FAYETTE COUNTY
GROUNDWATER CONSERVATION DISTRICT

MANAGEMENT PLAN

Adopted: October 20, 2003
Revised: November 3, 2008, October 7, 2013,
September 10, 2018, January 8, 2024

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Table of Contents

List of Tables

Appendices

INTRODUCTION

District Mission

The purpose of the Fayette County Groundwater Conservation District (the District), as required in the Texas Water Code, Chapter 36, is to provide for conserving, preserving, protecting, and recharging the underground water and prevention of waste of the District's groundwater.

The District will develop, promote, and implement management strategies to provide for the conservation, preservation, protection, recharging, and prevention of waste of the groundwater resources, over which it has jurisdictional authority, for the benefit of the people that the District serves.

Guiding Principles

The District was formed, and has been operated from its inception, with the guiding belief that the ownership and pumpage of groundwater is a private property right. It is understood that, through the confirmation election of the District, the landowners relinquished some of their control over that right for the collective benefit of the community which the District serves.

The District has adopted the principle of "education first" and regulation as a last resort in their effort to encourage conservation of the resource. As a result, the rules of the District are designed to give all landowners a fair and equal opportunity to use the groundwater resource underlying their property for beneficial purposes. If, at the request of the constituents of the District, more stringent management strategies are needed to better manage the resource, these strategies will be put in place after an extensive educational process and with the perceived majority approval of the constituents. The District will continue to monitor groundwater quality and quantity in order to better understand the dynamics of the aquifer systems over which it has jurisdiction.

This management document is intended to be used as a tool to provide continuity in the management of the District. It will be used by the District staff as a guide to ensure that all aspects of the goals of the District are carried out. It will be referred to by the Board for future planning, as well as a document to measure the performance of the staff on an annual basis

Conditions can change over time which may cause the Board to modify this document. The dynamic nature of this plan shall be maintained such that the District will continue to best serve the needs of the constituents. At the very least, the Board will review and readopt this plan every five years.

The goals, management objectives, and performance standards put forth in this planning document have been set at a reasonable level considering existing and future fiscal and technical resources. Conditions may change which could cause change in the management objectives defined to reach the stated goals. Whatever the future holds, the following guidelines will be used to insure that the management objectives are set at a sufficient level to be realistic and effective:

- The District's constituency will determine if the District's goals are set at a level that is both meaningful and attainable; through their voting right, the public will appraise the District's overall performance in the process of electing or re-electing Board members.

- The duly elected Board will guide and direct the District staff and will gauge the achievement of the goals set forth in this document.
- The interests and needs of the District's constituency shall control the direction of the management of the District.
- The Board will endeavor to maintain local control of the privately owned resource over which the District has jurisdictional authority.
- The District budget operates on an October 1 through September 30 fiscal year.
- The Board will evaluate District activities on a calendar year basis when considering stated goals, management objectives, and performance standards, any reference to the terms annual, annually, or yearly will refer to a standard calendar year of January 1 through December 31.

History

The Fayette County Groundwater Conservation District, formerly called the Colorado Valley Groundwater Conservation District, was created effective September 1, 2001 by the 77th Legislature in House Bill No. 1081 and was later confirmed by the voters of Fayette County in November of 2001, in accordance with the Underground Water Conservation Districts Act passed by the Texas Legislature in 1949 (currently codified as Chapters 35 and 36 of the Water Code, Vernon's Texas Codes Annotated).

Board of Directors

The Board of Directors is elected by the people within their Directors precincts, under the general Election laws of Texas.

Table 1: Board of Directors of the Fayette County Groundwater Conservation District*

Office	Name	Precinct	Term Ends
President	Leo J. Wick, Sr.	At Large	December 2026
Director	Mark Heinrich	4	December 2026
Secretary/Treasurer	Cynthia Rodibaugh	3	December 2024
Director	Harvey Hayek	2	December 2026
Vice-President	Robert Leer	1	December 2024

* This list of Directors is current as of the date of revision.

Location and Extent

The boundaries of the District are the same as, congruent with and coextensive with the boundaries of Fayette County, Texas, as stated in Section 3 of House Bill 1081, enacted by the Legislature of the State of Texas, meeting in Regular Session in 2001 as the 77th Legislature, and passed by the Texas House of Representatives on March 29, 2001 and by the Texas Senate on May 10, 2001, and signed by the Governor of the State of Texas on May 23, 2001.

Fayette County, 936 square miles in area, is in the Gulf Coastal Plain in east-central Texas. Bordering counties are: Bastrop on the northwest; Lee, Washington, and Austin on the north and northeast; Colorado on the east-southeast; and Lavaca and Gonzales on the south and southwest. La Grange, the county seat, is near the center of the county on U.S. Highway 77 and State Highway 71, about 60 miles southeast of Austin and 100 miles west of Houston.

Planning Period

This plan becomes effective upon review and approval by the Texas Water Development Board and remains in effect until a revised plan is approved or five (5) years from the date of approval as administratively complete, whichever is later. The plan may be reviewed annually. However, the plan must be reviewed by the Board of Directors, readopted with or without revisions, and be resubmitted to the TWDB for approval at least once every five years to insure that it is consistent with the applicable Regional Water Plans and the State Water Plan.

As outlined in Chapter 36.1071, Texas Water Code and in 31 Texas Administrative Code §356.52(a)(1), the Management Plan is required, as applicable, to address the following management goals:

- Providing the most efficient use of groundwater
- Controlling and preventing waste of groundwater
- Controlling and preventing subsidence
- Addressing conjunctive surface water management issues
- Addressing natural resource issues
- Addressing drought conditions,
- Addressing conservation, recharge enhancement, rainwater harvesting, precipitation enhancement, or brush control, where appropriate and cost effective, and
- Addressing the desired future conditions of the groundwater resources.

The following goals referenced in Chapter 36, Texas Water Code, have been determined not applicable to the District;

§ 36.1071(a)(3) Controlling and preventing subsidence
§ 36.1071(a)(4) Addressing conjunctive surface water management issues
§ 36.1071(a)(5) Addressing natural resource issues
§ 36.1071(a)(7) Addressing recharge enhancement
§ 36.1071(a)(7) Addressing precipitation enhancement
§ 36.1071(a)(7) Addressing brush control
§ 36.1071(a)(7) Addressing rainwater harvesting

GENERAL GEOLOGY AND HYDROLOGY

Topography

Topography in Fayette County consists of rolling to hilly uplands, and flat flood plains along the major streams. Flood-plain terraces, river flats, and marshes typify the valley bottoms. Elevation ranges from about 200 feet above sea level where the Colorado River crosses the Fayette-Colorado County line to over 550 feet in the southwest and northeast parts of the county. Most of the county is drained by the Colorado River and its tributaries. Major tributaries of the Colorado River draining Fayette County include Rabbs, Buckner's, and Cummins Creeks. The southern part of the county is drained by the east and west branches of the Navidad River and their tributaries, and the westernmost corner of the county is drained by Peach Creek, a tributary of the Guadalupe River.

Groundwater Resources

Aquifers of Fayette County have been divided by the Texas Water Development Board (TWDB) into two types, namely, major and minor aquifers. The TWDB has classified two major aquifers in Fayette County: the Carrizo-Wilcox and Gulf Coast. The Queen City, Sparta Sands, and the Yegua-Jackson are classified as minor aquifers. In addition to these aquifers, the alluvium of the Colorado River, as well as other geologic formations, are being tapped by wells within the County for domestic uses.

Most of the formations in Fayette County will yield some water, but only the sands of the Sparta Sand, Yegua Formation, Jackson Group, Catahoula Tuff, and Oakville Sandstone yield fresh to slightly saline water (having less than 3,000 parts per million dissolved solids) in significant quantities. The Carrizo Sand, sands of the Wilcox Group, the Queen City Sand, and the Quaternary alluvium are also capable of yielding water in the county; however, these contain usable quality water over limited areas of the county or occur at relatively great depths in comparison to other fresh water-bearing formations and consequently are not developed in Fayette County. The Wilcox Group is not known to yield water to wells in Fayette County. The Weches Greensand and Cook Mountain Formation generally do not yield usable quality water in sufficient quantities to constitute a supply.

Major Aquifers

Carrizo-Wilcox Aquifer

The Wilcox Group consisting of the Hooper Formation (lower Wilcox), the Simsboro Formation (Middle Wilcox), the Calvert Bluff (Upper Wilcox), and the overlying Carrizo Sand formation of the Claiborne Group form a hydrologically connected system known as the Carrizo-Wilcox Aquifer. The Carrizo-Wilcox crops out in a north-east trending belt 13 to 20 miles wide parallel to the Bastrop-Fayette county line through Lee, Bastrop and Caldwell Counties within Thornhill's study area.

Wilcox Group

The Simsboro Sands (Middle Wilcox) forms a prolific aquifer that is currently tapped or will be tapped in the future for large groundwater supplies in Bastrop, Lee, Milam, and Burleson Counties. The Calvert Bluff and Hooper Formations are not as favorable for development updip. The top of the Wilcox Group, in Fayette County, ranges from 1,500 feet below land surface in western Fayette County, to more than 5,500 feet in the downdip area. The Wilcox Group consists of various sediment material such as clay, silt, fine- to medium-grained sand and sandstone, shale, and some seams of lignite.

No known well is tapped into the Wilcox Group within the boundaries of the Fayette County Groundwater Conservation District.

Carrizo Sand

The Carrizo Sand is formed by massive, cross bedded, fine- to course grained ferruginous sand with a few relatively thin layers of clay. The Carrizo crops out on a north east trending band from one to four miles in width through Caldwell, Bastrop, and Lee counties, within Thornhill's study area. The Carrizo dips southeastward approximately 160 feet per mile near the outcrop, with the dip getting steeper, to approximately 250 feet per mile, downdip. Within Fayette County, the top of the Carrizo Sand's altitude ranges from 500 feet below mean sea level to more than 5,000 feet below mean sea level. Depth to the top of the Carrizo ranges from approximately 850 feet to more than 5,500 feet below land surface.

Based on information from the Fayette County Groundwater Conservation District database, there are 22 known wells in Fayette County known to be tapping this aquifer with an average depth of approximately 1,460 feet.

Gulf Coast Aquifer

The Gulf Coast Aquifer consists of four distinct units, the Jasper Aquifer, the Burkeville confining system, the Evangeline Aquifer, and the Chicot Aquifer. Within Fayette County, the Oakville Sandstone and the Catahoula Formation correspond to the Jasper Aquifer. The base of the Fleming Formation to the Burkeville confining unit, and the upper part of the Fleming Formation and the Willis Formation correspond to the Evangeline Aquifer. The Chicot Aquifer is not present in Fayette County.

The Gulf Coast Aquifer extends inland approximately 100 to 150 miles from the Gulf of Mexico in line approximately parallel to the Texas Gulf Coast. In Fayette County, the Gulf Coast Aquifer formations crop out along the central and eastern portions of the county, with the Catahoula Formation, Oakville Sandstone, and Fleming Formation forming a northeast trending belt 13 to 16 miles wide. This belt is parallel to the Fayette-Colorado county line.

The aquifer consists of complex interbedded clays, silts, sands, and gravels, which are hydrologically connected to form a large, leaky artesian aquifer system.

Water quality is generally good in the shallower portion of the aquifer. In several areas at or near the coast, including Galveston Island and the central and southern parts of Orange County, heavy municipal or industrial pumpage has caused an updip migration, or saltwater intrusion, of poor quality water into the aquifer. Years of heavy pumpage for municipal and manufacturing use in portions of the aquifer have resulted in areas of significant water-level decline. Some of these declines have resulted in compaction of dewatered clays and significant land-surface subsidence. Recent reductions in pumpage in those areas have resulted in a stabilization and, in some cases, even improvement of groundwater quality.

Based on information from the Fayette County Groundwater Conservation District water well database, a combined total of approximately 4,895 wells are currently tapping into the formations of the Gulf Coast Aquifer in Fayette County. Average well depth in the Gulf Coast Aquifer is approximately 202 feet.

Jasper Aquifer

The Jasper Aquifer consists of the Oakville Sandstone and the Catahoula Tuff. Hydrologically, it is part of the Gulf Coast Aquifer. The formations of the aquifer crop out in the central part of Fayette County and cover approximately 250 square miles. The formations that comprise the Jasper dip southeastward approximately 75 to 100 feet per mile. Depth to the top of the Jasper The formation overlays the Catahoula Tuff and underlies the Burkeville Unit in Fayette County. The aquifer contains local pockets of sand, shale, and clay. The aquifer's rate of dip in Fayette County is not known at the present time. Currently, rural domestic users are tapping this formation for water supply.

Water quality of the Jasper Aquifer is adequate for municipal and domestic uses although hardness is somewhat elevated.

Evangeline Aquifer

The Evangeline Aquifer is part of the Gulf Coast Aquifer and is separated from the Jasper Aquifer by the Burkeville Confining System. Comprised of the upper portion of the Fleming Formation and the Willis Sand, the Evangeline Aquifer outcrops throughout eastern Fayette County. The aquifer is under water table conditions throughout Fayette County with water levels generally shallow through the outcrop area. Sand thickness within the Evangeline ranges from zero feet to 200 feet near the southwestern county line. Water of good quality can be found in most wells producing from the aquifer.

Minor Aquifers and Formations

Oakville Sandstone and Lagarto Clay Formations

These formations are part of the Gulf Coast Aquifer and are composed of two separate units within Fayette County. The Oakville Sandstone overlays the Lagarto Clay and is considered as one unit in Fayette County due to the difficulty in distinguishing each unit uniquely. The outcrop of the two units are east of a northeasterly line from Flatonia to Carmine. The outcrop area for the two units is approximately 13 miles in width in Fayette County. The combined unit consists of sand, gravel, clay and shale. The rate of dip within the County is not known at the present time. This aquifer is currently providing water supply for the cities of Ellinger, Fayetteville, and Flatonia. Some rural domestic users are also taping this formation.

Water quality from these two formations is generally acceptable although hardness is somewhat of a problem.

Catahoula Tuff Formation

The Catahoula Tuff Formation is part of the Gulf Coast Aquifer and crops out in Fayette and Lee Counties varying in width from one to six miles in Fayette County. The formation follows a northeasterly line from Flatonia to La Grange. The formation consists of clay, sand, silt, and tufaceous sand. The rate of dip which the aquifer has within the County is unknown as is the downdip limit of fresh to slightly saline water. The Catahoula Tuff formation is supplying water to the cities of Carmine, La Grange, Flatonia, and Schulenburg and the rural population between these cities.

Water quality from this formation is generally acceptable for municipal and domestic purposes although hardness is somewhat of a problem.

Queen City Sand

The Queen City Sand crops out in Bastrop and Lee Counties in a narrow band approximately three to five miles in width and roughly parallel to the Bastrop-Fayette County line. In Fayette County, this formation downdips at a rate of approximately 150 feet per mile from east to west. The formation's altitude ranges from 10 feet above mean sea level near the intersection of Buckner's Creek and State Highway 95 to approximately 4,000 feet below mean sea level near Fayetteville.

Water quality from this formation is adequate for municipal and domestic purposes though TDS values approach the recommended secondary limit. Fresh to slightly saline water is available west of a line from Flatonia to Ledbetter. Presently, the Fayette County Groundwater Conservation District database indicates 82 wells tap into this aquifer in Fayette County. Average well depth in the Queen City Aquifer is approximately 639 feet.

Sparta Sand

The Sparta Sand Formation crops out in Bastrop and Lee counties in a very narrow band approximately one to two miles wide and along a line approximately parallel to the Bastrop-Fayette County line. The formation downdips approximately 175 feet per mile from the southwestern part of the County to the northeastern part of the County. The Sparta Sand's altitude ranges from 272 feet above mean sea level near the Bastrop County State Highway 95 intersection to 3,500 below mean sea level near Fayetteville.

Water quality from this formation is acceptable for municipal and domestic purposes although hardness and TDS concentrations approach Texas Department of Health's (TDH) recommended limits in some locations. Fresh to slightly saline water is available west of a line from slightly west of Carmine to Flatonia.

Current records indicate a total of 283 wells tapping into the Sparta Sand in Fayette County, with an average depth of 224 feet.

Yegua Formation

The Yegua Formation crops out in Fayette and Lee County in a band approximately four to eight miles wide and along the Bastrop-Fayette County line. The Yegua Formation is composed of alternating layers of clay and silt with some thin seams of lignite. The formation downdips at a rate of 150 feet per mile. The formation reaches its deepest depth of 2,800 feet below mean sea level along the Fayette-Lavaca County line. Presently, the Yegua Formation is being utilized by rural landowners for domestic and livestock water supply.

The water quality from this formation is acceptable for municipal and domestic purposes although TDS and sulfate constituents exceeded the recommended maximum limits, and chloride and hardness constituents approached the maximum limits.

Jackson Group

The Jackson Group Formation crops out in Fayette and Lee Counties in a band approximately three to eight miles in width and along a northeasterly line from Flatonia to La Grange. The formation is composed of clay and silt with some minor deposits of sandstone. The formation dips within the County at a rate of approximately 150 feet per mile. The formation reaches an estimated 2,200 feet below mean sea level near Fayetteville. Current use of the Jackson Group is by the cities of Ledbetter, Flatonia, and Schulenburg as well as rural property owners.

Water quality from this formation is marginal for municipal and domestic purposes due to constituent levels exceeding recommended maximum limits for TDS, chloride, sulfate, and calcium carbonate in many locations throughout the County.

Yegua-Jackson Aquifer

In 2002, Texas Water Development Board is designated the Yegua Formation and the Jackson Group as a minor aquifer, *the Yegua-Jackson Aquifer*. The primary rationale for this designation is that water use from the Yegua-Jackson Aquifer ranks in the upper half of annual water use for the minor aquifers, with more than 11,000 acre-feet of water produced in 1997. The Yegua-Jackson Aquifer extends in a narrow band from the Rio Grande and Mexico across the State to the Sabine River and Louisiana. Although the occurrence, quality, and quantity of water from this aquifer are erratic, domestic and livestock supplies are available from shallow wells over most of its extent. Locally water for municipal, industrial, and irrigation purposes is available. Yields of most wells are small, less than 50 gallons per minute, but in some areas, yields of adequately constructed wells may range to more than 500 gallons per minute. The Yegua-Jackson Aquifer consists of complex associations of sand, silt, and clay deposited during the Tertiary Period. Net freshwater sands are generally less than 200 feet deep at any location within the aquifer.

Water quality varies greatly within the aquifer, and shallow occurrences of poor-quality water are not uncommon. In general, however, small to moderate amounts of usable quality water can be found within shallow sands (less than 300 feet deep) over much of the Yegua-Jackson Aquifer.

Currently, 3,280 wells are known to be producing from the Yegua-Jackson Aquifer, with an average depth of 339 feet.

Alluvium

The alluvium (clay, silt, gravel, etc. deposited by running water) generally follows the flood plain of the Colorado River. The band's width varies from approximately one to eight miles. The alluvial's thickness is not known although some observations have estimated it does not exceed 60 feet. Wells in the alluvium are generally shallow and provide water in small quantities for rural domestic and livestock purposes within Fayette County.

Water quality from alluvial deposits is generally adequate for most uses in Fayette County although quantity is limited. These shallow wells use the alluvial deposits as a sand filter to provide some measure of water treatment. Currently, 549 wells are known to tap into this aquifer in Fayette County.

Physical Characteristics & Water-Bearing Properties

Of Geologic Units

Midway Group

Rocks of the Midway Group crop out in a northeast-trending belt, 2 to 3 miles wide, along the Bastrop-Travis County line and dip southeast toward the Gulf Coast. They underlie Fayette County at depths ranging from about 3,800 feet (well 67-14-901) to over 9,100 feet (well 66-18-402).

The Midway consists principally of shale, clay, and a few thin sand lenses. The thickness of the Midway Group in Fayette County is about 900 to 950 feet.

No water wells and only a few oil tests penetrate the Midway in Fayette County. The Midway generally does not yield usable quality water in significant quantities, even in its outcrop area, and is well below the base of fresh to slightly saline water in Fayette County.

Wilcox Group

Rocks of the Wilcox Group crop out in a northeast-trending belt, 9 to 15 miles wide, across northwestern Bastrop and adjoining counties. The Wilcox unconformably overlies the rocks of the Midway Group and unconformably underlies the Carrizo Sand of the Claiborne Group. The Wilcox is stratigraphically below all other aquifers in Fayette County and is the deepest rock unit containing fresh to slightly saline water.

The Wilcox consists of horizontally discontinuous beds of clay, silt, fine- to medium-grained sand and sandstone, sandy shale, and thin beds of lignite. The thickness of the Wilcox Group in Fayette County ranges from 2,400 to 3,800 feet. The depth to the top of the Wilcox Group in Fayette County ranges from 1,400 to about 6,000 feet.

Although the Wilcox Group occurs in the subsurface at varying depths throughout Fayette County, only that portion underlying the western and north western part of the county is believed to contain water of usable quality. The sands of the Wilcox Group contain fresh to slightly saline water at depths ranging from about 2,400 to over 3,800 feet in the county. The deepest fresh to slightly saline water in the Wilcox is east of Winchester and near the Lee County line. No water wells are known to penetrate the Wilcox Group in Fayette County, and the portion of the aquifer believed to contain fresh to slightly saline water is defined by interpretation of electric logs of oil tests penetrating the Wilcox.

Claiborne Group

Carrizo Sand

The Carrizo Sand crops out in a northeast band parallel to the Bastrop-Fayette County line about 4 to 5 miles wide through Bastrop and Lee Counties.

The Carrizo Sand lies unconformably on the Wilcox Group and underlies the Reklaw Formation. In the outcrop, the Carrizo is a white to gray, fine- to coarse-grained, massive sand containing abundant cross-beds and very thin laminae of carbonaceous material. Its thickness ranges from 200 to 300 feet. The top of the formation is about 500 feet below sea level in the northwest part of the county and about 5,500 feet below sea level in the southeast part of the county; the dip of the beds is variable, ranging from about 160 to over 250 feet per mile to the southeast.

Although the Carrizo is capable of yielding moderate to large quantities of water to wells, and is extensively developed in many areas of the State, it is underdeveloped in Fayette County.

Reklaw Formation

The Reklaw Formation conformably overlies the Carrizo Sand and crops out in a narrow belt, 1 to 1 1/2 miles wide, across Bastrop, Lee, Gonzales, and adjoining counties. The formation dips southeast and occurs in the subsurface throughout Fayette County.

The Reklaw consists of glauconitic sandstone interbedded with shale in the lower part of the formation and mainly clay and shale in the upper part. The thickness of the Reklaw ranges from about 225 to 400 feet in Fayette County.

In places in Fayette County the lower sands are very well developed and apparently are in hydrologic connection with the underlying Carrizo Sand. Although no wells are known to obtain water from the Reklaw in Fayette County, the lower sands probably contain fresh to slightly saline water in the northwestern part of the county.

Queen City Sand

The Queen City Sand conformably overlies the Reklaw Formation and is overlain conformably by the Weches Greensand. The Queen City crops out in Bastrop and Lee Counties and dips southeast toward the Gulf Coast at about 150 feet per mile.

The Queen City ranges from about 480 to 750 feet in thickness in Fayette County. Electric logs of oil tests penetrating the formation in Fayette County indicate that the formation consists of two or three 60-foot thick sands, usually near the top of the formation, separated by relatively thick sequences of thin sands interbedded with clay and sandy clay.

Approximately 36 water wells are known to be completed in the Queen City in Fayette County. The formation yields small to moderate quantities of water to wells in adjoining counties and provides a supply for the cities of Smithville and Giddings in adjoining Bastrop and Lee Counties, respectively. Small to moderate supplies of water could probably be developed in the northwestern part of Fayette County, but the water is very likely to be more mineralized than that from shallower formations such as the Sparta Sand and Yegua Formation.

Weches Greensand

The Weches Greensand conformably overlies the Queen City Sand and crops out in a northeast-trending belt about 1 mile wide in southeastern Bastrop County.

The Weches consists of about 75 to 150 feet of glauconitic shale with a few interbedded glauconitic sand and marl stringers. The Weches is relatively impermeable and is not known to yield water to wells in Fayette County.

Sparta Sand

The Sparta Sand is exposed in a band 1 to 2 miles wide from the west corner of Fayette County to near Smithville in Bastrop County generally paralleling the Fayette-Bastrop County line.

The Sparta Sand lies conformably on the Weches Greensand and grades upward into the sandy shale base of the Cook Mountain Formation.

The Sparta consists of fine- to medium-grained sand interbedded with a few lignitic shale beds. The thickness of the Sparta ranges from 0 to 275 feet and averages about 150 feet in Fayette County. The Sparta dips southeast at about 175 feet per mile.

The Sparta yields small to moderate quantities of fresh to moderately saline water to wells near the outcrop in western and northwestern Fayette County.

Cook Mountain Formation

The Cook Mountain Formation overlies the Sparta Sand and crops out in the extreme western and northwestern part of Fayette County. The Cook Mountain consists of clay, shale, and a few thin lenses of sandstone, limestone, glauconite, and gypsum.

The Cook Mountain ranges in thickness from 0 to 500 feet in Fayette County. The Cook Mountain is not known to yield water to wells in the county.

Yegua Formation

The Yegua Formation crops out in a 3½ to 5 mile wide band across western Fayette County. The trend of the outcrop is northeast, the median line of which extends generally from Winchester to about 2½ miles south of Elm Grove in the southwest portion of the county.

The Yegua Formation conformably and semi-gradationally overlies the Cook Mountain Formation and conformably underlies the Jackson Group. Local disconformities between the Yegua and Jackson have been observed but are not of regional extent.

The Yegua Formation consists of alternating beds of fine- to medium grained clay, silt, thin beds of lignite, and small quantities of gypsum. Thickness of the individual sand beds ranges up to 2 or 3 feet where observed but generally is much thinner. Some bentonite occurs in the upper beds.

Total thickness along the outcrop ranges from about 500 to 700 feet. Downdip in Fayette County, the thickness increases, ranging from 600 to over 1,000 feet. Over most of the area in which fresh water occurs, the total sand thickness ranges from 300 to 430 feet and is about 40 to 50 percent of the total formation thickness. The formation dips to the southeast approximately 150 feet per mile, attaining a depth of 2,800 feet below sea level at the southeast edge of the county.

The Yegua yields small to large quantities of water to wells in Fayette County for industrial, irrigation, livestock, and rural domestic purposes. All wells presently pumping from the Yegua in the county are in the outcrop or less than 4 miles downdip.

Jackson Group

The Jackson Group conformably overlies the Yegua Formation of the Claiborne Group and crops out in a band 4 to 6 miles wide trending northeast across central Fayette County. The Jackson consists mainly of clay, silt, and volcanic ash, interbedded with a few relatively thin lenticular beds of tuffaceous sandstone. The thickness of the Jackson in Fayette County ranges from 0 at the updip extent of the formation to a total thickness of from 600 to 1,100 feet. The strata comprising the Jackson Group dip toward the Gulf Coast at about 150 feet per mile, coincident with the general regional structure.

The Jackson Group yields moderate quantities of water to wells, principally for livestock and rural domestic purposes in the outcrop areas. The most productive strata consist of about 50 to 185 feet of tuffaceous sands in the uppermost part of the group. These upper Jackson sands apparently yield water of usable quality some distance downdip from the outcrop and are generally developed in conjunction with the overlying Catahoula Tuff.

Frio Clay

The Frio Clay does not crop out in Fayette County, but overlies the Jackson Group unconformably in the subsurface and is in turn overlain and overlapped by the Catahoula Tuff. The Frio Clay consists principally of clay and shale interbedded with a few thin sand beds. The Frio ranges in thickness from 0 at its updip pinchout to over 520 feet in southeast Fayette County. The Frio Clay is not known to yield water to wells in Fayette County.

Catahoula Tuff

The Catahoula Tuff overlies the upper part of the Jackson Group near its outcrop, but downdip in the southeastern part of Fayette County, the Catahoula overlies the Frio Clay which occupies a position stratigraphically between the Catahoula Tuff and the Jackson Group.

The Catahoula crops out in a belt approximately 1/2 to 4 miles wide across central Fayette County trending northeast through Flatonia, La Grange, and Carmine.

In Fayette County, the Catahoula consists of tuffaceous sand and sandstone interbedded with clay, silt, and tuff. The thickness ranges from 0 to over 500 feet. The Catahoula yields small to large quantities of water to wells in central and southeastern Fayette County for municipal, industrial, and irrigation as well as livestock and rural domestic purposes.

Oakville Sandstone and Lagarto Clay

The Oakville Sandstone overlies the Catahoula Tuff and is in turn overlain by the Lagarto Clay. The approximate outcrop areas of these units are shown on the regional geology map. Because the contact between the Oakville and Lagarto is difficult to distinguish in Fayette County, these formations are considered as a single unit in this report and are not differentiated on the county geologic map.

In general, the Oakville Sandstone consists of laterally discontinuous sand and gravel lenses interbedded with shaly sand, sandy shale, shale, and clay. Massive cross-bedded sandstone beds at the base grade upward into more thinly bedded sandy shale and clay near the top. The Lagarto Clay, in turn, consists mainly of massive clay interbedded with calcareous sand and shale.

The combined thickness of the Oakville and Lagarto ranges from 0 to over 950 feet.

The Oakville and Lagarto yield small to moderate quantities of water to wells for municipal, industrial, irrigation, livestock, and rural domestic purposes.

Alluvium

Alluvial deposits of Quaternary age in Fayette County occur as a broad band ½ to 6 miles wide coinciding generally with the flood plain of the Colorado River and along some of its major tributaries. Terrace gravel deposits, also of Quaternary age, occupy the tops of some of the hills adjoining the Colorado River flood plain, but these have not been mapped and probably are not important as a source of ground water in Fayette County.

The alluvial deposits consist of sand, gravel, black clay, sandy clay, and shale. Maximum thickness of the alluvial deposits is not known but where observed in stream cuts do not exceed 60 feet. Shallow wells completed in the alluvium yield small quantities of water for livestock and rural domestic purposes.

Natural or Artificial Recharge and Discharge

Recharge is the addition of water to an aquifer. The principal source of ground-water recharge in Fayette County is precipitation that falls on the outcrop of the various aquifers. In addition, seepage from streams and lakes located on the outcrop and possibly interformation leakage are sources of ground-water recharge. Recharge is a limiting factor in the amount of water that can be developed from an aquifer, as it must balance discharge over a long period of time or the water in storage in the aquifer will eventually be depleted. Among the factors that influence the amount of recharge received by an aquifer are: the amount and frequency of precipitation; the areal extent of the outcrop of intake area; topography, type and amount of vegetation, and the condition of soil cover in the outcrop area; and the ability of the aquifer to accept recharge and transmit it to areas of discharge. On aquifer outcrops where vegetation is dense, the removal of underbrush and non-beneficial plants will reduce evaporation and transpiration losses, making more water available for ground-water recharge.

Discharge is the loss of water from an aquifer. The discharge may be either artificial or natural. Artificial discharge takes place from flowing and pumped water wells, drainage ditches, gravel pits, and other excavations that intersect the water table. Natural discharge occurs as effluent seepage, springs, evaporation, transpiration, and interformational leakage.

Ground water moves from the areas of recharge to areas of discharge or from points of higher hydraulic head to points of lower hydraulic head. Movement is in the direction of the hydraulic gradient just as in the case of surface-water flow. Under normal artesian conditions, as in Fayette County, movement of ground water usually is in the direction of the aquifer's regional dip. Under water-table conditions, the slope of the water table and consequently the direction of ground-water movement usually is closely related to the slope of the land surface. However, for both artesian and water-table conditions, local anomalies are developed in areas of pumping and some water moves toward the point of artificial discharge. The rate of ground-water movement in an aquifer is usually very slow, being in the magnitude of a few feet to a few hundred feet per year.

Data required for this section of the Fayette County Groundwater Conservation District Management Plan is taken from the Texas Water Development Board GAM Run 23-008 dated June 12, 2023. Texas Water Development Board GAM Run 23-008 is adopted in this management plan, in its entirety, as Appendix A.

Groundwater Availability Estimates

According to *Texas Water Development Board Report 56, Availability and Quality of Ground Water In Fayette County, Texas*, computations of the amount of water that may be available from the Carrizo in Fayette County are based upon coefficients of transmissibility and storage of 40,000 gpd per foot and 0.00016, respectively. It is estimated that a maximum of 20,000 acre-feet of water per year could be induced to move through the aquifer from its recharge area to wells in Fayette County.

Data required for this section of the Fayette County Groundwater Conservation District Management Plan is found in GAM Run 21-017 MAG for GMA 12 and GAM Run 21-020 MAG for GMA 15 adopted in this management plan as Appendix C.

Table 2 shows estimated amounts of available groundwater as estimated by the Lower Colorado Regional Water Planning Group (LCRWPG) Regional Water Plan, Chapter 3, adopted January 19, 2021.

In the plan, it is stated that: "Early in the 2016-2021 regional water planning cycle, the GMAs in the LCRWPA adopted their Desired Future Condition (DFC) for their aquifers and the TWDB established the Modeled Available Groundwater (MAG) values for each aquifer. The GCDs within the PGMA had the same responsibility to adopt their DFC and establish a MAG for the aquifers in their district. If a MAG has been established for a particular aquifer, the TWDB requires that the MAG be considered the maximum amount of groundwater available for the regional water planning process. In cases where a MAG is not established for an aquifer, the local GCD or GMA representative was consulted regarding an appropriate availability volume."

Available groundwater in Fayette County, as shown in this table, is sufficient to meet all current municipal water needs, but due to large depths of water tables and locations of availability, development of some of the available water may not be economically feasible.

Table 2: Groundwater Availability Estimates in Fayette County Aquifers*

In Acre Feet/Year

Aquifer	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Gulf Coast	1,853	1,853	1,853	1,853	1,853	1,853
Carrizo-Wilcox	5,474	5,474	5,474	5,474	5,474	5,474
Queen City	2,708	2,708	2,708	2,708	2,708	2,708
Sparta	2,831	2,825	2,803	2,794	2,802	2,802
Yegua-Jackson	9,262	9,262	9,262	9,262	9,261	9,261
Other Aquifer	834	834	834	834	834	834
TOTAL	**22,962**	**22,956**	**22,934**	**22,925**	**22,932**	**22,932**

*Values in acre feet per year

Modeled Available Groundwater

Per Texas Water Code § 36.1084, Modeled Available Groundwater (MAG), for each aquifer within its jurisdiction, is provided to the Fayette County Groundwater Conservation District by the Texas Water Development Board and are calculated based on the desired future conditions adopted by the member districts of GMA 12 and GMA 15. Modeled Available Groundwater for the Fayette County Groundwater Conservation District in the following tables are taken from GAM Run 21-017 MAG: Modeled Available Groundwater for the Aquifers in Groundwater Management Area 12 and GAM Run 21-020 MAG: Modeled Available Groundwater for the Gulf Coast Aquifer System in Groundwater Management Area 15.

Table 3: Modeled Available Groundwater GMA 12 (acre feet/year)

Aquifer						
	2020	**2030**	**2040**	**2050**	**2060**	**2070**
Carrizo	5,155	5,155	5,155	5,155	5,155	5,155
Queen City	2,694	2,715	2,737	2,761	2,786	2,813
Sparta	2,765	2,779	2,783	2,796	2,828	2,853
Yegua-Jackson	9,984	9,984	9,984	9,983	9,983	9,983

Table 4: Modeled Available Groundwater GMA15 (acre feet/year)

Aquifer							
	2020	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Gulf Coast	7,168	7,394	7,683	8,011	8,387	8,660	8,590

Data required for this section of the Fayette County Groundwater Conservation District Management Plan is found in GAM Run 21-017 MAG for GMA 12 and GAM Run 21-020 MAG for GMA 15 adopted in this management plan as Appendix C.

<u>Projected Surface Water Supplies</u>

Surface water sources of Fayette County include the Colorado River, the Cedar Creek Reservoir, flood control reservoirs, and numerous small stock ponds. Among these, the Colorado River and the Cedar Creek Reservoir can be considered for any municipal use. At present, no surface water is used for municipal supply in Fayette County. The Fayette Power Plant uses water from the Cedar Creek Reservoir in its electricity generation activities. In addition to this, Colorado River provides water for small domestic uses.

Colorado River

Water quality of the Colorado River varies seasonally and along the length of the river. Since January 1984, water samples were collected and analyzed by the Lower Colorado River Authority (LCRA) Water Quality Monitoring Program for two locations on the Colorado River within Fayette County. These sampling sites are located at upstream and downstream of La Grange. The upstream sampling station is located on the Colorado River at the Highway 71 bridge and the downstream site is at the Highway 77 bridge.

Cedar Creek Reservoir

The LCRA water quality monitoring program collects and analyzes water samples from several locations of the Cedar Creek Reservoir since July 1986. One of these sampling sites is located near FM 159. This sampling site was selected for study to represent water quality of the reservoir because of the suitability of its location for an intake structure of a regional surface water system.

Surface Water Availability

Data required for this section of the Fayette County Groundwater Conservation District Management Plan is found in the Texas Water Development Board "Estimated Historical Water Use and 2022 State Water Plan Datasets: Fayette County Groundwater Conservation District", by Stephen Allen, P.G. dated June 12, 2023, adopted in this management plan as Appendix B .

Projected Surface Water and Groundwater Supply and Demand

Historical Water Usage

The Texas Water Development Board Water conducts an annual survey of ground and surface water use by municipal and industrial entities within the state of Texas. This survey collects the volume of both ground and surface water used, the source of the water, and other pertinent data from the users. The information obtained is then utilized by the Water Development Board for projects such as water use projections and resource allocation.

Data required for this section of the Fayette County Groundwater Conservation District Management Plan is found in the Texas Water Development Board "Estimated Historical Water Use and 2022 State Water Plan Datasets: Fayette County Groundwater Conservation District", by Stephen Allen, P.G. dated June 12, 2023, adopted in this management plan as Appendix B.

Population Projections

Fayette County has grown very modestly. The geographic distribution and population has remained relatively unchanged. The decline in the oil and gas exploration since the early 1980's and its distance from major population and employment centers have kept Fayette County's population relatively stable.

Fayette County has a diversified economy including livestock, poultry, crop production, power production, manufacturing industries, oil, gas and other mineral exploration, and recreation. Cattle raising and beef production is a major industry of the County. Agricultural products include grains, cotton, fruits, and vegetables.

The following total county population projections and designated water user groups (WUGs), which include the three major cities, rural water suppliers, and county-other within Fayette County, separated by river basin, were taken from Chapter 2 of the 2021 Region K Water Plan adopted by TWDB on January 19, 2021.

The three major cities in Fayette County are La Grange, Flatonia, and Schulenburg. Three other smaller cities of Fayette County are Carmine, Fayetteville, and Round Top.

Table 5: Population Projections by WUG for 2020-2070

City Name or WUG	2020	2030	2040	2050	2060	2070
Aqua WSC*	24	27	30	31	33	34
Fayette Co. WCID MH	760	803	870	926	970	1,003
Fayette WSC	4,350	4,965	5,383	5,728	5,997	6,206
La Grange	5,478	6,253	6,776	7,212	7,552	7,816
Lee County WSC*	1,435	1,638	1,775	1,889	1,979	2,047
West End WSC*	1,197	1,366	1,521	1,686	1,855	2,032
County-Other	6,241	7,166	7,743	8,192	8,522	8,744
Colorado Basin Total	**19,485**	**22,218**	**24,100**	**25,664**	**26,908**	**27,882**
Fayette WSC	282	322	349	371	389	402
Flatonia	313	357	387	412	432	446
County-Other	375	430	465	492	512	525
Guadalupe Basin Total	**970**	**1,109**	**1,201**	**1,275**	**1,333**	**1,373**
Fayette WSC	510	582	631	671	703	728
Flatonia	1,345	1,536	1,665	1,771	1,855	1,919
Schulenburg	3,147	3,592	3,894	4,143	4,339	4,490
County-Other	2,916	3,347	3,617	3,827	3,981	4,084
Lavaca Basin Total	**7,918**	**9,057**	**9,807**	**10,412**	**10,878**	**11,221**
TOTAL COUNTY	**28,373**	**32,384**	**35,108**	**37,351**	**39,119**	**40,476**

*A single asterisk next to a WUG's name denotes that the WUG is split by two or more planning regions.

Water Supply and Demand Projections

The water use categories shown in the projections below are defined by the Texas Water Development Board in *Water for Texas* and include: municipal, irrigation, livestock, steam electric, manufacturing, and mining.

Water for Texas 2007 defines municipal water use: "Municipal water use is defined as residential and commercial water use. Residential use includes single and multifamily residential household water use. Commercial use includes water for business establishments, public offices, and institutions but does not include industrial water use. Residential and commercial water uses are categorized together because both use water similarly for drinking, cleaning, sanitation, cooling, and landscape watering." Municipal use also includes subcounty groups including; cities with populations over 500 residents, utilities in unincorporated areas with water use in 2000 of 280 acre feet or greater, and unincorporated populations centers in sparsely populated counties.

The other user categories generally represent farm and industry. The agricultural water use categories (irrigation and livestock) include water used for on-farm irrigation of crops and livestock water consumption. Manufacturing water use primarily focuses on the five largest water-using industries in the state: chemicals, petroleum, paper and pulp, metals, and food processing. Mining use represents water used in the extraction of fuel and non-fuel minerals. Steam electric represents water used by the steam generating power plants – in this case, the Fayette Power Project.

Data required for this section of the Fayette County Groundwater Conservation District Management Plan is found in the Texas Water Development Board "Estimated Historical Water Use and 2022 State Water Plan Datasets: Fayette County Groundwater Conservation District", by Stephen Allen, P.G. dated June 12, 2023, adopted in this management plan as Appendix B.

Threats to Water Quality

The primary water quality issue for all of the surface water stream segments and the major groundwater aquifers in Fayette County is the increasing potential for water contamination due to nonpoint source pollution. Nonpoint source pollution is precipitation runoff that, as it flows over the land, picks up various pollutants that adhere to plants, soils, and man-made objects and, which eventually infiltrates into the groundwater table or flows into a surface water stream. As more and more land in the Colorado River watershed and aquifer recharge zones is developed, the runoff from precipitation events will pick up increasing amounts of pollution.

Another nonpoint source of pollution is the accidental spill of toxic chemicals near streams or over recharge zones that will send a concentrated pulse of contaminated water through stream segments and/or aquifers. Further, accidental subsurface contamination from activities associated with the exploration and production of oil and natural gas could cause water quality problems within the aquifers.

Public water supply groundwater wells that currently only use chlorination water treatment and domestic groundwater wells that may not treat the water before consumption, are especially vulnerable to nonpoint source pollution, as are the habitats of threatened and endangered species that live in and near springs and certain stream segments. Nonpoint sources of pollution are difficult to control and there has been increased awareness and research of this issue as well as interest in the initiation of abatement programs.

Threats to Water Quantity

The primary threat to agriculture in the Fayette County area is from external sources, such as the water shortages for irrigation that are anticipated to occur in Matagorda, Wharton, and Colorado counties during a repeat of the drought of record.

The primary water quantity issue in the Gulf Coast Aquifer is subsidence, which is the dewatering of the interlayers of clay within the aquifer as a result of over-pumping. This compaction of the clay causes a loss of water storage capacity in the aquifer, which in turn causes the land surface to sink, or subside. Once the ability of the clay to store water is gone it can never be restored. The implementation of water conservation practices and conversion to surface water sources are currently the only remedies for this situation. Saltwater intrusion from the Gulf of Mexico into the Gulf Coast Aquifer is also a potential concern due to groundwater pumping rates that are greater than the recharge rates of the aquifer.

The Carrizo-Wilcox Aquifer’s primary water quantity concern is the water-level declines anticipated through the year 2050 due to increased pumping. Groundwater withdrawals have increased an estimated 270 percent between 1988 and 1996, from 10,100 acre-feet/year to 37,200 acre-feet/year, from the mostly porous and permeable sandstone aquifer. The area in and around the Carrizo-Wilcox Aquifer is expected to see continued population growth and increases in water demand. The TWDB co-sponsored a study of the Central Texas portion of the Carrizo-Wilcox Aquifer using a computer model to assess the availability of groundwater in the area. In a meeting on July 24, 2020, Groundwater Management Area 12 members voted to have their consultants modify the Groundwater Availability Model for the central portion of the Carrizo-Wilcox, Queen City and Sparta aquifers. The modification updated the transmissivity properties of the Simsboro Aquifer in the vicinity of the Vista Ridge well field using newly obtained aquifer pumping test data. The modification resulted in relatively minor changes to the statistics of the model calibration from 1930 to 2020. This modified model (v.3.02, 2020) was reviewed and approved by TWDB staff and replaces the version 3.01 (2018) groundwater availability model for the central portion of Carrizo-Wilcox, Queen City and Sparta aquifers.

Water Level Changes

One indication of groundwater availability involves changes in water table elevations that occur over time at specific locations. The Texas Water Development Board monitors over 20 wells in Fayette County and has collected water level information on these wells for many years. The Fayette County GCD is monitoring over 30 volunteer and static water wells within the district. By comparing the yearly water level measurements of wells for many years, a general trend of rising or falling of an aquifer's water level can be determined.

Projected Water Supply Needs and Water Management Strategies for Fayette County

Demand and supply data developed as part of the Region K planning process in 2022, District records, and GMA 12 and 15 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. 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.

Projected water supply needs, for groundwater, in Fayette County for the plan period of 2020-2070 included: County-Other, Fayette in the Colorado and Lavaca river basins 2020-2070; Manufacturing, Fayette in the Lavaca River basin 2030-2070; Mining, Fayette in the Colorado River basin 2020-2030; and Schulenburg in the Lavaca River basin 2050-2070. Additionally, the primary surface water need in Fayette County for the planning period of 2020-2070 is Steam-Electric Power, Fayette in the Colorado River basin 2020-2070. Total projected water supply needs for Fayette County decrease over the 2020-2070 plan period from 5,494 AF in 2020 to 5,246 AF in 2070.

Projected water management strategies included in the 2020-2070 plan period include: Drought Management for Aqua WSC, County-Other, Fayette County WCID Monument Hill, Fayette WSC, Flatonia, La Grange, Schulenburg, and West End WSC; Expansion of Current Groundwater Supplies for County-Other and Mining; Development of New Groundwater Supplies for County-Other and Manufacturing; Municipal Conservation for Fayette County WCID Monument Hill, Flatonia, La Grange, and Schulenburg; Austin Return Flows for Steam Electric Power; and LCRA-Enhanced Municipal and Industrial Conservation for Steam-Electric Power. Total projected supply through the water management strategies increase supply from 2020-2070 from 6,902 AF in 2020 to 7,116 AF in 2070.

Data required for this section of the Fayette County Groundwater Conservation District Management Plan is found in the Texas Water Development Board "Estimated Historical Water Use and 2022 State Water Plan Datasets: Fayette County Groundwater Conservation District", by Stephen Allen, P.G. dated June 12, 2023, adopted in this management plan as Appendix B.

Desired Future Conditions

Pursuant to the requirements of Texas Water Code § 36.108, the Fayette County Groundwater Conservation District actively participates in developing the desired future conditions for the aquifers within the District's boundaries and within the boundaries of Groundwater Management Areas (GMAs) 12 and 15. In developing its desired future conditions for each aquifer within its boundaries, the Fayette County Groundwater Conservation District considers the condition of the aquifers within the management area, scientific data relevant to the development of the desired future conditions, and the results of groundwater availability modeling.

GMA 12 Desired Future Conditions

Current desired future conditions for the aquifers that lie within GMA 12 are listed in Table 6 below. Portions of the Wilcox Aquifer which underlie Fayette County have been deemed irrelevant in the district as there are no known water wells producing water from this aquifer. Should the need arise and conditions warrant management of the Wilcox Aquifer within the jurisdiction of the Fayette County Groundwater Conservation District, desired future conditions will be developed and adopted. Desired future conditions adopted by GMA 12 are the average water table drawdowns in feet measured from January 2011 to December 2070.

Table 6: Adopted Desired Future Conditions for Fayette County GCD in GMA 12

Aquifer	Average Drawdown (ft)
Carrizo	140
Queen City	73
Sparta	43
Yegua-Jackson	81

GMA 15 Desired Future Conditions

Current desired future conditions for the aquifers that lie within GMA 15 are listed in Table 7 below. Adopted desired future conditions for each county within the boundaries of GMA 15 are expressed as average drawdown between January 2000 and December 2080 in feet.

Table 7: Adopted Desired Future Conditions for Fayette County in GMA 15

Aquifer	Average Drawdown Fayette County (ft)
Gulf Coast	44

Data required for this section of the Fayette County Groundwater Conservation District Management Plan is found in GAM Run 21-017 MAG for GMA 12 and GAM Run 21-020 MAG for GMA 15 adopted in this management plan as Appendix C.

GOALS AND MANAGEMENT OBJECTIVES

Management of Groundwater Supplies

The District will manage the supply of groundwater within the District in order to conserve the resource while seeking to maintain the economic viability of all resource user groups, public and private. In consideration of the economic and cultural activities occurring within the District, the District will identify and engage in such activities and practices that, if implemented, would result in a reduction of groundwater use. An observation network shall be established and maintained in order to monitor changing storage conditions of groundwater supplies within the District. The District will make a regular assessment of water supply and groundwater storage conditions and will report those conditions to the Board and to the public. The District will undertake, as necessary, and cooperate with investigations of the groundwater resources within the District and will make the results of investigations available to the public upon adoption by the Board.

The District will adopt rules to regulate groundwater withdrawals by means of spacing and production limits. The District may deny a well construction permit or limit groundwater withdrawals in accordance with the guidelines stated in the rules of the District. In making a determination to deny a permit or limit groundwater withdrawals, the District will consider the public benefit against individual hardship after considering all appropriate testimony. The District shall pass rules specifying under what conditions the annual amount of groundwater permitted by the District for withdrawal from the aquifers located within the District may be curtailed.

The relevant factors to be considered in making a determination to deny a permit or limit groundwater withdrawals will include:

1. The purpose of the rules of the District
2. The equitable distribution of the resource
3. The economic hardship resulting from grant or denial of a permit or the terms prescribed by the permit

In pursuit of the District's mission of protecting and managing the resource, the District may require reduction of groundwater withdrawals to amounts which will not cause harm to the aquifer. To achieve this purpose, the District may, at the Board's discretion, amend or revoke any permits after notice and hearing. The determination to seek the amendment or revocation of a permit by the District will be based on aquifer conditions observed by the District. The District will enforce the terms and conditions of permits and the rules of the District by enjoining the permit holder in a court of competent jurisdiction as provided for in Section 36.102, Texas Water Code.

A contingency plan to cope with the effects of water supply deficits due to climatic or other conditions will be developed by the District and will be adopted by the Board after notice and hearing. In developing the contingency plan, the District will consider the economic effect of conservation measures upon all water resource user groups, the local implications of the degree and effect of changes in water storage conditions, the unique hydrogeologic conditions of the aquifers within the District and the appropriate conditions under which to implement the contingency plan.

The District will employ all technical resources at its disposal to evaluate the resources available within the District and to determine the effectiveness of regulatory or conservation measures. A public or private user may appeal to the Board for discretion in enforcement of the provisions of the water supply deficit contingency plan on grounds of adverse economic hardship or unique local conditions. The exercise of said discretion by the Board shall not be construed as limiting the power of the Board.

Actions, Procedures, Performance and Avoidance for Plan Implementation

The District will implement the provisions of this plan and will utilize the provisions of this plan as a guidepost for determining the direction or priority for all District activities. All operations of the District, all agreements entered into by the District and any additional planning efforts in which the District may participate will be consistent with the provisions of this plan.

The District will adopt rules relating to the permitting of wells and the production of groundwater. The rules adopted by the District shall be pursuant to Chapter 36, Texas Water Code and the provisions of this plan. All rules will be adhered to and enforced. The promulgation and enforcement of the rules will be based on the best technical evidence available. **District Rules, currently adopted and in effect, are available on the internet at:**

www.fayettecountygroundwater.com/district-rules

The District shall treat all citizens with equality. Citizens may apply to the District for discretion in enforcement of the rules on grounds of adverse economic effect or unique local conditions. In granting of discretion to any rule, the Board shall consider the potential for adverse effect on adjacent landowners. The exercise of said discretion by the Board shall not be construed as limiting the power of the Board.

The District will seek the cooperation in the implementation of this plan and the management of groundwater supplies within the District. All activities of the District will be undertaken in cooperation and coordinated with the appropriate state, regional, and local water management entities.

Methodology for Tracking District Progress in Achieving Management Goals

The District will prepare and present an annual report to the Board of Directors on District performance with regard to achieving management goals and objectives. The presentation of the report will occur within 60 days of the end of each fiscal year. The first annual report will be prepared upon completion of the year after which the management plan is approved by the Texas Water Development Board. The report will be prepared in a format that will be reflective of the performance standards listed following each management objective. The report will include the number of instances in which each of the activities specified in the District's management objectives was engaged in during the fiscal year. Each activity will be referenced to the estimated expenditure of staff time and budget in accomplishment of the activity. The notations of activity frequency, staff time and budget will be referenced to the appropriate performance standard for each management objective describing the activity, so that the effectiveness and efficiency of the District's operations may be evaluated. The Board will maintain the report on file for public inspection at the District's offices upon adoption. This methodology will apply to all management goals contained within this plan.

Goal 1 – Providing the Most Efficient Use of Groundwater

The District will manage the supply of groundwater within the District based on the District's assessment of water supply and groundwater storage conditions. The District will monitor groundwater conditions closely through water level and water quality monitoring programs and will continue to maintain and update the District's database, which was begun in 2002. Computer modeling projects may be utilized in the future which could also aid in the decision making process by this District in the management of groundwater.

The District will adopt rules to regulate groundwater withdrawals by means of spacing and production limits. In addition the District may choose to identify areas within the District which, based on its monitoring programs are potential groundwater depletion or drought sensitive areas. These areas when identified may require specific District rules to ensure that groundwater supply is maintained and protected.

Management Objective 1.1: Establish a Water Level Monitoring Program

Establish a water level monitoring network by first, identifying the wells to be monitored, and secondly, by annually measuring the depth to water in those wells; record all measurements and/or observations; enter all measurements into District's computer data base; file specific locations of wells in the District's filing system. Establish a baseline by using existing wells, preferably those for which the District already has some historical data, in all major and minor aquifers where wells are available.

Performance Standards

1.1.a. Annually report to the Board of Directors on:

- the number of water level monitoring wells for which measurements were recorded each year.
- the number of data records entered into District's data base each year.
- the number of wells in the water level measurement network each year.
- the number of wells added to the network, if required, each year.

Management Objective 1.2: Set and Enforce Maximum Allowable Production Limits

Annually, the District will investigate all reports filed by District constituents, on forms provided by the District, regarding pumpage of groundwater in excess of the maximum production allowable under the District's rules. Investigation of each occurrence shall occur within 30 days of receiving the report. Each case will be remedied in accordance with District rules.

Performance Standards

1.2.a. Annually report to the Board of Directors on:

- the number of reports investigated each year.
- the average amount of time taken to investigate reports each year.
- the number of incidents where violations occurred and violators were required to change operations to be in compliance with District rules each year.

Management Objective 1.3: Implement Well Permitting Process

Issue water well drilling permits for the drilling and completion of non-exempt water wells in the District within 30 days of application, or as soon thereafter as possible. Randomly inspect new well drilling sites to be assured that the District's completion and spacing standards are met. Send written notification to the well owner if the well fails to meet standards within 30 days of inspection. The Board will vote on final approval of the permit at the next scheduled meeting and insure that well completion standards have been met.

Performance Standards

1.3.a. Annually report to the Board of Directors on:

- the number of permits issued each year in Fayette County.
- the number of on-site inspections performed of all wells for which District staff have reason to question compliance with District rules.
- the number of permits field checked each year.
- the number of letters mailed to permit applicants requesting applicant to provide additional information or make changes to comply with District rules.
- the number of these letters which result in changes to comply with District rules and the number of cases still open at year-end.

Goal 2 - Controlling and Preventing Contamination and Waste of Groundwater

Management Objective 2.1: Establish a Water Quality Monitoring Program

The District staff will obtain water quality samples for analysis from wells within the monitoring network in order to track water quality changes in the District, and will resample a representative group of the wells sampled the previous year. The results of the tests will be published and entered in to the District's computer data base, and will be made available to the public.

Performance Standards

2.1.a. Annually report to the Board of Directors on:

- the number of samples collected and analyzed each year
- the number of previously sampled wells that were sampled in the current testing year.
- the number of analyses entered into District's computer data base each year.

Management Objective 2.2: Assure Proper Closing, Destruction, or Re-Equipping of Wells

The District staff will inspect all sites reported as being open or improperly covered in a timely manner and follow through to assure proper closing or repair.

Performance Standards

2.2.a. Annually report to the Board of Directors on:

- the number of open, improperly covered, or deteriorated wells reported and inspected each year.
- the number of letters of notification of an open hole or deteriorated well mailed to well owners and/or operators each year.
- the number of wells the District required to be closed each year.

Management Objective 2.3: Encourage Plugging of Abandoned Wells

Field inspect each reported well abandoned or replaced, and assure proper closing under Water Well Drillers' Rules or that the well is re-equipped in accordance with District rules.

Performance Standards

2.3.a. Annually report to the Board of Directors on:

- the number of reported wells abandoned or replaced each year.
- the number of reported wells destroyed and noted on the topographic map each year.
- the number of reported wells re-equipped in accordance with the District's rules each year.

Management Objective 2.4: Control and Prevention of Water Waste

The District will investigate all identified wasteful practices within a reasonable number of working days of identification or complaint received, depending upon the magnitude of the wasteful practice.

Performance Standards

2.4.a. Annually report to the Board of Directors on:

- the number of wasteful practices identified and the average number of days District personnel took to respond or investigate after identification or complaint received.
- the actions taken to resolve the identification or complaint received.

Goal 3 – Addressing Drought Conditions

Management Objective 3.1: Curtailment of Groundwater Withdrawal

The annual amount of groundwater permitted by the District for withdrawal from the portion of the aquifers located within the District may be curtailed during periods of extreme drought in the recharge zones of the aquifers or because of other conditions that cause significant declines in groundwater surface elevations. Such curtailment may be triggered by the District's Board based on the groundwater elevation measured in the District's monitoring well(s).

Performance Standards

The District shall monitor at least one well each year.

3.1.a. Annually report to the Board of Directors the number of measurements obtained from the water level monitoring network. A summary report of the water level measurement results and an analysis of any situations that may require curtailment of groundwater withdrawal will be included in the report.

3.1.b. Monitor drought conditions within the district using data from www.droughtmonitor.uni.edu or www.waterdatafortexas.org. Staff will report, at least quarterly, any changes in drought conditions within the district.

Goal 4 – Addressing Water Conservation

Management Objective 4.1: Emphasize Water Conservation Program

The District will develop and sponsor a water conservation education curriculum, available upon request for all schools within the District. The District will utilize the methodologies listed under Goal 5 in order to raise public awareness of the necessity and importance of a water conservation program.

Performance Standards

4.1.a. Annually report to the Board of Directors on:

- the number of schools where water conservation education curriculums are presented each year.
- the number of water conservation articles presented to the public via the various methodologies outlined in Goal 5.

4.1.b. Promotion of water conservation may be accomplished through articles published in the District's annual newsletter.

Goal 5 – Implementation of Public Relations and Educational Programs to Assist in Accomplishing Goals 1 through 4

Management Objective 5.1: Produce and Disseminate Annual Newsletter

At least annually, produce a newsletter for distribution to District constituents who request a free subscription, and other interested parties. Articles will strive to discuss methods to enhance and protect the quantity of usable quality ground water within the District.

Performance Standards

5.1.a. Annually document number of newsletters published.

5.1.b. Annually document the circulation of the newsletter during that year.

Management Objective 5.2: Provide News Releases to District Media

Each year, news releases discussing methods to enhance, conserve and protect the quantity of usable quality ground water are written and distributed to all print and electronic media within the District. This may also include radio public service announcements discussing methods to enhance, conserve and protect the groundwater.

Performance Standards

5.2.a. Annually document number of news releases prepared and distributed to local and regional media detailing methods to enhance and protect the quantity and quality of usable ground water within the District.

Management Objective 5.3:   Provide Public Information Boards at District Office

Each year, the District makes well information, technical reports, brochures, and other printed information available to the public in the District office.

Performance Standards

- 5.3.a. Annually document the number of publications made available to the public via the information boards.
- 5.3.b. Annually document the number of the items printed and/or photocopied for public distribution.

Management Objective 5.4:   Provide Public Information Displays at Fairs/Meetings

Each year, the District will place informative displays at regional fairs, farm shows, and professional meetings to address the protection and enhancement of usable quality groundwater in the District.

Performance Standards

- 5.4.a. Annually document the number of the displays placed at regional fairs, farm shows, and professional meetings within the District's service area.

Management Objective 5.5:   Offer Public Information Access via Internet

The District will make information about water and water conservation available to the public via its home page on the Internet. This information will be continuously updated.

Performance Standards

- 5.5.a. Annually document the number of "hits" the District web site receives.

Management Objective 5.6:   Provide Classroom Presentations

Upon request by instructors, District staff or Board members will assist area classrooms in presenting information about ground water quality, quantity, and water conservation to public school students. The District will make films and videos on a wide-range of water-related subjects available through the District office.   Eventually, the District will develop a conservation education program and its accompanying curriculum in public and/or private schools within its service area.

Performance Standards

- 5.6.a. Annually document the number of classroom presentations made or classroom and audio-visual materials provided.
- 5.6.b. Annually document the names of participating schools and any feedback from students/teachers.

Goal 6 - Addressing Desired Future Conditions of the Aquifers within the Boundaries of the Fayette County Groundwater Conservation District

Management Objective 6.1: Document meetings attended

The Fayette County Groundwater Conservation District shall actively participate in joint planning regarding the desired future conditions for the aquifers within the District's boundaries and within the boundaries of Groundwater Management Areas (GMAs) 12 and 15.

Performance Standard

6.1 a. Annually, document the number of GMA 12 and GMA 15 meetings attended

Management Objective 6.2: Report Water Level Changes

At least once every three years, the District will evaluate the water levels within the monitoring well network for each aquifer to determine whether any changes in the monitoring well levels are in conformance to the desired future conditions adopted by the District.

Performance Standard

6.2 a. At least once every three years, report to the board of directors, water well levels within the monitoring well network for each aquifer.

6.2 b. At least once every three years, report to the board of directors, any changes to the water well levels within the monitoring well network for each aquifer.

6.2 c. At least once every three years, report to the board of directors, a comparison of drawdown, if any, within the monitoring network of each aquifer and the desired future conditions set for each aquifer.

Management Objective 6.3: Report Water Production from Permitted Wells

At least once every three years, the District will, based on information submitted on the annual water use reports, calculate the total amount of groundwater produced from permitted wells and report that amount to the board of directors.

Performance Standard

6.3 a. At least once every three years, report to the board of directors, the total amount of water produced by permitted water well owners and compare that total amount to the modeled available groundwater calculated by the Texas Water Development Board based on the adopted desired future conditions of the District.

Goal 7 - Addressing Conjunctive Surface Water Management Issues

Management Objective 7.1: Participation in Regional Water Planning Efforts

Each year, the district will participate in the regional water planning process by attending the Region K water planning group meetings. By attending at least 50 percent of the Region K water planning group meetings. District staff will work to promote conservation of groundwater resources and work to coordinate with surface water entities in the district to meet water demand needs.

Performance Standard

7.1.a. Annually document all Region K water planning group meetings attended including date and location of the meeting.

Goal 8 – Addressing Natural Resource Issues Which Impact the Use and Availability of Groundwater and Which are Impacted by the Use of Groundwater

Management Objective 8.1: Report on new oil and gas activity

Staff will monitor the Railroad Commission of Texas and other appropriate databases to determine new location of oil and gas activity within the district boundaries.

Performance Standard

8.1.a. Annually report to the board of directors the number of new oil and/or gas units completed within the boundaries of Fayette County GCD.

Management Objective 8.2: Investigate complaints of contamination

The district will investigate, or refer to the proper agency, any and all complaints received from citizens of the district or district initiated complaints related to the possible contamination of surface water, groundwater, or other natural resource within the district boundaries.

Performance Standard

8.2.a. Annually report to the board the number of contamination complaints received and actions taken regarding those complaints.

Management Goals Not Applicable to the District

The Control and Prevention of Subsidence

TWDB Subsidence Report, *Identification of the Vulnerability of the Major and Minor Aquifers of Texas to Subsidence with Regard to Groundwater Pumping-TWDB Contract Number 1648302062,* by LRE Water, dated March 21, 2017, provides the following subsidence information for the aquifers underlying Fayette County:

- Carrizo – the report classifies the subsidence vulnerability (SV) of the Carrizo aquifer at well locations in Fayette County as Medium. This is based on data from three wells. (Figure 4.7, Page 4-13)
- Gulf Coast – the report classifies the SV of the Gulf Coast aquifer at well locations in Fayette County as ranging from low to medium-high. Lower well SV is found near the edge of the outcrop where the aquifer is most thin and there is less clay; higher values are found as you progress down-dip where there is more clay present in each well. (Figure 4.23, Page 4-42)
- Queen City – the report classifies the SV of the Queen City at well locations as medium-low to medium. This is based on a small number of wells on the far western edge of the county. (Figure 4.122, Page 4-193)
- Sparta – the report classifies the SV of the Sparta aquifer at well locations as generally medium-low with a few wells that appear to rate medium. (Figure 4.136, Page 4-213)
- Yegua Jackson – the report classifies the SV of the Yegua Jackson aquifer at well locations as ranging from medium-low to medium-high. The lowest values are from wells at the edges of the aquifer. (Figure 4.151, Page 4-236)

Current water levels within the district boundaries are stable, however, the district will continue to monitor water levels for response to any potential subsidence risk and will respond to any potential subsidence issues that are reported to the district.

Addressing Recharge Enhancement

This management goal is not applicable to the operations of the District as it is not appropriate and cost effective at this time.

Addressing Precipitation Enhancement

This management goal is not applicable to the operations of the District as it is not appropriate and cost effective at this time.

Addressing Brush Control

The District is supportive of activities related to brush control as it relates to the recharge of the aquifers, however, this management goal is not applicable to the operations of the District as it is not appropriate and cost effective at this time.

Addressing Rainwater Harvesting

This management goal is not applicable to the operation of the District as it is not appropriate and cost effective at this time.

Future Activities, Plans and Programs

The District is always open for suggestions which will help in the conservation and protection of water. This section of the Management Plan is provided to identify plans, programs, services, and activities the District may develop in the future. Some of the items included in this list may be in some stage of development only through the association it may have with current activities of the District. Other items may only be suggestions and never be developed. All activities, plans and programs of the District have been developed after consideration and approval of the Board based on the benefit to the residents and the financial and staff capabilities of the District. The items listed below are not in any particular order of preference or need.

- Enhance and/or develop mapping and Geographic Information System (GIS) capabilities,
- Develop groundwater modeling capabilities,
- Develop display of water quality and quantity information,
- Expand or enhance water level and water quality observation well program as needed,
- Develop additional public education programs,
- Develop additional public school education programs,
- Develop more extensive library of groundwater data,
- Develop additional exchange of information between the District and water well drillers and pump installers,
- Develop or acquire new or revised pamphlets, publications or brochures for distribution.

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RESOLUTION ADOPTING AND APPROVING THE FAYETTE COUNTY GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

WHEREAS, Texas Water Code, Chapter 36, §36.1071 requires the District to develop a comprehensive management plan which addresses the following management goals, as applicable: (1) providing the most efficient use of groundwater; (2) controlling and preventing waste of groundwater; (3) controlling and preventing subsidence; (4) addressing conjunctive surface water management issues; (5) addressing natural resource issues; (6) addressing drought conditions; and (7) addressing conservation; and

WHEREAS, The Texas Water Development Board has adopted rules concerning Groundwater Management Plan Certification, found at 31 Texas Administrative Code, Chapter 356, Subchapter A; and

WHEREAS, The Fayette County Groundwater Conservation District (the "District") was created by an Act of the 77th Legislature effective September 1, 2001 and by subsequent approval by the voters of the District, and has operated under the rights, powers, privileges, authority, functions, duties, and requirements of Chapter 36 of the Texas Water Code, other provisions of the Texas Water Code, provisions of the general law of Texas and the Texas Constitution and under sections of the Texas Administrative Code since its creation; and

WHEREAS, The Fayette County Groundwater Conservation District intends to continue to carry out the purpose for which the Texas Legislature and the people created the District; and

WHEREAS, The Texas Water Code, §36.1071(e) requires the District to identify the performance standards and management objectives under which the District will operate to achieve the management goals; and

WHEREAS, The Board of Directors of the Fayette County Groundwater Conservation District believes that the Management Plan of the District reflects the best management of the groundwater for the District and meets the requirements of §36.1071; and

WHEREAS, The Board further believes that the description of activities, programs, procedures, performance, avoidance, specifications included in the Management Plan, and proposed Rules of the District, provide performance standards and management objectives necessary to effect the Management Plan in accordance with §36.1071; and

WHEREAS, The Management Plan includes estimates of the existing total usable amount of groundwater, the amount of groundwater being used in the District on an annual basis, projected groundwater supply and demand within the District and includes estimates of the annual amount of recharge to the groundwater resources within the District and how natural and artificial recharge may be increased; and

WHEREAS, The District is preparing and reviewing proposed rules, resolutions, orders, and directives to implement this plan; and

WHEREAS, The District is fully prepared to amend and or adopt additional rules or adopt resolutions and orders or issue directives in the future as determined by the Board of Directors to address issues identified in the future; and

WHEREAS, The District is fully prepared to amend this Plan as determined by the Board of Directors as necessary and in accordance with applicable laws of this state.

NOW THEREFORE BE IT RESOLVED THAT The Board of Directors of the FAYETTE COUNTY GROUNDWATER CONSERVATION DISTRICT does hereby adopt and approve the Fayette County Groundwater Conservation District Management Plan and directs the submission of such Management Plan to the Texas Water Development Board for approval.

CONSIDERED, PASSED, APPROVED, ADOPTED, and RESOLVED, SIGNED AND DONE IN OPEN MEETING on this the ___________ day of ______________, 2024.

____

Leo J. Wick, Sr., President

____

Robert Leer, Vice President

____

Cynthia Rodibaugh, Secretary-Treasurer

____

Harvey Hayek, Director

____

Mark Heinrich, Director

ATTEST:

____

Cynthia Rodibaugh, Board Secretary

REFERENCES

Much of the information for this document was taken directly from the following sources:

Adopted Regional Water Supply Plan for the Lower Colorado Regional Water Planning Group (Region K), adopted January 19, 2021.

Adopted Management Plan for the Fayette County Groundwater Conservation District, Approved by the Texas Water Development Board on November 16, 2018.

GAM Run 23-008: Fayette County Groundwater Conservation District Management Plan, by Sofia Avendano and Ian Jones, Ph.D., P.G. dated June 12, 2023.

Estimated Historical Water Use and 2022 State Water Plan Datasets, by Stephen Allen, P.G., dated June 12, 2023.

GAM RUN 21-017 MAG: Modeled Available Groundwater for the Aquifers in Groundwater Management Area 12, by Jerry Shi, Ph.D., P.G. and Jevon Harding, P.G. dated November 1, 2022.

GAM RUN 21-020 MAG: Modeled Available Groundwater for the Gulf Coast Aquifer System in Groundwater Management Area 15, by Grayson Dowlearn, P.G. dated August 16, 2022.

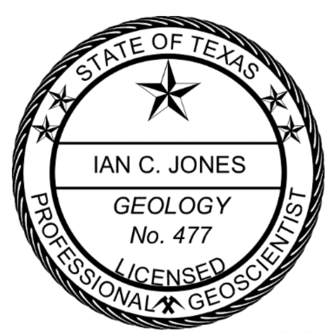
Identification of the Vulnerability of the Major and Minor Aquifers of Texas to Subsidence with Regard to Groundwater Pumping-TWDB Contract Number 1648302062, by LRE Water, dated March 21, 2017

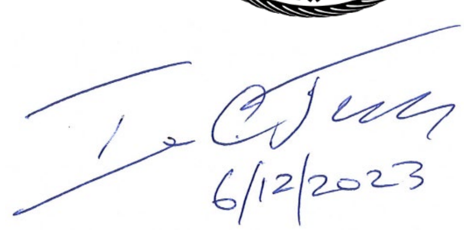
Rogers, Lowell T. 1967. *Availability and Quality of Ground Water in Fayette County, Texas.* Texas Water Development Board Report 56. August 1967. 117pp.

Appendix A

GAM RUN 23-008: FAYETTE COUNTY GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

Sofia Avendaño and Ian Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-936-6079
June 12, 2023





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GAM RUN 23-008: FAYETTE COUNTY GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

Sofia Avendaño and Ian Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-936-6079
June 12, 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 Fayette County 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 Fayette County Groundwater Conservation District should be adopted by the district on or before August 18, 2023 and submitted to the executive administrator of the TWDB on or before September 17, 2023. The current management plan for the Fayette County Groundwater Conservation District expires on November 16, 2023.

The management plan information for the aquifers within Fayette County Groundwater Conservation District was extracted from three 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 analyze the Carrizo-Wilcox, Queen City, and Sparta aquifers. We used the groundwater availability model for the Yegua-Jackson Aquifer (Deeds and others, 2010) to analyze the Yegua-Jackson Aquifer. Last, we used the groundwater availability model for the central portion of the Gulf Coast Aquifer System (Chowdhury and others, 2004) to analyze the Gulf Coast Aquifer System.

This report replaces the results of GAM Run 17-019 (Shi, 2018) because it includes results from the updated groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers. Values may also 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 5 summarize the groundwater availability model data required by statute. Figures 1, 3, 5, 7 and 9 show the area of the model from which the values in Tables 1 through 5 were extracted. Figures 2, 4, 6, 8 and 10 provide a generalized diagram of the groundwater flow components provided in Tables 1 through 5. If the Fayette County Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions after reviewing the figures, please notify the TWDB Groundwater Modeling Department 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 the provisions of the Texas Water Code § 36.1071(h), the groundwater availability models mentioned above were used to estimate information for the Fayette County Groundwater Conservation District management plan. Water budgets for the historical calibration period of the Gulf Coast Aquifer System (1981 through 1999) and the Yegua-Jackson Aquifer (1980 through 1997) groundwater availability models were extracted using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The water budgets for the historical calibration period of the Carrizo-Wilcox, Queen City and Sparta aquifers groundwater availability model were extracted using ZONEBUDGET for MODFLOW USG Version 1.0 (Panday and others, 2013). The average annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district, net cross-formation flow between aquifers, and net flow between aquifer and its equivalent portion located 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 ten layers which represent the following:
    - 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.

- The MODFLOW River package was used to simulate 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.

- The model was run with MODFLOW-USG (Panday and others, 2013).

- Water budget terms were averaged for the period 1980 through 2010 (stress periods 52 through 82).

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.

- This groundwater availability model for the Yegua-Jackson Aquifer includes five layers which represent the following:

    - 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

- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

- 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 Fayette County 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).

Gulf Coast Aquifer System

- We used version 1.01 of the groundwater availability model for the central portion of the Gulf Coast Aquifer System (Chowdhury and others, 2004) to analyze the Gulf Coast Aquifer System. See Chowdhury and others (2004) and Waterstone Environmental Hydrology and Engineering, Inc. and Parsons (2003) for assumptions and limitations of the groundwater availability model.

- The groundwater availability model for the Gulf Coast Aquifer System has four layers which represent the following:

    - 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

- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

- 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 1981 through 1999 (stress periods 3 through 87).

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the 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 Fayette County Groundwater Conservation District and averaged over the historical calibration period, as shown in Tables 1 through 5.

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 5. Figures 1, 3, 5, 7 and 9 show the area of the model from which the values in Tables 1 through 5 were extracted. Figures 2, 4, 6, 8 and 10 provide a generalized diagram of the groundwater flow components provided in Tables 1 through 5. 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 that is needed for the Fayette County 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	0
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	0
Estimated annual volume of flow into the district within each aquifer in the district	Carrizo-Wilcox Aquifer	3,165
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo-Wilcox Aquifer	1,138
Estimated net annual volume of flow between each aquifer in the district	From Carrizo-Wilcox Aquifer to Reklaw Confining Unit	345
	From Carrizo-Wilcox Aquifer to Carrizo-Wilcox equivalent units	1,829

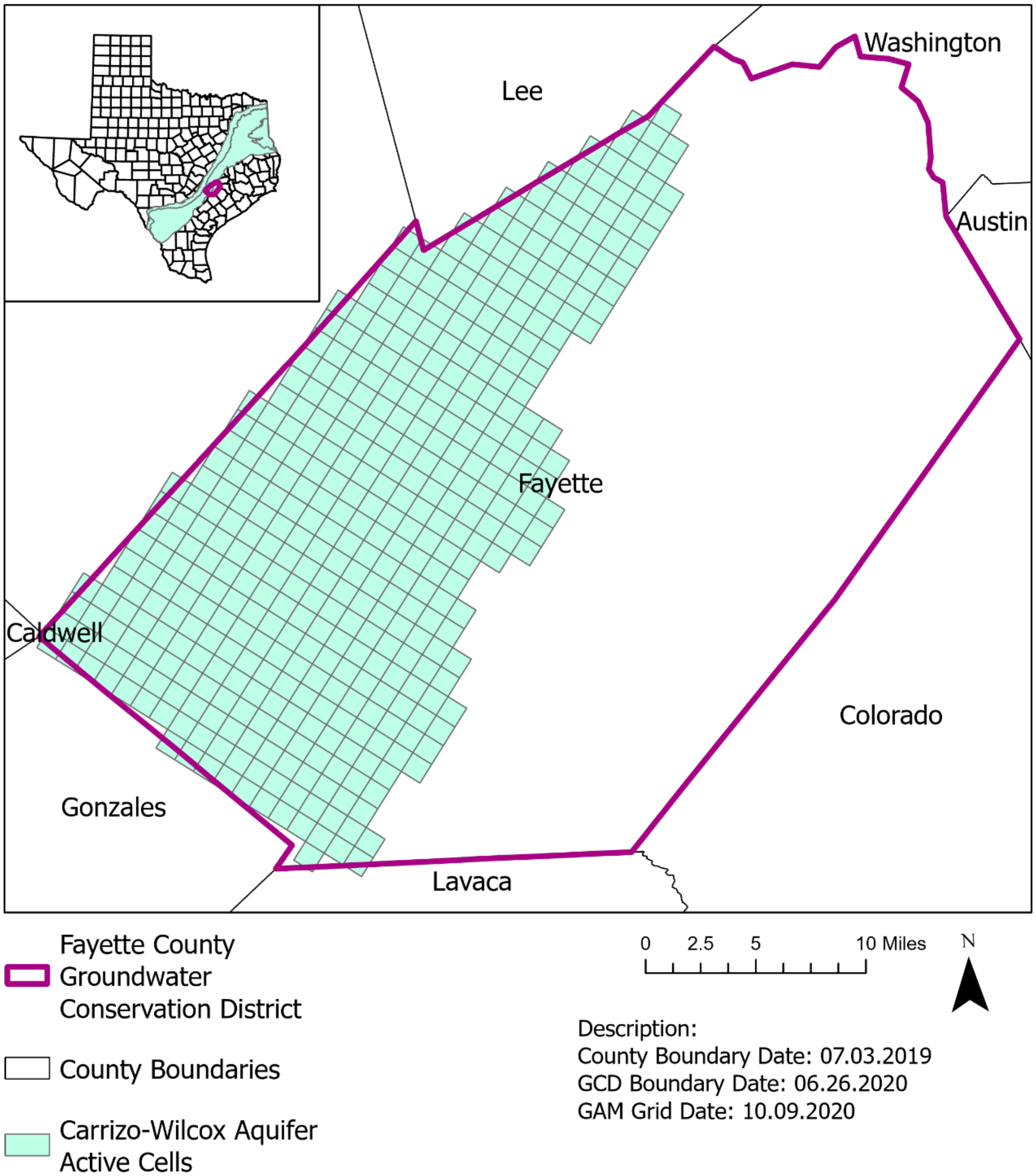
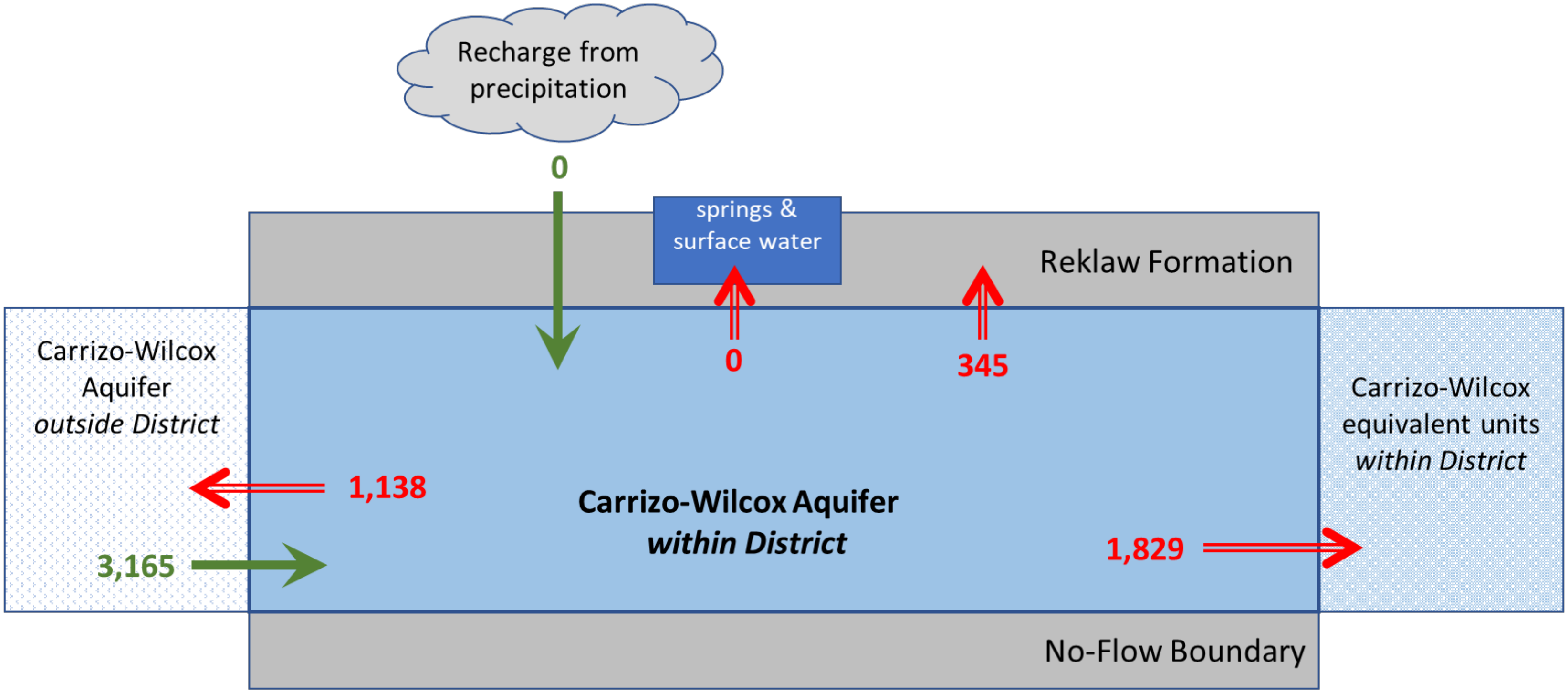


Figure 1: Area of the groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers from which the information in Table 1 was extracted (the Carrizo-Wilcox Aquifer extent within the district boundary).



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 Fayette County Groundwater Conservation District. Flow values are expressed in acre-feet per year.

Table 2: Summarized information for the Queen City Aquifer that is needed for the Fayette County 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	0
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	0
Estimated annual volume of flow into the district within each aquifer in the district	Queen City Aquifer	2,091
Estimated annual volume of flow out of the district within each aquifer in the district	Queen City Aquifer	486
Estimated net annual volume of flow between each aquifer in the district	From Queen City Aquifer to Weches Confining Unit	1,069
	To Queen City Aquifer from Reklaw Confining Unit	305
	From Queen City Aquifer to Queen City equivalent units	871

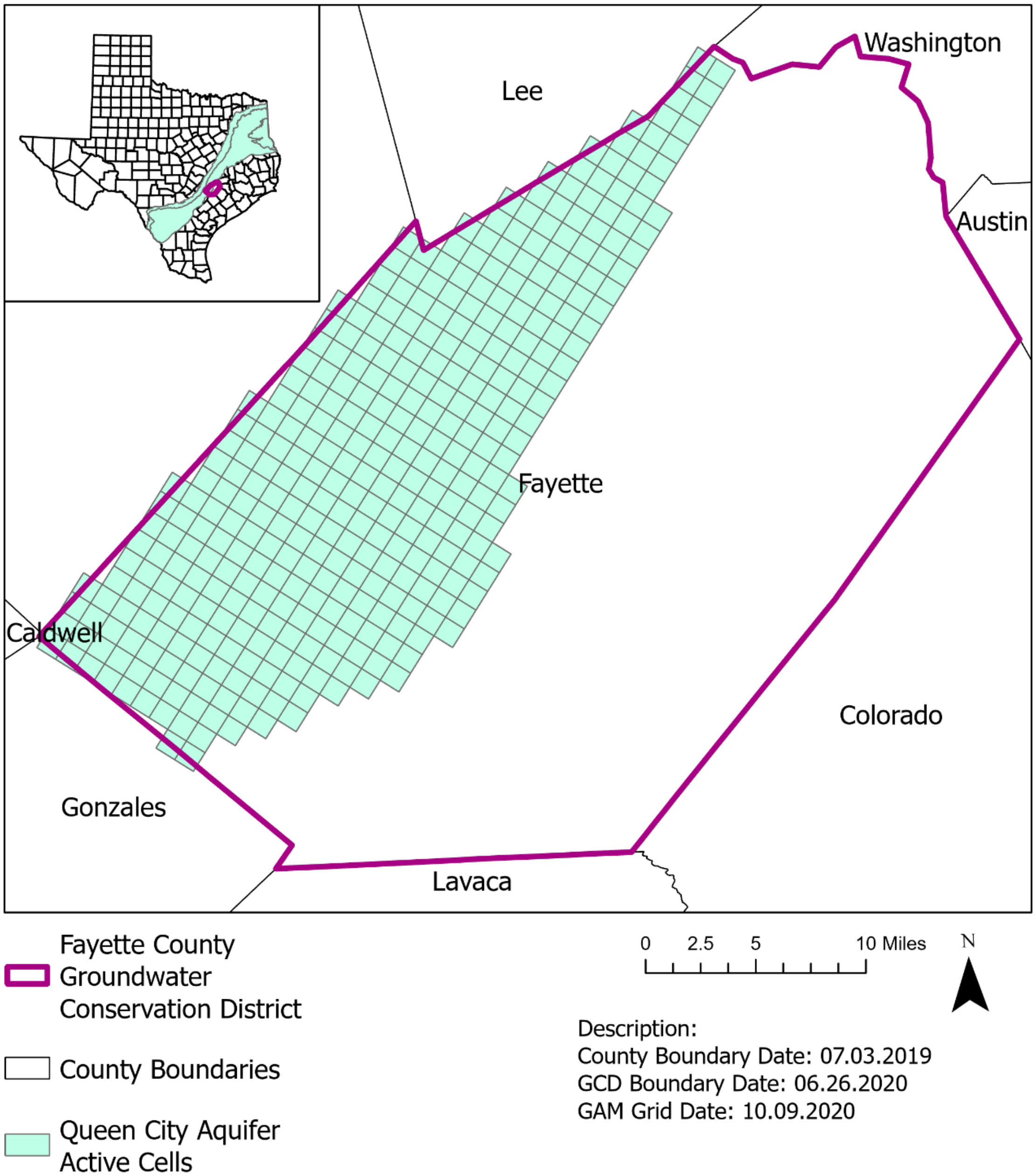
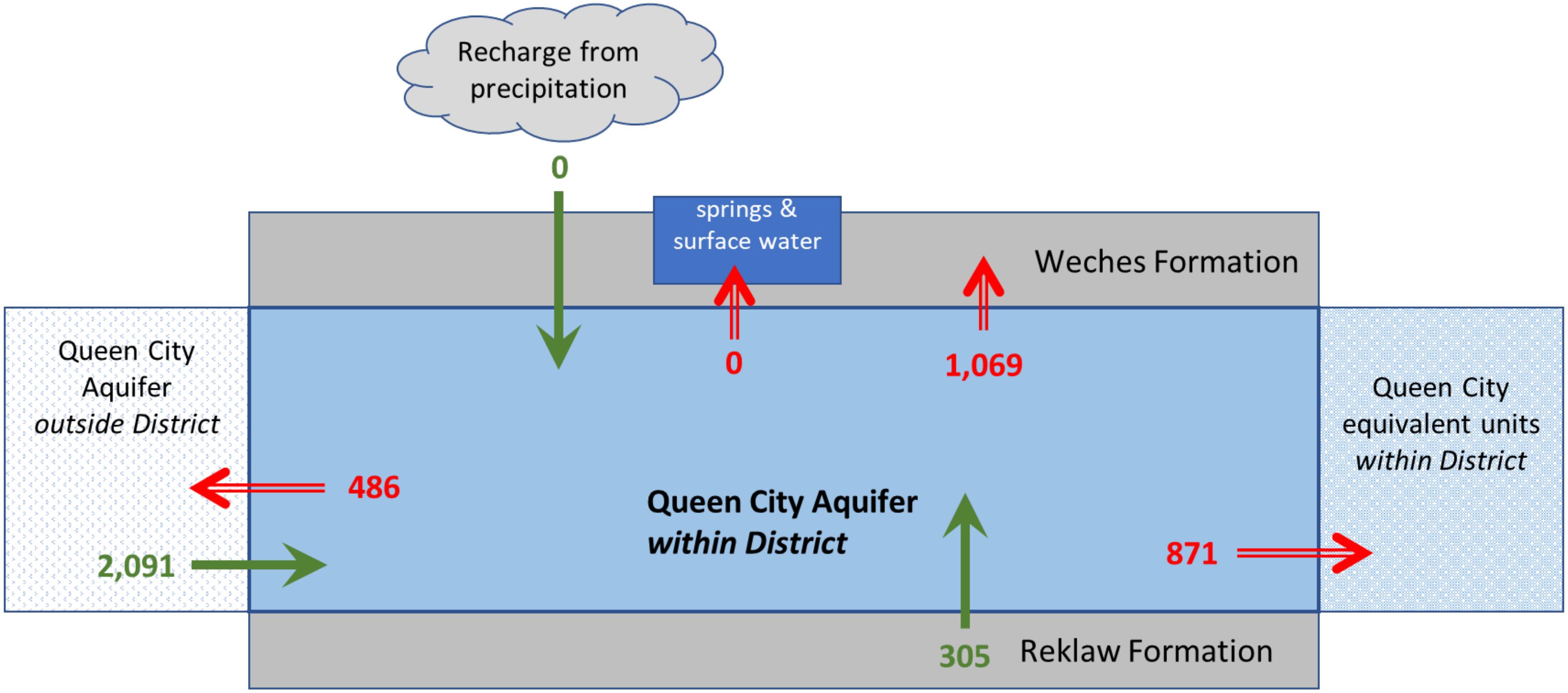


Figure 3: Area of the groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers from which the information in Table 2 was extracted (The Queen City Aquifer extent within the district boundary).



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 the Queen City Aquifer within the Fayette County Groundwater Conservation District. Flow values are expressed in acre-feet per year.

Table 3: Summarized information for the Sparta Aquifer that is needed for the Fayette County 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*	*Results*
Estimated annual amount of recharge from precipitation to the district	Sparta Aquifer	279
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Sparta Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Sparta Aquifer	1,512
Estimated annual volume of flow out of the district within each aquifer in the district	Sparta Aquifer	463
Estimated net annual volume of flow between each aquifer in the district	From Sparta Aquifer to overlying younger units	2,622
	To Sparta Aquifer from Weches Confining Unit	1,300
	From Sparta Aquifer to Sparta equivalent units	280

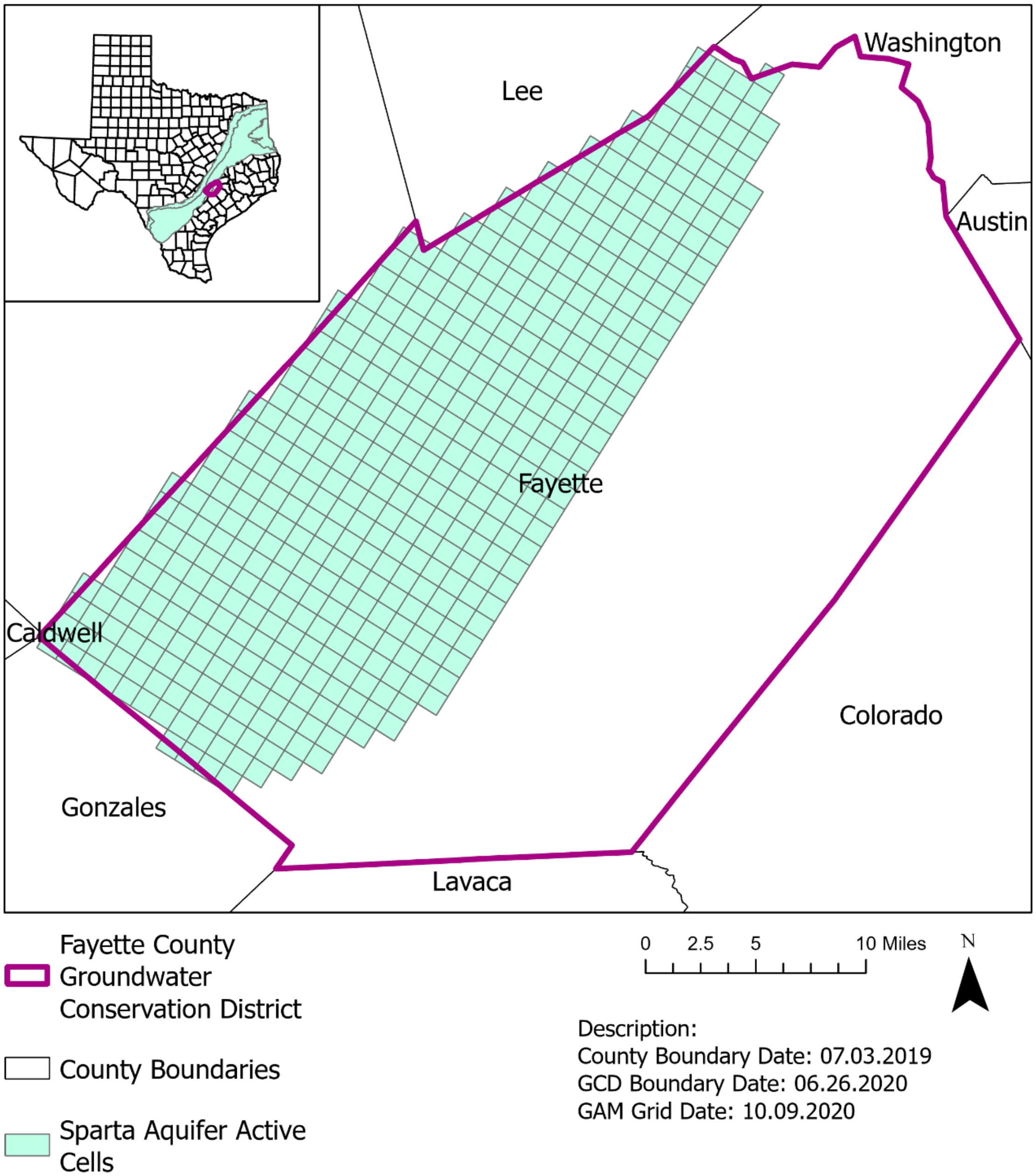
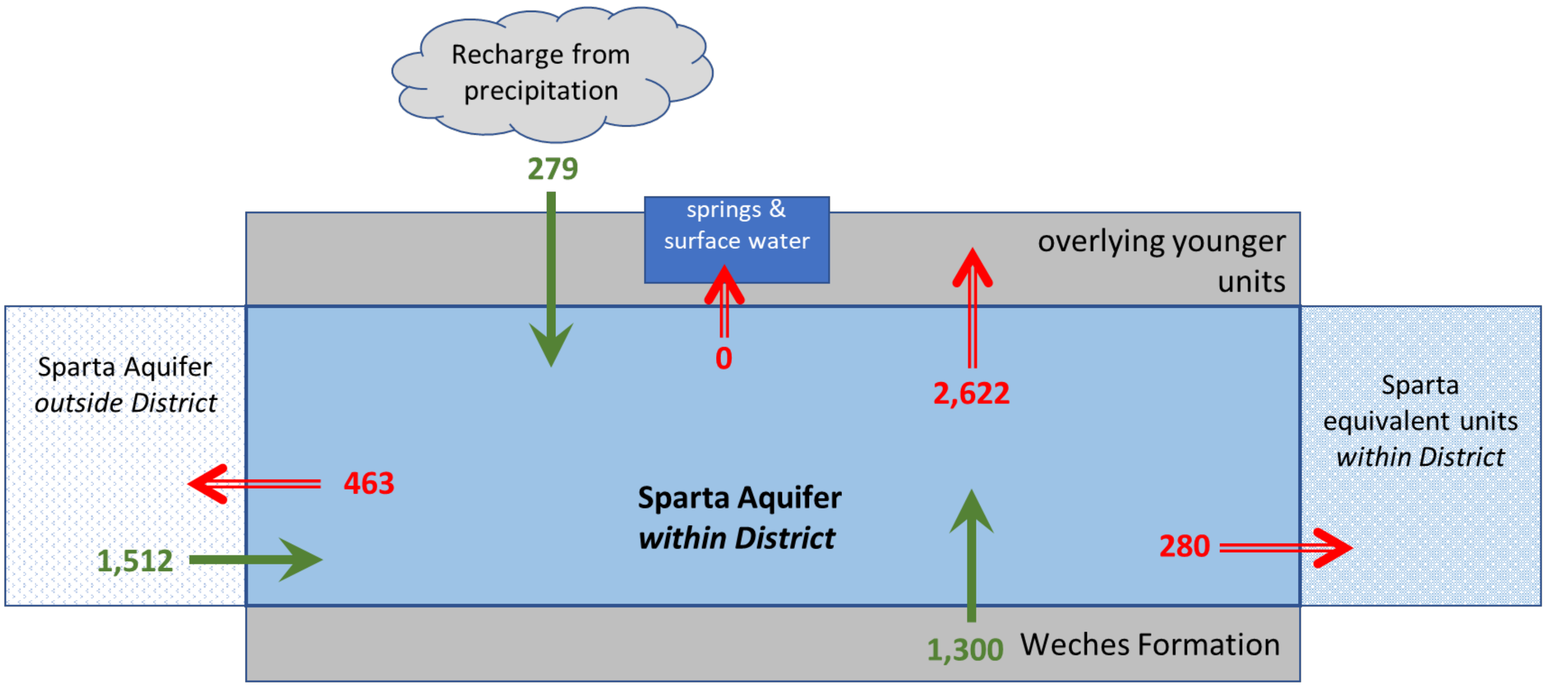


Figure 5: Area of the groundwater availability model for the central portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers from which the information in Table 3 was extracted (the Sparta Aquifer extent within the district boundary).



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 Fayette County Groundwater Conservation District. Flow values are expressed in acre-feet per year.

Table 4: Summarized information for the Yegua-Jackson Aquifer that is needed for the Fayette County 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	47,175
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	59,160
Estimated annual volume of flow into the district within each aquifer in the district	Yegua-Jackson Aquifer	10,032
Estimated annual volume of flow out of the district within each aquifer in the district	Yegua-Jackson Aquifer	7,063
Estimated net annual volume of flow between each aquifer in the district	From Yegua-Jackson Aquifer to Gulf Coast Aquifer	18
	From Yegua-Jackson Aquifer to Yegua-Jackson equivalent units	192

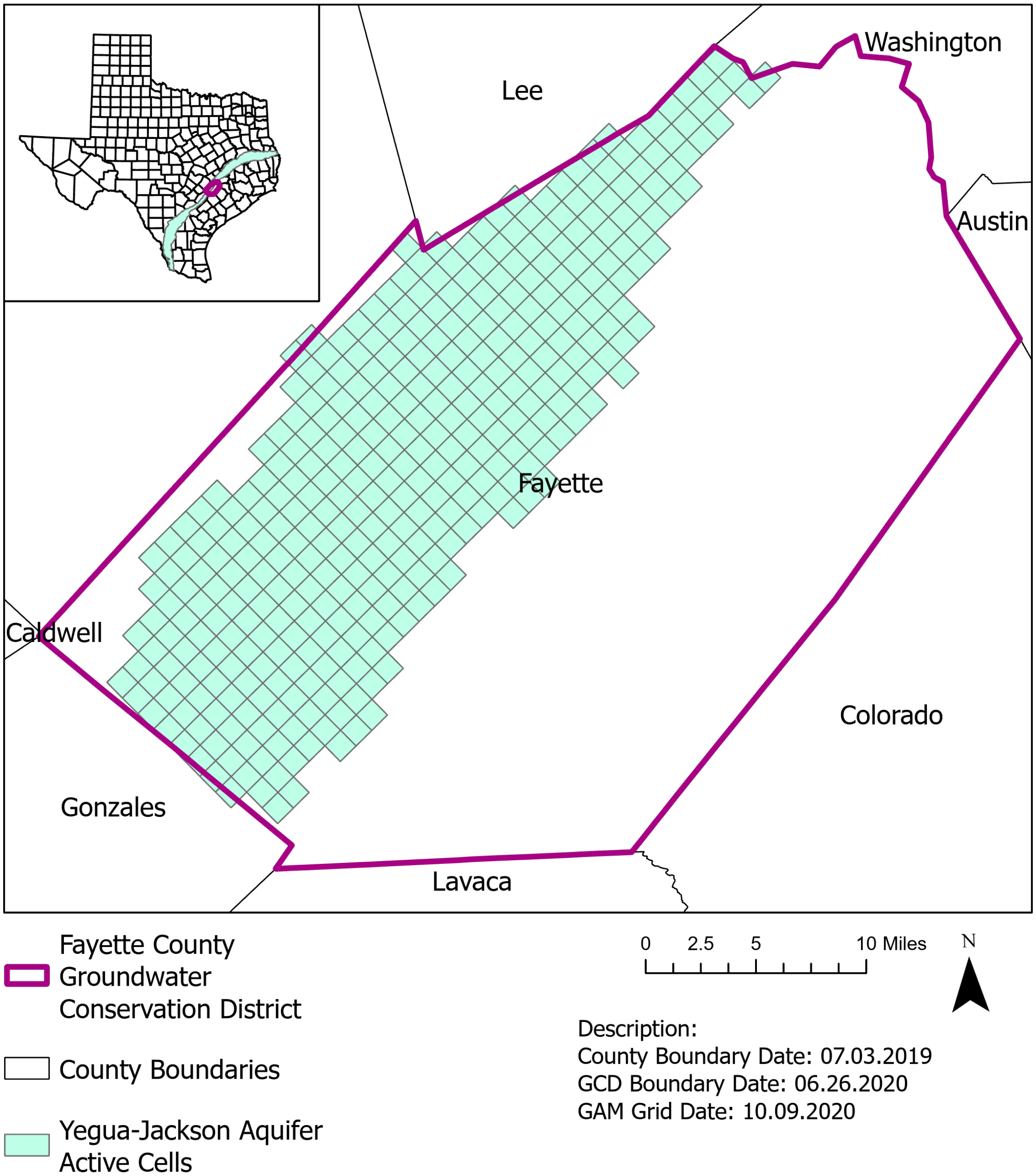
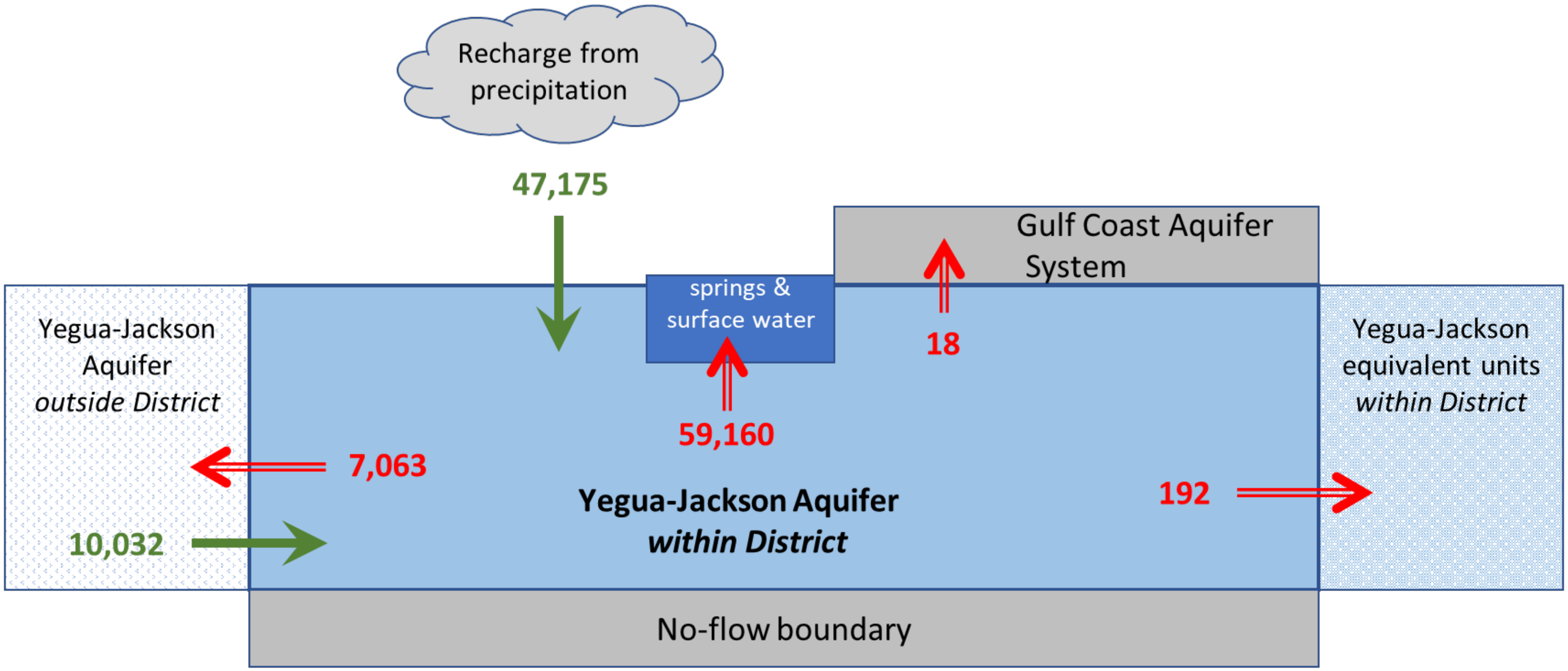


Figure 7: Area of the groundwater availability model for the Yegua-Jackson Aquifer from which the information in Table 4 was extracted (the Yegua-Jackson Aquifer extent within the district boundary).



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 Fayette County Groundwater Conservation District. Flow values are expressed in acre-feet per year.

Table 5: Summarized information for the Gulf Coast Aquifer System that is needed for the Fayette County 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	1,955
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	982
Estimated annual volume of flow into the district within each aquifer in the district	Gulf Coast Aquifer System	279
Estimated annual volume of flow out of the district within each aquifer in the district	Gulf Coast Aquifer System	1,375
Estimated net annual volume of flow between each aquifer in the district	To Gulf Coast Aquifer System from Yegua-Jackson Aquifer	18*

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

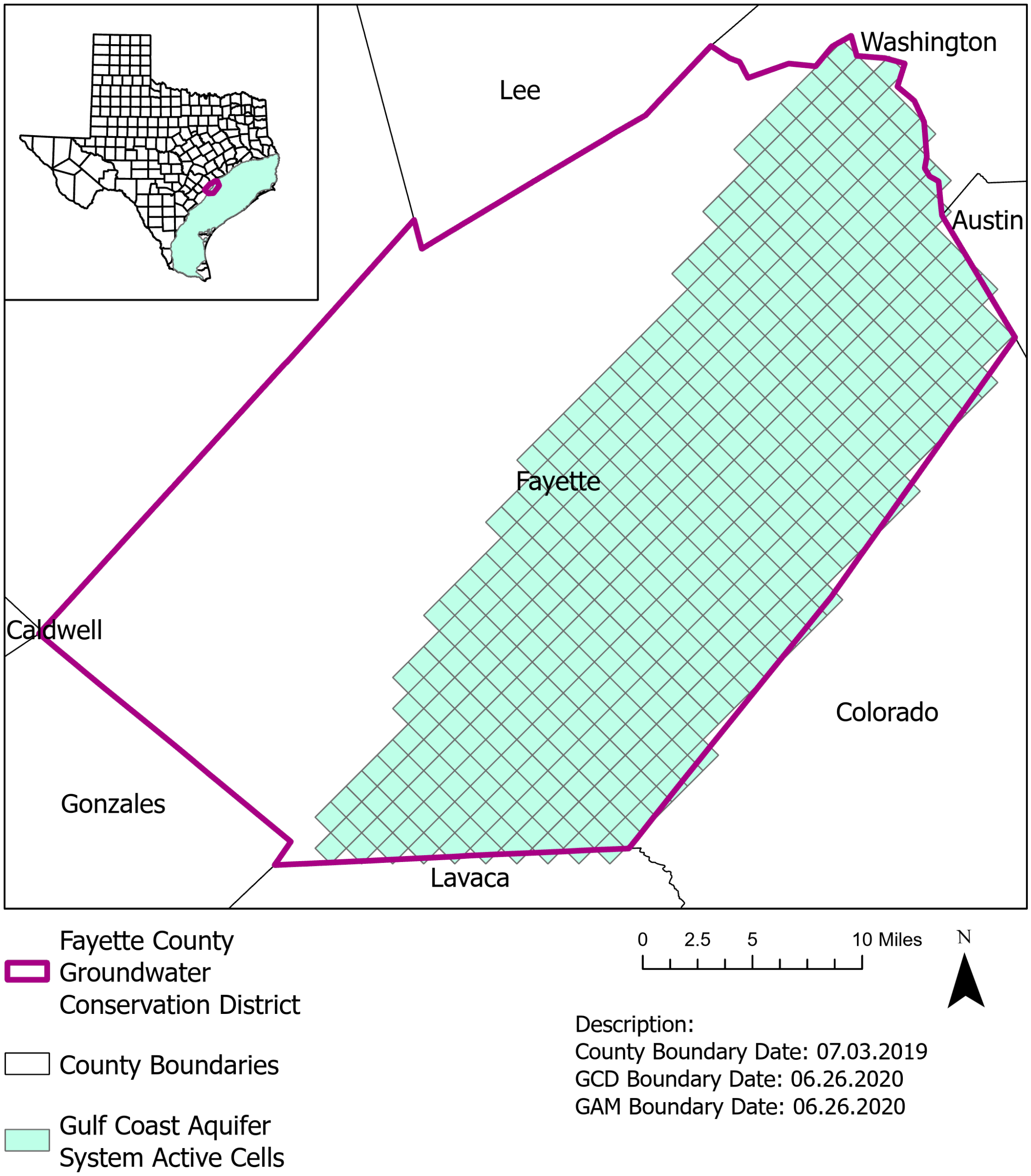
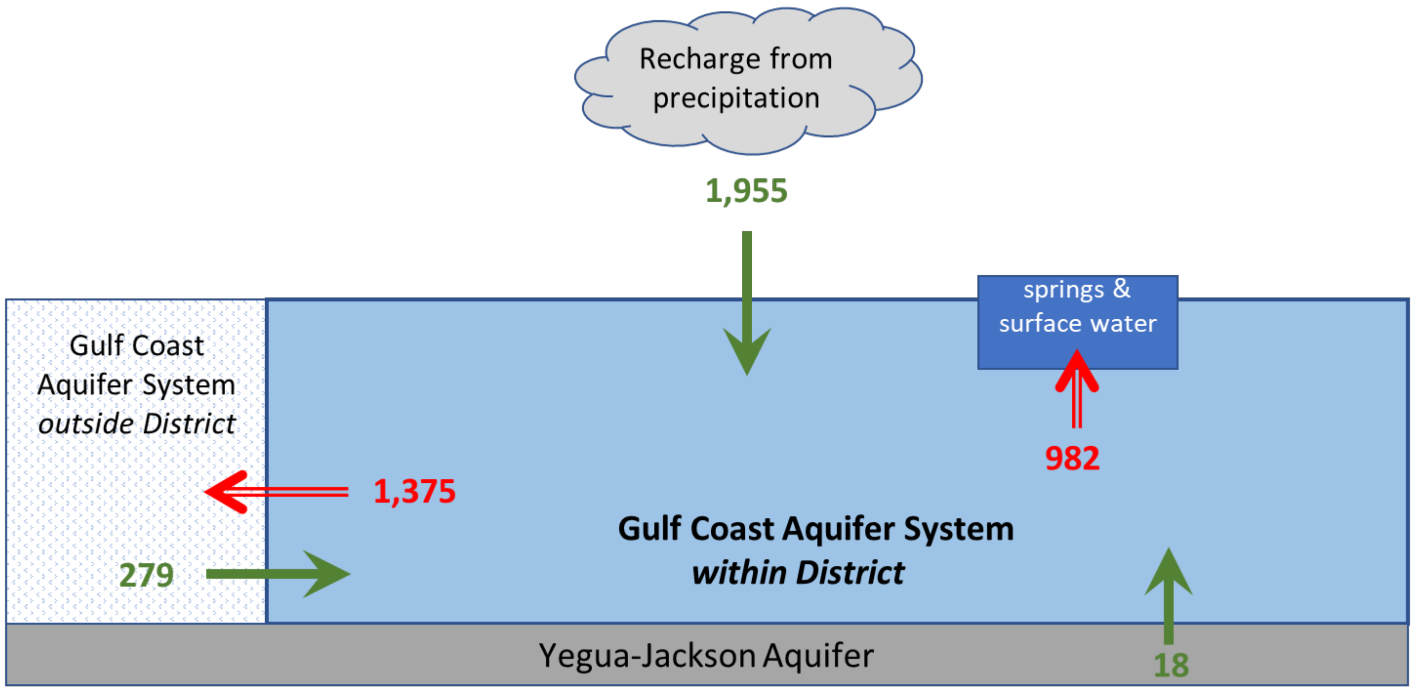


Figure 9: Area of the groundwater availability model for the central portion of the Gulf Coast Aquifer System from which the information in Table 5 was extracted (the Gulf Coast Aquifer System extent with the district boundary).



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 Fayette County 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.

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Texas Water Code § 36.1071

Appendix B

Estimated Historical Groundwater Use And 2022 State Water Plan Datasets:

Fayette County Groundwater Conservation District

Texas Water Development Board
Groundwater Division
Groundwater Technical Assistance Section
stephen.allen@twdb.texas.gov
(512) 463-7317
June 12, 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 Groundwater 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 2022 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 6/12/2023. 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 later on.

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

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2019	GW	2,655	311	679	2	842	172	4,661
	SW	0	0	75	12,899	0	1,551	14,525
2018	GW	2,615	259	349	14	732	172	4,141
	SW	0	0	38	19,059	0	1,551	20,648
2017	GW	2,577	277	122	27	859	167	4,029
	SW	0	0	14	17,428	0	1,506	18,948
2016	GW	2,683	317	87	15	702	169	3,973
	SW	0	0	10	7,832	9	1,526	9,377
2015	GW	2,858	363	194	15	378	165	3,973
	SW	0	0	22	8,696	94	1,484	10,296
2014	GW	2,924	325	461	11	423	165	4,309
	SW	0	0	51	13,939	76	1,485	15,551
2013	GW	3,190	254	178	16	418	145	4,201
	SW	0	0	20	21,577	76	1,302	22,975
2012	GW	3,131	280	67	12	1,091	167	4,748
	SW	0	0	8	14,138	76	1,503	15,725
2011	GW	3,828	285	0	9	1,579	186	5,887
	SW	0	0	0	48,669	76	1,675	50,420
2010	GW	3,157	187	31	15	200	200	3,790
	SW	0	0	93	18,797	125	1,804	20,819
2009	GW	3,291	214	65	12	424	214	4,220
	SW	0	0	77	20,552	176	1,921	22,726
2008	GW	3,255	224	59	11	0	213	3,762
	SW	0	0	62	19,135	76	1,917	21,190
2007	GW	2,659	233	39	0	376	242	3,549
	SW	0	0	0	18,789	174	2,181	21,144
2006	GW	3,357	205	47	0	730	229	4,568
	SW	0	0	0	20,742	270	2,062	23,074
2005	GW	3,123	183	3	0	869	239	4,417
	SW	0	0	0	27,923	231	2,145	30,299
2004	GW	2,836	163	10	0	724	138	3,871
	SW	0	0	0	14,390	201	2,191	16,782

Projected Surface Water Supplies
TWDB 2022 State Water Plan Data

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

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
K	County-Other, Fayette	Colorado	Highland Lakes Lake/Reservoir System	27	27	27	27	27	27
K	Irrigation, Fayette	Colorado	Colorado Run-of-River	534	534	534	534	534	534
K	Livestock, Fayette	Colorado	Colorado Livestock Local Supply	1,370	1,370	1,370	1,370	1,370	1,370
K	Livestock, Fayette	Guadalupe	Guadalupe Livestock Local Supply	142	142	142	142	142	142
K	Livestock, Fayette	Lavaca	Lavaca Livestock Local Supply	278	278	278	278	278	278
K	Steam-Electric Power, Fayette	Colorado	Colorado Run-of-River	396	396	396	396	396	396
K	Steam-Electric Power, Fayette	Colorado	Highland Lakes Lake/Reservoir System	44,516	44,516	44,516	44,516	44,516	44,516
	Sum of Projected Surface Water Supplies (acre-feet)			**47,263**	**47,263**	**47,263**	**47,263**	**47,263**	**47,263**

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.

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

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
K	Aqua WSC	Colorado	4	4	5	5	5	5
K	County-Other, Fayette	Colorado	810	897	945	988	1,025	1,052
K	County-Other, Fayette	Guadalupe	49	54	57	59	62	63
K	County-Other, Fayette	Lavaca	379	419	442	462	479	491
K	Fayette County WCID Monument Hill	Colorado	184	192	205	217	227	235
K	Fayette WSC	Colorado	610	679	725	765	799	827
K	Fayette WSC	Guadalupe	40	44	47	50	52	54
K	Fayette WSC	Lavaca	72	80	85	90	94	97
K	Flatonia	Guadalupe	65	73	78	82	86	89
K	Flatonia	Lavaca	281	313	334	353	369	381
K	Irrigation, Fayette	Colorado	521	521	521	521	521	521
K	Irrigation, Fayette	Guadalupe	83	83	83	83	83	83
K	Irrigation, Fayette	Lavaca	224	224	224	224	224	224
K	La Grange	Colorado	957	1,063	1,132	1,194	1,248	1,292
K	Lee County WSC	Colorado	182	202	215	226	236	244
K	Livestock, Fayette	Colorado	1,370	1,370	1,370	1,370	1,370	1,370
K	Livestock, Fayette	Guadalupe	78	78	78	78	78	78
K	Livestock, Fayette	Lavaca	278	278	278	278	278	278
K	Manufacturing, Fayette	Colorado	2	3	3	3	3	3
K	Manufacturing, Fayette	Lavaca	394	439	439	439	439	439
K	Mining, Fayette	Colorado	2,046	1,646	1,187	743	291	284
K	Mining, Fayette	Guadalupe	126	101	73	46	18	17
K	Mining, Fayette	Lavaca	354	285	205	129	50	49
K	Schulenburg	Lavaca	701	783	838	885	926	958
K	Steam-Electric Power, Fayette	Colorado	49,211	49,211	49,211	49,211	49,211	49,211
K	West End WSC	Colorado	130	142	153	167	183	201
		Sum of Projected Water Demands (acre-feet)	**59,151**	**59,184**	**58,933**	**58,668**	**58,357**	**58,546**

Projected Water Supply Needs
TWDB 2022 State Water Plan Data

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

FAYETTE COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
K	Aqua WSC	Colorado	0	0	0	0	0	0
K	County-Other, Fayette	Colorado	-69	-156	-204	-247	-284	-311
K	County-Other, Fayette	Guadalupe	75	70	67	65	62	61
K	County-Other, Fayette	Lavaca	-366	-406	-429	-449	-466	-478
K	Fayette County WCID Monument Hill	Colorado	51	43	30	18	8	0
K	Fayette WSC	Colorado	290	221	175	135	101	73
K	Fayette WSC	Guadalupe	110	106	103	100	98	96
K	Fayette WSC	Lavaca	29	21	16	11	7	4
K	Flatonia	Guadalupe	24	16	11	7	3	0
K	Flatonia	Lavaca	105	73	52	33	17	5
K	Irrigation, Fayette	Colorado	90	90	90	90	90	90
K	Irrigation, Fayette	Guadalupe	26	26	26	26	26	26
K	Irrigation, Fayette	Lavaca	78	78	78	78	78	78
K	La Grange	Colorado	337	231	162	100	46	2
K	Lee County WSC	Colorado	441	420	401	385	361	329
K	Livestock, Fayette	Colorado	185	185	185	185	185	185
K	Livestock, Fayette	Guadalupe	64	64	64	64	64	64
K	Livestock, Fayette	Lavaca	7	7	7	7	7	7
K	Manufacturing, Fayette	Colorado	1	0	0	0	0	0
K	Manufacturing, Fayette	Lavaca	5	-40	-40	-40	-40	-40
K	Mining, Fayette	Colorado	-760	-360	99	543	995	1,002
K	Mining, Fayette	Guadalupe	33	58	86	113	141	142
K	Mining, Fayette	Lavaca	0	0	0	55	134	135
K	Schulenburg	Lavaca	139	57	2	-45	-86	-118
K	Steam-Electric Power, Fayette	Colorado	-4,299	-4,299	-4,299	-4,299	-4,299	-4,299
K	West End WSC	Colorado	0	0	0	0	0	0
		Sum of Projected Water Supply Needs (acre-feet)	**-5,494**	**-5,261**	**-4,972**	**-5,080**	**-5,175**	**-5,246**

Projected Water Management Strategies
TWDB 2022 State Water Plan Data

FAYETTE COUNTY

WUG, Basin (RWPG)

All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Aqua WSC, Colorado (K)							
Drought Management	DEMAND REDUCTION [Fayette]	1	1	1	1	1	1
		1	**1**	**1**	**1**	**1**	**1**
County-Other, Fayette, Colorado (K)							
Drought Management	DEMAND REDUCTION [Fayette]	124	116	106	102	104	107
Expansion of Current Groundwater Supplies - Sparta Aquifer	Sparta Aquifer [Fayette]	0	40	98	145	180	204
		124	**156**	**204**	**247**	**284**	**311**
County-Other, Fayette, Guadalupe (K)							
Drought Management	DEMAND REDUCTION [Fayette]	7	7	6	6	6	6
		7	**7**	**6**	**6**	**6**	**6**
County-Other, Fayette, Lavaca (K)							
Development of New Groundwater Supplies - Sparta Aquifer	Sparta Aquifer [Fayette]	400	400	400	400	400	400
Drought Management	DEMAND REDUCTION [Fayette]	58	54	49	48	49	50
Expansion of Current Groundwater Supplies - Gulf Coast Aquifer	Gulf Coast Aquifer System [Fayette]	1	1	20	41	41	41
		459	**455**	**469**	**489**	**490**	**491**
Fayette County WCID Monument Hill, Colorado (K)							
Drought Management	DEMAND REDUCTION [Fayette]	33	32	31	30	30	31
Municipal Conservation - Fayette County WCID Monument Hill	DEMAND REDUCTION [Fayette]	17	33	50	68	75	78
		50	**65**	**81**	**98**	**105**	**109**
Fayette WSC, Colorado (K)							
Drought Management	DEMAND REDUCTION [Fayette]	122	126	128	131	136	141
		122	**126**	**128**	**131**	**136**	**141**
Fayette WSC, Guadalupe (K)							
Drought Management	DEMAND REDUCTION [Fayette]	8	8	8	9	9	9
		8	**8**	**8**	**9**	**9**	**9**
Fayette WSC, Lavaca (K)							
Drought Management	DEMAND REDUCTION [Fayette]	14	15	15	15	16	16
		14	**15**	**15**	**15**	**16**	**16**

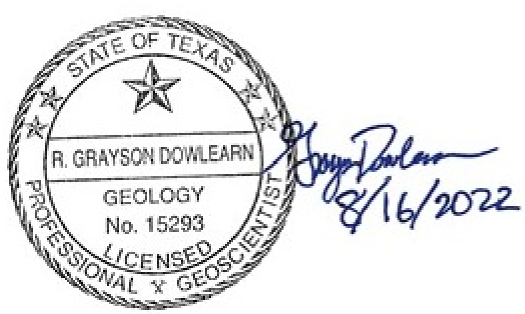
Flatonia, Guadalupe (K)							
Drought Management	DEMAND REDUCTION [Fayette]	12	12	12	13	14	14
Municipal Conservation - Flatonia	DEMAND REDUCTION [Fayette]	6	12	17	17	18	19
		18	**24**	**29**	**30**	**32**	**33**
Flatonia, Lavaca (K)							
Drought Management	DEMAND REDUCTION [Fayette]	51	53	52	56	58	60
Municipal Conservation - Flatonia	DEMAND REDUCTION [Fayette]	25	51	73	75	78	80
		76	**104**	**125**	**131**	**136**	**140**
La Grange, Colorado (K)							
Drought Management	DEMAND REDUCTION [Fayette]	174	196	213	226	237	245
Municipal Conservation - La Grange	DEMAND REDUCTION [Fayette]	86	82	69	63	64	66
		260	**278**	**282**	**289**	**301**	**311**
Lee County WSC, Colorado (K)							
Drought Management	DEMAND REDUCTION [Fayette]	25	24	23	22	23	23
		25	**24**	**23**	**22**	**23**	**23**
Manufacturing, Fayette, Lavaca (K)							
Development of New Groundwater Supplies - Yegua-Jackson Aquifer	Yegua-Jackson Aquifer [Fayette]	0	100	100	100	100	100
		0	**100**	**100**	**100**	**100**	**100**
Mining, Fayette, Colorado (K)							
Expansion of Current Groundwater Supplies - Yegua-Jackson Aquifer	Yegua-Jackson Aquifer [Fayette]	760	760	0	0	0	0
		760	**760**	**0**	**0**	**0**	**0**
Schulenburg, Lavaca (K)							
Drought Management	DEMAND REDUCTION [Fayette]	128	131	128	130	136	141
Municipal Conservation - Schulenburg	DEMAND REDUCTION [Fayette]	63	128	199	235	246	254
		191	**259**	**327**	**365**	**382**	**395**
Steam-Electric Power, Fayette, Colorado (K)							
Austin Return Flows	Indirect Reuse [Travis]	4,300	4,300	4,300	4,300	4,300	4,300
LCRA - Enhanced Municipal and Industrial Conservation	DEMAND REDUCTION [Fayette]	480	560	640	720	720	720
		4,780	**4,860**	**4,940**	**5,020**	**5,020**	**5,020**
West End WSC, Colorado (K)							
Drought Management	DEMAND REDUCTION [Fayette]	7	7	8	8	9	10
		7	**7**	**8**	**8**	**9**	**10**
Sum of Projected Water Management Strategies (acre-feet)		**6,902**	**7,249**	**6,746**	**6,961**	**7,050**	**7,116**

Appendix C

GAM RUN 21-020 MAG: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 15

Grayson Dowlearn, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Section
512-475-1552

August 16, 2022



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GAM RUN 21-020 MAG: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 15

Grayson Dowlearn, P.G.
Texas Water Development Board
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512-475-1552
August 16, 2022

EXECUTIVE SUMMARY:

Groundwater Management Area 15 adopted the desired future conditions listed in Table 1 for the Gulf Coast Aquifer System on October 14, 2021. The Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson aquifers were declared not relevant by Groundwater Management Area 15 for the purpose of joint planning. Groundwater Management Area 15 submitted model files as part of the Desired Future Conditions Explanatory Report for Groundwater Management Area 15 (Keester and others, 2021), which meet the desired future conditions adopted by the district representatives of Groundwater Management Area 15, to the Texas Water Development Board (TWDB) on December 13, 2021. The TWDB determined that the explanatory report and other materials submitted by the district representatives were administratively complete on April 22, 2022.

The modeled available groundwater values that meet the adopted desired future conditions for the Gulf Coast Aquifer System and its associated aquifers within Groundwater Management Area 15 are summarized by decade from 2020 to 2080 in Table 2 by groundwater conservation district and county. Figure 1 provides the groundwater conservation district and county boundaries within GMA 15. Table 3 provides modeled available groundwater values by decade from 2030 to 2080 summarized by county, regional water planning area, and river basin, for use in the regional water planning process. Figure 2 provides the county, regional water planning area, and river basin boundaries within Groundwater Management Area 15. Modeled available groundwater values fluctuate within Groundwater Management Area 15 over time, ranging from a maximum of 529,006 acre-feet per year in 2030 to a minimum of 522,307 acre-feet per year in 2040. The estimates were extracted from results of a model run using the groundwater availability model for the central portion of the Gulf Coast Aquifer System (Version 1.01; Chowdhury and others, 2004).

REQUESTOR:

Mr. Tim Andruss, Chair and Administrator of Groundwater Management Area 15.

DESCRIPTION OF REQUEST:

Mr. Tim Andruss provided the TWDB with the desired future conditions of the Gulf Coast Aquifer System on behalf of Groundwater Management Area (GMA) 15 in a letter dated December 10, 2021. Groundwater conservation district representatives in Groundwater Management Area 15 adopted desired future conditions for the Gulf Coast Aquifer System on October 14, 2021, as described in Resolution No. 2021-01 (Appendix 2 in Keester and others, 2021). The desired future conditions included in Table 1 are average water level drawdowns by county between January 2000 and December 2080 based on the predictive groundwater flow Scenario GMA15_2019_001_v1 (Keester and others, 2021). The predictive simulations were developed from the groundwater availability model for the Gulf Coast Aquifer System (Version 1.01; Chowdhury and others, 2004).

TABLE 1. DESIRED FUTURE CONDITIONS FOR EACH COUNTY WITHIN GROUNDWATER MANAGEMENT AREA 15 EXPRESSED AS AVERAGE DRAWDOWN BETWEEN JANUARY 2000 AND DECEMBER 2080 IN FEET SUBMITTED BY GROUNDWATER MANAGEMENT AREA 15. (ADAPTED FROM SUBMITTED RESOLUTION)

County	Aquifer	Desired future condition
Aransas	Gulf Coast Aquifer System	0
Bee	Gulf Coast Aquifer System	7
Calhoun	Gulf Coast Aquifer System	5
Colorado	Chicot and Evangeline	17
	Jasper	25
De Witt	Gulf Coast Aquifer System	17
Fayette	Gulf Coast Aquifer System	44
Goliad	Chicot	-4
	Evangeline	-2
	Burkeville	7
	Jasper	14
Jackson	Gulf Coast Aquifer System	15
Karnes	Gulf Coast Aquifer System	22
Lavaca	Gulf Coast Aquifer System	18
Matagorda	Chicot and Evangeline	11
Refugio	Gulf Coast Aquifer System	5
Victoria	Gulf Coast Aquifer System	5
Wharton	Chicot and Evangeline	15
Groundwater Management Area 15	Gulf Coast Aquifer System	13

After review of the explanatory report and model files, the TWDB was able to confirm that the submitted model files satisfactorily met the desired future conditions and did not require additional clarifications from Groundwater Management Area 15.

METHODS:

The TWDB ran the central portion of the Gulf Coast Aquifer System groundwater availability model (Version 1.01; Chowdhury and others, 2004) using the predictive model files submitted with the explanatory report (Keester and others, 2021) to calculate the drawdown and modeled available groundwater values for the Gulf Coast Aquifer System within Groundwater Management Area 15. The submitted predictive model files included the Scenario GMA15_2019_001_v1 (Keester and others, 2021) pumping file and the GAM Run 10-008 Addendum (Wade, 2010) model files extended to the year 2080. Drawdown was calculated for each county and model layer by first excluding model cells that went dry and model cells that fall outside of the official aquifer footprint, and then summing the drawdown (difference between the water levels from January 2000 [initial heads] to December 2080 [stress period 81]) in the remaining cells of each county and dividing by the number of model cells within that county. Drawdown values were compared to the desired future conditions and were determined to fall within the accepted tolerance for Groundwater Management Area 15.

Modeled available groundwater values were determined by extracting pumping rates by decade from the model results using ZONEBUDGET Version 3.01 (Harbaugh, 2009). Annual pumping rates by aquifer are presented from 2020 to 2080 by county and groundwater conservation district, subtotaled by groundwater conservation district, and summed for Groundwater Management Area 15 (Table 2). Annual pumping rates are also presented from 2030 to 2080 by county, river basin, and regional water planning area within Groundwater Management Area 15 for use in regional water planning (Table 3).

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 modeled available groundwater estimates are described below:

- Version 1.01 of the groundwater availability model for the central portion of the Gulf Coast Aquifer System by Chowdhury and others (2004) was the base model for this analysis. See Chowdhury and others (2004) for assumptions and limitations of the historical calibrated model. Keester and others (2021) constructed a predictive model simulation to extend the base model to 2080 for planning purposes. See Keester and others (2021) for assumptions of the predictive model simulation.

- The model has four layers representing the Chicot aquifer (Layer 1), the Evangeline aquifer (Layer 2), the Burkeville Confining Unit (Layer 3), and the Jasper aquifer and parts of the Catahoula Formation in direct hydrologic communication with the Jasper aquifer (Layer 4). Figures 3 to 6 show the extent of these active model layers within GMA 15.

- Pumping was not modeled in the Burkeville Confining Unit within Colorado, Matagorda, and Wharton counties and as such, this layer is excluded from the modeled available groundwater calculation in these counties.

- Pumping was not modeled in the Jasper aquifer within Matagorda and Wharton counties and as such this layer is excluded from the modeled available groundwater calculations in these counties.

- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

- Pumping volumes are reduced to zero if a cell becomes dry during the predictive model run. For this reason, the modeled available groundwater values from the ZONEBUDGET output may not match the pumping values in the input well file.

- Drawdown averages and modeled available groundwater volumes were calculated based on the extent of the official TWDB aquifer boundary. The most recent TWDB model grid file dated June 26, 2020 (glfc_c_grid_poly062620.csv) was used to determine model cell entity assignment (county, groundwater management area, groundwater conservation district, river basin, regional water planning area).

- Drawdowns for cells that became dry during the simulation were excluded from the drawdown averages. Pumping in dry cells was excluded from the modeled available groundwater calculations.

- To be consistent with Groundwater Management Area 15's assumptions (see Keester and others, 2021), a tolerance of three feet was assumed when comparing desired future conditions to modeled drawdown results for all counties except Goliad County. Goliad County was given a tolerance of ±17 feet for the Chicot aquifer, ±36 feet for the Evangeline aquifer, ±14 feet for the Burkeville Confining Unit, and ±7 feet for the Jasper aquifer. Goliad County Groundwater Conservation District plans to monitor achievement of their desired future conditions within these tolerances because they rely more heavily on their extensive monitoring program rather than modeled results.

- Estimates of modeled drawdown and available groundwater from the model simulation were rounded to whole numbers.

RESULTS:

The modeled available groundwater values for the Gulf Coast Aquifer System that achieve the desired future conditions adopted by Groundwater Management Area 15 fluctuate over time, ranging from 529,006 acre-feet per year in 2030 to 522,307 acre-feet per year in 2040. The modeled available groundwater values are summarized by groundwater conservation district and county in Table 2. Table 3 summarizes the modeled available groundwater values by county, river basin, and regional water planning area for use in the regional water planning process.

The Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson aquifers were declared not relevant for the purpose of joint planning by Groundwater Management Area 15; therefore, modeled available groundwater values were not calculated for those aquifers.

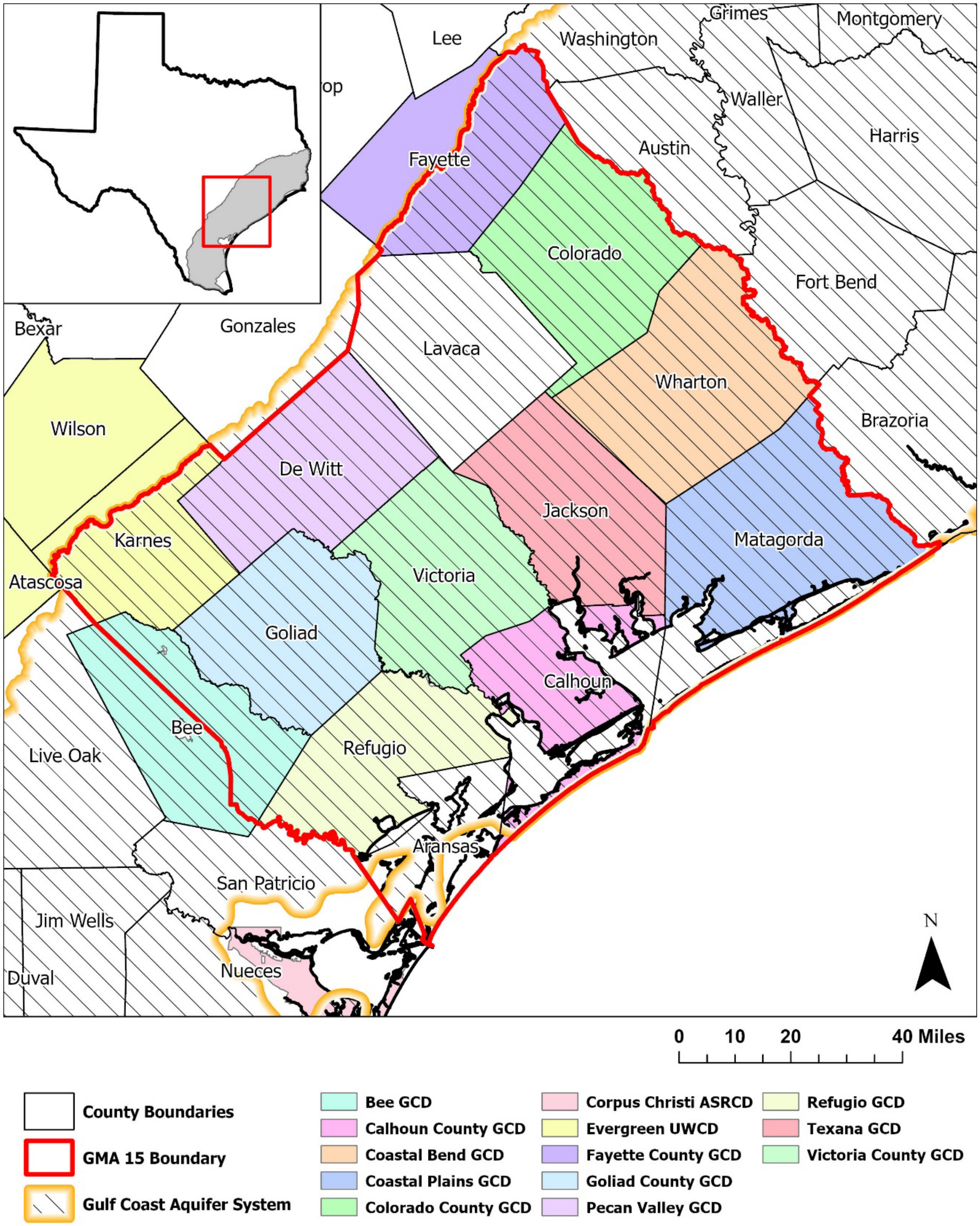

FIGURE 1. MAP SHOWING GROUNDWATER MANAGEMENT AREA (GMA) 15, GROUNDWATER CONSERVATION DISTRICTS (GCD), COUNTIES, AND THE EXTENT OF ACTIVE MODEL CELLS. (UWCD = UNDERGROUND WATER CONSERVATION DISTRICT)

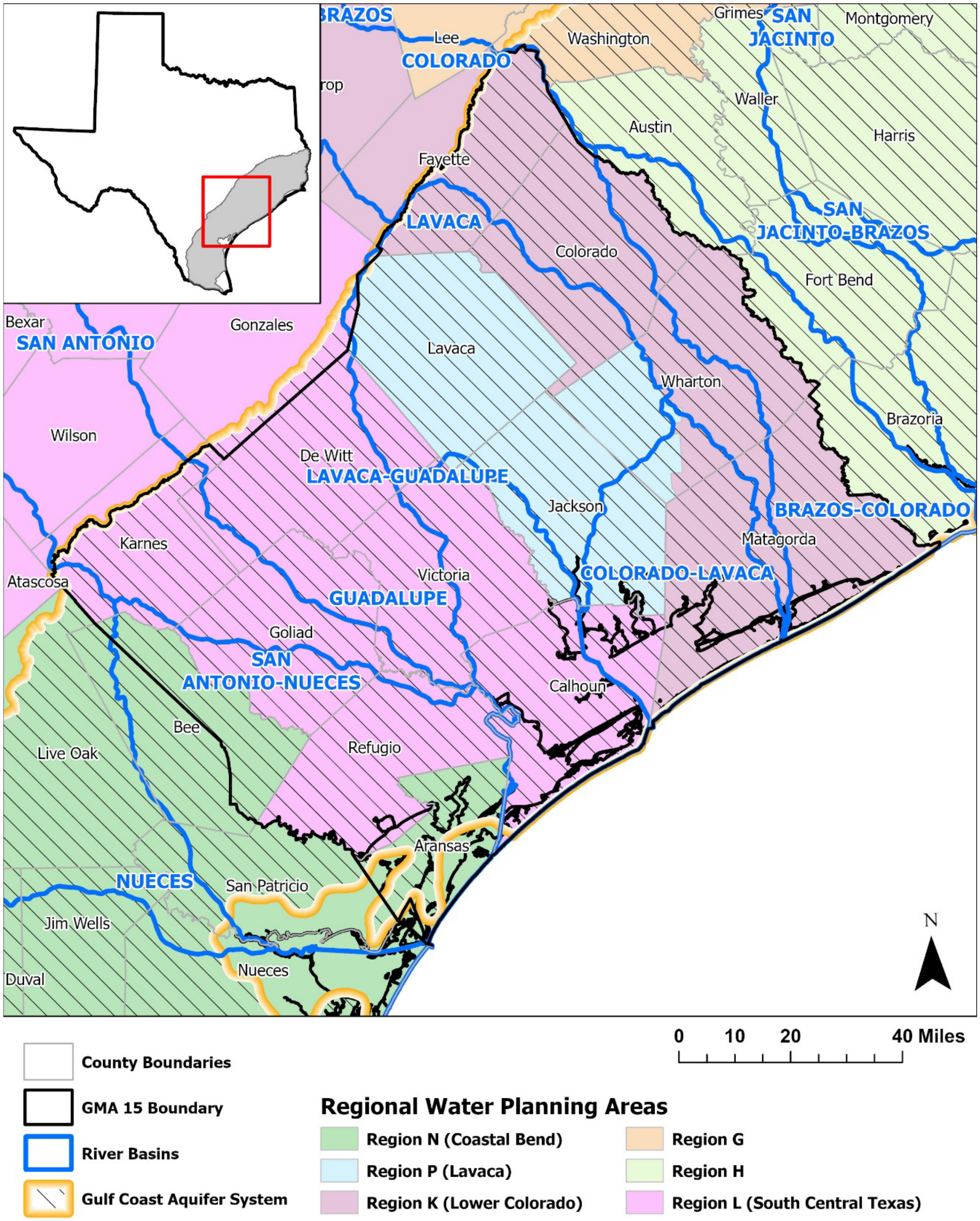

FIGURE 2. MAP SHOWING GROUNDWATER MANAGEMENT AREA (GMA) 15, REGIONAL WATER PLANNING AREAS, RIVER BASINS, COUNTIES, AND EXTENT OF ACTIVE MODEL CELLS.

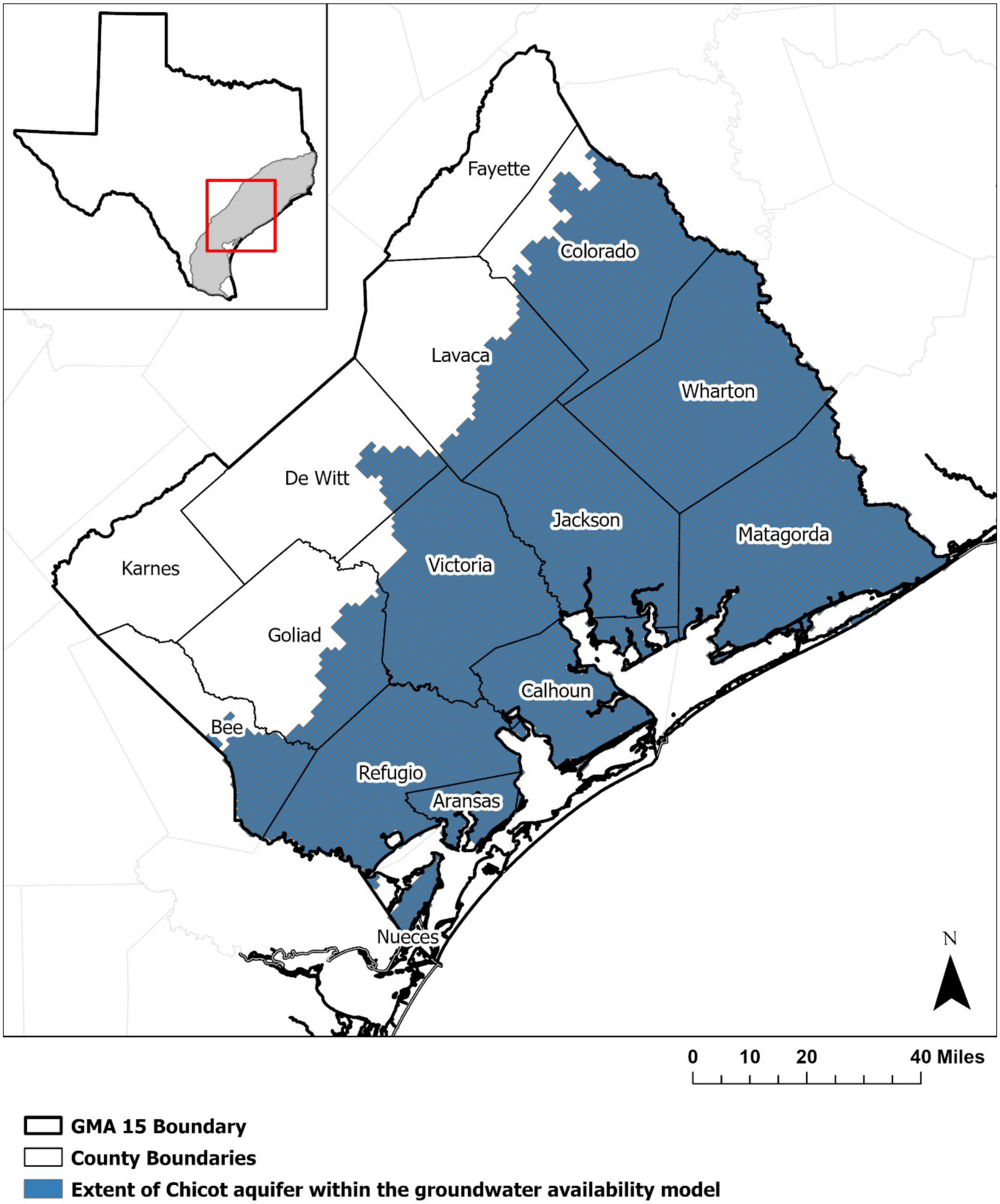

FIGURE 3. MAP SHOWING THE ACTIVE MODEL CELLS WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 15 REPRESENTING THE CHICOT AQUIFER IN LAYER 1 OF THE CENTRAL GULF COAST AQUIFER SYSTEM GROUNDWATER AVAILABILITY MODEL.

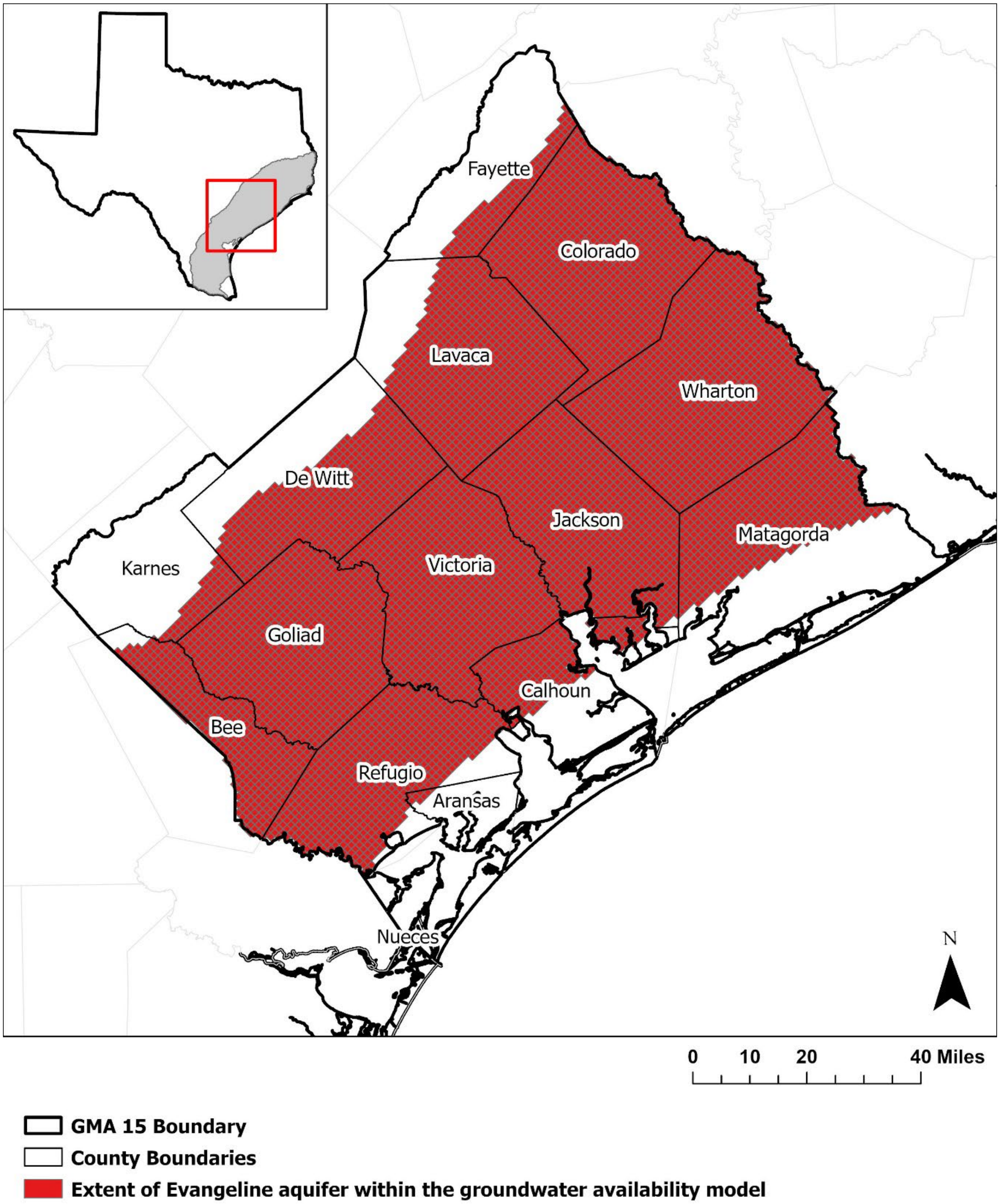

FIGURE 4. MAP SHOWING THE ACTIVE MODEL CELLS WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 15 REPRESENTING THE EVANGELINE AQUIFER IN LAYER 2 OF THE CENTRAL GULF COAST AQUIFER SYSTEM GROUNDWATER AVAILABILITY MODEL.

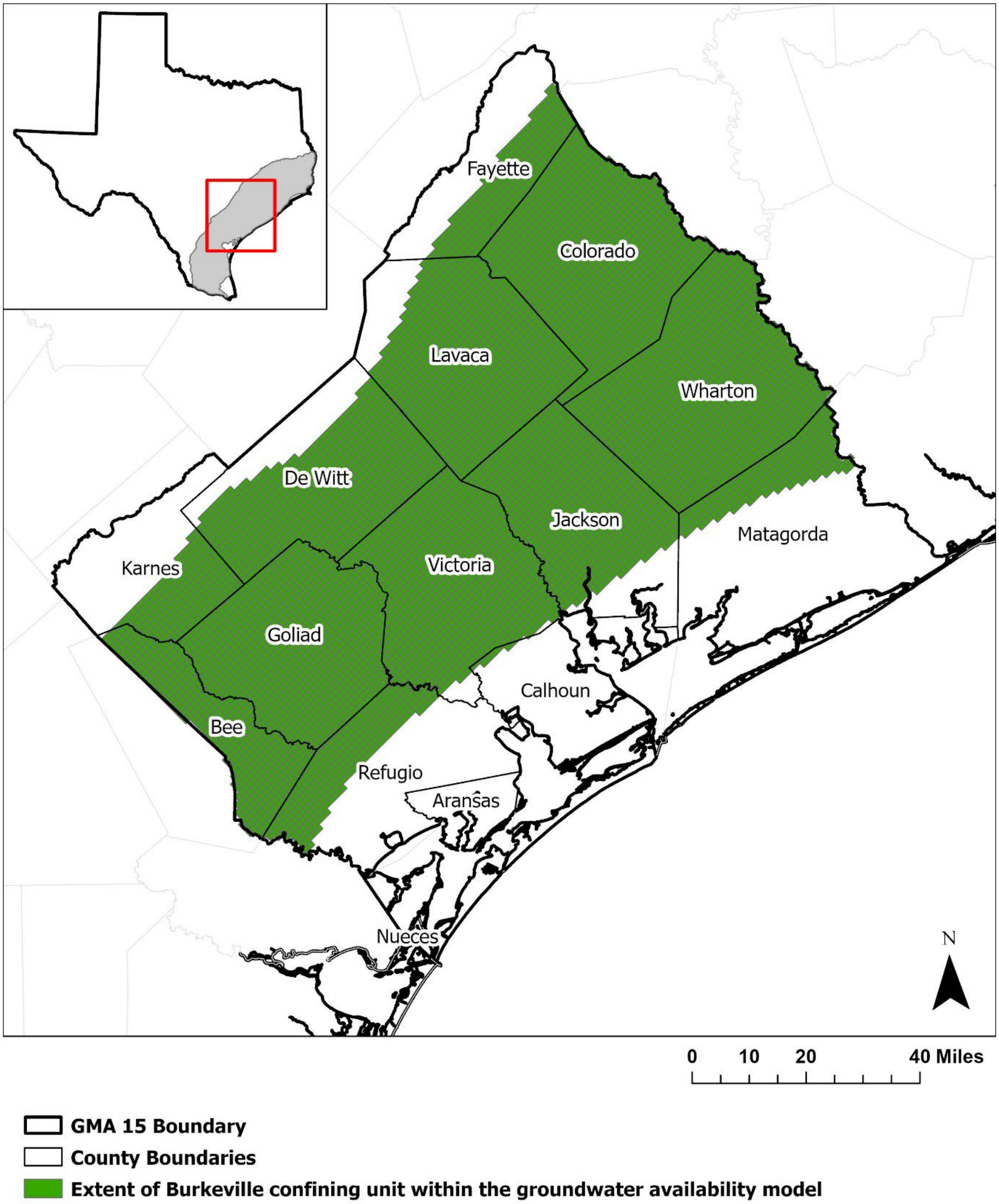

FIGURE 5. MAP SHOWING THE ACTIVE MODEL CELLS WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 15 REPRESENTING THE BURKEVILLE CONFINING UNIT IN LAYER 3 OF THE CENTRAL GULF COAST AQUIFER SYSTEM GROUNDWATER AVAILABILITY MODEL.

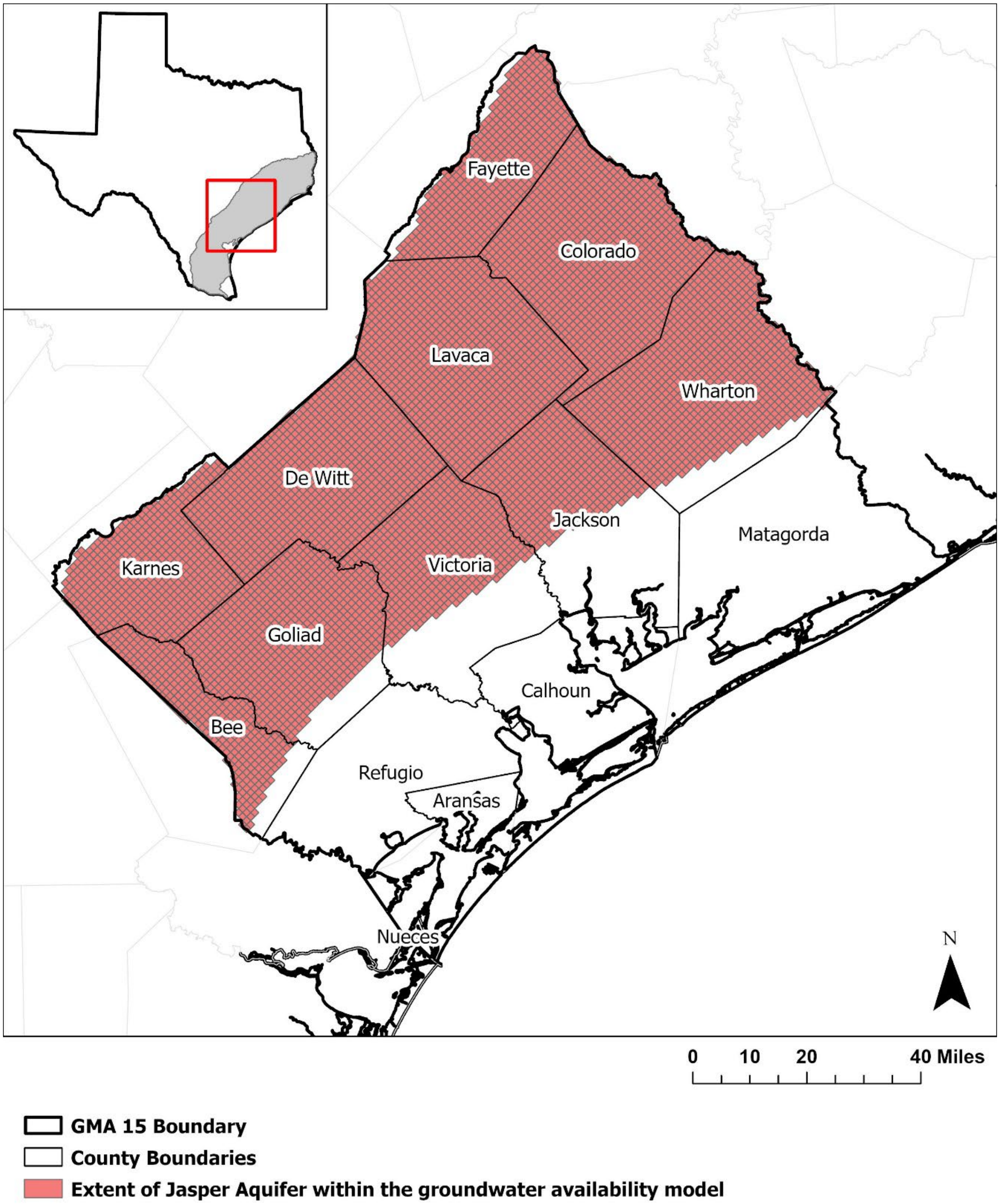

FIGURE 6. MAP SHOWING THE ACTIVE MODEL CELLS WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 15 REPRESENTING THE JASPER AQUIFER AND CATAHOULA FORMATION IN DIRECT HYDROLOGIC CONNECTION WITH THE JASPER AQUIFER IN LAYER 4 OF THE CENTRAL GULF COAST AQUIFER SYSTEM GROUNDWATER AVAILABILITY MODEL.

TABLE 2. MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 15 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR. (UWCD = UNDERGROUND WATER CONSERVATION DISTRICT; ND = NO DISTRICT))

Groundwater Conservation District	County	Portion of Gulf Coast Aquifer System	2020	2030	2040	2050	2060	2070	2080
Bee GCD	Bee	Total	8,017	8,018	8,020	8,000	8,002	8,003	7,989
Calhoun County GCD	Calhoun	Total	7,611	7,611	7,611	7,611	7,611	7,611	7,611
Coastal Bend GCD	Wharton	Chicot and Evangeline	181,446	181,446	181,446	181,446	181,446	181,446	181,446
Coastal Plains GCD	Matagorda	Chicot and Evangeline	38,892	38,892	38,892	38,892	38,892	38,892	38,892
Colorado County GCD	Colorado	Chicot and Evangeline	71,665	71,665	71,665	71,665	71,665	71,665	71,665
	Colorado	Jasper	918	918	918	918	918	918	918
Colorado County GCD Total	**Colorado**	**Total**	**72,583**	**72,583**	**72,583**	**72,583**	**72,583**	**72,583**	**72,583**
Evergreen UWCD	Karnes	Total	10,694	10,525	3,404	3,399	3,227	2,952	2,949
Fayette County GCD	Fayette	Total	7,168	7,394	7,683	8,011	8,387	8,660	8,590
Goliad County GCD	Goliad	Chicot	418	421	426	430	432	436	436
	Goliad	Evangeline	4,983	5,044	5,105	5,165	5,225	5,287	5,287
	Goliad	Burkeville	425	451	478	505	532	559	559
	Goliad	Jasper	250	338	427	515	602	690	690
Goliad County GCD Total	**Goliad**	**Total**	**6,076**	**6,254**	**6,436**	**6,615**	**6,791**	**6,972**	**6,972**
Pecan Valley GCD	DeWitt	Total	17,993	17,958	17,912	17,827	17,806	17,784	17,772
Refugio GCD	Refugio	Total	5,858	5,858	5,858	5,858	5,858	5,858	5,858
Texana GCD	Jackson	Total	90,571	90,571	90,571	90,571	90,571	90,571	90,571
Victoria County GCD	Victoria	Total	59,948	59,948	59,948	59,948	59,948	59,948	59,948
Total (GCDs)		**Total**	**506,857**	**507,058**	**500,364**	**500,761**	**501,122**	**501,280**	**501,181**

TABLE 2. CONTINUED: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 15 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2080. VALUES ARE IN ACRE-FEET PER YEAR. (UWCD = UNDERGROUND WATER CONSERVATION DISTRICT; ND = NO DISTRICT))

Groundwater Conservation District	County	Portion of Gulf Coast Aquifer System	2020	2030	2040	2050	2060	2070	2080
ND Aransas	Aransas	Total	1,547	1,547	1,547	1,547	1,547	1,547	1,547
ND Bee	Bee	Total	9	9	9	9	9	9	9
ND Lavaca	Lavaca	Total	20,384	20,384	20,379	20,379	20,372	20,368	20,350
ND Refugio	Refugio	Total	8	8	8	8	8	8	8
No District-County Total		**Total**	**21,948**	**21,948**	**21,943**	**21,943**	**21,936**	**21,932**	**21,914**
GMA 15 Total		**Total**	**528,805**	**529,006**	**522,307**	**522,704**	**523,058**	**523,212**	**523,095**

TABLE 3. MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 15. RESULTS ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE FROM 2030 TO 2080. VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Portion of Gulf Coast Aquifer System	2030	2040	2050	2060	2070	2080
Aransas	N	San Antonio-Nueces	Total	1,547	1,547	1,547	1,547	1,547	1,547
Bee	N	Nueces	Total	26	26	26	26	26	26
	N	San Antonio-Nueces	Total	8,001	8,003	7,983	7,985	7,986	7,972
Calhoun	L	Colorado-Lavaca	Total	5,221	5,221	5,221	5,221	5,221	5,221
	L	Guadalupe	Total	18	18	18	18	18	18
	L	Lavaca-Guadalupe	Total	2,365	2,365	2,365	2,365	2,365	2,365
	L	San Antonio-Nueces	Total	7	7	7	7	7	7
Colorado	K	Brazos-Colorado	Chicot and Evangeline	15,352	15,352	15,352	15,352	15,352	15,352
	K	Colorado	Chicot and Evangeline	20,079	20,079	20,079	20,079	20,079	20,079
	K	Lavaca	Chicot and Evangeline	36,234	36,234	36,234	36,234	36,234	36,234
	K	Brazos-Colorado	Jasper	49	49	49	49	49	49
	K	Colorado	Jasper	273	273	273	273	273	273
	K	Lavaca	Jasper	596	596	596	596	596	596
DeWitt	L	Guadalupe	Total	14,055	14,042	13,966	13,946	13,927	13,917
	L	Lavaca	Total	2,638	2,626	2,620	2,620	2,620	2,620
	L	Lavaca-Guadalupe	Total	298	298	298	298	298	298
	L	San Antonio	Total	967	946	943	942	939	937
Fayette	K	Brazos	Total	19	21	22	24	26	26
	K	Colorado	Total	4,894	5,041	5,196	5,370	5,406	5,392
	K	Lavaca	Total	2,481	2,621	2,793	2,993	3,228	3,172

TABLE 3. CONTINUED: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 15. RESULTS ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE FROM 2030 TO 2080. VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Portion of Gulf Coast Aquifer System	2030	2040	2050	2060	2070	2080
Goliad	L	Guadalupe	Chicot	10	11	11	11	11	11
	L	San Antonio	Chicot	136	137	139	140	141	141
	L	San Antonio-Nueces	Chicot	275	278	280	281	284	284
	L	Guadalupe	Evangeline	2,056	2,081	2,105	2,129	2,155	2,155
	L	San Antonio	Evangeline	2,660	2,692	2,724	2,755	2,788	2,788
	L	San Antonio-Nueces	Evangeline	328	332	336	341	344	344
	L	Guadalupe	Burkeville	0	0	0	0	0	0
	L	San Antonio	Burkeville	451	478	505	532	559	559
	L	San Antonio-Nueces	Burkeville	0	0	0	0	0	0
	L	Guadalupe	Jasper	0	1	1	1	1	1
	L	San Antonio	Jasper	338	426	514	601	689	689
	L	San Antonio-Nueces	Jasper	0	0	0	0	0	0
Jackson	P	Colorado-Lavaca	Total	28,157	28,157	28,157	28,157	28,157	28,157
	P	Lavaca	Total	49,484	49,484	49,484	49,484	49,484	49,484
	P	Lavaca-Guadalupe	Total	12,930	12,930	12,930	12,930	12,930	12,930
Karnes	L	Guadalupe	Total	18	18	18	18	18	18
	L	Nueces	Total	1,059	79	79	79	79	79
	L	San Antonio	Total	9,362	3,221	3,217	3,050	2,781	2,780
	L	San Antonio-Nueces	Total	86	86	85	80	74	72
Lavaca	P	Guadalupe	Total	41	41	41	41	41	41
	P	Lavaca	Total	19,942	19,937	19,937	19,930	19,926	19,908
	P	Lavaca-Guadalupe	Total	401	401	401	401	401	401
Matagorda	K	Brazos-Colorado	Chicot and Evangeline	15,321	15,321	15,321	15,321	15,321	15,321

TABLE 3. CONTINUED: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 15. RESULTS ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE FROM 2030 TO 2080. VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Portion of Gulf Coast Aquifer System	2030	2040	2050	2060	2070	2080
	K	Colorado	Chicot and Evangeline	3,219	3,219	3,219	3,219	3,219	3,219
	K	Colorado-Lavaca	Chicot and Evangeline	20,352	20,352	20,352	20,352	20,352	20,352
Refugio	L	San Antonio	Total	329	329	329	329	329	329
	L	San Antonio-Nueces	Total	5,537	5,537	5,537	5,537	5,537	5,537
Victoria	L	Guadalupe	Total	27,611	27,611	27,611	27,611	27,611	27,611
	L	Lavaca	Total	234	234	234	234	234	234
	L	Lavaca-Guadalupe	Total	30,421	30,421	30,421	30,421	30,421	30,421
	L	San Antonio	Total	1,682	1,682	1,682	1,682	1,682	1,682
Wharton	K	Brazos-Colorado	Chicot and Evangeline	50,560	50,560	50,560	50,560	50,560	50,560
	K	Colorado	Chicot and Evangeline	35,934	35,934	35,934	35,934	35,934	35,934
	K	Colorado-Lavaca	Chicot and Evangeline	16,207	16,207	16,207	16,207	16,207	16,207
	K	Lavaca	Chicot and Evangeline	579	579	579	579	579	579
	P	Colorado	Chicot and Evangeline	874	874	874	874	874	874
	P	Colorado-Lavaca	Chicot and Evangeline	14,100	14,100	14,100	14,100	14,100	14,100
	P	Lavaca	Chicot and Evangeline	63,193	63,193	63,193	63,193	63,193	63,193
GMA 15 Total				**529,007**	**522,308**	**522,705**	**523,059**	**523,213**	**523,096**

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.

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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 document is released for the purpose of interim review under the authority of Jerry Shi, P.G. 11113 on November 1, 2022. Materials and findings are subject to change and should not be applied for public use until the work is finalized.

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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.

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

11/3/2022

Date

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
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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.

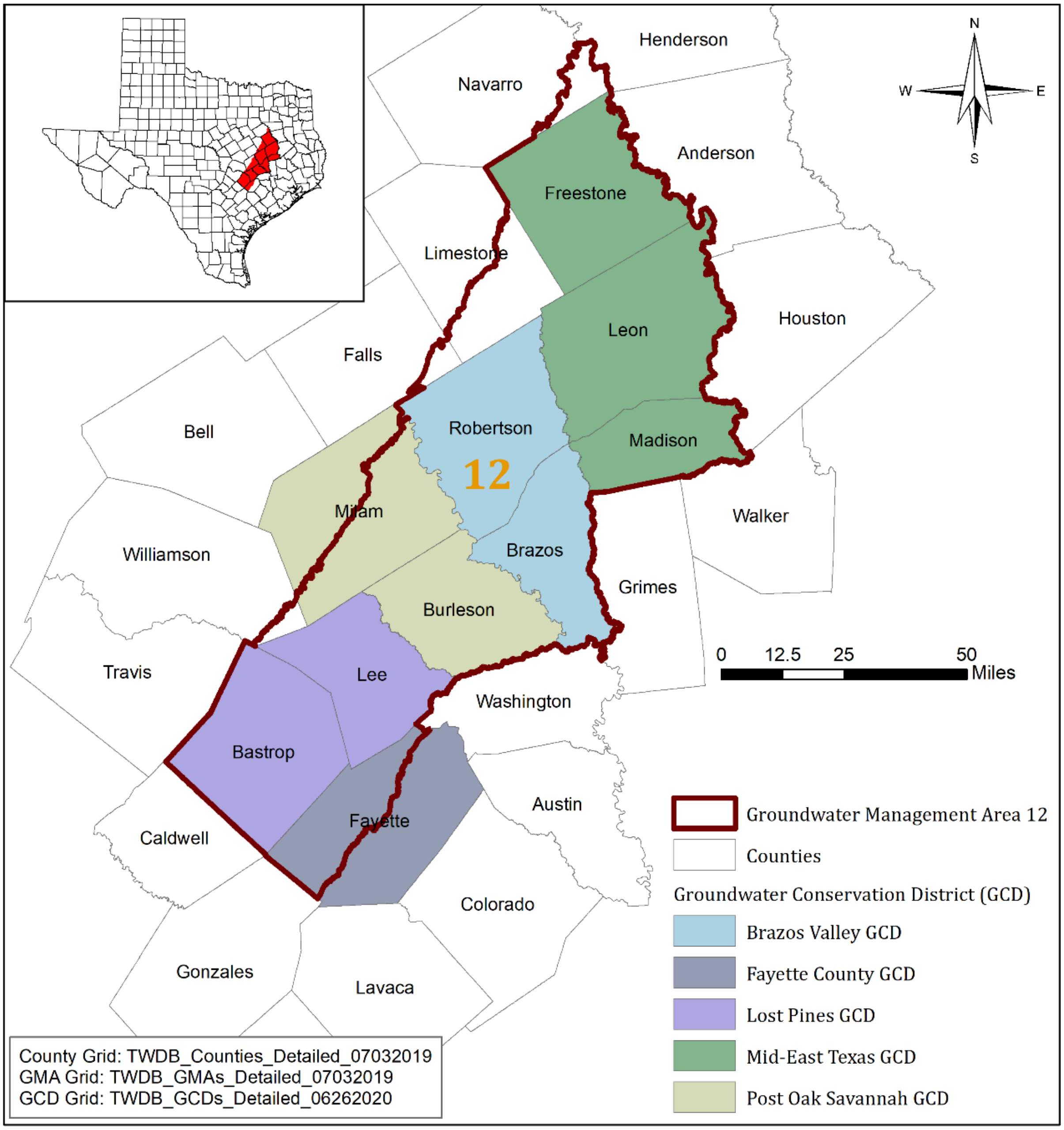

Figure 1. **GROUNDWATER CONSERVATION DISTRITS IN GROUNDWATER MANAGEMENT AREA 12.**

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. 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. Details of the drawdown calculations and a comparison with the correlated desired future conditions are summarized in Appendix B. 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. Details of the drawdown calculations and a comparison with the correlated desired future conditions are summarized in Appendix C. 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. Details of the percent saturation calculations and a comparison with the correlated desired future conditions are summarized in Appendix D. 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. Details of saturated thickness calculations and a comparison with the correlated desired future conditions are summarized in Appendix D. 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 using a methodology described in Appendix B.
- 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 described in Appendix B.
- During the predictive simulation model run, some model cells went dry, meaning the modeled water level fell below the bottom of the cell. Appendix B describes how dry cells were handled in the drawdown calculations. 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 using a methodology described in Appendix C.
- 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) using the methodology described in Appendix C.
- During the predictive simulation model run, some model cells went dry, meaning the modeled water level fell below the bottom of the cell. Appendix C describes how dry cells were handled in the drawdown calculations. 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). Appendix D provides the methodologies used to verify the achievability of desired future conditions.
- 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.

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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 B

Comparison of desired future conditions and simulated drawdowns for the Sparta, Queen City, Carrizo-Wilcox (Carrizo, Calvert Bluff, Simsboro, and Hooper formations) aquifers

The desired future conditions for the Carrizo-Wilcox, Queen City, and Sparta aquifers in Groundwater Management Area 12 are based on predictive simulation scenario 19 (Daniel B. Stephens & Associates and others, 2022). This predictive simulation is based on the calibrated groundwater availability model (Version 3.02) for the Central Portion of the Carrizo-Wilcox, Queen City, and Sparta Aquifers by INTERA Incorporated and others (2020). The calibrated groundwater availability model was based on MODFLOW-USG (Panday and others, 2015). The calibrated model contains one steady-state stress period (stress period 1) and 81 transient annual stress periods, representing 1929 (stress period 2) through 2010 (stress period 82).

The predictive simulation is a separate model that contains 60 annual transient stress periods representing 2011(stress period 1) through 2070 (stress period 60), with initial water level values copied from stress period 82 (end of 2010) of the calibrated groundwater availability model. The predictive model contains ten layers that can be differentiated by aquifer codes in the model grid file: czwx_v3_01_MFUSG_ModelGrid100920.csv.

The model layers and associated aquifer codes are summarized in Table B1 (from the shallowest to the deepest).

TABLE B1. GROUNDWATER AVAILABILITY MODEL FRAMEWORK FOR THE SPARTA, QUEEN CITY, AND CARRIZO-WILCOX AQUIFERS IN GROUNDWATER MANAGEMENT AREA 12.

<table>
<tr><th>Model Layer</th><th colspan="2">Hydrogeological Unit</th><th>Aquifer Code</th></tr>
<tr><td>1</td><td colspan="2">Alluvium</td><td>1</td></tr>
<tr><td rowspan="5">2</td><td rowspan="5">Surficial layer</td><td>Sparta Aquifer</td><td>3</td></tr>
<tr><td>Welches confining unit</td><td>4</td></tr>
<tr><td>Queen City Aquifer</td><td>5</td></tr>
<tr><td>Reklaw confining unit</td><td>6</td></tr>
<tr><td>Carrizo Aquifer</td><td>7</td></tr>
</table>

TABLE B1 (CONT). GROUNDWATER AVAILABILITY MODEL FRAMEWORK FOR THE SPARTA, QUEEN CITY, AND CARRIZO-WILCOX AQUIFERS IN GROUNDWATER MANAGEMENT AREA 12.

Model Layer	Hydrogeological Unit		Aquifer Code
		Wilcox (Calvert Bluff Formation) Aquifer	8
		Wilcox (Simsboro Formation) Aquifer	9
		Wilcox (Hooper Formation) Aquifer	10
3	Sparta Aquifer		3
4	Welches confining unit		4
5	Queen City Aquifer		5
6	Reklaw confining unit		6
7	Carrizo Aquifer		7
8	Wilcox (Calvert Bluff Formation) Aquifer		8
9	Wilcox (Simsboro Formation) Aquifer		9
10	Wilcox (Hooper Formation) Aquifer		10

The surficial layer is an artificial layer to represent the shallow flow system and contains outcrops of the Sparta, Weches, Queen City, Reklaw, and Carrizo formations, and the Calvert Bluff, Simsboro, and Hooper formations of the Wilcox (Figure B1). In addition to the outcrop portions represented in Layer 2, the Sparta, Queen City, Carrizo, Wilcox (Calvert Bluff Formation), Wilcox (Simsboro Formation), and Wilcox (Hooper Formation) aquifers are also represented in model layers 3 (Figure B2), 5 (Figure B3), 7 (Figure B4), 8 (Figure B5), 9 (Figure B6), and 10 (Figure B7), respectively.

The desired future conditions for each aquifer by groundwater conservation district or county are the average drawdowns between the end of 2010 (initial water levels) and 2070 (stress period 60). Since the model is composed of quadtree with variable cell sizes, the average drawdowns were weighted by model cell area using the following equation:

$$D = \frac{\sum_{i=1}^{N} A_i (H_{i,2010} - H_{i,2070})}{\sum_{i=1}^{N} A_i}$$

where:

D = Average drawdown for a groundwater conservation district or county (feet)
A_i = Area of model cell i (square feet)
$H_{i,2010}$ = Water level of model cell i at end of 2010 (feet above mean sea level)
$H_{i,2070}$ = Water level of model cell i at end of 2070 (feet above mean sea level)

N = Total model cell count in a groundwater conservation district or county

Model cells with water levels below the cell bottom in 2010 were excluded from the calculation. If the water level fell below the cell bottom in 2070, the water level was set at the cell bottom.

Per Groundwater Management Area 12, a desired future condition was met if the simulated drawdown was within 10 percent of the desired future condition. Using the water level (head) output file submitted by Groundwater Management Area 12 and the method described above, the TWDB calculated the average drawdowns and performed the comparison against the corresponding desired future conditions (Table B2). TWDB staff's review indicated that the predictive simulation meets the desired future conditions. The dry cell count is also included in Table B2.

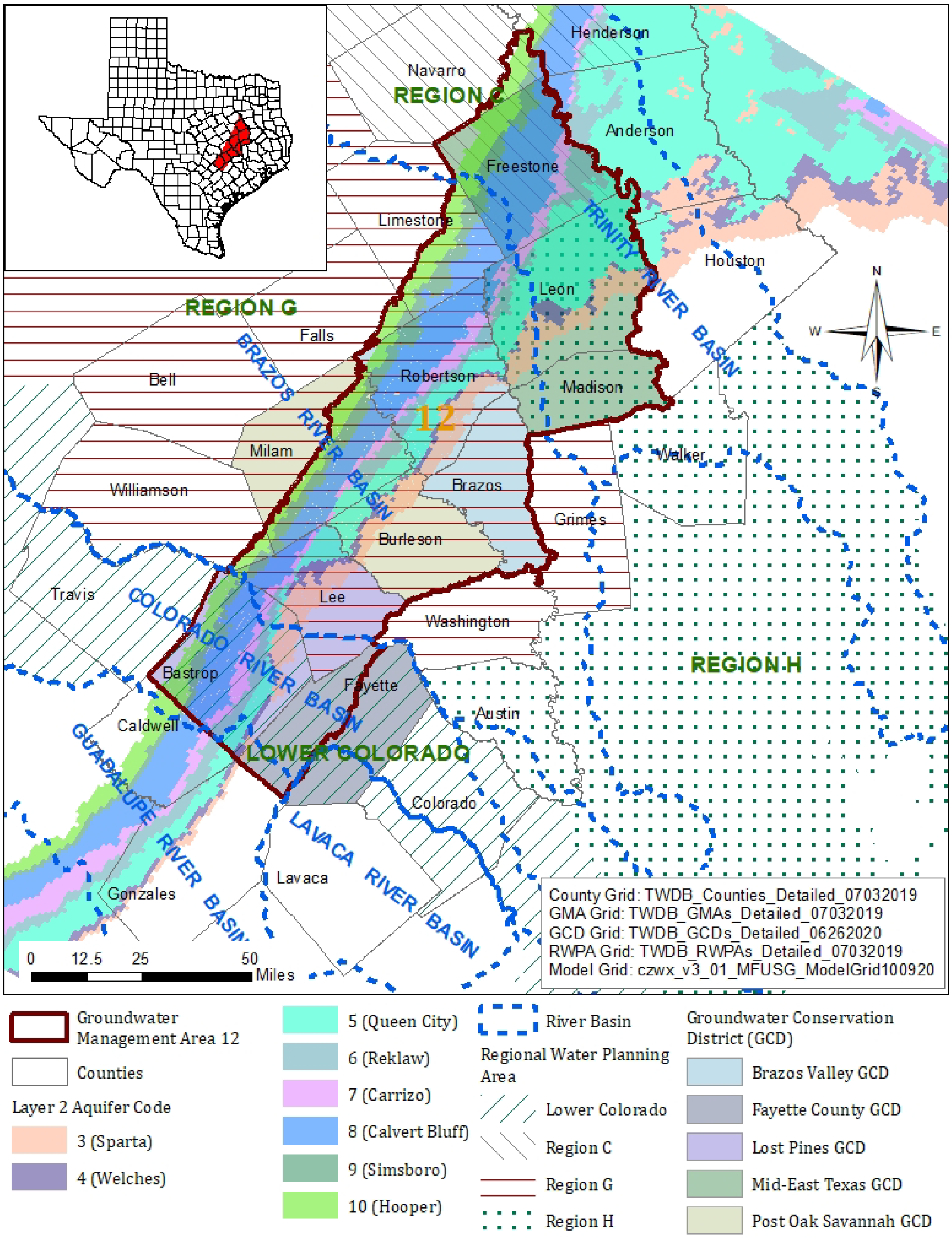

FIGURE B1. **LAYER 2 AQUIFER CODES FROM THE GROUNDWATER AVAILABILITY MODEL GRID FOR THE CENTRAL PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.**

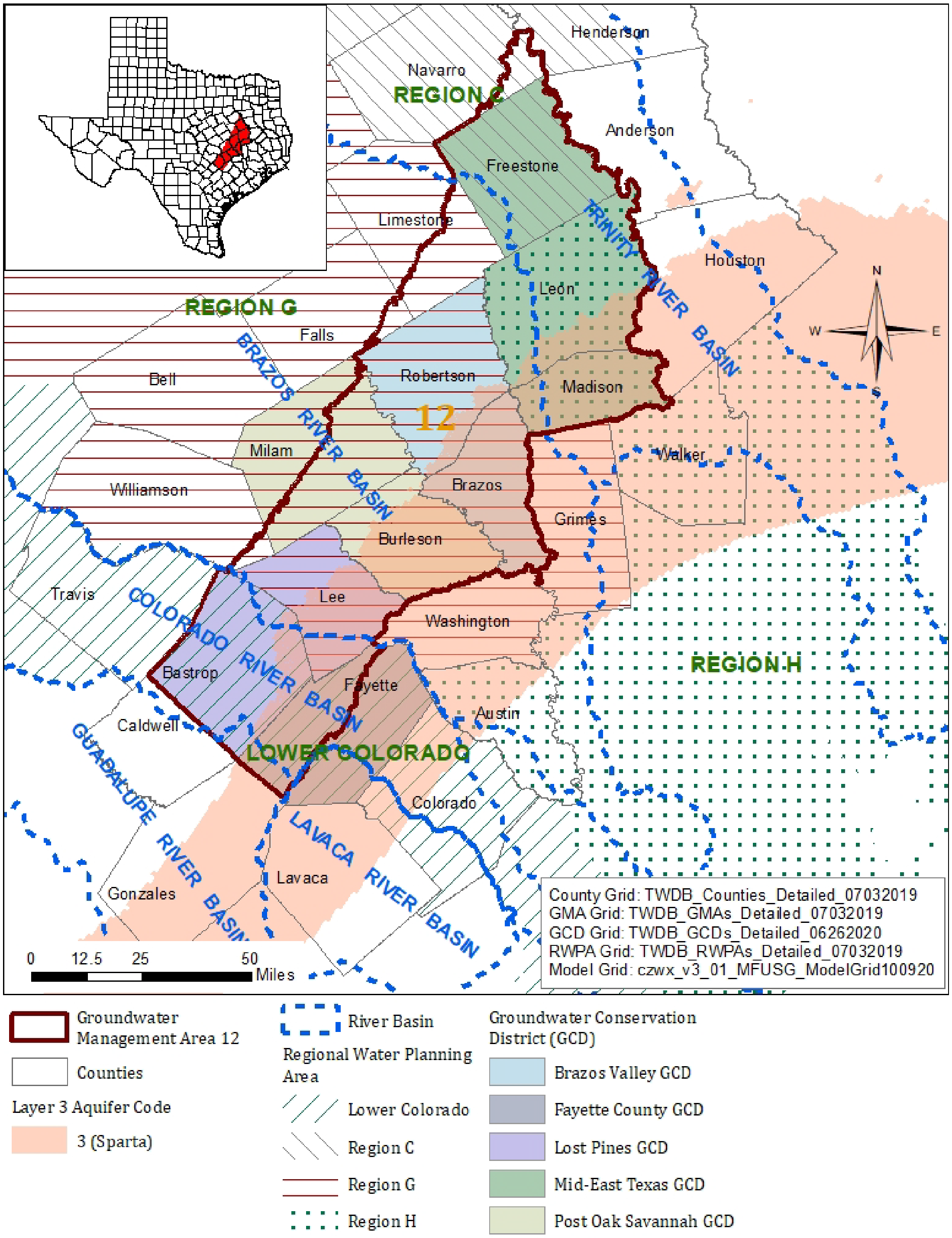

FIGURE B2. LAYER 3 (SPARTA) AQUIFER CODE FROM THE GROUNDWATER AVAILABILITY MODEL GRID FOR THE CENTRAL PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.

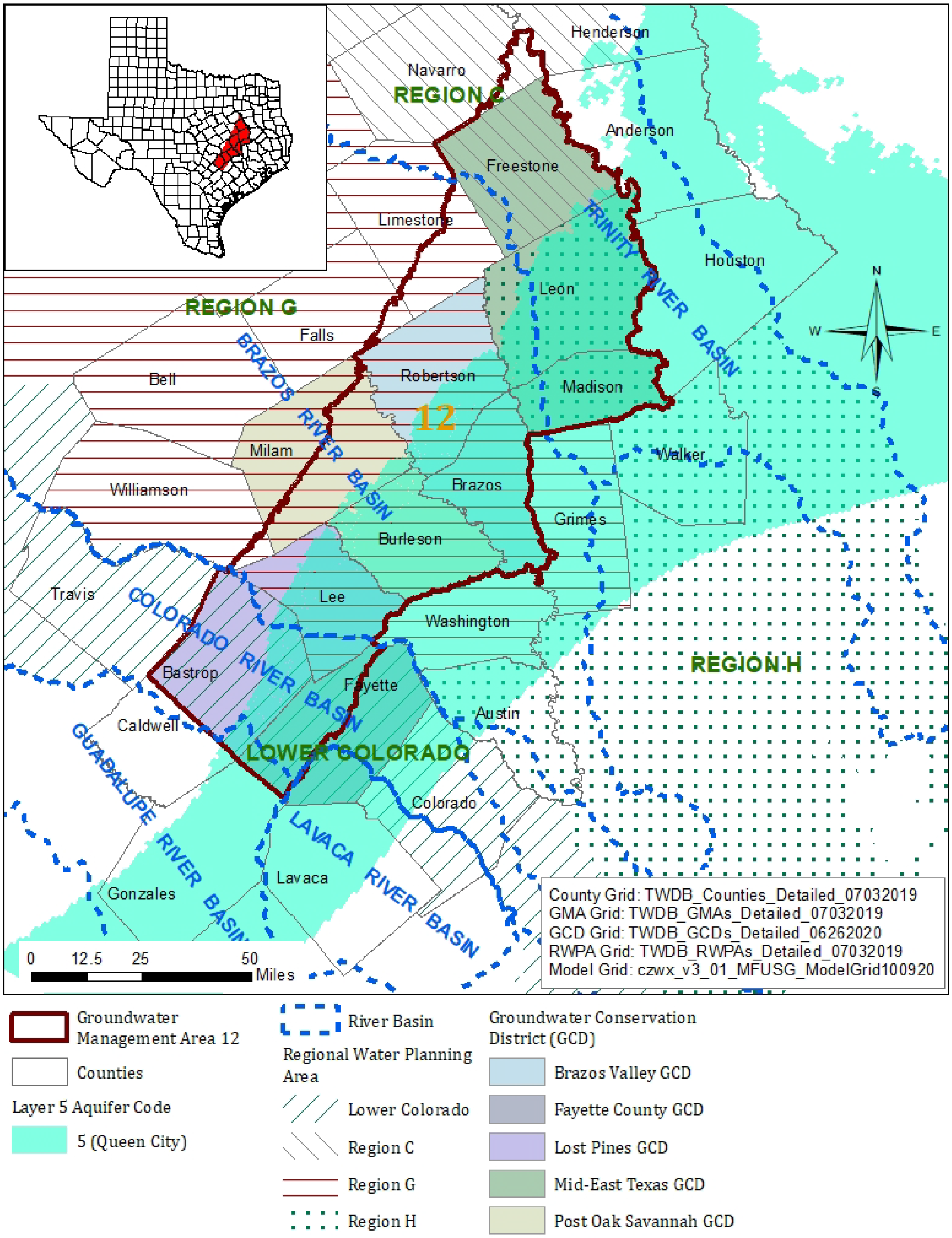

FIGURE B3. **LAYER 5 (QUEEN CITY) AQUIFER CODE FROM THE GROUNDWATER AVAILABILITY MODEL GRID FOR THE CENTRAL PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.**

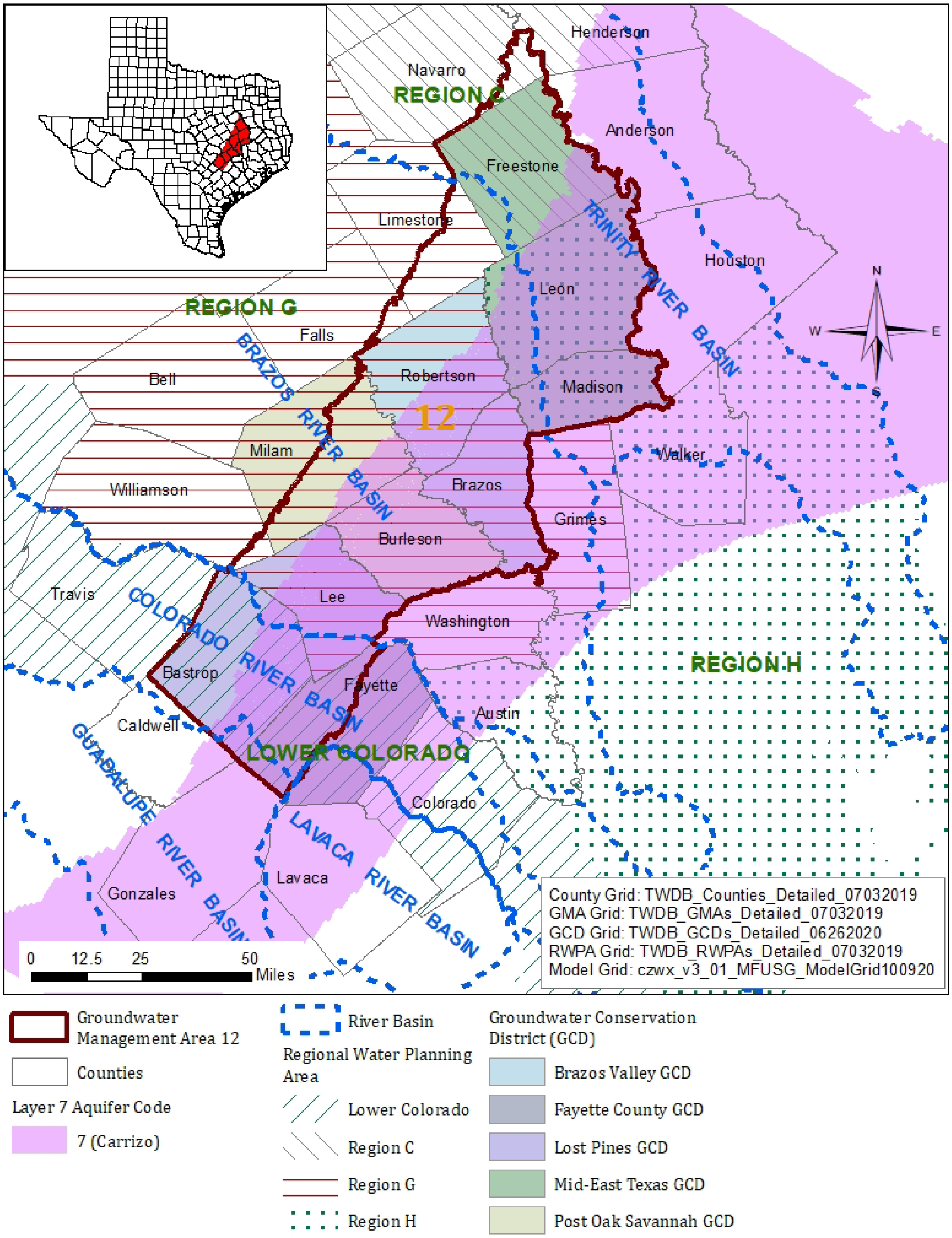

FIGURE B4. LAYER 7 (CARRIZO) AQUIFER CODE FROM GROUNDWATER AVAILABILITY MODEL GRID FOR THE GROUNDWATER AVAILABILITY MODEL GRID FOR THE CENTRAL PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.

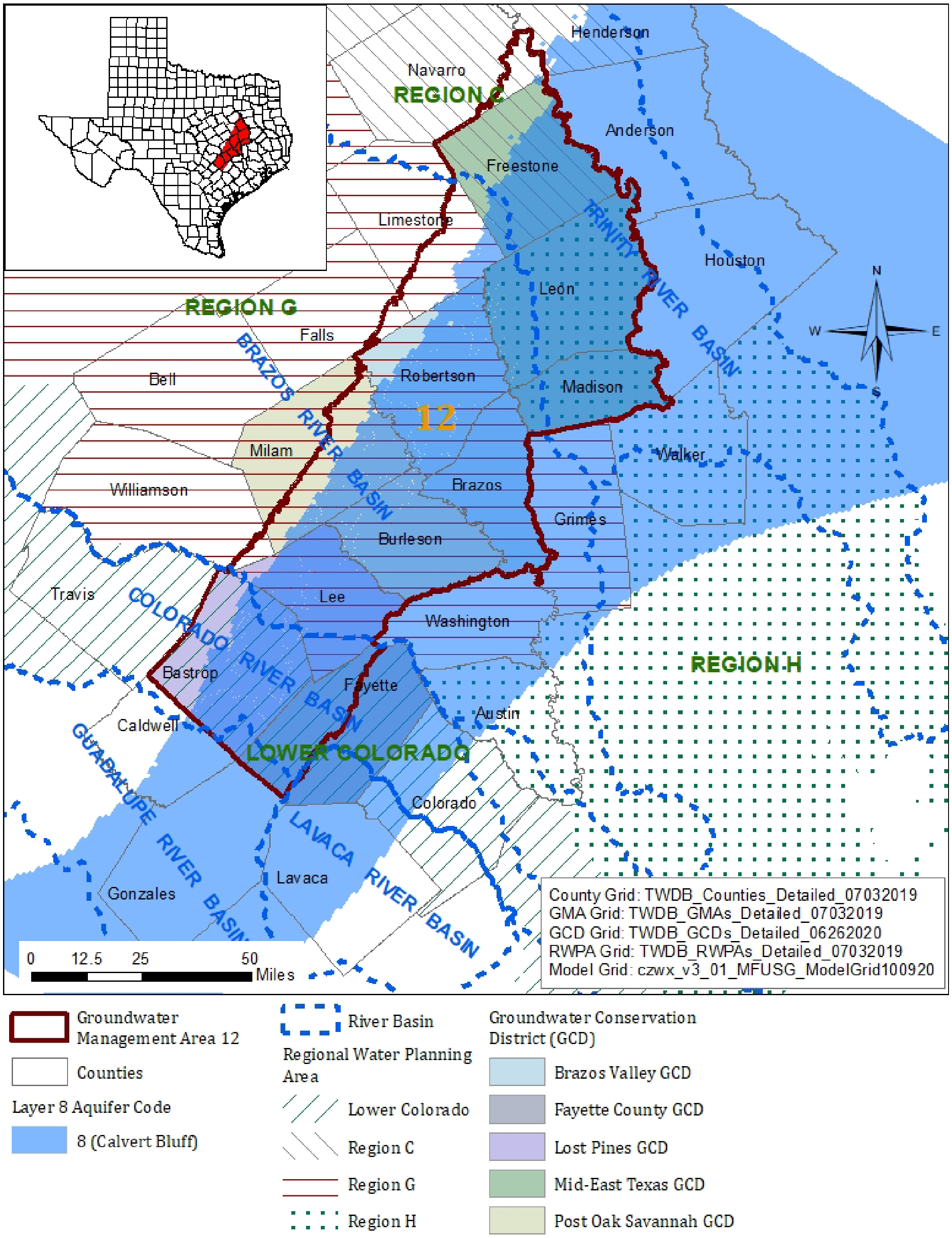

FIGURE B5. LAYER 8 (CALVERT BLUFF) AQUIFER CODE FROM THE GROUNDWATER AVAILABILITY MODEL GRID FOR THE CENTRAL PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.

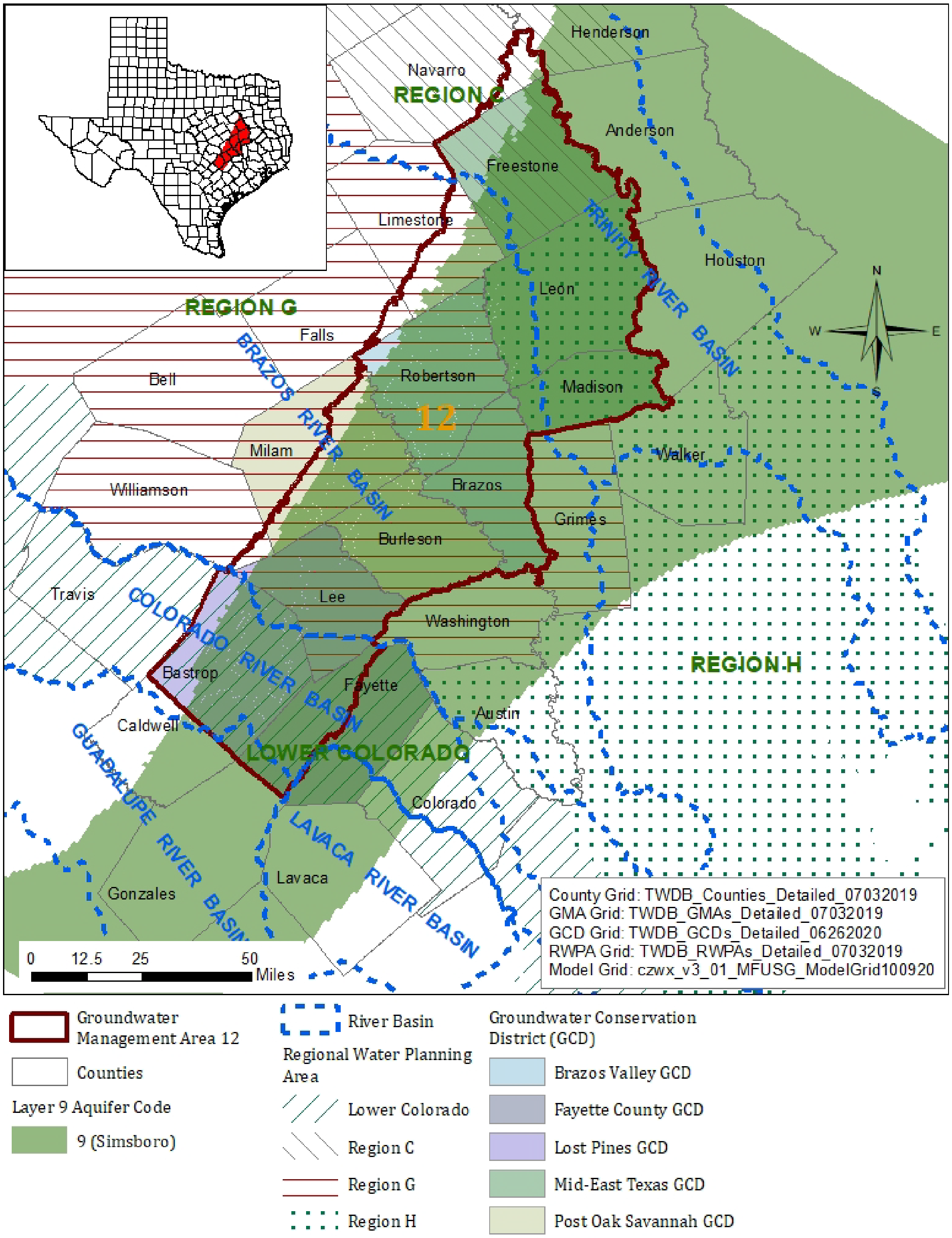

FIGURE B6. **LAYER 9 (SIMSBORO) AQUIFER CODE FROM THE GROUNDWATER AVAILABILITY MODEL GRID FOR THE CENTRAL PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.**

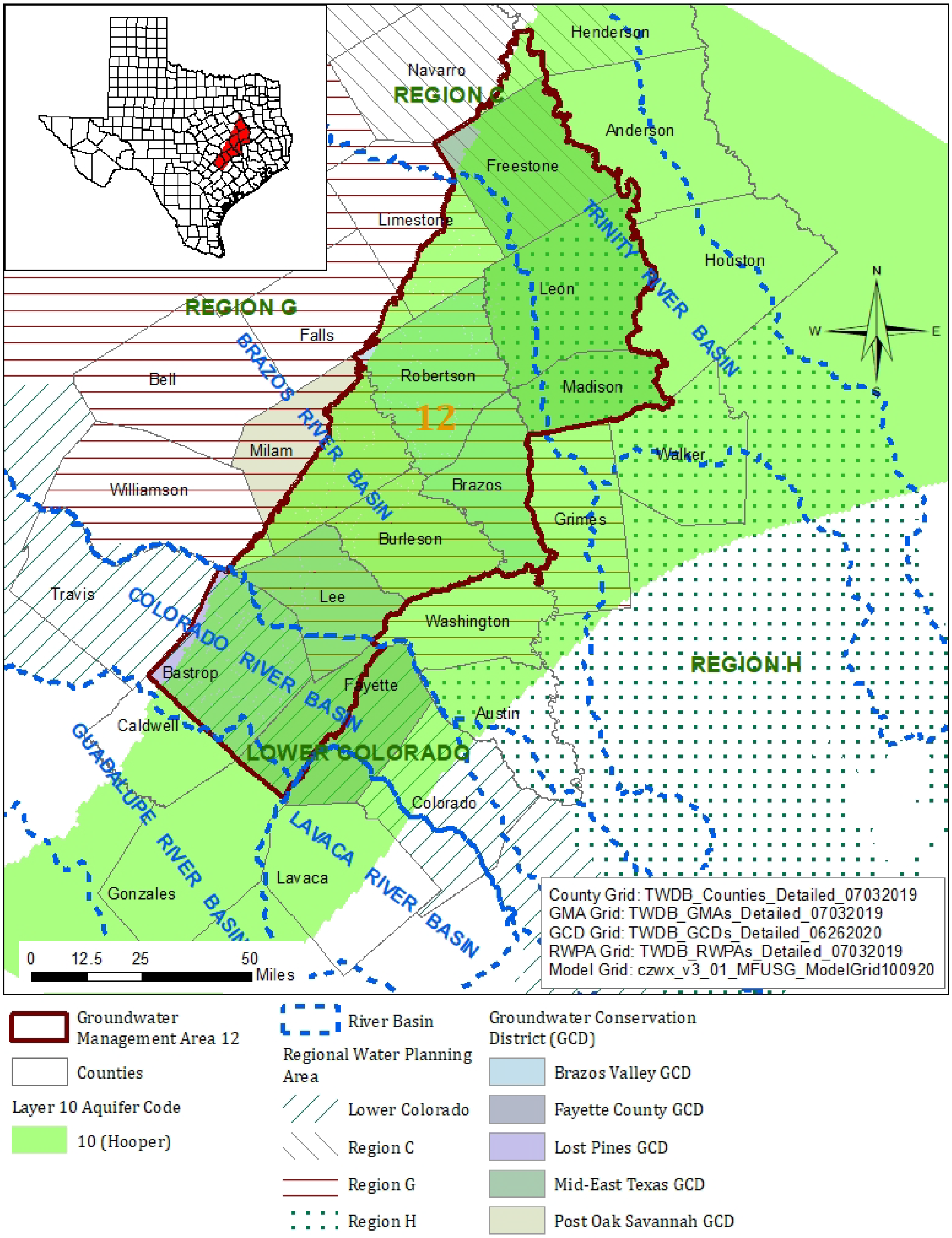

FIGURE B7. **LAYER 10 (HOOPER) AQUIFER CODE FROM THE GROUNDWATER AVAILABILITY MODEL GRID FOR THE CENTRAL PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.**

TABLE B2. SIMULATED DRAWDOWN VALUES FOR THE SPARTA AQUIFER, QUEEN CITY AQUIFER, CARRIZO AQUIFER, CALVERT BLUFF FORMATION, SIMSBORO FORMATION, AND HOOPER FORMATION IN GROUNDWATER MANAGEMENT AREA 12.

Groundwater Conservation District (GCD) or County	Stress Period/ Year	Aquifer	Dry Cells	Wet Cells	Desired Future Condition Drawdown (feet)	Calculated Average Drawdown (feet)	Is Desired Future Condition Violated?
Brazos Valley GCD	60/2070	Sparta	0	1007	53	46	No
Brazos Valley GCD	60/2070	Queen City	0	1535	44	40	No
Brazos Valley GCD	60/2070	Carrizo	0	1608	84	89	No
Brazos Valley GCD	60/2070	Calvert Bluff	0	2766	111	105	No
Brazos Valley GCD	60/2070	Simsboro	0	2439	262	257	No
Brazos Valley GCD	60/2070	Hooper	0	2410	167	172	No
Fayette County GCD*	60/2070	Sparta	0	965	43	31	No
Fayette County GCD*	60/2070	Queen City	0	961	73	57	No
Fayette County GCD*	60/2070	Carrizo	0	961	140	143	No
Fayette County GCD*	60/2070	Calvert Bluff	0	961	NR	145	NR
Fayette County GCD*	60/2070	Simsboro	0	961	NR	257	NR
Fayette County GCD*	60/2070	Hooper	0	961	NR	148	NR
Lost Pine GCD	60/2070	Sparta	21	2047	22	18	No
Lost Pine GCD	60/2070	Queen City	9	2665	28	26	No
Lost Pine GCD	60/2070	Carrizo	5	3308	134	130	No
Lost Pine GCD	60/2070	Calvert Bluff	40	6456	132	116	No
Lost Pine GCD	60/2070	Simsboro	0	6290	240	238	No
Lost Pine GCD	60/2070	Hooper	0	7807	138	129	No
Mid-East Texas GCD	60/2070	Sparta	6	917	25	24	No

TABLE B2 (CONT). SIMULATED DRAWDOWN VALUES FOR THE SPARTA AQUIFER, QUEEEN CITY AQUIFER, CARRIZO AQUIFER, CALVERT BLUFF FORMATION, SIMSBORO FORMATION, AND HOOPER FORMATION IN GROUNDWATER MANAGEMENT AREA 12.

Groundwater Conservation District (GCD) or County	Stress Period/ Year	Aquifer	Dry Cells	Wet Cells	Desired Future Condition Drawdown (feet)	Calculated Average Drawdown (feet)	Is Desired Future Condition Violated?
Mid-East Texas GCD	60/2070	Queen City	0	2062	20	16	No
Mid-East Texas GCD	60/2070	Carrizo	0	1868	48	48	No
Mid-East Texas GCD	60/2070	Calvert Bluff	0	2742	57	50	No
Mid-East Texas GCD	60/2070	Simsboro	0	2527	76	78	No
Mid-East Texas GCD	60/2070	Hooper	0	2710	69	68	No
Post Oak Savannah GCD	60/2070	Sparta	0	795	32	30	No
Post Oak Savannah GCD	60/2070	Queen City	0	1502	30	27	No
Post Oak Savannah GCD	60/2070	Carrizo	0	1414	146	161	No
Post Oak Savannah GCD	60/2070	Calvert Bluff	17	2107	156	150	No
Post Oak Savannah GCD	60/2070	Simsboro	3	2132	278	284	No
Post Oak Savannah GCD	60/2070	Hooper	0	2334	178	175	No
Falls County	60/2070	Sparta	0	0	NP	NP	NP
Falls County	60/2070	Queen City	0	0	NP	NP	NP
Falls County	60/2070	Carrizo	0	0	NP	NP	NP
Falls County	60/2070	Calvert Bluff	0	0	NP	NP	NP
Falls County	60/2070	Simsboro	0	12	7	7	No
Falls County	60/2070	Hooper	0	81	3	2	No
Limestone County	60/2070	Sparta	0	0	NP	NP	NP
Limestone County	60/2070	Queen City	0	0	NP	NP	NP
Limestone County	60/2070	Carrizo	0	0	NP	NP	NP

TABLE B2 (CONT). SIMULATED DRAWDOWN VALUES FOR THE SPARTA AQUIFER, QUEEEN CITY AQUIFER, CARRIZO AQUIFER, CALVERT BLUFF FORMATION, SIMSBORO FORMATION, AND HOOPER FORMATION IN GROUNDWATER MANAGEMENT AREA 12.

Groundwater Conservation District (GCD) or County	Stress Period/ Year	Aquifer	Dry Cells	Wet Cells	Desired Future Condition Drawdown (feet)	Calculated Average Drawdown (feet)	Is Desired Future Condition Violated?
Limestone County	60/2070	Calvert Bluff	0	326	2	2	No
Limestone County	60/2070	Simsboro	0	501	3	2	No
Limestone County	60/2070	Hooper	0	913	3	2	No
Navarro County	60/2070	Sparta	0	0	NP	NP	NP
Navarro County	60/2070	Queen City	0	0	NP	NP	NP
Navarro County	60/2070	Carrizo	0	0	NP	NP	NP
Navarro County	60/2070	Calvert Bluff	0	14	0	0	No
Navarro County	60/2070	Simsboro	0	27	1	1	No
Navarro County	60/2070	Hooper	0	160	0	0	No
Williamson County	60/2070	Sparta	0	0	NP	NP	NP
Williamson County	60/2070	Queen City	0	0	NP	NP	NP
Williamson County	60/2070	Carrizo	0	0	NP	NP	NP
Williamson County	60/2070	Calvert Bluff	1	0	NR	NR	NR
Williamson County	60/2070	Simsboro	0	10	31	30	No
Williamson County	60/2070	Hooper	0	124	24	18	No

**Fayette County GCD values are for all of Fayette County*
NR: non-relevant; NP: not present.

APPENDIX C

Comparison of desired future conditions and simulated drawdowns for the Yegua-Jackson Aquifer

The desired future conditions for the Yegua-Jackson Aquifer in Groundwater Management Area 12 are based on predictive simulation scenario 2 (Daniel B. Stephens & Associates and others, 2022). This predictive model contains two parts: first part is the calibrated groundwater availability model (Version 1.01; stress periods 1 through 27; Deeds and others, 2010) and second part is the predictive simulation for the desired future conditions (stress periods 28 through 100). The predictive simulation represents the annual stress periods from 1998 to 2070. The model was based on MODFLOW-2000 (Harbaugh and others, 2000).

The model contains five layers, and the hydrogeological units can be differentiated by IBOUND values in the model grid file, ygjk_07092020.csv. The model layers and associated hydrogeological units are summarized in Table C1 (from the shallowest to the deepest):

TABLE C1. GROUNDWATER AVAILABILITY MODEL FRAMEWORK FOR THE YEGUA-JACKSON AQUIFER IN GROUNDWATER MANAGEMENT AREA 12.

Model Layer	Hydrogeological Unit		IBOUND
1	Catahoula Formation		1
	Surficial Layer	Upper Jackson Aquifer	2
		Lower Jackson Aquifer	3
		Upper Yegua Aquifer	4
		Lower Yegua Aquifer	5
2	Upper Jackson Aquifer		2
	Pass-through cells		6
3	Lower Jackson Aquifer		3
	Pass-through cells		6
4	Upper Yegua Aquifer		4
	Pass-through cells		6
5	Lower Yegua Aquifer		5

The surficial layer is an artificial layer to represent the shallow flow system and contains outcrops of all units of the Yegua-Jackson Aquifer (Figure C1). In addition to the outcrop portions represented in model layer 1, the upper Jackson, the lower Jackson, the upper Yegua, and the lower Yegua aquifers are also represented by model layers 2 (Figure C2), 3 (Figure C3), 4 (Figure C4), and 5 (Figure C5), respectively.

The desired future conditions for the Yegua-Jackson Aquifer are expressed as average drawdowns between 2009 (stress period 39) and 2069 (stress period 99) from model cells with IBOUND values of 2, 3, 4, and 5. Since the model grid representing the aquifer has uniform cell size, drawdown was calculated using the following equation:

$$D = \frac{\sum_{i=1}^{N}(H_{i,2009} - H_{i,2069})}{N}$$

where:

D = Average drawdown for a groundwater conservation district or county (feet)
$H_{i,2009}$ = Water level of model cell i at end of 2009 (feet above mean sea level)
$H_{i,2069}$ = Water level of model cell i at end of 2069 (feet above mean sea level)
N = Total model cell count in a groundwater conservation district or county

Model cells with water level values below the cell bottom in 2009 were excluded from the calculation. Also, water level was set at the cell bottom if it fell below the cell bottom in 2069. Note that pass-through cells have different IBOUND values and were not included in this calculation.

Per Groundwater Management Area 12, a desired future condition was met if the simulated drawdown was within 10 percent of the desired future condition. Using the water level (head) output file submitted by Groundwater Management Area 12 and the method described above, the TWDB calculated the drawdowns and performed the comparison against the corresponding desired future conditions (Table C2). The review by the TWDB indicates that the predictive simulation meets the desired future conditions. The dry cell count is also included in Table C2.

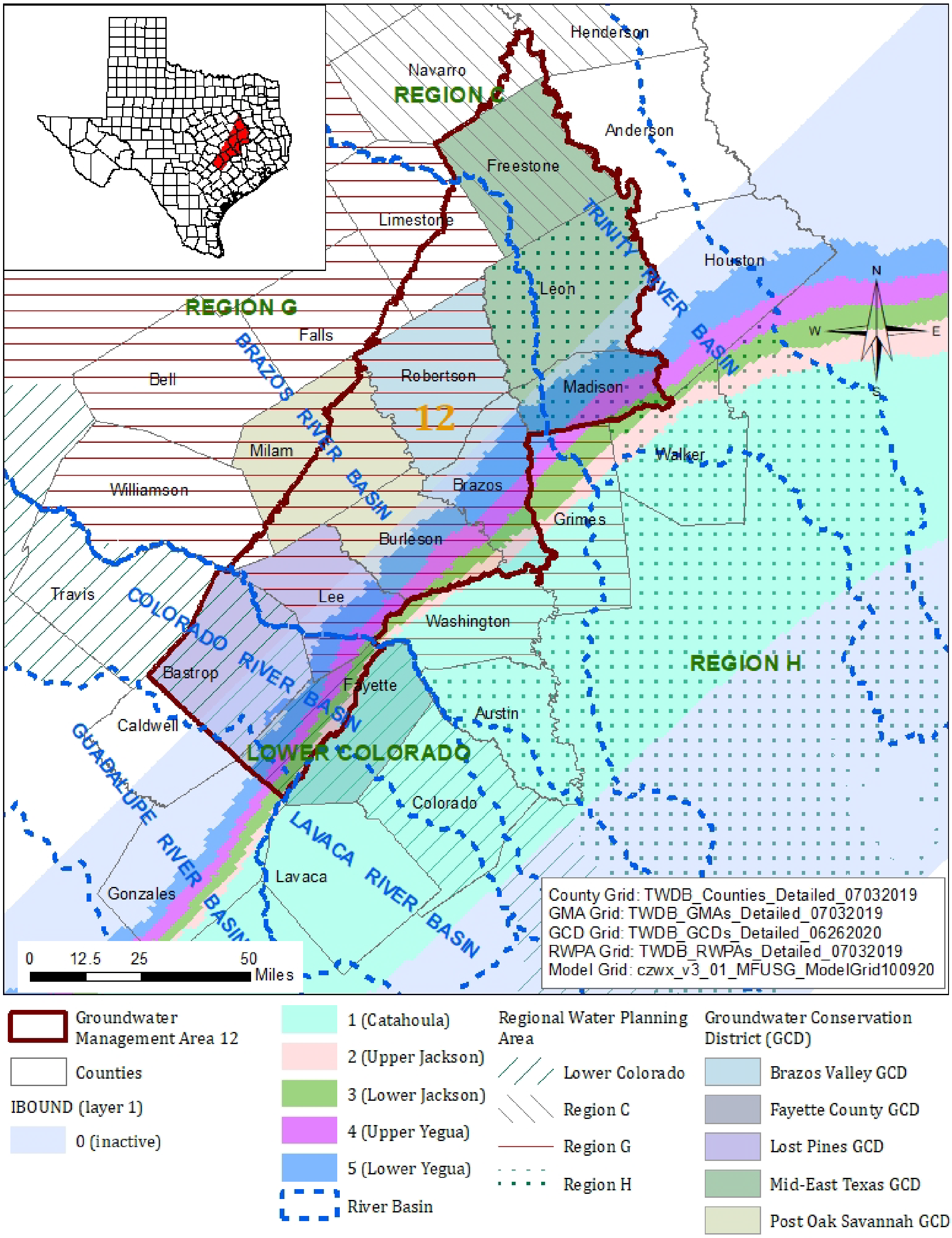

FIGURE C1. LAYER 1 IBOUND VALUES FROM GROUNDWATER AVAILABILITY MODEL GRID FOR THE YEGUA-JACKSON AQUIFER.

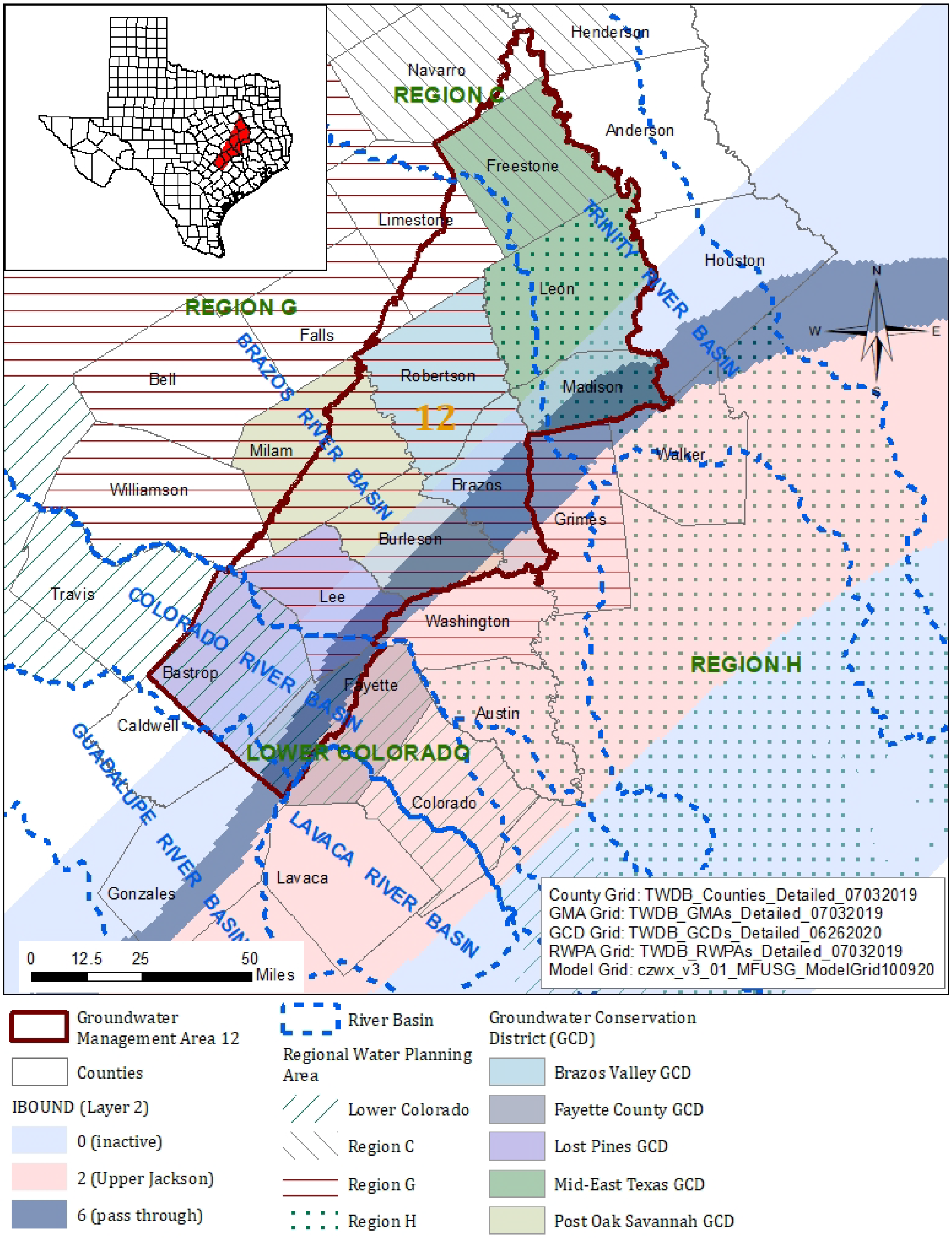

FIGURE C2. **LAYER 2 IBOUND VALUES FROM GROUNDWATER AVAILABILITY MODEL GRID FOR THE YEGUA-JACKSON AQUIFER.**

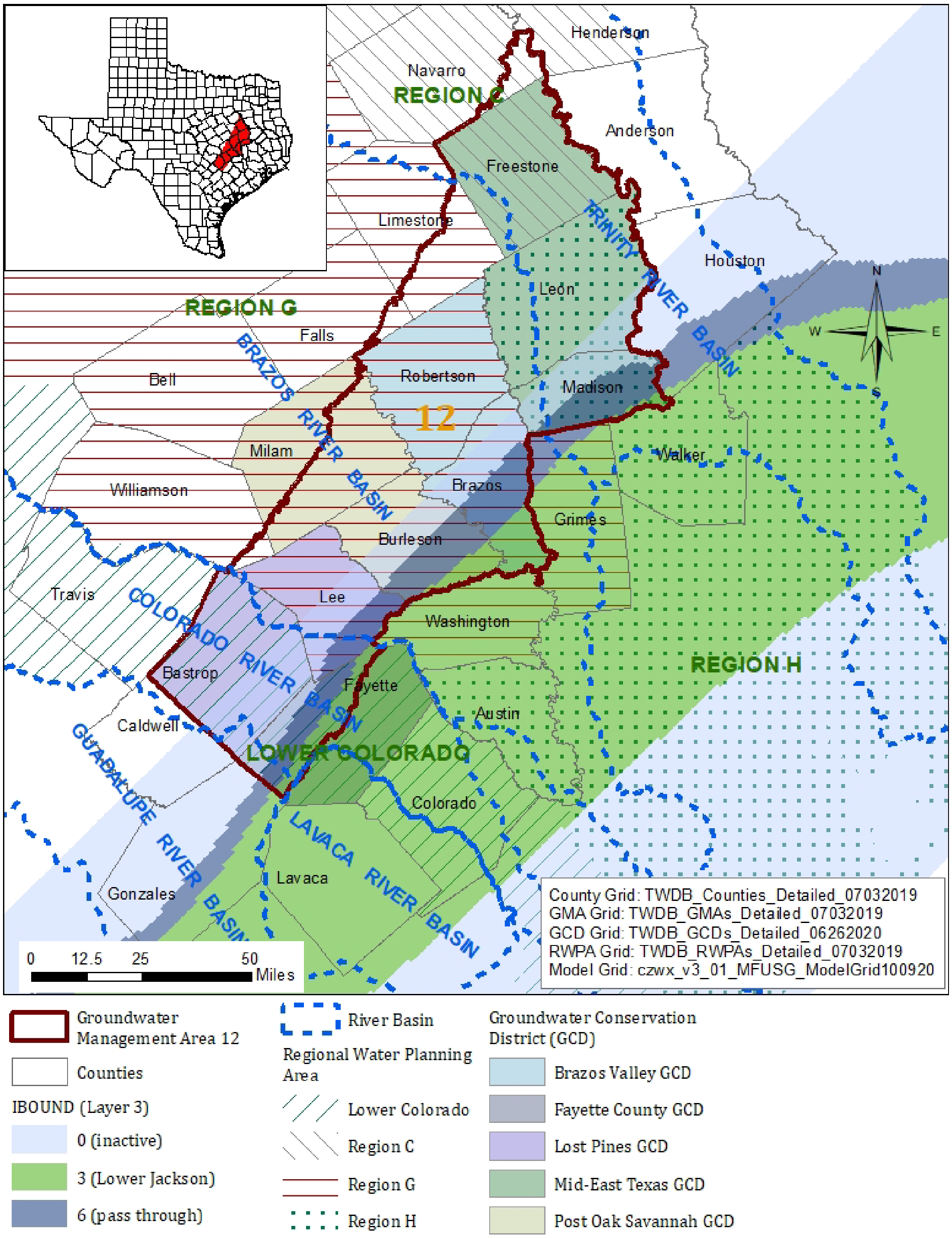

FIGURE C3. LAYER 3 IBOUND VALUES FROM GROUNDWATER AVAILABILITY MODEL GRID FOR THE YEGUA-JACKSON AQUIFER.

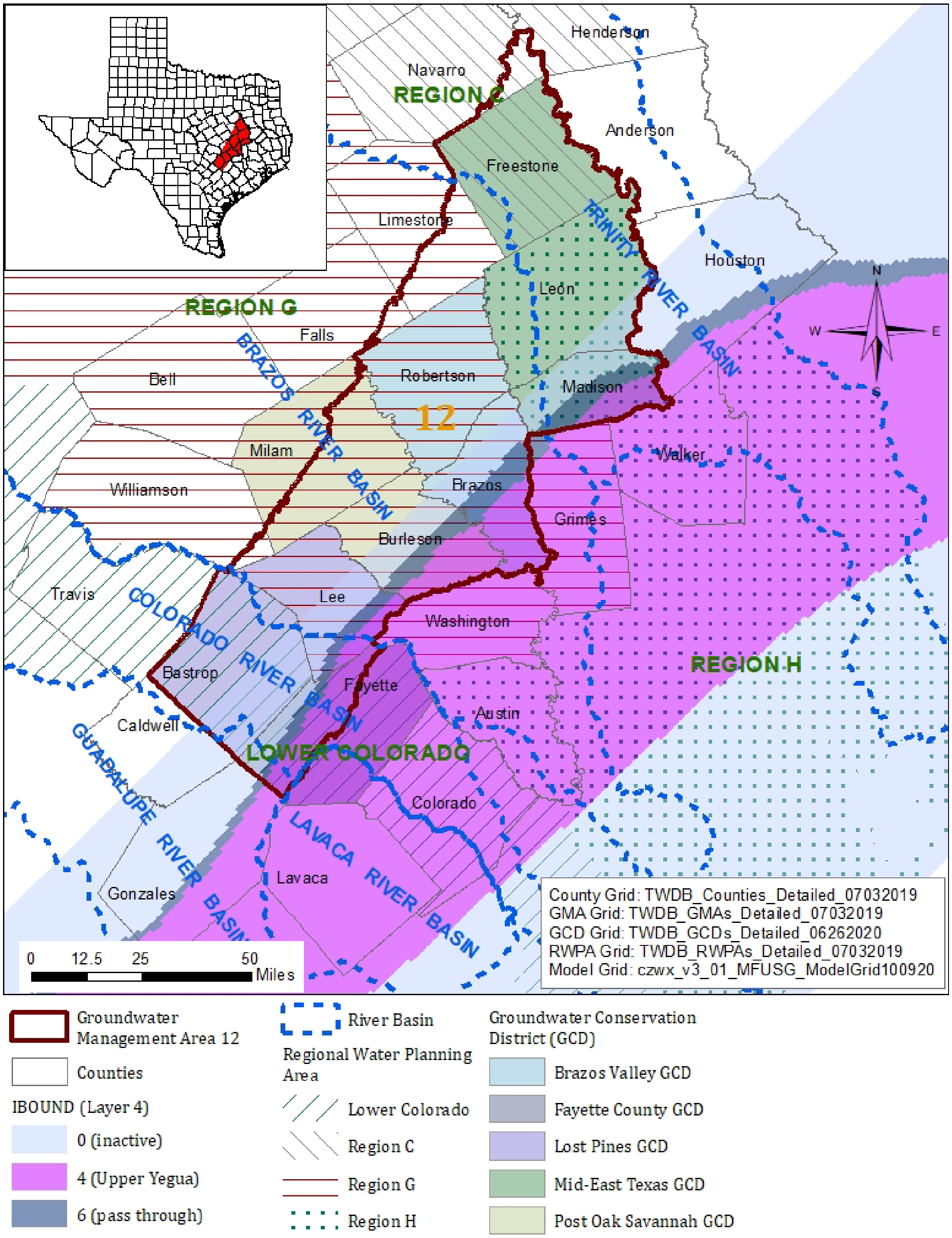

FIGURE C4. LAYER 4 IBOUND VALUES FROM GROUNDWATER AVAILABILITY MODEL GRID FOR THE YEGUA-JACKSON AQUIFER.

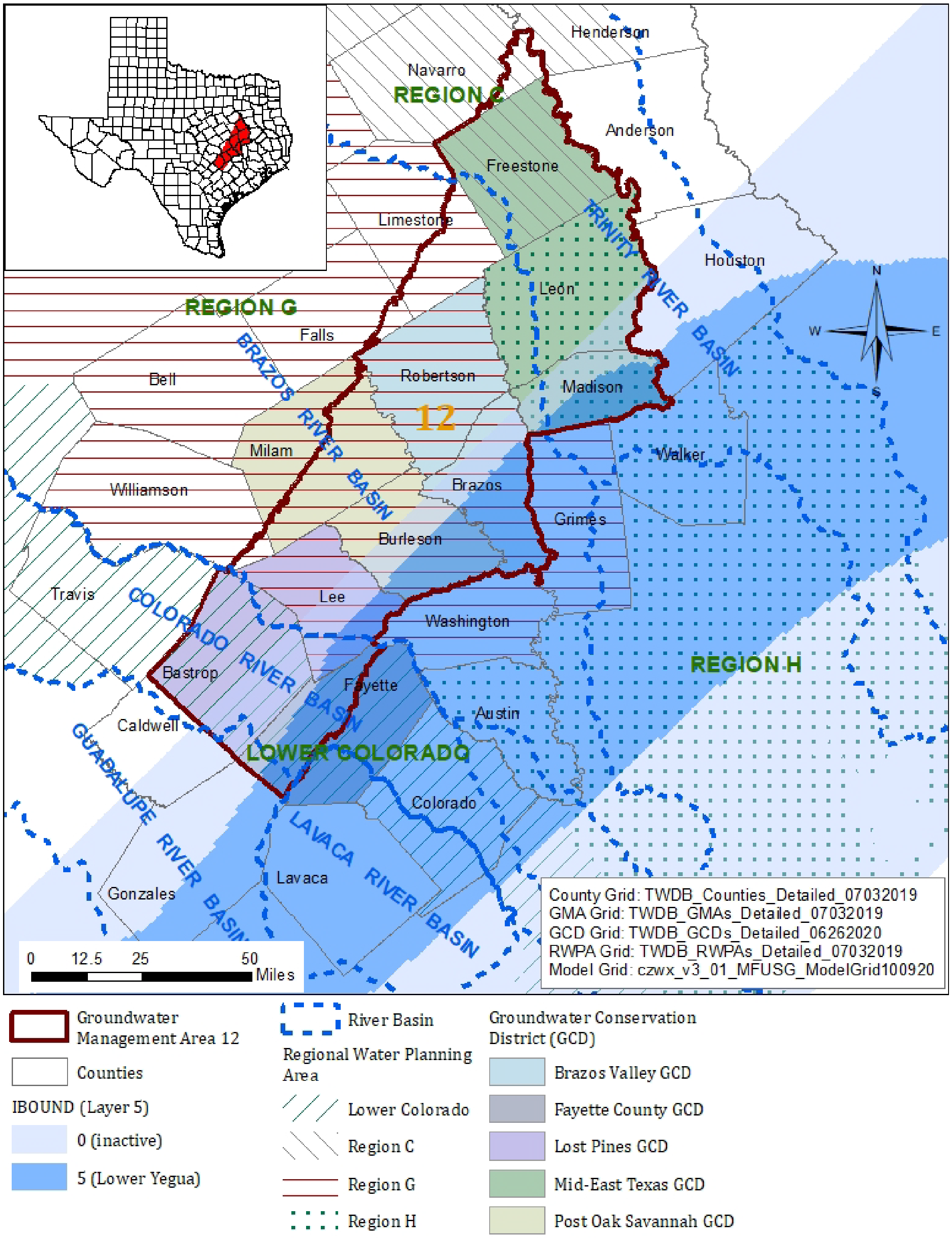

FIGURE C5. **LAYER 5 IBOUND VALUES FROM GROUNDWATER AVAILABILITY MODEL GRID FOR THE YEGUA-JACKSON AQUIFER.**

TABLE C2. SIMULATED DRAWDOWN VALUES FOR THE YEGUA-JACKSON AQUIFER IN GROUNDWATER MANAGEMENT AREA 12.

Groundwater Conservation District	Stress Period/ Year	Dry Cells	Wet Cells	Desired Future Condition Drawdown (feet)	Calculated Average Drawdown (feet)	Is Desired Future Condition Violated?
Brazos Valley GCD	99/2069	0	1126	67	67	No
Fayette County GCD*	99/2069	0	3328	81	81	No
Mid-East Texas GCD	99/2069	0	774	8	8	No
Post Oak Savannah GCD	99/2069	1	922	61	61	No

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

APPENDIX D

Comparison of desired future conditions and simulated drawdowns for the Brazos River Alluvium Aquifer

The desired future conditions for the Brazos River Alluvium Aquifer in Groundwater Management Area 12 are based on predictive simulation scenario 2 (Daniel B. Stephens & Associates and others, 2022). This predictive model contains two parts: first part is the calibrated groundwater availability model (Version 1.01; stress periods 1 through 427; Ewing and Jigmond, 2016) and second part is the predictive simulation for the desired future conditions (stress periods 428 through 485). The predictive simulation represents the annual stress periods from 2013 to 2070. The model was based on MODFLOW-USG (Panday and others, 2013).

The model contains three layers, and the Brazos River Alluvium Aquifer is located in layers 1 and 2, as shown in Table D1:

TABLE D1. GROUNDWATER AVAILABILITY MODEL FRAMEWORK FOR THE BRAZOS ALLUVIUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 12.

Model Layer	Hydrogeological Unit	IBOUND
1	Upper Brazos River Alluvium Aquifer	1
2	Lower Brazos River Alluvium Aquifer	1
3	Shallow flow system of underneath units	1

The Brazos River Alluvium Aquifer can be differentiated by the layer and IBOUND values in the model grid file, bra_grid_poly071020.csv. During the evaluation, only model cells with IBOUND value of 1 in layers 1 and 2 were used (Figure D1).

BRAZOS VALLEY GROUNDWATER CONSERVATION DISTRICT

The desired future conditions for the Brazos Valley Groundwater Conservation District are expressed as a saturation percentage of total well depth at the end of 2069 (stress period 99). In this evaluation, the well depth was assumed to be the same as the Brazos River Alluvium Aquifer thickness, that is, the combination of model layers 1 and 2.

Since the model grid representing the aquifer has uniform cell size, the percent saturation was calculated using the following equation:

$$PS = \frac{\sum_{i=1}^{N} MAX\{[MIN(H_i, T_i) - B_i], 0\}}{\sum_{i=1}^{N}(T_i - B_i)}$$

where:

PS = Average percent saturation for a groundwater conservation district or county
H_i = Water level of model cell i in layers 1 and 2 at end of 2069 (feet above mean sea level)
T_i = Top elevation of model cell i in layers 1 and 2 (feet above mean sea level)
B_i = Bottom elevation of model cell i in layers 1 and 2 (feet above mean sea level)
N = Total model cell count in layers 1 and 2 in a groundwater conservation district or county
MIN(a,b) means to select the minimum value between a and b. MAX(a,b) means to select the maximum value between a and b.

Per Groundwater Management Area 12, a desired future condition was met if the simulated percent saturation was within 10 percent saturation (not 10 percent of the desired future condition). Using the water level (head) output file submitted by Groundwater Management Area 12 and the method described above, the TWDB calculated the percent saturation and performed the comparison against the corresponding desired future conditions (Table D1).

TWDB staff's review indicated that the predictive simulation met the desired future conditions. No dry cells were present in the Brazos River Alluvium Aquifer in Brazos Valley Groundwater Conservation District (Table D1).

POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT

The desired future conditions for the Post Oak Savannah Groundwater Conservation District are expressed as a saturated thickness decrease between 2009 (stress period 391) and 2069 (stress period 484). Since the model grid representing the aquifer is uniform, the average saturated thickness decrease was calculated using the following equation:

$$STD = \frac{\sum_{i=1}^{N}[MIN(H_{i,2009}, T_i) - B_i] - \sum_{i=1}^{N} MAX\{[MIN(H_{i,2069}, T_i) - B_i], 0\}}{N/2}$$

where:

STD = Average saturated thickness decrease for a groundwater conservation district or county (feet)

$H_{i,2009}$ = Water level of model cell i in layers 1 and 2 at end of 2009 (feet above mean sea level)
$H_{i,2069}$ = Water level of model cell i in layers 1 and 2 at end of 2069 (feet above mean sea level)
T_i = Top elevation of model cell i in layers 1 and 2 (feet above mean sea level)
B_i = Bottom elevation of model cell i in layers 1 and 2 (feet above mean sea level)
N = Total model cell count in layers 1 and 2 in a groundwater conservation district or county
MIN(a,b) means to select the minimum value between a and b. MAX(a,b) means to select the maximum value between a and b.

Per Groundwater Management Area 12, a desired future condition was met if the simulated saturated thickness decrease was within 10 percent or 3 feet, whichever is greater, from the desired future condition. Using the water level (head) output file submitted by Groundwater Management Area 12 and the method described above, the TWDB calculated the average saturated thickness decrease and performed the comparison against the corresponding desired future conditions (Table D2).

The review by the TWDB indicates that the predictive simulation meets the desired future conditions. No dry cells were present in the Brazos River Alluvium Aquifer in Post Oak Savannah Groundwater Conservation District (Table D2).

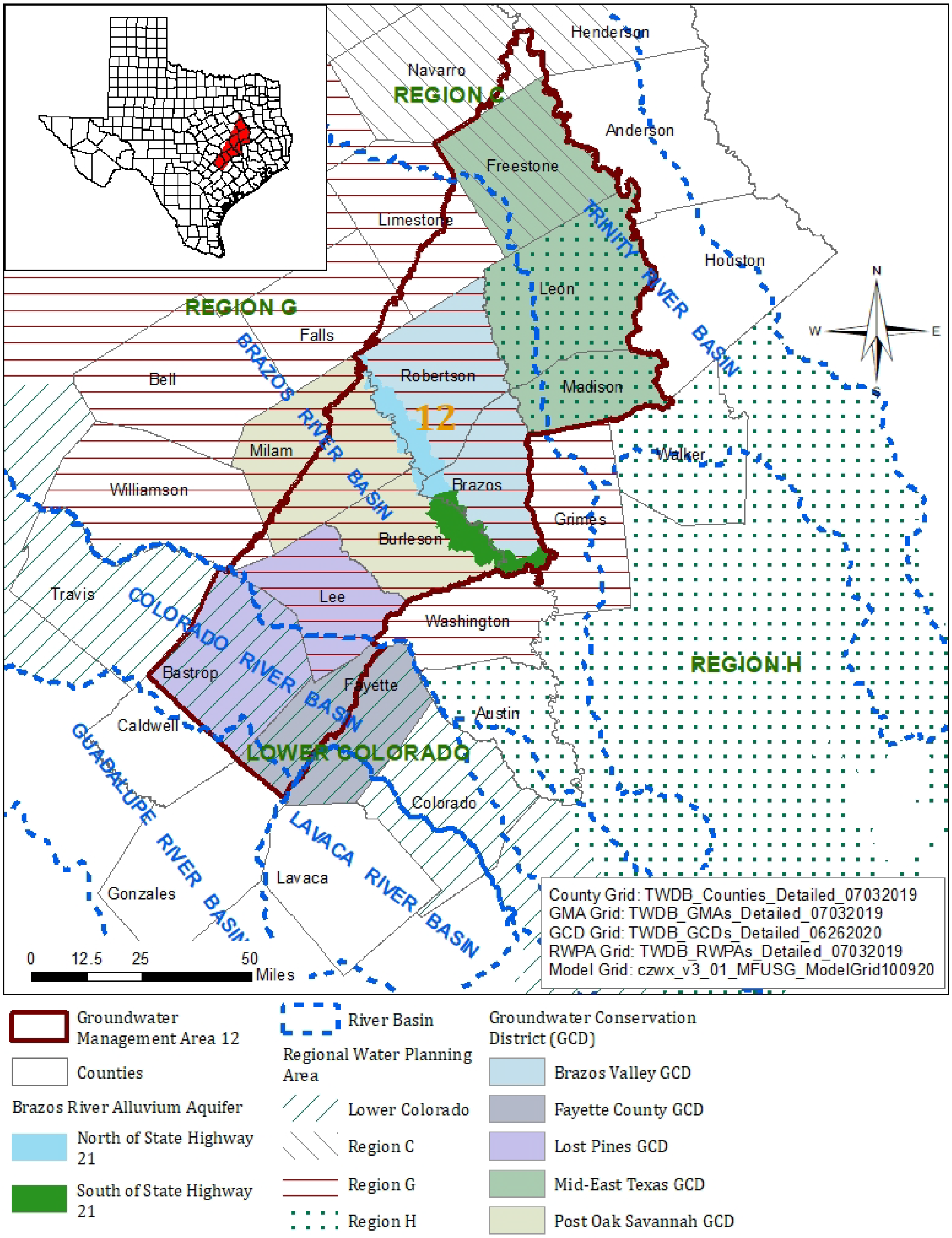

FIGURE D1. **SIMULATED BRAZOS RIVER ALLUVIUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 12.**

TABLE D1. SIMULATED PERCENT SATURATION OF BRAZOS RIVER ALLUVIUM AQUIFER IN BRAZOS VALLEY GROUNDWATER CONSERVATION DISTRICT OF GROUNDWATER MANAGEMENT AREA 12.

Groundwater Conservation District (GCD)/Area	Dry Cells	Wet Cells	Desired Future Condition (percent saturation)	Calculated Percent Saturation	Is DFC Violated?
Brazos Valley GCD/North of Highway 21	0	10268	0.3	0.23	No
Brazos Valley GCD/South of Highway 21	0	4421	0.4	0.46	No

TABLE D2. SIMULATED SATURATED THICKNESS DECREASE OF BRAZOS RIVER ALLUVIUM AQUIFER IN POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT OF GROUNDWATER MANAGEMENT AREA 12.

Groundwater Conservation District (GCD)/County	Dry Cells	Wet Cells	Desired Future Condition (saturated thickness decrease, feet)	Calculated Saturated Thickness Decrease (feet)	Is Desired Future Condition Violated?
Post Oak Savannah GCD/Burleson County	0	8245	6	8	No
Post Oak Savannah GCD/Milam County	0	1241	5	5	No