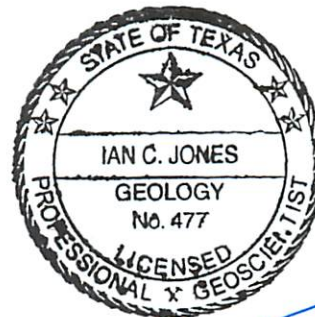

GAM RUN 17-012: STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT GROUNDWATER MANAGEMENT PLAN

Ian C. Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Section
(512) 463-6641
March 31, 2017



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3/27/17

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EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h) (Texas Water Code, 2015), 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 Sterling County Underground Water 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 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 Sterling County Underground Water Conservation District should be adopted by the district on or before May 28, 2018, and submitted to the Executive Administrator of the TWDB on or before June 27, 2018. The

current management plan for the Sterling County Underground Water Conservation District expires on August 26, 2018.

We used the groundwater availability models for the Edwards-Trinity (Plateau) Aquifer (Anaya and Jones, 2009), High Plains Aquifer System (Deeds and Jigmond, 2015), and Lipan Aquifer (Beach and others, 2004) to estimate the management plan information for the aquifers within Sterling County Underground Water Conservation District. This report replaces the results of GAM Run 10-026 (Aschenbach, 2010). GAM Run 17-012 meets current standards set after the release of GAM Run 10-026 and includes results from the groundwater availability model for the High Plains Aquifer System for the Dockum Aquifer. Tables 1 through 3 summarize the groundwater availability model data required by statute and Figures 1 through 3 show the areas of the respective models from which the values in the tables were extracted. If after reviewing the figure, the Sterling County Underground Water 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 groundwater availability models for the High Plains Aquifer System (for the Dockum Aquifer), the Edwards-Trinity (Plateau), and Lipan aquifers were used to estimate information for the Sterling County Underground Water Conservation District management plan. Water budgets were extracted for the respective historical model periods (1929 through 2012, 1980 through 2000, and 1980 through 1998 for the groundwater availability models for the High Plains Aquifer System, Edwards-Trinity (Plateau) Aquifer, and Lipan Aquifer, respectively) 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 aquifers within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Dockum Aquifer

- We used version 1.01 of the groundwater availability model for the High Plains Aquifer System. See Deeds and Jigmond (2015) for assumptions and limitations of the model.
- The model was run with MODFLOW-NWT (Niswonger and others, 2011).
- The groundwater availability model for the High Plains Aquifer System contains four layers:

- Layer 1—the Ogallala Aquifer and the Pecos Valley Alluvium Aquifer
 - Layer 2—the Rita Blanca Aquifer, the Edwards-Trinity (High Plains) Aquifer, the Edwards-Trinity (Plateau) Aquifer, and pass-through cells of the Dockum Aquifer
 - Layer 3—the upper Dockum Group and pass-through cells of the lower Dockum Group
 - Layer 4—the lower Dockum Group
- Perennial rivers and reservoirs were simulated using the MODFLOW-NWT river package. Springs, seeps, and draws were simulated using the MODFLOW-NWT drain package. For this analysis, groundwater discharge to surface water includes groundwater leakage to the river and drain packages.

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 groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers. The Pecos Valley Aquifer does not occur within Sterling County Underground Water District and therefore no groundwater budget values are included for it in this report.
- This groundwater availability model includes two layers within Sterling County Underground Water District, which generally represent the Edwards Group (Layer 1) and the Trinity Group (Layer 2) of the Edwards-Trinity (Plateau) Aquifer. Individual water budgets for the District were determined for the Edwards-Trinity (Plateau) Aquifer (Layer 1 and Layer 2 combined).
- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

Lipan Aquifer

- Version 1.01 of the groundwater availability model for the Lipan Aquifer was used for this analysis. See Beach and others (2004) for assumptions and limitations of the groundwater availability model.
- The Lipan Aquifer model includes one layer representing the Quaternary Leona Formation, portions of the underlying Permian Formations, and the Edwards-Trinity (Plateau) Aquifer to the west, south, and north.

- The model does not cover the entire Lipan Aquifer (Figure 3). Consequently, please contact Mr. Stephen Allen with the TWDB at (512) 463-7317 or stephen.allen@twdb.texas.gov for additional information on the aquifer in areas not covered by the groundwater availability model in the Sterling County Underground Water District.
- The model was run with MODFLOW-1996 (Harbaugh and MacDonald, 1996).

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 groundwater availability models for the High Plains Aquifer System (includes the Dockum Aquifer), the Edwards-Trinity (Plateau), and the Lipan aquifers within Sterling County Underground Water Conservation District and averaged over the respective historical calibration periods, 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 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 3. 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 FOR THE STERLING COUNTY UNDERGROUND WATER 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	10,202
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	6,077
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	1,709
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	4,472
Estimated net annual volume of flow between each aquifer in the district ¹	From the Edwards-Trinity (Plateau) Aquifer into the Dockum Aquifer.	579 to 1,166

¹ The model for the Edwards-Trinity (Plateau) and Pecos Valley Alluvium aquifers estimates an average of 1,166 acre-feet flowing from the Edwards-Trinity (Plateau) Aquifer into the Dockum Aquifer while the model for the High Plains Aquifer System estimates an average of 579 acre-feet flowing from the Edwards-Trinity (Plateau) Aquifer into the Dockum Aquifer. Differences are due to the various assumptions in each model.

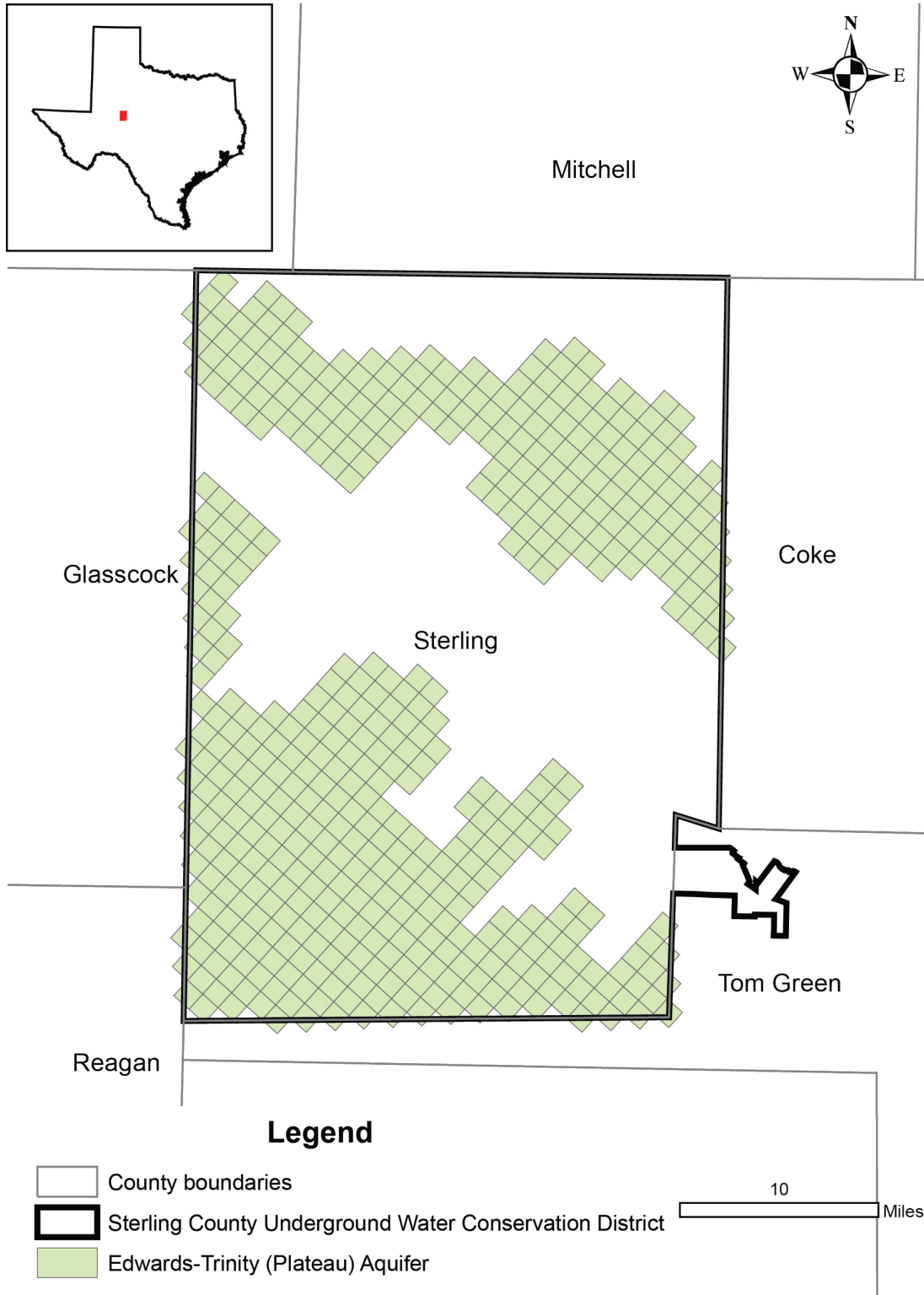


FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE EDWARDS-TRINITY (PLATEAU) AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE DOCKUM AQUIFER FOR THE STERLING COUNTY UNDERGROUND WATER 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	Dockum Aquifer	454
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Dockum Aquifer	382
Estimated annual volume of flow into the district within each aquifer in the district	Dockum Aquifer	132
Estimated annual volume of flow out of the district within each aquifer in the district	Dockum Aquifer	631
Estimated net annual volume of flow between each aquifer in the district ²	From the Edwards-Trinity (Plateau) Aquifer into the Dockum Aquifer.	579 to 1,166

² The model for the Edwards-Trinity (Plateau) and Pecos Valley Alluvium aquifers estimates an average of 1,166 acre-feet flowing from the Edwards-Trinity (Plateau) Aquifer into the Dockum Aquifer while the model for the High Plains Aquifer System estimates an average of 579 acre-feet flowing from the Edwards-Trinity (Plateau) Aquifer into the Dockum Aquifer. Differences are due to the various assumptions in each model.

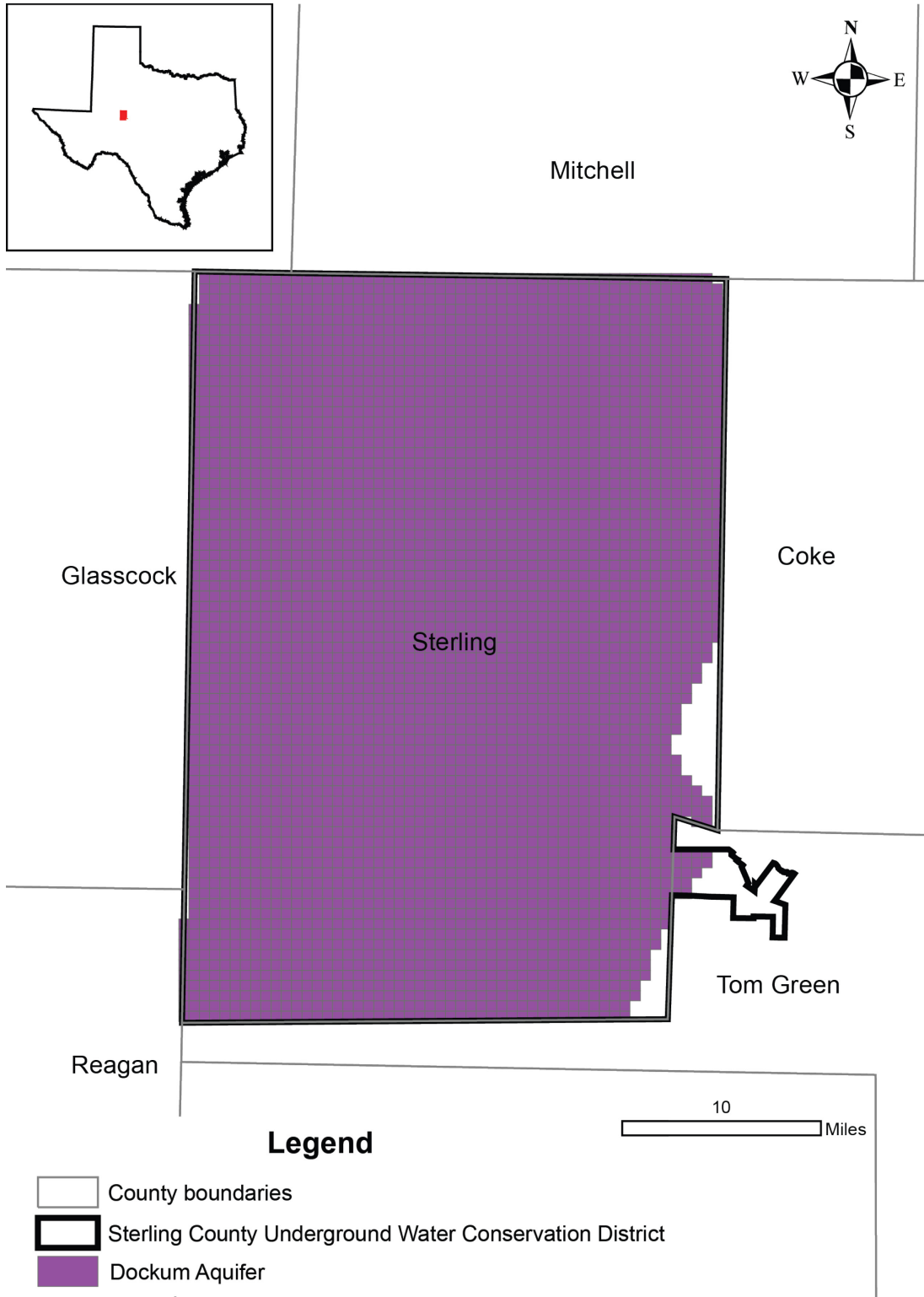


FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE HIGH PLAINS AQUIFER SYSTEM FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE DOCKUM AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 3: SUMMARIZED INFORMATION FOR THE LIPAN AQUIFER FOR THE STERLING COUNTY UNDERGROUND WATER 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	Lipan Aquifer	102
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Lipan Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Lipan Aquifer	277
Estimated annual volume of flow out of the district within each aquifer in the district	Lipan Aquifer	443
Estimated net annual volume of flow between each aquifer in the district		Not applicable ³

³ The model was developed prior to the extension of the Lipan Aquifer along the North Concho River. The western boundary of the model only extends into Tom Green County.

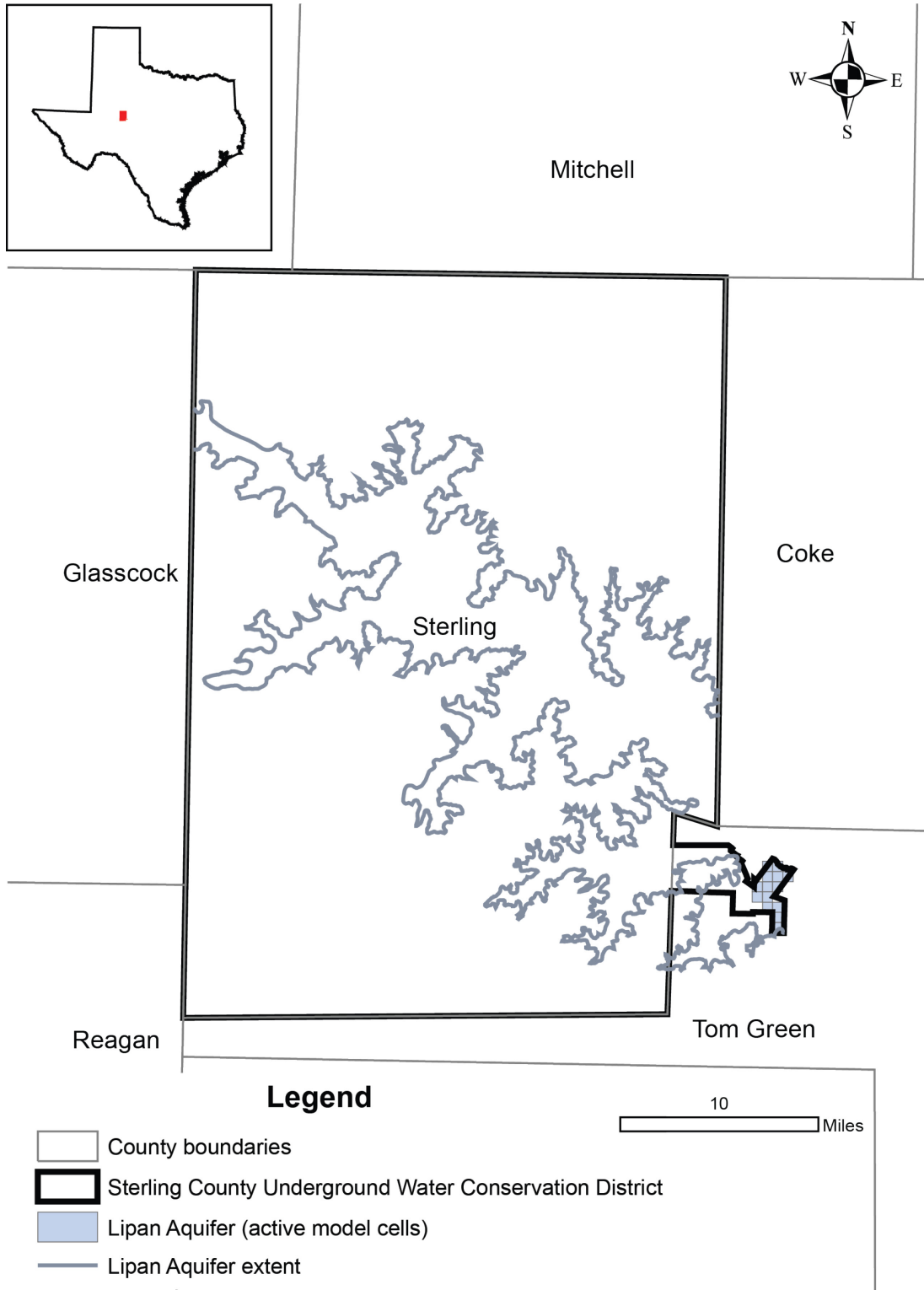


FIGURE 3: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE LIPAN AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE LIPAN AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

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 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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