GAM RUN 13-024: MID-EAST TEXAS GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

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Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-6641
August 28, 2013

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EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (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. Information derived from groundwater availability models that shall be included in the groundwater management plan includes:

- for each aquifer within the district, the annual amount of recharge from infiltration of precipitation to the groundwater resources within the district, if any;
- the annual volume of water that discharges from the aquifer to springs and any surface water bodies, including lakes, streams, and rivers; and
- the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

This report (Part 2 of a two-part package of information from the TWDB to Mid-East Texas Groundwater Conservation District) fulfills the requirements noted above. Part 1 of the two-part package is the Historical Water Use/State Water Plan data report. The District should have received, or will receive, this data report from the TWDB Groundwater Technical Assistance Section. Questions about the data report should be directed to Mr. Stephen Allen, Stephen.Allen@twdb.texas.gov or (512) 463-7317.

The groundwater management plan for the Mid-East Texas Groundwater Conservation District should be adopted by the district on or before July 1, 2014 and submitted to the executive administrator of the TWDB on or before July 31, 2014. The current management plan for the Mid-East Texas Groundwater Conservation District expires on September 29, 2014.

This report discusses the methods, assumptions, and results from model runs using the groundwater availability models for the central portions of the Carrizo-Wilcox, Queen City, and Sparta aquifers (version 2.02) and the Yegua-Jackson Aquifer (version 1.01) (Kelley and others, 2004; Deeds and others, 2010). Tables 1 through 4 summarize the groundwater availability model data required by the statute, and Figures 1 through 4 show the areas of the models from which the values in the tables were extracted. This model run replaces the results of GAM Run 08-077 (Aschenbach, 2009). GAM Run 13-024 meets current standards set after the release of Gam Run 08-077 including a refinement of using the extent of the official aquifer boundaries within the district. If after review of the figures, Mid-East Texas Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the Texas Water Development Board immediately.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability models for the central portions of the Carrizo-Wilcox, Queen City, and Sparta aquifers and the Yegua-Jackson Aquifer were run for this analysis. Mid-East Texas Groundwater Conservation District water budgets for the historical model periods were extracted 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, net inter-aquifer flow (upper), and net inter-aquifer flow (lower) for the portions of the aquifers located within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Carrizo-Wilcox, Queen City, and Sparta aquifers

- We used version 2.02 of the groundwater availability model for the central part of the Carrizo-Wilcox, Queen City, and Sparta aquifers. See Dutton and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model for the central 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 or Calvert Bluff Formation (Layer 6), the Middle Wilcox or Simsboro Formation (Layer 7), and the Lower Wilcox or Hooper Formation (Layer 8). Individual water budgets for the District were determined for the Sparta Aquifer (Layer 1), the Queen City Aquifer (Layer 3), and the Carrizo-Wilcox Aquifer (Layer 5 through Layer 8 collectively).

- 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.

- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

Yegua-Jackson Aquifer

- We used version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer. See Deeds and others (2010) for assumptions and limitations of the groundwater availability model.

- This groundwater availability model includes five layers which represent the outcrop section for the Yegua-Jackson Aquifer and younger overlying units (Layer 1), the upper portion of the Jackson Group (Layer 2), the lower portion of the Jackson Group (Layer 3), the upper portion of the Yegua Group (Layer 4), and the lower portion of the Yegua Group (Layer 5).

- An overall water budget for the District was determined for the Yegua-Jackson Aquifer (Layer 1 through Layer 5 collectively for the portions of the model that represent the Yegua-Jackson Aquifer).

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

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 duration of the calibration and verification portion of the model runs in the district, as shown in Tables 1 through 4.

- 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.
- Surface water outflow—The total water discharging from the aquifer (outflow) to surface water features such as streams, reservoirs, and drains (springs).
- Flow into and out of district—The lateral flow within the aquifer between the district and adjacent counties.
- Flow between aquifers—The net vertical flow between aquifers or confining units. This flow is controlled by the relative water levels in each aquifer or confining unit and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs. “Inflow” to an aquifer from an overlying or underlying aquifer will always equal the “Outflow” from the other aquifer.

The information needed for the District’s management plan is summarized in Tables 1 through 4. 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 YEGUA-JACKSON AQUIFER THAT IS NEEDED FOR THE MID-EAST TEXAS 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 groundwater resources within the district	Yegua-Jackson Aquifer	31,137
Estimated annual volume of water that discharges from the aquifer to springs and any surface water bodies, including lakes, streams, and rivers	Yegua-Jackson Aquifer	46,448
Estimated annual volume of flow into the district within each aquifer in the district	Yegua-Jackson Aquifer	16,334
Estimated annual volume of flow out of the district within each aquifer in the district	Yegua-Jackson Aquifer	11,401
Estimated net annual volume of flow between each aquifer in the district	Yegua-Jackson Aquifer	0[1]

[1] The model assumptions include no groundwater flow between the Yegua-Jackson Aquifer and underlying stratigraphic units.

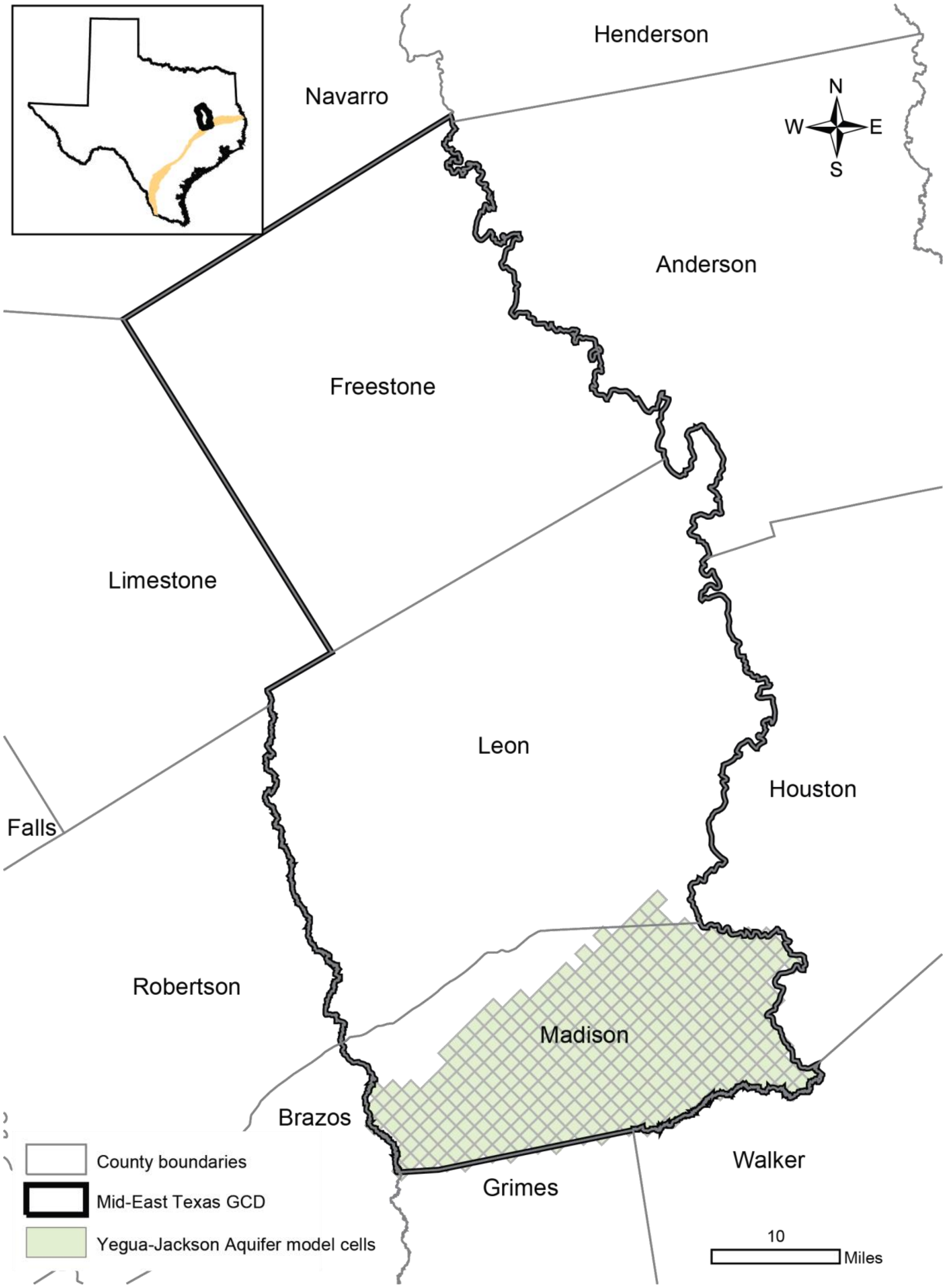

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE YEGUA-JACKSON AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED. ONLY THE CELLS REPRESENTING THE YEGUA-JACKSON AQUIFER WITHIN THE DISTRICT BOUNDARIES ARE SHOWN.

TABLE 2: SUMMARIZED INFORMATION FOR THE SPARTA AQUIFER THAT IS NEEDED FOR THE MID-EAST TEXAS 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 groundwater resources within the district	Sparta Aquifer	15,100
Estimated annual volume of water that discharges from the aquifer to springs and any surface water bodies, including lakes, streams, and rivers	Sparta Aquifer	3,702
Estimated annual volume of flow into the district within each aquifer in the district	Sparta Aquifer	1,135
Estimated annual volume of flow out of the district within each aquifer in the district	Sparta Aquifer	914
Estimated net annual volume of flow between each aquifer in the district	From the Sparta Aquifer to overlying stratigraphic Unit	445
	From the Sparta Aquifer to the Weches Confining Unit	1,121
	From the Sparta Aquifer to down-dip parts of the Sparta Formation	86

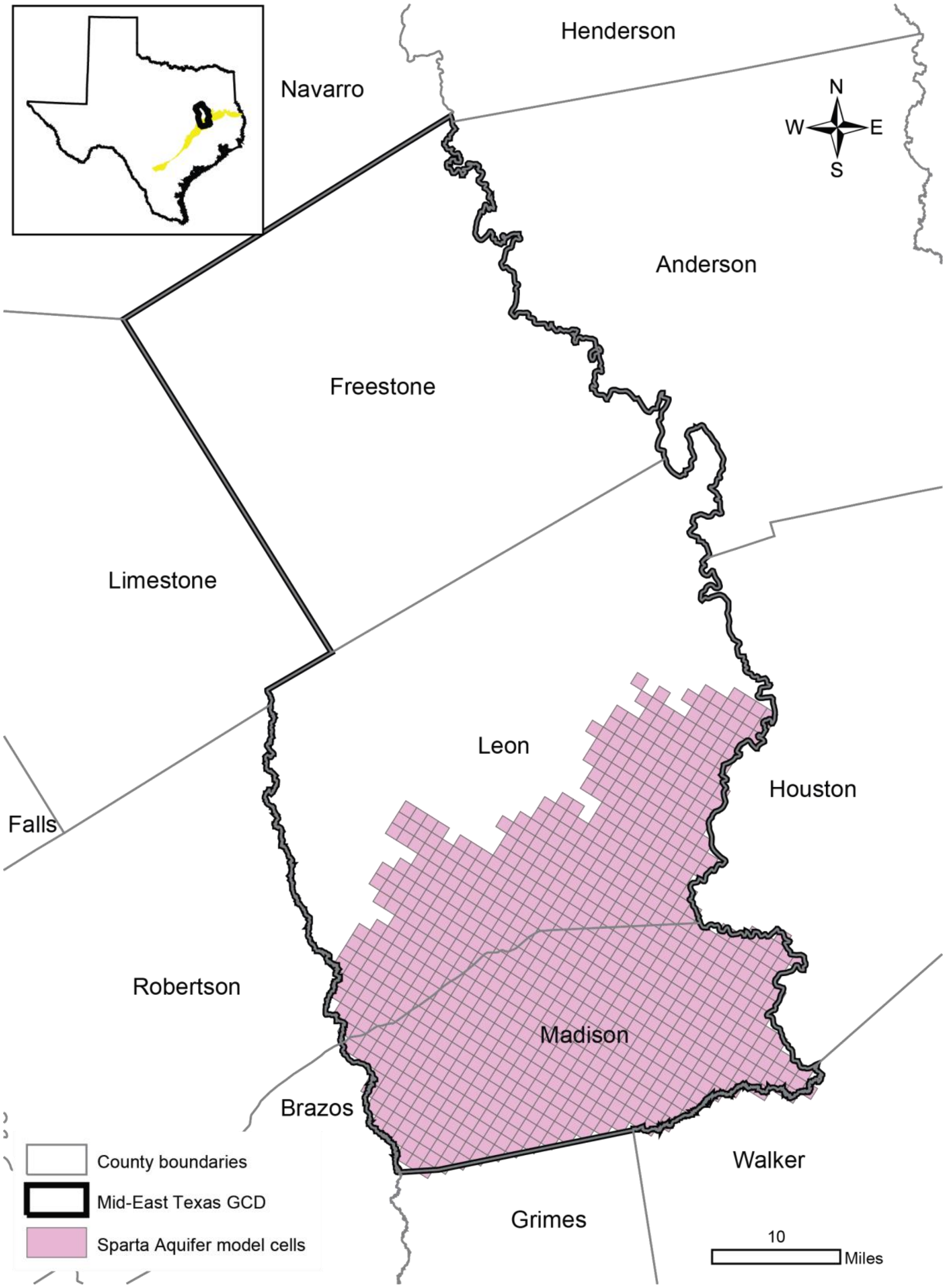

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE SPARTA AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED. ONLY THE CELLS REPRESENTING THE SPARTA AQUIFER WITHIN THE DISTRICT BOUNDARIES ARE SHOWN.

TABLE 3: SUMMARIZED INFORMATION FOR THE QUEEN CITY AQUIFER THAT IS NEEDED FOR THE MID-EAST TEXAS 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 groundwater resources within the district	Queen City Aquifer	26,645
Estimated annual volume of water that discharges from the aquifer to springs and any surface water bodies, including lakes, streams, and rivers	Queen City Aquifer	16,399
Estimated annual volume of flow into the district within each aquifer in the district	Queen City Aquifer	2,000
Estimated annual volume of flow out of the district within each aquifer in the district	Queen City Aquifer	2,294
Estimated net annual volume of flow between each aquifer in the district	To the Queen City Aquifer from the Weches Confining Unit	2,126
	To the Queen City Aquifer from the Reklaw Confining Unit	150
	From the Queen City Aquifer to down-dip parts of the Queen City Formation	130

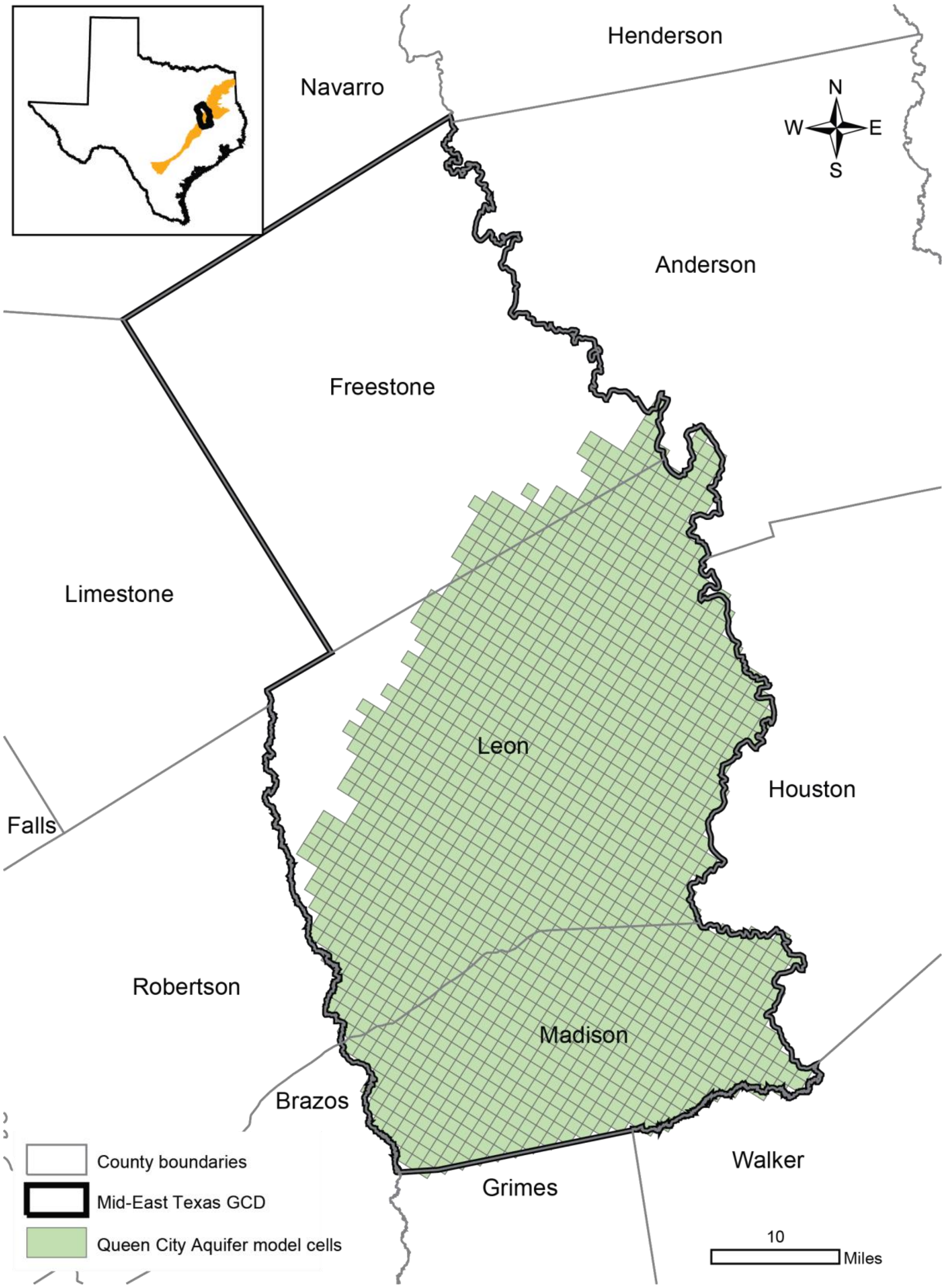

FIGURE 3: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE QUEEN CITY AQUIFER FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED. ONLY THE CELLS REPRESENTING THE QUEEN CITY AQUIFER WITHIN THE DISTRICT BOUNDARIES ARE SHOWN.

TABLE 4: SUMMARIZED INFORMATION FOR THE CARRIZO-WILCOX AQUIFER THAT IS NEEDED FOR THE MID-EAST TEXAS 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 groundwater resources within the district	Carrizo-Wilcox Aquifer	48,603
Estimated annual volume of water that discharges from the aquifer to springs and any surface water bodies, including lakes, streams, and rivers	Carrizo-Wilcox Aquifer	35,855
Estimated annual volume of flow into the district within each aquifer in the district	Carrizo-Wilcox Aquifer	10,474
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo-Wilcox Aquifer	21,365
Estimated net annual volume of flow between each aquifer in the district	To the Carrizo-Wilcox Aquifer from the Reklaw Confining Unit	29
	To the Carrizo-Wilcox Aquifer from down-dip stratigraphic units	4,184

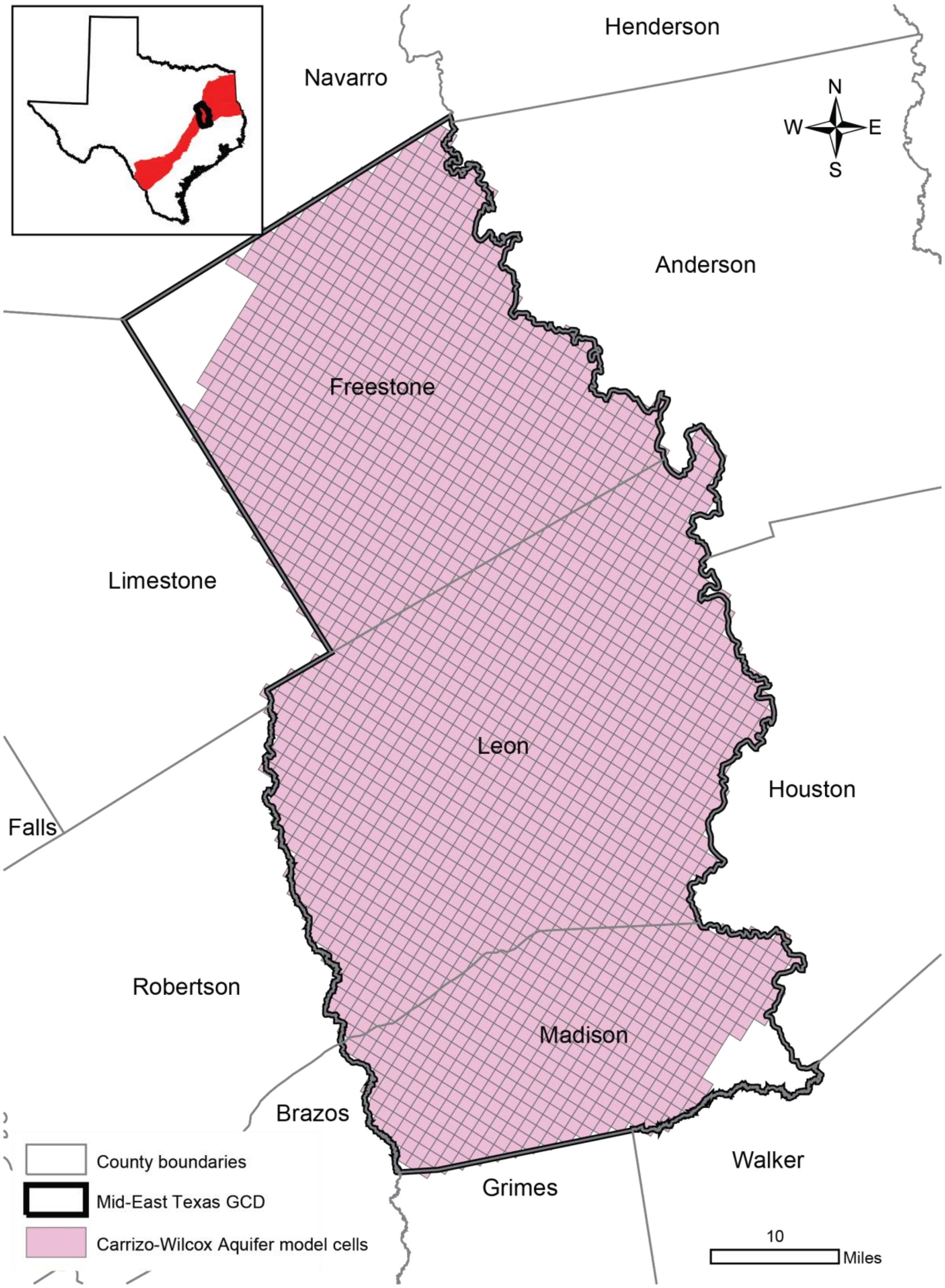

FIGURE 4: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CARRIZO-WILCOX AQUIFER FROM WHICH THE INFORMATION IN TABLE 4 WAS EXTRACTED. ONLY THE CELLS REPRESENTING THE CARRIZO-WILCOX AQUIFER WITHIN THE DISTRICT BOUNDARIES ARE SHOWN.

LIMITATIONS

The groundwater model(s) used in completing this analysis is the best available scientific tool that can be used to meet the stated objective(s). 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:

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