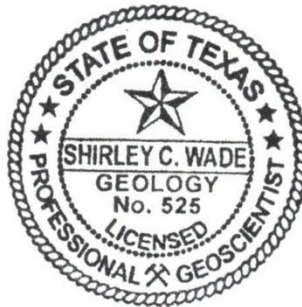


---

# GAM RUN 21-022: SAN PATRICIO COUNTY GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

Shirley Wade, Ph.D., P.G.  
Texas Water Development Board  
Groundwater Division  
Groundwater Modeling Department  
(512) 936-0883  
January 19, 2022



*Shirley C. Wade*  
1/19/22

*This page is intentionally blank*

---

# GAM RUN 21-022: SAN PATRICIO COUNTY GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

Shirley Wade, Ph.D., P.G.  
Texas Water Development Board  
Groundwater Division  
Groundwater Modeling Department  
(512) 936-0883  
January 19, 2022

## ***EXECUTIVE SUMMARY:***

Texas State Water Code, Section 36.1071, Subsection (h) (Texas Water Code, 2011), 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.

The TWDB provides data and information to the San Patricio County Groundwater Conservation District in two parts. Part 1 is the Estimated Historical Water Use/State Water Plan dataset report, which will be provided to you separately by the TWDB Groundwater Technical Assistance Department. Please direct questions about the water data report to Mr. Stephen Allen at 512-463-7317 or [stephen.allen@twdb.texas.gov](mailto:stephen.allen@twdb.texas.gov). Part 2 is the required groundwater availability modeling information and this information includes:

1. the annual amount of recharge from precipitation, if any, to the groundwater resources within the district;
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 groundwater management plan for the San Patricio County Groundwater Conservation District should be adopted by the district on or before February 7, 2022 and submitted to the executive administrator of the TWDB on or before March 9, 2022. The current management plan for the San Patricio County Groundwater Conservation District expires on May 8, 2022.

We used the groundwater availability model for the central portion of the Gulf Coast Aquifer System version 1.01 (Chowdhury and others, 2004) to estimate the management plan information for the Gulf Coast Aquifer System within the San Patricio County Groundwater Conservation District. An updated groundwater availability model for the central portion of the Gulf Coast Aquifer System is currently under development and is expected to be completed in late 2022. San Patricio County Groundwater Conservation District can request a new GAM Run report to update their management plan information when the model is available.

This report replaces the results of GAM Run 16-003 (Goswami, 2016). In this report the approach used for analyzing model output has been refined to better delineate groundwater flows. Additionally, we updated the spatial grid file used to define county, groundwater conservation district, and aquifer boundaries, which also impacted the water budget values. Table 1 summarizes the groundwater availability model data required by statute and Figure 1 shows the area of the model from which the values in Table 1 were extracted. Figure 2 is a generalized diagram of the groundwater flow components provided in Table 1. If, after review of the figures, the San Patricio County Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB at your earliest convenience.

### ***METHODS:***

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability model mentioned above was used to estimate information for the San Patricio County Groundwater Conservation District management plan. Water budgets were extracted for the historical model period for the Gulf Coast Aquifer System (1981-1999) using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The average annual water budget values for recharge, surface-water outflow, inflow to the district, outflow from the district, and the flow between aquifers within the district are summarized in this report.

## ***PARAMETERS AND ASSUMPTIONS:***

### ***Gulf Coast Aquifer System***

- We used version 1.01 of the groundwater availability model for the central portion of the Gulf Coast Aquifer for this analysis. See Chowdhury and others (2004) and Waterstone and others (2003) for assumptions and limitations of the groundwater availability model.
- The model for the central portion of the Gulf Coast Aquifer assumes partially penetrating wells in the Evangeline Aquifer due to a lack of data for aquifer properties in the deeper section of the aquifer located closer to the Gulf of Mexico.
- This groundwater availability model includes four layers, which generally represent the Chicot Aquifer (Layer 1), the Evangeline Aquifer (Layer 2), the Burkeville Confining Unit (Layer 3), and the Jasper Aquifer including parts of the Catahoula Formation (Layer 4).
- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

## ***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 groundwater availability model results for the Gulf Coast Aquifer System located within the San Patricio County Groundwater Conservation District and averaged over the historical calibration periods, as shown in Table 1.

1. 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.
2. Surface-water outflow—the total water discharging from the aquifer (outflow) to surface-water features such as streams, reservoirs, and springs.
3. Flow into and out of district—the lateral flow within the aquifer between the district and adjacent counties.
4. Flow between aquifers—the net vertical flow between the aquifer and adjacent aquifers or confining units. This flow is controlled by the relative

water levels in each aquifer and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs.

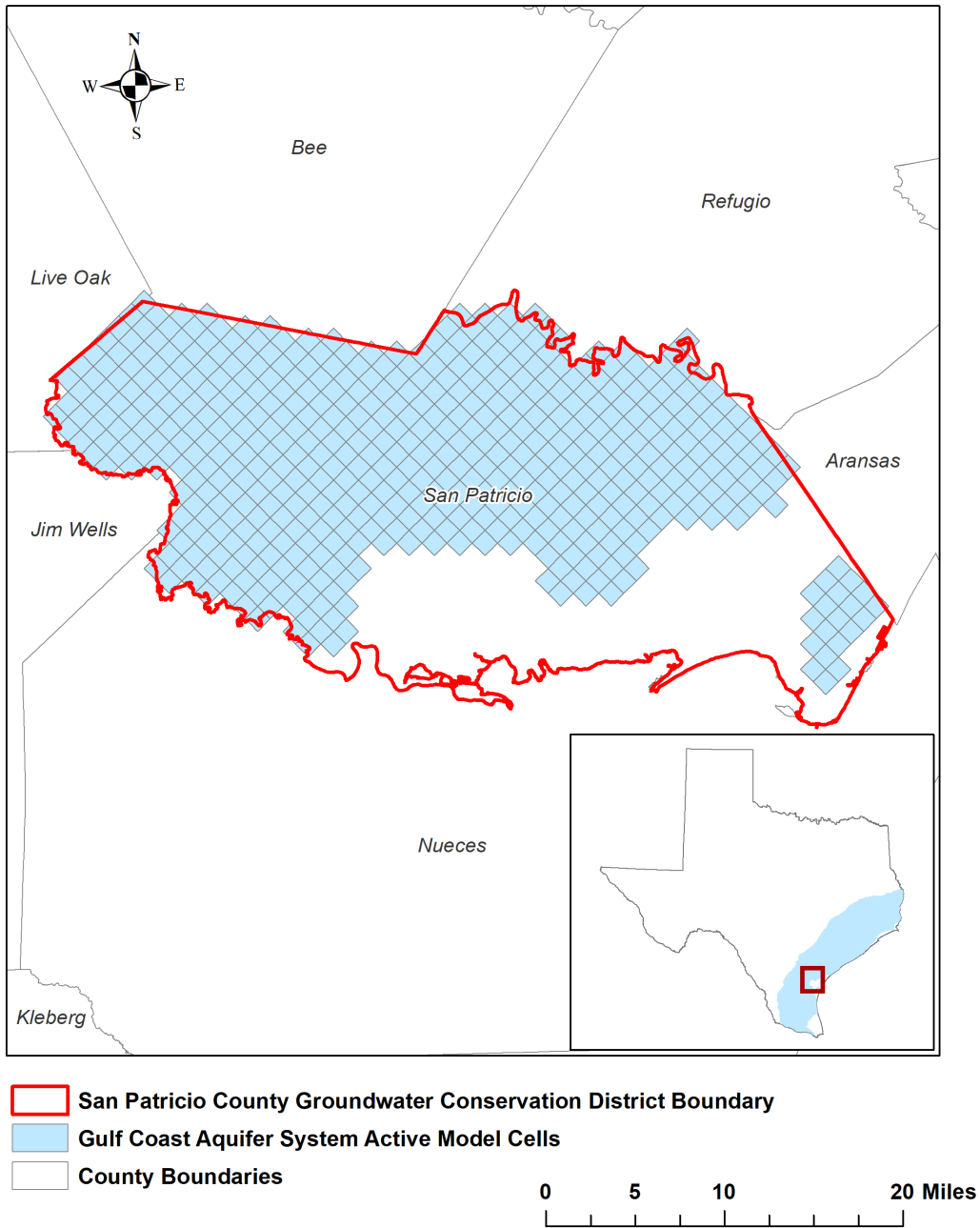
The information needed for the district's management plan is summarized in Table 1. It is important to note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double accounting, a model cell that straddles a political boundary, such as a district or county boundary, 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 FOR THE GULF COAST AQUIFER SYSTEM THAT IS NEEDED FOR THE SAN PATRICIO COUNTY 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 System   | 10,022                      |
| 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 System   | 10,262                      |
| Estimated annual volume of flow into the district within each aquifer in the district   | Gulf Coast Aquifer System   | 8,855                       |
| Estimated annual volume of flow out of the district within each aquifer in the district   | Gulf Coast Aquifer System   | 3,230                       |
| Estimated net annual volume of flow between each aquifer in the district  | From Gulf Coast Aquifer System to equivalent formations within the district | 3,503                       |
|   | Flow between the Gulf Coast Aquifer System and Underlying Units             | Not Applicable <sup>1</sup> |

---

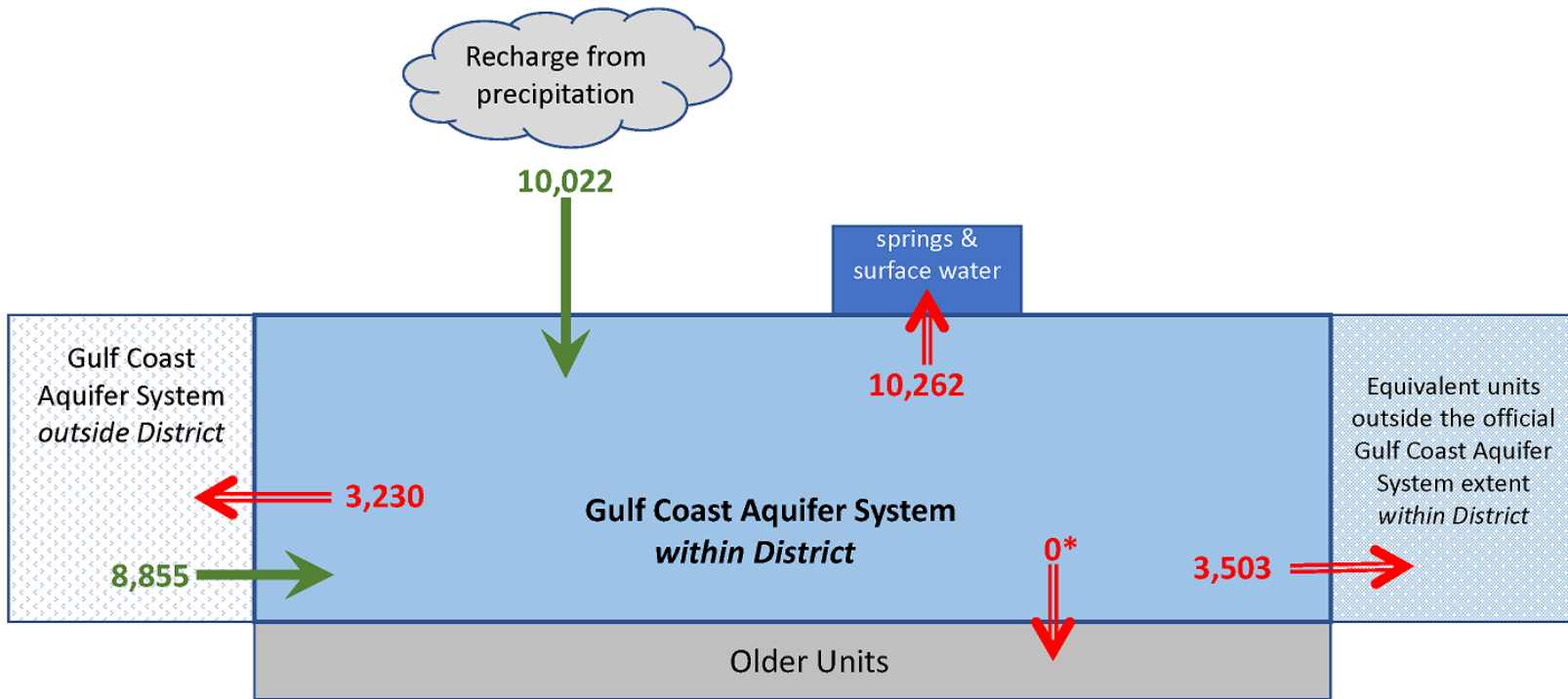
<sup>1</sup> Not applicable because the model assumes a no flow barrier at the base of the Gulf Coast Aquifer System



gcd boundaries date = 06.26.2020, county boundaries date = 07.03.2019, glfc\_c model grid date = 06.26.2020

**FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PORTION OF THE GULF COAST AQUIFER SYSTEM FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE GULF COAST AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).**





\* The groundwater availability model for the Gulf Coast Aquifer System assumes a no-flow condition at the base.

*Caveat: This diagram only includes the water budget items provided in Table 1. A complete water budget would include additional inflows and outflows. If the District requires values for additional water budget items, please contact TWDB.*

**FIGURE 2: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 1, REPRESENTING DIRECTIONS OF FLOW FOR THE GULF COAST AQUIFER SYSTEM WITHIN SAN PATRICIO COUNTY GROUNDWATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR (AFY).**

## ***LIMITATIONS:***

The groundwater models used in completing this analysis are the best available scientific tools that can be used to meet the stated objectives. 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 historical 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 interaction with streams are specific to particular historic time periods.

Because the application of the groundwater models was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations related 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, 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](http://www.twdb.texas.gov/groundwater/models/gam/glfc_c/TWDB_Recalibration_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., and McDonald, M. G., 1996, User's documentation for MODFLOW-96, an update to the U.S. Geological Survey modular finite-difference groundwater-water flow model: U.S. Geological Survey Open-File Report 96-485, 56 p.
- Goswami, R. R., 2016, GAM Run 16-003: Texas Water Development Board, GAM Run 16-003 Report, 9 p., <http://www.twdb.texas.gov/groundwater/docs/GAMruns/GR16-003.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., [http://www.nap.edu/catalog.php?record\\_id=11972](http://www.nap.edu/catalog.php?record_id=11972).
- Texas Water Code, 2011, <http://www.statutes.legis.state.tx.us/docs/WA/pdf/WA.36.pdf>
- Waterstone Environmental Hydrology and Engineering Inc. and Parsons, 2003, Groundwater availability of the Central Gulf Coast Aquifer: Numerical Simulations to 2050, Central Gulf Coast, Texas Contract report to the Texas Water Development Board, 157 p., [http://www.twdb.texas.gov/groundwater/models/gam/glfc\\_c/Waterstone\\_Conceptual\\_Report.pdf?](http://www.twdb.texas.gov/groundwater/models/gam/glfc_c/Waterstone_Conceptual_Report.pdf?)