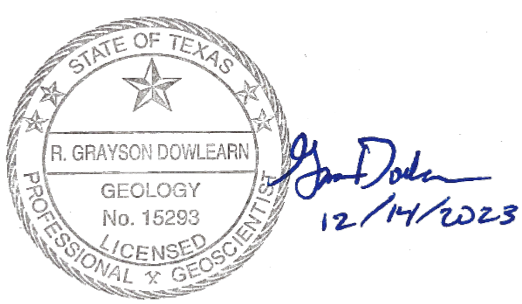
GAM RUN 23-023: PLATEAU UNDERGROUND WATER CONSERVATION & SUPPLY DISTRICT MANAGEMENT PLAN

Saheli Majumdar, Ph.D. and Grayson Dowlearn, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-936-2404
December 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 Plateau Underground Water Conservation & Supply 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 Plateau Underground Water Conservation & Supply District should be adopted by the district on or before February 9, 2024, and submitted to the executive administrator of the TWDB on or before March 10, 2024. The current management plan for the Plateau Underground Water Conservation & Supply District expires on May 9, 2024.

We used two groundwater availability models for the Plateau Underground Water Conservation & Supply District. Information for the Edwards-Trinity (Plateau) Aquifer is from version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers (Anaya and Jones, 2009). Information for the Lipan Aquifer is from version 1.01 of the groundwater availability model for the Lipan Aquifer (Beach and others, 2004).

This report replaces the results of GAM Run 13-009 (Boghici, 2013). 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 and 2 summarize the groundwater availability model data required by statute. Figures 1 and 3 show the area of the models from which the values in Tables 1 and 2 were extracted. Figures 2 and 4 provide a generalized diagram of the groundwater flow components provided in Tables 1 and 2. If the Plateau Underground Water Conservation & Supply District determines that the district boundaries used in the assessment do not reflect current conditions after reviewing the figures, please notify the TWDB Groundwater Modeling Department 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 the provisions of the Texas Water Code § 36.1071(h), the groundwater availability models mentioned above were used to estimate information for the Plateau Underground Water Conservation & Supply District management plan. Water budgets were extracted for the historical model periods in the respective groundwater availability models. Water budgets were extracted for the historical calibration periods of the Edwards-Trinity (Plateau) Aquifer (1981 through 2000) and for the Lipan Aquifer (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:

Groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers

- We used version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers (Anaya and Jones, 2009) to analyze the Edwards-Trinity (Plateau) Aquifer. See Anaya and Jones (2009) for assumptions and limitations of the model.
- The groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers contains the following two layers in the Plateau Underground Water Conservation & Supply District:
    - Layer 1 represents the Edwards hydrostratigraphic unit of the Edwards-Trinity (Plateau) Aquifer.
    - Layer 2 represents the Trinity hydrostratigraphic unit of the Edwards-Trinity (Plateau) Aquifer.
- The two layers were combined for calculating water budget flows in the Edwards-Trinity (Plateau) Aquifer within the district.
- Water budget terms were averaged for the period 1981 through 2000 (stress periods 2 through 21).
- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

Groundwater availability model for Lipan aquifer

- We used version 1.01 of the groundwater availability model for the Lipan aquifer (Beach and others, 2004) to analyze the Lipan aquifer. See Beach and others, (2004) for assumptions and limitations of the model.
- The groundwater availability model for the Lipan contains one layer with a constant thickness of 400 feet. The layer represents portions of the Quaternary Leona Formation, underlying Permian units, adjacent Permian units, and overlying Edwards-Trinity (Plateau) Aquifer.
- Streams, rivers, and springs were incorporated into the model using the MODFLOW Stream-routing package. The MODFLOW reservoir package was used to include the reservoirs. The North Concho River was simulated using the MODFLOW Drain package as it is a non-perennial river. For this management plan model run, there is no groundwater discharge to surface water though lateral groundwater flows in or out of the aquifer.
- Water budget terms were averaged for the period 1980 through 1998 (stress periods 2 through 20). The last stress period in the historical calibration, representing the year 1999, was not included because of incorrect pumping values applied to the model.
- 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 Edwards-Trinity (Plateau) and Lipan aquifers located within the Plateau Underground Water Conservation & Supply District and averaged over the historical calibration period, 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 the 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 defines the amount of leakage that occurs.

The information needed for the district's management plan is summarized in Tables 1 and 2. Figures 1 and 3 show the area of the models from which the values in Tables 1 and 2 were extracted. Figures 2 and 4 provide a generalized diagram of the groundwater flow components provided 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 Edwards-Trinity (Plateau) Aquifer that is needed for the Plateau Underground Water Conservation & Supply 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	Results
Estimated annual amount of recharge from precipitation to the district	Edwards-Trinity (Plateau) Aquifer	22,505
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	8,317
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	7,490
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	28,565
Estimated net annual volume of flow within each aquifer in the district	Not applicable	Not applicable

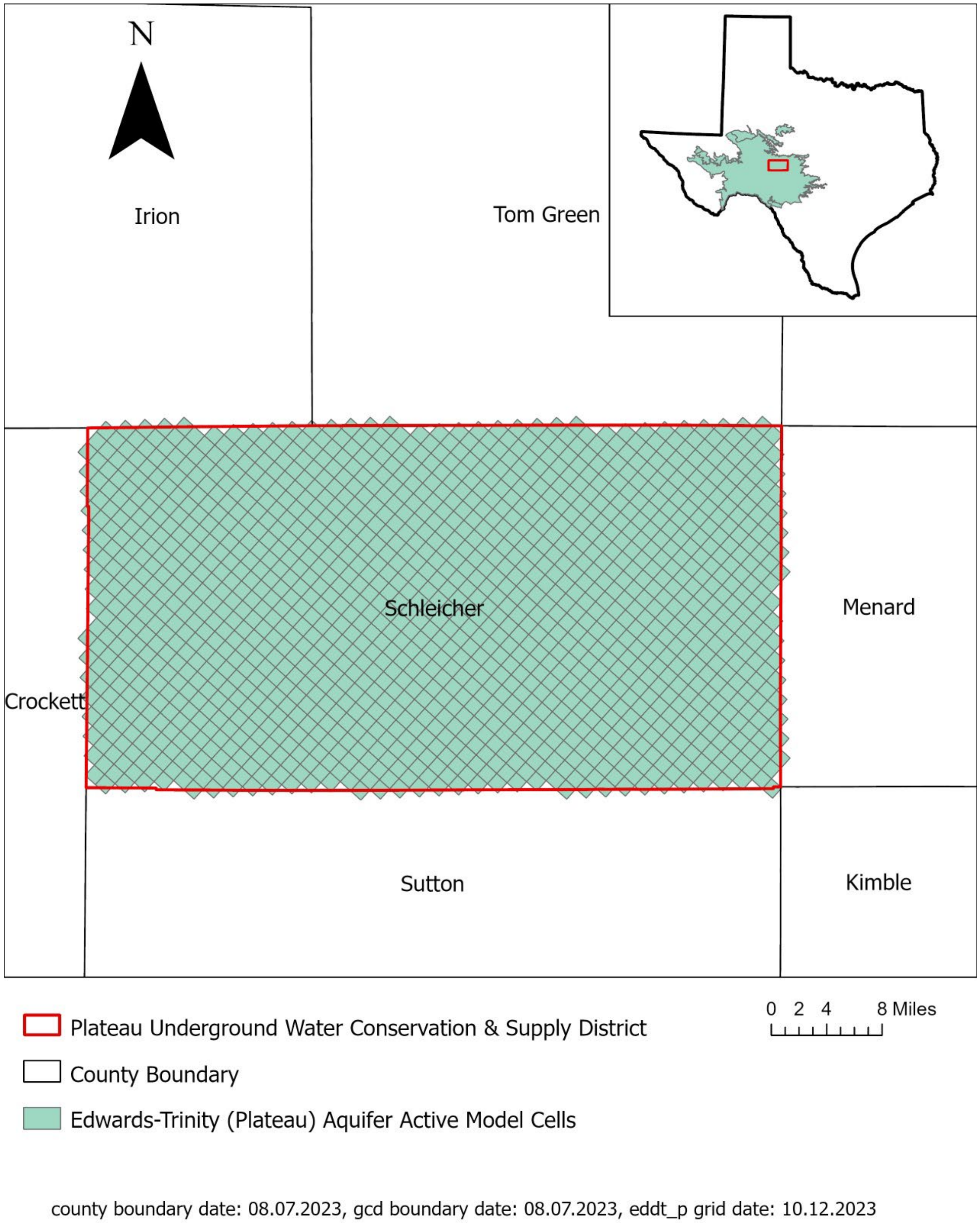

Figure 1: Area of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers from which the information in Table 1 was extracted (the Edwards-Trinity [Plateau] Aquifer extent within the district boundary).

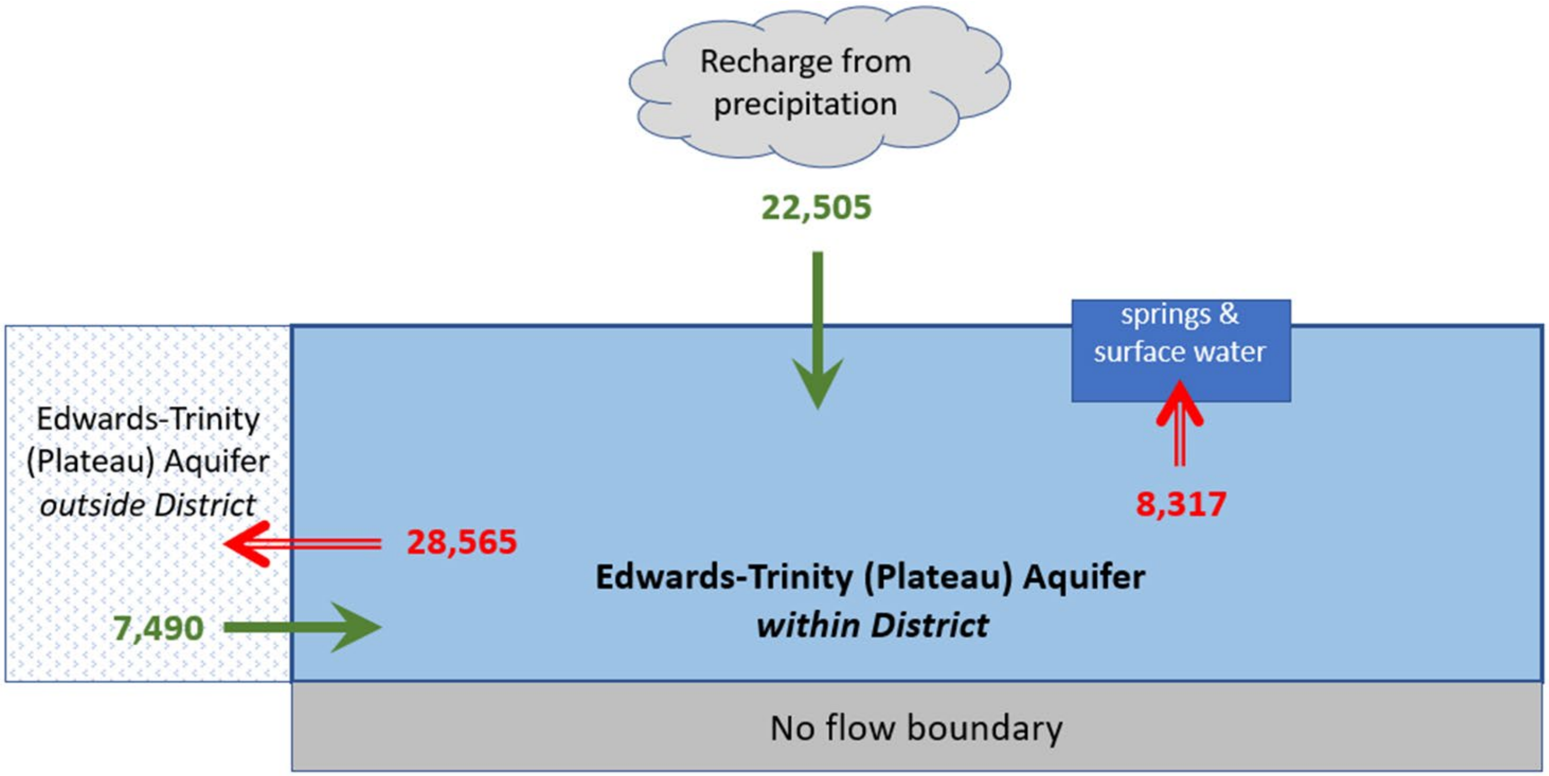

Figure 2: Generalized diagram of the summarized budget information from Table 1, representing directions of flow for the Edwards-Trinity (Plateau) Aquifer within the Plateau Underground Water Conservation & Supply District. Flow values are expressed in acre-feet per year.

Table 2: Summarized information for the Lipan Aquifer that is needed for the Plateau Underground Water Conservation & Supply 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	Results
Estimated annual amount of recharge from precipitation to the district	Lipan Aquifer	0*
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Lipan Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Lipan Aquifer	18
Estimated annual volume of flow out of the district within each aquifer in the district	Lipan Aquifer	413
Estimated net annual volume of flow within each aquifer in the district	Not applicable	Not applicable

* The portion of the Lipan Aquifer within the Plateau Underground Water Conservation & Supply District lies below the Edwards-Trinity (Plateau) Aquifer. Therefore, the 384 acre-feet per year of recharge from precipitation calculated from the groundwater availability model for the Lipan Aquifer is already included in the recharge value for the Edwards-Trinity (Plateau) Aquifer in Table 1, and recharge within this table is set to 0 acre-feet per year.

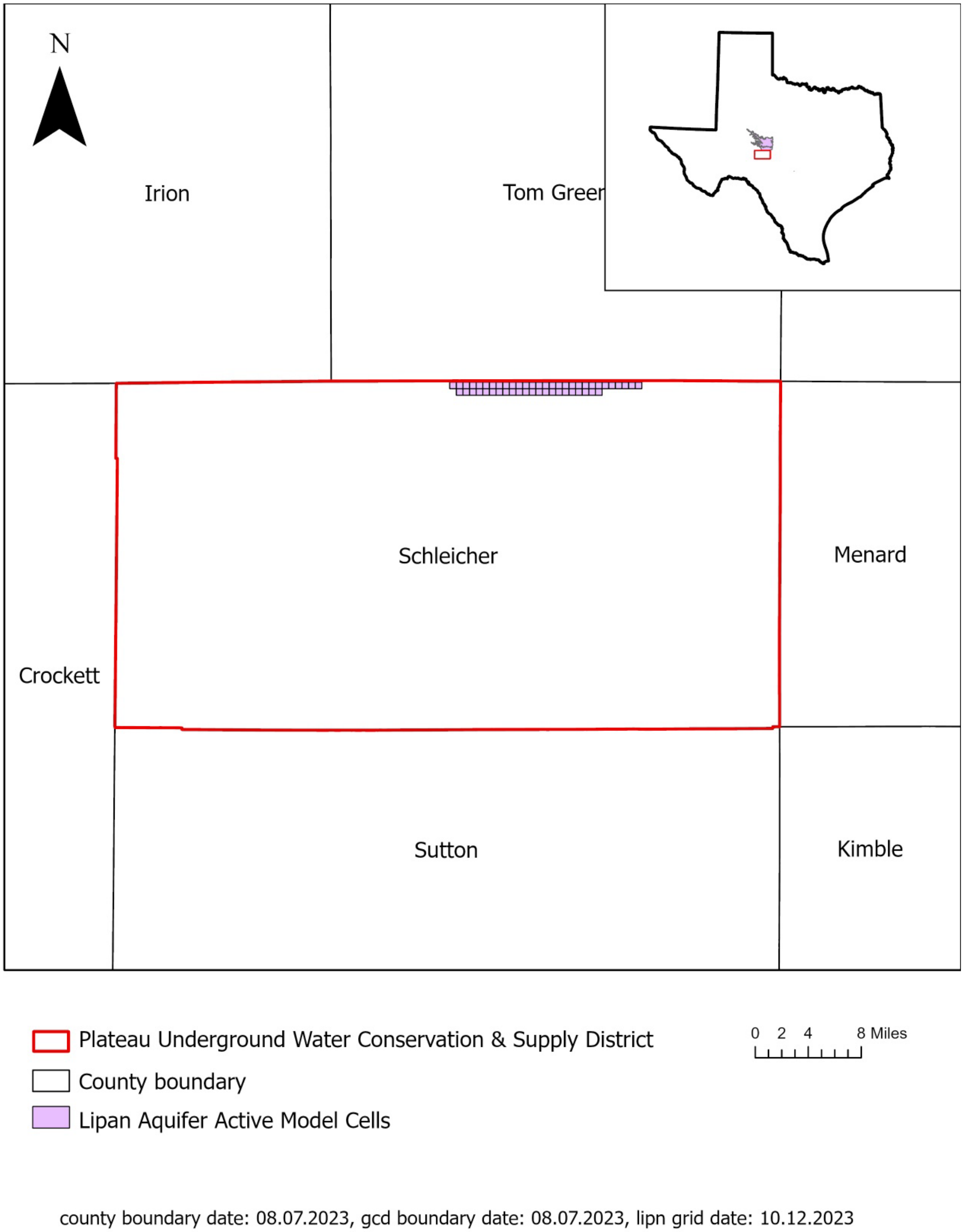

Figure 3: Area of the groundwater availability model for the Lipan Aquifer from which the information in Table 2 was extracted (the Lipan Aquifer extent within the district boundary).

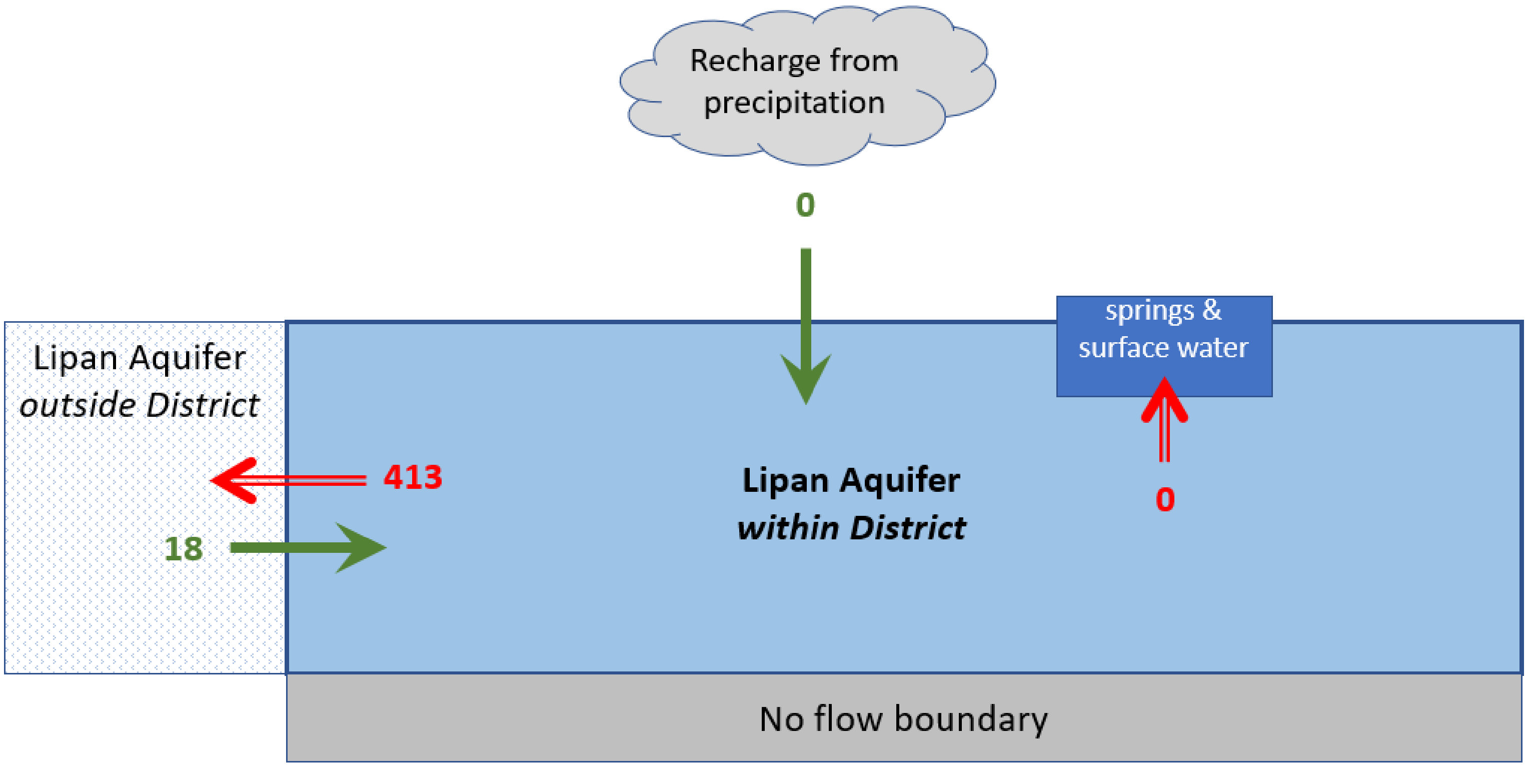

Figure 4: Generalized diagram of the summarized budget information from Table 2, representing directions of flow for the Lipan Aquifer within the Plateau Underground Water Conservation & Supply District. Flow values are expressed in acre-feet per year.

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.

REFERENCES:

Anaya, R., and Jones, I., 2009, Groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers of Texas: Texas Water Development Board, Report 373, 103 p., www.twdb.texas.gov/groundwater/models/gam/eddt_p/ET-Plateau_Full.pdf

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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 § 36.1071