GAM Run 12-023: Jeff Davis County Underground Water Conservation District Management Plan

by Marius Jigmond
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-8499
August 10, 2012

Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by Marius Jigmond under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on August 10, 2012.

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EXECUTIVE SUMMARY:

Texas State 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. Information derived from groundwater availability models that shall be included in the groundwater management plan includes:

- the annual amount of recharge from precipitation to the groundwater resources within the district, if any;
- 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
- the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

The purpose of this report is to provide Part 2 of a two-part package of information to Jeff Davis County Underground Water Conservation District for its groundwater management plan. The groundwater management plan for the Jeff Davis County Underground Water Conservation District is due for approval by the executive administrator of the TWDB before December 16, 2013.

This report discusses the methods, assumptions, and results from model runs using the groundwater availability models of the Edwards-Trinity (Plateau) and Pecos Valley aquifers, the Igneous and parts of the West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat) aquifers, and the West Texas Bolsons (Red Light Draw,

Green River Valley, and Eagle Flat) Aquifer. Tables 1 through 4 summarize the groundwater availability model data required by the statute, and figures 1 through 3 show the area of each model from which the values in the respective tables were extracted. This model run replaces the results of GAM Run 08-29 (Ridgeway, 2008). GAM Run 12-023 meets current standards set after the release of GAM Run 08-29 and it is based on the most current groundwater district boundaries and water budget extraction methods. If after review of the figures, the Jeff Davis County Underground Water Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB immediately.

METHODS:

Groundwater availability models of the Edwards-Trinity (Plateau) and Pecos Valley aquifers (1981 – 2000), the Igneous and parts of the West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat) aquifers (1980 – 2000), and the West Texas Bolsons (Red Light Draw, Green River Valley, and Eagle Flat) Aquifer (Steady state) were run for this analysis (Anaya and Jones, 2009, Harbaugh, 1996, Harbaugh and others, 2000). Water budgets for each year of the transient[1] model period were extracted (Harbaugh, 1990), as applicable, and 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 portions of the aquifers located within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Edwards-Trinity (Plateau) and Pecos Valley Aquifers

- Version 1.01 of the groundwater availability model of the Edwards-Trinity (Plateau) and Pecos Valley aquifers was used for this analysis. See Anaya and Jones (2009) for assumptions and limitations of the model.
- The model has two layers which represent the Edwards portions of the Edwards-Trinity (Plateau) Aquifer and Pecos Valley Aquifer in layer one, and Trinity portions of the Edwards-Trinity (Plateau) Aquifer in layer two. Water budgets for the district have been determined separately for the Edwards-Trinity (Plateau) Aquifer and Pecos Valley Aquifer.

[1] The groundwater availability model of the West Texas Bolsons (Red Light, Green River, and Eagle Flat) Aquifer does not contain a transient simulation due to lack of data when the model was built. The steady-state simulation was used to extract results.

- The root mean square error (a measure of the difference between simulated and actual water levels during model calibration) is 143 feet for the transient calibration period. This represents 6 percent of the range of measured water levels (Anaya and Jones, 2009).

Igneous and parts of the West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat) Aquifers

- Version 1.01 of the groundwater availability model of the Igneous and parts of the West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat) aquifers was used. See Beach and others (2004) for assumptions and limitations of the groundwater availability model.

- The model includes three layers representing the West Texas Bolsons Aquifer (layer 1), Igneous Aquifer (layer 2), and Cretaceous and Permian units (layer 3) (Beach and others, 2004, Oliver, 2009).

- Of the three layers, individual water budgets for the district were determined for the West Texas Bolsons Aquifer and Igneous Aquifer (layers 1 and 2).

- The root mean square error (a measure of the difference between simulated and actual water levels during model calibration) in the groundwater availability model is 35 feet for the West Texas Bolsons Aquifer, and 35 feet for the Igneous Aquifer for the transient calibration period. These root mean square errors represent four and three percent, respectively, of the range of measured water levels (Beach and others, 2004).

West Texas Bolsons (Red Light Draw, Green River Valley, and Eagle Flat) Aquifer

- Version 1.01 of the groundwater availability model of the West Texas Bolsons (Red Light Draw, Green River Valley, and Eagle Flat) aquifer was used. See Beach and others (2008) for assumptions and limitations of the groundwater availability model.

- The model includes three layers representing the West Texas Bolsons Aquifer (layer 1), Cretaceous and Permian units (layer 2), and Cretaceous and Paleozoic units (layer 3).

- Of the three layers, individual water budgets for the district were determined for the West Texas Bolsons Aquifer (layer 1).

- The mean absolute error (a measure of the difference between simulated and actual water levels during model calibration) in the groundwater availability model is 56 feet for the West Texas Bolsons Aquifer for the steady-state calibration period. The mean absolute error represents seven percent of the range of measured water levels (Beach and others, 2008).

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 runs in the district, as shown in tables 1 through 4. The components of the modified budget 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 drains (springs).
- Flow into and out of district—the lateral flow within the aquifer between the district and adjacent counties.
- Flow between aquifers—the flow between aquifers or confining units within the district. 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 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 (see figures 1 through 3).

TABLE 1. SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER THAT IS NEEDED FOR JEFF DAVIS 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	14,860
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	0
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	5,902
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	20,070
Estimated net annual volume of flow between each aquifer in the district[2]	From Edwards-Trinity (Plateau) Aquifer into Pecos Valley Aquifer	1,749
	From Edwards-Trinity (Plateau) into other formations	21

[2] The total estimated net annual volume of flow from Edwards-Trinity (Plateau) to Pecos Valley Aquifer and other formations is 1,770 acre-feet per year.

TABLE 2. SUMMARIZED INFORMATION FOR THE PECOS VALLEY AQUIFER THAT IS NEEDED FOR JEFF DAVIS 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	Pecos Valley Aquifer	361
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Pecos Valley Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Pecos Valley Aquifer	0
Estimated annual volume of flow out of the district within each aquifer in the district	Pecos Valley Aquifer	2,780
Estimated net annual volume of flow between each aquifer in the district	From Edwards-Trinity (Plateau) Aquifer into Pecos Valley Aquifer	1,749

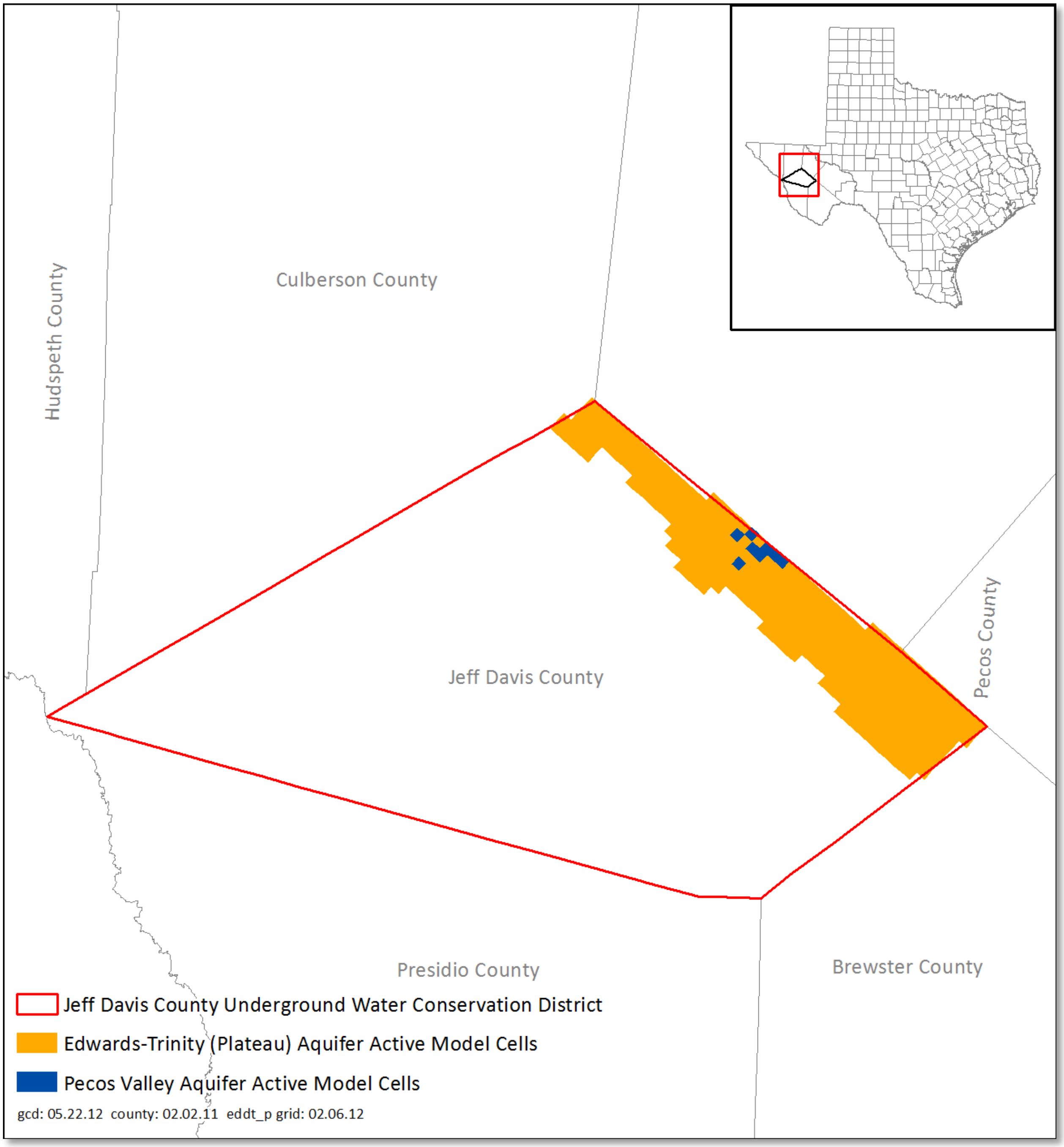

FIGURE 1. AREA OF THE GROUNDWATER AVAILABILITY MODEL OF THE EDWARDS-TRINITY (PLATEAU) AND PECOS VALLEY AQUIFERS FROM WHICH THE INFORMATION IN TABLES 1 AND 2 WAS EXTRACTED.

TABLE 3. SUMMARIZED INFORMATION FOR THE IGNEOUS AQUIFER THAT IS NEEDED FOR JEFF DAVIS 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	Igneous Aquifer	26,043[3]
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Igneous Aquifer	2,566
Estimated annual volume of flow into the district within each aquifer in the district	Igneous Aquifer	611
Estimated annual volume of flow out of the district within each aquifer in the district	Igneous Aquifer	4,322
Estimated net annual volume of flow between each aquifer in the district[4]	From Igneous Aquifer into overlying West Texas Bolsons Aquifer	1,726
	From Igneous Aquifer into underlying Cretaceous and Permian units	14,342

[3] Recharge applied with the recharge package to the Igneous Aquifer is both direct precipitation recharge and alluvial fan/stream bed recharge.
[4] The total estimated net annual volume of flow from Igneous Aquifer to West Texas Bolsons Aquifer and other formations is 16,068 acre-feet per year.

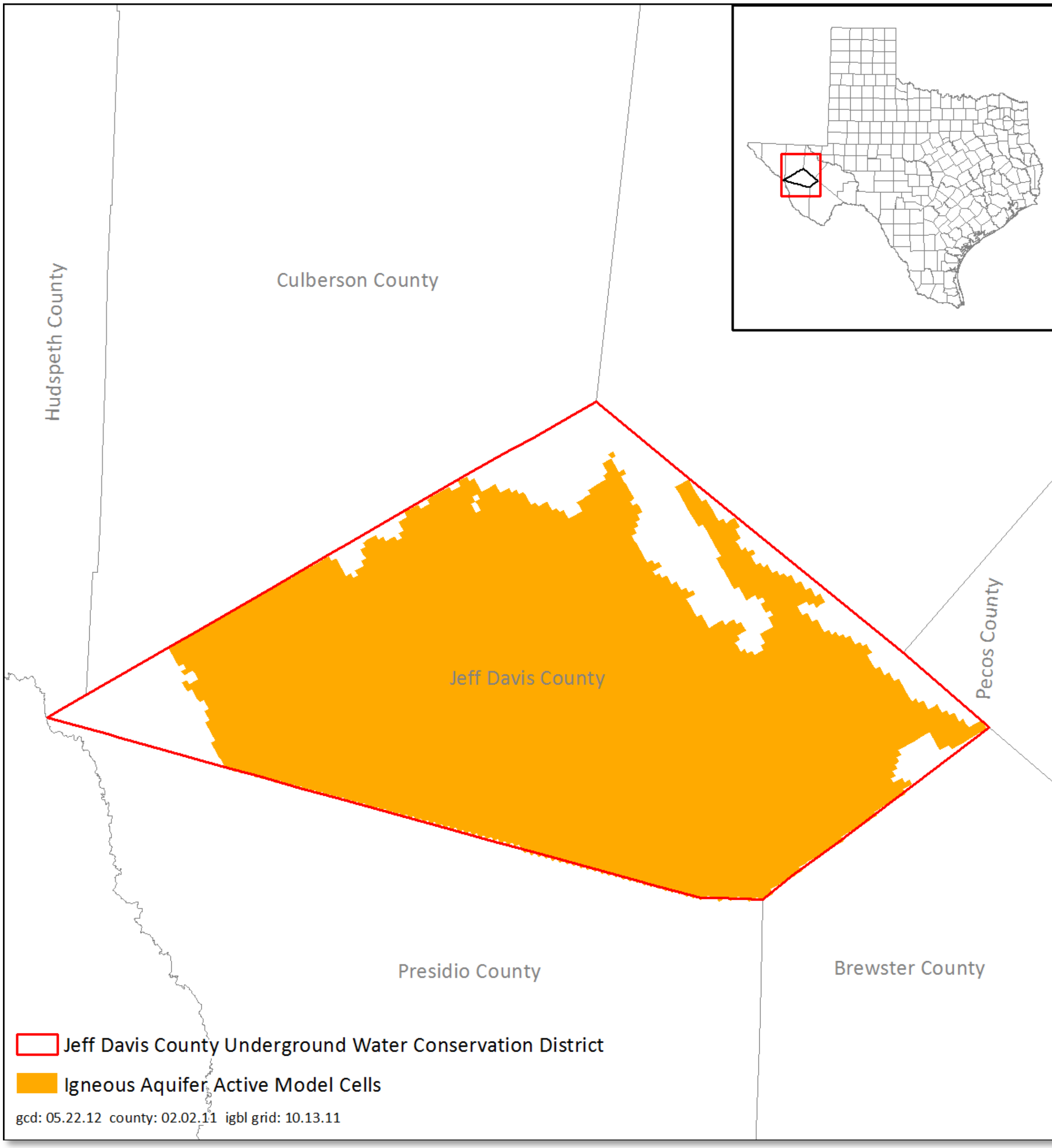

FIGURE 2. AREA OF THE GROUNDWATER AVAILABILITY MODEL OF THE IGNEOUS AND WEST TEXAS BOLSONS AQUIFERS FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED.

TABLE 4. SUMMARIZED INFORMATION FOR THE WEST TEXAS BOLSONS AQUIFER THAT IS NEEDED FOR JEFF DAVIS 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	West Texas Bolsons Aquifer	153[5]
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	West Texas Bolsons Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	West Texas Bolsons Aquifer	4,188
Estimated annual volume of flow out of the district within each aquifer in the district	West Texas Bolsons Aquifer	7,422
Estimated net annual volume of flow between each aquifer in the district[6]	From Igneous Aquifer into overlying West Texas Bolsons Aquifer	1,726
	From Cretaceous and Permian units into overlying West Texas Bolsons Aquifer	11

[5] It is assumed that precipitation recharge directly to the West Texas Bolsons Aquifer is zero. The recharge package suggests, on average, 153 acre-feet per year from alluvial fan/stream bed infiltration enters the aquifer in the district.

[6] The total estimated net annual volume of flow from Igneous Aquifer and Cretaceous and Permian units to West Texas Bolsons Aquifer is 1,737 acre-feet per year.

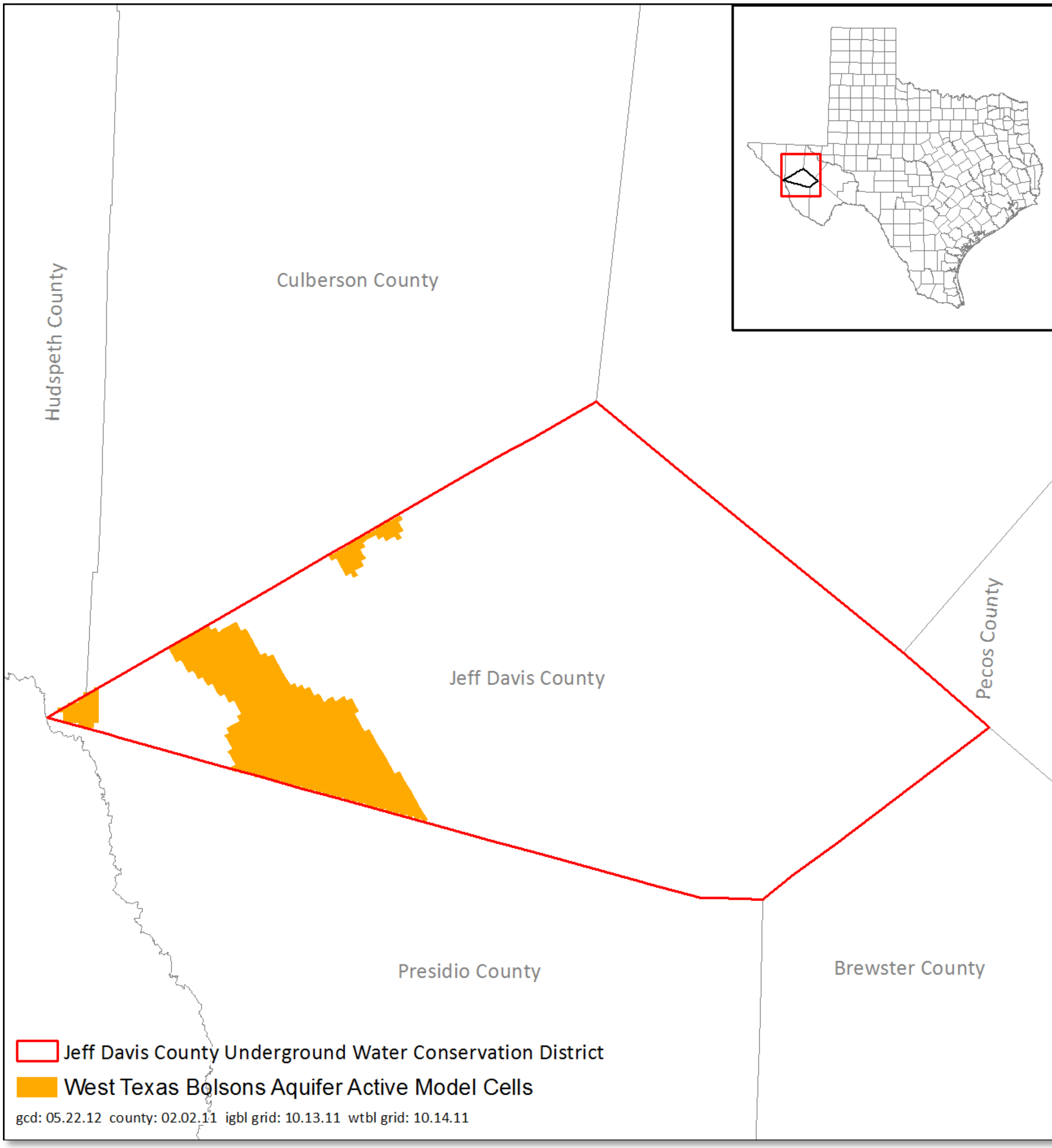

FIGURE 3. AREA OF THE GROUNDWATER AVAILABILITY MODEL OF THE IGNEOUS AND WEST TEXAS BOLSONS AQUIFERS AND GROUNDWATER AVAILABILITY MODEL OF THE WEST TEXAS BOLSONS AQUIFER FROM WHICH THE INFORMATION IN TABLE 4 WAS EXTRACTED.

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 streamflow are specific to a particular historic time period.

Because the application of the groundwater model was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations relating 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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