GAM Run 16-013: Permian Basin Underground Water Conservation District Management Plan

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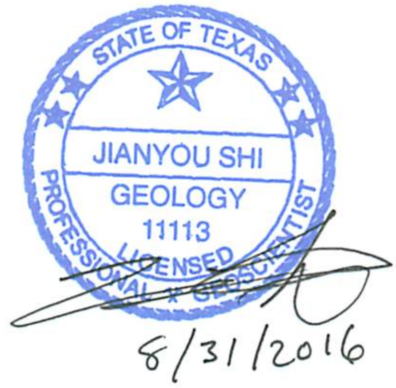
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Section
(512) 463-5076

August 31, 2016



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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 Permian Basin 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 Permian Basin Underground Water Conservation District should be adopted by the district on or before August 2, 2017, and submitted to the executive administrator of the TWDB on or before September 1,

2017. The current management plan for the Permian Basin Underground Water Conservation District expires on October 31, 2017.

In the Permian Basin Underground Water Conservation District, there are three aquifers identified by the TWDB: the Ogallala Aquifer, the Edwards-Trinity (Plateau) Aquifer, and the Dockum Aquifer. Two groundwater availability models were used to extract the management plan information for the aquifers within the Permian Basin Underground Water Conservation District. Information for the Ogallala and Dockum aquifers is from version 1.01 of the groundwater availability model for the High Plains Aquifer System (Deeds and Jigmond, 2015). Information for the Edwards-Trinity (Plateau) Aquifer is from version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer (Anaya and Jones, 2009).

This report discusses the methods, assumptions, and results from the model runs for the Ogallala Aquifer, the Edwards-Trinity (Plateau) Aquifer, and the Dockum Aquifer described above. This report replaces the results of GAM Run 12-007 (Kohlrenken, 2012). GAM Run 16-013 meets current standards set after the release of GAM Run 12-007 and includes results from the recently released groundwater availability model for the High Plains Aquifer System (Deeds and Jigmond, 2015). 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 review of the figures, the Permian Basin 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 model for the High Plains Aquifer System and the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer were used to extract information for the Ogallala Aquifer, the Edwards-Trinity (Plateau) Aquifer, and the Dockum Aquifer. The water budget for the Permian Basin Underground Water Conservation District was extracted for the historical model periods (1980 through 2012 for the Ogallala and Dockum aquifers and 1981 through 2000 for the Edwards-Trinity (Plateau) Aquifer) 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 three aquifers within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Ogallala and Dockum Aquifers

1. 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.

2. The model was run with MODFLOW-NWT (Niswonger and others, 2011).

3. 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

4. Perennial rivers and reservoirs were simulated using MODFLOW-NWT river package. Springs, seeps, and draws were simulated using 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

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

2. The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

3. The model has two active layers:

    - Layer 1—the Edwards-Trinity (Plateau) Aquifer and the Pecos Valley Alluvium Aquifer

    - Layer 2—the Edwards-Trinity (Plateau) Aquifer

4. Lakes and reservoirs were simulated using MODFLOW-2000 constant head. Springs and seeps were simulated using MODFLOW-2000 drain package. Perennial rivers were simulated using MODFLOW-2000 stream routing package. For this analysis, groundwater discharge to surface water includes groundwater leakage to the drain package because constant head and stream boundaries are not present in the Permian Basin Underground Water Conservation District.

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 two groundwater availability models for the Ogallala Aquifer, the Edwards-Trinity (Plateau) Aquifer, and the Dockum Aquifer within the district and averaged over the 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 OGALLALA AQUIFER FOR THE PERMIAN BASIN UNDERGROUND WATER CONSERVATION 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	Ogallala Aquifer	50,317
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Ogallala Aquifer	11,848
Estimated annual volume of flow into the district within each aquifer in the district	Ogallala Aquifer	5,218
Estimated annual volume of flow out of the district within each aquifer in the district	Ogallala Aquifer	3,462
Estimated net annual volume of flow between each aquifer in the district	From Dockum Aquifer to Ogallala Aquifer	13
	From Ogallala Aquifer to Edwards-Trinity (Plateau) Aquifer	253

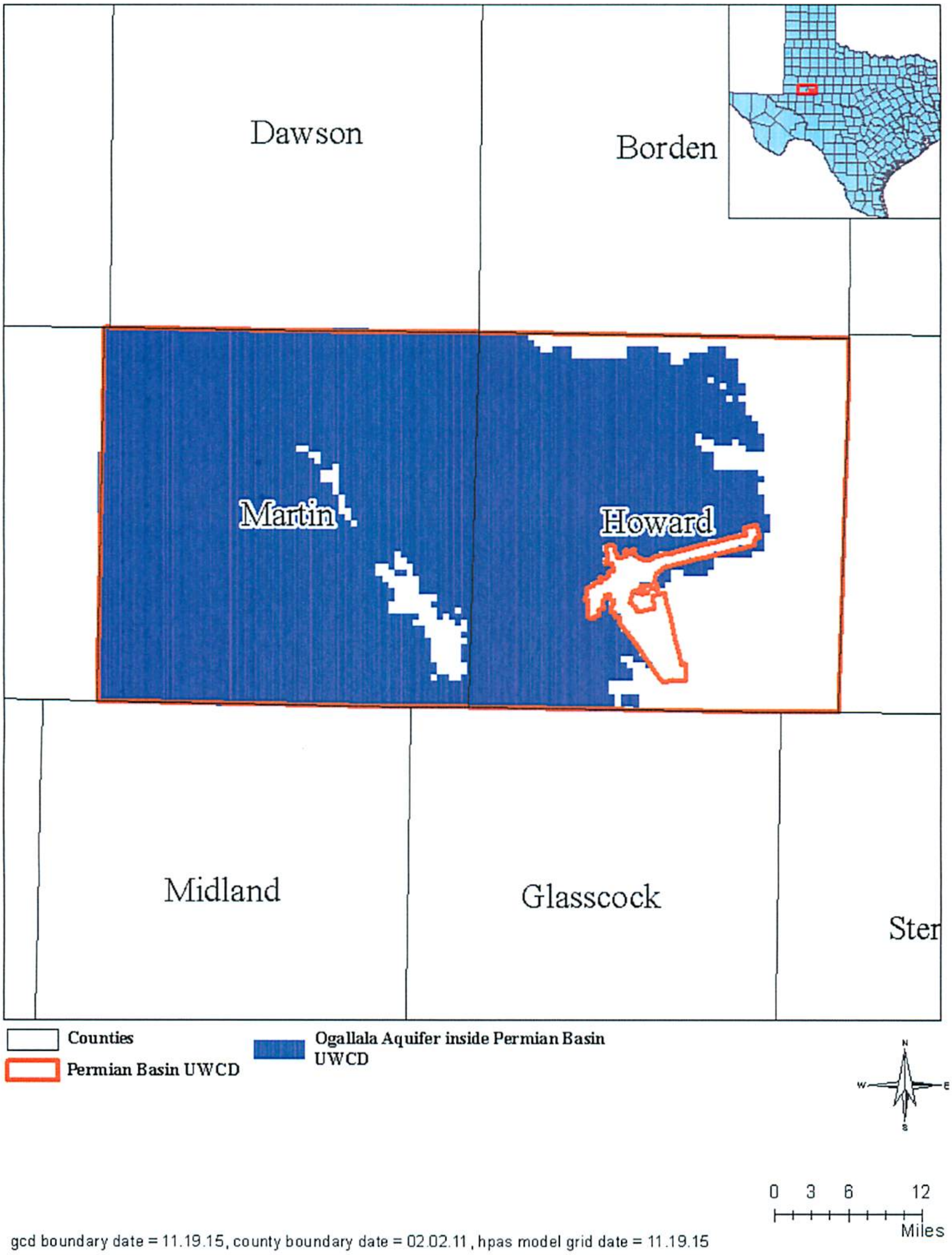

FIGURE 1: AREA OF THE OGALLALA AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE HIGH PLAINS AQUIFER SYSTEM FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED FOR THE PERMIAN BASIN UNDERGROUND WATER CONSERVATION DISTRICT (UWCD).

TABLE 2: SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER FOR THE PERMIAN BASIN UNDERGROUND WATER CONSERVATION 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	Edwards-Trinity (Plateau) Aquifer	3,884
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	124
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	2,620
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	6,167
Estimated net annual volume of flow between each aquifer in the district*	From Ogallala Aquifer to Edwards-Trinity (Plateau) Aquifer	253
	From Edwards-Trinity (Plateau) Aquifer to Dockum Aquifer	44

* Flows between each aquifer in the district were extracted from the groundwater availability model for the High Plains Aquifer System (see Tables 1 and 3).

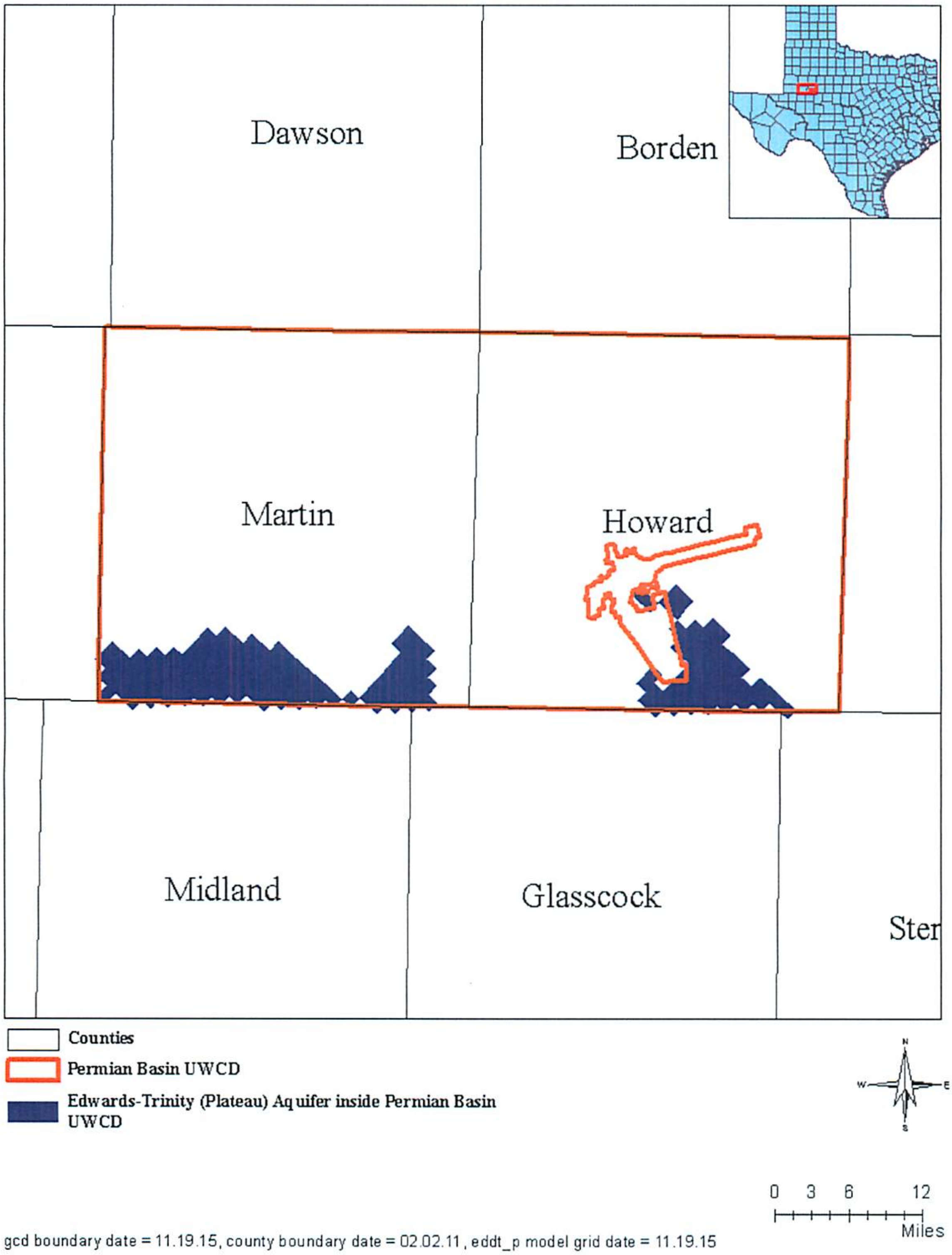

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED FOR THE PERMIAN BASIN UNDERGROUND WATER CONSERVATION DISTRICT (UWCD).

TABLE 3: SUMMARIZED INFORMATION FOR THE DOCKUM AQUIFER FOR THE PERMIAN BASIN UNDERGROUND WATER CONSERVATION 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	Dockum Aquifer	4,695
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Dockum Aquifer	1,696
Estimated annual volume of flow into the district within each aquifer in the district	Dockum Aquifer	40
Estimated annual volume of flow out of the district within each aquifer in the district	Dockum Aquifer	1,246
Estimated net annual volume of flow between each aquifer in the district	From Dockum Aquifer to Ogallala Aquifer	13
	From Edwards-Trinity (Plateau) Aquifer to Dockum Aquifer	44

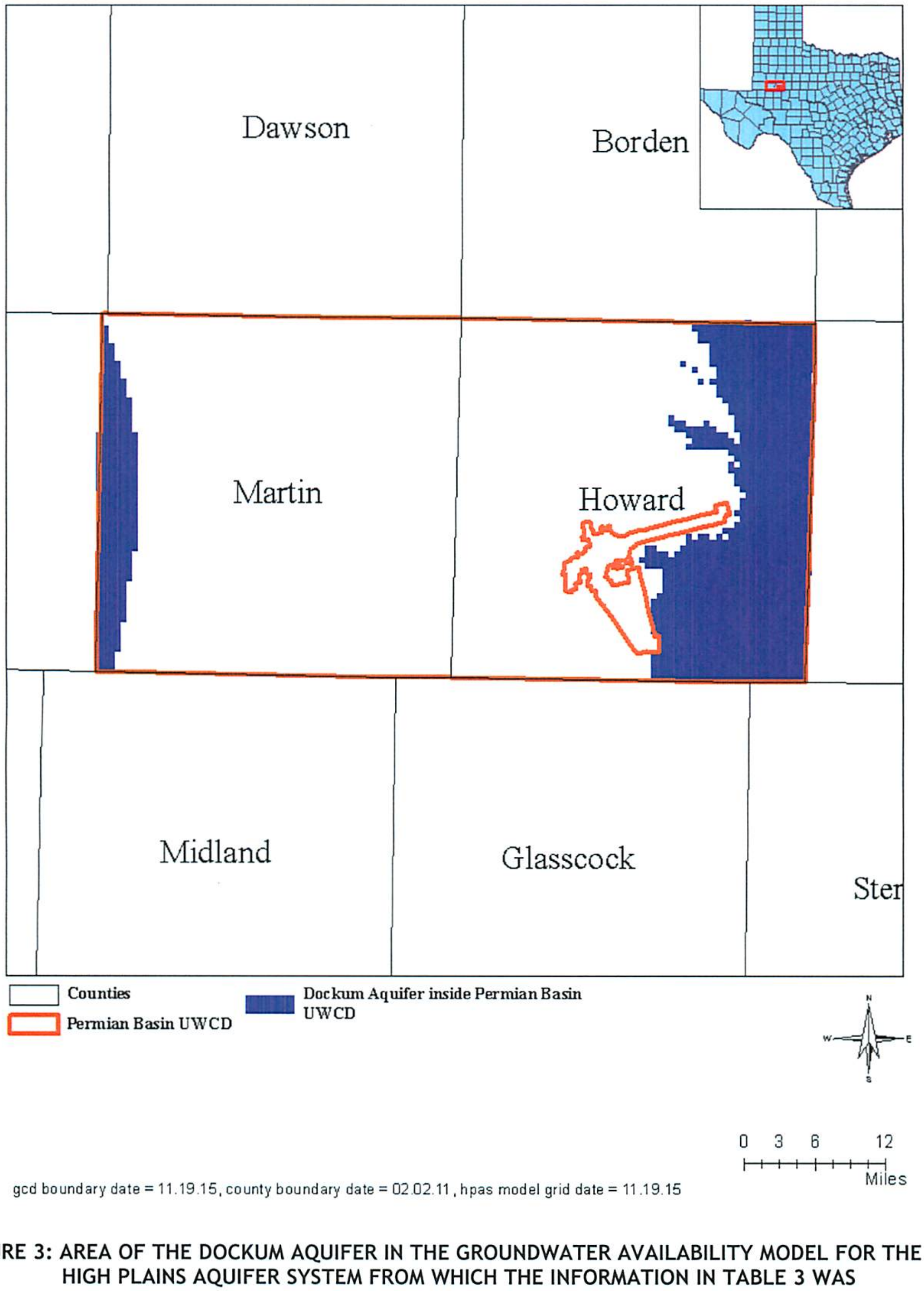

FIGURE 3: AREA OF THE DOCKUM AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE HIGH PLAINS AQUIFER SYSTEM FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED FOR THE PERMIAN BASIN UNDERGROUND WATER CONSERVATION DISTRICT (UWCD).

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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