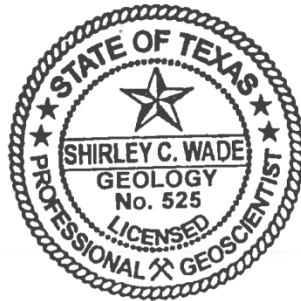

GAM RUN 16-024 MAG: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 14

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Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Section
(512) 936-0883
December 15, 2016



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12/15/16

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EXECUTIVE SUMMARY:

The modeled available groundwater for Groundwater Management Area 14 and the projected groundwater pumpage in subsidence districts for the Gulf Coast Aquifer System ranges from approximately 1,020,000 acre-feet per year in 2010 to 950,000 acre-feet per year in 2070. Table 1 presents the modeled available groundwater summarized by the decades 2010 to 2070 for groundwater conservation districts. Table 2 presents the projected groundwater pumpage in regulatory plans adopted by subsidence districts and factored into the development of desired future conditions adopted by groundwater conservation districts. Table 3 summarizes the modeled available groundwater for groundwater conservation districts and non-district counties, and the projected groundwater pumpage for subsidence districts by the decades 2020 to 2070 for use in the regional water planning process. The estimates are based on the desired future conditions for the Gulf Coast Aquifer System adopted by groundwater conservation districts in Groundwater Management Area 14 on April 29, 2016. The explanatory report and other materials submitted to the Texas Water Development Board (TWDB) were determined to be administratively complete on July 12, 2016.

REQUESTOR:

Ms. Kathy Turner Jones, chair of Groundwater Management Area 14.

DESCRIPTION OF REQUEST:

In a letter dated May 5, 2016, Ms. Kathy Turner Jones provided the TWDB with the desired future conditions of the Gulf Coast Aquifer System adopted by the groundwater

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conservation districts in Groundwater Management Area 14. The desired future conditions for the Gulf Coast Aquifer System, as described in Resolution No. 2016-01-01 and adopted April 29, 2016 by the groundwater conservation districts within Groundwater Management Area 14, are described below:

Groundwater Management Area 14 [all counties]

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 28.3 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately 23.6 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Burkeville confining unit should not exceed approximately 18.5 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Jasper Aquifer should not exceed approximately 66.2 feet after 61 years.

Austin County [Bluebonnet Groundwater Conservation District]

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 39 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Burkeville confining unit should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Jasper Aquifer should not exceed approximately 76 feet after 61 years.
- From estimated year 1890 conditions, the maximum subsidence in Austin County should not exceed approximately 2.83 feet by the year 2070.

Brazoria County [Brazoria County Groundwater Conservation District]

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately 27 feet after 61 years.

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Chambers County

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 32 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately 30 feet after 61 years.

Grimes County [Bluebonnet Groundwater Conservation District]

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 5 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately 5 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Burkeville confining unit should not exceed approximately 6 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Jasper Aquifer should not exceed approximately 52 feet after 61 years.
- From estimated year 1890 conditions, the maximum subsidence in Grimes County should not exceed approximately 0.12 feet by the year 2070.

Hardin County [Southeast Texas Groundwater Conservation District]

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 21 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately 27 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Burkeville confining unit should not exceed approximately 29 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Jasper Aquifer should not exceed approximately 89 feet after 61 years.

Jasper County [Southeast Texas Groundwater Conservation District]

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 23 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately 41 feet after 61 years.

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- From estimated year 2009 conditions, the average drawdown of the Burkeville confining unit should not exceed approximately 46 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Jasper Aquifer should not exceed approximately 40 feet after 61 years.

Jefferson County

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 15 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately 17 feet after 61 years.

Liberty County

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 27 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately 29 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Burkeville confining unit should not exceed approximately 25 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Jasper Aquifer should not exceed approximately 120 feet after 61 years.

Montgomery County [Lone Star Groundwater Conservation District]

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 26 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately -4 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Burkeville confining unit should not exceed approximately -4 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Jasper Aquifer should not exceed approximately 34 feet after 61 years.

Newton County [Southeast Texas Groundwater Conservation District]

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 35 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately 45 feet after 61 years.

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- From estimated year 2009 conditions, the average drawdown of the Burkeville confining unit should not exceed approximately 44 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Jasper Aquifer should not exceed approximately 37 feet after 61 years.

Orange County

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 14 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately 16 feet after 61 years.

Polk County [Lower Trinity Groundwater Conservation District]

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 26 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately 10 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Burkeville confining unit should not exceed approximately 15 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Jasper Aquifer should not exceed approximately 73 feet after 61 years.

San Jacinto County [Lower Trinity Groundwater Conservation District]

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 22 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately 19 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Burkeville confining unit should not exceed approximately 19 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Jasper Aquifer should not exceed approximately 108 feet after 61 years.

Tyler County [Southeast Texas Groundwater Conservation District]

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 42 feet after 61 years.

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- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately 35 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Burkeville confining unit should not exceed approximately 30 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Jasper Aquifer should not exceed approximately 62 feet after 61 years.

Walker County [Bluebonnet Groundwater Conservation District]

- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately 9 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Burkeville confining unit should not exceed approximately 4 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Jasper Aquifer should not exceed approximately 42 feet after 61 years.
- From estimated year 1890 conditions, the maximum subsidence in Walker County should not exceed approximately 0.04 feet by the year 2070.

Waller County [Bluebonnet Groundwater Conservation District]

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 39 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately 39 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Burkeville confining unit should not exceed approximately 40 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Jasper Aquifer should not exceed approximately 101 feet after 61 years.
- From estimated year 1890 conditions, the maximum subsidence in Waller County should not exceed approximately 4.73 feet by the year 2070.

Washington County

- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately 1 foot after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Burkeville confining unit should not exceed approximately 16 feet after 61 years.

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- From estimated year 2009 conditions, the average drawdown of the Jasper Aquifer should not exceed approximately 48 feet after 61 years.

Harris, Galveston, and Fort Bend Counties (Subsidence Districts)

Harris-Galveston Subsidence District and Fort Bend Subsidence District are not subject to the provisions of Section 36.108 of the Texas Water Code and therefore have not specified desired future conditions. Because desired future conditions were not adopted for the counties in the subsidence districts, modeled available groundwater values were not determined for those counties. The districts in Groundwater Management Area 14 incorporated the groundwater pumpage projections made by the subsidence districts in their regulatory plans so that all known regional groundwater pumping was factored into the joint planning process. The subsidence district groundwater pumpage projections are provided in Table 2 and are incorporated into the information relevant to regional water planning (Table 3).

METHODS:

The TWDB ran the groundwater availability model (version 3.01) for the northern part of the Gulf Coast Aquifer System (Figure 1) using the model files submitted with the explanatory report (GMA 14 and others, 2016; Appendix F) and an updated pumping file provided by the Groundwater Management Area 14 consultants on October 26, 2016. 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 were divided by county, river basin, regional water planning area, and groundwater conservation district within Groundwater Management Area 14 (Figure 2 and Tables 1 through 3).

As part of the process to calculate modeled available groundwater, the TWDB checked the model files submitted by Groundwater Management Area 14 to determine if the groundwater pumping scenarios were compatible with the adopted desired future conditions. The TWDB used these model files to extract model-calculated water levels for 2009 and 2070, and drawdown was calculated as the difference between water levels in 2009 and water levels in 2070. The results of this evaluation are provided in the Appendix. Drawdown averages were calculated for each county by aquifer and for the entire groundwater management area by aquifer. As specified in the explanatory report (GMA 14 and others, 2016; Appendix F), drawdown for cells which became dry during the simulation (water level dropped below the base of the cell) were excluded from the averaging. The calculated drawdown averages compared well with the desired future conditions and verified that the pumping scenarios defined by the districts achieved the desired future conditions. The subsidence values were also extracted from the model

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results and those were also compared to subsidence-based desired future conditions for the four counties where they were specified.

Modeled Available Groundwater and Permitting

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

PARAMETERS AND ASSUMPTIONS:

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

- Version 3.01 of the groundwater availability model for the northern portion of the Gulf Coast Aquifer System was used for this analysis. See Kasmarek (2013) for assumptions and limitations of the model.
- The model has four layers which represent the Chicot Aquifer (Layer 1), the Evangeline Aquifer (Layer 2), the Burkeville Confining Unit (Layer 3), and the Jasper Aquifer and parts of the Catahoula Formation in direct hydrologic communication with the Jasper Aquifer (Layer 4).
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).
- Drawdown averages and modeled available groundwater values are based on the extent of the model area rather than official aquifer boundaries (Figures 1 and 2).
- Drawdown for cells with water levels below the base elevation of the cell (“dry” cells) were excluded from the averaging per Appendix F of the explanatory report.
- Cells with water levels below the base are “dry” in terms of water level. However, the transmissivity of those cells remains constant and pumping from those cells continues.
- For those cells where water levels have dropped below the base we include pumping in the modeled available groundwater values.
- Estimates of modeled available groundwater from the model simulation were rounded to whole numbers.

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- Starting conditions were assumed reasonable since 2009 was the final year of the calibrated model.
- A model tolerance of up to one foot was assumed when comparing desired future condition average drawdown values per county to model results (Appendix).
- A model tolerance of 0.1 foot was assumed when comparing desired future condition maximum subsidence values per county to model results (Appendix).
- Average drawdown per county may include some model cells that represent portions of surface water such as bays, reservoirs, and the Gulf of Mexico.

RESULTS:

The modeled available groundwater for the Gulf Coast Aquifer System that achieves the desired future conditions adopted by Groundwater Management Area 14 decreases from 571,007 to 544,220 acre-feet per year between 2010 and 2070 (Table 1). Projected groundwater pumpage from the three counties in the Harris Galveston Subsidence District and Fort Bend Subsidence District range between 325,226 and 545,246 acre-feet per year during the period 2010 to 2070 (Table 2). The combination of modeled available groundwater and projected groundwater pumpage has been summarized by county, river basin, and regional water planning area for use in the regional water planning process (Table 3). The modeled available groundwater is also summarized by groundwater conservation district and county (Table 1).

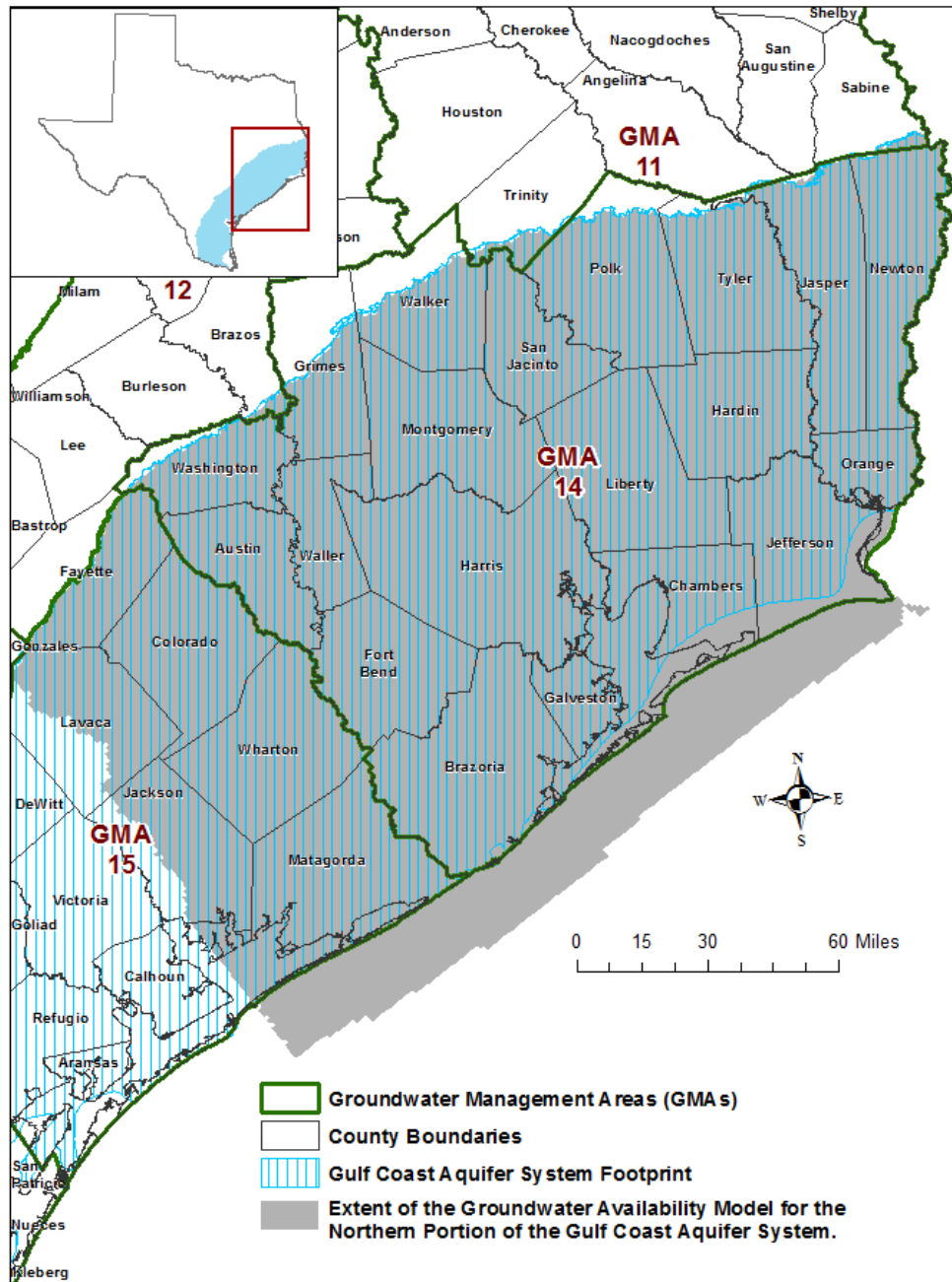


FIGURE 1. MAP SHOWING THE AREAS COVERED BY THE GROUNDWATER AVAILABILITY MODEL FOR THE NORTHERN PART OF THE GULF COAST AQUIFER SYSTEM.

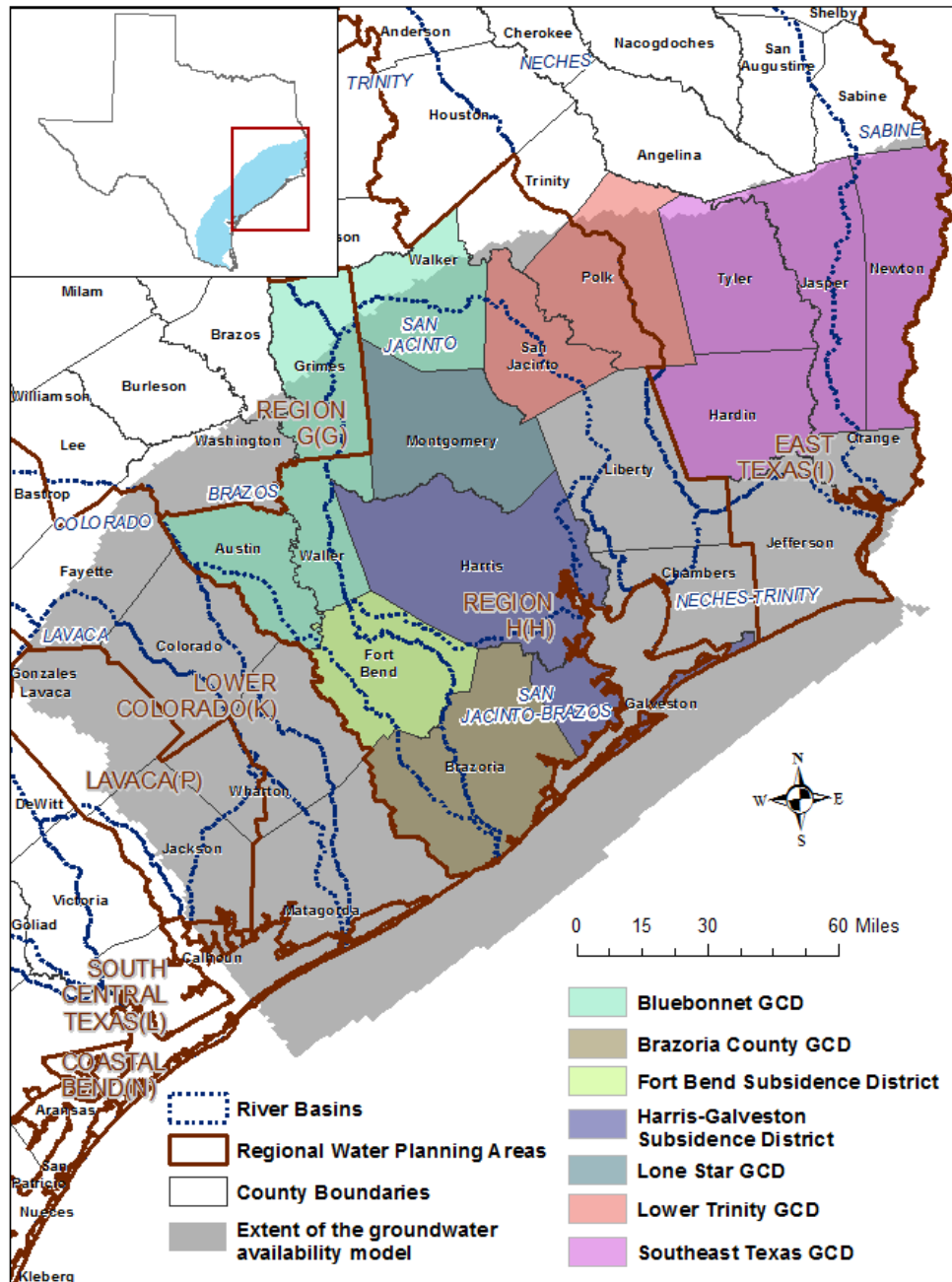


FIGURE 2. MAP SHOWING REGIONAL WATER PLANNING AREAS, GROUNDWATER CONSERVATION DISTRICTS (GCDs), SUBSIDENCE DISTRICTS, COUNTIES, AND RIVER BASINS IN GROUNDWATER MANAGEMENT AREA 14.

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TABLE 1. MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 14 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2010 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.

Groundwater Conservation District	County	Aquifer	2010	2020	2030	2040	2050	2060	2070
Bluebonnet GCD	Austin	Chicot Aquifer	1,300	1,300	1,300	1,300	1,300	1,300	1,300
Bluebonnet GCD	Austin	Evangelina Aquifer	19,998	19,998	19,998	19,998	19,998	19,998	19,998
Bluebonnet GCD	Austin	Burkeville confining	0	0	0	0	0	0	0
Bluebonnet GCD	Austin	Jasper Aquifer	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Bluebonnet GCD	Grimes	Chicot Aquifer	0	0	0	0	0	0	0
Bluebonnet GCD	Grimes	Evangelina Aquifer	2,999	2,999	2,999	2,999	2,999	2,999	2,999
Bluebonnet GCD	Grimes	Burkeville confining	0	0	0	0	0	0	0
Bluebonnet GCD	Grimes	Jasper Aquifer	10,998	10,998	10,998	10,998	10,998	10,998	10,998
Bluebonnet GCD	Walker	Chicot Aquifer	0	0	0	0	0	0	0
Bluebonnet GCD	Walker	Evangelina Aquifer	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Bluebonnet GCD	Walker	Burkeville confining	0	0	0	0	0	0	0
Bluebonnet GCD	Walker	Jasper Aquifer	15,972	15,972	15,972	15,972	15,972	15,972	15,972
Bluebonnet GCD	Waller	Chicot Aquifer	300	300	300	300	300	300	300
Bluebonnet GCD	Waller	Evangelina Aquifer	40,994	40,994	40,994	40,994	40,994	40,994	40,994
Bluebonnet GCD	Waller	Burkeville confining	0	0	0	0	0	0	0
Bluebonnet GCD	Waller	Jasper Aquifer	300	300	300	300	300	300	300
Bluebonnet GCD Total		Gulf Coast Aquifer System	95,859	95,859	95,859	95,859	95,859	95,859	95,859
Brazoria County	Brazoria	Chicot Aquifer	38,994	39,042	39,164	39,208	39,251	39,295	39,345
Brazoria County	Brazoria	Evangelina Aquifer	11,376	11,376	11,376	11,376	11,376	11,375	11,376
Brazoria County GCD Total		Gulf Coast Aquifer System	50,369	50,418	50,540	50,583	50,626	50,670	50,721
Lone Star GCD	Montgomery	Chicot Aquifer	11,922	12,600	13,870	13,944	15,026	14,717	14,175
Lone Star GCD	Montgomery	Evangelina Aquifer	37,734	27,525	27,553	27,773	26,575	26,615	26,529

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Groundwater Conservation District	County	Aquifer	2010	2020	2030	2040	2050	2060	2070
Lone Star GCD	Montgomery	Burkeville confining	0	0	0	0	0	0	0
Lone Star GCD	Montgomery	Jasper Aquifer	41,491	23,880	22,582	22,288	22,404	22,673	23,301
Lone Star GCD Total		Gulf Coast Aquifer System	91,146	64,004	64,004	64,004	64,004	64,004	64,004
Lower Trinity GCD	Polk	Chicot Aquifer	0	0	0	0	0	0	0
Lower Trinity GCD	Polk	Evangelina Aquifer	8,302	8,302	8,302	8,302	8,302	8,302	8,302
Lower Trinity GCD	Polk	Burkeville confining	743	743	743	743	743	743	743
Lower Trinity GCD	Polk	Jasper Aquifer	27,663	27,663	27,663	27,663	27,663	27,663	27,663
Lower Trinity GCD	San Jacinto	Chicot Aquifer	0	0	0	0	0	0	0
Lower Trinity GCD	San Jacinto	Evangelina Aquifer	8,170	8,170	8,170	8,170	8,170	8,170	8,170
Lower Trinity GCD	San Jacinto	Burkeville confining	2,697	2,697	2,697	2,697	2,697	2,697	2,697
Lower Trinity GCD	San Jacinto	Jasper Aquifer	10,116	10,116	10,116	10,116	10,116	10,116	10,116
Lower Trinity GCD Total		Gulf Coast Aquifer System	57,691	57,691	57,691	57,691	57,691	57,691	57,691
Southeast Texas	Hardin	Chicot Aquifer	1,262	1,262	1,262	1,262	1,262	1,262	1,262
Southeast Texas	Hardin	Evangelina Aquifer	33,665	33,665	33,665	33,665	33,665	33,665	33,665
Southeast Texas	Hardin	Burkeville confining	0	0	0	0	0	0	0
Southeast Texas	Hardin	Jasper Aquifer	0	0	0	0	0	0	0
Southeast Texas	Jasper	Chicot Aquifer	10,827	10,827	10,827	10,827	10,827	10,827	10,827
Southeast Texas	Jasper	Evangelina Aquifer	40,648	40,648	40,648	40,648	40,648	40,648	40,648
Southeast Texas	Jasper	Burkeville confining	1	1	1	1	1	1	1
Southeast Texas	Jasper	Jasper Aquifer	16,008	16,008	16,008	16,008	16,008	16,008	16,008
Southeast Texas	Newton	Chicot Aquifer	500	500	500	500	500	500	500
Southeast Texas	Newton	Evangelina Aquifer	21,343	21,343	21,343	21,343	21,343	21,343	21,343
Southeast Texas	Newton	Burkeville confining	0	0	0	0	0	0	0
Southeast Texas	Newton	Jasper Aquifer	12,376	12,376	12,376	12,376	12,376	12,376	12,376
Southeast Texas	Tyler	Chicot Aquifer	0	0	0	0	0	0	0

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Groundwater Conservation District	County	Aquifer	2010	2020	2030	2040	2050	2060	2070
Southeast Texas	Tyler	Evangelina Aquifer	20,576	20,576	20,576	20,576	20,576	20,576	20,576
Southeast Texas	Tyler	Burkeville confining	1	1	1	1	1	1	1
Southeast Texas	Tyler	Jasper Aquifer	17,634	17,634	17,634	17,634	17,634	17,634	17,634
Southeast Texas GCD Total		Gulf Coast Aquifer System	174,841	174,841	174,841	174,841	174,841	174,841	174,841
Total (groundwater conservation districts)		Gulf Coast Aquifer System	469,907	442,813	442,936	442,979	443,022	443,066	443,117
No District-County	Chambers	Chicot Aquifer	22,573	22,573	22,573	22,573	22,573	22,573	22,573
No District-County	Chambers	Evangelina Aquifer	378	378	378	378	378	378	378
No District-County	Jefferson	Chicot Aquifer	2,426	2,426	2,426	2,426	2,426	2,426	2,426
No District-County	Jefferson	Evangelina Aquifer	100	100	100	100	100	100	100
No District-County	Liberty	Chicot Aquifer	14,571	14,571	14,572	14,572	14,572	14,572	14,572
No District-County	Liberty	Evangelina Aquifer	27,654	27,654	27,656	27,655	27,656	27,656	27,656
No District-County	Liberty	Burkeville confining	215	215	215	215	215	215	215
No District-County	Liberty	Jasper Aquifer	787	787	787	787	787	787	787
No District-County	Orange	Chicot Aquifer	18,162	18,162	18,162	18,162	18,162	18,162	18,162
No District-County	Orange	Evangelina Aquifer	1,202	1,202	1,202	1,202	1,202	1,202	1,202
No District-County	Washington	Evangelina Aquifer	3,236	3,236	3,236	3,236	3,236	3,236	3,236
No District-County	Washington	Burkeville confining	367	367	367	367	367	367	367
No District-County	Washington	Jasper Aquifer	9,428	9,428	9,428	9,428	9,428	9,428	9,428
No District-County Total		Gulf Coast Aquifer System	101,100	101,100	101,103	101,101	101,102	101,103	101,103

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Groundwater Conservation District	County	Aquifer	2010	2020	2030	2040	2050	2060	2070
GMA 14	Total (all areas except subsidence districts)	Gulf Coast Aquifer System	571,007	543,913	544,039	544,080	544,124	544,169	544,020

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TABLE 2. GROUNDWATER PUMPAGE PROJECTIONS FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 14 FOR SUBSIDENCE DISTRICT COUNTIES FOR EACH DECADE BETWEEN 2010 AND 2070. VALUES ARE IN ACRE-FEET PER YEAR.

Subsidence District	County	Aquifer	2010	2020	2030	2040	2050	2060	2070
Fort Bend	Fort Bend	Chicot Aquifer	46,789	58,200	52,663	62,635	72,957	84,002	95,430
Fort Bend	Fort Bend	Evangeline Aquifer	75,249	71,572	51,072	56,656	61,875	66,942	71,651
Fort Bend	Fort Bend	Burkeville confining	0	0	0	0	0	0	0
Fort Bend	Fort Bend	Jasper Aquifer	0	0	0	0	0	0	0
Fort Bend Subsidence District Total		Gulf Coast Aquifer System	122,038	129,772	103,735	119,291	134,832	150,944	167,081
Harris-Galveston	Galveston	Chicot Aquifer	4,850	5,819	6,537	7,153	7,748	8,303	8,759
Harris-Galveston	Galveston	Evangeline Aquifer	167	215	254	284	314	346	371
Harris-Galveston	Harris	Chicot Aquifer	92,348	136,640	108,694	80,512	86,842	90,290	93,457
Harris-Galveston	Harris	Evangeline Aquifer	224,465	264,588	176,427	114,821	121,148	126,231	130,840
Harris-Galveston	Harris	Burkeville confining	0	0	0	0	0	0	0
Harris-Galveston	Harris	Jasper Aquifer	6,067	8,212	5,432	3,164	3,368	3,519	3,644
Harris-Galveston Subsidence District Total		Gulf Coast Aquifer System	327,897	415,474	297,343	205,935	219,420	228,688	237,071
GMA 14	Total (subsidence districts)	Gulf Coast Aquifer System	449,935	545,246	401,078	325,226	354,252	379,632	404,152

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TABLE 3. MODELED AVAILABLE GROUNDWATER AND PROJECTED GROUNDWATER PUMPAGE VALUES (*IN ITALICS*) BY DECADE FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 14. 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	Gulf Coast Aquifer System	2020	2030	2040	2050	2060	2070
Austin	H	Brazos-Colorado	Chicot Aquifer	1,005	1,005	1,005	1,005	1,005	1,005
Austin	H	Brazos-Colorado	Evangeline Aquifer	14,517	14,517	14,517	14,517	14,517	14,517
Austin	H	Brazos-Colorado	Burkeville confining unit	0	0	0	0	0	0
Austin	H	Brazos-Colorado	Jasper Aquifer	76	76	76	76	76	76
Austin	H	Brazos	Chicot Aquifer	295	295	295	295	295	295
Austin	H	Brazos	Evangeline Aquifer	5,458	5,458	5,458	5,458	5,458	5,458
Austin	H	Brazos	Burkeville confining unit	0	0	0	0	0	0
Austin	H	Brazos	Jasper Aquifer	826	826	826	826	826	826
Austin	H	Colorado	Chicot Aquifer	0	0	0	0	0	0
Austin	H	Colorado	Evangeline Aquifer	23	23	23	23	23	23
Austin	H	Colorado	Burkeville confining unit	0	0	0	0	0	0
Austin	H	Colorado	Jasper Aquifer	98	98	98	98	98	98
Brazoria	H	Brazos-Colorado	Chicot Aquifer	9,134	8,929	8,735	8,474	8,217	7,986
Brazoria	H	Brazos-Colorado	Evangeline Aquifer	1	1	2	2	2	2
Brazoria	H	Brazos	Chicot Aquifer	3,223	3,057	2,992	2,923	2,865	2,821
Brazoria	H	Brazos	Evangeline Aquifer	0	0	0	0	0	0
Brazoria	H	San Jacinto-Brazos	Chicot Aquifer	26,684	27,178	27,481	27,854	28,213	28,537
Brazoria	H	San Jacinto-Brazos	Evangeline Aquifer	11,375	11,374	11,374	11,374	11,374	11,374
Chambers	H	Neches-Trinity	Chicot Aquifer	10,798	10,798	10,798	10,798	10,798	10,798
Chambers	H	Neches-Trinity	Evangeline Aquifer	0	0	0	0	0	0
Chambers	H	Trinity-San Jacinto	Chicot Aquifer	1,671	1,671	1,671	1,671	1,671	1,671
Chambers	H	Trinity-San Jacinto	Evangeline Aquifer	378	378	378	378	378	378
Chambers	H	Trinity	Chicot Aquifer	10,104	10,104	10,104	10,104	10,104	10,104
Chambers	H	Trinity	Evangeline Aquifer	0	0	0	0	0	0
<i>Fort Bend</i>	<i>H</i>	<i>Brazos-Colorado</i>	<i>Chicot Aquifer</i>	<i>6,338</i>	<i>7,157</i>	<i>8,493</i>	<i>10,447</i>	<i>13,307</i>	<i>17,077</i>
<i>Fort Bend</i>	<i>H</i>	<i>Brazos-Colorado</i>	<i>Evangeline Aquifer</i>	<i>563</i>	<i>728</i>	<i>1,079</i>	<i>1,584</i>	<i>2,310</i>	<i>3,256</i>

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County	RWPA	River Basin	Gulf Coast Aquifer System	2020	2030	2040	2050	2060	2070
Fort Bend	H	Brazos-Colorado	Burkeville confining unit	0	0	0	0	0	0
Fort Bend	H	Brazos-Colorado	Jasper Aquifer	0	0	0	0	0	0
Fort Bend	H	Brazos	Chicot Aquifer	25,117	24,308	30,446	36,552	42,837	49,006
Fort Bend	H	Brazos	Evangeline Aquifer	17,216	13,537	16,080	18,582	21,174	23,754
Fort Bend	H	Brazos	Burkeville confining unit	0	0	0	0	0	0
Fort Bend	H	Brazos	Jasper Aquifer	0	0	0	0	0	0
Fort Bend	H	San Jacinto-Brazos	Chicot Aquifer	17,810	15,117	17,542	19,801	21,707	23,191
Fort Bend	H	San Jacinto-Brazos	Evangeline Aquifer	35,680	25,524	28,118	30,370	32,165	33,366
Fort Bend	H	San Jacinto-Brazos	Burkeville confining unit	0	0	0	0	0	0
Fort Bend	H	San Jacinto-Brazos	Jasper Aquifer	0	0	0	0	0	0
Fort Bend	H	San Jacinto	Chicot Aquifer	8,936	6,081	6,153	6,157	6,151	6,156
Fort Bend	H	San Jacinto	Evangeline Aquifer	18,113	11,282	11,379	11,340	11,293	11,275
Fort Bend	H	San Jacinto	Burkeville confining unit	0	0	0	0	0	0
Fort Bend	H	San Jacinto	Jasper Aquifer	0	0	0	0	0	0
Galveston	H	Neches-Trinity	Chicot Aquifer	0	0	0	0	0	1
Galveston	H	San Jacinto-Brazos	Chicot Aquifer	5,819	6,537	7,153	7,748	8,303	8,759
Galveston	H	San Jacinto-Brazos	Evangeline Aquifer	215	254	284	314	346	371
Grimes	G	Brazos	Chicot Aquifer	0	0	0	0	0	0
Grimes	G	Brazos	Evangeline Aquifer	2,256	2,256	2,256	2,256	2,256	2,256
Grimes	G	Brazos	Burkeville confining unit	0	0	0	0	0	0
Grimes	G	Brazos	Jasper Aquifer	8,624	8,624	8,624	8,624	8,624	8,624
Grimes	G	San Jacinto	Chicot Aquifer	0	0	0	0	0	0
Grimes	G	San Jacinto	Evangeline Aquifer	743	743	743	743	743	743
Grimes	G	San Jacinto	Burkeville confining unit	0	0	0	0	0	0
Grimes	G	San Jacinto	Jasper Aquifer	1,451	1,451	1,451	1,451	1,451	1,451
Grimes	G	Trinity	Jasper Aquifer	922	922	922	922	922	922
Hardin	I	Neches	Chicot Aquifer	1,262	1,262	1,262	1,262	1,262	1,262
Hardin	I	Neches	Evangeline Aquifer	33,527	33,527	33,527	33,527	33,527	33,527
Hardin	I	Neches	Burkeville confining unit	0	0	0	0	0	0

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County	RWPA	River Basin	Gulf Coast Aquifer System	2020	2030	2040	2050	2060	2070
Hardin	I	Neches	Jasper Aquifer	0	0	0	0	0	0
Hardin	I	Trinity	Chicot Aquifer	0	0	0	0	0	0
Hardin	I	Trinity	Evangeline Aquifer	138	138	138	138	138	138
Hardin	I	Trinity	Burkeville confining unit	0	0	0	0	0	0
Hardin	I	Trinity	Jasper Aquifer	0	0	0	0	0	0
Harris	H	San Jacinto-Brazos	Chicot Aquifer	4,331	4,858	5,405	5,959	6,383	6,853
Harris	H	San Jacinto-Brazos	Evangeline Aquifer	1,975	2,096	2,211	2,323	2,435	2,544
Harris	H	San Jacinto	Chicot Aquifer	129,749	101,232	72,499	78,104	81,042	83,662
Harris	H	San Jacinto	Evangeline Aquifer	262,218	173,938	112,257	118,444	123,397	127,883
Harris	H	San Jacinto	Burkeville confining unit	0	0	0	0	0	0
Harris	H	San Jacinto	Jasper Aquifer	8,212	5,432	3,164	3,368	3,519	3,644
Harris	H	Trinity-San Jacinto	Chicot Aquifer	2,560	2,604	2,609	2,779	2,865	2,942
Harris	H	Trinity-San Jacinto	Evangeline Aquifer	395	393	353	382	398	412
Harris	H	Trinity-San Jacinto	B Burkeville confining unit	0	0	0	0	0	0
Harris	H	Trinity-San Jacinto	Jasper Aquifer	0	0	0	0	0	0
Jasper	I	Neches	Chicot Aquifer	7,717	7,717	7,717	7,717	7,717	7,717
Jasper	I	Neches	Evangeline Aquifer	17,407	17,407	17,407	17,407	17,407	17,407
Jasper	I	Neches	Burkeville confining unit	0	0	0	0	0	0
Jasper	I	Neches	Jasper Aquifer	12,506	12,506	12,506	12,506	12,506	12,506
Jasper	I	Sabine	Chicot Aquifer	3,110	3,110	3,110	3,110	3,110	3,110
Jasper	I	Sabine	Evangeline Aquifer	23,241	23,241	23,241	23,241	23,241	23,241
Jasper	I	Sabine	Burkeville confining unit	1	1	1	1	1	1
Jasper	I	Sabine	Jasper Aquifer	3,502	3,502	3,502	3,502	3,502	3,502
Jefferson	I	Neches-Trinity	Chicot Aquifer	1,722	1,722	1,722	1,722	1,722	1,722
Jefferson	I	Neches-Trinity	Evangeline Aquifer	0	0	0	0	0	0
Jefferson	I	Neches	Chicot Aquifer	703	703	703	703	703	703
Jefferson	I	Neches	Evangeline Aquifer	100	100	100	100	100	100
Liberty	H	Neches-Trinity	Chicot Aquifer	327	327	327	327	327	327
Liberty	H	Neches-Trinity	Evangeline Aquifer	37	37	37	37	37	37

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County	RWPA	River Basin	Gulf Coast Aquifer System	2020	2030	2040	2050	2060	2070
Waller	H	Brazos	Burkeville confining unit	0	0	0	0	0	0
Waller	H	Brazos	Jasper Aquifer	300	300	300	300	300	300
Waller	H	San Jacinto	Chicot Aquifer	44	44	44	44	44	44
Waller	H	San Jacinto	Evangeline Aquifer	26,630	26,630	26,630	26,630	26,630	26,630
Waller	H	San Jacinto	Burkeville confining unit	0	0	0	0	0	0
Waller	H	San Jacinto	Jasper Aquifer	0	0	0	0	0	0
Washington	G	Brazos	Evangeline Aquifer	3,236	3,236	3,236	3,236	3,236	3,236
Washington	G	Brazos	Burkeville confining unit	367	367	367	367	367	367
Washington	G	Brazos	Jasper Aquifer	9,356	9,356	9,356	9,356	9,356	9,356
Washington	G	Colorado	Jasper Aquifer	72	72	72	72	72	72
GMA 14 Total			Gulf Coast Aquifer System	1,089,160	945,116	869,306	898,377	923,801	948,373

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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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Model “Dry” Cells

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

A total of 591 cells out of 10,968 cells (five percent) go “dry” in the Chicot Aquifer (Layer 1) along the thinnest part of the outcrop. There are 19 dry cells out of 8,184 total cells (0.02 percent) in the thinnest part of the Burkeville confining unit (Layer 3), and 18 dry cells out of 10,815 total cells (0.02 percent) in the thinnest part of the Jasper Aquifer (Layer 4) outcrop. As noted in the model assumptions pumping from dry cells is included in the modeled available groundwater values. Total pumping from dry cells in the Chicot Aquifer in model year 2070 is 77 acre-feet in Montgomery County. There are no dry cells for the model run in the Evangeline Aquifer. Total pumping from dry cells in the Burkeville Confining unit in model year 2070 is 2,697 acre-feet in San Jacinto County. The total pumping from dry cells in the Jasper Aquifer in model year 2070 is 5,084 acre-feet in Grimes, Jasper, Newton, Polk, Trinity, Tyler, and Walker counties.

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APPENDIX

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TABLE A.1 MODEL-CALCULATED AVERAGE DRAWDOWN VALUES (DDN) AND MODELED MAXIMUM SUBSIDENCE COMPARED WITH DESIRED FUTURE CONDITIONS (DFCS) BY COUNTY FOR THE NORTHERN PORTION OF THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 14. ALL VALUES ARE IN FEET.

County	Chicot Aquifer DDN	Evangeline Aquifer DDN	Burkeville Confining Unit DDN	Jasper Aquifer DDN	Maximum Subsidence (model estimate)	Chicot Aquifer DFC	Evangeline Aquifer DFC	Burkeville Unit DFC	Jasper Aquifer DFC	Maximum Subsidence DFC
Austin	40	23	23	76	2.82	39	23	23	76	2.83
Brazoria	23	28	na	na	na	23	27	na	na	ns
Chambers	33	30	na	na	na	32	30	na	na	ns
Fort Bend*	54	56	60	108	na	ns	ns	ns	ns	ns
Galveston*	34	31	na	na	na	ns	ns	ns	ns	ns
Grimes	5	5	6	53	0.10	5	5	6	52	0.12
Hardin	21	27	29	90	na	21	27	29	89	ns
Harris*	30	5	-15	63	na	ns	ns	ns	ns	ns
Jasper	24	42	46	40	na	23	41	46	40	ns
Jefferson	16	17	na	na	na	15	17	na	na	ns
Liberty	28	29	25	121	na	27	29	25	120	ns
Montgomery	26	-4	-4	35	na	26	-4	-4	34	ns
Newton	35	45	45	37	na	35	45	44	37	ns

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County	Chicot Aquifer DDN	Evangeline Aquifer DDN	Burkeville Confining Unit DDN	Jasper Aquifer DDN	Maximum Subsidence (model estimate)	Chicot Aquifer DFC	Evangeline Aquifer DFC	Burkeville Unit DFC	Jasper Aquifer DFC	Maximum Subsidence DFC
Orange	14	16	na	na	na	14	16	na	na	ns
Polk	26	10	16	73	na	26	10	15	73	ns
San Jacinto	22	19	20	109	na	22	19	19	108	ns
Tyler	42	36	30	62	na	42	35	30	62	ns
Walker	0	9	4	42	0.10	na	9	4	42	0.04
Waller	39	40	40	102	4.71	39	39	40	101	4.73
Washington	na	1	16	48	na	na	1	16	48	ns
GMA average	28.7	23.9	18.7	66.7	na	28.3	23.6	18.5	66.2	ns

*Desired Future Conditions were not specified for counties located in the subsidence districts

na = not applicable

ns = not specified

DFC = adopted desired future condition

DDN = average model calculated drawdown based on pumping scenario provided by districts in GMA 14