GAM Run 08-88

by Mr. Wade A. Oliver
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-3132
March 17, 2009

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 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 groundwater management plans include:

(1) the annual amount of recharge from precipitation to the groundwater resources within the district, if any;
(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 purpose of this model run is to provide information to Presidio County Underground Water Conservation District for its groundwater management plan. The groundwater management plan for Presidio County Underground Water Conservation District is due for approval by the Executive Administrator of the Texas Water Development Board before September 28, 2009.

This report discusses the methods, assumptions, and results from model runs using the groundwater availability model for the Igneous Aquifer and the Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat portions of the West Texas Bolsons Aquifer. In addition, this report also includes results from the newly approved groundwater availability model for the Red Light Draw, Green River Valley, and Eagle Flat portions of the West Texas Bolsons Aquifer. Table 1 summarizes the groundwater availability model data required by statute for Presidio County Underground Water Conservation District's groundwater management plan. Figure 1 shows the area of the groundwater availability models from which the values in Table 1 were extracted.

The Presidio-Redford Bolson, a portion of the West Texas Bolsons Aquifer, is also present in Presidio County Underground Water Conservation District; however, a groundwater availability model for this portion of the aquifer has not been completed at

this time. If the district would like information for the Presidio-Redford Bolson portion of the West Texas Bolsons Aquifer they may request it from the Groundwater Technical Assistance Section of the Texas Water Development Board.

METHODS:

We ran the groundwater availability model for the Igneous Aquifer and the Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat portions of the West Texas Bolsons Aquifer and (1) extracted annual water budgets from 1980 through 1999 and (2) averaged the 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 Igneous and West Texas Bolsons aquifers located within the district.

The groundwater availability model for the Red Light Draw, Green River Valley, and Eagle Flat portions of the West Texas Bolsons Aquifer is a steady-state model and therefore does not contain water budgets associated with any specific time period. For this reason, the steady-state water budget values from this groundwater availability model were used in Table 1.

PARAMETERS AND ASSUMPTIONS:

Groundwater availability model for the Igneous Aquifer and the Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat portions of the West Texas Bolsons Aquifer

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

- The model includes three layers, representing the Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat portions of the West Texas Bolsons Aquifer (Layer 1), the Igneous Aquifer (Layer 2), and the underlying Cretaceous and Permian units (Layer 3).

- Ryan Flat is the only portion of the West Texas Bolsons Aquifer in Presidio County Underground Water Conservation District characterized by this groundwater availability model (Beach and others, 2004).

- The mean absolute error (a measure of the difference between simulated and actual water levels during model calibration) in the entire model for the period of 1990 to 2000 is 64 feet, or four percent of the range of measured water levels (Beach and others, 2004).

- The model uses the MODFLOW recharge package to model both recharge from alluvial fans/stream beds and precipitation. It is assumed that precipitation recharge directly to the Ryan Flat portion of the West Texas Bolsons Aquifer is

zero; therefore, all recharge included in the recharge package to Layer 1 is from alluvial fan/stream bed infiltration. Recharge applied with the recharge package to the Igneous Aquifer (Layer 2) is both direct precipitation recharge and alluvial fan/stream bed recharge.

- We used Processing MODFLOW for Windows (PMWIN) version 5.3 (Chiang and Kinzelbach, 2001) as the interface to process model output.

Groundwater availability model for the Red Light Draw, Green River Valley, and Eagle Flat portions of the West Texas Bolsons Aquifer

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

- The groundwater availability model includes three layers representing the Red Light Draw, Green River Valley, and Eagle Flat portions of the West Texas Bolsons Aquifer (Layer 1) and the underlying Cretaceous, Paleozoic, Tertiary, Permian and other units in the model area (Layers 2 and 3).

- Green River Valley is the only portion of the West Texas Bolsons Aquifer characterized by this groundwater availability model in Presidio County Underground Water Conservation District (Beach and others, 2008).

- The mean absolute error (a measure of the difference between simulated and actual water levels during model calibration) of the steady-state groundwater availability model is 56 feet, or seven percent of the range of measured water levels, for the Red Light Draw, Green River Valley, and Eagle Flat portions of the West Texas Bolsons Aquifer.

- As described in Beach and others (2008), little to no recharge occurs directly from precipitation to the Red Light Draw, Green River Valley, and Eagle Flat portions of the West Texas Bolsons Aquifer. Instead, flows into the aquifer consist primarily of inflows from underlying units and from streams.

- We used Groundwater Vistas Version 5 (Environmental Simulations, Inc. 2007) as the interface to process model output.

RESULTS:

A groundwater budget summarizes the water entering and leaving the aquifer according to the groundwater availability model. Selected components were extracted from the groundwater budget. The components of the modified budgets shown in Table 1 include:

- Precipitation recharge—This is 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. As described above, recharge may also include inflow from alluvial fans and stream beds for the Igneous Aquifer and the Ryan Flat portion of the West Texas Bolsons Aquifer.

- Surface water outflow—This is the total water exiting the aquifer (outflow) to surface water features such as streams, reservoirs, and drains (springs).

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

- Flow between aquifers—This describes the vertical flow, or leakage, 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 Table 1. 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 needed for Presidio County Underground Water Conservation District's groundwater management plan. All values are reported in acre-feet per year. All numbers are 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	Green River Valley portion of the West Texas Bolsons Aquifer	3
	Ryan Flat portion of the West Texas Bolsons Aquifer	1,445
	Igneous Aquifer	9,369
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Green River Valley portion of the West Texas Bolsons Aquifer	4
	Ryan Flat portion of the West Texas Bolsons Aquifer	NA[a]
	Igneous Aquifer	3,252
Estimated annual volume of flow into the district within each aquifer in the district	Green River Valley portion of the West Texas Bolsons Aquifer	2
	Ryan Flat portion of the West Texas Bolsons Aquifer	723
	Igneous Aquifer	4,391
Estimated annual volume of flow out of the district within each aquifer in the district	Green River Valley portion of the West Texas Bolsons Aquifer	0
	Ryan Flat portion of the West Texas Bolsons Aquifer	3,992
	Igneous Aquifer	1,852
Estimated net annual volume of flow between each aquifer in the district	From the underlying units to the Green River Valley portion of the West Texas Bolsons Aquifer	18
	From the Igneous Aquifer to the Ryan Flat portion of the West Texas Bolsons Aquifer	1,492
	From the Igneous Aquifer to the underlying Cretaceous and Permian Units	5,872

[a]The groundwater availability model does not consider outflow to any major springs, lakes, streams, or rivers within the Ryan Flat portion of the West Texas Bolsons Aquifer in the district.

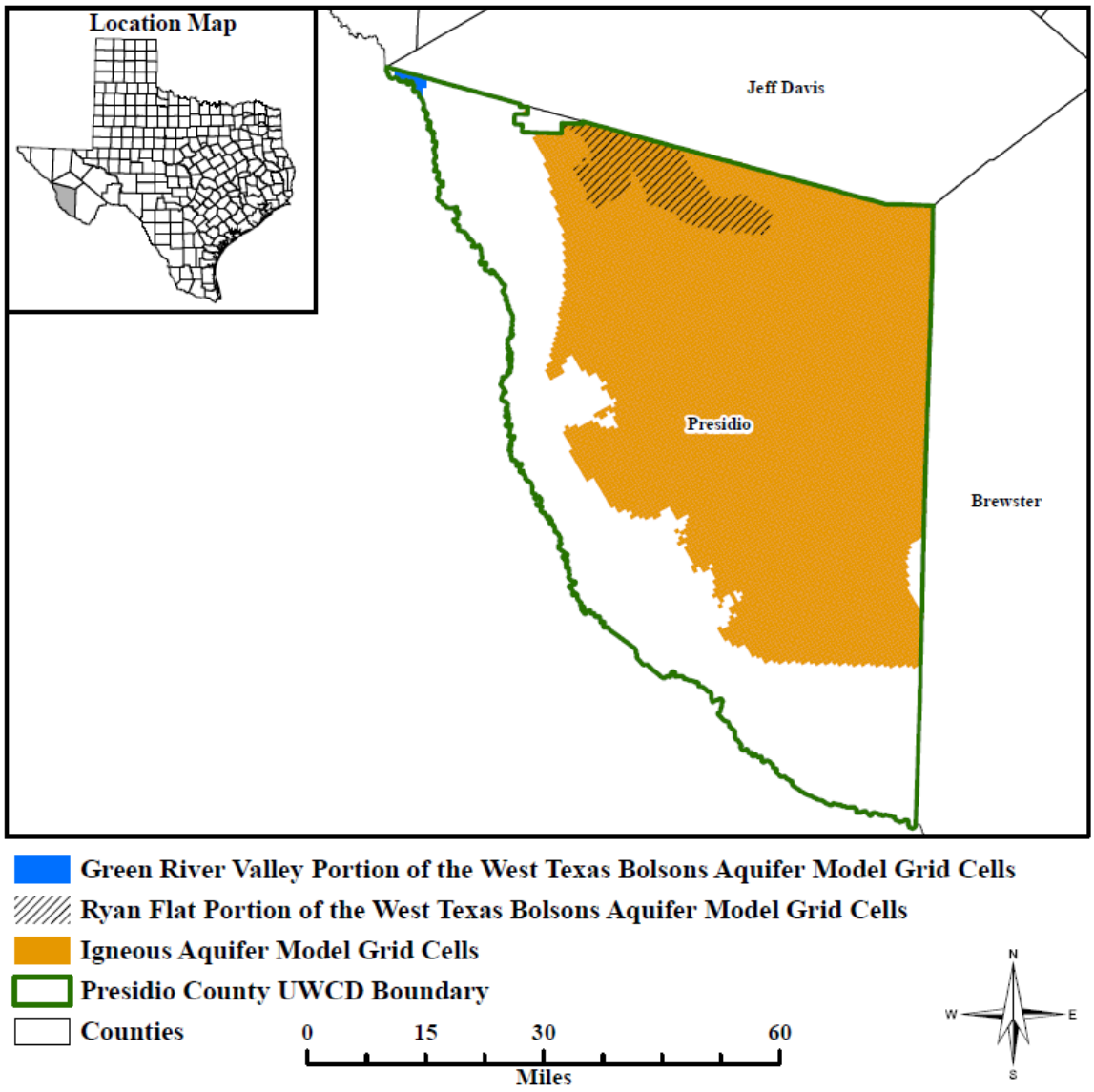

Figure 1: Areas of the groundwater availability models from which the information in Table 1 was extracted. Note that model grid cells that straddle a political boundary were assigned to one side of the boundary based on the centroid of the model cell as described above.

REFERENCES:

Beach, J.A., Ashworth, J.B., Finch, Jr., S.T., Chastain-Howley, A., Calhoun, K., Urbanczyk, K.M., Sharp, J.M., and Olson, J., 2004, Groundwater availability model for the Igneous and parts of the West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat and Lobo Flat) aquifers: contract report to the Texas Water Development Board, 208 p.

Beach, J.A., Symank, L., Huang, Y., Ashworth, J.B., Davidson, T., Collins, E.W., Hibbs, B., Darling, B.K., Urbancyk, K., Calhoun, K., Finch, S., 2008, Groundwater availability model for the West Texas Bolsons (Red Light Draw, Green River Valley, and Eagle Flat) Aquifer in Texas: contract report to the Texas Water Development Board, 320 p.

Chiang, W., and Kinzelbach, W., 2001, Groundwater Modeling with PMWIN, 346 p.

Environmental Simulations, Inc. 2007, Guide to Using Groundwater Vistas Version 5, 381 p.

The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G., on March 17, 2009.