GAM Run 10-034

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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 North Texas Groundwater Conservation District for its groundwater management plan based on the district boundaries. The groundwater management plan for North Texas Groundwater Conservation District is due for approval by the Executive Administrator of the Texas Water Development Board before December 31, 2012. The North Texas Groundwater Conservation District falls within two existing aquifer systems−the Trinity and the Woodbine aquifers.

This report discusses the method, assumptions, and results from model runs using the groundwater availability model for the northern section of the Trinity Aquifer and Woodbine Aquifer. Tables 1 and 2 summarize the groundwater availability model data required by statute for North Texas Groundwater Conservation District's groundwater management plan. Figure 1 and 2 shows the areas of the model from which the values in Table 1 and Table 2 were extracted respectively. If after review of the figures, North Texas Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the Texas Water Development Board immediately.

METHODS:

The transient portion of the calibrated groundwater availability model for the northern section of the Trinity Aquifer, which includes the Woodbine Aquifer, was used for this analysis. The results of the run were processed to (1) extract water budgets for each year of the 1980 through 1999 calibration period and to(2) average 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 Trinity and Woodbine aquifers located within the district.

PARAMETERS AND ASSUMPTIONS:

- We used version 1.01 of the groundwater availability model for the northern section of the Trinity Aquifer. See Bené and others (2004) for assumptions and limitations of the model.

- The northern section of the Trinity Aquifer model includes seven layers representing:
  1. the Woodbine Aquifer (Layer 1),

2. the Washita and Fredericksburg Confining Unit (Layer 2),
3. the Paluxy Aquifer (Layer 3),
4. the Glen Rose Confining Unit (Layer 4),
5. the Hensell Aquifer (Layer 5),
6. the Pearsall/Cow Creek/Hammett/Sligo Confining Unit (Layer 6), and
7. the Hosston Aquifer (Layer 7).

It should be noted that Layer 1 represent the Woodbine Aquifer and layers 3 to 7 represent the Trinity Aquifer.

- The mean absolute error (a measure of the difference between simulated and actual water levels during model calibration) for the four main aquifers in the model (Woodbine, Paluxy, Hensell, and Hosston) for the calibration and verification time periods (1980 through 1999) ranged from approximately 37 to 75 feet. The root mean squared error was less than ten percent of the maximum change in water levels across the model (Bené and others, 2004).

- As described in Bené and others (2004), the evapotranspiration package used in the groundwater availability model represents evaporation, transpiration, springs, seeps, and discharge to streams not modeled by the streamflow-routing package,. We used both the streamflow-routing package and the evapotranspiration package, as applicable, to extract information needed for discharges to surface water in this analysis.

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

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability models. Selected components were extracted from the groundwater budget for the aquifers located within the district and averaged over the duration of the calibration and verification portion of each model run (1980 through 1999) for the Trinity Aquifer and Woodbine Aquifer located in the district. The components of the modified budget shown in Tables 1 and 2 include:

- Precipitation recharge—This is the 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 and Table 2. 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 (see Figure 1 and Figure 2).

Table 1: The Trinity Aquifer's summarized information needed for the North Texas 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. Reported flow estimates include both fresh and brackish waters present in the aquifers.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Trinity Aquifer	11,846
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Trinity Aquifer	2,640[1]
Estimated annual volume of flow into the district within each aquifer in the district	Trinity Aquifer	19,824
Estimated annual volume of flow out of the district within each aquifer in the district	Trinity Aquifer	15,555[2]
Estimated net annual volume of flow between each aquifer in the district	Washita Fredericksburg Confining Unit into Trinity Aquifer	761

Note: 1) The evapotranspiration package of the groundwater availability model includes evaporation, transpiration, springs, seeps, and discharge to streams not modeled by the streamflow-routing package (Bené and others, 2004). The surface water outflow estimate in Table 1 includes the results from the evapotranspiration package for model grid cells containing springs and streams not modeled by the streamflow-routing package.
2) The River and Stream Package represent the flow between the aquifer and the Red River along the district's northern boundary. The amount of flow which is leaving the district boundary and also discharging to the Red River is 1,103 acre-feet per year.. To avoid double accounting, this volume has been included with the annual volume of flow leaving the district..

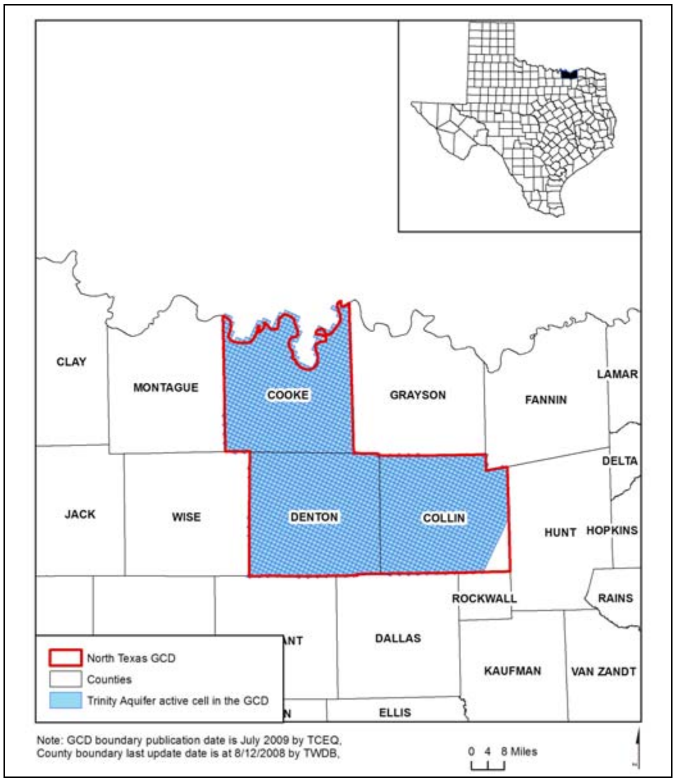

Figure 1: Area of the groundwater availability model for the northern portion of the Trinity Aquifer from which the information in Table 1 was extracted (the aquifer extent within the North Texas Groundwater Conservation District boundary).

Table 2: The Woodbine Aquifer's summarized information needed for the North Texas 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. Reported flow estimates include both fresh and brackish waters present in the aquifers.

Management Plan requirement	Aquifer	Results
Estimated annual amount of recharge from precipitation to the district	Woodbine Aquifer	43,743
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Woodbine Aquifer	13,191[1]
Estimated annual volume of flow into the district within each aquifer in the district	Woodbine Aquifer	1,805
Estimated annual volume of flow out of the district within each aquifer in the district	Woodbine Aquifer	1,777
Estimated net annual volume of flow between each aquifer in the district	Inflow from the overlying younger units	109
	Flow from underlying Washita and Fredericksburg Confining Unit to the Woodbine Aquifer	85

Note 1) The evapotranspiration package of the groundwater availability model includes evaporation, transpiration, springs, seeps, and discharge to streams not modeled by the streamflow-routing package (Bené and others, 2004). The surface water outflow estimate in Table 2 includes the results from the evapotranspiration package for model grid cells containing springs and streams not modeled by the streamflow-routing package.

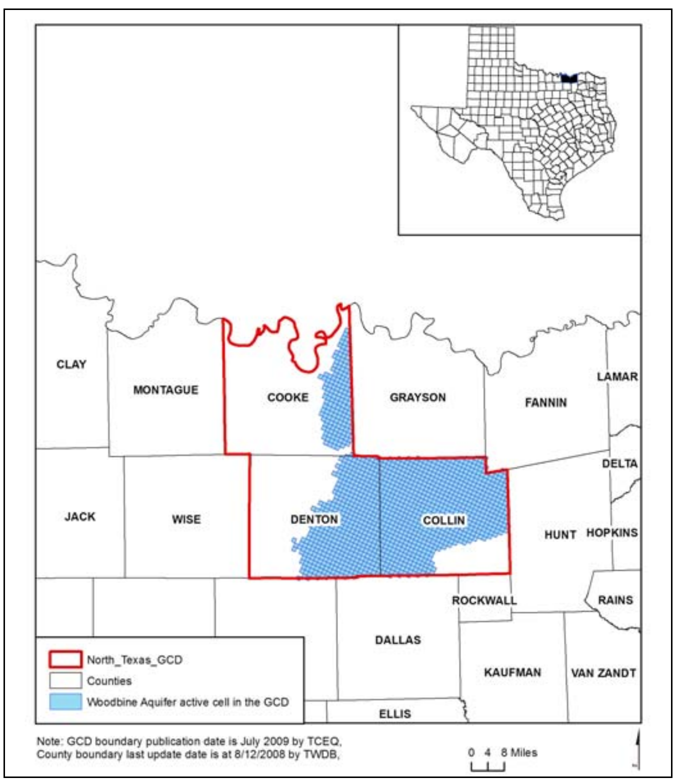

Figure 2: Area of the groundwater availability model for the Woodbine aquifer from which the information in Table 2 was extracted.

REFERENCES:

Bené, J., Harden, B., O'Rourke, D., Donnelly, A., and Yelderman, J., 2004, Northern Trinity/Woodbine Groundwater Availability Model: contract report to the Texas Water Development Board by R.W. Harden and Associates, 391 p., http://www.twdb.state.tx.us/gam/trnt_n/trnt_n.htm.

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

LBG-Guyton Associates, 2003, Brackish Groundwater Manual for Texas Regional Water Planning Groups: contract report to the Texas Water Development Board, 188 p., http://www.twdb.state.tx.us/RWPG/rpgm_rpts/2001483395.pdf.

Aschenbach, E., 2009, GAM Run 09-22, 6 p.
http://www.twdb.state.tx.us/gam/GAMruns/GR09-22.pdf