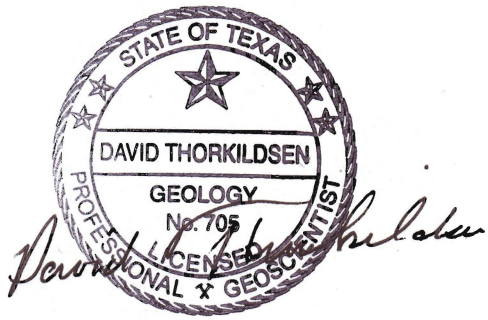
GTA Aquifer Assessment 10-06

by David Thorkildsen, P.G. and Sarah Backhouse
Texas Water Development Board
Groundwater Technical Assistance Section
(512) 936-0871



July 28, 2010

GTA Aquifer Assessment 10-06
Groundwater Management Area 10
Trinity Aquifer
Draft Managed Available Groundwater estimates
July 28, 2010

REQUESTOR:

Rick Illgner, of the Edwards Aquifer Authority acting on behalf of Groundwater Management Area 10.

DESCRIPTION OF REQUEST:

On 4/27/10, Mr. Illgner provided the Texas Water Development Board (TWDB) with alternative draft desired future conditions for the Trinity Aquifer subcrop (lumping the upper, middle, and lower Trinity into one aquifer) in Groundwater Management Area 10 and requested that TWDB estimate alternative draft managed available groundwater values. This request was addressed with GTA Aquifer Assessment 10-03. At the Groundwater Management Area 10 meeting on 6/16/10, the group requested TWDB to revise the assessment by splitting the aquifer out by layers and including the outcrop area. The assessment was further modified at the Groundwater Management Area 10 meeting on 7/19/10. The representatives requested that TWDB reduce the originally requested average drawdowns for the Trinity Aquifer. This aquifer assessment presents the revised alternative draft managed available groundwater for the Trinity Aquifer outcrop/subcrop in Groundwater Management Area 10.

DRAFT DESIRED FUTURE CONDITIONS:

Trinity Aquifer outcrop/subcrop – Allow average drawdowns of 5, 10, 15, 20, and 25 feet in the Trinity Aquifer outcrop and subcrop (upper, middle and lower zones) over the next 50 years.

METHODS:

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

Effective recharge is the amount of water that enters an aquifer and is available for development (Muller and Price, 1979, p. 5). Rejected recharge is the amount of total (or potential) recharge that discharges from an aquifer because it is over-full and cannot accept more water (Theis, 1940, p.1).

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, outcrop/subcrop, river basin, regional water planning area, area with water quality less than or equal to 3,000 milligrams per liter (mg/l) total dissolved solids (TDS), and groundwater conservation district boundaries were used to split the aquifer into map areas (Figure 1). The areal extent of each aquifer map area was calculated.

Annual effective recharge was calculated by multiplying each outcrop area by the average precipitation (1971-2000) and an effective recharge rate developed from base flow analysis for the Trinity Aquifer in the Hill Country of South-Central Texas (Ashworth, 1983).

Lateral inflow to the Trinity Aquifer in Groundwater Management Area 10 was estimated based on the average outflow across the Balcones Fault Zone results of Draft GAM Task 10-005 (Hutchison, 2010). Draft GAM Task 10-005 provides results of seven pumping scenarios from the Trinity Aquifer within Groundwater Management Area 9 using the Groundwater Availability Model (GAM) for the Hill Country portion of the Trinity Aquifer system in Texas (Jones and others, 2009). The average outflow across the Balcones Fault Zone results from Scenario 6

(total pumpage approximately 100,000 acre-feet per year) is used for the calculations in this assessment.

The areal extent of each map area in Travis and Hays counties was multiplied by the aquifer storage coefficient derived from aquifer tests performed and compiled by the Barton Springs/Edwards Aquifer Conservation District (BSEACD) for the Trinity Aquifer subcrop in Travis and Hays counties (BSEACD, in preparation).

The remaining subcrop map areas were multiplied by the aquifer storage coefficient derived for the calibrated Groundwater Availability Model (GAM) for the Hill Country portion of the Trinity Aquifer system in Texas (Jones and others, 2009). Each map area was then multiplied by several uniform water level drawdown scenarios specified in the draft desired future conditions.

In outcrop areas where unconfined conditions exist the aerial extent was multiplied by the aquifer specific yield and then by several uniform water level drawdown scenarios specified in the draft desired future conditions.

Volumes for each scenario were then divided by 50 years to obtain an annual volume.

The calculations were completed in a Microsoft Excel worksheet.

DETERMINING MANAGED AVAILABLE GROUNDWATER:

As defined in Chapter 36 of the Texas Water Code, “managed available groundwater” is the amount of water that may be permitted by a groundwater conservation district. The estimated total annual volume of groundwater calculated, however, represents the total amount of pumping from the aquifer. The total pumping includes uses of water both subject to permitting and exempt from permitting. Examples of exempt uses include domestic, livestock, and oil and gas exploration. Each district may also exempt additional uses as defined by its rules or enabling legislation.

Since exempt uses are not available for permitting, it is necessary to account for them when determining managed available groundwater. To do this the Texas Water Development Board developed a standardized method for estimating exempt use for domestic and livestock purposes based on projected changes in population and the ratio of domestic and livestock wells in an area to the total number of wells. Because other exempt uses can vary significantly from district to district and there is much higher uncertainty associated with estimating use

due to oil and gas exploration, estimates of exempt pumping outside domestic and livestock uses have not been included.

For this assessment estimated exempt use for districts with management jurisdiction of the Trinity Aquifer is the projected domestic and livestock use for the year 2060. If a district believes it has a more appropriate estimate of exempt pumping, they may submit it, along with a description of how it was developed, to the Texas Water Development Board for consideration. Once established, the estimates of exempt pumping are subtracted from the total pumping calculation to yield the estimated managed available groundwater for permitting purposes.

PARAMETERS AND ASSUMPTIONS:

- Outcrop and subcrop areas exist in the upper Trinity. Only subcrop areas exist in the middle and lower Trinity.
- Outcrop areas are calculated as unconfined areas of the aquifer and subcrop areas are calculated as confined areas of the aquifer.
- The aquifer is considered to contain water that is fresh to slightly saline (< = 3,000 TDS)
- The aquifer area was calculated from the TWDB shapefile for the Trinity Aquifer, projected into the GAM projection (Anaya, 2001).
- Areas, in acres, were calculated within ArcGIS 9.3.
- Map areas were designated as Plum Creek Conservation District only where their jurisdiction does not overlap with the BSEACD.
- The Edwards Aquifer Authority (EAA) is not included in this assessment because they are restricted by their legislation to manage only the Edwards Aquifer. Map areas where the EAA or no other district exists are designated as “n/a.”
- The draft managed available groundwater volume estimates are the annual volume of water depleted from the aquifer based on the draft desired future conditions.
- Water level drawdowns were assumed to be uniform across the aquifer.
- Annual volumes are calculated by dividing the total volume by 50 years.
- The average annual precipitation for outcrop map areas (Table 1) was determined from the Texas Climatic Atlas (Narasimhan and others, 2008) which is the average for years 1971 to 2000.
- Annual effective recharge from precipitation to outcrop areas is 4 percent of annual average precipitation (Ashworth, 1983).
- Lateral inflow to the Trinity Aquifer in Groundwater Management Area 10 is estimated to be 59,237 acre-feet per year based on the average outflow across the Balcones Fault Zone results (Scenario 6) from Draft GAM Task

10-005 (Hutchison, 2010) This volume was apportioned across the aquifer map areas. GAM Task 10-005 does not address Uvalde County; therefore the same value for total inflow to Medina County was used.

- Inflow is split between layers based on data from GAM Task 10-005. Inflow is only to the upper and middle Trinity units.
- Specific yield applied to the Trinity Aquifer outcrop areas is 0.05 (LBG-Guyton and Associates, 2003).
- The storage coefficient of the Trinity Aquifer subcrop is 0.00001 derived from aquifer tests of the Trinity Aquifer subcrop in Travis and Hays counties (BSEACD, in preparation). The storage coefficient of the Trinity Aquifer subcrop in the remaining counties is 0.00005 as derived from the calibrated GAM for the Hill Country portion of the Trinity Aquifer system in Texas (Jones and others, 2009).
- Conditions were assumed to be physically possible across Groundwater Management Area 10.

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

GMA	Aquifer	County	GCD	Map Area	Areal extent (acres)	Estimated average annual precipitation (inches)	Estimated average annual precipitation (feet)	Effective recharge rate (percent)	Estimated annual effective recharge (ac-ft/yr)
10	Upper Trinity	Hays	n/a	21	494	35	2.9	4	57
		Hays	Hays Trinity GCD	22	554	35	2.9	4	64
		Hays	Hays Trinity GCD	23	473	36	3	4	57
		Hays	n/a	24	419	36	3	4	50
		Comal	n/a	25	1,282	35	2.9	4	149
		Comal	n/a	26	513	34	2.8	4	57
		Uvalde	Uvalde County UWCD	27	372	29	2.4	4	36
								Total	470

GMA = groundwater management area
GCD = groundwater conservation district
ac-ft/yr = acre-feet per year
UWCD = underground water conservation district
n/a = Areas that are covered by the Edwards Aquifer Authority or areas that are not covered by a GCD
The formula for this table is: areal extent (acres) * estimated average annual precipitation (feet) * effective recharge rate = estimated annual effective recharge (ac-ft/yr).

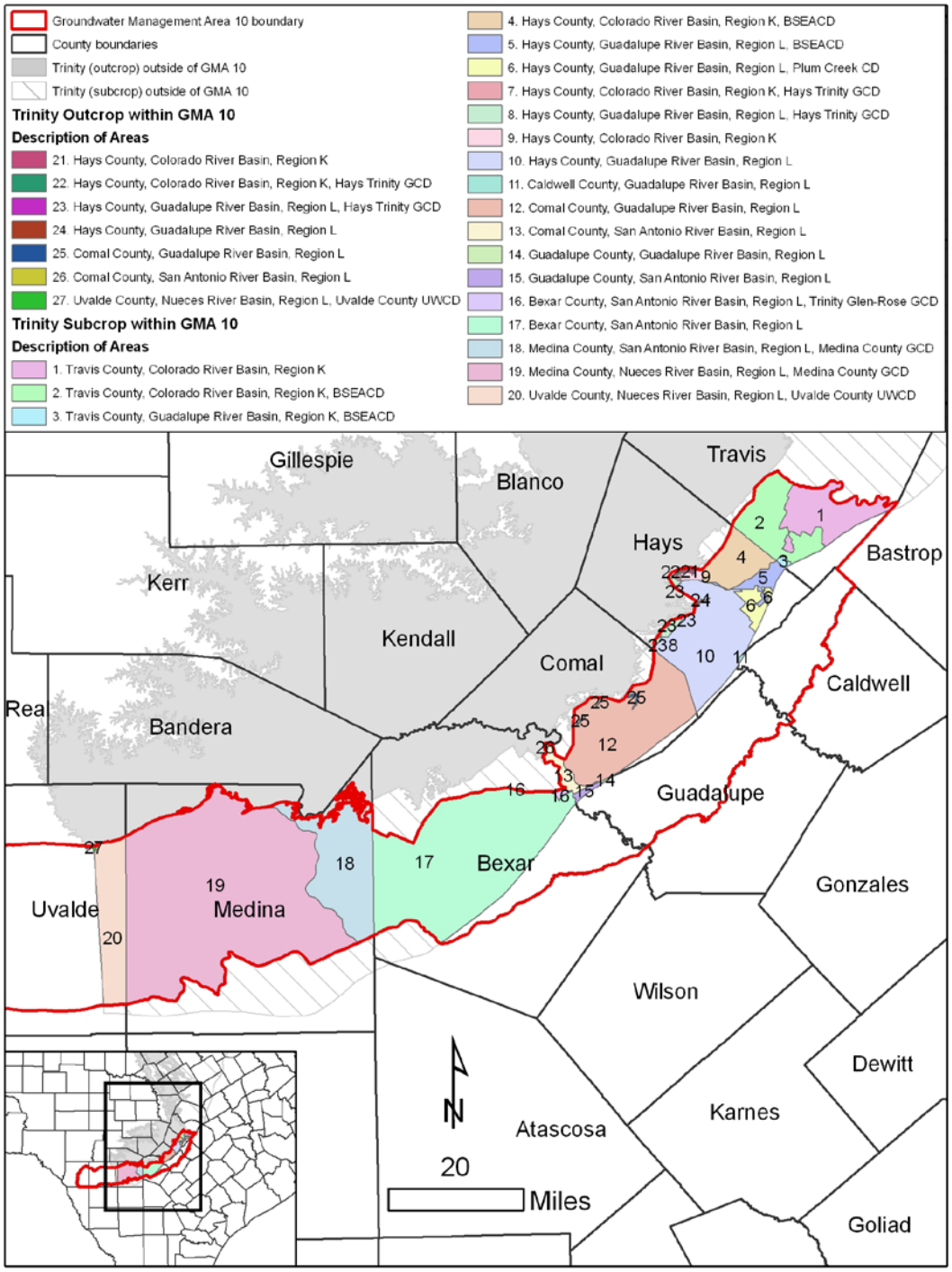


Figure 1. Geographic subdivisions for analyzing draft managed available groundwater for the Trinity Aquifer in GMA 10. GMA = groundwater management area, BSEACD = Barton Springs/Edwards Aquifer Conservation District, CD = conservation district, GCD = groundwater conservation district, UWCD = underground water conservation district

RESULTS:

The results (Tables 2-4) show the total pumping estimates for the Trinity Aquifer by layer in Groundwater Management Area 10.

Table 5 summarizes and combines the total pumping results from tables 2-4.

Table 6 shows exempt use estimates for year 2060 by county, river basin, regional water planning area, and groundwater conservation district for the Trinity Aquifer.

Table 7 summarizes the draft managed available groundwater for the Trinity Aquifer in Groundwater Management Area 10 by county, river basin, regional water planning area, and groundwater conservation district. As described above, these reflect the difference between the combined total pumping (table 5) and the estimated exempt use (table 6).

Table 8 summarizes the draft managed available groundwater for the Trinity Aquifer in Groundwater Management Area 10 by groundwater conservation district.

GTA Aquifer Assessment 10-06
Groundwater Management Area 10
Trinity Aquifer
Draft Managed Available Groundwater estimates
July 28, 2010

Table 2. Estimates of total pumping for the Upper Trinity Aquifer summarized by map areas (see Figure 1).

GMA	Aquifer	County	GCD	Map Area	Estimated storage coefficient	Areal extent (acres)	Desired total aquifer water level decline (feet)	Estimated total volume from water level decline (acre-feet)	Estimated annual volume from water level decline (ac-ft/yr)	Estimated annual effective recharge[1]	Estimated annual lateral inflow (ac-ft/yr)	Estimated annual total volume (ac-ft/yr)
10	Upper Trinity	Travis	n/a	1	0.00001	53,168	5	3	0	0	132	132
							10	5	0			132
							15	8	0			132
							20	11	0			132
							25	13	0			132
			BSEACD	2	0.00001	53,352	5	3	0	0	132	132
							10	5	0			132
							15	8	0			132
							20	11	0			132
							25	13	0			132
				3	0.00001	1,340	5	0	0	0	3	3
							10	0	0			3
							15	0	0			3
							20	0	0			3
							25	0	0			3
		Hays		4	0.00001	33,789	5	2	0	0	529	529
							10	3	0			529
							15	5	0			529
							20	7	0			529
							25	8	0			529
				5	0.00001	11,243	5	1	0	0	176	176
							10	1	0			176
							15	2	0			176
							20	2	0			176
							25	3	0			176
			Plum Creek CD	6	0.00001	11,042	5	1	0	0	176	176
							10	1	0			176
							15	2	0			176
							20	2	0			176
							25	3	0			176
			Hays Trinity GCD	7	0.00001	994	5	0	0	0	29	29
							10	0	0			29
							15	0	0			29
							20	0	0			29
							25	0	0			29
				8	0.00001	4,342	5	0	0	0	59	59
							10	0	0			59
							15	1	0			59
							20	1	0			59
							25	1	0			59
			n/a	9	0.00001	2,618	5	0	0	0	29	29
							10	0	0			29
							15	0	0			29
							20	1	0			29
							25	1	0			29
				10	0.00001	98,837	5	5	0	0	1,587	1,587
							10	10	0			1,587
							15	15	0			1,587
							20	20	0			1,587
							25	25	1			1,588
		Caldwell		11	0.00005	420	5	0	0	0	0	0
							10	0	0			0
							15	0	0			0
							20	0	0			0
							25	1	0			0
		Comal		12	0.00005	123,768	5	31	1	0	14,260	14,261
							10	62	1			14,261
							15	93	2			14,262
							20	124	2			14,262
							25	155	3			14,263
				13	0.00005	8,679	5	2	0	0	1,083	1,083
							10	4	0			1,083
							15	7	0			1,083
							20	9	0			1,083
							25	11	0			1,083
		Guadalupe		14	0.00005	302	5	0	0	0	0	0
							10	0	0			0
							15	0	0			0
							20	0	0			0
							25	0	0			0
				15	0.00005	2,362	5	1	0	0	0	0
							10	1	0			0
							15	2	0			0
							20	2	0			0
							25	3	0			0

GTA Aquifer Assessment 10-06
Groundwater Management Area 10
Trinity Aquifer
Draft Managed Available Groundwater estimates
July 28, 2010

Table 2 continued.

GMA	Aquifer	County	GCD	Map Area	Estimated storage coefficient	Areal extent (acres)	Desired total aquifer water level decline (feet)	Estimated total volume from water level decline (acre-feet)	Estimated annual volume from water level decline (ac-ft/yr)	Estimated annual effective recharge[1]	Estimated annual lateral inflow (ac-ft/yr)	Estimated annual total volume (ac-ft/yr)
10	Upper Trinity	Bexar	Trinity Glen-Rose GCD	16	0.00005	1,642	5	0	0	0	48	48
							10	1	0			48
							15	1	0			48
							20	2	0			48
							25	2	0			48
			n/a	17	0.00005	264,374	5	66	1	0	8,482	8,483
							10	132	3			8,485
							15	198	4			8,486
							20	264	5			8,487
							25	330	7			8,489
		Medina	Medina County GCD	18	0.00005	103,048	5	26	1	0	292	293
							10	52	1			293
							15	77	2			294
							20	103	2			294
							25	129	3			295
				19	0.00005	455,928	5	114	2	0	1,284	1,286
							10	228	5			1,289
							15	342	7			1,291
							20	456	9			1,293
							25	570	11			1,295
		Uvalde	Uvalde County UWCD	20	0.00005	63,462	5	16	0	0	175	175
							10	32	1			176
							15	48	1			176
							20	63	1			176
							25	79	2			177
		Hays	n/a	21	0.05	494	5	124	2	57	9	68
							10	247	5			71
							15	371	7			73
							20	494	10			76
							25	618	12			78
			Hays Trinity GCD	22	0.05	554	5	139	3	64	9	76
							10	277	6			79
							15	416	8			81
							20	554	11			84
							25	693	14			87
				23	0.05	473	5	118	2	57	9	68
							10	237	5			71
							15	355	7			73
							20	473	9			75
							25	591	12			78
			n/a	24	0.05	419	5	105	2	50	6	58
							10	210	4			60
							15	314	6			62
							20	419	8			64
							25	524	10			66
		Comal		25	0.05	1,282	5	321	6	149	2	157
							10	641	13			164
							15	962	19			170
							20	1,282	26			177
							25	1,603	32			183
				26	0.05	513	5	128	3	57	1	61
							10	257	5			63
							15	385	8			66
							20	513	10			68
							25	641	13			71
		Uvalde	Uvalde County UWCD	27	0.05	372	5	93	2	36	1	39
							10	186	4			41
							15	279	6			43
							20	372	7			44
							25	465	9			46
	Total					1,298,818	25			470	28,513	29,008
							50					29,036
							75					29,060
							100					29,083
							125					29,112

GMA = groundwater management area
GCD = groundwater conservation district
CD = conservation district
BSEACD = Barton Springs/Edwards Aquifer Conservation District
UWCD = underground water conservation district
ac-ft/yr = acre-feet per year
n/a = Areas that are covered by the Edwards Aquifer Authority or areas that are not covered by a GCD
1 - This is the estimated total annual effective recharge volume for the Trinity Aquifer by map areas as shown in Table 1.
The formulas for this table are: storage coefficient * areal extent * desired total aquifer water level decline = estimated total volume from water level decline/50 = estimated annual volume from water level decline. Estimated annual volume from water level decline + estimated annual effective recharge + estimated annual lateral inflow = estimated annual total volume.

Table 3. Estimates of total pumping for the Middle Trinity Aquifer summarized by map areas (see Figure 1).

GMA	Aquifer	County	GCD	Map Area	Estimated storage coefficient	Areal extent (acres)	Desired total aquifer water level decline (feet)	Estimated total volume from water level decline (acre-feet)	Estimated annual volume from water level decline (ac-ft/yr)	Estimated annual lateral inflow (ac-ft/yr)	Estimated annual total volume (ac-ft/yr)
10	Middle Trinity	Travis	n/a	1	0.00001	53,168	5	3	0	185	185
							10	5	0		185
							15	8	0		185
							20	11	0		185
							25	13	0		185
			BSEACD	2	0.00001	53,352	5	3	0	185	185
							10	5	0		185
							15	8	0		185
							20	11	0		185
							25	13	0		185
				3	0.00001	1,340	5	0	0	4	4
							10	0	0		4
							15	0	0		4
							20	0	0		4
							25	0	0		4
		Hays		4	0.00001	33,789	5	2	0	197	197
							10	3	0		197
							15	5	0		197
							20	7	0		197
							25	8	0		197
				5	0.00001	11,243	5	1	0	62	62
							10	1	0		62
							15	2	0		62
							20	2	0		62
							25	3	0		62
			Plum Creek CD	6	0.00001	11,042	5	1	0	62	62
							10	1	0		62
							15	2	0		62
							20	2	0		62
							25	3	0		62
			Hays Trinity GCD	7	0.00001	994	5	0	0	10	10
							10	0	0		10
							15	0	0		10
							20	0	0		10
							25	0	0		10
				8	0.00001	4,342	5	0	0	21	21
							10	0	0		21
							15	1	0		21
							20	1	0		21
							25	1	0		21
			n/a	9	0.00001	2,618	5	0	0	10	10
							10	0	0		10
							15	0	0		10
							20	1	0		10
							25	1	0		10
				10	0.00001	98,837	5	5	0	582	582
							10	10	0		582
							15	15	0		582
							20	20	0		582
							25	25	1		583

GTA Aquifer Assessment 10-06
Groundwater Management Area 10
Trinity Aquifer
Draft Managed Available Groundwater estimates
July 28, 2010

Table 3 continued.

GMA	Aquifer	County	GCD	Map Area	Estimated storage coefficient	Areal extent (acres)	Desired total aquifer water level decline (feet)	Estimated total volume from water level decline (acre-feet)	Estimated annual volume from water level decline (ac-ft/yr)	Estimated annual lateral inflow (ac-ft/yr)	Estimated annual total volume (ac-ft/yr)
10	Middle Trinity	Caldwell	n/a	11	0.00005	420	5	0	0	0	0
							10	0	0		0
							15	0	0		0
							20	0	0		0
							25	1	0		0
		Comal		12	0.00005	123,768	5	31	1	12,724	12,725
							10	62	1		12,725
							15	93	2		12,726
							20	124	2		12,726
							25	155	3		12,727
				13	0.00005	8,679	5	2	0	954	954
							10	4	0		954
							15	7	0		954
							20	9	0		954
							25	11	0		954
		Guadalupe		14	0.00005	302	5	0	0	0	0
							10	0	0		0
							15	0	0		0
							20	0	0		0
							25	0	0		0
				15	0.00005	2,362	5	1	0	0	0
							10	1	0		0
							15	2	0		0
							20	2	0		0
							25	3	0		0
		Bexar	Trinity Glen-Rose GCD	16	0.00005	1,642	5	0	0	65	65
							10	1	0		65
							15	1	0		65
							20	2	0		65
							25	2	0		65
			n/a	17	0.00005	264,374	5	66	1	11,495	11,496
							10	132	3		11,498
							15	198	4		11,499
							20	264	5		11,500
							25	330	7		11,502
		Medina	Medina County GCD	18	0.00005	103,048	5	26	1	695	696
							10	52	1		696
							15	77	2		697
							20	103	2		697
							25	129	3		698
				19	0.00005	455,928	5	114	2	3,056	3,058
							10	228	5		3,061
							15	342	7		3,063
							20	456	9		3,065
							25	570	11		3,067
		Uvalde	Uvalde County UWCD	20	0.00005	63,462	5	16	0	417	417
							10	32	1		418
							15	48	1		418
							20	63	1		418
							25	79	2		419
	Total					1,294,711	25			30,724	30,729
							50				30,735
							75				30,740
							100				30,743
							125				30,751

GMA = groundwater management area
GCD = groundwater conservation district
CD = conservation district
BSEACD = Barton Springs/Edwards Aquifer Conservation District
UWCD = underground water conservation district
ac-ft/yr = acre-feet per year
n/a = Areas that are covered by the Edwards Aquifer Authority or areas that are not covered by a GCD
The formulas for this table are: storage coefficient * areal extent * desired total aquifer water level decline = estimated total volume from water level decline/50 = estimated annual volume from water level decline. Estimated annual volume from water level decline + estimated annual lateral inflow = estimated annual total volume.

GTA Aquifer Assessment 10-06
Groundwater Management Area 10
Trinity Aquifer
Draft Managed Available Groundwater estimates
July 28, 2010

Table 4. Estimates of total pumping for the Lower Trinity Aquifer summarized by map areas (see Figure 1).

GMA	Aquifer	County	GCD	Map Area	Estimated storage coefficient	Areal extent (acres)	Desired total aquifer water level decline (feet)	Estimated total volume from water level decline (acre-feet)	Estimated annual volume from water level decline (ac-ft/yr)	Estimated annual lateral inflow (ac-ft/yr)	Estimated annual total volume (ac-ft/yr)
10	Lower Trinity	Travis	n/a	1	0.00001	53,168	5	3	0	0	0
							10	5	0		0
							15	8	0		0
							20	11	0		0
							25	13	0		0
			BSEACD	2	0.00001	53,352	5	3	0	0	0
							10	5	0		0
							15	8	0		0
							20	11	0		0
							25	13	0		0
				3	0.00001	1,340	5	0	0	0	0
							10	0	0		0
							15	0	0		0
							20	0	0		0
							25	0	0		0
		Hays		4	0.00001	33,789	5	2	0	0	0
							10	3	0		0
							15	5	0		0
							20	7	0		0
							25	8	0		0
				5	0.00001	11,243	5	1	0	0	0
							10	1	0		0
							15	2	0		0
							20	2	0		0
							25	3	0		0
			Plum Creek CD	6	0.00001	11,042	5	1	0	0	0
							10	1	0		0
							15	2	0		0
							20	2	0		0
							25	3	0		0
			Hays Trinity GCD	7	0.00001	994	5	0	0	0	0
							10	0	0		0
							15	0	0		0
							20	0	0		0
							25	0	0		0
				8	0.00001	4,342	5	0	0	0	0
							10	0	0		0
							15	1	0		0
							20	1	0		0
							25	1	0		0
			n/a	9	0.00001	2,618	5	0	0	0	0
							10	0	0		0
							15	0	0		0
							20	1	0		0
							25	1	0		0
				10	0.00001	98,837	5	5	0	0	0
							10	10	0		0
							15	15	0		0
							20	20	0		0
							25	25	1		1

GTA Aquifer Assessment 10-06
Groundwater Management Area 10
Trinity Aquifer
Draft Managed Available Groundwater estimates
July 28, 2010

Table 4 continued.

GMA	Aquifer	County	GCD	Map Area	Estimated storage coefficient	Areal extent (acres)	Desired total aquifer water level decline (feet)	Estimated total volume from water level decline (acre-feet)	Estimated annual volume from water level decline (ac-ft/yr)	Estimated annual lateral inflow (ac-ft/yr)	Estimated annual total volume (ac-ft/yr)
10	Lowe Trinity	Caldwell	n/a	11	0.00005	420	5	0	0	0	0
							10	0	0		0
							15	0	0		0
							20	0	0		0
							25	1	0		0
		Comal		12	0.00005	123,768	5	31	1	0	1
							10	62	1		1
							15	93	2		2
							20	124	2		2
							25	155	3		3
				13	0.00005	8,679	5	2	0	0	0
							10	4	0		0
							15	7	0		0
							20	9	0		0
							25	11	0		0
		Guadalupe		14	0.00005	302	5	0	0	0	0
							10	0	0		0
							15	0	0		0
							20	0	0		0
							25	0	0		0
				15	0.00005	2,362	5	1	0	0	0
							10	1	0		0
							15	2	0		0
							20	2	0		0
							25	3	0		0
		Bexar	Trinity Glen-Rose GCD	16	0.00005	1,642	5	0	0	0	0
							10	1	0		0
							15	1	0		0
							20	2	0		0
							25	2	0		0
			n/a	17	0.00005	264,374	5	66	1	0	1
							10	132	3		3
							15	198	4		4
							20	264	5		5
							25	330	7		7
		Medina	Medina County GCD	18	0.00005	103,048	5	26	1	0	1
							10	52	1		1
							15	77	2		2
							20	103	2		2
							25	129	3		3
				19	0.00005	455,928	5	114	2	0	2
							10	228	5		5
							15	342	7		7
							20	456	9		9
							25	570	11		11
		Uvalde	Uvalde County UWCD	20	0.00005	63,462	5	16	0	0	0
							10	32	1		1
							15	48	1		1
							20	63	1		1
							25	79	2		2
	Total					1,294,711	25			0	5
							50				11
							75				16
							100				19
							125				27

GMA = groundwater management area
GCD = groundwater conservation district
CD = conservation district
BSEACD = Barton Springs/Edwards Aquifer Conservation District
UWCD = underground water conservation district
ac-ft/yr = acre-feet per year
n/a = Areas that are covered by the Edwards Aquifer Authority or areas that are not covered by a GCD
The formulas for this table are: storage coefficient * areal extent * desired total aquifer water level decline = estimated total volume from water level decline/50 = estimated annual volume from water level decline. Estimated annual volume from water level decline + estimated annual lateral inflow = estimated annual total volume.

Table 5. Summary of total pumping estimates for the Trinity Aquifer (upper, middle, and lower units combined).

County	District	River Basin	Region	Water level decline (feet)	Total Pumping (ac-ft/yr)
Bexar	Trinity Glen-Rose GCD	San Antonio	L	5	113
				10	113
				15	113
				20	113
				25	113
	n/a	San Antonio	L	5	19,980
				10	19,986
				15	19,989
				20	19,992
				25	19,998
Caldwell	n/a	Guadalupe	L	5	0
				10	0
				15	0
				20	0
				25	0
Comal	n/a	Guadalupe	L	5	27,144
				10	27,151
				15	27,160
				20	27,167
				25	27,176
	n/a	San Antonio	L	5	2,098
				10	2,100
				15	2,103
				20	2,105
				25	2,108
Guadalupe	n/a	Guadalupe	L	5	0
				10	0
				15	0
				20	0
				25	0
	n/a	San Antonio	L	5	0
				10	0
				15	0
				20	0
				25	0

Table 5 continued.

County	District	River Basin	Region	Water level decline (feet)	Total Pumping (ac-ft/yr)
Hays	Barton Springs/Edwards Aquifer Conservation District	Colorado	K	5	726
				10	726
				15	726
				20	726
				25	726
		Guadalupe	L	5	238
				10	238
				15	238
				20	238
				25	238
	Hays Trinity GCD	Colorado	K	5	115
				10	118
				15	120
				20	123
				25	126
		Guadalupe	L	5	148
				10	151
				15	153
				20	155
				25	158
	Plum Creek Conservation District	Guadalupe	L	5	238
				10	238
				15	238
				20	238
				25	238
	n/a	Colorado	K	5	107
				10	110
				15	112
				20	115
				25	117
	n/a	Guadalupe	L	5	2,227
				10	2,229
				15	2,231
				20	2,233
				25	2,238

Table 5 continued.

County	District	River Basin	Region	Water level decline (feet)	Total Pumping (ac-ft/yr)
Medina	Medina County GCD	Nueces	L	5	4,346
				10	4,355
				15	4,361
				20	4,367
				25	4,373
		San Antonio	L	5	990
				10	990
				15	993
				20	993
				25	996
Travis	n/a	Colorado	K	5	317
				10	317
				15	317
				20	317
				25	317
	Barton Springs/Edwards Aquifer Conservation District	Colorado	K	5	317
				10	317
				15	317
				20	317
				25	317
		Guadalupe	K	5	7
				10	7
				15	7
				20	7
				25	7
Uvalde	Uvalde County UWCD	Nueces	L	5	631
				10	636
				15	638
				20	639
				25	644

GCD = groundwater conservation district
ac-ft/yr = acre-feet per year
UWCD = underground water conservation district

Table 6. Estimates of year 2060 exempt use for the Trinity Aquifer in Groundwater Management Area 10 by county, river basin, regional water planning area, and groundwater conservation district

County	Groundwater Conservation District	River Basin	Region	Exempt Use (ac-ft/yr)
Bexar	Trinity Glen-Rose GCD	San Antonio	L	0
Hays	Barton Springs/Edwards Aquifer CD	Colorado	K	42
		Guadalupe	L	0
	Hays Trinity GCD	Colorado	K	0
		Guadalupe	L	0
	Plum Creek CD	Guadalupe	L	0
Medina	Medina County GCD	Nueces	L	84
		San Antonio	L	113
Travis	Barton Springs/Edwards Aquifer CD	Colorado	K	9
		Guadalupe	K	0
Uvalde	Uvalde County UWCD	Nueces	L	0

GCD = groundwater conservation district
CD = conservation district
UWCD = underground water conservation district
ac-ft/yr = acre-feet per year

Table 7. Summary of draft managed available groundwater for the Trinity Aquifer in Groundwater Management Area 10 by county, river basin, regional water planning area, and groundwater conservation district.

County	Groundwater Conservation District	River Basin	Region	5 ft. decline	10 ft. decline	15 ft. decline	20 ft. decline	25 ft. decline
Bexar	Trinity Glen-Rose GCD	San Antonio	L	113	113	113	113	113
Hays	Barton Springs/Edwards Aquifer CD	Colorado	K	684	684	684	684	684
		Guadalupe	L	238	238	238	238	238
	Hays Trinity GCD	Colorado	K	115	118	120	123	126
		Guadalupe	L	148	151	153	155	158
	Plum Creek CD	Guadalupe	L	238	238	238	238	238
Medina	Medina County GCD	Nueces	L	4,262	4,271	4,277	4,283	4,289
		San Antonio	L	877	877	880	880	883
Travis	Barton Springs/Edwards Aquifer CD	Colorado	K	308	308	308	308	308
		Guadalupe	K	7	7	7	7	7
Uvalde	Uvalde County UWCD	Nueces	L	631	636	638	639	644
			Total (ac-ft/yr)	**7,621**	**7,641**	**7,656**	**7,668**	**7,688**

GCD = groundwater conservation district
CD = conservation district
UWCD = underground water conservation district
ac-ft/yr = acre-feet per year

Table 8. Summary of draft managed available groundwater for the Trinity Aquifer in Groundwater Management Area 10 by groundwater conservation district.

Groundwater Conservation District	5 ft. decline	10 ft. decline	15 ft. decline	20 ft. decline	25 ft. decline
BSEACD	1,237	1,237	1,237	1,237	1,237
Hays Trinity GCD	263	269	273	278	284
Medina County GCD	5,139	5,148	5,157	5,163	5,172
Plum Creek CD	238	238	238	238	238
Trinity Glen-Rose GCD	113	113	113	113	113
Uvalde County UWCD	631	636	638	639	644
Total (ac-ft/yr)	**7,621**	**7,641**	**7,656**	**7,668**	**7,688**

BSEACD = Barton Springs/Edwards Aquifer Conservation District
GCD = groundwater conservation district
UWCD = underground water conservation district
CD = conservation district
ac-ft/yr = acre-feet per year

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 Trinity Aquifer may not behave in a uniform manner.

Note that estimates of managed available groundwater are based on the best available scientific tools that can be used to develop 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.

REFERENCES:

Anaya, R., 2001, GAM technical memo 01-01(rev a): Texas Water Development Board technical memorandum, 2 p.

Ashworth, J. B., 1983, Ground-water availability of the lower Cretaceous formations in the Hill Country of South-Central Texas, Texas Department of Water Resources Report 273, 65 p.

BSEACD, in preparation, Compilation of aquifer tests in Travis and Hays counties, central Texas: Barton Springs/Edwards Aquifer Conservation District data series report.

Freeze, R. A., and Cherry, J. A., 1979, Groundwater: Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 604 p.

Hutchison, W.R., 2010, Draft GAM Task 10-005. Texas Water Development Board unpublished report.

Jones, I. C., Anaya, R., and Wade, S., 2009, Groundwater availability model for the Hill Country portion of the Trinity Aquifer system, Texas: Texas Water Development Board updated Trinity Hill Country GAM, 194 p.

LBG-Guyton Associates, 2003, Brackish Groudwater Manual for Texas Regional Water Planning Groups: Texas Water Development Board contract report. 188 p.

Muller, D. A., and Price, R. D., 1979, Ground-water availability in Texas, estimates and projections through 2030: Texas Department of Water Resources Report 238, 77 p.

Narasimhan, B., Srinvasan, R., Quiring, S., and Nielsen-Gammon, J.W., 2008, Digital Climatic Atlas of Texas: Texas A&M University, Texas Water Development Board contract, Report 2005-483-5591, 108 p.

Theis, C.V., 1940, The source of water derived from wells: Essential factors controlling the response of an aquifer to development: Civil Engineering 10, pp.277-280