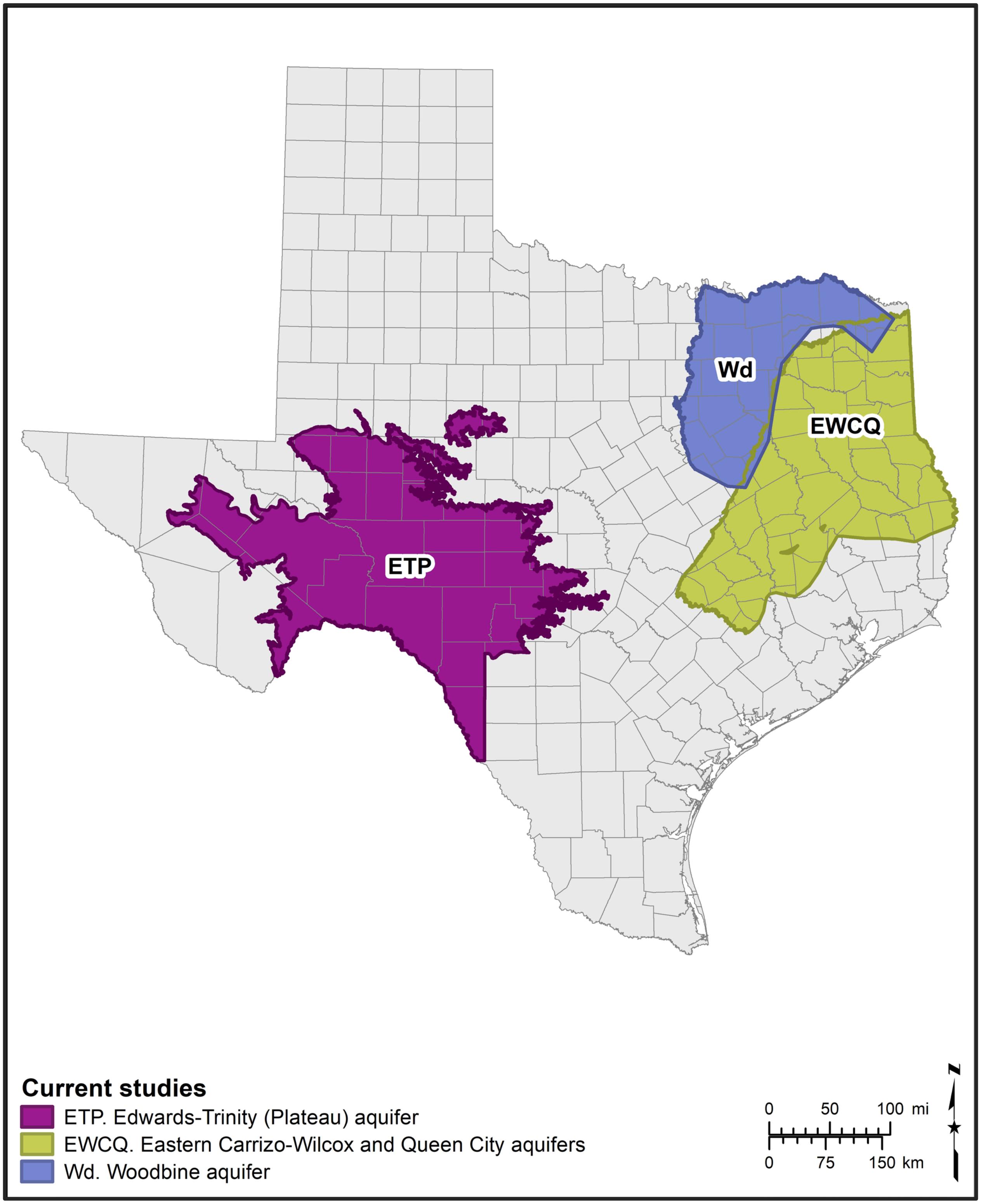


Figure 8. **Current brackish aquifer studies**



4.3 Zone designation requirements

The initial directive to designate brackish groundwater production zones required the TWDB to make designations in four aquifers—the Carrizo-Wilcox Aquifer located between the Colorado River and the Rio Grande, the Gulf Coast Aquifer and sediments bordering that aquifer, the Blaine Aquifer, and the Rustler Aquifer—and to report the designations to the legislature by December 1, 2016. The TWDB is required to identify and designate brackish groundwater production zones in the remaining aquifers of the state before December 1, 2032.

Texas Water Code § 16.060 requires that brackish groundwater production zones must be in areas with moderate to high availability and productivity. They must also be separated by sufficient hydrogeologic barriers to prevent significant impacts to water availability or water quality in geologic strata that have average total dissolved solids concentrations of 1,000 milligrams per liter or less. The statute also excluded certain areas from zone designation:

- The Edwards (Balcones Fault Zone) Aquifer located within the jurisdiction of the Edwards Aquifer Authority
- Areas within the boundaries of the Barton Springs-Edwards Aquifer Conservation District, the Harris-Galveston Subsidence District, and the Fort Bend Subsidence District
- Areas within a groundwater conservation district that overlies the Dockum Aquifer and includes wholly or partly 10 or more counties (High Plains Underground Water District)
- Aquifers, subdivisions of aquifers, or geologic strata that have an average total dissolved solids concentration of more than 1,000 milligrams per liter and serve as a significant source of water supply for municipal, domestic, or agricultural purposes
- Geologic formations that are designated or used for wastewater injection with injection or disposal wells permitted under Texas Water Code Chapter 27

For each zone, the TWDB is required to (1) determine the amount of brackish groundwater that can produce over 30- and 50-year periods without causing a significant impact to water availability or water quality, (2) make recommendations on reasonable monitoring to observe the effects of brackish groundwater production within the zone, (3) work with groundwater conservation districts and stakeholders on the studies in general, and (4) provide a summary of zone designations in the biennial desalination report due December 1 of each even-numbered year.

Based on comments received during the rulemaking process to implement Texas Water Code § 36.1015, the TWDB began developing procedures and guidance for amending designated brackish groundwater production zones. In June 2022, the TWDB hosted a meeting and held a public comment period to solicit feedback from stakeholders on how the zone amendment process should work. In May 2023, the TWDB published guidance to request amendments to designated brackish groundwater production zones after engaging with stakeholders for their input on the zone amendment process. TWDB staff are also developing new guidance on how buffers will be placed around existing use wells and mapped injectate around wastewater injection or disposal wells (see Section 4.5).

4.4 Status of zone designations

To achieve the goals of Texas Water Code § 16.060, the TWDB uses the following work process for current and future studies, updating as needed:

1. Conduct an aquifer characterization study (brackish aquifer study) of the whole or a portion of the aquifer
2. Apply statutory requirements and exclusion criteria and evaluate areas for brackish groundwater production zone designation
3. Receive stakeholder input on proposed brackish groundwater production zones
4. Recommend proposed brackish groundwater production zones to the agency's Board for approval and designation

At each step, the work is documented, and the deliverables are made publicly available as downloads from the TWDB website. The TWDB makes reasonable efforts to engage groundwater conservation districts and stakeholders at each step of the process, allowing ample opportunities to review and comment on materials. Throughout a study, TWDB staff share presentations at local groundwater management area and regional water planning group meetings within the vicinity of each aquifer. Information pertaining to all stakeholder meetings is posted on each of the BRACS study webpages in a timely manner.

To date, the TWDB has designated a total of 31 brackish groundwater production zones in the state with moderate to high availability and productivity of brackish groundwater that meet statutory requirements and exclusion criteria (Figure 9). In October 2016, the TWDB designated eight brackish groundwater production zones: one zone in the Carrizo-Wilcox Aquifer south of the Colorado River, four zones in the Gulf Coast Aquifer and bordering sediments, and three zones in the Rustler Aquifer. No zones were identified in the Blaine Aquifer. In March 2019, the TWDB designated an additional 23 brackish groundwater production zones: three zones in the Blossom Aquifer, five zones in the Nacatoch Aquifer, and 15 zones in the northern portion of the Trinity Aquifer. No zones were identified in the Lipan Aquifer.

The TWDB has focused agency resources on addressing some of our key challenges (described in Section 4.5) to continue improving mapping, characterization, and assessment of the extent and availability of brackish groundwater resources in Texas. TWDB staff recently completed an internal upgrade of the wastewater injectate mapping tools developed under a previous contract. This tool allows the TWDB to improve and refine zone designations around areas used for wastewater injection, and the upgrade allows the TWDB to proceed with analyzing and designating production zones. Additionally, to aid in modeling future production from designated zones, updates to groundwater availability models will include extensions of the modeled area into the brackish portions of aquifers.

In the future, three aquifer studies completed prior to the directive to designate brackish groundwater production zones will need to be evaluated: the Gulf Coast Aquifer System in the Lower Rio Grande Valley, the Pecos Valley Aquifer, and the Queen City and Sparta aquifers in Atascosa and McMullen counties. The TWDB will also evaluate three brackish aquifer studies completed since 2019 for zone designation using the tools and research funded by legislative appropriations: the Carrizo-Wilcox, Queen City, Sparta, and Yegua aquifers of the Upper Coastal Plains in Central Texas (study completed in 2020); the southern portion of the Trinity Aquifer (study completed in 2022); and the East Sparta aquifer (study completed in 2023).

When completed, the three current aquifer studies (Edwards-Trinity [Plateau] aquifer, the eastern portions of the Carrizo-Wilcox and Queen City aquifers, and the Woodbine Aquifer) will also need to be evaluated for brackish groundwater production zone designation. Of the ongoing aquifer characterization studies, the closest to completion is the Woodbine Aquifer. The TWDB has identified six additional aquifers that meet statutory requirements and exclusion criteria and are eligible for brackish groundwater production zone designation that will be mapped and characterized prior to assessing potential brackish groundwater production zones (Figure 10).

In addition, future work may include a secondary analysis of zone designations for the Gulf Coast Aquifer System and the southern portion of the Carrizo-Wilcox Aquifer (including the Queen City and Sparta aquifers) that were originally contracted in 2016.

The Dockum Aquifer within the area of the High Plains Underground Water Conservation District No. 1 and the Edwards (Balcones Fault Zone) Aquifer within the boundaries of the Edwards Aquifer Authority and Barton Springs/Edwards Aquifer Conservation District are not eligible for zone designation. The remaining 12 aquifers are ineligible for zone designation and will only be mapped and characterized after the TWDB meets the December 1, 2032, legislative deadline for completing the zone designations for qualifying aquifers (Figure 11).

Figure 9. **Brackish aquifer studies evaluated for brackish groundwater production zone designation and excluded districts per statute**

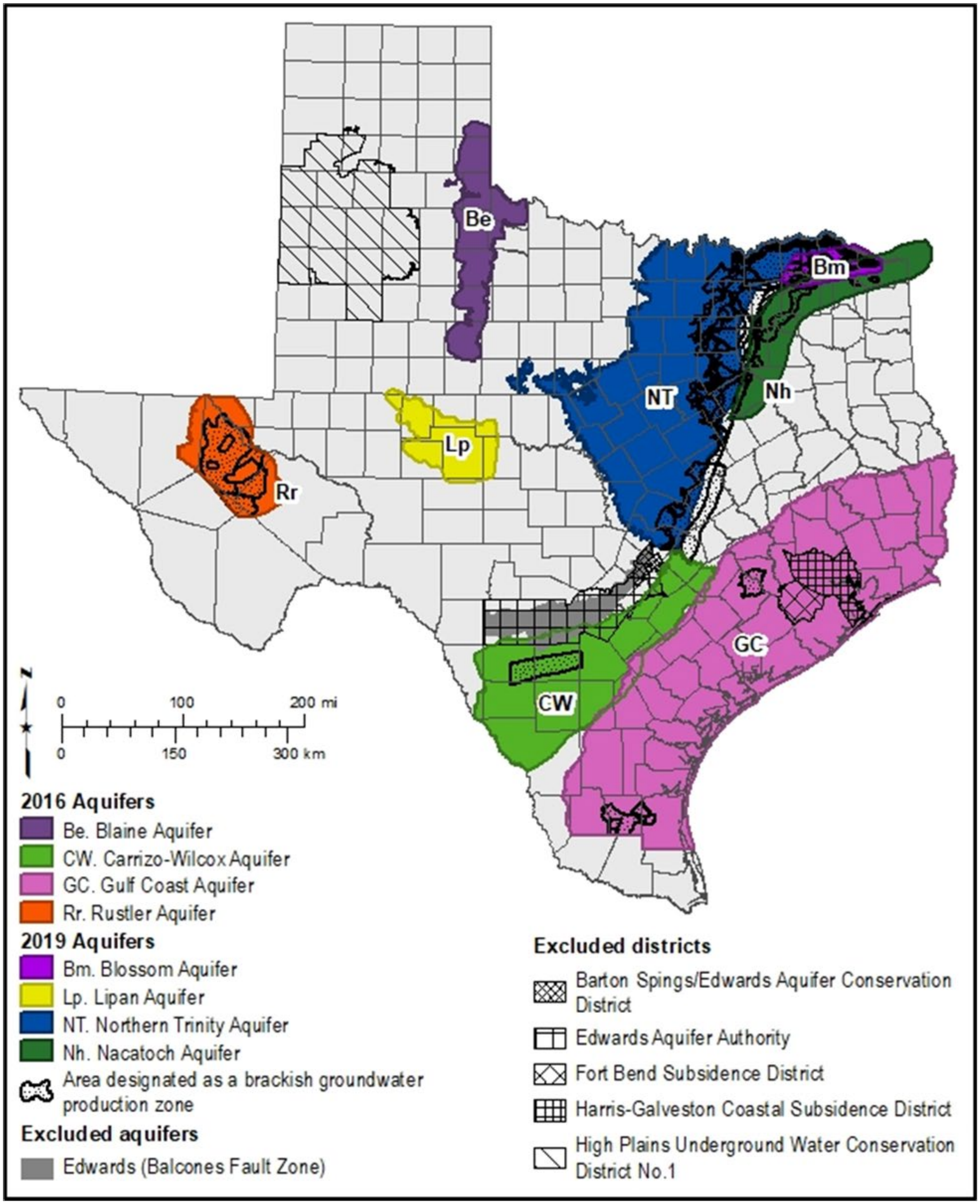


Figure 10. Future brackish aquifer studies that meet statutory criteria

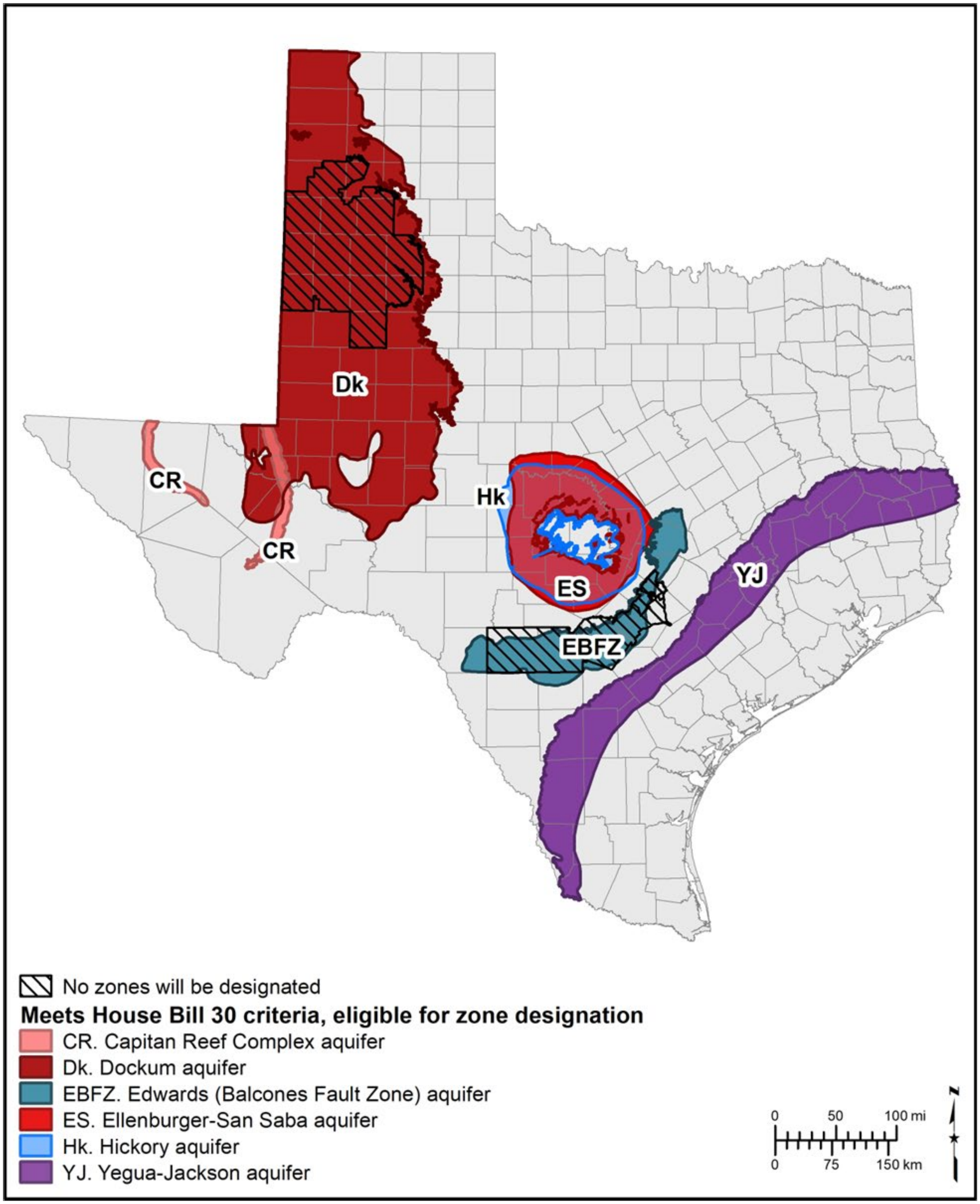
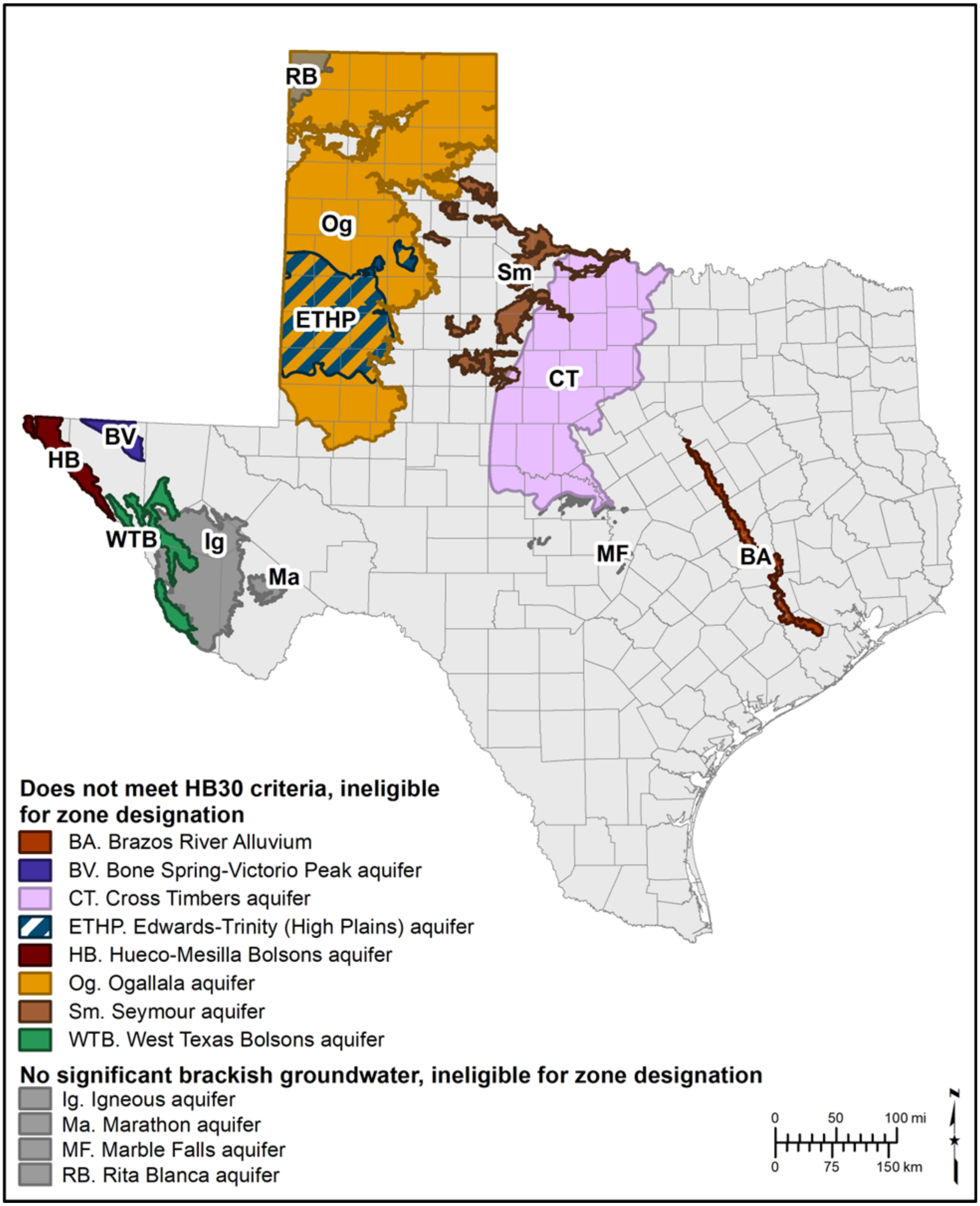


Figure 11. Future brackish groundwater studies that do not meet statutory criteria



4.5 Key challenges

In the ongoing process of conducting brackish aquifer studies, TWDB staff encountered the same four challenges found during previous aquifer studies: data gaps, limited water well and injection data availability, groundwater model accessibility, and injection well buffer applicability.

The first key challenge is the lack of data for the deeper portions of an aquifer. Most existing water wells are relatively shallow since drilling typically stops after encountering an adequate water supply, so most wells do not fully penetrate the water-bearing formation. However, if wells are drilled in deeper portions of the aquifer, all the necessary data collection activities are not conducted, such as running a full suite of geophysical logs, testing cores for key parameters, and conducting water samples at all intervals. The TWDB has attempted to close this data gap by using legislatively appropriated funds to sample and log brackish groundwater wells and to analyze existing core for key aquifer parameters. The TWDB is currently pursuing an exploratory brackish groundwater project that will survey stakeholders who are interested in brackish groundwater exploration projects and then rank the proposed projects based on a weighted scoring metric composed of various criteria, such as well depth, data collection parameters, discharge handling, land access, and permit requirements. The project will also partially fund a portion of the data collection for the selected project.

The second key challenge is that there is not a single database in Texas that has complete records of all water wells (domestic, municipal, and agricultural) and injection wells (Class I, II, III, IV, and V). Available datasets are maintained by different agencies, in different formats, and often have incomplete information. Since the statute excludes brackish groundwater production zone designations in specific areas, identifying water wells and injection wells within potential production zone areas is critically important in the agency's evaluation process. For each aquifer study, the TWDB attempts to contact groundwater conservation districts and stakeholders to obtain existing well information. The largest data gap is with Class I, II, III, IV, and V injection wells regulated by the TCEQ and the Railroad Commission of Texas.

The third key challenge is in modeling potential brackish groundwater production zones to estimate the volume of brackish groundwater production that will account for simultaneous well fields and regional water pumping. While the agency does have groundwater availability models used in regional groundwater planning, most of the models are not extended into the same areas as the brackish aquifer studies. Additionally, model calibration in extended areas becomes difficult due to the data gaps explained as the first key challenge. As a result, past studies used a simple analysis to estimate the impact to freshwater resources and to determine groundwater volume based on aquifer parameters and simulated drawdown. The TWDB has started to extend model areas with model updates and will continue to do so with future model updates. Pursuant to House Bill 722 (2019), 30- and 50-year production capacity assessments provided with zone designations are best assessed using groundwater models and are important for districts to consider in rulemaking and permitting of brackish groundwater projects within designated zones. The updates and extension of the models will serve as the best available science for this purpose.

A designated brackish groundwater production zone may need to be amended if there is relevant new data or modeling information available that the TWDB did not have when originally making the designation. Such new data or information could potentially alter the parameters of the brackish groundwater production zone or introduce possible changes to the anticipated operational or environmental impacts of the brackish groundwater production. For example, a zone amendment could occur when improved models modify the estimated amounts of brackish groundwater that an existing zone can produce over a 30- and 50-year period without causing a significant impact to water availability or water quality. Given the current modeling challenges, the TWDB guidance to request zone amendments requires that the entity requesting the amendment provides modeling simulations for any 'major' production zone amendment request. A 'major' amendment is one which requires modeling for analysis.

The final challenge is that TWDB staff does not know the distance that injected fluids may have traveled both laterally and vertically from Class II (types 1, 2, and 3) injection wells. Determining the distance that injected fluids travel is important, as TWDB staff have discovered that several Class II injection zones are installed above, below, lateral to, or overlapping with geologic strata containing brackish groundwater. In past evaluations, the TWDB placed a 15-mile buffer around injection wells, which is a very conservative buffer distance that needs further refinement.

The TWDB addressed this challenge by contracting a study that developed procedures and tools to design technically defensible mapping procedures. The TWDB executed a contract with a firm to update and host the Class II injection well buffer tool, a tool that allows refinement of the buffers around these wells. However, due to the exceptionally high proposed annual cost, this contract was canceled. To use these funds more effectively, TWDB staff completed the work internally in October 2024. In the future, the agency may amend and revise zone designations using the upgraded injectate mapping tools, which are designed for agency use only.

4.6 Permitting framework for zones

In 2019, the 86th Texas Legislature passed House Bill 722 (codified as Texas Water Code § 36.1015) and created a framework for groundwater conservation districts to establish permitting rules for producing brackish groundwater from TWDB-designated production zones for a municipal drinking water project or an electric generation project. Additionally, the legislature appropriated funding for one full-time equivalent staff member to support technical reviews associated with brackish groundwater production zone operating permits.

Texas Water Code § 36.1015 directs the TWDB to conduct technical reviews of operating permit applications submitted to groundwater conservation districts and, when requested by a district, investigate the impacts of brackish groundwater production as described in the annual reports of the permitted production. Texas Water Code § 36.1015 does not apply to a district that (1) overlies the Dockum Aquifer and (2) includes wholly or partly 10 or more counties, which is the High Plains Underground Water Conservation District No. 1.

When conducting a technical review of a brackish groundwater production zone operating permit application, the TWDB will submit a report to the groundwater conservation district that includes (1) findings regarding the compatibility of the proposed well field design with the designated brackish groundwater production zone and (2) recommendations for a monitoring system. There is no required timeline for conducting the technical review and preparing a report for the district.

In response to a groundwater conservation district's request for an investigation into permitted brackish groundwater production in designated production zones, the TWDB will submit a report to the district that addresses whether the production from the permitted project is projected to cause (1) significant, unanticipated aquifer level declines or (2) negative effects on water quality in the same or an adjacent aquifer, subdivision of an aquifer, or geologic stratum. The report will also include an analysis of any subsidence projected to be caused by brackish groundwater production during the permit term, if the brackish groundwater production zone is in the Gulf Coast Aquifer. The TWDB has 120 days to conduct technical investigations and provide the report to the district after receiving a request.

To clarify the process for technical reviews of operating permit applications and associated annual production reports as required by Texas Water Code § 36.1015, the Board adopted amendments to 31 Texas Administrative Code Chapter 356 in January 2021. To date, no permit applications have been submitted to the TWDB for technical review.

5 Identification and evaluation of research, regulatory, technical, and financial impediments to implementing seawater or brackish groundwater desalination projects

Desalination projects, both seawater and brackish groundwater, are driven by site-specific conditions. Source water quality, permitting requirements, and construction and operation costs all depend on local site conditions. Therefore, impediments for desalination projects can be different for each project.

5.1 Research

A common obstacle to conducting research is a lack of adequate funding. Should funding become available, potential research topics specific to Texas have been identified in past TWDB studies and biennial reports. However, there is a need to assess the relevance of the research topics and develop an updated desalination research agenda that contains research topics and tangible pilot- and demonstration-scale projects that would help advance desalination implementation in Texas. Guidance documents, such as the permit decision model (roadmap) developed by the TWDB in 2004, also need to be updated to reflect the new streamlined and flexible permitting process adopted as a requirement of House Bill 2031 and House Bill 4097 of the 84th Texas Legislature in 2015.

In October 2021, the TWDB submitted two separate applications related to reuse and desalination research to the U.S. Bureau of Reclamation WaterSmart Drought Resiliency Grant opportunity, but the applications were not funded. The TWDB proposed developing a comprehensive guidance tool that would cover the development of seawater, brackish groundwater, and brackish surface water desalination in Texas. The proposed tasks included

- building upon existing guidance manuals that the TWDB previously funded,
- updating permitting information to reflect recent statutory changes,
- identifying specific programs within the Texas Commission on Environmental Quality to contact about major permitting components,
- identifying available data from existing desalination facilities,
- addressing surface water desalination,
- expanding on electrodialysis reversal and other advancements in desalination technologies and processes,
- updating desalination costs using current cost information from existing facilities,
- creating a desalination research agenda that identifies future areas for study and demonstration testing to advance desalination implementation in the state.

Research topics may include energy usage and efficiency, concentrate harvesting to recover useful minerals, innovative concentrate management and disposal strategies, and the applicability of various desalination methods and technologies in different parts of Texas.

5.2 Regulatory

The permitting process is an important consideration for pursuing desalination. The City of Corpus Christi and the Port of Corpus Christi Authority are the first to initiate the permitting process for seawater desalination and present a learning opportunity for Texas. Another factor that can affect seawater desalination permitting is public opposition due to environmental concerns, as encountered in the Corpus Christi area.

When desalination initiatives began, there was a need to develop a permitting roadmap that allowed entities to determine the permits required to build a seawater or brackish groundwater desalination plant. As a result, the TWDB funded a study to develop a permit decision model that identifies 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 study also provides an example of how to apply the permit decision model to a seawater desalination plant co-located with a power plant. Currently, there is a need to update the permit decision model and corresponding guidance document for desalination that were prepared 12 and 18 years ago, respectively.

There was also a need to determine the specific permits required to build a seawater desalination plant. A TWDB-funded study determined that a total of 26 federal and state permits may be required to implement a seawater desalination project along the Gulf Coast (Brownsville Public Utilities Board, 2011). The study also included information about the timeframe, costs, and regulatory agencies associated with each permit.

5.3 Technical

Although there are currently brackish groundwater desalination facilities operating in the state and the TWDB has conducted desalination studies, desalination depends on site-specific parameters that require installing monitoring wells and conducting pilot- and demonstration-scale testing for a successful project. Therefore, providing public entities with grant funding for initial testing may help advance the implementation and construction of seawater and brackish groundwater desalination plants.

In addition, the Brownsville and South Padre Island seawater desalination pilot plant studies conducted from 2008 to 2010 tested treatment technologies that are now 14 to 16 years old. Recent advances in desalination technology make the results of these pilot tests dated. Consequently, piloting of more recent and updated technologies may be needed to pursue seawater and brackish groundwater desalination.

5.4 Financial

Despite improvements to reverse osmosis membranes and the increased cost competitiveness of desalination, creating a new water supply from seawater or brackish groundwater is still relatively more expensive than developing supplies from freshwater sources, if available. Desalinating, whether seawater or brackish groundwater, is more costly for a number of reasons, with the higher salinity level (measured in milligrams of total dissolved solids per liter of water) being the key driver. Water with a higher salinity requires more pressure and energy during the treatment process, which increases costs. Other factors that affect cost include the type and location of intake and outfall structures, the size and depth of water supply wells, the pre-treatment process, the brine disposal method, and the length of distribution pipelines. Additionally, the permitting process can increase costs by requiring entities to obtain numerous permits and conduct environmental studies.

Public entities may need financial assistance from the state to implement seawater and brackish desalination projects. The 88th Texas Legislature approved the Texas Water Fund and appropriated $250 million to the New Water Supply for Texas Fund, which can be used to finance new seawater and brackish groundwater desalination projects (TWDB, 2024c; Perry, 2024). Other TWDB financial assistance programs that assist entities with funding desalination projects include the State Water Implementation Fund for Texas, Drinking Water State Revolving Fund, Water Development Fund, and several others. While new funding sources for desalination are available, such as the New Water Supply for Texas Fund, the available funds are limited relative to the cost of large projects. For example, the City of Corpus Christi's proposed seawater desalination projects have a likely cost of more than $750 million as evidenced by past financial commitments that the TWDB has provided to this entity.

To help develop uniform cost estimates for projects across the state, the TWDB funded a study to develop a unified costing model for the 16 regional water planning groups (HDR Engineering, Inc. and Freese and Nichols, 2018). The groups first used the costing tool in the 2017 State Water Plan, which allowed them to employ a standardized costing framework for desalination plants in Texas. The costing model was last updated in November 2018.

6 Evaluation of the role the State should play in furthering the development of large-scale seawater or brackish groundwater desalination projects

The purpose of the seawater and brackish groundwater desalination initiatives in 2002 and 2004 was to accelerate the development of cost-effective desalinated water supplies and innovative technologies in Texas. The ultimate goal of these initiatives was to install desalination plants—with particular focus on a full-scale seawater desalination facility—to demonstrate the potential of desalination as a new water source. Although the early initiatives that focused on desalination demonstrations stalled due to lack of appropriations, funding available through the Texas Water Fund is now available to implement desalination projects in Texas.

The role of the State (Texas Legislature) is to continue providing leadership and support for the advancement of desalination in Texas. Fulfilling this role during the upcoming biennium would require consideration of the following:

- <u>Supporting the advancement of science</u>
  The State can assist by supporting the advancement of seawater and brackish groundwater desalination studies. The TWDB can continue to support entities by providing data and technical support through its existing programs and staff resources.

- <u>Facilitating an efficient permitting process</u>
  The State can assist in the permitting process by facilitating meetings between water providers or municipalities with state agencies. The TWDB can help direct stakeholders to the appropriate agencies. The TWDB can also provide technical reviews associated with brackish groundwater production zone operating permits to support simplifying permitting procedures and providing greater access to brackish groundwater.

- <u>Informing public entities of funding opportunities</u>
  The State can assist by informing public entities of funding opportunities. The TWDB can continue to support cities, counties, utility districts, and other political subdivisions by informing them of the TWDB and federal loan and grant programs, including new funding available through the Texas Water Fund, and providing low-interest loans for water supply projects, including seawater and brackish desalination projects.

7 Anticipated appropriation from general revenues necessary to continue investigating water desalination activities during the next biennium

The TWDB’s baseline budget request for FY 2026-2027 included $1.68 million for the Brackish Aquifer Characterization System Program to continue progress toward meeting statutory requirements for designating brackish groundwater production zones by the legislative deadline of December 1, 2032.

At present, one staff member covers the Desalination Program in the Innovative Water Technologies Department in addition to other job duties. Funding from existing and new programs, such as the New Water Supply for Texas Fund, will play an important role in implementing new desalination projects throughout Texas as desalination continues to grow in importance as a water source for the state.

References

AECOM Technical Services, Inc., 2020, 2021 Regional water plan: Contract report to Lavaca Regional Water Planning Group, 503 p.

AECOM Technical Services, Inc., James Kowis Consulting, LLC, Trungale Engineering & Science, 2020, 2021 Region K water plan: Contract report to Lower Colorado Regional Water Planning Group, 887 p.

Beam, Adam & Hofmann, Bryan, 2024, Port of Corpus Christi will no longer pursue La Quinta desalination location: KRIS 6 News Corpus Christi, retrieved August 2024, https://www.kristv.com/news/local-news/in-your-neighborhood/corpus-christi/port-of-corpus-christi-will-no-longer-pursue-la-quinta-desalination-location

Black & Veatch, 2020, 2021 Rio Grande regional water plan: Contract report to Rio Grande Regional Water Planning Group,1,006 p.

Black & Veatch, Daniel B. Stephens & Associates, Inc., SWCA, and Ximenes Associate, Inc., 2020, 2021 South Central Texas regional water plan, v. 2: Contract report to Rio Grande Regional Water Planning Group, 868 p.

Blandford, T. and Jenkins, R.N., 2016, Regional facility plan Lower Rio Grande Valley: Freese and Nichols, Inc., and University of Texas Pan American, Contract report to the Texas Water Development Board, 141 p.

Brownsville Public Utilities Board, 2011, Texas desal project environmental scoping for seawater desalination plants in Texas: NRS Consulting Engineers, Inc., Contract report to the Texas Water Development Board, 271 p.

California Department of Water Resources, 2024, Projected Brackish Water Desalination Projects in California, retrieved August 2024, https://water.ca.gov/-/media/DWR-Website/Web-Pages/Work-With-Us/Grants-And-Loans/Desalination/Files/Water-Supply-Strategy-Brackish-Desalination-Projects_02-16-24_v2.pdf

California Water Boards, 2024, Ocean plan requirements for seawater desalination facilities, retrieved July 2024, www.waterboards.ca.gov/water_issues/programs/ocean/desalination/

Carollo Engineers, 2018, Barton Springs Edwards Aquifer Conservation District regional plan for desalination and aquifer storage recovery report 1: Contract report 1548321870 to the Texas Water Development Board, 316 p.

City of Corpus Christi, 2020a, TCEQ Water Rights Permit Application Package Inner Harbor, retrieved August 2024 from Corpus Christi Water Inner Harbor Seawater Desalination: https://www.desal.cctexas.com/_files/ugd/d9f0ec_ed0c427f1a514adf9ddcdc4dd459ff11.pdf

City of Corpus Christi, 2020b, TCEQ Water Rights Permit Application Package La Quinta, retrieved August 2024 from Corpus Christi Water Inner Harbor Seawater Desalination: https://www.desal.cctexas.com/_files/ugd/0673fd_a6fc9050b1e54c8ab7a30391674b255c.pdf

City of Corpus Christi, 2020c, City of Corpus Christi Texas Pollutant Discharge Elimination System Application, retrieved August 2024 from Corpus Christi Water Inner Harbor Seawater Desalination: https://www.desal.cctexas.com/_files/ugd/0673fd_d2eadf47e38348ecb4b14f15052776cd.pdf

City of Corpus Christi, 2020d, City of Corpus Christi TCEQ Industrial Wastewater Permit Application, retrieved August 2024 from Corpus Christi Water Inner Harbor Seawater Desalination: https://www.desal.cctexas.com/_files/ugd/0673fd_4a9593c6ce1f444d85181a7c920de7f7.pdf

City of Marathon, 2022, City of Marathon, Florida Ordinance 2021-10, retrieved July 2024, https://www.ci.marathon.fl.us/sites/default/files/fileattachments/ordinance/32051/ordinance_2021-10.pdf

Clow, Rachel, 2023a, EPA declares Port of Corpus Christi's Harbor Island desalination permit a 'draft': KRIS 6 News Corpus Christi, retrieved August 2024, https://www.kristv.com/news/local-news/epa-declares-port-of-corpus-christis-harbor-island-desalination-permit-a-draft

Clow, Rachel, 2023b, Harbor Island desalination permit process hits roadblock: KRIS 6 News Corpus Christi, retrieved August 2024, https://www.kristv.com/news/local-news/harbor-island-desalination-permit-process-hits-roadblock

Congressional Research Service, 2024, Desalination: Converting Saline Water into a Municipal Water Source, retreived July 2024, https://crsreports.congress.gov/product/pdf/IN/IN12378#:~:text=Other%20full%2Dscale%20seawater%20desalination,%2C%20Florida%2C%20and%20other%20states

Construction Journal, 2022, Water Treatment Plant Construction Project Lead, Key West, FL (Monroe County), retrieved July 2024, https://www.constructionjournal.com/projects/details/95bfb25704ae45c684e6f3735b76cef9.html

Core Laboratories, 1972, A survey of the subsurface saline water of Texas: Texas Water Development Board Report 157, 8 volumes, 118 p.

Crow, Kirsten, 2024a, Here’s what commissioners decided on the City of Corpus Christi’s desalination permit: Corpus Christi Caller Times, retrieved August 2024, https://www.caller.com/story/news/local/2024/03/28/state-decides-on-city-of-corpus-christis-desalination-permit/73044465007/

Crow, Kirsten, 2024b, A bigger desal plant? Here are the details on the Port of Corpus Christi's new proposal: Corpus Christi Caller Times, retrieved August 2024, https://www.caller.com/story/news/local/2024/08/21/port-of-corpus-christi-proposes-new-permits-for-harbor-island-desal/74879250007/

Florida Keys Aqueduct Authority, 2020, How is my water treated and purified?, retrieved August 19, 2022, https://www.fkaa.com/169/Drinking-Water

Freese and Nichols, Plummer Associates, Inc., CP & Y, Inc., and Cooksey Communications, 2020a, 2021 Region C water plan: Contract report to Region C Water Planning Group, 1040 p.

Freese and Nichols, Inc. and WSP USA Inc., 2020, 2021 Region F water plan: Contract report to Region F Water Planning Group, 459 p.

Freese and Nichols, WSP USA Inc., and Ekistics Coporation, 2020b, 2021 regional water plan: Contract report to Region H Water Planning Group, 340 p.

Global Water Intelligence, 2024, Desal Data https://www.desaldata.com/

Hami, Eran, 2024, Contentious TCEQ meeting allows all sides to be heard on seawater desalination: KRIS 6 News Corpus Christi, Retrieved August 2, 2024, https://www.kristv.com/news/local-news/in-your-neighborhood/corpus-christi/contentious-tceq-meeting-allows-all-sides-to-be-heard-on-seawater-desalination

HDR Engineering, Inc. and Freese and Nichols, 2018, Unified costing model user's guide version 2: contract report to the Texas Water Development Board, 105 p.

HDR Engineering, Inc., 2020, Coastal Bend regional water planning area Region N 2021 regional water plan: contract report to Coastal Bend Regional Water Planning Group, 1060 p.

HDR Engineering, Inc., Freese and Nichols, and Susan Roth, 2020, 2021 Brazos G regional water plan, v. II: Contract report to Brazos G Water Planning Group, 754 p.

Ingleside on the Bay Coastal Watch Association, 2022, POCCA Desal Plant, retrieved August 2022, https://www.iobcwa.org/port-of-corpus-christi-authority.html

LBG-Guyton Associates, 2003, Brackish groundwater manual for Texas regional planning groups: Contract report to the Texas Water Development Board, 188 p.

Meyer, J.E., 2020, Brackish Resources Aquifer Characterization System database data dictionary: Texas Water Developmnet Board Open-File Report 12-02, fifth edition, 260 p.

Mickley, M.J., 2018, Updated and extended survey of U.S. municipal desalination plants, U.S. Bureau of Reclamation desalination and water purification research and development program report no. 207: 44 p.

NRS Consulting Engineers, Inc. and Boyle Engineering Corporation, 1997, Seawater desalination feasibility study in the Laguna Madre area: Contract report to the Texas Water Development Board, 141 p.

NRS Consulting Engineers, Inc., 2010, Feasibility and pilot study South Padre Island seawater desalination project: Contract report to the Texas Water Development Board, 155 p.

Nicot, Jean-Phillippe, Walden, Steven, Greenlee, Lauren, and Els, John, 2005, A desalination database for Texas: Bureau of Economic Geology, Contract report 2004-483-021 to the Texas Water Development Board, 133 p.

Pankratz, Tom, 2024a, Water desalination report, v. 60, no. 1, 3 p.

Pankratz, Tom, 2024b, Water desalination report, v. 60, no. 28, p. 1-2.

Perry, C., 2024, New Water Supply for Texas Fund Legislative Intent Letter. Senate Committee on Water, Agriculture, and Rural Affairs. Austin, Texas, USA: The Senate of Texas, retrieved August 2024, https://www.twdb.texas.gov/financial/programs/TWF/doc/New-Water-Supply-for-Texas-Fund-Legislative-Intent-Letter.pdf

R.W. Beck, Inc., 2004, Guidance manual for permitting requirements in Texas for desalination facilities using reverse osmosis processes: R.W. Beck, Inc., Contract report to the Texas Water Development Board, 86 p.

South Florida Water Management District, 2023a, Desalination, Retreived August 2024, www.sfwmd.gov/our-work/alternative-water-supply/desalination

South Florida Water Management District, 2023b, 2023 Facilities Using Brackish Groundwater and Seawater in South Florida, retrieved August 2024, https://www.sfwmd.gov/sites/default/files/documents/facilities-using-brackish-groundwater-seawater-2023.pdf

Texas Commission on Environmental Quality, 2024, Port of Corpus Christi Authority of Nueces County TCEQ Docket No. 2021-0421-WR; SOAH Docket No. 582-23-01502. Austin, Texas, USA: Texas Commission on Environmental Quality, retrieved August 2024

TWDB (Texas Water Development Board), 2017 Texas Water Development Board approves $2,750,000 to the City of Corpus Christi (Nueces County) for a seawater desalination project, retrieved August 2024, https://texaswaternewsroom.org/pressreleases/2017-07-20_corpus.html

TWDB (Texas Water Development Board), 2020 Texas Water Development Board approves $222,475,000 to the City of Corpus Christi (Nueces County) for a seawater desalination plant, retrieved August 2024, https://texaswaternewsroom.org/pressreleases/2020-07-23_corpus.html

TWDB (Texas Water Development Board), 2021 Water for Texas, 2022 State Water Plan: Texas Water Development Board, 203 p.

TWDB (Texas Water Development Board), 2024a Texas Water Development Board approves $535,110,000 to the City of Corpus Christi (Nueces County) for a seawater desalination plant, retrieved August 2024, https://texaswaternewsroom.org/pressreleases/2024-7-23_corpuschristi.html

TWDB (Texas Water Development Board), 2024b, Completed Brackish Aquifer Studies: Estimated Storage Volumes (all values are in acre-feet), retrieved August 2024, https://www.twdb.texas.gov/groundwater/bracs/img/BrackishGWVolumes_CompletedStudies_August2024.pdf

TWDB (Texas Water Development Board), 2024c, Proposition 6 and Texas Water Fund Frequently Asked Questions and Implementation Timeline, retrieved August 2024, https://www.twdb.texas.gov/financial/programs/TWF/doc/Proposition6-FAQ-timeline-Jan2024.pdf

U.S. Bureau of Reclamation, 2024, Reclamation awards $1.9M for new water treatment technology, retrieved July 2024, https://www.usbr.gov/newsroom/news-release/4803

Winslow, A.G., and Kister, L.R., 1956, Saline-water resources of Texas: U.S. Geological Survey Water Supply Paper 1365, 105 p.

WSP USA Inc. and Carollo Engineers, 2021, 2021 Plateau region water plan: Contract report to Plateau Water Planning Group, 460 p.

WSP USA Inc. and Freese and Nichols, 2021, 2021 Far West Texas water plan: Contract report to Region H Water Planning Group, 515 p.