GAM Run 12-016: Corpus Christi Aquifer Storage and Recovery Conservation District Management Plan

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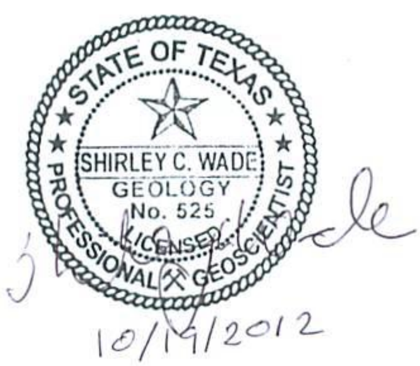
October 19, 2012



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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 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.

The purpose of this report is to provide Part 2 of a two-part package of information to Corpus Christi Aquifer Storage and Recovery Conservation District for its groundwater management plan. The groundwater management plan for the Corpus Christi Aquifer Storage and Recovery Conservation District Conservation District is due for approval by the Executive Administrator of the TWDB before October 16, 2013.

This report discusses the method, assumptions, and results from GAM run 12-016 using the alternate model developed for Groundwater Management Area 16 (Hutchison and others, 2011). 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 tables were extracted. This model run replaces the results of GAM Run 08-03 (Tu, 2008). GAM Run 12-016 meets current standards set after the release of GAM Run 08-03 and is based on the alternate model developed for Groundwater Management Area 16. Differences in the results of the two model runs are mainly due to differences in the assumed areas of the Gulf Coast Aquifer in the district. If after review of Figure 1, the Corpus Christi Aquifer Storage and Recovery 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 groundwater model for the Gulf Coast Aquifer in Groundwater Management Area 16 (Hutchison and others, 2011) was used for this analysis. Water budgets for selected years—1980 though 1999—of the transient model period were extracted using ZONEBUDGET Version 3.01 (Harbaugh, 2009) and the average annual water budget values for recharge, surface water outflow, lateral inflow to the district, lateral outflow from the district, and vertical flow for the portions of the aquifers located within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Gulf Coast Aquifer

- The alternative model for Groundwater Management Area 16 developed by Hutchison and others (2011) was used for this management plan data analysis. The model was calibrated based on groundwater elevation data from 1963 to 1999; however, data were extracted only for the period from 1980 to 1999 to be consistent with the analysis completed for previous management plan.
- The model has six layers representing the following hydrogeologic units—from top to bottom: Chicot Aquifer (layer 1), Evangeline Aquifer (layer 2), Burkeville Confining Unit (layer 3), Jasper Aquifer (layer 4), Yegua-Jackson

Aquifer (layer 5), and the combined Queen-City, Sparta, and Carrizo-Wilcox aquifers (layer 6). However, the bottom two layers were not simulated in the Corpus Christi Aquifer Storage and Recovery Conservation District.

- The standard deviation of groundwater elevation residuals (a measure of the difference between simulated and actual water levels during model calibration) for the entire model domain is 41 feet and the average residual is 15 feet.
- As reported by Kalaswad and Arroyo (2006), groundwater in the Gulf Coast Aquifer ranges from fresh, brackish, to saline (1,000 to 10,000 milligrams per liter of total dissolved solids). The reported flow values in this report include all categories of water quality: fresh (less than 1,000 milligrams per liter total dissolved solids), brackish (1,000 to 10,000 milligrams per liter total dissolved solids), and saline (greater than 10,000 milligrams per liter total dissolved solids) groundwater.
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected components were extracted from the groundwater budget for the Gulf Coast Aquifer and averaged over the 1980 to 1999 portion of the model runs in the district, as shown in Table 1. The components of the modified budget shown in Table 1 include:

- Precipitation recharge—The spatially-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 drains (springs).
- Flow into and out of district—The lateral flow within the aquifer between the district and adjacent counties and other areas.
- 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).

Comparison of the alternative model for Groundwater Management Area 16 and the groundwater availability model for the central portion of the Gulf Coast Aquifer

The Corpus Christi Aquifer Storage and Recovery Conservation District is included in the model areas of both the alternative model for Groundwater Management Area 16 (Hutchison and others, 2011) and the groundwater availability model for the central portion of the Gulf Coast Aquifer (Chowdhury and others, 2004). We ran both models for this analysis and compared the resulting water budgets.

The estimated annual amount of recharge from precipitation to the district from the groundwater availability model for the central portion of the Gulf Coast Aquifer is 7 acre-feet per year and the estimated annual amount from the Gulf Coast Aquifer layers of the alternative model for Groundwater Management Area 16 is 84 acre-feet per year.

The estimated annual volume of water that discharges from springs and any surface water body within the district from the groundwater availability model for the central portion of the Gulf Coast Aquifer is 417 acre-feet per year and the estimated annual amount from the Gulf Coast Aquifer layers of the alternative model for Groundwater Management Area 16 is 255 acre-feet per year. For both models this flow includes discharge to rivers or streams and discharge to the bay represented by general head boundaries.

The estimated annual volume of flow into the district for the groundwater availability model for the central portion of the Gulf Coast Aquifer is 415 acre-feet per year and the estimated annual amount for the Gulf Coast Aquifer layers of the alternative model for Groundwater Management Area 16 is 207 acre-feet per year.

The estimated annual volume of flow out of the district for the groundwater availability model for the central portion of the Gulf Coast Aquifer is 367 acre-feet per year and the estimated annual amount for the Gulf Coast Aquifer layers of the alternative model for Groundwater Management Area 16 is 210 acre-feet per year. The flows into and out of the district are a sum of flows into and out of Kenedy County Groundwater Conservation District and into and out of portions of the aquifer under the bay.

The estimated net annual volume of flow between each aquifer in the district for the groundwater availability model for the central portion of the Gulf Coast Aquifer is 397 acre-feet per year and the estimated annual amount for the Gulf Coast Aquifer layers of the alternative model for Groundwater Management Area 16 is 147 acre-feet per year. These values are represented by lateral flows from areas within the Corpus Christi Aquifer Storage and Recovery Conservation District representing brackish parts of the Gulf Coast Aquifer.

While both models cover the entire Corpus Christi Aquifer Storage and Recovery Conservation District and provide all of the information required for the district's management plan, the general head boundary conditions representing the bay are more realistic in the alternative model for Groundwater Management Area 16. Consequently, we used the alternative model for Groundwater Management Area 16 to meet the management plan requirements (see Table 1 for a summary).

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.

TABLE 1: SUMMARIZED INFORMATION FOR THE GULF COAST AQUIFER THAT IS NEEDED FOR CORPUS CHRISTI AQUIFER STORAGE AND RECOVERY 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	84
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	255
Estimated annual volume of flow into the district within each aquifer in the district	Gulf Coast Aquifer	207
Estimated annual volume of flow out of the district within each aquifer in the district	Gulf Coast Aquifer	210
Estimated net annual volume of flow between each aquifer in the district	From brackish units to the Gulf Coast Aquifer	147

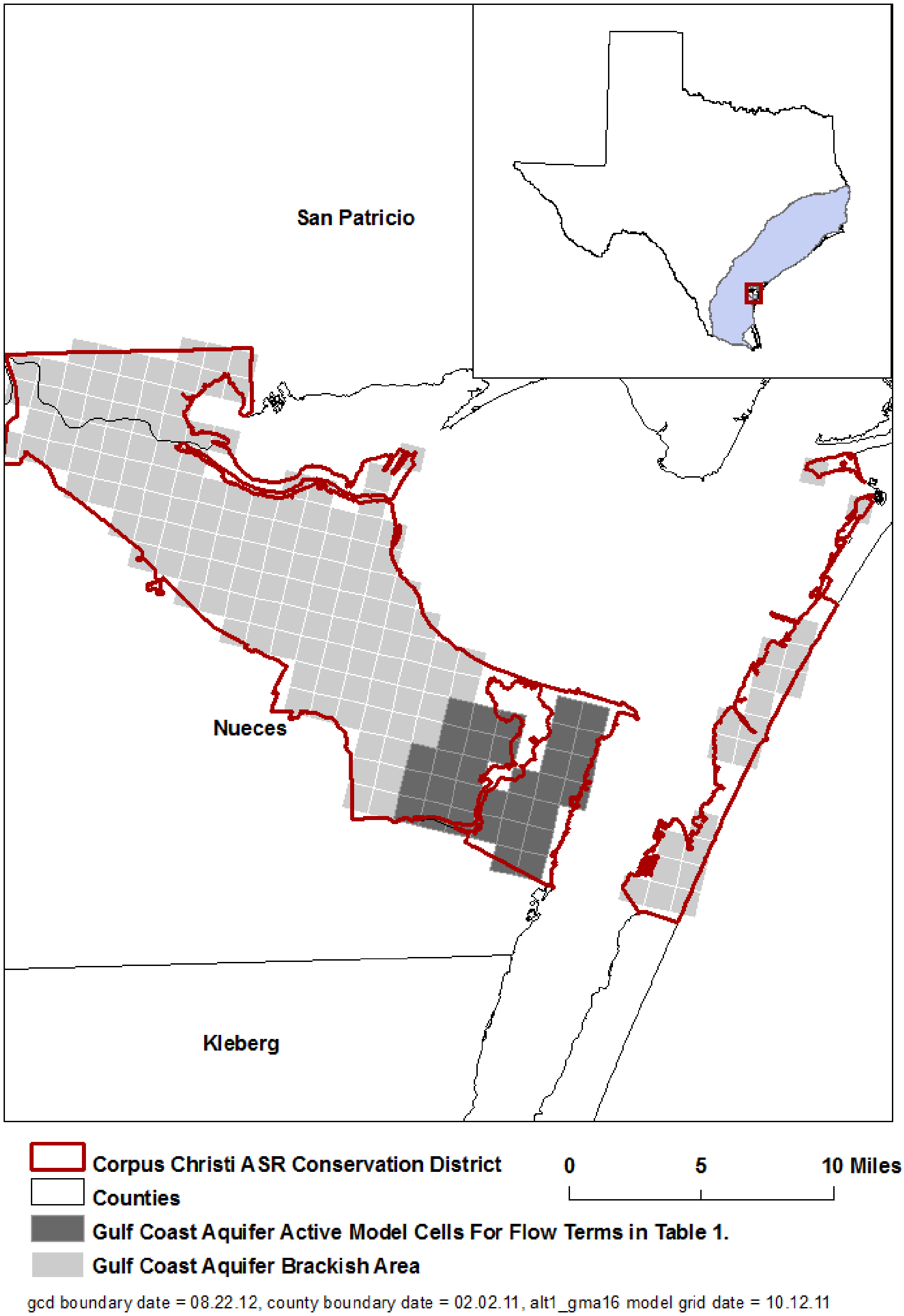

FIGURE 1: AREA OF THE GROUNDWATER MODEL FOR GROUNDWATER MANAGEMENT AREA 16 FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

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