# Brazos Valley Groundwater Conservation District

# Groundwater Management Plan

## ADOPTED

***APPROVED BY THE TEXAS WATER DEVELOPMENT BOARD ON***
***DECEMBER 20, 2023***

***OBJECTIVES AMENDED BY ACTION OF THE BOARD ON***
***NOVEMBER 16, 2023***

# BRAZOS VALLEY GROUNDWATER CONSERVATION DISTRICT

## GROUNDWATER MANAGEMENT PLAN

## TABLE OF CONTENTS

## FIGURES



## TABLES

PAGE LEFT BLANK

## 1. MISSION STATEMENT:

The Brazos Valley Groundwater Conservation District (BVGCD) was authorized to be created by the Texas Legislature to protect and conserve the groundwater resources of Robertson and Brazos counties through local management in concert with Groundwater Management Area 12 (GMA 12). The District directs its efforts toward preventing waste of water, collecting data, promoting water conservation, protecting existing water rights, and preventing irreparable harm to the aquifers. The District's rules and management plan are based on the best available science, the laws and rules in effect, and the area's beneficial needs.

## 2. TIME PERIOD FOR THIS PLAN:

This plan becomes effective upon adoption by the BVGCD Board of Directors and subsequent approval by the Texas Water Development Board (TWDB). The Management Plan is based on a ten-year planning period; however, the plan may be revised at any time to ensure that it is consistent with the applicable Regional Water plans, the State Water Plan, and additional science that may be developed. The District's Board of Directors shall re-adopt the management plan, with or without revisions, at least every five years.

## 3. STATEMENT OF GUIDING PRINCIPLES:

A vast majority of the residents of Brazos and Robertson counties rely solely on the local groundwater supplies to meet their drinking water needs and the majority of their industrial, agricultural, and livestock needs. Therefore, the local groundwater resources are vital to the Brazos Valley's growth, health, economy, and environment. The District believes this valuable resource can be managed in a reasonable manner through conservation, education, and regulation. The overall management goal will be to ensure a sustainable supply of water from local groundwater resources while recognizing the need to balance protection of rights of private landowners with the responsibility of managing the area's groundwater resources for future generations. A basic understanding of local aquifers and their hydrogeological properties, as well as quantification of available water supplies, is the foundation for development of prudent management strategies. The Carrizo-Wilcox Aquifer, as well as the minor aquifers in the area, must be conserved and preserved for future generations to the extent allowed by law and made possible through implementation of scientific data and information collected by the District. This Management Plan is intended as a tool for the District to provide continuity and consistency in decision making and to develop an understanding of local aquifer conditions for implementation of proper groundwater management policies.

The District has a responsibility to continually monitor aquifer conditions. As conditions warrant, this document may be modified to best serve the District in meeting its goals. At a minimum, the District Board will review and re-adopt this plan every five years.

## 4. DISTRICT INFORMATION

### A. Creation

The BVGCD was originally created as a temporary District by the 76th Legislature in 1999 through Senate Bill 1911. The District then operated with all of the powers granted to groundwater conservation districts by Chapter 36 of the Texas Water Code (TWC), except the authority to adopt a management plan or levy an ad-valorem tax. The District was ratified by House Bill 1784 in the 77th Legislative Session in 2001 and was subsequently confirmed by the voters of both Brazos and Robertson counties in a general election held on November 5, 2002. The District was then granted full authorities afforded groundwater conservation districts by Chapter 36 of the TWC, limited only by provisions of the District's enabling legislation. The District's enabling act has been codified in Chapter 8835 of the Special Districts and Local Laws Code.

The District was created to implement proper management techniques at the local level to address groundwater needs that are vital to Brazos and Robertson counties. The District directs its efforts toward preventing waste of groundwater, collecting data, and providing education about water conservation, protecting existing water rights, and preventing irreparable harm to the aquifers. This plan provides a template for the District to follow, aiding in the development of an understanding of local aquifer conditions for implementation of proper groundwater management policies.

### B. Location and Extent

The District encompasses Brazos and Robertson counties in Central Texas. The boundaries of the District are coterminous with the counties' boundaries. The District is bordered by Falls and Limestone counties to the North; Grimes and Washington counties to the South; Madison, Leon and Grimes counties to the East; and Milam and Burleson counties to the West. The District comprises an area of approximately 1,456 square miles or 932,000 acres.

### C. Background

The District's Board of Directors consists of eight (8) members appointed by their respective County Commissioners Courts. Four (4) members represent Robertson County and four (4) members represent Brazos County. The directors are appointed to represent the following interests:

Robertson County

1. One must represent municipal interests in the county.
2. One must be a bona fide agricultural producer who derives a substantial portion of his or her income from agriculture in the county.
3. One must be an employee or director of a rural water supply corporation in the county.
4. One must represent active industrial interests in the county.

Brazos County

1. One must be an employee or director of a rural water supply corporation in the county.
2. One must be a bona fide agricultural producer who derives a substantial portion of his or her income from agriculture in the county.
3. The governing body of the City of Bryan, with the approval of the Brazos County Commissioners Court, shall appoint one Director.
4. The governing body of the City of College Station, with the approval of the Brazos County Commissioners Court, shall appoint one Director.

## D. Authority/Regulatory Framework

In the preparation of its management plan, the District followed all procedures and satisfied all requirements of Chapter 36 of the TWC and Chapter 356 of the TWDB rules contained in Title 30 of the Texas Administrative Code (TAC). The District exercises the powers it was granted and authorized to use by and through the special and general laws that govern it, including Chapter 1307, Acts of the 77th Legislature, Regular Session, 2001, and Chapter 36 of the TWC.

## E. Groundwater Resources of the Brazos Valley Groundwater Conservation District

The five significant aquifers within the District's boundaries are the Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, and Brazos River Alluvium aquifers. The Simsboro Sand is the most prolific water-yielding unit and is part of the Carrizo-Wilcox Aquifer. The Brazos River Alluvium, located near the Brazos River, is the next most prolific aquifer. The Queen City, Sparta, and Yegua-Jackson aquifers provide small to large pumping rates of useable groundwater to wells, as noted in Groundwater Resources of Brazos and Burleson Counties, Texas, Report 185 (Follett, 1974). A large pumping rate is defined as 200 gallons per minute or more. The vertical sequence of geologic units in descending order is listed in *Figure 1*. The Carrizo-Wilcox (Simsboro Sand) and Sparta aquifers provide water for large capacity public water supply and agricultural wells. Water from the Yegua-Jackson Aquifer is used for domestic, livestock, irrigation, industrial, and some minor retail public water supply use. Brazos River Alluvium wells are used mostly for agricultural irrigation purposes. The outcrop of the Gulf Coast aquifer occurs in the very southern part of the District providing a small amount of water for domestic and livestock wells.

The primary freshwater aquifers consist of sandy fluvial and deltaic sediments, while marine silts and clays act as aquitards separating the water-yielding zones. The Wilcox Group, from the shallowest to the deepest, consists of the Calvert Bluff, Simsboro Sand, and Hooper aquifers. No freshwater aquifers are located below the Midway, which is a thick impermeable clay located at the base of the Hooper Aquifer. The Calvert Bluff Aquifer is comprised of clay, sandy clay, shale, silt, and sand. The Simsboro Sand is generally composed of sand, while the Hooper Aquifer is made up of sand, silt, clay, and shale. The Simsboro Sand is older than the Calvert Bluff, Carrizo, Queen City, Sparta, and Yegua-Jackson aquifers. The Carrizo Sand and Queen City Sand are separated by the Reklaw, which is a clay rich zone. The Cook Mountain Formation is composed of mostly clay separating the Sparta Sand and Yegua-Jackson aquifers. The Catahoula Sandstone or Catahoula Aquifer of the Gulf Coast Aquifer is composed of clay and sand in cross-bedded lenses. The Brazos River Alluvium can be found in a two-to-six-mile-wide zone of floodplain alluvial deposits along the Brazos River on the western boundary of the District. Sand, small gravel and clay compose the relatively thin Brazos River Alluvium. *Figure 2* illustrates a geologic cross section through Brazos and Robertson Counties and depicts the position, depth, thickness, and dip of the aquifers and confining units.

| System | Series | Geologic Unit | Hydrogeologic Unit |
|---|---|---|---|
| Quaternary | Holocene | Flood-plain alluvium | Brazos River alluvium |
| Quaternary | Pleistocene | Terrace deposits | |
| Tertiary | Miocene | Catahoula Sandstone | Gulf Coast aquifer |
| Tertiary | Eocene | Jackson Group<br>Whitsett Formation<br>Manning Formation<br>Wellborn Formation<br>Caddell Formation | Yegua-Jackson aquifer |
| Tertiary | Eocene | Yegua Formation | Yegua-Jackson aquifer |
| Tertiary | Eocene | Cook Mountain Formation | |
| Tertiary | Eocene | Sparta Sand | Sparta aquifer |
| Tertiary | Eocene | Weches Formation | |
| Tertiary | Eocene | Queen City Sand | Queen City aquifer |
| Tertiary | Eocene | Reklaw Formation | |
| Tertiary | Eocene | Carrizo Sand | Carrizo-Wilcox aquifer |
| Tertiary | Eocene | Wilcox Group<br>Calvert Bluff<br>Simsboro<br>Hooper | Carrizo-Wilcox aquifer |

**Figure 1: Geologic Units**

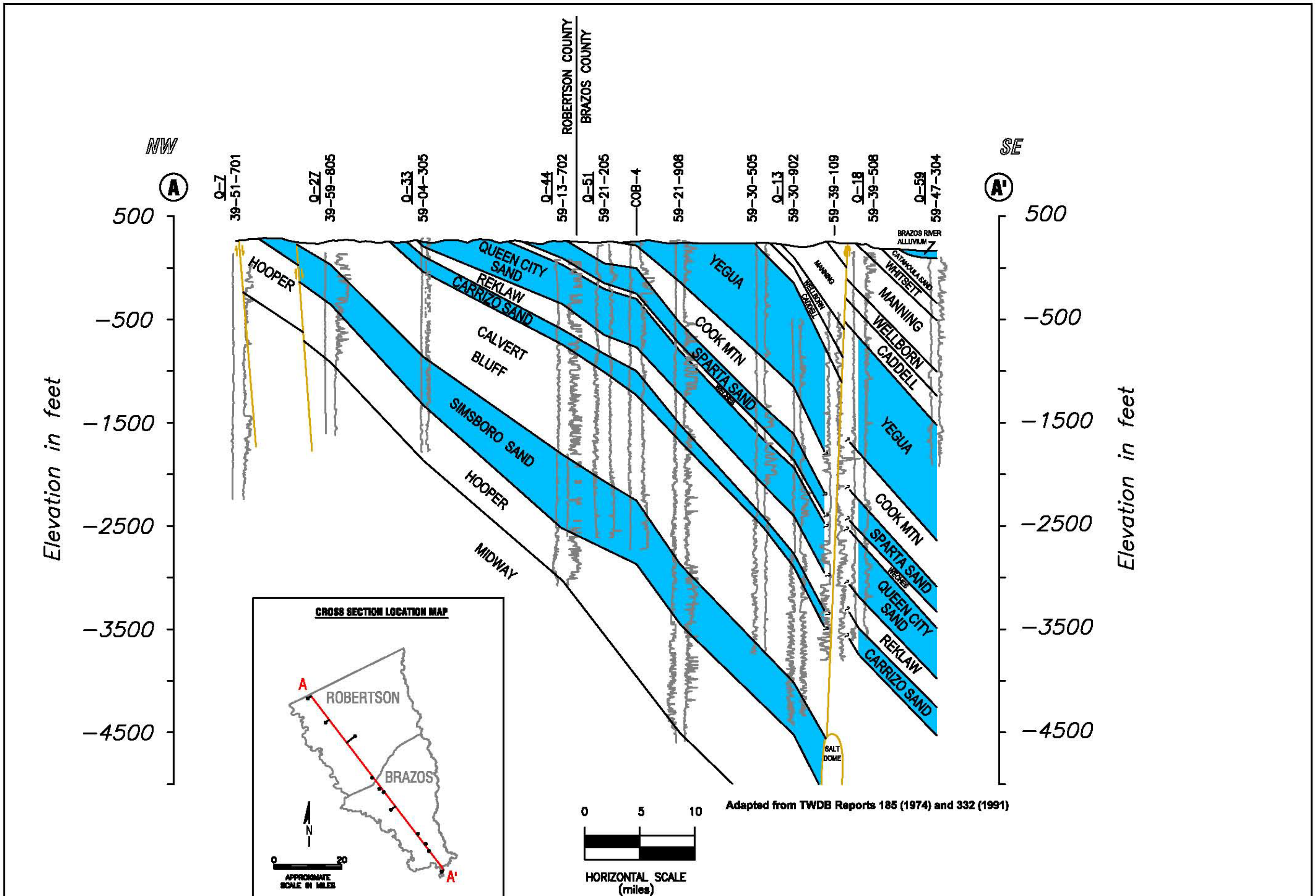
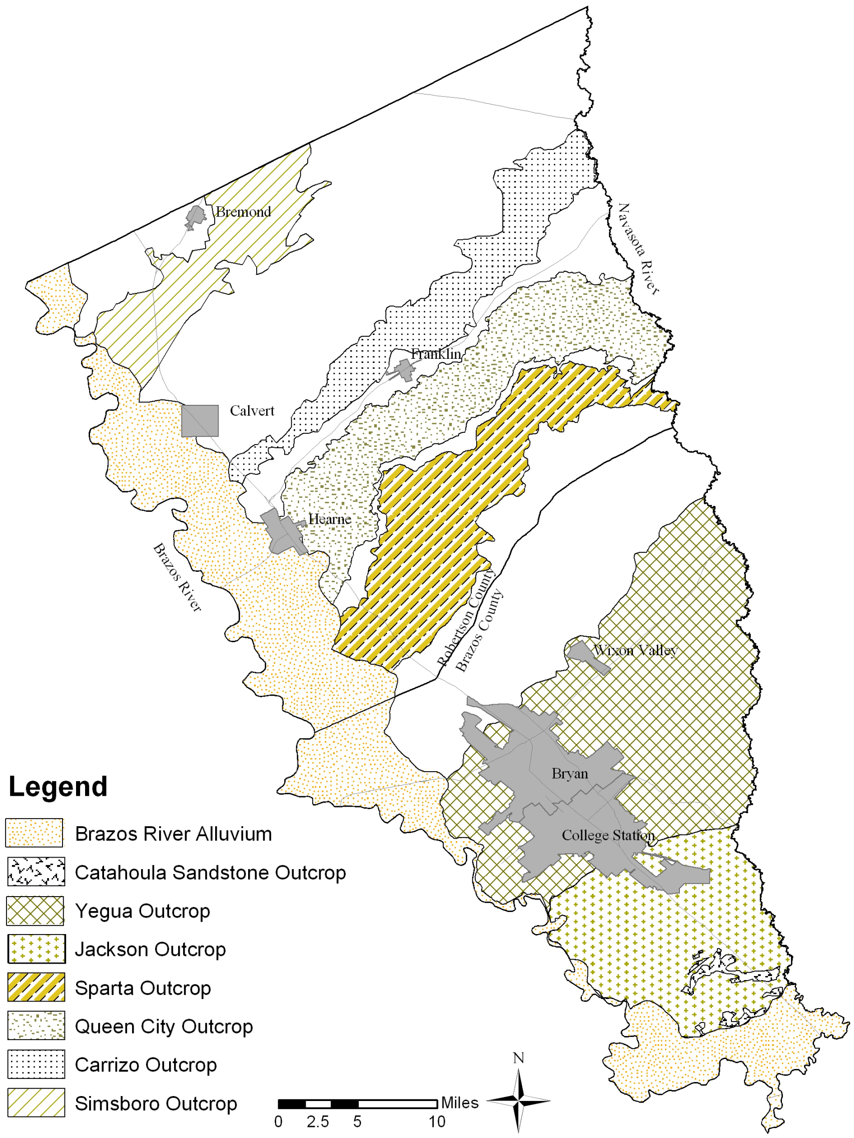


Figure 2: Geologic Cross Section

The Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson aquifers outcrop within the District's boundaries in northeast to southwest trending belts paralleling the Gulf coastline. An aquifer outcrop map is included for Brazos and Robertson counties in *Figure 3*. The aquifer outcrops extend outside of the two counties shown on the map.

**FIGURE 3: AQUIFER OUTCROPS LOCATED IN BRAZOS AND ROBERTSON COUNTIES**



Younger aquifers outcrop closest to the coast. Older aquifers outcrop progressively further inland with increased age of the aquifer. The Catahoula Sandstone, which is the basal sand of the Gulf Coast Aquifer, occurs in a very limited area in the southern tip of Brazos County.

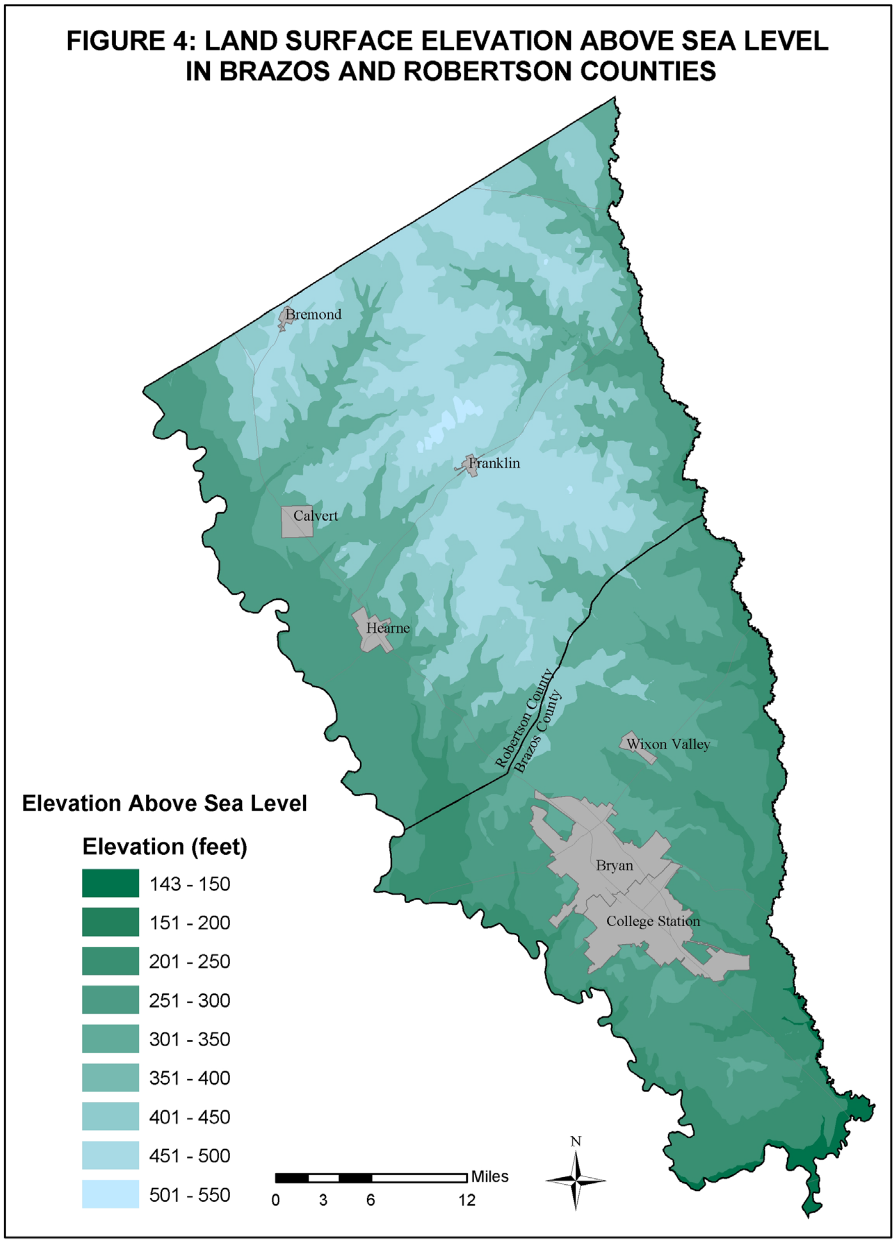
The general trend of the aquifers, except for the Brazos River Alluvium, is to dip underground southeastward towards the Gulf Coast from their surface exposure. The aquifers dip at a maximum rate of about 110 feet per mile. Each aquifer underlies younger aquifers that have a similar dip toward the coast. A salt dome occurs in the southern part of Brazos County. The top of the salt dome occurs at an elevation of about -4,600 feet relative to sea level and the approximate location of the dome is shown on Figure 2. The thickness and position of the Simsboro Sand is influenced by the salt dome, but the dome occurs significantly down dip of the area where the Simsboro Sand contains potable quality groundwater.

**Topography and Drainage**

Natural topography in Brazos and Robertson counties range from gently hilly terrain in the center of the counties to relatively flat terrain along the Brazos and Navasota river corridors. The western border of the counties is the Brazos River and the eastern is the Navasota River. The land surface elevation above sea level for Brazos and Robertson counties is shown on *Figure 4*. Altitudes in the District range from about 140 feet to 590 feet above mean sea level, with higher elevations in the center of the counties.

Numerous creeks drain runoff into the Brazos River, west of the surface water drainage divide and into the Navasota River east of the divide. At the southernmost tip of Brazos County, the Navasota River merges with the Brazos River. Drainages include Carters Creek, Cedar Creek, Duck Creek, Mud Creek, Peach Creek, Pin Oak Creek, Spring Creek, Thompson Creek, Walnut Creek, Wickson Creek, and the Little Brazos River. The Little Brazos River drains Walnut Creek, Mud Creek, Pin Oak Creek, and Spring Creek into the Brazos River.

Carters Creek has a stream gradient of about 10 feet per mile towards the Navasota River from its origin in central Brazos County. Cedar Creek drains from central Robertson County through Brazos County to the Navasota River and has a stream gradient of about 9 feet per mile. Duck Creek has a stream gradient of about 7 feet per mile and drains northeast Robertson County into the Navasota River. Mud Creek drains central Robertson County into the Little Brazos River and has a stream gradient of about 10 feet per mile. Peach Creek has a stream gradient of about 12 feet per mile and drains southern Brazos County into the Navasota River. Pin Oak Creek drains southern Robertson County into the Little Brazos River and has a stream gradient of about 22 feet per mile. Spring Creek has a stream gradient of about 17 feet per mile and drains southern Robertson County into the Little Brazos River. Thompson Creek drains northwest Brazos County into the Brazos River and has a stream gradient of about 11 feet per mile. Walnut Creek has a stream gradient of about 7 feet per mile and drains northwestern Robertson County into the Little Brazos River. Wickson Creek drains central Brazos County into the Navasota River and has a stream gradient of about 8 feet per mile.




**F.** **Surface Water Resources of Brazos and Robertson Counties**

Brazos and Robertson counties are within the Region G Regional Water Planning Group commonly designated as Brazos G. Each regional water group supplies their specific assessments to TWDB for incorporation into the State water plan.

Projected surface water supplies are the maximum amount of surface water available from existing sources for use during drought of record conditions that is physically and legally available for use. These are the existing surface water supply volumes that, without implementing any recommended water management strategies, could be used during a drought by water user groups located within the specified geographic area.

Surface water sources include any water resources where water is obtained directly from a surface water body. This would include rivers, streams, creeks, lakes, ponds, and tanks. In the State of Texas, all waters contained in a watercourse (rivers, natural streams and lakes, and storm water, flood water, and rainwater of every river, natural stream, canyon, ravine, depression, and watershed) are waters of the State and thus belong to the State. The State grants individuals, municipalities, water suppliers and industries the right to divert and use this water through water rights permits. Water rights are considered property rights and can be bought, sold, or transferred with state approval. These permits are issued based on the concept of prior appropriation, or "first-in-time, first-in-right." Because of the interruptible nature of these permits, water is not always available to all permit holders when low streamflow occurs. Water rights issued by the State generally fall into two major categories: run-of-river rights and stored water rights.

In addition to the water rights permits issued by the State, individual landowners may use State waters without a specific permit for certain types of uses. The most common of these uses is domestic and livestock use. These types of water sources are generally referred to as "Local Supply Sources". Many individuals with land along a river or stream that still have an old riparian right can also divert a reasonable amount of water for domestic and livestock uses without a permit.

## 5. REQUIRED ESTIMATES: 31 TAC 356.5(a)(5)(A)-(G

### A. Adopted Desired Future Conditions (2021).

The District's current DFCs for the area covered by GMA 12 are the average drawdowns listed in *Table 1*. The average drawdowns are for a 70-year period beginning January 2000 and ending December 2069. For each of the aquifers, the DFC average drawdowns are for the area covered by each aquifer in Brazos and Robertson counties as defined by the stratigraphy used in the TWDB Groundwater Availability Models (GAMs). The GMA 12 2020 update for the Central portion of the Sparta, Queen City, and Carrizo-Wilcox GAM was used to develop DFCs for the Sparta, Queen City, Carrizo, Calvert Bluff, Simsboro and Hooper aquifers. The Yegua-Jackson Aquifer GAM released in 2010 was used to develop DFCs for the Yegua and Jackson aquifers and the Brazos River Alluvium GAM released in 2016 was used to develop DFCs for the Brazos River Alluvium.

| Table 1. Adopted Aquifer DFCs based on the Average Threshold that occurs between 2000 and 2070. Yegua-Jackson (2010-2069), Brazos River Alluvium (2013-2070) | Artesian Head (ft) Adopted DFCs – 2016 | Artesian Head (ft) Adopted DFCs – 2021 |
|---|---|---|
| Sparta | 12 | 53 |
| Queen City | 12 | 44 |
| Carrizo | 61 | 84 |
| Upper Wilcox (Calvert Bluff Formation) | 125 | 111 |
| Middle Wilcox (Simsboro Formation) | 295 | 262 |
| Lower Wilcox (Hooper Formation) | 207 | 167 |
| Yegua-Jackson | Yegua – 70<br>Jackson – 114 | 67 |
| Brazos Alluvium Aquifer | | North of State Highway 21: Percent saturation shall average at least 30% of total well depth from January 2013 to December 2069.<br><br>South of State Highway 21: Percent saturation shall average at least 40% of total well depth from January 2013 to December 2069. |

*A. Resolution to Adopt Desired Future Conditions, November 30, 2021, letter from Gary Westbrook, General Manager, Post Oak Savannah GCD to Jeff Walker, Executive Administrator, Texas Water Development Board (Sparta, Queen City, Carrizo, Upper Wilcox, Middle Wilcox, Lower Wilcox, Yegua,, Jackson, and Brazos River Alluvium). .*

## B. <u>Changes to the DFCs Between 2016 & 2021</u>

Changes to the DFCs for the Sparta, Queen City, and Carrizo-Wilcox aquifers occurred between the 2016 and 2021 planning cycles and are listed in *Table 1* above. The primary reason for these modifications is the updating of the GAM for the Central portion of the Sparta, Queen City, and Carrizo-Wilcox. Districts had collected static water level measurements from monitoring wells and groundwater pumping data for years indicating the GAM needed to be updated and improved. The TWDB along with GMA 12 funded the 2018 update resulting in a substantially improved GAM followed by a local improvement to the GAM completed in 2020. The improved GAM predicted different amounts of artesian head decline to pumping than the previous GAM resulting in modifications to the DFCs used by the District as part of the 2021 cycle of GMA 12 planning.

The DFCs for the Yegua-Jackson Aquifer changed slightly due to an amalgamation of the DFCs for the Yegua Aquifer and Jackson Aquifer into one DFC for the combined aquifer. This action mirrors the other members of GMA 12 whose DFCs have always seen the Yegua-Jackson as one aquifer for planning purposes.

There was no change in the DFCs for the Brazos River Alluvium Aquifer.

## C. Modeled Available Groundwater (TWDB Estimates – 2021)

Section 36.001 of the TWC defines modeled available groundwater (MAG) as "the amount of water that the Executive Administrator [of the TWDB] determines may be produced on an average annual basis to achieve a desired future condition established under §36.108." Desired future condition (DFC) is defined in §36.001 of the TWC as "a quantitative description, adopted in accordance with §36.108 of the Texas Water Code, of the desired condition of the groundwater resources in a management area at one or more specified future times." The District participates in the joint planning process in GMA 12, as defined per TWC §36.108, and established DFCs for aquifers within the District. MAG values are enumerated in *Appendix D*.

The TWDB's **MAG Estimates** based on GMA 12 adopted DFCs: GAM Run 21-017 MAG and cover years 2020-2070. The 2010 modeled available groundwater values represented in all the charts below were generated from the previous GAM Run 17-030 MAG as were the 2013 values for the Brazos River Alluvium Aquifer.

### Carrizo

Modeled Available Groundwater for the Carrizo Aquifer summarized by county in GMA 12 for each decade between 2010 and 2070. Results are in ac-ft/yr.

| County | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| Brazos | 1,196 | 864 | 1,444 | 2,023 | 2,603 | 3,183 | 3,763 |
| Robertson | 887 | 81 | 412 | 743 | 1,074 | 1,405 | 1,736 |

### Calvert Bluff

Modeled Available Groundwater for the Calvert Bluff Aquifer summarized by county in GMA 12 for each decade between 2010 and 2070. Results are in ac-ft/yr.

| County | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| Brazos | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Robertson | 776 | 252 | 546 | 841 | 1,136 | 1,430 | 1,725 |

### Simsboro

Modeled Available Groundwater for the Simsboro Aquifer summarized by county in GMA 12 for each decade between 2010 and 2070. Results are in ac-ft/yr.

| County | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| Brazos | 35,086 | 37,282 | 42,709 | 48,137 | 53,565 | 58,993 | 64,421 |
| Robertson | 37,236 | 38,219 | 47,140 | 56,061 | 64,982 | 73,903 | 82,824 |

### Hooper

Modeled Available Groundwater for the Hooper Aquifer summarized by county in GMA 12 for each decade between 2010 and 2070. Results are in ac-ft/yr.

| County | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| Brazos | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Robertson | 836 | 798 | 1,066 | 1,334 | 1,603 | 1,871 | 2,139 |

**Queen City**

Modeled Available Groundwater for the Queen City Aquifer summarized by county in GMA 12 for each decade between 2010 and 2070. Results are in ac-ft/yr.

| County | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| Brazos | 541 | 133 | 245 | 357 | 469 | 582 | 694 |
| Robertson | 0 | 36 | 144 | 252 | 359 | 467 | 575 |

**Sparta**

Modeled Available Groundwater for the Sparta Aquifer summarized by county in GMA 12 for each decade between 2010 and 2070. Results are in ac-ft/yr.

| County | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| Brazos | 3,745 | 4,483 | 6,014 | 7,545 | 9.076 | 10,607 | 12,138 |
| Robertson | 16 | 167 | 338 | 509 | 680 | 851 | 1,022 |

**Yegua-Jackson**

Modeled Available Groundwater for the Yegua-Jackson Aquifer summarized by county in GMA 12 for each decade between 2010 and 2070. Results are in ac-ft/yr.

| County | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| Brazos | 6,863 | 4,207 | 6,270 | 7,092 | 7,091 | 7,091 | 7,091 |
| Robertson | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

**Brazos River Alluvium**

Modeled Available Groundwater for the Brazos River Alluvium Aquifer summarized by county in GMA 12 for each decade between 2013 and 2070. Results are in ac-ft/yr.

| County | 2013 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| Brazos | 122,785 | 77,816 | 76,978 | 76,393 | 76,195 | 76,100 | 76,039 |
| Robertson | 66,608 | 55,907 | 55,424 | 55,157 | 54,839 | 54,723 | 54,618 |

## D. Compliance with the Adopted 2021 DFCs

Under TWC §36.108.31, TAC 356.52(a)(1)(H) and TWC §36.1071(a)(8), it is incumbent upon the District to remain in compliance with the adopted DFCs. The beginning year of the Desired Future Conditions is 2000 and currently ends in 2070. The District is to remain within the adopted DFC for each of the managed aquifers throughout the 70-year period. District Rules provide that a DFC is noncompliant and curtailment procedures listed in the rules are to be implemented once the adopted DFC has been exceeded in three (3) consecutive years. The estimated average artesian head decline for the three (3) most recent years for each managed aquifers, estimated artesian head decline at the beginning of DFC calculations assumed to be zero, and the adopted DFC for managed aquifer are listed below in *Table 2.* For the Brazos River Alluvium, the matrix is a percent of saturation of the aquifer with the number being either 30 or 40 percent of saturation of the aquifer depending on the location within the District.

**Table 2. Estimated Average Artesian Head Decline compared to Adopted DFC from 2021 Cycle of GMA 12 Planning, (ft)**

| Aquifer | 2000 | 2021 | 2022 | 2023 | Adopted DFC, Average Feet of Decline |
|---|---|---|---|---|---|
| Sparta | 0 | 9 | 12 | 16 | 53 |
| Queen City | 0 | 13 | 7 | 0 | 44 |
| Carrizo | 0 | 7 | 11 | 14 | 84 |
| Calvert Bluff | 0 | +3 | +4 | +1 | 111 |
| Simsboro | 0 | 34 | 43 | 58 | 262 |
| Hooper | 0 | 14 | 6 | 5 | 167 |
| Yegua-Jackson | 0 | +11 | +8 | +9 | 67 |
| Brazos River Alluvium, Ave, Percent Saturation | ---- | 68.5% | 65% | 64% | ≥ 30% - N of Hwy 21<br>≥ 40% - S of Hwy 21 |

E. **<u>Historical Water Use Data</u>**

Data from the TWDB Historical Water Use Survey, included in *Appendix B1*, provides annual historical water use projections from 2004 to 2019, the most recent years of record availability. The table includes groundwater and surface water accounting for municipal, manufacturing, steam electric, irrigation, mining, and livestock usage. Data presented in *Table 3* reflects groundwater use within the District from metered wells required to report water production to the District.

The data is for the 2015-2022 period and delineated by aquifer. Exempt well use (domestic, livestock, wells used for oil and gas rig supply) are not included. Brazos River Alluvium wells have no requirement to be metered and are not a part of *Table 3*.

**Table 3. Metered Groundwater Use by Aquifer (ac-ft/yr)**

| Aquifer | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|---|
| Hooper | 1,084 | 909 | 756 | 809 | 700 | 746 | 918 | 1,045 |
| Simsboro | 56,638 | 54,237 | 53,326 | 55,229 | 50,528 | 53,164 | 51,128 | 58,313 |
| Calvert Bluff | 160 | 132 | 272 | 130 | 177 | 230 | 133 | 251 |
| Carrizo | 666 | 762 | 630 | 825 | 992 | 1,062 | 956 | 1,575 |
| Queen City | 190 | 100 | 237 | 147 | 401 | 103 | 45 | 93 |
| Sparta | 4,122 | 4,153 | 4,241 | 4,500 | 3,870 | 3,389 | 3,161 | 4,288 |
| Yegua-Jackson | 1,664 | 1,565 | 1,510 | 1,183 | 1,278 | 1,253 | 948 | 1,261 |
| Totals | 64,524 | 61,858 | 60,972 | 63,823 | 57,946 | 59,947 | 57,289 | 66,826 |

**F. Annual Recharge from Precipitation**

Scope: This is the recharge to aquifers from precipitation falling on outcrop areas of the aquifers within the District. Additional recharge to aquifers occurs in areas outside the District.

Methodology: Using data from the TWDB GAM Run 23-009, the annual estimated recharge is given in acre-feet per year (ac-ft/yr) in *Table 4*.

**G. Annual Volume of Water Discharging to Surface Water**

Scope: This includes groundwater discharging from each aquifer within the District to springs and surface water bodies including lakes, streams, and rivers.

Methodology: Using data from the TWDB GAM Run 23-009, *Table 4* summarizes the flow from each aquifer to surface water springs, lakes, streams, and rivers.

**Table 4. GAM Recharge & Discharge Estimates**

| **Management Plan Requirements** | **Aquifer or Confining Unit** | **Results** ac-ft/year |
|---|---|---|
| Estimated annual amount of recharge from precipitation to the District | Gulf Coast Aquifer System | 40 |
| | Yegua-Jackson Aquifer | 26,560 |
| | Sparta Aquifer | 8,333 |
| | Queen City Aquifer | 10,105 |
| | Carrizo-Wilcox Aquifer | 46,908 |
| | Brazos River Alluvium Aquifer | 23,418 |
| Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers | Gulf Coast Aquifer System | 255 |
| | Yegua-Jackson Aquifer | 42,656 |
| | Sparta Aquifer | 12,662 |
| | Queen City Aquifer | 9,923 |
| | Carrizo-Wilcox Aquifer | 54,346 |
| | Brazos River Alluvium Aquifer | 34,326 |

Source: TWDB GAM Run 23-009

GAM Run 23-009 Recharge & Discharge Estimates

**H. Annual Flow Into/Out and Between Aquifers**

Scope: Flow into and out of the District is described as lateral flow within the aquifers between the District and adjacent counties. Flow between aquifers describes the vertical flow, or leakage, between aquifers. Flow into the District from each aquifer is provided in the *Table 5*.

Methodology: Using data from the TWDB GAM Run 23-009, annual flow into/out and between aquifers was calculated. Groundwater flow results are provided in *Table 5*.

**Table 5. GAM Flow Estimates**

| Management Plan Requirements | Aquifer or Confining Unit | Results ac-ft/year |
|---|---|---|
| Estimated annual volume of flow into the District within each aquifer in the District | Gulf Coast Aquifer System | 332 |
| | Yegua-Jackson Aquifer | 12,578 |
| | Sparta Aquifer | 1,176 |
| | Queen City Aquifer | 2,976 |
| | Carrizo-Wilcox Aquifer | 33,140 |
| | Brazos River Alluvium Aquifer | 24,831 |
| Estimated annual volume of flow out of the District within each aquifer in the District | Gulf Coast Aquifer System | 48 |
| | Yegua-Jackson Aquifer | 7,122 |
| | Sparta Aquifer | 466 |
| | Queen City Aquifer | 1,228 |
| | Carrizo-Wilcox Aquifer | 10,125 |
| | Brazos River Alluvium Aquifer | 21,921 |
| | To Brazos River Alluvium Aquifer from Carrizo-Wilcox Aquifer | 2,286 |
| | To Brazos River Alluvium Aquifer from Queen City Aquifer | 6,262 |
| | To Brazos River Alluvium Aquifer from Sparta Aquifer | 3,860 |
| | To Brazos River Alluvium Aquifer from Yegua-Jackson Aquifer | 2,431 |
| | To Brazos River Alluvium Aquifer from Gulf Coast Aquifer System | 2,176 |
| | To Brazos River Alluvium Aquifer from older confining units | 771 |
| Estimated net annual volume of flow between each aquifer in the District | From Gulf Coast Aquifer System to Yegua-Jack Aquifer* | 17 |
| | From Gulf Coast Aquifer System to Brazos River Alluvium** | 2,176 |
| | To Yegua-Jackson Aquifer from Yegua-Jackson eqivalent units | 134 |
| | To Yegua-Jackson Aquifer from the Gulf Coast Aquifer System | 17 |
| | From Yegua-Jackson Aquifer to Brazos River Alluvium Aquifer** | 2,431 |
| | From Sparta Aquifer to Sparta Aquifer equivalent units | 5 |
| | From Sparta Aquifer to Queen City Aquifer | 153 |
| | To Sparta Aquifer from Weches confining unit | 3,138 |
| | From Sparta Aquifer to overlying units | 165 |

| | | |
|---|---|---|
| | From Sparta Aquifer to Brazos River Alluvium Aquifer** | 3,860 |
| | To Queen City Aquifer from Queen City Aquifer equivalent units | 33 |
| | To Queen City Aquifer from Carrizo-Wilcox Aquifer | 5 |
| | To Queen City Aquifer from Reklaw confining unit | 451 |
| | From Queen City Aquifer to Weches confining unit | 2,372 |
| | To Queen City Aquifer from Sparta Aquifer | 153 |
| | From Queen City Aquifer to Brazos River Alluvium Aquifer** | 6,262 |
| | To Carrizo-Wilcox Aquifer from Carrizo-Wilcox equivalent units | 2,149 |
| | From Carrizo-Wilcox Aquifer to Reklaw confining unit | 2,454 |
| | From Carrizo-Wilcox Aquifer to the Queen City Aquifer | 5 |
| | From Carrizo-Wilcox Aquifer to Brazos River Alluvium Aquifer** | 2,286 |

Source: TWDB GAM Run 23-009

* Estimated from the groundwater availability model for the Yegua-Jackson Aquifer.

** Estimated from the groundwater availability model for the Brazos River Alluvium Aquifer.

GAM Run 23-009 Flow Estimates

The same GAMs were used to develop the estimates of recharge from precipitation and other components of the aquifer water flow budgets as were used to develop the DFCs for the aquifers in the 2021 planning cycle with the exception that the GAM for the Central Portion of the Sparta, Queen City and Carrizo-Wilcox Aquifer released by the TWDB in 2018 was used to estimate the water flow budgets for the Sparta, Queen City and Carrizo-Wilcox aquifers. References regarding the GAMs used to develop the flow budgets are also given at the conclusion of TWDB report GAM Run 23-009 included as Appendix C.

## I. Projected Surface Water Supply

Surface water is currently allocated by the Texas Commission on Environmental Quality (TCEQ) for the use and benefit of all people of the State. Anyone seeking a new water right must submit an application to the TCEQ. The TCEQ then determines whether or not the permit will be issued and permit conditions. The water right grants a certain quantity of water to be diverted and/or stored, a priority date, and other conditions, which may include a maximum diversion rate and in stream flow restrictions to protect existing water rights and environmental flows.

The Brazos River Authority (BRA) is the largest surface water right holder within the District, holding most of the rights to the water within the Brazos River Basin, including the water in Lake Limestone in northeast Robertson County. There are several water rights within the District consisting primarily of irrigation rights along the rivers, steam electric, and water for public supply rights for surface water. The

BRA contracts raw water to various entities for long and short-term supplies for municipal, industrial, and agricultural irrigation uses.
Wellborn Special Utility District (Wellborn) is currently the only retail water supply within the District utilizing surface water in addition to groundwater, holding a permit for 4,000 ac-ft/yr.

Projected surface water supplies are described in the 2022 State Water Plan and are referenced in a table provided by the TWDB in *Appendix B2*.

## J. Projected Water Demands

The Brazos G Regional Water Planning Group (BGRWPG) and local water use data indicate that total water demands for the District will be 243,783 acre-feet, by the year 2070. This number includes use from all available groundwater and surface water sources within the District.

Current and projected water demands by user group within each county in the District through the year 2070 are described in *Appendix B3*. These estimates are in the current 2022 State Water Plan. Projected water demands were significantly adjusted in the 2022 State Water Plan regarding agricultural and public water supply needs and addressed the District's concerns relative to projected growth and current usage by these user groups. The District will continue to work to collect accurate data about current production as well as projected demands. This information will be provided to the TWDB for inclusion in future Regional and State water plans. As indicated in the regional water plan, these projections take into account population growth, rainfall, and conservation measures to be taken by each user group.

## K. Projected Water Supply Needs

The projected need for additional water supplies stated in the 2022 State Water Plan clearly indicates three primary areas of need; Agricultural irrigation, domestic/municipal use and potentially steam electric production. Each of these sectors faces their own hurdles and will meet their demand needs in different manners.

Agricultural irrigation will continue a pattern of conservation through best management practices. The industry is likely to use several methods to meet their needs including improved irrigation methods, dryland farming, crop selection and utilizing further development of available groundwater resources and potentially some surface water.

Municipalities and rural water supplier face decades of projected population increases. The water supply needs associated with the growth will likely be met using conservation methods including lowered gallons per day use per customer, aquifer storage and recovery, indirect and direct potable reuse projects, and further development of groundwater, with the available supply currently being assessed, and surface water resources.

Steam electric production in northern Robertson County could continue to grow, if it is cost competitive with other sources of electricity, due to the population growth throughout Texas and the favorable locations of the existing power plants with lignite deposits in close proximity or coal from out of state mines. Groundwater and surface water are readily available and likely sources of water to remedy any long-term needs.

The District has considered the future needs projects in the 2022 State Water Plan and believes that further development of groundwater and surface water resources along with conservation practices will meet the projected needs. Monitoring of large-scale production projects in GMA 12 will be an ongoing process.

Projected needs listed in the TWDB estimated historical water use (2022 State Water Plan data packet Apprendix H) are primarily municipal. Municipal needs in Brazos County exist for the following water user groups (WUGs): Bryan, College Station, Wellborn SUD and Texas A&M University. From 2020 to 2070, the total needs in Brazos County are projected to increase from 100 to 33,389 ac-ft/yr.

Projected needs listed in the TWDB estimated historical water use (2022 State Water Plan data packet Appendix H) are primarily irrigation and a small amount attributable to municipal water demands. Irrigation water user group (WUG) combined with a small municipal need for Robertson County WSC increases from 2020 to 2070 in Robertson County from 12,932 to 18,502 ac-ft/yr.

Projected water supply needs, based on projections in the 2022 State Water Plan, are included in *Appendix B4*. Negative values (listed in red) indicate a projected water supply need, and the plan identifies recommended water strategies for these needs. An updated groundwater availability model (GAM) was developed by the TWDB in 2018 for the Sparta, Queen City and Carrizo-Wilcox aquifers and Brazos River Alluvium for the area encompassing the District and all of GMA 12. The GAM will be used to reassess and most likely result in an increase in the estimates of the availability of groundwater. The anticipated increase in the groundwater supply can be used to help address water supply needs.

## L. Projected Water Management Strategies to Meet Future Supply Needs

Demand and supply data developed as part of the Region G planning process in 2022, District records, and GMA 12 planning efforts indicate that groundwater and surface water supplies should be adequate to meet the recommended strategies. There will be a need for infrastructure improvements to provide water at higher rates as water demands increase. However, if current conditions and projected needs from the State Water Plan are low, these shortages will be satisfied by further development of groundwater and surface water resources. While there seems to be sufficient water resources today to meet the 50-year planning horizon, large scale water development projects, both within the District and in neighboring districts, could alter available water supplies. Hydrogeological studies indicate that as groundwater production approaches the estimates of water demands being developed as part of the GMA 12 process, some older production wells in the Simsboro Sand may need to be replaced due to declining water levels and limited available drawdown. As part of its long-range management strategy, the District will review changes in aquifer utilization and well water level changes to help estimate appropriate future well construction and possible need for a change in the water management strategy. Some water management strategies, as given in the 2017 State Water Plan, are included in *Appendix B5*.

Projected water management strategies listed in the TWDB estimated historical water use (2022 state water plan data packet), and located in Brazos County are: Municipal Water Conservation (Bryan, College Station, Texas A&M University and Wellborn SUD), ASR (Bryan), Carrizo-Wilcox Groundwater Development (Bryan and College Station), Sparta Aquifer Development (Texas A&M University), Reuse DPR or Reuse (College Station and Bryan) and BRA System Operation-Surplus (Steam-Electric Power). From 2010 to 2070 the total water management strategies in Brazos County are projected to increase from 953 to 43,179 acre-feet per year.

Projected water management strategies listed in the TWDB estimated historical water use (2022 state water plan data packet), and located in Robertson County are: Municipal Water Conservation (Bremond, Hearne, Twin Creek WSC and Wellborn SUD), Carrizo-Wilcox Development (Robertson County WSC), Irrigation Water Conservation (Irrigation), and Purchase from Walnut Creek Mine-Reuse (Steam-Electric Power). From 2010 to 2070 the total water management strategies in Robertson County are projected to increase from 2,925 to 15,324 acre-feet per year.

## M. Natural or Artificial Recharge of Groundwater Resources

### 1. Estimate of Amount Recharge to the Groundwater Resources within the District.

Aquifers within the District receive recharge from infiltration of precipitation and water from streams that cross aquifer outcrops. Estimated locations of aquifer outcrops within the District are shown on *Figure 3*. Recharge to aquifers within the District can occur outside District boundaries as an aquifer outcrop extends to the north into an adjoining county or to the east and west of the District.

Estimates of recharge for the Carrizo-Wilcox Aquifer have been in the range of 3 to 5 inches per year based on groundwater flow modeling work. TWDB GAM Run 23-009 provides estimates of recharge for the aquifer systems. Based on areas of the aquifer outcrops within Robertson County, the resulting estimate of recharge to the Carrizo-Wilcox Aquifer is about 46,908 ac-ft/yr. Additional recharge occurs outside the District that contributes to the total recharge to the aquifer system.

The Queen City Aquifer is composed of fine-grained sands with interbedded clay. The outcrop area also can contain alternating areas of sands and other areas of lower permeability silt or clay. The TWDB GAM Run 23-009, estimates the recharge to the Queen City Aquifer within the District is about 10,105 ac-ft/yr. The Queen City Aquifer outcrop occurs over about 105 square miles in Robertson County.

The Sparta Aquifer is composed of quartz sand with a small amount of interbedded clay within the aquifer thickness. Recharge to the aquifer via infiltrated precipitation and stream flow is estimated at about 8,333 ac-ft/yr in the TWDB GAM Run 23-009. The estimated outcrop of the aquifer encompasses about 100 square miles within the District.

The Yegua-Jackson Aquifer is composed of sandstone, clay, and lignite beds in some areas. The outcrop area is extensive in Brazos County as shown on Figure 3. Estimated recharge to the Yegua-Jackson aquifer is about 26,560 ac-ft/yr, based on the TWDB GAM Run 23-009. The aquifer or overlying fluviatile terrace deposits outcrop over about 350 square miles in Brazos County.

The outcrop for the Catahoula sandstone of the Gulf Coast Aquifer System occurs in the very southern part of the District. In part of the outcrop area, either the Navasota River or Brazos River Alluvium has covered or washed away the surface sediments of the Catahoula sandstone. Most likely, some recharge to the buried sediments of the Gulf Coast Aquifer System occurs via leakage from the Navasota River or Brazos River Alluvium. It is estimated, based on the TWDB GAM Run 23-009 that recharge to the Gulf Coast Aquifer System is about 40 ac-ft/yr.

The Brazos River Alluvium, located in the area of the Brazos River floodplain encompasses about 140 square miles within Brazos and Robertson counties. Recharge to the Brazos River Alluvium is estimated to occur via infiltration of precipitation and stream flow. Recharge to the Brazos River Alluvium is about 23,418 ac-ft/yr based on the TWDB GAM Run 23-009.

GAM Run 23-009 Natural or Artificial Recharge of Groundwater Resources

**2. How Artificial Recharge Of Groundwater within the District May be Increased**

Recharge enhancement may increase the amount of groundwater available from the aquifers within the District. Increasing recharge can be difficult in geologic environments that occur within the District because a large percentage of the potential recharge is rejected due to shallow water levels in the sediments of the aquifer outcrops or to the low permeability of sediments in some of the aquifer outcrops. Recharge might be enhanced by the construction of rainfall runoff retention structures on ephemeral streams. Further study of the surface geology and soil characteristics in the District may result in the identification of areas with porous soils that could provide sites for enhanced recharge or test sites for recharge investigations.

The District encourages and supports the use of Aquifer Storage and Recovery projects as a means of water conservation. This most likely would occur in the form of reuse of effluent produced by municipalities or industry.

## 6. MANAGEMENT OF GROUNDWATER SUPPLIES – 31 TAC 356.5(A)(6)

Groundwater conservation districts have statutorily been designated as Texas' preferred method of groundwater management through the rules developed, adopted, and promulgated by individual groundwater districts, as authorized by Chapter 36 of the TWC and the individual district's enabling act (TWC §36.0015). The BVGCD may manage groundwater supplies, in part, by regulating the spacing and production of wells, to minimize drawdown of the water table or reduction of artesian pressure, to control subsidence, to prevent interference between wells, to prevent degradation of water quality, or to prevent waste (TWC §36.116). The method of groundwater production regulation must be based on hydrogeological conditions of aquifers in the District. However, the District may preserve historic use (TWC §36.116(b)).

The BVGCD, as authorized by law, has adopted the following groundwater management strategy:

**A.** **Availability Goal**

The water availability goals of the District are expressed through the Desired Future Conditions adopted by the GMA 12 pursuant to §36.108 of the TWC.

**B.** **Historic Use**

The District shall preserve historic or existing groundwater use in the District before the effective date of the District's rules, to the maximum extent practicable.

**C.** **Pumping Rate Limit**

The District will regulate groundwater withdrawal through permitting efforts and by setting a maximum pumping rate limit of 3,300 gpm/well. New wells producing water from all District aquifers, excluding the Brazos River Alluvium, will be required to have land legally assigned to the well in an amount to be determined in relationship to the average annual production rate of the well.

**D.** **Beneficial Use**

The District will regulate groundwater withdrawal by setting production limits on wells based on evidence of beneficial use; and the District will continue to study various management methods including regulating groundwater production based on surface acreage which may become appropriate for effective management of groundwater withdrawal.

**E.** **Well Spacing**

The District will require well spacing on new water wells as follows:

1. A new well may not be drilled within 50 feet from the property line of any adjoining landowners;
3. Spacing of new wells completed in all formations (other than the Brazos River Alluvium) shall be spaced two feet per average annual gallons per minute from existing wells in the same formation.

The District has incorporated these management strategies into its rules and will permit wells accordingly.

## 7. METHODOLOGY TO TRACK DISTRICT PROGRESS IN ACHIEVING MANAGEMENT GOALS 31 TAC 356.5 (a)(6)

An annual report will be developed by the General Manager and District staff and provided to the District's Board of Directors. The Annual Report will cover activities of the District including information on the District's performance regarding achieving the District's management goals and objectives. The Annual Report will be delivered to the District Board within 60 days following the completion of the District's fiscal year. A copy of the Annual Report will be kept on file and available for public inspection at the District's offices upon adoption.

## 8. ACTIONS, PROCEDURES, PERFORMANCE, AND AVOIDANCE FOR DISTRICT IMPLEMENTATION OF MANAGEMENT PLAN 31 TAC 356.5 (a)(4)

The District will act on goals and directives established in this District Management Plan. The District will use the objectives and provisions of the Management Plan as a guideline in its policy implementation and decision-making. In both its daily operations and long-term planning efforts, the District will continuously strive to comply with the initiatives and standards created by the Management Plan.

The District will amend rules in accordance with Chapter 36 of the TWC and rules will be followed and enforced. The District may amend the District rules as necessary to comply with changes to Chapter 36 of the TWC and to insure the best management of the groundwater within the District. Development and enforcement of the rules of the District will be based on the best scientific and technical evidence available to the District.

The District will encourage public cooperation and coordination in implementation of the District Management Plan. All operations and activities of the District will be performed in a manner that best encourages cooperation with appropriate state, regional, and local water entities, as well as landowners and the general public. Meetings of the District's Board of Directors will be noticed and conducted in accordance with the Texas Open Meetings Act. The District will also make available for public inspection all official documents, reports, records, and minutes of the District pursuant with the Texas Public Information Act.

For information concerning rules of the District, visit the District's website (https://brazosvalleygcd.org) or use the following hyperlink (Brazos Valley GCD Rules & Regulations).

## 9. MANAGEMENT GOALS AND OBJECTIVES 31 TAC 356.5(A)(1)

Unless indicated otherwise, performance on goals will be measured annually. The Management Plan will be subject to review at least every five years and modification will be made as deemed appropriate. Information describing programs, policies, and actions taken by the District to meet goals and objectives established by the District will be included in the Annual Report prepared by the General Manager and presented to the District's Board of Directors. Following District Board approval, the report will be made available to the County Commissioners Courts and general public.

### A. Management Goals:

#### 1. Providing for the Most Efficient Use of Groundwater:

**1a.** **Objective** – Require all existing and new non-exempt wells constructed within the boundaries of the District to be permitted by the District and operated in accordance with District Rules. In addition, the District will encourage all exempt wells constructed within the District boundaries to be registered with the District.

- **Performance Standard** – The number of exempt and permitted wells registered within the District will be reported annually in the District's Annual Report submitted to the District Board of Directors.

**1b.** **Objective** – Regulate the production of groundwater by permitting wells within the District boundaries based on beneficial use and in accordance with District Rules. Each year the District will accept and process applications for permitted use of groundwater in the District, in accordance with the permitting process established by District rules. The District will regulate production of groundwater from permitted wells by verification of pumpage using meters.

- **Performance Standard** – Number and type of applications made for permitted use of groundwater in the District, number and type of permits issued by the District, and amount of groundwater permitted will be included in the Annual Report given to the District Board of Directors.

- **Performance Standard** – Actual annual pumpage from each metered well within the District will be reported annually and compared to the amount permitted for that well. This information will be included in the District's Annual Report submitted to the District Board of Directors.

**1c.** **Objective** – Conduct ongoing monitoring of aquifers underlying the District and current groundwater production within the District, and then assess the available groundwater that can be produced from each aquifer within the District after sufficient data are collected and evaluated. Using this data and information developed for GMA 12, the District will re-evaluate availability goals as necessary and will permit wells in accordance with appropriate production goals.

- **Performance Standard** – The District will conduct appropriate studies to identify issues and criteria needed to address groundwater management needs within the District's boundaries. Groundwater availability goals will take into consideration GMA 12 planning and research of hydrogeological and geologic characteristics of the aquifers, which may include, but not necessarily be limited to, amount of water use, water quality, and water level declines.

- **Performance Standard** – A progress report on the work of the District regarding groundwater availability will be written annually, as substantial additional data are developed. The progress report will be included in the Annual Report to the District Board of Directors.

**2.** **Controlling and Preventing Waste of Groundwater:**

**2a.** **Objective** – Apply a water use fee to the permitted use of groundwater in the District to encourage conservation-oriented use of groundwater resources to eliminate or reduce waste.

- **Performance Standard –** Each year the District will apply a water use fee to the non-exempt permitted use of groundwater produced within the District pursuant to District rules. The amount of fees generated and amount of water produced for each type of permitted use will be a part of the Annual Report presented to the District Board of Directors.

**2b.** **Objective –** Evaluate District rules annually to determine whether any amendments are necessary to decrease the amount of waste within the District.

- **Performance Standard –** The District will include a discussion of the annual evaluation of District rules, and determination of whether any amendments to the rules are necessary to prevent waste of groundwater. The evaluation will be included in the Annual Report provided to the District Board of Directors.

**2c.** **Objective** – Provide information to the general public and schools within the District promoting water conservation, wise use of water, and the elimination and reduction of wasteful practices.

- **Performance Standard** – The District will include a page on the District's web-site devoted to wise use of water and providing tips to help eliminate and reduce wasteful use of groundwater. The District will provide information to local school districts including providing Texas Education Agency approved water curriculum and in-school presentations to encourage wise use of water and understanding of the significance of aquifers to District residents.

**3.** **Controlling and Preventing Subsidence**

**3a.** **Objective** - The District will monitor changes in water levels in its monitoring wells with due consideration to the potential for land subsidence. At least once every three years, the District will assess the potential for land subsidence for areas where water levels have decreased more than 100 feet since the year 2000. The District will review the sections in "Identification of the Vulnerability of the Major and Minor Aquifers of Texas to Subsidence with Regard to Groundwater Pumping" report (TWDB Contract Number 1648302062, by LRE Water) when discussing subsidence within the Districts aquifers. Those aquifers can be found on page 4-5, 4-104, 4-187, 4-207, and 4-229 of the report at http://www.twdb.texas.gov/groundwater/models/research/subsidence/subsidence.asp. Data reviewed in the report suggests a resulting average third quartile Subsidence Risk Value (SVR) of 3 for the Carrizo-Wilcox, Queen City and Sparta aquifers. The Yegua-Jackson Aquifer is deemed to be at medium to high risk of subsidence over time. The Brazos River Alluvium Aquifer is seen to be at a medium SRV risk. These estimated values are at odds with what has been observed throughout the District with the geologic ages, sand and clay layering and thicknesses of the managed aquifers.

- **Performance Standard** – Within three years of the approval of this plan and every three years thereafter, the District will map any region where more than 100 feet of drawdown has occurred since the year 2000 and assess the potential for land subsidence. The results of the assessment will be discussed in a District Board meeting and be documented in a presentation or a report.

- **Performance Standard** – As outlined in TWC Ch. 36.108 (d), The District will take into consideration the "Identification of the Vulnerability of the Major and Minor Aquifers of Texas to Subsidence with Regard to Groundwater Pumping" when considering subsidence during GMA 12 joint planning.

**4.** **Addressing Conjunctive Surface Water Management Issues:**

**4a.** **Objective** – Encourage the use of surface water supplies where available, to meet the needs of specific user groups within the District.

- **Performance Standard** – The District will participate in the Region G Regional Water Planning process by attending at least one BGRWPG meeting annually and will encourage the development of surface water supplies where appropriate. This activity will be noted in the Annual Report presented to the District Board of Directors.

**5.** **Addressing Natural Resource Issues that Impact the Use and Availability of Groundwater, and that are Impact the Use of Groundwater:**

**5a.** **Objective** – Determine if there are any natural spring flows within the District that may be impacted by increased groundwater pumping.

- **Performance Standard –** Annually monitor water levels in at least two (2) wells near natural spring flows, if found, for potential impact from groundwater production. Prepare an annual assessment statement and include in the Annual Report to the District Board of Directors.

**6.** **Addressing Drought Conditions:**

**6a.** **Objective** – A District staff member will download at least one Palmer Drought Severity Index (PDSI) map monthly. The Palmer Drought Severity Index map will be used to monitor drought conditions and will be used by the Board to determine trigger conditions provided by the District Drought Contingency Plan.

- **Performance Standard** –District staff will make an assessment of drought conditions in the District and will brief the District Board at each regularly scheduled board meeting.

**6b.** **Objective** – Require 100 percent of entities that are mandated by the State of Texas to have drought contingency plans, to submit those plans to the District or follow the District's plan when applying for a permit from the District for water production.

- **Performance Standard** – Review 100 percent of the drought contingency plans submitted as a result of permitting, whenever permit applications for water production are received. The number of drought contingency plans required to be submitted by permitted entities to the District as part of the well permitting process and the number of drought contingency plans actually submitted to the District will be described in the Annual Report to the District Board.

**6c.** **Objective** – The District drought contingency plan will be reviewed for effectiveness and needed updates at least once every three years.

- **Performance Standard –** A report summarizing findings of the review of the District drought contingency plan will be included in the Annual Report to the District Board of Directors. Additional drought information sources are available at: https://waterdatafortexas.org/drought.

**7. <u>Promoting Water Conservation:</u>**

**7a.** **Objective -** Require 100 percent of water applicants requesting a permit for water production within the District to submit a water conservation plan, unless one is already on file with the District at the time of the permit application, or agree to comply with the District Water Conservation Plan.

- **Performance Standard** – Review 100 percent of the water conservation plans submitted as a result of permit requirements to ensure compliance with permit conditions. Number of water conservation plans required to be submitted by water permittees to the District that year as part of the well permitting process and number of water conservation plans actually submitted to the District will be reported in the Annual Report to the District Board of Directors. If the water permittee chooses to agree to follow the District Water Conservation Plan in lieu of submitting a water conservation plan, then that number will be indicated in the Annual Report to the District Board.

**7b.** **Objective** – Develop a system for measurement and evaluation of groundwater supplies.

- **Performance Standard** – Water level monitoring wells will be identified for Brazos River Alluvium, Yegua-Jackson, Sparta, Queen City, Carrizo, Calvert Bluff, Simsboro, and Hooper aquifers. At least two (5) wells per aquifer will be monitored on an annual basis to track changes in static water levels.

- **Performance Standard** – 80% of all monitoring wells designated as Desired Future Condition well will be measured at least annually to track compliance with the Desired Future Condition for the relevant aquifer.

**7c.** **Objective** – Assist in funding and obtaining grant funds for the implementation of water conservation methods. Work with the appropriate state and federal agencies to facilitate bringing grant funds to various groups within the District boundaries to develop and implement water conservation methods. Work with local entities to help develop plans for obtaining grant funding from the District. The District will meet with at least one state or federal agency annually to discuss bringing water conservation methods grant funds into the District.

- **Performance Standard** – Number of meetings held annually with at least one state or federal agency and the number of grants for water conservation methods applied for and obtained will be included in the Annual Report to the District Board of Directors.

- **Performance Standard** – The District will address potential District grant funding for water conservation projects upon request by and/or submission to the District. Following proposal submission, applications will be reviewed for possible District Board approval. The number of water conservation projects submitted and the number of projects approved for grant funding by the District will be reported in the Annual Report to the District Board.

**8.** **<u>Protecting Water Quality:</u>**

**8a.** **Objective** - Develop baseline water quality data and a system for continued evaluation of groundwater quality.

- **Performance Standard** – Develop general understanding of water quality within aquifers in the District based on TCEQ, TWDB, and other data. Coordinate with TCEQ on water quality issues.

**8b.** **Objective –** Require all water permittees that are required by the TCEQ to have well vulnerability studies prior to constructing a well, to provide evidence of the study to the District prior to construction of a well within the District.

- **Performance Standard** – Review all vulnerability studies submitted as a result of permit requirements to help ensure water quality protection.

**8c.** **Objective** – Provide information to the general public and schools within the District on the importance of protecting water quality.

- **Performance Standard** – The District will include a page on the District's web-site devoted to water quality issues and will provide information to permittees on wellhead protection. The District will provide in-school presentations addressing aquifer contamination and aquifer protection.

**9. <u>Addressing the Adopted Desired Future Conditions:</u>**

**9a. Objective** - Annually, the District will evaluate well water level monitoring data and determine whether the change in water levels is in general conformance with the DFCs adopted by the District. The District will estimate total annual groundwater production for each aquifer based on the water use reports, estimated exempted use, and other relevant information, and compare these production estimates to the MAGs.

- **Performance Standard** – Annually, the General Manager will report to the District Board the water level data obtained from the monitoring wells in each aquifer, the average artesian head change for each aquifer calculated from the water levels of the monitoring wells in each aquifer, a comparison of the average artesian head change for each aquifer with the DFCs for each aquifer, and the District progress in conforming with the DFCs.

- **Performance Standard** – At least once every year, the General Manager will report to the District Board the total permitted groundwater production and the estimated total annual groundwater production for each aquifer and compare these amounts to the MAGs.

**B. <u>Management Goals Determined Not to be Applicable to the Brazos Valley Groundwater Conservation District</u>**

**1. Rainwater Harvesting:**

With average annual precipitation in the District about 39 inches, a goal of rainwater harvesting is not applicable at this time.

**2. Recharge Enhancement:**

With an average annual precipitation of about 39 inches and outcrop areas of the Carrizo-Wilcox limited to the northern part of Robertson County, this goal in not applicable at this time. The exception would be the utilization of Aquifer Storage and Recovery projects.

**3. Precipitation Enhancement:**

With the high amount of annual rainfall in the District, precipitation enhancement does not appear to be needed. This goal is therefore not applicable at this time.

**4. Brush Control:**

A significant amount of the District’s area is heavily forested with other areas in improved pasture or cultivated land. Brush control, as a goal, in not applicable at this time.

# APPENDIX A

DEFINITIONS, ACRONYMS and ABBREVIATIONS

## Definitions

**Desired Future Condition** – "a quantitative description, adopted in accordance with §36.108 of the Texas Water Code, of the desired future condition of the groundwater resources in a management area at one or more specified future times" as defined in §36.001 of the Texas Water Code.

**Modeled Available Groundwater** – "the amount of water that the Executive Administrator (of the TWDB) determines may be produced on an annual average basis to achieve a desired future condition established under §36.108".

## Data Definitions*

Projected Water Demands*

From the 2017 State Water Plan Glossary: "**WATER DEMAND – "**Quantity of water projected to meet the overall necessities of a water user group in a specific future year." (See 2017 State Water Plan Chapter 5 for more detail.)
**Additional explanation:** These are water demand volumes as projected for specific Water User Groups in the 2016 Regional Water Plans. This is NOT groundwater pumpage or demand based on any existing water source. This demand is how much water each Water User Group is projected to require in each decade over the planning horizon.

Projected Surface Water Supplies*

From the 2017 State Water Plan Glossary: "**EXISTING *[surface]* WATER SUPPLY -** Maximum amount of *[surface]* water available from existing sources for use during drought of record conditions that is physically and legally available for use." (See 2017 State Water Plan Chapter 6 for more detail.)
**Additional explanation:** These are the existing surface water supply volumes that, without implementing any recommended WMSs, could be used during a drought (in each planning decade) by Water User Groups located within the specified geographic area.

Projected Water Supply Needs*

From the 2017 State Water Plan Glossary: "**NEEDS -**Projected water demands in excess of existing water supplies for a water user group or a wholesale water provider." (See 2017 State Water Plan Chapter 7 for more detail.)
**Additional explanation:** These are the volumes of water that result from comparing each Water User Group's projected existing water supplies to its projected water demands. If the volume listed is a negative number, then the Water User Group shows a projected need during a drought if they do not implement any water management strategies. If the volume listed is a positive number, then the Water User Group shows a projected surplus. Note that if a Water User Group shows a need in any decade, then they are considered to have a potential need during the planning horizon, even if they show a surplus elsewhere.

Projected Water Management Strategies*

From the 2017 State Water Plan Glossary: "**RECOMMENDED WATER MANAGEMENT STRATEGY -** Specific project or action to increase water supply or maximize existing supply to meet a specific need." (See 2017 State Water Plan Chapter 8 for more detail.)
**Additional explanation:** These are the specific water management strategies (with associated water volumes) that were recommended in the 2016 Regional Water Plans.
**Terminology used by TWDB staff in providing data for 'Estimated Historical Water Use And 2017 State Water Plan Datasets' reports issued by TWDB.*

## Acronyms

**BGRWPG –** Brazos G Regional Water Planning Group

**BRA –** Brazos River Authority

**BVGCD –** Brazos Valley Groundwater Conservation District

**DFC(s) –** Desired Future Condition(s)

**MAG –** Modeled Available Groundwater

**GAM –** Groundwater Availability Model

**GCD –** Groundwater Conservation District

**GMA 12 –** Groundwater Management Area 12

**TAC –** Texas Administrative Code

**TWC –** Texas Water Code

**TWDB –** Texas Water Development Board

## Abbreviations

**ac-ft/yr –** acre feet per year

**gpm –** gallons per minute

# APPENDIX B1

Estimated Historical Water Use

# Estimated Historical Water Use And 2022 State Water Plan Datasets:

## Brazos Valley Groundwater Conservation District

Texas Water Development Board
Groundwater Division
Groundwater Technical Assistance Section
stephen.allen@twdb.texas.gov
(512) 463-7317
January 19, 2023

## GROUNDWATER MANAGEMENT PLAN DATA:

This package of water data reports (part 1 of a 2-part package of information) is being provided to groundwater conservation districts to help them meet the requirements for approval of their five-year groundwater management plan. Each report in the package addresses a specific numbered requirement in the Texas Water Development Board's groundwater management plan checklist. The checklist can be viewed and downloaded from this web address:

*http://www.twdb.texas.gov/groundwater/docs/GCD/GMPChecklist0113.pdf*

The five reports included in this part are:

1. Estimated Historical Water Use (checklist item 2)

   *from the TWDB Historical Water Use Survey (WUS)*

2. Projected Surface Water Supplies (checklist item 6)
3. Projected Water Demands (checklist item 7)
4. Projected Water Supply Needs (checklist item 8)
5. Projected Water Management Strategies (checklist item 9)

   *from the 2017 Texas State Water Plan (SWP)*

Part 2 of the 2-part package is the groundwater availability model (GAM) report for the District (checklist items 3 through 5). The District should have received, or will receive, this report from the Groundwater Availability Modeling Section. Questions about the GAM can be directed to Grayson Dowlearn, grayson.dowlearn@twdb.texas.gov, (512) 475-1552.

## *DISCLAIMER:*

The data presented in this report represents the most up to date WUS and 2022 SWP data available as of 1/19/2023. Although it does not happen frequently, either of these datasets are subject to change pending the availability of more accurate WUS data or an amendment to the 2022 SWP. District personnel must review these datasets and correct any discrepancies to ensure approval of their groundwater management plan.

The WUS dataset can be verified at this web address:

*http://www.twdb.texas.gov/waterplanning/waterusesurvey/estimates/*

The 2022 SWP dataset can be verified by contacting Sabrina Anderson (sabrina.anderson@twdb.texas.gov or 512-936-0886).

The values presented in the data tables of this report are county-based. In cases where groundwater conservation districts cover only a portion of one or more counties the data values are modified with an apportioning multiplier to create new values that more accurately represent conditions within district boundaries. The multiplier used in the following formula is a land area ratio: (data value * (land area of district in county / land area of county)). For two of the four SWP tables (Projected Surface Water Supplies and Projected Water Demands) only the county-wide water user group (WUG) data values (county other, manufacturing, steam electric power, irrigation, mining and livestock) are modified using the multiplier. WUG values for municipalities, water supply corporations, and utility districts are not apportioned; instead, their full values are retained when they are located within the district and eliminated when they are located outside (we ask each district to identify these entity locations).

The remaining SWP tables (Projected Water Supply Needs and Projected Water Management Strategies) are not modified because district-specific values are not statutorily required. Each district needs only "consider" the county values in these tables.

In the WUS table every category of water use (including municipal) is apportioned. Staff determined that breaking down the annual municipal values into individual WUGs was too complex.

TWDB recognizes that the apportioning formula used is not ideal but it is the best available process with respect to time and staffing constraints. If a district believes it has data that is more accurate it can add those data to the plan with an explanation of how the data were derived. Apportioning percentages that the TWDB used are listed above each applicable table.

For additional questions regarding this data, please contact Stephen Allen (stephen.allen@twdb.texas.gov or 512-463-7317).

# Estimated Historical Water Use
# TWDB Historical Water Use Survey (WUS) Data

Groundwater and surface water historical use estimates are currently unavailable for calendar year 2020. TWDB staff anticipates the calculation and posting of these estimates at a later date.

**BRAZOS COUNTY** *100% (multiplier)* All values are in acre-feet

| Year | Source | Municipal | Manufacturing | Mining | Steam Electric | Irrigation | Livestock | Total |
|---|---|---|---|---|---|---|---|---|
| 2019 | GW | 36,489 | 1,680 | 1,725 | 62 | 31,085 | 421 | 71,462 |
| | SW | 829 | 0 | 192 | 407 | 972 | 782 | 3,182 |
| 2018 | GW | 36,081 | 1,654 | 461 | 56 | 41,334 | 421 | 80,007 |
| | SW | 636 | 0 | 51 | 441 | 501 | 781 | 2,410 |
| 2017 | GW | 36,810 | 1,418 | 237 | 63 | 35,261 | 405 | 74,194 |
| | SW | 367 | 0 | 26 | 301 | 1,609 | 751 | 3,054 |
| 2016 | GW | 35,512 | 1,368 | 253 | 80 | 31,585 | 339 | 69,137 |
| | SW | 474 | 0 | 28 | 422 | 1,327 | 629 | 2,880 |
| 2015 | GW | 35,131 | 1,310 | 1,096 | 78 | 17,310 | 336 | 55,261 |
| | SW | 739 | 0 | 122 | 387 | 984 | 625 | 2,857 |
| 2014 | GW | 34,446 | 1,158 | 1,640 | 91 | 31,734 | 414 | 69,483 |
| | SW | 397 | 0 | 182 | 301 | 2,244 | 769 | 3,893 |
| 2013 | GW | 34,521 | 1,299 | 612 | 75 | 45,229 | 407 | 82,143 |
| | SW | 794 | 0 | 68 | 159 | 1,751 | 756 | 3,528 |
| 2012 | GW | 33,826 | 1,422 | 39 | 114 | 34,442 | 386 | 70,229 |
| | SW | 943 | 0 | 4 | 307 | 2,873 | 716 | 4,843 |
| 2011 | GW | 38,521 | 1,770 | 12 | 114 | 38,700 | 486 | 79,603 |
| | SW | 974 | 0 | 1 | 307 | 3,702 | 902 | 5,886 |
| 2010 | GW | 32,667 | 1,666 | 82 | 123 | 31,834 | 482 | 66,854 |
| | SW | 0 | 0 | 211 | 112 | 3,707 | 896 | 4,926 |
| 2009 | GW | 33,324 | 1,947 | 75 | 101 | 28,181 | 414 | 64,042 |
| | SW | 0 | 0 | 192 | 104 | 1,434 | 770 | 2,500 |
| 2008 | GW | 32,573 | 2,066 | 67 | 126 | 24,019 | 368 | 59,219 |
| | SW | 0 | 0 | 173 | 214 | 1,615 | 683 | 2,685 |
| 2007 | GW | 28,689 | 2,184 | 1 | 149 | 25,638 | 502 | 57,163 |
| | SW | 0 | 0 | 0 | 472 | 260 | 932 | 1,664 |
| 2006 | GW | 31,592 | 2,100 | 1 | 249 | 25,168 | 550 | 59,660 |
| | SW | 0 | 0 | 0 | 426 | 1,043 | 1,022 | 2,491 |
| 2005 | GW | 42,095 | 2,118 | 1 | 347 | 28,498 | 480 | 73,539 |
| | SW | 0 | 0 | 0 | 441 | 981 | 891 | 2,313 |
| 2004 | GW | 27,041 | 2,144 | 1 | 381 | 18,854 | 494 | 48,915 |
| | SW | 0 | 0 | 0 | 0 | 626 | 740 | 1,366 |

## ROBERTSON COUNTY

*100% (multiplier)*

All values are in acre-feet

| Year | Source | Municipal | Manufacturing | Mining | Steam Electric | Irrigation | Livestock | Total |
|---|---|---|---|---|---|---|---|---|
| 2019 | GW | 2,247 | 39 | 3,676 | 5,243 | 60,350 | 647 | 72,202 |
| | SW | 0 | 0 | 42 | 30,101 | 502 | 1,510 | 32,155 |
| 2018 | GW | 2,245 | 37 | 3,376 | 5,324 | 88,613 | 642 | 100,237 |
| | SW | 0 | 0 | 45 | 28,988 | 1,120 | 1,497 | 31,650 |
| 2017 | GW | 2,208 | 35 | 3,011 | 5,232 | 74,946 | 623 | 86,055 |
| | SW | 0 | 0 | 2 | 34,901 | 1,302 | 1,454 | 37,659 |
| 2016 | GW | 2,199 | 35 | 3,334 | 5,185 | 63,188 | 528 | 74,469 |
| | SW | 0 | 0 | 14 | 28,392 | 628 | 1,232 | 30,266 |
| 2015 | GW | 2,434 | 40 | 3,062 | 5,672 | 44,752 | 515 | 56,475 |
| | SW | 0 | 0 | 8 | 22,567 | 1,405 | 1,202 | 25,182 |
| 2014 | GW | 2,741 | 45 | 169 | 5,317 | 63,183 | 787 | 72,242 |
| | SW | 0 | 0 | 18 | 31,713 | 2,765 | 1,836 | 36,332 |
| 2013 | GW | 2,394 | 43 | 146 | 4,752 | 85,426 | 788 | 93,549 |
| | SW | 0 | 0 | 16 | 30,193 | 3,000 | 1,840 | 35,049 |
| 2012 | GW | 2,387 | 39 | 96 | 3,952 | 62,023 | 812 | 69,309 |
| | SW | 0 | 0 | 10 | 29,327 | 2,051 | 1,895 | 33,283 |
| 2011 | GW | 2,632 | 44 | 79 | 5,206 | 93,264 | 1,107 | 102,332 |
| | SW | 0 | 0 | 7 | 40,660 | 4,586 | 2,583 | 47,836 |
| 2010 | GW | 2,375 | 51 | 15,185 | 342 | 76,833 | 1,077 | 95,863 |
| | SW | 0 | 0 | 114 | 22,059 | 2,780 | 2,514 | 27,467 |
| 2009 | GW | 2,709 | 88 | 14,821 | 190 | 62,036 | 484 | 80,328 |
| | SW | 0 | 0 | 113 | 6,219 | 7,750 | 1,130 | 15,212 |
| 2008 | GW | 2,847 | 3,882 | 15,691 | 14 | 62,627 | 508 | 85,569 |
| | SW | 0 | 85 | 113 | 154 | 0 | 1,185 | 1,537 |
| 2007 | GW | 2,663 | 4,619 | 7,734 | 2 | 56,934 | 396 | 72,348 |
| | SW | 0 | 136 | 0 | 0 | 1,691 | 925 | 2,752 |
| 2006 | GW | 2,948 | 4,613 | 7,676 | 1 | 58,391 | 487 | 74,116 |
| | SW | 0 | 136 | 0 | 0 | 1,163 | 1,137 | 2,436 |
| 2005 | GW | 3,007 | 3,660 | 7,676 | 0 | 60,246 | 542 | 75,131 |
| | SW | 0 | 107 | 0 | 0 | 9,353 | 1,265 | 10,725 |
| 2004 | GW | 2,702 | 4,151 | 7,475 | 0 | 40,411 | 750 | 55,489 |
| | SW | 0 | 305 | 0 | 0 | 9,266 | 1,126 | 10,697 |

# APPENDIX B2

Projected Surface Water Supplies

# Projected Surface Water Supplies
# TWDB 2022 State Water Plan Data

## BRAZOS COUNTY

*100% (multiplier)*

All values are in acre-feet

| RWPG | WUG | WUG Basin | Source Name | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|---|
| G | Irrigation, Brazos | Brazos | Brazos River Authority Main Stem Lake/Reservoir System | 350 | 350 | 350 | 350 | 350 | 350 |
| G | Livestock, Brazos | Brazos | Brazos Livestock Local Supply | 1,243 | 1,243 | 1,243 | 1,243 | 1,243 | 1,243 |
| G | Steam-Electric Power, Brazos | Brazos | Dansby Power Plant/Bryan Utilities Lake/Reservoir | 195 | 195 | 195 | 195 | 195 | 195 |
| G | Wellborn SUD | Brazos | Brazos River Authority Main Stem Lake/Reservoir System | 874 | 938 | 949 | 960 | 969 | 977 |
| | **Sum of Projected Surface Water Supplies (acre-feet)** | | | **2,662** | **2,726** | **2,737** | **2,748** | **2,757** | **2,765** |

## ROBERTSON COUNTY

*100% (multiplier)*

All values are in acre-feet

| RWPG | WUG | WUG Basin | Source Name | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|---|
| G | Irrigation, Robertson | Brazos | Brazos Run-of-River | 366 | 297 | 228 | 159 | 90 | 21 |
| G | Livestock, Robertson | Brazos | Brazos Livestock Local Supply | 3,048 | 3,048 | 3,048 | 3,048 | 3,048 | 3,048 |
| G | Steam-Electric Power, Robertson | Brazos | BRA System Operations Permit Supply | 21,388 | 22,816 | 24,245 | 25,674 | 27,102 | 28,532 |
| G | Steam-Electric Power, Robertson | Brazos | Brazos River Authority Main Stem Lake/Reservoir System | 15,909 | 14,509 | 13,108 | 11,707 | 10,307 | 8,905 |
| G | Steam-Electric Power, Robertson | Brazos | Twin Oak Lake/Reservoir | 2,900 | 2,872 | 2,844 | 2,816 | 2,788 | 2,760 |
| G | Wellborn SUD | Brazos | Brazos River Authority Main Stem Lake/Reservoir System | 246 | 182 | 171 | 160 | 151 | 143 |
| | **Sum of Projected Surface Water Supplies (acre-feet)** | | | **43,857** | **43,724** | **43,644** | **43,564** | **43,486** | **43,409** |

# APPENDIX B3

Projected Water Demands

# Projected Water Demands
# TWDB 2022 State Water Plan Data

Please note that the demand numbers presented here include the plumbing code savings found in the Regional and State Water Plans.

## BRAZOS COUNTY

*100% (multiplier)*

All values are in acre-feet

| RWPG | WUG | WUG Basin | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| G | Bryan | Brazos | 14,944 | 17,356 | 20,223 | 23,804 | 28,205 | 35,620 |
| G | College Station | Brazos | 16,451 | 20,480 | 25,877 | 30,439 | 30,382 | 30,363 |
| G | County-Other, Brazos | Brazos | 393 | 392 | 390 | 387 | 385 | 384 |
| G | Irrigation, Brazos | Brazos | 39,243 | 39,243 | 39,243 | 39,243 | 39,243 | 39,243 |
| G | Livestock, Brazos | Brazos | 1,243 | 1,243 | 1,243 | 1,243 | 1,243 | 1,243 |
| G | Manufacturing, Brazos | Brazos | 1,770 | 1,780 | 1,780 | 1,780 | 1,780 | 1,780 |
| G | Mining, Brazos | Brazos | 1,088 | 1,610 | 1,433 | 1,144 | 923 | 814 |
| G | Steam-Electric Power, Brazos | Brazos | 421 | 421 | 421 | 421 | 421 | 421 |
| G | Texas A&M University | Brazos | 6,322 | 6,349 | 6,308 | 6,292 | 6,288 | 6,288 |
| G | Wellborn SUD | Brazos | 3,025 | 4,531 | 5,064 | 5,688 | 6,405 | 7,148 |
| G | Wickson Creek SUD | Brazos | 1,138 | 1,277 | 1,424 | 1,610 | 1,813 | 2,035 |
| | **Sum of Projected Water Demands (acre-feet)** | | **86,038** | **94,682** | **103,406** | **112,051** | **117,088** | **125,339** |

## ROBERTSON COUNTY

*100% (multiplier)*

All values are in acre-feet

| RWPG | WUG | WUG Basin | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| G | Bethany Hearne WSC | Brazos | 43 | 45 | 48 | 51 | 54 | 58 |
| G | Bremond | Brazos | 181 | 193 | 205 | 220 | 235 | 250 |
| G | Calvert | Brazos | 190 | 183 | 180 | 180 | 179 | 179 |
| G | County-Other, Robertson | Brazos | 152 | 146 | 145 | 144 | 144 | 144 |
| G | Franklin | Brazos | 274 | 291 | 330 | 379 | 439 | 509 |
| G | Hearne | Brazos | 759 | 898 | 1,065 | 1,062 | 1,060 | 1,060 |
| G | Irrigation, Robertson | Brazos | 79,182 | 79,182 | 79,706 | 80,166 | 80,167 | 80,167 |
| G | Livestock, Robertson | Brazos | 3,048 | 3,048 | 3,048 | 3,048 | 3,048 | 3,048 |
| G | Manufacturing, Robertson | Brazos | 51 | 51 | 51 | 51 | 51 | 51 |
| G | Mining, Robertson | Brazos | 9,913 | 11,753 | 12,000 | 12,000 | 12,000 | 12,000 |
| G | Robertson County WSC | Brazos | 424 | 500 | 578 | 675 | 776 | 869 |
| G | Steam-Electric Power, Robertson | Brazos | 45,866 | 45,866 | 45,866 | 45,866 | 45,866 | 45,866 |
| G | Twin Creek WSC | Brazos | 265 | 284 | 302 | 324 | 345 | 367 |
| G | Wellborn SUD | Brazos | 851 | 877 | 910 | 950 | 996 | 1,045 |
| G | Wickson Creek SUD | Brazos | 43 | 48 | 53 | 59 | 66 | 74 |
| | **Sum of Projected Water Demands (acre-feet)** | | **141,242** | **143,365** | **144,487** | **145,175** | **145,426** | **145,687** |

# **APPENDIX B4**

Projected Water Supply Needs

# Projected Water Supply Needs
# TWDB 2022 State Water Plan Data

Negative values (in red) reflect a projected water supply need, positive values a surplus.

## BROBRAZOS COUNTY

All values are in acre-feet

| RWPG | WUG | WUG Basin | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| G | Bryan | Brazos | 215 | -1,896 | -4,578 | -8,034 | -12,323 | -19,650 |
| G | College Station | Brazos | 413 | -3,492 | -8,874 | -13,436 | -13,379 | -13,360 |
| G | County-Other, Brazos | Brazos | 37 | 38 | 40 | 43 | 45 | 46 |
| G | Irrigation, Brazos | Brazos | 6,258 | 6,328 | 6,336 | 6,336 | 6,336 | 6,336 |
| G | Livestock, Brazos | Brazos | 0 | 0 | 0 | 0 | 0 | 0 |
| G | Manufacturing, Brazos | Brazos | 697 | 1,036 | 1,078 | 1,078 | 1,078 | 1,078 |
| G | Mining, Brazos | Brazos | 552 | 30 | 207 | 496 | 717 | 826 |
| G | Steam-Electric Power, Brazos | Brazos | -1 | 18 | 20 | 20 | 20 | 20 |
| G | Texas A&M University | Brazos | -99 | 43 | 104 | 120 | 124 | 124 |
| G | Wellborn SUD | Brazos | 3,030 | 1,969 | 1,513 | 962 | 310 | -379 |
| G | Wickson Creek SUD | Brazos | 1,138 | 1,071 | 845 | 586 | 326 | 42 |
| | **Sum of Projected Water Supply Needs (acre-feet)** | | **-100** | **-5,388** | **-13,452** | **-21,470** | **-25,702** | **-33,389** |

## ROBERTSON COUNTY

All values are in acre-feet

| RWPG | WUG | WUG Basin | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| G | Bethany Hearne WSC | Brazos | 0 | 0 | 0 | 0 | 0 | 0 |
| G | Bremond | Brazos | 210 | 198 | 186 | 171 | 156 | 141 |
| G | Calvert | Brazos | 339 | 346 | 349 | 349 | 350 | 350 |
| G | County-Other, Robertson | Brazos | 3 | 9 | 10 | 11 | 11 | 11 |
| G | Franklin | Brazos | 973 | 956 | 917 | 868 | 808 | 738 |
| G | Hearne | Brazos | 2,040 | 1,899 | 1,729 | 1,729 | 1,728 | 1,724 |
| G | Irrigation, Robertson | Brazos | -12,851 | -16,181 | -17,100 | -17,718 | -17,829 | -17,921 |
| G | Livestock, Robertson | Brazos | 0 | 0 | 0 | 0 | 0 | 0 |
| G | Manufacturing, Robertson | Brazos | 4,566 | 4,566 | 4,566 | 4,566 | 4,566 | 4,566 |
| G | Mining, Robertson | Brazos | 5,774 | 3,934 | 3,687 | 3,687 | 3,687 | 3,687 |
| G | Robertson County WSC | Brazos | -81 | -157 | -235 | -332 | -433 | -526 |
| G | Steam-Electric Power, Robertson | Brazos | 0 | 0 | 0 | 0 | 0 | 0 |
| G | Twin Creek WSC | Brazos | 427 | 408 | 390 | 368 | 347 | 325 |
| G | Wellborn SUD | Brazos | 853 | 382 | 272 | 159 | 48 | -55 |
| G | Wickson Creek SUD | Brazos | 43 | 41 | 32 | 23 | 13 | 3 |
| | **Sum of Projected Water Supply Needs (acre-feet)** | | **-12,932** | **-16,338** | **-17,335** | **-18,050** | **-18,262** | **-18,502** |

# APPENDIX B5

Projected Water Management Strategies

# Projected Water Management Strategies
# TWDB 2022 State Water Plan Data

## BRAZOS COUNTY

**WUG, Basin (RWPG)**

All values are in acre-feet

| Water Management Strategy | Source Name [Origin] | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| **Bryan, Brazos (G)** | | | | | | | |
| Bryan ASR (Carrizo-Wilcox) | Simsboro Aquifer ASR [Brazos] | 0 | 6,000 | 6,000 | 6,000 | 8,500 | 10,500 |
| Carrizo GW Development for Bryan in Brazos County | Carrizo-Wilcox Aquifer [Brazos] | 0 | 7,501 | 7,501 | 7,501 | 7,501 | 7,501 |
| Municipal Water Conservation - Bryan | DEMAND REDUCTION [Brazos] | 0 | 1,311 | 1,606 | 1,719 | 1,988 | 2,489 |
| | | **0** | **14,812** | **15,107** | **15,220** | **17,989** | **20,490** |
| **College Station, Brazos (G)** | | | | | | | |
| Carrizo GW Development for College Station in Brazos County | Carrizo-Wilcox Aquifer [Brazos] | 0 | 0 | 5,234 | 9,695 | 9,796 | 9,796 |
| Municipal Water Conservation - College Station | DEMAND REDUCTION [Brazos] | 0 | 234 | 0 | 0 | 0 | 0 |
| Reuse DPR- College Station | Direct Reuse [Brazos] | 0 | 8,232 | 8,232 | 8,232 | 8,232 | 8,232 |
| | | **0** | **8,466** | **13,466** | **17,927** | **18,028** | **18,028** |
| **Irrigation, Brazos, Brazos (G)** | | | | | | | |
| BRA System Operation--Surplus | BRA System Operations Permit Supply [Reservoir] | 348 | 348 | 348 | 348 | 348 | 348 |
| | | **348** | **348** | **348** | **348** | **348** | **348** |
| **Steam-Electric Power, Brazos, Brazos (G)** | | | | | | | |
| Reuse- Bryan (Option 1) | Direct Reuse [Brazos] | 605 | 605 | 605 | 605 | 605 | 605 |
| | | **605** | **605** | **605** | **605** | **605** | **605** |
| **Texas A&M University, Brazos (G)** | | | | | | | |
| Municipal Water Conservation - Texas A&M University | DEMAND REDUCTION [Brazos] | 0 | 560 | 1,072 | 1,557 | 2,006 | 2,415 |
| Texas A&M Sparta Aquifer Development | Sparta Aquifer [Brazos] | 0 | 0 | 638 | 638 | 638 | 638 |
| | | **0** | **560** | **1,710** | **2,195** | **2,644** | **3,053** |
| **Wellborn SUD, Brazos (G)** | | | | | | | |
| Municipal Water Conservation - Wellborn SUD | DEMAND REDUCTION [Brazos] | 0 | 355 | 501 | 533 | 591 | 655 |
| | | **0** | **355** | **501** | **533** | **591** | **655** |
| **Sum of Projected Water Management Strategies (acre-feet)** | | **953** | **25,146** | **31,737** | **36,828** | **40,205** | **43,179** |

## ROBERTSON COUNTY

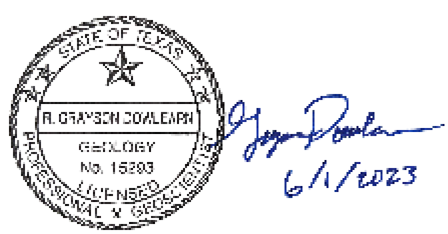
**WUG, Basin (RWPG)**

All values are in acre-feet

| Water Management Strategy | Source Name [Origin] | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|
| **Bremond, Brazos (G)** | | | | | | | |
| Municipal Water Conservation - Bremond | DEMAND REDUCTION [Robertson] | 0 | 13 | 21 | 21 | 23 | 24 |
| | | **0** | **13** | **21** | **21** | **23** | **24** |
| **Hearne, Brazos (G)** | | | | | | | |
| Municipal Water Conservation - Hearne | DEMAND REDUCTION [Robertson] | 0 | 43 | 22 | 19 | 17 | 17 |
| | | **0** | **43** | **22** | **19** | **17** | **17** |
| **Irrigation, Robertson, Brazos (G)** | | | | | | | |
| Irrigation Water Conservation | DEMAND REDUCTION [Robertson] | 2,375 | 3,959 | 5,579 | 5,612 | 5,612 | 5,612 |
| | | **2,375** | **3,959** | **5,579** | **5,612** | **5,612** | **5,612** |
| **Robertson County WSC, Brazos (G)** | | | | | | | |
| Carrizo Aquifer Development - Robertson County WSC | Carrizo-Wilcox Aquifer [Robertson] | 550 | 550 | 550 | 550 | 550 | 550 |
| | | **550** | **550** | **550** | **550** | **550** | **550** |
| **Steam-Electric Power, Robertson, Brazos (G)** | | | | | | | |
| Purchase from Walnut Creek Mine-Reuse | Brazos Other Local Supply [Robertson] | 0 | 0 | 0 | 9,000 | 9,000 | 9,000 |
| | | **0** | **0** | **0** | **9,000** | **9,000** | **9,000** |
| **Twin Creek WSC, Brazos (G)** | | | | | | | |
| Municipal Water Conservation - Twin Creek WSC | DEMAND REDUCTION [Robertson] | 0 | 21 | 23 | 23 | 23 | 25 |
| | | **0** | **21** | **23** | **23** | **23** | **25** |
| **Wellborn SUD, Brazos (G)** | | | | | | | |
| Municipal Water Conservation - Wellborn SUD | DEMAND REDUCTION [Robertson] | 0 | 69 | 90 | 89 | 92 | 96 |
| | | **0** | **69** | **90** | **89** | **92** | **96** |
| **Sum of Projected Water Management Strategies (acre-feet)** | | **2,925** | **4,655** | **6,285** | **15,314** | **15,317** | **15,324** |

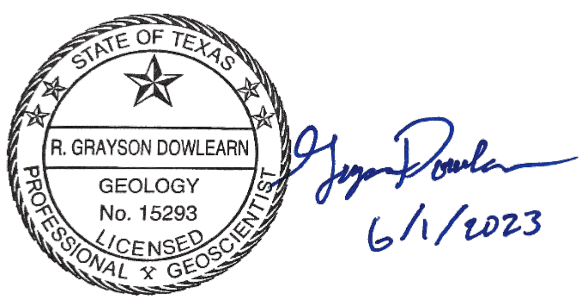
# GAM Run 23-009: Brazos Valley Groundwater Conservation District Management Plan

**Tim Cawthon, GIT and Grayson Dowlearn, P.G.**
**Texas Water Development Board**
**Groundwater Division**
**Groundwater Modeling Department**
**512-463-5076**
**June 1, 2023**



# GAM RUN 23-009: BRAZOS VALLEY GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

Tim Cawthon, GIT and Grayson Dowlearn, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-5076
June 1, 2023



*This page is intentionally blank*

# GAM RUN 23-009: BRAZOS VALLEY GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

Tim Cawthon, GIT and Grayson Dowlearn, P.G. Texas
Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-5076
June 1, 2023

## *EXECUTIVE SUMMARY:*

Texas Water Code § 36.1071(h), states that, in developing its groundwater management plan, a groundwater conservation district shall use groundwater availability modeling information provided by the Executive Administrator of the Texas Water Development Board (TWDB) in conjunction with any available site-specific information provided by the district for review and comment to the Executive Administrator.

The TWDB provides data and information to the Brazos Valley Groundwater Conservation District in two parts. Part 1 is the Estimated Historical Water Use/State Water Plan dataset report, which will be provided to you separately by the TWDB Groundwater Technical Assistance Department. Please direct questions about the water data report to Mr. Stephen Allen at 512-463-7317 or stephen.allen@twdb.texas.gov. Part 2 is the required groundwater availability modeling information, which includes:

1. the annual amount of recharge from precipitation, if any, to the groundwater resources within the district;

2. the annual volume of water that discharges from the aquifer to springs and any surface-water bodies, including lakes, streams, and rivers, for each aquifer within the district; and

3. the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

The groundwater management plan for the Brazos Valley Groundwater Conservation District should be adopted by the district on or before February 13, 2024 and submitted to the TWDB Executive Administrator on or before March 14, 2024. The current management plan for the Brazos Valley Groundwater Conservation District expires on May 13, 2024.

The management plan information for the aquifers within the Brazos Valley Groundwater Conservation District was extracted from four groundwater availability models. We used the groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Young and Kushnereit, 2020, and Young and others, 2018) to estimate the management plan information for the Carrizo-Wilcox, Queen City, and Sparta aquifers. We used the groundwater availability model for the Yegua-Jackson Aquifer (Deeds and others, 2010) to estimate the management plan information for the Yegua-Jackson Aquifer. We used the groundwater availability model for the northern portion of the Gulf Coast Aquifer System (Kasmarek, 2013) to estimate the management plan information for the Gulf Coast Aquifer System. Last, we used the groundwater availability model for the Brazos River Alluvium Aquifer (Ewing and Jigmond, 2016) to estimate the management plan information for the Brazos River Alluvium Aquifer.

This report replaces the results of GAM Run 18-021 (Wade, 2019) and includes results from the updated groundwater availability model for the central portion of the Carrizo- Wilcox, Queen City, and Sparta aquifers. Values may differ from the previous report as a result of routine updates to the spatial grid file used to define county, groundwater conservation district, and aquifer boundaries, which can impact the calculated water budget values. Additionally, the approach used for analyzing model results is reviewed during each update and may have been refined to better delineate groundwater flows. Tables 1 through 6 summarize the groundwater availability model data required by statute. Figures 1, 3, 5, 7, 9, and 11 show the areas of the respective models from which the values

in Tables 1 through 6 were extracted. Figures 2, 4, 6, 8, 10, and 12 provide a generalized diagram of the groundwater flow components provided in Tables 1 through 6. If, after review of the figures, the Brazos Valley Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB at your earliest convenience.

The flow components presented in this report do not represent the full groundwater budget. If additional inflow and outflow information would be helpful for planning purposes, the district may submit a request in writing to the TWDB Groundwater Modeling Department for the full groundwater budget.

***METHODS:***

In accordance with Texas Water Code § 36.1071(h), the groundwater availability models mentioned above were used to estimate information for the Brazos Valley Groundwater Conservation District management plan. Water budgets for the historical calibration period for the Carrizo-Wilcox, Queen City, and Sparta aquifers groundwater availability model (1980 through 2010) and the Brazos River Alluvium Aquifer groundwater availability model (1980 through 2012) were extracted using ZONEBUDGET for MODFLOW USG Version 1.0 (Panday and others, 2013). Water budgets for the historical calibration period for the Yegua-Jackson Aquifer (1980 through 1997) and the Gulf Coast Aquifer System (1980 through 2009) groundwater availability models were extracted using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The average annual water budget values for recharge, surface-water outflow, inflow to the district, outflow from the district, and the flow between aquifers within the district are summarized in this report.

***PARAMETERS AND ASSUMPTIONS:***

## *Carrizo-Wilcox, Queen City, and Sparta aquifers*

- We used version 3.02 of the groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Young and Kushnereit, 2020, and Young and others, 2018) to analyze the Carrizo-Wilcox, Queen City, and Sparta aquifers. See Young and Kushnereit (2020) and Young and others (2018) for assumptions and limitations of the model.
- The groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers contains the following ten layers:
    - Layer 1 represents the Colorado River and Brazos River alluvium.
    - Layer 2 represents the shallow flow system of all units in Layers 3 through 10.
    - Layer 3 represents the Sparta Aquifer and equivalent units.
    - Layer 4 represents the Weches Formation.
    - Layer 5 represents the Queen City Aquifer and equivalent units.
    - Layer 6 represents the Reklaw Formation.
    - Layers 7 through 10 represent the Carrizo-Wilcox Aquifer and equivalent units.

- Individual water budgets for the district were determined for the Sparta Aquifer (Layers 2 and 3), the Queen City Aquifer (Layers 2 and 5), and the Carrizo-Wilcox Aquifer (Layers 2 and 7 through 10, collectively).
- The MODFLOW River package was used to simulate the groundwater exchange with major rivers and perennial streams. Outflow from ephemeral streams, intermittent streams, and seeps were simulated using the MODFLOW Drain package. The evapotranspiration package was used to simulate groundwater evapotranspiration from the model.
- Water budget terms were averaged for the period 1980 through 2010 (stress periods 52 through 82).
- The model was run with MODFLOW-USG (Panday and others, 2013).

### *Yegua-Jackson Aquifer*

- We used version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer (Deeds and others, 2010) to analyze the Yegua-Jackson Aquifer. See Deeds and others (2010) for assumptions and limitations of the model.
- The groundwater availability model for the Yegua-Jackson Aquifer contains the following five layers:
    - Layer 1 represents the Yegua-Jackson Aquifer outcrop, the Catahoula Formation, and other younger overlying units.
    - Layer 2 represents the upper portion of the Jackson Group.
    - Layer 3 represents the lower portion of the Jackson Group.
    - Layer 4 represents the upper portion of the Yegua Group.
    - Layer 5 represents the lower portion of the Yegua Group.
- An overall water budget for the district was determined for the Yegua-Jackson Aquifer (layers 1 through 5, collectively, for the portions of the model that represent the Yegua-Jackson Aquifer).
- The Catahoula Formation within the Brazos Valley Groundwater Conservation District falls within the Gulf Coast Aquifer System, which allows us to estimate the exchange between the Yegua-Jackson Aquifer and the Gulf Coast Aquifer System in this assessment.
- Water budget terms were averaged for the period 1980 through 1997 (stress periods 10 through 27).
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

## *Gulf Coast Aquifer System*

- We used version 1.01 of the groundwater availability model for the northern portion of the Gulf Coast Aquifer System (Kasmarek, 2013) to analyze the Gulf Coast Aquifer System. See Kasmarek (2013) for assumptions and limitations of the model.
- The groundwater availability model for the northern portion of the Gulf Coast Aquifer System contains the following four layers:
    - Layer 1 represents the Chicot Aquifer.
    - Layer 2 represents the Evangeline Aquifer.
    - Layer 3 represents the Burkeville Confining Unit.
    - Layer 4 represents the Jasper Aquifer and parts of the Catahoula Formation in direct hydrologic communication with the Jasper Aquifer.
- Water budgets for the district were determined for the Gulf Coast Aquifer System (layers 1 through 4, collectively).
- Water budget terms were averaged for the period 1980 through 2009 (stress periods 16 through 78).
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

## *Brazos River Alluvium Aquifer*

- We used version 1.01 of the groundwater availability model for the Brazos River Alluvium Aquifer (Ewing and Jigmond, 2016) to analyze the Brazos River Alluvium Aquifer. See Ewing and Jigmond (2016) for assumptions and limitations of the model.
- The groundwater availability model for the Brazos River Alluvium Aquifer contains the following three layers:
    - Layers 1 and 2 represent the Brazos River Alluvium Aquifer.
    - Layer 3 represents the surficial portions of the Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, and Gulf Coast aquifers as well as various underlying confining units.
- The MODFLOW Streamflow-Routing package was used to simulate the groundwater exchange with perennial rivers and streams. Ephemeral streams were simulated using the MODFLOW River package. Springs were simulated using the MODFLOW Drain package.
- Water budget terms were averaged for the period 1980 through 2012 (stress periods 32 through 427).
- The model was run with MODFLOW-USG (Panday and others, 2013).
-

***RESULTS:***

A groundwater budget summarizes the amount of water entering and leaving an aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the groundwater availability model results for the aquifers located within the Brazos Valley Groundwater Conservation District and averaged over the historical calibration period, as shown in Tables 1 through 6.

1. Precipitation recharge—the areally distributed recharge sourced from precipitation falling on the outcrop areas of the aquifers (where the aquifer is exposed at land surface) within the district.
2. Surface-water outflow—the total water discharging from the aquifer (outflow) to surface-water features such as streams, reservoirs, and springs.
3. Flow into and out of district—the lateral flow within the aquifer between the district and adjacent counties.
4. Flow between aquifers—the net vertical flow between the aquifer and adjacent aquifers or confining units. This flow is controlled by the relative water levels in each aquifer and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs.

The information needed for the district's management plan is summarized in Tables 1 through 6. Figures 1, 3, 5, 7,9, and 11 show the area of the model from which the values in Tables 1 through 6 were extracted. Figures 2, 4, 6, 8, 10, and 12 provide a generalized diagram of the groundwater flow components provided in Tables 1 through 6. It is important to note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double accounting, a model cell that straddles a political boundary, such as a district or county boundary, is assigned to one side of the boundary based on the location of the centroid of the model cell. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located.

**Table 1: Summarized information for the Carrizo-Wilcox Aquifer for the Brazos Valley Groundwater Conservation District groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot.**

| Management plan requirement | Aquifer or confining unit | Results |
|---|---|---|
| Estimated annual amount of recharge from precipitation to the district | Carrizo-Wilcox Aquifer | 46,908 |
| Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers | Carrizo-Wilcox Aquifer | 54,346 |
| Estimated annual volume of flow into the district within each aquifer in the district | Carrizo-Wilcox Aquifer | 33,140 |
| Estimated annual volume of flow out of the district within each aquifer in the district | Carrizo-Wilcox Aquifer | 10,125 |
| Estimated net annual volume of flow between each aquifer in the district | To Carrizo-Wilcox Aquifer from Carrizo-Wilcox equivalent units | 2,149 |
| | From Carrizo-Wilcox Aquifer to Reklaw confining unit | 2,454 |
| | From Carrizo-Wilcox Aquifer to Queen City Aquifer | 5 |
| | From Carrizo-Wilcox Aquifer to Brazos River Alluvium Aquifer* | 2,286 |

* Estimated from the groundwater availability model for the Brazos River Alluvium Aquifer.

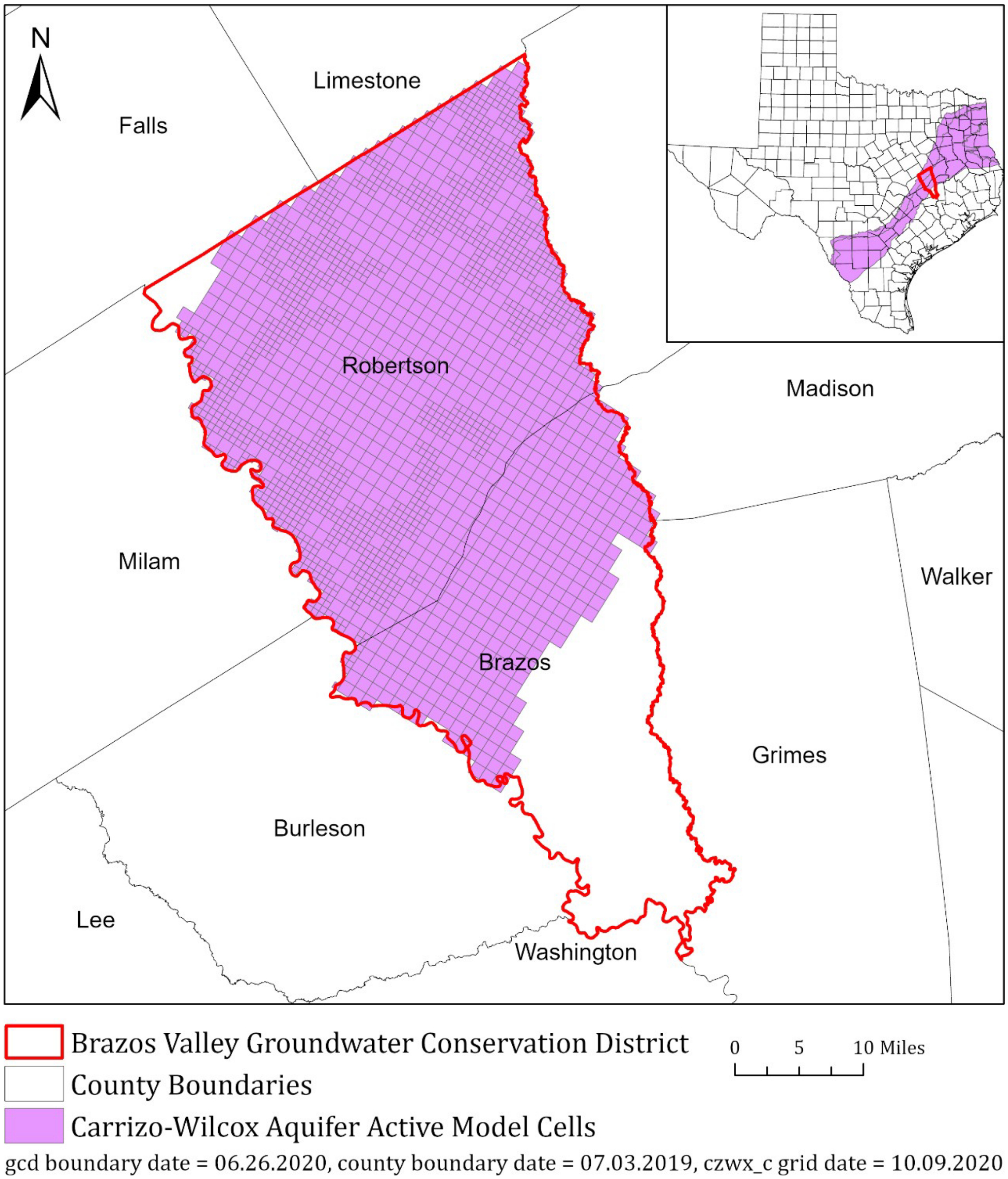
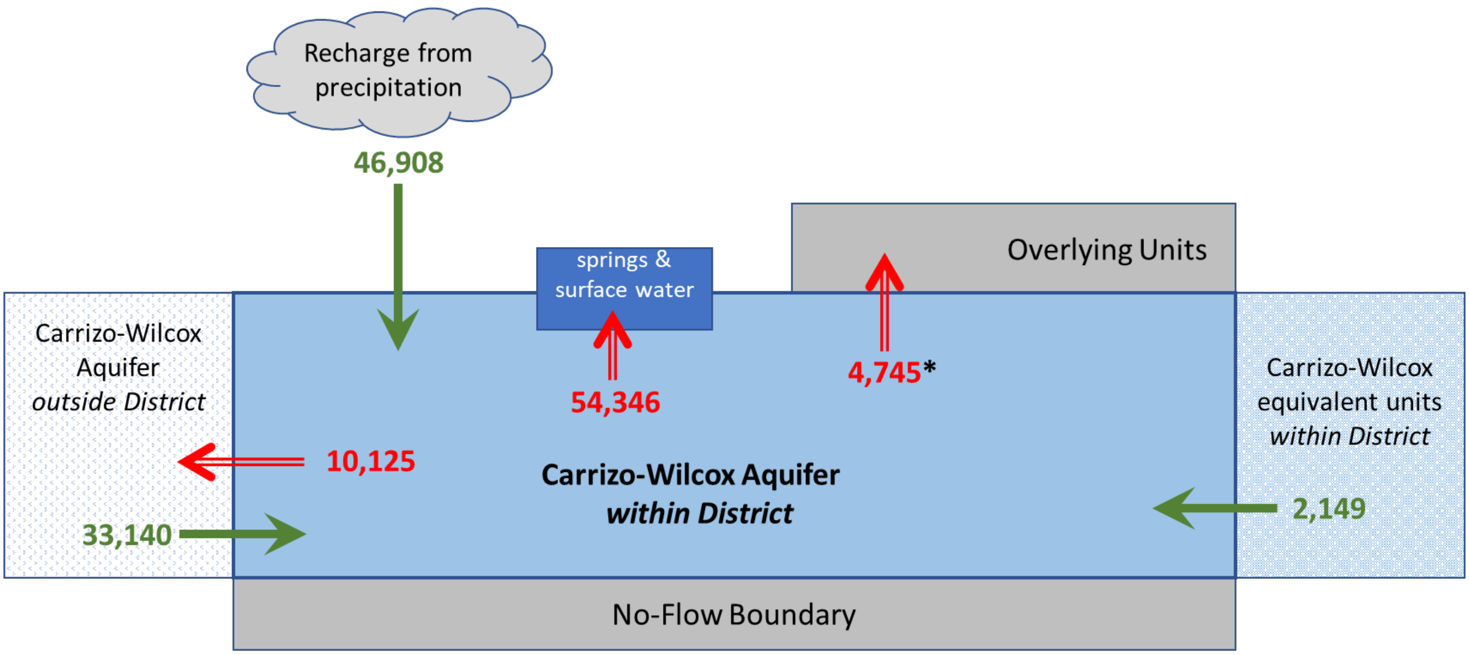



**Figure 1: Area of the groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers from which the information in Table 1 was extracted (the Carrizo-Wilcox Aquifer extent within the district boundary).**




* Flow to overlying units includes net outflow of 2,454 acre-feet per year to the Reklaw confining unit, net outflow of 5 acre-feet per year to the Queen City Aquifer, and net outflow of 2,286 acre-feet per year to the Brazos River Alluvium Aquifer.

*Caveat: This diagram only includes the water budget items provided in Table 1. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.*

**Figure 2: Generalized diagram of the summarized budget information from Table 1, representing directions of flow for the Carrizo-Wilcox Aquifer within the Brazos Valley Groundwater Conservation District. Flow values are expressed in acre-feet per year.**

**Table 2: Summarized information for the Queen City Aquifer for the Brazos Valley Groundwater Conservation District groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot.**

| Management plan requirement | Aquifer or confining unit | Results |
|---|---|---|
| Estimated annual amount of recharge from precipitation to the district | Queen City Aquifer | 10,105 |
| Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers | Queen City Aquifer | 9,923 |
| Estimated annual volume of flow into the district within each aquifer in the district | Queen City Aquifer | 2,976 |
| Estimated annual volume of flow out of the district within each aquifer in the district | Queen City Aquifer | 1,228 |
| Estimated net annual volume of flow between each aquifer in the district | To Queen City Aquifer from Queen City equivalent units | 33 |
| | To Queen City Aquifer from Carrizo-Wilcox Aquifer | 5 |
| | To Queen City Aquifer from Reklaw confining unit | 451 |
| | From Queen City Aquifer to Weches confining unit | 2,372 |
| | To Queen City Aquifer from Sparta Aquifer | 153 |
| | From Queen City Aquifer to Brazos River Alluvium Aquifer* | 6,262 |

* Estimated from the groundwater availability model for the Brazos River Alluvium Aquifer.

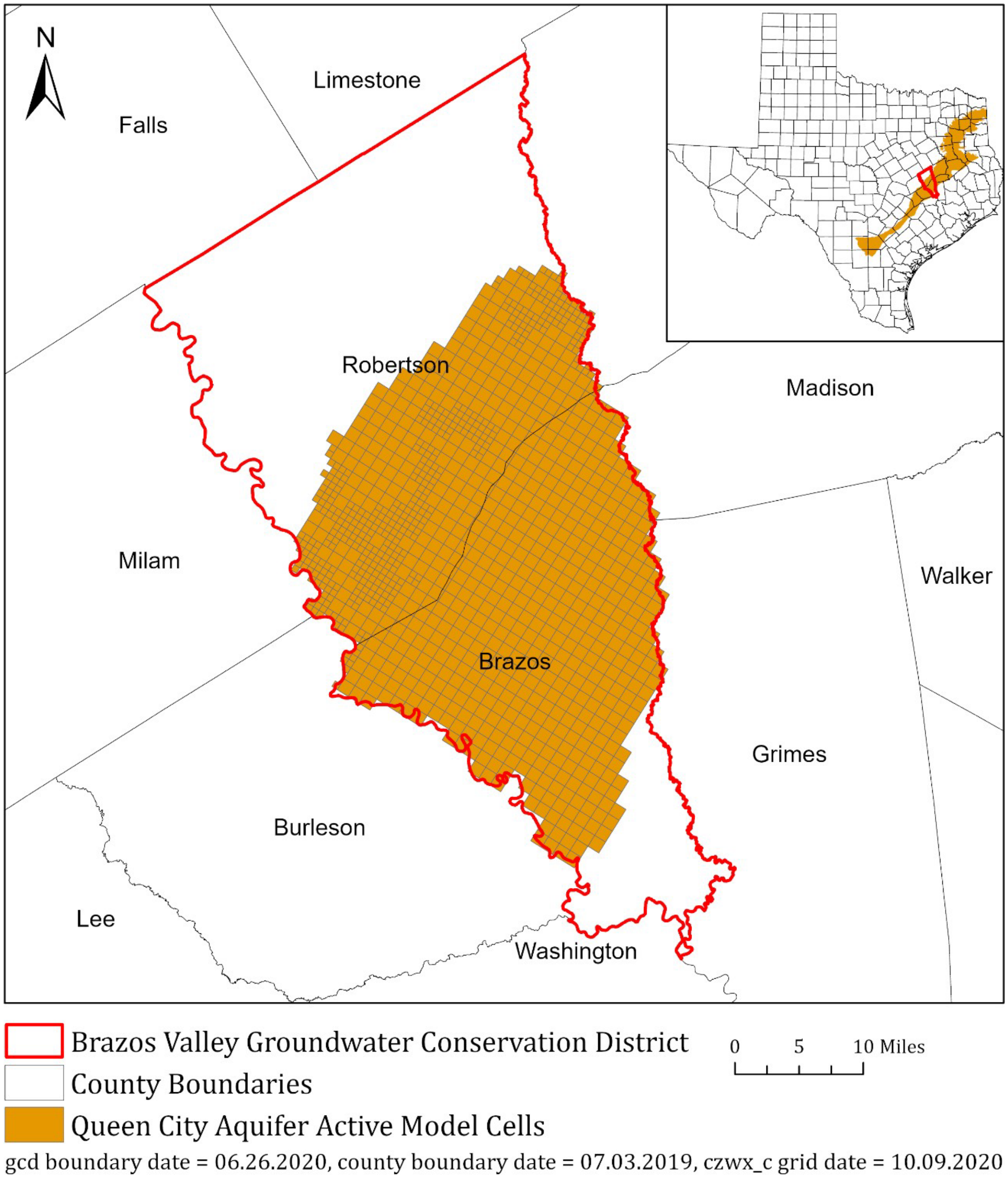
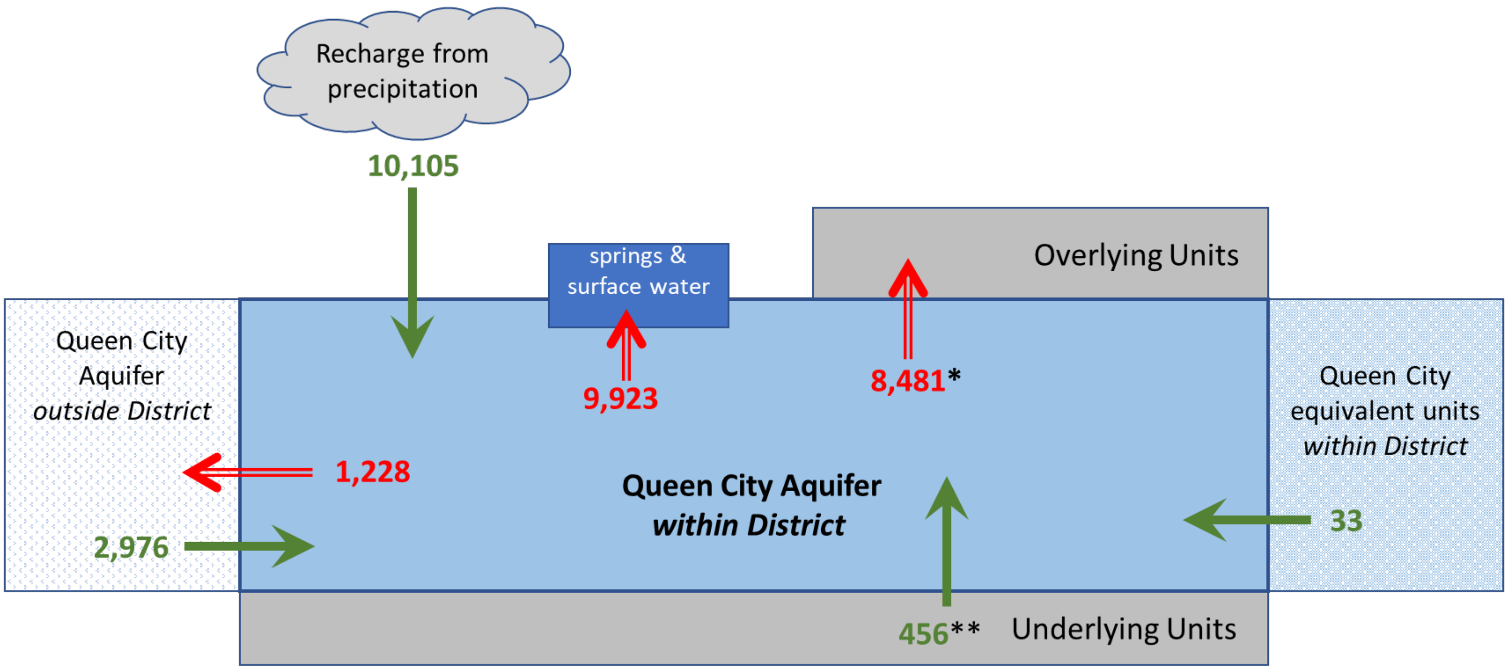



**Figure 3: Area of the groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers from which the information in Table 2 was extracted (the Queen City Aquifer extent within the district boundary).**




* Flow to overlying units includes net outflow of 2,372 acre-feet per year to the Weches confining unit, net inflow of 153 acre-feet per year from the Sparta Aquifer, and net outflow of 6,262 acre-feet per year to the Brazos River Alluvium Aquifer.

** Flow from underlying units includes net inflow of 451 acre-feet per year from the Reklaw confining unit and 5 acre-feet per year from the Carrizo Wilcox Aquifer.

*Caveat: This diagram only includes the water budget items provided in Table 2. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.*

**Figure 4: Generalized diagram of the summarized budget information from Table 2, representing directions of flow for Queen City Aquifer within Brazos Valley Groundwater Conservation District. Flow values expressed in acre-feet per year.**

**Table 3: Summarized information for the Sparta Aquifer for the Brazos Valley Groundwater Conservation District groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot.**

| Management plan requirement | Aquifer or confining unit | Results |
|---|---|---|
| Estimated annual amount of recharge from precipitation to the district | Sparta Aquifer | 8,333 |
| Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers | Sparta Aquifer | 12,662 |
| Estimated annual volume of flow into the district within each aquifer in the district | Sparta Aquifer | 1,176 |
| Estimated annual volume of flow out of the district within each aquifer in the district | Sparta Aquifer | 466 |
| Estimated net annual volume of flow between each aquifer in the district | From Sparta Aquifer to Sparta equivalent units | 5 |
| | From Sparta Aquifer to Queen City Aquifer | 153 |
| | To Sparta Aquifer from Weches confining unit | 3,138 |
| | From Sparta Aquifer to overlying units | 165 |
| | From Sparta Aquifer to Brazos River Alluvium Aquifer* | 3,860 |

* Estimated from the groundwater availability model for the Brazos River Alluvium Aquifer.

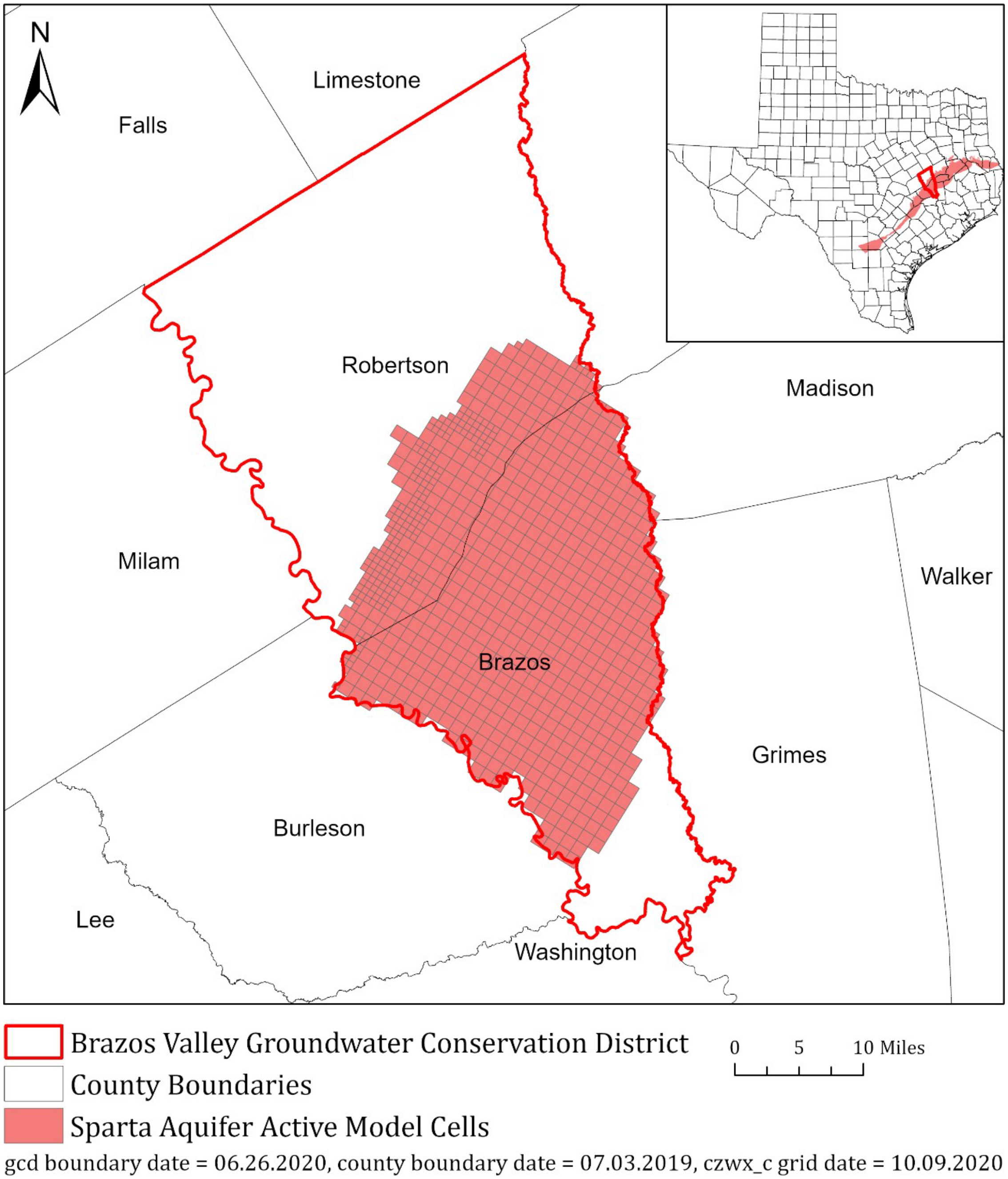
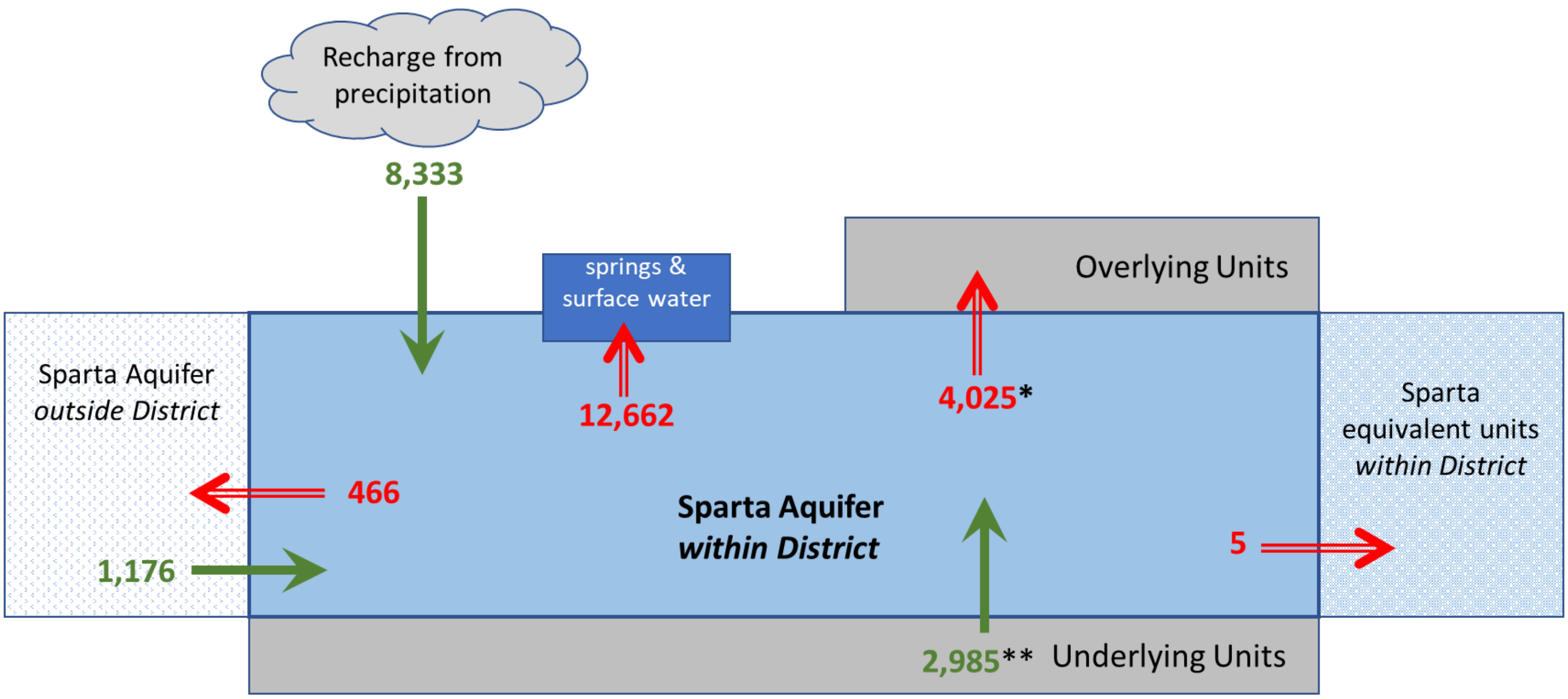



**Figure 5: Area of the groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers from which the information in Table 3 was extracted (the Sparta Aquifer extent within the district boundary).**




*  Flow to overlying units includes net outflow of 165 acre-feet per year to the overlying younger units and net outflow of 3,860 acre-feet per year to the Brazos River Alluvium Aquifer.

**  Flow from underlying units includes net outflow of 153 acre-feet per year to the Queen City Aquifer and net inflow of 3,138 acre-feet per year from the Weches confining unit.

*Caveat: This diagram only includes the water budget items provided in Table 3. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department*

**Figure 6: Generalized diagram of the summarized budget information from Table 3, representing directions of flow for the Sparta Aquifer within the Brazos Valley Groundwater Conservation District. Flow values are expressed in acre-feet per year.**

**Table 4: Summarized information for the Yegua-Jackson Aquifer for the Brazos Valley Groundwater Conservation District groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot.**

| Management plan requirement | Aquifer or confining unit | Results |
|---|---|---|
| Estimated annual amount of recharge from precipitation to the district | Yegua-Jackson Aquifer | 26,560 |
| Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers | Yegua-Jackson Aquifer | 42,656 |
| Estimated annual volume of flow into the district within each aquifer in the district | Yegua-Jackson Aquifer | 12,578 |
| Estimated annual volume of flow out of the district within each aquifer in the district | Yegua-Jackson Aquifer | 7,122 |
| Estimated net annual volume of flow between each aquifer in the district | To Yegua-Jackson Aquifer from Yegua-Jackson equivalent units | 134 |
| | To Yegua-Jackson Aquifer from the Gulf Coast Aquifer System | 17 |
| | From Yegua-Jackson Aquifer to Brazos River Alluvium Aquifer* | 2,431 |

* Estimated from the groundwater availability model for the Brazos River Alluvium Aquifer.

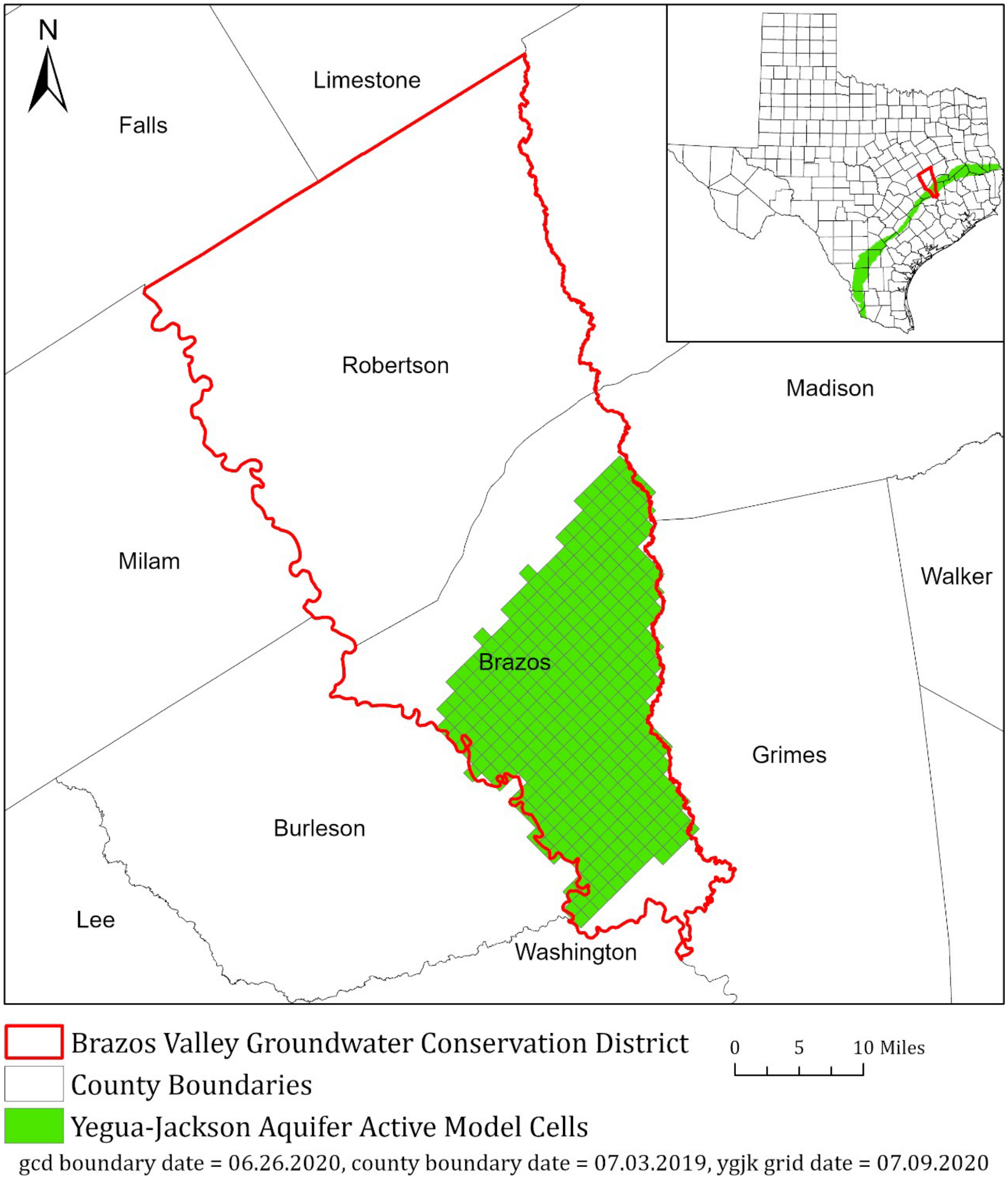
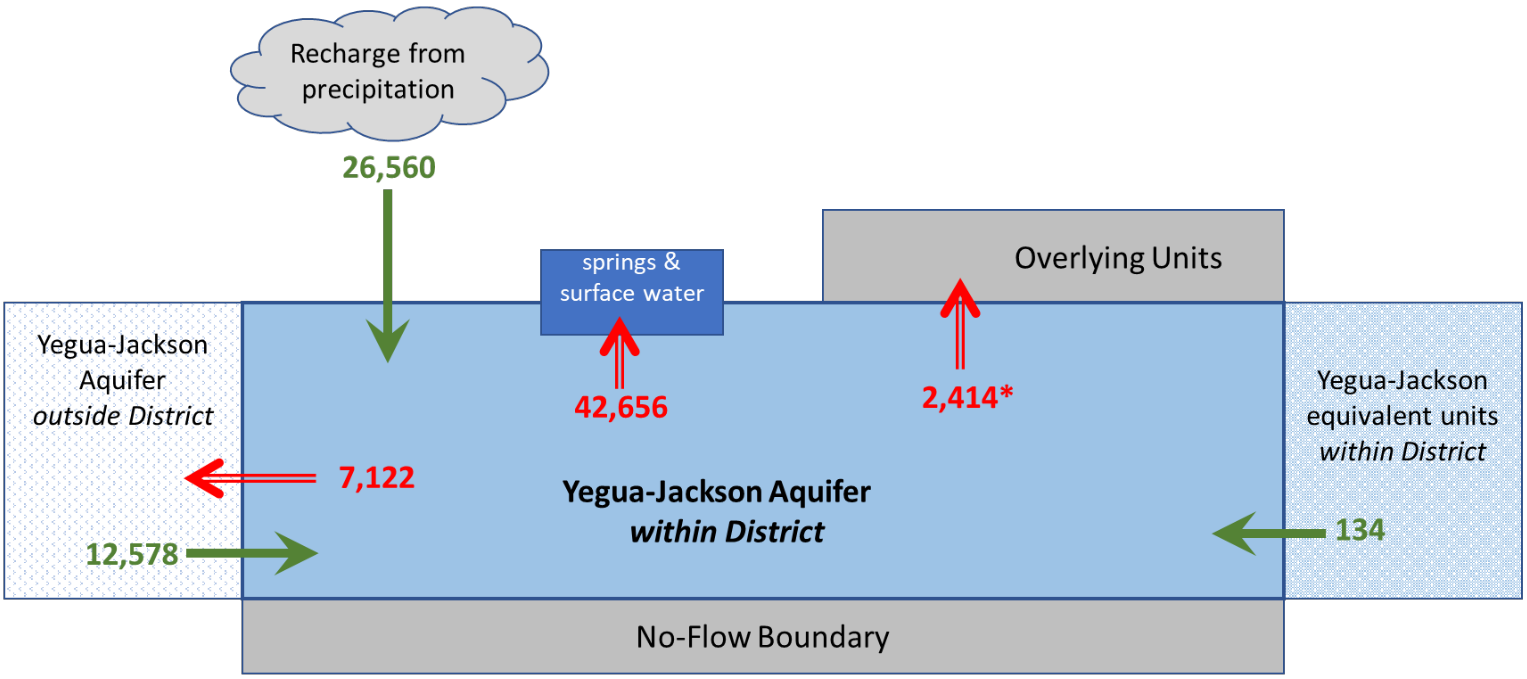



**Figure 7: Area of the groundwater availability model for the Yegua-Jackson Aquifer from which the information in Table 4 was extracted (the Yegua-Jackson Aquifer extent within the district boundary).**




* Flow to overlying units includes net outflow of 2,431 acre-feet per year to the Brazos River Alluvium Aquifer and a net inflow of 17 acre-feet per year from the Gulf Coast Aquifer System.

*Caveat: This diagram only includes the water budget items provided in Table 4. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.*

**Figure 8: Generalized diagram of the summarized budget information from Table 4, representing directions of flow for the Yegua-Jackson Aquifer within the Brazos Valley Groundwater Conservation District. Flow values are expressed in acre-feet per year.**

**Table 5: Summarized information for the Gulf Coast Aquifer System for the Brazos Valley Groundwater Conservation District groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot.**

| Management plan requirement | Aquifer or confining unit | Results |
|---|---|---|
| Estimated annual amount of recharge from precipitation to the district | Gulf Coast Aquifer System | 40 |
| Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers | Gulf Coast Aquifer System | 255 |
| Estimated annual volume of flow into the district within each aquifer in the district | Gulf Coast Aquifer System | 332 |
| Estimated annual volume of flow out of the district within each aquifer in the district | Gulf Coast Aquifer System | 48 |
| Estimated net annual volume of flow between each aquifer in the district | From Gulf Coast Aquifer System to Yegua-Jackson Aquifer* | 17 |
| | From Gulf Coast Aquifer System to Brazos River Alluvium Aquifer** | 2,176 |

* Estimated from the groundwater availability model for the Yegua-Jackson Aquifer.

** Estimated from the groundwater availability model for the Brazos River Alluvium Aquifer.

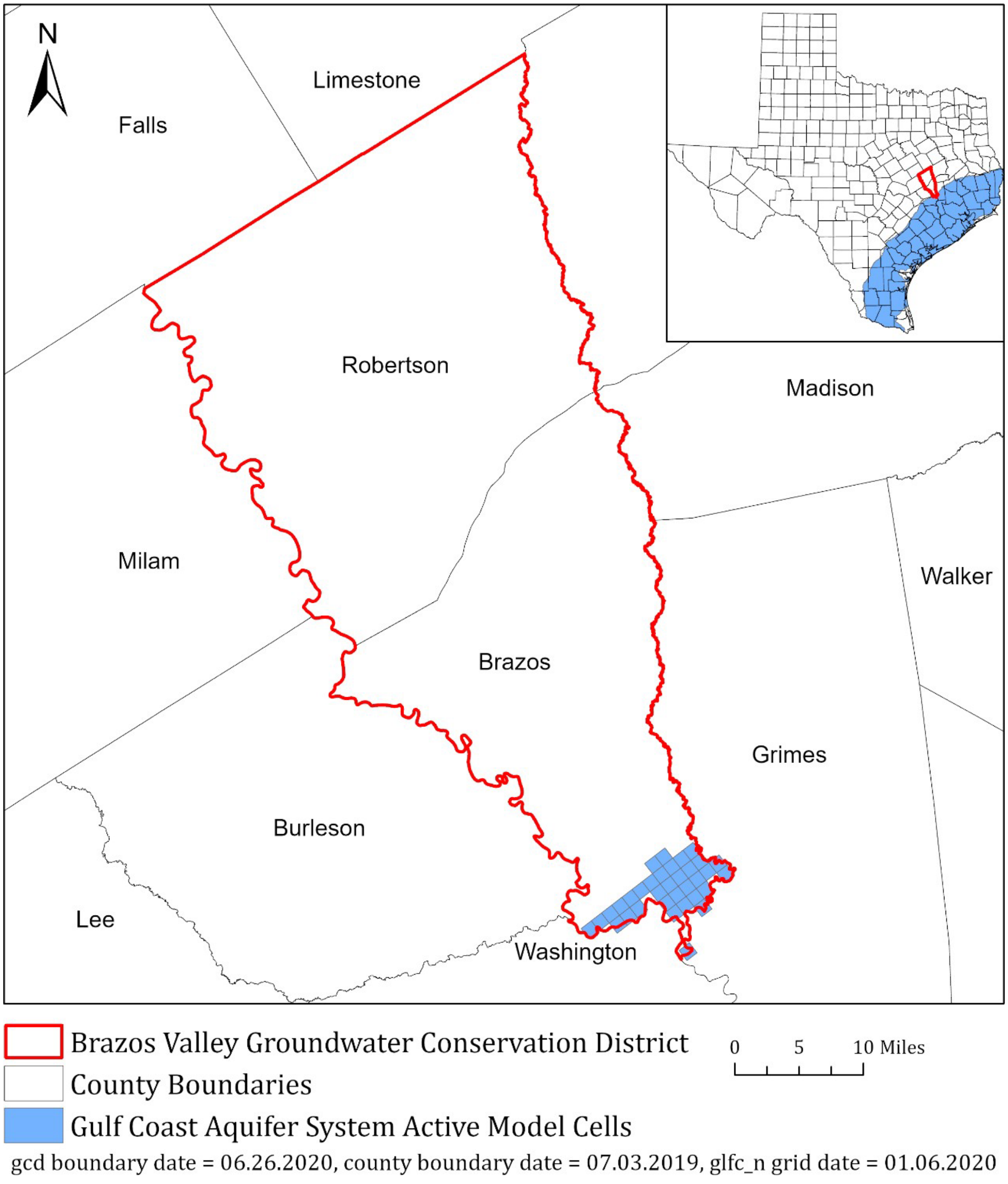
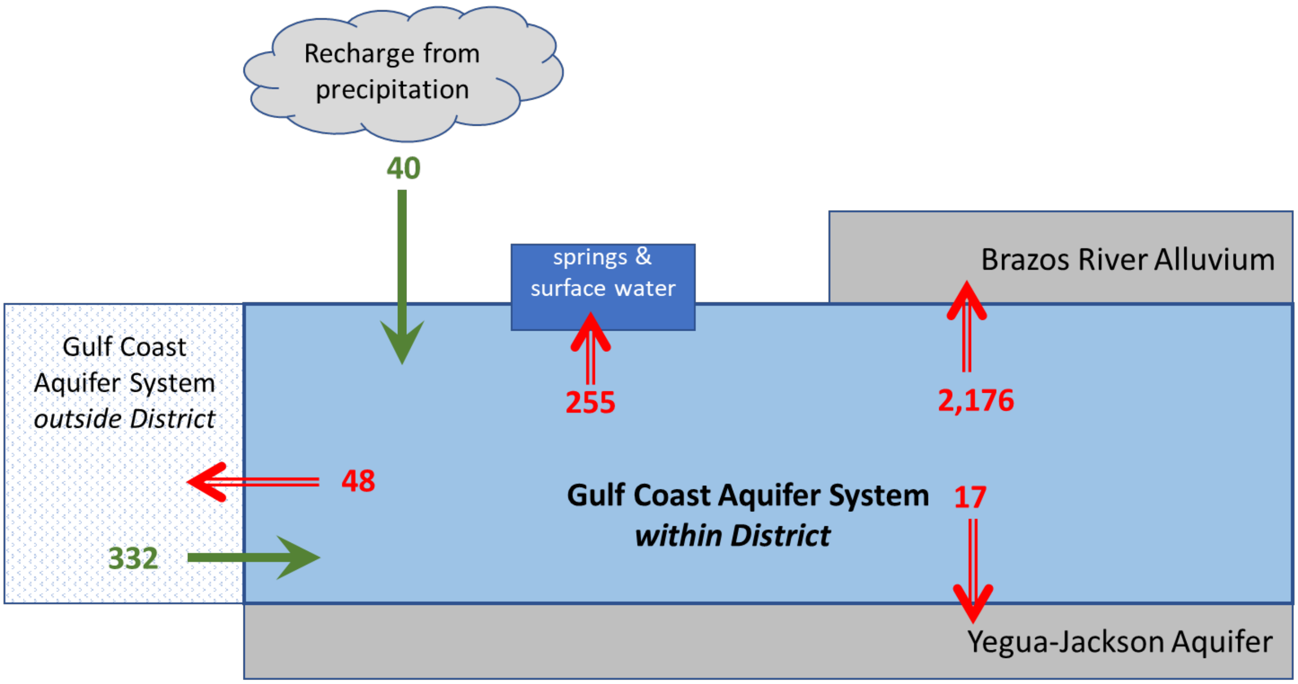



**Figure 9: Area of the groundwater availability model for the northern portion of the Gulf Coast Aquifer System from which the information in Table 5 was extracted (the Gulf Coast Aquifer System extent within the district boundary).**




*Caveat: This diagram only includes the water budget items provided in Table 5. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.*

**Figure 10:** **Generalized diagram of the summarized budget information from Table 5, representing directions of flow for the Gulf Coast Aquifer System within the Brazos Valley Groundwater Conservation District. Flow values are expressed in acre-feet per year.**

**Table 6: Summarized information for the Brazos River Alluvium Aquifer for the Brazos Valley Groundwater Conservation District groundwater management plan. All values are reported in acre-feet per year and rounded to the nearest 1 acre-foot.**

| Management plan requirement | Aquifer or confining unit | Results |
|---|---|---|
| Estimated annual amount of recharge from precipitation to the district | Brazos River Alluvium Aquifer | 23,418 |
| Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers | Brazos River Alluvium Aquifer | 34,326 |
| Estimated annual volume of flow into the district within each aquifer in the district | Brazos River Alluvium Aquifer | 24,831 |
| Estimated annual volume of flow out of the district within each aquifer in the district | Brazos River Alluvium Aquifer | 21,921 |
| Estimated net annual volume of flow between each aquifer in the district | To Brazos River Alluvium Aquifer from Carrizo-Wilcox Aquifer | 2,286 |
| | To Brazos River Alluvium Aquifer from Queen City Aquifer | 6,262 |
| | To Brazos River Alluvium Aquifer from Sparta Aquifer | 3,860 |
| | To Brazos River Alluvium Aquifer from Yegua-Jackson Aquifer | 2,431 |
| | To Brazos River Alluvium Aquifer from Gulf Coast Aquifer System | 2,176 |
| | To Brazos River Alluvium Aquifer from older confining units | 771 |

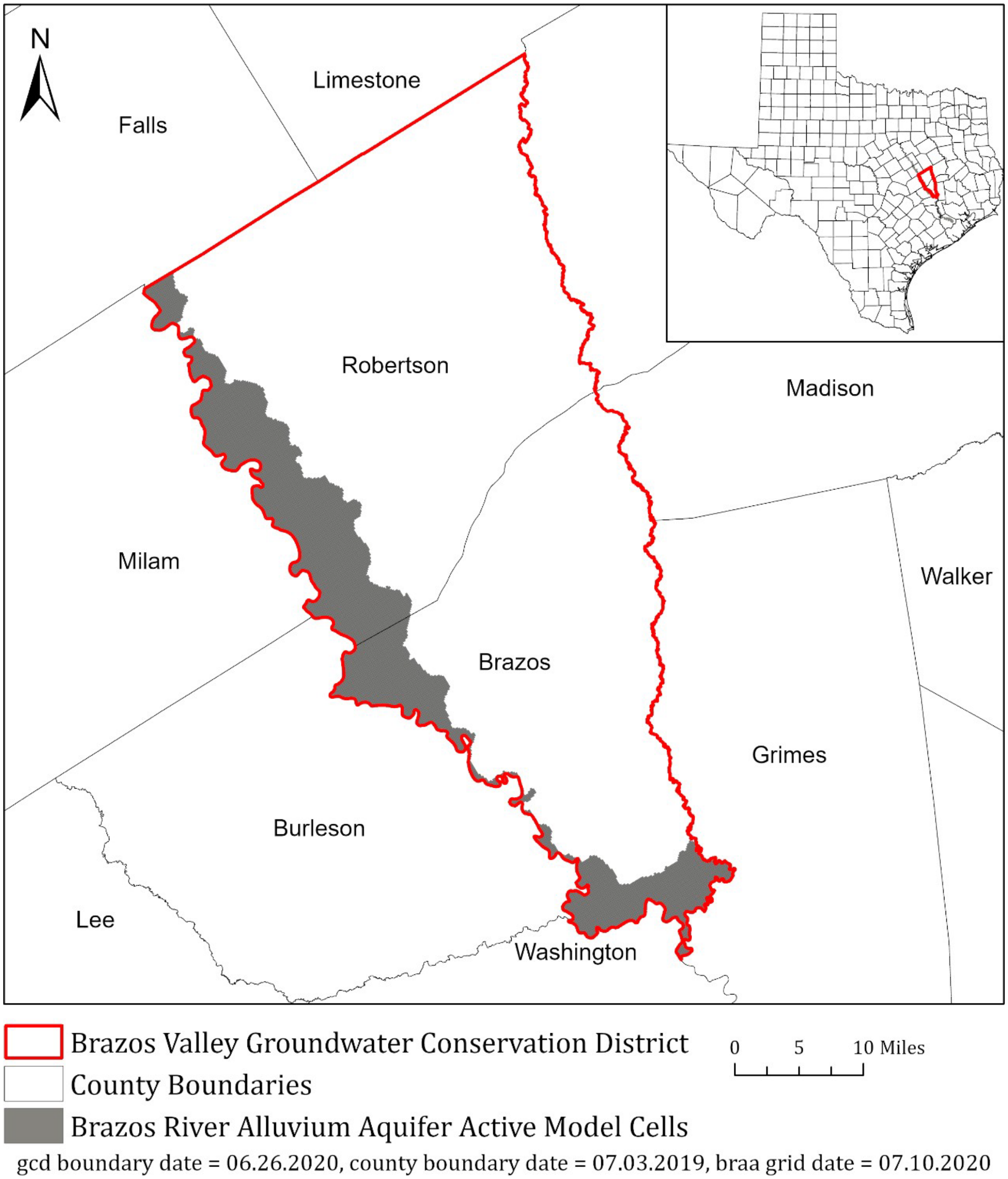
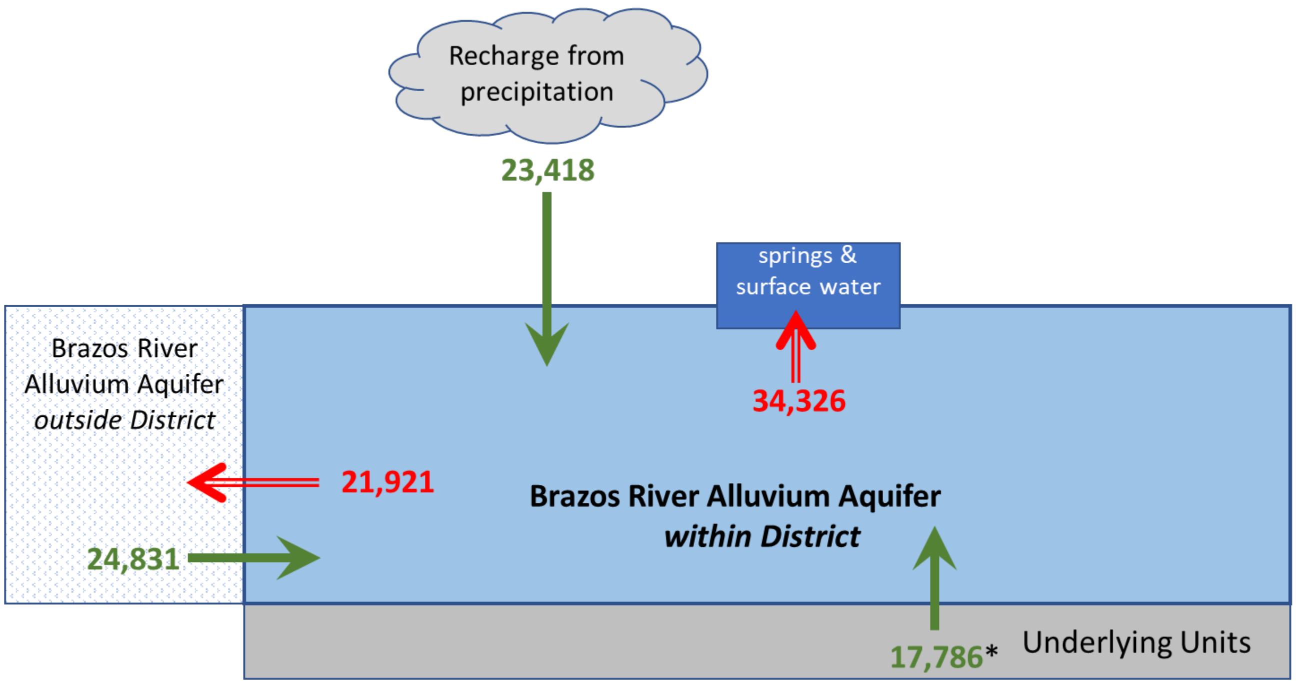



**Figure 11: Area of the groundwater availability model for the Brazos River Alluvium Aquifer from which the information in Table 6 was extracted (the Brazos River Alluvium Aquifer extent within the district boundary).**




* Flow from underlying units includes net inflow of 2,286 acre-feet per year from the Carrizo-Wilcox Aquifer, net inflow of 6,262 acre-feet per year from the Queen City Aquifer, net inflow of 3,860 acre-feet per year from the Sparta Aquifer, net inflow of 2,431 acre-feet per year from the Yegua-Jackson Aquifer, net inflow of 2,176 acre-feet per year from the Gulf Coast Aquifer System, and net inflow of 771 acre-feet per year from older confining units.

*Caveat: This diagram only includes the water budget items provided in Table 6. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.*

**Figure 12: Generalized diagram of the summarized budget information from Table 6, representing directions of flow for the Brazos River Alluvium Aquifer within the Brazos Valley Groundwater Conservation District. Flow values are expressed in acre-feet per year.**

***LIMITATIONS:***

The groundwater models used in completing this analysis are the best available scientific tools that can be used to meet the stated objectives. To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

> *"Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application.*
>
> *These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results."*

A key aspect of using the groundwater model to evaluate historic groundwater flow conditions includes the assumptions about the location in the aquifer where historic pumping was placed. Understanding the amount and location of historical pumping is as important as evaluating the volume of groundwater flow into and out of the district, between aquifers within the district (as applicable), interactions with surface water (as applicable), recharge to the aquifer system (as applicable), and other metrics that describe the impacts of that pumping. In addition, assumptions regarding precipitation, recharge, and interaction with streams are specific to particular historic time periods.

Because the application of the groundwater models was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations related to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor groundwater pumping and overall conditions of the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

## *REFERENCES:*


Deeds, N. E., Yan, T., Singh, A., Jones, T. L., Kelley, V. A., Knox, P. R., and Young, S. C., 2010, Groundwater availability model for the Yegua-Jackson Aquifer: Final report prepared for the Texas Water Development Board by INTERA, Inc., 582 p., http://www.twdb.texas.gov/groundwater/models/gam/ygjk/YGJK_Model_Report.pdf.

Ewing, J.E., and Jigmond, M., 2016, Final Numerical Model Report for the Brazos River Alluvium Aquifer Groundwater Availability Model: Contract report to the Texas Water Development Board, 357 p., http://www.twdb.texas.gov/groundwater/models/gam/bzrv/BRAA_NM_REPORT_FINAL.pdf?d=1502891797831.

Harbaugh, A. W., 2009, Zonebudget Version 3.01, A computer program for computing subregional water budgets for MODFLOW ground-water flow models, U.S. Geological Survey Groundwater Software.

Harbaugh, A. W., Banta, E. R., Hill, M. C., and McDonald, M. G., 2000, MODFLOW-2000, the U.S. Geological Survey modular ground-water model -- User guide to modularization concepts and the Ground-Water Flow Process: U.S. Geological Survey Open-File Report 00- 92, 121 p.

Kasmarek, M. C., 2013, Hydrogeology and simulation of groundwater flow and land-surface subsidence in the northern part of the Gulf Coast Aquifer System, Texas, 1891-2009: United States Geological Survey Scientific Investigations Report 2012-5154, 55 p. http://www.twdb.texas.gov/groundwater/models/gam/glfc_n/HAGM.SIR.Version1.1.November2013.pdf.

National Research Council, 2007, Models in Environmental Regulatory Decision Making Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p., http://www.nap.edu/catalog.php?record_id=11972.

Panday, S., Langevin, C.D., Niswonger, R.G., Ibaraki, M., and Hughes, J.D., 2013, MODFLOW- USG version 1: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation: U.S. Geological Survey Techniques and Methods, book 6, chap. A45, 66 p., https://doi.org/10.3133/tm6A45.

Texas Water Code § 36.1071.

Wade, S.C., 2019, GAM Run 18-021: Brazos Valley Groundwater Conservation District Management Plan, 22 p., http://www.twdb.texas.gov/groundwater/docs/GAMruns/GR18-021.pdf.

Young, S., Jigmond, M., Jones, T. and Ewing, T., 2018, Final Report: Groundwater Availability Model for the Central Portion of the Sparta, Queen City, and Carrizo-Wilcox Aquifers. Model Report, Vol I-II, 932 p., https://www.twdb.texas.gov/groundwater/models/gam/czwx_c/Updated_CWQCSP_GAM_vol1_all.pdf?d=7944938.

Young, S., Kushnereit, R. and INTERA, 2020, GMA 12 Update to the Groundwater Availability Model for the central portion of the Sparta, Queen City, and Carrizo-Wilcox Aquifers: Update to Improve Representation of the Transmissive Properties of the Simsboro Aquifer in the Vicinity of the Vista Ridge Well Field, 30 p., https://www.twdb.texas.gov/groundwater/models/gam/czwx_c/PE_Report_GMA12_final_october_2020_merge.pdf?d=28007.

# APPENDIX D

GAM Run 21-017 MAG

# GAM RUN 21-017 MAG: MODELED AVAILABLE GROUNDWATER FOR THE AQUIFERS IN GROUNDWATER MANAGEMENT AREA 12

Jerry Shi, Ph.D., P.G. and Jevon Harding, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-5076
November 1, 2022

*This page is intentionally left blank.*

## Geoscientist Seals

The following professional geoscientists contributed to this conceptual model report and associated data compilation and analyses:

Jianyou (Jerry) Shi, Ph.D., P.G.

Dr. Shi was responsible for the calculations to verify the attainability of desired future conditions and the calculations of modeled available groundwater values. He was the primary author of the report.

STATE OF TEXAS
JIANYOU SHI
GEOLOGY
11113
LICENSED
PROFESSIONAL GEOSCIENTIST

Signature

11/10/2022

Date

Jevon Harding, P.G.

Ms. Harding was responsible for editing the report and adding additional documentation as necessary to meet TWDB standards after Dr. Shi had left the agency.

Signature

STATE OF TEXAS
JEVON HARDING
GEOLOGY
12050
LICENSED
PROFESSIONAL GEOSCIENTIST

11/3

Da

# GAM RUN 21-017 MAG:
# Modeled Available Groundwater for the Aquifers in Groundwater Management Area 12

Jerry Shi, Ph.D., P.G. and Jevon Harding, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-5076
November 1, 2022

***EXECUTIVE SUMMARY:***

Groundwater Management Area 12 submitted a desired future conditions explanatory report and associated predictive groundwater availability model files to the Texas Water Development Board (TWDB) on February 2, 2022. The TWDB Executive Administrator determined that the explanatory report and other materials submitted to the TWDB were administratively complete on July 1, 2022.

The TWDB calculated modeled available groundwater in Groundwater Management Area 12 for the Sparta, Queen City, Yegua-Jackson, and Brazos River Alluvium aquifers, as well as for the following formations of the Carrizo-Wilcox Aquifer: Carrizo, Calvert Bluff (upper Wilcox), Simsboro (middle Wilcox), and Hooper (lower Wilcox) formations.

Modeled available groundwater is summarized by decade, county, and groundwater conservation district (Tables 4 through 11) and by county, regional water planning area, and river basin for use in the regional water planning process (Tables 12 through 19). Modeled available groundwater for each aquifer in Groundwater Management Area 12 is summarized below.

**Carrizo-Wilcox, Queen City, and Sparta aquifers**

Sparta Aquifer: Modeled available groundwater ranges from approximately 11,530 to 26,210 acre-feet per year during the period from 2020 to 2070. Values are summarized by groundwater conservation district and county (Table 4) and by county, regional water planning area, and river basin (Table 12).

Queen City Aquifer: Modeled available groundwater ranges from approximately 5,650 to 15,310 acre-feet per year during the period from 2020 to 2070. Values are summarized by groundwater conservation district and county (Table 5) and by county, regional water planning area, and river basin (Table 13).

Carrizo-Wilcox Aquifer (Carrizo Formation): Modeled available groundwater ranges from approximately 27,460 to 52,370 acre-feet per year during the period from 2020 to 2070. Values are summarized by groundwater conservation district and county (Table 6) and by county, regional water planning area, and river basin (Table 14).

Carrizo-Wilcox Aquifer (Calvert Bluff Formation): Modeled available groundwater ranges from approximately 7,160 to 16,450 acre-feet per year during the period from 2020 to 2070. Values are summarized by groundwater conservation district and county (Table 7) and by county, regional water planning area, and river basin (Table 15).

Carrizo-Wilcox Aquifer (Simsboro Formation): Modeled available groundwater ranges from approximately 129,990 to 314,460 acre-feet per year during the period from 2020 to 2070. Values are summarized by groundwater conservation district and county (Table 8) and by county, regional water planning area, and river basin (Table 16).

Carrizo-Wilcox Aquifer (Hooper Formation): Modeled available groundwater ranges from approximately 7,420 to 14,440 acre-feet per year during the period from 2020 to 2070. Values are summarized by groundwater conservation district and county (Table 9) and by county, regional water planning area, and river basin (Table 17).

**Yegua-Jackson Aquifer**

Modeled available groundwater for the Yegua-Jackson Aquifer ranges from approximately 17,070 to 25,860 acre-feet per year during the period from 2020 to 2070. Values are summarized by groundwater conservation district and county (Table 10) and by county, regional water planning area, and river basin (Table 18).

**Brazos River Alluvium Aquifer**

Modeled available groundwater for the Brazos River Alluvium Aquifer ranges from approximately 194,220 to 197,360 acre-feet per year during the period from 2020 to 2070. Values are summarized by county and groundwater conservation districts (Table 11) and by county, regional water planning area, and river basin (Table 19).

***REQUESTOR:***

Mr. Gary Westbrook, Groundwater Management Area 12 Coordinator.

***DESCRIPTION OF REQUEST:***

The groundwater conservation districts (Figure 1) in Groundwater Management Area 12 adopted desired future conditions for the Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, and Brazos River Alluvium aquifers on November 30, 2021.

### Carrizo-Wilcox, Queen City, and Sparta Aquifers

The desired future conditions for the Carrizo-Wilcox, Queen City, and Sparta aquifers, described in the resolution adopted by Groundwater Management Area 12 on November 30, 2021, are listed in Table 1. The desired future conditions are the average water level drawdowns in feet measured from January 2011 through December 2070.

**TABLE 1. ADOPTED DESIRED FUTURE CONDITIONS FOR THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS IN GROUNDWATER MANAGEMENT AREA 12.**

| Groundwater Conservation District (GCD) or County | Sparta Aquifer | Queen City Aquifer | Carrizo-Wilcox Aquifer | | | |
|---|---|---|---|---|---|---|
| | | | Carrizo Formation | Wilcox (Calvert Bluff Formation) | Wilcox (Simsboro Formation) | Wilcox (Hooper Formation) |
| Brazos Valley GCD* | 53 | 44 | 84 | 111 | 262 | 167 |
| Fayette County GCD** | 43 | 73 | 140 | NR | NR | NR |
| Lost Pines GCD | 22 | 28 | 134 | 132 | 240 | 138 |
| Mid-East Texas GCD | 25 | 20 | 48 | 57 | 76 | 69 |
| Post Oak Savannah GCD | 32 | 30 | 146 | 156 | 278 | 178 |
| Falls County | NP | NP | NP | NP | 7 | 3 |
| Limestone County | NP | NP | NP | 2 | 3 | 3 |
| Navarro County | NP | NP | NP | 0 | 1 | 0 |
| Williamson County | NP | NP | NP | NR | 31 | 24 |

** Brazos Valley GCD desired future conditions are for 2000 through 2070*
***Fayette County GCD desired future conditions are for all of Fayette County*
*NR: non-relevant for the purposes of joint planning; NP: not present*

### Yegua-Jackson Aquifer

The desired future conditions for the Yegua-Jackson Aquifer, described in the resolution adopted by Groundwater Management Area 12 on November 30, 2021, are listed in Table 2. The desired future conditions are the average water level drawdowns in feet measured from January 2010 through December 2069.

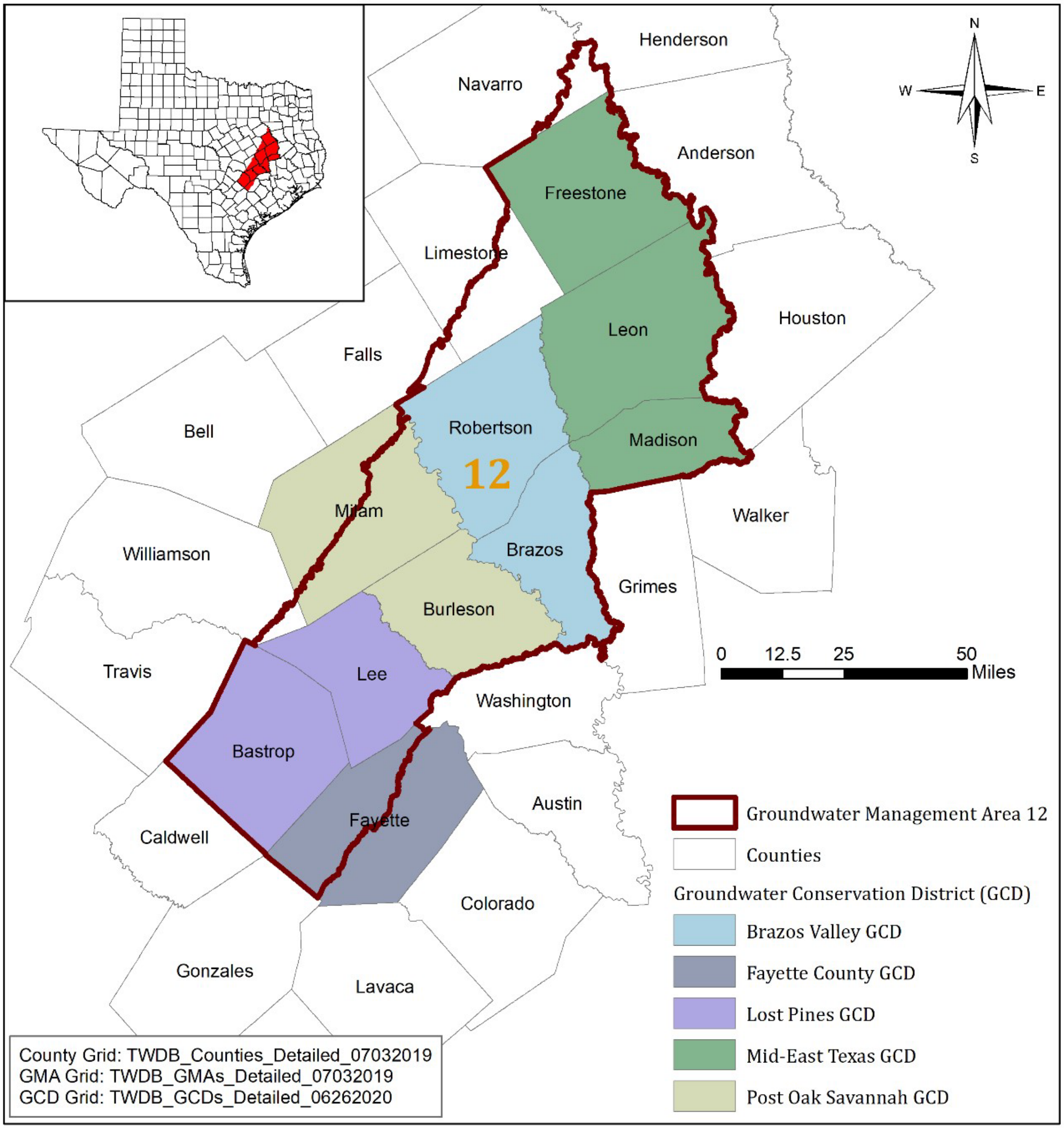



**Figure 1.** **GROUNDWATER CONSERVATION DISTRICTS IN GROUNDWATER MANAGEMENT AREA 12.**

**TABLE 2. ADOPTED DESIRED FUTURE CONDITIONS FOR THE YEGUA-JACKSON AQUIFER IN GROUNDWATER MANAGEMENT AREA 12.**

| Groundwater Conservation District (GCD) | Desired Future Condition |
|---|---|
| Brazos Valley GCD | 67 |
| Fayette County GCD* | 81 |
| Lost Pines GCD | NR |
| Mid-East Texas GCD | 8 |
| Post Oak Savannah GCD | 61 |

* *Fayette County GCD desired future conditions are for all of Fayette County NR: non-relevant.*

## Brazos River Alluvium Aquifer

The desired future conditions for the Brazos River Alluvium Aquifer, described in the resolution adopted by Groundwater Management Area 12 on November 30, 2021, are presented in Table 3. The desired future conditions for Brazos Valley Groundwater Conservation District are defined in terms of an average percent saturation and the desired future conditions for Post Oak Savannah Groundwater Conservation District are defined in terms of a decrease in the average saturated thickness.

**TABLE 3 ADOPTED DESIRED FUTURE CONDITIONS FOR THE BRAZOS RIVER ALLUVIUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 12.**

| Groundwater Conservation District (GCD) | County | Desired Future Condition |
|---|---|---|
| Brazos Valley GCD | Brazos and Robertson | North of State Highway 21: Percent saturation shall average at least 30% of total well depth from January 2013 to December 2069.<br><br>South of State Highway 21: Percent saturation shall average at least 40% of total well depth from January 2013 to December 2069. |
| Post Oak Savannah GCD | Burleson | A decrease in 6 feet in the average saturated thickness over the period from January 2010 to December 2069. |
| | Milam | A decrease of 5 feet in average saturated thickness over the period from January 2010 to December 2069. |

All desired future conditions in Groundwater Management Area 12 are based on modeled extent, which may contain portions of an aquifer that do not fall within the official TWDB aquifer boundary. In addition, the desired future conditions for Fayette County Groundwater Conservation District are based on the entire county, although only part of the district is within Groundwater Management Area 12.

Groundwater Management Area 12 provided the TWDB with the desired future conditions, associated predictive groundwater availability model files, and supporting documents on February 2, 2022 (Daniel B. Stephens & Associates and others, 2022).

TWDB staff reviewed the materials submitted by Groundwater Management Area 12 and requested clarifications on several items on April 21, 2022. On May 6, 2022, Groundwater Management Area 12 met to discuss the TWDB clarifications request and reviewed and approved two response documents titled "Calvert Bluff Aquifer Memo-Draft-20220503" and "Memo on TWDB Items-Draft-2022050". The response is summarized in Appendix A.

***METHODS:***

**Carrizo-Wilcox, Queen City, and Sparta aquifers**

The desired future conditions for the Carrizo-Wilcox, Queen City, and Sparta aquifers in Groundwater Management Area 12 are based on the predictive model files for "Scenario 19" submitted with the desired future conditions explanatory report (Daniel B. Stephens & Associates and others, 2022). This predictive simulation was constructed as an extension of the calibrated groundwater availability model (Version 3.02) for the Central Portion of the Sparta, Queen City, and Carrizo-Wilcox aquifers (INTERA Incorporated and others, 2020).

The desired future conditions for each aquifer by groundwater conservation district or county are expressed as average drawdown between 2010 and 2070. The modeled available groundwater values were determined by extracting pumping rates by decade from the MODFLOW cell-by-cell budget files using custom Fortran scripts developed by the TWDB.

**Yegua-Jackson Aquifer**

The desired future conditions for the Yegua-Jackson Aquifer in Groundwater Management Area 12 are based on the predictive model files for "Scenario 2 (PS2)" submitted with the desired future conditions explanatory report (Daniel B. Stephens & Associates and others, 2022). Stress periods 1 through 27 in this predictive model represent the original calibrated groundwater availability model (Version 1.01; Deeds and others, 2010) and stress periods 28 through 100 represent the predictive simulation for the desired future conditions.

The desired future conditions for the Yegua-Jackson Aquifer are expressed as average drawdown between 2009 and 2069. The modeled available groundwater values were determined by extracting pumping rates by decade from the MODFLOW cell-by-cell budget files using custom Fortran scripts developed by the TWDB.

**Brazos River Alluvium Aquifer**

The desired future conditions for the Brazos River Alluvium Aquifer in Groundwater Management Area 12 are based on the predictive model files for "Scenario 2 (PS2)" submitted with the explanatory report (Daniel B. Stephens & Associates and others, 2022).

Stress periods 1 through 427 in this predictive model represent the original calibrated groundwater availability model (Version 1.01; Ewing and Jigmond, 2016) and stress periods 428 through 485 represent the predictive simulation for the desired future conditions.

***BRAZOS VALLEY GROUNDWATER CONSERVATION DISTRICT***

The desired future conditions for the Brazos Valley Groundwater Conservation District are expressed as percent saturation of total well depth at the end of 2069. The modeled available groundwater values were determined by extracting pumping rates by decade from the MODFLOW cell-by-cell budget files using custom Fortran scripts developed by the TWDB.

***POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT***

The desired future conditions for the Post Oak Savannah Groundwater Conservation District are expressed as a decrease in saturated thickness between 2009 and 2069. The modeled available groundwater values were determined by extracting pumping rates by decade from the MODFLOW cell-by-cell budget files using custom Fortran scripts developed by the TWDB.

## MODELED AVAILABLE GROUNDWATER AND PERMITTING

As defined in Chapter 36 of the Texas Water Code (2011), "modeled available groundwater" is the estimated average amount of water that may be produced annually to achieve a desired future condition. Groundwater conservation districts are required to consider modeled available groundwater, along with several other factors, when issuing permits in order to manage groundwater production to achieve the desired future condition(s). The other factors districts must consider include annual precipitation and production patterns, the estimated amount of pumping exempt from permitting, existing permits, and a reasonable estimate of actual groundwater production under existing permits.

***PARAMETERS AND ASSUMPTIONS:***

The parameters and assumptions for the groundwater availability simulations are described below:

### Carrizo-Wilcox, Queen City, and Sparta aquifers

- Version 3.02 of the updated groundwater availability model for Central Portion of the Sparta, Queen City, and Carrizo-Wilcox aquifers was the base model for this analysis. See INTERA Incorporated and others (2020) for the assumptions and limitations of the historical calibrated model. Groundwater Management Area 12 constructed a predictive model simulation to extend the base model to 2070 for planning purposes. See Groundwater Management Area 12 explanatory report (Daniel B. Stephens & Associates and others, 2022) for the assumptions of this predictive model simulation.

- The predictive model was run with MODFLOW-USG (Panday and others, 2015).
- The model has ten layers that represent alluvium (Layer 1), the surficial layer of all aquifers (Layer 2), the Sparta Aquifer (Layer 3), the Weches confining unit (Layer 4), the Queen City Aquifer (Layer 5), the Reklaw confining unit (Layer 6), and the subunits that comprise the Carrizo-Wilcox Aquifer (Layers 7 to 10).
- The most recent TWDB model grid file, dated October 9, 2020 (*czwx_v3_01_MFUSG_ModelGrid100920.csv*), was used to assign model cells to counties, groundwater management areas, groundwater conservation districts, river basins, and regional water planning areas. This grid was also used to assign model grid cells to aquifer layers.
- Drawdown was calculated as the difference in modeled water levels between the baseline date of January 1, 2011 (initial water levels) and the final date of December 31, 2070 (stress period 60) using an area-weighted averaging methodology.
- During the predictive simulation model run, some model cells went dry, meaning the modeled water level fell below the bottom of the cell. Pumping in dry cells was excluded from the modeled available groundwater calculations.
- The drawdown averages and modeled available groundwater values were calculated using the modeled extent of aquifers, rather than the official TWDB boundaries for the Carrizo-Wilcox, Queen City, and Sparta Aquifers. Note that the TWDB does not maintain official boundaries for the Carrizo-Wilcox subunits.
- The drawdown calculations and modeled available drawdown values for Fayette County Groundwater Conservation District was based on all of Fayette County, including areas in both Groundwater Management Areas 12 and 15.
- Estimates of modeled available groundwater from the model simulation were rounded to whole numbers.

## Yegua-Jackson Aquifer

- Version 1.01 of the updated groundwater availability model for the Yegua-Jackson Aquifer was the base model for this analysis. See Deeds and others (2010) for the assumptions and limitations of the historical calibrated model. Groundwater Management Area 12 constructed a predictive model simulation to extend the base model to 2070 for planning purposes. See Groundwater Management Area 12 explanatory report (Daniel B. Stephens & Associates and others, 2022) for the assumptions of this predictive model simulation.

- The predictive model was run with MODFLOW 2000 (Harbaugh and others, 2000).
- The model has five layers that represent the Yegua-Jackson Aquifer and younger overlying units—the Catahoula Formation (Layer 1), the upper portion of the Jackson Group (Layer 2), the lower portion of the Jackson Group (Layer 3), the upper portion of the Yegua Group (Layer 4), and the lower portion of the Yegua Group (Layer 5).
- The most recent TWDB model grid file, dated July 9, 2020 (*ygjk_07092020.csv*), was used to assign model cells to counties, groundwater management areas, groundwater conservation districts, river basins, and regional water planning areas. This grid was also used to assign model grid cells to aquifer layers.
- Although the original groundwater availability model was only calibrated to 1997, a TWDB analysis (Oliver, 2010) verified that the model satisfactorily matched measured water levels for the period from 1997 to 2009. For this reason, the TWDB considers it acceptable to use the January 2010 as the reference date for drawdown calculations.
- Drawdown was calculated as the difference in modeled water levels between the baseline date of January 1, 2010 (stress period 39) and the final date of December 31, 2069 (stress period 99).
- During the predictive simulation model run, some model cells went dry, meaning the modeled water level fell below the bottom of the cell. Pumping in dry cells was excluded from the modeled available groundwater calculations.
- The drawdown averages and modeled available groundwater values were calculated using the modeled extent of aquifers, rather than the official TWDB boundaries for the Yegua-Jackson Aquifer.
- The drawdown calculations and modeled available drawdown values for Fayette County Groundwater Conservation District was based on all of Fayette County including areas in both Groundwater Management Areas 12 and 15.
- Estimates of modeled available groundwater from the model simulation were rounded to whole numbers.

**Brazos River Alluvium Aquifer**

- Version 1.01 of the updated groundwater availability model for the Brazos River Alluvium Aquifer was the base model for this analysis. See Ewing and Jigmond

(2016) for the assumptions and limitations of the historical calibrated model. Groundwater Management Area 12 constructed a predictive model simulation to extend the base model to 2070 for planning purposes. See Groundwater Management Area 12 explanatory report (Daniel B. Stephens & Associates and others, 2022) for the assumptions of this predictive model simulation.

- The predictive model was run with MODFLOW-USG beta (development) version (Panday and others, 2013).
- The model has three layers that represent the Brazos River Alluvium Aquifer (Layers 1 and 2) and the surficial portions of the underlying Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, and Gulf Coast aquifers as well as various geologic units of the Cretaceous System (Layer 3).
- The most recent TWDB model grid file, dated July 10, 2020 (*bra_grid_poly071020.csv*), was used to assign model cells to counties, groundwater management areas, groundwater conservation districts, river basins, and regional water planning areas.
- In Brazos Valley Groundwater Conservation District, the calculation was for the average percent saturation on December 31, 2069 (stress period 484). In Post Oak Savannah Groundwater Conservation District, the calculation was for the decrease in average saturated thickness from January 1, 2013 (stress period 391) to December 31, 2069 (stress period 484).
- The drawdown averages and modeled available groundwater values were calculated using the modeled extent of the aquifer, which is coincident with the official TWDB boundary for the Brazos River Alluvium Aquifer.
- Estimates of modeled available groundwater from the model simulation were rounded to whole numbers.

## *RESULTS:*

The modeled available groundwater values that achieve the desired future conditions adopted by Groundwater Management Area 12 are described below:

**Carrizo-Wilcox, Queen City, and Sparta Aquifers**

*Sparta Aquifer*: The modeled available groundwater ranges from approximately 11,530 to 26,210 acre-feet per year during the period from 2020 to 2070 (Tables 4 and 12). *Queen City Aquifer*: The modeled available groundwater ranges from approximately 5,650 to 15,310 acre-feet per year during the period from 2020 to 2070 (Tables 5 and 13).

*Carrizo-Wilcox Aquifer (Carrizo Formation)*: The modeled available groundwater ranges from approximately 27,460 to 52,370 acre-feet per year during the period from 2020 to 2070 (Tables 6 and 14).

*Carrizo-Wilcox Aquifer (Calvert Bluff Formation)*: The modeled available groundwater ranges from approximately 7,160 to 16,450 acre-feet per year during the period from 2020 to 2070 (Tables 7 and 15).

*Carrizo-Wilcox Aquifer (Simsboro Formation)*: The modeled available groundwater ranges from approximately 129,990 to 314,460 acre-feet per year during the period from 2020 to 2070 (Tables 8 and 16).

*Carrizo-Wilcox Aquifer (Hooper Formation)*: The modeled available groundwater ranges from approximately 7,420 to 14,440 acre-feet per year during the period from 2020 to 2070 (Tables 9 and 17).

**Yegua-Jackson Aquifer**

The modeled available groundwater for the Yegua-Jackson Aquifer ranges from approximately 17,070 to 25,860 acre-feet per year during the period from 2020 to 2070 (Tables 10 and 18).

**Brazos River Alluvium Aquifer**

The modeled available groundwater for the Brazos River Alluvium Aquifer ranges from approximately 194,220 to 197,360 acre-feet per year during the period from 2020 to 2070 (Tables 11 and 19).

**TABLE 4 MODELED AVAILABLE GROUNDWATER FOR THE SPARTA AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.**

| Groundwater Conservation District (GCD) | County | Aquifer | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Brazos Valley GCD | Brazos | Sparta | 4,483 | 6,014 | 7,545 | 9,076 | 10,607 | 12,138 |
| | Robertson | Sparta | 167 | 338 | 509 | 680 | 851 | 1,022 |
| **Brazos Valley GCD Total** | | **Sparta** | **4,650** | **6,352** | **8,054** | **9,756** | **11,458** | **13,160** |
| Fayette County GCD | Fayette | Sparta | 2,765 | 2,779 | 2,783 | 2,796 | 2,828 | 2,853 |
| **Fayette County GCD Total*** | | **Sparta** | **2,765** | **2,779** | **2,783** | **2,796** | **2,828** | **2,853** |
| Lost Pines GCD | Bastrop | Sparta | 368 | 437 | 529 | 644 | 788 | 972 |
| | Lee | Sparta | 674 | 809 | 975 | 1,181 | 1,434 | 1,751 |
| **Lost Pines GCD Total** | | **Sparta** | **1,042** | **1,246** | **1,504** | **1,825** | **2,222** | **2,723** |
| Mid-East Texas GCD | Leon | Sparta | 249 | 248 | 249 | 251 | 253 | 254 |
| | Madison | Sparta | 1,589 | 1,900 | 2,211 | 2,523 | 2,834 | 3,115 |
| **Mid-East Texas GCD Total** | | **Sparta** | **1,838** | **2,148** | **2,460** | **2,774** | **3,087** | **3,369** |
| Post Oak Savannah GCD | Burleson | Sparta | 1,237 | 2,840 | 3,131 | 3,437 | 3,760 | 4,105 |
| **Post Oak Savannah GCD Total** | | **Sparta** | **1,237** | **2,840** | **3,131** | **3,437** | **3,760** | **4,105** |
| **GMA 12 Total** | | **Sparta** | **11,532** | **15,365** | **17,932** | **20,588** | **23,355** | **26,210** |

**Fayette County GCD values are for all of Fayette County.*

**TABLE 5 MODELED AVAILABLE GROUNDWATER FOR THE QUEEN CITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.**

| Groundwater Conservation District (GCD) | County | Aquifer | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Brazos Valley GCD | Brazos | Queen City | 133 | 245 | 357 | 469 | 582 | 694 |
| | Robertson | Queen City | 36 | 144 | 252 | 359 | 467 | 575 |
| **Brazos Valley GCD Total** | | **Queen City** | **169** | **389** | **609** | **828** | **1,049** | **1,269** |
| Fayette County GCD | Fayette | Queen City | 2,694 | 2,715 | 2,737 | 2,761 | 2,786 | 2,813 |
| **Fayette County GCD Total*** | | **Queen City** | **2,694** | **2,715** | **2,737** | **2,761** | **2,786** | **2,813** |
| Lost Pines GCD | Bastrop | Queen City | 469 | 519 | 573 | 632 | 698 | 771 |
| | Lee | Queen City | 640 | 700 | 767 | 839 | 917 | 1,000 |
| **Lost Pines GCD Total** | | **Queen City** | **1,109** | **1,219** | **1,340** | **1,471** | **1,615** | **1,771** |
| Mid-East Texas GCD | Freestone | Queen City | 77 | 77 | 77 | 77 | 77 | 77 |
| | Leon | Queen City | 871 | 919 | 967 | 1,014 | 1,063 | 1,106 |
| | Madison | Queen City | 221 | 264 | 308 | 351 | 394 | 433 |
| **Mid-East Texas GCD Total** | | **Queen City** | **1,169** | **1,260** | **1,352** | **1,442** | **1,534** | **1,616** |
| Post Oak Savannah GCD | Burleson | Queen City | 366 | 3,090 | 3,467 | 3,883 | 4,344 | 4,863 |
| Post Oak Savannah GCD | Milam | Queen City | 147 | 1,348 | 1,643 | 2,003 | 2,441 | 2,976 |
| **Post Oak Savannah GCD Total** | | **Queen City** | **513** | **4,438** | **5,110** | **5,886** | **6,785** | **7,839** |
| **GMA 12 Total** | | **Queen City** | **5,654** | **10,021** | **11,148** | **12,388** | **13,769** | **15,308** |

** Fayette County GCD values are for all of Fayette County.*

**TABLE 6 MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO FORMATION OF THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.**

| Groundwater Conservation District (GCD) | County | Aquifer | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Brazos Valley GCD | Brazos | Carrizo | 864 | 1,444 | 2,023 | 2,603 | 3,183 | 3,763 |
| | Robertson | Carrizo | 81 | 412 | 743 | 1,074 | 1,405 | 1,736 |
| **Brazos Valley GCD Total** | | **Carrizo** | **945** | **1,856** | **2,766** | **3,677** | **4,588** | **5,499** |
| Fayette County GCD | Fayette | Carrizo | 5,155 | 5,155 | 5,155 | 5,155 | 5,155 | 5,155 |
| **Fayette County GCD Total*** | | **Carrizo** | **5,155** | **5,155** | **5,155** | **5,155** | **5,155** | **5,155** |
| Lost Pines GCD | Bastrop | Carrizo | 2,591 | 3,451 | 4,416 | 5,533 | 6,873 | 8,534 |
| | Lee | Carrizo | 2,125 | 2,452 | 2,821 | 3,255 | 3,783 | 4,446 |
| **Lost Pines GCD Total** | | **Carrizo** | **4,716** | **5,903** | **7,237** | **8,788** | **10,656** | **12,980** |
| Mid-East Texas GCD | Freestone | Carrizo | 79 | 79 | 79 | 79 | 79 | 79 |
| | Leon | Carrizo | 5,356 | 6,396 | 7,435 | 8,474 | 9,514 | 10,450 |
| | Madison | Carrizo | 0 | 0 | 0 | 0 | 0 | 0 |
| **Mid-East Texas GCD Total** | | **Carrizo** | **5,435** | **6,475** | **7,514** | **8,553** | **9,593** | **10,529** |
| Post Oak Savannah GCD | Burleson | Carrizo | 10,669 | 16,656 | 16,806 | 16,956 | 17,108 | 17,261 |
| Post Oak Savannah GCD | Milam | Carrizo | 540 | 607 | 680 | 759 | 847 | 945 |
| **Post Oak Savannah GCD Total** | | **Carrizo** | **11,209** | **17,263** | **17,486** | **17,715** | **17,955** | **18,206** |
| **GMA 12 Total** | | **Carrizo** | **27,460** | **36,652** | **40,158** | **43,888** | **47,947** | **52,369** |

**Fayette County GCD values are for all of Fayette County.*

**TABLE 7 MODELED AVAILABLE GROUNDWATER FOR THE CALVERT BLUFF FORMATION OF THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.**

| Groundwater Conservation District (GCD) | County | Aquifer | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Brazos Valley GCD | Brazos | Calvert Bluff | 0 | 0 | 0 | 0 | 0 | 0 |
| | Robertson | Calvert Bluff | 252 | 546 | 841 | 1,136 | 1,430 | 1,725 |
| **Brazos Valley GCD Total** | | **Calvert Bluff** | **252** | **546** | **841** | **1,136** | **1,430** | **1,725** |
| Lost Pines GCD | Bastrop | Calvert Bluff | 1,837 | 2,419 | 3,010 | 3,609 | 4,217 | 4,834 |
| | Lee | Calvert Bluff | 318 | 395 | 475 | 557 | 642 | 729 |
| **Lost Pines GCD Total** | | **Calvert Bluff** | **2,155** | **2,814** | **3,485** | **4,166** | **4,859** | **5,563** |
| Mid-East Texas GCD | Freestone | Calvert Bluff | 590 | 613 | 637 | 661 | 685 | 706 |
| | Leon | Calvert Bluff | 1,832 | 2,176 | 2,519 | 2,863 | 3,206 | 3,515 |
| | Madison | Calvert Bluff | 0 | 0 | 0 | 0 | 0 | 0 |
| **Mid-East Texas GCD Total** | | **Calvert Bluff** | **2,422** | **2,789** | **3,156** | **3,524** | **3,891** | **4,221** |
| Post Oak Savannah GCD | Burleson | Calvert Bluff | 117 | 129 | 140 | 152 | 163 | 174 |
| | Milam | Calvert Bluff | 2,062 | 2,811 | 3,162 | 3,558 | 4,012 | 4,532 |
| **Post Oak Savannah GCD Total** | | **Calvert Bluff** | **2,179** | **2,940** | **3,302** | **3,710** | **4,175** | **4,706** |
| No District | Limestone | Calvert Bluff | 140 | 153 | 168 | 184 | 202 | 222 |
| | Navarro | Calvert Bluff | 7 | 7 | 7 | 8 | 8 | 9 |
| **No District Total** | | **Calvert Bluff** | **147** | **160** | **175** | **192** | **210** | **231** |
| **GMA 12 Total** | | **Calvert Bluff** | **7,155** | **9,249** | **10,959** | **12,728** | **14,565** | **16,446** |

**Fayette County GCD values are for all of Fayette County.*

**TABLE 8** **MODELED AVAILABLE GROUNDWATER FOR THE SIMSBORO FORMATION OF THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.**

| Groundwater Conservation District (GCD) | County | Aquifer | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Brazos Valley GCD | Brazos | Simsboro | 37,282 | 42,709 | 48,137 | 53,565 | 58,993 | 64,421 |
| | Robertson | Simsboro | 38,219 | 47,140 | 56,061 | 64,982 | 73,903 | 82,824 |
| **Brazos Valley GCD Total** | | **Simsboro** | **75,501** | **89,849** | **104,198** | **118,547** | **132,896** | **147,245** |
| Lost Pines GCD | Bastrop | Simsboro | 16,424 | 38,836 | 41,484 | 43,946 | 46,429 | 48,977 |
| | Lee | Simsboro | 3,940 | 26,406 | 27,620 | 28,836 | 30,052 | 30,968 |
| **Lost Pines GCD Total** | | **Simsboro** | **20,364** | **65,242** | **69,104** | **72,782** | **76,481** | **79,945** |
| Mid-East Texas GCD | Freestone | Simsboro | 2,843 | 3,371 | 3,900 | 4,429 | 4,958 | 5,434 |
| | Leon | Simsboro | 733 | 876 | 1,020 | 1,163 | 1,307 | 1,436 |
| | Madison | Simsboro | 0 | 0 | 0 | 0 | 0 | 0 |
| **Mid-East Texas GCD Total** | | **Simsboro** | **3,576** | **4,247** | **4,920** | **5,592** | **6,265** | **6,870** |
| Post Oak Savannah GCD | Burleson | Simsboro | 27,267 | 39,656 | 48,662 | 52,267 | 52,273 | 52,278 |
| | Milam | Simsboro | 2,686 | 25,883 | 26,170 | 26,475 | 26,798 | 27,144 |
| **Post Oak Savannah GCD Total** | | **Simsboro** | **29,953** | **65,539** | **74,832** | **78,742** | **79,071** | **79,422** |
| No District | Falls | Simsboro | 10 | 11 | 12 | 14 | 15 | 17 |
| | Limestone | Simsboro | 555 | 612 | 676 | 746 | 824 | 910 |
| | Navarro | Simsboro | 11 | 12 | 13 | 14 | 15 | 16 |
| | Williamson | Simsboro | 19 | 21 | 23 | 25 | 28 | 31 |
| **No District Total** | | **Simsboro** | **595** | **656** | **724** | **799** | **882** | **974** |
| **GMA 12 Total** | | **Simsboro** | **129,989** | **225,533** | **253,778** | **276,462** | **295,595** | **314,456** |

**Fayette County GCD values are for all of Fayette County.*

**TABLE 9** **MODELED AVAILABLE GROUNDWATER FOR THE HOOPER FORMATION OF THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.**

| Groundwater Conservation District (GCD) | County | Aquifer | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Brazos Valley GCD | Brazos | Hooper | 0 | 0 | 0 | 0 | 0 | 0 |
| | Robertson | Hooper | 798 | 1,066 | 1,334 | 1,603 | 1,871 | 2,139 |
| **Brazos Valley GCD Total** | | **Hooper** | **798** | **1,066** | **1,334** | **1,603** | **1,871** | **2,139** |
| Lost Pines GCD | Bastrop | Hooper | 1,664 | 1,957 | 2,259 | 2,572 | 2,897 | 3,234 |
| | Lee | Hooper | 27 | 30 | 32 | 35 | 40 | 44 |
| **Lost Pines GCD Total** | | **Hooper** | **1,691** | **1,987** | **2,291** | **2,607** | **2,937** | **3,278** |
| Mid-East Texas GCD | Freestone | Hooper | 2,642 | 3,140 | 3,639 | 4,138 | 4,637 | 5,085 |
| | Leon | Hooper | 85 | 102 | 118 | 135 | 152 | 167 |
| | Madison | Hooper | 0 | 0 | 0 | 0 | 0 | 0 |
| **Mid-East Texas GCD Total** | | **Hooper** | **2,727** | **3,242** | **3,757** | **4,273** | **4,789** | **5,252** |
| Post Oak Savannah GCD | Burleson | Hooper | 25 | 27 | 30 | 32 | 35 | 37 |
| | Milam | Hooper | 1,781 | 1,999 | 2,234 | 2,491 | 2,774 | 3,089 |
| **Post Oak Savannah GCD Total** | | **Hooper** | **1,806** | **2,026** | **2,264** | **2,523** | **2,809** | **3,126** |
| No District | Falls | Hooper | 31 | 35 | 38 | 42 | 47 | 52 |
| | Limestone | Hooper | 176 | 195 | 215 | 238 | 262 | 290 |
| | Navarro | Hooper | 79 | 86 | 94 | 103 | 113 | 124 |
| | Williamson | Hooper | 108 | 119 | 132 | 146 | 161 | 177 |
| **No District Total** | | **Hooper** | **394** | **435** | **479** | **529** | **583** | **643** |
| **GMA 12 Total** | | **Hooper** | **7,416** | **8,756** | **10,125** | **11,535** | **12,989** | **14,438** |

**Fayette County GCD values are for all of Fayette County.*

**TABLE 10** **MODELED AVAILABLE GROUNDWATER FOR THE YEGUA-JACKSON AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.**

| Groundwater Conservation District (GCD) | County | Aquifer | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Brazos Valley GCD | Brazos | Yegua-Jackson | 4,207 | 6,270 | 7,092 | 7,091 | 7,091 | 7,091 |
| **Brazos Valley GCD Total** | | **Yegua-Jackson** | **4,207** | **6,270** | **7,092** | **7,091** | **7,091** | **7,091** |
| Fayette County GCD | Fayette | Yegua-Jackson | 9,984 | 9,984 | 9,984 | 9,983 | 9,983 | 9,983 |
| **Fayette County GCD Total*** | | **Yegua-Jackson** | **9,984** | **9,984** | **9,984** | **9,983** | **9,983** | **9,983** |
| Mid-East Texas GCD | Leon | Yegua-Jackson | 0 | 0 | 0 | 0 | 0 | 0 |
| | Madison | Yegua-Jackson | 1,122 | 1,122 | 1,122 | 1,122 | 1,122 | 1,122 |
| **Mid-East Texas GCD Total** | | **Yegua-Jackson** | **1,122** | **1,122** | **1,122** | **1,122** | **1,122** | **1,122** |
| Post Oak Savannah GCD | Burleson | Yegua-Jackson | 1,094 | 5,315 | 7,004 | 7,004 | 7,000 | 6,058 |
| **Post Oak Savannah GCD Total** | | **Yegua-Jackson** | **1,094** | **5,315** | **7,004** | **7,004** | **7,000** | **6,058** |
| **GMA 12 Total** | | **Yegua-Jackson** | **16,407** | **22,691** | **25,202** | **25,200** | **25,196** | **24,254** |

**Fayette County GCD values are for all of Fayette County.*

**TABLE 11 MODELED AVAILABLE GROUNDWATER FOR BRAZOS RIVER ALLUVIUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR. GCD = GROUNDWATER CONSERVATION DISTRICT.**

| GCD | County | Aquifer | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Brazos Valley GCD | Brazos | Brazos River Alluvium | 77,816 | 76,978 | 76,393 | 76,195 | 76,100 | 76,039 |
| | Robertson | Brazos River Alluvium | 55,907 | 55,424 | 55,157 | 54,839 | 54,723 | 54,618 |
| Post Oak Savannah GCD | Burleson | Brazos River Alluvium | 32,222 | 32,207 | 32,207 | 32,206 | 32,206 | 32,206 |
| | Milam | Brazos River Alluvium | 31,412 | 31,375 | 31,366 | 31,362 | 31,359 | 31,358 |
| **Total** | | | **197,357** | **195,984** | **195,123** | **194,602** | **194,388** | **194,221** |

**TABLE 12 MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE SPARTA AQUIFER IN GROUNDWATER MANAGEMENT AREA 12. VALUES ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WAER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.**

| County | RWPA | River Basin | Aquifer | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Bastrop | K | Brazos | Sparta | 60 | 71 | 86 | 103 | 125 |
| | | Colorado | Sparta | 370 | 450 | 547 | 672 | 830 |
| | | Guadalupe | Sparta | 7 | 8 | 11 | 13 | 17 |
| Brazos | G | Brazos | Sparta | 6,014 | 7,545 | 9,076 | 10,607 | 12,138 |
| Burleson | G | Brazos | Sparta | 2,840 | 3,131 | 3,437 | 3,760 | 4,105 |
| Fayette* | K | Colorado | Sparta | 1,618 | 1,617 | 1,617 | 1,640 | 1,657 |
| | | Guadalupe | Sparta | 1,161 | 1,166 | 1,179 | 1,188 | 1,196 |
| | | Lavaca | Sparta | 0 | 0 | 0 | 0 | 0 |
| Lee | G | Brazos | Sparta | 694 | 833 | 1,003 | 1,212 | 1,472 |
| | | Colorado | Sparta | 115 | 142 | 178 | 222 | 279 |
| Leon | H | Brazos | Sparta | 97 | 97 | 97 | 97 | 97 |
| | | Trinity | Sparta | 151 | 152 | 154 | 156 | 157 |
| Madison | H | Brazos | Sparta | 238 | 277 | 316 | 355 | 390 |
| | | Trinity | Sparta | 1,662 | 1,934 | 2,207 | 2,479 | 2,725 |
| Robertson | G | Brazos | Sparta | 338 | 509 | 680 | 851 | 1,022 |
| **GMA 12 Total** | | | **Sparta** | **15,365** | **17,932** | **20,588** | **23,355** | **26,210** |

**Fayette County GCD values are for all of Fayette County.*

**TABLE 13** **MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE QUEEN CITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 12. VALUES ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.**

| County | RWPA | River Basin | Aquifer | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Bastrop | K | Brazos | Queen City | 45 | 49 | 54 | 60 | 66 |
| | | Colorado | Queen City | 410 | 453 | 500 | 552 | 610 |
| | | Guadalupe | Queen City | 64 | 71 | 78 | 86 | 95 |
| Brazos | G | Brazos | Queen City | 245 | 357 | 469 | 582 | 694 |
| Burleson | G | Brazos | Queen City | 3,090 | 3,467 | 3,883 | 4,344 | 4,863 |
| Fayette* | K | Colorado | Queen City | 1,879 | 1,891 | 1,905 | 1,919 | 1,935 |
| | | Guadalupe | Queen City | 836 | 846 | 856 | 867 | 878 |
| | | Lavaca | Queen City | 0 | 0 | 0 | 0 | 0 |
| Freestone | C | Trinity | Queen City | 77 | 77 | 77 | 77 | 77 |
| Lee | G | Brazos | Queen City | 601 | 656 | 717 | 783 | 854 |
| | | Colorado | Queen City | 99 | 111 | 122 | 134 | 146 |
| Leon | H | Brazos | Queen City | 408 | 451 | 493 | 536 | 575 |
| | | Trinity | Queen City | 511 | 516 | 521 | 527 | 531 |
| Madison | H | Brazos | Queen City | 132 | 154 | 175 | 197 | 216 |
| | | Trinity | Queen City | 132 | 154 | 176 | 197 | 217 |
| Milam | G | Brazos | Queen City | 1,348 | 1,643 | 2,003 | 2,441 | 2,976 |
| Robertson | G | Brazos | Queen City | 144 | 252 | 359 | 467 | 575 |
| **GMA 12 Total** | | | **Queen City** | **10,021** | **11,148** | **12,388** | **13,769** | **15,308** |

**Fayette County GCD values are for all of Fayette County.*

**TABLE 14 MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE CARRIZO FORMATION OF THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 12. VALUES ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.**

| County | RWPA | River Basin | Aquifer | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Bastrop | K | Brazos | Carrizo | 189 | 241 | 314 | 417 | 565 |
| | | Colorado | Carrizo | 3,000 | 3,853 | 4,815 | 5,937 | 7,289 |
| | | Guadalupe | Carrizo | 262 | 322 | 404 | 519 | 680 |
| Brazos | G | Brazos | Carrizo | 1,444 | 2,023 | 2,603 | 3,183 | 3,763 |
| Burleson | G | Brazos | Carrizo | 16,656 | 16,806 | 16,956 | 17,108 | 17,261 |
| Fayette* | K | Colorado | Carrizo | 4,875 | 4,875 | 4,875 | 4,875 | 4,875 |
| | | Guadalupe | Carrizo | 280 | 280 | 280 | 280 | 280 |
| | | Lavaca | Carrizo | 0 | 0 | 0 | 0 | 0 |
| Freestone | C | Trinity | Carrizo | 79 | 79 | 79 | 79 | 79 |
| Lee | G | Brazos | Carrizo | 1,680 | 1,942 | 2,269 | 2,690 | 3,246 |
| | | Colorado | Carrizo | 772 | 879 | 986 | 1,093 | 1,200 |
| Leon | H | Brazos | Carrizo | 1,258 | 1,457 | 1,656 | 1,855 | 2,035 |
| | | Trinity | Carrizo | 5,138 | 5,978 | 6,818 | 7,659 | 8,415 |
| Madison | H | Brazos | Carrizo | 0 | 0 | 0 | 0 | 0 |
| | | Trinity | Carrizo | 0 | 0 | 0 | 0 | 0 |
| Milam | G | Brazos | Carrizo | 607 | 680 | 759 | 847 | 945 |
| Robertson | G | Brazos | Carrizo | 412 | 743 | 1,074 | 1,405 | 1,736 |
| **GMA 12 Total** | | | **Carrizo** | **36,652** | **40,158** | **43,888** | **47,947** | **52,369** |

**Fayette County GCD values are for all of Fayette County.*

**TABLE 15 MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE CALVERT BLUFF FORMATION OF THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 12. VALUES ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.**

| County | RWPA | River Basin | Aquifer | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Bastrop | K | Brazos | Calvert Bluff | 29 | 32 | 36 | 40 | 44 |
| | | Colorado | Calvert Bluff | 2,390 | 2,978 | 3,573 | 4,177 | 4,790 |
| | | Guadalupe | Calvert Bluff | 0 | 0 | 0 | 0 | 0 |
| Brazos | G | Brazos | Calvert Bluff | 0 | 0 | 0 | 0 | 0 |
| Burleson | G | Brazos | Calvert Bluff | 129 | 140 | 152 | 163 | 174 |
| Freestone | C | Brazos | Calvert Bluff | 100 | 101 | 103 | 104 | 105 |
| | | Trinity | Calvert Bluff | 513 | 536 | 558 | 581 | 601 |
| Lee | G | Brazos | Calvert Bluff | 395 | 475 | 557 | 642 | 729 |
| | | Colorado | Calvert Bluff | 0 | 0 | 0 | 0 | 0 |
| Leon | H | Brazos | Calvert Bluff | 806 | 925 | 1,044 | 1,163 | 1,270 |
| | | Trinity | Calvert Bluff | 1,370 | 1,594 | 1,819 | 2,043 | 2,245 |
| Limestone | G | Brazos | Calvert Bluff | 153 | 168 | 184 | 202 | 222 |
| Madison | H | Brazos | Calvert Bluff | 0 | 0 | 0 | 0 | 0 |
| | | Trinity | Calvert Bluff | 0 | 0 | 0 | 0 | 0 |
| Milam | G | Brazos | Calvert Bluff | 2,811 | 3,162 | 3,558 | 4,012 | 4,532 |
| Navarro | C | Trinity | Calvert Bluff | 7 | 7 | 8 | 8 | 9 |
| Robertson | G | Brazos | Calvert Bluff | 546 | 841 | 1,136 | 1,430 | 1,725 |
| **GMA 12 Total** | | | **Calvert Bluff** | **9,249** | **10,959** | **12,728** | **14,565** | **16,446** |

**TABLE 16 MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE SIMSBORO FORMATION OF THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 12. VALUES ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.**

| County | RWPA | River Basin | Aquifer | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Bastrop | K | Brazos | Simsboro | 9,215 | 9,327 | 9,439 | 9,552 | 9,664 |
| | | Colorado | Simsboro | 29,621 | 32,157 | 34,507 | 36,877 | 39,313 |
| | | Guadalupe | Simsboro | 0 | 0 | 0 | 0 | 0 |
| Brazos | G | Brazos | Simsboro | 42,709 | 48,137 | 53,565 | 58,993 | 64,421 |
| Burleson | G | Brazos | Simsboro | 39,656 | 48,662 | 52,267 | 52,273 | 52,278 |
| Falls | G | Brazos | Simsboro | 11 | 12 | 14 | 15 | 17 |
| Freestone | C | Brazos | Simsboro | 461 | 525 | 589 | 653 | 710 |
| | | Trinity | Simsboro | 2,910 | 3,375 | 3,840 | 4,305 | 4,724 |
| Lee | G | Brazos | Simsboro | 26,405 | 27,619 | 28,835 | 30,051 | 30,967 |
| | | Colorado | Simsboro | 1 | 1 | 1 | 1 | 1 |
| Leon | H | Brazos | Simsboro | 519 | 604 | 689 | 774 | 850 |
| | | Trinity | Simsboro | 357 | 416 | 474 | 533 | 586 |
| Limestone | G | Brazos | Simsboro | 612 | 676 | 746 | 824 | 910 |
| Madison | H | Brazos | Simsboro | 0 | 0 | 0 | 0 | 0 |
| | | Trinity | Simsboro | 0 | 0 | 0 | 0 | 0 |
| Milam | G | Brazos | Simsboro | 25,883 | 26,170 | 26,475 | 26,798 | 27,144 |
| Navarro | C | Trinity | Simsboro | 12 | 13 | 14 | 15 | 16 |
| Robertson | G | Brazos | Simsboro | 47,140 | 56,061 | 64,982 | 73,903 | 82,824 |
| Williamson | G | Brazos | Simsboro | 21 | 23 | 25 | 28 | 31 |
| **GMA 12 Total** | | | **Simsboro** | **225,533** | **253,778** | **276,462** | **295,595** | **314,456** |

**TABLE 17 MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE HOOPER FORMATION OF THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 12. VALUES ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.**

| County | RWPA | River Basin | Aquifer | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Bastrop | K | Brazos | Hooper | 0 | 0 | 0 | 0 | 0 |
| | | Colorado | Hooper | 1,957 | 2,259 | 2,572 | 2,897 | 3,234 |
| | | Guadalupe | Hooper | 0 | 0 | 0 | 0 | 0 |
| Brazos | G | Brazos | Hooper | 0 | 0 | 0 | 0 | 0 |
| Burleson | G | Brazos | Hooper | 27 | 30 | 32 | 35 | 37 |
| Falls | G | Brazos | Hooper | 35 | 38 | 42 | 47 | 52 |
| Freestone | C | Brazos | Hooper | 696 | 806 | 917 | 1,027 | 1,126 |
| | | Trinity | Hooper | 2,444 | 2,833 | 3,221 | 3,610 | 3,959 |
| Lee | G | Brazos | Hooper | 18 | 19 | 21 | 24 | 26 |
| | | Colorado | Hooper | 12 | 13 | 14 | 16 | 18 |
| Leon | H | Brazos | Hooper | 0 | 0 | 0 | 0 | 0 |
| | | Trinity | Hooper | 102 | 118 | 135 | 152 | 167 |
| Limestone | G | Brazos | Hooper | 190 | 210 | 232 | 256 | 283 |
| | | Trinity | Hooper | 5 | 5 | 6 | 6 | 7 |
| Madison | H | Brazos | Hooper | 0 | 0 | 0 | 0 | 0 |
| | | Trinity | Hooper | 0 | 0 | 0 | 0 | 0 |
| Milam | G | Brazos | Hooper | 1,999 | 2,234 | 2,491 | 2,774 | 3,089 |
| Navarro | C | Trinity | Hooper | 86 | 94 | 103 | 113 | 124 |
| Robertson | G | Brazos | Hooper | 1,066 | 1,334 | 1,603 | 1,871 | 2,139 |
| Williamson | G | Brazos | Hooper | 118 | 130 | 144 | 159 | 175 |
| | | Colorado | Hooper | 1 | 2 | 2 | 2 | 2 |
| **GMA 12 Total** | | | **Hooper** | **8,756** | **10,125** | **11,535** | **12,989** | **14,438** |

**TABLE 18** **MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE YEGUA-JACKSON AQUIFER IN GROUNDWATER MANAGEMENT AREA 12. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.**

| County | RWPA | River Basin | Aquifer | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Brazos | G | Brazos | Yegua-Jackson | 6,270 | 7,092 | 7,091 | 7,091 | 7,091 |
| Burleson | G | Brazos | Yegua-Jackson | 5,315 | 7,004 | 7,004 | 7,000 | 6,058 |
| Fayette* | K | Colorado | Yegua-Jackson | 7,644 | 7,644 | 7,643 | 7,643 | 7,643 |
| | | Guadalupe | Yegua-Jackson | 727 | 727 | 727 | 727 | 727 |
| | | Lavaca | Yegua-Jackson | 1,613 | 1,613 | 1,613 | 1,613 | 1,613 |
| Leon | H | Trinity | Yegua-Jackson | 0 | 0 | 0 | 0 | 0 |
| Madison | H | Brazos | Yegua-Jackson | 11 | 11 | 11 | 11 | 11 |
| | | Trinity | Yegua-Jackson | 1,111 | 1,111 | 1,111 | 1,111 | 1,111 |
| **GMA 12 Total** | | | **Yegua-Jackson** | **22,691** | **25,202** | **25,200** | **25,196** | **24,254** |

**Fayette County GCD values are for all of Fayette County.*

**TABLE 19 MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE BRAZOS RIVER ALLUVIUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 12. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.**

| County | RWPA | River Basin | Aquifer | 2030 | 2040 | 2050 | 2060 | 2070 |
|---|---|---|---|---|---|---|---|---|
| Brazos | G | Brazos | Brazos River Alluvium | 76,978 | 76,393 | 76,195 | 76,100 | 76,039 |
| Burleson | G | Brazos | Brazos River Alluvium | 32,207 | 32,207 | 32,206 | 32,206 | 32,206 |
| Milam | G | Brazos | Brazos River Alluvium | 31,375 | 31,366 | 31,362 | 31,359 | 31,358 |
| Robertson | G | Brazos | Brazos River Alluvium | 55,424 | 55,157 | 54,839 | 54,723 | 54,618 |
| **GMA 12 Total** | | | **Brazos River Alluvium** | **195,984** | **195,123** | **194,602** | **194,388** | **194,221** |

## *LIMITATIONS:*

The groundwater model used in completing this analysis is the best available scientific tool that can be used to meet the stated objectives. To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

> "Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results."

A key aspect of using the groundwater model to evaluate historic groundwater flow conditions includes the assumptions about the location in the aquifer where historic pumping was placed. Understanding the amount and location of historic pumping is as important as evaluating the volume of groundwater flow into and out of the district, between aquifers within the district (as applicable), interactions with surface water (as applicable), recharge to the aquifer system (as applicable), and other metrics that describe the impacts of that pumping. In addition, assumptions regarding precipitation, recharge, and streamflow are specific to a particular historic time period.

Because the application of the groundwater model was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations relating to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor groundwater pumping and groundwater levels in the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

## *REFERENCES:*


Daniel B. Stephens & Associates, INTERA Incorporated, and Ground Water Consultants, LLC, 2022, Desired Future Condition Explanatory Report for Groundwater Management Area 12, 859 p.

Deeds, N. E., Yan, T., Singh, A., Jones, T. L., Kelley, V. A., Knox, P. R., and Young, S. C., 2010, Groundwater availability model for the Yegua-Jackson Aquifer: Final report prepared for the Texas Water Development Board by INTERA, Inc., 582 p., http://www.twdb.texas.gov/groundwater/models/gam/ygjk/YGJK_Model_Report.p df.

Ewing, J.E., and Jigmond, M., 2016, Final Numerical Model Report for the Brazos River Alluvium Aquifer Groundwater Availability Model: Contract report to the Texas Water Development Board, 357 p., http://www.twdb.texas.gov/groundwater/models/gam/bzrv/BRAA_NM_REPORT_FINAL.pdf?d=1502891797831.

Harbaugh, A. W., Banta, E. R., Hill, M. C., and McDonald, M. G., 2000, MODFLOW-2000, the U.S. Geological Survey modular ground-water model -- User guide to modularization concepts and the Ground-Water Flow Process: U.S. Geological Survey Open-File Report 00-92, 121 p.

INTERA Incorporated, D.B. Stephens & Associates, and Ground Water Consultants, LLC, 2020, GMA 12 Update to the Groundwater Availability Model for the Central Portion of the Sparta, Queen City, Carrizo-Wilcox Aquifers: Update to Improve Representation of the Transmissive Properties of the Simsboro Aquifer in the Vicinity of the Vista Ridge Well Field, 30 p.

Oliver, W., 2010, GAM Task 10-012 Model Run Report: Texas Water Development Board, GAM Task 10-012 Report, 48 p., http://www.twdb.texas.gov/groundwater/docs/GAMruns/Task10-012.pdf

National Research Council, 2007, Models in Environmental Regulatory Decision Making Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p., http://www.nap.edu/catalog.php?record_id=11972.

Panday, S., Langevin, C.D., Niswonger, R.G., Ibaraki, M., and Hughes, J.D., 2013, MODFLOWUSG version 1: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finitedifference formulation: U.S. Geological Survey Techniques and Methods, book 6 chap. A45, 66 p.

Panday, S., C.D. Langevin, R.G. Niswonger, M. Ibaraki, and J.D. Hughes. 2015. MODFLOWUSG version 1.3.00: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation: U.S. Geological Survey Software Release, 01 December 2015, http://dx.doi.org/10.5066/F7R20ZFJ

Texas Water Code, 2011, http://www.statutes.legis.state.tx.us/docs/WA/pdf/WA.36.pdf.

*APPENDIX A*

## *Summary of Groundwater Management Area 12 Response to the TWDB's Review of the Desired Future Condition Deliverable*

After reviewing the initial Groundwater Management Area 12 submittal, the TWDB sent an email on April 21, 2022, requesting clarifications on the desired future condition definitions. In response, Groundwater Management Area 12 consultants produced two memorandums dated May 5, 2022, that were presented and approved at the May 6, 2022, Groundwater Management Area 12 meeting. One memo provides the responses to the TWDB clarifications and is reproduced in Figure A1. Numbered entries represent the TWDB clarification questions and the entries beginning in “RESPONSE:” represent Groundwater Management Area 12's responses. This document is also available on the Post Oak Savannah Groundwater Conservation district website. The second memo provides a non-relevant statement for the Calvert Bluff Aquifer that was missing in the original submittal package (see Clarification #1 under Carrizo-Wilcox, Queen City, and Sparta aquifers). This document is not reproduced here.

## Memorandum

**To:** Texas Water Development Board

**From:** GMA 12

**Date:** May 5, 2022

**Subject:** Items to address prior to calculating DFCs

GMA 12 has reviewed the email from the TWDB dated April, 21, 2022 regarding items that need to be addressed before calculating modeled available groundwater. The following is a summary of these items and GMA 12's response to them.

**Carrizo-Wilcox, Queen City, and Sparta aquifers**

1) Our analysis does not achieve the DFC for the Calvert Bluff Aquifer in Williamson County. There is only one active model cell for this aquifer in Williamson County and the cell goes dry around 2065 in the DFC predictive model. We suggest declaring the Calvert Bluff Aquifer as non-relevant in Williamson County. Please consider declaring the Calvert Bluff Aquifer non-relevant in Williamson County or provide additional information for our DFC analysis.

*RESPONSE: GMA 12 will declare the Calvert Bluff Aquifer non-relevant in Williamson County at a GMA meeting on May 6, 2022. A memorandum providing the required documentation for this declaration will be submitted to the TWDB.*

2) Please confirm that the DFCs for the Carrizo-Wilcox are calculated using a cell count averaging method, rather than an area-weighted averaging method.
   a. If a cell count averaging method is used, the current DFC error tolerance of 10% is good enough to make all DFCs compliant with our calculation, except the Calvert Bluff Aquifer in Williamson County (See Note #1 above).
   b. If an area-weighted averaging method is used, we recommend clarifying a tolerance of 11% for the GMA-wide Simsboro Aquifer DFC in order to be compliant with our calculation.

*RESPONSE: GMA 12 uses an area-weighted averaging method. However, GMA 12 did not adopt a GMA-wide DFC for any of these aquifers. GMA-wide averages were erroneously included in the DFC summary tables in the Explanatory Report. The GMA 12 DFC resolution, dated November 30, 2022 and for which the Explanatory Report was submitted in support of, does not contain any GMA-wide DFCs. Therefore, no tolerance changes are needed to be compliant with TWDB calculations other than the declaration of the Calvert Bluff in Williamson County as a non-relevant aquifer*

**Yegua-Jackson Aquifer**

1) Please confirm that the reference time period for the Yegua-Jackson Aquifer DFCs only goes to the end of December 2069 (stress period 99), even though the predictive model goes to December 2070 (stress period 100).

*RESPONSE: The Yegua-Jackson DFCs are specified as from January 2010 (the end of Stress Period 39) through December 2069 (the end of Stress Period 99), for a total of 60 years.*

2) Since there are no monthly stress periods, please confirm that the baseline year of "January 2010" refers to the end of 2009/beginning of January 2010 (stress period 39), rather than the end of 2010 (stress period 40).

*RESPONSE: That is correct. The beginning of the GMA 12 predictive model runs is Stress Period 40, so the baseline year is the end of Stress Period 39.*

**Figure A1. Response Memorandum from Groundwater Management Area 12 to clarifications requested from the Texas Water Development Board.**

3) Our analysis results in a 1-foot difference in the GMA-wide DFC for the Yegua-Jackson Aquifer. We recommend clarifying a tolerance of 1 foot for the GMA-wide Yegua-Jackson DFC in order to be compliant with the TWDB-calculated value.

*RESPONSE: As with the Carrizo-Wilcox Aquifer, GMA 12 did not adopt a GMA-wide DFC for the Yegua-Jackson Aquifer. GMA averages were erroneously included in the DFC summary tables in the Explanatory Report. The actual GMA 12 DFC resolution, dated November 30, 2022 and for which the Explanatory Report was submitted in support of, does not contain any GMA-wide DFCs. Therefore, no tolerance changes are needed to be compliant with TWDB for the Yegua-Jackson Aquifer.*

**Brazos River Alluvium Aquifer**

1) Please confirm that the reference time period for the Brazos River Alluvium Aquifer DFCs only goes to the end of December 2069 (stress period 484), even though the predictive model goes to the end of 2070 (stress period 485).

*RESPONSE: The reference time period for the BRAA DFCs only extents to the end of December 2069 (Stress Period 484).*

2) Since there are no monthly stress periods in 2013, please confirm that the Brazos Valley GCD baseline of "January 2013" refers to the end of 2012/beginning of January 2013 (stress period 427), rather than the end of 2013 (stress period 428).

*RESPONSE: The baseline "January 2013" refers to the end of 2012/beginning of January 2013 (Stress Period 427).*

3) Since there are monthly stress periods in 2010, please clarify whether the Post Oak Savannah GCD baseline of "January 2010" refers to the end of 2009/beginning of January 2010 (stress period 391) or the end of January 2010 (stress period 392).

*RESPONSE: The baseline "January 2010" refers to the end of 2009/beginning of January 2010 (Stress Period 391).*

4) For Brazos Valley GCD, please clarify how average percent saturation was defined by GMA 12. Is the average of only the final stress period (2069) or the average over the entire period from 2013 through 2069?

*RESPONSE: The average percent saturation is for the final stress period (2069) and not for the entire period from 2013 through 2069.*

5) The drawdown values calculated using the official TWDB grid shapefile and TWDB methodology are not compliant with the provided GMA 12 county-specific DFCs in the Brazos River Alluvium Aquifer. We recommend adopting the tolerances listed below in order to be compliant with the TWDB methodology. Alternatively, please provide the detailed methodology and zoned grid shapefile used to define the GMA 12 county-specific DFCs in the Brazos River Alluvium Aquifer, as these are not provided in the explanatory report or accompanying files:
   a. For Brazos Valley GCD, we suggest replacing the current tolerance of "1 foot or 5 percent (whichever was greater)" with "10% of total well depth" as the error tolerance for the DFC evaluation of the percent saturation. This will make the DFC compliant with our calculation regardless how the percent saturation is calculated (see Note #4 above).
   b. For Post Oak Savannah GCD, we suggest replacing the current tolerance of "1 foot or 5 percent (whichever was greater)" with "3 feet or 10 percent (whichever is greater)" as the error tolerance for the DFC evaluation of the decrease in average saturated thickness. This modification will make the DFC compliant with our calculation regardless of which baseline year is used (see Note #3 above).

*RESPONSE: GMA 12 will adopt tolerances for the DFC evaluation of the percent saturation for the Brazos River Alluvium Aquifer as proposed by the TWDB.*

**Figure A1 (Cont).** **Response Memorandum from Groundwater Management Area 12 to clarifications requested from the Texas Water Development Board.**

# APPENDIX E

Administrative Documents

# APPENDIX F

Brazos Valley GCD Contact Information

# BRAZOS VALLEY GROUNDWATER CONSERVATION DISTRICT

## District Staff

Alan M. Day, General Manager
Cynthia Lopez, Office Manager/Administrative Assistant
Megan Lamb, Educational & Outreach Coordinator
John Crabtree, Field Technician

## Physical Address:

112 W. 3rd Street
Hearne, Texas 77859

## Mailing Address:

P.O. Box 528
Hearne, Texas 77859

## Telephone Numbers:

979-279-9350 (office)

## Email Address:

info@brazosvalleygcd.org

## Website Address:

https://brazosvalleygcd.org/