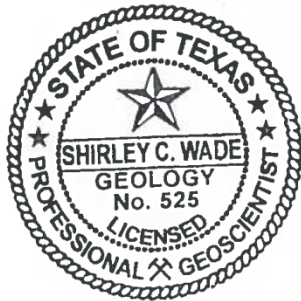

**GAM RUN 17-027 MAG:
MODELED AVAILABLE GROUNDWATER FOR THE
CARRIZO-WILCOX, QUEEN CITY, SPARTA, AND
YEGUA-JACKSON AQUIFERS IN
GROUNDWATER MANAGEMENT AREA 13**

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Texas Water Development Board
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October 27, 2017



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10/27/17

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

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EXECUTIVE SUMMARY:

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

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

REQUESTOR:

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

DESCRIPTION OF REQUEST:

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

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

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

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

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

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

METHODS:

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

The groundwater availability model for the Yegua-Jackson Aquifer (Figures 5 and 6) was run using the model files submitted on March 29, 2017, as supplemental information and drawdowns were calculated for the year 2070. County-wide average drawdowns were

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calculated for Gonzales and Karnes counties within Groundwater Management Area 13 using all model layers in the average. Based on clarifications, the reference year for drawdown calculation was the end of 2009 (or the beginning of 2010). As specified in the clarifications, drawdowns for cells that became dry during the simulation (water level dropped below the base of the cell) were excluded from the averaging. The calculated drawdown averages were compared with the desired future conditions for Gonzales and Karnes counties to verify that the pumping scenario (Hutchison, 2017b) achieved the desired future conditions within one foot.

The modeled available groundwater values were determined by extracting pumping rates by decade from the model results using ZONEBUDGET Version 3.01 (Harbaugh, 2009). Annual pumping rates by aquifer are presented by county and groundwater conservation district, subtotaled by groundwater conservation district, and then summed for Groundwater Management Area 13 (Tables 1 through 4). Annual pumping rates by aquifer are also presented by county, river basin, and regional water planning area within Groundwater Management Area 13 (Tables 5 through 8). Additional tables are provided in Appendix A which summarize the total modeled available groundwater for the Carrizo-Wilcox, Queen City, and Sparta aquifers by regional water planning area, county, river basin, and groundwater conservation district. Tables are provided in Appendix B which split the Carrizo-Wilcox, Queen City, and Sparta aquifers modeled pumping by model layer for each groundwater conservation district.

Modeled Available Groundwater and Permitting

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

PARAMETERS AND ASSUMPTIONS:

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

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Carrizo-Wilcox, Queen City, and Sparta aquifers

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

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Yegua-Jackson Aquifer

- We used version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer. See Deeds and others (2010) for assumptions and limitations of the groundwater availability model.
- This groundwater availability model includes five layers which represent the outcrop of the Yegua-Jackson Aquifer and younger overlying units—the Catahoula Formation (Layer 1), the upper portion of the Jackson Group (Layer 2), the lower portion of the Jackson Group (Layer 3), the upper portion of the Yegua Group (Layer 4), and the lower portion of the Yegua Group (Layer 5).
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).
- The end of the calibration period was extended from 1997 to 2009 (Oliver, 2010) and the reference year for drawdown calculations was the end of 2009.
- Drawdown averages and modeled available groundwater values were based on the extent of the model area rather than the official aquifer boundaries.
- Drawdown for cells where water levels dropped below the base elevation of the cell causing the cell to become inactive (dry cells) were excluded from the averaging.
- A tolerance of one foot was assumed when comparing desired future conditions (Table 1, average drawdown values per county) to model drawdown results.
- Estimates of modeled available groundwater from the model simulation were rounded to whole numbers.

RESULTS:

The modeled available groundwater estimates for the Carrizo-Wilcox Aquifer range from approximately 626,000 acre-feet per year in 2012 to approximately 589,000 acre-feet per year in 2070 (Table 1). The modeled available groundwater estimates for the Queen City Aquifer range from approximately 19,000 acre-feet per year in 2012 to approximately 15,000 acre-feet per year in 2070 (Table 2). The modeled available groundwater estimate for the Sparta Aquifer ranges from approximately 7,000 acre-feet per year in 2012 to approximately 6,000 acre-feet per year in 2070 (Table 3). The modeled available groundwater is summarized by groundwater conservation district and county for the Carrizo-Wilcox, Queen City, and Sparta aquifers (Tables 1, 2, and 3 respectively). The modeled available groundwater has also been summarized by county, river basin, and regional water planning area for use in the regional water planning process for the Carrizo-Wilcox, Queen City, and Sparta aquifers (Tables 5, 6, and 7 respectively). Small differences

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in values between table summaries are due to rounding. Additional tables are provided in Appendix A which summarize the total modeled available groundwater for all three aquifers by regional water planning area, county, river basin, and groundwater conservation district. Tables are provided in Appendix B which split the modeled pumping by each model aquifer layer for each groundwater conservation district.

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

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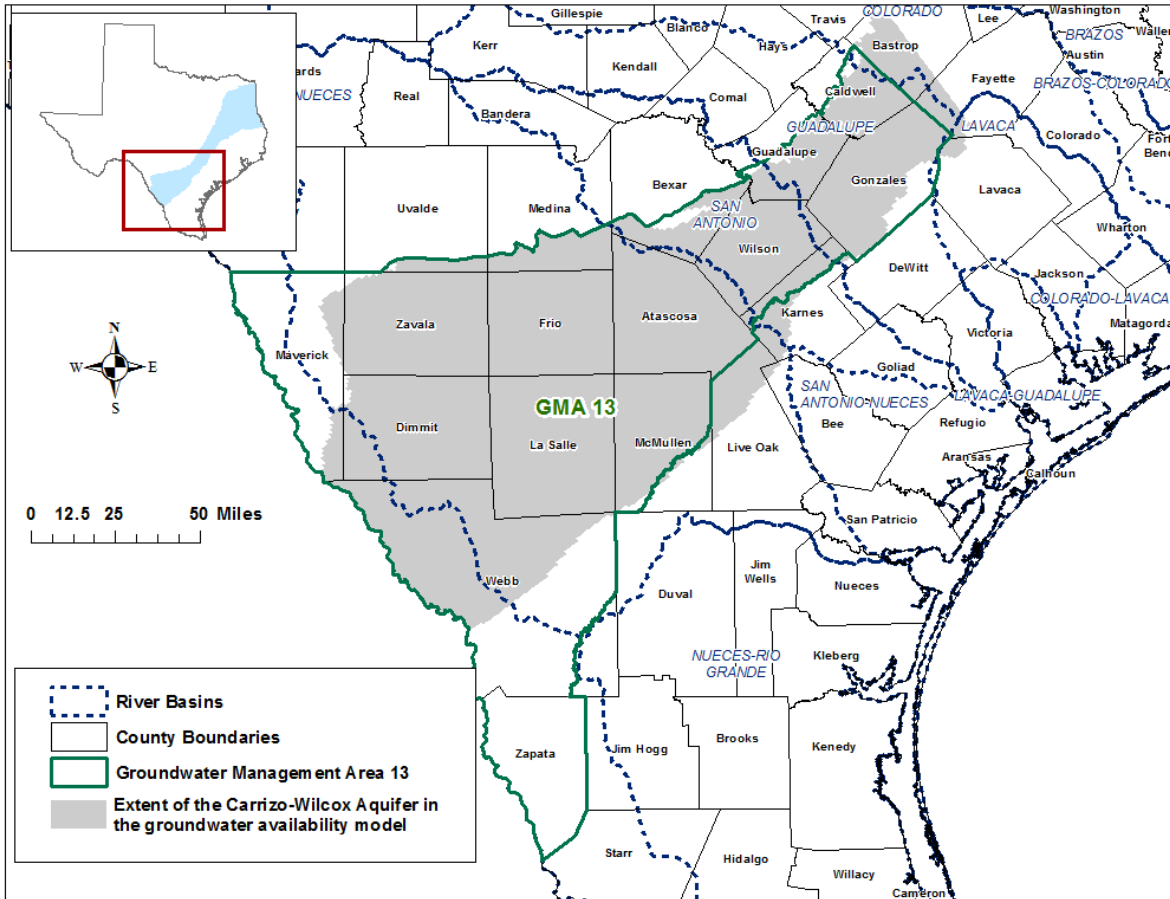


FIGURE 1. GROUNDWATER MANAGEMENT AREA (GMA) 13 BOUNDARY, RIVER BASINS, AND COUNTIES OVERLAIN ON THE EXTENT OF THE CARRIZO-WILCOX AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.

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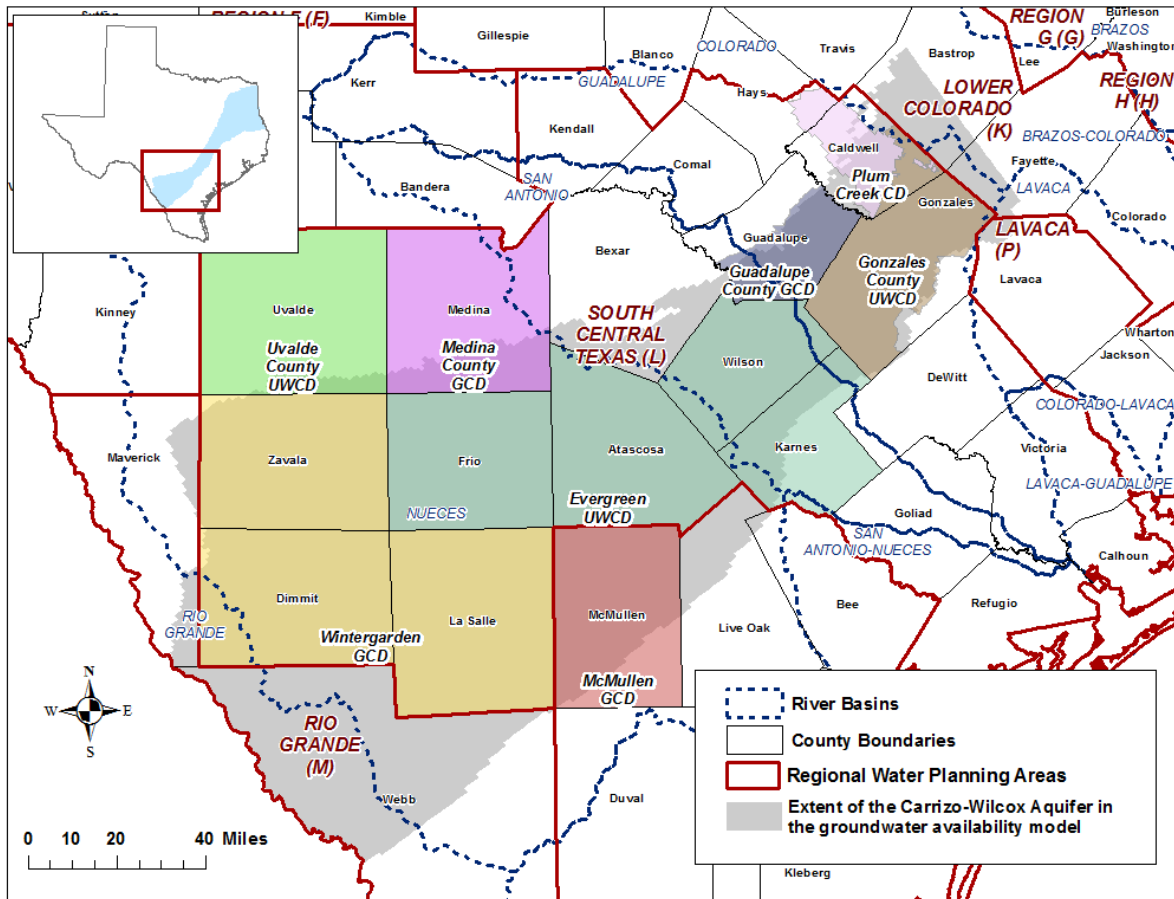


FIGURE 2. REGIONAL WATER PLANNING AREAS (RWPAS), RIVER BASINS, GROUNDWATER CONSERVATION DISTRICTS (GCDs), AND COUNTIES OVERLAIN ON THE EXTENT OF THE CARRIZO-WILCOX AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.

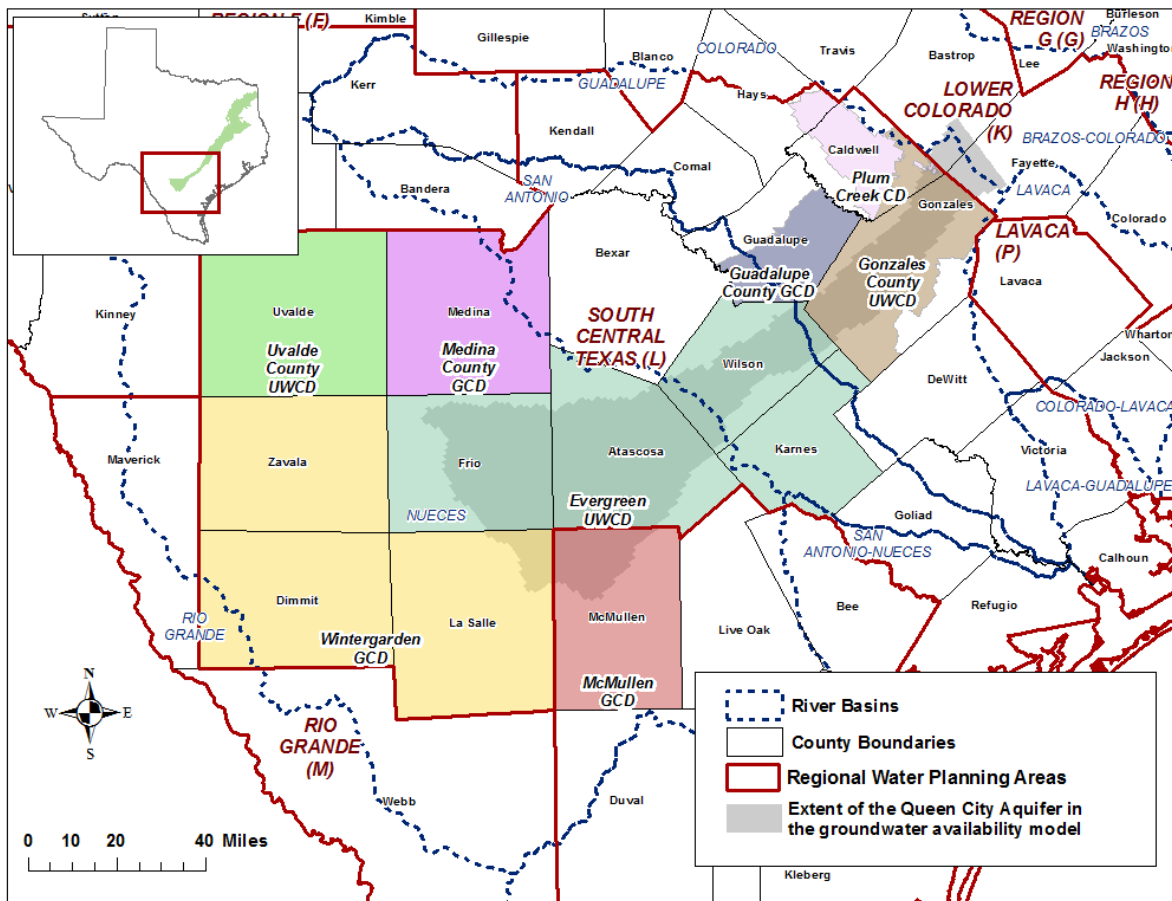


FIGURE 3. REGIONAL WATER PLANNING AREAS (RWPAS), RIVER BASINS, GROUNDWATER CONSERVATION DISTRICTS (GCDs), AND COUNTIES OVERLAIN ON THE EXTENT OF THE QUEEN CITY AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.

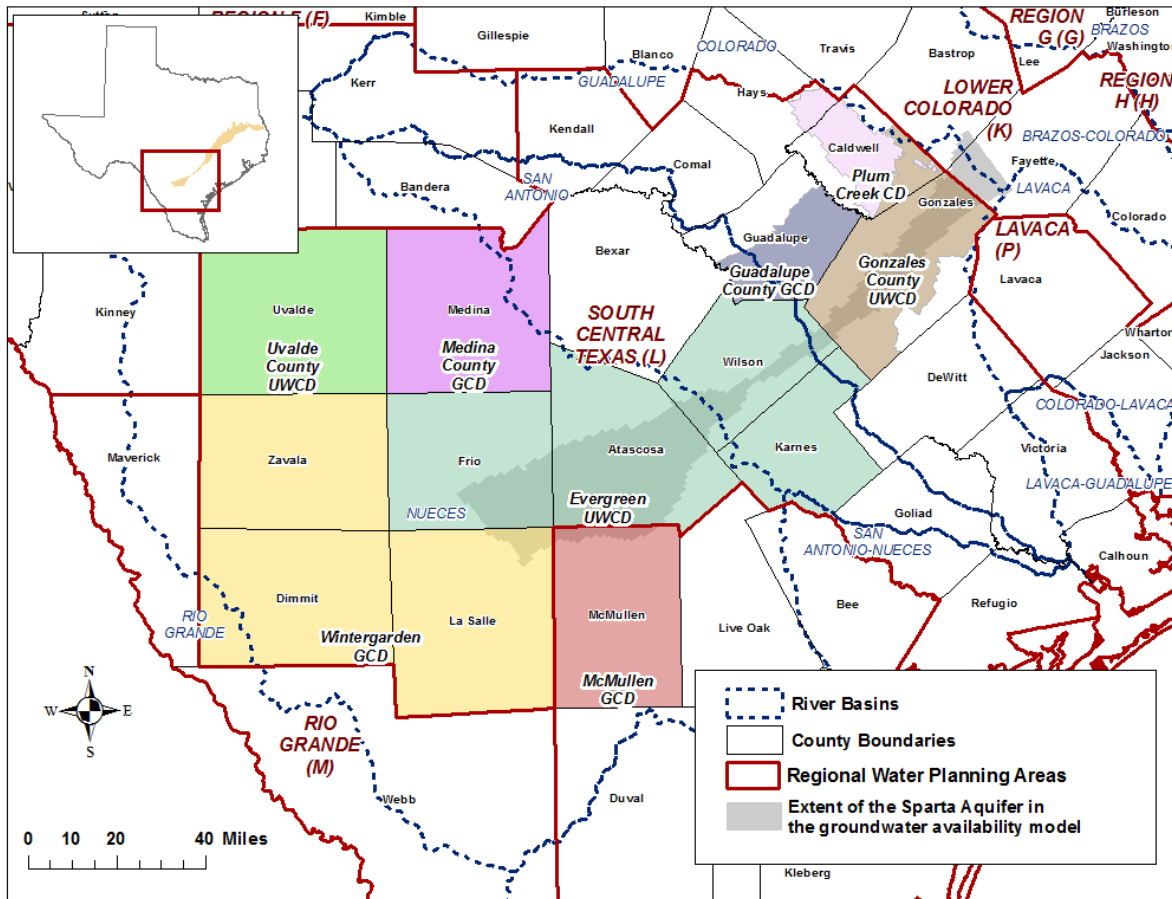


FIGURE 4. REGIONAL WATER PLANNING AREAS (RWPAS), RIVER BASINS, GROUNDWATER CONSERVATION DISTRICTS (GCDs), AND COUNTIES OVERLAIN ON THE EXTENT OF THE SPARTA AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS.

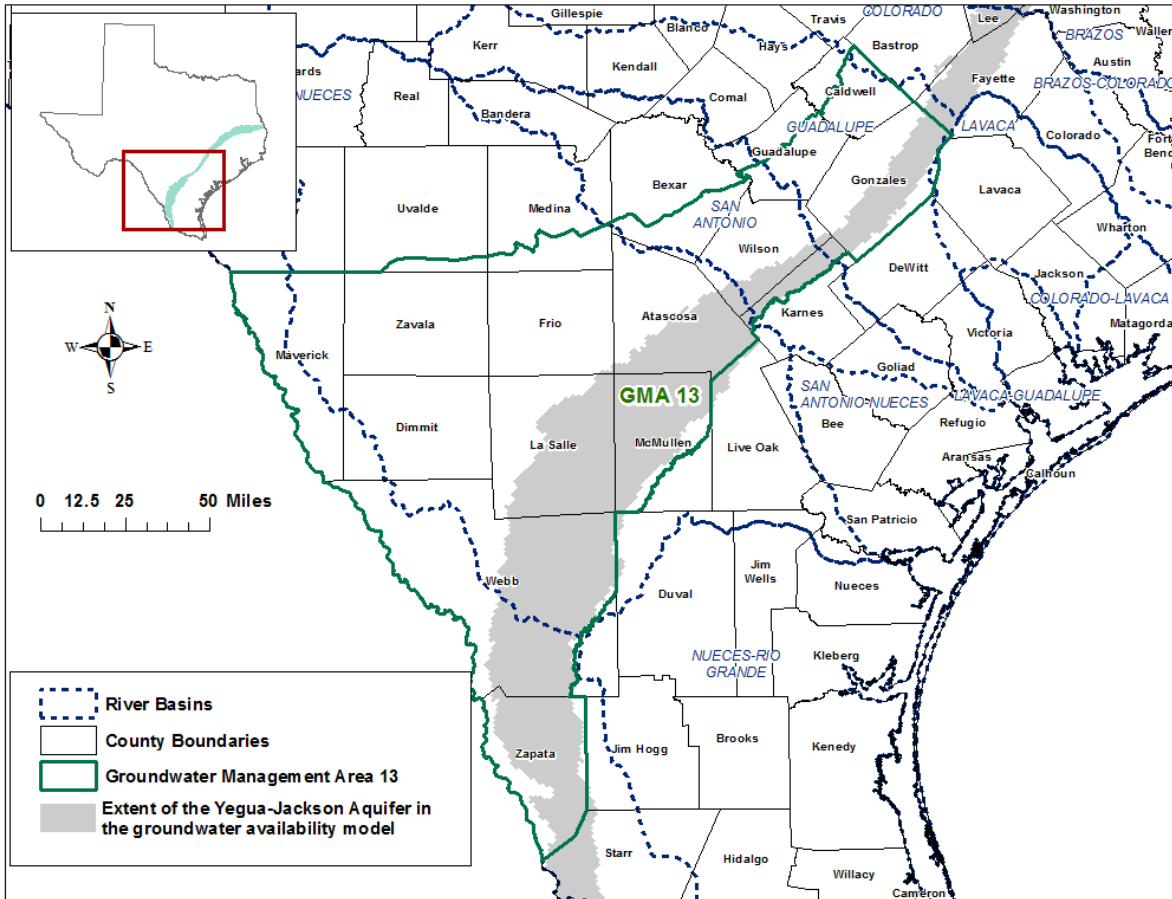


FIGURE 5. GROUNDWATER MANAGEMENT AREA (GMA) 13 BOUNDARY, RIVER BASINS, AND COUNTIES OVERLAIN ON THE EXTENT OF THE YEGUA-JACKSON AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL.

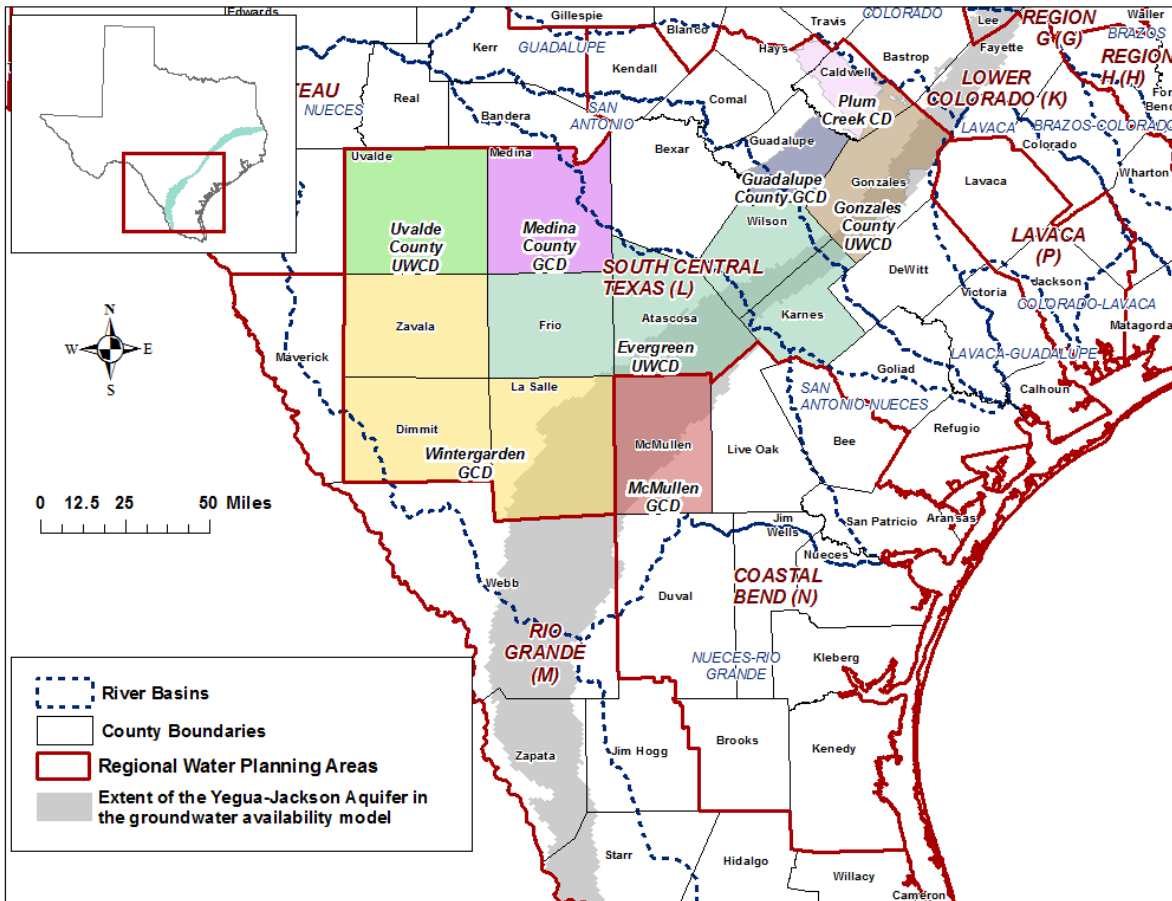


FIGURE 6. REGIONAL WATER PLANNING AREAS (RWPAS), RIVER BASINS, GROUNDWATER CONSERVATION DISTRICTS (GCDs), AND COUNTIES OVERLAIN ON THE EXTENT OF THE YEGUA-JACKSON AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL.

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

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

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

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

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

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TABLE 5. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 13. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.

County	RWPA	River Basin	Aquifer	2020	2030	2040	2050	2060	2070
Atascosa	L	Nueces	Carrizo-Wilcox	67,548	70,166	70,946	72,598	74,178	75,754
Atascosa	L	San Antonio	Carrizo-Wilcox	120	120	120	120	120	120
Bexar	L	Nueces	Carrizo-Wilcox	48,152	48,152	48,152	48,152	48,152	48,176
Bexar	L	San Antonio	Carrizo-Wilcox	33,322	32,665	32,196	31,318	30,825	30,631
Caldwell	L	Colorado	Carrizo-Wilcox	593	593	593	593	593	593
Caldwell	L	Guadalupe	Carrizo-Wilcox	60,652	60,652	57,208	57,208	53,596	53,596
Dimmit	L	Nueces	Carrizo-Wilcox	4,022	4,022	4,022	4,022	4,022	4,022
Dimmit	L	Rio Grande	Carrizo-Wilcox	107	107	107	107	107	107
Frio	L	Nueces	Carrizo-Wilcox	111,920	85,036	82,999	81,083	79,197	77,353
Gonzales	L	Guadalupe	Carrizo-Wilcox	81,438	81,438	85,216	85,579	85,832	85,840
Gonzales	L	Lavaca	Carrizo-Wilcox	215	215	215	215	215	215
Guadalupe	L	Guadalupe	Carrizo-Wilcox	36,180	32,150	29,767	31,569	31,793	31,744
Guadalupe	L	San Antonio	Carrizo-Wilcox	16,347	15,693	16,008	16,426	16,172	16,089
Karnes	L	Guadalupe	Carrizo-Wilcox	177	185	195	207	215	220
Karnes	L	Nueces	Carrizo-Wilcox	83	87	92	97	101	103
Karnes	L	San Antonio	Carrizo-Wilcox	783	813	859	909	948	972
La Salle	L	Nueces	Carrizo-Wilcox	6,863	6,863	6,863	6,863	6,863	6,863
Medina	L	Nueces	Carrizo-Wilcox	2,652	2,643	2,643	2,642	2,641	2,641
Medina	L	San Antonio	Carrizo-Wilcox	5	5	5	5	5	5
Uvalde	L	Nueces	Carrizo-Wilcox	2,975	1,231	828	828	828	828
Wilson	L	Guadalupe	Carrizo-Wilcox	20,287	20,186	20,340	20,452	20,783	20,923

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

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TABLE 6. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE QUEEN CITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 13. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.

County	RWPA	River Basin	Aquifer	2020	2030	2040	2050	2060	2070
Atascosa	L	Nueces	Queen City	4,075	4,543	4,543	4,513	4,407	4,302
Caldwell	L	Guadalupe	Queen City	307	307	307	307	307	307
Frio	L	Nueces	Queen City	6,759	4,745	4,573	4,429	4,257	4,113
Gonzales	L	Guadalupe	Queen City	5,032	5,032	5,032	5,032	5,032	5,032
Gonzales	L	Lavaca	Queen City	35	35	35	35	35	35
Guadalupe	L	Guadalupe	Queen City	0	0	0	0	0	0
La Salle	L	Nueces	Queen City	2	2	2	2	2	2
Wilson	L	Guadalupe	Queen City	236	128	114	101	90	80
Wilson	L	Nueces	Queen City	273	148	132	117	104	93
Wilson	L	San Antonio	Queen City	2,271	1,232	1,094	973	865	772
McMullen	N	Nueces	Queen City	134	134	134	134	134	134
GMA 13 Total			Queen City	19,123	16,307	15,965	15,643	15,233	14,869

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TABLE 7. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE SPARTA AQUIFER IN GROUNDWATER MANAGEMENT AREA 13. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.

County	RWPA	River Basin	Aquifer	2020	2030	2040	2050	2060	2070
Atascosa	L	Nueces	Sparta	1,215	1,188	1,129	1,083	1,044	1,013
Frio	L	Nueces	Sparta	1,045	728	702	674	651	624
Gonzales	L	Guadalupe	Sparta	3,531	3,531	3,531	3,531	3,531	3,531
Gonzales	L	Lavaca	Sparta	23	23	23	23	23	23
La Salle	L	Nueces	Sparta	983	983	983	983	983	983
Wilson	L	Guadalupe	Sparta	42	23	20	18	16	14
Wilson	L	Nueces	Sparta	102	55	49	44	39	34
Wilson	L	San Antonio	Sparta	319	173	154	137	121	108
McMullen	N	Nueces	Sparta	89	89	89	89	89	89
GMA 13 Total			Sparta	7,349	6,793	6,682	6,582	6,497	6,419

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TABLE 8. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE YEGUA-JACKSON AQUIFER IN GROUNDWATER MANAGEMENT AREA 13. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.

County	RWPA	River Basin	Aquifer	2020	2030	2040	2050	2060	2070
Atascosa	L	Nueces	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
Frio	L	Nueces	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
Gonzales	L	Guadalupe	Yegua-Jackson	4,694	4,694	4,694	4,694	4,694	4,694
Gonzales	L	Lavaca	Yegua-Jackson	19	19	19	19	19	19
Karnes	L	Guadalupe	Yegua-Jackson	327	327	327	327	327	327
Karnes	L	Nueces	Yegua-Jackson	91	91	91	91	91	91
Karnes	L	San Antonio	Yegua-Jackson	1,641	1,641	1,641	1,641	1,641	1,641
La Salle	L	Nueces	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
Wilson	L	Guadalupe	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
Wilson	L	Nueces	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
Wilson	L	San Antonio	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
Webb	M	Nueces	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
Webb	M	Rio Grande	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
Zapata	M	Rio Grande	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
McMullen	N	Nueces	Yegua-Jackson	NULL	NULL	NULL	NULL	NULL	NULL
GMA 13 Total			Yegua-Jackson	6,771	6,771	6,771	6,771	6,771	6,771

NULL: Groundwater Management Area 13 declared the Yegua-Jackson Aquifer not relevant in these areas.

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LIMITATIONS:

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

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

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

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

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

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Appendix A

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

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

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

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

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

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

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

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

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

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Appendix B

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

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

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

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