GAM Run 10-035 MAG Version 3: Modeled Available Groundwater for the Dockum Aquifer

by Mr. Wade Oliver

Edited and finalized by Radu Boghici to reflect statutory changes effective September 1, 2011

Texas Water Development Board
Groundwater Availability Modeling Section
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Cynthia K. Ridgeway, the Manager of the Groundwater Availability Modeling Section is responsible for oversight of work performed by employees under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on July 9, 2012.

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EXECUTIVE SUMMARY:

The modeled available groundwater from the Dockum Aquifer as a result of the desired future condition adopted by the members of Groundwater Management Area 2 is approximately 14,100 acre-feet per year. This is shown divided by county, regional water planning area, and river basin in Table 1 for use in the regional water planning process. Modeled available groundwater is summarized by county, regional water planning area, river basin, and groundwater conservation district in tables 2 through 5. The estimates were extracted from Groundwater Availability Modeling Task 10-025, which Groundwater Management Area 2 used as the basis for developing the desired future condition of an average decline of no more than 40 feet between 2010 and 2060. Earlier versions of this report showed modeled available groundwater for Dawson, Garza, Howard, Martin, Terry, and Yoakum counties based on the pumping assumed in the groundwater availability model simulation. However, Groundwater Management Area 2 declared those counties "not relevant" for joint planning purposes. Since modeled available groundwater only applies to areas with a specified desired future condition, we updated this report to depict modeled available groundwater only in counties with specified desired future conditions.

REQUESTOR:

Mr. Jason Coleman of South Plains Underground Water Conservation District on behalf of Groundwater Management Area 2

DESCRIPTION OF REQUEST:

In a letter dated August 10, 2010 and received August 13, 2010, Mr. Jason Coleman provided the Texas Water Development Board (TWDB) with the desired future condition of the Dockum Aquifer adopted by the members of Groundwater Management Area 2. The desired future condition for the Dockum Aquifer, as described in Resolution No. 2010-01 and adopted August 5, 2010 by the groundwater conservation districts within Groundwater Management Area 2, are described below:

> [T]*he members of* [Groundwater Management Area] *#2 adopt the desired future condition of the Dockum Aquifer as described in Table A-8, GAM Task 10-025 whereby the decline in water levels averages no more than forty feet over the time period 2010-2060 and further declare that the Dockum Aquifer is not relevant for the following counties: Dawson, Garza, Howard, Martin, Terry, and Yoakum.*

In response to receiving the adopted desired future condition, the TWDB has estimated the modeled available groundwater for the above desired future condition in Groundwater Management Area 2 where the Dockum Aquifer was considered by the management area to be relevant for joint planning purposes.

METHODS:

Groundwater Management Area 2 contains a portion of the Dockum Aquifer, a minor aquifer in Texas as defined in the 2007 State Water Plan (TWDB, 2007). The location of Groundwater Management Area 2, the Dockum Aquifer, and the groundwater model cells that represent the aquifer are shown in Figure 1. The TWDB previously completed several predictive groundwater model simulations for the Dockum Aquifer in Groundwater Management Area 2, documented in Groundwater Availability Modeling (GAM) Task 10-025 (Oliver, 2010). As described in the desired future conditions statement above, the model simulation scenario on which the desired future condition is based is shown in Table A-8 of GAM Task 10-025 (Oliver, 2010). The pumping results for Groundwater Management Area 2 presented here, taken directly from the above scenario, achieve the adopted desired future condition for the Dockum Aquifer and have been divided by county, regional water planning area, river basin, and groundwater conservation district. These areas are shown in Figure 2.

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the model run using the modified groundwater model for the Dockum Aquifer are described below:

- The results presented in this report are based on the "160 percent of base" scenario in GAM Task 10-025 (Oliver, 2010). This is the scenario shown in Table A-8 of Oliver (2010) and referred to in the Groundwater Management Area 2 desired future condition statement for the Dockum Aquifer. See Oliver (2010) for a full description of the methods, assumptions, and results for the groundwater availability model run.

- The modified version the groundwater model for the Dockum Aquifer described in Oliver and Hutchison (2010) was used for this analysis. This model is an update to the previously developed groundwater availability model for the Dockum Aquifer described in Ewing and others (2008) in order to more effectively simulate predictive conditions. See Oliver and Hutchison (2010) and Ewing and others (2008) for assumptions and limitations of the model.

- The model includes two active layers which represent the upper and lower portions of the Dockum Aquifer. Layer 2 represents the upper portion of the Dockum Aquifer. Layer 3 represents the lower portion of the Dockum Aquifer. Layer 1, which is active in version 1.01 of the model documented in Ewing and others (2008), was inactivated in the modified model as described in Oliver and Hutchison (2010).

- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) for the lower portion of the Dockum Aquifer between 1980 and 1997 is 53 feet.

- Cells were assigned to individual counties, river basins, regional water planning areas, and groundwater conservation districts as shown in the August 3, 2010 version of file that associates the model grid to political and natural boundaries for the Dockum Aquifer.

Note that some minor adjustments were made to the file better reflect the relationship of model cells to political boundaries.

- The recharge used for the model run represents average recharge as described in Ewing and others (2008).

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," shown in version 2 of this report dated August 30, 2011, 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 Texas Water Development Board 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 for the Dockum Aquifer in Groundwater Management Area 2 consistent with the desired future condition is approximately 14,100 acre-feet per year. This has been divided by county, regional water planning area, and river basin for each decade between 2010 and 2060 for use in the regional water planning process (Table 1).

The modeled available groundwater is also summarized by county, regional water planning area, river basin, and groundwater conservation district as shown in tables 2, 3, 4, and 5, respectively. In Table 5, note that the modeled available groundwater is also totaled for those districts that considered the Dockum Aquifer relevant for joint planning purposes: High Plains Underground Water Conservation District No. 1 and Llano Estacado Underground Water Conservation District.

LIMITATIONS:

The groundwater model used in developing estimates of total pumping is the best available scientific tool that can be used to estimate the pumping that will achieve the desired future condition. Although the groundwater model used in this analysis is the best available scientific tool for this purpose, it, like all models, has limitations. 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 develop estimates of total pumping is the need to make assumptions about the location in the aquifer where future pumping will occur. As actual pumping changes in the future, it will be necessary to evaluate the amount of that pumping as well as its location in the context of the assumptions associated with this analysis. Evaluating the amount and location of future pumping is as important as evaluating the changes in groundwater levels, spring flows, and other metrics that describe the condition of the groundwater resources in the area that relate to the adopted desired future condition(s).

In addition, certain assumptions have been made regarding future precipitation, recharge, and streamflow in developing these total pumping estimates. Those assumptions also need to be considered and compared to actual future data when evaluating compliance with the desired future condition.

Given these limitations, users of this information are cautioned that the total pumping numbers should not be considered a definitive, permanent description of the amount of groundwater that can be pumped to meet the adopted desired future condition. 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 future groundwater pumping as well as whether or not they are achieving their desired future conditions. 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 these managed available groundwater numbers given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future.

REFERENCES:

Ewing, J.E., Jones, T.L., Yan, T., Vreugdenhil, A.M., Fryar, D.G., Pickens, J.F., Gordon, K., Nicot, J.P., Scanlon, B.R., Ashworth, J.B., Beach, J., 2008, Groundwater Availability Model for the Dockum Aquifer – Final Report: contract report to the Texas Water Development Board, 510 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., Hutchison, W.R., 2010, Modification and recalibration of the Groundwater Availability Model of the Dockum Aquifer: Texas Water Development Board, 114 p.

Oliver, W., 2010, GAM Task 10-025: Texas Water Development Board, GAM Task 10-025 Report, 61 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 Dockum Aquifer in Groundwater Management Area 2 by county, regional water planning area, and river basin. Results are in acre-feet per year.

County	Regional Water Planning Area	Basin	Year					
			2010	2020	2030	2040	2050	2060
Andrews	F	Colorado	715	715	715	715	715	715
		Rio Grande	135	135	135	135	135	135
Bailey	O	Brazos	1	1	1	1	1	1
Borden	F	Brazos	33	33	33	33	33	33
		Colorado	482	482	482	482	482	482
Briscoe	O	Red	231	231	231	231	231	231
Castro	O	Brazos	0	0	0	0	0	0
		Red	1	1	1	1	1	1
Cochran	O	Brazos	0	0	0	0	0	0
		Colorado	0	0	0	0	0	0
Crosby	O	Brazos	4,061	4,061	4,061	4,061	4,061	4,061
		Red	48	48	48	48	48	48
Deaf Smith	O	Canadian	1,082	1,082	1,082	1,082	1,082	1,082
		Red	3,630	3,630	3,630	3,630	3,630	3,630
Floyd	O	Brazos	745	745	745	745	745	745
		Red	939	939	939	939	939	939
Gaines	O	Colorado	0	0	0	0	0	0
Hale	O	Brazos	734	734	734	734	734	734
		Red	4	4	4	4	4	4
Hockley	O	Brazos	571	571	571	571	571	571
		Colorado	0	0	0	0	0	0
Lamb	O	Brazos	0	0	0	0	0	0
Lubbock	O	Brazos	15	15	15	15	15	15
Lynn	O	Brazos	5	5	5	5	5	5
		Colorado	0	0	0	0	0	0
Parmer	O	Brazos	0	0	0	0	0	0
		Red	2	2	2	2	2	2
Swisher	O	Brazos	83	83	83	83	83	83
		Red	614	614	614	614	614	614
Total			**14,131**	**14,131**	**14,131**	**14,131**	**14,131**	**14,131**

Table 2. Modeled available groundwater for the Dockum Aquifer summarized by county in Groundwater Management Area 2 for each decade between 2010 and 2060. Results are in acre-feet per year.

County	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Andrews	850	850	850	850	850	850
Bailey	1	1	1	1	1	1
Borden	515	515	515	515	515	515
Briscoe	231	231	231	231	231	231
Castro	1	1	1	1	1	1
Cochran	0	0	0	0	0	0
Crosby	4,109	4,109	4,109	4,109	4,109	4,109
Deaf Smith	4,712	4,712	4,712	4,712	4,712	4,712
Floyd	1,684	1,684	1,684	1,684	1,684	1,684
Gaines	0	0	0	0	0	0
Hale	738	738	738	738	738	738
Hockley	571	571	571	571	571	571
Lamb	0	0	0	0	0	0
Lubbock	15	15	15	15	15	15
Lynn	5	5	5	5	5	5
Parmer	2	2	2	2	2	2
Swisher	697	697	697	697	697	697
Total	**14,131**	**14,131**	**14,131**	**14,131**	**14,131**	**14,131**

Table 3. Modeled available groundwater for the Dockum Aquifer summarized by regional water planning area in Groundwater Management Area 2 for each decade between 2010 and 2060. Results are in acre-feet per year.

Regional Water Planning Area	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
F	1,365	1,365	1,365	1,365	1,365	1,365
O	12,766	12,766	12,766	12,766	12,766	12,766
Total	**14,131**	**14,131**	**14,131**	**14,131**	**14,131**	**14,131**

Table 4. Modeled available groundwater for the Dockum Aquifer summarized by river basin in Groundwater Management Area 2 for each decade between 2010 and 2060. Results are in acre-feet per year.

Basin	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Brazos	6,248	6,248	6,248	6,248	6,248	6,248
Canadian	1,082	1,082	1,082	1,082	1,082	1,082
Colorado	1,197	1,197	1,197	1,197	1,197	1,197
Red	5,469	5,469	5,469	5,469	5,469	5,469
Rio Grande	135	135	135	135	135	135
Total	**14,131**	**14,131**	**14,131**	**14,131**	**14,131**	**14,131**

Table 5. Modeled available groundwater for the Dockum Aquifer summarized by groundwater conservation district (GCD) in Groundwater Management Area 2 for each decade between 2010 and 2060. Results are in acre-feet per year. UWCD refers to Underground Water Conservation District.

Groundwater Conservation District	Year					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
High Plains UWCD No. 1	10,092	10,092	10,092	10,092	10,092	10,092
Llano Estacado UWCD	0	0	0	0	0	0
Total (districts where aquifer is relevant)	**10,092**	**10,092**	**10,092**	**10,092**	**10,092**	**10,092**
No District	4,039	4,039	4,039	4,039	4,039	4,039
Total (all areas)	**14,131**	**14,131**	**14,131**	**14,131**	**14,131**	**14,131**

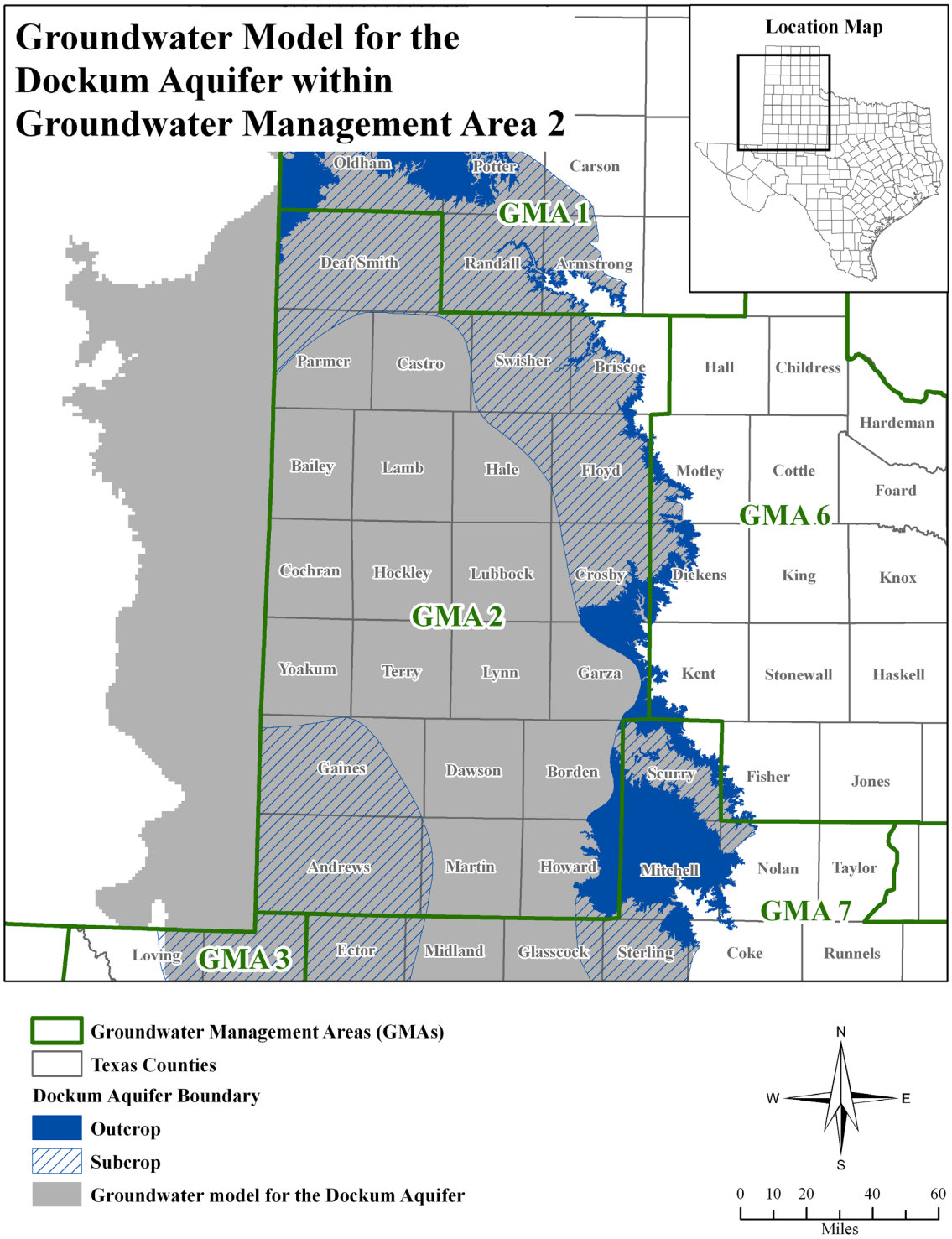

Figure 1. Map showing the areas covered by the groundwater model for the Dockum Aquifer and the boundary of Groundwater Management Area 2.

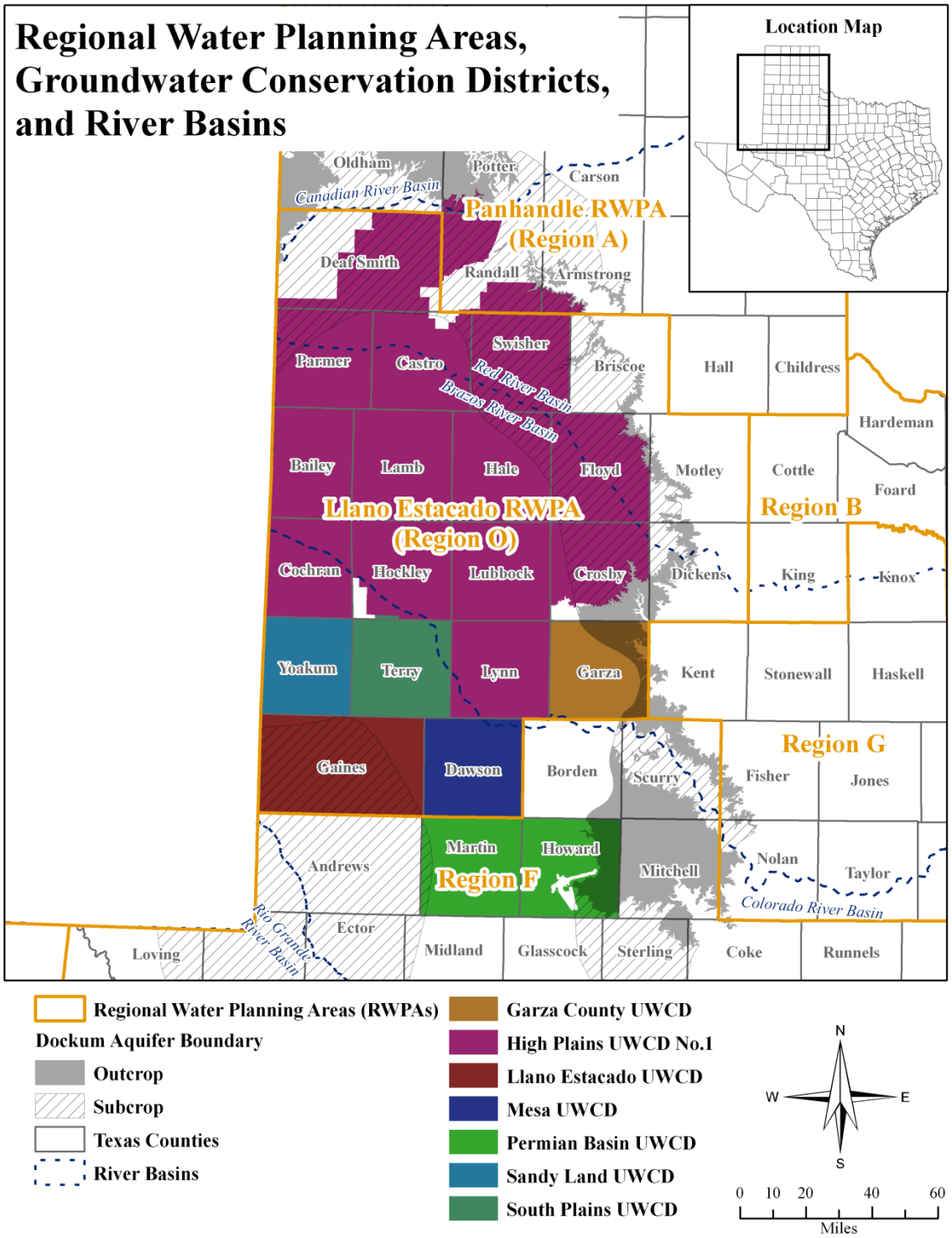

Figure 2. Map showing regional water planning areas (RWPAs), groundwater conservation districts (GCDs), counties, and river basins in and neighboring Groundwater Management Area 2. UWCD refers to Underground Water Conservation District.