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

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

November 1, 2022

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Geoscientist Seals

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

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

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

STATE OF TEXAS
JIANYOU SHI
GEOLOGY
11113
LICENSED
PROFESSIONAL GEOSCIENTIST

Signature

11/10/2022
Date

Jevon Harding, P.G.

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

Jevon Harding
Signature

11/3/2022
Date

STATE OF TEXAS
JEVON HARDING
GEOLOGY
12050
LICENSED
PROFESSIONAL GEOSCIENTIST

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EXECUTIVE SUMMARY:

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

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

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

Carrizo-Wilcox, Queen City, and Sparta aquifers
Sparta Aquifer: Modeled available groundwater ranges from approximately 11,530 to 26,210 acre-feet per year during the period from 2020 to 2070. Values are summarized by groundwater conservation district and county (Table 4) and by county, regional water planning area, and river basin (Table 12).
Queen City Aquifer: Modeled available groundwater ranges from approximately 5,650 to 15,310 acre-feet per year during the period from 2020 to 2070. Values are summarized by

groundwater conservation district and county (Table 5) and by county, regional water planning area, and river basin (Table 13).

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

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

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

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

Yegua-Jackson Aquifer

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

Brazos River Alluvium Aquifer

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

REQUESTOR:

Mr. Gary Westbrook, Groundwater Management Area 12 Coordinator.

DESCRIPTION OF REQUEST:

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

Carrizo-Wilcox, Queen City, and Sparta Aquifers

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

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

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

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

Yegua-Jackson Aquifer

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

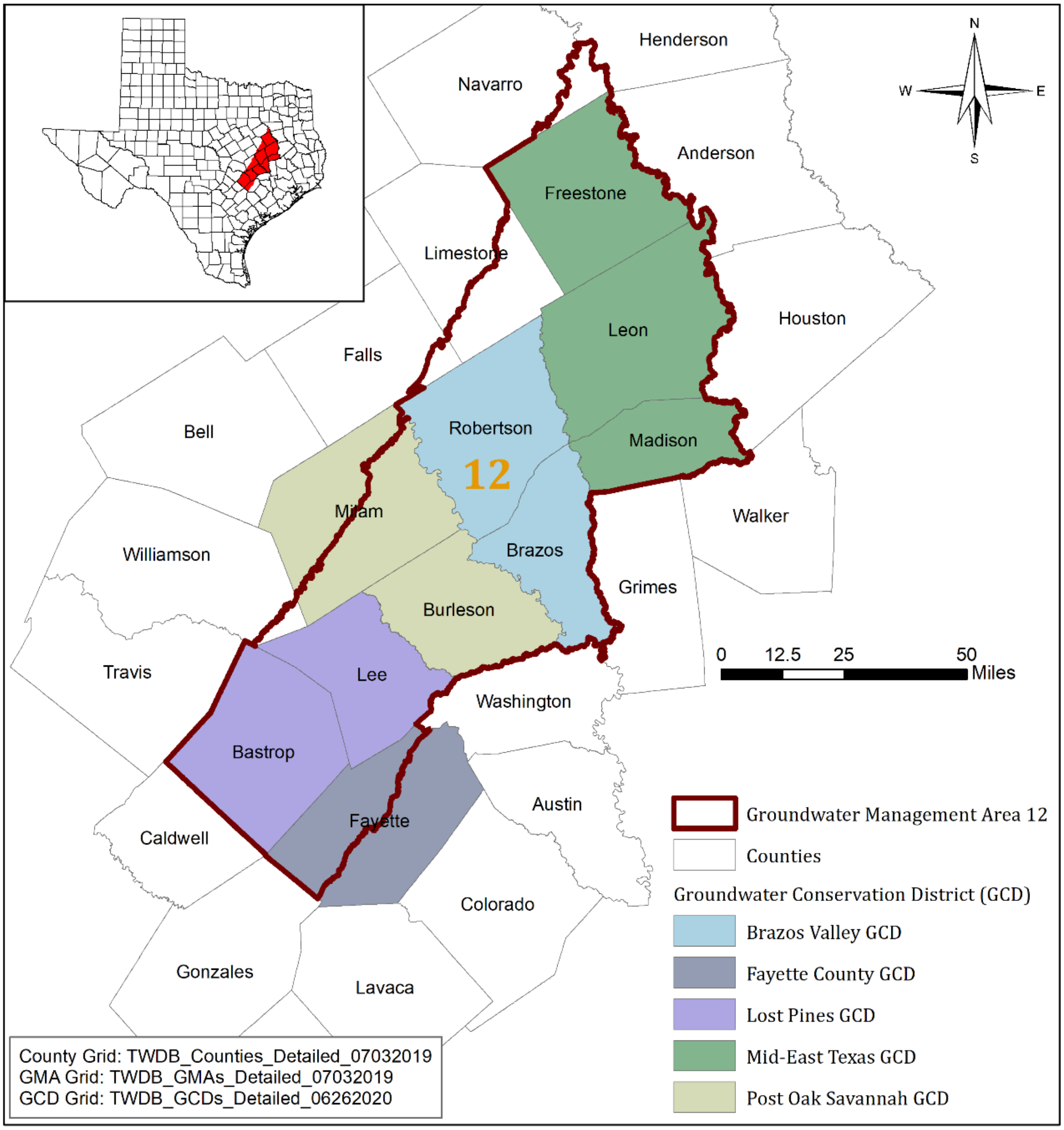

Figure 1. **GROUNDWATER CONSERVATION DISTRITS IN GROUNDWATER MANAGEMENT AREA 12.**

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

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

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

Brazos River Alluvium Aquifer

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

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

<table>
<tr><th>Groundwater Conservation District (GCD)</th><th>County</th><th>Desired Future Condition</th></tr>
<tr><td>Brazos Valley GCD</td><td>Brazos and Robertson</td><td>North of State Highway 21: Percent saturation shall average at least 30% of total well depth from January 2013 to December 2069.

South of State Highway 21: Percent saturation shall average at least 40% of total well depth from January 2013 to December 2069.</td></tr>
<tr><td rowspan="2">Post Oak Savannah GCD</td><td>Burleson</td><td>A decrease in 6 feet in the average saturated thickness over the period from January 2010 to December 2069.</td></tr>
<tr><td>Milam</td><td>A decrease of 5 feet in average saturated thickness over the period from January 2010 to December 2069.</td></tr>
</table>

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

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

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

METHODS:

Carrizo-Wilcox, Queen City, and Sparta aquifers

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

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

Yegua-Jackson Aquifer

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

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

Brazos River Alluvium Aquifer

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

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

BRAZOS VALLEY GROUNDWATER CONSERVATION DISTRICT

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

POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT

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

MODELED AVAILABLE GROUNDWATER AND PERMITTING

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

PARAMETERS AND ASSUMPTIONS:

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

Carrizo-Wilcox, Queen City, and Sparta aquifers

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

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

Yegua-Jackson Aquifer

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

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

Brazos River Alluvium Aquifer

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

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

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

RESULTS:

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

Carrizo-Wilcox, Queen City, and Sparta Aquifers

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

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

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

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

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

Yegua-Jackson Aquifer

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

Brazos River Alluvium Aquifer

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

LIMITATIONS:

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

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

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

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

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

REFERENCES:

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

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

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

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

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

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

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

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

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

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

APPENDIX A

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

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

Memorandum

To: Texas Water Development Board

From: GMA 12

Date: May 5, 2022

Subject: Items to address prior to calculating DFCs

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

Carrizo-Wilcox, Queen City, and Sparta aquifers

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

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

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

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

Yegua-Jackson Aquifer

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

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

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

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

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

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

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

Brazos River Alluvium Aquifer

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

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

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

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

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

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

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

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

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

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

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