FAYETTE COUNTY GROUNDWATER CONSERVATION DISTRICT

MANAGEMENT PLAN

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

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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 insure 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 2018
Vice-President	Terry Hays	4	December 2018
Secretary/Treasurer	Cynthia Rodibaugh	3	December 2020
Director	Harvey Hayek	2	December 2018
Director	Robert Leer	1	December 2020

* 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 ten (10) 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 19 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 north-east 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 4,413 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 40 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 225 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, 2910 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, 612 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 17-019 dated January 31, 2018. Texas Water Development Board GAM Run 17-019 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 17-030 MAG for GMA 12 and GAM Run 16-025 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 November 2015.

In the plan, it is stated that: "Early in 2011-2016 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	9,073	8,905	8,895	8,886	8,856	8,856
Carrizo-Wilcox	1,000	1,000	1,000	1,000	1,000	1,000
Queen City	436	478	513	565	570	570
Sparta	3,592	3,637	3,656	3,711	3,729	3,729
Yegua-Jackson	5,762	5,762	5,762	5,762	5,762	5,762
Other Aquifer	834	834	834	834	834	834
TOTAL	**20,697**	**20,616**	**20,660**	**20,758**	**20,751**	**20,751**

Modeled Available Groundwater

Per Texas Water Code § 36.108 (9) (o), 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 17-030 MAG: Modeled Available Groundwater for the_Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, and Brazos River Alluvium aquifers for GMA 12 and GAM Run 16-025 MAG: Modeled Available Groundwater for the Gulf Coast Aquifer System for GMA 15.

Table 3: Modeled Available Groundwater GMA 12

Aquifer	Year						
	2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2069**
Carrizo	37	5,474	5,474	5,474	5,474	5,474	5,474
Queen City	268	2,708	2,708	2,708	2,708	2,708	2,708
Sparta	1,176	2,831	2,825	2,803	2,794	2,802	2,802
Yegua-Jackson	9,262	9,262	9,262	9,262	9,262	9,261	9,261

Table 4: Modeled Available Groundwater GMA15

Aquifer	Year						
	2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2069**
Gulf Coast	1,977	1,853	1,853	1,853	1,853	1,853	1,703

Projected Surface Water Supplies

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 2017 State Water Plan Datasets: Fayette County Groundwater Conservation District", by Stephen Allen, P.G. dated May 1, 2018, 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 2017 State Water Plan Datasets: Fayette County Groundwater Conservation District", by Stephen Allen, P.G. dated May 1, 2018, 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, were taken from Volume 1 of the Lower Colorado Regional Water Planning Group (LCRWPG) Regional Water Plan adopted November 2015.

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 WSC	6,116	6,980	7,568	8,051	8,432	8,725
Lee County WSC	1,161	1,325	1,436	1,528	1,601	1,656
Flatonia	1,598	1,824	1,977	2,103	2,203	2,279
La Grange	5,362	6,120	6,635	7,059	7,393	7,650
Schulenburg	3,295	3,761	4,077	4,338	4,543	4,701
County-Other	10,817	12,347	13,385	14,241	14,914	15,431
TOTAL COUNTY	**28,373**	**32,384**	**35,108**	**37,351**	**39,119**	**40,476**

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 2017 State Water Plan Datasets: Fayette County Groundwater Conservation District", by Stephen Allen, P.G. dated May 1, 2018, 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. Six water demand scenarios were simulated in the model, which ranged from considering only the current 1999 demand, to analyzing all projected future water demands through the year 2050. On the basis of the calibrated model, all withdrawal scenario water demands appear to be met by groundwater from the Carrizo-Wilcox Aquifer through the year 2050. The simulations indicate that the aquifer units remain fully saturated over most of the study area. The simulated water-level declines in the Carrizo-Wilcox Aquifer mainly reflect a pressure reduction within the aquifer's artesian zone. Some dewatering takes place in the center of certain pumping areas. In addition, simulations indicate that drawdown within the confined portion of the aquifer will significantly increase the movement of groundwater out of the shallow, unconfined portions to the deeper artesian portions of the aquifer. The relationships that currently exist between surface and groundwater may also change. Simulations indicate that the Colorado River, which currently gains water from the Carrizo-Wilcox Aquifer, may begin to lose water to the aquifer by the year 2050.

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 15 volunteer 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 Management Strategies for Fayette County

Demand and supply data developed as part of the Region K planning process in 2017, 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. Some water management strategies, as given in the 2017 State Water Plan, are:

Table 6: Projected Water Management Strategies for Fayette County

WUG	STRATEGY	2020	2030	2040	2050	2060	2070
AQUA WSC	DEMAND REDUCTION	1	1	1	1	1	1
AQUA WSC	DEMAND REDUCTION	0	1	1	0	1	1
COUNTY-OTHER, FAYETTE	DEMAND REDUCTION	186	202	213	225	234	242
COUNTY-OTHER, FAYETTE	GULF COAST AQUIFER | FAYETTE	639	639	639	639	639	639
FAYETTE WSC	DEMAND REDUCTION	113	125	133	141	148	152
FLATONIA	DEMAND REDUCTION	51	56	59	63	65	68
FLATONIA	DEMAND REDUCTION	17	29	43	60	84	105
FLATONIA	DIRECT REUSE	134	149	159	168	176	182
FLATONIA	GULF COAST AQUIFER | FAYETTE	100	100	100	100	100	100
LA GRANGE	DEMAND REDUCTION	130	144	153	161	168	174
LA GRANGE	DEMAND REDUCTION	42	21	0	0	0	0

LEE COUNTY WSC	DEMAND REDUCTION	30	33	35	37	38	40
MANUFACTURING, FAYETTE	GULF COAST AQUIFER | FAYETTE	391	391	391	391	391	391
MINING, FAYETTE	GULF COAST AQUIFER | FAYETTE	1920	1520	1061	618	344	344
MINING, FAYETTE	SPARTA AQUIFER | FAYETTE	66	42	13	0	0	0
SCHULENBURG	DEMAND REDUCTION	110	123	132	139	146	150
SCHULENBURG	DEMAND REDUCTION	37	63	96	141	188	232
STEAM ELECTRIC POWER, FAYETTE	CARRIZO-WILCOX AQUIFER | FAYETTE	500	500	500	500	500	500
STEAM ELECTRIC POWER, FAYETTE	GULF COAST AQUIFER | FAYETTE	700	700	700	700	700	700
STEAM ELECTRIC POWER, FAYETTE	YEGUA-JACKSON AQUIFER | FAYETTE	2000	2000	2000	2000	2000	2000
STEAM ELECTRIC POWER, FAYETTE	LAKE LONG/RESERVOIR	2000	2000	2000	2000	2000	2000
STEAM ELECTRIC POWER, FAYETTE	LCRA NEW OFF-CHANNEL RESERVOIRS (2020 DECADE)	6000	7000	9000	11000	13000	15000
AQUA WSC	DEMAND REDUCTION	1	1	1	1	1	1

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 2017 State Water Plan Datasets: Fayette County Groundwater Conservation District", by Stephen Allen, P.G. dated May 1, 2018, 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. Potions 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 in cover the 2000 to 2069 timeframe.

Table 7: Adopted Desired Future Conditions for Fayette County GCD in GMA 12

Aquifer	Average Drawdown (ft)
Carrizo	110
Queen City	64
Sparta	47
Yegua-Jackson	77

GMA 15 Desired Future Conditions

Current desired future conditions for the aquifers that lie within GMA 15 are listed in Table 7 below. Desired future conditions adopted by GMA 15 cover the 2000 to 2069 timeframe. The adopted desired future conditions cover the portion of the Gulf Coast Aquifer within the boundaries of GMA 15.

Table 8: Adopted Desired Future Conditions for Fayette County in GMA 15

Aquifer	Average Drawdown Fayette County (ft)	Average Drawdown GMA 15 (ft)
Gulf Coast	16	13

Data required for this section of the Fayette County Groundwater Conservation District Management Plan is found in GAM Run 17-030 MAG for GMA 12 and GAM Run 16-025 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 – Management Strategies 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 - Management Strategies Provideing for the 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 – Management Strategies 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.

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.

Management Goals Not Applicable to the District

The Control and Prevention of Subsidence

The geologic framework, the population level, and the current groundwater demands of the District preclude any significant subsidence from occurring. This management goal is not applicable at this time to the operations of the District.

Addressing Conjunctive Surface Water Management Issues

Since the District's boundaries fall within the bounds of the Lower Colorado River Authority (LCRA), the District will establish communications and share information with LCRA, as well as with the Cummins Creek Water Control and Improvement Project. These two entities are now receiving the District's newsletter. Additionally, the District will regularly invite these two entities to the District Board meetings, and a District representative will attend at least one of their meetings per year.

Addressing Natural Resource Issues Which Impact the Use and Availability of Groundwater and Which Are Impacted by the Use of Groundwater

This management goal is not applicable to the operations of the District, as there are at this time no known natural resource issues which impact groundwater in Fayette County. However, there is a concern about the possibility of oil and gas contamination. The District will investigate any reported contamination and work with the Railroad Commission to insure that any contamination is minimized or eliminated.

Addressing Recharge Enhancement

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

Addressing Precipitation Enhancement

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

Addressing Rainwater Harvesting

This management goal is not applicable to the operation of the District as it is cost prohibitive 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, RESOLVED, SIGNED AND DONE IN OPEN MEETING on this the __________ day of _____________, 2018.

____

Leo J. Wick, Sr., President

____

Terry Hays, Vice President

____

Cynthia Rodibaugh, Secretary-Treasurer

____

Harvey Hayek, Director

____

Robert Leer, 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 November 2015.

Adopted Management Plan for the Fayette County Groundwater Conservation District, Approved by the Texas Water Development Board on December 2, 2013.

GAM Run 17-019: Fayette County Groundwater Conservation District Management Plan, by Jerry Shi, Ph.D., P.G. dated January 31, 2018.

Estimated Historical Water Use and 2017 State Water Plan Datasets, by Stephen Allen, P.G., dated May 1, 2018.

GAM RUN 17-030 MAG: Modeled Available Groundwater for the Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, and Brazos River Alluvium Aquifers in Groundwater Management Area 12, by Shirley C. Wade, Ph.D., P.G. and Natalie Ballew, GIT dated December 15, 2017.

GAM RUN 16-025 MAG: Modeled Available Groundwater for the Gulf Coast Aquifer System in Groundwater Management Area 15, by Rohit Raj Goswami, Ph.D., P.E. dated March 22, 2017.

Appendix A

GAM RUN 17-019: FAYETTE COUNTY GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

Jerry Shi, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
(512) 463-5076
January 31, 2018

STATE OF TEXAS
JIANYOU SHI
GEOLOGY
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PROFESSIONAL GEOSCIENTIST

1/31/2018

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GAM RUN 17-019: FAYETTE COUNTY GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

Jerry Shi, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
(512) 463-5076
January 31, 2018

EXECUTIVE SUMMARY:

Texas Water Code, Section 36.1071, Subsection (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 and this information includes:

1. the annual amount of recharge from precipitation, if any, to the groundwater resources within the district;
2. for each aquifer within the district, the annual volume of water that discharges from the aquifer to any surface-water bodies, including lakes, streams, rivers, and springs; 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 September 3, 2018, and submitted to the Executive Administrator of the TWDB on or before October 3, 2018. The current management plan for the Fayette County Groundwater Conservation District expires on December 2, 2018.

The management plan information for the aquifers within Fayette County Groundwater Conservation District was extracted from three groundwater availability models:

1. the groundwater availability model for the central Gulf Coast Aquifer System (Chowdhury and others, 2004);
2. the groundwater availability model for the central part of the Carrizo-Wilcox, Queen-City, and Sparta aquifers (Dutton and others, 2003; Kelley and others, 2004); and
3. the groundwater availability model for the Yegua-Jackson Aquifer (Deeds and others, 2010).

This report replaces the results of GAM Run 13-002 (Wade, 2013). GAM Run 17-019 meets current standards set after the release of GAM Run 13-002. Tables 1 through 5 summarize the groundwater availability model data required by statute and Figures 1 through 5 show the area of the models from which the values in the tables were extracted. If after review of the figures, the Fayette County Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB at your earliest convenience.

METHODS:

In accordance with the provisions of the Texas Water Code, Section 36.1071, Subsection (h), groundwater availability models for the central portion of the Gulf Coast Aquifer System (1981 through 1999); the Queen City and Sparta aquifers, which includes the Carrizo-Wilcox Aquifer (1981 through 1999); and the Yegua-Jackson Aquifer (1980 through 1997) were run for this analysis. Water budgets for each year of the transient model periods were extracted using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The average annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district, net cross-formation flow between aquifers, and net flow between aquifer and its brackish portion located within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Carrizo-Wilcox, Queen City, and Sparta Aquifers

- Version 2.02 of the groundwater availability model for the central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers was used for this analysis. See Dutton and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model.

- This groundwater availability model includes eight layers, which generally represent the Sparta Aquifer (Layer 1), the Weches Formation confining unit (Layer 2), the Queen City Aquifer (Layer 3), the Reklaw Formation confining unit (Layer 4), the Carrizo Formation (Layer 5), the Calvert Bluff Formation (Layer 6), the Simsboro Formation (Layer 7), and the Hooper Formation (Layer 8).

- Individual water budgets for the district were determined for the Sparta Aquifer (Layer 1), the Queen City Aquifer (Layer 3), and the Carrizo-Wilcox Aquifer (Layers 5 through 8, collectively).

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

Yegua-Jackson Aquifer

- Version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer was used for this analysis. See Deeds and others (2010) for assumptions and limitations of the groundwater availability model.

- This groundwater availability model includes five layers which represent the outcrop of 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 model was run with MODFLOW-2000 (Harbaugh and others, 2000).

- An overall water budget for the district was determined for the Yegua-Jackson Aquifer (Layer 1 through Layer 5, collectively, for the portions of the model that represent the Yegua-Jackson Aquifer).

Gulf Coast Aquifer System

- Version 1.01 of the groundwater availability model for the Central Gulf Coast Aquifer System was used for this analysis. 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 model has four layers which represent 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).
- 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).

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 model results for the aquifers located within the district and averaged over the duration of the calibration and verification portion of the model runs in the district. The components of the modified budget shown in tables 1 through 5 include:

- 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.
- Surface-water outflow—the total water discharging from the aquifer (outflow) to surface-water features such as streams, reservoirs, and springs.
- Flow into and out of district—the lateral flow within the aquifer between the district and adjacent counties.
- 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. 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 district or county boundaries, 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 (Figures 1 through 5).

TABLE 1: SUMMARIZED INFORMATION FOR THE CARRIZO-WILCOX AQUIFER THAT IS NEEDED FOR FAYETTE COUNTY GROUNDWATER CONSERVATION DISTRICT'S 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	7,133
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo-Wilcox Aquifer	2,980
Estimated net annual volume of flow between each aquifer in the district	From the Carrizo-Wilcox Aquifer into the Reklaw Confining Unit	217
	From the Carrizo-Wilcox Aquifer into its brackish portion	4,090

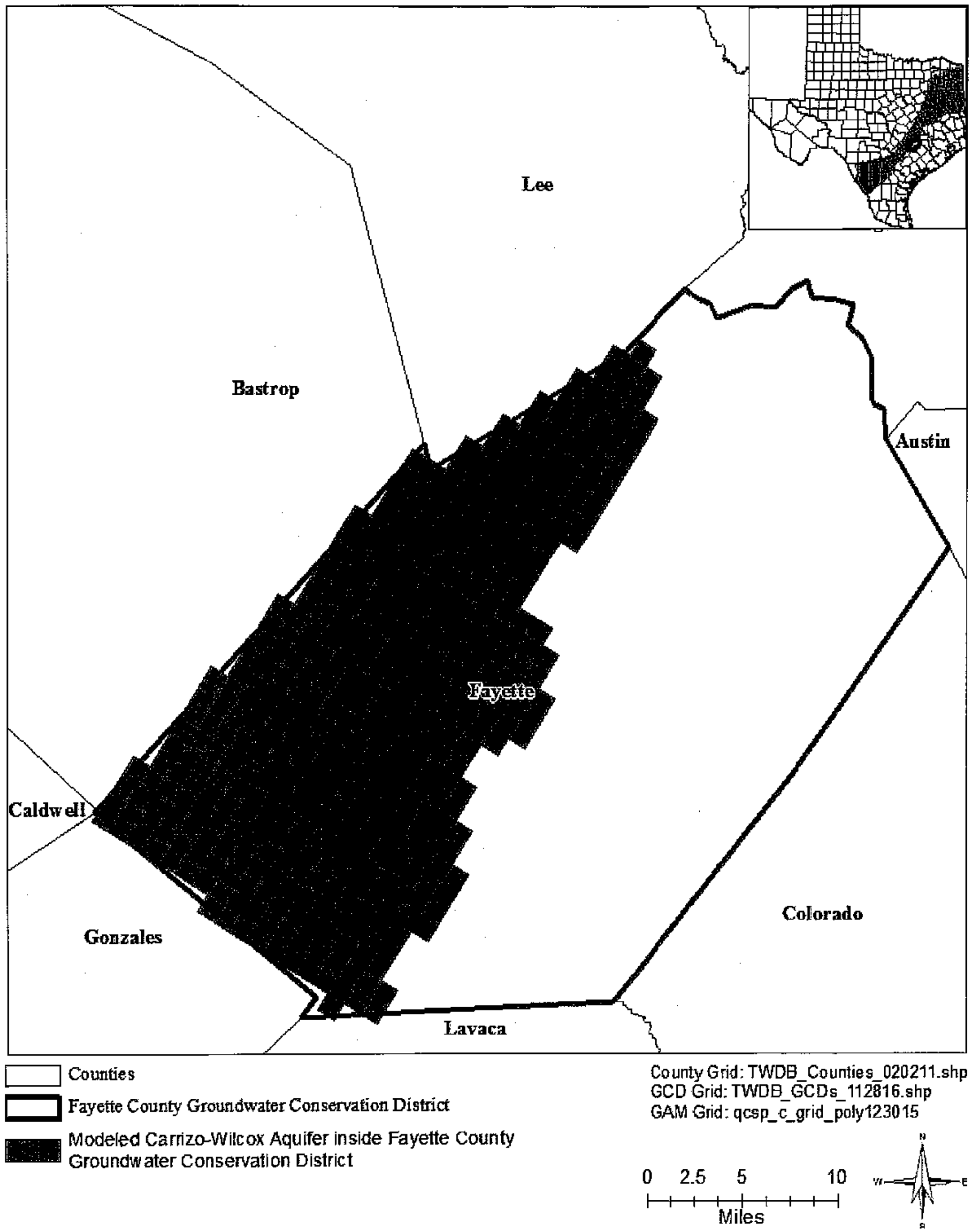


FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE CARRIZO-WILCOX AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE QUEEN CITY AQUIFER THAT IS NEEDED FOR FAYETTE COUNTY GROUNDWATER CONSERVATION DISTRICT'S 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	1,932
Estimated annual volume of flow out of the district within each aquifer in the district	Queen City Aquifer	505
Estimated net annual volume of flow between each aquifer in the district	From the Queen City Aquifer into the Weches Confining Unit	1,417
	From the Reklaw Confining Unit into the Queen City Aquifer	181
	From the Queen City Aquifer into its brackish portion	79

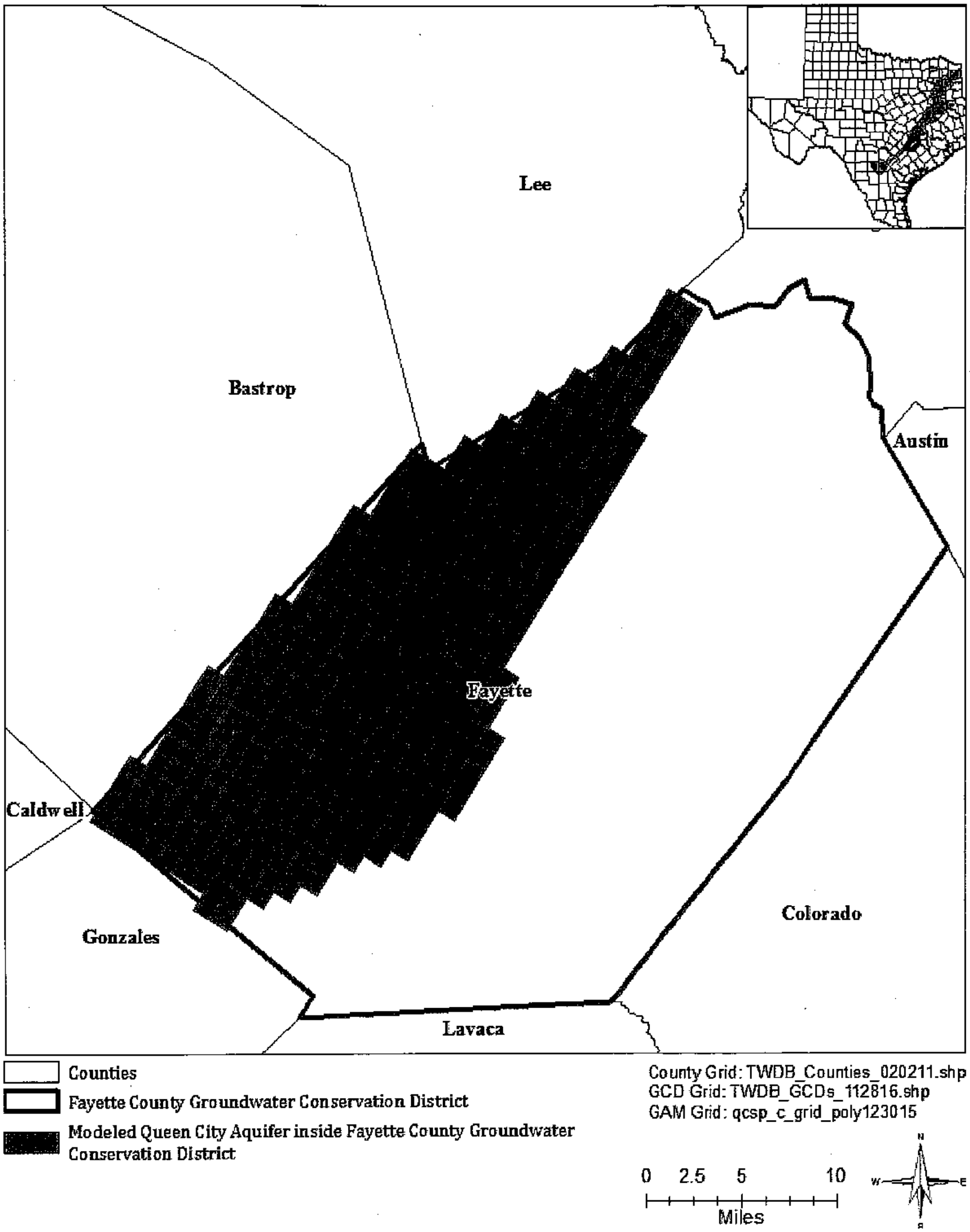


FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE QUEEN CITY AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 3: SUMMARIZED INFORMATION FOR THE SPARTA AQUIFER THAT IS NEEDED FOR FAYETTE COUNTY GROUNDWATER CONSERVATION DISTRICT'S 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	382
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	516
Estimated annual volume of flow out of the district within each aquifer in the district	Sparta Aquifer	197
Estimated net annual volume of flow between each aquifer in the district	From the Sparta Aquifer into the overlying younger units	1,666
	From the Weches Confining Unit into the Sparta Aquifer	1,522
	From the Sparta Aquifer into its brackish portion	15

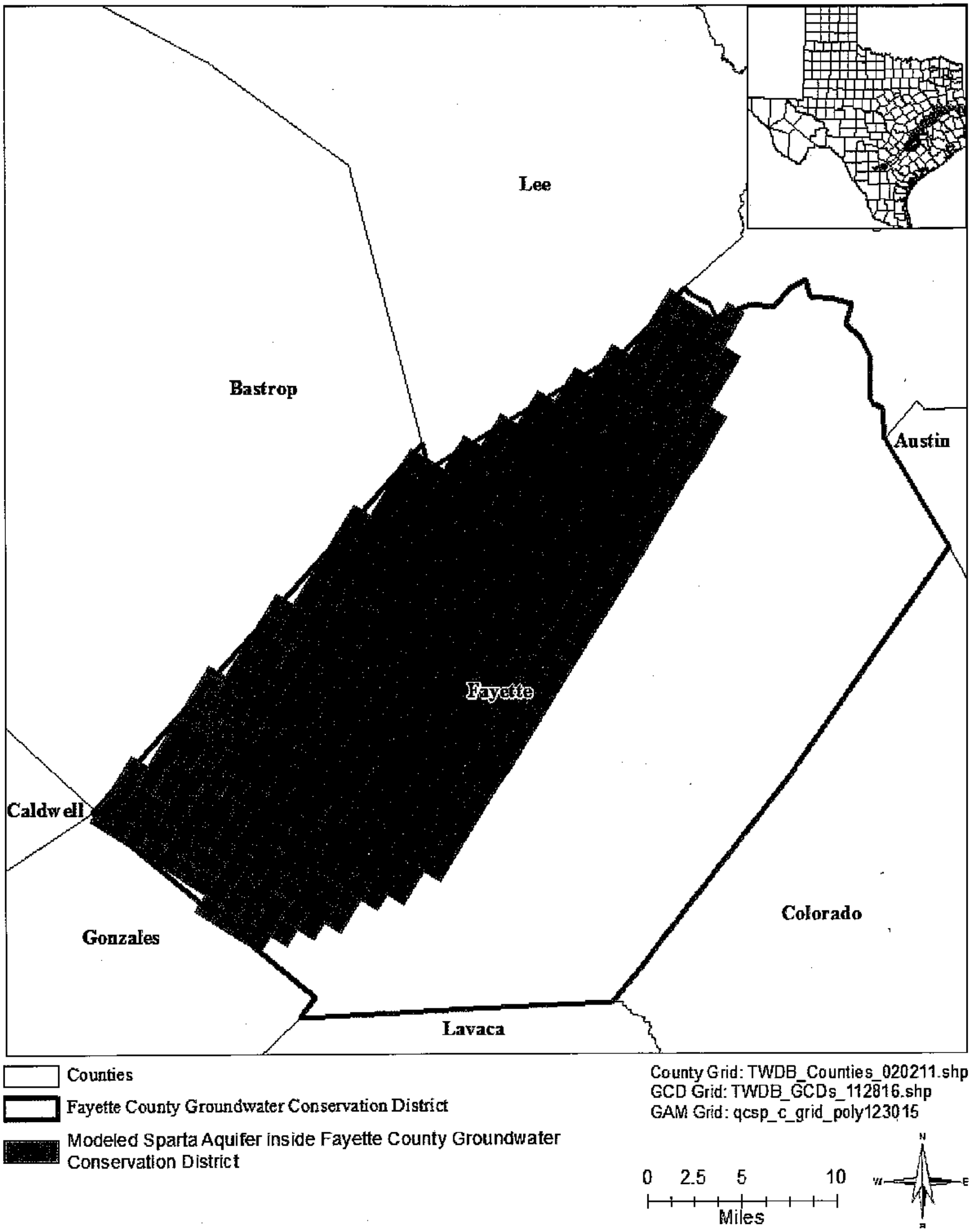


FIGURE 3: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (THE SPARTA AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 4: SUMMARIZED INFORMATION FOR THE YEGUA-JACKSON AQUIFER THAT IS NEEDED FOR FAYETTE COUNTY GROUNDWATER CONSERVATION DISTRICT'S 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	47,304
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	59,161
Estimated annual volume of flow into the district within each aquifer in the district	Yegua-Jackson Aquifer	9,885
Estimated annual volume of flow out of the district within each aquifer in the district	Yegua-Jackson Aquifer	7,045
Estimated net annual volume of flow between each aquifer in the district	From the Yegua-Jackson Aquifer into the Catahoula Formation	18
	From the Yegua-Jackson Aquifer into its brackish portion	193

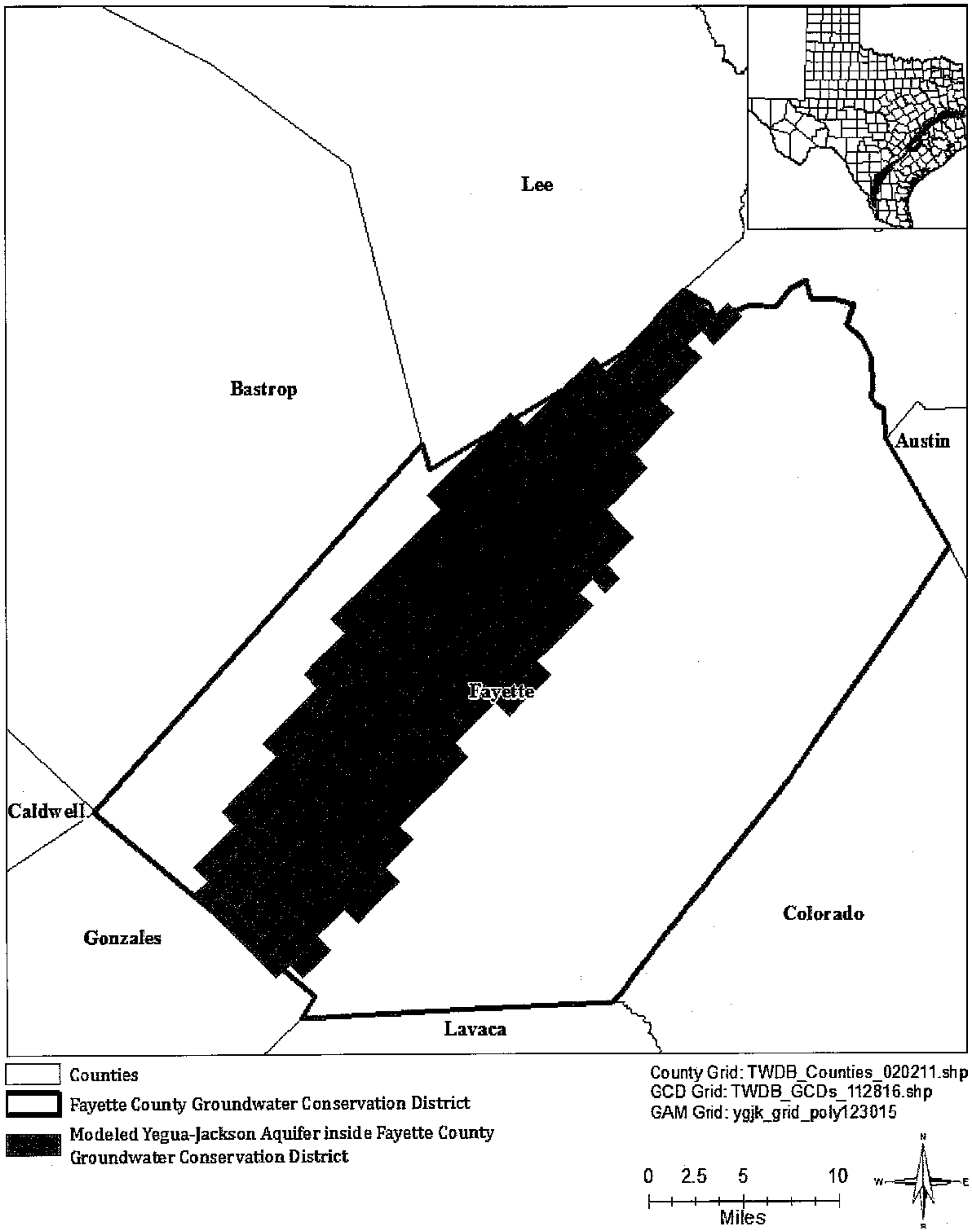


FIGURE 4: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE YEGUA-JACKSON AQUIFER FROM WHICH THE INFORMATION IN TABLE 4 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 5: SUMMARIZED INFORMATION FOR THE GULF COAST AQUIFER SYSTEM THAT IS NEEDED FOR FAYETTE COUNTY GROUNDWATER CONSERVATION DISTRICT'S 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	From the Yegua-Jackson Aquifer into the Catahoula Formation	18*

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

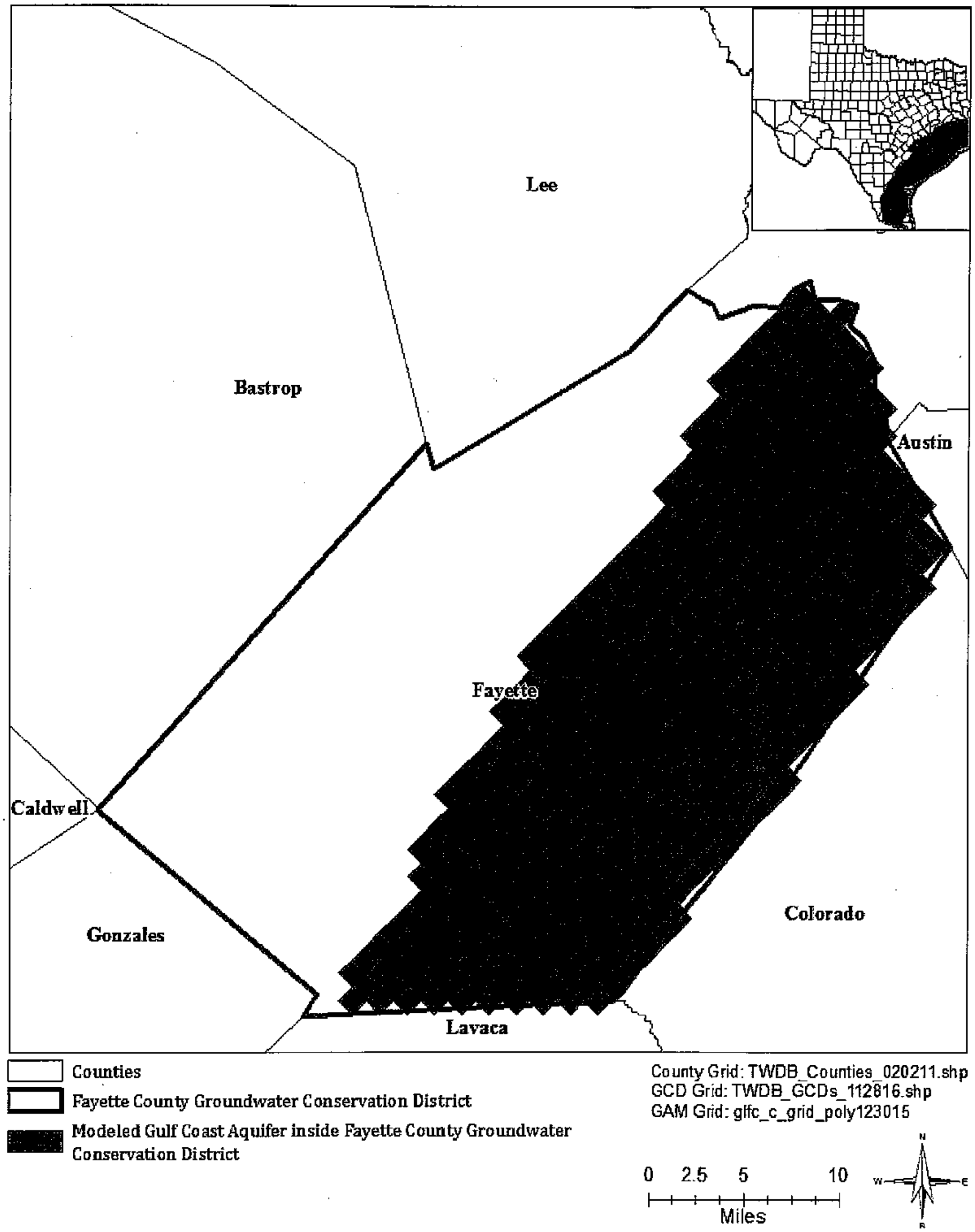


FIGURE 5: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE GULF COAST AQUIFER SYSTEM FROM WHICH THE INFORMATION IN TABLE 5 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

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 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 interaction with streams are specific to particular historic time periods.

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

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

REFERENCES:

Chowdhury, Ali. H., Wade, S., Mace, R.E., and Ridgeway, C., 2004, Groundwater Availability Model of the Central Gulf Coast Aquifer System: Numerical Simulations through 1999- Model Report, 114 p., http://www.twdb.texas.gov/groundwater/models/gam/glfc_c/TWDB_Recalibration_Report.pdf.

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

Dutton, A.R., R.W. Harden, J.P. Nicot, and D. O'Rourke, 2003, Groundwater Availability Model for the Central Part of the Carrizo-Wilcox Aquifer in Texas,The University of Texas at Austin, Bureau of Economic Geology, Prepared for the Texas Water Development Board, 295 p.

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

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

Harbaugh, A.W. and McDonald, M.G., 1996, User's documentation for MODFLOW-96, an update to the U.S. Geological Survey Modular Finite-Difference Ground-Water Flow Model: U.S. Geological Survey, Open-File Report 96-485.

Kelley, V.A., Deeds, N.E., Fryar, D.G., and Nicot, J.P., 2004, Groundwater availability models for the Queen City and Sparta aquifers: Contract report to the Texas Water Development Board, 867 p., http://www.twdb.texas.gov/groundwater/models/gam/qcsp/QCSP_Model_Report.pdf.

National Research Council, 2007, Models in Environmental Regulatory Decision Making Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p.

Wade, S., 2013, GAM Run 13-002: Fayette County Groundwater Conservation District Management Plan, 19 p., http://www.twdb.texas.gov/groundwater/docs/GAMruns/GR13-002.pdf?d=1509480605960.

Waterstone Environmental Hydrology and Engineering Inc. and Parsons, 2003, Groundwater availability of the Central Gulf Coast Aquifer: Numerical Simulations to 2050, Central Gulf Coast, Texas Contract report to the Texas Water Development Board, 157 p.

Appendix B

Estimated Historical Water Use And 2017 State Water Plan Datasets:

Fayette County Groundwater Conservation District

by Stephen Allen
Texas Water Development Board
Groundwater Division
Groundwater Technical Assistance Section
stephen.allen@twdb.texas.gov
(512) 463-7317
May 1, 2018

GROUNDWATER MANAGEMENT PLAN DATA:

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

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

The five reports included in this part are:

1. Estimated Historical Water Use (checklist item 2)

   from the TWDB Historical Water Use Survey (WUS)

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

   from the 2017 Texas State Water Plan (SWP)

Part 2 of the 2-part package is the groundwater availability model (GAM) report for the District (checklist items 3 through 5). The District should have received, or will receive, this report from the Groundwater Availability Modeling Section. Questions about the GAM can be directed to Dr. Shirley Wade, shirley.wade@twdb.texas.gov, (512) 936-0883.

DISCLAIMER:

The data presented in this report represents the most up-to-date WUS and 2017 SWP data available as of 5/1/2018. 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 2017 SWP. District personnel must review these datasets and correct any discrepancies in order 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 2017 SWP dataset can be verified by contacting Sabrina Anderson (sabrina.anderson@twdb.texas.gov or 512-936-0886).

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 2016. TWDB staff anticipates the calculation and posting of these estimates at a later date.

FAYETTE COUNTY

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2015	GW	2,858	363	194	15	378	175	3,983
	SW	0	0	22	8,696	94	1,577	10,389
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	176	16	418	145	4,199
	SW	0	0	18	21,577	76	1,302	22,973
2012	GW	3,131	280	98	12	1,091	167	4,779
	SW	0	0	9	14,138	76	1,503	15,726
2011	GW	3,828	285	57	9	1,579	186	5,944
	SW	0	0	172	48,669	76	1,675	50,592
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
2003	GW	2,926	160	10	0	691	137	3,924
	SW	0	0	0	4,759	326	2,180	7,265
2002	GW	2,782	134	10	0	511	139	3,576
	SW	42	0	0	6,993	209	2,205	9,449
2001	GW	2,748	128	5	0	522	138	3,541
	SW	0	0	0	23,427	213	2,195	25,835
2000	GW	3,150	114	3	0	559	239	4,065
	SW	0	0	0	3,145	230	2,155	5,530

Projected Surface Water Supplies
TWDB 2017 State Water Plan Data

FAYETTE COUNTY

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	102	102	102	102	102	102
K	LIVESTOCK, FAYETTE	COLORADO	COLORADO LIVESTOCK LOCAL SUPPLY	1,746	1,746	1,746	1,746	1,746	1,746
K	LIVESTOCK, FAYETTE	GUADALUPE	GUADALUPE LIVESTOCK LOCAL SUPPLY	108	108	108	108	108	108
K	LIVESTOCK, FAYETTE	LAVACA	LAVACA LIVESTOCK LOCAL SUPPLY	386	386	386	386	386	386
K	STEAM ELECTRIC POWER, FAYETTE	COLORADO	COLORADO RUN-OF-RIVER	871	871	871	871	871	871
K	STEAM ELECTRIC POWER, FAYETTE	COLORADO	HIGHLAND LAKES LAKE/RESERVOIR SYSTEM	45,117	45,117	45,117	45,117	45,117	45,117
	Sum of Projected Surface Water Supplies (acre-feet)			**48,330**	**48,330**	**48,330**	**48,330**	**48,330**	**48,330**

Projected Water Demands
TWDB 2017 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

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
K	AQUA WSC	COLORADO	4	5	5	5	6	6
K	COUNTY-OTHER, FAYETTE	COLORADO	885	968	1,021	1,070	1,117	1,156
K	COUNTY-OTHER, FAYETTE	GUADALUPE	38	41	43	46	48	50
K	COUNTY-OTHER, FAYETTE	LAVACA	313	343	361	379	396	409
K	FAYETTE WSC	COLORADO	639	709	755	795	831	860
K	FAYETTE WSC	GUADALUPE	42	46	49	52	54	56
K	FAYETTE WSC	LAVACA	76	83	89	94	98	101
K	FLATONIA	GUADALUPE	64	71	76	80	83	86
K	FLATONIA	LAVACA	270	301	321	339	356	368
K	IRRIGATION, FAYETTE	COLORADO	380	355	332	311	292	276
K	IRRIGATION, FAYETTE	GUADALUPE	62	58	55	51	48	45
K	IRRIGATION, FAYETTE	LAVACA	181	170	158	149	140	132
K	LA GRANGE	COLORADO	865	959	1,020	1,075	1,123	1,162
K	LEE COUNTY WSC	COLORADO	148	164	174	184	192	198
K	LIVESTOCK, FAYETTE	COLORADO	1,903	1,903	1,903	1,903	1,903	1,903
K	LIVESTOCK, FAYETTE	GUADALUPE	108	108	108	108	108	108
K	LIVESTOCK, FAYETTE	LAVACA	386	386	386	386	386	386
K	MANUFACTURING, FAYETTE	LAVACA	358	395	431	462	501	543
K	MINING, FAYETTE	COLORADO	2,046	1,646	1,187	744	291	284
K	MINING, FAYETTE	GUADALUPE	126	102	73	45	18	17
K	MINING, FAYETTE	LAVACA	354	284	205	129	50	49
K	SCHULENBURG	LAVACA	735	821	878	927	970	1,003
K	STEAM ELECTRIC POWER, FAYETTE	COLORADO	35,702	35,702	37,802	44,102	48,602	53,402
	Sum of Projected Water Demands (acre-feet)		**45,685**	**45,620**	**47,432**	**53,436**	**57,613**	**62,600**

Projected Water Supply Needs
TWDB 2017 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	2	1	1	1	0	0
K	COUNTY-OTHER, FAYETTE	COLORADO	-74	-157	-210	-259	-306	-345
K	COUNTY-OTHER, FAYETTE	GUADALUPE	38	35	33	30	28	26
K	COUNTY-OTHER, FAYETTE	LAVACA	-198	-228	-246	-264	-281	-294
K	FAYETTE WSC	COLORADO	266	196	150	110	74	45
K	FAYETTE WSC	GUADALUPE	15	11	8	5	3	1
K	FAYETTE WSC	LAVACA	25	18	12	7	3	0
K	FLATONIA	GUADALUPE	28	21	16	12	7	4
K	FLATONIA	LAVACA	117	86	66	48	33	21
K	IRRIGATION, FAYETTE	COLORADO	567	592	615	636	655	671
K	IRRIGATION, FAYETTE	GUADALUPE	0	4	7	11	14	17
K	IRRIGATION, FAYETTE	LAVACA	0	11	23	32	41	49
K	LA GRANGE	COLORADO	429	335	274	219	171	132
K	LEE COUNTY WSC	COLORADO	343	324	309	299	282	258
K	LIVESTOCK, FAYETTE	COLORADO	716	716	716	716	716	716
K	LIVESTOCK, FAYETTE	GUADALUPE	179	179	179	179	179	179
K	LIVESTOCK, FAYETTE	LAVACA	176	176	176	176	176	176
K	MANUFACTURING, FAYETTE	LAVACA	-206	-243	-279	-310	-349	-391
K	MINING, FAYETTE	COLORADO	-1,576	-1,176	-717	-274	179	186
K	MINING, FAYETTE	GUADALUPE	-66	-42	-13	15	42	43
K	MINING, FAYETTE	LAVACA	-344	-274	-195	-119	-40	-39
K	SCHULENBURG	LAVACA	1	-85	-142	-191	-234	-267
K	STEAM ELECTRIC POWER, FAYETTE	COLORADO	10,286	10,286	8,186	1,886	-2,614	-7,414
	Sum of Projected Water Supply Needs (acre-feet)		**-2,464**	**-2,205**	**-1,802**	**-1,417**	**-3,824**	**-8,750**

Projected Water Management Strategies
TWDB 2017 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
MUNICIPAL CONSERVATION - AQUA WSC	DEMAND REDUCTION [FAYETTE]	0	1	1	0	1	1
		1	**2**	**2**	**1**	**2**	**2**
COUNTY-OTHER, FAYETTE, COLORADO (K)							
DROUGHT MANAGEMENT	DEMAND REDUCTION [FAYETTE]	133	145	153	161	168	173
EXPANSION OF CURRENT GROUNDWATER SUPPLIES - GULF COAST AQUIFER	GULF COAST AQUIFER [FAYETTE]	345	345	345	345	345	345
		478	**490**	**498**	**506**	**513**	**518**
COUNTY-OTHER, FAYETTE, GUADALUPE (K)							
DROUGHT MANAGEMENT	DEMAND REDUCTION [FAYETTE]	6	6	6	7	7	8
		6	**6**	**6**	**7**	**7**	**8**
COUNTY-OTHER, FAYETTE, LAVACA (K)							
DROUGHT MANAGEMENT	DEMAND REDUCTION [FAYETTE]	47	51	54	57	59	61
EXPANSION OF CURRENT GROUNDWATER SUPPLIES - GULF COAST AQUIFER	GULF COAST AQUIFER [FAYETTE]	294	294	294	294	294	294
		341	**345**	**348**	**351**	**353**	**355**
FAYETTE WSC, COLORADO (K)							
DROUGHT MANAGEMENT	DEMAND REDUCTION [FAYETTE]	96	106	113	119	125	129
		96	**106**	**113**	**119**	**125**	**129**
FAYETTE WSC, GUADALUPE (K)							
DROUGHT MANAGEMENT	DEMAND REDUCTION [FAYETTE]	6	7	7	8	8	8
		6	**7**	**7**	**8**	**8**	**8**
FAYETTE WSC, LAVACA (K)							
DROUGHT MANAGEMENT	DEMAND REDUCTION [FAYETTE]	11	12	13	14	15	15
		11	**12**	**13**	**14**	**15**	**15**
FLATONIA, GUADALUPE (K)							
DROUGHT MANAGEMENT	DEMAND REDUCTION [FAYETTE]	10	11	11	12	12	13

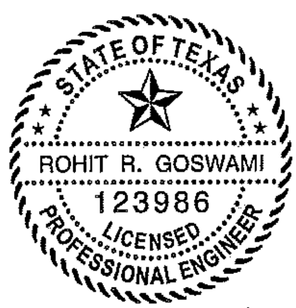
MUNICIPAL CONSERVATION - FLATONIA	DEMAND REDUCTION [FAYETTE]	4	6	9	12	16	20
		14	**17**	**20**	**24**	**28**	**33**
FLATONIA, LAVACA (K)							
DIRECT REUSE - FLATONIA	DIRECT REUSE [FAYETTE]	134	149	159	168	176	182
DROUGHT MANAGEMENT	DEMAND REDUCTION [FAYETTE]	41	45	48	51	53	55
EXPANSION OF CURRENT GROUNDWATER SUPPLIES - GULF COAST AQUIFER	GULF COAST AQUIFER [FAYETTE]	100	100	100	100	100	100
MUNICIPAL CONSERVATION - FLATONIA	DEMAND REDUCTION [FAYETTE]	13	23	34	48	68	85
		288	**317**	**341**	**367**	**397**	**422**
LA GRANGE, COLORADO (K)							
DROUGHT MANAGEMENT	DEMAND REDUCTION [FAYETTE]	130	144	153	161	168	174
MUNICIPAL CONSERVATION - LA GRANGE	DEMAND REDUCTION [FAYETTE]	42	21	0	0	0	0
		172	**165**	**153**	**161**	**168**	**174**
LEE COUNTY WSC, COLORADO (K)							
DROUGHT MANAGEMENT	DEMAND REDUCTION [FAYETTE]	30	33	35	37	38	40
		30	**33**	**35**	**37**	**38**	**40**
MANUFACTURING, FAYETTE, LAVACA (K)							
EXPANSION OF CURRENT GROUNDWATER SUPPLIES - GULF COAST AQUIFER	GULF COAST AQUIFER [FAYETTE]	391	391	391	391	391	391
		391	**391**	**391**	**391**	**391**	**391**
MINING, FAYETTE, COLORADO (K)							
EXPANSION OF CURRENT GROUNDWATER SUPPLIES - GULF COAST AQUIFER	GULF COAST AQUIFER [FAYETTE]	1,576	1,176	717	274	0	0
		1,576	**1,176**	**717**	**274**	**0**	**0**
MINING, FAYETTE, GUADALUPE (K)							
EXPANSION OF CURRENT GROUNDWATER SUPPLIES - SPARTA AQUIFER	SPARTA AQUIFER [FAYETTE]	66	42	13	0	0	0
		66	**42**	**13**	**0**	**0**	**0**
MINING, FAYETTE, LAVACA (K)							
EXPANSION OF CURRENT GROUNDWATER SUPPLIES - GULF COAST AQUIFER	GULF COAST AQUIFER [FAYETTE]	344	344	344	344	344	344
		344	**344**	**344**	**344**	**344**	**344**
SCHULENBURG, LAVACA (K)							
DROUGHT MANAGEMENT	DEMAND REDUCTION [FAYETTE]	110	123	132	139	146	150
MUNICIPAL CONSERVATION - SCHULENBURG	DEMAND REDUCTION [FAYETTE]	37	63	96	141	188	232
		147	**186**	**228**	**280**	**334**	**382**
STEAM ELECTRIC POWER, FAYETTE, COLORADO (K)							

CITY OF AUSTIN - LAKE LONG ENHANCED STORAGE	LAKE LONG/RESERVOIR [RESERVOIR]	2,000	2,000	2,000	2,000	2,000	2,000
LCRA - GROUNDWATER SUPPLY FOR FPP (OFF-SITE)	CARRIZO-WILCOX AQUIFER [FAYETTE]	500	500	500	500	500	500
LCRA - GROUNDWATER SUPPLY FOR FPP (OFF-SITE)	YEGUA-JACKSON AQUIFER [FAYETTE]	2,000	2,000	2,000	2,000	2,000	2,000
LCRA - GROUNDWATER SUPPLY FOR FPP (ON-SITE)	GULF COAST AQUIFER [FAYETTE]	700	700	700	700	700	700
LCRA - LANE CITY RESERVOIR	LCRA NEW OFF-CHANNEL RESERVOIRS (2020 DECADE) [RESERVOIR]	6,000	7,000	9,000	11,000	13,000	15,000
		11,200	**12,200**	**14,200**	**16,200**	**18,200**	**20,200**
Sum of Projected Water Management Strategies (acre-feet)		**15,167**	**15,839**	**17,429**	**19,084**	**20,923**	**23,021**

Appendix C

GAM RUN 16-025 MAG: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 15

Rohit Raj Goswami, Ph.D., P.E.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Section
(512) 463-0495
March 22, 2017



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GAM Run 16-025 MAG:
Modeled Available Groundwater for the Gulf Coast Aquifer System in Groundwater Management Area 15

Rohit Raj Goswami, Ph.D., P.E.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Section
(512) 463-0495
March 22, 2017

EXECUTIVE SUMMARY:

The modeled available groundwater for Groundwater Management Area 15 for the Gulf Coast Aquifer System is summarized by decade for the groundwater conservation districts (Table 1) and for use in the regional water planning process (Table 2). The modeled available groundwater estimates range from approximately 515,000 acre-feet per year in 2020 to approximately 518,000 acre-feet per year in 2069(Table 1). The estimates were extracted from results of a model run using the groundwater availability model for the central part of the Gulf Coast Aquifer System (version 1.01). The model run files, which meet the desired future conditions adopted by district representatives of Groundwater Management Area 15, were submitted to the Texas Water Development Board (TWDB) on June 28, 2016, as part of the Desired Future Conditions Explanatory Report for Groundwater Management Area 15. The explanatory report and other materials submitted to the Texas Water Development Board (TWDB) were determined to be administratively complete on October 20, 2016.

REQUESTOR:

Mr. Tim Andruss, chair of Groundwater Management Area 15.

DESCRIPTION OF REQUEST:

In a letter dated June 23, 2016, Mr. Tim Andruss provided the TWDB with the desired future conditions of the Gulf Coast Aquifer System adopted by the groundwater conservation districts in Groundwater Management Area 15. The Gulf Coast Aquifer System includes the Chicot Aquifer, Evangeline Aquifer, Burkeville Confining Unit and the Jasper Aquifer (including parts of the Catahoula Formation). TWDB staff worked with INTERA Incorporated, the consultant for Groundwater Management Area 15, in reviewing model files associated with the desired future conditions. We received clarification from INTERA Incorporated, on behalf of Groundwater Management Area 15, on September 18, 2016, concerning assumptions on variances of average drawdown values per county to model results, which was ±3.5 feet for nearly all areas within the Groundwater Management Area 15. The exception is Goliad County which has a variance in drawdown of ±5 feet. The desired future conditions for the Gulf Coast Aquifer System, as described in Resolution No. 2016-01 and adopted April 29, 2016, by the groundwater conservation districts within Groundwater Management Area 15, are described below:

Groundwater Management Area 15 [all counties]

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 13 feet in December 2069 from estimated year 2000 conditions.

Aransas County

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 0 feet in December 2069 from estimated year 2000 conditions.

Bee County

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 7 feet in December 2069 from estimated year 2000 conditions.

Calhoun County

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 5 feet in December 2069 from estimated year 2000 conditions.

Colorado County

Drawdown shall not exceed an average of 17 feet in Chicot and Evangeline Aquifers and 23 feet in in the Jasper Aquifer in December 2069 from estimated year 2000 conditions.

DeWitt County

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 17 feet in December 2069 from estimated year 2000 conditions.

Fayette County

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 16 feet in December 2069 from estimated year 2000 conditions.

Goliad County

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 10 feet in December 2069 from estimated year 2000 conditions.

Jackson County

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 15 feet in December 2069 from estimated year 2000 conditions.

Karnes County

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 22 feet in December 2069 from estimated year 2000 conditions.

Lavaca County

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 18 feet in December 2069 from estimated year 2000 conditions.

Matagorda County

Drawdown shall not exceed an average of 11 feet in Chicot and Evangeline Aquifers in December 2069 from estimated year 2000 conditions.

Refugio County

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 5 feet in December 2069 from estimated year 2000 conditions.

Victoria County

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 5 feet in December 2069 from estimated year 2000 conditions.

Wharton County

Drawdown shall not exceed an average of 15 feet in Chicot and Evangeline Aquifers in December 2069 from estimated year 2000 conditions.

Based on the adopted desired future conditions, TWDB has estimated the modeled available groundwater for the Gulf Coast Aquifer System in Groundwater Management Area 15.

METHODS:

The groundwater availability model for the central part of the Gulf Coast Aquifer System (Figure 1) was run using the model files submitted with the explanatory report (GMA 15 and others, 2016). Model-calculated water levels were extracted for the year 2000 and the end of the year 2069, and drawdown was calculated as the difference between water levels at the beginning of 2000 and water levels at the end of 2069. Drawdown averages were calculated for each county by aquifer and for the entire Groundwater Management Area 15 by aquifer. As specified in the explanatory report (GMA 15 and others, 2016), drawdown for cells which became dry during the simulation (water level dropped below the base of the cell) were excluded from the averaging. The calculated drawdown averages were compared with the desired future conditions to verify that the pumping scenario achieved the desired future conditions within one foot.

The 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 are presented by county and groundwater conservation district, subtotaled by groundwater conservation district, and then summed by Groundwater Management Area 15 (Figure 2 and Table 1). Annual pumping rates are also presented by county, river basin, and regional water planning area within Groundwater Management Area 15 (Figure 2 and Table 2).

Modeled Available Groundwater and Permitting

As defined in Chapter 36 of the Texas Water Code, "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 are described below:

- Version 1.01 of the groundwater availability model for the central portion of the Gulf Coast Aquifer System was used for this analysis. See Chowdhury and others (2004) and Waterstone and others (2003) for assumptions and limitations of the model.
- The model has four layers which represent 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).
- The model was run with MODFLOW-96 (Harbaugh and others, 1996).
- Drawdown averages and modeled available groundwater values are based on the extent of the model area rather than official aquifer boundaries (Figures 1 and 2).
- Drawdown for cells with water levels below the base elevation of the cell ("dry" cells) were excluded from the averaging per emails exchanged with INTERA, Inc. dated October 21, 2015.
- Estimates of modeled available groundwater from the model simulation were rounded to whole numbers.
- A model drawdown tolerance of up to 5 feet was assumed for Goliad County and up to 3.5 feet for the rest of Groundwater Management Area 15 when comparing desired future conditions (average drawdown values per county) to model drawdown results.
- Average drawdown by county may include some model cells that represent portions of surface water such as bays, reservoirs, and the Gulf of Mexico.

RESULTS:

The modeled available groundwater for the Gulf Coast Aquifer System that achieves the desired future conditions adopted by Groundwater Management Area 15 increases from approximately 515,000 acre-feet per year in 2020 to approximately 518,000 acre-feet per year in 2069 (Table 1). The modeled available groundwater is summarized by groundwater conservation district and county (Table 1). The modeled available groundwater has also been summarized by county, river basin, and regional water planning area for use in the regional water planning process (Table 2). Small differences of values between table summaries are due to rounding.

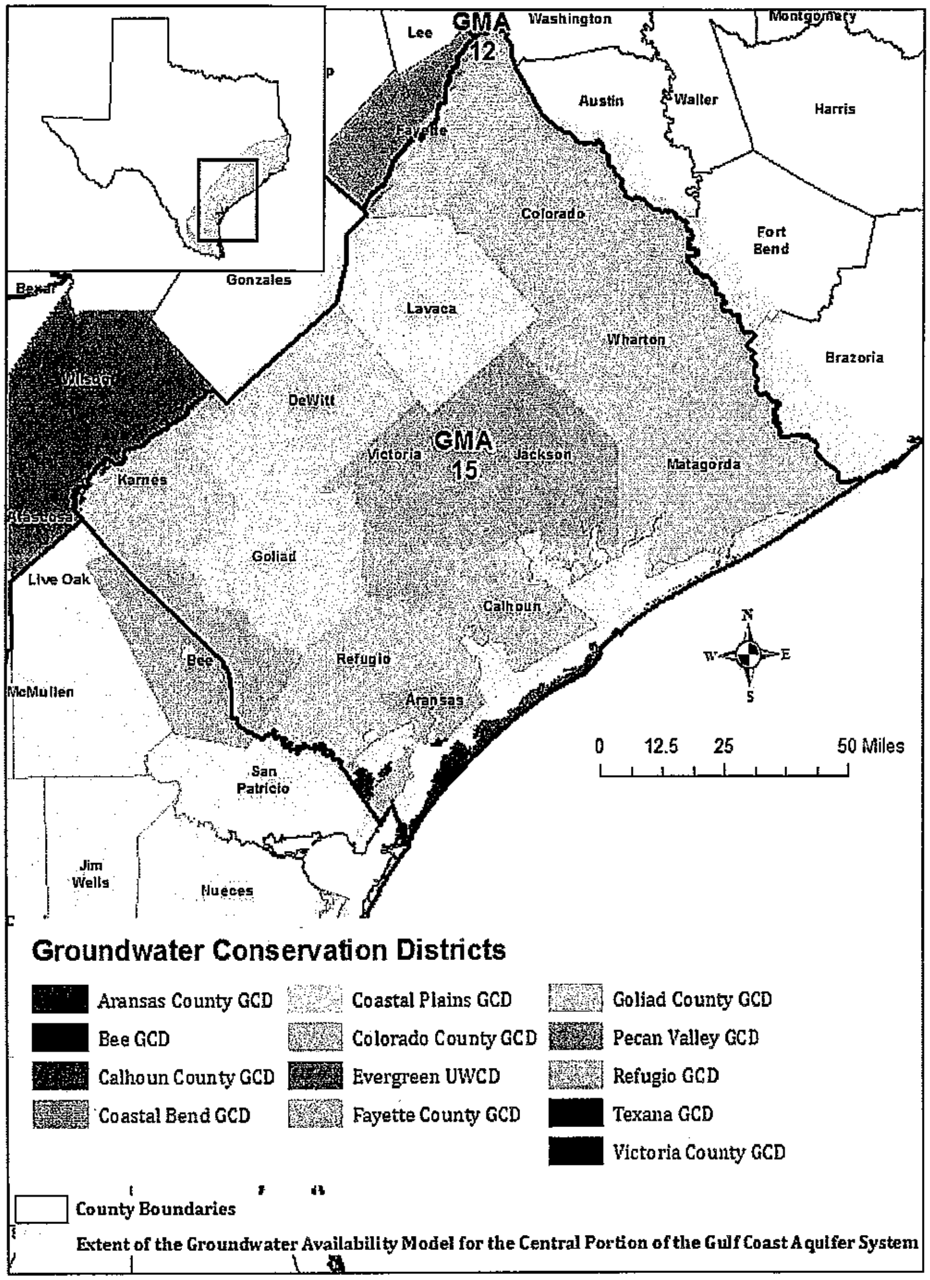

FIGURE 1. **MAP SHOWING GROUNDWATER CONSERVATION DISTRICTS (GCDS) AND COUNTIES IN GROUNDWATER MANAGEMENT AREA 15 OVERLAIN ON THE EXTENT OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PORTION OF THE GULF COAST AQUIFER SYSTEM.**

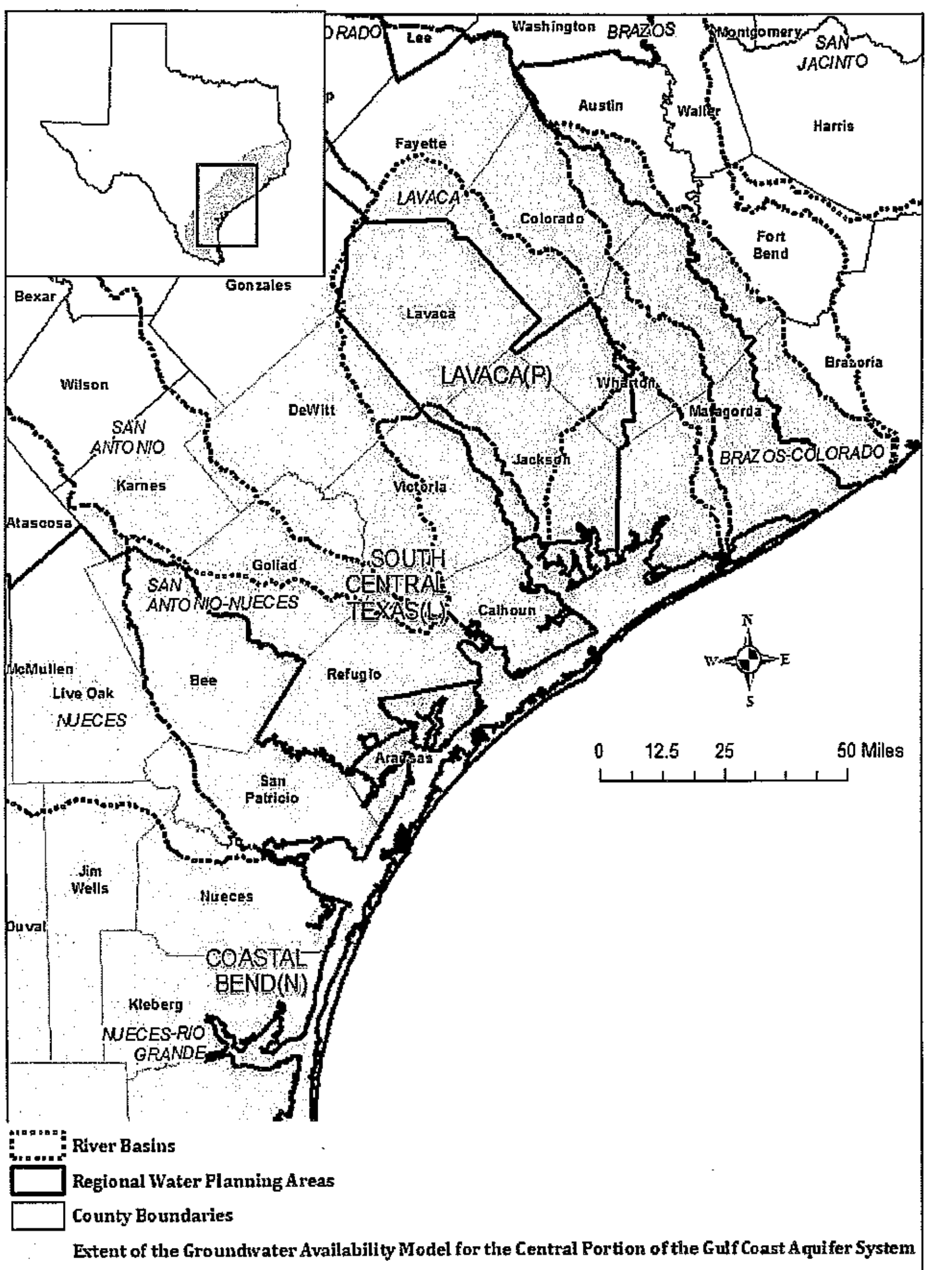

FIGURE 2. **MAP SHOWING REGIONAL WATER PLANNING AREAS, GROUNDWATER CONSERVATION DISTRICTS (GCDS), COUNTIES, AND RIVER BASINS IN GROUNDWATER MANAGEMENT AREA 15 OVERLAIN ON THE EXTENT OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PORTION OF THE GULF COAST AQUIFER SYSTEM.**

TABLE 1. 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 2010 AND 2069. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2010	2020	2030	2040	2050	2060	2069
Aransas County GCD Total	**Aransas**	**Gulf Coast Aquifer System**	**1,542**	**1,542**	**1,542**	**1,542**	**1,542**	**1,542**	**1,542**
Bee County GCD Total	**Bee**	**Gulf Coast Aquifer System**	**9,456**	**9,456**	**9,431**	**9,431**	**9,379**	**9,379**	**9,361**
Calhoun County GCD Total	**Calhoun**	**Gulf Coast Aquifer System**	**2,569**	**7,565**	**7,565**	**7,565**	**7,565**	**7,565**	**7,565**
Coastal Bend GCD Total	**Wharton**	**Gulf Coast Aquifer System (Chicot and Evangeline)**	**181,168**	**181,168**	**181,168**	**181,168**	**181,168**	**181,168**	**181,168**
Coastal Plains GCD Total	**Matagorda**	**Gulf Coast Aquifer System (Chicot and Evangeline)**	**38,828**	**38,828**	**38,828**	**38,828**	**38,828**	**38,828**	**38,828**
Colorado County GCD	Colorado	Gulf Coast Aquifer System (Chicot and Evangeline)	79,780	74,964	74,964	72,765	72,765	71,618	71,618
Colorado County GCD	Colorado	Gulf Coast Aquifer System (Jasper)	918	918	918	918	918	918	918
Colorado County GCD Total	**Colorado**	**Gulf Coast Aquifer System**	**80,698**	**75,882**	**75,882**	**73,683**	**73,683**	**72,536**	**72,536**
Evergreen UWCD Total	**Karnes**	**Gulf Coast Aquifer System**	**10,196**	**10,196**	**10,196**	**3,015**	**2,917**	**2,751**	**2,751**
Fayette County GCD Total	**Fayette**	**Gulf Coast Aquifer System**	**1,977**	**1,853**	**1,853**	**1,853**	**1,853**	**1,853**	**1,703**
Goliad County GCD Total	**Goliad**	**Gulf Coast Aquifer System**	**11,420**	**11,539**	**11,539**	**11,539**	**11,539**	**11,552**	**11,539**

Groundwater Conservation District	County	Aquifer	2010	2020	2030	2040	2050	2060	2069
Pecan Valley GCD Total	**DeWitt**	**Gulf Coast Aquifer System**	**15,471**	**15,476**	**15,476**	**14,485**	**14,485**	**14,485**	**14,485**
Refugio GCD Total	**Refugio**	**Gulf Coast Aquifer System**	**5,847**	**5,847**	**5,847**	**5,847**	**5,847**	**5,847**	**5,847**
Texana GCD Total	**Jackson**	**Gulf Coast Aquifer System**	**76,787**	**90,482**	**90,482**	**90,482**	**90,482**	**90,482**	**90,482**
Victoria County GCD Total	**Victoria**	**Gulf Coast Aquifer System**	**35,640**	**44,974**	**49,970**	**54,966**	**54,966**	**59,963**	**59,963**
Total (GCDs)		**Gulf Coast Aquifer System**	**471,599**	**494,808**	**499,779**	**494,404**	**494,254**	**497,951**	**497,770**
No District-County	Bee	Gulf Coast Aquifer System	10	10	10	10	10	10	10
No District-County	Lavaca	Gulf Coast Aquifer System	20,253	20,253	20,253	20,253	20,253	20,253	20,239
No district-County Total		**Gulf Coast Aquifer System**	**20,263**	**20,263**	**20,263**	**20,263**	**20,263**	**20,263**	**20,249**
Total for GMA 15		**Gulf Coast Aquifer System**	**491,862**	**515,071**	**520,042**	**514,667**	**514,517**	**518,214**	**518,019**

TABLE 2 MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 15. 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	2020	2030	2040	2050	2060
Aransas	N	San Antonio- Nueces	Gulf Coast Aquifer System	1,542	1,542	1,542	1,542	1,542
Bee	N	San Antonio- Nueces	Gulf Coast Aquifer System	9,439	9,414	9,414	9,362	9,362
Bee	N	Nueces	Gulf Coast Aquifer System	27	27	27	27	27
Calhoun	L	Colorado- Lavaca	Gulf Coast Aquifer System	5,210	5,210	5,210	5,210	5,210
Calhoun	L	Guadalupe	Gulf Coast Aquifer System	18	18	18	18	18
Calhoun	L	Lavaca-Guadalupe	Gulf Coast Aquifer System	2,330	2,330	2,330	2,330	2,330
Calhoun	L	San Antonio- Nueces	Gulf Coast Aquifer System	7	7	7	7	7
Colorado	K	Brazos-Colorado	Gulf Coast Aquifer System (Chicot and Evangeline)	15,342	15,342	15,342	15,342	15,342
Colorado	K	Brazos-Colorado	Gulf Coast Aquifer System (Jasper Aquifer)	49	49	49	49	49
Colorado	K	Colorado	Gulf Coast Aquifer System (Chicot and Evangeline)	20,506	20,506	20,066	20,066	20,066
Colorado	K	Colorado	Gulf Coast Aquifer System (Jasper Aquifer)	273	273	273	273	273
Colorado	K	Lavaca	Gulf Coast Aquifer System (Chicot and Evangeline)	39,116	39,116	37,357	37,357	36,210
Colorado	K	Lavaca	Gulf Coast Aquifer System (Jasper Aquifer)	596	596	596	596	596
Dewitt	L	Guadalupe	Gulf Coast Aquifer System	11,358	11,358	10,470	10,470	10,470
Dewitt	L	Lavaca-Guadalupe	Gulf Coast Aquifer System	417	417	417	417	417
Dewitt	L	Lavaca	Gulf Coast Aquifer System	2,935	2,935	2,935	2,874	2,874
Dewitt	L	San Antonio	Gulf Coast Aquifer System	766	766	724	724	724

County	RWPA	River Basin	Aquifer	2020	2030	2040	2050	2060
Fayette	K	Brazos	Gulf Coast Aquifer System	2	2	2	2	2
Fayette	K	Colorado	Gulf Coast Aquifer System	989	989	989	989	989
Fayette	K	Lavaca	Gulf Coast Aquifer System	862	862	862	862	862
Goliad	L	Guadalupe	Gulf Coast Aquifer System	4,377	4,377	4,377	4,377	4,380
Goliad	L	San Antonio- Nueces	Gulf Coast Aquifer System	1,190	1,190	1,190	1,190	1,195
Goliad	L	San Antonio	Gulf Coast Aquifer System	5,972	5,972	5,972	5,972	5,977
Jackson	P	Colorado-Lavaca	Gulf Coast Aquifer System	28,025	28,025	28,025	28,025	28,025
Jackson	P	Lavaca-Guadalupe	Gulf Coast Aquifer System	12,875	12,875	12,875	12,875	12,875
Jackson	P	Lavaca	Gulf Coast Aquifer System	49,582	49,582	49,582	49,582	49,582
Karnes	L	Guadalupe	Gulf Coast Aquifer System	11	11	11	11	11
Karnes	L	Nueces	Gulf Coast Aquifer System	1,057	1,057	78	78	78
Karnes	L	San Antonio	Gulf Coast Aquifer System	9,082	9,082	2,880	2,782	2,616
Karnes	L	San Antonio-Nueces	Gulf Coast Aquifer System	46	46	46	46	46
Lavaca	P	Guadalupe	Gulf Coast Aquifer System	41	41	41	41	41
Lavaca	P	Lavaca-Guadalupe	Gulf Coast Aquifer System	401	401	401	401	401
Lavaca	P	Lavaca	Gulf Coast Aquifer System	19,811	19,811	19,811	19,811	19,811
Matagorda	K	Brazos-Colorado	Gulf Coast Aquifer System (Chicot and Evangeline)	15,282	15,282	15,282	15,282	15,282
Matagorda	K	Colorado-Lavaca	Gulf Coast Aquifer System (Chicot and Evangeline)	20,329	20,329	20,329	20,329	20,329
Matagorda	K	Colorado	Gulf Coast Aquifer System (Chicot and Evangeline)	3,217	3,217	3,217	3,217	3,217
Refugio	L	San Antonio- Nueces	Jasper Aquifer	5,526	5,526	5,526	5,526	5,526
Refugio	L	San Antonio	Gulf Coast Aquifer System	321	321	321	321	321
Victoria	L	Guadalupe	Gulf Coast Aquifer System	17,600	22,596	27,592	27,592	27,592
Victoria	L	Lavaca-Guadalupe	Gulf Coast Aquifer System	25,451	25,451	25,451	25,451	30,448
Victoria	L	Lavaca	Gulf Coast Aquifer System	234	234	234	234	234
Victoria	L	San Antonio	Gulf Coast Aquifer System	1,689	1,689	1,689	1,689	1,689

County	RWPA	River Basin	Aquifer	2020	2030	2040	2050	2060
Wharton	K	Brazos-Colorado	Gulf Coast Aquifer System (Chicot and Evangeline)	50,527	50,527	50,527	50,527	50,527
Wharton	K	Colorado-Lavaca	Gulf Coast Aquifer System (Chicot and Evangeline)	16,196	16,196	16,196	16,196	16,196
Wharton	P	Colorado-Lavaca	Gulf Coast Aquifer System (Chicot and Evangeline)	14,091	14,091	14,091	14,091	14,091
Wharton	K	Colorado	Gulf Coast Aquifer System (Chicot and Evangeline)	35,910	35,910	35,910	35,910	35,910
Wharton	P	Colorado	Gulf Coast Aquifer System (Chicot and Evangeline)	873	873	873	873	873
Wharton	K	Lavaca	Gulf Coast Aquifer System (Chicot and Evangeline)	579	579	579	579	579
Wharton	P	Lavaca	Gulf Coast Aquifer System (Chicot and Evangeline)	62,992	62,992	62,992	62,992	62,992
GMA 15 Total			Gulf Coast Aquifer System	515,071	520,042	514,667	514,517	518,214

LIMITATIONS:

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

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

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

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

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

REFERENCES:

Chowdhury, A., Wade, S., Mace, R.E., and Ridgeway, C. 2004. Groundwater Availability of the Central Gulf Coast Aquifer System: Numerical Simulations through 1999: Texas Water Development Board, unpublished report.

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

Harbaugh, A.W. and McDonald, M.G., 1996, User's documentation for MODFLOW-96, an update to the U.S. Geological Survey Modular Finite-Difference Ground-Water Flow Model: U.S. Geological Survey, Open-File Report 96-485.

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

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

Waterstone Engineering, Inc., and Parsons, Inc., 2003, Groundwater Availability of the Central Gulf Coast Aquifer: Numerical Simulations to 2050, Central Gulf Coast, Texas: Contract draft report submitted to Texas Water Development Board

GAM RUN 17-030 MAG: MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX, QUEEN CITY, SPARTA, YEGUA-JACKSON, AND BRAZOS RIVER ALLUVIUM AQUIFERS IN GROUNDWATER MANAGEMENT AREA 12

Shirley C. Wade, Ph.D., P.G. and Natalie Ballew, GIT
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
(512) 936-0883
December 15, 2017

STATE OF TEXAS
SHIRLEY C. WADE
GEOLOGY
No. 525
LICENSED
PROFESSIONAL GEOSCIENTIST

Shirley C. Wade
12/15/17

STATE OF TEXAS
CYNTHIA K. RIDGEWAY
GEOLOGY
No. 471
LICENSED
PROFESSIONAL GEOSCIENTIST

Cynthia K. Ridgeway
12/15/17

Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by Natalie Ballew under her direct supervision.

GAM RUN 17-030 MAG: MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX, QUEEN CITY, SPARTA, YEGUA-JACKSON, AND BRAZOS RIVER ALLUVIUM AQUIFERS IN GROUNDWATER MANAGEMENT AREA 12

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EXECUTIVE SUMMARY:

This report presents modeled available groundwater for Groundwater Management Area 12 for the Carrizo-Wilcox, Queen City, Sparta, Yegua-Jackson, and Brazos River Alluvium aquifers by decade for the groundwater conservation districts (Tables 4 through 11 respectively) and for use in the regional water planning process (Tables 12 through 19 respectively). The total modeled available groundwater estimates for the Carrizo-Wilcox Aquifer range from approximately 135,000 acre-feet per year in 2010 to approximately 260,000 acre-feet per year in 2069 (Tables 4 through 7). The modeled available groundwater estimates for the Queen City Aquifer range from approximately 3,000 acre-feet per year in 2010 to approximately 7,000 acre-feet per year in 2069 (Table 8). The modeled available groundwater estimates for the Sparta Aquifer range from approximately 8,000 acre-feet per year in 2010 to approximately 24,000 acre-feet per year in 2069 (Table 9). The estimates were extracted from results of a model run using the groundwater availability model for the central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers (version 2.02). District representatives in Groundwater Management Area 12 prepared and approved the model run files that meet the desired future condition adopted for the Carrizo-Wilcox, Queen City, and Sparta Aquifers. The files were submitted to the Executive Administrator of the Texas Water Development Board (TWDB) on October 6, 2017, as part of the resubmittal of the Desired Future Conditions Explanatory Report for Groundwater Management Area 12.

TABLE 1 ADOPTED DESIRED FUTURE CONDITIONS FOR THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS IN GROUNDWATER MANAGEMENT AREA 12. VALUES ARE AVERAGE AQUIFER DRAWDOWN IN FEET FROM JANUARY 2000 THROUGH DECEMBER 2069 (DANIEL B. STEPHENS AND ASSOCIATES AND OTHERS, 2017).

Groundwater Conservation District (GCD) or County	Sparta	Queen City	Carrizo	Calvert Bluff	Simsboro	Hooper
Brazos Valley GCD	12	12	61	125	295	207
Fayette County GCD	47*	64*	110*	NR	NR	NR
Lost Pines GCD	5	15	62	100	240	165
Mid-East Texas GCD	5	2	80	90	138	125
Post Oak Savannah GCD	28	30	67	149	318	205
Falls County	NP	NP	NP	NP	-2	27
Limestone County	NP	NP	NP	11	50	50
Navarro County	NP	NP	NP	-1	3	3
Williamson County	NP	NP	NP	-11	47	69
GMA12	16	16	75	114	228	168

*Fayette County GCD desired future conditions are for all of Fayette County.
NR = Not relevant; NP = Not present

The desired future condition for Fayette County Groundwater Conservation District is for all of Fayette County including both Groundwater Management Areas 12 and 15. The Calvert Bluff, Simsboro, and Hooper aquifers occur in Fayette County but are not used so they were declared non-relevant (NR in Table 1). The Sparta, Queen City, and Carrizo aquifers do not occur (NP in Table 1) in Falls, Limestone, Navarro, and Williamson counties. The Calvert Bluff Aquifer does not occur in Falls County.

Groundwater availability models are regional in scale and are developed with data from many sources with differing levels of confidence (refer to the Limitations section at the end of this report). Therefore, groundwater availability models — like all numerical models — generate predictions that contain some uncertainty. Considering this situation, Groundwater Management Area 12 considers the desired future conditions to be compatible and physically possible if the difference between the modeled drawdown results and the desired future condition drawdown targets are within a 10 percent or a 5-foot variance, whichever is greater, for the Carrizo-Wilcox, Queen City, and Sparta aquifers

TABLE 3 ADOPTED DESIRED FUTURE CONDITIONS FOR THE BRAZOS RIVER ALLUVIUM AQUIFER FOR GROUNDWATER MANAGEMENT AREA 12. (DANIEL B. STEPHENS AND ASSOCIATES AND OTHERS, 2017).

Groundwater Conservation District	County	Desired Future Condition
Brazos Valley	Brazos and Robertson	North of State Highway 21: Percent saturation shall average at least 30 percent of total well depth. South of State Highway 21: Percent Saturation shall average at least 40 percent of total well depth.
Post Oak Savannah	Burleson	A decrease in 6 feet in the average saturated thickness over the period from 2010 to 2070.
Post Oak Savannah	Milam	A decrease in 5 feet in average saturated thickness over the period from 2010 to 2070.

TWDB staff reviewed the model files associated with the desired future conditions, requested clarification on certain technical elements of the files, and received clarification on procedures and assumptions from Groundwater Management Area 12 in Appendix V of the re-submittal of the Explanatory Report on October 6, 2017, and via email on November 3, 2017. Questions for the Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson aquifers included whether drawdown averages and modeled available groundwater values were based on official aquifer extent or model extent, whether desired future conditions for Fayette County were for all of the county or for only the Groundwater Management Area 12 part, whether to include dry cells (dry cells are explained in the Methods section) in drawdown averaging, and which stress periods to use for drawdown calculations. In addition, the original model file submission for the Carrizo-Wilcox, Queen City, and Sparta aquifers (July 6, 2017) did not match the desired future conditions for the Lost Pines Groundwater Conservation District. The revised model files for the Carrizo-Wilcox, Queen City, and Sparta aquifers submitted on October 6, 2017, did match the desired future conditions for all of the groundwater conservation districts (Table 1) within the specified variance. All clarifications are included in the Parameters and Assumptions Section of this report.

Groundwater Management Area 12 did not submit model files for the Brazos River Alluvium Aquifer, so the TWDB developed a predictive scenario using the calibrated historical groundwater availability model of the Brazos River Alluvium Aquifer. The TWDB averaging. The calculated drawdown averages were compared with the desired future to verify that the pumping scenario achieved the desired future conditions (Table 2) within 10 percent or 5-foot variance.

We developed a predictive model scenario for the Brazos River Alluvium Aquifer based on the calibrated historical groundwater availability model. We extended the model period from 2012 to 2070 by adding 58 annual stress periods and we used average recharge and average streamflow for 2013 to 2070. The pumping distribution for 2013 through 2070 is based on the average annual pumping for 2012 and the pumping amounts were adjusted uniformly within each groundwater conservation district to achieve the desired future conditions (Table 3).

We calculated the average percent saturation of the aquifer for the two areas within Brazos Valley Groundwater Conservation District by determining the ratio of the saturated thickness to the total alluvium thickness for each model cell in 2070 and averaging the ratios for all cells within the groundwater district areas (north of Highway 21 and south of Highway 21). The total alluvium thickness was used as an estimate for total well depth. The decrease in average saturated thickness in Post Oak Savannah Groundwater Conservation District was calculated by subtracting the average saturated thickness in 2070 from the average saturated thickness in 2010. The desired future conditions were achieved within one foot or one percentage point with the exception that it was not possible to decrease percent saturation in the Brazos Valley Groundwater Conservation District south of Highway 21 below 45 percent, because the model would not converge with additional pumping.

The modeled available groundwater values for aquifers in Groundwater Management Area 12 were determined by extracting pumping rates by decade from the model results using ZONEBUDGET Version 3.01 (Harbaugh, 2009). Tables 4 through 11 present the modeled available groundwater values (annual pumping rates to achieve the desired future conditions) for each aquifer by county and groundwater conservation district. Tables 12 through 19 present the modeled available groundwater (annual pumping rates to achieve the desired future conditions) for each aquifer by county, river basin, and regional water planning area.

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

- A tolerance of 10 percent (5 percent for the Simsboro) or 5 feet was assumed when comparing desired future conditions (Table 1, average drawdown values per county) to model drawdown results.
- Estimates of modeled available groundwater from the model simulation were rounded to whole numbers.

Yegua-Jackson Aquifer

- We used version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer. See Deeds and others (2010) for assumptions and limitations of the groundwater availability model.
- This groundwater availability model includes five layers which represent the outcrop of 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 model was run with MODFLOW-2000 (Harbaugh and others, 2000).
- The end of the calibration period was extended from 1997 to 2009 (Oliver, 2010).
- Drawdowns were based on water levels in December 2069 (stress period 99) and water levels from December 2009/January 2000 (stress period 39).
- Drawdown averages and modeled available groundwater values were based on the extent of the model area within Groundwater Management Area 12 rather than the official aquifer boundaries.
- The drawdown average for Fayette County Groundwater Conservation District was based on all of Fayette County including areas in Groundwater Management Area 12 and Groundwater Management Area 15.
- Drawdown for cells where water levels dropped below the base elevation of the cell causing the cell to become inactive (dry cells) were excluded from the averaging.
- Modeled available groundwater values are extracted from the model output files and do not include pumping in dry cells or inactive cells.
- A tolerance of 10 percent or 5 feet was assumed when comparing desired future conditions (Table 2, average drawdown values per county) to model drawdown results.

RESULTS:

The modeled available groundwater estimates for the Carrizo-Wilcox Aquifer range from approximately 135,000 acre-feet per year in 2010 to approximately 260,000 acre-feet per year in 2069 (Tables 4 through 7). The modeled available groundwater estimates for the Queen City Aquifer range from approximately 3,000 acre-feet per year in 2010 to approximately 7,000 acre-feet per year in 2069 (Table 8). The modeled available groundwater estimates for the Sparta Aquifer range from approximately 8,000 acre-feet per year in 2010 to approximately 24,000 acre-feet per year in 2069 (Table 9). The modeled available groundwater is summarized by groundwater conservation district and county for the Hooper, Simsboro, Calvert Bluff, Carrizo, Queen City, and Sparta aquifers (Tables 4, 5, 6, 7, 8, and 9 respectively). The modeled available groundwater has also been summarized by county, river basin, and regional water planning area for use in the regional water planning process for the Hooper, Simsboro, Calvert Bluff, Carrizo, Queen City, and Sparta aquifers (Tables 12, 13, 14, 15, 16, and 17 respectively). Small differences in values between table summaries are due to rounding.

The modeled available groundwater estimates for the Yegua-Jackson Aquifer range from approximately 31,000 acre-feet per year in 2010 to 27,000 acre-feet per year in 2069 (Table 10). The modeled available groundwater for the Yegua-Jackson Aquifer is summarized by groundwater conservation district and county (Table 10) and by county, river basin, and regional water planning area for use in the regional water planning process (Table 18). Small differences in values between table summaries are due to rounding.

The modeled available groundwater estimates for the Brazos River Alluvium Aquifer range from approximately 269,000 acre-feet per year in 2013 to 214,000 acre-feet per year in 2070 (Table 11). The modeled available groundwater for the Brazos River Alluvium Aquifer is summarized by groundwater conservation district and county (Table 11) and by county, river basin, and regional water planning area for use in the regional water planning process (Table 19). Small differences in values between table summaries are due to rounding.

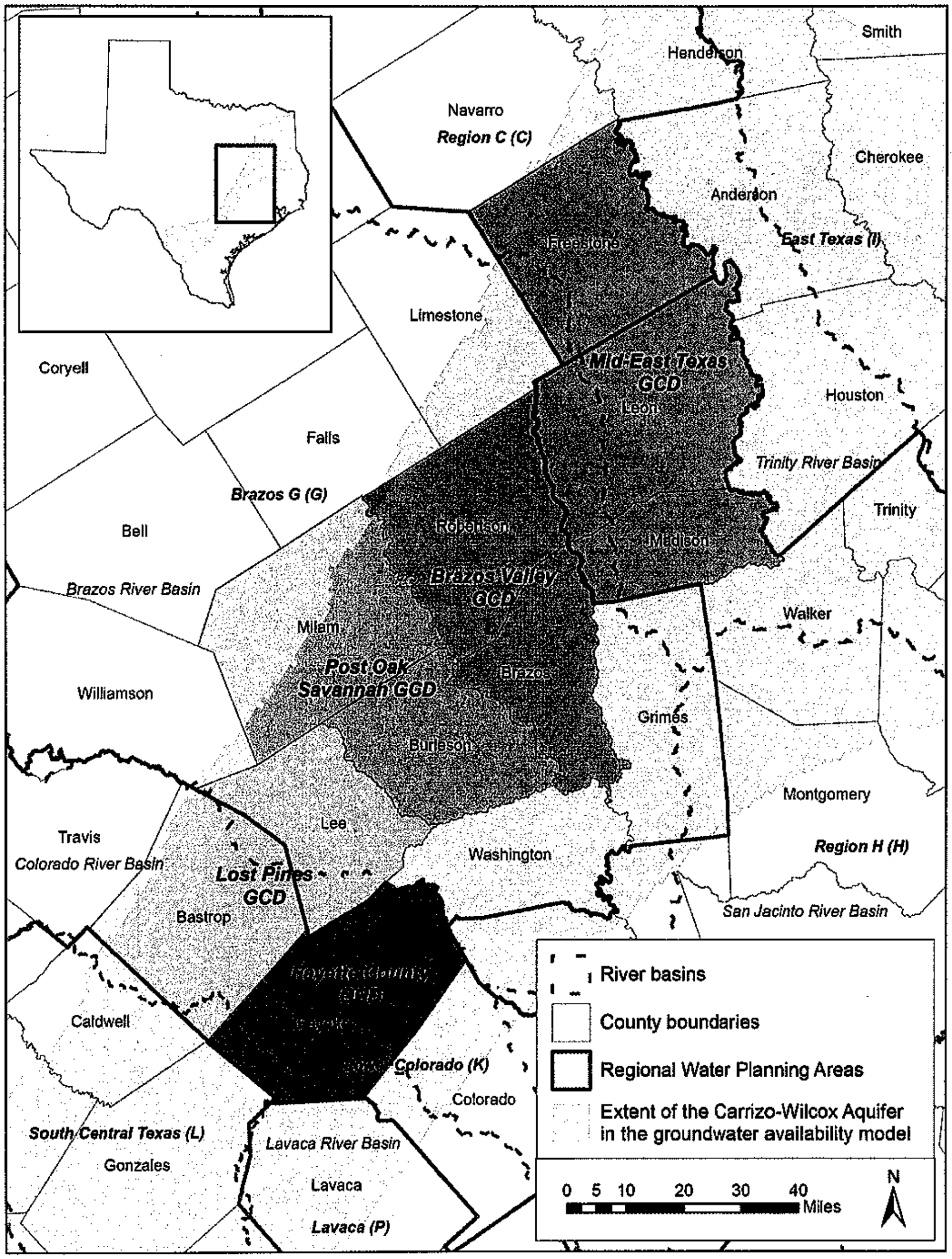

FIGURE 2. REGIONAL WATER PLANNING AREAS , RIVER BASINS, GROUNDWATER CONSERVATION DISTRICTS(GCDS), AND COUNTIES OVERLAIN ON THE EXTENT OF THE CARRIZO-WILCOX AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.

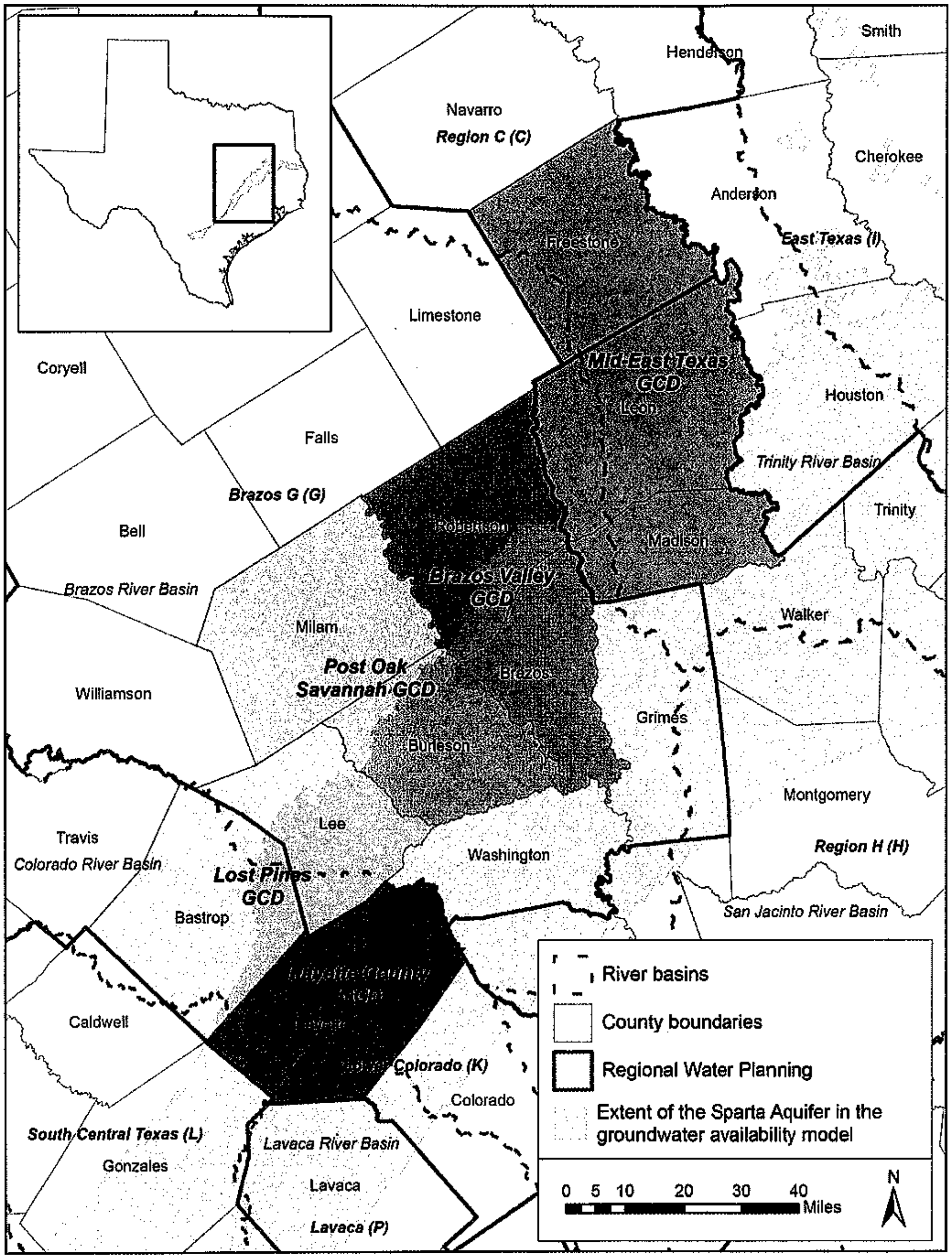

FIGURE 4. REGIONAL WATER PLANNING AREAS, RIVER BASINS, GROUNDWATER CONSERVATION DISTRICTS (GCDS), AND COUNTIES OVERLAIN ON THE EXTENT OF THE SPARTA AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.

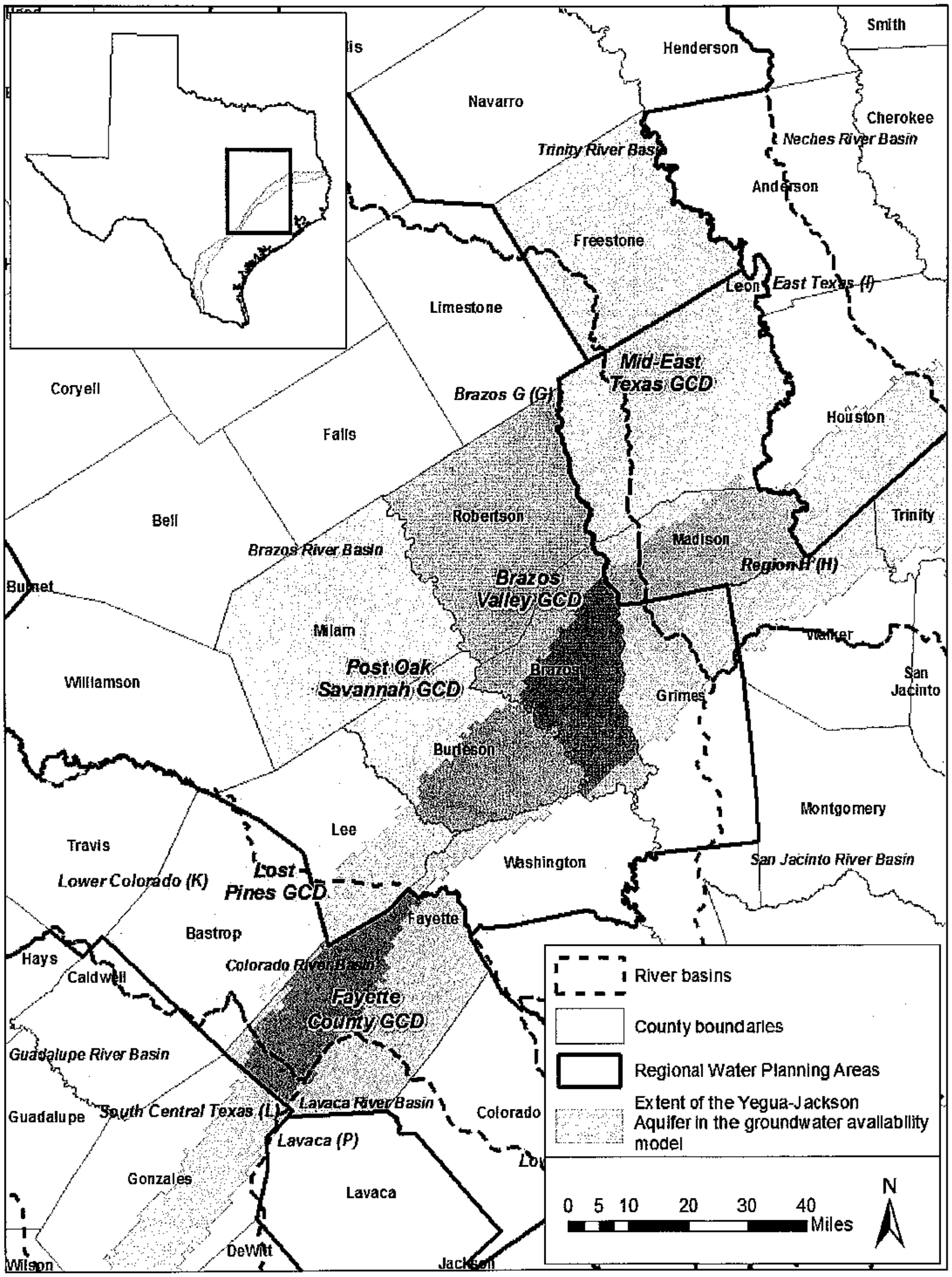

FIGURE 6. REGIONAL WATER PLANNING AREAS, RIVER BASINS, GROUNDWATER CONSERVATION DISTRICTS (GCDS), AND COUNTIES OVERLAIN ON THE EXTENT OF THE YEGUA-JACKSON AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL.

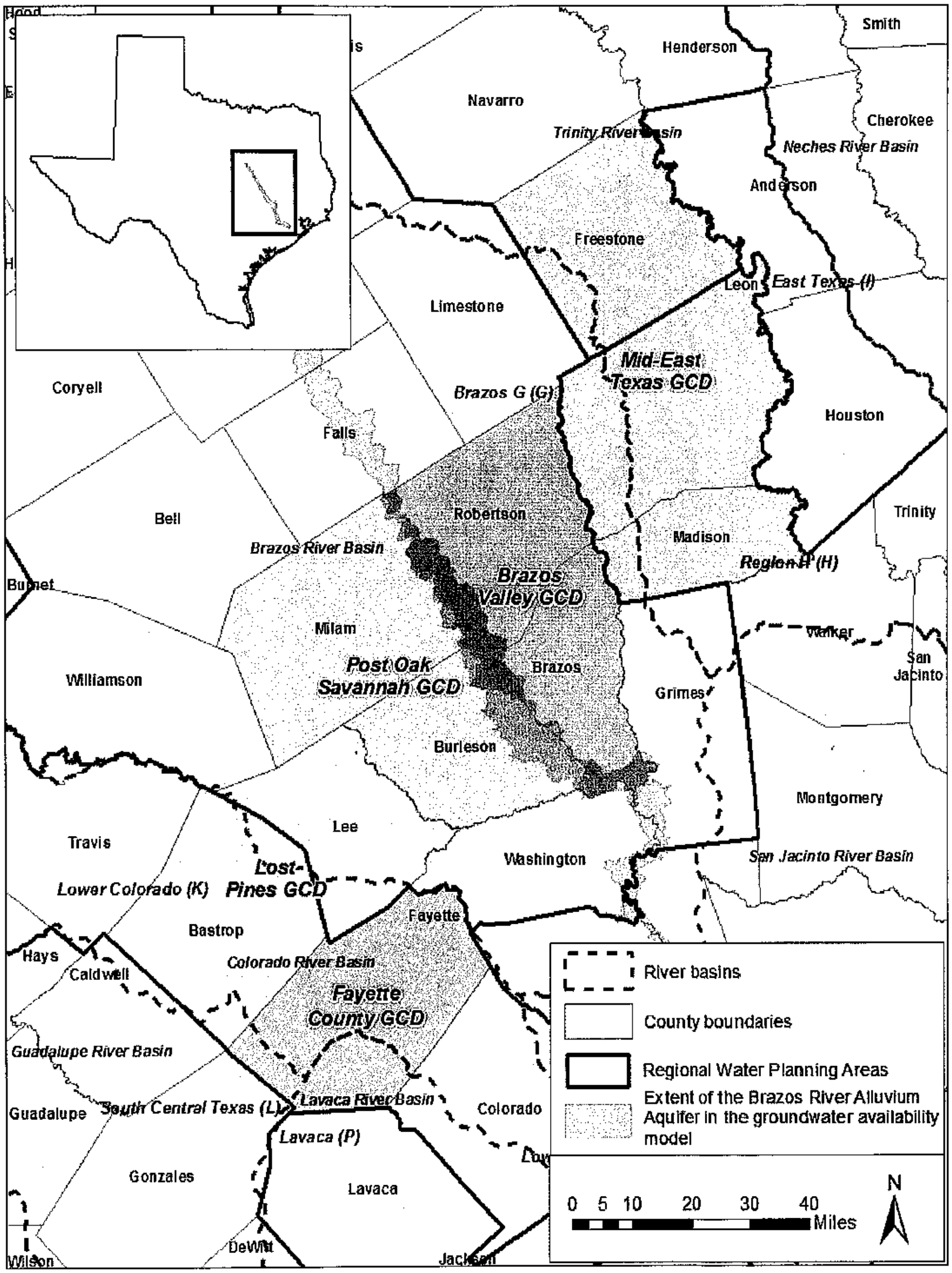

FIGURE 8 REGIONAL WATER PLANNING AREAS, RIVER BASINS, GROUNDWATER CONSERVATION DISTRICTS (GCDS), AND COUNTIES OVERLAIN ON THE EXTENT OF THE BRAZOS RIVER ALLUVIUM AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL.

Groundwater Conservation District	County	Aquifer	2010	2020	2030	2040	2050	2060	2069
No District-County	Falls	Hooper	726	727	734	741	749	749	749
No District-County	Limestone	Hooper	1,488	1,382	1,410	1,444	1,496	1,496	1,414
No District-County	Navarro	Hooper	16	11	11	11	11	11	11
No District-County	Williamson	Hooper	5	5	5	5	5	5	5
No District-County Total[1]		**Hooper**	**2,235**	**2,125**	**2,160**	**2,201**	**2,261**	**2,261**	**2,178**
GMA 12 Total[1]		**Hooper**	**11,836**	**11,586**	**13,617**	**14,439**	**15,040**	**15,267**	**15,357**

1. Individual estimates are rounded and may not always sum up to the total value displayed.
2. NR: Groundwater Management Area 12 declared the Hooper Aquifer not relevant in these areas.

Groundwater Conservation District	County	Aquifer	2010	2020	2030	2040	2050	2060	2069
Post Oak Savannah GCD	Burleson	Simsboro	627	17,687	21,616	25,103	28,858	30,409	30,409
Post Oak Savannah GCD	Milam	Simsboro	10,702	20,783	16,284	14,940	17,171	18,094	18,094
Post Oak Savannah GCD Total[1]		**Simsboro**	**11,329**	**38,470**	**37,900**	**40,042**	**46,028**	**48,503**	**48,503**
No District-County	Falls	Simsboro	139	140	141	143	146	146	146
No District-County	Limestone	Simsboro	9,801	9,753	9,850	9,992	10,235	10,235	10,235
No District-County	Navarro	Simsboro	6	4	4	4	4	4	4
No District-County	Williamson	Simsboro	2	2	2	2	2	2	2
No District Total		**Simsboro**	**9,948**	**9,899**	**9,997**	**10,141**	**10,387**	**10,387**	**10,387**
GMA 12 Total[1]		**Simsboro**	**105,484**	**170,343**	**174,020**	**178,799**	**191,099**	**193,104**	**192,565**

1. Individual estimates are rounded and may not always sum up to the total value displayed.
2. NR: Groundwater Management Area 12 declared the Simsboro Aquifer not relevant in these areas.

Groundwater Conservation District	County	Aquifer	2010	2020	2030	2040	2050	2060	2069
Post Oak Savannah GCD	Burleson	Calvert Bluff	0	87	87	87	87	87	87
Post Oak Savannah GCD	Milam	Calvert Bluff	1,713	949	949	949	949	949	949
Post Oak Savannah GCD Total[1]		**Calvert Bluff**	**1,713**	**1,036**	**1,036**	**1,036**	**1,036**	**1,036**	**1,036**
No District-County	Limestone	Calvert Bluff	248	218	223	228	235	235	235
No District-County	Navarro	Calvert Bluff	0	0	0	0	0	0	0
No District-County	Williamson	Calvert Bluff	1	2	2	2	3	2	1
No District Total		**Calvert Bluff**	**248**	**220**	**225**	**230**	**237**	**237**	**236**
GMA 12 Total[1]		**Calvert Bluff**	**8,020**	**8,817**	**9,336**	**9,998**	**10,842**	**10,927**	**10,927**

1. Individual estimates are rounded and may not always sum up to the total value displayed.
2. NR: Groundwater Management Area 12 declared the Calvert Bluff Aquifer not relevant in these areas.

TABLE 8 MODELED AVAILABLE GROUNDWATER FOR THE QUEEN CITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2010 AND 2069. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2010	2020	2030	2040	2050	2060	2069
Brazos Valley GCD	Brazos	Queen City	541	836	883	887	891	891	891
Brazos Valley GCD	Robertson	Queen City	0	368	309	309	309	309	309
Brazos Valley GCD Total[1]		**Queen City**	**541**	**1,204**	**1,192**	**1,196**	**1,200**	**1,200**	**1,200**
Fayette County GCD	**Fayette[2]**	**Queen City**	**268**	**2,708**	**2,708**	**2,708**	**2,708**	**2,708**	**2,708**
Lost Pines GCD	Bastrop	Queen City	192	558	541	523	505	486	467
Lost Pines GCD	Lee	Queen City	394	757	774	792	810	829	848
Lost Pines GCD Total[1]		**Queen City**	**587**	**1,315**	**1,315**	**1,315**	**1,315**	**1,315**	**1,315**
Mid-East Texas GCD	Freestone	Queen City	0	0	0	0	0	0	0
Mid-East Texas GCD	Leon	Queen City	624	594	594	594	594	594	594
Mid-East Texas GCD	Madison	Queen City	148	380	380	380	380	380	380
Mid-East Texas GCD Total[1]		**Queen City**	**772**	**974**	**974**	**974**	**974**	**974**	**974**
Post Oak Savannah GCD	Burleson	Queen City	685	416	447	447	447	447	447
Post Oak Savannah GCD	Milam	Queen City	20	53	56	56	56	56	56
Post Oak Savannah GCD Total[1]		**Queen City**	**705**	**469**	**504**	**504**	**504**	**504**	**504**
GMA 12 Total[1]		**Queen City**	**2,873**	**6,669**	**6,693**	**6,696**	**6,700**	**6,701**	**6,700**

1. Individual estimates are rounded and may not always sum up to the total value displayed.
2. Modeled available groundwater values for Fayette County include all of the county (GMA 12 and GMA 15 portions)

TABLE 10 MODELED AVAILABLE GROUNDWATER FOR THE YEGUA-JACKSON AQUIFER IN GROUNDWATER MANAGEMENT AREA 12 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2010 AND 2069. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2010	2020	2030	2040	2050	2060	2069
Brazos Valley GCD	Brazos	Jackson	4,411	4,404	4,402	4,402	4,402	4,402	4,402
Brazos Valley GCD	Brazos	Yegua	2,452	2,452	2,452	2,452	2,452	2,452	2,452
Brazos Valley GCD Total[1]		**Yegua-Jackson**	**6,863**	**6,856**	**6,854**	**6,854**	**6,854**	**6,854**	**6,854**
Fayette County GCD[1]	**Fayette[3]**	**Yegua-Jackson**	**9,262**	**9,262**	**9,262**	**9,262**	**9,262**	**9,261**	**9,261**
Lost Pines GCD[2]	Bastrop	Yegua-Jackson	NR	NR	NR	NR	NR	NR	NR
Lost Pines GCD[2]	Lee	Yegua-Jackson	NR	NR	NR	NR	NR	NR	NR
Lost Pines GCD Total[1,2]		**Yegua-Jackson**	**NR**	**NR**	**NR**	**NR**	**NR**	**NR**	**NR**
Mid-East Texas GCD	Leon	Yegua-Jackson	0	0	0	0	0	0	0
Mid-East Texas GCD	Madison	Yegua-Jackson	809	809	809	809	809	809	809
Mid-East Texas GCD Total[1]		**Yegua-Jackson**	**809**	**809**	**809**	**809**	**809**	**809**	**809**
Post Oak Savannah GCD[1]	**Burleson**	**Yegua-Jackson**	**14,544**	**14,544**	**12,576**	**12,564**	**12,478**	**12,326**	**10,200**
GMA 12 Total[1]		**Yegua-Jackson**	**31,478**	**31,471**	**29,501**	**29,489**	**29,403**	**29,250**	**27,124**

1. Individual estimates are rounded and may not always sum up to the total value displayed.
2. NR: Groundwater Management Area 12 declared the Yegua-Jackson Aquifer not relevant in these areas .
3. Modeled available groundwater values for Fayette County include all of the county (GMA 12 and GMA 15 portions)

TABLE 12 MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE HOOPER 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	2020	2030	2040	2050	2060
Bastrop	K	Brazos	Hooper	0	0	0	0	0
Bastrop	K	Colorado	Hooper	651	781	953	1,176	1,179
Bastrop	K	Guadalupe	Hooper	0	0	0	0	0
Brazos	G	Brazos	Hooper	0	0	0	0	0
Burleson	G	Brazos	Hooper	1,085	1,515	1,623	1,623	1,623
Falls	G	Brazos	Hooper	727	734	741	749	749
Fayette	K	Colorado	Hooper	NR	NR	NR	NR	NR
Fayette	K	Guadalupe	Hooper	NR	NR	NR	NR	NR
Fayette	K	Lavaca	Hooper	NR	NR	NR	NR	NR
Freestone	C	Brazos	Hooper	518	543	568	593	619
Freestone	C	Trinity	Hooper	3,823	4,035	4,246	4,458	4,669
Lee	G	Brazos	Hooper	59	72	90	112	111
Lee	G	Colorado	Hooper	3	4	5	7	6
Leon	H	Brazos	Hooper	0	0	0	0	0
Leon	H	Trinity	Hooper	0	0	0	0	0
Limestone	G	Brazos	Hooper	1,382	1,410	1,444	1,496	1,496
Madison	H	Brazos	Hooper	0	0	0	0	0
Madison	H	Trinity	Hooper	0	0	0	0	0
Milam	G	Brazos	Hooper	1,874	2,623	2,811	2,811	2,800
Navarro	C	Trinity	Hooper	11	11	11	11	11
Robertson	G	Brazos	Hooper	1,446	1,884	1,942	2,000	2,000

TABLE 13 MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE SIMSBORO 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	2020	2030	2040	2050	2060
Bastrop	K	Brazos	Simsboro	398	529	653	776	765
Bastrop	K	Colorado	Simsboro	13,855	15,145	15,658	16,558	15,182
Bastrop	K	Guadalupe	Simsboro	0	0	0	0	0
Brazos	G	Brazos	Simsboro	41,115	44,120	45,681	50,208	53,404
Burleson	G	Brazos	Simsboro	17,687	21,616	25,103	28,858	30,409
Falls	G	Brazos	Simsboro	140	141	143	146	146
Fayette	K	Colorado	Simsboro	NR	NR	NR	NR	NR
Fayette	K	Guadalupe	Simsboro	NR	NR	NR	NR	NR
Fayette	K	Lavaca	Simsboro	NR	NR	NR	NR	NR
Freestone	C	Brazos	Simsboro	685	673	668	657	657
Freestone	C	Trinity	Simsboro	2,897	2,916	2,917	2,895	2,893
Lee	G	Brazos	Simsboro	17,993	17,221	17,031	17,179	14,896
Lee	G	Colorado	Simsboro	0	0	0	0	0
Leon	H	Brazos	Simsboro	553	555	563	575	576
Leon	H	Trinity	Simsboro	2,807	2,902	2,976	3,042	3,047
Limestone	G	Brazos	Simsboro	9,753	9,850	9,992	10,235	10,235
Madison	H	Brazos	Simsboro	0	0	0	0	0
Madison	H	Trinity	Simsboro	0	0	0	0	0
Milam	G	Brazos	Simsboro	20,783	16,284	14,940	17,171	18,094
Navarro	C	Trinity	Simsboro	4	4	4	4	4

TABLE 14 MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE CALVERT BLUFF 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	2020	2030	2040	2050	2060
Bastrop	K	Brazos	Calvert Bluff	97	104	122	154	134
Bastrop	K	Colorado	Calvert Bluff	1,958	2,349	2,837	3,446	3,627
Bastrop	K	Guadalupe	Calvert Bluff	9	9	11	13	12
Brazos	G	Brazos	Calvert Bluff	0	0	0	0	0
Burleson	G	Brazos	Calvert Bluff	87	87	87	87	87
Fayette	K	Colorado	Calvert Bluff	NR	NR	NR	NR	NR
Fayette	K	Guadalupe	Calvert Bluff	NR	NR	NR	NR	NR
Fayette	K	Lavaca	Calvert Bluff	NR	NR	NR	NR	NR
Freestone	C	Brazos	Calvert Bluff	130	127	126	124	124
Freestone	C	Trinity	Calvert Bluff	624	607	602	590	590
Lee	G	Brazos	Calvert Bluff	161	169	211	296	209
Lee	G	Colorado	Calvert Bluff	0	0	0	0	0
Leon	H	Brazos	Calvert Bluff	585	589	590	590	592
Leon	H	Trinity	Calvert Bluff	2,235	2,364	2,475	2,600	2,609
Limestone	G	Brazos	Calvert Bluff	218	223	228	235	235
Madison	H	Brazos	Calvert Bluff	0	0	0	0	0
Madison	H	Trinity	Calvert Bluff	0	0	0	0	0
Milam	G	Brazos	Calvert Bluff	949	949	949	949	949
Navarro	C	Trinity	Calvert Bluff	0	0	0	0	0
Robertson	G	Brazos	Calvert Bluff	1,764	1,757	1,758	1,757	1,757
Williamson	G	Brazos	Calvert Bluff	2	2	2	3	2
GMA 12 Total			**Calvert Bluff**	**8,819**	**9,336**	**9,998**	**10,844**	**10,927**

NR: Groundwater Management Area 12 declared the Calvert Bluff Aquifer not relevant in these areas.

TABLE 16 **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	2020	2030	2040	2050	2060
Bastrop	K	Brazos	Queen City	49	47	46	44	42
Bastrop	K	Colorado	Queen City	353	333	311	288	264
Bastrop	K	Guadalupe	Queen City	156	161	166	173	180
Brazos	G	Brazos	Queen City	836	883	887	891	891
Burleson	G	Brazos	Queen City	416	447	447	447	447
Fayette[1]	K	Colorado	Queen City	2,278	2,278	2,278	2,278	2,278
Fayette[1]	K	Guadalupe	Queen City	430	430	430	430	430
Fayette[1]	K	Lavaca	Queen City	0	0	0	0	0
Freestone	C	Trinity	Queen City	0	0	0	0	0
Lee	G	Brazos	Queen City	709	713	716	721	727
Lee	G	Colorado	Queen City	48	61	75	89	102
Leon	H	Brazos	Queen City	245	245	245	245	245
Leon	H	Trinity	Queen City	349	349	349	349	349
Madison	H	Brazos	Queen City	1	1	1	1	1
Madison	H	Trinity	Queen City	379	379	379	379	379
Milam	G	Brazos	Queen City	53	56	56	56	56
Robertson	G	Brazos	Queen City	368	309	309	309	309
GMA 12 Total			**Queen City**	**6,670**	**6,692**	**6,695**	**6,700**	**6,700**

1. Modeled available groundwater values for Fayette County include all of the county (GMA 12 and GMA 15 portions)

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	2020	2030	2040	2050	2060
Bastrop	K	Colorado	Yegua-Jackson	NR	NR	NR	NR	NR
Brazos	G	Brazos	Yegua-Jackson	6,856	6,854	6,854	6,854	6,854
Burleson	G	Brazos	Yegua-Jackson	14,544	12,576	12,564	12,478	12,326
Fayette[1]	K	Colorado	Yegua-Jackson	7,075	7,075	7,075	7,075	7,074
Fayette[1]	K	Guadalupe	Yegua-Jackson	694	694	694	694	694
Fayette[1]	K	Lavaca	Yegua-Jackson	1,493	1,493	1,493	1,493	1,493
Lee	G	Brazos	Yegua-Jackson	NR	NR	NR	NR	NR
Lee	G	Colorado	Yegua-Jackson	NR	NR	NR	NR	NR
Leon	H	Trinity	Yegua-Jackson	0	0	0	0	0
Madison	H	Brazos	Yegua-Jackson	8	8	8	8	8
Madison	H	Trinity	Yegua-Jackson	802	802	802	802	802
GMA 12 Total			**Yegua-Jackson**	**31,471**	**29,501**	**29,489**	**29,403**	**29,250**

1. Modeled available groundwater values for Fayette County include all of the county (GMA 12 and GMA 15 portions)
2. NR: Groundwater Management Area 12 declared the Yegua-Jackson Aquifer not relevant in these areas.

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.

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

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

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