# GAM Run 12-013: Brush Country Groundwater Conservation District Management Plan

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July 20, 2012

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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.

The purpose of this report is to provide Part 2 of a two-part package of information to Brush Country Groundwater Conservation District for its groundwater management plan. The groundwater management plan for the Brush Country Groundwater Conservation District is due for approval by the executive administrator of the TWDB before November 3, 2012.

This report discusses the method, assumptions, and results from model runs using the groundwater availability model for the Yegua Jackson Aquifer and the model developed for Groundwater Management Area 16 (Hutchison and others, 2011) which was used to estimate the modeled available groundwater for Groundwater

Management Area 16. This model run is an alternative for the Gulf Coast Aquifer results of GAM Run 10-005, which was based on the groundwater availability models for the southern and central portions of the Gulf Coast Aquifer. The Brush Country Groundwater Conservation District can use either GAM Run 10-005 or GAM Run 12-013 for their groundwater management plan. Tables 1 and 2 summarize the groundwater model data required by the statute and figures 1 and 2 show the area of the model from which the values in the tables were extracted. If after review of the figures, Brush Country Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB immediately.

## *METHODS:*

The alternative numerical groundwater flow model for the Gulf Coast Aquifer (1963 through 1999; Hutchison and others, 2011) in Groundwater Management Area 16 and the groundwater availability model for the Yegua Jackson Aquifer (1980 through 1997: Deeds and others, 2010) were run for this analysis. Water budgets for each year 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, 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.

## *PARAMETERS AND ASSUMPTIONS:*

### *Gulf Coast Aquifer*

- The area covered by the alternative model developed by Hutchison and others (2011) includes all of Groundwater Management Area 16 with Brush Country Groundwater Conservation District approximately located at the center of the model domain. The models for the central portion of the Gulf Coast Aquifer System (Chowdhury and others, 2004) and the Gulf Coast Aquifer in the Lower Rio Grande Valley (Chowdhury and Mace, 2007) only cover parts of the Brush Country Groundwater Conservation District. The model was calibrated based on groundwater elevation data from 1963 to 1999.

- 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 Queen-City/Sparta/Carrizo-Wilcox aquifers (layer 6).

- 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 absolute residual mean is 15 feet.
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

### *Yegua Jackson Aquifer*

- Version 1.01 of the groundwater availability model for the Yegua Jackson Aquifer was used for this analysis. See Deeds and others (2010) for assumptions and limitations of the groundwater availability model.
- This groundwater availability model includes five layers, which generally correspond to (from top to bottom):

    1. the outcrop section of the Yegua Jackson Aquifer and younger overlying units,
    2. the upper portion of the Jackson Group,
    3. the lower portion of the Jackson Group,
    4. the upper portion of the Yegua Group, and
    5. the lower portion of the Yegua Group.

- An overall water budget for the district was determined for the Yegua Jackson Aquifer (Layer 1 through Layer 5 collectively for the portions that represent the Yegua Jackson Aquifer).
- As reported in Deeds and others (2010), the mean absolute errors (a measure of the difference between simulated and measured water levels during model calibration) for the Jackson Group (combined upper and lower Jackson units), Upper Yegua, and Lower Yegua portions of the Yegua Jackson Aquifer for the historical-calibration period of the model are 31.1, 23.9, and 24.5 feet, respectively. These represent 10.3, 5.7 and 6.3 percent of the hydraulic head drop across each model area, respectively.
- 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 groundwater budget components listed below were extracted from the model results for the aquifers located within the district and averaged over the duration of the calibration and verification portion of the model runs in the district. The components of the modified budget shown in tables 1 through 5 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 drains (springs).
- Flow into and out of district—The lateral flow within the aquifer between the district and adjacent counties.
- Flow between aquifers—The vertical 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. “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 tables 1 and 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 figures 1 and 2).

**TABLE 1: SUMMARIZED INFORMATION FOR THE GULF COAST AQUIFER THAT IS NEEDED FOR BRUSH COUNTRY 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 | 8,199 |
| 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 | 1,475 |
| Estimated annual volume of flow into the district within each aquifer in the district | Gulf Coast Aquifer | 25,390 |
| Estimated annual volume of flow out of the district within each aquifer in the district | Gulf Coast Aquifer | 40,832 |
| Estimated net annual volume of flow between each aquifer in the district | From underlying older units into the Gulf Coast Aquifer | 7,955 |

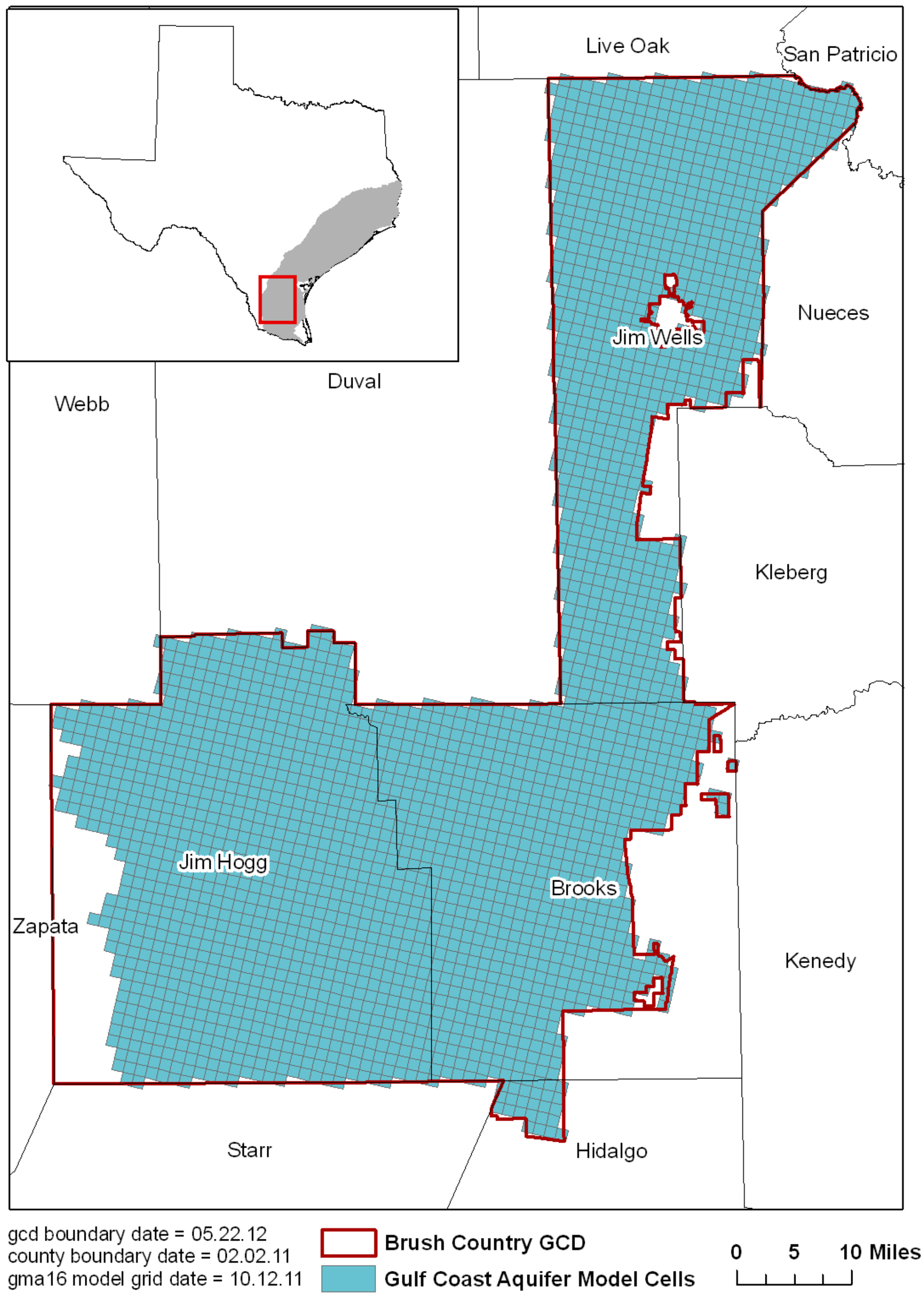


**FIGURE 1: AREA OF ACTIVE MODEL CELLS FOR THE GULF COAST AQUIFER IN BRUSH COUNTRY GROUNDWATER CONSERVATION DISTRICT FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).**

**TABLE 2: SUMMARIZED INFORMATION FOR THE YEGUA JACKSON AQUIFER THAT IS NEEDED FOR BRUSH COUNTRY 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 | Yegua Jackson Aquifer | 0 |
| Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers | Yegua Jackson Aquifer | 0 |
| Estimated annual volume of flow into the district within each aquifer in the district | Yegua Jackson Aquifer | 151 |
| Estimated annual volume of flow out of the district within each aquifer in the district | Yegua Jackson Aquifer | 156 |
| Estimated net annual volume of flow between each aquifer in the district | Not Applicable | *Not applicable |

*Groundwater availability model assumes no interaction between the Yegua Jackson and underlying units.

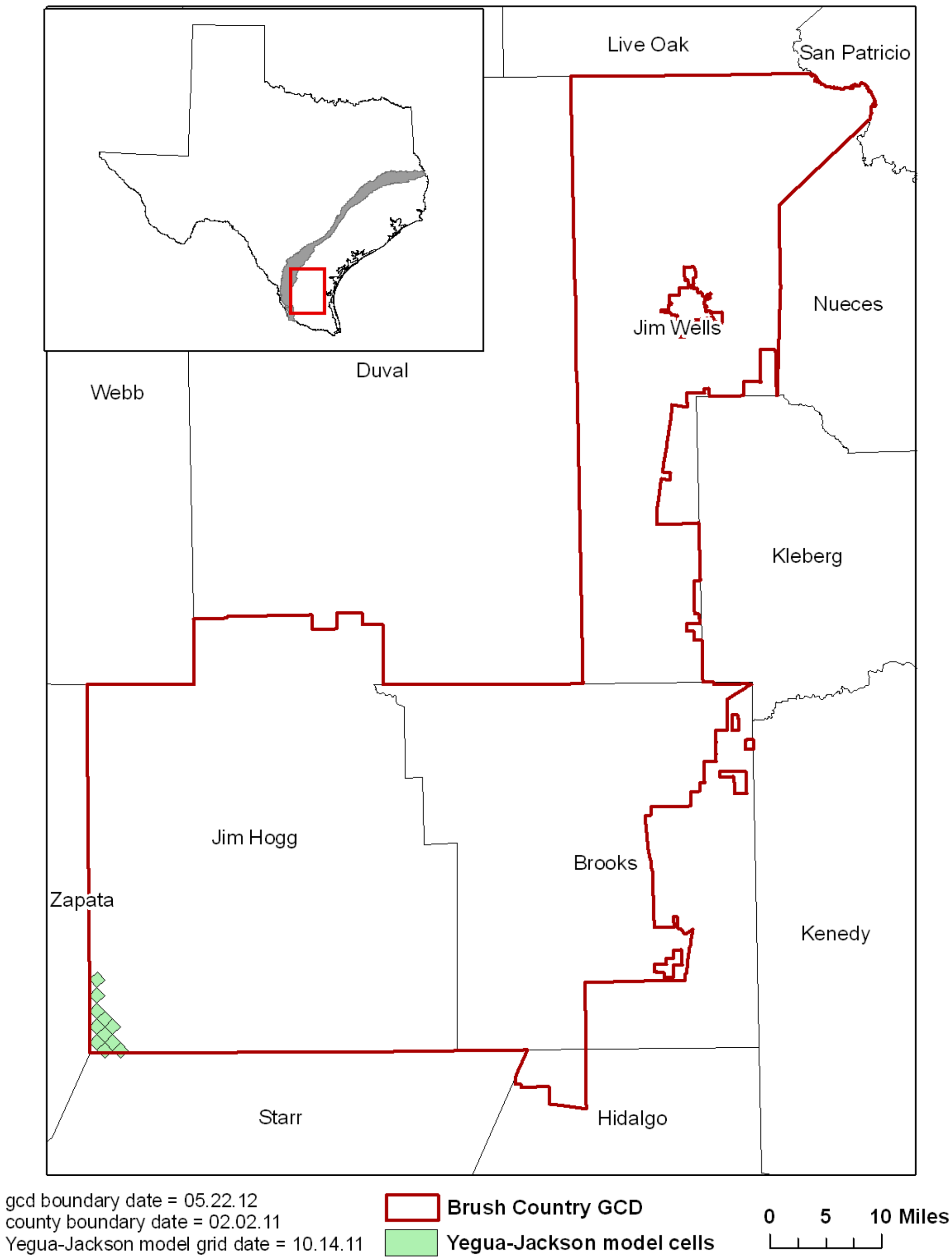


**FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE YEGUA JACKSON AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).**

## *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.

## *REFERENCES:*

Chowdhury, A. H. and Mace, R. E., 2007. Groundwater Resource Evaluation and Availability Model of the Gulf Coast Aquifer in the Lower Rio Grande Valley of Texas.

Chowdhury, Ali. H., Wade, S., Mace, R.E., and Ridgeway, C., 2004, Groundwater Availability Model of the Central Gulf Coast Aquifer System: Numerical Simulations through 1999- Model Report, 114 p., http://www.twdb.texas.gov/groundwater/models/gam/glfc_c/TWDB_Recalibration_Report.pdf.

Deeds, N.E., Yan, T., Singh, A., Jones, T.L., Kelley, V.A., Knox, P.R., Young, S.C., 2010, Groundwater availability model for the Yegua-Jackson Aquifer: Final report prepared for the Texas Water Development Board by INTERA, Inc., 582 p., http://www.twdb.texas.gov/groundwater/models/gam/ygjk/YGJK_Model_Report.pdf.

Harbaugh, A. W., 2009, Zonebudget Version 3.01, A computer program for computing subregional water budgets for MODFLOW ground-water flow models, U.S. Geological Survey Groundwater Software.

Harbaugh, A. W., Banta, E. R., Hill, M. C., and McDonald, M. G., 2000. MODFLOW-2000, the U.S. Geological Survey modular ground-water model -- User guide to modularization concepts and the Ground-Water Flow Process: U.S. Geological Survey Open-File Report 00-92, 121 p.

Hutchison, W. R., Hill, M. E., Anaya, R., Hassan, M. M., Oliver, W., Jigmond, M., Wade, S., and Aschenbach, E., 2011. Groundwater Management Area 16 Groundwater Flow Model, http://www.twdb.texas.gov/groundwater/models/alt/gma16/GMA16_Model_Report_DRAFT.pdf

National Research Council, 2007, Models in Environmental Regulatory Decision Making Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p.