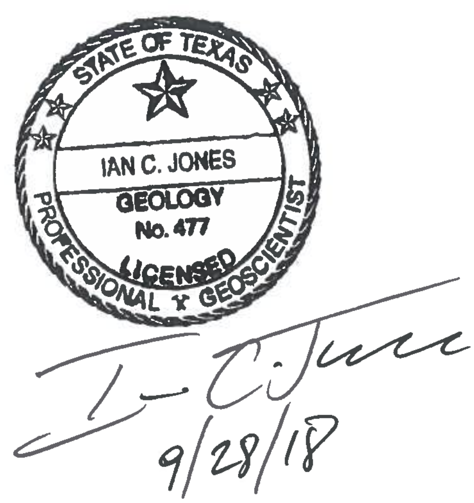
GAM Run 18-015: Kimble County Groundwater Conservation District Groundwater Management Plan

Ian C. Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
512-463-6641
September 28, 2018



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EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h) (Texas Water Code, 2011), states that, in developing its groundwater management plan, a groundwater conservation district shall use groundwater availability modeling information provided by the Executive Administrator of the Texas Water Development Board (TWDB) in conjunction with any available site-specific information provided by the district for review and comment to the Executive Administrator.

The TWDB provides data and information to the Kimble County Groundwater Conservation District in two parts. Part 1 is the Estimated Historical Water Use/State Water Plan dataset report, which will be provided to you separately by the TWDB Groundwater Technical Assistance Department. Please direct questions about the water data report to Mr. Stephen Allen at 512-463-7317 or stephen.allen@twdb.texas.gov. Part 2 is the required groundwater availability modeling information and this information includes:

1. the annual amount of recharge from precipitation, if any, to the groundwater resources within the district;
2. for each aquifer within the district, the annual volume of water that discharges from the aquifer to springs and any surface-water bodies, including lakes, streams, and rivers; and
3. the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

The groundwater management plan for the Kimble County Groundwater Conservation District should be adopted by the district on or before April 12, 2019, and submitted to the Executive Administrator of the TWDB on or before May 12, 2019. The current management plan for the Kimble County Groundwater Conservation District expires on July 11, 2019.

We used two groundwater availability models to estimate the management plan information for the aquifers within the Kimble County Groundwater Conservation District. Information for the Marble Falls, Ellenburger-San Saba, and Hickory aquifers is from version 1.01 of the groundwater availability model for the minor aquifers of the Llano Uplift Region (Shi and others, 2016). Information for the Edwards-Trinity (Plateau) Aquifer is from version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers (Anaya and Jones, 2009).

This report replaces the results of GAM Run 13-018 (Seiter-Weatherford, 2013). GAM Run 18-015 includes results from the groundwater availability model for the minor aquifers of the Llano Uplift Region (Shi and others, 2016). Tables 1 through 4 summarize the groundwater availability model data required by statute and Figures 1 through 4 show the area of the models from which the values in the tables were extracted. If, after review of the figures, the Kimble County Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB at your earliest convenience.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the two groundwater availability models mentioned above were used to estimate information for the Kimble County Groundwater Conservation District management plan. Water budgets were extracted for the historical model periods for the Marble Falls, Ellenburger-San Saba, and Hickory aquifers (1981 through 2010) using ZONEBUDGET-USG (Panday and others, 2013). The water budget for the Edwards-Trinity (Plateau) Aquifer was extracted for the historical model period (1981 through 2000) using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The average annual water budget values for recharge, surface-water outflow, flows between aquifers in the district, inflow to the district, and outflow from the district for the aquifers within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Edwards-Trinity (Plateau) Aquifer

- We used version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers. See Anaya and Jones (2009) for assumptions and limitations of the model.

- The groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers contains 2 layers: Layer 1—represents the Edwards Group and equivalent limestone hydrostratigraphic units of the Edwards-Trinity (Plateau) Aquifer, and Layer 2—comprised of the undifferentiated Trinity Group hydrostratigraphic units or equivalent units of the Edwards-Trinity (Plateau) Aquifer. The two layers were lumped for calculating water budgets in the Edwards-Trinity (Plateau) Aquifer within the district.

- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

Marble Falls, Ellenburger-San Saba, and Hickory aquifers

- We used version 1.01 of the groundwater availability model for the minor aquifers in the Llano Uplift Region. See Shi and others (2016) for assumptions and limitations of the model.

- The groundwater availability model for the minor aquifers in Llano Uplift Region contains eight layers:
    - Layer 1 — the Trinity Aquifer, Edwards-Trinity (Plateau) Aquifer, and younger alluvium deposits
    - Layer 2 — confining units
    - Layer 3 — the Marble Falls Aquifer and equivalent
    - Layer 4 — confining units
    - Layer 5 — the Ellenburger-San Saba Aquifer and equivalent
    - Layer 6 — confining units
    - Layer 7 — the Hickory Aquifer and equivalent
    - Layer 8 — confining (Precambrian) units

- Perennial rivers and reservoirs were simulated using the MODFLOW-USG river package. Springs were simulated using MODFLOW-USG drain package. For this management plan, groundwater discharge to surface water includes groundwater leakage to rivers and springs.

- The model was run with MODFLOW-USG beta (development) version (Panday and others, 2013).

- These aquifers are part of a complex geological environment in the Llano Uplift Region characterized by numerous faults that can offset and/or juxtapose multiple aquifer layers with different hydrologic properties and water-quality characteristics. Therefore the water budget and flow information provided in the summary tables is footnoted where appropriate to clarify these aquifer relationships.

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifers according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the groundwater availability model results for the Marble Falls, Ellenburger-San Saba, Hickory, and Edwards-Trinity (Plateau) aquifers located within Kimble County Groundwater Conservation District and averaged over the historical calibration periods, as shown in Tables 1 through 4.

1. Precipitation recharge—the areally distributed recharge sourced from precipitation falling on the outcrop areas of the aquifers (where the aquifer is exposed at land surface) within the district.
2. Surface-water outflow—the total water discharging from the aquifer (outflow) to surface-water features such as streams, reservoirs, and springs.
3. Flow into and out of district—the lateral flow within the aquifer between the district and adjacent counties.
4. Flow between aquifers—the net vertical flow between the aquifer and adjacent aquifers or confining units. This flow is controlled by the relative water levels in each aquifer and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs.

The information needed for the district's management plan is summarized in Tables 1 through 4. It is important to note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double accounting, a model cell that straddles a political boundary, such as a district or county boundary, is assigned to one side of the boundary based on the location of the centroid of the model cell. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located.

TABLE 1. SUMMARIZED INFORMATION FOR THE MARBLE FALLS AQUIFER FOR KIMBLE COUNTY GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Marble Falls Aquifer	14
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Marble Falls Aquifer	1,313
Estimated annual volume of flow into the district within each aquifer in the district	Marble Falls Aquifer	0
Estimated annual volume of flow out of the district within each aquifer in the district	Marble Falls Aquifer	77
Estimated net annual volume of flow between each aquifer in the district	Flow into the Marble Falls Aquifer from the Edwards-Trinity (Plateau) Aquifer/alluvium	1
	Flow into the Marble Falls Aquifer from the Ellenburger-San Saba Aquifer	861
	Flow into the Marble Falls Aquifer from the underlying confining unit	64
	Flow into the Marble Falls Aquifer from the Marble Falls stratigraphic unit	452

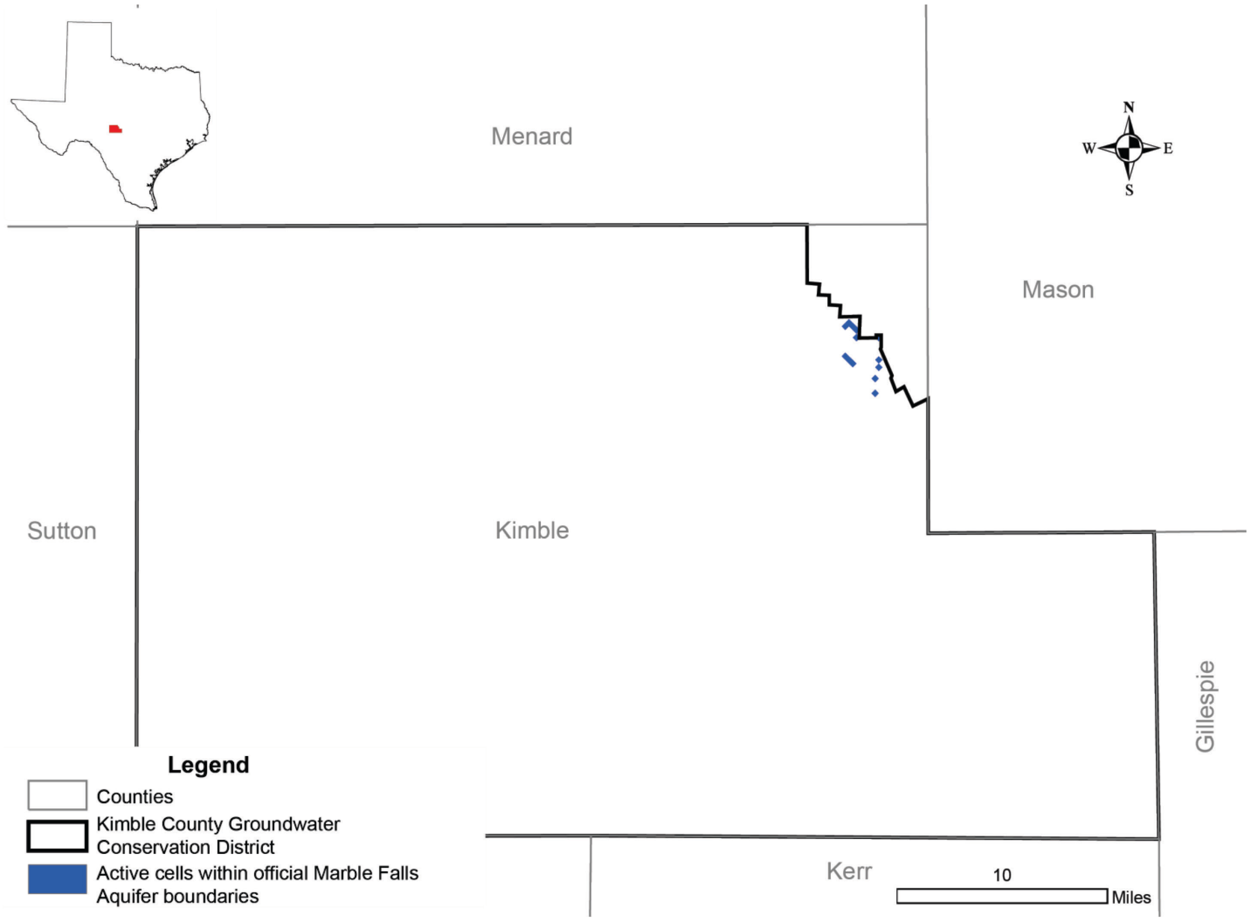

FIGURE 1. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE MARBLE FALLS AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2. SUMMARIZED INFORMATION FOR THE ELLENBURGER-SAN SABA AQUIFER FOR KIMBLE COUNTY GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Ellenburger-San Saba Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Ellenburger-San Saba Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Ellenburger-San Saba Aquifer	3,261
Estimated annual volume of flow out of the district within each aquifer in the district	Ellenburger-San Saba Aquifer	5,625
Estimated net annual volume of flow between each aquifer in the district	Flow into the Ellenburger-San Saba Aquifer from the Hickory Aquifer	1
	Flow into the Ellenburger-San Saba Aquifer from adjacent confining units	2,814
	Flow from the Ellenburger-San Saba Aquifer into the Marble Falls Aquifer	863
	Flow from the brackish Ellenburger-San Saba stratigraphic unit into the Ellenburger-San Saba Aquifer	772

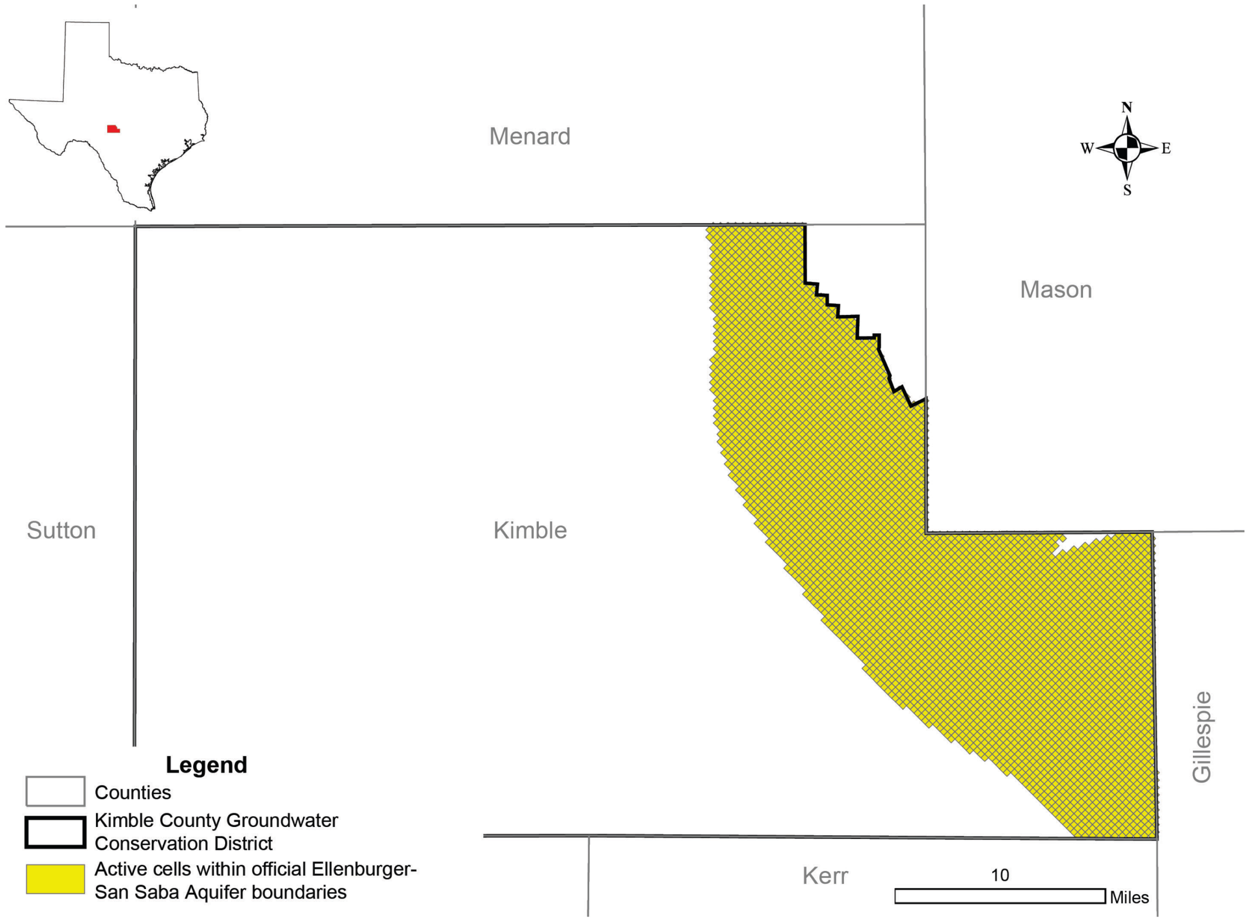

FIGURE 2. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE ELLENBURGER-SAN SABA AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 3. SUMMARIZED INFORMATION FOR THE HICKORY AQUIFER FOR KIMBLE COUNTY GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Hickory Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Hickory Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Hickory Aquifer	3,699
Estimated annual volume of flow out of the district within each aquifer in the district	Hickory Aquifer	8,206
Estimated net annual volume of flow between each aquifer in the district	Flow from the Hickory Aquifer into the Ellenburger-San Saba Aquifer	2
	Flow into the Hickory Aquifer from adjacent confining units	4,822
	Flow from the Hickory Aquifer into the brackish Hickory Formation	279

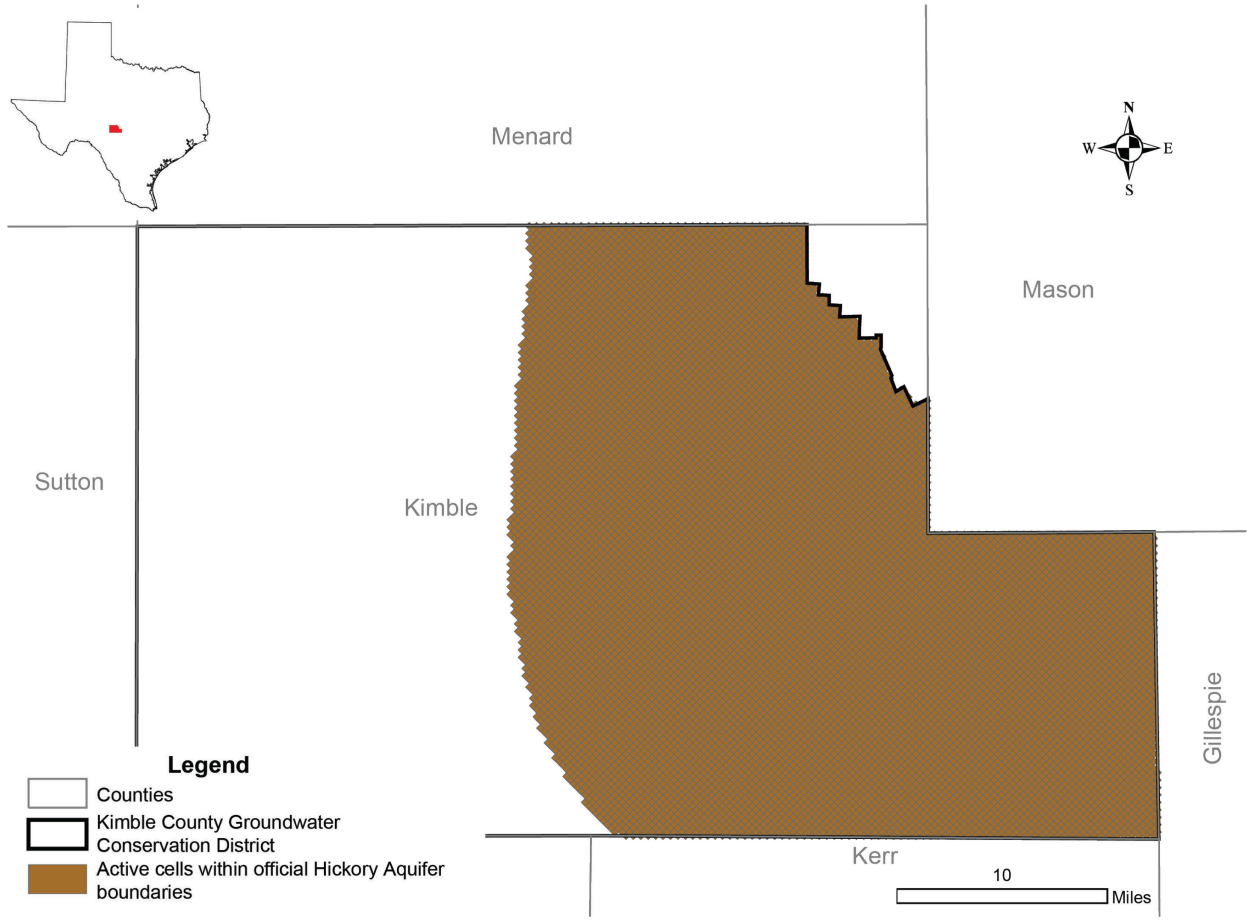

FIGURE 3. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE HICKORY AQUIFER FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 4. SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER FOR KIMBLE COUNTY GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Edwards-Trinity (Plateau) Aquifer	31,514
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Edwards-Trinity (Plateau) Aquifer	57,664
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	29,787
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	10,859
Estimated net annual volume of flow between each aquifer in the district	Flow between the Edwards-Trinity (Plateau) Aquifer and adjacent formations	1*

*—From the groundwater availability model for the minor aquifers in the Llano Uplift Region (Shi and others, 2016).

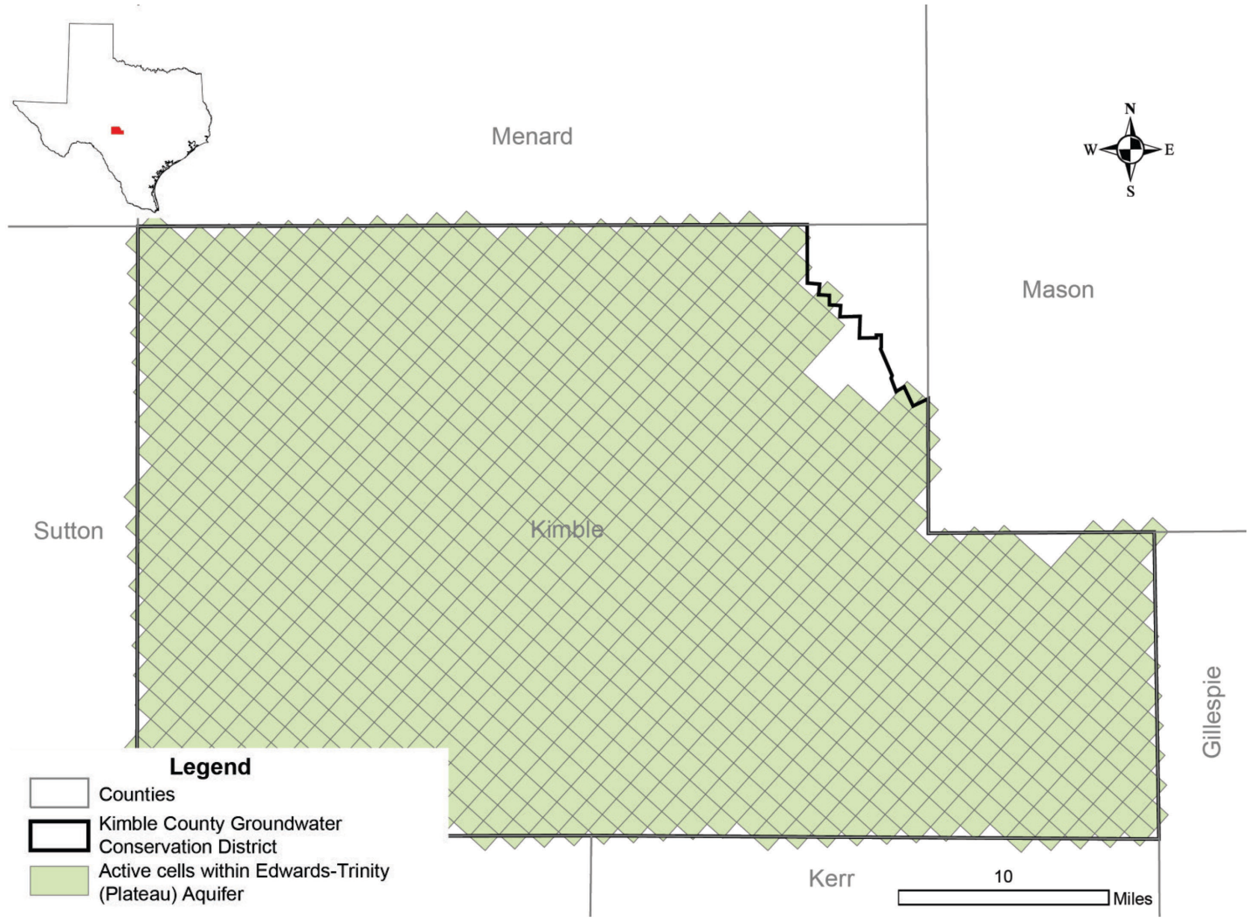

FIGURE 4. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER FROM WHICH THE INFORMATION IN TABLE 4 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

LIMITATIONS:

The groundwater models used in completing this analysis are the best available scientific tools 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 historical groundwater flow conditions includes the assumptions about the location in the aquifer where historical pumping was placed. Understanding the amount and location of historical 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 interaction with streams are specific to particular historical time periods.

Because the application of the groundwater models was designed to address regional-scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations related 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. Historical 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:

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