Cow Creek Groundwater Conservation District
GROUNDWATER MANAGEMENT PLAN

Originally Adopted
September 7, 2004

Board of Directors
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Precinct 4
W. K. "Skip" Shumpes, Vice-President
Precinct 2
Bill Haas, Secretary
Precinct 3
Dalton F. Neill, Treasurer
At Large
Stan Scott, Asst. Secretary/Treasurer
Precinct 1

Revision, Adopted
December 14, 2009

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Revision, Adopted
January 20, 2015

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Revision, Adopted
January 13, 2020

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Bob Webster, Vice-President
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Alan Bloxsom, Secretary
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GROUNDWATER MANAGEMENT PLAN
REVISION RECORD

Date Adopted	Effective Date	Affected Sections or General Comments
9/7/04	9/7/04	Original Adoption, CCGCD Board Resolution 090704-1
12/14/09	12/14/09	Revision, Re-adoption, CCGCD Board Resolution 2009-019
1/20/15	1/20/15	Revision, Re-adoption, CCGCD Board Resolution 2015-01
1/13/20	1/13/20	Revision, Re-adoption, CCGCD Board Resolution 2020-001

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TIME PERIOD FOR THIS PLAN

This plan becomes effective upon adoption by the Cow Creek Groundwater Conservation District Board of Directors (District Board) and subsequent approval by the Texas Water Development Board (TWDB). This plan incorporates a planning period of 50 years. After five years, the plan will be reviewed for consistency with the applicable Regional Water Plans, the State Water Plan and Groundwater Management Area 9's Desired Future Conditions (DFC) and shall be readopted with or without amendments. The plan may be revised at anytime in order to maintain such consistency or as necessary to address any new or revised data, Groundwater Availability Models, Desired Future Conditions in GMA 9, or District management strategies.

DISTRICT MISSION

The Cow Creek Groundwater Conservation District (CCGCD or District) was created for the purpose of conserving, preserving, recharging, protecting and preventing waste of groundwater from the aquifers within the District. The District will conduct administrative and technical activities and programs to achieve these purposes. The District will collect and archive water well and aquifer data, regulate water well drilling and production from permitted, non-exempt wells, promote the capping or plugging of abandoned wells, provide information and educational material to local property owners, interact with other governmental or organizational entities, and undertake other groundwater-related activities that may help meet the purposes of the District. The Texas Hill Country Area, which includes the Cow Creek GCD, was declared a Critical Groundwater Area by the then Texas Water Commission in 1990. This declaration, now known as the Hill Country Priority Groundwater Management Area (PGMA), gave notice to the residents of the area that water availability and quality will be at risk within the next 25 years.

STATEMENT OF GUIDING PRINCIPLES FOR AQUIFER MANAGEMENT

The CCGCD was created so that appropriate groundwater management techniques and strategies could be implemented at the local level to address groundwater issues or problems within the District. The District will continue to incorporate the best and most current site-specific data available in the development of this plan to ensure the sustainability of the aquifers and achievement of the DFC's. This plan serves as a guideline the District can follow to ensure greater understanding of local aquifer conditions, development of groundwater management concepts and strategies, and subsequent implementation of appropriate groundwater management policies.

COMMITMENT TO IMPLEMENT GROUNDWATER MANAGEMENT PLAN

To address potential groundwater quantity and quality issues, the District is committed to, and will actively pursue, the groundwater management strategies identified in this groundwater management plan. The management plan will be coordinated with District Rules, policies, and activities in order to effectively manage and regulate the drilling of wells, production of groundwater within the District, protection of recharge features, prevention of pollution and waste, the transfer of groundwater into and out of the District, and encouragement of conservation practices and efficient water use within the District. This includes the evaluation of the impact(s) of conjunctive use of surface and groundwater. A conjunctive water source is the combined use of groundwater and surface water sources to optimize the beneficial characteristics of each. The term "conjunctive use" means the combined use of groundwater and surface water sources that optimizes the beneficial characteristics of each source (Texas Water Code, Chapter 36).

Three basic terms form the basis of water planning. The key terms that need to be understood are available water, existing water supplies and drought. Note there is a critical distinction between available water and existing water supplies.

As the agency responsible for the State Water Plan, the Texas Water Development Board (TWDB) defines available water as "the maximum amount of water available during the drought of record, regardless of whether the supply is physically or legally available." The existing water supply is defined by the TWDB as the "maximum amount of water available from existing sources for use during drought of record conditions that is physically and legally available for use."

Texas water planning requires both must be managed under a worst-case scenario - the drought of record. By TWDB definition, this is "the period of time during recorded history when natural hydrological conditions provided the least amount of water supply. For Texas as a whole, the drought of record is generally considered to be from about 1950 to 1957."

The District will cooperate with and coordinate its management plan and regulatory policies with adjacent groundwater districts, Regional Water Planning Groups, and Groundwater Management Area 9 (GMA9).

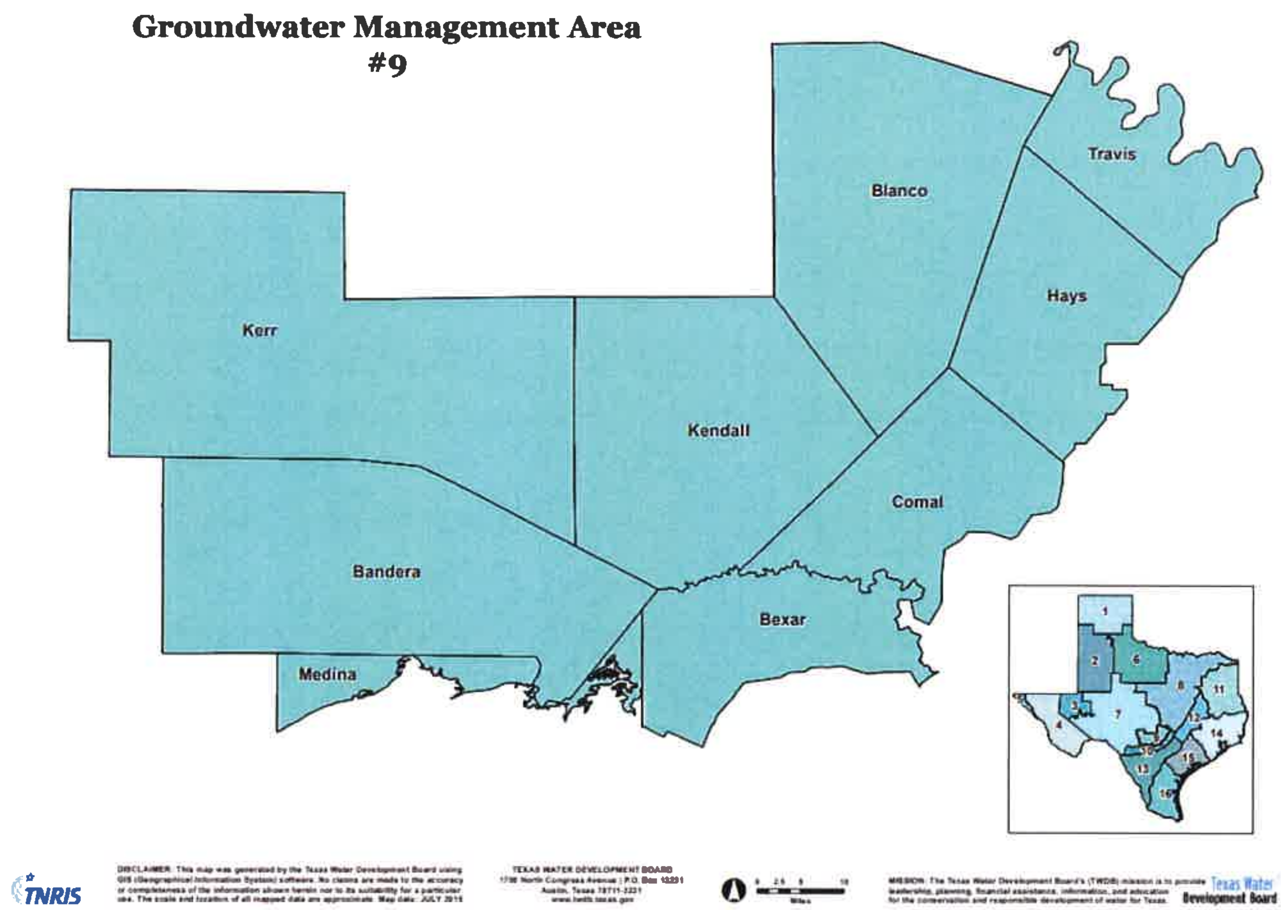
An electronic copy of the management plan is available online at www.ccgcd.org. A paper copy may be requested at the CCGCD office, located at 9 Toepperwein Road in Boerne, Texas 78006.

JOINT PLANNING IN MANAGEMENT AREA

Every five years, the districts in GMA 9 shall consider groundwater availability models and other data or information for the management area and shall establish desired future conditions for the relevant aquifers within the management area. In establishing the desired future conditions of the aquifers under this section, the districts shall consider uses or conditions of an aquifer within the management area that differ substantially from one geographic area to another.

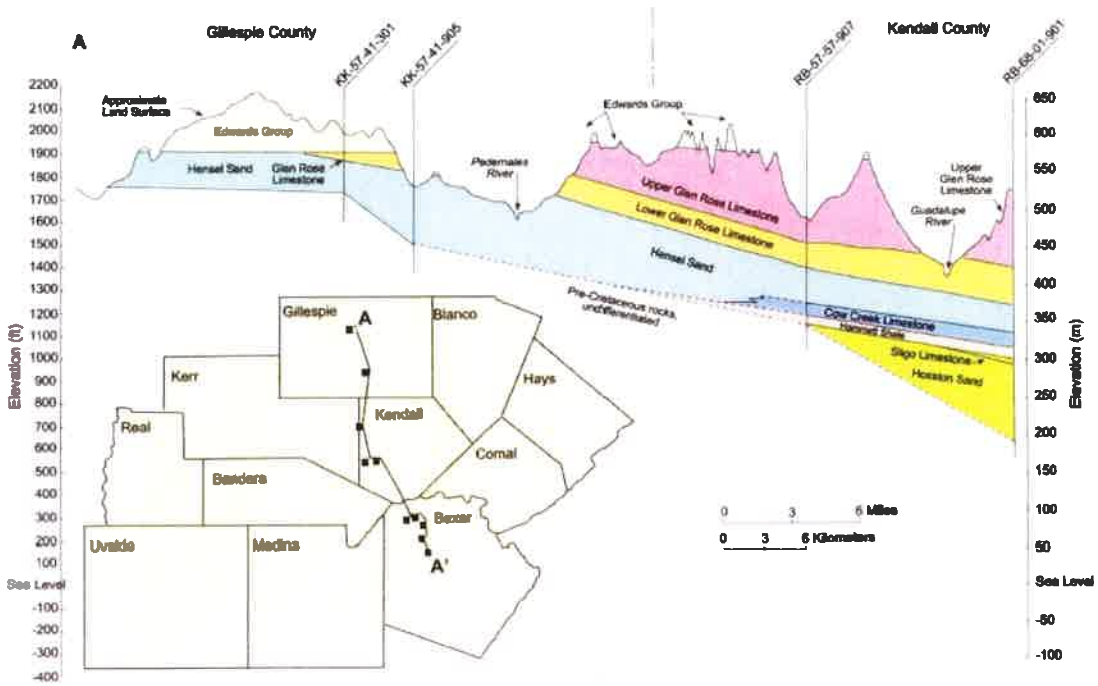
The GMA may establish different desired future conditions for each aquifer, subdivision of an aquifer, or geologic strata located in whole or in part within the boundaries of the management area; or each geographic area overlying an aquifer in whole or in part or subdivision of an aquifer within the boundaries of the management area. The Texas Water Development Board will calculate the Modeled Available Groundwater (MAG) from the adopted Desired Future Conditions (DFC) of the management area.

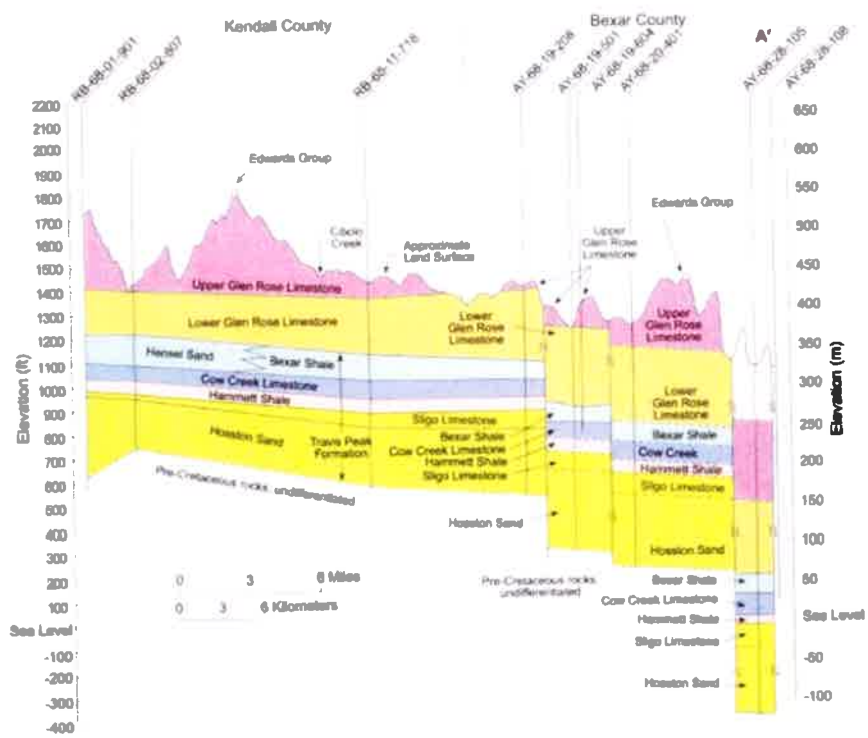
Map of Groundwater Management Area 9:



Source: TWDB GMA9 website:
http://www.twdb.texas.gov/mapping/doc/maps/gma/GMA_9_8x11.pdf?d=4205.130000016652

Stratigraphic cross-sections of the Hill Country Area:

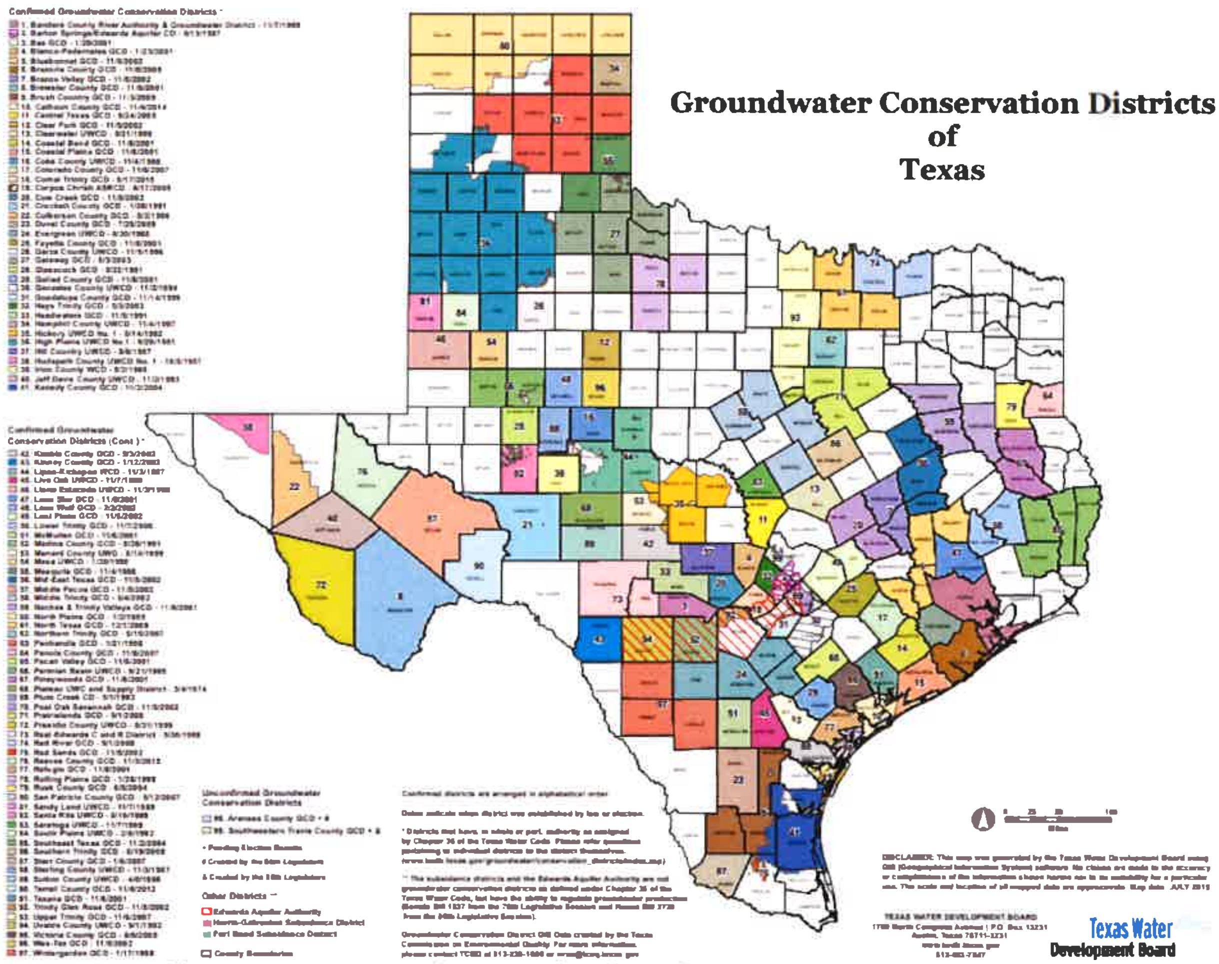




Source: modified from Ashworth, 1983; Mace and others, 2000

GENERAL DESCRIPTION OF THE DISTRICT

The Cow Creek Groundwater Conservation District includes all of Kendall County and encompasses roughly 663 square miles (424,320 acres), excluding the incorporated area of the City of Fair Oaks Ranch. The CCGCD was created in accordance with Chapter 36, HB 3544 and SB 2 of the 77th Legislature. On November 5, 2002, Kendall County voters approved the creation of the District and elected five Directors to govern the District. The District is currently funded through ad valorem property taxes and fees. The District's authority and duties are derived primarily from Chapter 36 of the Texas Water Code, Vernon's Texas Civil Statues.



Source: http://www.twdb.texas.gov/mapping/doc/maps/GCDs_8x11.pdf?d=3021.3100000983104

The current District Board of Directors is comprised of:

Board President Milan J. Michalec, Director District 2;
Vice President Bob Webster, Director District 1;
Treasurer Curt Campbell, Director District 4;
Secretary Alan Bloxsom, Director At Large;
Assistant Secretary/Treasurer, Benjamin Eldredge, Director District 3.
The District General Manager is Micah Voulgaris.

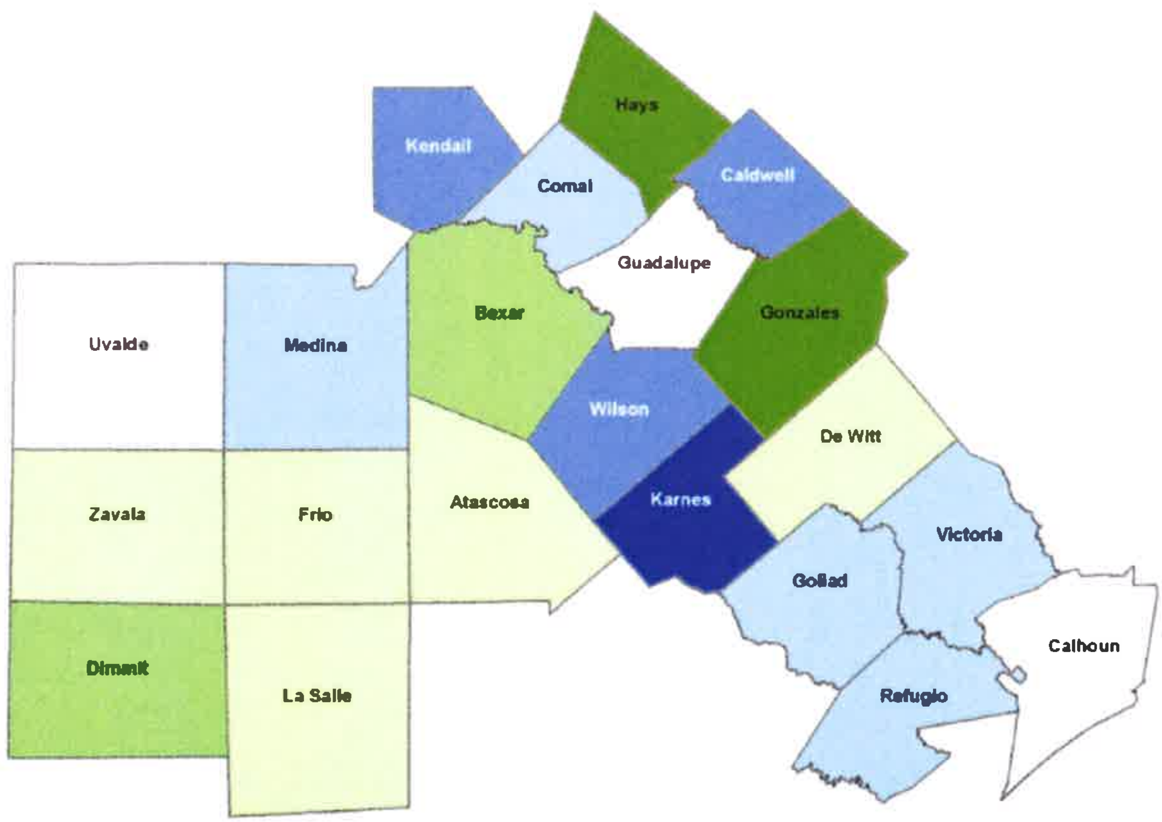
The District's current economy is best characterized as a service oriented, bedroom community tied closely to San Antonio, the Interstate 10 corridor, and to a lesser extent, U.S. 281 and Interstate 35 corridors. Originally considered an area relying primarily on an agricultural-based economy, the District still retains that same rural flavor, but may be even better known for its shopping, antique stores, restaurants, small industries, and tourist facilities. Wildlife hunting, some fishing, and other outdoor activities also contribute significantly to the local economy. Tourists visiting nearby State Parks and other attractions also contribute revenues to the local economy.

Over the past few decades, Kendall County and other Hill Country counties in close proximity to the cities of Austin or San Antonio have seen rapid growth in population due to subdivision of large tracts of land into smaller acreage.

The City of Boerne and the townships of Comfort, Sisterdale, Waring, Bergheim, Kendalia, and Welfare are located in the District.

The District lies primarily within the Guadalupe River basin and for statewide water planning purposes is part of the 21 county South Central Texas Regional Water Planning Group (Region L).

Map of Region L:



Source: http://www.regionltexas.org/

Drainage and Topography

Source: http://www.twdb.texas.gov/surfacewater/rivers/river_basins/index.asp

The topography of the District is predominantly rough and hilly. The primary geologic feature in the area, the Edwards Plateau, is dominated by stream-dissected hills grading into rolling terrain and shallow valleys. This is an elevated structure made up of Cretaceous age limestone, dolomite and marl. The Edwards Plateau extends westward from the Balcones Fault Zone and covers many West Texas counties. The District lies near the southeastern edge of the Plateau. Elevation within the District ranges from a low of approximately 1,000 feet above sea level where Curry Creek leaves southeastern Kendall County to approximately 2,081 feet above sea level in the northwestern part of the District.

WATER RESOURCES WITHIN THE COW CREEK GROUNDWATER CONSERVATION DISTRICT

Groundwater Resources and Usage in the Cow Creek GCD

Estimated groundwater usage in Cow Creek GCD between 2013 and 2017 has been compiled by the TWDB.

The TWDB Estimated Historical Groundwater Use Values for Kendall County/CCGCD are included in the Appendix as Table A.

Within the CCGCD there are two primary aquifers, the Trinity and the Edwards Group of the Edwards-Trinity (Plateau) Aquifer, which provide groundwater to county residents. Well depths vary from shallow, hand-dug wells 20-30 feet deep to drilled wells that are up to 1,200 feet deep. Depths are highly variable even within the same aquifer and depend entirely on site-specific topography and geology. Water quality and water quantity also vary greatly throughout the District. Water quality within a specific aquifer can often be defined or characterized in a general sense, but can still be affected by local geology and hydrology. The District will consider new data as it becomes available and will amend this plan as appropriate.

Modeled Available Groundwater (Based on Desired Future Conditions)

Groundwater Management Area 9 has adopted Desired Future Conditions for the Aquifers located within the planning area. Current groundwater availability for the CCGCD has been estimated by the TWDB using GAM Run 16-023 MAG (**included in the appendix**). The time period over which the MAG would apply is for each decade from the year 2010 to 2070. The Modeled Available Groundwater (MAG) for the Trinity Aquifer is 10,622 acre-feet per year. The MAG for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer is 199 acre-feet per year. The MAG for the Ellenburger-San Saba Aquifer is 75 acre-feet per year and the MAG for the Hickory is 140 acre-feet per year.

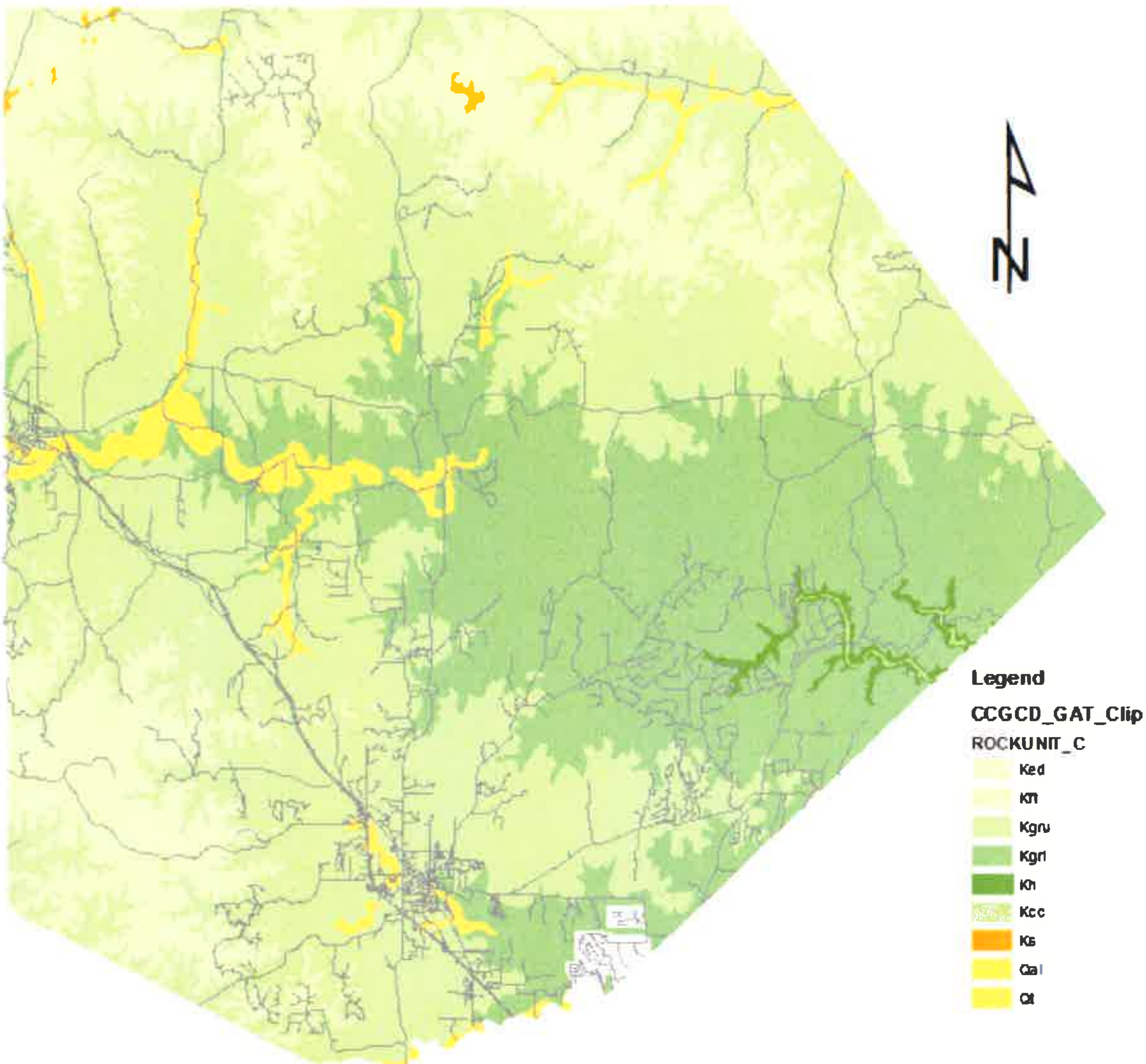
Aquifer Descriptions

The Trinity Aquifer in the District is comprised primarily of the Upper Glen Rose (Upper Trinity), Lower Glen Rose Limestone, Hensell Sand, and the Cow Creek Limestone (Middle Trinity), and to a lesser extent, the Hosston and Sligo formations (Lower Trinity). It extends across the majority of the District. The Trinity Aquifer is recharged primarily from local precipitation on its outcrop and through fracturing and porosity in the overlying units where the Trinity is in the subsurface. Most recharge originates from outside of the District and flows down gradient into and through the District. Well yields vary greatly and are highly dependent on local subsurface hydro-geological characteristics. Yields are generally low, less than 20 gpm, but can occasionally be higher, with yields of 200-275 gpm being reported. Production from Trinity wells is primarily used for municipal, rural domestic, and livestock demands. A small amount of irrigation occurs for golf courses, nurseries, vegetables, hay crops, peaches, pecans, grapes and grains.

The Edwards Group of the Edwards-Trinity (Plateau) Aquifer within the District is located at higher elevations along ridges in the northern and southwestern portions of the county. It is comprised of relatively thin layers of limestone and dolomite that is an extension of the Edwards Plateau into the District from the west. In general, yields from the aquifer are low (less than 20 gpm) and the water is used occasionally for rural domestic and livestock demands. The Edwards Group of the Edwards-Trinity (Plateau) Aquifer in the District exists in an unconfined condition. Recharge is solely from local precipitation occurring over the outcrop. Water not pumped from wells will generally discharge from small seeps and springs at the base of the Edwards outcrop and provides some base flow to small streams within the county.

Several minor aquifers occur in the District. These include alluvial aquifers, the Ellenburger, the Hickory, and the Marble Falls aquifers.

Geologic Map of the District:



Surface Water Resources and Usage in CCGCD

Groundwater supplies in the District are augmented by several other water sources. The City of Boerne has a firm supply of 645 acre feet per year of surface water from Boerne Lake and 3,611 acre feet per year of surface water from Canyon Lake (GBRA). Rural water systems (Kendall West Utility, Cordillera Ranch, and Miralomas MUD) supplies have a total of 2,488 acre feet per year of surface water from Canyon Lake (GBRA). Irrigation and livestock make up the additional surface water supplies (7,552 acre feet). Other adjudicated surface water withdrawals total approximately 3,417 acre feet per year (Guadalupe River, other surface water streams, and reservoirs).

In summary, annual surface water availability in the District totals approximately 7,522 acre feet per year in 2020 increasing to 7,907 acre feet per year in 2070. This is based on contracted amounts of surface water from GBRA and Boerne Lake. Total County Supply in Table 3 does not include the adjudicated surface water withdrawals (approximately 3,417 acre feet per year).

Projected Total Water Supply in CCGCD

As shown in the Table 1 below, the projected total water supply in the Cow Creek GCD currently stands at about 18,174 acre feet per year and is expected to increase to 18,529 acre feet per year in 2060 due to the increase in GBRA surface water (which includes all sources except adjudicated surface water withdrawals). The District's projected estimates of surface water supplies are based on actual contracted amounts between the water providers and the GBRA. The most recently adopted state water plan projected surface water supply is included as Table B in the appendix.

TABLE 1
District's projected total supply in acre feet per year

	2020	2030	2040	2050	2060	2070
Available **Groundwater**	10,622	10,622	10,622	10,622	10,622	10,622
Projected Available **Surface Water**	7,552	7,657	7,742	7,807	7,862	7,907
Other adjudicated surface water rights	3,417	3,417	3,417	3,417	3,417	3,417
Total (excluding Run of the River)	18,174	18,279	18,364	18,429	18,484	18,529

Source: CCGCD

Based on the District's estimated projected supply from Table 1 and the estimated demands from Table 4, the District has compiled Table 2 to illustrate projected surpluses and shortages.

TABLE 2
Projected Supply, Demand, and Surplus/Shortage in acre feet per year

	2020	2030	2040	2050	2060	2070
Total County Supply (all sources)	18,174	18,279	18,364	18,429	18,484	18,529
Total Demand (all sources)	**7,520**	**9,080**	**10,748**	**12,404**	**14,176**	**15,923**
Surplus/Shortage	10,654	9,199	7,616	6,025	4,308	2,606

Source: CCGCD

The Texas Water Development Board (TWDB) defines available water as "the maximum amount of water available during the drought of record, regardless of whether the supply is physically or legally available."

The existing water supply is defined by the TWDB as the "maximum amount of water available from existing sources for use during drought of record conditions that is physically and legally available for use."

The District has reviewed the 2017 Texas State Water Plan Projected Water Supply Needs table (Table D in the appendix) and can see that a shortfall is anticipated to exist for Boerne of 650 acre-feet in 2050, 1,639 acre-feet in 2060, and 2,613 acre-feet in 2070.

The District has also reviewed the 2017 Texas State Water Plan Projected Water Management Strategies table (Table E in the appendix) and understands that municipal water conservation, Trinity Aquifer development, and Canyon Lake expansion are listed as potential strategies to meet future water needs.

Projected Population and Water Demands in CCGCD

Population projections for the District were derived from the Region L Plan.

TABLE 3
CCGCD Population Summary

KENDALL COUNTY COLORADO BASIN	2020	2030	2040	2050	2060	2070
COUNTY-OTHER	329	406	489	571	655	736
COLORADO BASIN TOTAL POPULATION	**329**	**406**	**489**	**571**	**655**	**736**
GUADALUPE BASIN						
KENDALL COUNTY WCID #1	3,190	3,750	4,341	4,927	5,525	6,112
COUNTY-OTHER	13,000	16,289	19,764	23,208	26,724	30,175
GUADALUPE BASIN TOTAL POPULATION	**16,190**	**20,039**	**24,105**	**28,135**	**32,249**	**36,287**
SAN ANTONIO BASIN						
BOERNE	14,367	18,820	23,524	28,187	32,947	37,619
FAIR OAKS RANCH	2,482	3,431	4,318	4,965	5,898	6,814
WATER SERVICES INC	280	346	417	487	558	628
COUNTY-OTHER	8,537	9,171	9,954	10,963	11,721	12,465
SAN ANTONIO BASIN TOTAL POPULATION	**25,666**	**31,768**	**38,213**	**44,602**	**51,124**	**57,526**
KENDALL COUNTY TOTAL POPULATION	**42,185**	**52,213**	**62,807**	**73,308**	**84,028**	**94,549**

Source: Region L 2016 Water Plan

Table 4 illustrates the estimated water demands through 2070. The most recently adopted state water plan projected total demand for water is included as Table C in the appendix.

TABLE 4

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.

KENDALL COUNTY *99.51% (multiplier)* All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
L	BOERNE	SAN ANTONIO	3,091	3,985	4,942	5,900	6,889	7,863
L	COUNTY-OTHER, KENDALL	COLORADO	41	48	57	66	75	85
L	COUNTY-OTHER, KENDALL	GUADALUPE	1,579	1,916	2,278	2,649	3,043	3,433
L	COUNTY-OTHER, KENDALL	SAN ANTONIO	1,037	1,079	1,147	1,251	1,334	1,417
L	FAIR OAKS RANCH	SAN ANTONIO	656	898	1,125	1,290	1,531	1,768
L	IRRIGATION, KENDALL	GUADALUPE	304	298	291	286	281	275
L	IRRIGATION, KENDALL	SAN ANTONIO	70	68	67	65	64	63
L	KENDALL COUNTY WCID #1	GUADALUPE	303	341	384	430	481	531
L	LIVESTOCK, KENDALL	COLORADO	13	13	13	13	13	13
L	LIVESTOCK, KENDALL	GUADALUPE	314	314	314	314	314	314
L	LIVESTOCK, KENDALL	SAN ANTONIO	66	66	66	66	66	66
L	WATER SERVICES INC	SAN ANTONIO	46	54	64	74	85	95
		Sum of Projected Water Demands (acre-feet)	**7,520**	**9,080**	**10,748**	**12,404**	**14,176**	**15,923**

Growth Patterns and Groundwater Impacts in CCGCD

Between 2020 and 2070, total District-wide water demand is estimated to increase from 7,520 acre feet per year in 2020 to 15,923 acre feet per year in 2060 (Table 4). The estimated amount of groundwater currently available within the District is approximately 10,622 acft/yr per year.

In the absence of new surface water sources, groundwater may have to be completely allocated to partially meet increased demands and water shortages that will occur in the District sometime between 2040 and 2060. As the demand increases, aquifers with areas of low production capability will probably experience a stressed condition sooner than anticipated and may not be able to meet higher demands. This may be particularly true in those areas where development is more intense. The most recently adopted state water plan water supply needs are included as Table E in the appendix. The State Water Plan also addresses Projected Water Management Strategies adopted by Region L. These strategies are included as Table F in the appendix.

Much of the growth now occurring in the District is focused on the southern end of the District. This area is served primarily by private water wells producing from various stratigraphic units of the Trinity Aquifer. This aquifer is known for low yield wells and water quality concerns involving hardness and other factors. TWDB Priority Groundwater Management Area studies and the Trinity GAM indicate that with continued growth, this particular aquifer will be over extended to the point where quantity and quality problems are likely.

The Edwards Group of the Edwards-Trinity (Plateau) Aquifer is located in areas that are expected to slowly undergo development. The Edwards Group of the Edwards-Trinity (Plateau) Aquifer will be unlikely to provide enough water to support extensive growth. Therefore, any growth that does occur during the 50 year planning horizon will more than likely have to rely on some other water source such as the Trinity, and may have to take in consideration the associated water quantity or quality problems.

Recharge of Groundwater in CCGCD

The annual natural recharge occurring in the Cow Creek GCD is thought to be primarily through percolation of rainfall. More localized recharge, along with potentially higher rates of recharge, is probably occurring in the beds of rivers, creeks, and tributaries, particularly if associated with cave entrances or fracture zones. Recharge also occurs from flow through fracturing and porosity in the overlying units where the Trinity is in the subsurface. Most recharge originates from areas outside of the District and flows into and through the District. The District is aware of several significant recharge features in the area that are providing a major avenue for recharge.

Initial studies of the Trinity Aquifer calculated an annual recharge coefficient of approximately 4% of annual rainfall. This was documented in the September 2000 TWDB report on "Groundwater Availability of the Trinity Aquifer, Hill Country Area, and Texas: Numerical simulations through 2050" by Robert E. Mace, et. al. John Ashworth also developed a similar annual effective recharge coefficient (also 4% of average annual rainfall…about 30 inches) for the Trinity Aquifer in the Texas Department of Water Resources Report 273, Ground-Water Availability of the Lower Cretaceous Formations in the Hill Country of South-Central Texas, January 1983. A subsequent 2008 study, funded by the District, indicated more realistic recharge rates to range between 6% and 9% for the Guadalupe River Basin portion of the District. This was documented in Wet Rock Groundwater Services report "An Evaluation of the Trinity Aquifer Within Kendall County and Analysis of the Trinity (Hill Country) GAM", June 25, 2008, Kaveh Khorzad.

GAM RUN 19-011 (included in the appendix) provides a flow budget and recharge variables for the District based on version 2.01 of the GAM for the Hill Country portion of the Trinity Aquifer and the Edwards-Trinity (Plateau) Aquifer (TWDB 2011). Information for the Ellenburger-San Saba and Hickory aquifers is from version 1.01 of the groundwater availability model for the minor aquifers of the Llano Uplift region (TWDB 2016).

The groundwater availability model includes some portions of the Edwards Group outside the official boundary of the Edwards-Trinity (Plateau) Aquifer. Though flow for these areas is not explicitly reported, the interaction between the Edwards Group (outside the Edwards-Trinity Plateau Aquifer) and the underlying Trinity Aquifer is shown in the model.

These recharge potentials are not to be confused with "recoverable" groundwater. Not all groundwater is recoverable. Some contributes to spring flow and seeps, some is used by plant life while the water is still near the surface, while some is almost permanently retained within the rock itself. For instance, much of the Trinity is a rather "tight" formation, particularly in the vertical direction. The Trinity is known for its low porosity and permeability, limited fracturing and faulting, and a complicated stratigraphy that includes layers of rock that reduce transmissivity and retard downward-moving recharge water. As a result, individual well yields are often quite low and, though large quantities of water may be present in the subsurface in specific local sites and in certain wells, much of the groundwater in the Cow Creek GCD as a whole may be unrecoverable due to local hydrogeological conditions.

Whereas, significant recharge occurs within the District for the Edwards Trinity (Plateau) and the Upper and Lower Glen Rose, formations underlying these are predominantly recharged from outside the District's Boundary.

As previously mentioned, considerable amounts of water that could potentially recharge the Trinity Aquifer will be utilized through biological processes and a significant amount discharged at springs and seeps that provide relatively reliable base flow to local rivers and tributaries. Thus, much of the annual recharge may enter the ground, only to leave it again as base flow to surface streams. This is water that the aquifer rejects on an average annual basis and is potentially available and can theoretically be retrieved (at least on a short-term basis) without diminishing the average volume of groundwater being recharged to storage or, in other words, without creating a mining situation within the aquifer. However, if extensive pumping of this available water occurs, then base flow to area springs and streams will be greatly reduced and the effects of this reduction may be undesirable. Extensive pumping will also reduce the pressure head and may result in a significantly smaller quantity of recharge water actually percolating downward through the complex geology before providing deeper aquifer recharge that would be available for more reliable, long-term well production. Once pumping exceeds average annual recharge, then an aquifer mining condition will clearly exist and groundwater availability will decline.

Recharge Enhancement Potential

The District has yet to assess potential recharge projects in the area. The District may solicit ideas and information and may investigate any potential recharge enhancement opportunities, natural or artificial, that are brought to the District's attention. Such projects may include, but are not limited to: cleanup or site protection projects at any identified significant recharge feature, encouragement of prudent brush control/water enhancement projects, non-point source pollution mitigation projects, aquifer storage and recovery projects, development of recharge ponds or small reservoirs, and the encouragement of appropriate and practical erosion and sedimentation control at construction projects located near surface streams.

GROUNDWATER MANAGEMENT POLICIES
(Actions, Procedures, Performance and Avoidance for Plan Implementation)

The District will manage the supply of groundwater within the District based on the District's best available data and its assessment of water availability and groundwater storage conditions. The Groundwater Availability Model (including subsequent runs) and the Modeled Available Groundwater developed by the TWDB for the Trinity Aquifer will also aid in the decision making process of the District.

The District has adopted Rules that require the permitting of wells and groundwater production limits for non-exempt wells within the District consistent with this Groundwater Management Plan, the provisions of Chapter 36.113 and other pertinent sections of Chapter 36.

The District is in agreement with the commonly accepted groundwater management principle that opposes the mining of groundwater. Therefore, it shall be the policy of the District to limit withdrawal of groundwater from all current and future wells producing from the District's aquifers to no more than the current existing supply. Development or analysis of new or existing groundwater or aquifer data (MAG revisions) may result in changes to the groundwater availability volumes, with a corresponding change in production limits from the affected aquifers. It may also necessitate an increase in well spacing.

The District has adopted Rules that regulate the spacing of wells and the production of groundwater consistent with the provisions Chapter 36.116. The District wishes to emphasize that in regulating or limiting groundwater production, it shall be the policy of the District to preserve historic use to the greatest extent practical and consistent with this plan. A copy of the District's Rules are available at: http://www.ccgcd.org/rules.

The District will implement and utilize the provisions of this groundwater management plan as a guidepost for determining the direction or priority for all District activities. All operations of the District, all agreements entered into by the District, and any additional planning efforts in which the District may participate will be consistent with the provisions of this plan. The District's current and future Rules will be promulgated pursuant to the provisions of Texas Water Code Chapter 36 shall be based on the best technical evidence available, and will address, implement, and be consistent with the provisions and policies of this plan.

The District shall review and re-adopt this plan, with or without revisions, at least once every five years in accordance with Chapter 36.1072(e). Any amendment to this plan shall be in accordance with Chapter 36.1073.

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

The District will seek cooperation and coordination in the development and implementation of this plan, management of groundwater resources, and appropriate District activities with the appropriate state, regional and local water management or planning entities.

The District will encourage cooperative and voluntary Rule compliance, but if Rule enforcement becomes necessary, the enforcement will be legal, fair, and impartial. The promulgation and enforcement of the Rules will be based on the best technical evidence available.

METHODOLOGY FOR TRACKING PROGRESS IN ACHIEVING MANAGEMENT GOALS

The District will use the following methodology to track its progress toward achieving its management goals:

The District General Manager, District Board President, or a Contracting Consultant will present an annual report to the District's Board of Directors on District performance and progress in achieving management goals and objectives at the November Regular Meeting.

GROUNDWATER MANAGEMENT GOALS

1.0 Provide for the most efficient use of groundwater.

1.1 Management Objective

Implement and maintain a program of issuing well operating permits for non-exempt wells within the District.

Performance Standard(s)

Ongoing program of issuance or re-issuance of one or more well operating permits each year. The number of well operating permit applications and the number of permits issued will be included in the annual report to the District Board of Directors.

1.2 Management Objective

Ongoing program of collecting and maintaining actual meter readings from permitted non-exempt wells within the District.

Performance Standard(s)

Annual report submitted to the District Board outlining the previous year's water use from at least 25% of the District's permitted non-exempt wells.

1.3 Management Objective

Implement and maintain a program of issuing registrations for exempt domestic and livestock wells within the District.

Performance Standard(s)

Annual report submitted to the District Board outlining the previous year's registration program.

1.4 Management Objective

The District will evaluate the effectiveness of current well spacing requirements in District Rules to help reduce or prevent interference between nearby wells. Spacing requirements will be coordinated to the greatest extent possible with Kendall County subdivision regulations and the Water Well Drillers Rules (16 Texas Administrative Code Chapter 76).

Performance Standards

Annual report submitted to the District Board regarding suitability of current District well spacing rules and their compatibility with Kendall County subdivision regulations and the Water Well Drillers Rules.

2.0 Control and prevent waste of groundwater.

2.1 Management Objective

Each year the District will provide to local media articles describing groundwater waste prevention practices available for implementation by groundwater users.

Performance Standard(s)

Each year provide at least one article to the local media related to groundwater waste prevention practices.

2.2 Management Objective

Provide to the public water efficient literature handouts.

Performance Standard(s)

Each year provide water efficient literature handouts at a public event on at least one occasion. The District will also maintain a supply of water efficient literature at the office.

2.3 Management Objective

Have District personel available to speak at a local club or organization or a display booth at public events.

Performance Standard(s)

Each year the District will provide a speaker at a local club or organization or a display booth at public events a minimum of twice a year.

3.0 Control and prevent subsidence.

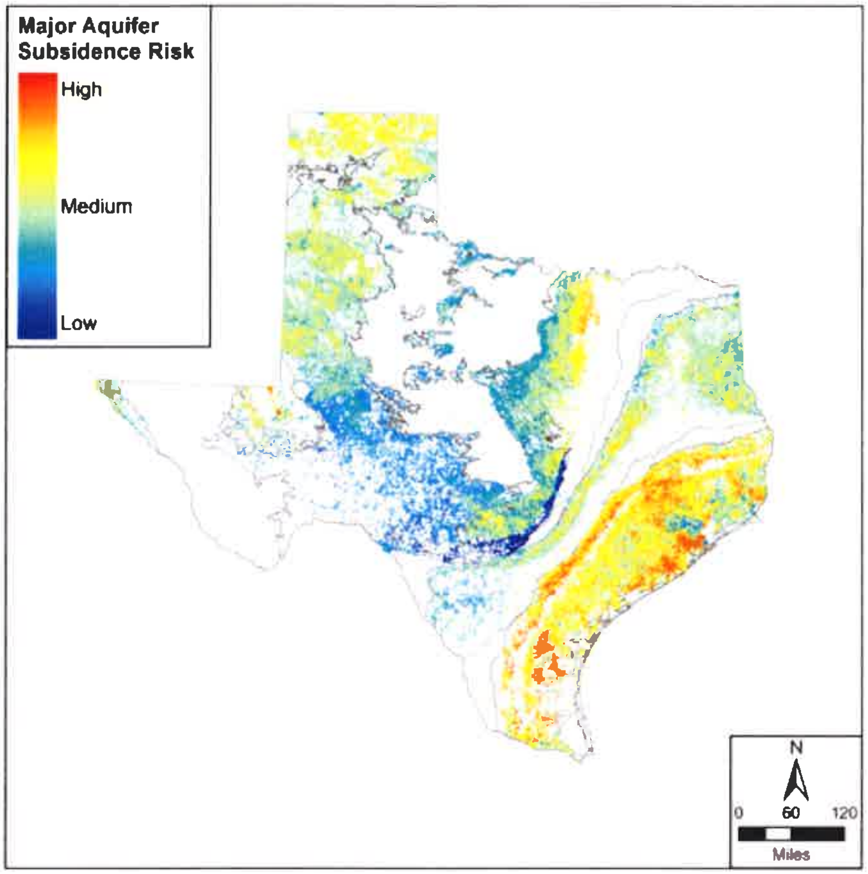
3.1 Management Objective

Controlling and preventing subsidence will be addressed during the review and processing of all new, renewed, and amended permit applications on a continual basis.

Performance Standard

If review results demonstrate potential subsidence, the District will implement actions ranging from reducing requested permitted pumping to including permit conditions imposing subsidence monitoring requirements and establishment of threshold limits that could result in reduced production based on monitoring results.

Figure 1 on page 1.7 (Map on following page) of the subsidence report shows that the District has a medium level of major aquifer subsidence risk. Going forward the District will monitor for any evidence of subsidence in areas of heavy pumping of groundwater.



Source: *Identification of the Vulnerability of the Major and Minor Aquifers of Texas to Subsidence with Regard to Groundwater Pumping* – TWDB Contract Number 1648302062, by LRE Water: http://www.twdb.texas.gov/groundwater/models/research/subsidence/subsidence.asp

4.0 Address conjunctive surface water management issues.

4.1 Management Objective

Meet with Kendall County, City of Boerne and Retail Water Utility Officials regarding water availability reports, City/County development requirements, and District Rules.

Performance Standard(s)

Meet with Kendall County, City of Boerne and Retail Water Utility Officials regarding water availability reports, City/County development requirements, and District Rules at least once a year and submit a comparative analysis of the Rules and requirements.

4.2 Management Objective

Maintain ongoing studies regarding correlations between spring flow, surface stream elevations/flows, rainfall, and groundwater levels.

Performance Standard(s)

An annual report submitted to the District Board will include a review of the ongoing studies and the number of "Aquifer Watch" reports submitted to local media.

4.3 Management Objective

Meet with the local entities responsible for surface water management.

Performance Standard(s)

Meet with the Guadalupe Blanco River Authority and appropriate local entities responsible for surface water management at least once a year.

5.0 Address natural resource issues which impact the use and availability of groundwater, or which are impacted by the use of groundwater.

5.1 Management Objective

Maintain an ongoing spring flow monitoring program in the District.

Performance Standard(s)

The District will take at least one annual flow rate measurement from a spring in the District and report the measurements to the Board in an annual report.

5.2 Management Objective

The District will maintain a database cataloging recharge features in the District.

Performance Standard(s)

A summary of the database will be included in the annual report to the District Board of Directors.

6.0 Address drought conditions.

6.1 Management Objective

Review the District's monitor well data, the Palmer Drought Severity Index, stream flow and rainfall data to determine status of drought condition and, if necessary, report to District Board on need to implement drought contingency plan.

Performance Standards(s)

The District Board will conduct a review of the current drought stage status on a monthly basis. A copy of the review will be included in the annual report to the District Board of Directors.

6.2 Management Objective

Provide to the public drought-orientated literature handouts.

Performance Standards(s)

Each year provide drought-oriented literature handouts on at least one occasion. The District will also maintain a supply of drought-oriented literature at the office. https://www.waterdatafortexas.org/drought/

6.3 Management Objective

To evaluate groundwater availability the District will monitor water levels on selected wells representative of the Edwards Trinity (Plateau) and Trinity aquifers within the District in accordance with the water level monitoring schedule in Table 5. Of the 41 monitor wells the District currently checks, eleven of those are remotely monitored and reported digitally to the TWDB.

Table 5

Water Level Monitoring Schedule

Aquifer	# of Wells	Minimum Frequencies
Edwards Trinity	1	1 time per month
Upper Trinity	1	1 time per month
Middle Trinity	25	1 time per month
Lower Trinity	3	1 time per month

Performance Standard(s)

The District will take a minimum of 250 well readings annually and report the findings to the District Board.

7.0 Address:

Conservation

7.1 <u>Management Objective</u>

Each year the District will provide to local media articles identifying the importance of groundwater conservation and various groundwater conservation methods available for implementation by groundwater users.

<u>Performance Standards(s)</u>

Each year provide at least one article to the local media related to the importance of groundwater conservation and various groundwater conservation methods available for implementation by groundwater users.

7.2 <u>Management Objective</u>

Provide to the public water conservation literature handouts.

<u>Performance Standards(s)</u>

Each year provide water conservation literature handouts at a public event on at least one occasion and will maintain a supply which will be available at the District Office.

Recharge Enhancement

7.3 <u>Management Objective</u>

The District will investigate potential recharge enhancement sites either natural or artificial.

<u>Performance Standard(s)</u>

Annually, the General Manager will include a report to the District's Board on the District's findings related to recharge enhancement.

7.4 <u>Management Objective</u>

The District will investigate, identify, and catalog existing recharge features and adopt best management practices to protect these features.

<u>Performance Standard(s)</u>

Annually, the District will conduct a review of the policies related to the identification of and best management strategies for existing recharge features. A copy of the review will be included in the annual report to the District Board of Directors.

Rainwater Harvesting

7.5 Management Objective

The District will encourage rainwater harvesting and provide to the public literature related to rainwater harvesting and support demonstration sites within the District.

Performance Standard(s)

Annually, the District will provide rainwater harvesting literature at a public event on at least one occasion and the General Manager will include a report to the District's Board on the demonstration sites.

Precipitation Enhancement

7.6 Not applicable to include since this objective is not cost effective at this time.

Brush Control

7.7 Management Objective

The District will encourage brush control and Best Management Practices related to the same where appropriate.

Performance Standard(s)

Annually, the District will conduct a review of the policies adopted by the District Board related to brush control practices and/or the progression of brush control within the District. A copy of the review will be included in the annual report to the District Board of Directors. If it is found from review that no policies that relate to brush control practices were adopted by the District Board of Directors during the previous year, then a statement of such will be included in the annual report to the District Board of Directors.

8.0 Addressing Desired Future Conditions

8.1 Management Objective

The District will monitor the static water level in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer to track the achievement of the adopted DFC.

Performance Standard(s)

The District will monitor the static water level in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer on a bi-monthly basis. The data will be presented to the District Board of Directors in an annual report.

8.2 Management Objective

The District will monitor the static water level in the Trinity Aquifer to track the achievement of the adopted DFC.

Performance Standard(s)

The District will monitor the static water level in the Trinity Aquifer on a bi-monthly basis. The data will be presented to the District Board of Directors in an annual report.

8.3 Management Objective

Upon completion of any well in the Ellenburger-San Saba Aquifer the District will monitor the static water level in the Ellenburger-San Saba Aquifer to track the achievement of the adopted DFC.

Performance Standard(s)

Upon completion of a well in the Ellenburger-San Saba Aquifer the District will monitor the static water level in the Ellenburger-San Saba Aquifer on a bi-monthly basis. The data will be presented to the District Board of Directors in an annual report.

8.4 Management Objective

Upon completion of any well in the Hickory Aquifer the District will monitor the static water level in the Hickory Aquifer to track the achievement of the adopted DFC.

Performance Standard(s)

Upon completion of a well in the Ellenburger-San Saba Aquifer the District will monitor the static water level in the Ellenburger-San Saba Aquifer on a bi-monthly basis. The data will be presented to the District Board of Directors in an annual report.

Appendix

TABLE A

Historical Groundwater Use Values TWDB - Water Use Survey

KENDALL COUNTY *99.51% (multiplier)* All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2016	GW	3,680	3	0	0	180	307	4,170
	SW	2,358	0	0	0	190	55	2,603
2015	GW	3,301	2	0	0	249	306	3,858
	SW	2,228	0	0	0	86	54	2,368
2014	GW	3,361	1	0	0	210	300	3,872
	SW	2,306	0	0	0	42	54	2,402
2013	GW	3,529	1	0	0	475	308	4,313
	SW	2,323	0	0	0	75	55	2,453
2012	GW	3,758	1	0	0	572	259	4,590
	SW	2,093	0	0	0	67	47	2,207
2011	GW	4,103	0	0	0	820	408	5,331
	SW	2,010	0	0	0	65	72	2,147
2010	GW	3,466	0	0	0	540	396	4,402
	SW	1,684	0	0	0	150	70	1,904
2009	GW	2,975	0	0	0	732	329	4,036
	SW	1,646	0	0	0	166	58	1,870
2008	GW	3,174	0	0	0	12	299	3,485
	SW	1,590	0	0	0	175	53	1,818
2007	GW	2,764	0	0	0	113	347	3,224
	SW	1,354	0	0	0	0	61	1,415
2006	GW	3,473	0	0	0	137	364	3,974
	SW	1,251	0	0	0	0	64	1,315
2005	GW	3,817	0	0	0	134	335	4,286
	SW	788	0	0	0	0	59	847
2004	GW	3,149	0	0	0	115	170	3,434
	SW	679	0	0	0	104	157	940
2003	GW	3,050	0	0	0	130	164	3,344
	SW	629	0	0	0	356	151	1,136
2002	GW	3,119	0	0	0	722	201	4,042
	SW	468	0	0	0	281	185	934
2001	GW	3,438	0	0	0	722	230	4,390
	SW	60	0	0	0	281	211	552

TABLE B

Projected Surface Water Supplies
TWDB 2017 State Water Plan Data

KENDALL COUNTY *99.51% (multiplier)* All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
L	BOERNE	SAN ANTONIO	BOERNE LAKE/RESERVOIR	645	645	645	645	645	645
L	BOERNE	SAN ANTONIO	CANYON LAKE/RESERVOIR	3,611	3,611	3,611	3,611	3,611	3,611
L	COUNTY-OTHER, KENDALL	GUADALUPE	CANYON LAKE/RESERVOIR	2,488	2,488	2,488	2,488	2,488	2,488
L	FAIR OAKS RANCH	SAN ANTONIO	CANYON LAKE/RESERVOIR	585	690	775	840	895	940
L	IRRIGATION, KENDALL	GUADALUPE	GUADALUPE RUN-OF-RIVER	26	26	26	26	26	26
L	LIVESTOCK, KENDALL	COLORADO	COLORADO LIVESTOCK LOCAL SUPPLY	6	6	6	6	6	6
L	LIVESTOCK, KENDALL	GUADALUPE	GUADALUPE LIVESTOCK LOCAL SUPPLY	158	158	158	158	158	158
L	LIVESTOCK, KENDALL	SAN ANTONIO	SAN ANTONIO LIVESTOCK LOCAL SUPPLY	33	33	33	33	33	33
	Sum of Projected Surface Water Supplies (acre-feet)			**7,552**	**7,657**	**7,742**	**7,807**	**7,862**	**7,907**

TABLE C

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.

KENDALL COUNTY *99.51% (multiplier)* All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
L	BOERNE	SAN ANTONIO	3,091	3,985	4,942	5,900	6,889	7,863
L	COUNTY-OTHER, KENDALL	COLORADO	41	48	57	66	75	85
L	COUNTY-OTHER, KENDALL	GUADALUPE	1,579	1,916	2,278	2,649	3,043	3,433
L	COUNTY-OTHER, KENDALL	SAN ANTONIO	1,037	1,079	1,147	1,251	1,334	1,417
L	FAIR OAKS RANCH	SAN ANTONIO	656	898	1,125	1,290	1,531	1,768
L	IRRIGATION, KENDALL	GUADALUPE	304	298	291	286	281	275
L	IRRIGATION, KENDALL	SAN ANTONIO	70	68	67	65	64	63
L	KENDALL COUNTY WCID #1	GUADALUPE	303	341	384	430	481	531
L	LIVESTOCK, KENDALL	COLORADO	13	13	13	13	13	13
L	LIVESTOCK, KENDALL	GUADALUPE	314	314	314	314	314	314
L	LIVESTOCK, KENDALL	SAN ANTONIO	66	66	66	66	66	66
L	WATER SERVICES INC	SAN ANTONIO	46	54	64	74	85	95
		Sum of Projected Water Demands (acre-feet)	**7,520**	**9,080**	**10,748**	**12,404**	**14,176**	**15,923**

TABLE D

Projected Water Supply Needs
TWDB 2017 State Water Plan Data

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

KENDALL COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
L	BOERNE	SAN ANTONIO	2,159	1,265	308	-650	-1,639	-2,613
L	COUNTY-OTHER, KENDALL	COLORADO	47	40	31	22	13	3
L	COUNTY-OTHER, KENDALL	GUADALUPE	2,327	1,989	1,625	1,252	856	464
L	COUNTY-OTHER, KENDALL	SAN ANTONIO	383	341	272	168	84	1
L	FAIR OAKS RANCH	SAN ANTONIO	540	512	459	426	298	153
L	IRRIGATION, KENDALL	GUADALUPE	55	61	68	73	78	84
L	IRRIGATION, KENDALL	SAN ANTONIO	30	32	33	35	36	37
L	KENDALL COUNTY WCID #1	GUADALUPE	472	434	391	345	294	244
L	LIVESTOCK, KENDALL	COLORADO	0	0	0	0	0	0
L	LIVESTOCK, KENDALL	GUADALUPE	0	0	0	0	0	0
L	LIVESTOCK, KENDALL	SAN ANTONIO	0	0	0	0	0	0
L	WATER SERVICES INC	SAN ANTONIO	28	25	23	18	13	8
	Sum of Projected Water Supply Needs (acre-feet)		**0**	**0**	**0**	**-650**	**-1,639**	**-2,613**

TABLE E

Projected Water Management Strategies
TWDB 2017 State Water Plan Data

KENDALL COUNTY

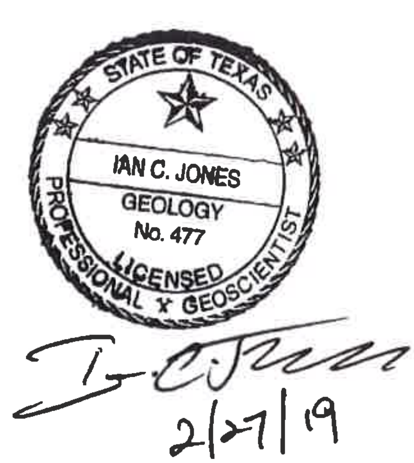
WUG, Basin (RWPG)

All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
BOERNE, SAN ANTONIO (L)							
LOCAL TRINITY AQUIFER DEVELOPMENT	TRINITY AQUIFER [KENDALL]	0	0	0	1,000	1,000	1,000
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [KENDALL]	136	484	985	1,513	1,888	2,294
WESTERN CANYON EXPANSION	CANYON LAKE/RESERVOIR [RESERVOIR]	0	0	0	0	639	1,613
		136	**484**	**985**	**2,513**	**3,527**	**4,907**
COUNTY-OTHER, KENDALL, COLORADO (L)							
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [KENDALL]	0	0	0	0	0	0
		0	**0**	**0**	**0**	**0**	**0**
COUNTY-OTHER, KENDALL, GUADALUPE (L)							
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [KENDALL]	0	0	0	0	0	9
		0	**0**	**0**	**0**	**0**	**9**
COUNTY-OTHER, KENDALL, SAN ANTONIO (L)							
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [KENDALL]	0	0	0	0	0	4
		0	**0**	**0**	**0**	**0**	**4**
FAIR OAKS RANCH, SAN ANTONIO (L)							
MUNICIPAL WATER CONSERVATION (SUBURBAN)	DEMAND REDUCTION [KENDALL]	37	123	243	373	546	715
		37	**123**	**243**	**373**	**546**	**715**
WATER SERVICES INC, SAN ANTONIO (L)							
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [KENDALL]	1	1	2	3	5	8
		1	**1**	**2**	**3**	**5**	**8**
Sum of Projected Water Management Strategies (acre-feet)		**174**	**608**	**1,230**	**2,889**	**4,078**	**5,643**

GAM Run 19-011: Cow Creek Groundwater Conservation District Groundwater Management Plan

Ian C. Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
512-463-6641
March 5, 2019



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GAM RUN 19-011: COW CREEK GROUNDWATER CONSERVATION DISTRICT GROUNDWATER MANAGEMENT PLAN

Ian C. Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
512-463-6641
March 5, 2019

EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h) (Texas Water Code, 2011), states that, in developing its groundwater management plan, a groundwater conservation district shall use groundwater availability modeling information provided by the Executive Administrator of the Texas Water Development Board (TWDB) in conjunction with any available site-specific information provided by the district for review and comment to the Executive Administrator.

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

1. the annual amount of recharge from precipitation, if any, to the groundwater resources within the district;
2. for each aquifer within the district, the annual volume of water that discharges from the aquifer to springs and any surface-water bodies, including lakes, streams, and rivers; and
3. the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

The groundwater management plan for the Cow Creek Groundwater Conservation District should be adopted by the district on or before November 4, 2019 and submitted to the Executive Administrator of the TWDB on or before December 4, 2019. The current management plan for the Cow Creek Groundwater Conservation District expires on

February 2, 2020.

We used two groundwater availability models to estimate the management plan information for the aquifers within the Cow Creek Groundwater Conservation District. Information for the Trinity and Edwards-Trinity (Plateau) aquifers is from version 2.01 of the groundwater availability model for the Hill Country portion of the Trinity Aquifer (Jones and others, 2011). Information for the Ellenburger-San Saba and Hickory aquifers is from version 1.01 of the groundwater availability model for the minor aquifers of the Llano Uplift region (Shi and others, 2016).

This report replaces the results of GAM Run 13-029 (Wade, 2013). GAM Run 19-011 includes results from the newly released groundwater availability model for the minor aquifers of the Llano Uplift Area (Shi and others, 2016). Tables 1 through 4 summarize the groundwater availability model data required by statute and Figures 1 through 4 show the area of the models from which the values in the tables were extracted. If, after review of the figures, the Cow Creek Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB at your earliest convenience.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the two groundwater availability models mentioned above were used to estimate information for the Cow Creek Groundwater Conservation District management plan. Water budgets were extracted for the historical model periods for the Trinity and Edwards-Trinity (Plateau) aquifers (1981 through 1997), and the Ellenburger-San Saba and Hickory aquifers (1980 through 2010) using ZONEBUDGET Version 3.01 (Harbaugh, 2009) or ZONEBUDGET-USG (Panday and others, 2013), as applicable. The average annual water budget values for recharge, surface-water outflow, inflow to the district, and outflow from the district for the aquifers within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Edwards-Trinity (Plateau) and Trinity Aquifers

- We used version 2.01 of the groundwater availability model for the Hill Country portion of the Trinity Aquifer System. See Jones and others (2011) for assumptions and limitations of the groundwater availability model.
- The groundwater availability model includes four layers, representing (from top to bottom):

    1. the Edwards Group of the Edwards-Trinity (Plateau) Aquifer,
    2. the Upper Trinity Aquifer,
    3. the Middle Trinity Aquifer, and
    4. the Lower Trinity Aquifer.

- Water budget information for the Edwards-Trinity (Plateau) and Trinity aquifers were extracted from active model cells within the respective aquifer footprints.
- The General-Head Boundary (GHB) package of MODFLOW was used to represent flow out of the study area between the Hill Country portion of the Trinity Aquifer and the Edwards (Balcones Fault Zone) Aquifer or the confined parts of the Trinity Aquifer underlying the Edwards (Balcones Fault Zone) Aquifer.
- The groundwater availability model includes some portions of the Edwards Group outside the official boundary of the Edwards-Trinity (Plateau) Aquifer. Though flow for these areas is not explicitly reported, the interaction between the Edwards Group (outside the Edwards-Trinity Plateau Aquifer) and the underlying Trinity Aquifer would be shown in the "flow between aquifers" segment of Table 1, if Layer 1 was present in the district.
- Only the outcrop area of the Hill County portion of the Trinity Aquifer was modeled, and the down-dip extent that underlies the Edwards (Balcones Fault Zone) Aquifer is not included.
- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

Marble Falls, Ellenburger-San Saba, and Hickory Aquifers

- We used version 1.01 of the groundwater availability model for the minor aquifers in the Llano Uplift area. See Shi and others (2016) for assumptions and limitations of the model.
- The groundwater availability model for the minor aquifers in Llano Uplift area contains eight layers: Layer 1 (the Trinity Aquifer, Edwards-Trinity (Plateau) Aquifer, and younger alluvium deposits), Layer 2 (confining units), Layer 3 (the Marble Falls Aquifer and equivalent unit), Layer 4 (confining units), Layer 5 (Ellenburger-San Saba Aquifer and equivalent unit), Layer 6 (confining units), Layer 7 (the Hickory Aquifer and equivalent unit), and Layer 8 (Precambrian units).
- Perennial rivers and reservoirs were simulated using MODFLOW-USG river package. Springs were simulated using MODFLOW-USG drain package. For this management plan, groundwater discharge to surface water includes groundwater leakage to the river and drain boundaries.
- The model was run with MODFLOW-USG beta version (Panday and others, 2013).

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifers according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the groundwater availability model results for the Trinity, Edwards-Trinity (Plateau), Ellenburger-San Saba, and Hickory aquifers, located within Cow Creek Groundwater Conservation District and averaged over the historical calibration periods, as shown in Tables 1 through 4.

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

each aquifer and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs.

The information needed for the district's management plan is summarized in Tables 1 through 4. It is important to note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double accounting, a model cell that straddles a political boundary, such as a district or county boundary, is assigned to one side of the boundary based on the location of the centroid of the model cell. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located.

TABLE 1. SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER FOR COW CREEK GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Edwards-Trinity (Plateau) Aquifer	6,046
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Edwards-Trinity (Plateau) Aquifer	3,061
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	4,020
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	290
Estimated net annual volume of flow between each aquifer in the district	Flow from the Edwards-Trinity (Plateau) Aquifer into the Trinity Aquifer	6,429

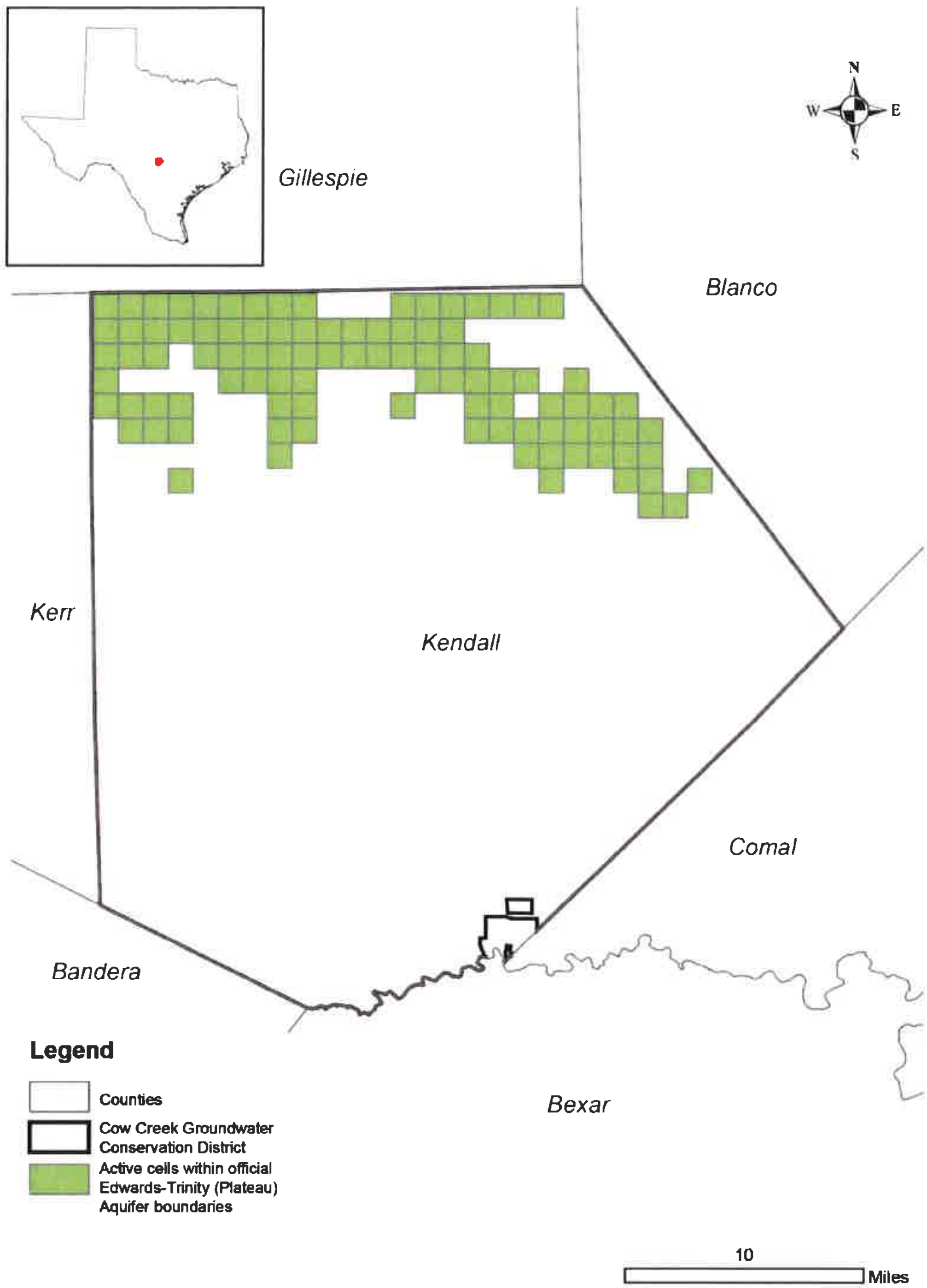

FIGURE 1. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2. SUMMARIZED INFORMATION FOR THE TRINITY AQUIFER FOR COW CREEK GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Trinity Aquifer	50,110
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Trinity Aquifer	31,131
Estimated annual volume of flow into the district within each aquifer in the district	Trinity Aquifer	7,917
Estimated annual volume of flow out of the district within each aquifer in the district	Trinity Aquifer	30,915
Estimated net annual volume of flow between each aquifer in the district	Flow from the Edwards-Trinity (Plateau) Aquifer into the Trinity Aquifer	6,429
	Flow from the Edwards Group into the Trinity Aquifer	58

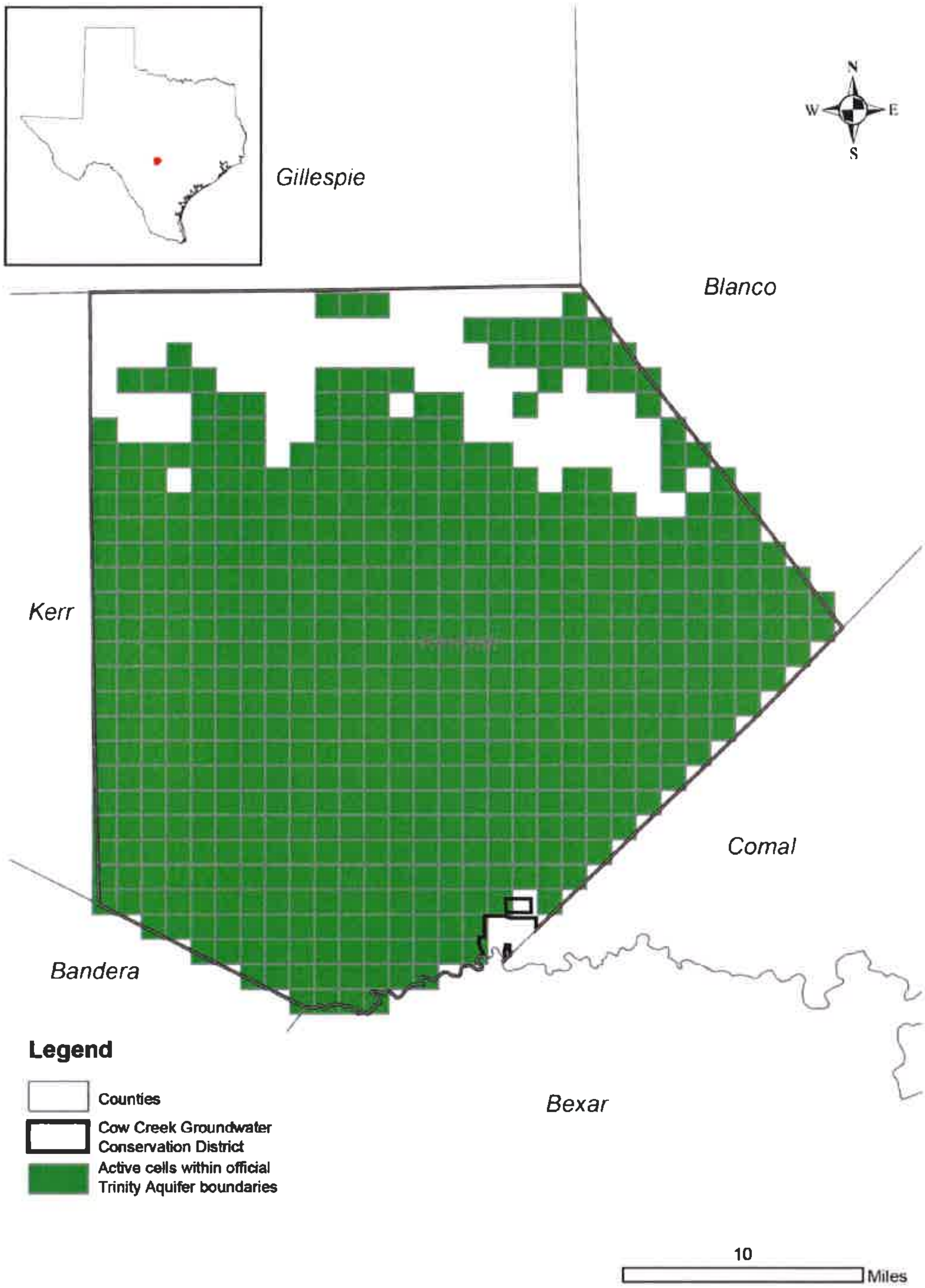

FIGURE 2. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE TRINITY AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 3. SUMMARIZED INFORMATION FOR THE ELLENBURGER-SAN SABA AQUIFER FOR COW CREEK GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Ellenburger-San Saba Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Ellenburger-San Saba Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Ellenburger-San Saba Aquifer	5,059
Estimated annual volume of flow out of the district within each aquifer in the district	Ellenburger-San Saba Aquifer	4,811
Estimated net annual volume of flow between each aquifer in the district	Flow into the Ellenburger-San Saba Aquifer from the Hickory Aquifer	1,626
	Flow from the Ellenburger-San Saba Aquifer to brackish units	3,948
	Flow into the Ellenburger-San Saba Aquifer from overlying confining unit	4,743
	Flow from the Ellenburger-San Saba Aquifer into underlying confining unit	2,746
	Flow into the Ellenburger-San Saba Aquifer from underlying Precambrian units	75

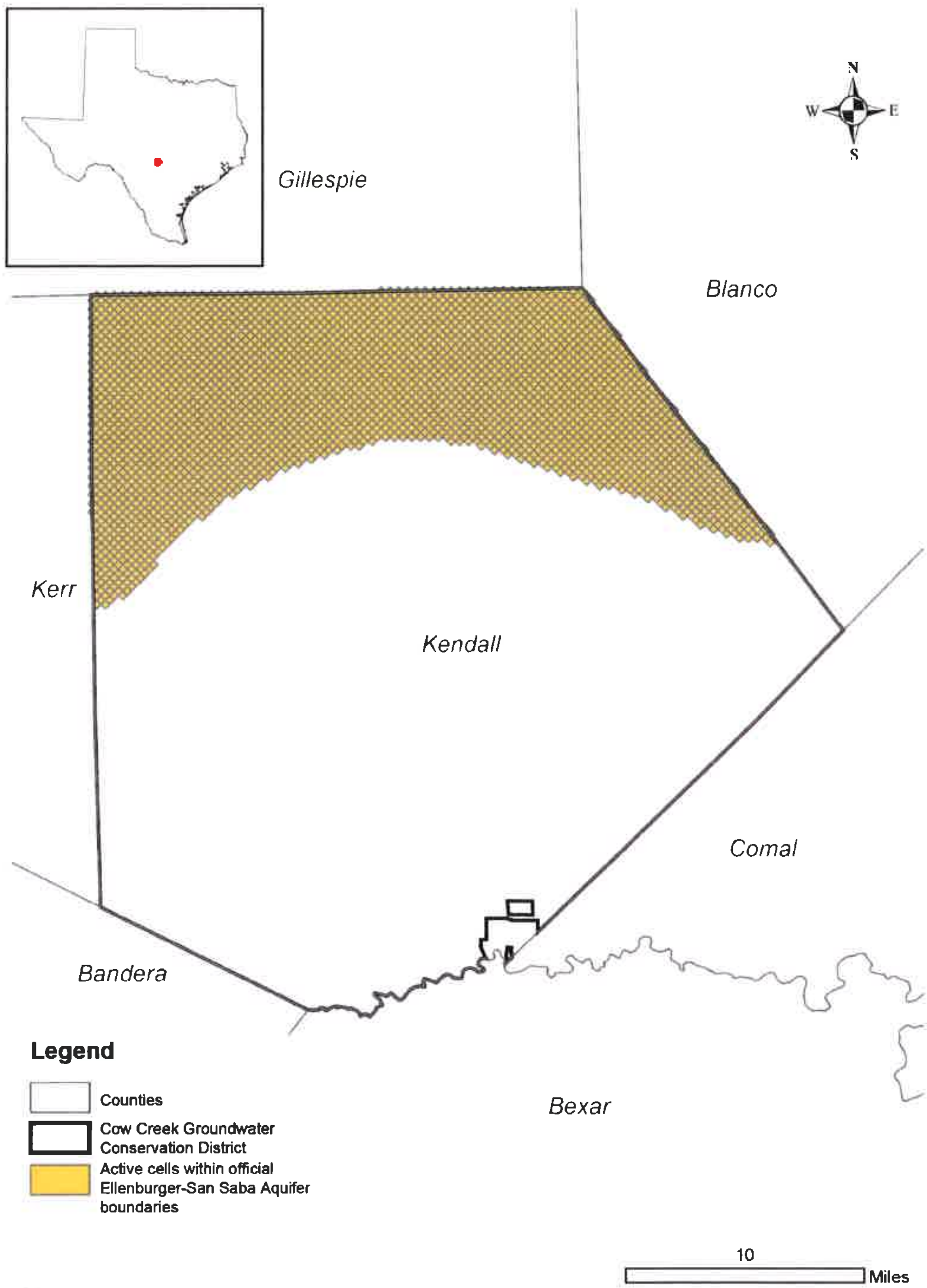

FIGURE 3. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE ELLENBURGER-SAN SABA AQUIFER FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 4. SUMMARIZED INFORMATION FOR THE HICKORY AQUIFER FOR COW CREEK GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Hickory Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Hickory Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Hickory Aquifer	2,696
Estimated annual volume of flow out of the district within each aquifer in the district	Hickory Aquifer	2,065
Estimated net annual volume of flow between each aquifer in the district	Flow from the Hickory Aquifer into the Ellenburger-San Saba Aquifer	1,623
	Flow into the Hickory Aquifer from overlying confining units	2,753
	Flow from the Hickory Aquifer into underlying confining units	200
	Flow into the Hickory Aquifer from brackish Ellenburger-San Saba	1,288
	Flow from the Hickory Aquifer into the brackish Hickory Formation	280

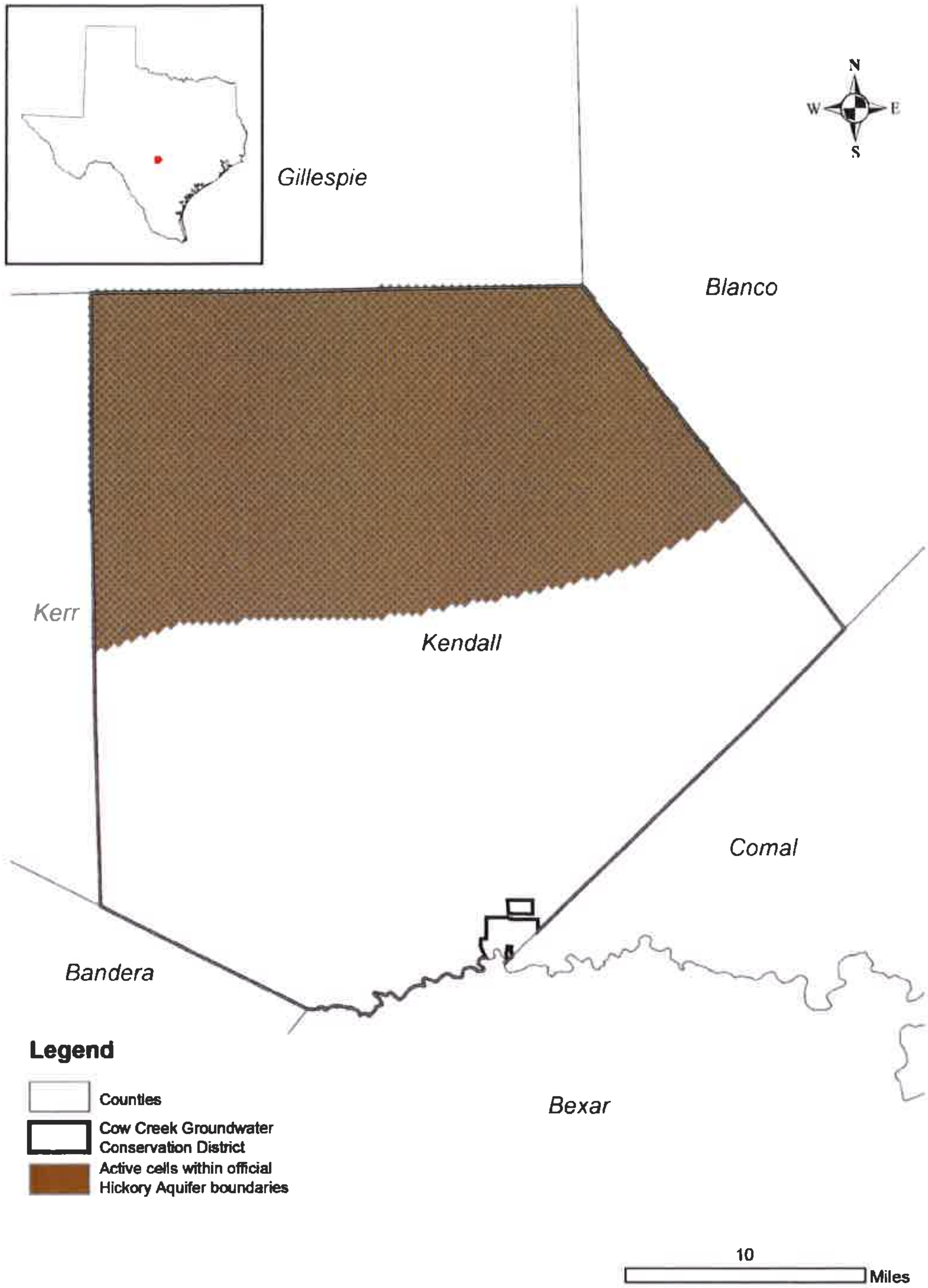

FIGURE 4. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE HICKORY AQUIFER FROM WHICH THE INFORMATION IN TABLE 4 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

LIMITATIONS:

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

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

A key aspect of using the groundwater model to evaluate 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 interaction with streams are specific to particular historical time periods.

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

It is important for groundwater conservation districts to monitor groundwater pumping and overall conditions of the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. 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.

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GAM Run 16-023 MAG: Modeled Available Groundwater for the Aquifers in Groundwater Management Area 9

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Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Section
(512) 463-6641
February 28, 2017

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GAM RUN 16-023 MAG: MODELED AVAILABLE GROUNDWATER FOR THE AQUIFERS IN GROUNDWATER MANAGEMENT AREA 9

Ian C. Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
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(512) 463-6641
February 28, 2017

EXECUTIVE SUMMARY:

We have prepared estimates of the modeled available groundwater for the relevant aquifers of Groundwater Management Area 9—the Trinity, Edwards Group of the Edwards-Trinity (Plateau), Ellenburger-San Saba, and Hickory aquifers. The estimates are based on the desired future conditions for these aquifers adopted by the groundwater conservation districts in Groundwater Management Area 9 on April 28, 2016. The explanatory report and other materials submitted to the Texas Water Development Board (TWDB) were determined to be administratively complete on November 23, 2016.

The modeled available groundwater values are summarized by decade for the groundwater conservation districts (Tables 1, 3, 5, and 7) and for use in the regional water planning process (Tables 2, 4, 6, and 8). The modeled available groundwater estimates are 2,208 acre-feet per year in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer, up to 75 acre-feet per year in the Ellenburger-San Saba Aquifer, 140 acre-feet per year in the Hickory Aquifer, and range from approximately 93,000 acre-feet per year in 2010 to about 90,500 acre-feet per year in 2060 in the Trinity Aquifer. Please note that the Trinity Aquifer includes both the Trinity Aquifer as defined by the TWDB and the Trinity Group of the Edwards-Trinity (Plateau) Aquifer. The modeled available groundwater estimates were extracted from results of model runs using the groundwater availability models for the Hill Country portion of the Trinity Aquifer version 2.01 (Jones and others, 2011), and the minor aquifers of the Llano Uplift Area (Shi and others, 2016).

REQUESTOR:

Mr. Ronald Fieseler, chair of Groundwater Management Area 9 districts.

DESCRIPTION OF REQUEST:

In a letter dated April 25, 2016, Mr. Ronald Fieseler provided the TWDB with the desired future conditions of the Trinity, Edwards Group of the Edwards-Trinity (Plateau), Ellenburger-San Saba, and Hickory aquifers in Groundwater Management Area 9. Mr.

Fieseler provided additional clarifications for baseline years for each desired future condition, areas not covered by the models, assumed climatic conditions, and spatial pumping distributions through emails to the TWDB on June 8, 2016, August 15, 2016 and September 9, 2016. Mr. Fieseler also clarified the water level drawdown for the Ellenburger-San Saba Aquifer in Kendall County in a letter dated October 19, 2016.

The final adopted desired future conditions for the aquifers in Groundwater Management Area 9 are:

- Trinity Aquifer *[Upper, Middle, and Lower undifferentiated]* - Allow for an increase in average drawdown of approximately 30 feet through 2060 (throughout GMA-9) consistent with "Scenario 6" in TWDB GAM Task 10-005.
- Edwards Group of Edwards-Trinity (Plateau) *[Aquifer]* in Kendall and Bandera counties - Allow for no net increase in average drawdown in Bandera and Kendall counties through 2070.
- Ellenburger-San Saba Aquifer in Kendall County - Allow for an increase in average drawdown of no less than 7 feet in Kendall County through 2070.
- Hickory Aquifer in Kendall County - Allow for an increase in average drawdown of no more than 7 Feet in Kendall County through 2070.

The Trinity Aquifer includes both the Trinity Aquifer as defined by the TWDB and the Trinity Group of the Edwards-Trinity (Plateau) Aquifer.

Additionally, districts in Groundwater Management Area 9 voted to declare that the following aquifers or parts of aquifers be classified as non-relevant for the purposes of joint planning:

- Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Kerr and Blanco counties.
- Ellenburger-San Saba Aquifer in Blanco and Kerr counties.
- Hickory Aquifer in Blanco, Hays, Kerr, and Travis counties.
- Marble Falls Aquifer in Blanco County.
- Edwards (Balcones Fault Zone) Aquifer in Bexar, Comal, Hays, and Travis counties.

METHODS:

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

The desired future condition for the Trinity Aquifer is identical to the one adopted in 2010 and the associated modeled available groundwater is based on a specific model run and scenario—Scenario 6 in GAM Task 10-005 (Hutchison, 2010) and GAM Task 10-050 (Hassan, 2012). Trinity Aquifer water-level drawdown is based on 2008 water levels.

For other relevant aquifers—the Edwards Group of the Edwards-Trinity (Plateau), Ellenburger-San Saba, and Hickory aquifers—the groundwater availability models for the Hill Country portion of the Trinity Aquifer version 2.01 (Jones and others, 2011), and the minor aquifers of the Llano Uplift Area (Shi and others, 2016) were used to simulate the desired future conditions outlined in the explanatory report (GMA 9 and others, 2016) and further clarified as noted in the previous section. Water level drawdown calculations were based on the water levels simulated in final years of the historical versions of the respective models. These final years are 1997 in the groundwater availability model for the Hill Country portion of the Trinity Aquifer and 2010 in the groundwater availability model for the minor aquifers of the Llano Uplift Area. The predictive model runs retain pumping rates from the historic period—1980 through 1997—except in the aquifer or area of interest. In those areas, pumping rates are varied such that they produce the desired future average water level drawdown conditions. Pumping rates were reported on 10-year intervals from 2010 through 2060 (for the Trinity Aquifer) and 2010 through 2070 (for all other relevant aquifers). The groundwater availability estimates for 2070 for the Trinity Aquifer will be determined by the regional water planning groups.

Water level drawdown averages were calculated for the relevant portions of each aquifer. Drawdown for model cells which became dry during the simulation (water level dropped below the base of the cell) were excluded from the averaging. Estimates of modeled available groundwater therefore decrease over time as continued simulated pumping predicts the development of dry model cells in areas of Hays, Kerr, and Travis counties. The calculated water-level drawdown averages were compared with the desired future conditions to verify that the pumping scenario achieved the desired future conditions.

Modeled available groundwater values for the Trinity Aquifer and the Edwards Group of the Edwards-Trinity (Plateau) Aquifer were determined by extracting pumping rates by decade from the model results using ZONEBUDGET Version 3.01 (Harbaugh, 2009). For the Ellenburger-San Saba and Hickory aquifers, modeled available groundwater values were determined by extracting pumping rates by decade from the model results using ZONBUDUSG Version 1.01 (Panday and others, 2013).

PARAMETERS AND ASSUMPTIONS:

Trinity and Edwards-Trinity (Plateau) Aquifers

We used the groundwater availability model (version 2.01) for the Hill Country portion of the Trinity Aquifer developed by Jones and others (2009) to determine modeled available groundwater in the Trinity Aquifer and the Edwards Group of the Edwards-Trinity (Plateau) Aquifer. See Jones and others (2009) for details on model construction, recharge, discharge, assumptions, and limitations. The parameters and assumptions for the groundwater availability model for the Hill Country portion of the Trinity Aquifer are described below:

- The model has four layers:
    - Layer 1 represents mostly the Edwards Group of the Edwards-Trinity (Plateau) Aquifer and larger portions of the Edwards Group not classified as an aquifer,
    - Layer 2 represents the Upper Trinity Aquifer,
    - Layer 3 represents the Middle Trinity Aquifer, and
    - Layer 4 represents the Lower Trinity Aquifer.
- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).
- Parts of Bandera, Blanco, and Kerr counties are not included in the model and consequently are not included in the modeled available groundwater calculations.
- Drawdown for cells with water levels below the base elevation of the cell ("dry" cells) were excluded from calculation of average drawdown and the modeled available groundwater values.
- In separate model runs, modeled available groundwater was calculated for the Trinity Aquifer and the Edwards Group of the Edwards-Trinity (Plateau) Aquifer. The Trinity Aquifer is defined as the Trinity Group occurring within Groundwater Management Area 9, irrespective of whether it forms part of the Trinity Aquifer or Edwards-Trinity (Plateau) Aquifer.
- The results for the Trinity Aquifer presented in this report are based on Scenario 6 of GAM Task 10-005 (Hutchison, 2010). See Hutchison (2010) for a full description of the methods, assumptions, and results of the model simulations. Each scenario in GAM Task 10-005 consisted of a series of 387 separate 50-year

model simulations, each with a different recharge configuration. Though the pumping input to the model was the same for each of the 387 simulations, the pumping output differed depending on the occurrence of inactive (or dry) cells. Because the analysis was statistical any baseline year may be assumed, therefore average drawdown is based on 2008 conditions as noted in the Groundwater Management Area 9 explanatory report.

- The results for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer are based on a single model run using historic pumping rates in all parts of the model area except the Edwards Group of Kendall and Bandera counties and average recharge from GAM Task 10-005. Recharge used in this model run represents the average recharge taken from the 387 simulations (Run 169) used in Trinity Aquifer model runs. Average drawdown was calculated based on the last historic stress period (1997).

Minor aquifers of the Llano Uplift Area

We used version 1.01 of the groundwater availability model for the minor aquifers in the Llano Uplift Area. See Shi and others (2016) for assumptions and limitations of the model. The parameters and assumptions for the groundwater availability model for the minor aquifers of the Llano Uplift Area are described below:

- The model contains eight layers:
    - Layer 1 (the Trinity Aquifer, Edwards-Trinity (Plateau) Aquifer, and younger alluvium deposits),
    - Layer 2 (confining units),
    - Layer 3 (the Marble Falls Aquifer and equivalent units),
    - Layer 4 (confining units),
    - Layer 5 (Ellenburger-San Saba Aquifer and equivalent units),
    - Layer 6 (confining units),
    - Layer 7 (the Hickory Aquifer and equivalent units), and
    - Layer 8 (Precambrian units).
- The model was run with MODFLOW-USG beta (development) version (Panday and others, 2013).

- Perennial rivers and reservoirs were simulated using the MODFLOW-USG river package. Springs were simulated using the MODFLOW-USG drain package.

- There is no historic pumping information available for the Ellenburger-San Saba and Hickory aquifers of Kendall County. Consequently, we used uniformly distributed pumping to simulate the desired future condition and determine the modeled available groundwater.

RESULTS:

The modeled available groundwater for the Trinity Aquifer that achieves the desired future conditions adopted by districts in Groundwater Management Area 9 decreases from 93,052 to 90,503 acre-feet per year between 2010 and 2060 (Tables 1 and 2). This decline is attributable to the occurrence of increasing numbers of dry model cells over time in parts of Hays, Kerr, and Travis counties. The modeled available groundwater for the Edwards Group of the Edwards-Trinity (Plateau), Ellenburger-San Saba, and Hickory aquifers are 2,208, 75, and 140 acre-feet per year, respectively (Tables 3 through 8). The modeled available groundwater for the respective aquifers has been summarized by aquifer, county, and groundwater conservation district (Tables 1, 3, 5, and 7). The modeled available groundwater is also summarized by county, regional water planning area, river basin, and aquifer for use in the regional water planning process (Tables 2, 4, 6, and 8).

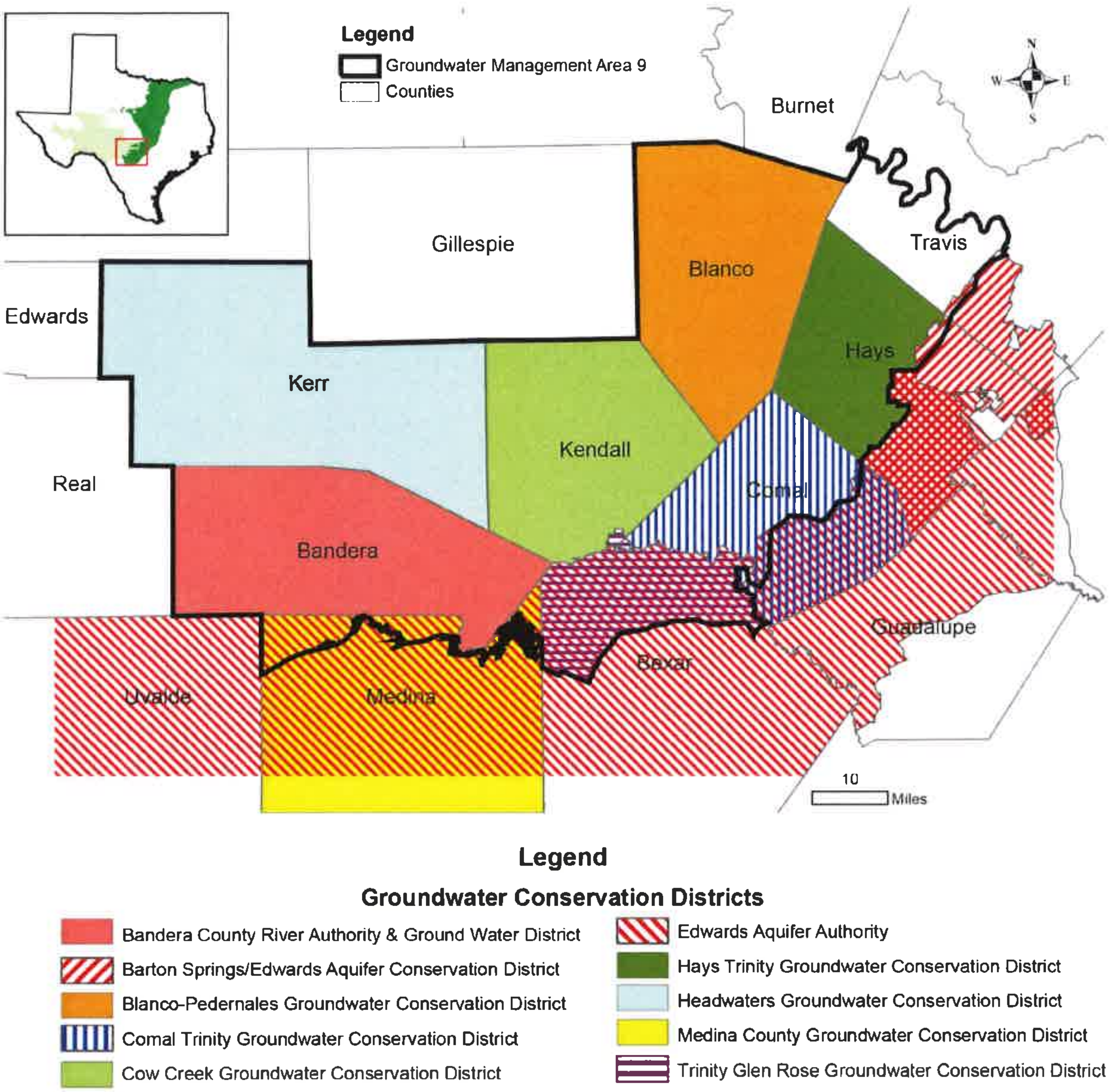

FIGURE 1. MAP SHOWING THE GROUNDWATER CONSERVATION DISTRICTS IN GROUNDWATER MANAGEMENT AREA 9. NOTE: THE BOUNDARIES OF THE EDWARDS AQUIFER AUTHORITY OVERLAP WITH THE MEDINA COUNTY, TRINITY GLEN ROSE, AND COMAL TRINITY GROUNDWATER CONSERVATION DISTRICTS AND THE BARTON SPRINGS/EDWARDS AQUIFER CONSERVATION DISTRICT.

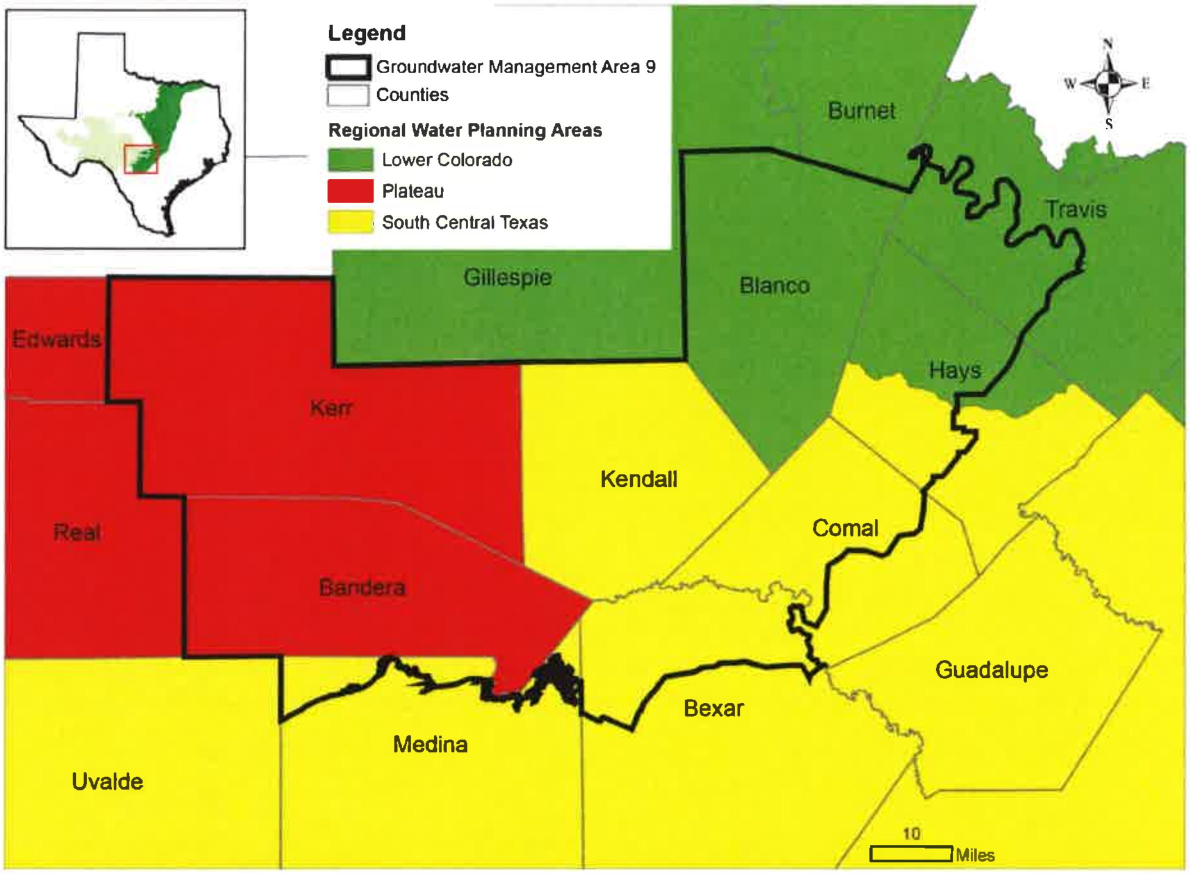

FIGURE 2. MAP SHOWING REGIONAL WATER PLANNING AREAS IN GROUNDWATER MANAGEMENT AREA 9.

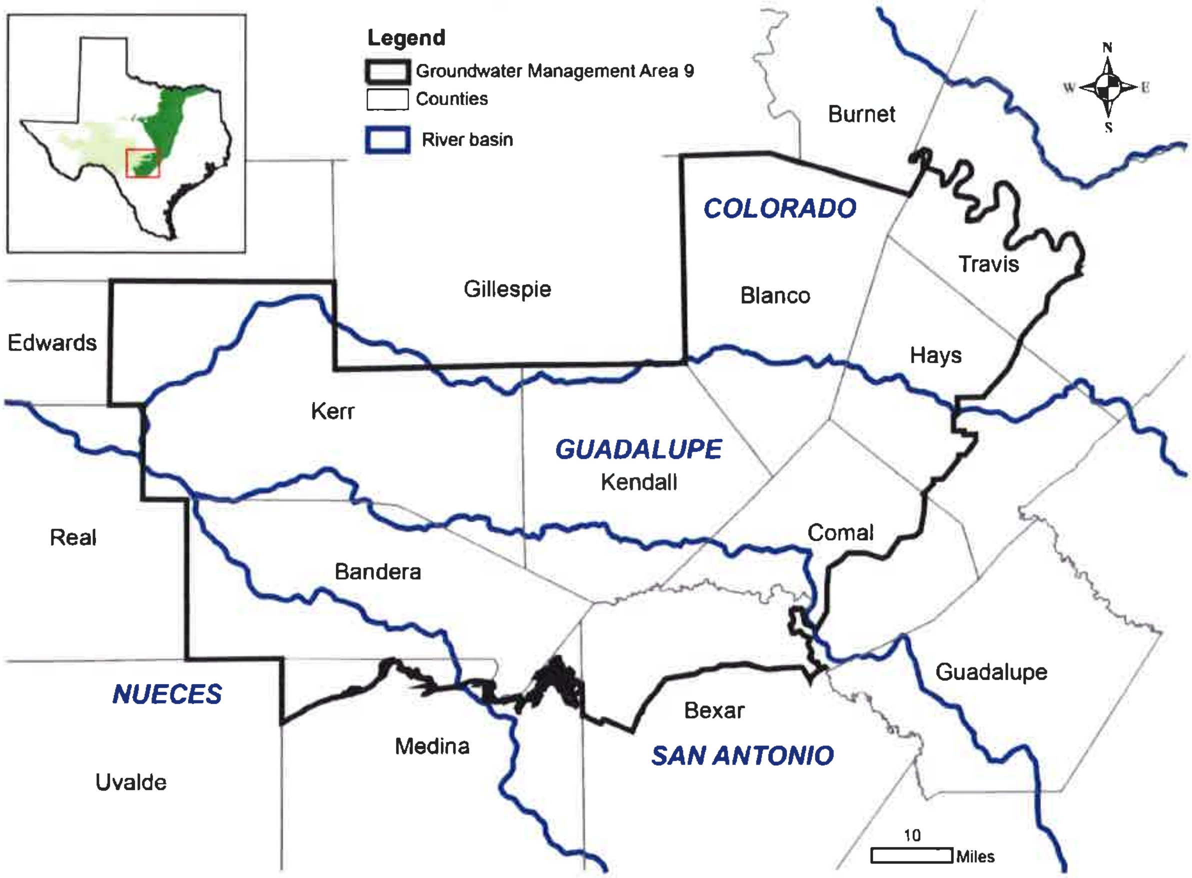

FIGURE 3. MAP SHOWING RIVER BASINS IN GROUNDWATER MANAGEMENT AREA 9. THESE INCLUDE PARTS OF THE COLORADO, GUADALUPE, SAN ANTONIO, AND NUECES RIVER BASINS.

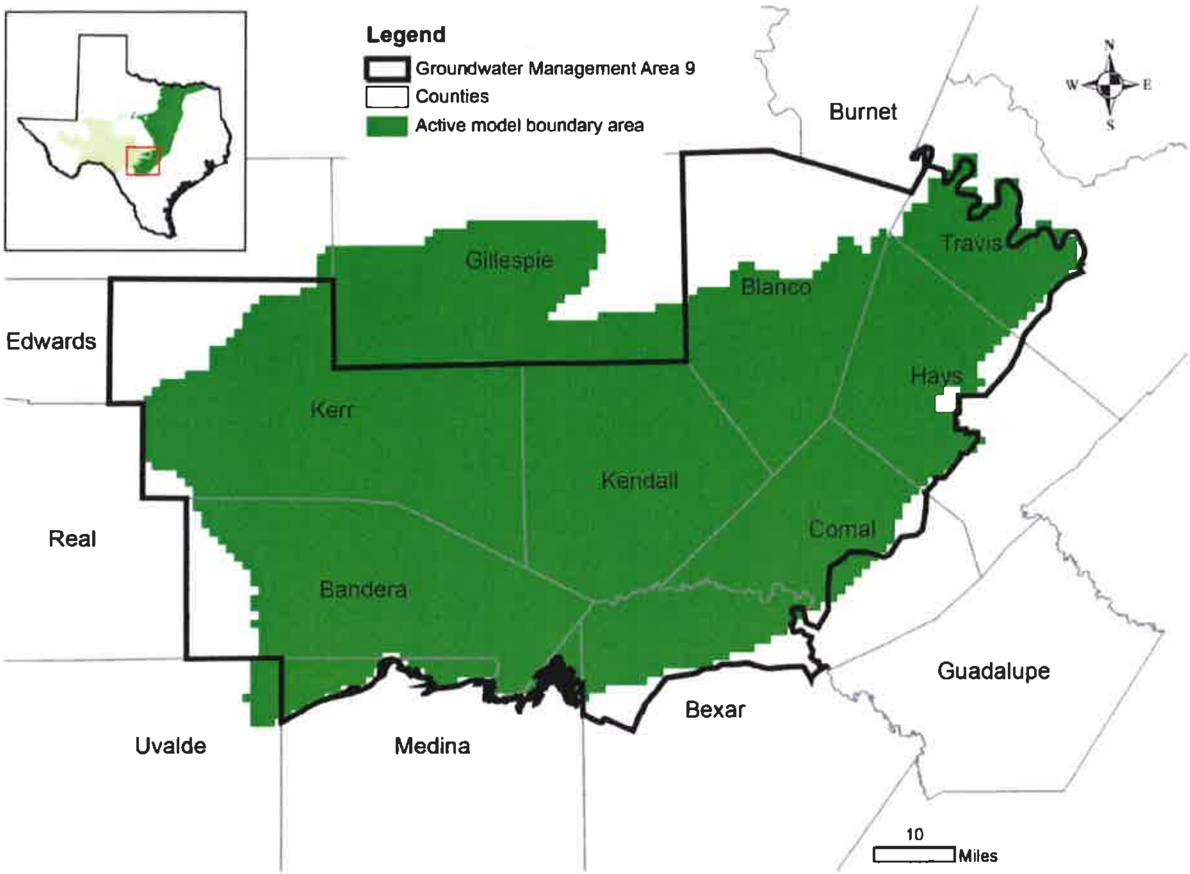

FIGURE 4. MAP SHOWING THE AREAS COVERED BY THE TRINITY AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE HILL COUNTRY PORTION OF THE TRINITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 9.

TABLE 1. MODELED AVAILABLE GROUNDWATER FOR THE TRINITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 9 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

District	County	Year					
		2010	2020	2030	2040	2050	2060
Bandera County River Authority & Groundwater District Total	Bandera	7,284	7,284	7,284	7,284	7,284	7,284
Barton Springs/Edwards Aquifer Conservation District Total	Hays	22	22	22	22	22	22
Blanco-Pedernales Groundwater Conservation District Total	Blanco	2,573	2,573	2,573	2,573	2,573	2,573
Comal Trinity Groundwater Conservation District Total	Comal	10,076	10,076	10,076	10,076	10,076	10,076
Cow Creek Groundwater Conservation District Total	Kendall	10,622	10,622	10,622	10,622	10,622	10,622
Hays Trinity Groundwater Conservation District Total	Hays	9,109	9,098	9,095	9,094	9,094	9,094
Headwaters Groundwater Conservation District Total	Kerr	16,435	14,918	14,845	14,556	14,239	14,223
Medina County Groundwater Conservation District Total	Medina	2,500	2,500	2,500	2,500	2,500	2,500

TABLE 1. CONTINUED.

District	County	Year					
		2010	2020	2030	2040	2050	2060
Trinity Glen Rose Groundwater Conservation District	Bexar	24,856	24,856	24,856	24,856	24,856	24,856
Trinity Glen Rose Groundwater Conservation District	Comal	138	138	138	138	138	138
Trinity Glen Rose Groundwater Conservation District	Kendall	517	517	517	517	517	517
Trinity Glen Rose Groundwater Conservation District Total		**25,511**	**25,511**	**25,511**	**25,511**	**25,511**	**25,511**
No district Total	**Travis**	**8,920**	**8,672**	**8,655**	**8,643**	**8,627**	**8,598**
GMA 9	**Total**	**93,052**	**91,276**	**91,183**	**90,881**	**90,548**	**90,503**

TABLE 2. MODELED AVAILABLE GROUNDWATER FOR THE TRINITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 9 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year					
			2010	**2020**	**2030**	**2040**	**2050**	**2060**
Bandera	J	Guadalupe	76	76	76	76	76	76
		Nueces	903	903	903	903	903	903
		San Antonio	6,305	6,305	6,305	6,305	6,305	6,305
		Total	**7,284**	**7,284**	**7,284**	**7,284**	**7,284**	**7,284**
Bexar	L	San Antonio	24,856	24,856	24,856	24,856	24,856	24,856
		Total	**24,856**	**24,856**	**24,856**	**24,856**	**24,856**	**24,856**
Blanco	K	Colorado	1,322	1,322	1,322	1,322	1,322	1,322
		Guadalupe	1,251	1,251	1,251	1,251	1,251	1,251
		Total	**2,573**	**2,573**	**2,573**	**2,573**	**2,573**	**2,573**
Comal	L	Guadalupe	6,906	6,906	6,906	6,906	6,906	6,906
		San Antonio	3,308	3,308	3,308	3,308	3,308	3,308
		Total	**10,214**	**10,214**	**10,214**	**10,214**	**10,214**	**10,214**

TABLE 2. CONTINUED.

County	RWPA	River Basin	Year					
			2010	**2020**	**2030**	**2040**	**2050**	**2060**
Hays	K	Colorado	4,721	4,710	4,707	4,706	4,706	4,706
	L	Guadalupe	4,410	4,410	4,410	4,410	4,410	4,410
		Total	**9,131**	**9,120**	**9,117**	**9,116**	**9,116**	**9,116**
Kendall	L	Colorado	135	135	135	135	135	135
		Guadalupe	6,028	6,028	6,028	6,028	6,028	6,028
		San Antonio	4,976	4,976	4,976	4,976	4,976	4,976
		Total	**11,139**	**11,139**	**11,139**	**11,139**	**11,139**	**11,139**
Kerr	J	Colorado	318	318	318	318	318	318
		Guadalupe	15,646	14,129	14,056	13,767	13,450	13,434
		San Antonio	471	471	471	471	471	471
		Total	**16,435**	**14,918**	**14,845**	**14,556**	**14,239**	**14,223**
Medina	L	Nueces	1,575	1,575	1,575	1,575	1,575	1,575
		San Antonio	925	925	925	925	925	925
		Total	**2,500**	**2,500**	**2,500**	**2,500**	**2,500**	**2,500**

TABLE 2. CONTINUED.

County	RWPA	River Basin	Year					
			2010	2020	2030	2040	2050	2060
Travis	K	Colorado (Total)	8,920	8,672	8,655	8,643	8,627	8,598
GMA 9			93,052	91,276	91,183	90,881	90,548	90,503

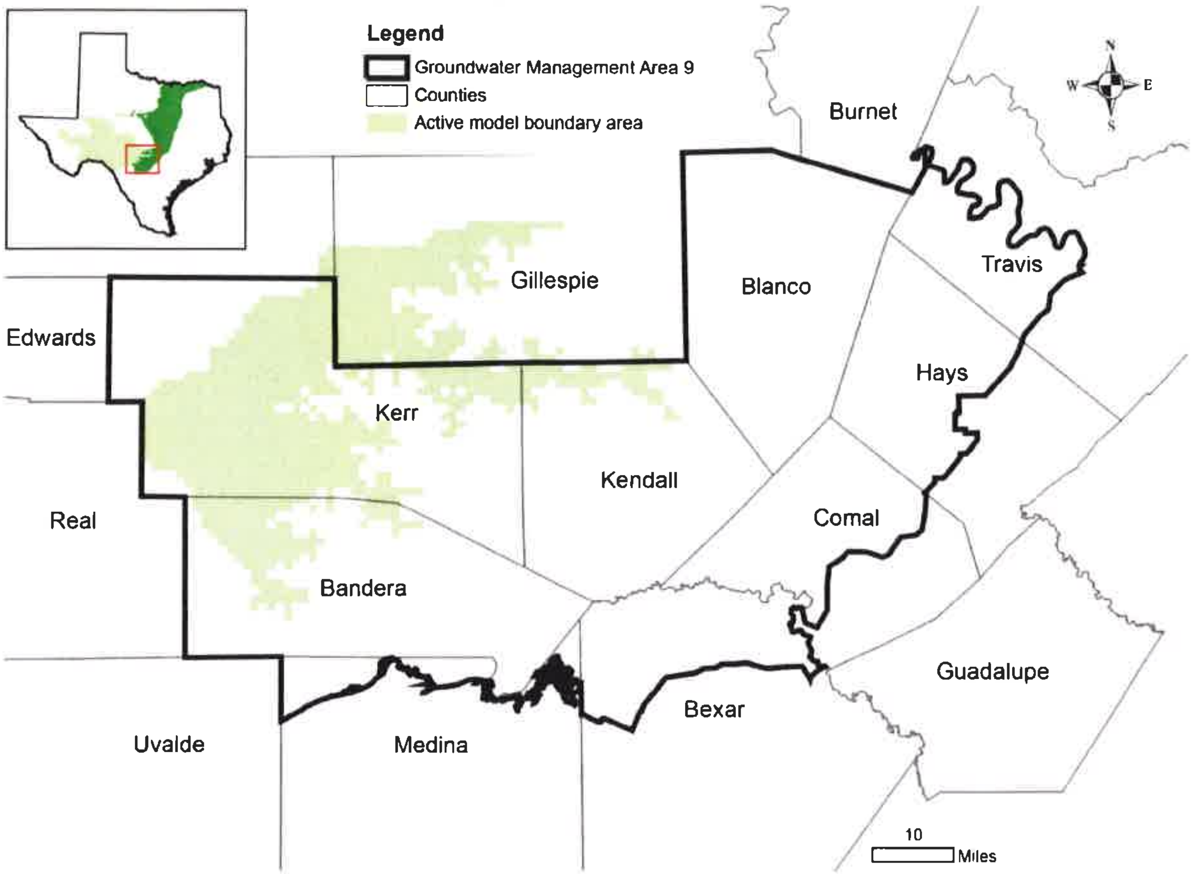

FIGURE 5. MAP SHOWING THE AREAS COVERED BY THE EDWARDS GROUP OF THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE HILL COUNTRY PORTION OF THE TRINITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 9.

TABLE 3. MODELED AVAILABLE GROUNDWATER FOR THE EDWARDS GROUP OF THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN GROUNDWATER MANAGEMENT AREA 9 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY, FOR EACH DECADE BETWEEN 2010 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

District	County	Year						
		2010	2020	2030	2040	2050	2060	2070
Bandera County River Authority & Groundwater District Total	Bandera	2,009	2,009	2,009	2,009	2,009	2,009	2,009
Cow Creek Groundwater Conservation District Total	Kendall	199	199	199	199	199	199	199
Grand Total		2,208	2,208	2,208	2,208	2,208	2,208	2,208

TABLE 4. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE EDWARDS GROUP OF THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN GROUNDWATER MANAGEMENT AREA 9 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2010 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year						
			2010	2020	2030	2040	2050	2060	2070
Bandera	Plateau (J)	Guadalupe	81	81	81	81	81	81	81
		Nueces	38	38	38	38	38	38	38
		San Antonio	1,890	1,890	1,890	1,890	1,890	1,890	1,890
		Total	**2,009**	**2,009**	**2,009**	**2,009**	**2,009**	**2,009**	**2,009**
Kendall	South Central Texas (L)	Colorado	69	69	69	69	69	69	69
		Guadalupe	130	130	130	130	130	130	130
		Total	**199**	**199**	**199**	**199**	**199**	**199**	**199**
Grand Total			**2,208**	**2,208**	**2,208**	**2,208**	**2,208**	**2,208**	**2,208**

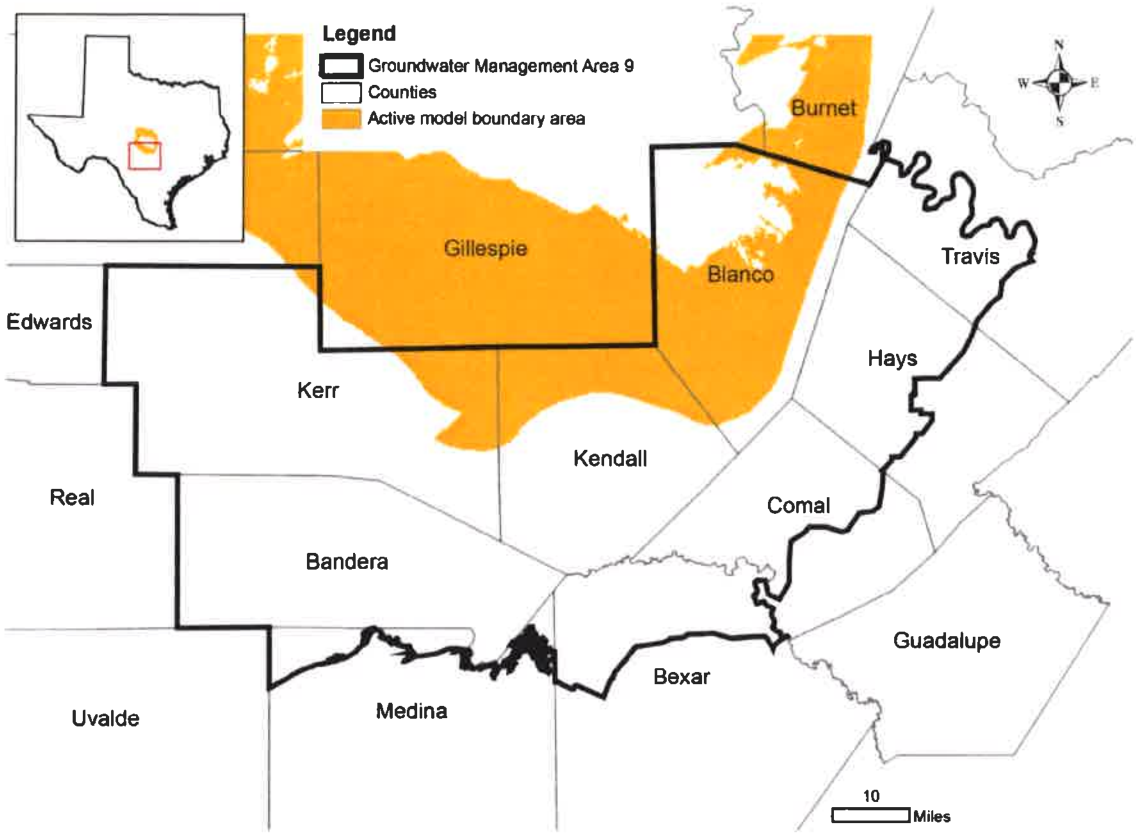

FIGURE 6. MAP SHOWING THE AREAS COVERED BY THE ELLENBURGER-SAN SABA AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE MINOR AQUIFERS OF THE LLANO UPLIFT AREA IN GROUNDWATER MANAGEMENT AREA 9.

TABLE 5. MODELED AVAILABLE GROUNDWATER FOR THE ELLENBURGER-SAN SABA AQUIFER IN GROUNDWATER MANAGEMENT AREA 9 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2010 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

District	County	Year						
		2010	2020	2030	2040	2050	2060	2070
Cow Creek Groundwater Conservation District Total	**Kendall**	**75**	**75**	**75**	**75**	**75**	**75**	**75**

TABLE 6. MODELED AVAILABLE GROUNDWATER FOR THE ELLENBURGER-SAN SABA AQUIFER IN GROUNDWATER MANAGEMENT AREA 9 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2010 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year						
			2010	2020	2030	2040	2050	2060	2070
Kendall	South Central Texas (L)	Colorado	10	10	10	10	10	10	10
		Guadalupe	64	64	64	64	64	64	64
		Total	**75**	**75**	**75**	**75**	**75**	**75**	**75**

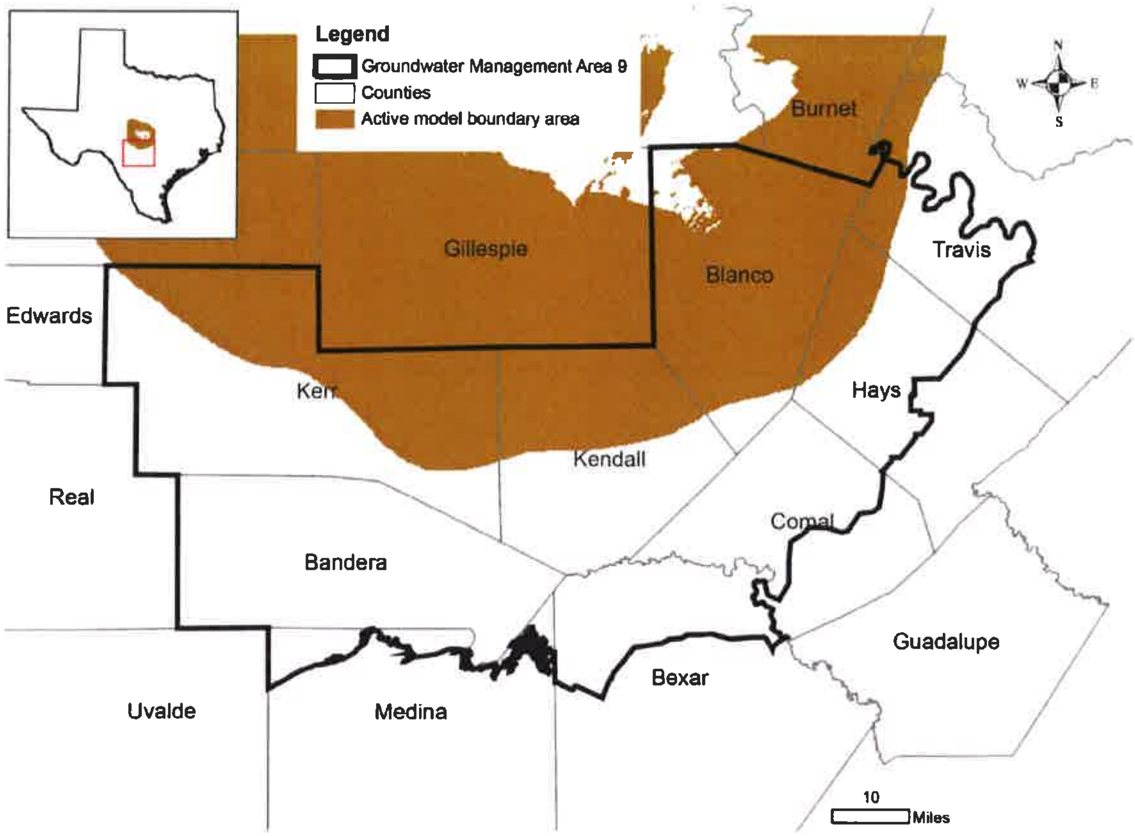

FIGURE 7. MAP SHOWING AREAS COVERED BY THE HICKORY AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE MINOR AQUIFERS OF THE LLANO UPLIFT AREA IN GROUNDWATER MANAGEMENT AREA 9.

TABLE 7. MODELED AVAILABLE GROUNDWATER FOR THE HICKORY AQUIFER IN GROUNDWATER MANAGEMENT AREA 9 SUMMARIZED BY DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2010 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

District	County	Year						
		2010	2020	2030	2040	2050	2060	2070
Cow Creek Groundwater Conservation District Total	Kendall	140	140	140	140	140	140	140

TABLE 8. MODELED AVAILABLE GROUNDWATER FOR THE HICKORY AQUIFER IN GROUNDWATER MANAGEMENT AREA 9 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2010 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RPWA	River Basin	Year						
			2010	2020	2030	2040	2050	2060	2070
Kendall	South Central Texas (L)	Colorado	12	12	12	12	12	12	12
		Guadalupe	128	128	128	128	128	128	128
		Total	**140**	**140**	**140**	**140**	**140**	**140**	**140**

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.

Model "Dry" Cells

The predictive model run for this analysis results in water levels in some model cells dropping below the base elevation of the cell during the simulation. In terms of water level, the cells have gone dry. However, as noted in the model assumptions the transmissivity of the cell remains constant and will produce water.

A total of 18 cells out of 23,805 active cells simulating the Trinity Aquifer cells go "dry" during the predictive period through 2060. These dry cells are located in western Travis County, central Hays County and Kerr County. These dry cells are associated either with areas of high pumping or thin parts of the Trinity Aquifer.

REFERENCES:

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Shi, J., Boghici, R., Kohlrenken, W., and Hutchison, W., 2016, Numerical model report: minor aquifers of the Llano Uplift Region of Texas (Marble Falls, Ellenburger-San Saba, and Hickory): Texas Water Development Board published report, 400 p.

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

Estimated Historical Groundwater Use And 2017 State Water Plan Datasets:

Cow Creek Groundwater Conservation District

by Stephen Allen
Texas Water Development Board
Groundwater Division
Groundwater Technical Assistance Section
stephen.allen@twdb.texas.gov
(512) 463-7317
August 15, 2019

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 8/15/2019. 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 2017. TWDB staff anticipates the calculation and posting of these estimates at a later date.

KENDALL COUNTY *99.51% (multiplier)* All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2017	GW	3,731	3	0	0	220	292	4,246
	SW	2,617	0	0	0	48	52	2,717

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2016	GW	3,680	3	0	0	180	307	4,170
	SW	2,358	0	0	0	190	55	2,603
2015	GW	3,301	2	0	0	249	306	3,858
	SW	2,228	0	0	0	86	54	2,368
2014	GW	3,361	1	0	0	210	300	3,872
	SW	2,306	0	0	0	42	54	2,402
2013	GW	3,529	1	0	0	475	308	4,313
	SW	2,323	0	0	0	75	55	2,453
2012	GW	3,758	1	0	0	572	259	4,590
	SW	2,093	0	0	0	67	47	2,207
2011	GW	4,103	0	0	0	820	408	5,331
	SW	2,010	0	0	0	65	72	2,147
2010	GW	3,466	0	0	0	540	396	4,402
	SW	1,684	0	0	0	150	70	1,904
2009	GW	2,975	0	0	0	732	329	4,036
	SW	1,646	0	0	0	166	58	1,870
2008	GW	3,174	0	0	0	12	299	3,485
	SW	1,590	0	0	0	175	53	1,818
2007	GW	2,764	0	0	0	113	347	3,224
	SW	1,354	0	0	0	0	61	1,415
2006	GW	3,473	0	0	0	137	364	3,974
	SW	1,251	0	0	0	0	64	1,315
2005	GW	3,817	0	0	0	134	335	4,286
	SW	788	0	0	0	0	59	847
2004	GW	3,149	0	0	0	115	170	3,434
	SW	679	0	0	0	104	157	940
2003	GW	3,050	0	0	0	130	164	3,344
	SW	629	0	0	0	356	151	1,136

Projected Surface Water Supplies
TWDB 2017 State Water Plan Data

KENDALL COUNTY *99.51% (multiplier)* All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
L	BOERNE	SAN ANTONIO	BOERNE LAKE/RESERVOIR	645	645	645	645	645	645
L	BOERNE	SAN ANTONIO	CANYON LAKE/RESERVOIR	3,611	3,611	3,611	3,611	3,611	3,611
L	COUNTY-OTHER, KENDALL	GUADALUPE	CANYON LAKE/RESERVOIR	2,488	2,488	2,488	2,488	2,488	2,488
L	FAIR OAKS RANCH	SAN ANTONIO	CANYON LAKE/RESERVOIR	585	690	775	840	895	940
L	IRRIGATION, KENDALL	GUADALUPE	GUADALUPE RUN-OF-RIVER	26	26	26	26	26	26
L	LIVESTOCK, KENDALL	COLORADO	COLORADO LIVESTOCK LOCAL SUPPLY	6	6	6	6	6	6
L	LIVESTOCK, KENDALL	GUADALUPE	GUADALUPE LIVESTOCK LOCAL SUPPLY	158	158	158	158	158	158
L	LIVESTOCK, KENDALL	SAN ANTONIO	SAN ANTONIO LIVESTOCK LOCAL SUPPLY	33	33	33	33	33	33
	Sum of Projected Surface Water Supplies (acre-feet)			**7,552**	**7,657**	**7,742**	**7,807**	**7,862**	**7,907**

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.

KENDALL COUNTY *99.51% (multiplier)* All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
L	BOERNE	SAN ANTONIO	3,091	3,985	4,942	5,900	6,889	7,863
L	COUNTY-OTHER, KENDALL	COLORADO	41	48	57	66	75	85
L	COUNTY-OTHER, KENDALL	GUADALUPE	1,579	1,916	2,278	2,649	3,043	3,433
L	COUNTY-OTHER, KENDALL	SAN ANTONIO	1,037	1,079	1,147	1,251	1,334	1,417
L	FAIR OAKS RANCH	SAN ANTONIO	656	898	1,125	1,290	1,531	1,768
L	IRRIGATION, KENDALL	GUADALUPE	304	298	291	286	281	275
L	IRRIGATION, KENDALL	SAN ANTONIO	70	68	67	65	64	63
L	KENDALL COUNTY WCID #1	GUADALUPE	303	341	384	430	481	531
L	LIVESTOCK, KENDALL	COLORADO	13	13	13	13	13	13
L	LIVESTOCK, KENDALL	GUADALUPE	314	314	314	314	314	314
L	LIVESTOCK, KENDALL	SAN ANTONIO	66	66	66	66	66	66
L	WATER SERVICES INC	SAN ANTONIO	46	54	64	74	85	95
		Sum of Projected Water Demands (acre-feet)	**7,520**	**9,080**	**10,748**	**12,404**	**14,176**	**15,923**

Projected Water Supply Needs
TWDB 2017 State Water Plan Data

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

KENDALL COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
L	BOERNE	SAN ANTONIO	2,159	1,265	308	-650	-1,639	-2,613
L	COUNTY-OTHER, KENDALL	COLORADO	47	40	31	22	13	3
L	COUNTY-OTHER, KENDALL	GUADALUPE	2,327	1,989	1,625	1,252	856	464
L	COUNTY-OTHER, KENDALL	SAN ANTONIO	383	341	272	168	84	1
L	FAIR OAKS RANCH	SAN ANTONIO	540	512	459	426	298	153
L	IRRIGATION, KENDALL	GUADALUPE	55	61	68	73	78	84
L	IRRIGATION, KENDALL	SAN ANTONIO	30	32	33	35	36	37
L	KENDALL COUNTY WCID #1	GUADALUPE	472	434	391	345	294	244
L	LIVESTOCK, KENDALL	COLORADO	0	0	0	0	0	0
L	LIVESTOCK, KENDALL	GUADALUPE	0	0	0	0	0	0
L	LIVESTOCK, KENDALL	SAN ANTONIO	0	0	0	0	0	0
L	WATER SERVICES INC	SAN ANTONIO	28	25	23	18	13	8
	Sum of Projected Water Supply Needs (acre-feet)		**0**	**0**	**0**	**-650**	**-1,639**	**-2,613**

Projected Water Management Strategies
TWDB 2017 State Water Plan Data

KENDALL COUNTY

WUG, Basin (RWPG)

All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
BOERNE, SAN ANTONIO (L)							
LOCAL TRINITY AQUIFER DEVELOPMENT	TRINITY AQUIFER [KENDALL]	0	0	0	1,000	1,000	1,000
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [KENDALL]	136	484	985	1,513	1,888	2,294
WESTERN CANYON EXPANSION	CANYON LAKE/RESERVOIR [RESERVOIR]	0	0	0	0	639	1,613
		136	**484**	**985**	**2,513**	**3,527**	**4,907**
COUNTY-OTHER, KENDALL, COLORADO (L)							
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [KENDALL]	0	0	0	0	0	0
		0	**0**	**0**	**0**	**0**	**0**
COUNTY-OTHER, KENDALL, GUADALUPE (L)							
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [KENDALL]	0	0	0	0	0	9
		0	**0**	**0**	**0**	**0**	**9**
COUNTY-OTHER, KENDALL, SAN ANTONIO (L)							
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [KENDALL]	0	0	0	0	0	4
		0	**0**	**0**	**0**	**0**	**4**
FAIR OAKS RANCH, SAN ANTONIO (L)							
MUNICIPAL WATER CONSERVATION (SUBURBAN)	DEMAND REDUCTION [KENDALL]	37	123	243	373	546	715
		37	**123**	**243**	**373**	**546**	**715**
WATER SERVICES INC, SAN ANTONIO (L)							
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [KENDALL]	1	1	2	3	5	8
		1	**1**	**2**	**3**	**5**	**8**
Sum of Projected Water Management Strategies (acre-feet)		**174**	**608**	**1,230**	**2,889**	**4,078**	**5,643**