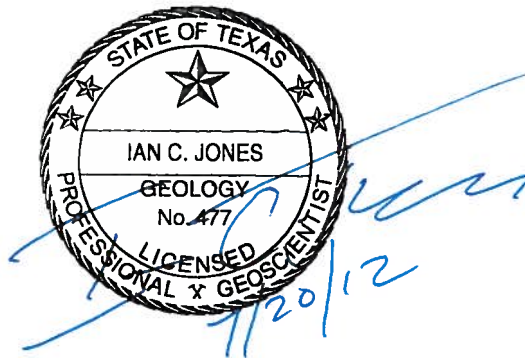

GAM RUN 12-004: CROCKETT COUNTY GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

by Ian C. Jones, Ph.D., P.G.
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Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-6641
July 20, 2012



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EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h), states that, in developing its groundwater management plan, groundwater conservation districts shall use groundwater availability modeling information provided by the executive administrator of the Texas Water Development Board 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.

This report supersedes Groundwater Availability Model (GAM) Run 08-27 which did not include a water budget for the Dockum Aquifer. A groundwater availability model for the Dockum Aquifer was released in January 2009 (Ewing and others, 2008) and an alternate version of the groundwater availability model for the Dockum Aquifer was released in April 2010 (Oliver and Hutchison, 2010). The purpose of this report is to provide information to Crockett County Groundwater Conservation District for its groundwater management plan. The groundwater management plan for Crockett County Groundwater Conservation District is due for approval by the executive administrator of the Texas Water Development Board before September 5, 2013.

This report discusses the methods, assumptions, and results from model runs using groundwater models for the Dockum Aquifer and the Pecos Valley and Edwards-Trinity (Plateau) aquifers. Tables 1 through 3 summarize the groundwater 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. If after review of the figures, Crockett County Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the Texas Water Development Board immediately.

METHODS:

Groundwater models for the Pecos Valley and Edwards-Trinity (High Plains) aquifers and the Dockum Aquifer were run for this analysis. Water budgets for the transient model period (1980 through 1999) were extracted using ZONEBUDGET version 3.01 (Harbaugh, 1990) 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. The estimated net annual volume of flow between the Pecos Valley and Edwards-Trinity (Plateau) aquifers in the district was calculated as the net lateral flow in the Pecos Valley Aquifer of Crockett County Groundwater Conservation District that occurs along the Pecos River. This estimate is based on the assumption that there is no groundwater flow crossing the Pecos River—a major discharge zone from the Pecos Valley Aquifer.

PARAMETERS AND ASSUMPTIONS:

Edwards-Trinity (Plateau) Aquifer

- The recently modified and calibrated one-layer groundwater flow model of the Edwards Trinity (Plateau) and Pecos Valley aquifers (Hutchison and others, 2011) was used for these simulations. This differs from GAM Run 08-027 where results were taken from the original two-layer model (Anaya and Jones, 2009). The modified model version was developed to more effectively simulate groundwater conditions and was used for this management plan data extraction analysis due to enhancements in the calibration and in order to be consistent with the Modeled Available Groundwater (MAG) process. The model was calibrated based on groundwater elevation data from 1930 to 2005; however, data was

extracted from 1980 to 1999 to be more consistent with the analysis completed for the Dockum Aquifer.

- The model has one layer which represents the Pecos Valley Aquifer in the northwest portion of the model area, the Edwards-Trinity (Plateau) Aquifer, the Hill Country portion of the Trinity Aquifer in the southeast portion of the model area, and a lumped representation of both the Pecos Valley and Edwards-Trinity (Plateau) aquifers in the relatively narrow area where the Pecos Valley Aquifer overlies the Edwards-Trinity (Plateau) Aquifer.
- The standard deviation of groundwater elevation residuals (a measure of the difference between simulated and actual water levels during model calibration) for the entire model domain is 70 feet and the average residual is -1.3 feet.
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

Dockum Aquifer

- We used version 1.01 of the groundwater availability model for the Dockum Aquifer. See Ewing and others (2008) for assumptions and limitations of the groundwater availability model.
- The model includes three layers representing: geologic units overlying the Dockum Aquifer including the Ogallala, Edwards-Trinity (High Plains), Edwards-Trinity (Plateau), Pecos Valley, and Rita Blanca aquifers (Layer 1), the upper portion of the Dockum Aquifer (Layer 2), and the lower portion of the Dockum Aquifer (Layer 3).
- The aquifers represented in Layer 1 of the groundwater availability model are only included in the model for the purpose of more accurately representing flow between these units and the Dockum Aquifer. This model is not intended to explicitly simulate flow in these overlying units (Ewing and others, 2008).
- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) in the entire model between 1980 and 1997 is 65.0 feet and 69.6 feet for the upper and lower portions of the Dockum Aquifer, respectively (Ewing and others, 2008). This represents 2.7 and 3.0 percent of the hydraulic head drop across the model area for these same aquifers, respectively.

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

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected components were extracted from the groundwater budget 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 3. 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 drains (springs).
- Flow into and out of district—The lateral flow within the aquifer between the district and adjacent counties.
- Flow between aquifers—The vertical flow between 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. “Inflow” to an aquifer from an overlying or underlying aquifer will always equal the “Outflow” from the other aquifer.

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 (see figures 1 through 3).

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.

TABLE 1: SUMMARIZED INFORMATION FOR THE EDWARD-TRINITY (PLATEAU) AQUIFER THAT IS NEEDED FOR CROCKETT COUNTY GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

<i>Management Plan requirement</i>	<i>Aquifer or confining unit</i>	<i>Results</i>
Estimated annual amount of recharge from precipitation to the district	Edwards-Trinity (Plateau) Aquifer	72,769
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	51,505
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	144,023
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	178,768
Estimated net annual volume of flow between each aquifer in the district	From the Edwards-Trinity (Plateau) Aquifer to the Pecos Valley Aquifer	1,121

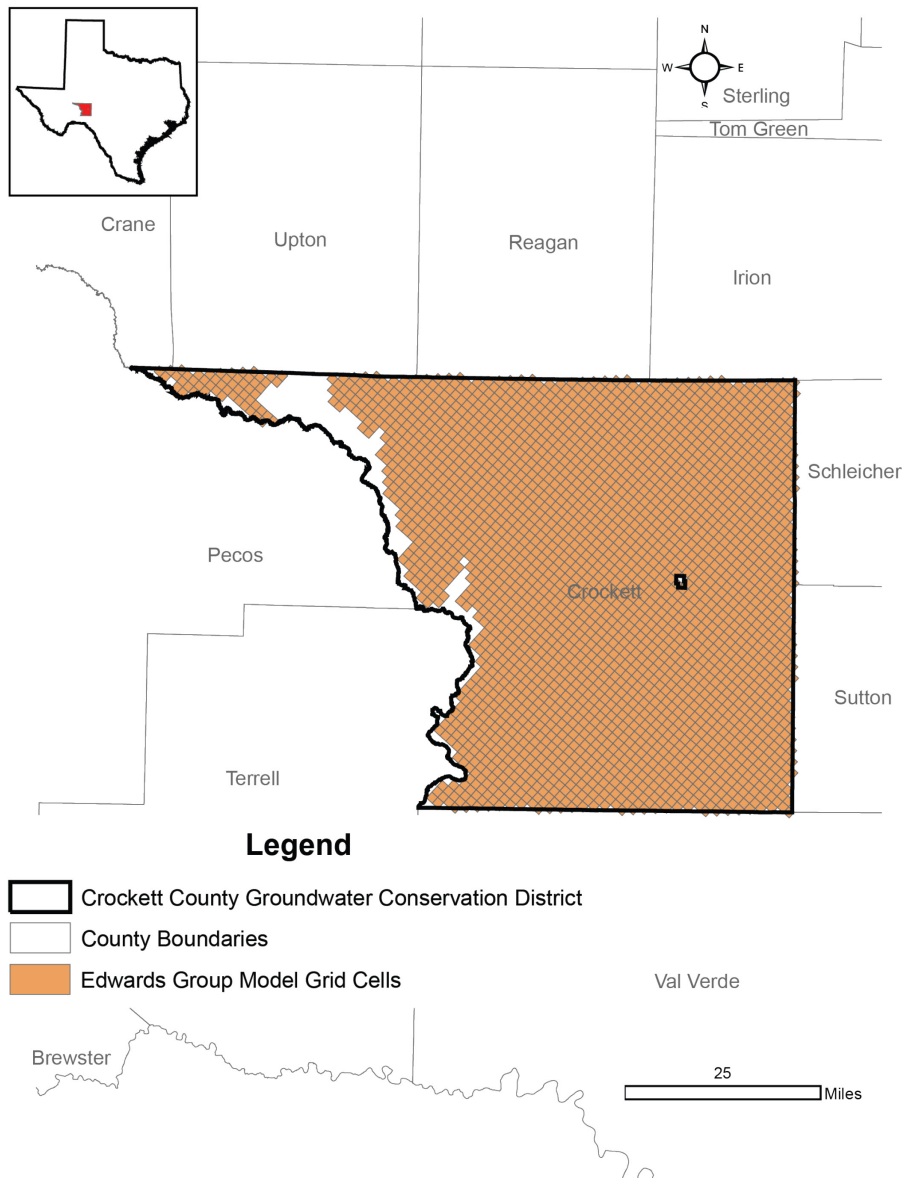


FIGURE 1: AREA OF THE GROUNDWATER MODEL FOR THE EDWARD-TRINITY (PLATEAU) AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE DOCKUM AQUIFER THAT IS NEEDED FOR CROCKETT COUNTY GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

<i>Management Plan requirement</i>	<i>Aquifer or confining unit</i>	<i>Results</i>
Estimated annual amount of recharge from precipitation to the district	Dockum Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Dockum Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Dockum Aquifer	1,487
Estimated annual volume of flow out of the district within each aquifer in the district	Dockum Aquifer	154
Estimated net annual volume of flow between each aquifer in the district	From the Dockum Aquifer to overlying younger units	1,333

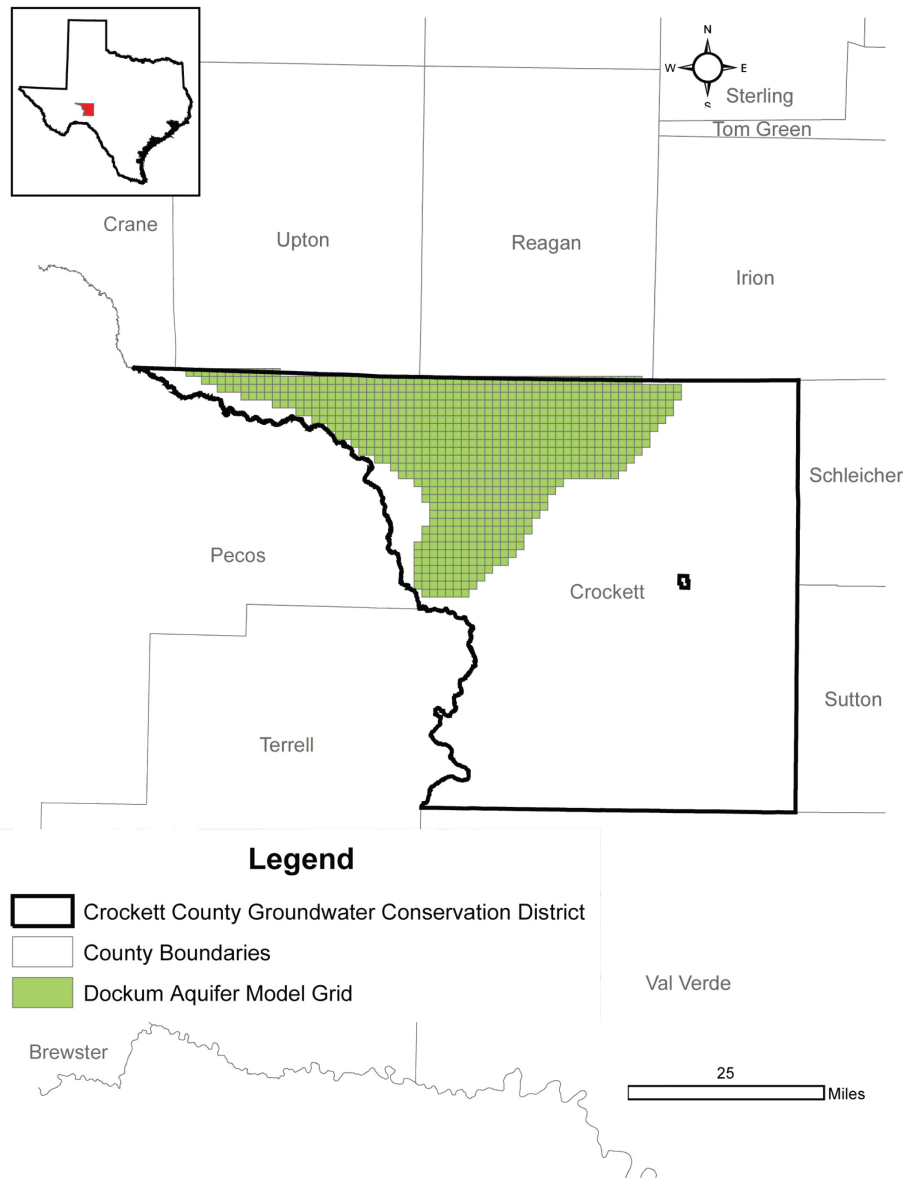


FIGURE 2: AREA OF THE GROUNDWATER MODEL FOR THE DOCKUM AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 3: SUMMARIZED INFORMATION FOR THE PECOS VALLEY AQUIFER THAT IS NEEDED FOR CROCKETT COUNTY GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

<i>Management Plan requirement</i>	<i>Aquifer or confining unit</i>	<i>Results</i>
Estimated annual amount of recharge from precipitation to the district	Pecos Valley Aquifer	5
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	1,136
Estimated annual volume of flow into the district within each aquifer in the district	Pecos Valley Aquifer	1,625
Estimated annual volume of flow out of the district within each aquifer in the district	Pecos Valley Aquifer	504
Estimated net annual volume of flow between each aquifer in the district	From the Edwards-Trinity (Plateau) Aquifer to the Pecos Valley Aquifer	1,121

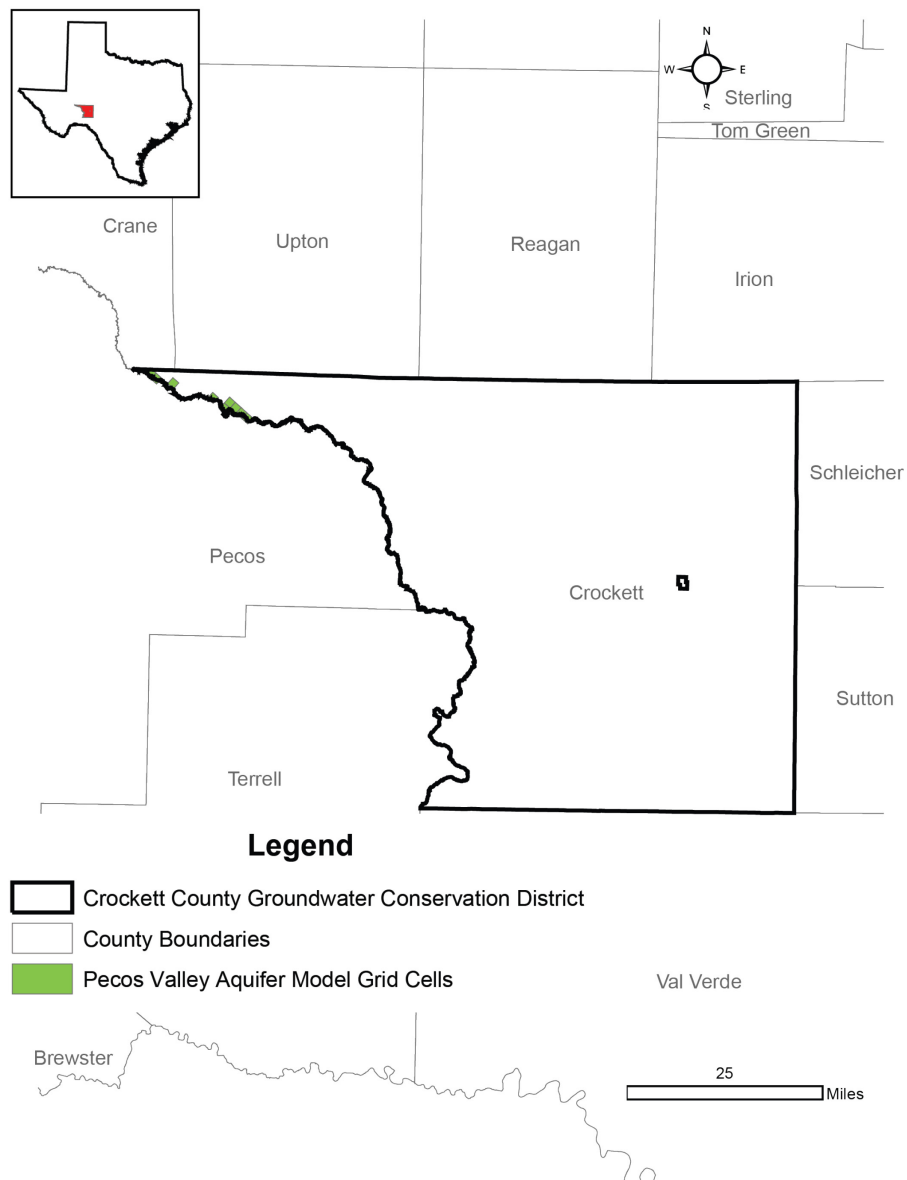


FIGURE 3: AREA OF THE GROUNDWATER MODEL FOR THE PECOS VALLEY AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

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