GAM Run 13-007: Lone Star Groundwater Conservation District Management Plan

by William Kohlrenken
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-8279
February 25, 2013

Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by William Kohlrenken under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on February 25, 2013.

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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 (TWDB) 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:

- the annual amount of recharge from precipitation to the groundwater resources within the district, if any;
- 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
- the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

This report (Part 2 of a two-part package of information from the TWDB to Lone Star Groundwater Conservation District) fulfills the requirements noted above. Part 1 of the 2-part package is the Historical Water Use/State Water Plan data report. The District should have received, or will receive, this data report from the Groundwater Technical Assistance Section. Questions about the data report can be directed to Mr. Stephen Allen, Stephen.Allen@twdb.texas.gov, (512)463-7317. The groundwater management plan for the Lone Star Groundwater Conservation District should be adopted by the district on or before December 25, 2013 and submitted to the executive administrator of the TWDB on or before January 24, 2014. The current management plan for the Lone Star Groundwater Conservation District expires on March 25, 2014.

This report discusses the method, assumptions, and results from model runs using the groundwater availability models for the northern portion of the Gulf Coast Aquifer as well as the Yegua-Jackson Aquifer (to determine groundwater flows from the Catahoula Formation into underlying formations). Table 1 summarizes the groundwater availability model data required by the statute, and figure 1 shows the area of the model from which the values in the table were extracted. This model run replaces the results of GAM Run 08-36 (Chowdhury, 2008). GAM Run 13-007 meets current standards set after the release of GAM Run 08-36 and it is based on the most current groundwater district boundaries and water budget extraction methods. If after review of the figure, Lone Star Groundwater Conservation District determines that the district boundary used in the assessment does not reflect current conditions, please notify the TWDB immediately.

METHODS:

The groundwater availability model for the northern portion of the Gulf Coast Aquifer was run for this analysis. Water budgets for 1980 through 1999 were extracted using ZONEBUDGET Version 3.01 (Harbaugh, 2009) and the average 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 aquifers located within the district are summarized in this report.

The groundwater availability model for the northern portion 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 aquifer. 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 then calculated the water budget of these zones using ZONEBUDGET Version 3.01 (Harbaugh, 2009). This approach is different than those used in the past in that we are using a different program to extract the data from the model. We are also using two separate analyses to perform the budget calculations. In one analysis we calculate aquifer flows. In the second analysis we calculate discharge to streams and recharge from the general head boundary flows.

PARAMETERS AND ASSUMPTIONS:

Gulf Coast Aquifer (northern portion)

- We used version 2.01 of the groundwater availability model for the northern portion of the Gulf Coast Aquifer for this analysis. See Kasmarek and Robinson (2004) for assumptions and limitations of the model.
- The model has four layers which represent the Chicot Aquifer in layer one, the Evangeline Aquifer in layer two, the Burkeville confining unit in layer 3, and the Jasper Aquifer and parts of the Catahoula Formation in direct hydrologic communication with the Jasper Aquifer in layer 4.
- Water budgets for the district were determined for the Gulf Coast Aquifer (Layers 1 through 4).
- The model was run with MODFLOW-96 (Harbaugh and MacDonald, 1996).
- We also used version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer, run with MODFLOW-2000 (Harbaugh and others, 2000), to investigate groundwater flows from the Catahoula Formation into underlying formations. See Deeds and others (2010) for assumptions and limitations of the groundwater availability model.

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the model results for the aquifers located within the district and averaged over the period 1980 through 1999 in the district. The components of the modified budget shown in table 1 include:

- Precipitation recharge—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—the total water discharging from the aquifer (outflow) to surface water features such as streams, reservoirs, and springs.
- Flow into and out of district—the lateral flow within the aquifer between the district and adjacent counties.
- Flow between aquifers—the flow 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.

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 (see figure 1).

TABLE 1: SUMMARIZED INFORMATION FOR THE NORTHERN PORTION OF THE GULF COAST AQUIFER THAT IS NEEDED FOR LONE STAR GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND 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	Gulf Coast Aquifer	30,913
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Gulf Coast Aquifer	882
Estimated annual volume of flow into the district within each aquifer in the district	Gulf Coast Aquifer	19,159
Estimated annual volume of flow out of the district within each aquifer in the district	Gulf Coast Aquifer	61,787
Estimated net annual volume of flow between each aquifer in the district	From the Catahoula Formation portion of the Gulf Coast into underlying units.	599[1]

[1] Calculated using the groundwater availability model for the Yegua-Jackson Aqufier.

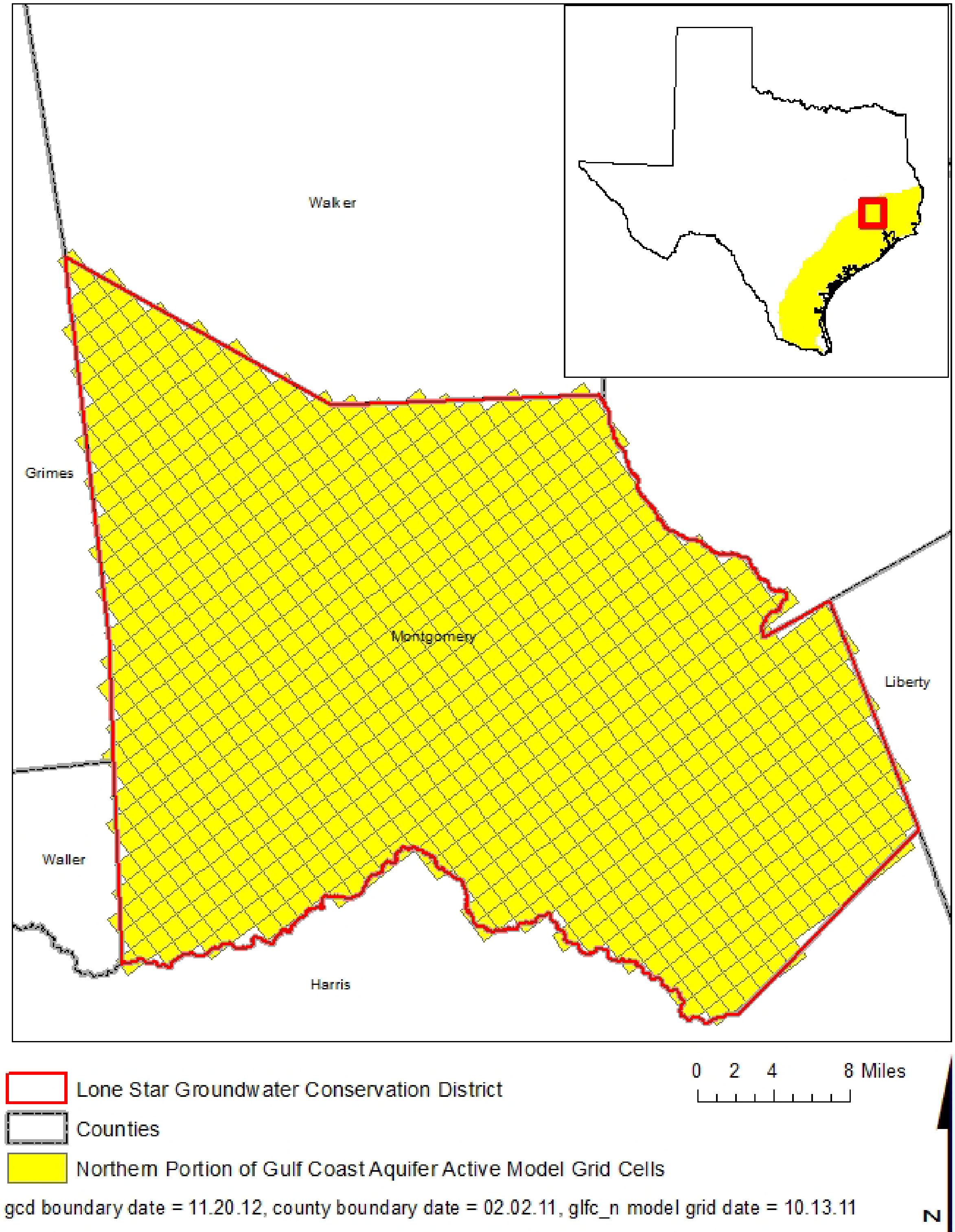

FIGURE 1: AREA OF ACTIVE MODEL CELLS FOR THE NORTHERN PORTION OF THE GULF COAST AQUIFER IN LONE STAR GROUNDWATER CONSERVATION DISTRICT FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

LIMITATIONS:

The groundwater model(s) used in completing this analysis is the best available scientific tool that can be used to meet the stated objective(s). To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

> "Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results."

A key aspect of using the groundwater model to evaluate historic groundwater flow conditions includes the assumptions about the location in the aquifer where historic pumping was placed. Understanding the amount and location of historic pumping is as important as evaluating the volume of groundwater flow into and out of the district, between aquifers within the district (as applicable), interactions with surface water (as applicable), recharge to the aquifer system (as applicable), and other metrics that describe the impacts of that pumping. In addition, assumptions regarding precipitation, recharge, and streamflow are specific to a particular historic time period.

Because the application of the groundwater model was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations relating to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor groundwater pumping and overall conditions of the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

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