GAM Run 17-014: Coke County Underground Water Conservation District Groundwater Management Plan

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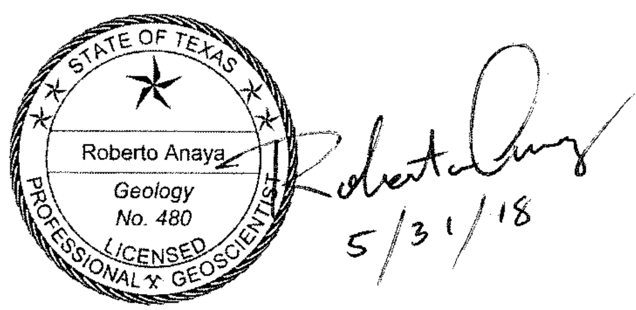
Groundwater Division
Groundwater Availability Modeling Department
(512) 463-6115
May 31, 2018



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EXECUTIVE SUMMARY:

Texas Water Code, Section 36.1071, Subsection (h), 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 Coke 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 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 any surface-water bodies, including lakes, streams, rivers, and springs; 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 Coke County Underground Water Conservation District should be adopted by the district on or before June 1, 2018, and submitted to the Executive Administrator of the TWDB on or before July 1, 2018. The current management plan for the Coke County Underground Water Conservation District expires on August 30, 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 Coke County Underground Water Conservation District. This report replaces the results of GAM Run 12-019 (Kohlrenken, 2012). GAM Run 17-014 meets current standards set after GAM Run 12-019 was released and includes results from the recently released groundwater availability model for the High Plains Aquifer System. Tables 1 through 3 summarize the groundwater availability model data required by statute and Figures 1 through 3 show the area of the models from which the values in the tables were extracted. If after review of the figures, the Coke 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 Water Code, Section 36.1071, Subsection (h), groundwater availability models for the High Plains Aquifer System (1980 through 2012), Edwards-Trinity (Plateau) and Pecos Valley aquifers (1981 through 2000), and the Lipan Aquifer (1980 through 1998) were run for this analysis. Water budgets for each year of the transient model periods were extracted using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The average annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district, net cross-formation flow between aquifers, and net flow between aquifer and its brackish portion located within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

High Plains Aquifer System

- We used version 1.01 of the groundwater availability model for the High Plains Aquifer System to analyze the Dockum Aquifer. See Deeds and Jigmond (2015) for assumptions and limitations of the model.
- The model has four layers which represent the Ogallala Aquifer (Layer 1), the Edwards-Trinity (High Plains) or (Plateau) Aquifer (Layer 2), and the Dockum

Aquifer (Layers 3 and 4). Within the Coke County Underground Water Conservation District the Ogallala and Edwards-Trinity (High Plains) aquifers are not present.

- Water budgets for the district were determined for the Dockum Aquifer (layers 3 and 4 combined). Interaction between the Edwards-Trinity (Plateau) and Dockum aquifers was determined using water budget information for layer 2, 3, and 4.
- The model was run with MODFLOW-NWT (Niswonger and others, 2011).

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 Coke County Underground Water District and therefore no groundwater budget values are included for it in this report.
- Within Coke County Underground Water District only layer two of the groundwater availability model is active and it generally represents the Edwards Group and the Trinity Group of the Edwards-Trinity (Plateau) Aquifer.
- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

Lipan Aquifer

- We used version 1.01 of the groundwater availability model for the Lipan Aquifer for this analysis. See Beach and others (2004) for assumptions and limitations of the 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 include all of the aquifer within the district boundaries.
- The model uses general head boundaries to simulate the eastern and western aquifer boundaries. Inflow on the general-head boundary to the west represents inflow from the Edwards-Trinity (Plateau) Aquifer.
- Recharge rates are based on a fraction of precipitation (Beach and others, 2004).
- The model was run with MODFLOW-96 (Harbaugh and McDonald, 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 model results for the aquifers located within the district and averaged over the duration of the calibration portion of the model runs in the district. The components of the modified budget shown in tables 1 through 3 include:

- 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.

- Surface-water outflow—the total water discharging from the aquifer (outflow) to surface-water features such as streams, reservoirs, and springs.

- Flow into and out of district—the lateral flow within the aquifer between the district and adjacent counties.

- 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 district or county boundaries, 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 (Figures 1 through 3).

TABLE 1: SUMMARIZED INFORMATION FOR THE DOCKUM AQUIFER THAT IS NEEDED FOR COKE 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	129
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Dockum Aquifer	264
Estimated annual volume of flow into the district within each aquifer in the district	Dockum Aquifer	56
Estimated annual volume of flow out of the district within each aquifer in the district	Dockum Aquifer	39
Estimated net annual volume of flow between each aquifer in the district	From Dockum Aquifer into Dockum equivalent unit	15*
	From Edwards-Trinity (Plateau) Aquifer into Dockum Aquifer	63

* Groundwater flow from the Dockum Aquifer into hydraulically connected active model cells of a Dockum Group equivalent unit.

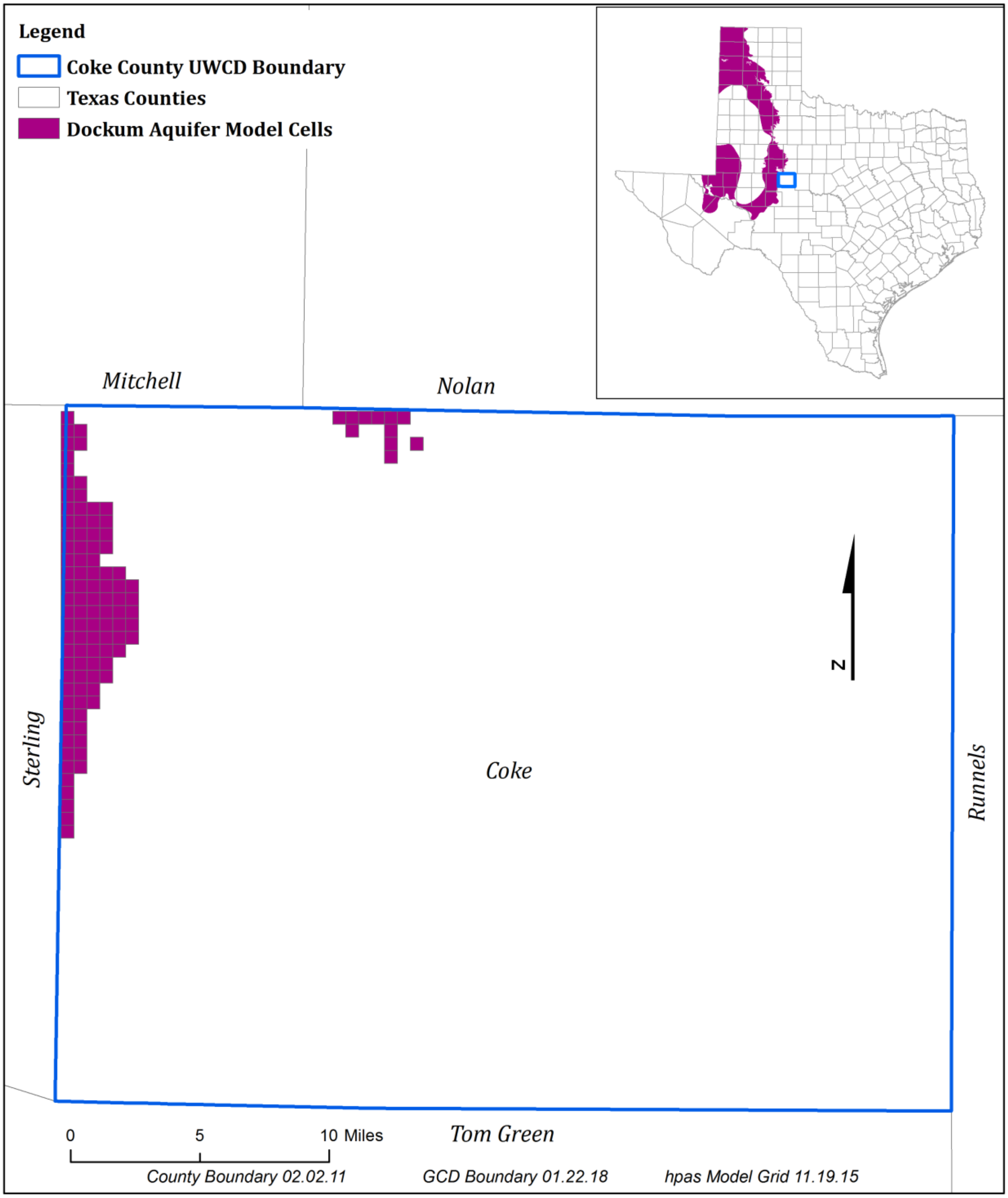

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE HIGH PLAINS AQUIFER SYSTEM FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE DOCKUM AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER THAT IS NEEDED FOR COKE 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	5,828
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	6,688
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	1,234
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	1,024
Estimated net annual volume of flow between each aquifer in the district	From the Edwards-Trinity (Plateau) Aquifer into older Paleozoic units undifferentiated	56*

* Groundwater flow from the Edwards-Trinity (Plateau) Aquifer into underlying Permian units. This value differs from the value Table 3 because it does not include flows into the adjacent Lipan Aquifer.

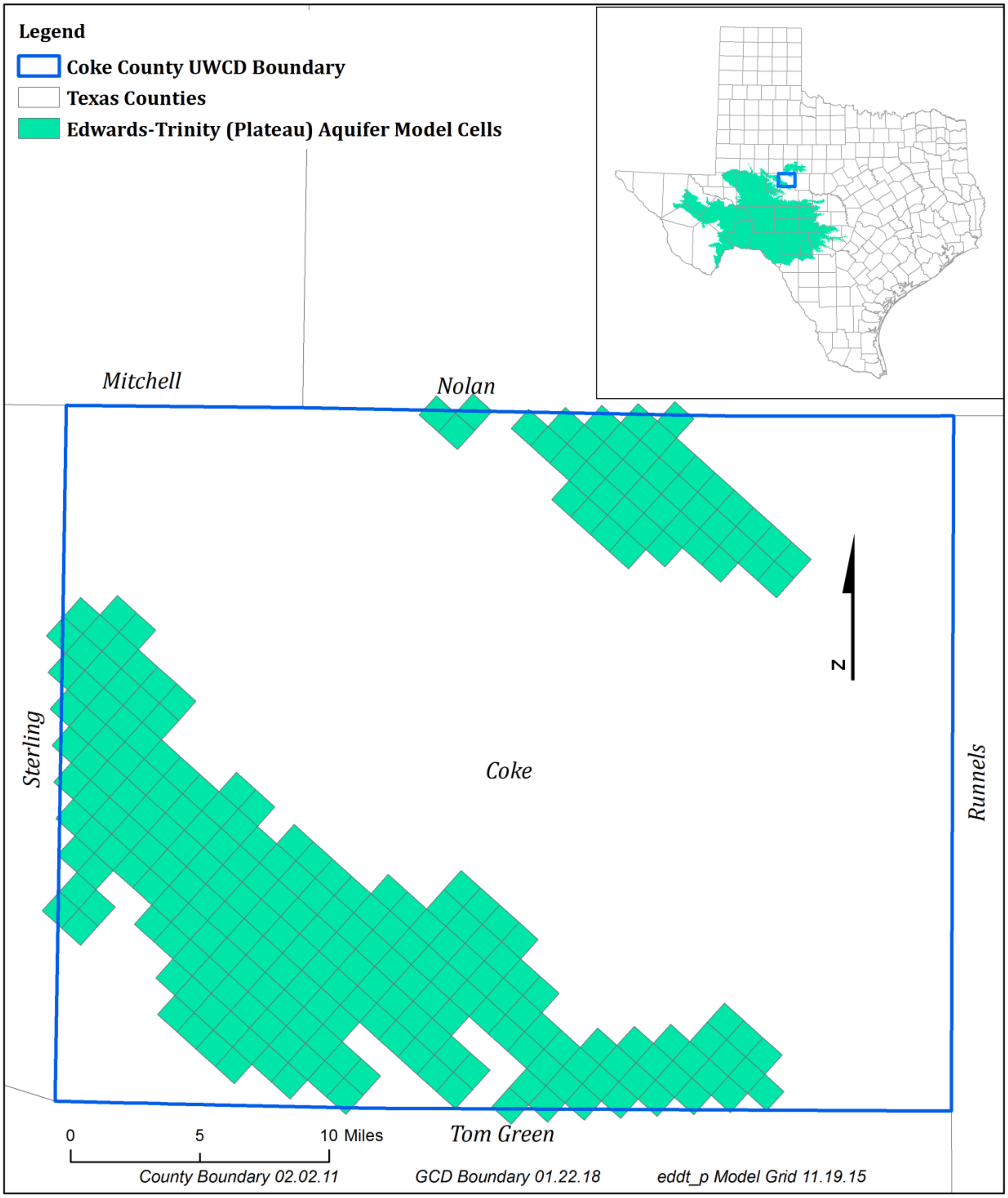

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE EDWARDS-TRINITY (PLATEAU) AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 3: SUMMARIZED INFORMATION FOR THE LIPAN AQUIFER THAT IS NEEDED FOR COKE 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***	***Results***
Estimated annual amount of recharge from precipitation to the district	Lipan Aquifer	271
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	0
Estimated annual volume of flow out of the district within each aquifer in the district	Lipan Aquifer	648
Estimated net annual volume of flow between each aquifer in the district	From the Edwards-Trinity (Plateau) Aquifer into the Lipan Aquifer	503*

* Groundwater flow consists of flows from the adjacent Edwards-Trinity (Plateau) Aquifer in hydraulic connection with the Lipan Aquifer as well as flows from adjacent Permian units underlying the Edwards-Trinity (Plateau) Aquifer and in hydraulic connection with the Lipan Aquifer.

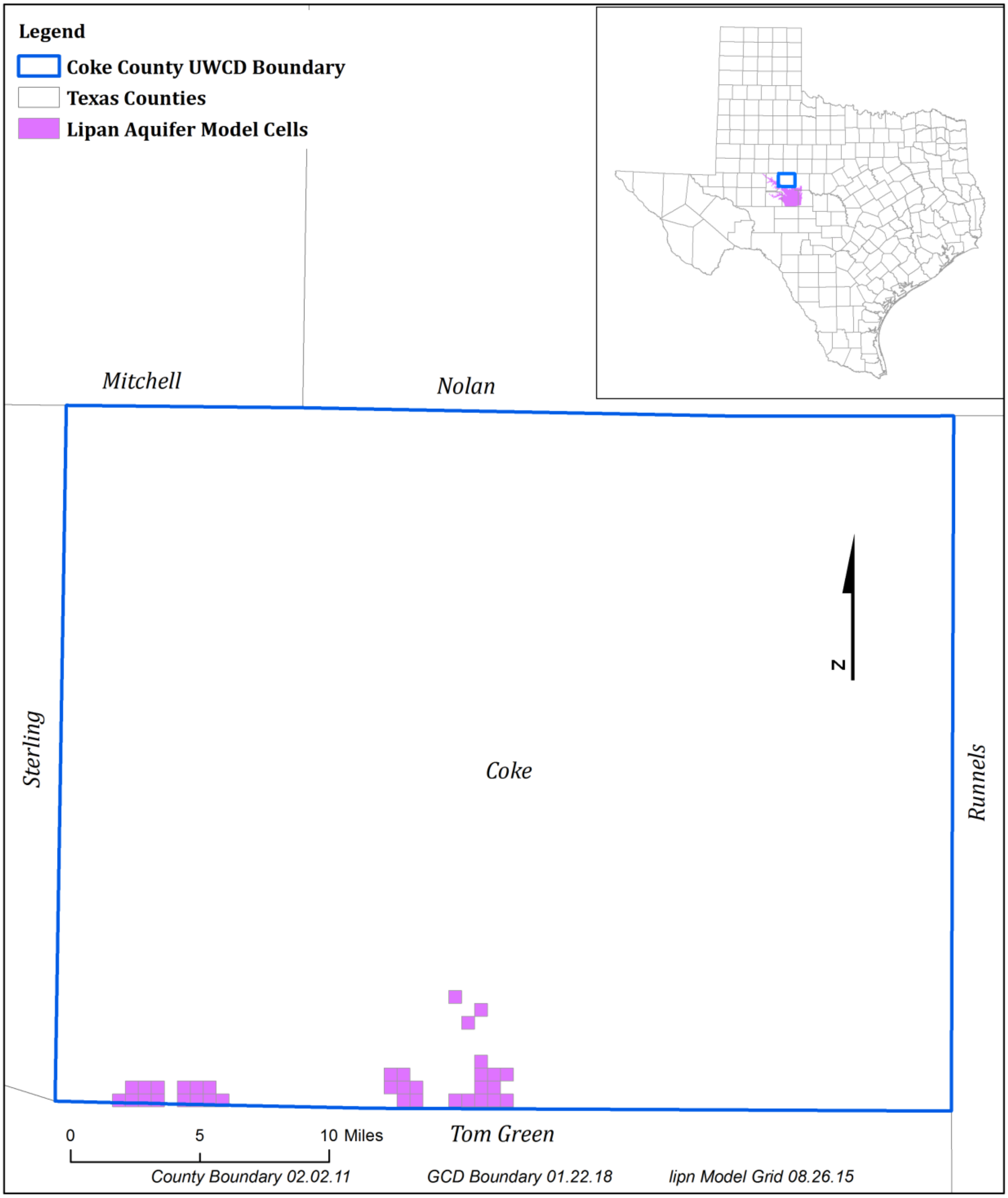

FIGURE 3: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE LIPAN AQUIFER FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (THE LIPAN AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

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 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.

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