GAM Run 20-003: Medina County Groundwater Conservation District Management Plan

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Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
(512) 936-0883
August 24, 2020

Cynthia K. Ridgeway is the manager of the Groundwater Availability Modeling Department and is responsible for the oversight of work performed by Jiabao Guan and Grayson Dowlearn under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on August 24, 2020.

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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 Medina 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. 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 Medina County Groundwater Conservation District should be adopted by the district on or before March 9, 2021 and submitted to the executive administrator of the TWDB on or before April 8, 2021. The current management plan for the Medina County Groundwater Conservation District expires on June 7, 2021.

We used two groundwater availability models to estimate the management plan information for the aquifers within Medina County Groundwater Conservation District. Information for the Trinity Aquifer is from version 2.01 of the Groundwater Availability Model for the Hill Country portion of the Trinity Aquifer (Jones and others, 2011). Information for the Carrizo-Wilcox Aquifer is from version 2.01 of the Groundwater Availability Model for the southern portion of the Carrizo-Wilcox, Queen City, and Sparta Aquifers (Kelley and others, 2004).

This report replaces the results of GAM Run 15-002 (Kohlrenken, 2015), as the approach used for analyzing model results has been since refined to more accurately delineate flows between hydraulically connected units. GAM Run 20-003 meets the current standards set after the release of GAM Run 15-002. Tables 1 and 2 summarize the groundwater availability model data required by statute and Figures 1 and 2 show the area of the models from which the values in the tables were extracted. If, after review of the figures, the Medina 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.

Please note that the Edwards (Balcones Faults Zone) Aquifer occurs within the boundaries of the Medina County Groundwater Conservation District but is excluded from this report since the District does not have jurisdiction over that aquifer. The Trinity Aquifer underlies the Edwards (Balcones Faults Zone) Aquifer within the boundaries of the District. However, the underlying portion of the Trinity Aquifer is not included in the groundwater availability model for the Hill Country portion of the Trinity Aquifer.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability models mentioned above were used to estimate the information for the Medina County Groundwater Conservation District management plan. Water Budgets were extracted for the outcrop of the Trinity Aquifer (1981-1997) and the Carrizo-Wilcox Aquifer (1980-1999). We used ZONEBUDGET Version 3.01 (Harbaugh, 2009) to extract water budgets from the model results. 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:

Hill Country portion of the Trinity Aquifer System

- We used version 2.01 of the groundwater availability model for the Hill Country portion of the Trinity Aquifer System. See Jones and others (2011) for assumptions and limitations of the groundwater availability model.
- The groundwater availability model includes four layers, representing (from top to bottom):
    - Layer 1 — the Edwards Group of the Edwards-Trinity (Plateau) Aquifer,
    - Layer 2 — the Upper Trinity Aquifer,
    - Layer 3 — the Middle Trinity Aquifer, and
    - Layer 4 — the Lower Trinity Aquifer.
- We determined the overall water budget for the Medina County Groundwater Conservation District for the Hill Country portion of the Trinity Aquifer System (Layers 2 through 4 collectively for the portions of the model that represent the outcrop of the Trinity Aquifer System).
- The General-Head Boundary (GHB) package of MODFLOW was used to represent flow out of the study area and across the Balcones Fault Zone into the Edwards (Balcones Fault Zone) Aquifer and the deeper Trinity Aquifer units located beneath the Edwards Aquifer. This flow is summarized as the estimated average net flow from the Trinity Aquifer to the Edwards (Balcones Fault Zone) Aquifer and the confined portion of the Trinity Aquifer underlying the Edwards (Balcones Fault Zone) Aquifer listed in Table 1.
- Water budgets were estimated by averaging over the period 1981 to 1997 (stress periods 2 through 18).
- Only the outcrop area of the Hill County portion of the Trinity Aquifer was modeled, and the down-dip extent that underlies the Edwards (Balcones Fault Zone) Aquifer was not included.
- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

Carrizo-Wilcox Aquifers

- We used version 2.01 of the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers. See Deeds and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers.
- This groundwater availability model includes eight layers which generally represent the Sparta Aquifer (Layer 1), the Weches Confining Unit (Layer 2), the Queen City Aquifer (Layer 3), the Reklaw Confining Unit (Layer 4), the Carrizo Aquifer (Layer 5), the Upper Wilcox (Layer 6), the Middle Wilcox (Layer 7), and the Lower Wilcox (Layer 8). The Sparta Aquifer (Layer 1), and Queen City Aquifer (Layer 3) are not present in Medina County Groundwater Conservation District. Water budgets were extracted collectively for the Carrizo-Wilcox Aquifer (Layer 5 through Layer 8).
- Groundwater in the Carrizo-Wilcox, Queen City, and Sparta aquifers ranges from fresh to brackish in composition (Kelley and others, 2004). Groundwater with total dissolved solids of less than 1,000 milligrams per liter are considered fresh and total dissolved solids of 1,000 to 10,000 milligrams per liter are considered brackish.
- Water budgets were estimated by averaging over the period 1980 to 1999 (stress periods 6 through 25).
- 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 model results for the aquifers located within the district and averaged over the historical calibration periods, as shown in Tables 1 and 2.

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 the 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 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 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 TRINITY AQUIFER THAT IS NEEDED FOR THE MEDINA 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	Trinity Aquifer	6,918
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Trinity Aquifer	6,412
Estimated annual volume of flow into the district within each aquifer in the district	Trinity Aquifer	21,749
Estimated annual volume of flow out of the district within each aquifer in the district	Trinity Aquifer	6,268
Estimated net annual volume of flow between each aquifer in the district	Flow from the Trinity Aquifer to the Edwards (Balcones Fault Zone) Aquifer and the confined portion of the Trinity Aquifer underlying the Edwards (Balcones Fault Zone) Aquifer.	15,911

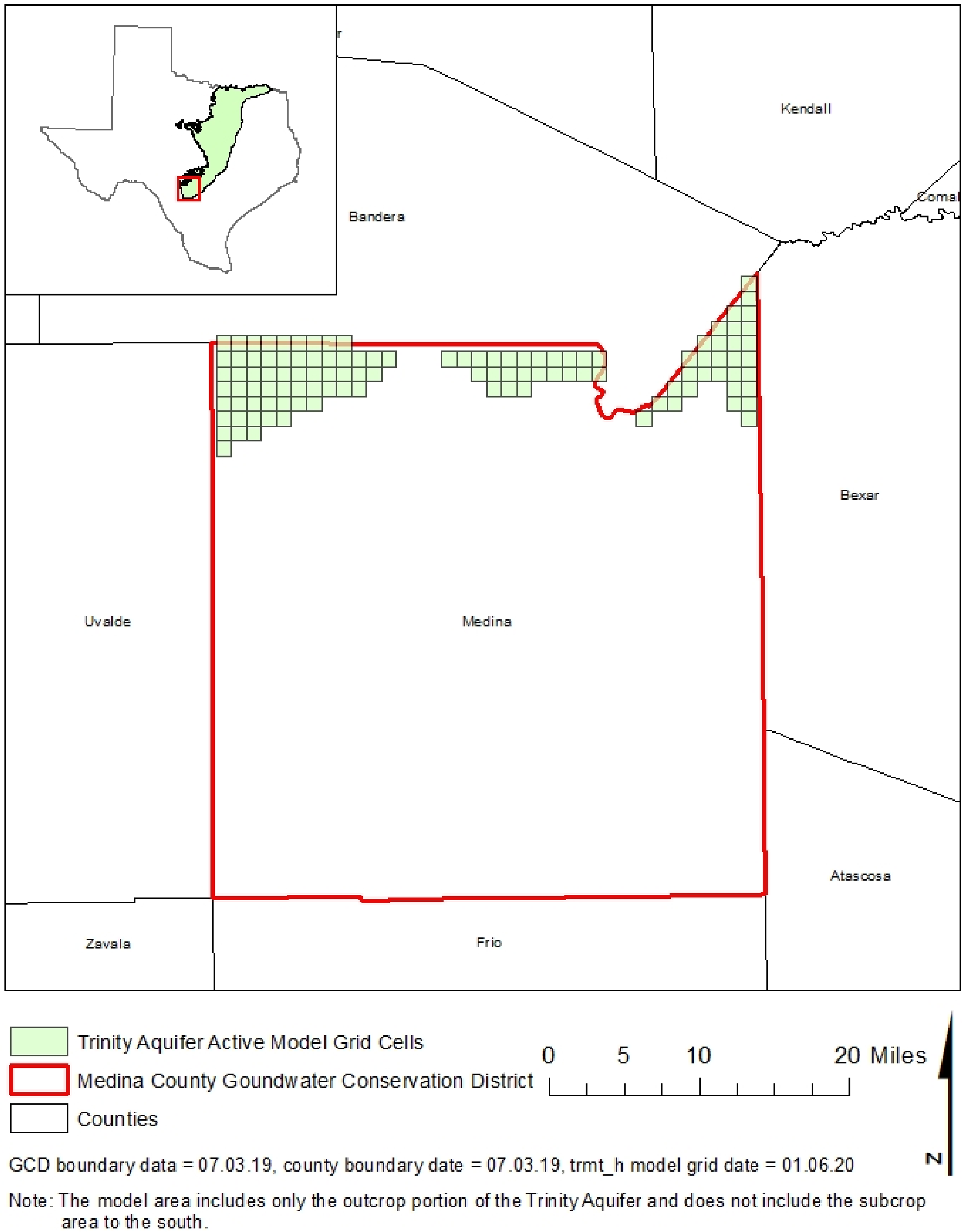

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE HILL COUNTRY PORTION OF THE TRINITY AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE TRINITY AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE CARRIZO-WILCOX AQUIFER THAT IS NEEDED FOR THE MEDINA 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	Carrizo-Wilcox Aquifer	14,077
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Carrizo-Wilcox Aquifer	588
Estimated annual volume of flow into the district within each aquifer in the district	Carrizo-Wilcox Aquifer	1,294
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo-Wilcox Aquifer	29,772
Estimated net annual volume of flow between each aquifer in the district	To the Carrizo-Wilcox Aquifer from the Reklaw formation	14

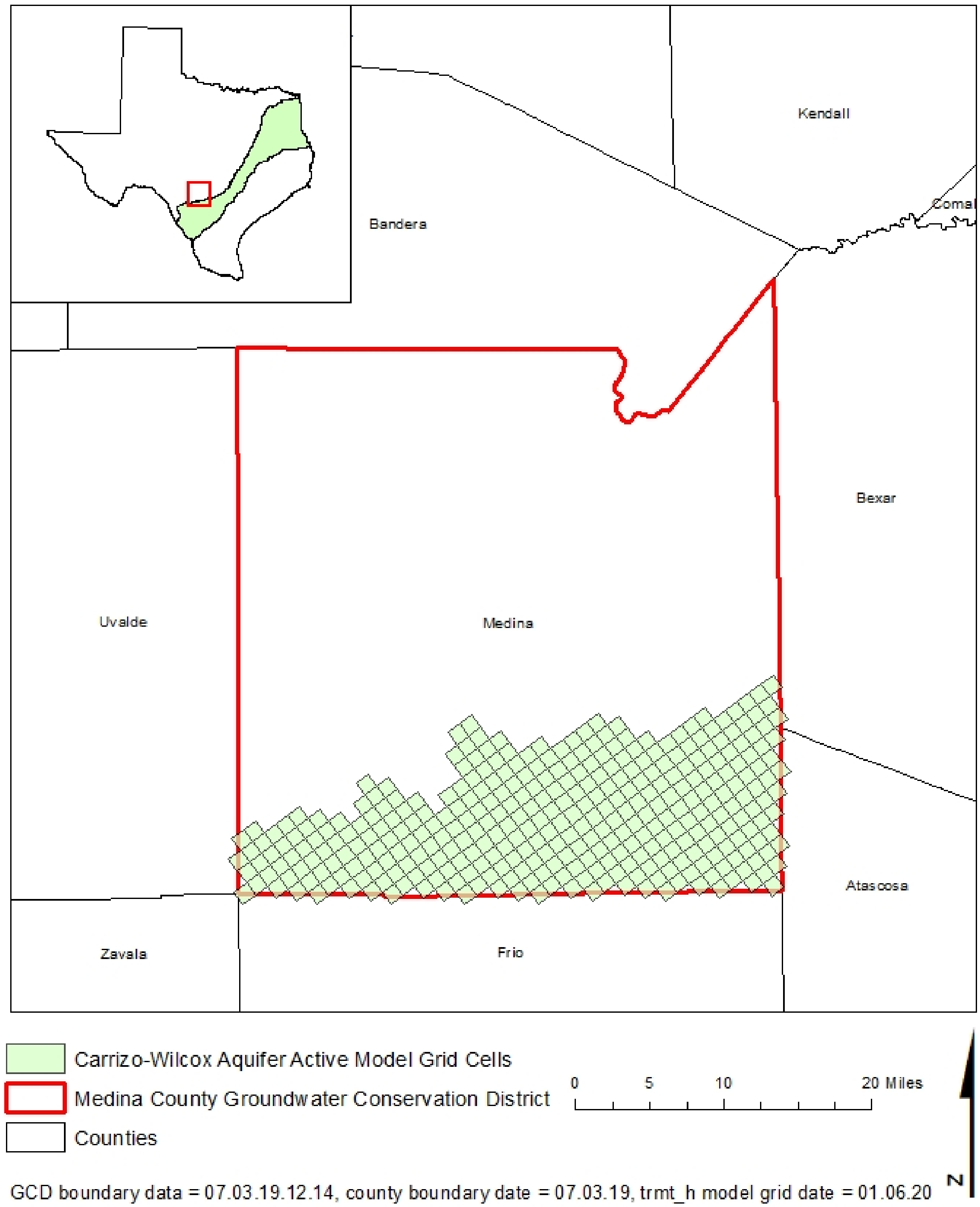

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PART OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE CARRIZO-WILCOX AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

LIMITATIONS:

The groundwater models used in completing this analysis is the best available scientific tool 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 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 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:

Deeds, N., Kelley, V., Fryar, D., Jones, T., Whallon, A.J., and Dean, K.E., 2003, Groundwater Availability Model for the Southern Carrizo-Wilcox Aquifer: Contract report to the Texas Water Development Board, 452 p., http://www.twdb.texas.gov/groundwater/models/gam/czwx_s/CZWX_S_Full_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.

Jones, Ian. C., Anaya, R. and Wade, S., 2011, Groundwater Availability Model: Hill County Portion of the Trinity Aquifer of Texas, 165 p., http://www.twdb.texas.gov/groundwater/models/gam/trnt_h/R377_HillCountryGAM.pdf

Kelley, V.A., Deeds, N.E., Fryar, D.G., and Nicot, J.P., 2004, Groundwater availability models for the Queen City and Sparta aquifers: Contract report to the Texas Water Development Board, 867 p., http://www.twdb.texas.gov/groundwater/models/gam/qcsp/qcsp.asp.

Kohlrenken, W., 2015, GAM Run 15-002: Texas Water Development Board, GAM Run 15-002: Medina County Groundwater Conservation District Management Plan, 13 p., http://www.twdb.texas.gov/groundwater/docs/GAMruns/GR15-002.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.

Texas Water Code, 2011, http://www.statutes.legis.state.tx.us/docs/WA/pdf/WA.36.pdf