GAM Run 16-019: Headwaters Groundwater Conservation District Management Plan

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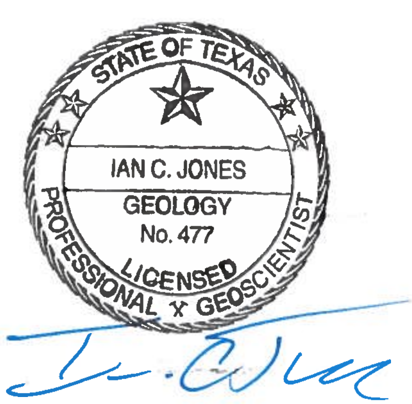
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Section
(512) 463-6641
August 31, 2016



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EXECUTIVE SUMMARY:

Texas 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 Headwaters 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 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. 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 Headwaters Groundwater Conservation District should be adopted by the district on or before November 15, 2017, and submitted to the Executive Administrator of the TWDB on or before December 15, 2017. The current management plan for the Headwaters Groundwater Conservation District expires on February 13, 2018.

The Edwards-Trinity (Plateau), Trinity, Ellenburger-San Saba, and Hickory aquifers are identified by the TWDB as being located within the Headwaters Groundwater Conservation District. Information for the Edwards-Trinity (Plateau) and Trinity aquifers were extracted from version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer (Anaya and Jones, 2009), while information for the Ellenburger-San Saba and Hickory aquifers were extracted from draft version 1.01 of the groundwater availability model for the minor aquifers of the Llano Uplift area (Shi and others, 2016).

This report discusses the methods, assumptions, and results from model runs using the groundwater availability models for the Edwards-Trinity (Plateau) Aquifer and the minor aquifers of the Llano Uplift area (Anaya and Jones, 2009; Shi and others, 2016). This model run replaces GAM Run 12-021 (Jones, 2012). GAM Run 16-019 meets current standards set after the release of GAM Run 12-021 and includes information from the draft groundwater availability model for the minor aquifers of the Llano Uplift area (Shi and others, 2016). Tables 1 through 4 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 review of the figures, Headwaters 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, Subsections (e) and (h), the groundwater availability models for the Edwards-Trinity (Plateau) Aquifer and the aquifers of the Llano Uplift were run for this analysis. The water budget for the Headwaters Groundwater Conservation District was extracted for the historical model periods of 1981through 2000 and 1981through 2010 for the Edwards-Trinity (Plateau) and Llano Uplift models, respectively, 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 inter-aquifer flow (upper), and net inter-aquifer flow (lower) for the portion of the aquifer system located 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 groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers. The Pecos Valley Aquifer does not occur within the Headwaters Groundwater Conservation District and therefore no groundwater budget values are included for it in this report.

- This groundwater availability model includes two layers within Headwaters Groundwater Conservation 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) and for the Trinity Aquifer (Layer 2).

- 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 draft groundwater availability model for the minor aquifers in the Llano Uplift area. See Shi and others (2016) for assumptions and limitations of the model.

- The draft groundwater availability model for the minor aquifers in Llano Uplift area 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 unit), Layer 4 (confining units), Layer 5 (Ellenburger-San Saba Aquifer and equivalent unit), Layer 6 (confining units), Layer 7 (the Hickory Aquifer and equivalent unit), and Layer 8 (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 Table 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.
- 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 or confining unit 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.

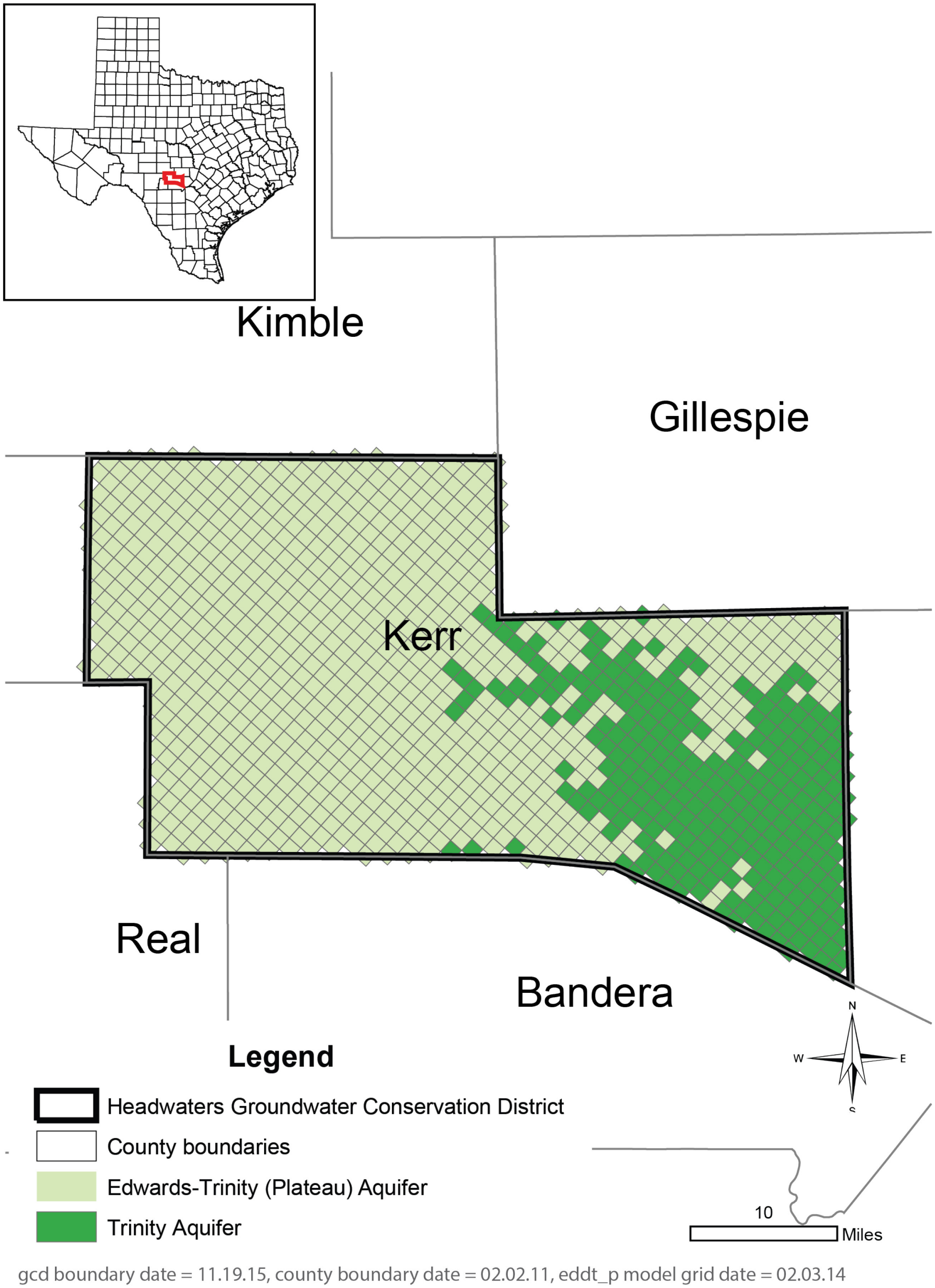

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER FROM WHICH THE INFORMATION IN TABLES 1 AND 2 WAS EXTRACTED.

TABLE 1: SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER THAT IS NEEDED FOR HEADWATERS GROUNDWATER 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	26,419
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	17,697
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	8,311
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	20,066
Estimated net annual volume of flow between each aquifer in the district	From the Edwards-Trinity (Plateau) Aquifer to the Trinity Aquifer	5,831

TABLE 2: SUMMARIZED INFORMATION FOR THE HILL COUNTRY PORTION OF THE TRINITY AQUIFER SYSTEM THAT IS NEEDED FOR HEADWATERS GROUNDWATER 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	Trinity Aquifer	21,331
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Trinity Aquifer	18,473
Estimated annual volume of flow into the district within each aquifer in the district	Trinity Aquifer	2,238
Estimated annual volume of flow out of the district within each aquifer in the district	Trinity Aquifer	8,264
Estimated net annual volume of flow between each aquifer in the district	From the Edwards-Trinity (Plateau) Aquifer to the Trinity Aquifer	5,831

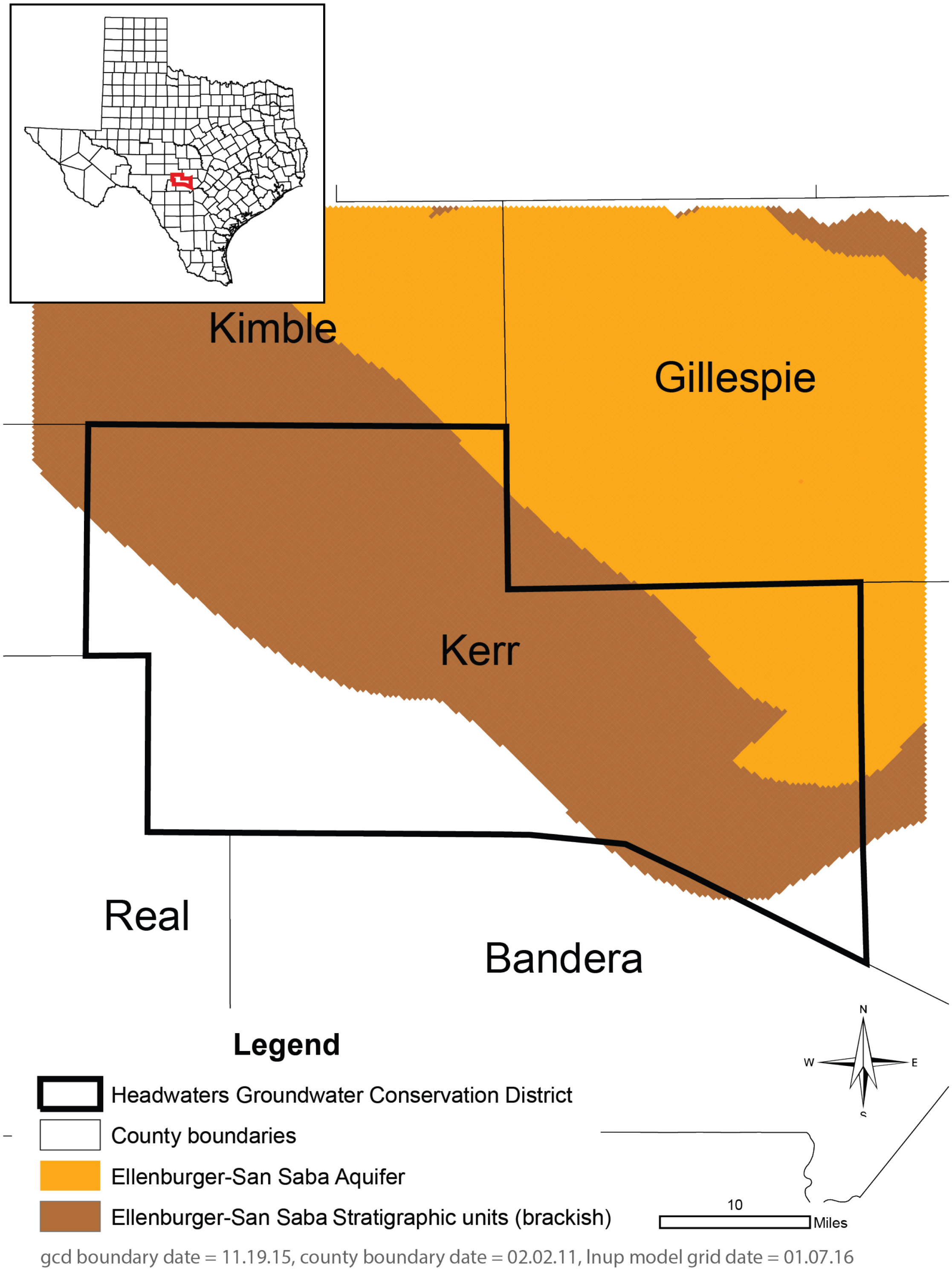

FIGURE 2: AREA OF THE DRAFT GROUNDWATER AVAILABILITY MODEL FOR THE MINOR AQUIFERS IN THE LLANO UPLIFT AREA FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (THE ELLENBURGER-SAN SABA AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 3: SUMMARIZED INFORMATION FOR THE ELLENBURGER-SAN SABA AQUIFER THAT IS NEEDED FOR HEADWATERS GROUNDWATER 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	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	3,967
Estimated annual volume of flow out of the district within each aquifer in the district	Ellenburger-San Saba Aquifer	4,031
Estimated net annual volume of flow between each aquifer in the district	From the Hickory Aquifer to the Ellenburger-San Saba Aquifer	238
	From the Ellenburger-San Saba Aquifer to the brackish Ellenburger-San Saba stratigraphic unit	1,189

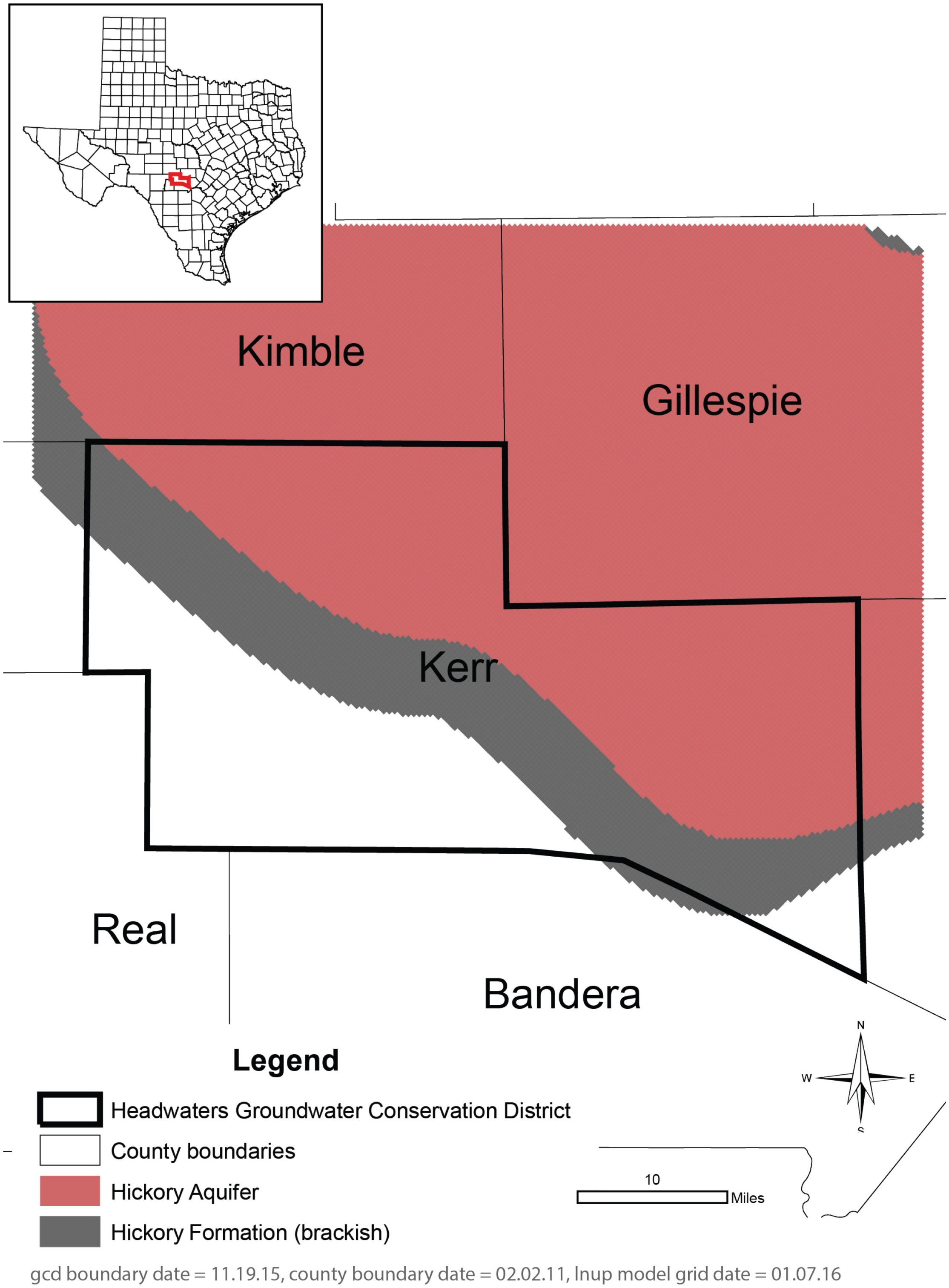

FIGURE 3: AREA OF THE DRAFT GROUNDWATER AVAILABILITY MODEL FOR THE MINOR AQUIFERS IN THE LLANO UPLIFT AREA FROM WHICH THE INFORMATION IN TABLE 4 WAS EXTRACTED (THE HICKORY AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 4: SUMMARIZED INFORMATION FOR THE HICKORY AQUIFER THAT IS NEEDED FOR HEADWATERS GROUNDWATER 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	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	4,831
Estimated annual volume of flow out of the district within each aquifer in the district	Hickory Aquifer	2,347
Estimated net annual volume of flow between each aquifer in the district	From the Hickory Aquifer to the Ellenburger-San Saba Aquifer	213
	From the Hickory Aquifer to the brackish Ellenburger-San Saba stratigraphic unit	2,113
	From the Hickory Aquifer to the brackish Hickory Formation	3,933

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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