GAM TASK 13-026: TOTAL ESTIMATED RECOVERABLE STORAGE FOR AQUIFERS IN GROUNDWATER MANAGEMENT AREA 2

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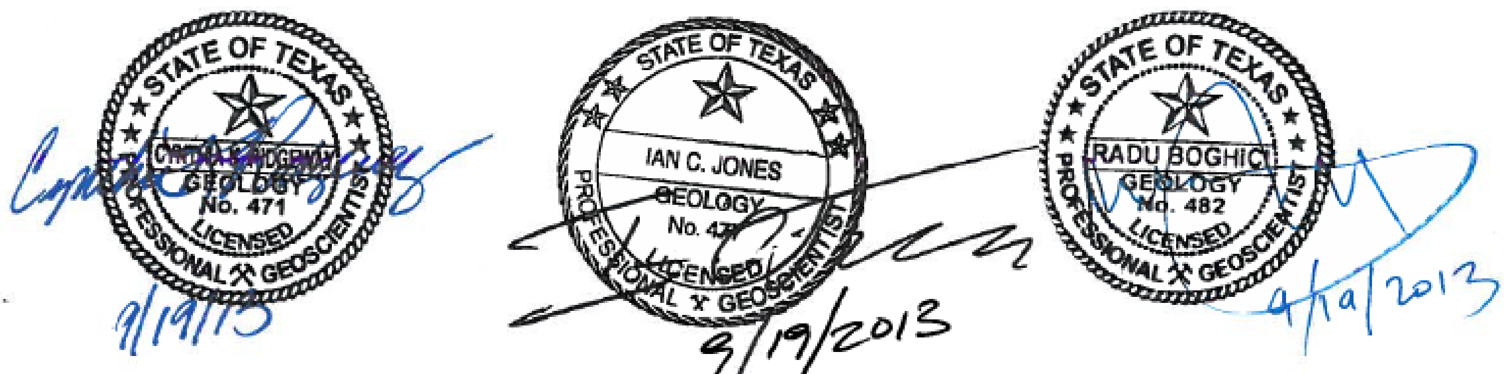
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-8279[1]
September 19, 2013



Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by William Kohlrenken under her direct supervision. The seals appearing on this document were authorized by Cynthia K. Ridgeway, P.G. 471, Ian C. Jones, P.G. 477, and Radu Boghici, P.G. 482 on September 19, 2013.

The total estimated recoverable storage in this report was calculated as follows: the Dockum Aquifer, Edwards-Trinity (High Plains), and Ogallala aquifers (William Kohlrenken); the Seymour Aquifer (Radu Boghici); and the Edwards-Trinity (Plateau) and Pecos Valley aquifers (Ian Jones).

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EXECUTIVE SUMMARY:

Texas Water Code, § 36.108 (d) (Texas Water Code, 2011) states that, before voting on the proposed desired future conditions for a relevant aquifer within a groundwater management area, the groundwater conservation districts shall consider the total estimated recoverable storage as provided by the executive administrator of the Texas Water Development Board (TWDB) along with other factors listed in §36.108 (d). Texas Administrative Code Rule §356.10 (Texas Administrative Code, 2011) defines the total estimated recoverable storage as the estimated amount of groundwater within an aquifer that accounts for recovery scenarios that range between 25 percent and 75 percent of the porosity-adjusted aquifer volume.

This report discusses the methods, assumptions, and results of analyses to estimate the total recoverable storage for the Dockum, Edwards-Trinity (High Plains), Edwards-Trinity (Plateau), Ogallala, Seymour, and Pecos Valley aquifers within Groundwater Management Area 2. Tables 1 through 12 summarize the total estimated recoverable storage required by the statute. Figures 2 through 7 indicate the extent of the groundwater availability models used to estimate the total recoverable storage.

DEFINITION OF TOTAL ESTIMATED RECOVERABLE STORAGE:

The total estimated recoverable storage is defined as the estimated amount of groundwater within an aquifer that accounts for recovery scenarios that range between 25 percent and 75

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percent of the porosity-adjusted aquifer volume. In other words, we assume that between 25 and 75 percent of groundwater held within an aquifer can be removed by pumping.

The total recoverable storage was estimated for the portion of each aquifer within Groundwater Management Area 2 that lies within the official lateral aquifer boundaries as delineated by George and others (2011). Total estimated recoverable storage values may include a mixture of water quality types, including fresh, brackish, and saline groundwater, because the available data and the existing groundwater availability models do not permit the differentiation of different water quality types. These values do not take into account the effects of land surface subsidence, degradation of water quality, or any changes to surface water-groundwater interaction as the result of extracting groundwater from the aquifer.

METHODS:

To estimate the total recoverable storage of an aquifer, we first calculated the total storage in an aquifer within the official aquifer boundary in the groundwater management area. The total storage is the volume of groundwater that can be removed by completely draining the aquifer.

Aquifers can be either unconfined or confined (Figure 1). A well screened in an unconfined aquifer will have a water level equal to the water level in the aquifer outside the well. Thus, unconfined aquifers have water levels within the aquifers. A confined aquifer is bounded by low permeable geologic units at the top and bottom, and the aquifer is under hydraulic pressure above the ambient atmospheric pressure. The water level at a well screened in a confined aquifer will be above the top of the aquifer. As a result, calculation of total storage is also different between unconfined and confined aquifers. For an unconfined aquifer, the total storage is equal to the volume of groundwater that makes the water level fall to the aquifer bottom. For a confined aquifer, the total storage contains two parts. The first part is the groundwater released from the aquifer when the water level falls from above the top of the aquifer to the top of the aquifer. The reduction of hydraulic pressure in the aquifer by pumping causes expansion of groundwater and deformation of aquifer solids. The aquifer is still fully saturated to this point. The second part, just like unconfined aquifer, is the groundwater released from the aquifer when the water level falls from the top to the bottom of the aquifer. Given the same aquifer area and water level drop, the amount of water released in the second part is much greater than the first part. The difference is quantified by two parameters: storativity related to confined aquifer and specific yield related to unconfined aquifer. For example, storativity values range from 10^{-5} to 10^{-3} for most confined aquifers, while the specific yield values can be 0.01 to 0.3 for most unconfined aquifers. The equations for calculating the total storage are presented below:

- for unconfined aquifers

$$Total\ Storage\ = V_{drained} = Area \times S_y \times (Water\ Level - Bottom)$$

- for confined aquifers

$$Total\ Storage\ = V_{confined} + V_{drained}$$

  - confined part

$$V_{confined} = \ Area \times [\ S \times (Water\ Level - Top)]$$

or

$$V_{confined} = \ Area \times [\ S_s\ \times (\mathrm{Top} - \mathrm{Bottom}) \times (Water\ Level - Top)]$$

  - unconfined part

$$V_{drained} = \ Area \times \left[S_y \times (Top - Bottom)\right]$$

where:

- $V_{drained}$ = storage volume due to water draining from the formation (acre-feet)
- $V_{confined}$ = storage volume due to elastic properties of the aquifer and water(acre-feet)
- *Area* = area of aquifer (acre)
- *Water Level* = groundwater elevation (feet above mean sea level)
- *Top* = elevation of aquifer top (feet above mean sea level)
- *Bottom* = elevation of aquifer bottom (feet above mean sea level)
- S_y = specific yield (no units)
- S_s = specific storage (1/feet)
- S = storativity or storage coefficient (no units)

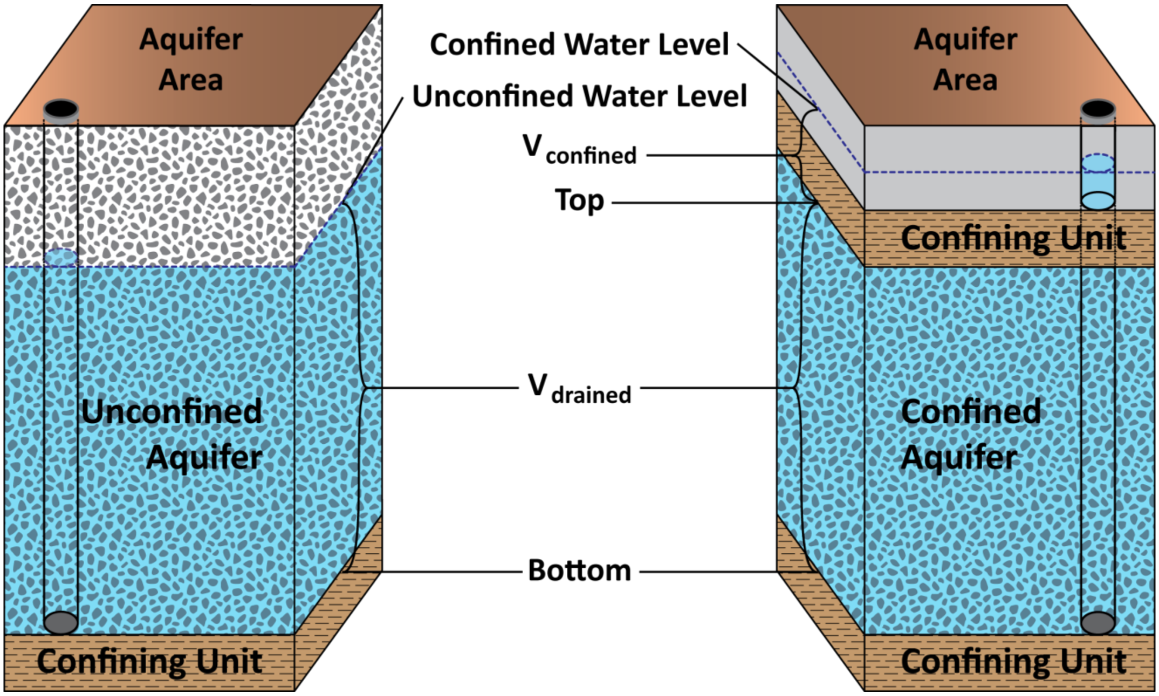

FIGURE 1. SCHEMATIC GRAPH SHOWING THE DIFFERENCE BETWEEN UNCONFINED AND CONFINED AQUIFERS.

As presented in the equations, calculation of the total storage requires data, such as aquifer top, aquifer bottom, aquifer storage properties, and water level. For the Dockum, Edwards-Trinity (High Plains), Edwards-Trinity (Plateau), Ogallala, and Seymour aquifers in Groundwater Management Area 2, we extracted this information from existing groundwater availability model input and output files on a cell-by-cell basis. This information was contained in model input and output files on a cell-by-cell basis. In the absence of groundwater availability model(s), the total storage will be calculated using other approaches.

Python scripts and a FORTRAN-90 program were developed and used to expedite the storage calculation. The total recoverable storage was calculated as the product of the total storage and an estimated factor ranging from 25 percent to 75 percent.

The following methodology was used to estimate total recoverable storage for parts of the Pecos Valley and Edwards-Trinity (Plateau) aquifers in Groundwater Management Area 2 that were not included in the 1-layered alternative groundwater flow model covering these aquifers (Hutchison and others, 2011). The excluded parts of the respective aquifers are relatively thin, mostly located along the margins of the respective aquifers in the western part of the model.

Recoverable storage in areas outside of the model but within the official aquifer boundaries is estimated by first establishing a relationship between aquifer thickness and saturated thickness. Where aquifer thickness is the difference between the elevations of the aquifer top and base, and saturated thickness is the difference between the water table and aquifer base elevations. In each of the three aquifers included in this model there is a generally linear relationship between aquifer thickness and saturated thickness. In the Pecos Valley Aquifer, the ratio between saturated thickness and aquifer thickness is approximately 0.8, while in the Edwards-Trinity (Plateau) and Trinity aquifers, it is 0.9 and 0.6, respectively. Saturated thickness in the non-modeled areas is estimated using these ratios.

The three aquifers—Pecos Valley and Edwards-Trinity (Plateau) aquifers, and the Hill Country portion of the Trinity Aquifer—are assumed to be unconfined. Consequently, storage in each model cell representing parts of the respective aquifers excluded from the groundwater flow model is estimated using the following equation:

$$Total\ Storage = V_{drained} = Area \times S_y \times H_{sat}$$

where:

- $V_{drained}$ = storage volume due to water draining from the formation (acre-feet)
- $Area$ = area of aquifer (acre)
- S_y = specific yield (no units)
- H_{sat} = estimated saturated thickness (feet)

Storage volumes estimated using this method were added to the storage volumes from the remainder of the modeled area to estimate the total recoverable storage for the entire aquifer.

PARAMETERS AND ASSUMPTIONS:

Dockum Aquifer

- We used version 1.01 of the groundwater availability model for the Dockum Aquifer to estimate the total recoverable storage. See Ewing and others (2008) for assumptions and limitations of the groundwater availability model.
- This groundwater availability model includes three layers which generally represent the younger geologic units overlying the Dockum Aquifer (Layer 1), the upper portion of the Dockum Aquifer (Layer 2), and the lower portion of the Dockum Aquifer (Layer 3).
- Of the three layers, total estimated recoverable storage was determined and combined for layers representing the Dockum Aquifer (layers 2 and 3).
- The down-dip boundary of the Dockum Aquifer in this model was set to approximately coincide with the extent of the available geologic data, well beyond any active portion (groundwater use) of the aquifer (Ewing and others, 2008). Consequently, the model extends into zones of brackish and saline groundwater. The official extent of the Dockum Aquifer was used to exclude this area (George and others, 2011).

Southern portion of the Ogallala Aquifer and Edwards-Trinity (High Plains) Aquifer

- We used version 2.01 of the groundwater availability model to estimate the total recoverable storages of the southern portion of the Ogallala and Edwards-Trinity (High Plains) aquifers. This model is an expansion on and update to the previously developed groundwater availability model for the southern portion of the Ogallala Aquifer described in Blandford and others (2003). See Blandford and others (2008) and Blandford and others (2003) for assumptions and limitations of the groundwater availability model.
- This groundwater availability model includes 4 layers which represent the southern portion of the Ogallala (Layer 1) and the Edwards-Trinity (High Plains) (primarily Edwards, Comanche Peak, and Antlers Sand formations; layers 2-4).

- Of the four layers, total estimated recoverable storage was determined for the Ogallala Aquifer (Layer 1) and Edwards-Trinity (High Plains) Aquifer (layers 2-4) in Groundwater Management Area 2.

Edwards-Trinity (Plateau) and Pecos Valley aquifers

- We used alternative groundwater flow model for the Edwards-Trinity (Plateau) Aquifer. See Hutchison and Others (2011) for assumptions and limitations of the alternative numerical groundwater flow model.
- This 1-layer groundwater flow model simulates groundwater flow through the Pecos Valley and Edwards-Trinity (Plateau) aquifers, and the Hill Country portion of the Trinity Aquifer.
- In this model, where the Pecos Valley and Edwards-Trinity (Plateau) aquifer overlap, total storage is assigned to the Pecos Valley Aquifer.

Seymour Aquifer

- We used version 1.01 of the groundwater availability model for the Seymour and Blaine aquifers. See Ewing and others (2004) for assumptions and limitations of the groundwater availability model.
- This groundwater availability model includes two layers, representing the Seymour (Layer 1) and Blaine (Layer 2) aquifers. In areas where the Blaine Aquifer does not exist the model roughly replicates the various Permian units located in the study area.
- Of the two layers, total estimated recoverable storage was determined using the cells in the model that represent the Seymour Aquifer in Layer 1.

RESULTS:

Tables 1 through 12 summarize the total estimated recoverable storage required by statute. The county and groundwater conservation district total estimates are rounded to two significant figures. Figures 2 through 7 indicate the extent of the groundwater availability models in Groundwater Management Area 2 for the Dockum, Edwards-Trinity (High Plains), Edwards-Trinity (Plateau), Ogallala, Seymour, and Pecos Valley aquifers from which the storage information was extracted.

TABLE 1. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE DOCKUM AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 2. COUNTY TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Andrews	220,000,000	55,000,000	165,000,000
Borden	7,600,000	1,900,000	5,700,000
Briscoe	18,000,000	4,500,000	13,500,000
Castro	7,000,000	1,750,000	5,250,000
Crosby	30,000,000	7,500,000	22,500,000
Deaf Smith	130,000,000	32,500,000	97,500,000
Floyd	40,000,000	10,000,000	30,000,000
Gaines	200,000,000	50,000,000	150,000,000
Garza	4,900,000	1,225,000	3,675,000
Hale	16,000,000	4,000,000	12,000,000
Howard	22,000,000	5,500,000	16,500,000
Martin	11,000,000	2,750,000	8,250,000
Parmer	30,000,000	7,500,000	22,500,000
Swisher	66,000,000	16,500,000	49,500,000
Total	**802,500,000**	**200,625,000**	**601,875,000**

TABLE 2. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT (GCD)[3] FOR THE DOCKUM AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 2. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

Groundwater Conservation District (GCD)	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Garza County UWCD[4]	4,900,000	1,225,000	3,675,000
High Plains UWCD No.1	250,000,000	62,500,000	187,500,000
Llano Estacado UWCD	200,000,000	50,000,000	150,000,000
Permian Basin UWCD	32,000,000	8,000,000	24,000,000
No District	310,000,000	77,500,000	232,500,000
Total	**796,900,000**	**199,225,000**	**597,675,000**

[3] The total estimated recoverable storages by groundwater conservation district and county aquifer may not be the same because the numbers have been rounded to two significant figures.
[4] UWCD is the abbreviation for Underground Water Conservation District.

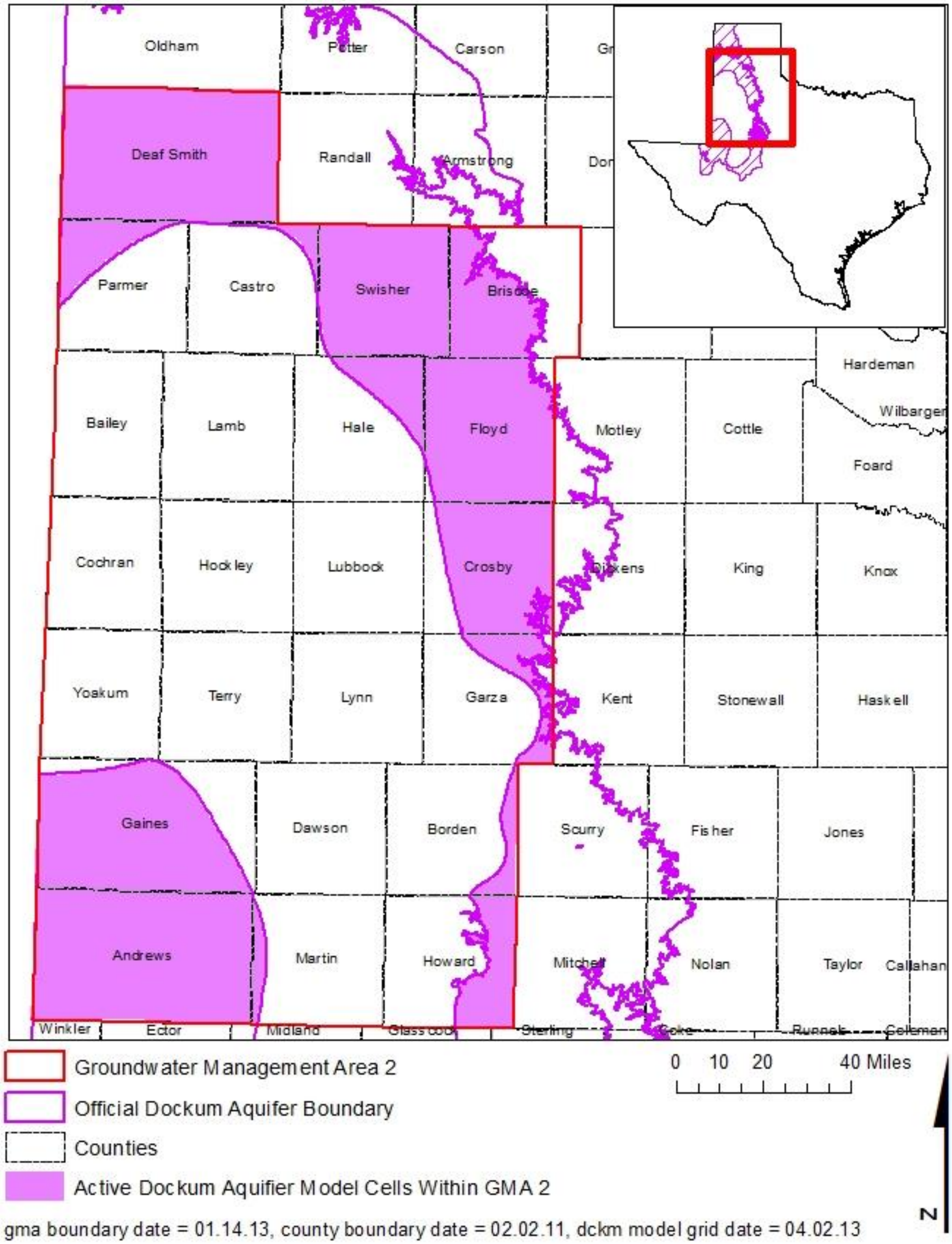

FIGURE 2. EXTENT OF THE GROUNDWATER AVAILABILITY MODEL OF THE DOCKUM AQUIFER USED TO ESTIMATE TOTAL RECOVERABLE STORAGE (TABLES 1 AND 2) WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 2.

TABLE 3. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE EDWARDS-TRINITY (HIGH PLAINS) AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 2. COUNTY TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

County	***Total Storage (acre-feet)***	***25 percent of Total Storage (acre-feet)***	***75 percent of Total Storage (acre-feet)***
Bailey	690,000	172,500	517,500
Borden	1,600,000	400,000	1,200,000
Cochran	1,700,000	425,000	1,275,000
Dawson	1,000,000	250,000	750,000
Floyd	730,000	182,500	547,500
Gaines	3,100,000	775,000	2,325,000
Garza	120,000	30,000	90,000
Hale	870,000	217,500	652,500
Hockley	2,200,000	550,000	1,650,000
Lamb	500,000	125,000	375,000
Lubbock	2,000,000	500,000	1,500,000
Lynn	3,400,000	850,000	2,550,000
Terry	3,300,000	825,000	2,475,000
Yoakum	2,500,000	625,000	1,875,000
Total	**23,710,000**	**5,927,500**	**17,782,500**

TABLE 4. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT (GCD)[5] FOR THE EDWARDS-TRINITY (HIGH PLAINS) AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 2. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

Groundwater Conservation District (GCD)	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Garza County UWCD[6]	120,000	30,000	90,000
High Plains UWCD No.1	12,000,000	3,000,000	9,000,000
Llano Estacado UWCD	3,100,000	775,000	2,325,000
Mesa UWCD	1,000,000	250,000	750,000
Sandy Land UWCD	2,500,000	625,000	1,875,000
South Plains UWCD	3,300,000	825,000	2,475,000
No District	1,700,000	425,000	1,275,000
Total	**23,720,000**	**5,930,000**	**17,790,000**

[5] The total estimated recoverable storages by groundwater conservation district and county aquifer may not be the same because the numbers have been rounded to two significant figures.
[6] UWCD is the abbreviation for Underground Water Conservation District.

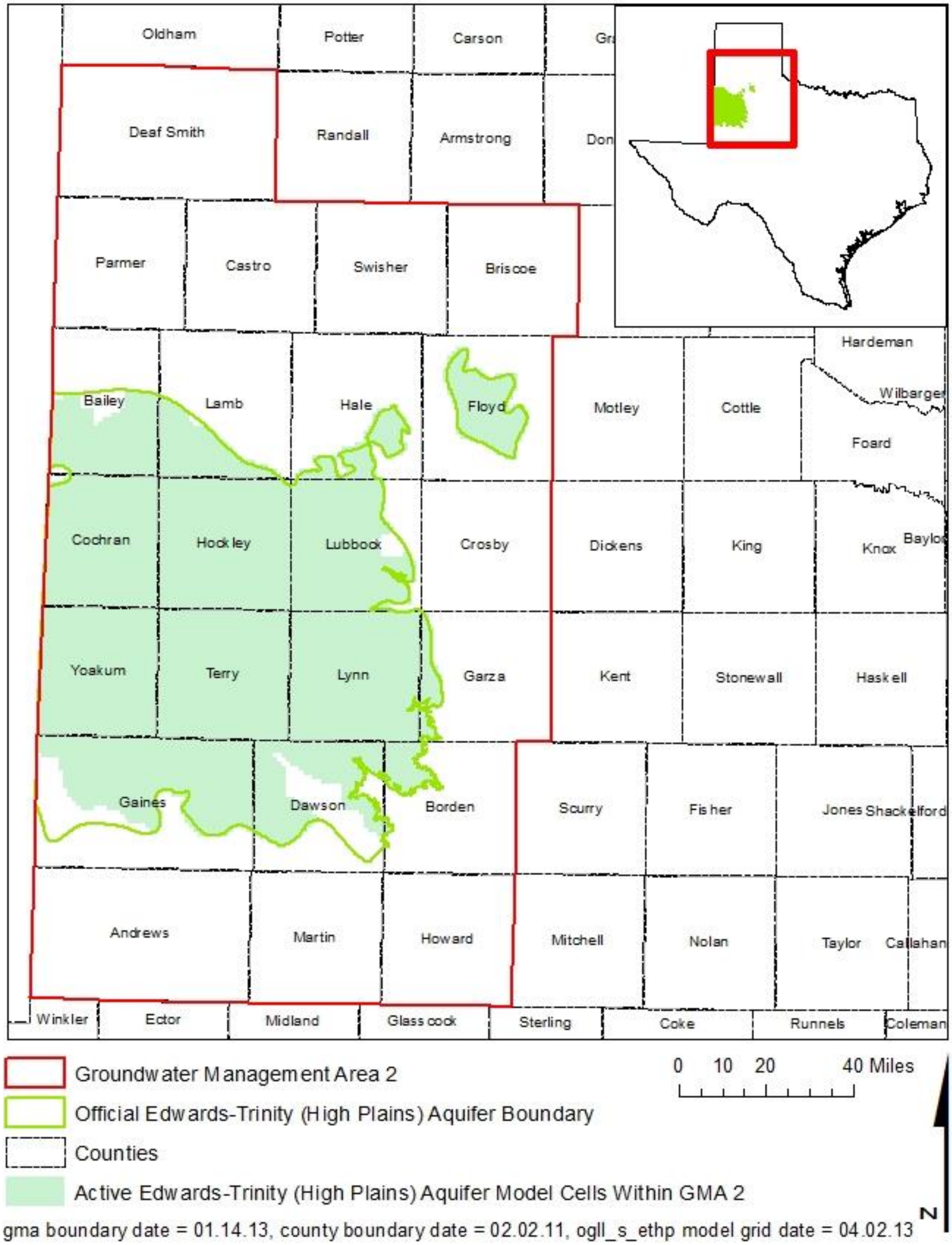

FIGURE 3. EXTENT OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (HIGH PLAINS) AQUIFER USED TO ESTIMATE TOTAL RECOVERABLE STORAGE (TABLES 3 AND 4) WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 2.

TABLE 5. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 2. COUNTY TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Andrews	32,000	8,000	24,000
Howard	61,000	15,250	45,750
Martin	49,000	12,250	36,750
Total	**142,000**	**35,500**	**106,500**

TABLE 6. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT (GCD) FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 2. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

Groundwater Conservation District (GCD)	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Permian Basin UWCD[7]	95,000	23,750	71,250
No District	47,000	11,750	35,250
Total	**142,000**	**35,500**	**106,500**

[7] UWCD is the abbreviation for Underground Water Conservation District.

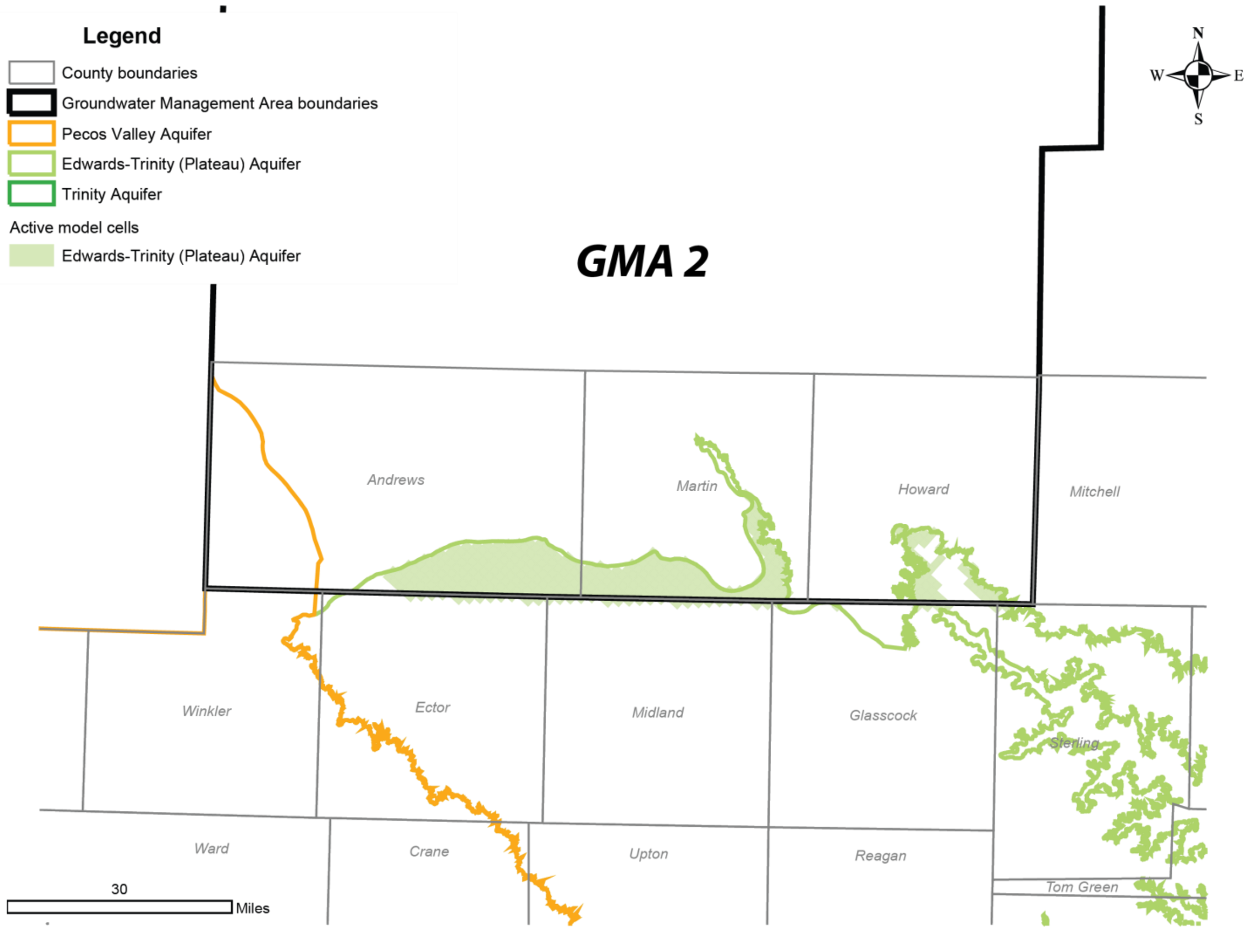

FIGURE 4. EXTENT OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER USED TO ESTIMATE TOTAL RECOVERABLE STORAGE (TABLES 5 AND 6) WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 2.

TABLE 7. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE OGALLALA AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 2. COUNTY TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Andrews	5,400,000	1,350,000	4,050,000
Bailey	2,900,000	725,000	2,175,000
Borden	310,000	77,500	232,500
Briscoe	2,100,000	525,000	1,575,000
Castro	9,500,000	2,375,000	7,125,000
Cochran	2,900,000	725,000	2,175,000
Crosby	12,000,000	3,000,000	9,000,000
Dawson	7,400,000	1,850,000	5,550,000
Deaf Smith	8,300,000	2,075,000	6,225,000
Floyd	12,000,000	3,000,000	9,000,000
Gaines	11,000,000	2,750,000	8,250,000
Garza	1,100,000	275,000	825,000
Hale	9,500,000	2,375,000	7,125,000
Hockley	5,900,000	1,475,000	4,425,000
Howard	2,300,000	575,000	1,725,000
Lamb	8,600,000	2,150,000	6,450,000
Lubbock	7,000,000	1,750,000	5,250,000
Lynn	5,000,000	1,250,000	3,750,000
Martin	7,100,000	1,775,000	5,325,000
Parmer	3,900,000	975,000	2,925,000
Swisher	7,600,000	1,900,000	5,700,000
Terry	5,200,000	1,300,000	3,900,000
Yoakum	2,200,000	550,000	1,650,000
Total	**139,210,000**	**34,802,500**	**104,407,500**

TABLE 8. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT (GCD)[8] FOR THE OGALLALA AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 2. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

Groundwater Conservation District (GCD)	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Garza County UWCD[9]	1,100,000	275,000	825,000
High Plains UWCD No.1	90,000,000	22,500,000	67,500,000
Llano Estacado UWCD	11,000,000	2,750,000	8,250,000
Mesa UWCD	7,400,000	1,850,000	5,550,000
Permian Basin UWCD	9,300,000	2,325,000	6,975,000
Sandy Land UWCD	2,200,000	550,000	1,650,000
South Plains UWCD	5,300,000	1,325,000	3,975,000
No District	12,000,000	3,000,000	9,000,000
Total	**138,300,000**	**34,575,000**	**103,725,000**

[8] The total estimated recoverable storages by groundwater conservation district and county aquifer may not be the same because the numbers have been rounded to two significant figures.
[9] UWCD is the abbreviation for Underground Water Conservation District.

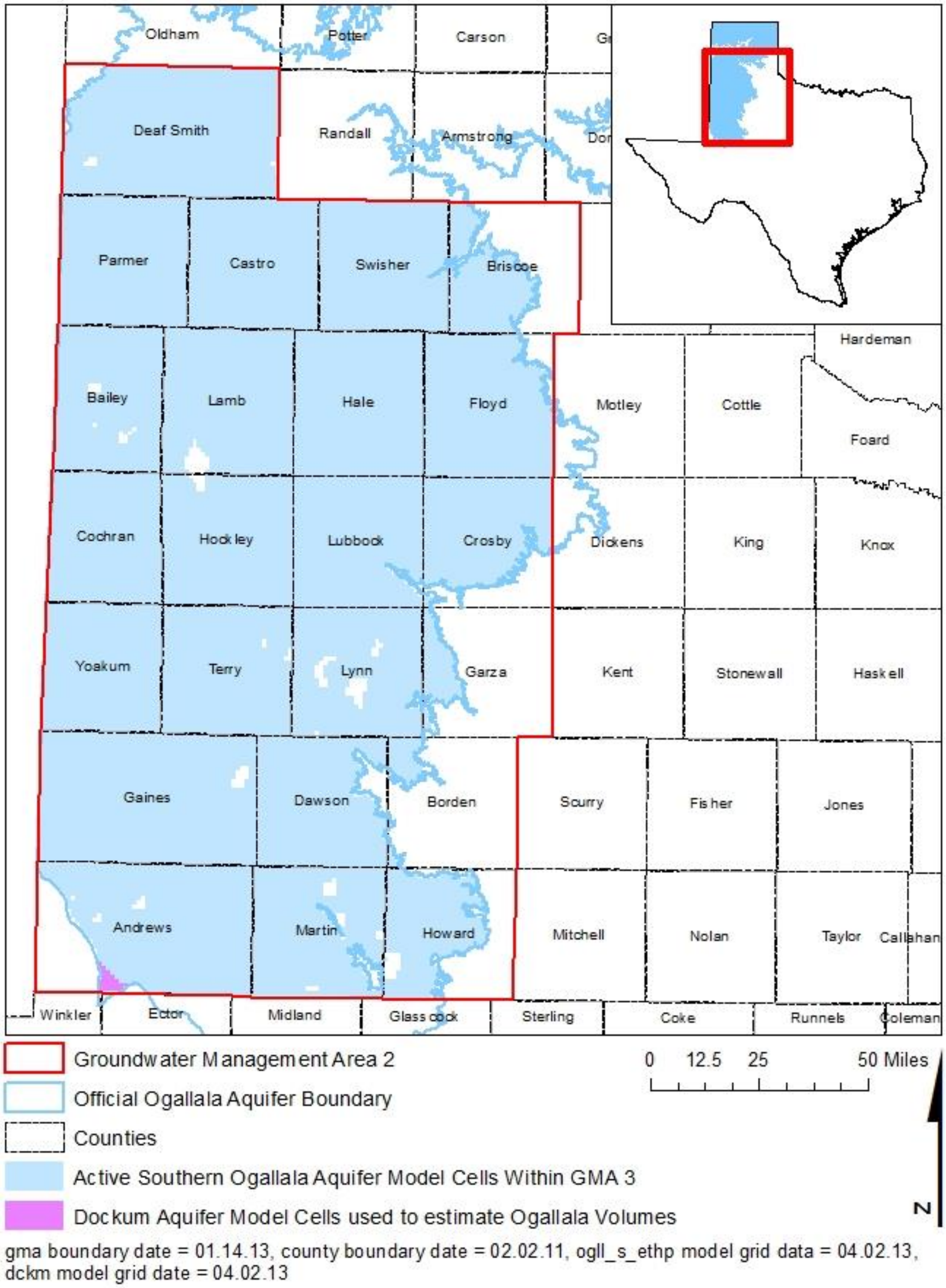

FIGURE 5. EXTENT OF THE GROUNDWATER AVAILABILITY MODELS FOR THE SOUTHERN PORTION OF THE OGALLALA AQUIFER AND DOCKUM AQUIFER USED TO ESTIMATE TOTAL RECOVERABLE STORAGE (TABLES 7 AND 8) WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 2.

TABLE 9. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE SEYMOUR AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 2. COUNTY TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Briscoe	57,000	14,250	42,750
Total	**57,000**	**14,250**	**42,750**

TABLE 10. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT (GCD) FOR THE SEYMOUR AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 2. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

Groundwater Conservation District	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
No District	57,000	14,250	42,750
Total	**57,000**	**14,250**	**42,750**

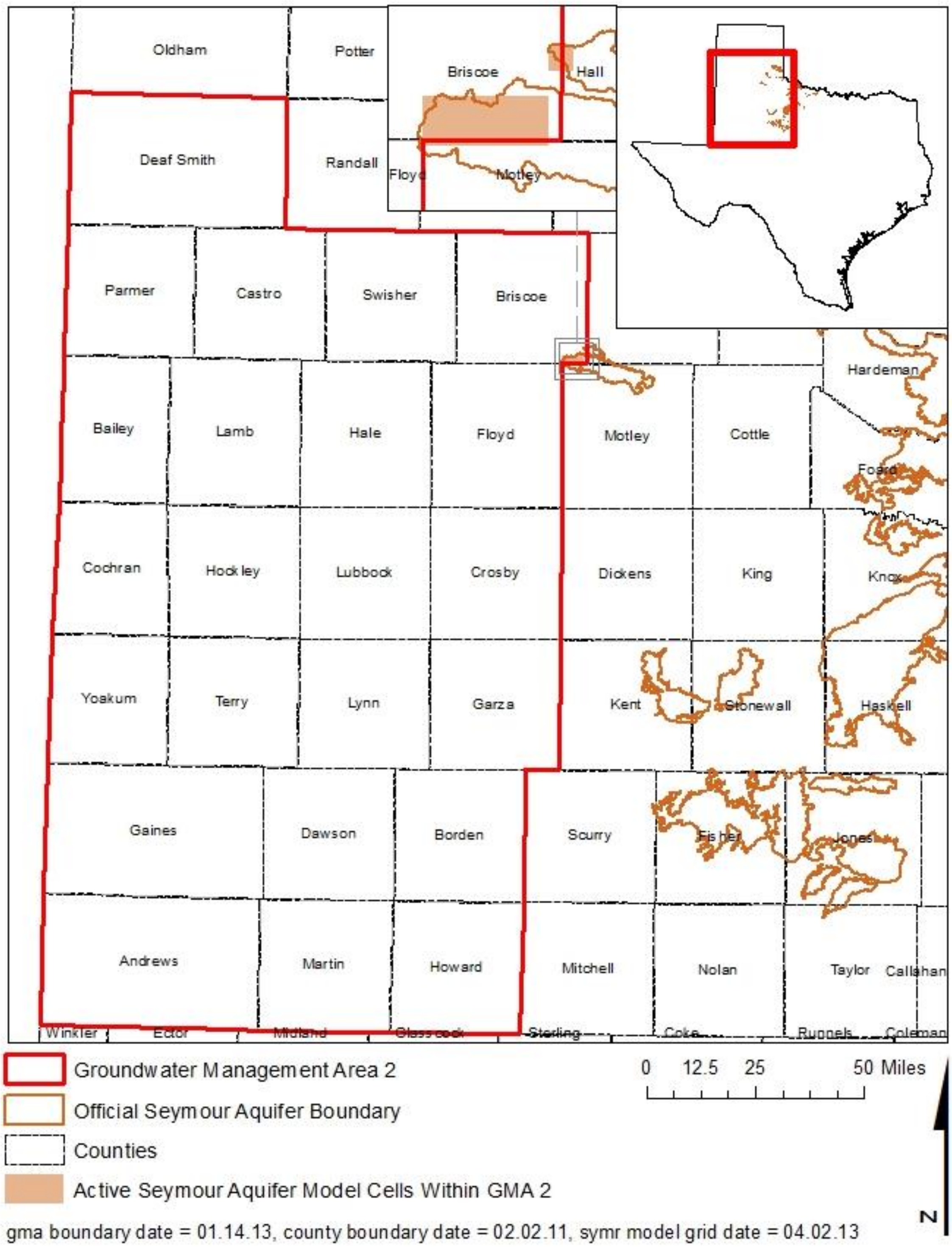

FIGURE 6. EXTENT OF THE GROUNDWATER AVAILABILITY MODEL OF THE SEYMOUR AQUIFER USED TO ESTIMATE TOTAL RECOVERABLE STORAGE (TABLES 9 AND 10) WITHIN GROUNDWATER MANAGEMENT AREA 2.

TABLE 11. TOTAL ESTIMATED RECOVERABLE STORAGE BY COUNTY FOR THE PECOS VALLEY AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 2. COUNTY TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

County	*Total Storage (acre-feet)*	*25% of Total Storage (acre-feet)*	*75% of Total Storage (acre-feet)*
Andrews	2,000,000	500,000	1,500,000
Total	**2,000,000**	**500,000**	**1,500,000**

TABLE 12. TOTAL ESTIMATED RECOVERABLE STORAGE BY GROUNDWATER CONSERVATION DISTRICT (GCD) FOR THE PECOS VALLEY AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 2. GROUNDWATER CONSERVATION DISTRICT TOTAL ESTIMATES ARE ROUNDED TO TWO SIGNIFICANT FIGURES.

Groundwater Conservation District	*Total Storage (acre-feet)*	*25% of Total Storage (acre-feet)*	*75% of Total Storage (acre-feet)*
No District	2,000,000	500,000	1,500,000
Total	**2,000,000**	**500,000**	**1,500,000**

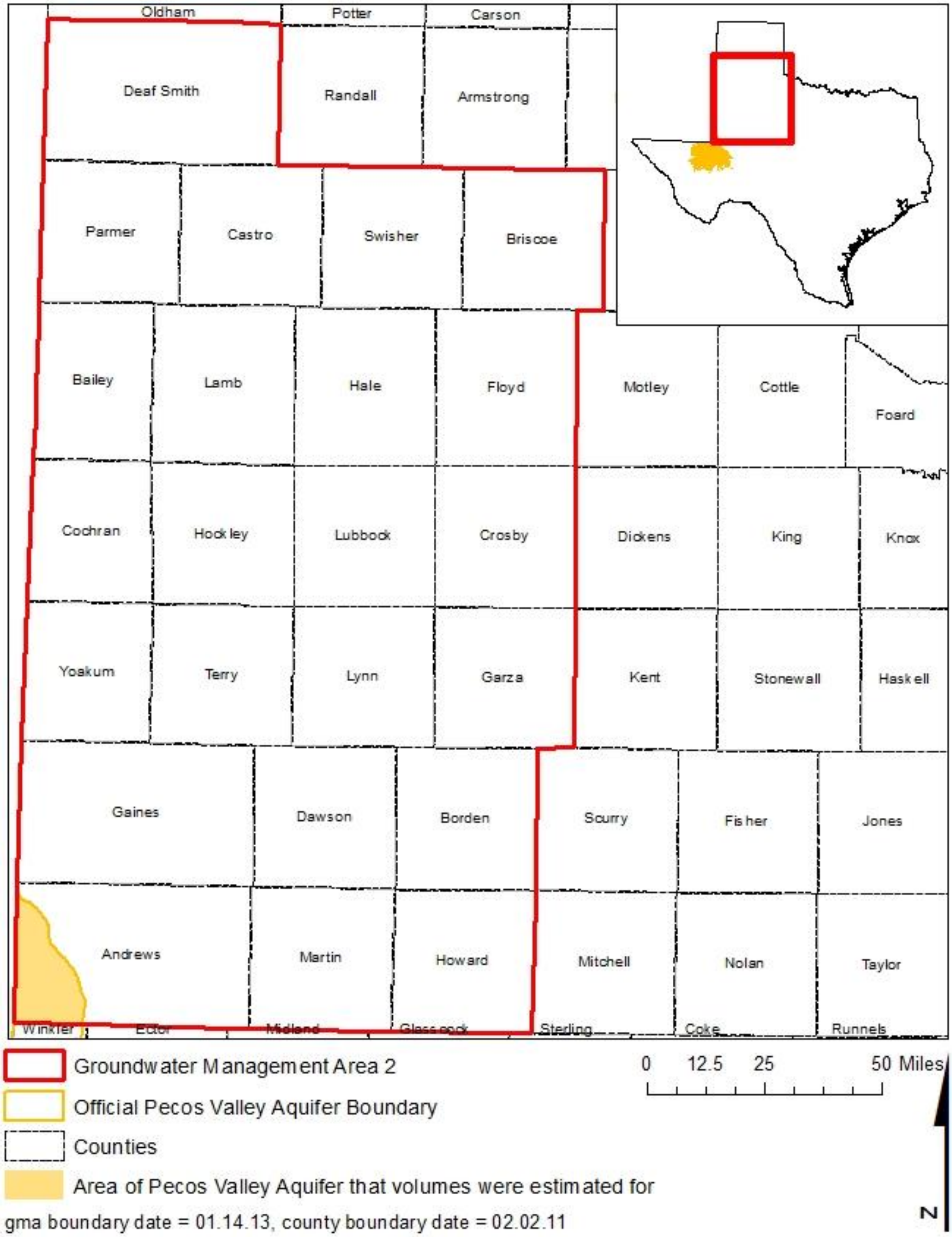

FIGURE 7. AREA OF THE PECOS VALLEY AQUIFER USED TO ESTIMATE TOTAL RECOVERABLE STORAGE (TABLES 11 AND 12) WITHIN GROUNDWATER MANAGEMENT AREA (GMA) 2.

LIMITATIONS

The groundwater models used in completing this analysis are the best available scientific tools 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."*

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.

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