GAM Run 08-90mag

by Ali H. Chowdhury, Ph.D., P.G.
Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-3132
January 23, 2009

REQUESTOR:

Mr. Ronald G. Fieseler of the Blanco Pedernales Groundwater Conservation District acting on behalf of Groundwater Management Area 9.

DESCRIPTION OF REQUEST:

In a letter dated October 22, 2008, Mr. Ronald G. Fieseler provided the Texas Water Development Board (TWDB) with the desired future conditions for the Ellenberger, Hickory, Marble Falls, and the Edwards Group of the Edwards-Trinity (Plateau) aquifers in Groundwater Management Area 9 and requested that TWDB estimate managed available groundwater values. This groundwater availability modeling run presents the managed available groundwater estimate for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Groundwater Management Area 9.

DESIRED FUTURE CONDITIONS:

Desired future condition for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer submitted to TWDB by the groundwater conservation districts in Groundwater Management Area 9:

> Allow for no net increase in average drawdown (from current conditions in the Edwards Group of the Edwards-Trinity (Plateau) Aquifer).

EXECUTIVE SUMMARY:

We ran the groundwater availability model for the Hill Country portion of the Trinity Aquifer to determine the managed available groundwater based on the desired future conditions for the Edwards Group Aquifer adopted by the groundwater conservation districts in Groundwater Management Area 9. We estimate a total of about 2,118 acre-feet of managed available groundwater for the Edwards Group Aquifer in Groundwater Management Area 9. Detailed results by geographic subdivisions are listed in Table 1.

METHODS:

This report is based on previous GAM Run 08-15 (Chowdhury, 2008). In that groundwater flow simulation, pumpage for 2008 was assigned in the model based on pumpage estimates provided by Groundwater Management Area 9. Average recharge rates were used for each year of the predictive simulation to 2060. The water level decline in 2060 using the specified pumpage resulted in no net increase in average drawdown for the Edwards Group of the

Edwards-Trinity (Plateau) Aquifer. Since the desired future condition for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer prescribes no changes in drawdown from the simulated water level elevations in 2008, the assigned pumpage in the model layer representing the Edwards Group forms the managed available groundwater for the aquifer. However, some parts of counties in Groundwater Management Area 9 are located outside the model boundary (Figure 1). To consider these areas in the managed available groundwater calculation, we calculated geographic areas outside the model extent but within the county lines and aquifer boundaries. We averaged the pumpage values for all active cells within the model and determined average pumpage per square mile. This estimated average pumpage per square mile was then assigned to the area of the aquifer that lies outside the model boundary within Groundwater Management Area 9. Pumpage for areas outside the model containing the aquifer and pumpage inside active cells within the model formed the managed available groundwater for each county and/or groundwater conservation district.

Estimates of managed available groundwater were calculated for several geographic subdivisions created by the geographic information systems overlay analysis of counties, groundwater conservation districts, regional water planning areas, major river basins, the boundary extents of Groundwater Management Area 9, and the extent of the Edwards Group of the Edwards-Trinity (Plateau) Aquifer These geographically subdivided managed available groundwater values provide the greatest amount of flexibility to the groundwater management districts for summarizing managed available groundwater for both desired future conditions of the groundwater management area and for district level groundwater management planning. The geographically subdivided managed available groundwater values also assist the regional water planning areas with their planning efforts (Table 1).

PARAMETERS AND ASSUMPTIONS:

- We used the groundwater availability model for the Hill Country portion of the Trinity Aquifer developed by Mace and others (2000).

- See Mace and others (2000) for details on model construction, recharge, discharge, assumptions and limitation of the model. A slightly updated version of this model (version 1.03) was used for this run (Chowdhury, 2007).

- The model has three layers: layer 1 represents the Edwards Group, layer 2 represents the Upper Trinity Aquifer, and layer 3 represents the Middle Trinity Aquifer.

- The model has a total of 79 stress periods with 2 stress periods representing pre-development conditions, 24 monthly stress periods for representing transient conditions (1996 to 1997), and 53 predictive annual stress periods (2008 to 2060).

- The calibrated model has a root-mean squared error of 56 feet .The root-mean squared error means that, on average, the simulated water level differs by about 56 feet. This root-mean squared error is about 5 percent of the total hydraulic head drop across the modeled area.

- The rivers, streams, and springs were simulated in the model using MODFLOW's Drain package. MODFLOW's drain package was also used to simulate spring flow along bedding contacts of the Edwards Group and the Upper Trinity Aquifer in the northwestern parts of the model area. This resulted in the assignment of numerous drain cells along this outcrop contact.

- Reservoirs/lakes in the model area were simulated using constant heads.

- Pumpage used for the predictive period was developed as per instruction of the districts in Groundwater Management Area 9.

- We assigned the baseline pumpage to the first predictive stress period in the model to represent 2008 pumping conditions based on the assumption that the aquifers in the area recharges rapidly and groundwater movement is fast enough to bring about a dynamic equilibrium relatively quickly. Comparison of water level changes in selected hydrographs in the predictive period suggests that the aquifer attains a dynamic equilibrium within a year.

- The pumpage specified by the districts in Groundwater Management Area 9 was developed using the spatial pattern of initial predictive pumpage included in the groundwater availability model (Mace and others, 2000).

- Average recharge was used throughout the predictive period for this model run. Average recharge in the model was estimated for normal climatic conditions by using the average precipitation for the period 1960 to 1990 and the recharge coefficients estimated from baseflow analyses for each model cell (Mace and others, 2000).

- In assigning pumpage to areas outside the model boundary but within county areas covered by the aquifer, we assumed that the areal average pumpage in those areas equal to areal average pumpage inside the model area. This assumption was considered valid in the absence of a precise groundwater pumping estimate in the area outside the model. We used ESRI ArcGIS version 9.2 to calculate the area outside the model.

- The Edwards Group of the Edwards-Trinity (Plateau) Aquifer also extends out to a small area in the central part of Blanco County. However, this portion of the aquifer was not considered in the calculation of managed available groundwater as the aquifer was considered to be too thin to be suitable for meaningful groundwater production.

The model was run in Processing Modflow for Windows (version 5.3; Chiang and Kinzelbach, 1998).

RESULTS:

We estimated a total of 2,118 acre-feet of managed available groundwater for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer in Groundwater Management Area 9. Of this amount, 1,804 acre-feet of water is located inside the model boundary and 314 acre-feet of water is located outside the model boundary but within the county and groundwater conservation district boundaries. We reported managed available groundwater for the Edwards Group Aquifer split by county, regional planning group, groundwater conservation district, and river basins (Table 1 and Figure 2).

In some cases the outline of the official aquifer boundary and the model grid is not exactly coincident. As a result the centroid of some model cells fall outside the aquifer boundary. The managed available groundwater for those areas is denoted as outside (the aquifer) in table 1 (see footnotes). Based on our calculations, Bandera County River Authority and Ground Water District has 619 acre-feet per year, Cow Creek Groundwater Conservation District has 288 acre-feet per year, Headwaters Groundwater Conservation District has 1,211 acre-feet per year, and Blanco-Pedernales Groundwater Conservation District has 0 acre-feet per year of managed available groundwater from the Edwards Group of the Edwards-Trinity (Plateau) Aquifer. The Plateau Regional Planning Group (RWPG J) has 1,830 acre-feet per year and the South Central Texas (RWPG L) has 288 acre-feet per year of managed available groundwater from the Edwards Group of the Edwards-Trinity (Plateau) Aquifer located within Groundwater Management Area 9.

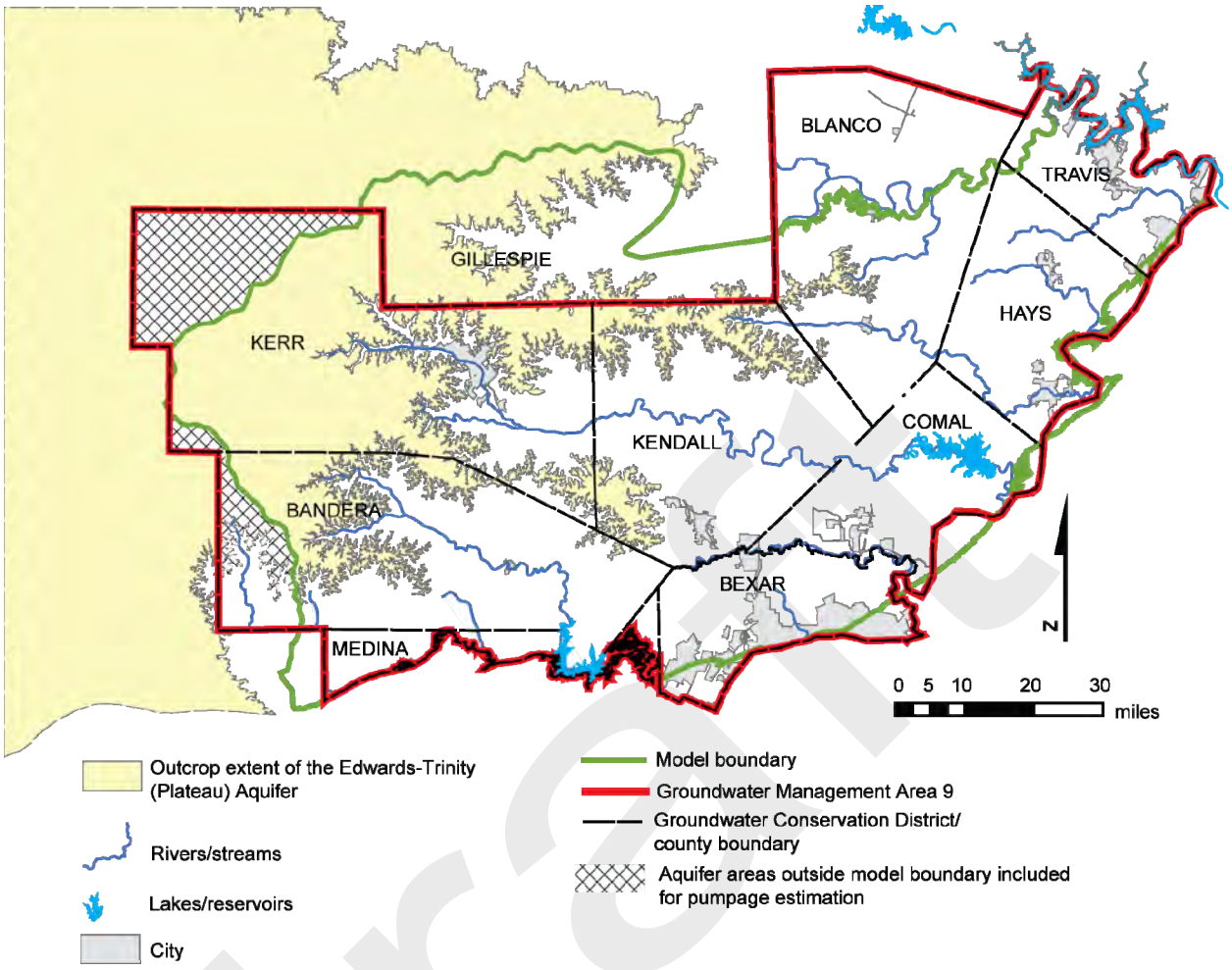


Figure 1. Map showing outcrop extent of the Edwards-Trinity (Plateau) Aquifer, rivers/streams, lakes/reservoirs, counties, and cities in Groundwater Management Area 9. Outlines of Groundwater Management Area 9 and the model boundary are also shown. Note the groundwater model boundary also includes areas outside Groundwater Management Area 9.

Table 1. Estimates of managed available groundwater for the Edwards Group of the Edwards-Trinity (Plateau) Aquifer by geographic subdivisions (See figure 2 for map reference).

MapRef	Aquifer	County	RWPA	River Basin	GCD	GMA	GeoArea	Year	MAG (acre-feet per year)	Comments
2	Edwards Group[a]	Bandera	J	Guadalupe	Bandera	9	n/a	n/a	21	Estimated MAG from the GAM
4	Edwards Group [a]	Bandera	J	San Antonio	Bandera	9	n/a	n/a	500	Estimated MAG from the GAM
7	Edwards Group [a]	Bandera	J	Nueces	Bandera	9	n/a	n/a	11	Estimated MAG from the GAM
27	Edwards Group [a]	Kendall	L	Colorado	Cow Creek	9	n/a	n/a	44	Estimated MAG from the GAM
30	Edwards Group [a]	Kendall	L	Guadalupe	Cow Creek	9	n/a	n/a	75	Estimated MAG from the GAM
33	Edwards Group [a]	Kendall	L	San Antonio	Cow Creek	9	n/a	n/a	169	Estimated MAG from the GAM
35	Edwards Group [a]	Kerr	J	Colorado	Headwaters	9	n/a	n/a	17	Estimated MAG from the GAM
38	Edwards Group [a]	Kerr	J	Guadalupe	Headwaters	9	n/a	n/a	964	Estimated MAG from the GAM
41	Edwards Group [a]	Kerr	J	San Antonio	Headwaters	9	n/a	n/a	3	Estimated MAG from the GAM
43	Edwards Group [a]	Kerr	J	Colorado	Headwaters	9	n/a	n/a	227	Estimated MAG for areas outside model but within county boundary
44	Edwards Group [a]	Bandera	J	Nueces	Bandera	9	n/a	n/a	87	Estimated MAG for areas outside model but within county boundary

Not shown in table 1 are results for zones 5, 8, 28, 31, and 39 (61, 3, 1, 28, and 51 acre-feet per year, respectively) because these areas represent model grid areas that fall beyond the aquifer outline due to 1 mile square model grid size. RWPA = Regional Water Planning Area, GCD = Groundwater Conservation District, GMA = Groundwater Management Area, GeoArea =Geographic areas defined by unique desired future conditions by the Groundwater Managed Area, MAG = Managed available groundwater in acre-feet per year, n/a = not applicable, [a] = Edwards Group of the Edwards-Trinity (Plateau) Aquifer, GAM = Groundwater Availability Model for the Hill Country portion of the Trinity Aquifer.

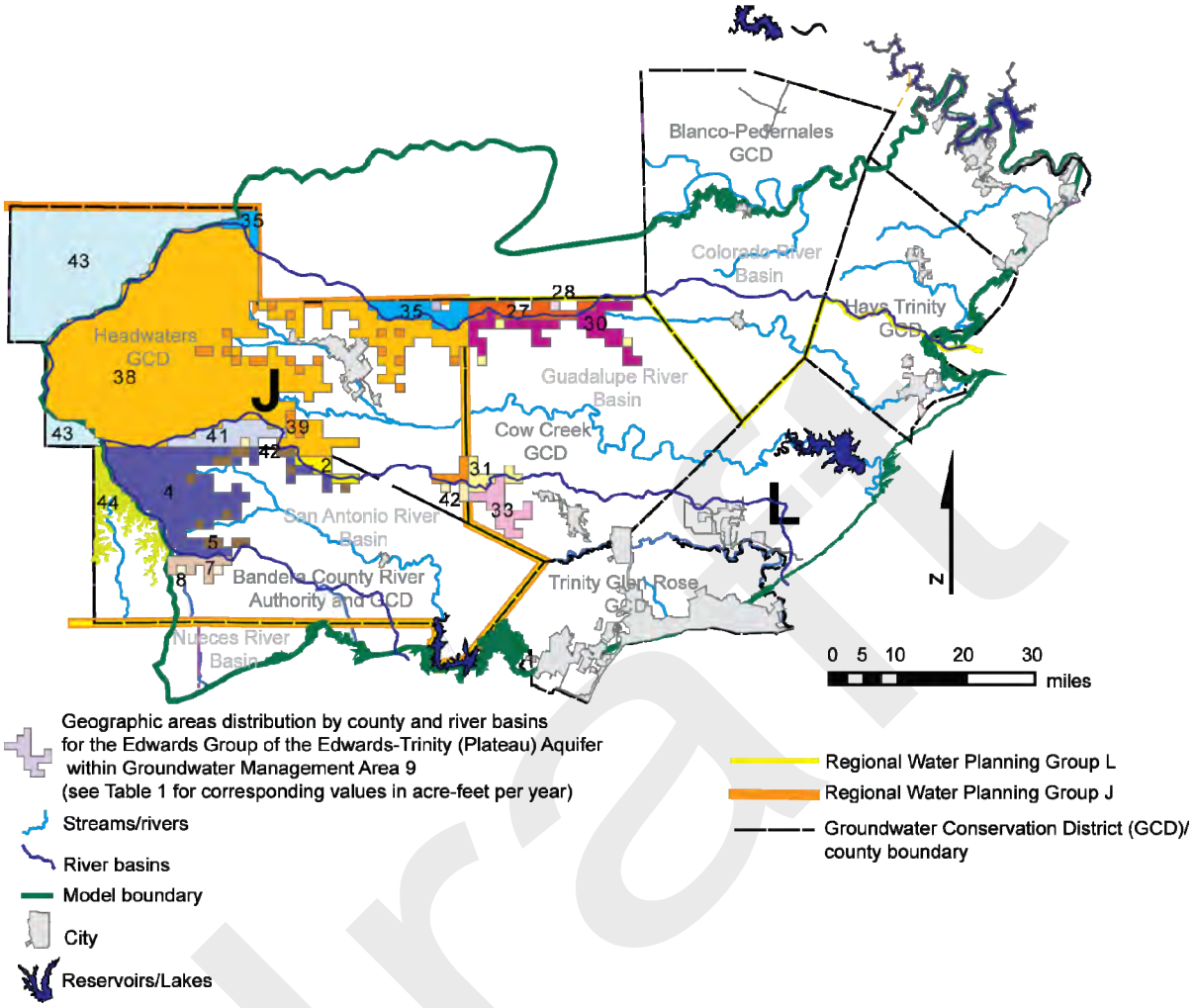


Figure 2. Geographic subdivisions of managed available groundwater for the Edwards Group Aquifer in Groundwater Management Area 9. See Table 1 for descriptions of the geographic subdivisions.

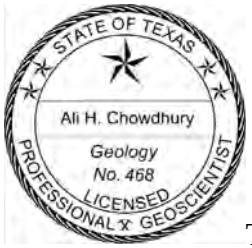
REFERENCES:

Chiang, W.H. and Kinzelbach, W., 1998, Processing Modflow: A simulation system for modeling groundwater flow and pollution: Hamburgh, Zurich, variously paginated.

Chowdhury, A.H., 2008, GAM Run 8-15, Texas Water Development Board unpublished report, 25 p.

ESRI ArcGIS 9.2, 2006, Environmental Research System Institute, Inc., Redlands, California.

Mace, R.E., Chowdhury, A.H., Anaya, R., and Way, S-C., 2000, Groundwater availability of the Trinity Aquifer, Hill Country Area, Texas—Numerical simulations through 2050: Texas Water Development Board Report 353, 119 p.



The seal appearing on this document was authorized by Ali H. Chowdhury, P.G., on January 23, 2009.