GAM Run 08-67

by Mr. Wade Oliver
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-3132
September 3, 2008

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 the groundwater management plan includes:

(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 the Edwards Aquifer Authority for its groundwater management plan. This report discusses the methods, assumptions, and results from model runs using the groundwater availability model for the San Antonio Segment of the Edwards (Balcones Fault Zone) Aquifer. Table 1 summarizes the groundwater availability model data required by statute for Edwards Aquifer Authority's groundwater management plan. Figure 1 shows the area of the model from which the values in Table 1 were extracted.

METHODS:

We ran the groundwater availability model for the San Antonio Segment of the Edwards (Balcones Fault Zone) Aquifer and (1) extracted water budgets for each year of the 1980 through 1999 period 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 Edwards Aquifer located within the district.

PARAMETERS AND ASSUMPTIONS:

- We used version 1.01 of the groundwater availability model for the San Antonio segment of the Edwards (Balcones Fault Zone) Aquifer. See Lindgren and others (2004) for assumptions and limitations of the model.

- The groundwater availability model for the San Antonio segment of the Edwards (Balcones Fault Zone) Aquifer contains only one layer representing the Edwards Aquifer and associated limestones.

- The root mean square error (a measure of the difference between simulated and actual water levels during model calibration) for the model between 1947 and 2000 ranged from 4.1 to 23.2 feet (Lindgren and others, 2004).

- Conduit flow was simulated in the model by an increase in hydraulic conductivity as described in Lindgren and others (2004). The locations of these conduits caused an inflation of the values for lateral inflow and outflow as described below.

- Inflow from the adjacent Trinity Aquifer was simulated in the model using the MODFLOW Well Package as described in Lindgren and others (2004). Though the flow from the Trinity Aquifer occurs laterally, this flow was only included in the "Flow Between Aquifers" portion of Table 1.

- We used Groundwater Vistas Version 5.3 (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 for the aquifers located within the district and averaged over the calibrated portion of the model run (1980 to 1999) in the district, as shown in Table 1. 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.

- 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. The area of the model from which the information in Table 1 was extracted is shown in Figure 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.

Conduit flow in the model was simulated by increasing hydraulic conductivity (typically to a range between 2,000 and 300,000 feet per day) as described in Lindgren and others (2004). The locations of the conduits were based on those inferred in Worthington (2004). Conduit flows represent the major flow paths in karst aquifers such as the Edwards Aquifer (Lindgren and others, 2004). The conduits simulated in the model frequently pass back and forth across the boundary of the area from which the water budgets were extracted (the Edwards Aquifer extent within the Edwards Aquifer Authority). Examples of locations where this occurs is the western edge of Uvalde County, the downdip extent of the aquifer in south central Uvalde County, the southern edge of Medina County, and the downdip extent of the aquifer in Comal and Hays counties. The result of the many times that the conduits pass in and out the district is that values for lateral inflow and outflow are highly inflated to values that would otherwise seem unreasonable (Table 1). The net lateral flow, a measure of the difference between lateral inflows and outflows, is a much smaller portion of the budget, representing a net outflow of 21,935 acre-feet per year.

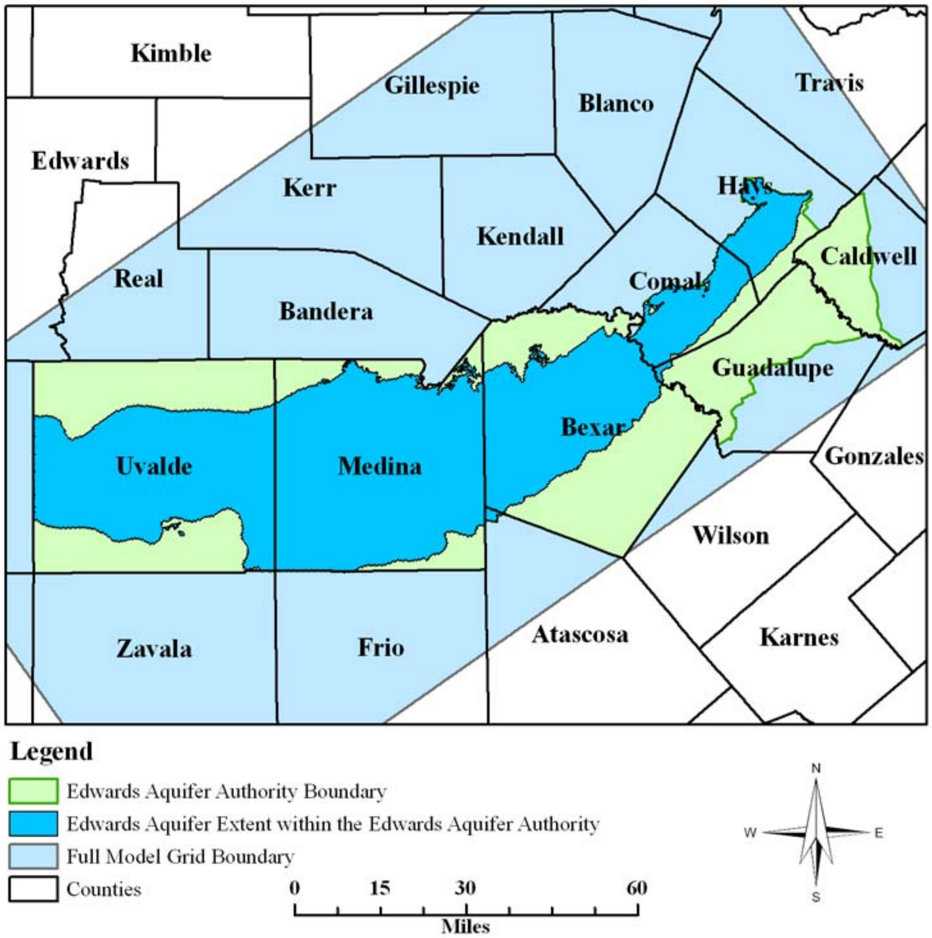
Inflow from the adjacent Trinity Aquifer was considered to be constant and was simulated in the model using the MODFLOW Well Package as described in Lindgren and others (2004). Though the flow from the Trinity Aquifer occurs laterally, this flow was only included in the "Flow Between Aquifers" portion of Table 1 in order to prevent double-accounting.

Table 1: Summarized information needed for the Edwards Aquifer Authority 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	Edwards and associated limestones	596,521
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Edwards and associated limestones	143,897
Estimated annual volume of flow into the district within each aquifer in the district	Edwards and associated limestones	1,405,223[a]
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards and associated limestones	1,427,158[a]
Estimated net annual volume of flow between each aquifer in the district	Edwards and associated limestones	13,622[b]

[a]Lateral flow into and out of the district is inflated due to simulated conduits passing back and forth across district and aquifer boundaries as described above.
[b]Inflow from the adjacent Trinity Aquifer was simulated in the model using the MODFLOW Well Package as mentioned above and described in Lindgren and others (2004).

Figure 1: Area of the groundwater availability model for the San Antonio Segment of the Edwards (Balcones Fault Zone) Aquifer from which the information in Table 1 was extracted (the aquifer extent within the Edwards Aquifer Authority boundary). 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:

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Lindgren, R.J., Dutton, A.R., Hovorka, S.D., Worthington, S.R.H, and Painter, S., 2004, Conceptualization and Simulation of the Edwards Aquifer, San Antonio Region, Texas: U.S. Geological Survey Scientific Investigations Report 2004-5277, 143 p.

Worthington, S.R.H., 2004, Conduits and Turbulent flow in the Edwards Aquifer: Worthington Groundwater Contract Report to Edwards Aquifer Authority, 41 p.

Cynthia K. Ridgeway is Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by employees under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G., on September 3, 2008.