# An update on brackish groundwater mapping in Texas by the Texas Water Development Board

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## Introduction

The 2022 State Water Plan estimates that by 2070 Texas will derive 156,897 acre-feet of water per year from desalinated brackish groundwater (TWDB, 2021a). This is an increase from the 2017 State Water Plan which estimated 111,000 acre-feet of water per year from groundwater desalination (TWDB, 2016). The TWDB defines brackish groundwater as water with total dissolved solids (TDS) between 1,000 and 10,000 mg/L. The state water planning process reveals that stakeholders across the state have a continued interest in developing brackish groundwater resources. Crucial to developing these supplies is establishing basic knowledge of where brackish groundwater occurs in the state, estimating groundwater salinity, and estimating storage volumes.

## History

The first statewide water salinity study in Texas was conducted by Winslow and Kister (1956) during the Texas "drought of record" from October 1950 to February 1957 (TWDB, 2021a). In this statewide survey, they discuss water-bearing geologic units in Texas, provide summarized information about known salinity, and make qualitative estimates about potential saline groundwater volumes. In their report, Winslow and Kister note that "despite the large quantities of surface or underground saline water available almost everywhere, these waters have not been studied as sources of potable water" (Winslow and Kister, 1956). After this report, Texas made slow strides in studying brackish groundwater until the 2000s.

The next report on saline groundwater in Texas was a contracted report prepared by Core Laboratories for the TWDB in 1972 (Core Laboratories, 1972). In this report, information regarding the salinity and productivity of the water-bearing geologic formations of Texas was summarized. As an improvement from Winslow and Kister (1956), Core Laboratories (1972) mapped groundwater salinity from both measured water quality data and salinity estimations derived from geophysical well logs. Although Core Laboratories (1972) improved salinity mapping by mapping beyond available measured water quality, they state that "[this report] provides the groundwork for future investigations and more detailed studies."

The next statewide survey of groundwater salinity (LBG-Guyton, 2003) illuminated brackish groundwater for consideration in the Regional Water Planning process. The study only focused on the major and minor aquifers of Texas instead of all water-bearing geologic strata, and it provided best estimates of brackish groundwater volumes in the state. LBG-Guyton (2003) utilized existing water quality samples to map aquifer salinity within the Board designated footprint of the major and minor aquifers, and prepared volume estimates for the 1,000 to 10,000 mg/L TDS range. The study concluded that more than 2.5 billion acre-feet of brackish groundwater occur in these aquifers.

## Recent brackish groundwater mapping

In 2009, the 81st Texas Legislature funded the establishment of the Brackish Resources Aquifer Characterization System (BRACS) program. The goal of the BRACS program is to improve on existing knowledge of the state's brackish groundwater resources. Since BRACS was established, the program has completed thirteen mapping projects with groundwater volume estimates produced for twelve of the studies. To date, BRACS has estimated there are more than 3.8 billion acre-feet of brackish groundwater (1,000 to 10,000 mg/L TDS) in the state with an additional 13 aquifers or portions of aquifers to map by 2032. Summaries of estimated volumes are in Table 1 and a map of completed aquifer studies is presented in Figure 1.

BRACS studies map aquifer salinity from outcrop to approximately 35,000 mg/L TDS downdip. This typically expands what we know about the aquifers of Texas, as most are mapped and designated up to 3,000 mg/L TDS. We accomplish this mapping by first gathering oil and gas geophysical well logs, water well data, driller's lithology descriptions, water quality sample data, etc. and processing it into the downloadable BRACS database (http://www.twdb.texas.gov/groundwater/bracs/database.asp). Next, we map the aquifer framework by making stratigraphic picks on geophysical well logs, and then interpolate the picks in GIS to make stratigraphic surfaces. We may also interpret net sands from a well log. Then, we'll interpret groundwater salinity from resistivity tools on the geophysical well logs and map salinity in the aquifer. Finally, we will estimate volumes of brackish groundwater in the aquifer by using either aquifer properties or aquifer properties and net sand thicknesses. Figures 2 through 4 show example maps from various aquifer studies.

We record study methodologies and results in publicly available reports. In addition to releasing reports, we make data used and generated by the study, including geophysical well logs and GIS datasets, publicly available. To download reports or datasets, please visit http://www.twdb.texas.gov/groundwater/bracs/studies.asp.

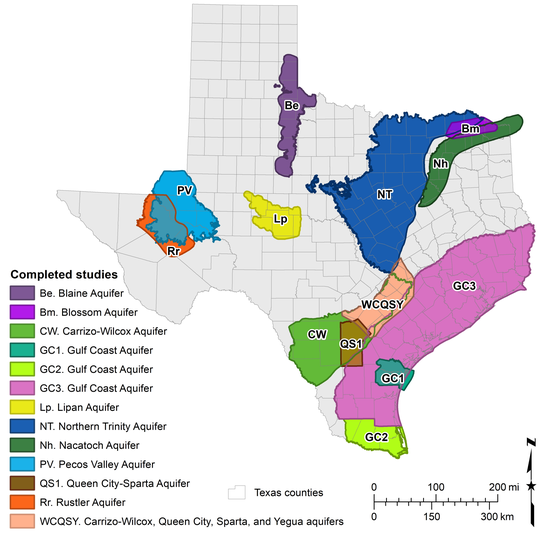


**Figure 1.** Completed BRACS studies. Refer to Table 1 for summaries on estimated brackish groundwater storage volumes.

**Table 1.** Brackish groundwater storage volumes estimated and mapped by BRACS from 2012 to present. Map identifier refers to Figure 1. CCASR = Corpus Christi Aquifer Storage and Recovery District. LRGV = Lower Rio Grande Valley.

| Aquifer | Map identifier | Brackish groundwater storage volume (acre-feet) | | Reference |
|---|---|---|---|---|
| Blaine | Be | 17,896,879 | | Finch et al., 2016 |
| Blossum | Bm | 1,880,000 | *** | Andrews and Croskrey, 2019 |
| Carrizo-Wilcox (South) | CW | | * | TWDB, 2016 |
| Gulf Coast (CCASR) | GC1 | | ** | Meyer, 2012 |
| Gulf Coast (LRGV) | GC2 | 152,000,000 | | Meyer et al., 2014 |
| Gulf Coast | GC3 | 2,030,000,000 | | Young et al., 2016 |
| Lipan | Lp | 6,050,000 | | Robinson et al., 2018 |
| Trinity (North) | NT | 1,189,000,000 | | Robinson et al., 2019 |
| Nacatoch | Nh | 5,700,000 | *** | Croskrey et al., 2019 |
| Pecos Valley | PV | 85,000,000 | | Meyer et al., 2012 |
| Queen City and Sparta (McMullen and Atascosa) | QS1 | 58,260,000 | | Wise, 2014 |
| Rustler | Rr | 18,077,000 | | Lupton et al., 2016 |
| Carrizo-Wilcox, Queen City, Sparta, and Yegua (Central) | WCQSY | 237,000,000 | *** | Meyer et al., 2020 |
| Total | | 3,800,863,879 | | n/a |

* = Volumes were calculated for the brackish groundwater production zones.
** = Volumes were not calculated.
*** = Volume does not include brackish groundwater mapped with fresh or more saline water in mixed classes.

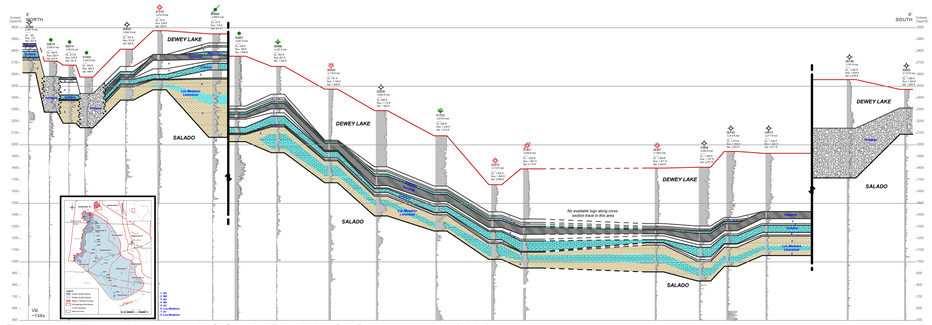


**Figure 2.** North to south cross-section O-O' in the Rustler Aquifer. From Lupton et al. (2016).

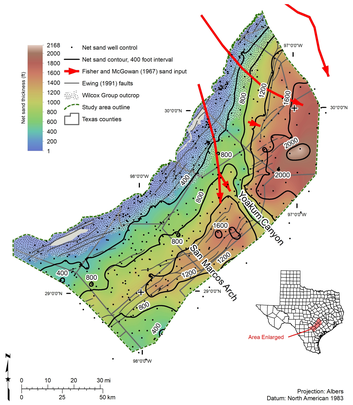


**Figure 3.** Net sand thickness (feet) map for the Wilcox Group within the Upper Coastal Plains Central study area. Note the effect of the Yoakum Canyon on sand distribution. From Meyer et al. (2020).

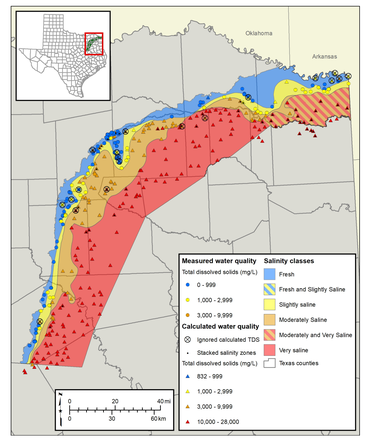


**Figure 4.** Mapped salinity classes for the Nacatoch Aquifer. Fresh = 0-1,000 mg/L TDS, Slightly Saline = 1,000-3,000 mg/L TDS, Moderately Saline = 3,000-10,000 mg/L TDS, and Very Saline = 10,000-35,000 mg/L TDS. From Croskrey et al. (2019).

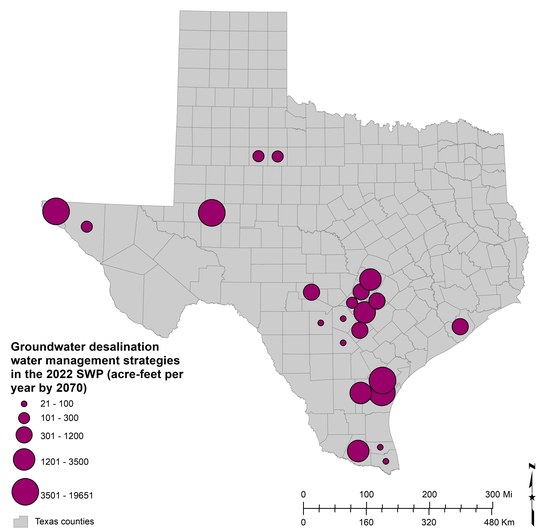


**Figure 5.** Water supply volumes by 2070 from groundwater desalination water management strategies in the 2022 State Water Plan (SWP). Note: locations are approximate and set to county centers.

BRACS study web page

BRACS database web page

Desalination database web page

## Trends in brackish groundwater use

Water desalination has grown in Texas since 1999. The number of plants has grown, and total capacity has grown more than seven-fold since 1999 to more than 175,000 acre-feet per year (Figure 6). Brackish groundwater supplies 39 of the 56 desalination plants in the TWDB Desalination Database and is the source water for 57% of the capacity (TWDB, 2021b).

Brackish groundwater desalination is expected to grow in the future. Current brackish groundwater desalination supplies approximately 100,000 acre-feet per year of desalinated water (TWDB, 2021b), but the 2022 State Water Plan projects groundwater desalination will supply more than 156,000 acre-feet per year of desalinated water by 2070 (TWDB, 2021a). West, Central, and South Texas display the most interest in new or expanded brackish groundwater desalination as shown in Figure 5. Brackish groundwater mapping completed to date and to be completed by 2032 (S.B. 1041, 2019) will provide basic information, like estimated groundwater salinity maps and volumes, that can be used by stakeholders interested in developing groundwater desalination. Additionally, this information will be crucial in mapping and designating brackish groundwater production zones (BGPZs), which is to be completed by 2032.

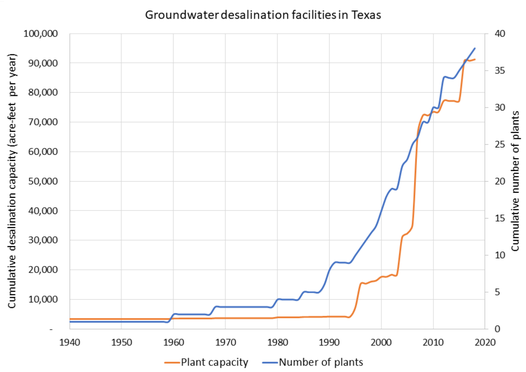


**Figure 6.** Cumulative number of groundwater desalination plants and cumulative groundwater desalination capacity in Texas. Data compiled for this graphic includes desalination plants that use groundwater, are for municipal purposes, and have an individual capacity of greater than 0.023 million gallons per day.

## Brackish groundwater production zones

In 2015, the Texas Legislature directed the TWDB to designate BGPZs. These are portions of aquifers that can produce significant volumes of brackish groundwater over 50 years without causing significant impact to water availability or water quality (H.B. 30, 2015). Several mapping criteria are required and presented in Table 2. To date, the TWDB has designated 31 BGPZs that are estimated to supply more than 120,000 acre-feet per year of brackish groundwater over 50 years.

**Table 2.** Brackish groundwater production zone designation criteria.

| BGPZ designation criteria | Texas Water Code (TWC) language | Reference |
|---|---|---|
| Must have sufficient brackish groundwater | "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" | TWC Chapter 16 § 060 |
| Must have hydrogeologic barriers between brackish and fresh groundwater | "are separated by hydrogeologic barriers sufficient to prevent significant impacts to water availability or water quality in any area of the same or other aquifers, subdivisions of aquifers, or geologic strata that have an average total dissolved solids level of 1,000 milligrams per liter or less at the time of designation of the zones" | TWC Chapter 16 § 060 |
| Cannot be located within these boundaries | • "an area of the Edwards Aquifer subject to the jurisdiction of the Edwards Aquifer Authority"<br>• "Barton Springs-Edwards Aquifer Conservation District"<br>• "Harris-Galveston Subsidence District"<br>• "Fort Bend Subsidence District"<br>• "a district that…overlies the Dockum Aquifer; and…includes wholly or partly 10 or more counties" | TWC Chapter 16 § 060, TWC Chapter 36 § 1015 |
| Brackish groundwater cannot be already in use | "an aquifer, subdivision of an aquifer, or geologic stratum that…is serving as a significant source of water supply for municipal, domestic, or agricultural purposes at the time of designation of the zones" | TWC Chapter 16 § 060 |
| Aquifer cannot be used for wastewater injection | "an area of a geologic stratum that is designated or used for wastewater injection through the use of injection wells or disposal wells permitted under Chapter 27" | TWC Chapter 16 § 060 |

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