PLUM CREEK CONSERVATION DISTRICT
PROPOSED
Groundwater Management Plan

10/22/2018

PLUM CREEK CONSERVATION DISTRICT

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GROUNDWATER MANAGEMENT PLAN

1. DISTRICT MISSION

The Plum Creek Conservation District (PCCD) mission for groundwater management is to conserve and preserve groundwater availability and protect permitted and exempt groundwater users, by gathering information about groundwater conditions and uses within the District; obtaining information from surrounding Groundwater Districts to assist in understanding groundwater availability within Plum Creek's area; by using that information to adopt Rules consistent with state law in order to maximize the beneficial development and use of the groundwater resources on a sustainable basis in keeping with the desired future conditions of aquifers within Plum Creek Conservation District's jurisdictional area; and by then enforcing these adopted Rules. The District will accomplish this mission by identifying aquifers within the District; and then by (1) determining zones of the various aquifers within the District, (2) imposing spacing requirements, (3) limiting production, (4) requiring permits for non-exempt wells and groundwater production, (5) noting information on exempt wells, (6) establishing water drawdown levels, (7) monitoring aquifer levels and production, (8) making appropriate adjustments to allowable and permitted production as more data become available, and (9) encouraging conservation to limit pumping. These actions are designed to extend the quantity and preserve the quality of the water available in the aquifers in Caldwell and Hays counties regulated by the District. PCCD is committed to protecting, conserving, and preventing waste of the groundwater resources in its District for the benefit of the citizens, economy and environment.

2. TIME PERIOD OF THIS PLAN

This plan will become effective upon adoption by the PCCD Board of Directors and approval as administratively complete by the Texas Water Development Board. The plan will remain in effect for five (5) years after the date of approval or until a revised plan is adopted and approved, or as otherwise directed by the Texas Legislature.

3. BACKGROUND

The PCCD is situated in parts of Caldwell and Hays Counties. The District was created as a Water Control and Improvement District in the 55th Texas Regular Legislative Session in 1957 with the passage of Senate Bill 289 under the provisions of Section 59, Article XVI of the Texas Constitution. The enabling statute provided the District with the power to control, conserve, protect, distribute and utilize the storm and floodwaters and unappropriated flow of Plum Creek and its tributaries as a Water Control and Improvement District. In 1989 the original 1957 legislation was amended to additionally authorize the District, upon approval of the qualified voters of the District, to exercise the powers and duties imposed under what is now Chapter 36 of the Texas Water Code, for the preservation, conservation, protection, recharge, and prevention of waste and pollution of the underground water of the District except in those areas of the District that were part of the Barton Springs-Edwards Aquifer Conservation District or the Edwards Underground Water District on January 1, 1989. The voters in the District approved the implementation of the powers granted by the Legislature after the 1989 amendment was passed in the Legislature.

1. Introduction: The District recognizes that the groundwater resources of the region are of vital importance not only within the District but to areas outside the District. The District was created, in part, to conserve, preserve, protect, and prevent waste of all of the water resources within its jurisdiction. The District believes that the groundwater resources in the District can be managed in a prudent and cost effective manner through education and conservation, coupled with reasonable regulation, including permitting of new and existing non-exempt wells and registering of exempt wells. Although the District has undertaken studies and has developed information about the occurrence and quality of groundwater in various geologic formations in and near the District, the District continues to conclude that one of the greatest threats to prevent the District from achieving the stated mission are inadequate information about groundwater occurrence, quality, groundwater production volumes, groundwater production rates, groundwater movement and groundwater uses within and from aquifers regulated by the District based in part on a lack of knowledge about groundwater production from exempt wells both within the District and groundwater occurrence and production from all aquifers in areas without groundwater districts adjacent to or in close proximity with the area of Plum Creek Conservation District. The District has concerns about the potential for groundwater quality degradation in some areas of the District related to existing groundwater pumping and to old oil and gas activities. The District continually needs to develop more information to understand how groundwater production, recharge, and flow into and out of the District are interrelated with

production, recharge and flow in areas surrounding the District. Basic knowledge of the aquifers and their hydrogeological properties, a quantification of resources, and development of data on groundwater quality are the foundation from which to build prudent planning measures. This Management Plan is intended as a tool to focus the thoughts and actions of those given the responsibility for the execution of the District's activities in developing information and in driving activities implementing the District's goals.

2. Policy: It shall be the policy of the Board of Directors that the most beneficial use of groundwater in the District is to maintain present non-wasteful groundwater uses of those in the District and then to provide for future groundwater needs of citizens. Groundwater shall be beneficially used, conserved, preserved, protected, and waste prevented within the District to maintain the viability of those resources for current users and for users in the future who are in the District's area. , The Board of Directors, with the cooperation of the citizens of the District and of surrounding political subdivisions, shall implement this management plan and any necessary modifications thereof to achieve this goal.

3. Governing Board: The District is governed by an appointed six member Board of Directors.

4. Daily Operations: The day-to-day management of District activities is carried out currently by a three-member staff led by Johnie Halliburton, Executive Manager and Daniel Meyer, Assistant Manager.

5. Topography: The land surface of Caldwell County ranges from nearly flat to hilly. The minimum elevation, about 295 feet, is at the southern tip of the County where Plum Creek joins the San Marcos River. The maximum elevation in Caldwell County, about 725 feet, is in the area of the so-called "Iron Mountains" peaks, approximately 2.5 miles southeast of McMahan, a small community approximately 9 miles southeast of Lockhart. Regionally, the topographic elevations increase from southeast to northwest.

The portion of District located in Hays County generally exhibits the same type of terrain, although the elevation differences are more pronounced. Some of the surface of the District's area extends into Hays County, which overlies the Balcones Escarpment, and provides drainage to a portion of Plum Creek.

Plum Creek drains about 310 square miles, or about 60% of Caldwell County. In addition, a portion of Hays County that is drained by Plum Creek is also in the boundaries of the District. There is a small area of Travis County that drains into Plum Creek but that area is not within the District's boundaries.

6. Location and Extent: The District is situated within parts of Caldwell and Hays Counties, but the District's boundaries are not conterminous with those of either Caldwell or Hays Counties. The original boundaries of the District are described in Section 3 of the enabling statute that first created the District. In 2008 there were additional properties located in the southeastern portion of Caldwell County annexed into PCCD at the request of the landowners of the properties, however; the area where those properties were located was also annexed into the Gonzales County Underground Water Conservation District. S.B 1225 of the 82nd legislature enacted in 2011 was passed to and allowed the property owners annexed by Plum Creek to choose which district they wanted to belong to with the result that the original boundaries of the District were expanded by approximately 4672 acres. The most downstream point of the boundaries of the District is in the most southerly southeast corner of Caldwell County near the confluence of Plum Creek and the San Marcos River. The calls in the original description of the boundaries of Plum Creek Conservation District are, generally, along tract or survey lines.

7. Water Resources: The District does not hold, own or otherwise control any groundwater or surface water rights. The District is located within the territory of the Guadalupe-Blanco River Authority ("GBRA"), which controls substantial surface water rights associated with GBRA owned or operated facilities and reservoirs, including Canyon Lake. Some water supply corporations providing retail water service within the District have access to surface water supplies either through direct ownership, through lease, or through long term supply contracts. Most of the permitted surface water rights in the vicinity of Plum Creek Conservation District are from the San Marcos River, which is not in the Boundaries of the District. There are few surface water rights permits for diversions from Plum Creek and none known for diversion from Plum Creek for any purpose other than agricultural use.

As a part of this Plan, each year the District will confer at least once with GBRA on cooperative opportunities for conjunctive resource management between ground and surface water suppliers to retail providers and other users.

4. Groundwater Resources

The PCCD has within its surface area boundaries the following geological formations: Quaternary Alluvium, Leona Gravel, Austin-Pecan Gap, Navarro, Midway, Wilcox Group, Queen City, Reklaw, Saline Edwards, Trinity Group and the Carrizo Sands. A geologic map of the area of the District is appended as Appendix C. The Texas Water Development Board recently ran a groundwater availability model for the Southern portions of the Carrizo-Wilcox, Queen City, and Sparta, aquifers within the District. No information on discharges from, exchanges among aquifers, or flow into or out of the Leona Gravel, or from recent alluvium deposits in the District is currently available from the Texas Water Development Board. The full modeling report, GAM Run 12-001-Plum Creek Conservation District Management Plan, is appended to this Plan as Appendix B.

5. MANAGEMENT ZONES

1. **Alluvium** – occurs along present day streams and rivers. Consists of sand, silt and clay. Serves as a limited household and livestock aquifer within the predominant sand facies.

2. **Leona** – occurs along scattered outcrops perpendicular to the Balcones Fault System and the IH-35 corridor. Serves as a shallow limited aquifer utilized manly as a small lot irrigation aquifer. Cotton and grain farming has polluted much of the aquifer with nitrates, which are not recommended for human or livestock consumption.

3. **Weches** – is primarily a glauconitic marine clay and is seldom utilized as stray sand or silt aquifer.

4. **Queen City** – occurs as a shallow limited sand and silt aquifer with lesser amounts of clay. The completed wells are generally utilized for household and livestock.

5. **Reklaw** – primarily consists of clay with broken silt and sand intervals that can serve as shallow household and livestock aquifers in limited areas.

6. **Carrizo** – occurs as a major irrigation and municipal aquifer. Consists of ancient barrier island loose fine-coarse sand bodies separated by thin estuary silty clays. It is the major aquifer along the Upper Gulf Coastal Plain across southern Texas capable of high production rates of fresh water.

7. **Wilcox** – often studied and associated with the overlying Carrizo aquifer. It is separated from the Carrizo by a regional disconformity and exhibits some very different deltaic facies as compared to the Carrizo. It is utilized as a household, livestock and municipal source of fresh water over a wide area.
8. **Midway** – occurs primarily as a thick clay with minor amounts of silt near the top of the unit. It does not generally serve as a reliable aquifer, even in limited silty zones.

9. **Navarro** – consists mainly as a thick sequence of expansive clay. It does not serve as an aquifer within the boundaries of the Plum Creek District.

10. **Pecan Gap** – this limestone and chalk unit does serve as a very limited household and livestock fractured low yield aquifer along and parallel to the southeast side of the IH-35 corridor. Many of the wells eventually go dry.

11. **Austin Chalk** – this very limited limestone and chalk aquifer immediately underlies the Pecan Gap and exhibits similar characteristics.

12. **Eagle Ford –** this unit is a petroliferous thin clay and does not serve as an aquifer.

13. **Buda** – occurs as a dense limestone unit in the PCCD area and does not serve as any known aquifer. It does serve as an aquifer in the Uvalde County area.

14. **Del Rio** – does not serve as an aquifer in Texas. It occurs a weathered volcanic ash expansive clay.

15. **Georgetown** – occurs a dense limestone and is not expected to serve as a brackish or saline aquifer in the PCCD area.

16. **Edwards** – this limestone and dolomite karst aquifer is the major fresh water source for the cities, towns and industries along the IH-35 corridor which partially fall within the PCCD area. The unit is also a very strong future candidate of brackish and saline water southeast of the IH-35 corridor that may eventually rival the Carrizo aquifer.

17. **Glen Rose** – certain areas within the Glen Rose along the axis of the San Marcos Arch do harbor large carbonate patch reefs that do contain substantial amounts of brackish and saline water. These Glen Rose patch reefs will undoubtedly be utilized as desalination targets.

18. **Bexar –** occurs as a thin clay and does not serve as an aquifer.

19. **James (Cow Creek) –** does serve as a highly-used household and livestock aquifer along the northwest side of the IH-35 corridor in the Hill Country Balcones Fault System. Recently discovered higher yield Cow Creek wells have been tested in a limited area of the Balcones Fault System.

20. **Pine Island –** occurs as natural gas charged expansive clay that does not serve as an aquifer.

21. **Sligo –** occurs as sandy glauconitic limestone that may serve as a future limited brackish and saline aquifer.

22. **Hosston** – occurs as a sand and basal gravel aquifer, it serves most of the small town fresh water municipal needs across the Texas Hill Country. The future desalination era will undoubtedly target the brackish and saline portions of the Hosston clastics with the PCCD boundaries.

Management Zone Descriptive Table:

Period	Epoch	Group/Formation/Member	Description
Quaternary	Holocene	Alluvium	Sand, silt, clay
	Pleistocene	Leona	Gravel, sand, silt, clay
Tertiary	Eocene/Paleocene	Weches	Clay, silt, sand
		Queen City	Sand, clay
		Reklaw	Clay, sand, silt
		Carrizo	Sand, clay
		Wilcox	Sand, clay. silt
		Midway	Clay, silt, sand
Cretaceous	Upper	Navarro	Clay, silt, sand
		Pecan Gap	Limestone, clay
		Austin Chalk	Limestone, clay
		Eagle Ford	Clay
	Lower	Buda	Limestone
		Del Rio	Clay
		Georgetown	Limestone
		Edwards	Limestone, dolomite
		Glen Rose	Limestone, dolomite, clay
		Bexar	Clay
		James (Cow Creek)	Limestone
		Pine Island (Hammett)	Clay
		Sligo	Limestone, silt
		Hosston	Sand, clay

6. Production and Spacing of Wells

Production and spacing of all wells within the District is regulated by the District according to the Rules of the District. As noted, the Rules may be changed from time to time. The District has recently revised its Rules, with the latest revision becoming effective as of August 1, 2012, to take into account knowledge gained through its geologic studies that have been ongoing and to address anticipated increases in demands on the aquifers in and regulated by the District.

7. Management of Groundwater Supplies

The District evaluates and monitors groundwater availability, and regulates production consistent with the District Rules, the GMAs(10 & 13) adopted Desired Future Conditions, ("DFC") and the Modeled Available Groundwater determination of the Texas Water Development Board. In consideration of the importance of groundwater availability to the economy and welfare of those in the District, the District anticipates that in the future, groundwater production will be regulated as needed to conserve groundwater, preserve groundwater availability, and protect permitted and exempt groundwater users, in a manner not to unnecessarily and adversely limit production or impact the economic viability of public and private groundwater users. The District will identify and engage in such activities and practices that will permit groundwater production and, as appropriate, will protect the aquifer and groundwater availability by restricting future requested pumping quantities, if necessary, according to the best information then available to the District.

Currently there are a number of monitoring wells that are in PCCD's Aquifer Water Level Observation Program that are being used in order to monitor aquifer conditions within the district and to track compliance with the DFCs. On an annual basis, in accord with advice from its technical consultant, PCCD will, if necessary, modify the program. The District will make a regular assessment of water supply and groundwater storage conditions as observed in data from its network and will report those conditions to the Board and to the public. The District will undertake investigations, and co-operate with third-party investigations including neighboring districts, of the groundwater resources within the District, and the results of the investigations will be made available to the public upon being presented at a meeting of the Board. The District will manage the available groundwater based on the *"Desired Future Conditions"* and Modeled Available Groundwater determination of the aquifers.

The District has adopted Rules to regulate groundwater withdrawals by means of well spacing and production limits or, alternatively, in accord with a study of the effects of the proposed well on the targeted aquifer. The District may deny a water well production permit or limit groundwater withdrawals in accordance with the Rules of the District. In making a determination to deny a permit or limit groundwater withdrawals, the District will consider the available data and evidence and then weigh the public benefit against the individual needs and hardship in accord with State law.

The relevant factors to be considered in a determination to grant or deny a well or a production permit or limit groundwater withdrawals are stated in the District's Rules and information furnished can include:

1. Whether the application contains all the information required to be submitted to the District pursuant to these Rules;
2. Whether the application is in conformance with any applicable requirements under Rule 20 – Classification, Spacing and Production Provisions established by the District;
3. Whether the proposed use of groundwater unreasonably affects existing groundwater or surface water resources;
4. Whether the proposed use of groundwater is a beneficial use consistent with District's Certified Groundwater Management Plan;
5. Whether the applicant has agreed to avoid waste and achieve water conservation;
6. Whether the proposed use of the groundwater will result in subsidence;
7. Whether the applicant has agreed that reasonable diligence will be used to protect groundwater quality, and that the applicant will follow well plugging guidelines at the time of well closure;
8. The equitable distribution of the resource; and
9. The potential effect the permit may have on the aquifer, sustainability of the recharge on the aquifer as a whole, and potential impacts to prior existing permitted groundwater users and exempt groundwater users.
10. The modeled available groundwater determined by the executive administrator;
11. The executive administrator's estimate of the current and projected amount of groundwater produced under exemptions granted by district rules and Section 36.117;
12. The amount of groundwater authorized under permits previously issued by the district
13. A reasonable estimate of the amount of groundwater that is actually produced under permits issued by the district;
14. Yearly precipitation and production patterns.
15. Estimated Average Annual Recharge

The transport of groundwater out of the District is regulated by the District according to the Rules of the District.

In pursuit of the District's mission of protecting the resource to facilitate its maximum beneficial use, the District may require reduction of permitted groundwater withdrawals to amounts that, based on then available current information, will not knowingly cause permanent harm to an aquifer. To achieve this purpose, the District may, at the Board's discretion and after notice and hearing, amend or revoke any permit for non-compliance, or reduce the production authorized by permit based upon reliable scientific data for the purpose of protecting the aquifer and groundwater availability. The determination to seek the amendment of a permit will be based on aquifer conditions observed by the District confirmed by reliable scientific analysis. The determination to seek revocation of a permit will be based on compliance and non-compliance with the District's Rules and regulations, and reliable scientific evidence. The District will enforce the terms and conditions of permits and the Rules of the District, as necessary, by fine and/or enjoining the permit holder, or non-permit holder, in a court of competent jurisdiction as provided for in Chapter 36, Texas Water Code.

A drought management plan has been adopted by the Board to cope with the effects of water supply deficits due to climatic or other conditions. In its annual review of the drought management plan, the District, in establishing drought triggers and stages, anticipates consideration of 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 hydrogeological conditions of the aquifers within the District and the appropriate conditions under which to implement the drought management plan.

The District will employ reasonable and necessary technical resources at its disposal to evaluate the groundwater resources available within the District and to determine the effectiveness of regulatory or conservation measures. The District anticipates that its drought management plan will provide that a public or private user may appeal to the Board for discretion in enforcement of the provisions of the water supply deficit drought management plan on grounds of adverse economic hardship or unique local conditions. The exercise of discretion by the Board, shall not be construed as limiting the power of the Board.

8. ACTIONS, PROCEDURES, PERFORMANCE AND PLAN IMPLEMENTATION

The District will implement the provisions of this Plan and will utilize the provisions of this Plan as a guidepost for on-going evaluation 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 has adopted Rules relating to the permitting of wells, production and transport of groundwater. The Rules adopted by the District will be modified to take into account this Plan once it has been approved and shall be amended as necessary, pursuant to Chapter 36 of the TEXAS WATER CODE consistent with the provisions of this Plan based upon reliable scientific evidence. All Rules will be enforced. The promulgation and enforcement of the Rules will be based on the best technical data reasonably available. A link to the District rules is provides as follows:

http://www.pccd.org/PCCD%20GW%20Management%20&%20Protection%20Rules.pdf

The District shall treat all citizens equally. Citizens may apply to the District for a variance in enforcement of the Rules on grounds of adverse economic effect or unique local conditions. In granting a variance to any rule, the Board shall consider the potential for adverse effect on adjacent landowners and the rights of other groundwater owners and users within the District. The exercise of said discretion by the Board, shall not be construed as limiting the power of the Board.

The District will seek cooperation with other agencies in the implementation of this Plan and the management of groundwater supplies within the District.

The District believes that there is a significant issue that affects groundwater within its boundaries and affects the District's ability to effectively manage the groundwater resources within the District. That issue is that there are very productive regions of aquifers that are near but not within Plum Creek Conservation District's regulatory authority. Should there be large volume water production from aquifers in these areas, there is significant potential that such production will impact water quantity and/or water quality of users in the District.

The fact that Plum Creek Conservation District's surface boundaries also includes areas that are within the Barton Springs Edwards Aquifer Conservation District and the Edwards Aquifer Authority [the District does have authority over any aquifers in Hays and Caldwell County within its boundary that are not regulated by either the Edwards Aquifer Authority or the Barton Springs-Edwards Aquifer Conservation District -] indicates that Plum Creek should cooperate with [and provide some assistance to] the EAA and the Barton Springs-Edwards District while developing plans for understanding and use of water resources to the fast growing area along Interstate 35 between San Antonio and Austin. PCCD's territory extends from Northwest of IH 35 to IH 10 and encompasses much of an area that is projected to have rapid growth. The completion of SH 130, along with other regional projects is considered by many to be a necessary infrastructure component to allow for population and economic growth. Developers and retail water suppliers are already searching for additional water supplies to meet growing demand.

Finally, there are significant long-existing oil and gas operations in the southern part of the District along with the possible future exploration and development of gas-liquids shale plays. Should those activities continue to increase as the price for oil and gas resources stays high, there may be significant consumption of water, or other groundwater impacts such as the potential for pollution, related to such activities that is outside the scope of regulatory power of any groundwater district.

For these reasons, all activities of the District will be undertaken in co-operation and coordinated with the appropriate state, regional or local water management entities where they are present. However, simply stated, in Hays County there are many such agencies looking at management of groundwater; in Caldwell County the absence of a groundwater agency in the eastern and western part of the county makes management of the groundwater resources in the District more challenging.

9. METHODOLOGY FOR TRACKING DISTRICT PROGRESS IN ACHIEVING MANAGEMENT GOALS

The Groundwater Manager of the District will prepare and present an annual report to the Board of Directors on the performance of the District with respect to achieving its management goals and objectives. The presentation of the report will occur during the last monthly Board meeting each fiscal year, beginning after the adoption and approval of this Plan. The report will include an enumeration and listing of activities furthering the District's management objectives during the fiscal year. Each activity will be referenced to the estimated expenditure of staff time and District resources used in accomplishment of the activity. The notations of activity frequency, staff time and resources used 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 adopted report on file, for public inspection, at the District's offices. This methodology will apply to all management goals contained within this plan.

10. Management Goals, Objectives, & Performance Standards

10.1 Providing the Most Efficient Use of Groundwater

Management Objectives:

1. The PCCD Aquifer Water Level Observation Well Program will have at least 6 observation wells located according to management zones within the District, and measure those wells at least one time a year.

2. As part of the Aquifer Water Level Observation Program, the District will geographically divide the surface area overlying the aquifers of Plum Creek Conservation District into a grid-type network of units.

3. The district will have a goal of establishing at least one monitoring water well in each of these units.

4. The District will provide educational leadership to citizens within the District concerning this subject. The activity will be accomplished annually through at least one printed publication, such as a brochure, and public speaking at service organizations and public schools as provided for in the District's Public Education Program.

5. The District will use its best efforts to obtain information on water being produced from areas in Caldwell County that are outside the boundaries of the District.

6. The District will use its best efforts to obtain information on groundwater being produced from groundwater aquifers in counties surrounding the District as well as in areas close to the District that are not in a groundwater conservation district in order to develop information about impacts of such production on groundwater in the District.

Performance Standards:

1. The PCCD Aquifer Water Level Observation Well Program will have at least 6 observation wells located according to management zones within the District.

2. Water levels at these observation wells will be measured a minimum of one time during the year.

3. As part of the Aquifer Water Level Observation Program the District will geographically divide the surface area overlying the aquifers of Plum Creek Conservation District into a grid type network of units within one year of the adoption of this plan.

4. On an annual basis the district will assess the District's progress of establishing at least one monitoring well in each of these units.

5. PCCD representatives will circulate at least one publication and participate in one speaking engagement each year.

6. PCCD representatives will attend and participate in GMA meetings appropriate to the District's regulatory authority.

7. PCCD will periodically seek information from nearby groundwater districts not in the same GMA but drawing from the same aquifers regulated by the District.

10.2 Controlling and Preventing Waste of Groundwater.

Management Objective:

The District will provide educational leadership to citizens within the District concerning this subject. The activity will be accomplished annually through at least one printed publication, such as a brochure.

Performance Standard:

1. Each calendar year Representatives of Plum Creek will prepare at least one informational article listing current data related to groundwater production and well levels. The goal of the article is to make those who use and depend on the groundwater aware of their use, aware of the impacts of their use, and the need to be responsible in that use.

2. At its offices Plum Creek will maintain an inventory of publications of others, such as those prepared by the Guadalupe Blanco River Authority about the necessity for conservation, and serve as a local source for distribution of those publications.

10.3 Controlling and Preventing Subsidence

It is uncertain as to whether subsidence from the production of groundwater would likely occur in the Plum Creek Conservation District. The District historically has not, as we know, experienced any subsidence from any cause. Accordingly, the District's Plan does not contain any "Management Objective" or related "Performance Standards" to address the issue of non-existent subsidence. The TWDB has commissioned a subsidence study for the Major and Minor aquifers of Texas. If after reviewing TWDB's report, it shows scientific evidence of subsidence or the potential there of in PCCD, then the District would further investigate the possibility of whether there would be landowners negatively impacted. Alluvium is poorly consolidated, but generally too thin to experience measurable (if any) subsidence due to groundwater withdrawals.

10.4 Addressing Conjunctive Surface Water Management Issues

Management Objective:

Each year the District will seek conferral with the Guadalupe-Blanco River Authority (GBRA) and/or other local political subdivisions and water and wastewater utilities on cooperative opportunities for conjunctive resource management.

Performance Standard:

1. Each year the District will seek conferral with the GBRA, other political subdivisions or water and wastewater utilities providing retail water service within Plum Creek's boundaries, to gain information about conjunctive resource management.

2. The District will continue to participate in the quarterly meetings of the Plum Creek Watershed Project through the time of completion of the water quality management plan being developed in that effort

10.5 Addressing Drought Conditions

Management Objective:

Review the Drought Management Strategy Plan annually, and revise it if necessary based upon the availability of additional scientific data collected by or presented to the Board . The Drought Management Strategy Plan will be implemented when specified conditions require.

Performance Standards:

1. Review on an annual basis all of the conditions and requirements specified in the Drought Management Strategy Plan that would trigger its implementation.

2. Use data that are available from local weather stations monitoring rainfall, looking at the correlation between rainfall, water levels, groundwater recharge and availability.

3. Provide a link on the District's website for TWDB's drought web page. https://waterdatafortexas.org/drought

10.6 Addressing Natural Resource Issues That Impact the Use and Availability of Groundwater and Which are Impacted By the Use of Groundwater

Management Objectives:

1. Each year the District will seek conferral with a representative of the Texas Railroad Commission (RRC) on the impact of oil and gas production or waste and disposal operations associated with oil and gas production on groundwater availability and quality, as well as the impact of groundwater production on the production of oil and gas in the District.

2. Also, during each year the District will evaluate all permit applications for new production injection or disposal wells permitted by the Railroad Commission, if any are filed, and the information submitted by the applicants on those wells prior to drilling, in order to assess the impact of these wells on the groundwater resources in the District.

Performance Standards:

1. Will seek conferral annually with a representative of the Texas RRC ;

2. The addition of available RRC well data to the District's database;

3. Report to the PCCD Board of Directors when new groundwater well permit applications are filed, and the possible impacts of those new wells on the groundwater resources in the District; and

4. Annual reports to the Board about consumption and use of groundwater for commercial purposes, including irrigation uses and enhanced oil and gas production when information is available.

10.7 Addressing Conservation, Recharge Enhancement, Rainwater Harvesting, Precipitation Enhancement, or Brush Control where appropriate and cost-effective

Management Objectives:

1. The District will provide educational leadership and encouragement to citizens within the District on the need for water conservation and publicize the benefits of rainwater harvesting and brush control. The educational efforts and publicity will be through distribution of brochures produced either by the District or by others and made available by the District and through the presentation annually of informational articles that tabulate data developed by the District on the groundwater resources being monitored. Each of the following topics will be addressed in the publications:

   A. Conservation

   B. Rainwater Harvesting

   C. Brush Control

2. With respect to recharge enhancement, the District will continue to develop geologic data to map and gain understanding of the relationship between recharge to and discharge from various formations to each other and to Plum Creek as it flows through the District. At this time, the relationships among the aquifers and the Creek are not well documented or understood. It is known that recharge of much of the groundwater that can be found in the District, and in areas next to the District that are not in any groundwater district, originate outside the boundaries of the District. There is some natural recharge to aquifers in the District from both streams and from areas where those aquifers are at the surface. However, the formations found in the District are not readily susceptible to recharge enhancement.

3. The District has an active brush control program for the flood water retention structures that it maintains. The

District also cooperates with the US Department of Agriculture in agricultural conservation efforts and actively supports the local Soil and Water Conservation District.

4. The District has participated in the funding of a rainwater harvesting demonstration project at the Luling Foundation and will continue to monitor the results of that project and report those results in its articles.

5. The District does not believe that precipitation enhancement is appropriate and cost effective in its area. At the same time, PCCD is aware of efforts being implemented by other districts and will continue to monitor the information gathered from those and determine whether such efforts might be attempted by the District. The District will continue to assess the need and opportunity for precipitation enhancement in the District at least once every five years.

Performance Standards:

1. Preparation and distribution of at least two publications each year containing information about conservation, rainwater harvesting and brush control efforts.

2. The District staff will continue to cooperate with the Natural Resource Conservation Service to control brush on the 28 flood water retention structures maintained by the District. In addition, the District will participate in at least one meeting each year with the local soil and water conservation district to discuss brush control efforts, and will continue to support the local soil and water conservation districts efforts through and annual financial contribution.

3. The District will obtain, if available, at least one report each year about the relationship between recharge of aquifers in the District and rainfall on the surface to determine whether it would be appropriate and cost effective to develop a trial plan for recharge enhancement.

4. At least once every 5 years the staff will report to the Board on the results of nearby precipitation enhancement activities so the Board can consider the feasibility of participating in any efforts in the area of lands that are serving as sources of recharge for groundwater found in the District. If the Board determines that precipitation enhancement might be appropriate and cost effective, within two years the Board will develop and adopt a

program allowing participation in precipitation efforts ongoing in the region.

10.8. Mitigation & Desired Future Conditions of Groundwater Resources

The mitigation plan will be reviewed on an annual basis and revised if necessary in order to be compliant with the adopted DFCs and any current or new state law in effect. Further, any projects that have been mitigated will also be reviewed on an annual basis.

Review of groundwater resources in the District in comparison with the Desired Future Conditions of those resources and preparation of a recommendation for any mitigation actions within six (6) months or later if warranted.

10.9 Addressing the Desired Future Conditions established under TWC §36.108

Management Objective:

At least once every three years, the District will monitor water levels and evaluate whether the change in water levels is in conformance with the DFCs adopted by the District. The District will estimate total annual groundwater production for each aquifer based on the water use reports, estimated exempted use, and other relevant information, and compare these production estimates to the MAGs.

Performance Standard:

1. At least once every three years, the executive manager will report to the Board the measured water levels obtained from the monitoring wells within each Management Zone, the average measured drawdown for each Management Zone calculated from the measured water levels of the monitoring wells within the Management Zone, a comparison of the average measured drawdowns for each Management Zone with the DFCs for each Management Zone, and the District's progress in conforming with the DFCs.

2. At least once every three years, the executive manager will report to the Board the total permitted production and the estimated total annual production for each aquifer and compare these amounts to the MAGs for each aquifer.

4. In conjunction with information from PCCD's drought management plan, Aquifer Water Level Observation Well Program , water use production patterns, analysis from PCCD's geological consultant and other pertinent technical data, the board, at least once every three(3) years will determine if conditions are present that would jeopardize

DFC compliance and if so, schedule a hearing to address limiting water use for water well production permit holders.

10.10 Alternative Supply

Management Objective:

1. The District will assess the need and feasibility, including funding options, of developing a program to research, participate in regional studies with other groundwater conservation districts and regional agencies in order to look at the potential benefits of alternative water supply sources such as underdeveloped aquifers, one being the Trinity Aquifer, desalinization, rainwater harvesting, and aquifer recovery and storage in and around our district.

Performance Standard:

1. Assess the groundwater resources of the Trinity Group and saline Edwards. The district will assess the need to develop one or more monitoring wells in order to determine the aquifer characteristics and potential for public supply and to cooperate with GCDs that have similar goals.

2. The district will evaluate and support studies on ASR and on desalination projects through cooperative collaboration or financial assistance.

11. PROJECTED WATER DEMANDS WITHIN THE DISTRICT

Please refer to Appendix A-Estimated Historical Groundwater Use and 2017 State Water Plan Datasets

12. PROJECTED SURFACE WATER SUPPLIES WITHIN THE DISTRICT

Please refer to Appendix A-Estimated Historical Groundwater Use and 2017 State Water Plan Datasets

13. WATER NEEDS WITHIN THE DISTRICT

Please refer to Appendix A-Estimated Historical Groundwater Use and 2017 State Water Plan Datasets

14. WATER MANAGEMENT STRATEGIES WITHIN THE DISTRICT

Please refer to Appendix A-Estimated Historical Groundwater Use and 2017 State Water Plan Datasets

15. ESTIMATE OF GROUNDWATER USE IN THE DISTRICT

Please refer to Appendix A-Estimated Historical Groundwater Use and 2017 State Water Plan Datasets

16. Annual Amount of Recharge From Precipitation to the Groundwater Resources within the District

Please refer to Appendix B-GAM Run 12-001: Plum Creek Conservation District Management Plan.

17. Annual Volume of Water that Discharges from the Aquifer to Springs and Surface Water Bodies

Please refer to Appendix B-GAM Run 12-001: Plum Creek Conservation District Management Plan.

18. Estimate of the Annual Volume of Flow into the District, out of the District, and Between Aquifers in the District

Please refer to Appendix B-GAM Run 12-001: Plum Creek Conservation District Management Plan.

19. Estimate of Modeled Available Groundwater in District Based on Desired Future Conditions

Texas Water Code § 36.001 defines modeled available groundwater as "the amount of water that the executive administrator determines may be produced on an average annual basis to achieve a desired future condition established under Section 36.108".

The joint planning process set forth in Texas Water Code § 36.108 must be collectively conducted by all groundwater conservation districts within the same GMA. The District is a member of GMA 10 & 13. GMA 10 and GMA 13 adopted DFCs, as summarized below, and then forwarded them to the TWDB for MAG development which are also shown below.

TABLE 1: Desired Future Conditions for GMA 10 & 13

GMA	Aquifers	Adopted DFC	Adoption Date
10	Trinity Group	Trinity Aquifer, in the hydrologically confined zone downdip of the Trinity outcrop: Outside of Uvalde and Bexar Counties: Average regional well drawdown not exceeding 25 feet during average recharge conditions (including exempt and non-exempt use)	June 26, 2017
10	Saline Edwards	Saline Edwards Aquifer in the Northern GMA Subdivision: No more than 75 feet of regional average potentiometric surface drawdown due to pumping when compared to pre-development conditions	June 26, 2017
13	Carrizo-Wilcox, Etal	The first proposed desired future condition for the Carrizo-Wilcox, Queen City and Sparta aquifers in Groundwater Management Area 13 is that 75 percent of the saturated thickness in the outcrop at the end of 2012 remains in 2070. This desired future condition is considered feasible despite model predictions to the contrary as detailed in GMA 13 Technical Memorandum 16-08", **And** In addition, a secondary proposed desired future condition for the Carrizo-Wilcox, Queen City, and Sparta aquifers in Groundwater Management Area 13 is an average drawdown of 48 feet for all of GMA 13. The drawdown is calculated from the end of 2012 conditions to	November 21, 2016

		the year 2070. This desired future condition is consistent with Scenario 9 as detailed in GMA 13 Technical Memorandum 16-01 and GMA 13 Technical Memorandum 16-08	

TABLE 2: Summary of Modeled Available Groundwater for the Plum Creek Conservation District (complete set of values is available in the appendix)

GMA	Aquifers	MAG (acre-ft/ per year)	TWDB MAG Report
10	Trinity Group	276	GAM Run 16-033 MAG:
10	Saline Edwards	812	GAM Run 16-033 MAG:
13	Carrizo-Wilcox	Year 2012 = 21,073	GAM Run 17-027 MAG
		Year 2070 = 19,625	
13	Carrizo	6057	GAM Run 17-027 MAG
13	Wilcox Group (Upper, Middle & Lower)	Year 2012 = 15,015	GAM Run 17-027 MAG
		Year 2070 = 13,567	
13	Queen City	22	GAM Run 17-027 MAG

20. GEOLOGY MAP OF PCCD

Please refer to Appendix C.

We the undersigned members of the Board of Directors do hereby certify and confirm the adoption of this revised and amended Groundwater Management Plan of the Plum Creek Conservation District on this the 13th day of November, 2007 as evidenced by our signatures below:

Board of Directors

____
James A. Holt, Jr., President

____
James O. Lipscomb, Vice President

____
Lucy Knight, Director

____
Peter Reinecke, Director

____
Ben Twidwell, Director

____
Fred Rothert, Director

Attested by: __________________________________
Johnie Halliburton, Executive Manager

Estimated Historical Groundwater Use And 2017 State Water Plan Datasets:

Plum Creek Conservation District

by Stephen Allen
Texas Water Development Board
Groundwater Division
Groundwater Technical Assistance Section
stephen.allen@twdb.texas.gov
(512) 463-7317
September 20, 2017

GROUNDWATER MANAGEMENT PLAN DATA:

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

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

The five reports included in this part are:

1. Estimated Historical Groundwater Use (checklist item 2)

    from the TWDB Historical Water Use Survey (WUS)

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

    from the 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 9/20/2017. 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).

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

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

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

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

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

Estimated Historical Water Use

TWDB Historical Water Use Survey (WUS) Data

Groundwater and surface water historical use estimates are currently unavailable for calendar year 2016. TWDB staff anticipates the calculation and posting of these estimates at a later date.

CALDWELL COUNTY *51.56% (multiplier)* All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2015	GW	933	0	0	0	207	82	1,222
	SW	1,511	4	0	0	27	326	1,868
2014	GW	1,053	0	1	0	335	81	1,470
	SW	1,521	3	0	0	30	322	1,876
2013	GW	1,046	0	0	0	297	77	1,420
	SW	1,509	2	0	0	20	306	1,837
2012	GW	1,207	0	0	0	390	77	1,674
	SW	1,615	0	0	0	42	305	1,962
2011	GW	1,546	0	13	0	527	86	2,172
	SW	1,624	0	27	0	41	344	2,036
2010	GW	1,357	1	2	0	368	87	1,815
	SW	1,580	0	3	0	19	349	1,951
2009	GW	1,400	1	0	0	76	85	1,562
	SW	1,486	0	0	0	9	338	1,833
2008	GW	1,278	1	0	0	134	91	1,504
	SW	1,617	0	0	0	589	360	2,566
2007	GW	914	1	0	0	32	107	1,054
	SW	1,593	0	0	0	606	427	2,626
2006	GW	1,038	1	0	0	179	99	1,317
	SW	1,393	0	0	0	0	396	1,789
2005	GW	1,131	1	0	0	155	140	1,427
	SW	1,257	0	0	0	13	558	1,828
2004	GW	1,922	1	0	0	82	39	2,044
	SW	704	0	0	0	12	503	1,219
2003	GW	1,994	1	0	0	66	36	2,097
	SW	671	0	0	0	483	462	1,616
2002	GW	2,014	3	0	0	115	36	2,168
	SW	557	0	0	0	705	458	1,720
2001	GW	1,999	4	0	0	115	33	2,151
	SW	622	0	0	0	705	425	1,752
2000	GW	2,043	5	0	0	71	47	2,166
	SW	560	0	0	0	439	426	1,425

HAYS COUNTY

9.11% (multiplier)

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2015	GW	797	16	27	0	23	8	871
	SW	1,260	0	0	145	17	272	1,694
2014	GW	821	17	34	69	57	7	1,005
	SW	1,208	0	0	0	0	293	1,501
2013	GW	1,073	16	34	91	42	7	1,263
	SW	1,193	0	0	0	0	254	1,447
2012	GW	1,184	18	45	0	60	6	1,313
	SW	1,214	0	0	0	8	223	1,445
2011	GW	1,267	16	59	0	80	9	1,431
	SW	1,221	0	30	0	1	213	1,465
2010	GW	1,179	14	61	0	60	9	1,323
	SW	797	0	32	0	1	249	1,079
2009	GW	1,096	14	60	0	67	28	1,265
	SW	797	0	31	0	0	260	1,088
2008	GW	1,103	16	59	0	65	28	1,271
	SW	724	0	30	0	2	581	1,337
2007	GW	941	13	31	0	112	29	1,126
	SW	635	1	1	0	18	353	1,008
2006	GW	1,120	17	32	0	22	28	1,219
	SW	581	0	0	0	0	313	894
2005	GW	965	16	32	0	13	26	1,052
	SW	481	0	0	0	3	309	793
2004	GW	938	14	32	0	11	18	1,013
	SW	437	1	0	0	29	384	851
2003	GW	949	14	51	0	9	18	1,041
	SW	560	0	0	0	23	217	800
2002	GW	936	14	67	0	1	21	1,039
	SW	456	0	0	0	19	219	694
2001	GW	952	19	56	0	1	19	1,047
	SW	413	0	0	0	19	335	767
2000	GW	908	22	40	0	1	16	987
	SW	414	0	0	0	15	330	759

Projected Surface Water Supplies
TWDB 2017 State Water Plan Data

CALDWELL COUNTY

51.56% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
L	COUNTY LINE WSC	GUADALUPE	CANYON LAKE/RESERVOIR	103	83	61	39	18	0
L	COUNTY-OTHER, CALDWELL	GUADALUPE	GUADALUPE RUN-OF-RIVER	258	258	258	258	258	258
L	GONZALES COUNTY WSC	GUADALUPE	CANYON LAKE/RESERVOIR	19	21	22	23	25	25
L	LIVESTOCK, CALDWELL	COLORADO	COLORADO LIVESTOCK LOCAL SUPPLY	15	15	15	15	15	15
L	LIVESTOCK, CALDWELL	GUADALUPE	GUADALUPE LIVESTOCK LOCAL SUPPLY	243	243	243	243	243	243
L	MARTINDALE	GUADALUPE	CANYON LAKE/RESERVOIR	90	90	90	90	90	90
L	MARTINDALE	GUADALUPE	GUADALUPE RUN-OF-RIVER	100	100	100	100	100	100
L	MAXWELL WSC	GUADALUPE	CANYON LAKE/RESERVOIR	359	368	373	375	376	376
L	MAXWELL WSC	GUADALUPE	GUADALUPE RUN-OF-RIVER	543	557	565	568	569	569
L	SAN MARCOS	GUADALUPE	CANYON LAKE/RESERVOIR	2	2	2	3	3	3
L	UHLAND	GUADALUPE	CANYON LAKE/RESERVOIR	79	94	110	126	142	158
	Sum of Projected Surface Water Supplies (acre-feet)			**1,811**	**1,831**	**1,839**	**1,840**	**1,839**	**1,837**

HAYS COUNTY

9.11% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
K	AUSTIN	COLORADO	COLORADO RUN-OF-RIVER	13	127	249	631	1,519	2,749
K	BUDA	COLORADO	CANYON LAKE/RESERVOIR	1,381	1,292	1,181	1,041	882	701
K	COUNTY-OTHER, HAYS	COLORADO	HIGHLAND LAKES LAKE/RESERVOIR SYSTEM	128	128	128	128	128	128
K	DRIPPING SPRINGS	COLORADO	HIGHLAND LAKES LAKE/RESERVOIR SYSTEM	506	506	506	506	506	506
K	DRIPPING SPRINGS WSC	COLORADO	HIGHLAND LAKES LAKE/RESERVOIR SYSTEM	133	280	461	691	953	1,126
K	LIVESTOCK, HAYS	COLORADO	COLORADO LIVESTOCK LOCAL SUPPLY	17	17	17	17	17	17
K	WEST TRAVIS COUNTY	COLORADO	HIGHLAND LAKES	4,521	4,521	4,521	4,521	4,521	4,521

	PUBLIC UTILITY AGENCY		LAKE/RESERVOIR SYSTEM						
L	BUDA	GUADALUPE	CANYON LAKE/RESERVOIR	299	388	499	639	798	979
L	COUNTY LINE WSC	GUADALUPE	CANYON LAKE/RESERVOIR	226	197	161	113	57	0
L	COUNTY-OTHER, HAYS	GUADALUPE	CANYON LAKE/RESERVOIR	353	353	353	353	353	353
L	CRYSTAL CLEAR WSC	GUADALUPE	CANYON LAKE/RESERVOIR	323	317	319	329	340	354
L	GOFORTH SUD	GUADALUPE	CANYON LAKE/RESERVOIR	1,050	1,050	1,050	1,050	1,050	1,050
L	IRRIGATION, HAYS	GUADALUPE	GUADALUPE RUN-OF-RIVER	12	12	12	12	12	12
L	KYLE	GUADALUPE	CANYON LAKE/RESERVOIR	5,743	5,743	5,743	5,743	5,743	5,732
L	LIVESTOCK, HAYS	GUADALUPE	GUADALUPE LIVESTOCK LOCAL SUPPLY	19	19	19	19	19	19
L	MAXWELL WSC	GUADALUPE	CANYON LAKE/RESERVOIR	101	92	87	85	84	84
L	MAXWELL WSC	GUADALUPE	GUADALUPE RUN-OF-RIVER	153	139	131	128	127	127
L	SAN MARCOS	GUADALUPE	CANYON LAKE/RESERVOIR	9,998	9,998	9,998	9,997	9,997	9,997
L	STEAM ELECTRIC POWER, HAYS	GUADALUPE	CANYON LAKE/RESERVOIR	224	224	224	224	224	224
L	UHLAND	GUADALUPE	CANYON LAKE/RESERVOIR	99	133	175	229	290	360
	Sum of Projected Surface Water Supplies (acre-feet)			**25,299**	**25,536**	**25,834**	**26,456**	**27,620**	**29,039**

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.

CALDWELL COUNTY

51.56% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
L	AQUA WSC	COLORADO	43	51	60	68	77	86
L	AQUA WSC	GUADALUPE	242	289	336	385	435	484
L	COUNTY LINE WSC	GUADALUPE	82	97	114	132	149	166
L	COUNTY-OTHER, CALDWELL	COLORADO	26	31	36	41	46	52
L	COUNTY-OTHER, CALDWELL	GUADALUPE	348	410	474	541	612	681
L	CREEDMOOR-MAHA WSC	COLORADO	114	133	152	172	195	216
L	CREEDMOOR-MAHA WSC	GUADALUPE	29	34	39	45	50	56
L	GOFORTH SUD	GUADALUPE	41	49	56	64	73	81
L	GONZALES COUNTY WSC	GUADALUPE	58	70	83	95	91	102
L	IRRIGATION, CALDWELL	COLORADO	10	9	8	7	6	6
L	IRRIGATION, CALDWELL	GUADALUPE	309	274	244	217	192	175
L	LIVESTOCK, CALDWELL	COLORADO	37	37	37	37	37	37
L	LIVESTOCK, CALDWELL	GUADALUPE	483	483	483	483	483	483
L	LOCKHART	GUADALUPE	2,251	2,676	3,105	3,547	4,010	4,465
L	LULING	GUADALUPE	950	1,125	1,301	1,484	1,678	1,868
L	MANUFACTURING, CALDWELL	GUADALUPE	4	5	5	6	6	7
L	MARTINDALE	GUADALUPE	187	221	256	292	330	367
L	MAXWELL WSC	GUADALUPE	414	487	561	638	720	802
L	MINING, CALDWELL	COLORADO	6	5	3	2	1	1
L	MINING, CALDWELL	GUADALUPE	58	46	34	22	9	4
L	MUSTANG RIDGE	COLORADO	69	82	95	108	122	136
L	MUSTANG RIDGE	GUADALUPE	2	2	2	3	3	3
L	NIEDERWALD	GUADALUPE	16	19	22	25	28	31
L	POLONIA WSC	COLORADO	282	333	386	440	498	554
L	POLONIA WSC	GUADALUPE	596	707	819	935	1,055	1,175
L	SAN MARCOS	GUADALUPE	2	3	4	5	6	7
L	UHLAND	GUADALUPE	79	94	110	126	142	158
		Sum of Projected Water Demands (acre-feet)	**6,738**	**7,772**	**8,825**	**9,920**	**11,054**	**12,203**

HAYS COUNTY

9.11% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
K	AUSTIN	COLORADO	13	127	249	631	1,519	2,749

K	BUDA	COLORADO	1,769	2,508	3,420	4,564	5,860	7,338
K	CIMARRON PARK WATER COMPANY	COLORADO	249	241	234	230	229	229
K	COUNTY-OTHER, HAYS	COLORADO	283	337	421	517	599	681
K	DRIPPING SPRINGS	COLORADO	479	537	610	704	813	938
K	DRIPPING SPRINGS WSC	COLORADO	533	680	861	1,091	1,353	1,652
K	GOFORTH SUD	COLORADO	85	130	185	255	334	425
K	IRRIGATION, HAYS	COLORADO	10	10	10	10	10	10
K	LIVESTOCK, HAYS	COLORADO	20	20	20	20	20	20
K	MANUFACTURING, HAYS	COLORADO	32	36	41	45	49	53
K	MINING, HAYS	COLORADO	77	98	124	132	151	172
K	MOUNTAIN CITY	COLORADO	57	56	54	54	54	54
K	PLUM CREEK WATER COMPANY	COLORADO	163	264	283	300	312	322
K	WEST TRAVIS COUNTY PUBLIC UTILITY AGENCY	COLORADO	4,093	5,758	7,795	10,343	13,226	16,508
L	BUDA	GUADALUPE	299	388	499	639	798	979
L	COUNTY LINE WSC	GUADALUPE	181	231	298	383	478	587
L	COUNTY-OTHER, HAYS	GUADALUPE	188	208	416	572	1,077	1,638
L	CREEDMOOR-MAHA WSC	GUADALUPE	10	12	15	19	23	28
L	CRYSTAL CLEAR WSC	GUADALUPE	632	717	827	973	1,143	1,338
L	GOFORTH SUD	GUADALUPE	1,384	1,753	2,220	2,818	3,504	4,287
L	IRRIGATION, HAYS	GUADALUPE	59	59	58	58	57	56
L	KYLE	GUADALUPE	5,156	7,680	9,133	9,119	9,108	9,104
L	LIVESTOCK, HAYS	GUADALUPE	37	37	37	37	37	37
L	MANUFACTURING, HAYS	GUADALUPE	10	11	13	14	15	16
L	MAXWELL WSC	GUADALUPE	117	122	131	144	160	179
L	MOUNTAIN CITY	GUADALUPE	24	30	38	48	60	73
L	NIEDERWALD	GUADALUPE	59	75	96	122	151	185
L	PLUM CREEK WATER COMPANY	GUADALUPE	736	1,068	1,048	1,032	1,019	1,009
L	SAN MARCOS	GUADALUPE	11,934	13,941	16,430	19,485	23,205	27,655
L	STEAM ELECTRIC POWER, HAYS	GUADALUPE	67	88	181	247	336	458
L	UHLAND	GUADALUPE	99	133	175	229	290	360
L	WIMBERLEY	GUADALUPE	626	800	1,018	1,300	1,622	1,990
L	WIMBERLEY WSC	GUADALUPE	450	657	919	1,247	1,617	2,039
L	WOODCREEK	GUADALUPE	282	311	349	399	458	525
	Sum of Projected Water Demands (acre-feet)		**30,213**	**39,123**	**48,208**	**57,781**	**69,687**	**83,694**

Projected Water Supply Needs
TWDB 2017 State Water Plan Data

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

CALDWELL COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
L	AQUA WSC	COLORADO	43	35	26	18	9	0
L	AQUA WSC	GUADALUPE	242	195	148	99	49	0
L	COUNTY LINE WSC	GUADALUPE	56	19	-22	-64	-104	-141
L	COUNTY-OTHER, CALDWELL	COLORADO	182	173	163	154	143	133
L	COUNTY-OTHER, CALDWELL	GUADALUPE	1,108	986	862	732	596	462
L	CREEDMOOR-MAHA WSC	COLORADO	0	0	0	0	0	0
L	CREEDMOOR-MAHA WSC	GUADALUPE	0	0	0	0	0	0
L	GOFORTH SUD	GUADALUPE	0	0	0	0	0	0
L	GONZALES COUNTY WSC	GUADALUPE	14	11	4	-3	6	-3
L	IRRIGATION, CALDWELL	COLORADO	0	2	4	6	7	8
L	IRRIGATION, CALDWELL	GUADALUPE	34	101	160	213	261	294
L	LIVESTOCK, CALDWELL	COLORADO	0	0	0	0	0	0
L	LIVESTOCK, CALDWELL	GUADALUPE	0	0	0	0	0	0
L	LOCKHART	GUADALUPE	-188	-613	-1,042	-1,484	-1,947	-2,402
L	LULING	GUADALUPE	133	-41	-217	-400	-594	-784
L	MANUFACTURING, CALDWELL	GUADALUPE	5	4	3	2	1	0
L	MARTINDALE	GUADALUPE	3	-31	-66	-102	-140	-177
L	MAXWELL WSC	GUADALUPE	624	578	519	448	368	286
L	MINING, CALDWELL	COLORADO	0	0	0	0	0	0
L	MINING, CALDWELL	GUADALUPE	0	0	0	0	0	0
L	MUSTANG RIDGE	COLORADO	0	0	0	0	0	0
L	MUSTANG RIDGE	GUADALUPE	0	0	0	0	0	0
L	NIEDERWALD	GUADALUPE	-13	-16	-20	-23	-26	-29
L	POLONIA WSC	COLORADO	118	65	11	-45	-104	-164
L	POLONIA WSC	GUADALUPE	262	146	26	-101	-237	-377
L	SAN MARCOS	GUADALUPE	1	0	-1	-1	-2	-3
L	UHLAND	GUADALUPE	0	0	0	0	0	0
	Sum of Projected Water Supply Needs (acre-feet)		**-201**	**-701**	**-1,368**	**-2,223**	**-3,154**	**-4,080**

HAYS COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
K	AUSTIN	COLORADO	0	0	0	0	0	0
K	BUDA	COLORADO	161	-667	-1,690	-2,974	-4,429	-6,088

K	CIMARRON PARK WATER COMPANY	COLORADO	0	8	15	19	20	20
K	COUNTY-OTHER, HAYS	COLORADO	983	394	-530	-1,587	-2,489	-3,382
K	DRIPPING SPRINGS	COLORADO	27	-31	-104	-198	-307	-432
K	DRIPPING SPRINGS WSC	COLORADO	0	0	0	0	0	-126
K	GOFORTH SUD	COLORADO	0	0	0	0	0	0
K	IRRIGATION, HAYS	COLORADO	333	333	333	333	333	333
K	LIVESTOCK, HAYS	COLORADO	2	2	2	2	2	2
K	MANUFACTURING, HAYS	COLORADO	236	185	134	88	46	0
K	MINING, HAYS	COLORADO	-531	-761	-1,047	-1,131	-1,340	-1,579
K	MOUNTAIN CITY	COLORADO	0	0	0	0	0	0
K	PLUM CREEK WATER COMPANY	COLORADO	0	0	0	0	0	0
K	WEST TRAVIS COUNTY PUBLIC UTILITY AGENCY	COLORADO	728	-937	-2,974	-5,522	-8,405	-11,687
L	BUDA	GUADALUPE	0	0	0	0	0	0
L	COUNTY LINE WSC	GUADALUPE	122	45	-56	-187	-336	-500
L	COUNTY-OTHER, HAYS	GUADALUPE	3,101	2,881	601	-1,109	-6,654	-12,812
L	CREEDMOOR-MAHA WSC	GUADALUPE	0	0	0	0	0	0
L	CRYSTAL CLEAR WSC	GUADALUPE	84	-13	-118	-243	-388	-551
L	GOFORTH SUD	GUADALUPE	2,763	2,340	1,810	1,133	358	-525
L	IRRIGATION, HAYS	GUADALUPE	88	94	100	106	112	118
L	KYLE	GUADALUPE	1,176	-1,348	-2,801	-2,787	-2,776	-2,783
L	LIVESTOCK, HAYS	GUADALUPE	0	0	0	0	0	0
L	MANUFACTURING, HAYS	GUADALUPE	573	558	542	528	515	501
L	MAXWELL WSC	GUADALUPE	176	144	120	101	83	64
L	MOUNTAIN CITY	GUADALUPE	4	-1	-7	-17	-29	-42
L	NIEDERWALD	GUADALUPE	-49	-65	-85	-111	-140	-174
L	PLUM CREEK WATER COMPANY	GUADALUPE	248	-185	-184	-185	-184	-184
L	SAN MARCOS	GUADALUPE	1,867	-140	-2,629	-5,685	-9,405	-13,855
L	STEAM ELECTRIC POWER, HAYS	GUADALUPE	4,646	4,411	3,394	2,668	1,688	353
L	UHLAND	GUADALUPE	0	0	0	0	0	0
L	WIMBERLEY	GUADALUPE	218	44	-174	-456	-778	-1,146
L	WIMBERLEY WSC	GUADALUPE	233	26	-236	-564	-934	-1,356
L	WOODCREEK	GUADALUPE	716	687	649	599	540	473
	Sum of Projected Water Supply Needs (acre-feet)		**-580**	**-4,148**	**-12,635**	**-22,756**	**-38,594**	**-57,222**

Projected Water Management Strategies
TWDB 2017 State Water Plan Data

CALDWELL COUNTY

WUG, Basin (RWPG)

All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
COUNTY LINE WSC, GUADALUPE (L)							
BRACKISH WILCOX GROUNDWATER FOR CRWA	CARRIZO-WILCOX AQUIFER [WILSON]	0	0	0	64	105	141
CRWA SIESTA PROJECT	DIRECT REUSE [BEXAR]	0	0	10	0	0	0
CRWA SIESTA PROJECT	SAN ANTONIO RUN-OF-RIVER [WILSON]	0	0	12	0	0	0
REUSE - KYLE/COUNTY LINE WSC	DIRECT REUSE [HAYS]	16	15	14	13	12	11
		16	**15**	**36**	**77**	**117**	**152**
COUNTY-OTHER, CALDWELL, COLORADO (L)							
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [CALDWELL]	0	0	0	0	0	0
		0	**0**	**0**	**0**	**0**	**0**
COUNTY-OTHER, CALDWELL, GUADALUPE (L)							
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [CALDWELL]	0	0	0	0	0	2
		0	**0**	**0**	**0**	**0**	**2**
GOFORTH SUD, GUADALUPE (L)							
GBRA - MBWSP - SURFACE WATER W/ ASR (OPTION 3C)	GUADALUPE RUN-OF-RIVER [GONZALES]	0	0	0	0	0	0
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [CALDWELL]	0	0	0	0	0	0
		0	**0**	**0**	**0**	**0**	**0**
GONZALES COUNTY WSC, GUADALUPE (L)							
LOCAL CARRIZO AQUIFER DEVELOPMENT	CARRIZO-WILCOX AQUIFER [GONZALES]	0	0	0	3	3	3
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [CALDWELL]	8	12	20	29	32	42
		8	**12**	**20**	**32**	**35**	**45**
LOCKHART, GUADALUPE (L)							
DROUGHT MANAGEMENT - LOCKHART	DEMAND REDUCTION [CALDWELL]	113	0	0	0	0	0
GBRA - MBWSP - SURFACE WATER W/ ASR (OPTION 3C)	GUADALUPE RUN-OF-RIVER [GONZALES]	1,120	1,120	1,120	1,484	1,947	2,402
MUNICIPAL WATER CONSERVATION (SUBURBAN)	DEMAND REDUCTION [CALDWELL]	0	0	0	0	0	72
		1,233	**1,120**	**1,120**	**1,484**	**1,947**	**2,474**
LULING, GUADALUPE (L)							
GBRA - MBWSP - SURFACE WATER W/	GUADALUPE RUN-OF-	1,673	1,674	1,674	1,673	1,678	1,868

ASR (OPTION 3C)	RIVER [GONZALES]						
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [CALDWELL]	0	0	0	0	0	3
		1,673	**1,674**	**1,674**	**1,673**	**1,678**	**1,871**
MARTINDALE, GUADALUPE (L)							
DROUGHT MANAGEMENT - MARTINDALE	DEMAND REDUCTION [CALDWELL]	9	0	0	0	0	0
HAYS/CALDWELL PUA PROJECT	CARRIZO-WILCOX AQUIFER [CALDWELL]	0	31	66	102	140	177
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [CALDWELL]	0	0	0	0	0	1
		9	**31**	**66**	**102**	**140**	**178**
MUSTANG RIDGE, COLORADO (L)							
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [CALDWELL]	0	0	0	0	0	1
		0	**0**	**0**	**0**	**0**	**1**
MUSTANG RIDGE, GUADALUPE (L)							
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [CALDWELL]	0	0	0	0	0	0
		0	**0**	**0**	**0**	**0**	**0**
NIEDERWALD, GUADALUPE (L)							
DROUGHT MANAGEMENT - NIEDERWALD	DEMAND REDUCTION [CALDWELL]	1	0	0	0	0	0
GBRA - MBWSP - SURFACE WATER W/ ASR (OPTION 3C)	GUADALUPE RUN-OF-RIVER [GONZALES]	13	16	20	23	26	29
		14	**16**	**20**	**23**	**26**	**29**
POLONIA WSC, COLORADO (L)							
LOCAL CARRIZO AQUIFER WITH CONVERSION	CARRIZO-WILCOX AQUIFER [CALDWELL]	0	0	0	45	104	164
		0	**0**	**0**	**45**	**104**	**164**
POLONIA WSC, GUADALUPE (L)							
LOCAL CARRIZO AQUIFER WITH CONVERSION	CARRIZO-WILCOX AQUIFER [CALDWELL]	0	0	0	101	237	377
		0	**0**	**0**	**101**	**237**	**377**
SAN MARCOS, GUADALUPE (L)							
GBRA - MBWSP - SURFACE WATER W/ ASR (OPTION 3C)	GUADALUPE RUN-OF-RIVER [GONZALES]	0	0	1	1	1	1
HAYS/CALDWELL PUA PROJECT	CARRIZO-WILCOX AQUIFER [CALDWELL]	0	0	0	1	1	2
MUNICIPAL WATER CONSERVATION (SUBURBAN)	DEMAND REDUCTION [CALDWELL]	0	0	0	0	1	1
REUSE - SAN MARCOS	DIRECT REUSE [HAYS]	0	1	1	1	2	2
		0	**1**	**2**	**3**	**5**	**6**
UHLAND, GUADALUPE (L)							
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [CALDWELL]	0	0	0	0	2	6
		0	**0**	**0**	**0**	**2**	**6**
Sum of Projected Water Management Strategies (acre-feet)		**2,953**	**2,869**	**2,938**	**3,540**	**4,291**	**5,305**

HAYS COUNTY

WUG, Basin (RWPG)

All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
AUSTIN, COLORADO (K)							
DROUGHT MANAGEMENT	DEMAND REDUCTION [HAYS]	1	13	25	63	152	275
		1	**13**	**25**	**63**	**152**	**275**
BUDA, COLORADO (K)							
DIRECT REUSE - BUDA	DIRECT REUSE [HAYS]	2,240	2,240	1,740	1,740	1,740	1,740
DROUGHT MANAGEMENT	DEMAND REDUCTION [HAYS]	177	251	342	456	586	734
EDWARDS / MIDDLE TRINITY ASR	TRINITY AQUIFER ASR [HAYS]	0	600	600	600	600	600
HCPUA PIPELINE - REGION K RECOMMENDED	CARRIZO-WILCOX AQUIFER [GONZALES]	0	667	1,690	2,467	2,467	2,467
MUNICIPAL CONSERVATION - BUDA	DEMAND REDUCTION [HAYS]	88	206	434	552	709	888
SALINE EDWARDS ASR	EDWARDS AQUIFER ASR [TRAVIS]	0	100	100	100	100	100
SALINE EDWARDS ASR (SALINE)	EDWARDS-BFZ AQUIFER [TRAVIS]	0	400	400	400	400	400
		2,505	**4,464**	**5,306**	**6,315**	**6,602**	**6,929**
COUNTY-OTHER, HAYS, COLORADO (K)							
BRUSH CONTROL	COLORADO RUN-OF-RIVER [HAYS]	425	425	425	425	425	425
DROUGHT MANAGEMENT	DEMAND REDUCTION [HAYS]	466	554	693	852	987	1,121
EDWARDS / MIDDLE TRINITY ASR	TRINITY AQUIFER ASR [HAYS]	0	200	200	200	200	200
HAYS COUNTY PIPELINE - REGION K RECOMMENDED	CARRIZO-WILCOX AQUIFER [GONZALES]	0	2,000	2,000	2,000	2,000	2,000
SALINE EDWARDS ASR	EDWARDS AQUIFER ASR [TRAVIS]	0	100	100	100	100	100
SALINE EDWARDS ASR (SALINE)	EDWARDS-BFZ AQUIFER [TRAVIS]	0	100	100	100	100	100
		891	**3,379**	**3,518**	**3,677**	**3,812**	**3,946**
DRIPPING SPRINGS, COLORADO (K)							
DROUGHT MANAGEMENT	DEMAND REDUCTION [HAYS]	96	107	122	141	163	188
HAYS COUNTY PIPELINE - REGION K RECOMMENDED	CARRIZO-WILCOX AQUIFER [GONZALES]	0	0	0	0	134	407
MUNICIPAL CONSERVATION - DRIPPING SPRINGS	DEMAND REDUCTION [HAYS]	48	67	98	141	195	262
WATER PURCHASE	HIGHLAND LAKES LAKE/RESERVOIR SYSTEM [RESERVOIR]	0	31	104	198	173	0
		144	**205**	**324**	**480**	**665**	**857**
DRIPPING SPRINGS WSC, COLORADO (K)							
DROUGHT MANAGEMENT	DEMAND REDUCTION	107	136	172	218	271	330

	[HAYS]						
HAYS COUNTY PIPELINE - REGION K RECOMMENDED	CARRIZO-WILCOX AQUIFER [GONZALES]	0	1,000	1,000	1,000	866	593
MUNICIPAL CONSERVATION - DRIPPING SPRINGS WSC	DEMAND REDUCTION [HAYS]	54	124	152	187	232	283
		161	**1,260**	**1,324**	**1,405**	**1,369**	**1,206**
GOFORTH SUD, COLORADO (K)							
DROUGHT MANAGEMENT	DEMAND REDUCTION [HAYS]	21	33	46	64	84	106
GBRA - MBWSP - SURFACE WATER W/ ASR (OPTION 3C)	GUADALUPE RUN-OF-RIVER [GONZALES]	0	0	0	0	0	0
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [HAYS]	0	0	0	0	0	0
		21	**33**	**46**	**64**	**84**	**106**
MINING, HAYS, COLORADO (K)							
DIRECT REUSE - BUDA	DIRECT REUSE [HAYS]	0	0	500	500	500	500
EDWARDS / MIDDLE TRINITY ASR	TRINITY AQUIFER ASR [HAYS]	0	100	100	100	100	100
EXPANSION OF CURRENT GROUNDWATER SUPPLIES - TRINITY AQUIFER	TRINITY AQUIFER [HAYS]	531	761	1,047	1,047	1,047	1,047
		531	**861**	**1,647**	**1,647**	**1,647**	**1,647**
PLUM CREEK WATER COMPANY, COLORADO (K)							
DROUGHT MANAGEMENT	DEMAND REDUCTION [HAYS]	8	13	14	15	16	16
HAYS/CALDWELL PUA PROJECT	CARRIZO-WILCOX AQUIFER [CALDWELL]	0	37	39	42	43	45
		8	**50**	**53**	**57**	**59**	**61**
WEST TRAVIS COUNTY PUBLIC UTILITY AGENCY, COLORADO (K)							
DROUGHT MANAGEMENT	DEMAND REDUCTION [HAYS]	819	1,152	1,559	2,069	2,645	3,302
HAYS COUNTY PIPELINE - REGION K RECOMMENDED	CARRIZO-WILCOX AQUIFER [GONZALES]	0	1,000	1,000	1,000	1,000	1,000
LCRA - LANE CITY RESERVOIR	LCRA NEW OFF-CHANNEL RESERVOIRS (2020 DECADE) [RESERVOIR]	0	500	2,700	3,000	5,800	5,800
MUNICIPAL CONSERVATION - WEST TRAVIS COUNTY PUA	DEMAND REDUCTION [HAYS]	405	1,070	2,064	3,501	5,348	7,674
		1,224	**3,722**	**7,323**	**9,570**	**14,793**	**17,776**
COUNTY LINE WSC, GUADALUPE (L)							
BRACKISH WILCOX GROUNDWATER FOR CRWA	CARRIZO-WILCOX AQUIFER [WILSON]	0	0	0	187	335	500
CRWA SIESTA PROJECT	DIRECT REUSE [BEXAR]	0	0	25	0	0	0
CRWA SIESTA PROJECT	SAN ANTONIO RUN-OF-RIVER [WILSON]	0	0	31	0	0	0
REUSE - KYLE/COUNTY LINE WSC	DIRECT REUSE [HAYS]	34	35	36	37	38	39
		34	**35**	**92**	**224**	**373**	**539**
COUNTY-OTHER, HAYS, GUADALUPE (L)							
GBRA - MBWSP - SURFACE WATER W/ ASR (OPTION 3C)	GUADALUPE RUN-OF-RIVER [GONZALES]	0	0	0	0	2,029	7,220
TWA REGIONAL CARRIZO AQUIFER	CARRIZO-WILCOX	0	0	0	1,169	4,685	4,388

DEVELOPMENT	AQUIFER [GONZALES]						
TWA TRINITY AQUIFER DEVELOPMENT	TRINITY AQUIFER [COMAL]	0	0	0	0	0	1,263
VISTA RIDGE PROJECT	CARRIZO-WILCOX AQUIFER [BURLESON]	3,781	5,000	5,000	5,000	5,000	5,000
		3,781	**5,000**	**5,000**	**6,169**	**11,714**	**17,871**
CRYSTAL CLEAR WSC, GUADALUPE (L)							
CRWA WELLS RANCH PROJECT PHASE II	CARRIZO-WILCOX AQUIFER [GUADALUPE]	75	261	317	0	0	0
HAYS/CALDWELL PUA PROJECT	CARRIZO-WILCOX AQUIFER [CALDWELL]	124	296	243	577	597	621
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [HAYS]	0	0	0	0	0	22
		199	**557**	**560**	**577**	**597**	**643**
GOFORTH SUD, GUADALUPE (L)							
GBRA - MBWSP - SURFACE WATER W/ ASR (OPTION 3C)	GUADALUPE RUN-OF-RIVER [GONZALES]	0	0	0	0	0	525
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [HAYS]	0	0	0	0	0	2
		0	**0**	**0**	**0**	**0**	**527**
KYLE, GUADALUPE (L)							
HAYS/CALDWELL PUA PROJECT	CARRIZO-WILCOX AQUIFER [CALDWELL]	0	1,163	2,616	2,602	2,591	2,598
MUNICIPAL WATER CONSERVATION (SUBURBAN)	DEMAND REDUCTION [HAYS]	0	0	0	53	266	480
REUSE - KYLE/COUNTY LINE WSC	DIRECT REUSE [HAYS]	2,329	3,591	4,318	4,284	4,172	4,063
		2,329	**4,754**	**6,934**	**6,939**	**7,029**	**7,141**
MOUNTAIN CITY, GUADALUPE (L)							
DROUGHT MANAGEMENT - MOUNTAIN CITY	DEMAND REDUCTION [HAYS]	1	0	0	0	0	0
EDWARDS / MIDDLE TRINITY ASR	TRINITY AQUIFER ASR [HAYS]	0	44	44	44	44	44
LOCAL TRINITY AQUIFER DEVELOPMENT	TRINITY AQUIFER [HAYS]	60	60	60	60	60	60
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [HAYS]	0	0	0	0	0	1
		61	**104**	**104**	**104**	**104**	**105**
NIEDERWALD, GUADALUPE (L)							
DROUGHT MANAGEMENT - NIEDERWALD	DEMAND REDUCTION [HAYS]	3	0	0	0	0	0
GBRA - MBWSP - SURFACE WATER W/ ASR (OPTION 3C)	GUADALUPE RUN-OF-RIVER [GONZALES]	49	65	85	111	140	174
		52	**65**	**85**	**111**	**140**	**174**
PLUM CREEK WATER COMPANY, GUADALUPE (L)							
HAYS/CALDWELL PUA PROJECT	CARRIZO-WILCOX AQUIFER [CALDWELL]	0	148	146	143	142	140
LOCAL TRINITY AQUIFER DEVELOPMENT	TRINITY AQUIFER [HAYS]	0	185	185	185	185	185
		0	**333**	**331**	**328**	**327**	**325**
SAN MARCOS, GUADALUPE (L)							

GBRA - MBWSP - SURFACE WATER W/ ASR (OPTION 3C)	GUADALUPE RUN-OF-RIVER [GONZALES]	0	0	2,379	3,470	4,580	5,716
HAYS/CALDWELL PUA PROJECT	CARRIZO-WILCOX AQUIFER [CALDWELL]	0	0	0	1,964	4,575	7,889
MUNICIPAL WATER CONSERVATION (SUBURBAN)	DEMAND REDUCTION [HAYS]	179	778	1,122	1,684	2,506	3,587
REUSE - SAN MARCOS	DIRECT REUSE [HAYS]	1,932	2,886	3,959	5,206	6,654	8,339
		2,111	**3,664**	**7,460**	**12,324**	**18,315**	**25,531**
UHLAND, GUADALUPE (L)							
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [HAYS]	0	0	0	0	3	13
		0	**0**	**0**	**0**	**3**	**13**
WIMBERLEY, GUADALUPE (L)							
GBRA - MBWSP - SURFACE WATER W/ ASR (OPTION 3C)	GUADALUPE RUN-OF-RIVER [GONZALES]	0	0	74	356	678	933
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [HAYS]	10	55	78	123	187	272
TWA REGIONAL CARRIZO AQUIFER DEVELOPMENT	CARRIZO-WILCOX AQUIFER [GONZALES]	0	0	100	100	100	100
TWA TRINITY AQUIFER DEVELOPMENT	TRINITY AQUIFER [COMAL]	0	0	0	0	0	113
		10	**55**	**252**	**579**	**965**	**1,418**
WIMBERLEY WSC, GUADALUPE (L)							
GBRA - MBWSP - SURFACE WATER W/ ASR (OPTION 3C)	GUADALUPE RUN-OF-RIVER [GONZALES]	0	0	136	464	834	1,123
TWA REGIONAL CARRIZO AQUIFER DEVELOPMENT	CARRIZO-WILCOX AQUIFER [GONZALES]	0	0	100	100	100	100
TWA TRINITY AQUIFER DEVELOPMENT	TRINITY AQUIFER [COMAL]	0	0	0	0	0	133
		0	**0**	**236**	**564**	**934**	**1,356**
WOODCREEK, GUADALUPE (L)							
MUNICIPAL WATER CONSERVATION (SUBURBAN)	DEMAND REDUCTION [HAYS]	10	25	31	41	57	76
		10	**25**	**31**	**41**	**57**	**76**

Sum of Projected Water Management Strategies (acre-feet) 14,073 28,579 40,651 51,238 69,741 88,522

GAM Run 16-033 MAG: Modeled Available Groundwater for the Aquifers in Groundwater Management Area 10

Robert G. Bradley, P.G. and Radu Boghici, P.G.
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Groundwater Division
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July 20, 2018

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GAM Run 16-033 MAG:
Modeled Available Groundwater Aquifers in Groundwater Management Area 10

Robert G. Bradley, P.G. and Radu Boghici, P.G.
Texas Water Development Board
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(512) 463-5808
July 20, 2018

EXECUTIVE SUMMARY:

The modeled available groundwater for the relevant aquifers of Groundwater Management Area 10—the Austin Chalk-Buda Limestone (relevant in Uvalde County), Barton Springs segment of the Edwards (Balcones Fault Zone), saline portion of the Barton Springs segment of the Edwards (Balcones Fault Zone), western portion of the San Antonio segment of the Edwards (Balcones Fault Zone) in Kinney County, Leona Gravel (relevant in Uvalde County), and Trinity—are summarized for the groundwater conservation districts (Tables 1, 3, 5, and 8) and by decade for use in the regional water planning process (Tables 2, 4, 6, and 9) . The modeled available groundwater estimates are 2,935 acre-feet per year in the Austin Chalk Aquifer (Uvalde County); 758 acre-feet per year in the Buda Limestone Aquifer (Uvalde County); 11,557 acre-feet per year in the Barton Springs segment of the Edwards (Balcones Fault Zone) Aquifer during average recharge conditions (3,765 acre-feet per year during drought conditions); 8,564 acre-feet per year in the saline portion of the Barton Springs segment of the Edwards (Balcones Fault Zone) Aquifer; 6,321 acre-feet per year in the freshwater portion of the western part of the San Antonio segment of the Edwards (Balcones Fault Zone) Aquifer; 9,385 acre-feet per year in the Leona Gravel Aquifer (Uvalde County); and 46,481 acre-feet per year in the Trinity Aquifer. Appropriate groundwater availability models were used to determine the modeled available groundwater for the Kinney County area of the Edwards (Balcones Fault Zone) Aquifer and to determine average recharge conditions for the Barton Springs segment of the Edwards (Balcones Fault Zone) Aquifer. Water budget methods were used to calculate the modeled available groundwater for the rest of the relevant aquifers in Groundwater Management Area 10. The Texas Water Development Board (TWDB) determined that the explanatory report and other materials were administratively complete on February 12, 2018.

REQUESTOR:

Mr. John Dupnik, Chair of Groundwater Management Area 10.

DESCRIPTION OF REQUEST:

In a letter dated November 3, 2017, Mr. John Dupnik provided the TWDB with the desired future conditions of the relevant aquifers in Groundwater Management Area 10. The desired future conditions, adopted June 26, 2017, by the groundwater conservation districts within Groundwater Management Area 10, are reproduced below:

Austin [Chalk-]Buda Limestone Aquifer(s), relevant in Uvalde County only:

- Buda Limestone: no drawdown (including exempt and non-exempt use); and
- Austin Chalk: no drawdown (including exempt and non-exempt use).

Freshwater Edwards Aquifer in the Northern [Groundwater Management Area 10] Subdivision

- Springflow at Barton Springs during average recharge conditions shall be no less than 49.7 [cubic feet per second] averaged over an 84-month (7-year) period; and,
- Springflow of Barton Springs during extreme drought conditions, including those as severe as a recurrence of the 1950s drought of record, shall be no less than 6.5 [cubic feet per second] average on a monthly basis.

Saline Edwards Aquifer in the Northern [Groundwater Management Area 10] Subdivision

- No more than 75 feet of regional average potentiometric surface drawdown due to pumping when compared to pre-development.

Freshwater Edwards Aquifer in the Western [Groundwater Management Area 10] Subdivision

- The water level in well 70-38-902 shall not fall below 1,184 [feet above] mean sea level.

Leona Gravel Aquifer, relevant in Uvalde County only:

- No drawdown (including exempt and non-exempt use).

Trinity Aquifer, in hydrologically confined zone downdip of the Trinity outcrop:

- Outside of Uvalde and Bexar counties: average regional well drawdown not exceeding 25 feet during average recharge conditions (including exempt and non-exempt use);
- In Uvalde County: no (zero) regional well drawdown (including exempt and non-exempt use); [and]
- In Bexar County: non-relevant for joint planning purpose.

In response to a request for clarifications from the TWDB on December 14, 2017, and January 29, 2018 Mr. John Dupnik indicated the following preferences for calculating modeled available groundwater volumes in Groundwater Management Area 10:

Austin Chalk-Buda Limestone aquifers (only in Uvalde County)

The TWDB will use the methods and assumptions from AA 10-26 MAG and AA 10-27 MAG, with a planning period from 2010 to 2060.

Freshwater Edwards, Northern Subdivision

The TWDB will use the methods and assumptions from GAM Run 10-059 MAG Version 2, with a planning period from 2010 to 2060. Groundwater Management Area 10 specified two desired future conditions for this aquifer. We will provide only the drought conditions modeled available groundwater for regional water planning purposes because this corresponds to the methods used in regional water planning (planning for water in times of drought). We will provide both the average recharge conditions and the drought conditions modeled available groundwater in the final report. The modeled available groundwater values will be unchanged from the previous planning cycle.

Saline Edwards, Northern Subdivision

The TWDB will use aquifer parameters from AA 10-35 MAG, with a planning period from 2010 to 2060, but we will recalculate with a simple water budget as outlined in Table 1 of the Saline Edwards explanatory report, instead of the method used in AA 10-35 MAG. On January 29, 2018, we received Technical Memo 2017-1221 from the Barton Springs/ Edwards Aquifer Conservation District, which outlines the technical clarification on the method to use for this aquifer.

Freshwater Edwards, Western Subdivision (only in Kinney County)

The TWDB will use the methods and assumptions from GAM Run 12-002 MAG, with a planning period from 2010 to 2060. The modeled available groundwater values will be unchanged from the previous planning cycle.

Leona Gravel (only in Uvalde County)

The TWDB will use the methods and assumptions from AA 10-28 MAG, with a planning period from 2010 to 2060.

Trinity (downdip of recharge zone)

The TWDB will use the methods and assumptions from AA 10-06 with a planning period from 2010 to 2060. The changes in groundwater district boundaries since AA 10-06 will require reapportionment of the modeled available groundwater.

METHODS:

The desired future conditions for the Austin Chalk-Buda Limestone aquifers (relevant in Uvalde County), Leona Gravel Aquifer (relevant in Uvalde County), Barton Springs segment of the Edwards (Balcones Fault Zone) Aquifer, saline portion of the Barton Springs segment of the Edwards (Balcones Fault Zone) Aquifer, Trinity Aquifer, and western portion of the San Antonio segment of the Edwards (Balcones Fault Zone) Aquifer in Kinney County are identical to the ones adopted in 2010. The applicable water budget methodologies to calculate modeled available groundwater are unchanged except for the saline Edwards (Balcones Fault Zone) and Trinity aquifers.

Therefore, the modeled available groundwater volumes presented for most of the aquifers are the same as those shown in the previous water budget assessments and model runs. These reports are AA 10-26 MAG (Thorkildsen and Backhouse, 2011a), AA 10-27 MAG (Thorkildsen and Backhouse, 2011b), GAM Run 10-059 MAG Version 2 (Hutchison and Oliver, 2011), GAM Run 12-002 MAG (Shi, 2012), and AA 10-28 MAG (Bradley, 2013).

The modeled available groundwater numbers were recalculated for the Trinity Aquifer to incorporate changes in the Groundwater Management Area 10 and groundwater conservation district boundaries. Additionally, a change in methodology required the recalculation of the Saline Edwards (Balcones Fault Zone) Aquifer modeled available groundwater, however, aquifer parameters from AA 10-35 MAG (Bradley, 2011) were incorporated into this assessment.

For the water budget approaches, modeled available groundwater volumes were determined by summing estimates of effective recharge and the change in aquifer storage. The water budget for these analyses were a simplified version of one found in Freeze and Cherry (1979, p.365).

This was the best method to calculate a modeled available groundwater estimate at this time; however, this method has limitations and should be replaced with better tools, including groundwater models and additional data as they become available. These analyses assume homogeneous and isotropic aquifers; however, real aquifer conditions do not satisfy these assumptions. These analyses further assume that precipitation is the only source of aquifer recharge, that lateral inflow to the aquifer is equal to lateral outflow from the aquifer, and that future pumping will not alter this balance. In addition, certain assumptions have been made regarding future precipitation, recharge, and streamflow in developing these estimates. Those assumptions also need to be considered and compared to actual future data when evaluating achievement of the desired future condition.

Estimates of modeled available groundwater volumes from the numerical flow models were determined by extracting pumping rates by decade from the model results using ZONEBUDGET Version 3.01 (Harbaugh, 2009). Annual pumping rates were divided by county, river basin, regional water planning area, and groundwater conservation district within Groundwater Management Area 10 (Figures 1 through 7 and Tables 1 through 9).

Modeled Available Groundwater and Permitting

Chapter 36 of the Texas Water Code defines “modeled available groundwater” to be 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 to manage groundwater production to achieve the desired future condition(s). Districts must also 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:

Austin Chalk-Buda Limestone Aquifers

- All parameters and assumptions for the Austin Chalk Aquifer are described in AA 10-26 MAG (Thorkildsen and Backhouse, 2011a) and for the Buda Limestone in AA 10-27 MAG (Thorkildsen and Backhouse, 2011b). Both reports assumed a planning period from 2010 to 2060.
- The Austin Chalk Aquifer in Uvalde County is in a state of dynamic equilibrium and the 2008 estimated pumpage of 2,935 acre-feet (Green and others, 2009) achieves the adopted desired future condition.

- The Buda Limestone Aquifer in Uvalde County is in a state of dynamic equilibrium and the 2008 estimated pumpage of 758 acre-feet (Green and others, 2009) achieves the adopted desired future condition.
- Conditions are physically possible across the management area and a water-level decline of 0 feet is uniform across the aquifer(s).

Freshwater Edwards (Balcones Fault Zone) Aquifer

NORTHERN SUBDIVISION OF GROUNDWATER MANAGEMENT AREA 10

- All parameters and assumptions for the freshwater portion of the Edwards (Balcones Fault Zone) Aquifer in the northern subdivision of Groundwater Management Area 10 are described in GAM Run 10-059 MAG Version 2 (Hutchison and Oliver, 2011). Both approaches discussed below assumed a 50-year planning period. From clarifications we received from Mr. John Dupnik, we assume a 50-year planning period from 2010 to 2060.
- A water balance approach was used to estimate modeled available groundwater during extreme drought conditions[1] based on information provided by Barton Springs/Edwards Aquifer Conservation District. See Hunt and others (2011) for additional details on the methods and assumptions for this approach.
- The total amount of water available for discharge by both springs and pumping during extreme drought conditions (11.7 cubic feet per second or 8,470 acre-feet per year) was estimated using information from the 1950's drought of record as described in Hunt and (2011).
- The water balance approach does not contain information about the spatial distribution of pumping. For the purposes of regional water planning, the estimated total pumping available during extreme drought conditions was divided by county, regional water planning area, river basin, and groundwater conservation district based on the distribution of pumping in the modeled approach under average recharge conditions (Hutchison and Oliver, 2011).
- For average recharge conditions, we used the numerical groundwater flow model that was recalibrated to include the 1950s drought for the Barton Springs segment of the Edwards (Balcones Fault Zone) Aquifer. See Hutchison and Hill (2011a) for assumptions and limitations of the numerical flow model.

[1] The desired future conditions statement adopted by the district representatives in GMA 10 uses the term "extreme drought conditions" to include the drought of record.

- The model does not cover the Edwards Aquifer (Balcones Fault Zone) in the southernmost Barton Springs/Edwards Aquifer Conservation District jurisdiction (see Figure 4). However, given that, during average recharge conditions, the contributing zone for the flow at Barton Springs does not extend this far south, we deemed the use of the model appropriate for this purpose.
- Similar to GAM Run 09-019 (Hutchison and Hill, 2011b), the simulations consisted of 342 7-year simulations extending from 1648 through 1995 based on a tree-ring dataset from Cleaveland (2006). Each 7-year simulation consisted of 84 monthly stress periods.
- Model simulations indicated that, during average recharge conditions, an average springflow of 49.7 cubic feet per second could be maintained by allowing 11,557 acre-feet per year pumping.

KINNEY COUNTY

- All parameters and assumptions for the freshwater portion of the Edwards (Balcones Fault Zone) Aquifer in the western subdivision of Groundwater Management Area 10 (Kinney County) are described in GAM Run 12-002 MAG (Shi, 2012). We used a 50-year planning period from 2010 to 2060.
- We used version 1.01 of the numerical groundwater flow model of the Kinney County Area. See Hutchison and others (2011) for assumptions and limitations of the numerical groundwater flow model. The model was run with MODFLOW-2000 (Harbaugh and others, 2000).
- The model has four layers: layer 1 represents the Carrizo-Wilcox and associated aquifers, layer 2 represents the upper Cretaceous formations that yield groundwater, layer 3 represents the Edwards (Balcones Fault Zone) Aquifer and the Edwards Group of the Edward-Trinity (Plateau) Aquifer, and layer 4 represents the Trinity Aquifer.

Saline Edwards (Balcones Fault Zone) Aquifer

- A detailed description of all parameters is available for the saline portion of the Edwards (Balcones Fault Zone) Aquifer in the northern subdivision of Groundwater Management Area 10 in AA 10-35 MAG (Bradley, 2011). Table 1 from Barton Springs/Edwards Aquifer Conservation District Technical Memo 2017-1221 (Hunt, 2017) outlines the approach used to estimate modeled available groundwater. We used a 50-year planning period from 2010 to 2060.

- Map areas (Figure 5) from AA 10-35 MAG (Bradley, 2011) were used to calculate volumes based on a storage coefficient of 7.0×10^{-4} (Hunt and others, 2010) and a desired future condition of 75 feet of drawdown. Map areas are designated as Plum Creek Conservation District only where their jurisdiction does not overlap with the Barton Springs/Edwards Aquifer Conservation District.
- A water-level decline of 75 feet is uniform across the aquifer for the 50-year planning period.
- The aquifer is homogeneous and isotropic, lateral inflow to the aquifer is equal to lateral outflow from the aquifer, and future pumping will not alter this balance.

Leona Gravel Aquifer

- A detailed description of all parameters and assumptions is available for the Leona Gravel Aquifer in Uvalde County in AA 10-28 MAG (Bradley, 2013). We used a 50-year planning period from 2010 to 2060.
- See George (2010) for assumptions and parameters used to estimate effective recharge. Recharge is received mainly from inflow from the Edwards Aquifer (Green and others, 2008) with additional recharge from direct precipitation. The period 1996 to 2011 was selected for analysis of J-27 water levels due to the start of mandated management of the Edwards Aquifer in 1996.

Trinity Aquifer

- A detailed description of all parameters and assumptions is available in AA 10-06 (Thorkildsen and Backhouse, 2010b). We used a 50-year planning period from 2010 to 2060.
- The methods and assumptions used to estimate modeled available groundwater for the Trinity Aquifer remain unchanged from AA 10-06 (Thorkildsen and Backhouse, 2010b). Because the Groundwater Management Area 10 boundary was adjusted since the last round of joint planning, this required a reapportionment of the modeled available groundwater as estimated in the original aquifer assessment. First, changes were made to the Groundwater Management Area 10 boundary to exclude the Guadalupe County, Hays Trinity, and Trinity Glen Rose groundwater conservation districts. There were also changes in to the Barton Springs/Edwards Aquifer Conservation District boundary to include a portion of the Trinity Aquifer in Hays County.

- Bexar County is excluded from the modeled available groundwater calculations because the groundwater management area designated the Trinity Aquifer in Bexar County not relevant for joint planning.
- Outcrop areas are calculated as unconfined areas of the aquifer and subcrop areas are calculated as confined areas of the aquifer. Map areas 1-10 represent outcrop areas, and map areas 11-31 are subcrop areas (see Figure 8 and Table 7).
- Recharge is assigned only to the outcrop areas. The average annual precipitation for outcrop map areas was determined from the Texas Climatic Atlas (Narasimhan and others, 2008), which is the average for years 1971 to 2000; the values range from 29 to 36 inches per year. The effective recharge rate is estimated to be 4 percent. The effective recharge calculation is the map area, in acres, multiplied by the estimated average annual precipitation, in feet, and the effective recharge rate, in percent.
- Lateral inflow to the Trinity Aquifer in Groundwater Management Area 10 is estimated to be 46,018 acre-feet per year based on the average outflow across the Balcones Fault Zone results (Scenario 6) from GAM Task 10-005 (Hutchison, 2010). This volume was apportioned across each county by aquifer map areas. GAM Task 10-005 does not include inflows to Uvalde County, so a proportional amount based on inflow to Medina County was used to estimate the inflow to Uvalde County.
- The storage coefficient for the Trinity Aquifer subcrop is assumed to be 1×10^{-5} derived from aquifer tests of the Trinity Aquifer subcrop in Travis and Hays counties (Hunt and others, 2010). The storage coefficient for the Trinity Aquifer subcrop in the remaining counties is assumed to be 5×10^{-5} as derived from the calibrated groundwater availability model for the Hill Country portion of the Trinity Aquifer system in Texas (Jones and others, 2009). The average specific yield of the Trinity Aquifer outcrop is estimated to be 5×10^{-2} (Ashworth, 1983).
- Water-level drawdowns are uniform across the aquifer. Annual volumes from drawdowns are calculated by dividing the total volume by 50 years.
- Modeled available groundwater estimates are the sum of the effective recharge, lateral inflow, and volume from water-level decline.

RESULTS:

Tables 1 through 6 and 8 through 9 show the combination of modeled available groundwater summarized (1) by groundwater conservation district and county; and (2) by county, river basin, and regional water planning area for use in the regional water planning process. The modeled available groundwater results for the groundwater conservation districts (Tables 1, 3, 5, and 8), reflect the ending year discussed in the Parameters and Assumption Section of this report. For purposes of planning (Tables 2, 4, 6, and 9), the values may have been populated past the dates noted in Parameters and Assumption Section using the trend of results.

The modeled available groundwater estimates are 2,935 acre-feet per year in the Austin Chalk Aquifer (Uvalde County); 758 acre-feet per year in the Buda Limestone Aquifer (Uvalde County); 11,557 acre-feet per year in the Barton Springs segment of the Edwards (Balcones Fault Zone) Aquifer during average recharge conditions (3,765 acre-feet per year during drought conditions); 8,564 acre-feet per year in the saline portion of the Barton Springs segment of the Edwards (Balcones Fault Zone) Aquifer; 6,321 acre-feet per year in the freshwater portion of the western part of the San Antonio segment of the Edwards (Balcones Fault Zone) Aquifer; 9,385 acre-feet per year in the Leona Gravel Aquifer (Uvalde County); and 46,481 acre-feet per year in the Trinity Aquifer.

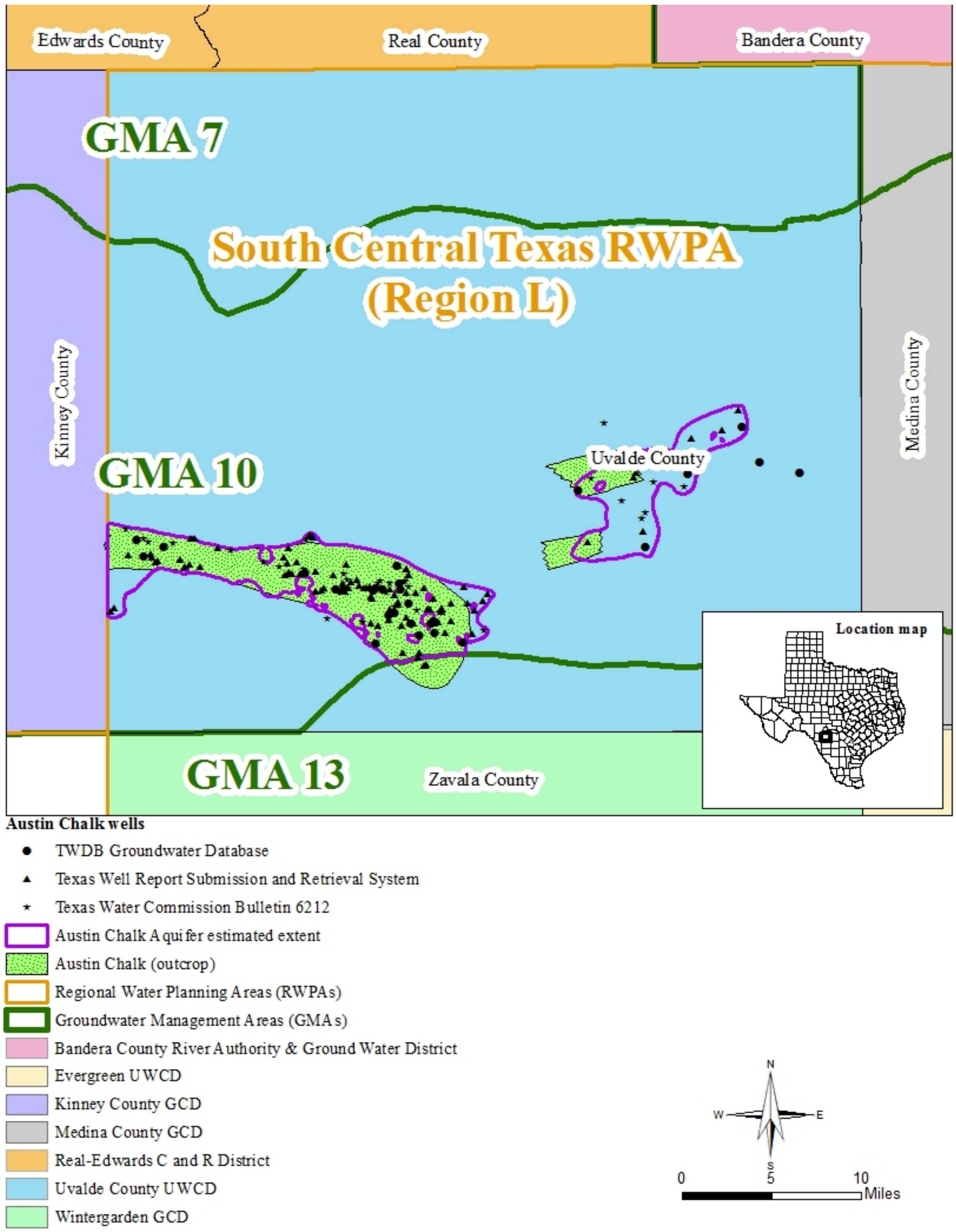

FIGURE 1. MAP SHOWING REGIONAL WATER PLANNING AREAS (RWPAS), GROUNDWATER CONSERVATION DISTRICTS (GCDS), AND COUNTIES IN THE VICINITY OF THE AUSTIN CHALK AQUIFER IN UVALDE COUNTY.

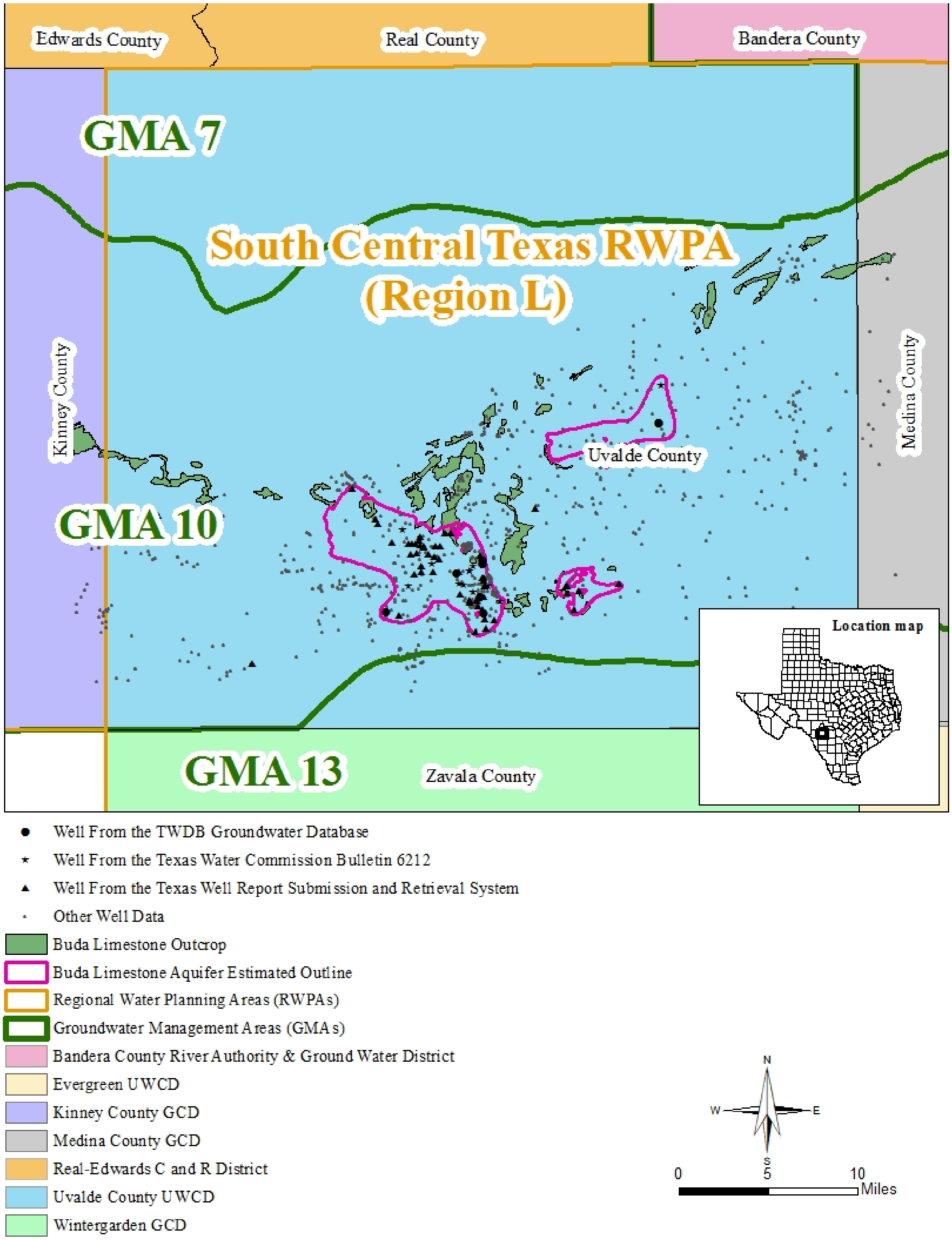

FIGURE 2. MAP SHOWING REGIONAL WATER PLANNING AREAS (RWPAS), GROUNDWATER CONSERVATION DISTRICTS (GCDS), AND COUNTIES IN THE VICINITY OF THE BUDA LIMESTONE AQUIFER IN UVALDE COUNTY.

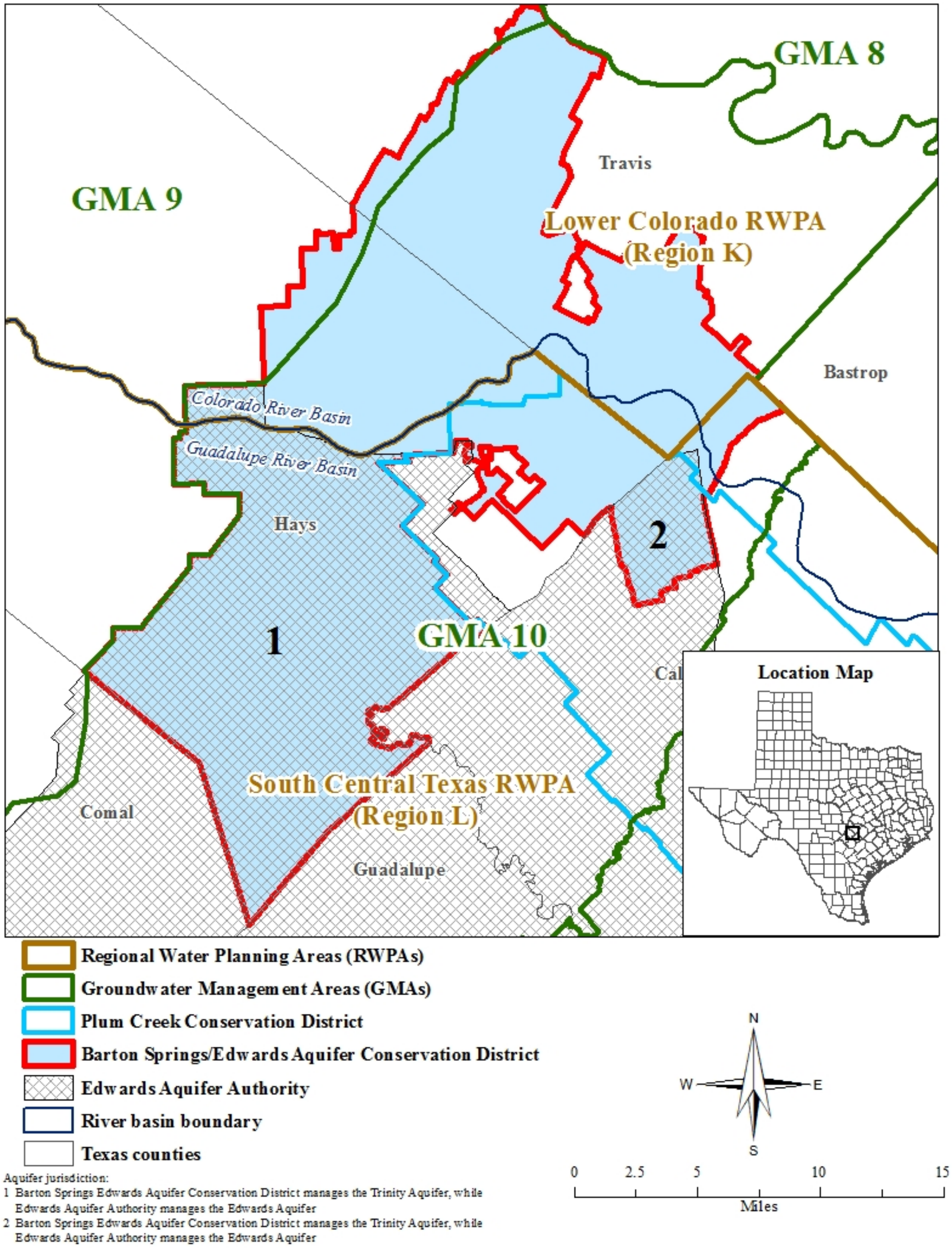

FIGURE 3. **MAP SHOWING REGIONAL WATER PLANNING AREAS (RWPAS), GROUNDWATER CONSERVATION DISTRICTS (GCDS), AND COUNTIES IN THE VICINITY OF THE FRESHWATER AND SALINE EDWARDS (BALCONES FAULT ZONE) AQUIFER IN THE NORTHERN SUBDIVISION OF GROUNDWATER MANAGEMENT AREA 10.**

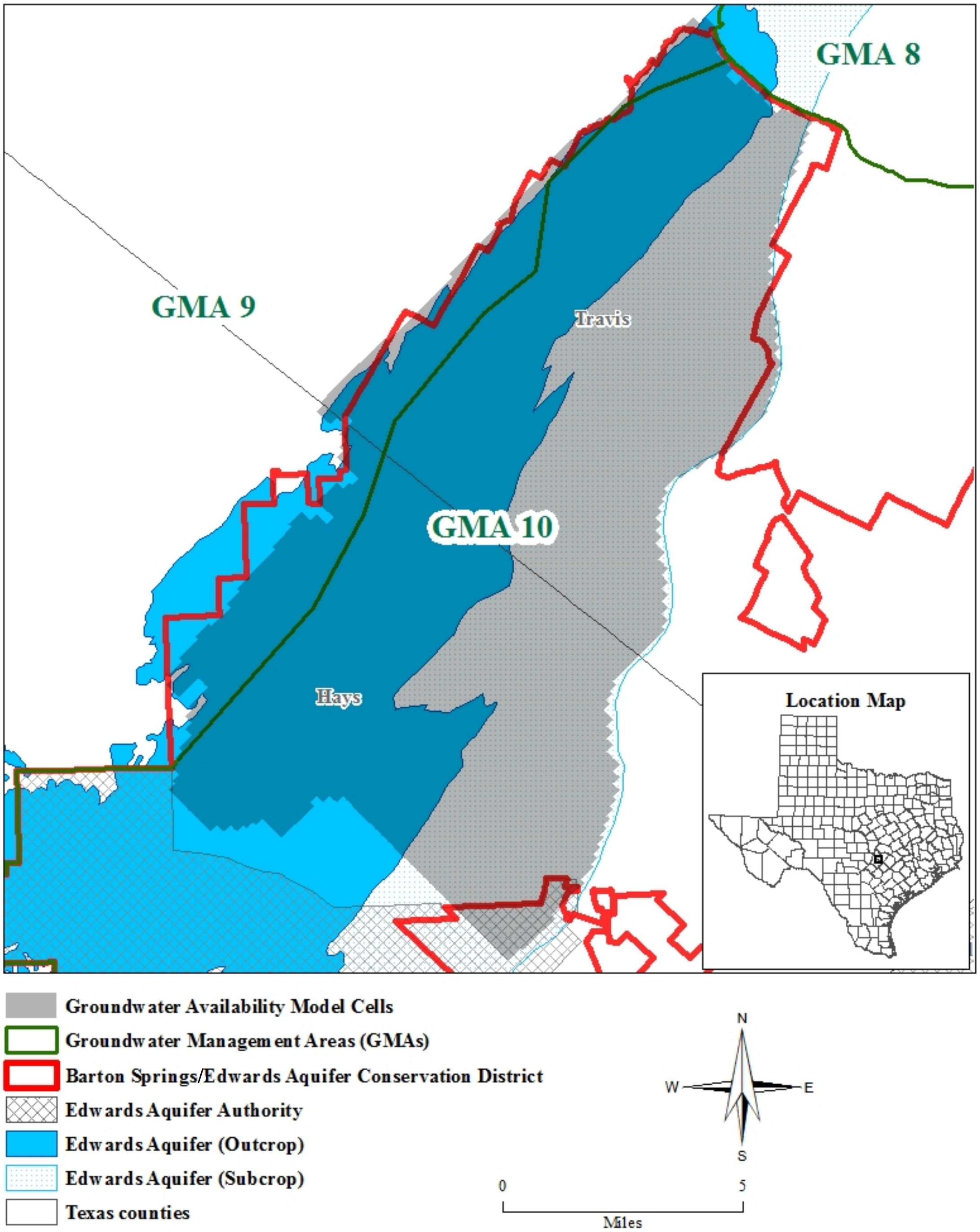

FIGURE 4. **MAP SHOWING GROUNDWATER AVAILABILITY MODEL EXTENT, EDWARDS (BALCONES FAULT ZONE) AQUIFER, AND ADMINISTRATIVE BOUNDARIES IN THE NORTHERN PART OF THE BARTON SPRINGS/EDWARDS AQUIFER CONSERVATION DISTRICT IN THE NORTHERN SUBDIVISION OF GROUNDWATER MANAGEMENT AREA 10.**

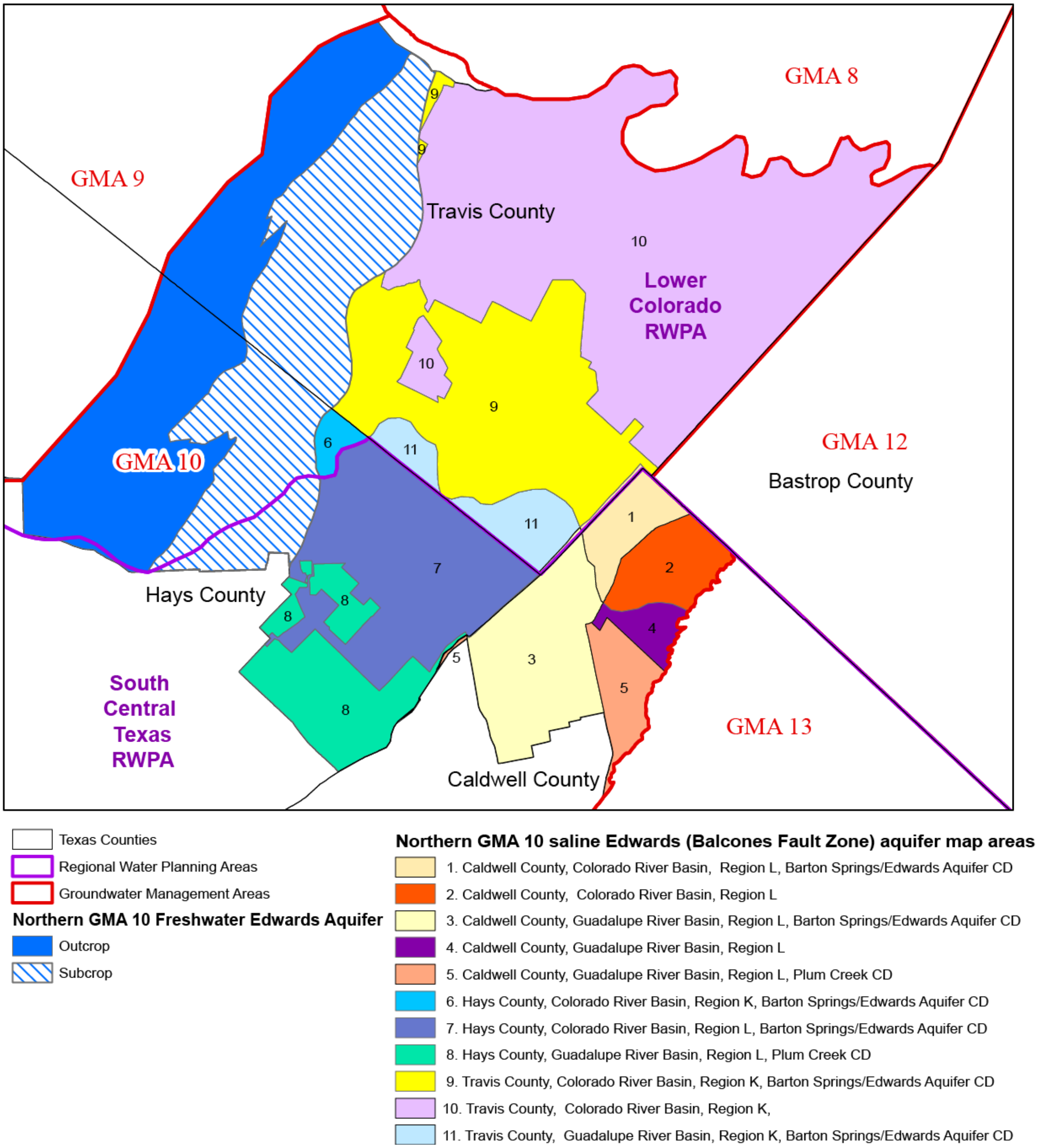

FIGURE 5. MAP SHOWING AREAS USED FOR ESTIMATING THE SALINE, EDWARDS (BALCONES FAULT ZONE) AQUIFER, MODELED AVAILABLE GROUNDWATER IN THE NORTHERN SUBDIVISION OF GROUNDWATER MANAGEMENT AREA 10, (MODIFIED FROM BRADLEY,2011) .

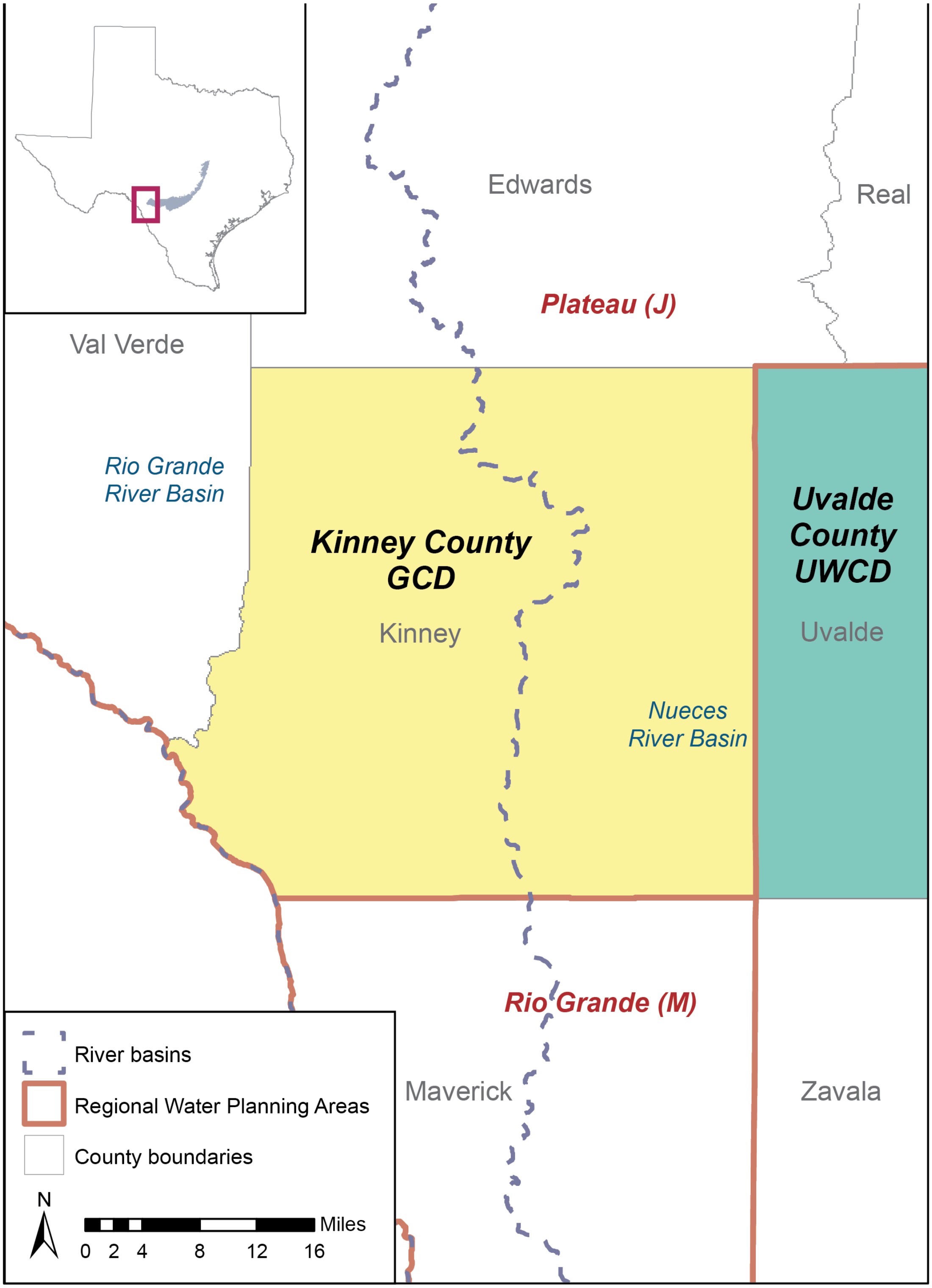

FIGURE 6. **MAP SHOWING REGIONAL WATER PLANNING AREAS (RWPAS), GROUNDWATER CONSERVATION DISTRICTS (GCDS), AND COUNTIES IN THE VICINITY OF THE FRESHWATER EDWARDS (BALCONES FAULT ZONE) AQUIFER IN THE WESTERN SUBDIVISION OF GROUNDWATER MANAGEMENT AREA 10 (KINNEY COUNTY).**

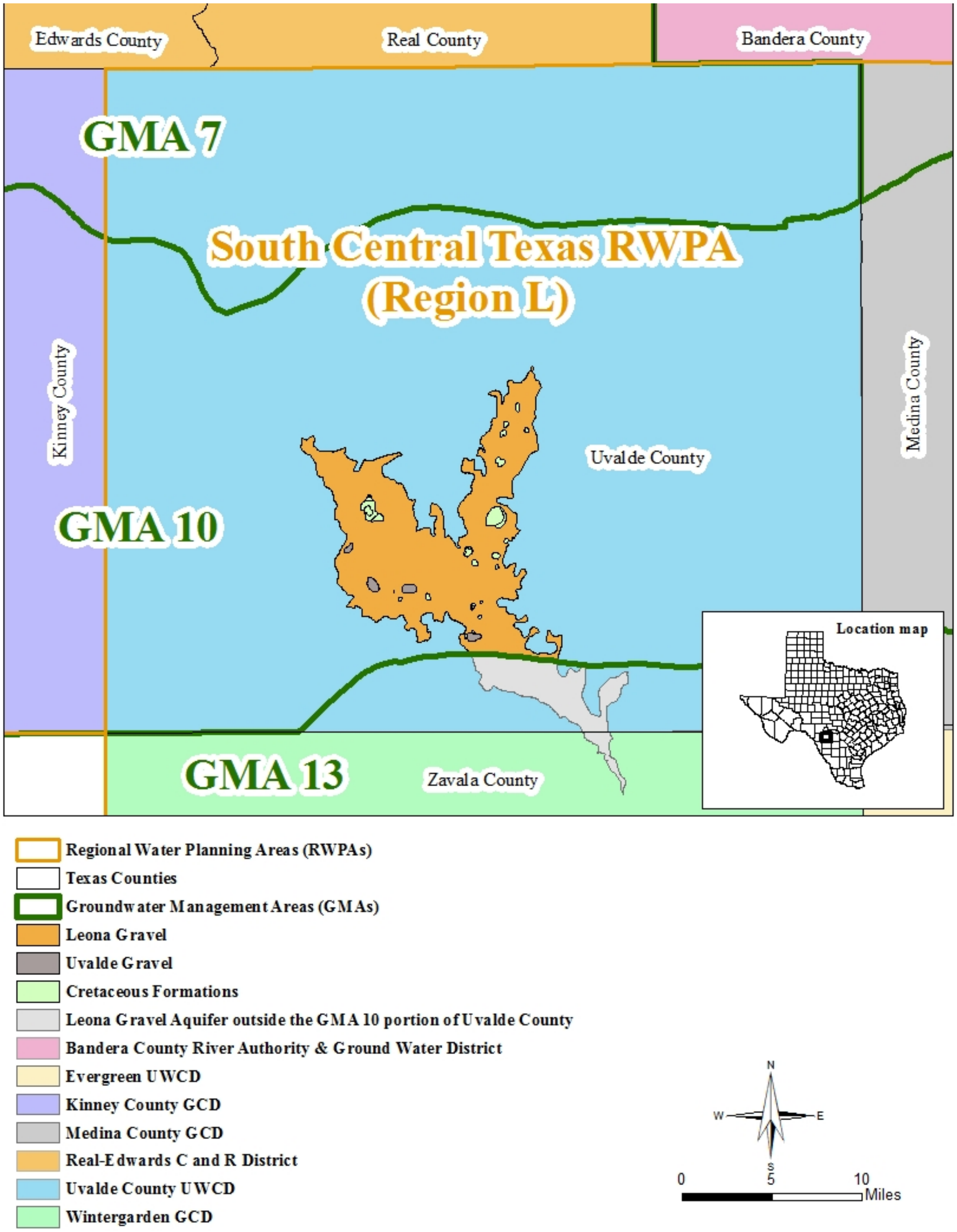

FIGURE 7. MAP SHOWING REGIONAL WATER PLANNING AREAS (RWPAS), GROUNDWATER CONSERVATION DISTRICTS (GCDS, UWCDS), AND COUNTIES IN THE VICINITY OF THE LEONA GRAVEL AQUIFER IN GROUNDWATER MANAGEMENT AREA 10 (UVALDE COUNTY).

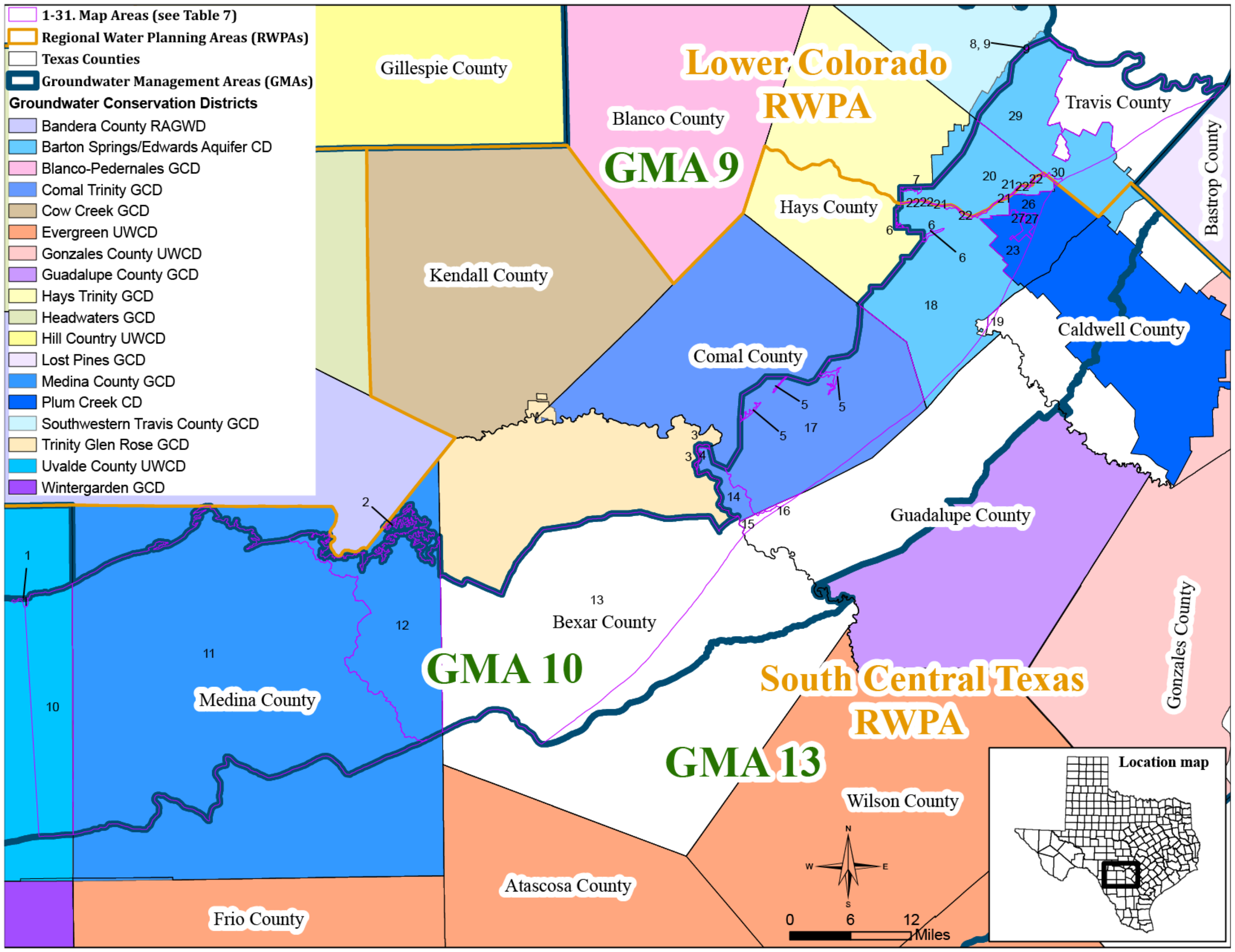

FIGURE 8 MAP SHOWING REGIONAL WATER PLANNING AREAS (RWPAS), GROUNDWATER CONSERVATION DISTRICTS (GCDS), AND COUNTIES IN THE VICINITY OF THE TRINITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 10.

TABLE 1. MODELED AVAILABLE GROUNDWATER FOR THE AUSTIN CHALK, BUDA LIMESTONE, AND LEONA GRAVEL AQUIFERS IN UVALDE COUNTY IN GROUNDWATER MANAGEMENT AREA 10 FOR EACH DECADE BETWEEN 2010 AND 2060. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2010	2020	2030	2040	2050	2060
Uvalde County Underground Water Conservation District	Uvalde	Austin Chalk	2,935	2,935	2,935	2,935	2,935	2,935
		Buda Limestone	758	758	758	758	758	758
		Leona Gravel	9,385	9,385	9,385	9,385	9,385	9,385
Total			**16,013**	**16,013**	**16,013**	**16,013**	**16,013**	**16,013**

TABLE 2. MODELED AVAILABLE GROUNDWATER FOR THE AUSTIN CHALK, BUDA LIMESTONE, AND LEONA GRAVEL AQUIFERS IN UVALDE COUNTY IN GROUNDWATER MANAGEMENT AREA 10 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Aquifer	2020	2030	2040	2050	2060	2070
Uvalde	L	Nueces	Austin Chalk	2,935	2,935	2,935	2,935	2,935	2,935
			Buda Limestone	758	758	758	758	758	758
			Leona Gravel	9,385	9,385	9,385	9,385	9,385	9,385
Total				**16,013**	**16,013**	**16,013**	**16,013**	**16,013**	**16,013**

TABLE 3. MODELED AVAILABLE GROUNDWATER FOR THE FRESHWATER PORTION OF THE EDWARDS (BALCONES FAULT ZONE) AQUIFER IN GROUNDWATER MANAGEMENT AREA 10 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2010 AND 2060. VALUES ARE IN ACRE-FEET PER YEAR.

Recharge Condition	Groundwater Conservation District	County	2010	2020	2030	2040	2050	2060
Average	Barton Springs/Edwards Aquifer Conservation District	Hays	7,950	7,950	7,950	7,950	7,950	7,950
		Travis	3,578	3,578	3,578	3,578	3,578	3,578
	Non-District Areas	Hays	29	29	29	29	29	29
Total for average recharge conditions			**11,557**	**11,557**	**11,557**	**11,557**	**11,557**	**11,557**
Drought	Barton Springs/Edwards Aquifer Conservation District	Hays	2,590	2,590	2,590	2,590	2,590	2,590
		Travis	1,166	1,166	1,166	1,166	1,166	1,166
	Non-District Areas	Hays	9	9	9	9	9	9
Total for drought recharge conditions			**3,765**	**3,765**	**3,765**	**3,765**	**3,765**	**3,765**
Kinney County Groundwater Conservation District		Kinney	6,321	6,321	6,321	6,321	6,321	6,321

TABLE 4. MODELED AVAILABLE GROUNDWATER FOR THE FRESHWATER PORTION OF THE EDWARDS (BALCONES FAULT ZONE) AQUIFER IN GROUNDWATER MANAGEMENT AREA 10 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.

Recharge Condition	County	RWPA	River Basin	2020	2030	2040	2050	2060	2070
Average	Hays	K	Colorado	7,037	7,037	7,037	7,037	7,037	7,037
	Hays	L	Guadalupe	942	942	942	942	942	942
	Travis	K	Colorado	3,578	3,578	3,578	3,578	3,578	3,578
	Total for average recharge conditions			**11,557**	**11,557**	**11,557**	**11,557**	**11,557**	**11,557**
Drought	Hays	K	Colorado	2,292	2,292	2,292	2,292	2,292	2,292
	Hays	L	Guadalupe	307	307	307	307	307	307
	Travis	K	Colorado	1,166	1,166	1,166	1,166	1,166	1,166
	Total for drought recharge conditions			**3,765**	**3,765**	**3,765**	**3,765**	**3,765**	**3,765**
Not applicable	Kinney	J	Nueces	6,319	6,319	6,319	6,319	6,319	6,319
			Rio Grande	2	2	2	2	2	2

TABLE 5. MODELED AVAILABLE GROUNDWATER FOR THE SALINE PORTION OF THE EDWARDS (BALCONES FAULT ZONE) AQUIFER IN GROUNDWATER MANAGEMENT AREA 10 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2010 AND 2060. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	2010	2020	2030	2040	2050	2060
Barton Springs/Edwards Aquifer Conservation	Caldwell	858	858	858	858	858	858
	Hays	1,171	1,171	1,171	1,171	1,171	1,171
	Travis	1,770	1,770	1,770	1,770	1,770	1,770
Non-District Areas	Caldwell	369	369	369	369	369	369
	Travis	3,583	3,583	3,583	3,583	3,583	3,583
Plum Creek Conservation District	Caldwell	210	210	210	210	210	210
	Hays	602	602	602	602	602	602
Total		**8,563**	**8,563**	**8,563**	**8,563**	**8,563**	**8,563**

TABLE 6. MODELED AVAILABLE GROUNDWATER FOR THE SALINE PORTION OF THE EDWARDS (BALCONES FAULT ZONE) AQUIFER IN GROUNDWATER MANAGEMENT AREA 10 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR

County	RWPA	River Basin	2020	2030	2040	2050	2060	2070
Caldwell	L	Colorado	469	469	469	469	469	469
		Guadalupe	968	968	968	968	968	968
Hays	K	Colorado	66	66	66	66	66	66
	L	Guadalupe	1,707	1,707	1,707	1,707	1,707	1,707
Travis	K	Colorado	5,073	5,073	5,073	5,073	5,073	5,073
		Guadalupe	280	280	280	280	280	280
Total			**8,563**	**8,563**	**8,563**	**8,563**	**8,563**	**8,563**

TABLE 7. INPUTS TO CALULATE MODELED AVAILABLE GROUNDWATER FOR THE TRINITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 10, SUMMARIZED BY MAP AREA REPRESENTING EACH GROUNDWATER CONSERVATION DISTRICT (GCD), COUNTY, RIVER BASIN, AND REGIONAL WATER PLANNING AREA (RWPA) COMBINATIONS. AREA VALUES ARE IN ACRES, AND OTHER VALUES ARE IN ACRE-FEET PER YEAR.

Map area[1,2,3]	GCD	County	River Basin	RWPG	Areal extent	Estimated annual effective recharge	Estimated annual lateral inflow	Estimated annual volume from water-level decline	Modeled available groundwater
1	Uvalde County UWCD	Uvalde	Nueces	L	372	36	4	0	40
2	Medina GCD	Medina	San Antonio	L	1	0	0	0	0
3	No GCD	Bexar	San Antonio	L	N/A	N/A	N/A	N/A	N/A
4	Comal Trinity GCD	Comal	San Antonio	L	594	67	147	15	229
5	Comal Trinity GCD	Comal	Guadalupe	L	1,282	149	318	32	499
6	Barton Springs/ Edwards Aquifer Conservation District	Hays	Guadalupe	L	505	61	13	13	87
7	Barton Springs/ Edwards Aquifer Conservation District	Hays	Colorado	K	494	57	12	12	81
8	Barton Springs/ Edwards Aquifer Conservation District	Travis	Colorado	K	3	0	0	0	0
9	Southwestern Travis County GCD	Travis	Colorado	K	11	1	0	0	1
10	Uvalde County UWCD	Uvalde	Nueces	L	63,464	N/A	755	0	755
11	Medina GCD	Medina	Nueces	L	459,975	N/A	5,470	12	5,482
12	Medina GCD	Medina	San Antonio	L	98,983	N/A	1,177	2	1,179

1. Map areas 1-10 represent outcrop areas and were assumed to be under unconfined aquifer conditions.

2. Map areas 11-31 represent subcrop areas and were assumed to be under confined aquifer conditions.

3. Map areas 24-26 cover the Barton Springs/Edwards Aquifer Conservation District and Plum Creek Conservation District where the two districts overlap. These values are assigned to the Barton Springs/Edwards Aquifer Conservation District.

Table 7 (Continued)

Map area[1,2,3]	GCD	County	River basin	RWPG	Areal extent	Estimated annual effective recharge	Estimated annual lateral inflow	Estimated annual volume from water-level decline	Modeled available groundwater
13	No GCD	Bexar	San Antonio	L	N/A	N/A	N/A	N/A	N/A
14	Comal Trinity GCD	Comal	San Antonio	L	9,243	N/A	2,290	0	2,290
15	No GCD	Guadalupe	San Antonio	L	1,907	N/A	472	0	472
16	No GCD	Guadalupe	Guadalupe	L	757	N/A	188	0	188
17	Comal Trinity GCD	Comal	Guadalupe	L	123,232	N/A	30,533	3	30,536
18	Barton Springs/ Edwards Aquifer Conservation District	Hays	Guadalupe	L	104,045	N/A	2,597	3	2,600
19	No GCD	Caldwell	Guadalupe	L	420	N/A	10	0	10
20	Barton Springs/ Edwards Aquifer Conservation District	Hays	Colorado	K	36,033	N/A	899	0	899
21	Barton Springs/ Edwards Aquifer Conservation District	Hays	Guadalupe	K	354	N/A	9	0	9
22	Barton Springs/ Edwards Aquifer Conservation District	Hays	Colorado	L	1,286	N/A	32	0	32
23	Plum Creek CD	Hays	Guadalupe	L	9,934	N/A	248	0	248

1. Map areas 1-10 represent outcrop areas and were assumed to be under unconfined aquifer conditions.

2. Map areas 11-31 represent subcrop areas and were assumed to be under confined aquifer conditions.

3. Map areas 24-26 cover the Barton Springs/Edwards Aquifer Conservation District and Plum Creek Conservation District where the two districts overlap. These values are assigned to the Barton Springs/Edwards Aquifer Conservation District.

Table 7 (Continued)

Map area[1,2,3]	GCD	County	River basin	RWPG	Areal extent	Estimated annual effective recharge	Estimated annual lateral inflow	Estimated annual volume from water-level decline	Modeled available groundwater
24	Barton Springs/ Edwards Aquifer Conservation District[3]	Hays	Guadalupe	K	17	N/A	0	0	0
25	Barton Springs/ Edwards Aquifer Conservation District[3]	Hays	Colorado	K	1	N/A	0	0	0
26	Barton Springs/ Edwards Aquifer Conservation District[3]	Hays	Guadalupe	L	5,864	N/A	146	0	146
27	Plum Creek CD	Hays	Guadalupe	L	1,108	N/A	28	0	28
28	Southwestern Travis County GCD	Travis	Colorado	K	18	N/A	0	0	0
29	Barton Springs/ Edwards Aquifer Conservation District	Travis	Colorado	K	55,223	N/A	339	0	339
30	Barton Springs/ Edwards Aquifer Conservation District	Travis	Guadalupe	K	396	N/A	2	0	2
31	No GCD	Travis	Colorado	K	53,547	N/A	329	0	329

1. Map areas 1-10 represent outcrop areas and were assumed to be under unconfined aquifer conditions.

2. Map areas 11-31 represent subcrop areas and were assumed to be under confined aquifer conditions.

3. Map areas 24-26 cover the Barton Springs/Edwards Aquifer Conservation District and Plum Creek Conservation District where the two districts overlap. These values are assigned to the Barton Springs/Edwards Aquifer Conservation District.

TABLE 8. MODELED AVAILABLE GROUNDWATER FOR THE TRINITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 10 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2010 AND 2060. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	2010	2020	2030	2040	2050	2060
Barton Springs/ Edwards Aquifer Conservation District	Hays	3,854	3,854	3,854	3,854	3,854	3,854
	Travis	341	341	341	341	341	341
Comal Trinity GCD	Comal	33,554	33,554	33,554	33,554	33,554	33,554
Medina County GCD	Medina	6,661	6,661	6,661	6,661	6,661	6,661
Non-District Areas	Caldwell	10	10	10	10	10	10
	Guadalupe	660	660	660	660	660	660
	Travis	329	329	329	329	329	329
Plum Creek Conservation District	Hays	276	276	276	276	276	276
Southwestern Travis County GCD	Travis	1	1	1	1	1	1
Uvalde County UWCD	Uvalde	795	795	795	795	795	795
Total		**46,481**	**46,481**	**46,481**	**46,481**	**46,481**	**46,481**

TABLE 9. MODELED AVAILABLE GROUNDWATER FOR THE TRINITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 10 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2020 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	2020	2030	2040	2050	2060	2070
Caldwell	L	Guadalupe	10	10	10	10	10	10
Comal	L	Guadalupe	31,035	31,035	31,035	31,035	31,035	31,035
		San Antonio	2,519	2,519	2,519	2,519	2,519	2,519
Guadalupe	L	Guadalupe	188	188	188	188	188	188
		San Antonio	472	472	472	472	472	472
Hays	K	Colorado	980	980	980	980	980	980
		Guadalupe	9	9	9	9	9	9
	L	Colorado	32	32	32	32	32	32
		Guadalupe	3,109	3,109	3,109	3,109	3,109	3,109
Medina	L	Nueces	5,482	5,482	5,482	5,482	5,482	5,482
		San Antonio	1,179	1,179	1,179	1,179	1,179	1,179
Travis	K	Colorado	669	669	669	669	669	669
		Guadalupe	2	2	2	2	2	2
Uvalde	L	Nueces	795	795	795	795	795	795

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

Ashworth, J. B., 1983, Ground-water availability of the Lower Cretaceous formations in the Hill Country of south-central Texas: Texas Department of Water Resources Report 273, 173 p.

Bradley, R. G., 2011, GTA Aquifer Assessment 10-35 MAG, Northern saline Edwards Aquifer Modeled Available Groundwater Estimates, Texas Water Development Board, 13 p. http://www.twdb.texas.gov/groundwater/docs/AA/AA10-35_MAG.pdf

Bradley, R. G., 2013, Aquifer Assessment 10-28 MAG: Aquifer Assessment for the Leona Gravel Aquifer Within Uvalde County in Groundwater Management Area 10, Texas Water Development Board, 13 p. http://www.twdb.texas.gov/groundwater/docs/AA/AA10-28_MAG.pdf

Cleaveland, M.K., 2006, Extended chronology of drought in the San Antonio area, revised report: University of Arkansas, 29 p. http://www.gbra.org/Documents/Reports/TreeRingStudy.pdf

Freeze, A.R. and Cherry, J.A., 1979, Groundwater, Prentice-Hall, 604 p.

George, P., 2010, GTA Aquifer Assessment 09-01: Texas Water Development Board, 14 p. http://www.twdb.texas.gov/groundwater/docs/AA/AA09-01.pdf

Green, R.T, Winterle, J.R., and Prikryl, J.D., 2008, Discharge from the Edwards Aquifer through the Leona River floodplain, Uvalde, Texas: Journal of the American Water Resources Association, v. 44, No. 4, pp. 887-901.

Green, R.T., Bertetti, F.P., and McGinnis, R., 2009, Analysis of the Water Resources of the Area Centered Within and Near Uvalde and Zavala Counties and Review of a Report on a Potential Well Field and Pipeline in Uvalde County, Texas: SwRI Project No. 20-14842, 53 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.

Hunt, B.B, 2017, Refining the northern Saline Edwards Aquifer desired future condition, northern subdivision of GMA-10, Hays and Travis counties, Texas, Barton Springs Edwards Aquifer Conservation District, Technical Memo 2017-1221, 2p.

Hunt, B.B., Smith, B.A., Kromann, J.,Wierman, D.A., and Mikels, J.K., 2010, Compilation of pumping tests in Travis and Hays counties, central Texas: Barton Springs/Edwards Aquifer Conservation District Data Series Report 2010-0701, 12p.

Hunt, B.B., Smith, B.A., Holland, W.F., 2011, Technical Note 2011-0707: Information in Support of the Drought DFC and Drought MAG, Barton Springs Segment of the Edwards Aquifer, Barton Springs/Edwards Aquifer Conservation District, 5 p.

Hutchison, W. R., 2011, Draft GAM Task 10-027 (revised): Texas Water Development Board, 8 p. http://www.twdb.texas.gov/groundwater/docs/GAMruns/Task10-027revised_draft.pdf

Hutchison, W.R., 2010, GAM Task 10-005, Texas Water Development Board, 27p. http://www.twdb.texas.gov/groundwater/docs/GAMruns/Task10-005.pdf

Hutchison, W.R. and Hill, M., 2011a, Report: Recalibration of the Edwards (Balcones Fault Zone) Aquifer—Barton Springs Segment—Groundwater Flow Model, Texas Water Development Board, 115.p. http://www.twdb.texas.gov/groundwater/models/alt/ebfz_b/EBFZ_B_Model_Recalibration_Report.pdf

Hutchison, W.R. and Hill, M.E., 2011b, GAM Run 09-019: Groundwater Model Runs to Estimate Monthly Average Discharge from Barton Springs under Alternative Pumping Scenarios and Alternative Initial Conditions, June 1, 2011, 29 p.

Hutchison, W.R. and Oliver, W., 2011, GAM Run 10-058 MAG Version 2: Groundwater Management Area 10 Model Runs to Estimate Springflow Under Assumed Future Pumping and Recharge Conditions for the Northern Subdivision of the Edwards (Balcones Fault Zone) Aquifer, Texas Water Development Board, 17.p. http://www.twdb.texas.gov/groundwater/docs/GAMruns/GR10-059_MAG_v2.pdf

Hutchison, W.R., Shi, J, and Jigmond, M, 2011, Groundwater Flow Model of The Kinney County Area, Texas Water Development Board, 219 p. http://www.twdb.texas.gov/groundwater/models/alt/knny/Kinney_County_Model_Report.pdf

Jones, I. C., Anaya, R., and Wade, S., 2009, Groundwater availability model for the Hill Country portion of the Trinity Aquifer system, Texas, Texas Water Development Board updated Trinity Hill Country GAM, 194 p.

Narasimhan, B., Srinvasan, R., Quiring, S., and Nielsen-Gammon, J.W., 2008, Digital Climatic Atlas of Texas: Texas A&M University, Texas Water Development Board contract, Report 2005-483-5591, 108 p.

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.

Shi, J, 2012, GAM Run 12-002 MAG: Modeled Available Groundwater for the Edwards (Balcones Fault Zone) Aquifer in Groundwater Management Area 10 for Kinney County, Texas Water Development Board, 9 p. http://www.twdb.texas.gov/groundwater/docs/GAMruns/GR12-002_MAG.pdf

Texas Water Code, 2017, http://www.statutes.legis.state.tx.us/docs/WA/pdf/WA.36.pdf.

Thorkildsen, D. and Backhouse, S., 2010, GTA Aquifer Assessment 10-06: Groundwater Management Area 10 Trinity Aquifer Draft Managed Available Groundwater estimates, Texas Water Development Board, 20 p. http://www.twdb.texas.gov/groundwater/docs/AA/AA10-06.pdf

Thorkildsen, D. and Backhouse, S., 2011a, GTA Aquifer Assessment 10-26, Austin Chalk Aquifer Managed Available Groundwater Estimates, Texas Water Development Board 11 p. http://www.twdb.texas.gov/groundwater/docs/AA/AA10-26_MAG.pdf

Thorkildsen, D. and Backhouse, S., 2011b, GTA Aquifer Assessment 10-27, Buda Limestone Aquifer Managed Available Groundwater Estimates, Texas Water Development Board 10 p. http://www.twdb.texas.gov/groundwater/docs/AA/AA10-27_MAG.pdf

GAM RUN 17-027 MAG: MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX, QUEEN CITY, SPARTA, AND YEGUA-JACKSON AQUIFERS IN GROUNDWATER MANAGEMENT AREA 13

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October 27, 2017

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10/27/17

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GAM RUN 17-027 MAG:
MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX, QUEEN CITY, SPARTA, AND YEGUA-JACKSON AQUIFERS IN GROUNDWATER MANAGEMENT AREA 13

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(512) 936-0883
October 27, 2017

EXECUTIVE SUMMARY:

The modeled available groundwater for Groundwater Management Area 13 for the Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson aquifers is summarized by decade for the groundwater conservation districts (Tables 1 through 4 respectively) and for use in the regional water planning process (Tables 5 through 8 respectively). The modeled available groundwater estimates for the Carrizo-Wilcox Aquifer range from approximately 626,000 acre-feet per year in 2012 to approximately 589,000 acre-feet per year in 2070 (Table 1). The modeled available groundwater estimates for the Queen City Aquifer range from approximately 19,000 acre-feet per year in 2012 to approximately 15,000 acre-feet per year in 2070 (Table 2). The modeled available groundwater estimates for the Sparta Aquifer range from approximately 7,000 acre-feet per year in 2012 to approximately 6,000 acre-feet per year in 2070 (Table 3). The estimates were extracted from results of a model run using the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers (version 2.01). The model run files, which meet the secondary desired future condition adopted by district representatives of Groundwater Management Area 13 for the Carrizo-Wilcox, Queen City, and Sparta Aquifers, were submitted to the Texas Water Development Board (TWDB) on February 28, 2017, as part of the Desired Future Conditions Explanatory Report for Groundwater Management Area 13. The modeled available groundwater estimates for the Yegua-Jackson Aquifer are approximately 7,000 acre-feet per year from 2010 to 2070 (Table 4). The estimates were extracted from results of a model run using the groundwater availability model for the

Yegua-Jackson Aquifer version 1.01. The model run files, which meet the desired future conditions adopted by district representatives of Groundwater Management Area 13 for the Yegua-Jackson Aquifer, were submitted to the TWDB on March 29, 2017 as supplemental information for the original February 28, 2017 submittal. The explanatory reports and other materials submitted to the TWDB were determined to be administratively complete on September 8, 2017.

REQUESTOR:

Mr. Greg Sengelmann, coordinator of Groundwater Management Area 13.

DESCRIPTION OF REQUEST:

In a letter dated February 24, 2017, Dr. William R. Hutchison, on behalf of Groundwater Management Area 13, provided the TWDB with the desired future conditions of the Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson aquifers adopted by the groundwater conservation districts in Groundwater Management Area 13. The desired future conditions for the Carrizo-Wilcox, Queen City, and Sparta aquifers described in Resolution 16-01 from Groundwater Management Area 13, adopted November 21, 2016 are:

- *"The first proposed desired future condition for the Carrizo-Wilcox, Queen City and Sparta aquifers in Groundwater Management Area 13 is that 75 percent of the saturated thickness in the outcrop at the end of 2012 remains in 2070. This desired future condition is considered feasible despite model predictions to the contrary as detailed in GMA 13 Technical Memorandum 16-08", and*
- *"In addition, a secondary proposed desired future condition for the Carrizo-Wilcox, Queen City, and Sparta aquifers in Groundwater Management Area 13 is an average drawdown of 48 feet for all of GMA 13. The drawdown is calculated from the end of 2012 conditions to the year 2070. This desired future condition is consistent with Scenario 9 as detailed in GMA 13 Technical Memorandum 16-01 and GMA 13 Technical Memorandum 16-08."*

The desired future conditions for the Yegua-Jackson Aquifer described in Resolution 16-02 from Groundwater Management Area 13, adopted November 21, 2016 are:

- *"For Gonzales County, the average drawdown from 2010 to 2070 is 3 feet*
- *For Karnes County, the average drawdown from 2010 to 2070 is 1 foot*
- *For all other counties in GMA 13, the Yegua-Jackson is classified as not relevant for purposes of joint planning."*

TWDB staff reviewed the model files associated with the desired future conditions and received clarification on procedures and assumptions from the Groundwater Management Area 13 Technical Coordinator on April 4, 2017, and on September 21, 2017. Groundwater Management Area 13 adopted two desired future conditions for the Carrizo-Wilcox, Queen City, and Sparta Aquifers and they were not mutually compatible in the groundwater availability model. The technical coordinator for the groundwater management area confirmed that their intention was for the modeled available groundwater values to be based on the secondary desired future condition and Pumping Scenario 9 (Hutchison, 2017a). The first proposed desired future condition was not intended for the calculation of modeled available groundwater. Other questions included whether drawdown averages and modeled available groundwater values were based on official aquifer extent or model extent, whether to include dry cells in drawdown averaging, which stress periods to use for drawdown calculation, and whether to provide modeled available groundwater separately for the Carrizo-Wilcox, Queen City, and Sparta aquifers or as a combined value for all three aquifers .

In addition, TWDB staff requested and received supplemental model files for the Yegua-Jackson Aquifer on March 29, 2017, and supplemental documentation (Hutchison, 2017d) related to initial conditions for modeling the Carrizo-Wilcox, Queen City, and Sparta aquifers from Dr. William R. Hutchison on August 25, 2017, on behalf of Groundwater Management Area 13. All clarifications are included in the Parameters and Assumptions Section of this report.

METHODS:

The groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Figures 1 through 4) was run using the model files submitted with the explanatory reports (Hutchison, 2017c). Model-calculated drawdowns were extracted for the year 2070. An overall drawdown average was calculated for the entire Groundwater Management Area 13 using all aquifer layers in the average. Based on clarifications, the reference year for drawdown calculations was the end of 2011 (or the beginning of 2012). As specified in the clarifications, drawdowns for cells that became dry during the simulation (water level dropped below the base of the cell) were excluded from the averaging. The calculated drawdown average was compared with the desired future condition of 48 feet to verify that the pumping scenario (Hutchison, 2017a) achieved the desired future conditions within one foot.

The groundwater availability model for the Yegua-Jackson Aquifer (Figures 5 and 6) was run using the model files submitted on March 29, 2017, as supplemental information and drawdowns were calculated for the year 2070. County-wide average drawdowns were calculated for Gonzales and Karnes counties within Groundwater Management Area 13 using all model layers in the average. Based on clarifications, the reference year for drawdown calculation was the end of 2009 (or the beginning of 2010). As specified in the clarifications, drawdowns for cells that 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 for Gonzales and Karnes counties to verify that the pumping scenario (Hutchison, 2017b) 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 by aquifer are presented by county and groundwater conservation district, subtotaled by groundwater conservation district, and then summed for Groundwater Management Area 13 (Tables 1 through 4). Annual pumping rates by aquifer are also presented by county, river basin, and regional water planning area within Groundwater Management Area 13 (Tables 5 through 8). Additional tables are provided in Appendix A which summarize the total modeled available groundwater for the Carrizo-Wilcox, Queen City, and Sparta aquifers by regional water planning area, county, river basin, and groundwater conservation district. Tables are provided in Appendix B which split the Carrizo-Wilcox, Queen City, and Sparta aquifers modeled pumping by model layer for each groundwater conservation district.

Modeled Available Groundwater and Permitting

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

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the modeled available groundwater estimates are described below:

Carrizo-Wilcox, Queen City, and Sparta aquifers

- We used Version 2.01 of the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers. See Deeds and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers.
- This groundwater availability model includes eight layers, which generally represent the Sparta Aquifer (Layer 1), the Weches Confining Unit (Layer 2), the Queen City Aquifer (Layer 3), the Reklaw Confining Unit (Layer 4), the Carrizo (Layer 5), the Upper Wilcox (Layer 6), the Middle Wilcox (Layer 7), and the Lower Wilcox (Layer 8). Parts of the Upper Wilcox do not exist in Groundwater Management Area 13 and the official extent of the Queen City and Sparta aquifers end around the Frio River. Layers represent equivalent geologic units outside of the official aquifer extents.
- The model was run with MODFLOW-96 (Harbaugh and others, 1996).
- The end of the calibration period was extended from 1999 to 2011 (Hutchison, 2017e) and the reference year for drawdown calculations was the end of 2011.
- Drawdown averages and modeled available groundwater values were based on the extent of the model area rather than the official aquifer boundaries.
- Drawdowns 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.
- A tolerance of one foot 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.
- Although the desired future condition for the Carrizo-Wilcox, Queen City, and Sparta aquifers is a combined value for all three aquifers, the modeled available groundwater values will be provided individually for each aquifer per clarification from the Groundwater Management Area 13 Technical Coordinator on September 21, 2017.

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) and the reference year for drawdown calculations was the end of 2009.
- Drawdown averages and modeled available groundwater values were based on the extent of the model area rather than the official aquifer boundaries.
- 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.
- A tolerance of one foot 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.

RESULTS:

The modeled available groundwater estimates for the Carrizo-Wilcox Aquifer range from approximately 626,000 acre-feet per year in 2012 to approximately 589,000 acre-feet per year in 2070 (Table 1). The modeled available groundwater estimates for the Queen City Aquifer range from approximately 19,000 acre-feet per year in 2012 to approximately 15,000 acre-feet per year in 2070 (Table 2). The modeled available groundwater estimate for the Sparta Aquifer ranges from approximately 7,000 acre-feet per year in 2012 to approximately 6,000 acre-feet per year in 2070 (Table 3). The modeled available groundwater is summarized by groundwater conservation district and county for the Carrizo-Wilcox, Queen City, and Sparta aquifers (Tables 1, 2, and 3 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 Carrizo-Wilcox, Queen City, and Sparta aquifers (Tables 5, 6, and 7 respectively). Small differences in values between table summaries are due to rounding. Additional tables are provided in Appendix A which summarize the total modeled available groundwater for all three aquifers by regional water planning area, county, river basin, and groundwater conservation district. Tables are provided in Appendix B which split the modeled pumping by each model aquifer layer for each groundwater conservation district.

The modeled available groundwater estimate for the Yegua-Jackson Aquifer is approximately 7,000 acre-feet per year from 2010 to 2070 (Table 4). The modeled available groundwater for the Yegua-Jackson Aquifer is summarized by groundwater conservation district and county (Table 4) and by county, river basin, and regional water planning area for use in the regional water planning process (Table 8). Small differences of values between table summaries are due to rounding.

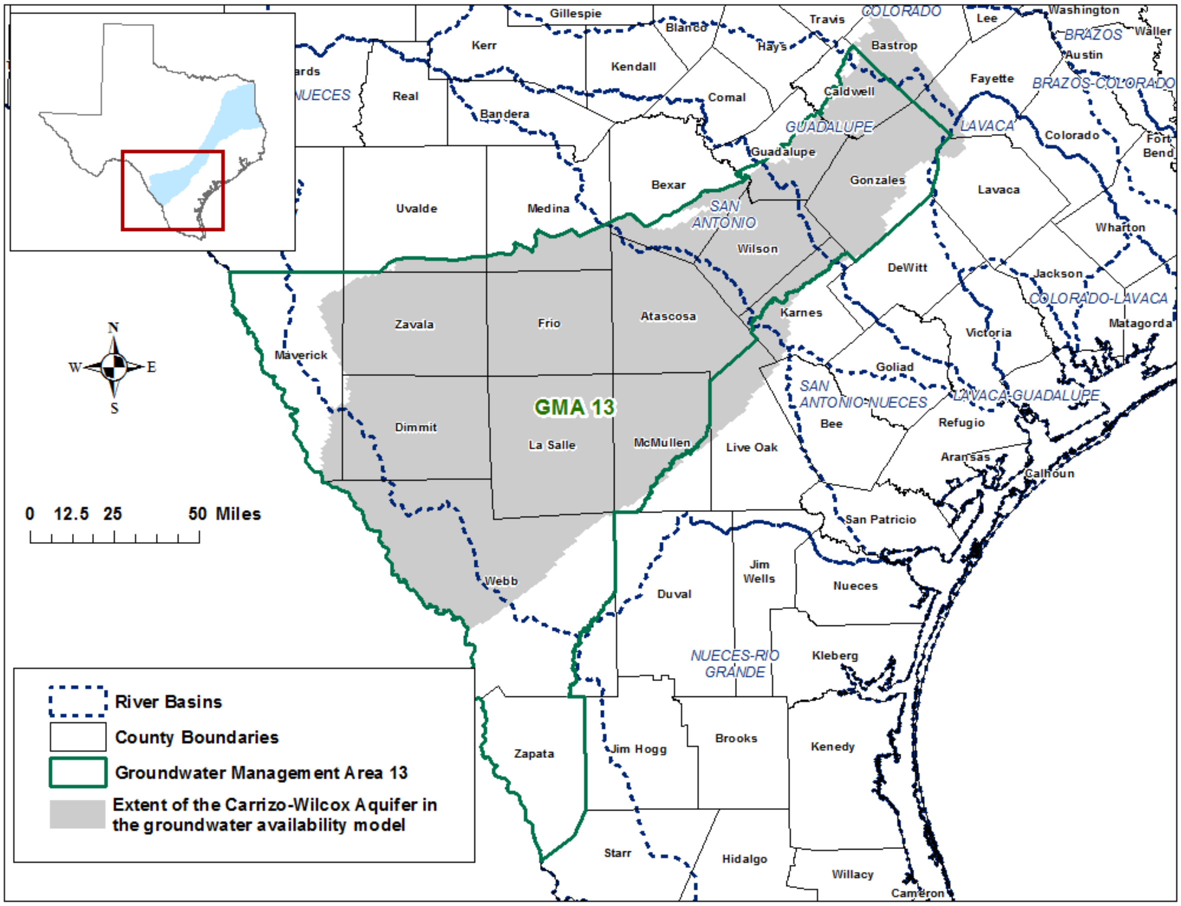


FIGURE 1. GROUNDWATER MANAGEMENT AREA (GMA) 13 BOUNDARY, RIVER BASINS, AND COUNTIES OVERLAIN ON THE EXTENT OF THE CARRIZO-WILCOX AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.

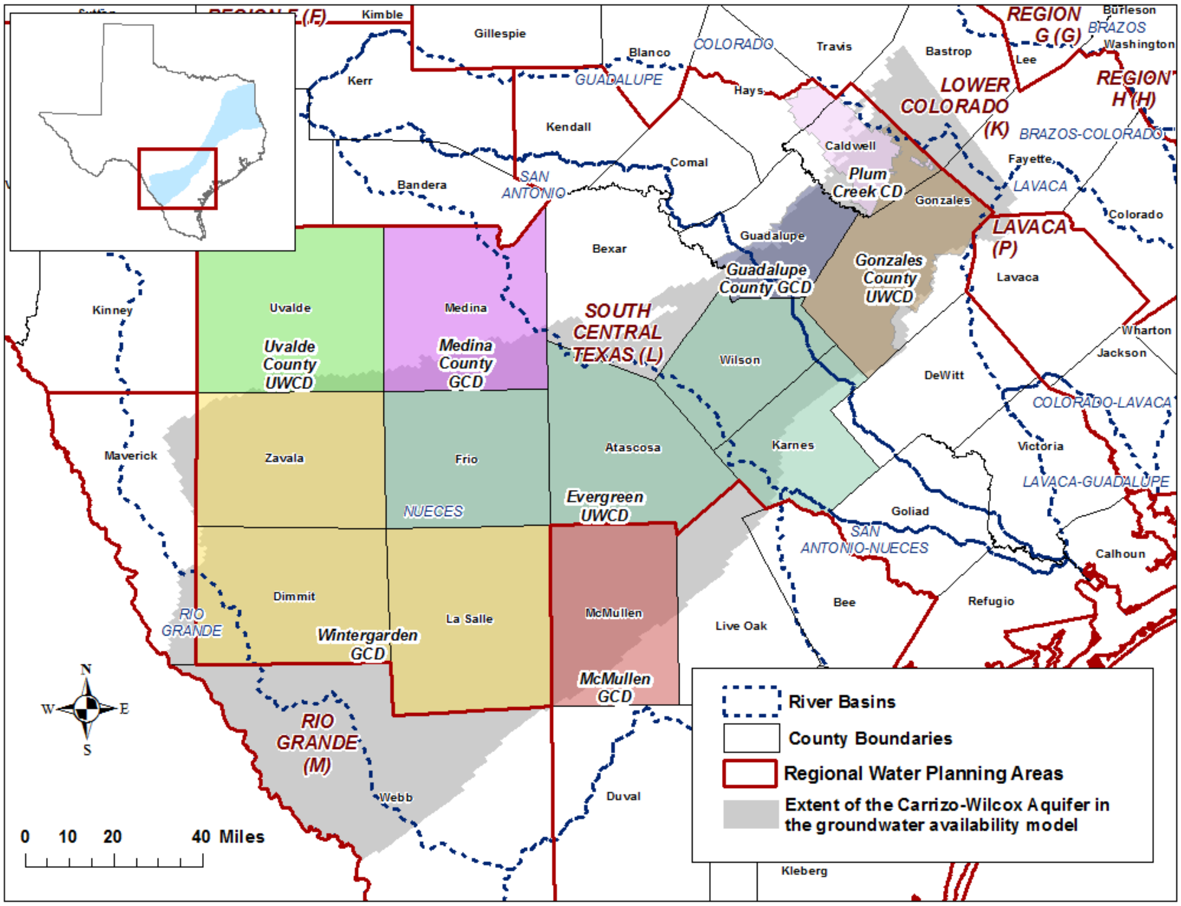


FIGURE 2. **REGIONAL WATER PLANNING AREAS (RWPAS), RIVER BASINS, GROUNDWATER CONSERVATION DISTRICTS (GCDS), AND COUNTIES OVERLAIN ON THE EXTENT OF THE CARRIZO-WILCOX AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.**

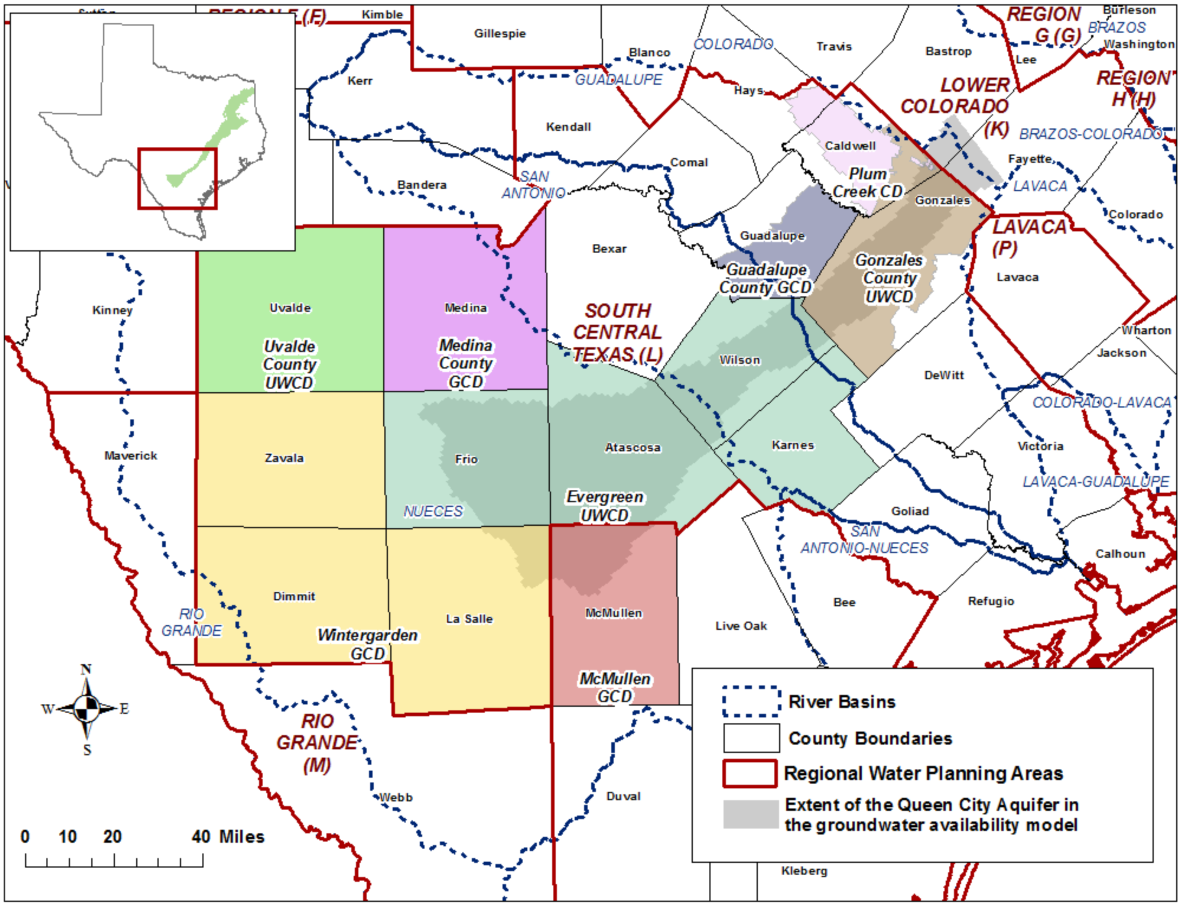


FIGURE 3. **REGIONAL WATER PLANNING AREAS (RWPAS), RIVER BASINS, GROUNDWATER CONSERVATION DISTRICTS (GCDS), AND COUNTIES OVERLAIN ON THE EXTENT OF THE QUEEN CITY AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.**

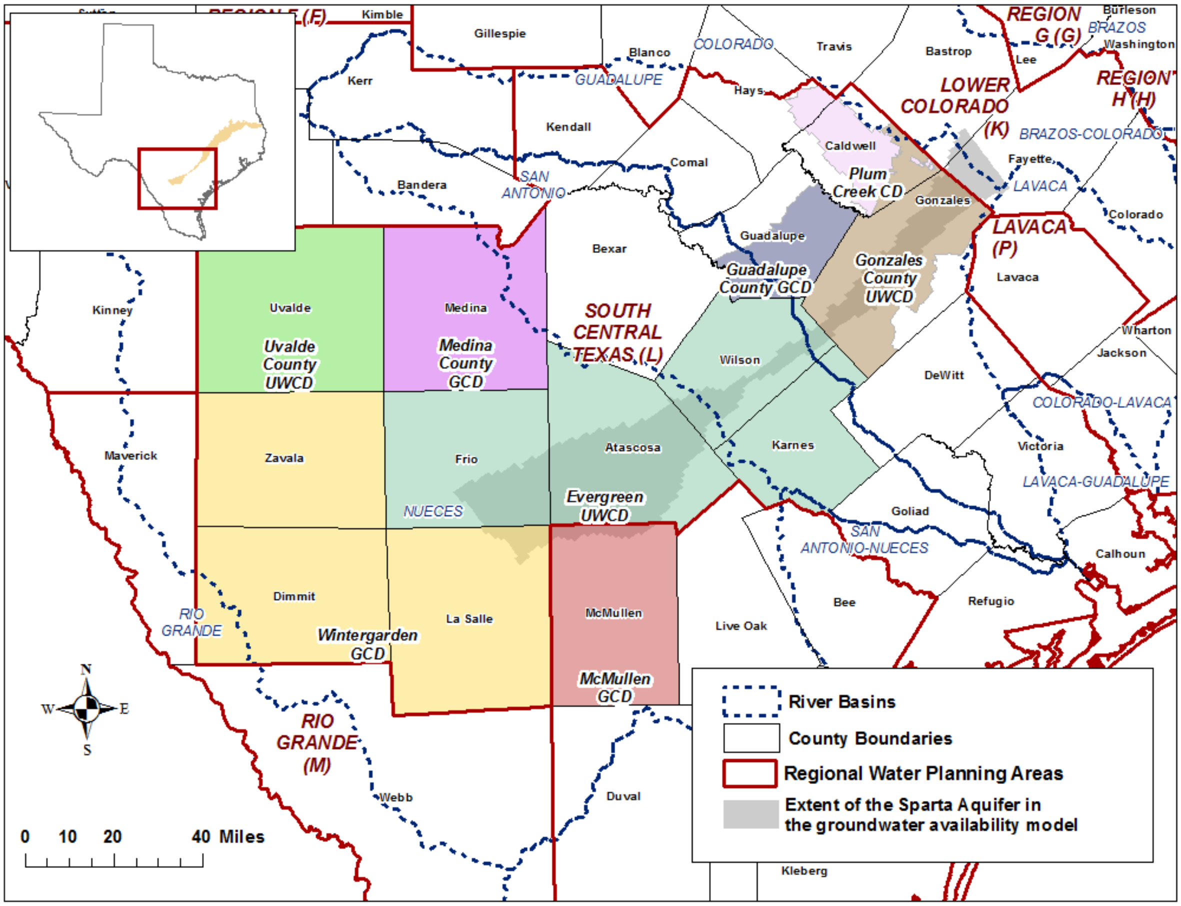


FIGURE 4. **REGIONAL WATER PLANNING AREAS (RWPAS), RIVER BASINS, GROUNDWATER CONSERVATION DISTRICTS (GCDS), AND COUNTIES OVERLAIN ON THE EXTENT OF THE SPARTA AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.**

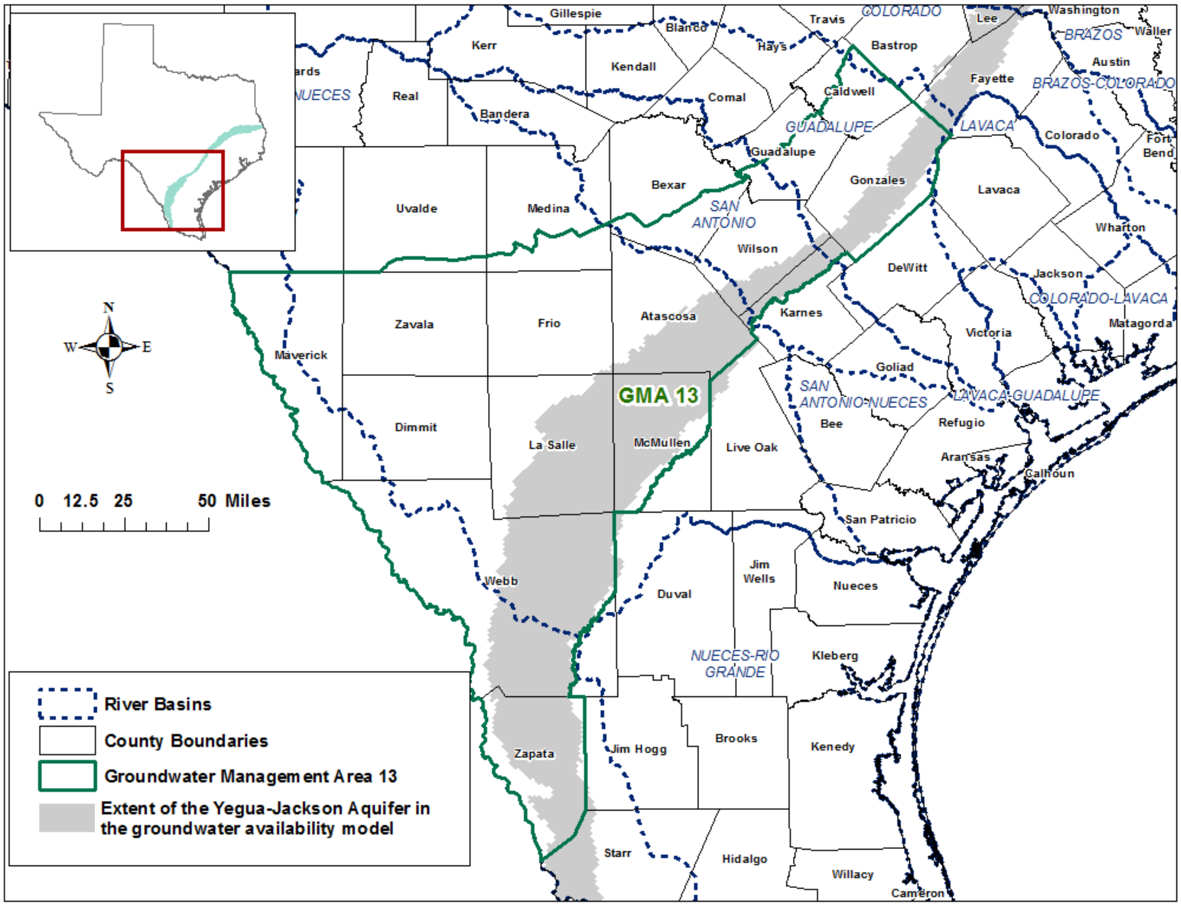


FIGURE 5. GROUNDWATER MANAGEMENT AREA (GMA) 13 BOUNDARY, RIVER BASINS, AND COUNTIES OVERLAIN ON THE EXTENT OF THE YEGUA-JACKSON AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL.

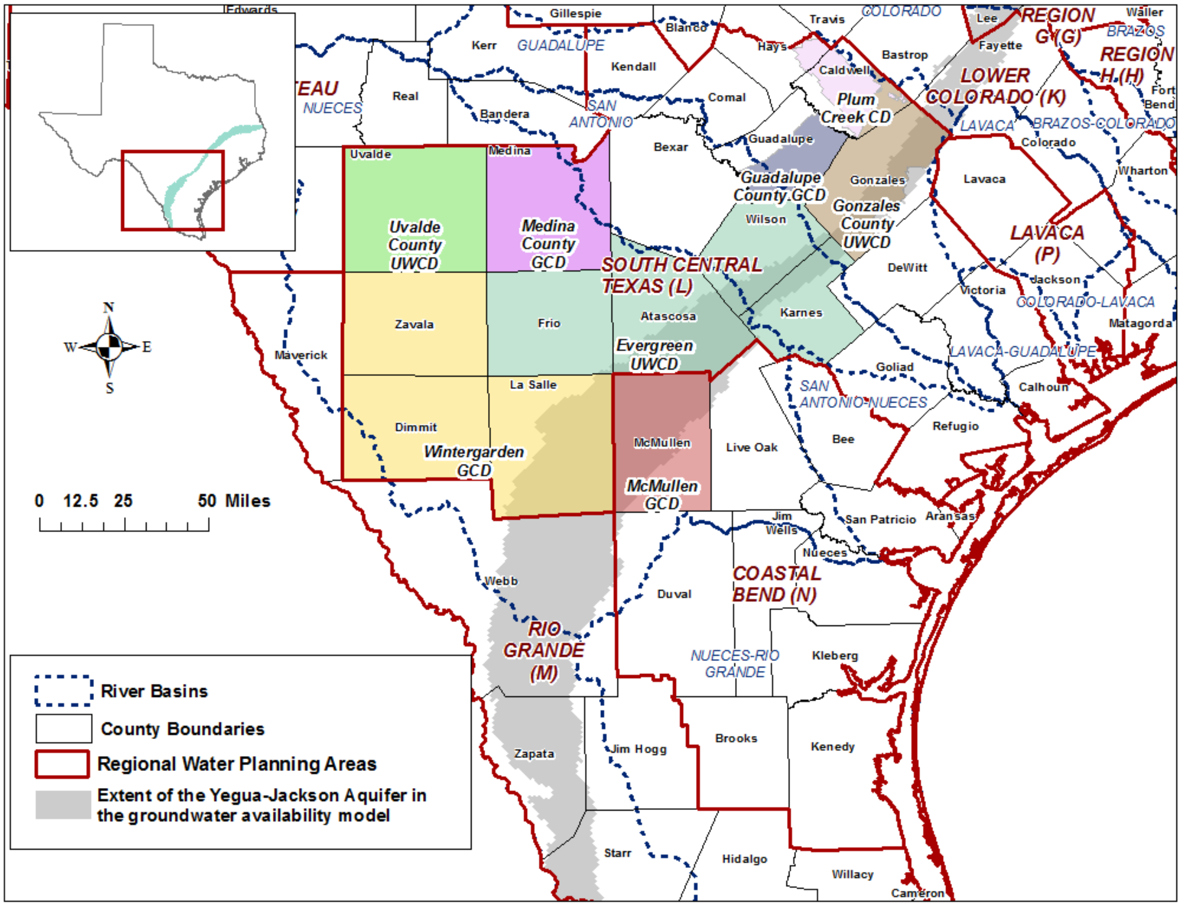


FIGURE 6. REGIONAL WATER PLANNING AREAS (RWPAS), RIVER BASINS, GROUNDWATER CONSERVATION DISTRICTS (GCDS), AND COUNTIES OVERLAIN ON THE EXTENT OF THE YEGUA-JACKSON AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL.

TABLE 1. MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 13 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2012 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2012	2020	2030	2040	2050	2060	2070
Evergreen UWCD	Atascosa	Carrizo-Wilcox	67,668	67,668	70,286	71,066	72,718	74,298	75,874
Evergreen UWCD	Frio	Carrizo-Wilcox	111,920	111,920	85,036	82,999	81,083	79,197	77,353
Evergreen UWCD	Karnes	Carrizo-Wilcox	1,042	1,042	1,085	1,146	1,212	1,264	1,296
Evergreen UWCD	Wilson	Carrizo-Wilcox	108,465	108,465	104,918	106,196	107,653	109,358	111,093
Evergreen UWCD Total		**Carrizo-Wilcox**	**289,096**	**289,096**	**261,325**	**261,406**	**262,666**	**264,116**	**265,616**
Gonzales County UWCD	Caldwell	Carrizo-Wilcox	39,713	39,713	39,713	36,678	36,678	33,643	33,643
Gonzales County UWCD	Gonzales	Carrizo-Wilcox	81,594	81,594	81,594	85,371	85,735	85,987	85,996
Gonzales County UWCD Total		**Carrizo-Wilcox**	**121,307**	**121,307**	**121,307**	**122,049**	**122,413**	**119,630**	**119,638**
Guadalupe County GCD	**Guadalupe**	**Carrizo-Wilcox**	**48,032**	**52,528**	**47,844**	**45,776**	**47,995**	**47,965**	**47,833**
McMullen GCD	**McMullen**	**Carrizo-Wilcox**	**7,002**	**7,056**	**7,056**	**4,405**	**4,405**	**4,405**	**4,405**
Medina County GCD	**Medina**	**Carrizo-Wilcox**	**2,657**	**2,657**	**2,648**	**2,647**	**2,647**	**2,646**	**2,646**
Plum Creek CD	**Caldwell**	**Carrizo-Wilcox**	**21,073**	**20,610**	**20,610**	**20,202**	**20,202**	**19,625**	**19,625**
Uvalde County UWCD	**Uvalde**	**Carrizo-Wilcox**	**4,451**	**2,975**	**1,231**	**828**	**828**	**828**	**828**

Groundwater Conservation District	County	Aquifer	2012	2020	2030	2040	2050	2060	2070
Wintergarden GCD	Dimmit	Carrizo-Wilcox	4,129	4,129	4,129	4,129	4,129	4,129	4,129
Wintergarden GCD	La Salle	Carrizo-Wilcox	6,863	6,863	6,863	6,863	6,863	6,863	6,863
Wintergarden GCD	Zavala	Carrizo-Wilcox	35,653	35,653	35,305	35,171	35,071	34,750	34,695
Wintergarden GCD Total		**Carrizo-Wilcox**	**46,645**	**46,645**	**46,297**	**46,163**	**46,063**	**45,742**	**45,687**
No District-County	Bexar	Carrizo-Wilcox	81,992	81,474	80,817	80,348	79,470	78,977	78,807
No District-County	Caldwell	Carrizo-Wilcox	921	921	921	921	921	921	921
No District-County	Gonzales	Carrizo-Wilcox	59	59	59	59	59	59	59
No District-County	Maverick	Carrizo-Wilcox	2,203	2,042	2,042	2,001	1,914	1,570	1,531
No District-County	Webb	Carrizo-Wilcox	916	916	916	916	916	916	916
No District-County Total		**Carrizo-Wilcox**	**86,091**	**85,412**	**84,755**	**84,245**	**83,280**	**82,443**	**82,235**
Total for GMA 13		**Carrizo-Wilcox**	**626,354**	**628,284**	**593,072**	**587,722**	**590,498**	**587,400**	**588,514**

TABLE 2. MODELED AVAILABLE GROUNDWATER FOR THE QUEEN CITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 13 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2012 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2012	2020	2030	2040	2050	2060	2070
Evergreen UWCD	Atascosa	Queen City	4,075	4,075	4,543	4,543	4,513	4,407	4,302
Evergreen UWCD	Frio	Queen City	6,759	6,759	4,745	4,573	4,429	4,257	4,113
Evergreen UWCD	Wilson	Queen City	2,780	2,780	1,508	1,339	1,191	1,059	945
Evergreen UWCD Total		**Queen City**	**13,614**	**13,614**	**10,797**	**10,455**	**10,133**	**9,723**	**9,359**
Gonzales County UWCD	**Caldwell**	**Queen City**	284	284	284	284	284	284	284
Gonzales County UWCD	**Gonzales**	**Queen City**	5,067	5,067	5,067	5,067	5,067	5,067	5,067
Gonzales County UWCD Total		**Queen City**	**5,351**	**5,351**	**5,351**	**5,351**	**5,351**	**5,351**	**5,351**
Guadalupe County GCD	**Guadalupe**	**Queen City**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
McMullen GCD	**McMullen**	**Queen City**	**134**	**134**	**134**	**134**	**134**	**134**	**134**
Plum Creek CD	**Caldwell**	**Queen City**	**22**	**22**	**22**	**22**	**22**	**22**	**22**
Wintergarden GCD	**La Salle**	**Queen City**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
Total for GMA 13		**Queen City**	**19,123**	**19,123**	**16,307**	**15,965**	**15,643**	**15,233**	**14,869**

TABLE 3. MODELED AVAILABLE GROUNDWATER FOR THE SPARTA AQUIFER IN GROUNDWATER MANAGEMENT AREA 13 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2012 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2012	2020	2030	2040	2050	2060	2070
Evergreen UWCD	Atascosa	Sparta	1,219	1,215	1,188	1,129	1,083	1,044	1,013
Evergreen UWCD	Frio	Sparta	1,045	1,045	728	702	674	651	624
Evergreen UWCD	Wilson	Sparta	462	462	251	224	198	176	156
Evergreen UWCD Total		**Sparta**	**2,726**	**2,723**	**2,166**	**2,056**	**1,955**	**1,870**	**1,792**
Gonzales County UWCD	**Gonzales**	**Sparta**	**3,554**	**3,554**	**3,554**	**3,554**	**3,554**	**3,554**	**3,554**
McMullen GCD	**McMullen**	**Sparta**	**89**	**89**	**89**	**89**	**89**	**89**	**89**
Wintergarden GCD	**La Salle**	**Sparta**	**983**	**983**	**983**	**983**	**983**	**983**	**983**
Total for GMA 13		**Sparta**	**7,353**	**7,349**	**6,793**	**6,682**	**6,582**	**6,497**	**6,419**

TABLE 4. MODELED AVAILABLE GROUNDWATER FOR THE YEGUA-JACKSON AQUIFER IN GROUNDWATER MANAGEMENT AREA 13 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2010 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2010	2020	2030	2040	2050	2060	2070
Evergreen UWCD	Karnes	Yegua-Jackson	2,059	2,059	2,059	2,059	2,059	2,059	2,059
Gonzales County UWCD	Gonzales	Yegua-Jackson	4,140	4,140	4,140	4,140	4,140	4,140	4,140
No District-County	Gonzales	Yegua-Jackson	573	573	573	573	573	573	573
Total for GMA 13		**Yegua-Jackson**	**6,771**	**6,771**	**6,771**	**6,771**	**6,771**	**6,771**	**6,771**

TABLE 5. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 13. 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	2070
Atascosa	L	Nueces	Carrizo-Wilcox	67,548	70,166	70,946	72,598	74,178	75,754
Atascosa	L	San Antonio	Carrizo-Wilcox	120	120	120	120	120	120
Bexar	L	Nueces	Carrizo-Wilcox	48,152	48,152	48,152	48,152	48,152	48,176
Bexar	L	San Antonio	Carrizo-Wilcox	33,322	32,665	32,196	31,318	30,825	30,631
Caldwell	L	Colorado	Carrizo-Wilcox	593	593	593	593	593	593
Caldwell	L	Guadalupe	Carrizo-Wilcox	60,652	60,652	57,208	57,208	53,596	53,596
Dimmit	L	Nueces	Carrizo-Wilcox	4,022	4,022	4,022	4,022	4,022	4,022
Dimmit	L	Rio Grande	Carrizo-Wilcox	107	107	107	107	107	107
Frio	L	Nueces	Carrizo-Wilcox	111,920	85,036	82,999	81,083	79,197	77,353
Gonzales	L	Guadalupe	Carrizo-Wilcox	81,438	81,438	85,216	85,579	85,832	85,840
Gonzales	L	Lavaca	Carrizo-Wilcox	215	215	215	215	215	215
Guadalupe	L	Guadalupe	Carrizo-Wilcox	36,180	32,150	29,767	31,569	31,793	31,744
Guadalupe	L	San Antonio	Carrizo-Wilcox	16,347	15,693	16,008	16,426	16,172	16,089
Karnes	L	Guadalupe	Carrizo-Wilcox	177	185	195	207	215	220
Karnes	L	Nueces	Carrizo-Wilcox	83	87	92	97	101	103
Karnes	L	San Antonio	Carrizo-Wilcox	783	813	859	909	948	972
La Salle	L	Nueces	Carrizo-Wilcox	6,863	6,863	6,863	6,863	6,863	6,863
Medina	L	Nueces	Carrizo-Wilcox	2,652	2,643	2,643	2,642	2,641	2,641
Medina	L	San Antonio	Carrizo-Wilcox	5	5	5	5	5	5
Uvalde	L	Nueces	Carrizo-Wilcox	2,975	1,231	828	828	828	828
Wilson	L	Guadalupe	Carrizo-Wilcox	20,287	20,186	20,340	20,452	20,783	20,923

County	RWPA	River Basin	Aquifer	2020	2030	2040	2050	2060	2070
Wilson	L	Nueces	Carrizo-Wilcox	7,652	7,154	7,317	7,510	7,709	7,938
Wilson	L	San Antonio	Carrizo-Wilcox	80,526	77,577	78,538	79,691	80,865	82,232
Zavala	L	Nueces	Carrizo-Wilcox	35,653	35,305	35,171	35,071	34,750	34,695
Maverick	M	Nueces	Carrizo-Wilcox	777	777	777	777	472	472
Maverick	M	Rio Grande	Carrizo-Wilcox	1,265	1,265	1,224	1,137	1,097	1,059
Webb	M	Nueces	Carrizo-Wilcox	92	92	92	92	92	92
Webb	M	Rio Grande	Carrizo-Wilcox	824	824	824	824	824	824
McMullen	N	Nueces	Carrizo-Wilcox	7,056	7,056	4,405	4,405	4,405	4,405
GMA 13 Total			**Carrizo-Wilcox**	**628,284**	**593,072**	**587,722**	**590,498**	**587,400**	**588,514**

TABLE 6. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE QUEEN CITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 13. 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	2070
Atascosa	L	Nueces	Queen City	4,075	4,543	4,543	4,513	4,407	4,302
Caldwell	L	Guadalupe	Queen City	307	307	307	307	307	307
Frio	L	Nueces	Queen City	6,759	4,745	4,573	4,429	4,257	4,113
Gonzales	L	Guadalupe	Queen City	5,032	5,032	5,032	5,032	5,032	5,032
Gonzales	L	Lavaca	Queen City	35	35	35	35	35	35
Guadalupe	L	Guadalupe	Queen City	0	0	0	0	0	0
La Salle	L	Nueces	Queen City	2	2	2	2	2	2
Wilson	L	Guadalupe	Queen City	236	128	114	101	90	80
Wilson	L	Nueces	Queen City	273	148	132	117	104	93
Wilson	L	San Antonio	Queen City	2,271	1,232	1,094	973	865	772
McMullen	N	Nueces	Queen City	134	134	134	134	134	134
GMA 13 Total			**Queen City**	**19,123**	**16,307**	**15,965**	**15,643**	**15,233**	**14,869**

TABLE 7. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE SPARTA AQUIFER IN GROUNDWATER MANAGEMENT AREA 13. 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	2070
Atascosa	L	Nueces	Sparta	1,215	1,188	1,129	1,083	1,044	1,013
Frio	L	Nueces	Sparta	1,045	728	702	674	651	624
Gonzales	L	Guadalupe	Sparta	3,531	3,531	3,531	3,531	3,531	3,531
Gonzales	L	Lavaca	Sparta	23	23	23	23	23	23
La Salle	L	Nueces	Sparta	983	983	983	983	983	983
Wilson	L	Guadalupe	Sparta	42	23	20	18	16	14
Wilson	L	Nueces	Sparta	102	55	49	44	39	34
Wilson	L	San Antonio	Sparta	319	173	154	137	121	108
McMullen	N	Nueces	Sparta	89	89	89	89	89	89
GMA 13 Total			**Sparta**	**7,349**	**6,793**	**6,682**	**6,582**	**6,497**	**6,419**

TABLE 8. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE YEGUA-JACKSON AQUIFER IN GROUNDWATER MANAGEMENT AREA 13. 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	2070
Atascosa	L	Nueces	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
Frio	L	Nueces	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
Gonzales	L	Guadalupe	Yegua-Jackson	4,694	4,694	4,694	4,694	4,694	4,694
Gonzales	L	Lavaca	Yegua-Jackson	19	19	19	19	19	19
Karnes	L	Guadalupe	Yegua-Jackson	327	327	327	327	327	327
Karnes	L	Nueces	Yegua-Jackson	91	91	91	91	91	91
Karnes	L	San Antonio	Yegua-Jackson	1,641	1,641	1,641	1,641	1,641	1,641
La Salle	L	Nueces	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
Wilson	L	Guadalupe	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
Wilson	L	Nueces	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
Wilson	L	San Antonio	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
Webb	M	Nueces	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
Webb	M	Rio Grande	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
Zapata	M	Rio Grande	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
McMullen	N	Nueces	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
GMA 13 Total			**Yegua-Jackson**	**6,771**	**6,771**	**6,771**	**6,771**	**6,771**	**6,771**

NULL: Groundwater Management Area 13 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.

REFERENCES:

Deeds, N., Kelley, V., Fryar, D., Jones, T., Whallon, A.J., and Dean, K.E., 2003, Groundwater Availability Model for the Southern Carrizo-Wilcox Aquifer: Contract report to the Texas Water Development Board, 452 p., http://www.twdb.texas.gov/groundwater/models/gam/czwx_s/CZWX_S_Full_Report.pdf.

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

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.

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.

Hutchison, W.R., 2017a, GMA 13 Technical Memorandum 16-08 Final, Sparta, Queen City, and Carrizo-Wilcox Aquifers: Summary of Scenario 9 Drawdown and Outcrop Results, 13 p.

Hutchison, W.R., 2017b, GMA 13 Technical Memorandum 16-04 Final, Yegua-Jackson Aquifer: GAM Predictive Simulations, 7 p.

Hutchison, W.R., 2017c, Desired Future Condition Explanatory Report (Final) Carrizo-Wilcox/Queen City/Sparta Aquifers for Groundwater Management Area 13, 481 p., http://www.twdb.texas.gov/groundwater/dfc/docs/GMA13_DFCExpRep_CWQCSp.pdf

Hutchison, W.R., 2017d, GMA 13 Explanatory Report – Final Yegua-Jackson Aquifer, 152 p., http://www.twdb.texas.gov/groundwater/dfc/docs/GMA13_DFCExpRep_YJ.pdf

Hutchison, W.R., 2017e, GMA 13 Technical Memorandum 17-01 Final, Extension of GAM Calibration Period for Carrizo-Wilcox, Queen City, and Sparta Aquifers, 81p.

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.

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.

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

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

Appendix A

Modeled Available Groundwater for the Carrizo-Wilcox, Queen City, and Sparta Aquifers Summarized by County, River Basin, Regional Water Planning Area, and Groundwater Conservation District in Groundwater Management Area 13

TABLE A.1 MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS SUMMARIZED BY COUNTY IN GROUNDWATER MANAGEMENT AREA 13. RESULTS ARE IN ACRE-FEET PER YEAR.

County	2020	2030	2040	2050	2060	2070
Atascosa	72,959	76,017	76,739	78,315	79,749	81,189
Bexar	81,474	80,817	80,348	79,470	78,977	78,807
Caldwell	61,551	61,551	58,108	58,108	54,495	54,495
Dimmit	4,129	4,129	4,129	4,129	4,129	4,129
Frio	119,724	90,509	88,274	86,185	84,104	82,089
Gonzales	90,273	90,273	94,051	94,415	94,667	94,675
Guadalupe	52,528	47,844	45,776	47,995	47,965	47,833
Karnes	1,042	1,085	1,146	1,212	1,264	1,296
La Salle	7,848	7,848	7,848	7,848	7,848	7,848
Maverick	2,042	2,042	2,001	1,914	1,570	1,531
McMullen	7,279	7,279	4,629	4,629	4,629	4,629
Medina	2,657	2,648	2,647	2,647	2,646	2,646
Uvalde	2,975	1,231	828	828	828	828
Webb	916	916	916	916	916	916
Wilson	111,707	106,677	107,759	109,041	110,593	112,193
Zavala	35,653	35,305	35,171	35,071	34,750	34,695
GMA 13 Total	**654,757**	**616,172**	**610,369**	**612,723**	**609,130**	**609,802**

TABLE A.2 MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS SUMMARIZED BY RIVER BASIN IN GROUNDWATER MANAGEMENT AREA 13. RESULTS ARE IN ACRE-FEET PER YEAR.

River Basin	2020	2030	2040	2050	2060	2070
Colorado	593	593	593	593	593	593
Guadalupe	207,880	203,631	201,729	204,002	201,193	201,286
Lavaca	273	273	273	273	273	273
Nueces	310,122	281,200	276,645	276,208	275,121	274,730
Rio Grande	2,196	2,196	2,155	2,068	2,028	1,990
San Antonio	133,693	128,278	128,974	129,578	129,922	130,929
GMA 13 Total	**654,757**	**616,172**	**610,369**	**612,723**	**609,130**	**609,802**

TABLE A.3 MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS SUMMARIZED BY REGIONAL WATER PLANNING AREA IN GROUNDWATER MANAGEMENT AREA 13. RESULTS ARE IN ACRE-FEET PER YEAR.

Regional Water Planning Area	2020	2030	2040	2050	2060	2070
L	644,520	605,934	602,823	605,264	602,016	602,726
M	2,958	2,958	2,917	2,829	2,485	2,447
N	7,279	7,279	4,629	4,629	4,629	4,629
GMA 13 Total	**654,757**	**616,172**	**610,369**	**612,723**	**609,130**	**609,802**

TABLE A.4 MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT IN GROUNDWATER MANAGEMENT AREA 13. RESULTS ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	2020	2030	2040	2050	2060	2070
Evergreen UWCD	305,432	274,288	273,917	274,754	275,710	276,768
Gonzales County UWCD	130,212	130,212	130,954	131,318	128,535	128,543
Guadalupe County GCD	52,528	47,844	45,776	47,995	47,965	47,833
McMullen GCD	7,279	7,279	4,629	4,629	4,629	4,629
Medina County GCD	2,657	2,648	2,647	2,647	2,646	2,646
Plum Creek CD	20,633	20,633	20,224	20,224	19,647	19,647
Uvalde County UWCD	2,975	1,231	828	828	828	828
Wintergarden GCD	47,630	47,282	47,149	47,048	46,727	46,673
No District-Bexar County	81,474	80,817	80,348	79,470	78,977	78,807
No District-Caldwell County	921	921	921	921	921	921
No District-Gonzales County	59	59	59	59	59	59
No District-Maverick County	2,042	2,042	2,001	1,914	1,570	1,531
No District-Webb County	916	916	916	916	916	916
GMA 13 Total	**654,757**	**616,172**	**610,369**	**612,723**	**609,130**	**609,802**

Appendix B

Total Pumping Associated with Modeled Available Groundwater Run for the Carrizo-Wilcox, Queen City, and Sparta Aquifers Split by Model Layers for Groundwater Conservation Districts in Groundwater Management Area 13

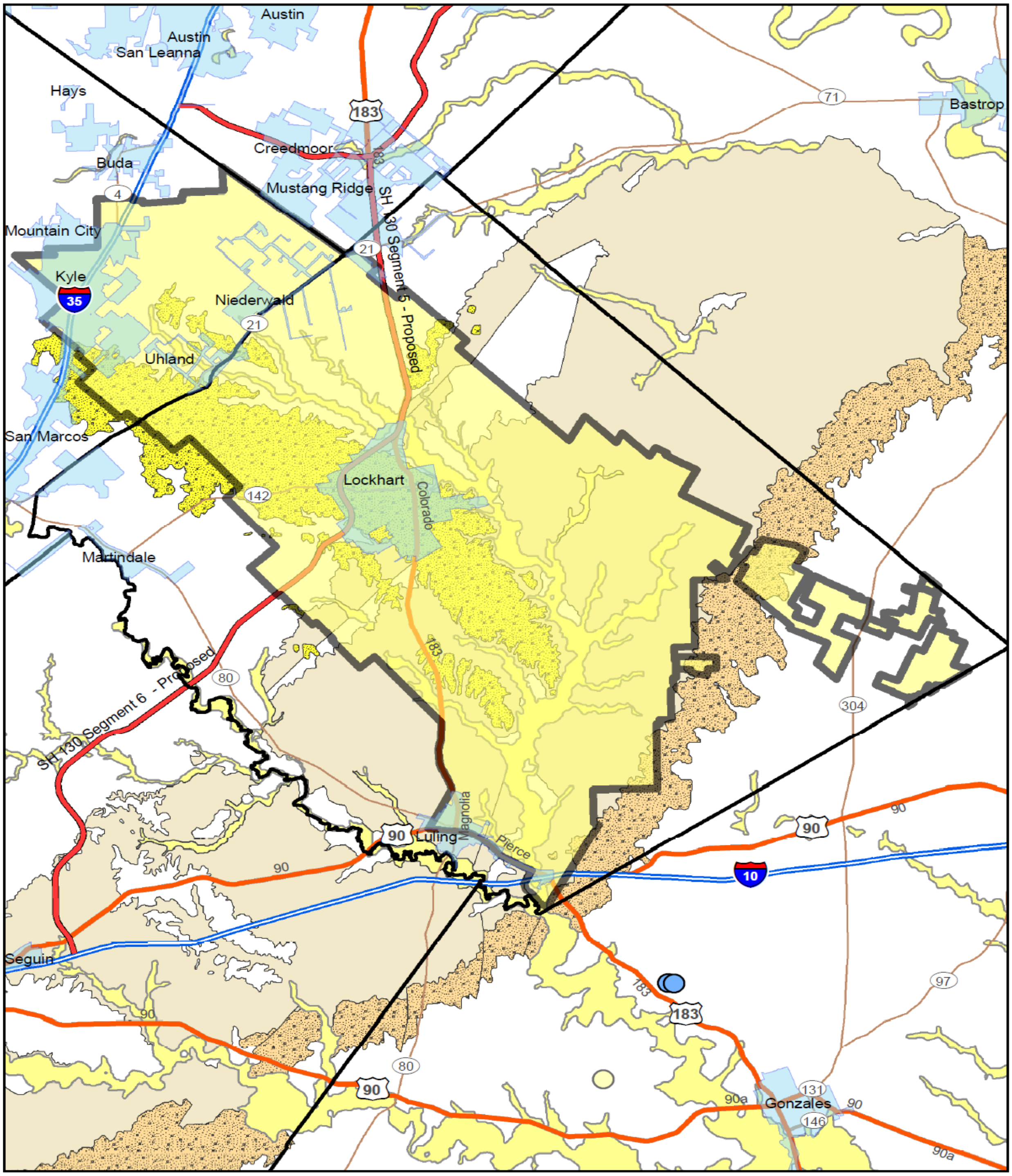
TABLE B.1 TOTAL PUMPING BY MODEL LAYER ASSOCIATED WITH THE MODELED AVAILABLE GROUNDWATER RUN FOR THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS IN GROUNDWATER MANAGEMENT AREA 13 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD).

Groundwater Conservation District	Model Layer (Aquifer)	2012	2020	2030	2040	2050	2060	2070
Evergreen UWCD	1 (Sparta)	2,726	2,723	2,166	2,056	1,955	1,870	1,792
Evergreen UWCD	3 (Queen City)	13,614	13,614	10,797	10,455	10,133	9,723	9,359
Evergreen UWCD	5 (Carrizo)	199,165	199,165	171,394	171,475	172,735	174,186	175,686
Evergreen UWCD	6 (Upper Wilcox)	374	374	374	374	374	374	374
Evergreen UWCD	7 (Middle Wilcox)	370	370	370	370	370	370	370
Evergreen UWCD	8 (Lower Wilcox)	89,186	89,186	89,186	89,186	89,186	89,186	89,186
Evergreen UWCD Total		**305,436**	**305,432**	**274,288**	**273,917**	**274,754**	**275,710**	**276,768**
Gonzales County UWCD	1 (Sparta)	3,554	3,554	3,554	3,554	3,554	3,554	3,554
Gonzales County UWCD	3 (Queen City)	5,351	5,351	5,351	5,351	5,351	5,351	5,351
Gonzales County UWCD	5 (Carrizo)	83,284	83,284	83,284	84,026	84,390	81,607	81,615
Gonzales County UWCD	6 (Upper Wilcox)	0	0	0	0	0	0	0
Gonzales County UWCD	7 (Middle Wilcox)	12,187	12,187	12,187	12,187	12,187	12,187	12,187
Gonzales County UWCD	8 (Lower Wilcox)	25,836	25,836	25,836	25,836	25,836	25,836	25,836
Gonzales County UWCD Total		**130,212**	**130,212**	**130,212**	**130,954**	**131,318**	**128,535**	**128,543**

Groundwater Conservation District	Model Layer (Aquifer)	2012	2020	2030	2040	2050	2060	2070
Guadalupe County GCD	5 (Carrizo)	25,143	25,143	20,771	16,367	16,470	16,783	16,862
Guadalupe County GCD	6 (Upper Wilcox)	0	0	0	0	0	0	0
Guadalupe County GCD	7 (Middle Wilcox)	3,299	6,290	5,978	7,377	8,700	8,435	8,224
Guadalupe County GCD	8 (Lower Wilcox)	19,590	21,094	21,094	22,031	22,825	22,747	22,747
Guadalupe County GCD Total		**48,032**	**52,528**	**47,844**	**45,776**	**47,995**	**47,965**	**47,833**
McMullen GCD	1 (Sparta)	89	89	89	89	89	89	89
McMullen GCD	3 (Queen City)	134	134	134	134	134	134	134
McMullen GCD	5 (Carrizo)	7,002	7,056	7,056	4,405	4,405	4,405	4,405
McMullen GCD	6 (Upper Wilcox)	0	0	0	0	0	0	0
McMullen GCD	7 (Middle Wilcox)	0	0	0	0	0	0	0
McMullen GCD	8 (Lower Wilcox)	0	0	0	0	0	0	0
McMullen GCD Total		**7,226**	**7,279**	**7,279**	**4,629**	**4,629**	**4,629**	**4,629**
Medina County GCD	5 (Carrizo)	545	545	537	536	535	535	534
Medina County GCD	6 (Upper Wilcox)	0	0	0	0	0	0	0
Medina County GCD	7 (Middle Wilcox)	1,248	1,248	1,248	1,248	1,248	1,248	1,248

Groundwater Conservation District	Model Layer (Aquifer)	2012	2020	2030	2040	2050	2060	2070
Medina County GCD	8 (Lower Wilcox)	864	864	864	864	864	864	864
Medina County GCD Total		**2,657**	**2,657**	**2,648**	**2,647**	**2,647**	**2,646**	**2,646**
Plum Creek CD	3 (Queen City)	22	22	22	22	22	22	22
Plum Creek CD	5 (Carrizo)	6,057	6,057	6,057	6,057	6,057	6,057	6,057
Plum Creek CD	6 (Upper Wilcox)	0	0	0	0	0	0	0
Plum Creek CD	7 (Middle Wilcox)	5,301	4,838	4,838	4,838	4,838	4,261	4,261
Plum Creek CD	8 (Lower Wilcox)	9,714	9,714	9,714	9,306	9,306	9,306	9,306
Plum Creek CD Total		**21,095**	**20,633**	**20,633**	**20,224**	**20,224**	**19,647**	**19,647**
Uvalde County UWCD	5 (Carrizo)	828	828	828	828	828	828	828
Uvalde County UWCD	6 (Upper Wilcox)	3,622	2,147	402	0	0	0	0
Uvalde County UWCD	7 (Middle Wilcox)	0	0	0	0	0	0	0
Uvalde County UWCD	8 (Lower Wilcox)	0	0	0	0	0	0	0
Uvalde County UWCD Total		**4,451**	**2,975**	**1,231**	**828**	**828**	**828**	**828**
Wintergarden GCD	1 (Sparta)	983	983	983	983	983	983	983
Wintergarden GCD	3 (Queen City)	2	2	2	2	2	2	2
Wintergarden GCD	5 (Carrizo)	32,962	32,962	32,615	32,481	32,381	32,060	32,005
Wintergarden GCD	6 (Upper Wilcox)	9,261	9,261	9,261	9,261	9,261	9,261	9,261

Groundwater Conservation District	Model Layer (Aquifer)	2012	2020	2030	2040	2050	2060	2070
Wintergarden GCD	7 (Middle Wilcox)	4,006	4,006	4,006	4,006	4,006	4,006	4,006
Wintergarden GCD	8 (Lower Wilcox)	416	416	416	416	416	416	416
Wintergarden GCD Total		**47,630**	**47,630**	**47,282**	**47,149**	**47,048**	**46,727**	**46,673**



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1 in = 5 miles