GAM Run 09-030

by Mr. Wade Oliver
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-3132
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EXECUTIVE SUMMARY:

Texas 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 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:

(1) the annual amount of recharge from precipitation to the groundwater resources within the district, if any;
(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 purpose of this model run is to provide updated information to Cow Creek Groundwater Conservation District for its groundwater management plan. This modeling information, which is derived from the updated groundwater availability model for the Hill Country portion of the Trinity Aquifer, is to be used in place of the results presented in Groundwater Availability Model Run 07-24 (Wade, 2007) in development of the district's groundwater management plan. The groundwater management plan for Cow Creek Groundwater Conservation District is due for approval by the Executive Administrator of the Texas Water Development Board on November 23, 2009.

This report discusses the methods, assumptions, and results from a model run using the updated groundwater availability model for the Hill Country portion of the Trinity Aquifer, which includes the portions of the Edwards-Trinity (Plateau) Aquifer in the district. Table 1 summarizes the groundwater availability model data required by statute for Cow Creek Groundwater Conservation District's groundwater management plan. Figure 1 shows the area of the model from which the values in Table 1 were extracted.

METHODS:

We ran the groundwater availability model and (1) extracted water budgets for each year of the 1981 through 1997 period, and (2) averaged the 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.

PARAMETERS AND ASSUMPTIONS:

- We used version 2.01 of the groundwater availability model for the Hill County portion of the Trinity Aquifer. See Jones and others (2009) for assumptions and limitations of the groundwater availability model.

- The groundwater availability model includes four layers, representing:
  1. the Edwards Group of the Edwards-Trinity (Plateau) Aquifer (Layer 1)
  2. the Upper Trinity Aquifer (Layer 2)
  3. the Middle Trinity Aquifer (Layer 3)
  4. the Lower Trinity Aquifer (Layer 4)

- The Trinity Aquifer and the Trinity portion of the Edwards-Trinity (Plateau) Aquifer are both divided in the model into upper, middle, and lower Trinity units. The values for the Trinity portions of each of these aquifers are reported separately in Table 1.

- The mean absolute errors (a measure of the difference between simulated and measured water levels during model calibration) for the aquifers in the model for 1990 and 1997 were 52 and 57 feet, respectively (Jones and others, 2009).

- The groundwater availability model includes some portions of the Edwards Group outside the official boundary of the Edwards-Trinity (Plateau) Aquifer. Though flow for these areas is not explicitly reported, the interaction between the Edwards Group (outside the Edwards-Trinity Plateau Aquifer) and the underlying Trinity Aquifer is shown in the "flow between aquifers" segment of Table 1.

- We used Processing Modflow for Windows (PMWIN) version 5.3 (Chiang and Kinzelbach, 2001) as the interface to process model output.

RESULTS:

A groundwater budget summarizes the water entering and leaving the aquifer according to the groundwater availability model. Selected components were extracted from the groundwater budget for the aquifers located within the district and averaged over the duration of the calibrated portion of the model run (1981 - 1997) in the district, as shown in Table 1. The components of the modified budgets shown in Table 1 include:

- Precipitation recharge—This is 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—This is the total water exiting the aquifer (outflow) to surface water features such as streams, reservoirs, and drains (springs).

- Flow into and out of district—This component describes lateral flow within the aquifer between the district and adjacent counties.

- Flow between aquifers—This describes the vertical flow, or leakage, 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 Table 1. 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 needed for Cow Creek Groundwater Conservation District's groundwater management plan. All values are reported in acre-feet per year. All values are 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 Group (Edwards-Trinity Plateau Aquifer)	3,346
	Upper Trinity (Edwards-Trinity Plateau Aquifer)	123
	Middle Trinity (Edwards-Trinity Plateau Aquifer)	0
	Lower Trinity (Edwards-Trinity Plateau Aquifer)	0
	Upper Trinity (Trinity Aquifer)	29,514
	Middle Trinity (Trinity Aquifer)	22,654
	Lower Trinity (Trinity Aquifer)	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Edwards Group (Edwards-Trinity Plateau Aquifer)	3,061
	Upper Trinity (Edwards-Trinity Plateau Aquifer)	0
	Middle Trinity (Edwards-Trinity Plateau Aquifer)	0
	Lower Trinity (Edwards-Trinity Plateau Aquifer)	0
	Upper Trinity (Trinity Aquifer)	4,521
	Middle Trinity (Trinity Aquifer)	24,728
	Lower Trinity (Trinity Aquifer)	0
Estimated annual volume of flow into the district within each aquifer in the district	Edwards Group (Edwards-Trinity Plateau Aquifer)	238
	Upper Trinity (Edwards-Trinity Plateau Aquifer)	2,848
	Middle Trinity (Edwards-Trinity Plateau Aquifer)	5,504
	Lower Trinity (Edwards-Trinity Plateau Aquifer)	294
	Upper Trinity (Trinity Aquifer)	3,555
	Middle Trinity (Trinity Aquifer)	11,549
	Lower Trinity (Trinity Aquifer)	1,551
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards Group (Edwards-Trinity Plateau Aquifer)	333
	Upper Trinity (Edwards-Trinity Plateau Aquifer)	2,332
	Middle Trinity (Edwards-Trinity Plateau Aquifer)	5,719
	Lower Trinity (Edwards-Trinity Plateau Aquifer)	721
	Upper Trinity (Trinity Aquifer)	11,632
	Middle Trinity (Trinity Aquifer)	18,432
	Lower Trinity (Trinity Aquifer)	7,065

Table 1: cont.

Management Plan requirement	Aquifer or confining unit	Results
Estimated net annual volume of flow between each aquifer in the district	Edwards Group to the Upper Trinity (Edwards-Trinity Plateau Aquifer)	97
	Upper Trinity to the Middle Trinity (Edwards-Trinity Plateau Aquifer)	659
	Middle Trinity to the Lower Trinity (Edwards-Trinity Plateau Aquifer)	427
	Edwards Group (outside Edwards-Trinity Plateau Aquifer) to the Upper Trinity (Trinity Aquifer)	58*
	Upper Trinity to the Middle Trinity (Trinity Aquifer)	15,988
	Middle Trinity to the Lower Trinity (Trinity Aquifer)	5,571

* The groundwater availability model includes some portions of the Edwards Group outside the official boundary of the Edwards-Trinity (Plateau) Aquifer. Though flow for these areas is not explicitly reported, the interaction between the Edwards Group (outside the Edwards-Trinity Plateau Aquifer) and the underlying Trinity Aquifer is shown here.

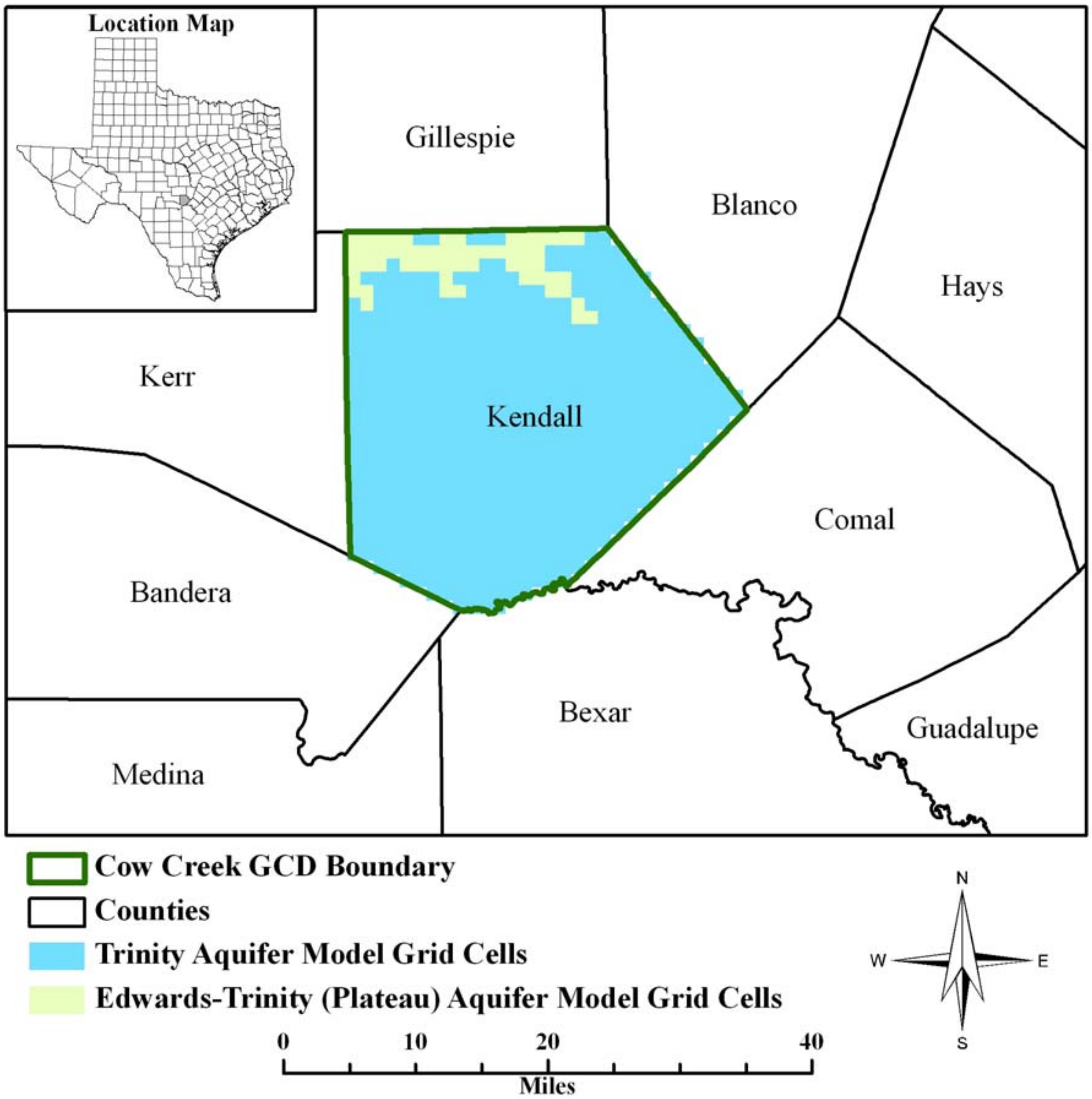

Figure 1: Area of the groundwater availability model for the Hill Country portion of the Trinity Aquifer, which also includes portions of the Edwards-Trinity (Plateau) Aquifer, from which the information in Table 1 was extracted. Note that model grid cells that straddle a political boundary were assigned to one side of the boundary based on the location of the centroid of the model cell as described above.

REFERENCES:

Jones, I.C., Anaya, R., Wade, S., 2009, Groundwater Availability Model for the Hill Country Portion of the Trinity Aquifer System, Texas, 193 p.

Chiang, W., and Kinzelbach, W., 2001, Groundwater Modeling with PMWIN, 346 p.

Wade, S., 2007, GAM run 07-24: Texas Water Development Board, GAM Run 07-24 Report, 4 p.

Cynthia K. Ridgeway is Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by employees under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G., on October 21, 2009.

Appendix A
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Full water budget for the historical model run scenario
(1981 through 1997)

Table 1. Full averaged water budget for the historical period of record (1981-1997) for Cow Creek Groundwater Conservation District. All values are reported in acre-feet per year.

	Trinity Aquifer			Edwards-Trinity (Plateau) Aquifer			
	Upper	**Middle**	**Lower**	**Edwards Group**	**Upper Trinity**	**Middle Trinity**	**Lower Trinity**
Inflow							
Recharge	29,514	22,654	0	3,346	123	0	0
Vertical Leakage Upper	58	15,991	12,341	0	97	659	465
Vertical Leakage Lower	3	6,769	0	0	0	39	0
Lateral Flow	3,555	11,549	1,551	238	2,848	5,504	294
Total Inflow	33,129	56,964	13,892	3,584	3,068	6,202	760
Outflow							
Springs and Seeps	4,521	24,728	0	3,061	0	0	0
Wells	822	1,330	54	25	35	0	0
Vertical Leakage Upper	0	3	6,769	0	0	0	39
Vertical Leakage Lower	15,991	12,341	0	97	659	465	0
Lateral Flow	11,632	18,423	7,065	333	2,332	5,719	721
Total Outflow	32,967	56,825	13,888	3,515	3,026	6,185	760
Inflow - Outflow	**163**	**139**	**4**	**69**	**42**	**17**	**0**
Storage Change	**165**	**139**	**4**	**69**	**42**	**17**	**0**
Model Error	**2**	**1**	**0**	**0**	**0**	**0**	**0**
Model Error (percent)	**0.01%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**