GAM Run 08-58

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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 (GAM) 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 Lower Trinity Groundwater Conservation District for its groundwater management plan. The groundwater management plan for Lower Trinity Groundwater Conservation District is due for approval by the executive administrator of the Texas Water Development Board before November 7, 2009.

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 Lower Trinity Groundwater Conservation District's groundwater management plan.

The Yegua-Jackson Aquifer also occurs in the northern part of Polk County; however, a groundwater availability model for this minor aquifer has not been completed at this time. If the district would like information on 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 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 parts 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),
    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.

Although there are no independent sources of information on groundwater recharge from precipitation, Tarver (1968) reported that about 38,000 acre-feet of groundwater flows through the Catahoula Sandstone, Evangeline, and the Chicot aquifers in Polk County. In order to maintain this level of groundwater flow, he suggested that precipitation infiltration should be about 2 inches of rainfall. This amount of rainfall represents about 4.2 percent of the total annual average rainfall over the 154,000 acre outcrop in Polk County (Tarver, 1968).

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.

Table 1: Summarized information needed for Lower Trinity 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	9,329
	Evangeline Aquifer	6,437
	Burkeville Confining System	8
	Jasper Aquifer	3,761
Estimated annual volume of water that discharges from the aquifer to any surface water body including lakes, streams, and rivers	Chicot Aquifer	1,043
	Evangeline Aquifer	3,630
	Burkeville Confining System	2
	Jasper Aquifer	852
Estimated annual volume of flow into the district within each aquifer in the district	Chicot Aquifer	58
	Evangeline Aquifer	3,436
	Burkeville Confining System	58
	Jasper Aquifer	9,842
Estimated annual volume of flow out of the district within each aquifer in the district	Chicot Aquifer	151
	Evangeline Aquifer	9,316
	Burkeville Confining System	151
	Jasper Aquifer	12,210
Estimated net annual volume of flow between each aquifer in the district	Chicot to Evangeline Aquifer	5,854
	Evangeline to Burkeville Confining System	680
	Burkeville Confining System to the Jasper Aquifer	1,809

*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.

Tarver, G.R., 1968, Groundwater resources of Polk County, Texas Water Development Board Report 82, 35 p.

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