

GTA Aquifer Assessment 08-06

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Texas Water Development Board
Groundwater Technical Assistance Section
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REQUESTOR:

Caroline Runge, of the Menard County Underground Water Conservation District acting on behalf of the member groundwater conservation districts of Groundwater Management Area 7.

DESCRIPTION OF REQUEST:

In a letter dated July 8, 2008, Ms. Caroline Runge provided the Texas Water Development Board (TWDB) with draft desired future conditions for the Edwards-Trinity (Plateau) Aquifer covering two separate areas in Groundwater Management Area 7 and requested that TWDB estimate draft managed available groundwater values for each of those areas. This aquifer assessment presents the draft managed available groundwater for the Edwards-Trinity (Plateau) Aquifer in the Glasscock and Santa Rita districts as well as Upton and the southeast corner of Midland counties in Groundwater Management Area 7.

DRAFT DESIRED FUTURE CONDITIONS:

- Glasscock, Reagan, Upton and the southeast corner of Midland counties should maintain approximately 50 percent of the aquifer saturated thickness after 50 years.

METHODS:

The requested analysis for the Edwards-Trinity (Plateau) Aquifer was based on maintaining a percentage of the estimated saturated thickness left in 50 years.

The amount of data available for the Edwards-Trinity (Plateau) Aquifer is considerable; information on effective recharge, specific yield and geologic structure for the aquifer is available from the TWDB Groundwater Availability Model (GAM) (Anaya and Jones, 2004) for the aquifer. Water level data (2000-present) is also sufficient to determine average aquifer saturated thickness for the estimation of draft managed available groundwater (TDLR, 2009; TWDB, 2009).

An alternative method to calculate estimates for the Edwards-Trinity (Plateau) Aquifer was requested due to possible simulation problems with the GAM in Glasscock and Reagan counties (Tu, 2008).

A transient hydrologic budget for the saturated portion of an aquifer is described by Freeze and Cherry (1979, p.365):

$$Q(t) = R(t) - D(t) + \frac{dS}{dt}$$

Where: Q(t)= total rate of groundwater withdrawal
R(t)= total rate of groundwater recharge to the basin
D(t)= total rate of groundwater discharge from the basin
 $\frac{dS}{dt}$ = rate of change of storage in the saturated zone of the basin

For this analysis, it is assumed that:

$$R(t) = R(r) + R(e)$$

Where: R(r) = rejected recharge for the basin
R(e) = effective recharge

In addition, it is assumed that:

$$R(r) \cong D(t)$$

Therefore, the total rate of groundwater withdrawal equals effective recharge plus the change in storage of the aquifer, or:

$$Q(t) = R(e) + \frac{dS}{dt}$$

County, river basin, subcrop/outcrop, and groundwater conservation district boundaries subdivided the aquifer into map areas (Figure 1). The areal extent of each aquifer map area was calculated. These areas were used to calculate estimated average effective recharge.

To determine the volume from storage used, the areas were multiplied by the estimated aquifer specific yield, and then by the drained saturated thickness. This volume was then divided by 50 years to obtain a yearly volume.

Average annual effective recharge to the aquifer was calculated by multiplying each area by the average precipitation (1971 to 2000) and an effective recharge rate developed for the Edwards-Trinity (Plateau) Aquifer GAM.

Water-level data from the TWDB groundwater database and aquifer structure from the GAM was used to calculate average saturated thickness.

The calculations were completed in a Microsoft Excel worksheet.

Conditions were assumed to be physically possible across the groundwater management area.

PARAMETERS AND ASSUMPTIONS:

- The estimated average saturated thickness of the Edwards-Trinity (Plateau) Aquifer within Glasscock, Reagan, Upton and the southeast corner of Midland counties, based on static water levels and the structural base of the aquifer, ranges from 78 to 255 feet (Anaya and Jones, 2004; TDLR, 2009; TWDB 2009).
- The areas for each subdivision were calculated from the Texas Water Development Board (TWDB) shapefile for the Edwards-Trinity (Plateau) Aquifer, projected into the GAM projection (Anaya, 2001).
- Areas, in acres, were calculated within ArcGIS 9.2.
- Average annual precipitation was used to calculate annual average effective recharge volumes.
- The average annual precipitation for each aquifer map area (Table 1) was determined from the Texas Climatic Atlas (Narasimhan and others, 2008) which is for the average for years 1971 to 2000.
- The estimated average effective recharge for the Edwards-Trinity (Plateau) Aquifer in the analyzed area of GMA 7 is 62,329 acre-feet per year (Table 1).
- Average effective recharge from precipitation is 2 to 3 percent of annual precipitation (Anaya and Jones, 2004).
- The draft managed available groundwater volume estimates are the sum of the annual average effective recharge amount and the volume of water depleted from the aquifer based on the draft desired future condition.
- Annual volumes are calculated by dividing the total volume by 50 years.
- Specific yield of the aquifer ranges from 0.01 to 0.0018 (Anaya and Jones, 2004).

Table 1. Estimated total annual average effective recharge volume for the Edwards-Trinity (Plateau) Aquifer by map area subdivisions (See Figure 1).

GMA	Aquifer	County	GCD	Map Area	Areal Extent (acres)	Average Precipitation (inches)	Average Precipitation (feet)	Effective recharge rate (percent)	Estimated annual effective recharge (ac-ft/yr)
7	Edwards-Trinity Plateau	Midland	None	1	159,388	15	1.3	2	4,144
				2	96,386	17	1.4	3	4,048
		Glasscock	Glasscock GCD	3	437,869	18	1.5	2	13,136
				4	61,827	17	1.4	2	1,731
		Reagan	Santa Rita UWCD	5	638,880	18	1.5	2	19,166
				6	51,865	17	1.4	2	1,452
		Upton	None	7	303,295	16	1.3	2	7,886
				8	414,079	15	1.3	2	10,766
Total									62,329

GMA = groundwater management area

UWCD = underground water conservation district

GCD = groundwater conservation district

ac-ft/yr = acre-feet per year

RESULTS:

The results (Tables 2, 3, and 4) show 69,508 acre-feet per year of draft managed available groundwater for the Edwards-Trinity (Plateau) Aquifer in the Glasscock and Santa Rita districts as well as Upton and the southeast corner of Midland counties in Groundwater Management Area 7. The Glasscock Groundwater Conservation District, in Glasscock and Reagan counties, has 20,249 acre-feet per year of draft managed available groundwater and the Santa Rita Underground Water Groundwater Conservation District has 23,444 acre-feet per year respectively.

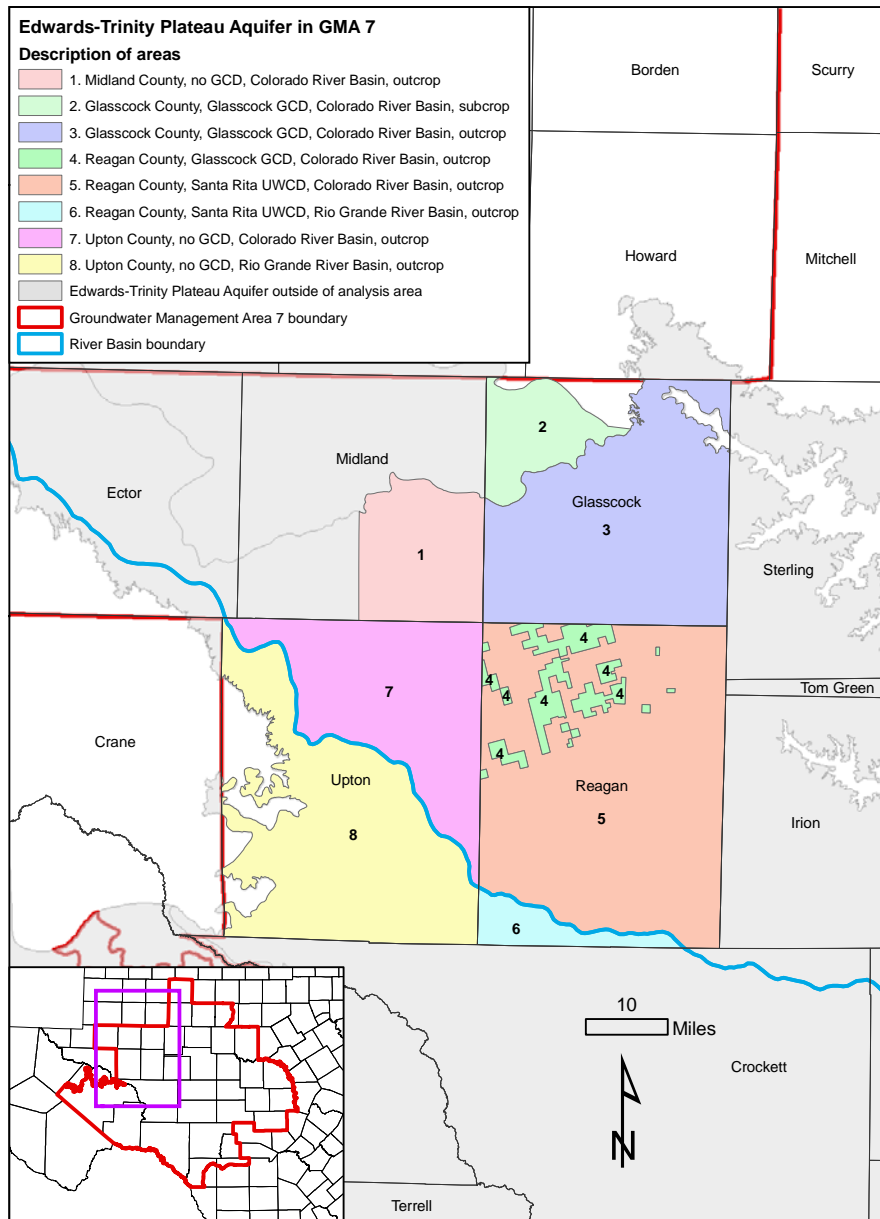


Figure 1. Geographic subdivisions for analyzing draft managed available groundwater for the Edwards-Trinity (Plateau) Aquifer in the Glasscock and Santa Rita districts as well as Upton and the southeast corner of Midland counties in Groundwater Management Area 7. GMA = groundwater management area, UWCD = underground water conservation district, GCD = groundwater conservation district.

Table 2. Estimates of draft managed available groundwater for the Edwards-Trinity (Plateau) Aquifer summarized by map areas (see Figure 1).

GMA	Aquifer	County	GCD	Map Area	Specific yield	Areal Extent (acres)	Estimated current saturated thickness (feet)	Desired percent of current saturated thickness	Desired future saturated thickness (feet)	Saturated thickness drained (feet)	Estimated total volume reduction from storage (acre-feet)	Estimated annual volume from storage (ac-ft/yr)	Estimated annual effective recharge ¹ (ac-ft/yr)	Estimated annual total volume (ac-ft/yr)
7	Edwards-Trinity Plateau	Midland	None	1	0.01	159,388	78	50%	39.0	39.0	62,161	1,243	4,144	5,387
				2	0.002	96,386	147	50%	73.5	73.5	14,169	284	4,048	4,332
		Glasscock	Glasscock GCD	3	0.0018	437,869	108	50%	54.0	54.0	42,561	851	13,136	13,987
				4	0.0018	61,827	179	50%	89.5	89.5	9,960	199	1,731	1,930
		Reagan	Santa Rita UWCD	5	0.0018	638,880	225	50%	112.5	112.5	129,373	2,588	19,166	21,754
				6	0.0018	51,865	255	50%	127.5	127.5	11,903	238	1,452	1,690
		Upton	None	7	0.0018	303,295	126	50%	63.0	63.0	34,394	688	7,886	8,574
				8	0.0018	414,079	146	50%	73.0	73.0	54,410	1,088	10,766	11,854
Total						2,163,589					358,931	7,179	62,329	69,508

GMA = groundwater management area

UWCD = underground water conservation district

GCD = groundwater conservation district

ac-ft/yr = acre-feet per year

1 - This is the estimated total annual effective recharge volume for the Edwards-Trinity (Plateau) Aquifer by map areas as shown in Table 1.

Table 3. Estimates of draft managed available groundwater for the Edwards-Trinity (Plateau) Aquifer (see Figure 1).

Aquifer	Map Key	County	RWPA	River Basin	GCD	GMA	GeoArea	Year	Draft MAG (acre-feet per year)
Edwards-Trinity Plateau	1	Midland	F	Colorado	None	7	n/a	n/a	5,387
Edwards-Trinity Plateau	2	Glasscock	F	Colorado	Glasscock GCD	7	n/a	n/a	4,332
Edwards-Trinity Plateau	3	Glasscock	F	Colorado	Glasscock GCD	7	n/a	n/a	13,987
Edwards-Trinity Plateau	4	Reagan	F	Colorado	Glasscock GCD	7	n/a	n/a	1,930
Edwards-Trinity Plateau	5	Reagan	F	Colorado	Santa Rita UWCD	7	n/a	n/a	21,754
Edwards-Trinity Plateau	6	Reagan	F	Rio Grande	Santa Rita UWCD	7	n/a	n/a	1,690
Edwards-Trinity Plateau	7	Upton	F	Colorado	None	7	n/a	n/a	8,574
Edwards-Trinity Plateau	8	Upton	F	Rio Grande	None	7	n/a	n/a	11,854

RWPA = regional water planning area GCD = groundwater conservation district UWCD = under water conservation district GMA = groundwater management area
 GeoArea = Geographic areas defined by unique desired future conditions as specified by a groundwater management area.
 MAG = Managed available groundwater in units of acre-feet per year.

Table 4. Estimates of draft managed available groundwater for the Edwards-Trinity (Plateau) Aquifer summarized by groundwater conservation district and county.

Aquifer	GCD	County	Draft managed available groundwater (acre-feet per year)
Edwards-Trinity Plateau	GGCD	Glasscock	18,319
Edwards-Trinity Plateau	GGCD	Reagan	1,930
Edwards-Trinity Plateau	SRUWCD	Reagan	23,444
Edwards-Trinity Plateau	None	Upton	20,428
Edwards-Trinity Plateau	None	SE Midland	5,387

GCD = groundwater conservation district

GGCD = Glasscock Groundwater Conservation District

SRUWCD = Santa Rita Under Water Conservation District

Limitations:

Additional data are needed to create improved estimates; these estimates are a fundamental interpretation of the requested conditions. This analysis assumes homogeneous and isotropic aquifers; however, conditions for the Edwards-Trinity (Plateau) Aquifer may not behave in a uniform manner. The analysis further assumes that lateral inflow to the aquifer is equal to lateral outflow from the aquifer, and that future pumping will not alter this balance.

Note that estimates of managed available groundwater are based on the best available scientific tools that can be used to evaluate managed available groundwater and that these estimates can be a function of assumptions made on the magnitude and distribution of pumping in the aquifer. Therefore, it is important for groundwater conservation districts to monitor whether or not they are achieving their desired future conditions and to work with the TWDB to refine managed available groundwater given the reality of how the aquifer responds to the actual magnitude and distribution of pumping now and in the future.

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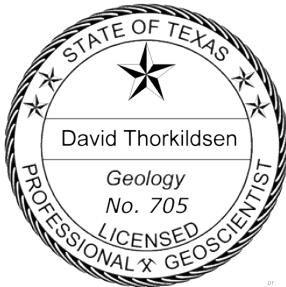
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