GAM Run 17-028: Menard County Underground Water District Management Plan

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March 31, 2017

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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 Menard County Underground Water 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 Section. 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 Menard County Underground Water District should be adopted by the district on or before December 19, 2016, and submitted to the Executive Administrator of the TWDB on or before January 18, 2017. The current management plan for the Menard County Underground Water District expires on March 19, 2017.

There are three aquifers identified by TWDB in the Menard County Underground Water District: the Edwards-Trinity (Plateau), the Ellenburger-San Saba, and the Hickory aquifers. Two groundwater availability models were used to extract the management plan information for the aquifers within the Menard County Underground Water District. Information for the Edwards-Trinity (Plateau) Aquifer was extracted from version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley Alluvium aquifers (Anaya and Jones, 2009). Information for the Ellenburger-San Saba and Hickory aquifers was extracted from version 1.01 of the groundwater availability model for the minor aquifers in the Llano Uplift region (Shi and others, 2016).

This report discusses the methods, assumptions, and results from the model runs for the Edwards-Trinity (Plateau), Ellenburger-San Saba, and Hickory aquifers described above. This model run report replaces the results of GAM Run 15-008 (Boghici, 2015), which only included information for the Edwards-Trinity (Plateau) Aquifer. Tables 1 through 3 summarize the groundwater availability model data required by statute. Figures 1 through 3 show the areas of the models from which the values in Tables 1 through 3 were extracted. If after reviewing the figures, the Menard County Underground Water 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 groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley Alluvium aquifers was used to extract information for the Edwards-Trinity (Plateau) Aquifer. The water budget for the Edwards-Trinity (Plateau) Aquifer within the Menard County Underground Water District was extracted for selected years of 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, inflow to the district, and outflow from the district for the Trinity Aquifer within the district are summarized in this report.

The water budgets for the Ellenburger-San Saba and Hickory aquifers within the Menard County Underground Water District were extracted for selected years of the historical model period (1981 through 2010) using ZONEBUDGET USG Version 1.00. The average annual water budget values for recharge, surface-water outflow, inflow to the district, and outflow from the district for the Ellenburger-San Saba and Hickory 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 Alluvium aquifers. See Anaya and Jones (2009) for assumptions and limitations of the model. The Pecos Valley Alluvium Aquifer does not occur within Menard County Underground Water District and, therefore, no groundwater budget for this aquifer is included in this report.
- The groundwater availability model includes two layers:
    - Layer 1 — the Edwards Group of the Edwards-Trinity (Plateau) Aquifer
    - Layer 2 — the Trinity Group of the Edwards-Trinity (Plateau) Aquifer
- The water budget for the district was based on both model layers.
- For Menard County Underground Water District, groundwater in the Edwards-Trinity (Plateau) Aquifer is generally fresh, with total dissolved solids of less than 500 milligrams per liter in nearly 85 percent of the entries in the TWDB groundwater database. (TWDB Groundwater Database, queried June 8, 2015).
- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

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 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 the river and drain boundaries.

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

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the model results for the aquifers located within the district and averaged over the duration of the calibration and verification portion of the model run in the district, as shown in Tables 1 through 3.

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 or confining unit and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs.

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 EDWARDS-TRINITY (PLATEAU) AQUIFER THAT IS NEEDED FOR THE MENARD COUNTY UNDERGROUND WATER 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	19,258
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	20,347
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	10,201
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	10,284
Estimated net annual volume of flow between each aquifer in the district	From Edwards-Trinity (Plateau) Aquifer to underlying confining units*	3,650

* Flow was extracted from the groundwater availability model for the minor aquifers in the Llano Uplift region.

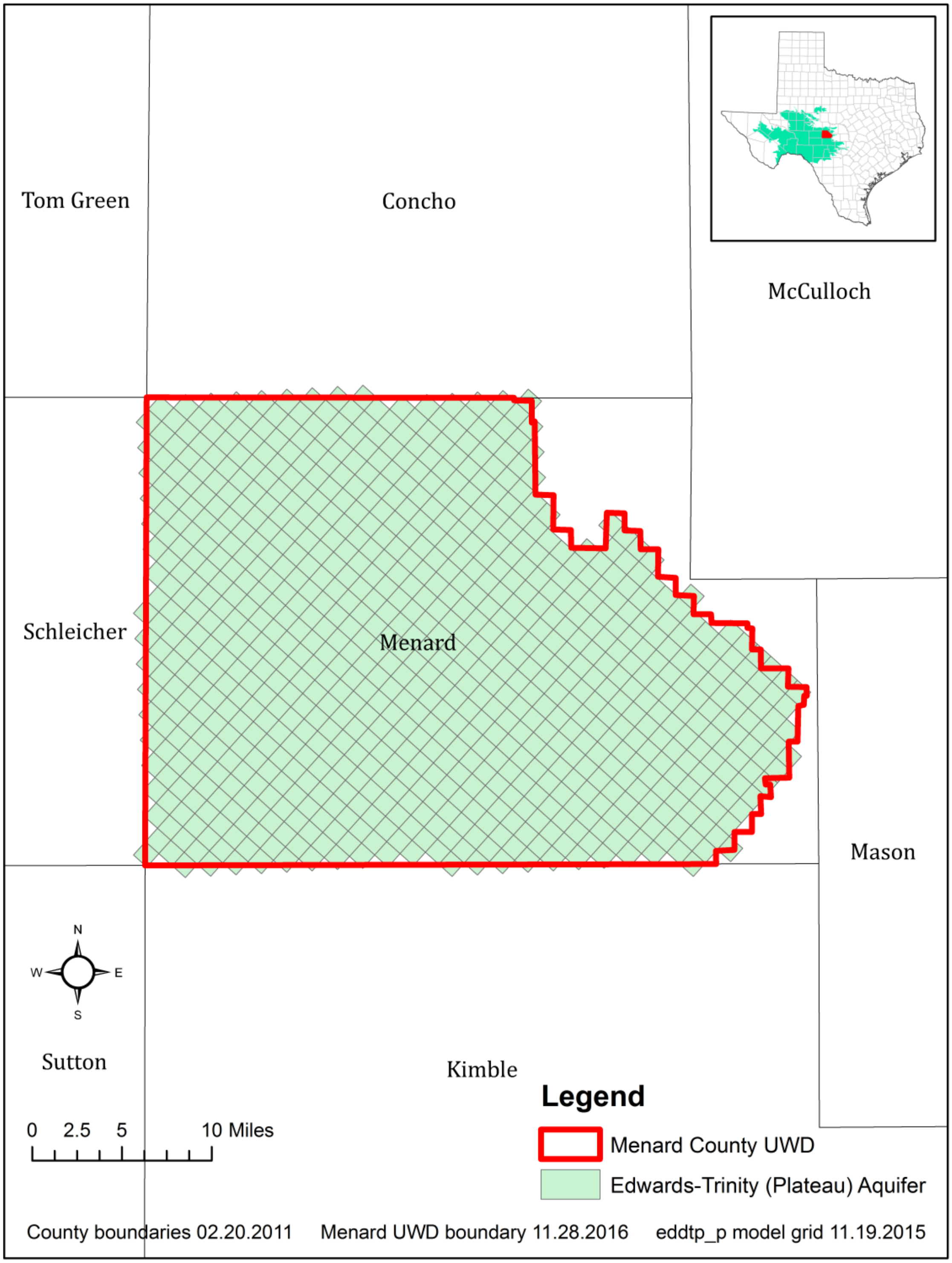

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER WITHIN MENARD UNDERGROUND WATER DISTRICT FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED.

TABLE 2: SUMMARIZED INFORMATION FOR ELLENBURGER-SAN SABA AQUIFER THAT IS NEEDED FOR MENARD COUNTY UNDERGROUND WATER DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST ONE 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	126
Estimated annual volume of flow out of the district within each aquifer in the district	Ellenburger-San Saba Aquifer	269
Estimated net annual volume of flow between each aquifer in the district	From younger confining units to Ellenburger-San Saba Aquifer	1,468
	From Ellenburger-San Saba Aquifer to older confining units	1,469
	From brackish portion to Ellenburger-San Saba Aquifer	152

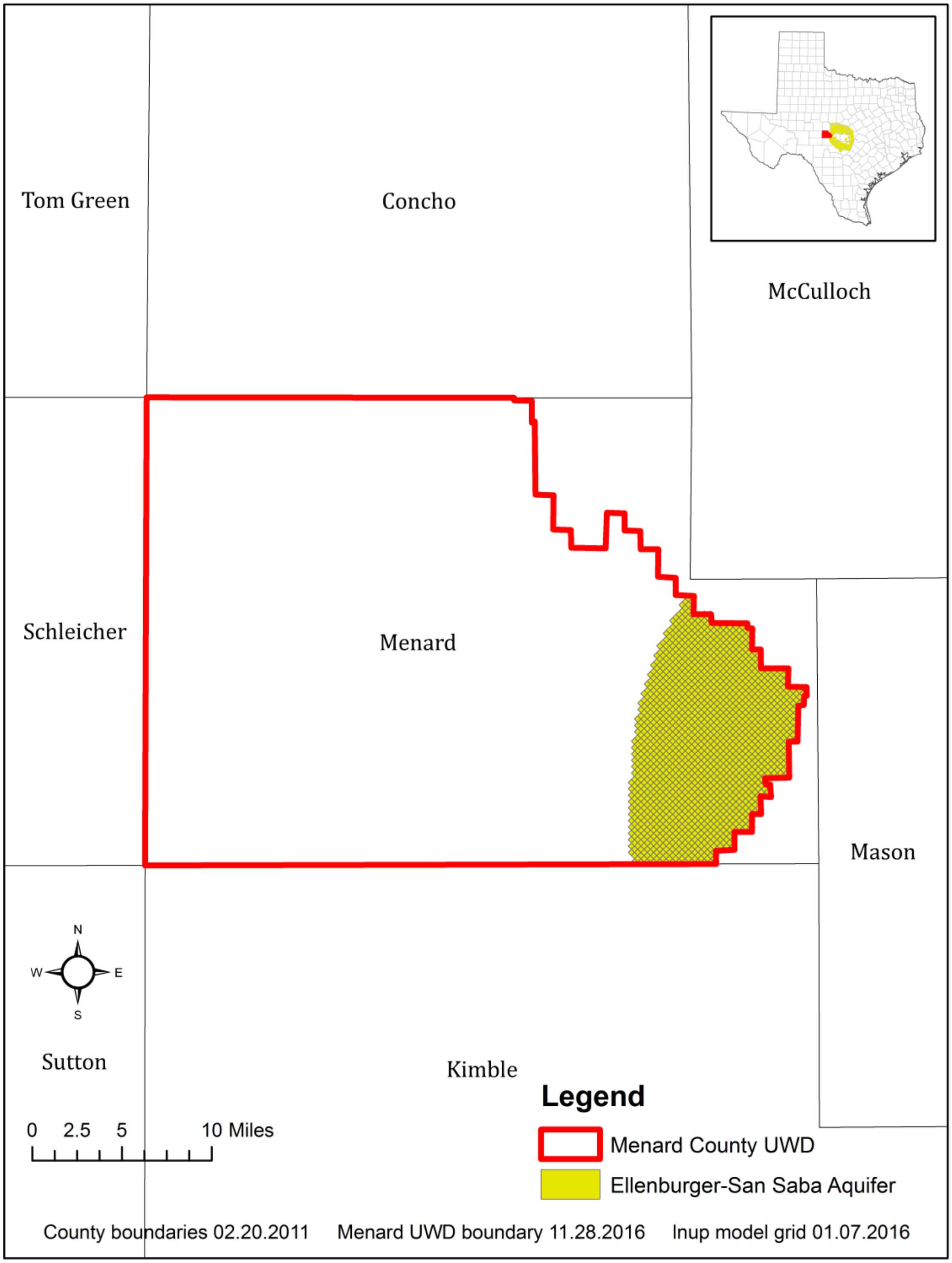

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE ELLENBURGER-SAN SABA AQUIFER WITHIN MENARD UNDERGROUND WATER DISTRICT FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED.

TABLE 3: SUMMARIZED INFORMATION FOR THE HICKORY AQUIFER THAT IS NEEDED FOR MENARD COUNTY UNDERGROUND WATER DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST ONE 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	1,679
Estimated annual volume of flow out of the district within each aquifer in the district	Hickory Aquifer	4,164
Estimated net annual volume of flow between each aquifer in the district	From younger confining units to Hickory Aquifer	2,451
	From Hickory Aquifer to underlying Precambrian Units	219
	From brackish portion to Hickory Aquifer	289

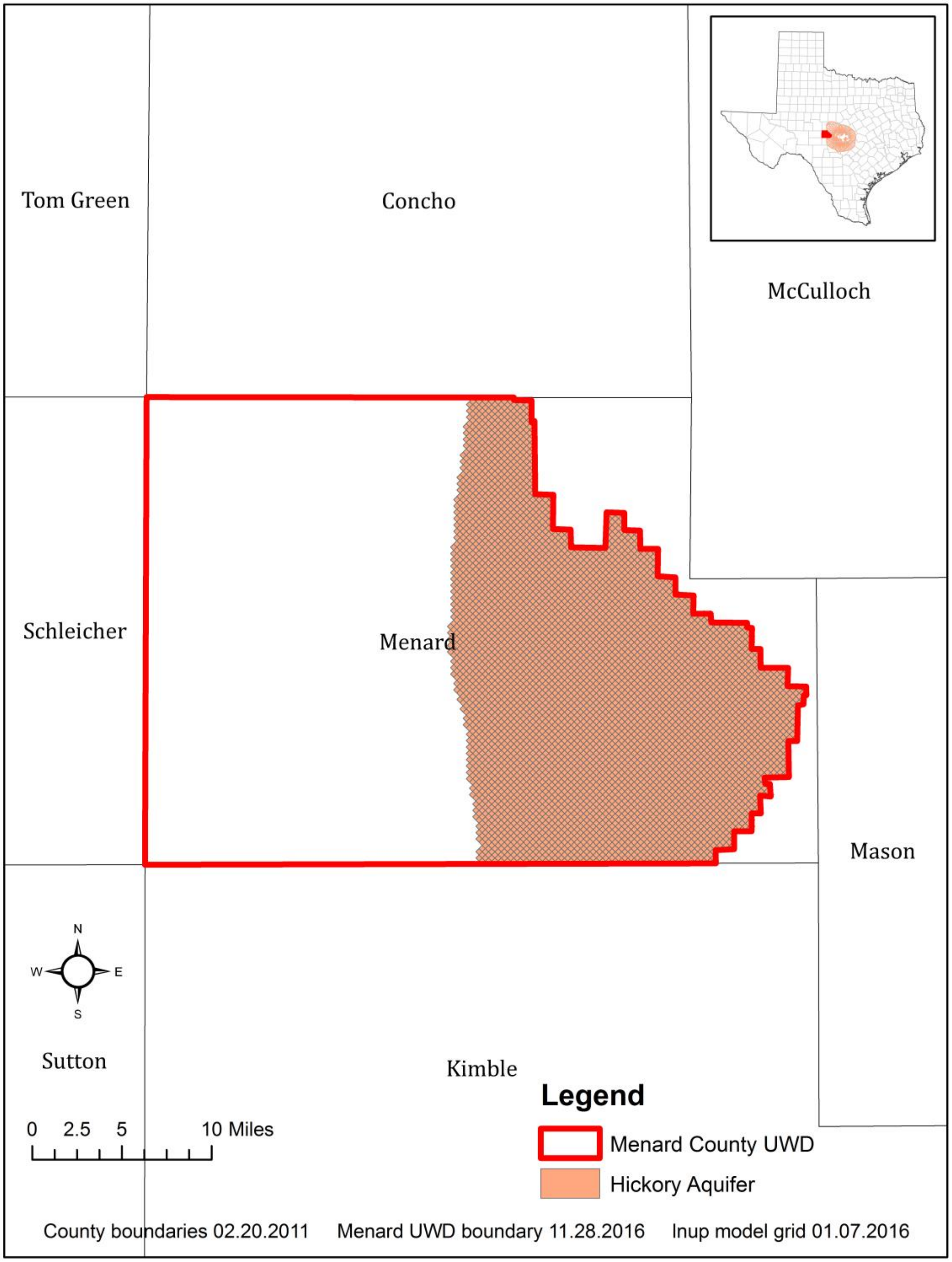

FIGURE 3: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE HICKORY AQUIFER WITHIN MENARD UNDERGROUND WATER DISTRICT FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED.

LIMITATIONS:

The groundwater model(s) 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 interaction with streams are specific to particular historic 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. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

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