GAM Run 18-022: Glasscock Groundwater Conservation District Groundwater Management Plan

Shirley C. Wade, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
512-936-0883

February 11, 2019

Shirley C. Wade
2/11/19

This page is intentionally blank.

GAM RUN 18-022: GLASSCOCK GROUNDWATER CONSERVATION DISTRICT GROUNDWATER MANAGEMENT PLAN

Shirley C. Wade, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
512-936-0883
February 11, 2019

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 Glasscock 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. 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 Glasscock Groundwater Conservation District should be adopted by the district on or before October 17, 2019 and submitted to the

Executive Administrator of the TWDB on or before November 16, 2019. The current management plan for the Glasscock Groundwater Conservation District expires on January 15, 2020.

We used two groundwater availability models to estimate the management plan information for the aquifers within the Glasscock Groundwater Conservation District. Information for the Dockum and Ogallala aquifers is from version 1.01 of the groundwater availability model for the High Plains Aquifer System (Deeds and Jigmond, 2015). Information for the Edwards-Trinity (Plateau) Aquifer is from the alternative groundwater model for the Edwards-Trinity (Plateau) Aquifer (Hutchison and others, 2011).

This report replaces the results of GAM Run 12-020 (Wade, 2012). GAM Run 18-022 includes results from the groundwater availability model for the High Plains Aquifer System released in 2015 (Deeds and Jigmond, 2015). Tables 1 through 3 summarize the groundwater availability model data required by statute and Figures 1 through 3 show the area of the models from which the values in the tables were extracted. If, after review of the figures, Glasscock 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 two groundwater availability models mentioned above were used to estimate information for the Glasscock Groundwater Conservation District management plan. Water budgets were extracted for the historical model periods for the Dockum and Ogallala aquifers (1980 through 2012) and Edwards-Trinity (Plateau) Aquifer (1980 through 2005) using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The average annual water budget values for recharge, surface-water outflow, inflow to the district, and outflow from the district for the aquifers within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

High Plains Aquifer System (Dockum and Ogallala aquifers)

- We used version 1.01 of the groundwater availability model for the High Plains Aquifer System. See Deeds and Jigmond (2015) for assumptions and limitations of the model.
- The model was run with MODFLOW-NWT (Niswonger and others, 2011).
- The groundwater availability model for the High Plains Aquifer System contains four layers:
    - Layer 1—the Ogallala Aquifer and the Pecos Valley Alluvium Aquifer
    - Layer 2—the Rita Blanca Aquifer, the Edwards-Trinity (High Plains) Aquifer, the Edwards-Trinity (Plateau) Aquifer, and pass through cells of the Dockum Aquifer
    - Layer 3—the upper Dockum Group and pass through cells of the lower Dockum Group
    - Layer 4—the lower Dockum Group
- Perennial rivers and reservoirs were simulated using MODFLOW-NWT river package. Springs, seeps, and draws were simulated using MODFLOW-NWT drain package.

Edwards-Trinity (Plateau) Aquifer

- The one-layer alternative groundwater flow model of the Edwards-Trinity (Plateau) and Pecos Valley aquifers (Hutchison and others, 2011) was used for these simulations. The modified model version was developed to more effectively simulate groundwater conditions. The model was calibrated based on groundwater elevation data from 1930 to 2005.
- The model has one layer which represents the Pecos Valley Aquifer in the northwest portion of the model area, the Edwards-Trinity (Plateau) Aquifer in the middle, and the Hill Country portion of the Trinity Aquifer in the southeast portion of the model area. A lumped representation of both the Pecos Valley and Edwards-Trinity (Plateau) aquifers was used in the relatively narrow area where the Pecos Valley

Aquifer overlies the Edwards-Trinity (Plateau) Aquifer. Only the Edwards-Trinity (Plateau) Aquifer underlies the district.

- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifers according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the groundwater availability model results for the Dockum, Ogallala, and Edwards-Trinity (Plateau) aquifers over the historical calibration periods, as shown in Tables 1 through 3.

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 Tables 1 through 3. 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 DOCKUM AQUIFER FOR GLASSCOCK 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	Dockum Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Dockum Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Dockum Aquifer	2
Estimated annual volume of flow out of the district within each aquifer in the district	Dockum Aquifer	67
Estimated net annual volume of flow between each aquifer in the district	Into the Dockum Aquifer from the Edwards-Trinity (Plateau) Aquifer and other overlying units	1
	From the saline portions of the Dockum Group into the Dockum Aquifer	44

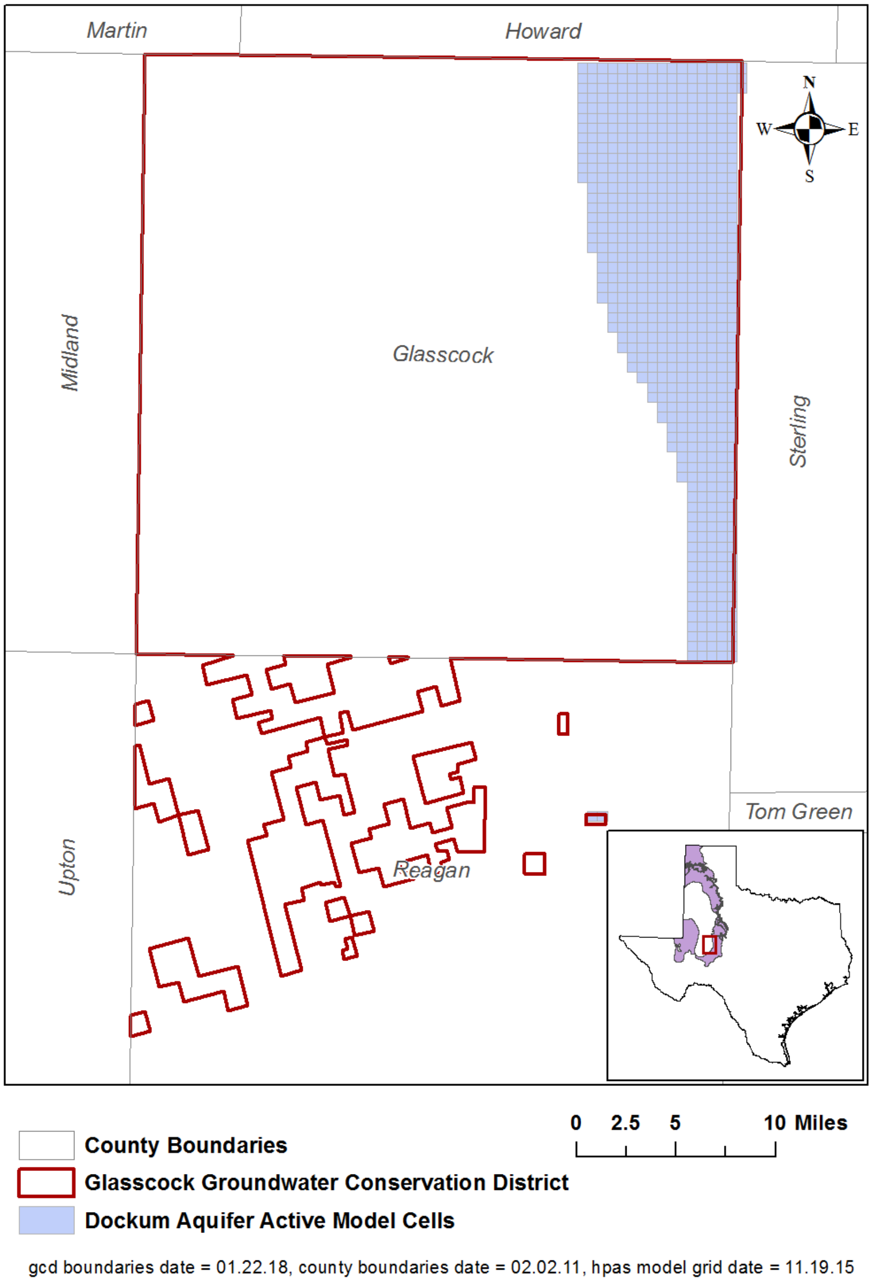

FIGURE 1. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE DOCKUM AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2. SUMMARIZED INFORMATION FOR THE OGALLALA AQUIFER FOR GLASSCOCK 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	Ogallala Aquifer	3,186
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Ogallala Aquifer	951
Estimated annual volume of flow into the district within each aquifer in the district	Ogallala Aquifer	751
Estimated annual volume of flow out of the district within each aquifer in the district	Ogallala Aquifer	420
Estimated net annual volume of flow between each aquifer in the district	From the Ogallala Aquifer into the Edwards-Trinity (Plateau) Aquifer	5,412[1]

[1] This value was extracted from the alternative groundwater model for the Edwards-Trinity (Plateau) Aquifer. The groundwater availability model for the High Plains Aquifer System indicates 445 acre-feet per year flows into the Ogallala Aquifer from the Edwards-Trinity (Plateau) Aquifer; however, the Edwards-Trinity (Plateau) is included mainly as a boundary condition for the High Plains Aquifer System model.

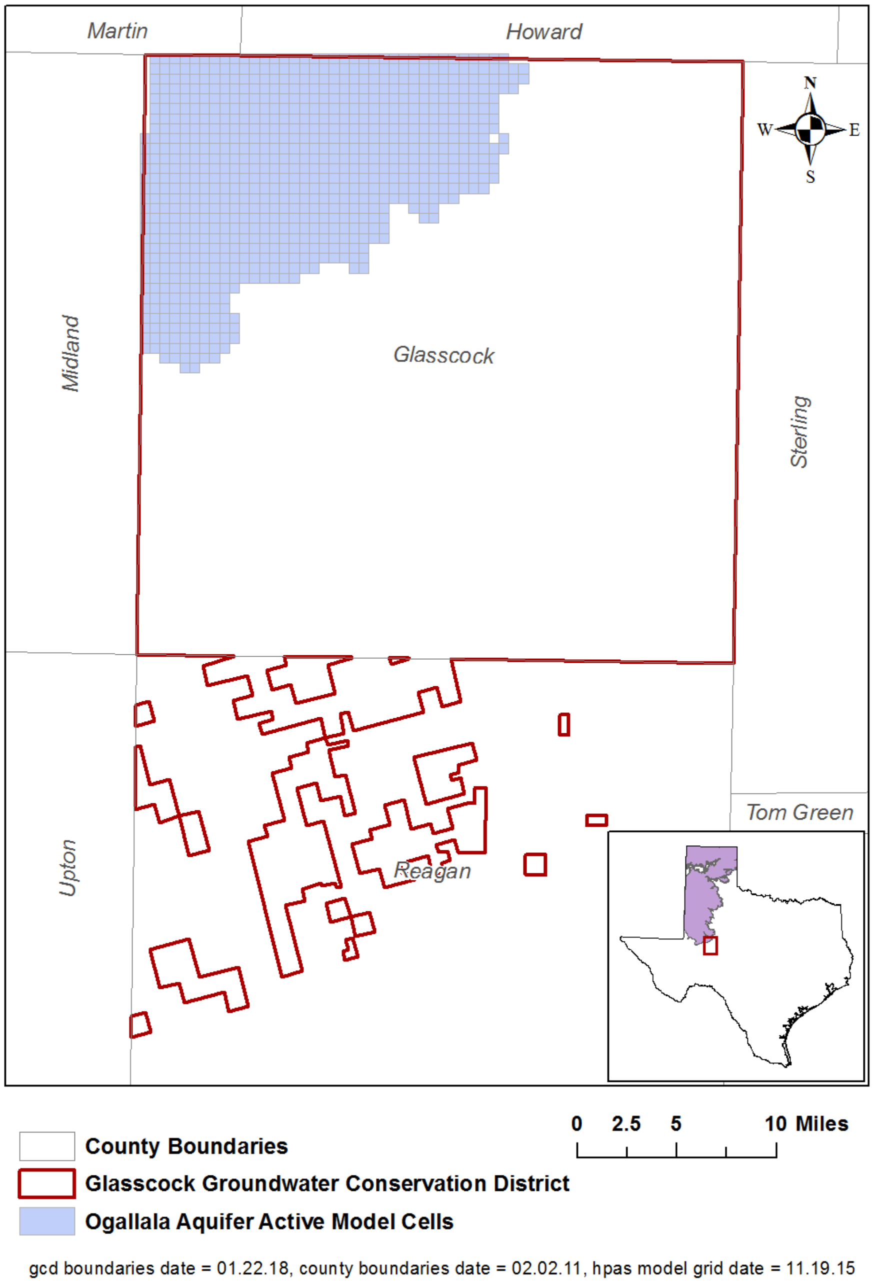

FIGURE 2. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE OGALLALA AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 3. SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER FOR GLASSCOCK 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	Edwards-Trinity (Plateau) Aquifer	23,079
Estimated annual volume of water that discharges from the aquifer to springs and any surface-water body including lakes, streams, and rivers	Edwards-Trinity (Plateau) Aquifer	431
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	50,475
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	51,411
Estimated net annual volume of flow between each aquifer in the district	From the Ogallala Aquifer into the Edwards-Trinity (Plateau) Aquifer	5,412

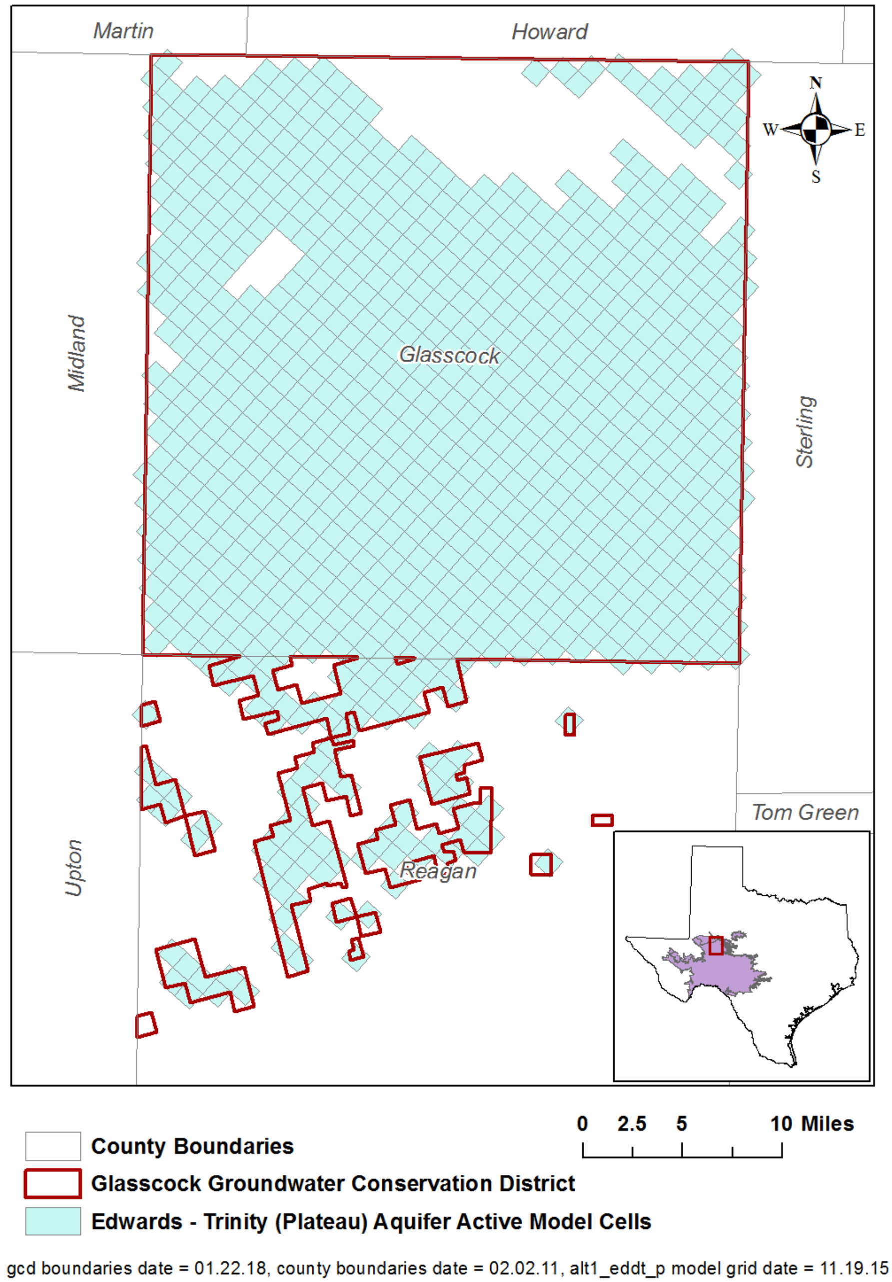

FIGURE 3. AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (THE AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

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 historical groundwater flow conditions includes the assumptions about the location in the aquifer where historical 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 historical 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. Historical 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:

Deeds, N. E., and Jigmond, M., 2015, Numerical Model Report for the High Plains Aquifer System Groundwater Availability Model: Prepared for the Texas Water Development Board by INTERA Inc., 640 p. http://www.twdb.texas.gov/groundwater/models/gam/hpas/HPAS_GAM_Numerical_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., Jones, I. C., and Anaya, R., 2011. Update of the Groundwater Availability Model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas. Texas Water Development Board Unpublished Report. http://www.twdb.texas.gov/groundwater/models/alt/eddt_p_2011/alt1_eddt_p.asp

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.

Niswonger, R.G., Panday, S., and Ibaraki, M., 2011, MODFLOW-NWT, a Newton formulation for MODFLOW-2005: USGS, Techniques and Methods 6-A37, 44 p.

Texas Water Code, 2011, https://statutes.capitol.texas.gov/docs/WA/pdf/WA.36.pdf

Wade, S. C., 2012, GAM Run 12-020: Glasscock Groundwater Conservation District Management Plan, 18 p., http://www.twdb.texas.gov/groundwater/docs/GAMruns/GR12-020.pdf