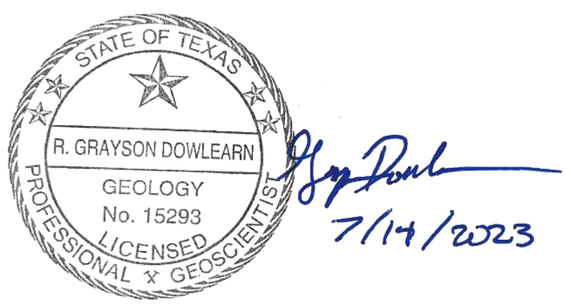
GAM RUN 23-013: MESQUITE GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

Dwight Zedric Q. Capus, GIT and Grayson Dowlearn, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-936-2404
July 14, 2023



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EXECUTIVE SUMMARY:

Texas Water Code § 36.1071(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.

The TWDB provides data and information to the Mesquite 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, which includes:

1. the annual amount of recharge from precipitation, if any, to the groundwater resources within the district;
2. the annual volume of water that discharges from the aquifer to springs and any surface-water bodies, including lakes, streams, and rivers, for each aquifer within the district; 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 Mesquite Groundwater Conservation District should be adopted by the district on or before September 21, 2023, and submitted to the TWDB Executive Administrator on or before October 21, 2023. The current management plan for the Mesquite Groundwater Conservation District expires on December 20, 2023.

The management plan information for the aquifers within Mesquite Groundwater Conservation District was extracted from two groundwater availability models. We used the groundwater availability model for the High Plains Aquifer System (Deeds and Jigmond, 2015, and Deeds and others, 2015) to estimate management plan information for the Ogallala Aquifer. We used the groundwater availability model for the Seymour Aquifer (Ewing and others, 2004) to estimate management plan information for the Seymour and Blaine aquifers.

This report replaces the results of GAM Run 18-010 (Shi, 2018). Values may differ from the previous report as a result of routine updates to the spatial grid file used to define county, groundwater conservation district, and aquifer boundaries, which can impact the calculated water budget values. Additionally, the approach used for analyzing model results is reviewed during each update and may have been refined to better delineate groundwater flows. Tables 1 through 3 summarize the groundwater availability model data required by statute. Figures 1, 3, and 5 show the areas of the respective models from which the values in Tables 1 through 3 were extracted. Figures 2, 4, and 6 provide a generalized diagram of the groundwater flow components provided in Tables 1 through 3. If, after review of the figures, the Mesquite 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.

The flow components presented in this report do not represent the full groundwater budget. If additional inflow and outflow information would be helpful for planning purposes, the district may submit a request in writing to the TWDB Groundwater Modeling Department for the full groundwater budget.

METHODS:

In accordance with Texas Water Code § 36.1071(h), the groundwater availability models mentioned above were used to estimate information for the Mesquite Groundwater Conservation District management plan. Water budgets were extracted for the historical calibration period for the Ogallala Aquifer (1980 through 2012) and the Seymour and Blaine aquifers (1980 through 1998) 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:

Ogallala Aquifer

- We used version 1.01 of the groundwater availability model for High Plains Aquifer System (Deeds and Jigmond, 2015, and Deeds and others, 2015) to analyze the Ogallala Aquifer. See Deeds and others (2015) and Deeds and Jigmond (2015) for assumptions and limitations of the model.
- The groundwater availability model for the High Plains Aquifer System contains four layers:
    - Layer 1 represents the Ogallala and Pecos Valley aquifers
    - Layer 2 represents the Rita Blanca, the Edwards-Trinity (Plateau), and the Edwards-Trinity (High Plains) aquifers
    - Layer 3 represents the upper portion of the Dockum Aquifer
    - Layer 4 represents the lower portion of the Dockum Aquifer
- Budget values were estimated only for the Ogallala Aquifer within Mesquite Groundwater Conservation District.
- Water budget terms were averaged for the period 1980 through 2012 (stress periods 52 through 84).
- The model was run with MODFLOW-NWT (Niswonger and others, 2011).

Seymour and Blaine aquifers

- We used version 1.01 of the groundwater availability model for the Seymour Aquifer (Ewing and others, 2004) to analyze the Seymour and Blaine aquifers. See Ewing and others (2004) for assumptions and limitations of the model.
- The groundwater availability model for the Seymour Aquifer contains the two layers:
    - Layer 1 represents the Seymour Aquifer
    - Layer 2 represents the Blaine Aquifer
- Water budget terms were averaged for the period 1980 through 1998 (stress periods 61 through 288). The last modeled stress period representing the year 1999 was not included because of incorrect pumping values.
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000)

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving an aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the groundwater availability model results for the Ogallala, Seymour, and Blaine aquifers located within Mesquite Groundwater Conservation District and averaged 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. Figures 1, 3, and 5 show the areas of the respective models from which the values in Tables 1 through 3 were extracted. Figures 2, 4, and 6 provide a generalized diagram of the groundwater flow components provided 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 Ogallala Aquifer for the Mesquite Groundwater Conservation District 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	647
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Ogallala Aquifer	670
Estimated annual volume of flow into the district within each aquifer in the district	Ogallala Aquifer	434
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	Ogallala Aquifer	Not Applicable*

*** The Ogallala Aquifer was the only hydrogeological unit simulated by the model within the Mesquite Groundwater Conservation District.**

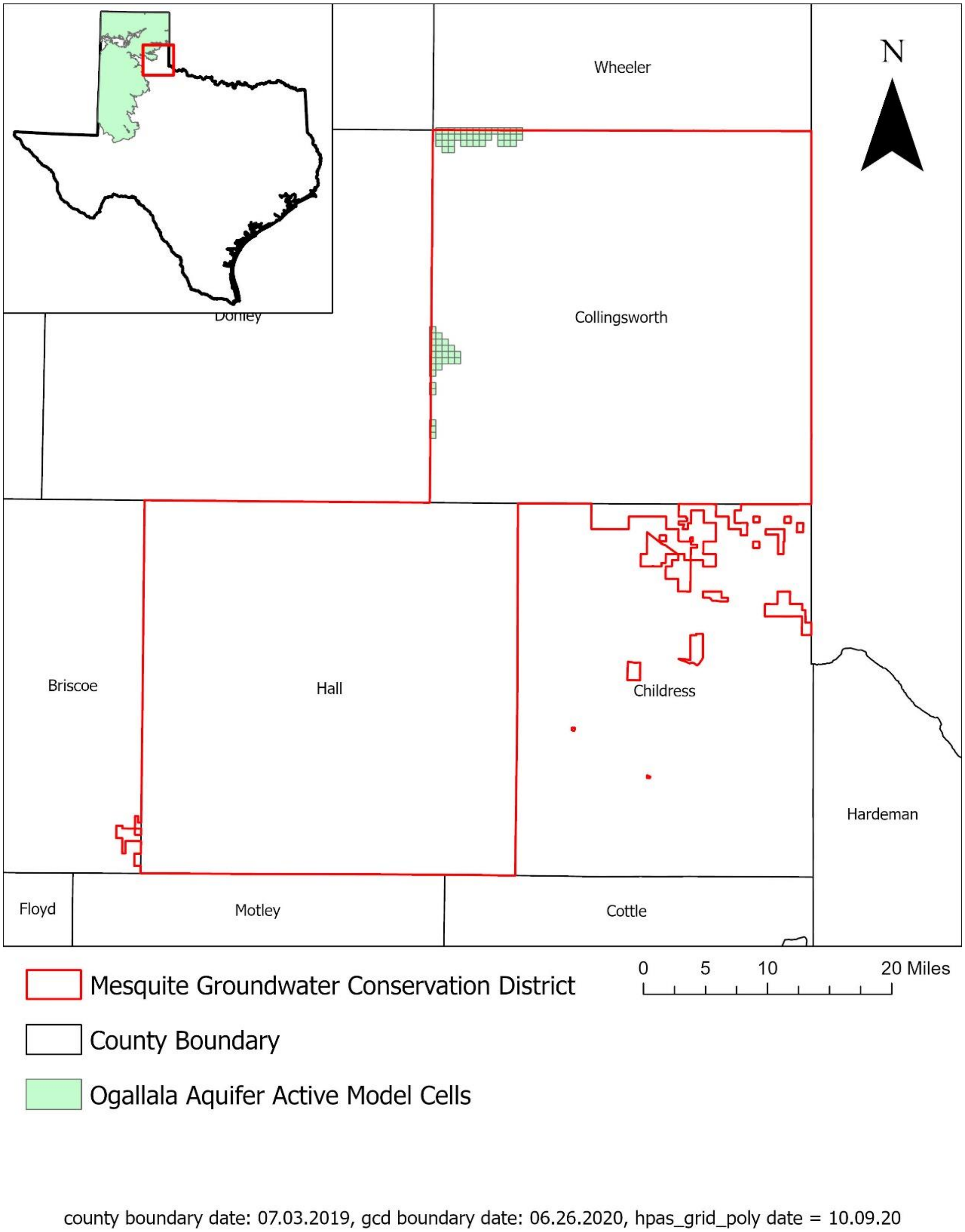


Figure 1: Area of the groundwater availability model for the High Plains Aquifer System from which the information in Table 1 was extracted (the Ogallala Aquifer extent within the district boundary).

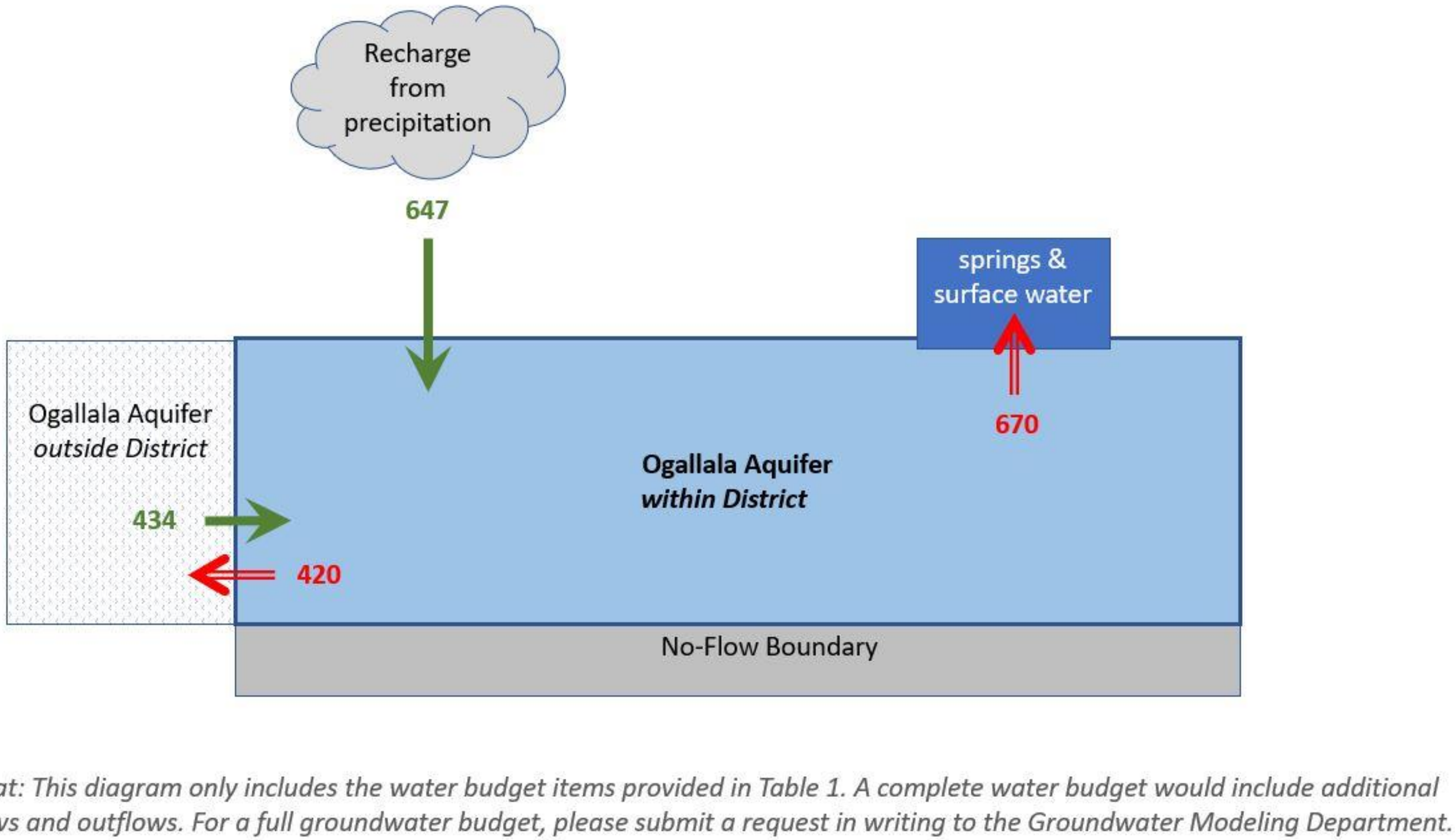


Figure 2: Generalized diagram of the summarized budget information from Table 1, representing directions of flow for the Ogallala Aquifer within the Mesquite Groundwater Conservation District. Flow values are expressed in acre-feet per year.

Table 2: Summarized information for the Seymour Aquifer for the Mesquite Groundwater Conservation District 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	Seymour Aquifer	43,600
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Seymour Aquifer	4,267
Estimated annual volume of flow into the district within each aquifer in the district	Seymour Aquifer	1,684
Estimated annual volume of flow out of the district within each aquifer in the district	Seymour Aquifer	964
Estimated net annual volume of flow between each aquifer in the district	From Seymour Aquifer to Blaine Aquifer	12,807
	To Seymour Aquifer from underlying confining units	7,943
	From Seymour Aquifer to Seymour equivalent units in Oklahoma	60

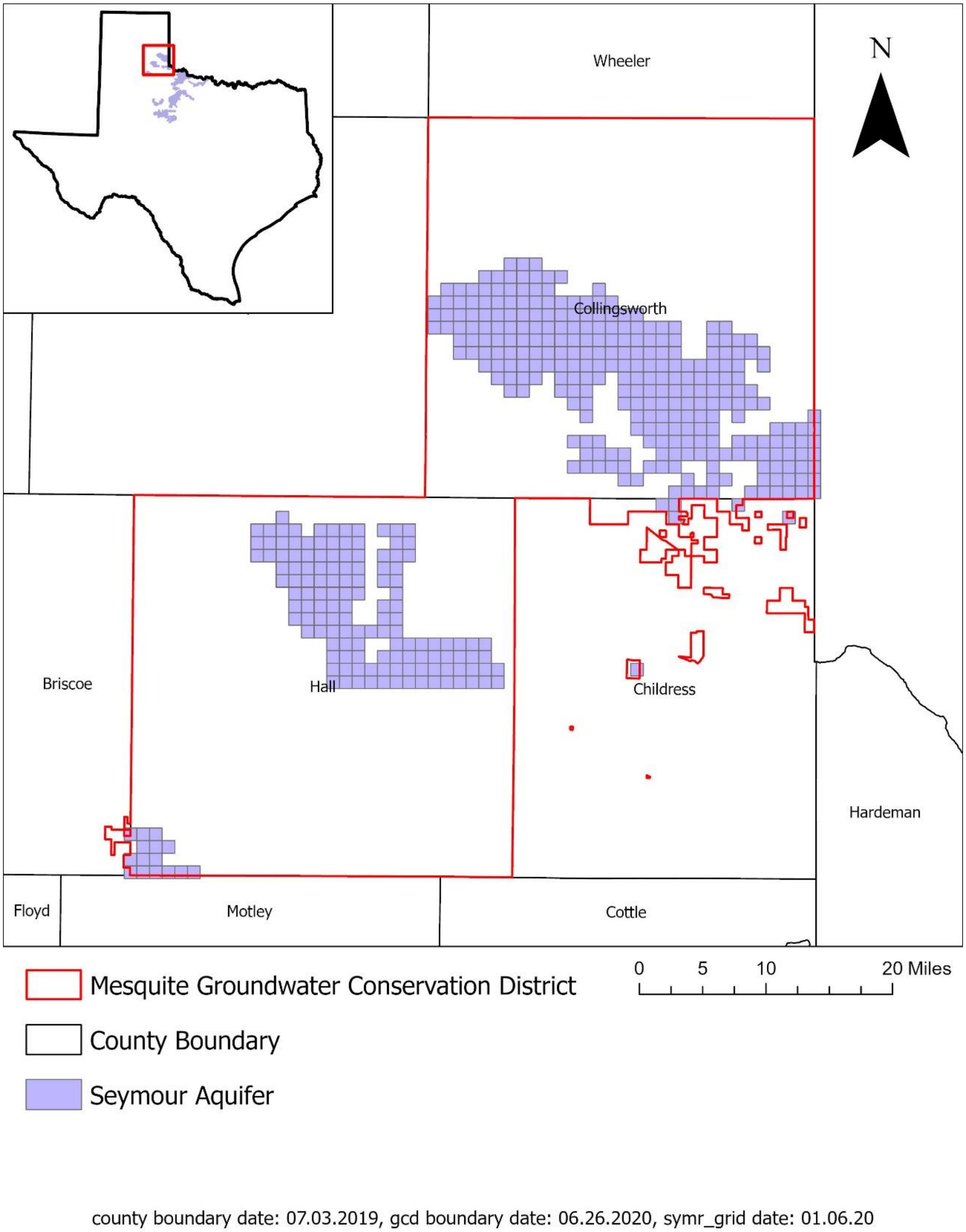
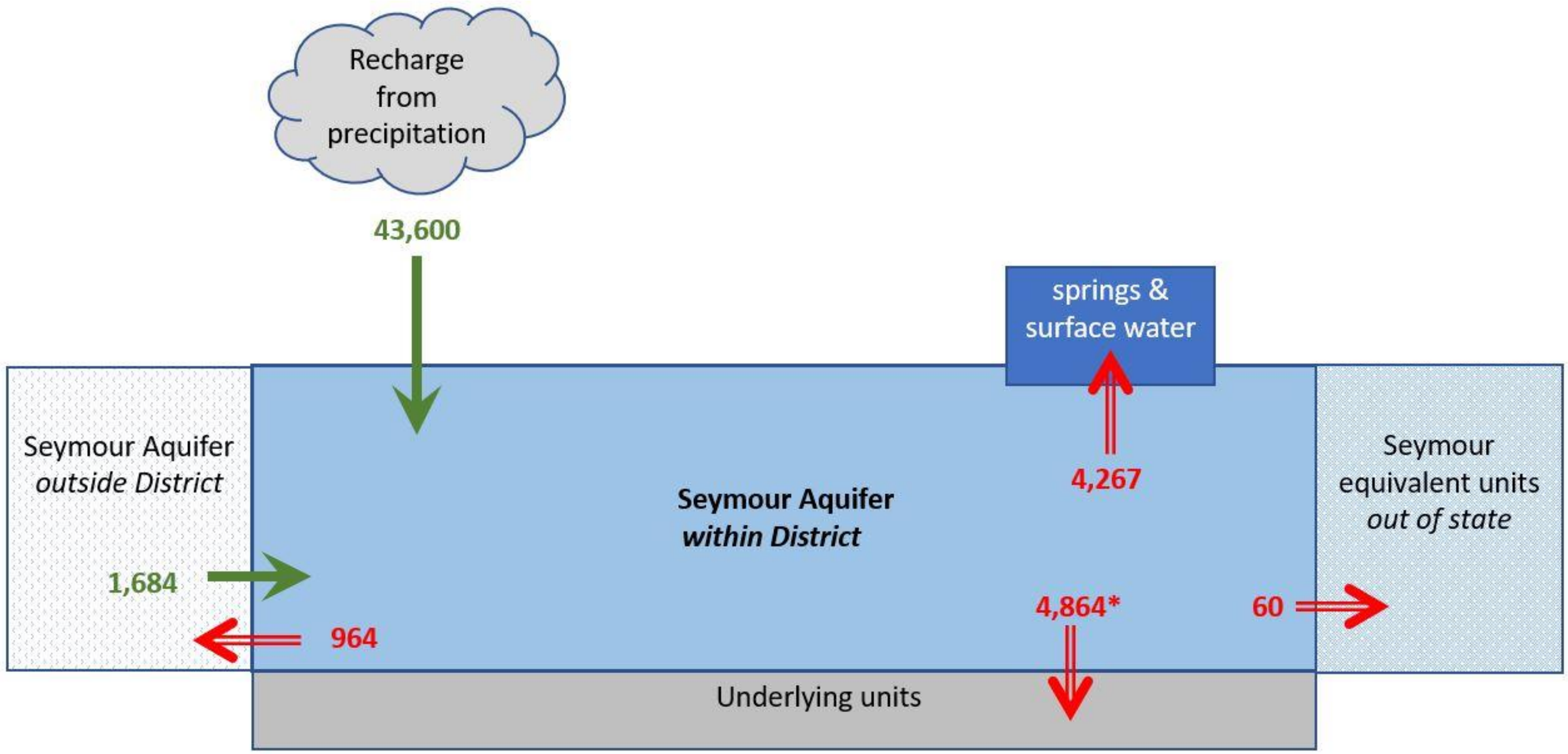


Figure 3: Area of the groundwater availability model for the Seymour Aquifer from which the information in Table 2 was extracted (the Seymour Aquifer extent within the district boundary).



* Flow from Underlying units within District includes net flow of 12,807 acre-feet per year from Seymour Aquifer to Blaine Aquifer and 7,943 acre-feet per year to Seymour Aquifer from underlying confining units

Caveat: This diagram only includes the water budget items provided in Table 2. A complete water budget would include additional inflows and outflows. For a full groundwater budget, please submit a request in writing to the Groundwater Modeling Department.

Figure 4: Generalized diagram of the summarized budget information from Table 2, representing directions of flow for Seymour Aquifer within Mesquite Groundwater Conservation District. Flow values are expressed in acre-feet per year.

Table 3: Summarized information for the Blaine Aquifer for the Mesquite Groundwater Conservation District 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	Blaine Aquifer	23,766
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Blaine Aquifer	21,668
Estimated annual volume of flow into the district within each aquifer in the district	Blaine Aquifer	12,088
Estimated annual volume of flow out of the district within each aquifer in the district	Blaine Aquifer	17,054
Estimated net annual volume of flow between each aquifer in the district	To Blaine Aquifer from Seymour Aquifer	12,807
	To Blaine Aquifer from Permian confining units	13,663
	From Blaine Aquifer to Blaine equivalent units in Oklahoma	3,911

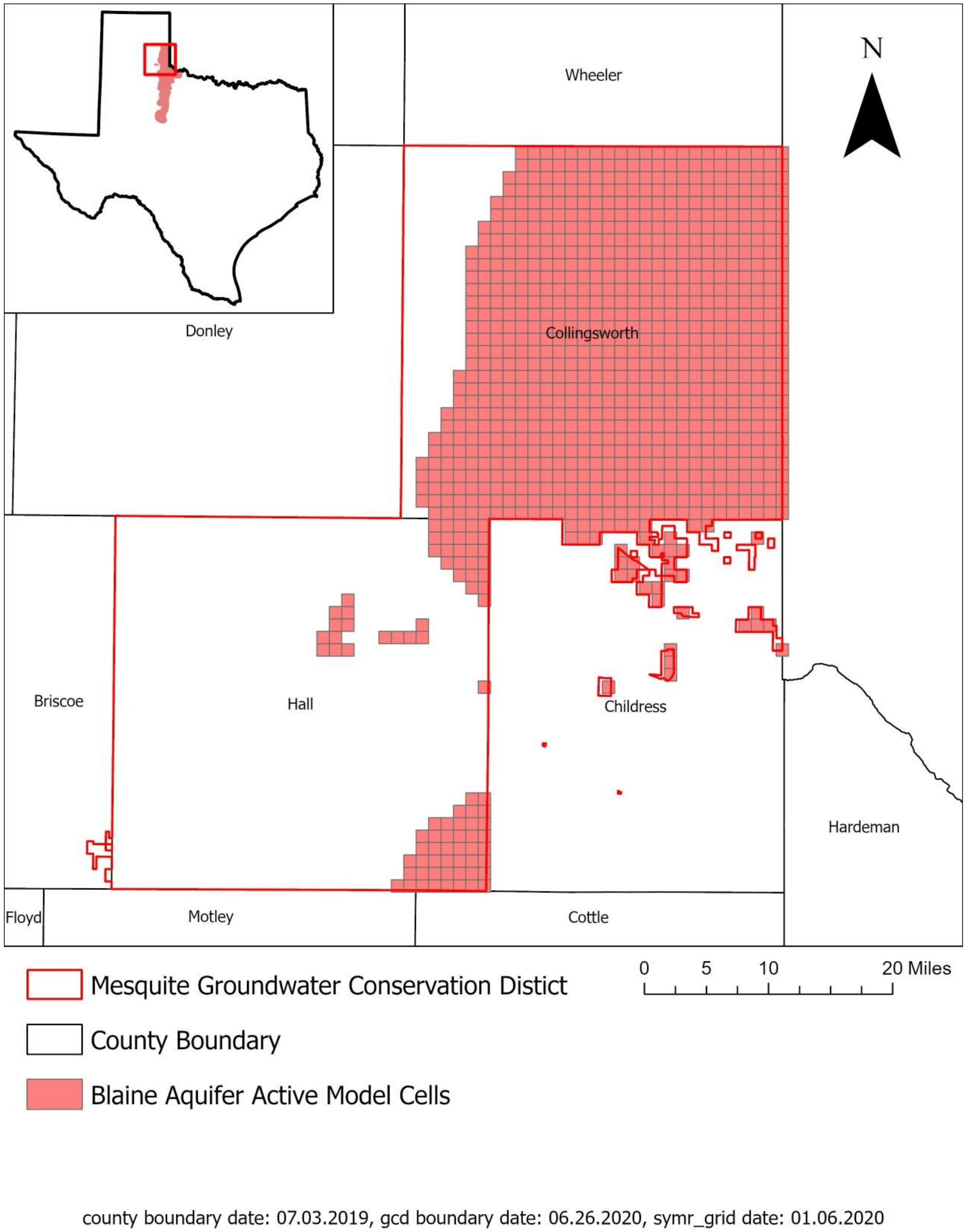


Figure 5: Area of the groundwater availability model for the Seymour Aquifer from which the information in Table 3 was extracted (the Blaine Aquifer extent within the district boundary).

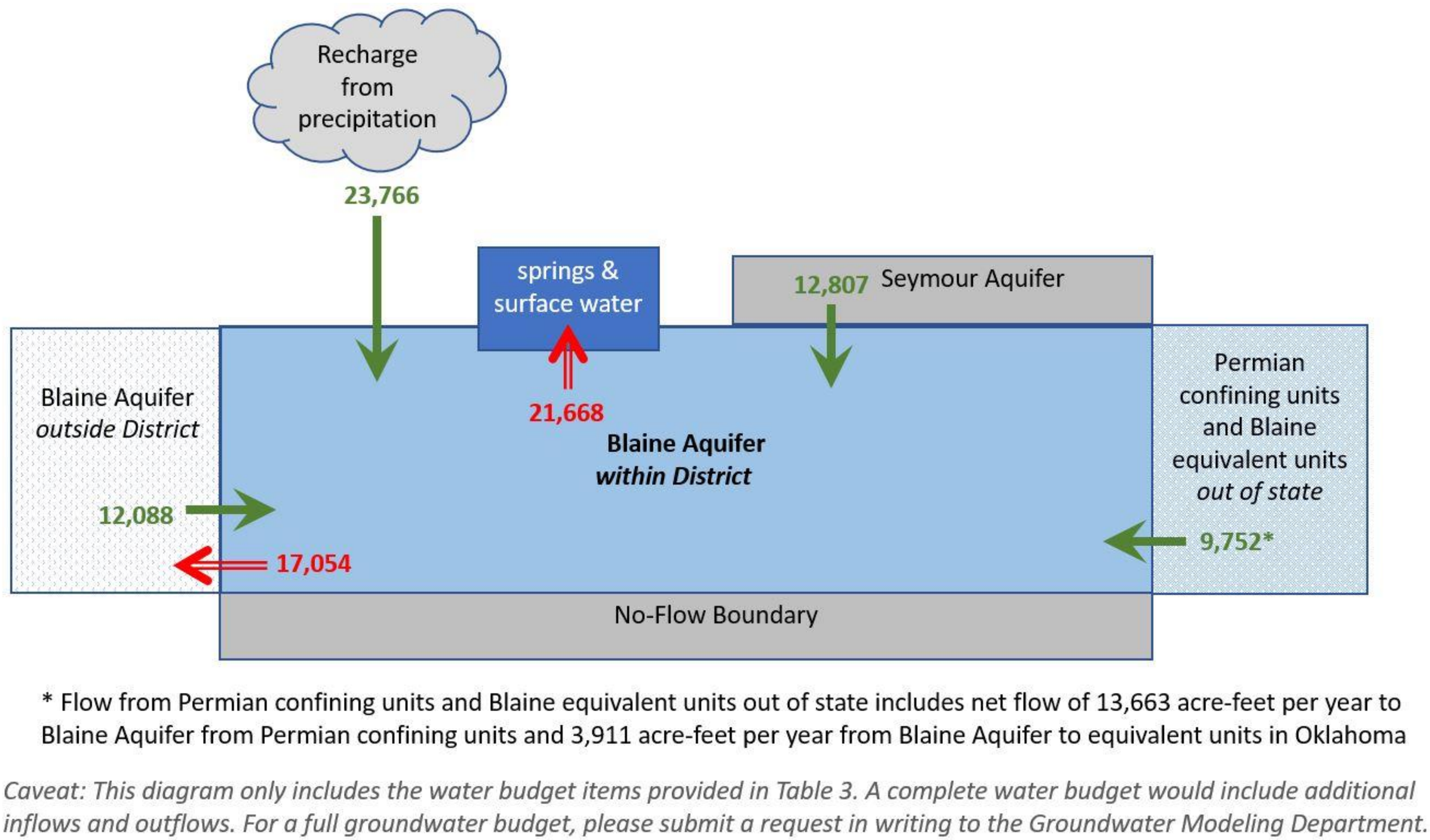


Figure 6: Generalized diagram of the summarized budget information from Table 3, representing directions of flow for the Blaine Aquifer within the Mesquite Groundwater Conservation District. Flow values are expressed in acre-feet per year

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.

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Texas Water Code § 36.1071.