GAM Run 08-62

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 Evergreen Underground Water Conservation District for its groundwater management plan. The groundwater management plan for the Evergreen Underground Water Conservation District is due for approval by the executive administrator of the Texas Water Development Board before May 3, 2009.

This report discusses the methods, assumptions, and results from model runs using the groundwater availability models for the southern parts of the Carrizo-Wilcox, Queen City, and Sparta aquifers, the central part of the Gulf Coast Aquifer, and the San Antonio segment of the Edwards (Balcones Fault Zone) Aquifer. Table 1 summarizes the groundwater availability model data required by statute for Evergreen Underground Water Conservation District's groundwater management plan. Figure 1 shows the area of each model from which the values in Table 1 were extracted.

The Yegua Jackson Aquifer also underlies the Evergreen Underground Water Conservation District; however, a groundwater availability model for this minor aquifer has not been completed at this time. If the 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 southern parts of the Carrizo-Wilcox, Queen City, and Sparta aquifers, the central part of the Gulf Coast Aquifer, and 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).

PARAMETERS AND ASSUMPTIONS:

Groundwater availability model for the southern parts of the Carrizo-Wilcox, Queen City, and Sparta aquifers

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

- This 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 root mean squared error (a measure of the difference between simulated and actual water levels during model calibration) in the groundwater availability model is 23 feet for the Sparta Aquifer, 18 feet for the Queen City Aquifer, and 33 feet for the Carrizo Aquifer for the calibration period (1980 to 1989) and 19, 22, and 48 feet for the same aquifers, respectively, in the verification period (1990 to 1999) (Kelley others, 2004). These root mean squared errors are between seven and ten percent of the range of measured water levels (Kelley others, 2004)

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

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. This mean absolute error is 4.6 percent of the hydraulic head drop across the model area (Chowdhury and others, 2004).

- The transient portion of the model has a total of 85 stress periods. Of these, monthly stress periods were assigned for 1987 through 1989 and 1996 through 1998. Monthly stress periods were assigned to better simulate possible effects of drought on the groundwater flow system. The remainder of the stress periods are annual.

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

Groundwater availability model for the San Antonio segment of the Edwards (Balcones Fault Zone) Aquifer

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

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

- The root mean square error in the groundwater availability 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).

- 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 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. Since this model is a single-layer, flow between aquifers was not included.

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.

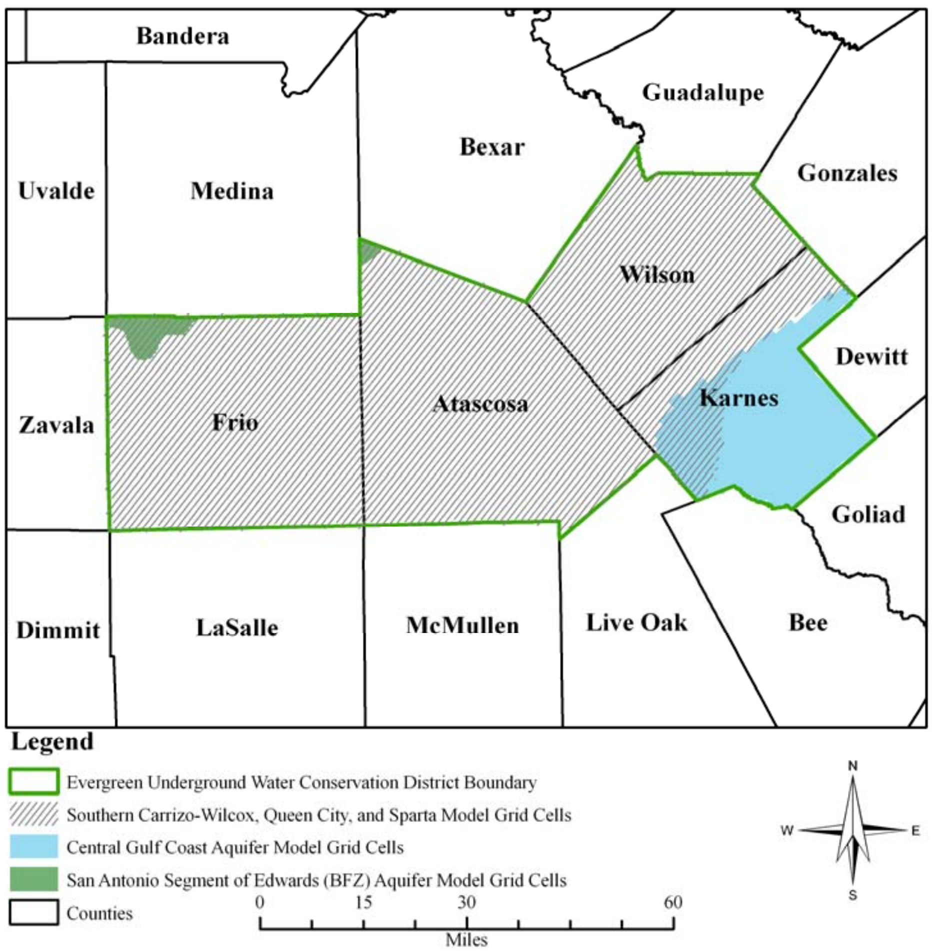
Table 1: Summarized information needed for Evergreen Underground Water Conservation District's groundwater management plan. All values are reported in acre-feet per year. All numbers are rounded to the nearest 1 acre-foot.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Chicot Aquifer	0
	Evangeline Aquifer	0
	Burkeville Confining Unit	3
	Jasper Aquifer	381
	Sparta Aquifer	9,286
	Weches Confining Unit	1,643
	Queen City Aquifer	27,417
	Reklaw Confining Unit	2,162
	Carrizo Aquifer	19,361
	Wilcox (upper) Aquifer	0
	Wilcox (middle) Aquifer	1,594
	Wilcox (lower) Aquifer	70
	Edwards (Balcones Fault Zone) Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Chicot Aquifer	0
	Evangeline Aquifer	0
	Burkeville Confining Unit	184
	Jasper Aquifer	1,395
	Sparta Aquifer	4,912
	Weches Confining Unit	825
	Queen City Aquifer	7,095
	Reklaw Confining Unit	176
	Carrizo Aquifer	915
	Wilcox (upper) Aquifer	0
	Wilcox (middle) Aquifer	2,639
	Wilcox (lower) Aquifer	70
	Edwards (Balcones Fault Zone) Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Chicot Aquifer	0
	Evangeline Aquifer	0
	Burkeville Confining Unit	18
	Jasper Aquifer	535
	Sparta Aquifer	438
	Weches Confining Unit	60
	Queen City Aquifer	736
	Reklaw Confining Unit	298
	Carrizo Aquifer	51,861
	Wilcox (upper) Aquifer	1,489
	Wilcox (middle) Aquifer	5,244
	Wilcox (lower) Aquifer	13,865
	Edwards (Balcones Fault Zone) Aquifer	274,826[a]

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual volume of flow out of the district within each aquifer in the district	Chicot Aquifer	0
	Evangeline Aquifer	0
	Burkeville Confining Unit	23
	Jasper Aquifer	647
	Sparta Aquifer	2,380
	Weches Confining Unit	237
	Queen City Aquifer	2,911
	Reklaw Confining Unit	393
	Carrizo Aquifer	10,372
	Wilcox (upper) Aquifer	283
	Wilcox (middle) Aquifer	1,409
	Wilcox (lower) Aquifer	5,871
	Edwards (Balcones Fault Zone) Aquifer	274,832[a]
Estimated net annual volume of flow between each aquifer in the district	Burkeville Confining Unit into the Jasper Aquifer	44
	Sparta Aquifer into the Weches Confining Unit	6,081
	Weches Confining Unit into the Queen City Aquifer	8,714
	Queen City Aquifer into the Reklaw Confining Unit	11,935
	Reklaw Confining Unit into the Carrizo Aquifer	18,691
	Wilcox (upper) Aquifer into the Carrizo Aquifer	2,394
	Wilcox (middle) Aquifer into the Wilcox (upper) Aquifer	6,392
	Wilcox (lower) Aquifer into the Wilcox (middle) Aquifer	3,509

[a]Lateral flow into and out of the district in the Edwards (Balcones Fault Zone) Aquifer may be inflated due to simulated conduits passing back and forth across district boundaries.

Figure 1: Area of each groundwater availability model 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:

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

Deeds, N., Kelley, V.A., Fryar, D., Jones, T., Whallon, A.J., and Dean, K.E., 2003, Groundwater availability model for the Southern Carrizo-Wilcox Aquifer: Contract report to the Texas Water Development Board, 452 p.

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

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.

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, unpublished report, variously paginated.

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.