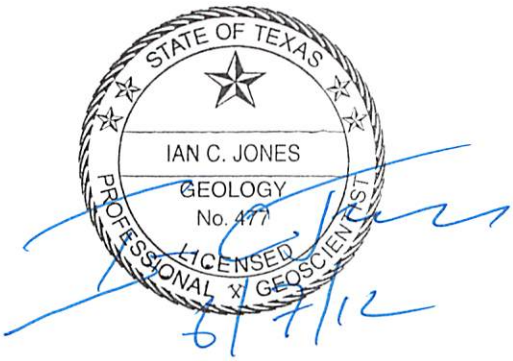
GAM Run 10-016 MAG (Version 2): Model Run for the Yegua-Jackson, Sparta, Queen City, and Carrizo-Wilcox Aquifers in Groundwater Management Area 11

by Ian C. Jones, Ph.D., P.G., Jerry Shi, Ph.D., P.G., and Oliver Wade, P.G.
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-6641
June 7, 2012



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GAM RUN 10-016 MAG (VERSION 2): MODEL RUN FOR THE YEGUA-JACKSON, SPARTA, QUEEN CITY, AND CARRIZO-WILCOX AQUIFERS IN GROUNDWATER MANAGEMENT AREA 11

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EXECUTIVE SUMMARY:

The modeled available groundwater for Groundwater Management Area 11 is summarized for the Carrizo-Wilcox (Table 1), Queen City (Table 2), Sparta (Table 3), and Yegua-Jackson (Table 4) aquifers. Modeled available groundwater values for these aquifers are also summarized by county (Table 5), regional planning area (Table 6), river basin (Table 7), and groundwater conservation district (Table 8). The pumping estimates are based on Groundwater Availability Modeling Task 10-009. This previously completed model simulation meets the desired future condition adopted by the members of Groundwater Management Area 11 of an overall average drawdown of 17 feet.

The modeled available groundwater within the groundwater conservation districts that reflects the desired future conditions adopted by Groundwater Management Area 11 declines from approximately 195,000 acre-feet per year in 2010 to 189,000 acre-feet per year in 2060 (Table 8). When areas outside of groundwater conservation districts are considered, the modeled available groundwater is approximately 559,000 acre-feet per year in 2010 and declines to 543,000 acre-feet per year in 2060.

The total modeled available groundwater for each aquifer in Groundwater Management Area 11, including areas outside a groundwater conservation district, is also summarized by groundwater conservation district for each decade between 2010 and 2060 (Tables 9 through 15).

REQUESTOR:

Ms. Monique Norman, General Counsel, and Mr. Len Luscomb, General Manager, of Rusk County Groundwater Conservation District on behalf of Groundwater Management Area 11.

DESCRIPTION OF REQUEST:

In a letter dated May 4th, 2010 and received by the Texas Water Development Board (TWDB) on May 6th, 2010, Ms. Norman and Mr. Luscomb provided the Texas Water Development Board (TWDB) with the desired future condition (DFC) of the Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson aquifers within Groundwater Management Area 11. The desired future condition for the aquifers, as described in Resolution No. 1 and adopted April 13, 2010 by the groundwater conservation districts (GCDs) within Groundwater Management Area 11, is described below:

> *The Desired Future Condition is defined as allowing up to an average draw down of 17 feet that applies throughout [Groundwater Management Area] 11. … The Desired Future Condition of 17 feet average drawdown is based on 178 individual drawdowns by aquifer and county.*

METHODS:

The aquifers referred to above are covered by two groundwater availability models: one for the northern portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Fryar and others, 2003; Kelley and others, 2004) and one for the Yegua-Jackson Aquifer (Deeds and others, 2010). The aquifers covered by each of the groundwater availability models are shown in Figures 1 and 2.

In the previously completed Groundwater Availability Modeling Task 10-009, both of these models were run and achieved the above desired future condition (Oliver, 2010). The pumping results for Groundwater Management Area 11 presented here, taken directly from the simulations documented in Oliver (2010), have been divided by county, regional water planning area, river basin, and groundwater conservation district. These areas are shown in Figure 3. See Oliver (2010) for a full description of the methods, assumptions, and results for the groundwater availability model run.

The model results presented in this report were extracted from all areas of the model representing the units of the Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson aquifers. This includes some areas outside the "official" boundaries of the aquifers shown in the 2007 State Water Plan (TWDB, 2007). For this reason, the area over which the average drawdown that meets the desired future condition was calculated may reflect water of quality ranging from fresh to brackish and saline.

PARAMETERS AND ASSUMPTIONS:

Northern Portion of the Carrizo-Wilcox, Queen City, and Sparta Aquifers

The parameters and assumptions for the groundwater availability model run for the northern portion of the Carrizo-Wilcox, Queen City, and Sparta Aquifers are described below:

- Version 2.01 of the groundwater availability model for the northern portion of the Carrizo-Wilcox, Queen City, and Sparta Aquifers was used for this analysis. See Fryar and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model for the northern part of the Carrizo-Wilcox, Queen City, and Sparta Aquifers.
- The model includes eight layers, representing:
    1. Sparta Aquifer (Layer 1)
    2. Weches confining unit (Layer 2)
    3. Queen City Aquifer (Layer 3)
    4. Reklaw confining unit (Layer 4)
    5. Carrizo Aquifer (Layer 5)
    6. Upper Wilcox Aquifer (Layer 6)
    7. Middle Wilcox Aquifer (Layer 7)
    8. Lower Wilcox Aquifer (Layer 8)
- In the Sabine Uplift area, a portion of Layer 8, though active in the model, is outside the extent of the Lower Wilcox unit of the Carrizo-Wilcox Aquifer as described in Kelley and others (2004). Because of this, results for Layer 8 in

this area were not included when determining the average drawdown over Groundwater Management Area 11.

- Cells were assigned to individual counties and groundwater conservation districts as shown in the September 14, 2009 version of the cell assignment model grid for the northern portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers.
- Recharge rates are based on average (1961 to 1990) precipitation (Kelley and others, 2004).

Yegua-Jackson Aquifer

The parameters and assumptions for the model run using the groundwater availability model for the Yegua-Jackson Aquifer are described below:

- Version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer was used for this analysis. See Deeds and others (2010) for assumptions and limitations of the groundwater availability model.
- The model includes five layers representing the Yegua-Jackson Aquifer and the overlying Catahoula unit.
- Cells were assigned to individual counties and groundwater conservation districts as shown in the March 23, 2010 version of the cell assignment model grid for the Yegua-Jackson Aquifer.
- The recharge used for the model run represents average recharge as described in Deeds and others (2010).

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. This is distinct from "managed available groundwater", which was a permitting value and accounted for the estimated use of the aquifer exempt from permitting. This change was made to reflect changes in statute by the 82nd Texas Legislature, effective September 1, 2011.

Groundwater conservation districts are required to consider modeled available groundwater, along with several other factors, when issuing permits in order to

manage groundwater production to achieve the desired future condition(s). The other factors districts must consider include annual precipitation and production patterns, the estimated amount of pumping exempt from permitting, existing permits, and a reasonable estimate of actual groundwater production under existing permits. The estimated amount of pumping exempt from permitting, which the TWDB is now required to develop after soliciting input from applicable groundwater conservation districts, will be provided in a separate report.

RESULTS:

The modeled available groundwater in Groundwater Management Area 11 from the Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson aquifers that achieves the desired future condition declines from approximately 559,000 acre-feet per year in 2010 to 543,000 acre-feet per year in 2060. Tables 1 through 4 contain the estimates of total pumping for the Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson aquifers, respectively. In these tables, results have been subdivided by county, regional water planning area, and river basin for use in the regional water planning process.

Tables 5 through 7 show the modeled available groundwater for all aquifers summarized by county, regional water planning area, and river basin, respectively, within Groundwater Management Area 11. The modeled available groundwater for all aquifers within and outside the groundwater conservation districts in Groundwater Management Area 11 are presented in Table 8. Tables 9 through 15 show the modeled available groundwater for each model layer—Lower Wilcox Formation, Middle Wilcox Formation, Upper Wilcox Formation, Carrizo Formation, Queen City Aquifer, Sparta Aquifer, and Yegua-Jackson Aquifer— within and outside the groundwater conservation districts in Groundwater Management Area 11.

LIMITATIONS:

The groundwater model used in completing this analysis is the best available scientific tool that can be used to meet the stated objective(s). 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 overall conditions of the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

REFERENCES:

Deeds, N.E., Yan, T., Singh, A., Jones, T.L., Kelley, V.A., Knox, P.R., 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.

Fryar, D., Senger, R., Deeds, N., Pickens, J., Jones, T., Whallon, A. J., and Dean, K. E., 2003, Groundwater Availability Model for the Northern Carrizo-Wilcox Aquifer: contract report to the Texas Water Development Board, 529 p.

Kelley, V. A., Deeds, N. E., Fryar, D. G., and Nicot, J. P., 2004, Groundwater availability models for the Queen City and Sparta aquifers: contract report to the Texas Water Development Board, 867 p.

National Research Council, 2007, Models in Environmental Regulatory Decision Making. Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p.

Oliver, W., 2010, Texas Water Development Board, GAM Task 10-009 Model Run Report, 11 p.

Texas Water Development Board, 2007, Water for Texas – 2007—Volumes I-III; Texas Water Development Board Document No. GP-8-1, 392 p.

TABLE 1. MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX AQUIFER IN GROUNDWATER MANAGEMENT AREA 11. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE DIVIDED BY COUNTY, REGIONAL WATER PLANNING AREA, AND RIVER BASIN.

County	Region	Basin	Year					
			2010	2020	2030	2040	2050	2060
Anderson	I	Neches	4,393	4,393	4,393	4,393	4,393	4,393
		Trinity	5,684	5,684	5,684	5,684	5,684	5,684
Angelina	I	Neches	26,414	26,414	26,414	26,414	26,414	26,414
Bowie	D	Sulphur	11,126	8,216	7,976	7,533	7,533	7,083
Camp	D	Cypress	4,041	4,041	4,041	4,041	4,041	4,041
Cass	D	Cypress	2,955	2,955	2,955	2,955	2,955	2,955
		Sulphur	578	578	578	578	578	578
Cherokee	I	Neches	11,222	11,222	11,222	11,222	11,222	11,222
Franklin	D	Cypress	7,794	7,736	7,736	7,736	7,736	7,736
		Sulphur	1,952	1,748	1,748	1,748	1,748	1,748
Gregg	D	Cypress	820	820	820	820	820	820
		Sabine	6,829	6,829	6,829	6,829	6,829	6,829
Harrison	D	Cypress	4,892	4,873	4,839	4,787	4,772	4,728
		Sabine	4,019	3,964	3,947	3,911	3,911	3,911
Henderson	C	Trinity	5,254	5,187	5,187	5,187	5,187	5,187
	I	Neches	3,999	3,999	3,999	3,999	3,999	3,999
Hopkins	D	Cypress	253	253	253	253	253	253
		Sabine	2,043	2,001	2,001	2,001	2,001	2,001
		Sulphur	1,137	1,137	1,137	1,137	1,137	1,137
Houston	I	Neches	1,924	1,924	1,924	1,924	1,924	1,924
		Trinity	3,432	3,432	3,432	3,432	3,432	3,432
Marion	D	Cypress	2,077	2,077	2,077	2,077	2,077	2,077
Morris	D	Cypress	2,196	2,196	2,174	2,174	2,174	2,174
		Sulphur	420	420	384	384	384	384
Nacogdoches	I	Neches	21,385	21,385	21,385	21,385	21,385	21,385
Panola	I	Cypress	6	6	6	6	6	6
		Sabine	9,091	8,221	8,221	8,063	8,063	8,063
Rains	D	Sabine	1,703	1,703	1,620	1,620	1,620	1,583
Red River	D	Sulphur	0	0	0	0	0	0
Rusk	I	Neches	11,776	11,776	11,766	11,766	11,766	11,747
		Sabine	9,067	9,067	9,067	9,067	9,067	9,067
Sabine	I	Neches	1,254	1,254	1,254	1,254	1,254	1,254
		Sabine	5,612	5,604	5,604	5,604	5,604	5,604
San Augustine	I	Neches	1,490	1,490	1,490	1,490	1,490	1,490
		Sabine	291	291	291	291	291	291
Shelby	I	Neches	2,900	2,736	2,578	2,288	2,152	2,019
		Sabine	9,144	8,481	8,323	8,159	8,159	7,710
Smith	D	Sabine	12,245	12,245	12,245	12,235	12,221	12,221
	I	Neches	21,004	21,004	21,004	21,004	21,004	21,004

TABLE 1. CONTINUED.

County	Region	Basin	Year					
			2010	2020	2030	2040	2050	2060
Titus	D	Cypress	8,051	7,516	7,214	7,063	6,833	6,833
		Sulphur	2,805	2,805	2,805	2,805	2,805	2,805
Trinity	H	Trinity	1,101	1,101	1,101	1,101	1,101	1,101
	I	Neches	1,114	1,114	1,114	1,114	1,114	1,114
Upshur	D	Cypress	5,426	5,426	5,426	5,426	5,426	5,426
		Sabine	1,689	1,689	1,689	1,689	1,689	1,689
Van Zandt	D	Neches	4,288	4,288	4,288	4,288	4,288	4,288
		Sabine	4,942	4,611	4,611	4,611	4,611	4,379
		Trinity	1,384	1,384	1,384	1,384	1,384	1,384
Wood	D	Cypress	2,053	2,053	2,053	2,053	2,053	2,053
		Sabine	19,663	19,486	19,398	19,355	19,280	19,258
Total			**274,938**	**268,835**	**267,687**	**266,340**	**265,870**	**264,484**

TABLE 2. MODELED AVAILABLE GROUNDWATER FOR THE QUEEN CITY AQUIFER IN GROUNDWATER MANAGEMENT AREA 11. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE DIVIDED BY COUNTY, REGIONAL WATER PLANNING AREA, AND RIVER BASIN.

County	Region	Basin	Year					
			2010	2020	2030	2040	2050	2060
Anderson	I	Neches	9,762	9,762	9,762	9,762	9,762	9,762
		Trinity	9,039	9,039	9,039	9,039	9,039	9,039
Angelina	I	Neches	1,093	1,093	1,093	1,093	1,093	1,093
Camp	D	Cypress	3,705	3,542	3,542	3,542	3,542	3,542
Cass	D	Cypress	35,970	35,970	35,970	35,970	35,970	35,970
		Sulphur	3,223	3,223	3,223	3,223	3,223	3,223
Cherokee	I	Neches	22,396	22,396	22,396	22,396	22,396	22,396
Gregg	D	Cypress	1,359	1,359	1,359	1,359	1,359	1,359
		Sabine	6,214	6,214	6,214	6,214	6,214	6,214
Harrison	D	Cypress	7,890	7,890	7,890	7,890	7,890	7,890
		Sabine	2,483	2,483	2,483	2,483	2,483	2,483
Henderson	C	Trinity	3,533	3,533	3,533	3,533	3,533	3,533
	I	Neches	12,316	12,316	12,316	12,316	12,316	12,316
Houston	I	Neches	131	131	131	131	131	131
		Trinity	279	279	279	279	279	279
Marion	D	Cypress	15,549	15,549	15,549	15,549	15,549	15,549
Morris	D	Cypress	9,652	9,652	9,652	9,652	9,537	9,537
Nacogdoches	I	Neches	5,002	5,002	5,002	5,002	5,002	5,002
Panola	I	Sabine	0	0	0	0	0	0
Rusk	I	Neches	40	40	40	40	40	40
		Sabine	18	18	18	18	18	18
Sabine	I	Neches	0	0	0	0	0	0
		Sabine	0	0	0	0	0	0
San Augustine	I	Neches	7	7	7	7	7	7
		Sabine	0	0	0	0	0	0
Shelby	I	Sabine	0	0	0	0	0	0
Smith	D	Sabine	25,994	25,994	25,994	25,994	25,994	25,994
	I	Neches	28,259	28,259	28,259	28,259	28,259	28,259
Titus	D	Cypress	138	138	138	138	138	138
Trinity	H	Trinity	0	0	0	0	0	0
	I	Neches	0	0	0	0	0	0
Upshur	D	Cypress	18,324	18,324	18,324	18,324	18,143	18,143
		Sabine	7,246	7,246	7,246	7,246	7,246	7,246
Van Zandt	D	Neches	3,814	3,814	3,814	3,814	3,814	3,814
Wood	D	Cypress	1,009	1,009	1,009	1,009	1,009	1,009
		Sabine	9,103	9,103	9,103	9,103	9,103	9,103
Total			**243,548**	**243,385**	**243,385**	**243,385**	**243,089**	**243,089**

TABLE 3. MODELED AVAILABLE GROUNDWATER FOR THE SPARTA AQUIFER IN GROUNDWATER MANAGEMENT AREA 11. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE DIVIDED BY COUNTY, REGIONAL WATER PLANNING AREA, AND RIVER BASIN.

County	Region	Basin	Year					
			2010	2020	2030	2040	2050	2060
Anderson	I	Neches	344	344	344	344	344	344
		Trinity	272	272	272	272	272	272
Angelina	I	Neches	689	689	689	689	689	689
Cherokee	I	Neches	359	359	359	359	359	359
Houston	I	Neches	302	302	302	302	302	302
		Trinity	594	594	594	594	594	594
Nacogdoches	I	Neches	409	409	409	409	409	409
Rusk	I	Neches	4,362	0	0	0	0	0
Sabine	I	Neches	61	61	61	61	61	61
		Sabine	235	235	235	235	235	235
San Augustine	I	Neches	202	202	202	202	202	202
		Sabine	3	3	3	3	3	3
Smith	I	Neches	0	0	0	0	0	0
	D	Sabine	0	0	0	0	0	0
Trinity	I	Neches	313	313	313	313	313	313
	H	Trinity	302	302	302	302	302	302
Upshur	D	Sabine	0	0	0	0	0	0
Wood	D	Sabine	0	0	0	0	0	0
Total			**8,447**	**4,085**	**4,085**	**4,085**	**4,085**	**4,085**

TABLE 4. MODELED AVAILABLE GROUNDWATER FOR THE YEGUA-JACKSON AQUIFER IN GROUNDWATER MANAGEMENT AREA 11. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE DIVIDED BY COUNTY, REGIONAL WATER PLANNING AREA, AND RIVER BASIN.

County	Region	Basin	Year					
			2010	2020	2030	2040	2050	2060
Angelina	I	Neches	16,890	16,890	16,890	16,890	16,890	16,507
Houston	I	Neches	1,324	1,324	1,324	1,324	1,324	1,324
		Trinity	4,061	4,061	4,061	4,061	4,061	4,061
Nacogdoches	I	Neches	235	235	235	235	235	235
Sabine	I	Neches	3,724	3,724	3,724	3,724	3,724	3,724
		Sabine	575	575	575	575	575	575
San Augustine	I	Neches	2,102	2,102	2,102	2,102	2,102	2,102
		Sabine	9	9	9	9	9	9
Trinity	H	Trinity	2,191	2,191	2,191	2,191	2,191	2,191
	I	Neches	700	700	700	700	700	700
Total			**31,811**	**31,811**	**31,811**	**31,811**	**31,811**	**31,428**

TABLE 5. MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX, QUEEN CITY, SPARTA, AND YEGUA-JACKSON AQUIFERS BY COUNTY FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

County	Year					
	2010	2020	2030	2040	2050	2060
Anderson	29,494	29,494	29,494	29,494	29,494	29,494
Angelina	45,086	45,086	45,086	45,086	45,086	44,703
Bowie	11,126	8,216	7,976	7,533	7,533	7,083
Camp	7,746	7,583	7,583	7,583	7,583	7,583
Cass	42,726	42,726	42,726	42,726	42,726	42,726
Cherokee	33,977	33,977	33,977	33,977	33,977	33,977
Franklin	9,746	9,484	9,484	9,484	9,484	9,484
Gregg	15,222	15,222	15,222	15,222	15,222	15,222
Harrison	19,284	19,210	19,159	19,071	19,056	19,012
Henderson	25,102	25,035	25,035	25,035	25,035	25,035
Hopkins	3,433	3,391	3,391	3,391	3,391	3,391
Houston	12,047	12,047	12,047	12,047	12,047	12,047
Marion	17,626	17,626	17,626	17,626	17,626	17,626
Morris	12,268	12,268	12,210	12,210	12,095	12,095
Nacogdoches	27,031	27,031	27,031	27,031	27,031	27,031
Panola	9,097	8,227	8,227	8,069	8,069	8,069
Rains	1,703	1,703	1,620	1,620	1,620	1,583
Red River	0	0	0	0	0	0
Rusk	25,263	20,901	20,891	20,891	20,891	20,872
Sabine	11,461	11,453	11,453	11,453	11,453	11,453
San Augustine	4,104	4,104	4,104	4,104	4,104	4,104
Shelby	12,044	11,217	10,901	10,447	10,311	9,729
Smith	87,502	87,502	87,502	87,492	87,478	87,478
Titus	10,994	10,459	10,157	10,006	9,776	9,776
Trinity	5,721	5,721	5,721	5,721	5,721	5,721
Upshur	32,685	32,685	32,685	32,685	32,504	32,504
Van Zandt	14,428	14,097	14,097	14,097	14,097	13,865
Wood	31,828	31,651	31,563	31,520	31,445	31,423
Total	**558,744**	**548,116**	**546,968**	**545,621**	**544,855**	**543,086**

TABLE 6. MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX, QUEEN CITY, SPARTA, AND YEGUA-JACKSON AQUIFERS BY REGIONAL WATER PLANNING AREA FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

Region	Year					
	2010	2020	2030	2040	2050	2060
C	8,787	8,720	8,720	8,720	8,720	8,720
D	269,054	264,560	263,738	263,003	262,373	261,588
H	3,594	3,594	3,594	3,594	3,594	3,594
I	277,309	271,242	270,916	270,304	270,168	269,184
Total	**558,744**	**548,116**	**546,968**	**545,621**	**544,855**	**543,086**

TABLE 7. MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX, QUEEN CITY, SPARTA, AND YEGUA-JACKSON AQUIFERS BY RIVER BASIN FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

Basin	Year					
	2010	2020	2030	2040	2050	2060
Cypress	134,160	133,385	133,027	132,824	132,283	132,239
Neches	227,999	223,473	223,305	223,015	222,879	222,344
Sabine	138,218	136,072	135,726	135,315	135,226	134,486
Sulphur	21,241	18,127	17,851	17,408	17,408	16,958
Trinity	37,126	37,059	37,059	37,059	37,059	37,059
Total	**558,744**	**548,116**	**546,968**	**545,621**	**544,855**	**543,086**

TABLE 8. MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO-WILCOX, QUEEN CITY, SPARTA, AND YEGUA-JACKSON AQUIFERS BY GROUNDWATER CONSERVATION DISTRICT (GCD) FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD REFERS TO UNDERGROUND WATER CONSERVATION DISTRICT.

District	Year					
	2010	2020	2030	2040	2050	2060
Anderson County UWCD	1,361	1,361	1,361	1,361	1,361	1,361
Neches & Trinity Valleys GCD	87,212	87,145	87,145	87,145	87,145	87,145
Panola GCD	9,097	8,227	8,227	8,069	8,069	8,069
Pineywoods GCD	72,117	72,117	72,117	72,117	72,117	71,734
Rusk County GCD	25,263	20,901	20,891	20,891	20,891	20,872
Total (excluding non-district areas)	**195,050**	**189,751**	**189,741**	**189,583**	**189,583**	**189,181**
No District	363,694	358,365	357,227	356,038	355,272	353,905
Total (including non-district areas)	**558,744**	**548,116**	**546,968**	**545,621**	**544,855**	**543,086**

TABLE 9. MODELED AVAILABLE GROUNDWATER FOR THE LOWER WILCOX FORMATION BY GROUNDWATER CONSERVATION DISTRICT (GCD) FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD REFERS TO UNDERGROUND WATER CONSERVATION DISTRICT.

District	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Anderson County UWCD	7	7	7	7	7	7
Neches & Trinity Valleys GCD	1,886	1,886	1,886	1,886	1,886	1,886
Panola GCD	725	725	725	725	725	725
Pineywoods GCD	0	0	0	0	0	0
Rusk County GCD	0	0	0	0	0	0
Total (excluding non-district areas)	**2,618**	**2,618**	**2,618**	**2,618**	**2,618**	**2,618**
No District	2,717	2,717	2,717	2,717	2,717	2,717
Total (including non-district areas)	**5,335**	**5,335**	**5,335**	**5,335**	**5,335**	**5,335**

TABLE 10. MODELED AVAILABLE GROUNDWATER FOR THE MIDDLE WILCOX FORMATION BY GROUNDWATER CONSERVATION DISTRICT (GCD) FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD REFERS TO UNDERGROUND WATER CONSERVATION DISTRICT.

District	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Anderson County UWCD	15	15	15	15	15	15
Neches & Trinity Valleys GCD	1,719	1,719	1,719	1,719	1,719	1,719
Panola GCD	5,764	5,764	5,764	5,764	5,764	5,764
Pineywoods GCD	678	678	678	678	678	678
Rusk County GCD	8,731	8,731	8,731	8,731	8,731	8,731
Total (excluding non-district areas)	**16,907**	**16,907**	**16,907**	**16,907**	**16,907**	**16,907**
No District	44,427	44,223	44,194	44,179	44,179	44,165
Total (including non-district areas)	**61,334**	**61,130**	**61,101**	**61,086**	**61,086**	**61,072**

TABLE 11. MODELED AVAILABLE GROUNDWATER FOR THE UPPER WILCOX FORMATION BY GROUNDWATER CONSERVATION DISTRICT (GCD) FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD REFERS TO UNDERGROUND WATER CONSERVATION DISTRICT.

District	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Anderson County UWCD	107	107	107	107	107	107
Neches & Trinity Valleys GCD	9,652	9,652	9,652	9,652	9,652	9,652
Panola GCD	770	770	770	770	770	770
Pineywoods GCD	12,581	12,581	12,581	12,581	12,581	12,581
Rusk County GCD	5,156	5,156	5,156	5,156	5,156	5,156
Total (excluding non-district areas)	**28,266**	**28,266**	**28,266**	**28,266**	**28,266**	**28,266**
No District	45,600	42,690	42,396	41,968	41,968	41,495
Total (including non-district areas)	**73,866**	**70,956**	**70,662**	**70,234**	**70,234**	**69,761**

TABLE 12. MODELED AVAILABLE GROUNDWATER FOR THE CARRIZO FORMATION BY GROUNDWATER CONSERVATION DISTRICT (GCD) FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD REFERS TO UNDERGROUND WATER CONSERVATION DISTRICT.

District	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Anderson County UWCD	281	281	281	281	281	281
Neches & Trinity Valleys GCD	16,885	16,818	16,818	16,818	16,818	16,818
Panola GCD	1,838	968	968	810	810	810
Pineywoods GCD	34,540	34,540	34,540	34,540	34,540	34,540
Rusk County GCD	6,956	6,956	6,946	6,946	6,946	6,927
Total (excluding non-district areas)	**60,500**	**59,563**	**59,553**	**59,395**	**59,395**	**59,376**
No District	73,903	71,851	71,036	70,290	69,820	68,940
Total (including non-district areas)	**134,403**	**131,414**	**130,589**	**129,685**	**129,215**	**128,316**

TABLE 13. MODELED AVAILABLE GROUNDWATER FOR THE QUEEN CITY AQUIFER BY GROUNDWATER CONSERVATION DISTRICT (GCD) FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD REFERS TO UNDERGROUND WATER CONSERVATION DISTRICT.

District	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Anderson County UWCD	951	951	951	951	951	951
Neches & Trinity Valleys GCD	56,095	56,095	56,095	56,095	56,095	56,095
Panola GCD	0	0	0	0	0	0
Pineywoods GCD	6,095	6,095	6,095	6,095	6,095	6,095
Rusk County GCD	58	58	58	58	58	58
Total (excluding non-district areas)	**63,199**	**63,199**	**63,199**	**63,199**	**63,199**	**63,199**
No District	180,349	180,186	180,186	180,186	179,890	179,890
Total (including non-district areas)	**243,548**	**243,385**	**243,385**	**243,385**	**243,089**	**243,089**

TABLE 14. MODELED AVAILABLE GROUNDWATER FOR THE SPARTA AQUIFER BY GROUNDWATER CONSERVATION DISTRICT (GCD) FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD REFERS TO UNDERGROUND WATER CONSERVATION DISTRICT.

District	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Anderson County UWCD	0	0	0	0	0	0
Neches & Trinity Valleys GCD	975	975	975	975	975	975
Panola GCD	0	0	0	0	0	0
Pineywoods GCD	1,098	1,098	1,098	1,098	1,098	1,098
Rusk County GCD	4,362	0	0	0	0	0
Total (excluding non-district areas)	**6,435**	**2,073**	**2,073**	**2,073**	**2,073**	**2,073**
No District	2,012	2,012	2,012	2,012	2,012	2,012
Total (including non-district areas)	**8,447**	**4,085**	**4,085**	**4,085**	**4,085**	**4,085**

TABLE 15. MODELED AVAILABLE GROUNDWATER FOR THE YEGUA-JACKSON AQUIFER BY GROUNDWATER CONSERVATION DISTRICT (GCD) FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD REFERS TO UNDERGROUND WATER CONSERVATION DISTRICT.

District	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Anderson County UWCD	0	0	0	0	0	0
Neches & Trinity Valleys GCD	0	0	0	0	0	0
Panola GCD	0	0	0	0	0	0
Pineywoods GCD	17,125	17,125	17,125	17,125	17,125	16,742
Rusk County GCD	0	0	0	0	0	0
Total (excluding non-district areas)	**17,125**	**17,125**	**17,125**	**17,125**	**17,125**	**16,742**
No District	14,686	14,686	14,686	14,686	14,686	14,686
Total (including non-district areas)	**31,811**	**31,811**	**31,811**	**31,811**	**31,811**	**31,428**

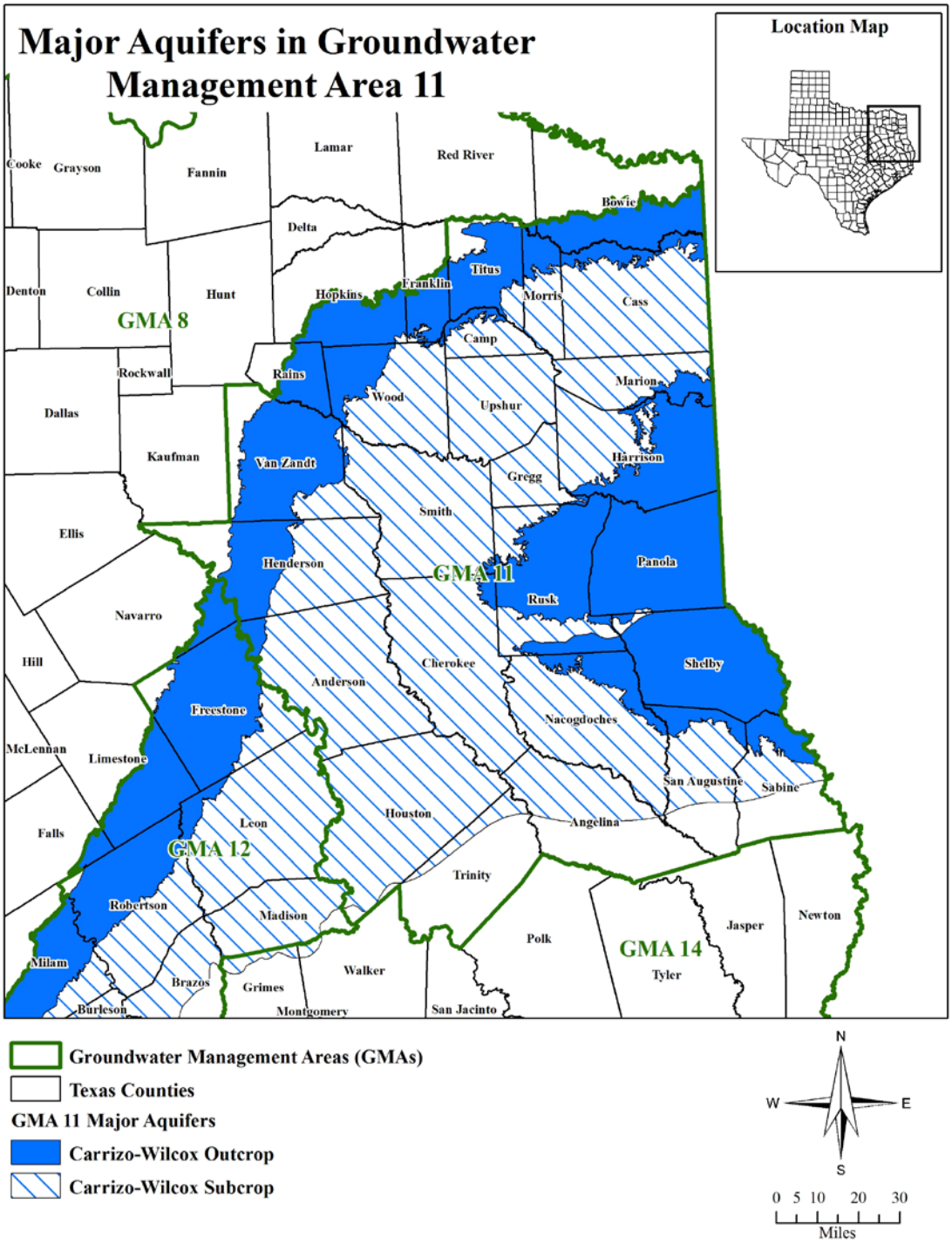

FIGURE 1. MAP SHOWING THE BOUNDARY OF THE CARRIZO-WILCOX AQUIFER ACCORDING TO THE 2007 STATE WATER PLAN (TWDB, 2007).

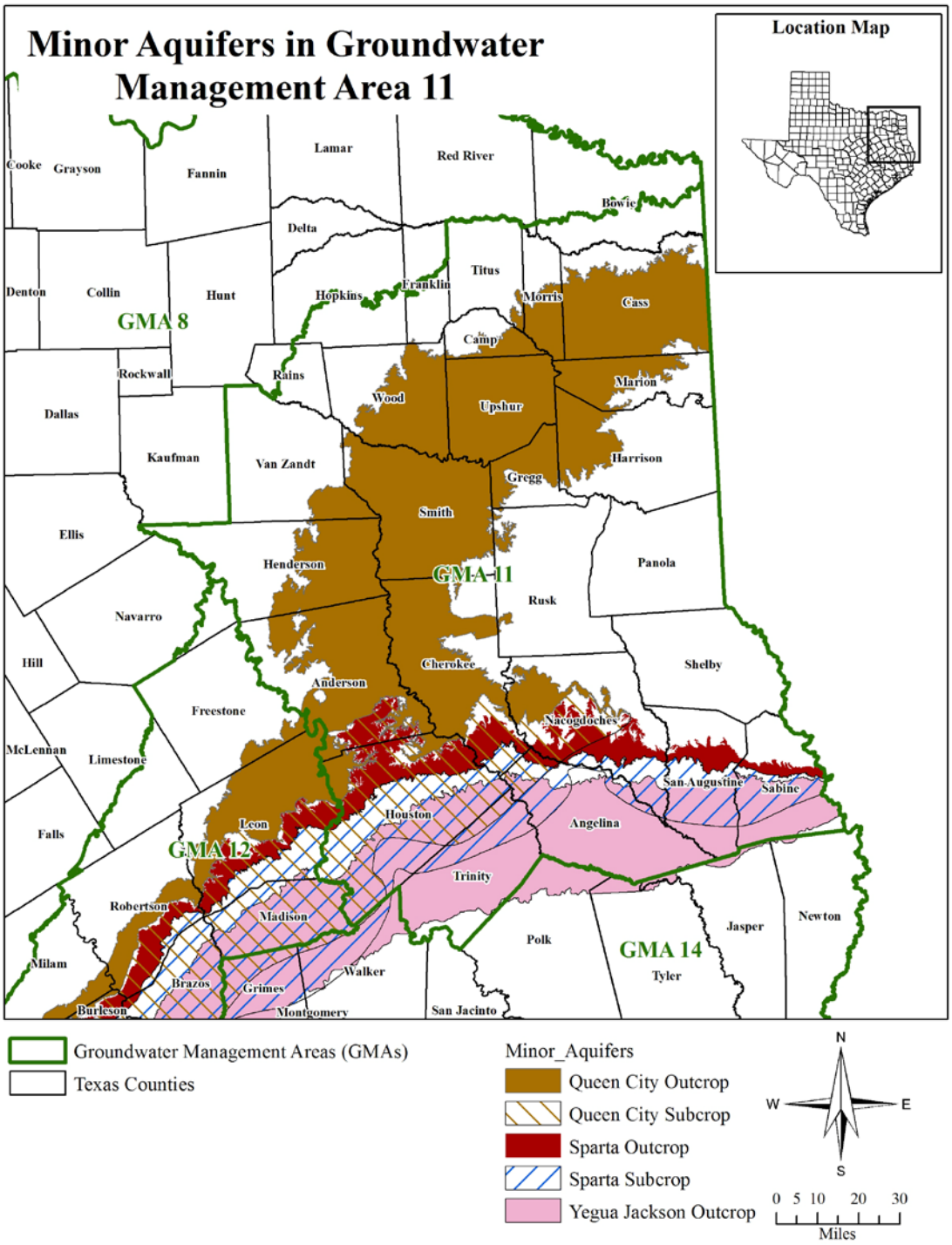

FIGURE 2. MAP SHOWING THE BOUNDARIES OF THE QUEEN CITY, SPARTA, AND YEGUA-JACKSON AQUIFERS ACCORDING TO THE 2007 STATE WATER PLAN (TWDB, 2007).

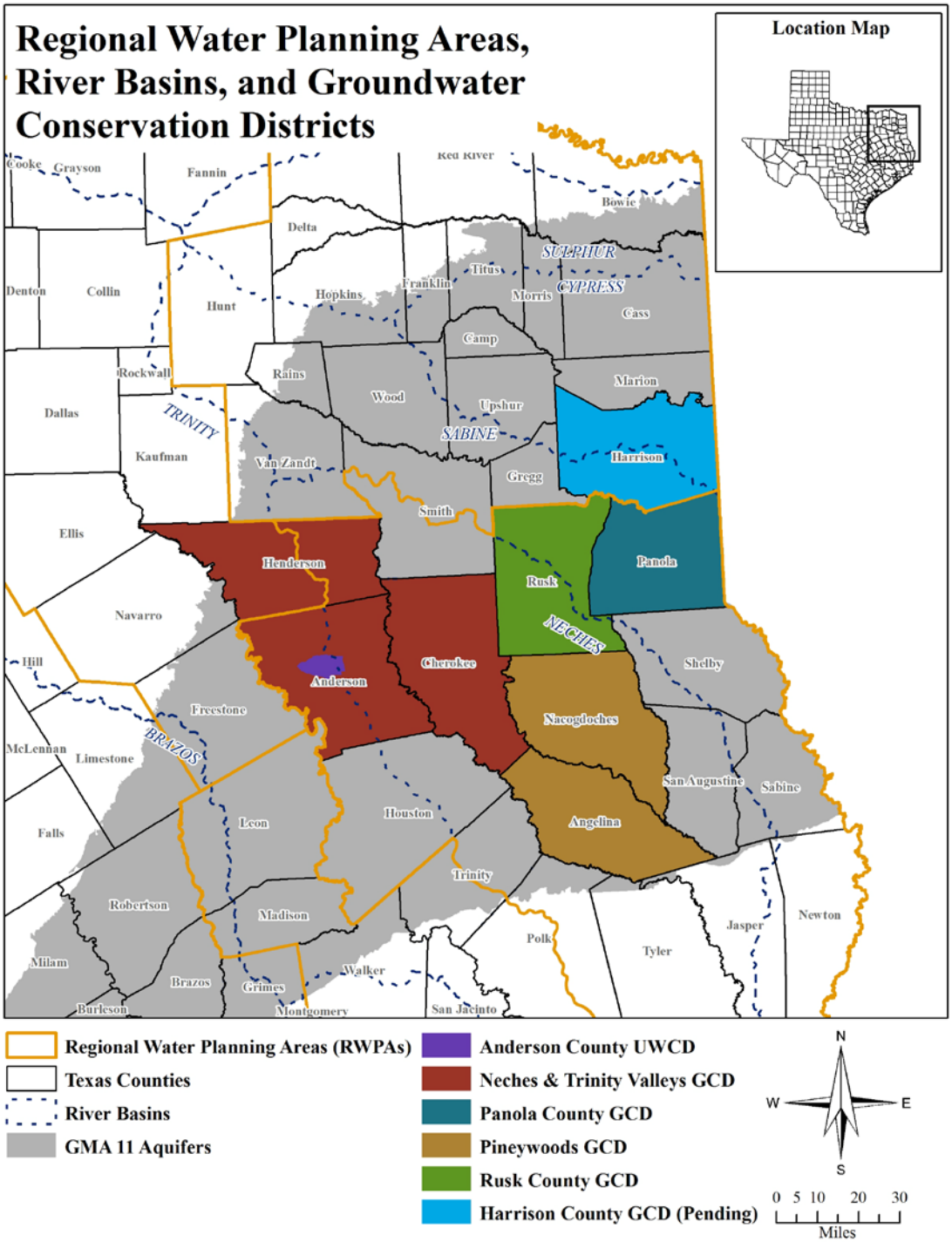

FIGURE 3. MAP SHOWING REGIONAL WATER PLANNING AREAS, GROUNDWATER CONSERVATION DISTRICTS, COUNTIES, AND RIVER BASINS IN AND NEIGHBORING OF GROUNDWATER MANAGEMENT AREA 11.

Appendix

TABLE A1. AVERAGE DRAWDOWN OVER THE 51-YEAR PREDICTIVE GROUNDWATER AVAILABILITY MODEL RUN IN GROUNDWATER MANAGEMENT AREA 11 FOR THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS AND WECHES AND REKLAW CONFINING UNITS. ALL VALUES ARE IN FEET. "ANDERSON (ACUWCD)" REFERS TO THE ANDERSON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT WITHIN ANDERSON COUNTY. "ANDERSON (NTVGCD)" REFERS TO THE PORTION OF NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT IN ANDERSON COUNTY. NEGATIVE VALUES INDICATE A RISE IN WATER LEVELS.

County	Sparta	Weches (CU)	Queen City	Reklaw (CU)	Carrizo	Upper Wilcox	Middle Wilcox	Lower Wilcox	Overall
Anderson (ACUWCD)			1	12	35	26	12	5	15
Anderson (NTVGCD)	-2	1	7	15	36	26	11	4	16
Angelina	10	11	16	22	42	5	-18	-3	11
Bowie						21	0	0	1
Camp			12	0	18	17	39	0	19
Cass			8	6	10	7	7	0	8
Cherokee	7	14	11	11	32	32	15	10	18
Franklin				-16	-3	7	19	0	11
Gregg			7	11	42	49	56	79	35
Harrison			0	2	24	13	5	4	9
Henderson			4	15	41	32	27	15	23
Hopkins				-22	-12	-15	-28	0	-26
Houston	2	1	2	15	35	12	2	-2	8
Marion			17	11	21	15	15	0	16
Morris			13	10	29	25	23	0	21
Nacogdoches	3	3	11	10	14	11	-10	-6	4
Panola			-11	-19	11	2	1	4	2
Rains						7	-10	-5	-8
Rusk	0	-46	-15	-2	6	6	23	21	12
Sabine	5	5	7	15	24	13	6	5	10
San Augustine	-4	-4	-3	11	20	9	-3	-2	3
Shelby			-18	-19	23	-3	3	1	1
Smith	-5	-5	11	34	103	118	92	76	68
Titus			-1	-3	31	14	5	0	9
Trinity	5	4	4	12	33	-3	-7	-1	6
Upshur	-5	-5	5	17	56	66	66	97	44
Van Zandt			7	11	31	13	17	11	14
Wood	-5	-7	-2	36	110	83	55	114	59
Total	**3**	**4**	**7**	**15**	**38**	**26**	**15**	**11**	**17**