GAM Run 08-35

by Cynthia K. Ridgeway, P.G.
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 936-2386
May 29, 2008

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 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 the Fayette County Groundwater Conservation District for its groundwater management plan. The groundwater management plan for the Fayette County Groundwater Conservation District is due for approval by the executive administrator of the Texas Water Development Board before December 17, 2008.

This report discusses the method, assumptions, and results from model runs using the groundwater availability models for the central part of the Gulf Coast Aquifer and the central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers. Table 1 summarizes the groundwater availability model data required by statute for the Fayette County Groundwater Conservation Districts groundwater management plan.

Although the Yegua-Jackson Aquifer also occurs in Fayette County, a groundwater availability model for this minor aquifer has not been developed at this time. If the Fayette County Groundwater Conservation District would like information for the Yegua-Jackson Aquifer, they can request it from the Groundwater Technical Assistance Section of the Texas Water Development Board.

METHODS:

We ran the groundwater availability models for the central part of the Gulf Coast Aquifer and the central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers and (1) extracted water budgets for each year of the 1980 or 1981 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 Gulf Coast Aquifer and the Carrizo-Wilcox, Queen City, and Sparta aquifers located within the district.

PARAMETERS AND ASSUMPTIONS:

Groundwater availability model for the central part of the Gulf Coast Aquifer

- We used Version 1.01 of the groundwater availability model for the central part of the Gulf Coast Aquifer. See Chowdhury and others (2004) and Waterstone and others (2003) for assumptions and limitations of the groundwater availability model for the central part of the Gulf Coast Aquifer.

- The model simulates groundwater flow through four hydrostratigraphic layers. From top to bottom, these layers are: the Chicot Aquifer, Evangeline Aquifer, Burkeville Confining System, and the Jasper Aquifer.

- The mean absolute error (a measure of the difference between simulated and actual water levels during model calibration) in the entire model for 1999 is 26 feet, which is 4.6 percent of the hydraulic head drop across the model area (Chowdhury and others, 2004).

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

Groundwater availability model for the central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers

- We used Version 2.01 of the groundwater availability model for the central part of the Carrizo-Wilcox, Queen City and Sparta aquifers. See Dutton and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model for the central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers.

- The groundwater availability model includes eight layers, representing:

    1. the Sparta Aquifer (Layer 1),
    2. the Weches Confining Unit (Layer 2),
    3. the Queen City Aquifer (Layer 3),
    4. the Reklaw Confining Unit (Layer 4),

5. the Carrizo Aquifer (Layer 5),
6. the Upper Wilcox Aquifer (Calvert Bluff Formation—Layer 6),
7. the Middle Wilcox Aquifer (Simsboro Formation—Layer 7), and
8. the Lower Wilcox Aquifer (Hooper Formation—Layer 8).

- 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 1980 to 1999 ranges from 3.2 percent (Carrizo aquifer) to 7.8 percent (Sparta aquifer) of measured water levels (Kelley and others, 2004).

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

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 duration of the calibrated portion of the model run: 1981 to 1999 for the Gulf Coast Aquifer and 1980 to 1999 for the Carrizo-Wilcox, Queen City, and Sparta aquifers. 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. 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.

As depicted by Kalaswad and Arroyo (2006) and Kelley and others (2004), groundwater in the Gulf Coast Aquifer and the Carrizo-Wilcox, Queen City, and Sparta aquifers ranges from fresh, brackish, to saline (1,000 to 10,000 milligrams per liter of total dissolved solids). The reported flow values in this report include all categories of water quality: fresh (less than 1,000 milligrams per liter total dissolved solids), brackish (1,000 to 10,000 milligrams per liter total dissolved solids), and saline (greater than 10,000 milligrams per liter total dissolved solids) groundwater.

REFERENCES:

Chowdhury, A.H., Wade, S.W., Mace, R.E., and Ridgeway, C., 2004, Groundwater availability model of the central Gulf Coast Aquifer system—Numerical simulations through 1999: Unpublished Texas Water Development Board report, 114 p. http://www.twdb.state.tx.us /gam /glfc_c/glfc_c_TWDB_SummaryReport.pdf

Dutton, A.R., Harden, R., Nicot, J.P., and O'Rourke, D., 2003, Groundwater availability model for the central part of the Carrizo-Wilcox aquifer in Texas: Bureau of Economic Geology, Final report prepared for the Texas Water Development Board.

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

Kalaswad, S., and Arroyo, J., 2006, Status report on brackish groundwater and desalination in the Gulf Coast Aquifer of Texas *in* Mace, R.E., Davison, S.C., Angle, E.S., and Mullican, III, W.F., eds., Aquifers of the Gulf Coast of Texas: Texas Water Development Board Report 365, p. 231–240.

Kelley, V.A., Deeds, N.E., Fryar, D.G., and Nicot, J.P., 2004, Groundwater availability models for the Queen City and Sparta aquifers: Contract report to the Texas Water Development Board, 867 p.

Waterstone Environmental Hydrology and Engineering Inc. and Parsons, 2003, Groundwater availability of the Central Gulf Coast Aquifer: Numerical Simulations to 2050, Central Gulf Coast, Texas Contract report to the Texas Water Development Board, 157 p.

The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G., on May 29, 2008.

Table 1: Summarized information needed for the Fayette County Groundwater 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. Negative values indicate water is leaving the aquifer system using the parameters or boundaries listed in the table. Flows include fresh, brackish, and saline waters.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Chicot	0
	Evangeline	1,619
	Burkeville	3
	Jasper	335
	Sparta	390
	Weches	0
	Queen City	0
	Reklaw	0
	Carrizo	0
	Wilcox (upper)	0
	Wilcox (middle)	0
	Wilcox (lower)	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Chicot	0
	Evangeline	-937
	Burkeville	-193
	Jasper	-681
	Sparta	0
	Weches	0
	Queen City	0
	Reklaw	0
	Carrizo	0
	Wilcox (upper)	0
	Wilcox (middle)	0
	Wilcox (lower)	0

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual volume of flow into the district within each aquifer in the district	Chicot	0
	Evangeline	129
	Burkeville	6
	Jasper	155
	Sparta	528
	Weches	97
	Queen City	1,951
	Reklaw	157
	Carrizo	4,765
	Wilcox (upper)	936
	Wilcox (middle)	908
	Wilcox (lower)	1,741
Estimated annual volume of flow out of the district within each aquifer in the district	Chicot	0
	Evangeline	--677
	Burkeville	-18
	Jasper	-489
	Sparta	-294
	Weches	-100
	Queen City	-545
	Reklaw	-105
	Carrizo	-4,009
	Wilcox (upper)	-722
	Wilcox (middle)	-1,276
	Wilcox (lower)	-1,391
Estimated net annual volume of flow between each aquifer in the district	Chicot into Evangeline	0
	Evangeline into Burkeville	39
	Burkeville into Jasper	-153
	Sparta into Weches	-1,898
	Weches into Queen City	-2,002
	Queen City into Rekalw	-1,322
	Reklaw into Carrizo	-1,273
	Carrizo into Wilcox (upper)	-269
	Wilcox (upper) in Wilcox (middle)	-35
	Wilcox middle into lower	-373