GAM Run 08-49

by Mr. Wade Oliver
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-3132
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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 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 Pineywoods Groundwater Conservation District for its groundwater management plan. The groundwater management plan for the Pineywoods Groundwater Conservation District is due for approval by the executive administrator of the Texas Water Development Board before February 25, 2009.

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

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

METHODS:

We ran the groundwater availability models for the northern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers and the northern part of the Gulf Coast 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 Carrizo-Wilcox, Queen City, Sparta, and Gulf Coast aquifers located within the district.

PARAMETERS AND ASSUMPTIONS:

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

- We used Version 2.01 of the groundwater availability model for the northern part of the Carrizo-Wilcox, Queen City and Sparta aquifers. See Fryar and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model for the northern 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 Processing Modflow for Windows (PMWIN) version 5.3 (Chiang and Kinzelbach, 2001) as the interface to process model output.

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

- We used Version 2.01 of the groundwater availability model for the northern part of the Gulf Coast Aquifer. See Kasmarek and Robinson (2004) for assumptions and limitations of the groundwater availability model for the northern part of the Gulf Coast Aquifer.

- The model simulates groundwater flow through four hydrostratigraphic layers shown in Table 2. From top to bottom, these layers are: the Chicot Aquifer, Evangeline Aquifer, Burkeville Confining System, and the Jasper Aquifer. Only a small portion of the Jasper Aquifer occurs within the districts boundaries.

- The root mean square (RMS) errors for the entire model in 2000 ranged from 6 percent (Chicot) to 11 percent (Jasper) of the measured water levels (Kasmarek and Robinson 2004).

- We used Processing Modflow for Windows (PMWIN) version 5.3 (Chiang and Kinzelbach, 2001) 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 duration of 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. 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), Fryar and others (2003) and Kelley and others (2004), groundwater quality in the Gulf Coast Aquifer and the Carrizo-Wilcox,

Queen City, and Sparta aquifers can range from fresh to brackish to saline within the district. The majority of brackish and saline water in the district is located in the Queen City Formation outside of the official Queen City Aquifer boundary as defined by the Texas Water Development Board. The reported flow values below 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.

Table 1: Summarized information needed for the Pineywoods 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.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Jasper	16
	Sparta	18,401
	Weches	3,200
	Queen City	8,030
	Reklaw	3,025
	Carrizo	18,455
	Wilcox (upper)	2,464
	Wilcox (middle)	409
	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	Jasper	0
	Sparta	8,509
	Weches	546
	Queen City	601
	Reklaw	351
	Carrizo	4,056
	Wilcox (upper)	2,737
	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	Jasper	0
	Sparta	1,488
	Weches	139
	Queen City	383
	Reklaw	685
	Carrizo	11,677
	Wilcox (upper)	12,574
	Wilcox (middle)	9,381
	Wilcox (lower)	1,398
Estimated annual volume of flow out of the district within each aquifer in the district	Jasper	16
	Sparta	357
	Weches	87
	Queen City	317
	Reklaw	530
	Carrizo	2,282
	Wilcox (upper)	2,191
	Wilcox (middle)	1,397
	Wilcox (lower)	271
Estimated net annual volume of flow between each aquifer in the district	Burkeville into Jasper	0
	Sparta into Weches	9,482
	Weches into Queen City	9,957
	Queen City into Reklaw	11,307
	Reklaw into Carrizo	16,402
	Carrizo into Wilcox (upper)	1,891
	Wilcox (middle) into Wilcox (upper)	1,936
	Wilcox (lower) into Wilcox (middle)	2,227

REFERENCES:

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

Fryar, D., Senger, R., Deeds, N., Pickens, J., Jones, T., Whallon, A.J., Dean, K.E., 2003, Groundwater availability model for the northern Carrizo-Wilcox aquifer: Contract report to the Texas Water Development Board, 529 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.

Kasmarek, M.C., Robinson, J.L., 2004, Hydrogeology and simulation of groundwater flow and land-surface subsidence in the northern part of the Gulf Coast Aquifer system, Texas: Scientific Investigations Report 2004-5102, U.S. Geological Survey, 111 p.

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.

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 July 7, 2008.