GAM Run 08-31

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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 Brazoria County Groundwater Conservation District for its groundwater management plan. The groundwater management plan for Brazoria County Groundwater Conservation District is due for approval by the executive administrator of the Texas Water Development Board before November 8, 2008.

This report discusses the method, assumptions, and results from model runs using the groundwater availability model for the northern part of the Texas Gulf Coast Aquifer. Table 1 summarizes the groundwater availability model data required by statute for Brazoria County Groundwater Conservation District's groundwater management plan.

METHODS:

We ran the groundwater availability model for the northern part of the Texas 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 Texas Gulf Coast Aquifer located within the district.

The groundwater availability model for the northern part of the Gulf Coast Aquifer uses MODFLOW's General Head Boundary Package to simulate groundwater recharge and groundwater-surface water interaction. The general head boundary was assigned over the outcrop areas of the Chicot, Evangeline, and the Jasper aquifers and the Burkeville Confining System. To estimate groundwater recharge and groundwater-surface water interaction separately, we zoned the surface water courses separate from the remainder of the outcrop areas in ArcGIS. We loaded these zones into Processing Modflow for Windows (Chiang and Kinzelbach, 1998) and ran the water budget tool to estimate groundwater flow in each zone.

PARAMETERS AND ASSUMPTIONS:

- We used version 2.01 of the groundwater availability model for the northern part of the Texas Gulf Coast Aquifer. For detailed discussion on assumptions and limitations of the groundwater availability model for the northern part of the Gulf Coast aquifer, please refer to Kasmarek and Robinson (2004) and Kasmarek and others (2005).

- The groundwater availability model for the northern parts of the Texas Gulf Coast Aquifer includes four layers representing:

    1. the Chicot Aquifer (Layer 1),
    2. the Evangeline Aquifer (Layer 2),
    3. the Burkeville Confining System (Layer 3), and
    4. the Jasper Aquifer (Layer 4).

- We used Processing Modflow for Windows (Chiang and Kinzelbach, 1998) version 5.3 as the interface to process model output results.

- Quality of model calibration can be estimated using root mean square error. The root mean square error evaluates differences between measured and simulated water levels in the wells considered for calibration. The root mean square error is 31 feet for the Chicot aquifer, 45 feet for the Evangeline aquifer, and 38 feet for the Jasper aquifer for the calibration year 2000.

- We assumed that in the outcrop where surface water courses intersect the general head boundary, the general head boundary simulates groundwater-surface water interaction. In the rest of the outcrop, groundwater recharge occurs into the aquifer depending on the water level elevation head and hydraulic conductance values assigned in the general head boundary model cells.

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 wetlands.

- 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.

Although independent groundwater recharge estimates from precipitation are not available at the present time from other sources, Sandeen and Wesselman (1973) estimated the amount of water that may flow out of the Chicot and Evangeline aquifers into adjacent counties. They suggested that about 37,000 acre-feet per year (33 million gallons per day) of groundwater may flow out of the Chicot and Evangeline aquifers when 1,120 acre-feet per year (1 million gallons per day) of water was being pumped causing development of a hydraulic gradient of 21 feet per mile.

Table 1: Summarized information needed for Brazoria 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.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district*	Chicot Aquifer	16,182
	Evangeline Aquifer	0
	Burkeville Confining System	0
	Jasper Aquifer	0
Estimated annual volume of water that discharges from the aquifer to any surface water body including lakes, streams, and rivers	Chicot Aquifer	0
	Evangeline Aquifer	0
	Burkeville Confining System	0
	Jasper Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Chicot Aquifer	45,567
	Evangeline Aquifer	34,235
	Burkeville Confining System	0
	Jasper Aquifer	0
Estimated annual volume of flow out of the district within each aquifer in the district	Chicot Aquifer	39,586
	Evangeline Aquifer	35,598
	Burkeville Confining System	0
	Jasper Aquifer	0
Estimated net annual volume of flow between each aquifer in the district	Evangeline to Chicot Aquifer	3,959
	Evangeline to Burkeville Confining System	0
	Burkeville Confining System to the Jasper Aquifer	0

*Note that groundwater recharge in the groundwater availability model for the northern parts of the Texas Gulf Coast Aquifer was estimated using a General Head Boundary Package.

REFERENCES:

Chiang, W.H. and Kinzelbach, W., 1998, Processing Modflow: A simulation system for modeling groundwater flow and pollution, Hamburgh, Zurich, variously paginated.

Kasmarek, M.C., and 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: U.S. Geological Survey Scientific Investigations Report 2004-5102, 111p.

Kasmarek, M.C., Reece, B.D., and Houston, N.A., 2005, Evaluation of groundwater flow and land-surface subsidence caused by hypothetical withdrawals in the northern part of the northern part of the Gulf Coast aquifer system, Texas: U.S. Geological Survey Scientific Investigations Report 2005-5024, 70p.

Sandeen, W.M, and Wesselman, J.B., 1973, Groundwater resources of Brazoria County, Texas, Texas Water Development Board Report 163, 40p.

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