GTA Aquifer Assessment 09-02

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April 20, 2010

GTA Aquifer Assessment 09-02
Groundwater Management Area 10
Deep middle and lower Trinity Aquifer
Draft Managed Available Groundwater estimates
April 20, 2010

REQUESTOR:

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

DESCRIPTION OF REQUEST:

Mr. Illgner provided the Texas Water Development Board (TWDB) with draft desired future conditions for the aquifers in the Northern Subdivision of Groundwater Management Area 10 and requested that TWDB estimate draft managed available groundwater values for that area. This aquifer assessment presents the draft managed available groundwater for the deep middle and lower Trinity Aquifer in the Northern Subdivision within Groundwater Management Area 10.

DRAFT DESIRED FUTURE CONDITIONS:

- Middle Trinity Aquifer – During Drought of Record (DOR) conditions, pumping from the middle Trinity Aquifer will cause drawdown in the potentiometric surface that does not exceed [15, 25, 35, 45 – to be determined] feet, averaged across the Northern Subdivision of GMA-10, relative to a steady-state potentiometric surface of the middle Trinity Aquifer in this area that would exist without pumping.
- Lower Trinity Aquifer - During DOR conditions, pumping from the lower Trinity Aquifer will cause drawdown in the potentiometric surface that does not exceed [10, 20, 30, 40, 50 – to be determined] feet, averaged across the Northern Subdivision of GMA-10, relative to a steady-state potentiometric surface of the lower Trinity Aquifer in this area that would exist without pumping.

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, 1978, 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, 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 greater than 3,000 mg/l 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. Approximately 135 acres of the Barton Springs/Edwards Aquifer Conservation District (BSEACD) in Hays County that falls within the central subdivision of GMA 10 was added to the northern subdivision (Map Area 5).

Because the Northern Subdivision of GMA 10 does not include any outcrop area for the middle and lower Trinity Aquifer and draft desired future conditions are for DOR conditions, no estimated effective recharge based on precipitation was included in the draft managed available groundwater calculations.

Lateral inflow to the middle and lower Trinity Aquifer was estimated based on the calibrated Groundwater Availability Model (GAM) for the hill country portion of the Trinity Aquifer system in Texas (Jones and others, 2009) and analysis of regional flow in the Trinity Aquifer performed by the BSEACD (Smith and Hunt, 2009).

The areal extent of each map area was multiplied by the aquifer storage coefficient derived from aquifer tests performed and compiled by the BSEACD for the middle and lower Trinity Aquifer in Travis and Hays counties (BSEACD, in preparation), 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.

PARAMETERS AND ASSUMPTIONS:

- The entire aquifer extent is assumed to be under artesian conditions and calculated as a confined aquifer.
- Water level drawdowns were assumed to be uniform across the aquifer.
- 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.
- The Northern Subdivision boundary is based on maps from email correspondence between the BSEACD and the Edwards Aquifer Authority on 2/18/10.
- Areas were designated as Plum Creek Conservation District only where their jurisdiction does not overlap with the BSEACD.
- The draft managed available groundwater volume estimates are the annual volume of water depleted from the aquifer based on the draft desired future conditions.
- Annual volumes are calculated by dividing the total volume by 50 years.
- Because the Northern Subdivision does not include any outcrop area for the middle and lower Trinity Aquifer and DOR conditions are specified in the draft desired future conditions annual effective recharge from precipitation is assumed to be zero.
- Lateral inflow to the middle and lower Trinity aquifers is estimated to be 2,860 ac-ft/yr and 1,430 ac-ft/yr respectively based on the calibrated GAM for the hill country portion of the Trinity Aquifer system in Texas (Jones and others, 2009) and analysis of regional flow in the Trinity Aquifer performed by BSEACD (Smith and Hunt, 2009). This volume was apportioned evenly across the aquifer map areas.
- The storage coefficient of the lower and middle Trinity Aquifer is 0.001 derived from aquifer tests of the middle and lower Trinity aquifers in Travis and Hays counties (BSEACD, in preparation).
- Conditions were assumed to be physically possible across the Northern Subdivision of GMA 10.

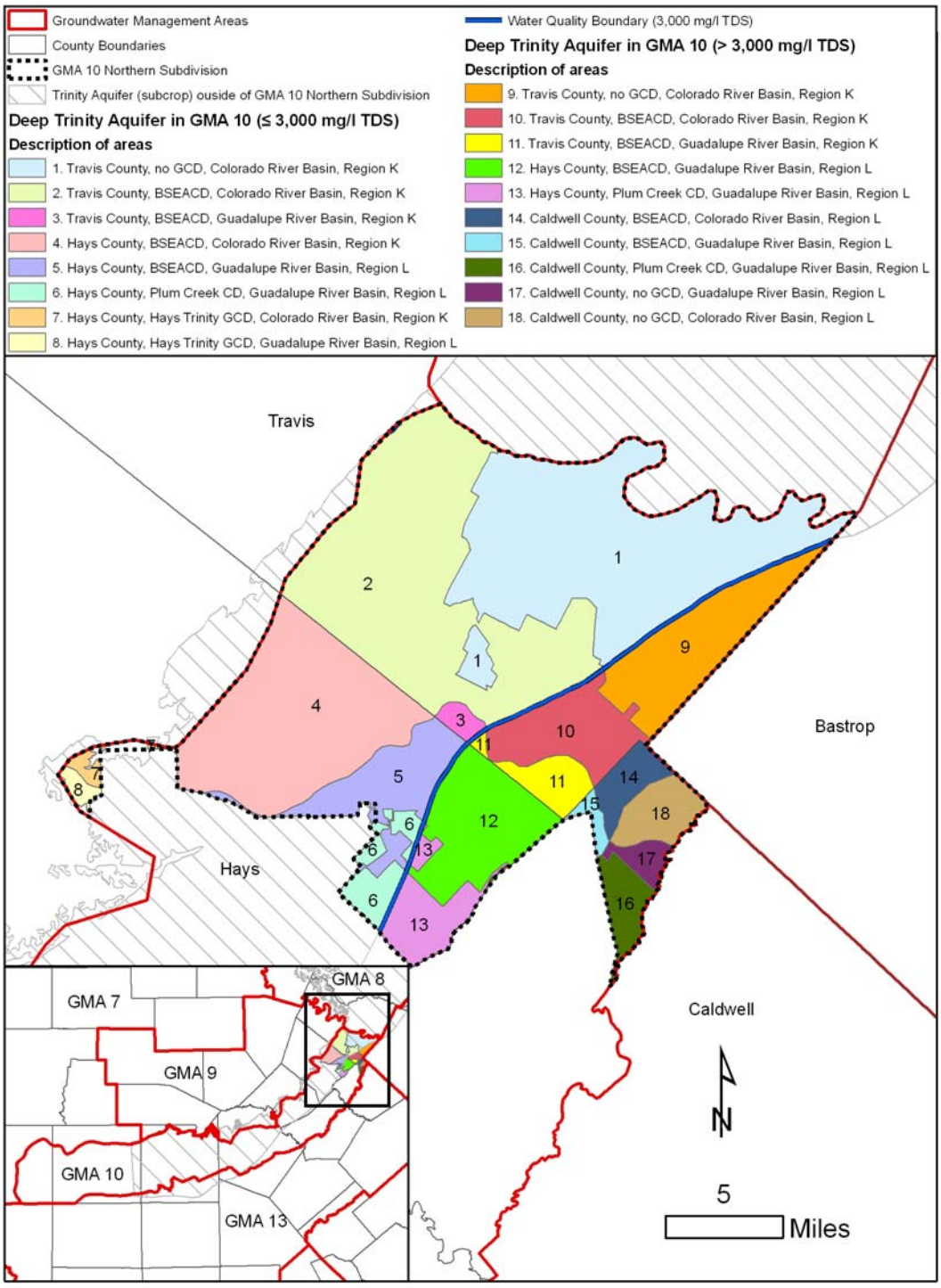

Figure 1. Geographic subdivisions for analyzing draft managed available groundwater for the middle and lower Trinity Aquifer in the Northern Subdivision of GMA 10. BSEACD = Barton Springs/Edwards Aquifer Conservation District, CD = Conservation District, GCD = groundwater conservation district, GMA = groundwater management area, TDS = total dissolved solids.

RESULTS:

The results (Tables 1-11) show the draft managed available groundwater estimates for the middle and lower Trinity Aquifer in the Northern Subdivision of GMA 10. For the middle Trinity Aquifer drawdowns of 15, 25, 35, and 45 feet result in an estimated annual total volume of 2,926; 2,974; 3,020 and 3,065 acre-feet per year, respectively. For the lower Trinity Aquifer drawdowns of 10, 20, 30, 40, and 50 feet result in an estimated annual total volume of 1,475; 1,520; 1,567; 1,613 and 1,657 acre-feet per year, respectively.

Based on 15, 25, 35, and 45 foot declines for the middle Trinity Aquifer:

- BSEACD has 1,285; 1,307; 1,326 and 1,345 acre-feet per year (≤ 3,000 mg/l TDS), and 436, 444, 451 and 458 acre-feet per year (> 3,000 mg/l TDS) of draft managed available groundwater, respectively;
- Plum Creek Conservation District has 60, 61, 62, 63 acre-feet per year (≤ 3,000 mg/l TDS), and 140, 142, 145 and 147 acre-feet per year (> 3,000 mg/l TDS) of draft managed available groundwater, respectively;
- Hays Trinity Groundwater Conservation District has 26, 26, 28, and 28 acre-feet per year (≤ 3,000 mg/l TDS) of draft managed available groundwater, respectively.

Based on 10, 20, 30, 40, and 50 foot declines for the lower Trinity Aquifer:

- BSEACD has 648, 668, 688, 708 and 727 acre-feet per year (≤ 3,000 mg/l TDS), and 221, 227, 235, 241 and 248 acre-feet per year (> 3,000 mg/l TDS) of draft managed available groundwater, respectively;
- Plum Creek Conservation District has 30, 31, 32, 33 and 34 acre-feet per year (≤ 3,000 mg/l TDS), and 70, 73, 74, 76 and 79 acre-feet per year (> 3,000 mg/l TDS) of draft managed available groundwater, respectively;
- Hays Trinity Groundwater Conservation District has 12, 12, 14, 14, and 14 acre-feet per year (≤ 3,000 mg/l TDS) of draft managed available groundwater, respectively.

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Table 1. Estimates of draft managed available groundwater for the northern subdivision of 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 ≤ 3,000 mg/l TDS	Travis	none	1	0.001	53,168	15	798	16	669	685
							25	1,329	27		696
							35	1,861	37		706
							45	2,393	48		717
			BSEACD	2	0.001	53,352	15	800	16	672	688
							25	1,334	27		699
							35	1,867	37		709
							45	2,401	48		720
				3	0.001	1,340	15	20	0	17	17
							25	34	1		18
							35	47	1		18
							45	60	1		18
		Hays		4	0.001	33,789	15	507	10	425	435
							25	845	17		442
							35	1,183	24		449
							45	1,521	30		455
				5	0.001	11,243	15	169	3	142	145
							25	281	6		148
							35	394	8		150
							45	506	10		152
			Plum Creek CD	6	0.001	4,657	15	70	1	59	60
							25	116	2		61
							35	163	3		62
							45	210	4		63
			Hays Trinity GCD	7	0.001	994	15	15	0	13	13
							25	25	0		13
							35	35	1		14
							45	45	1		14
				8	0.001	994	15	15	0	13	13
							25	25	0		13
							35	35	1		14
							45	45	1		14
	Middle Trinity > 3,000 mg/l TDS	Travis	none	9	0.001	15,763	15	236	5	198	203
							25	394	8		206
							35	552	11		209
							45	709	14		212
			BSEACD	10	0.001	10,597	15	159	3	133	136
							25	265	5		138
							35	371	7		140
							45	477	10		143
				11	0.001	4,175	15	63	1	53	54
							25	104	2		55
							35	146	3		56
							45	188	4		57
		Hays		12	0.001	14,446	15	217	4	182	186
							25	361	7		189
							35	506	10		192
							45	650	13		195
			Plum Creek CD	13	0.001	6,811	15	102	2	86	88
							25	170	3		89
							35	238	5		91
							45	306	6		92

Table 1 continued.

10	Middle Trinity > 3,000 mg/l TDS	Caldwell	BSEACD	14	0.001	3,649	15	55	1	46	47
							25	91	2		48
							35	128	3		49
							45	164	3		49
				15	0.001	1,063	15	16	0	13	13
							25	27	1		14
							35	37	1		14
							45	48	1		14
			Plum Creek CD	16	0.001	4,040	15	61	1	51	52
							25	101	2		53
							35	141	3		54
							45	182	4		55
			none	17	0.001	2,005	15	30	1	25	26
							25	50	1		26
							35	70	1		26
							45	90	2		27
				18	0.001	5,023	15	75	2	63	65
							25	126	3		66
							35	176	4		67
							45	226	5		68
	Total					227,109	15			2,860	2,926
							25				2,974
							35				3,020
							45				3,065

GMA = groundwater management area
GCD = groundwater conservation district
CD = Conservation District
ac-ft/yr = acre-feet per year
BSEACD = Barton Springs/Edwards Aquifer Conservation District
TDS = total dissolved solids
mg/l = milligrams per liter
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 2. Estimates of draft managed available groundwater for the northern subdivision of 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 ≤ 3,000 mg/l TDS	Travis	none	1	0.001	53,168	10	532	11	335	346
							20	1,063	21		356
							30	1,595	32		367
							40	2,127	43		378
							50	2,658	53		388
			BSEACD	2	0.001	53,352	10	534	11	336	347
							20	1,067	21		357
							30	1,601	32		368
							40	2,134	43		379
							50	2,668	53		389
				3	0.001	1,340	10	13	0	8	8
							20	27	1		9
							30	40	1		9
							40	54	1		9
							50	67	1		9
		Hays		4	0.001	33,789	10	338	7	213	220
							20	676	14		227
							30	1,014	20		233
							40	1,352	27		240
							50	1,689	34		247
				5	0.001	11,243	10	112	2	71	73
							20	225	4		75
							30	337	7		78
							40	450	9		80
							50	562	11		82
			Plum Creek CD	6	0.001	4,657	10	47	1	29	30
							20	93	2		31
							30	140	3		32
							40	186	4		33
							50	233	5		34
			Hays Trinity GCD	7	0.001	994	10	10	0	6	6
							20	20	0		6
							30	30	1		7
							40	40	1		7
							50	50	1		7
				8	0.001	994	10	10	0	6	6
							20	20	0		6
							30	30	1		7
							40	40	1		7
							50	50	1		7

Table 2 continued.

10	Lower Trinity > 3,000 mg/l TDS	Travis	none	9	0.001	15,763	10	158	3	99	102
							20	315	6		105
							30	473	9		108
							40	631	13		112
							50	788	16		115
			BSEACD	10	0.001	10,597	10	106	2	67	69
							20	212	4		71
							30	318	6		73
							40	424	8		75
							50	530	11		78
				11	0.001	4,175	10	42	1	26	27
							20	84	2		28
							30	125	3		29
							40	167	3		29
							50	209	4		30
		Hays		12	0.001	14,446	10	144	3	91	94
							20	289	6		97
							30	433	9		100
							40	578	12		103
							50	722	14		105
			Plum Creek CD	13	0.001	6,811	10	68	1	43	44
							20	136	3		46
							30	204	4		47
							40	272	5		48
							50	341	7		50
		Caldwell	BSEACD	14	0.001	3,649	10	36	1	23	24
							20	73	1		24
							30	109	2		25
							40	146	3		26
							50	182	4		27
				15	0.001	1,063	10	11	0	7	7
							20	21	0		7
							30	32	1		8
							40	43	1		8
							50	53	1		8
			Plum Creek CD	16	0.001	4,040	10	40	1	25	26
							20	81	2		27
							30	121	2		27
							40	162	3		28
							50	202	4		29
			none	17	0.001	2,005	10	20	0	13	13
							20	40	1		14
							30	60	1		14
							40	80	2		15
							50	100	2		15
				18	0.001	5,023	10	50	1	32	33
							20	100	2		34
							30	151	3		35
							40	201	4		36
							50	251	5		37
		Total				227,109	10			1,430	1,475
							20				1,520
							30				1,567
							40				1,613
							50				1,657

GMA = groundwater management area
GCD = groundwater conservation district
CD = Conservation District
ac-ft/yr = acre-feet per year
BSEACD = Barton Springs/Edwards Aquifer Conservation District
TDS = total dissolved solids
mg/l = milligrams per liter

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 3. Estimates of draft managed available groundwater for water level declines of 15 feet in the middle Trinity Aquifer (see Figure 1).

Map Key	Aquifer	County	RWPA	River Basin	GCD	GMA	GeoArea	Year	Draft MAG (ac-ft/yr)
1	Middle Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	685
2	Middle Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	688
3	Middle Trinity (≤ 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	17
4	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	BSEACD	10	Northern Subdivision	n/a	435
5	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	145
6	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	60
7	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	Hays Trinity GCD	10	Northern Subdivision	n/a	13
8	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Hays Trinity GCD	10	Northern Subdivision	n/a	13
9	Middle Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	203
10	Middle Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	136
11	Middle Trinity (> 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	54
12	Middle Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	186
13	Middle Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	88
14	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	BSEACD	10	Northern Subdivision	n/a	47
15	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	13
16	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	52
17	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	none	10	Northern Subdivision	n/a	26
18	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	none	10	Northern Subdivision	n/a	65

RWPA = regional water planning area
GMA = groundwater management area
GCD = groundwater conservation district
TDS = total dissolved solids
mg/l = milligrams per liter
ac-ft/yr = acre-feet per year
CD = Conservation District
BSEACD = Barton Springs/Edwards Aquifer Conservation District
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 water level declines of 25 feet in the middle Trinity Aquifer (see Figure 1).

Map Key	Aquifer	County	RWPA	River Basin	GCD	GMA	GeoArea	Year	Draft MAG (ac-ft/yr)
1	Middle Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	696
2	Middle Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	699
3	Middle Trinity (≤ 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	18
4	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	BSEACD	10	Northern Subdivision	n/a	442
5	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	148
6	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	61
7	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	Hays Trinity GCD	10	Northern Subdivision	n/a	13
8	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Hays Trinity GCD	10	Northern Subdivision	n/a	13
9	Middle Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	206
10	Middle Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	138
11	Middle Trinity (> 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	55
12	Middle Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	189
13	Middle Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	89
14	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	BSEACD	10	Northern Subdivision	n/a	48
15	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	14
16	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	53
17	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	none	10	Northern Subdivision	n/a	26
18	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	none	10	Northern Subdivision	n/a	66

RWPA = regional water planning area
GMA = groundwater management area
GCD = groundwater conservation district
TDS = total dissolved solids
mg/l = milligrams per liter
ac-ft/yr = acre-feet per year
CD = Conservation District
BSEACD = Barton Springs/Edwards Aquifer Conservation District
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 5. Estimates of draft managed available groundwater for water level declines of 35 feet in the middle Trinity Aquifer (see Figure 1).

Map Key	Aquifer	County	RWPA	River Basin	GCD	GMA	GeoArea	Year	Draft MAG
1	Middle Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	706
2	Middle Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	709
3	Middle Trinity (≤ 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	18
4	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	BSEACD	10	Northern Subdivision	n/a	449
5	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	150
6	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	62
7	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	Hays Trinity GCD	10	Northern Subdivision	n/a	14
8	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Hays Trinity GCD	10	Northern Subdivision	n/a	14
9	Middle Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	209
10	Middle Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	140
11	Middle Trinity (> 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	56
12	Middle Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	192
13	Middle Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	91
14	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	BSEACD	10	Northern Subdivision	n/a	49
15	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	14
16	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	54
17	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	none	10	Northern Subdivision	n/a	26
18	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	none	10	Northern Subdivision	n/a	67

RWPA = regional water planning area
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TDS = total dissolved solids
mg/l = milligrams per liter
ac-ft/yr = acre-feet per year
CD = Conservation District
BSEACD = Barton Springs/Edwards Aquifer Conservation District
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 6. Estimates of draft managed available groundwater for water level declines of 45 feet in the middle Trinity Aquifer (see Figure 1).

Map Key	Aquifer	County	RWPA	River Basin	GCD	GMA	GeoArea	Year	Draft MAG (ac-ft/yr)
1	Middle Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	717
2	Middle Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	720
3	Middle Trinity (≤ 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	18
4	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	BSEACD	10	Northern Subdivision	n/a	455
5	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	152
6	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	63
7	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	Hays Trinity GCD	10	Northern Subdivision	n/a	14
8	Middle Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Hays Trinity GCD	10	Northern Subdivision	n/a	14
9	Middle Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	212
10	Middle Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	143
11	Middle Trinity (> 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	57
12	Middle Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	195
13	Middle Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	92
14	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	BSEACD	10	Northern Subdivision	n/a	49
15	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	14
16	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	55
17	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	none	10	Northern Subdivision	n/a	27
18	Middle Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	none	10	Northern Subdivision	n/a	68

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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 7. Estimates of draft managed available groundwater for water level declines of 10 feet in the lower Trinity Aquifer (see Figure 1).

Map Key	Aquifer	County	RWPA	River Basin	GCD	GMA	GeoArea	Year	Draft MAG (ac-ft/yr)
1	Lower Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	346
2	Lower Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	347
3	Lower Trinity (≤ 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	8
4	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	BSEACD	10	Northern Subdivision	n/a	220
5	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	73
6	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	30
7	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	Hays Trinity GCD	10	Northern Subdivision	n/a	6
8	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Hays Trinity GCD	10	Northern Subdivision	n/a	6
9	Lower Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	102
10	Lower Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	69
11	Lower Trinity (> 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	27
12	Lower Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	94
13	Lower Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	44
14	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	BSEACD	10	Northern Subdivision	n/a	24
15	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	7
16	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	26
17	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	none	10	Northern Subdivision	n/a	13
18	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	none	10	Northern Subdivision	n/a	33

RWPA = regional water planning area
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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 8. Estimates of draft managed available groundwater for water level declines of 20 feet in the lower Trinity Aquifer (see Figure 1).

Map Key	Aquifer	County	RWPA	River Basin	GCD	GMA	GeoArea	Year	Draft MAG (ac-ft/yr)
1	Lower Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	356
2	Lower Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	357
3	Lower Trinity (≤ 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	9
4	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	BSEACD	10	Northern Subdivision	n/a	227
5	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	75
6	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	31
7	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	Hays Trinity GCD	10	Northern Subdivision	n/a	6
8	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Hays Trinity GCD	10	Northern Subdivision	n/a	6
9	Lower Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	105
10	Lower Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	71
11	Lower Trinity (> 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	28
12	Lower Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	97
13	Lower Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	46
14	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	BSEACD	10	Northern Subdivision	n/a	24
15	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	7
16	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	27
17	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	none	10	Northern Subdivision	n/a	14
18	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	none	10	Northern Subdivision	n/a	34

RWPA = regional water planning area
GMA = groundwater management area
GCD = groundwater conservation district
TDS = total dissolved solids
mg/l = milligrams per liter
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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 9. Estimates of draft managed available groundwater for water level declines of 30 feet in the lower Trinity Aquifer (see Figure 1).

Map Key	Aquifer	County	RWPA	River Basin	GCD	GMA	GeoArea	Year	Draft MAG (ac-ft/yr)
1	Lower Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	367
2	Lower Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	368
3	Lower Trinity (≤ 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	9
4	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	BSEACD	10	Northern Subdivision	n/a	233
5	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	78
6	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	32
7	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	Hays Trinity GCD	10	Northern Subdivision	n/a	7
8	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Hays Trinity GCD	10	Northern Subdivision	n/a	7
9	Lower Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	108
10	Lower Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	73
11	Lower Trinity (> 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	29
12	Lower Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	100
13	Lower Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	47
14	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	BSEACD	10	Northern Subdivision	n/a	25
15	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	8
16	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	27
17	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	none	10	Northern Subdivision	n/a	14
18	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	none	10	Northern Subdivision	n/a	35

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TDS = total dissolved solids
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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 10. Estimates of draft managed available groundwater for water level declines of 40 feet in the lower Trinity Aquifer (see Figure 1).

Map Key	Aquifer	County	RWPA	River Basin	GCD	GMA	GeoArea	Year	Draft MAG (ac-ft/yr)
1	Lower Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	378
2	Lower Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	379
3	Lower Trinity (≤ 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	9
4	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	BSEACD	10	Northern Subdivision	n/a	240
5	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	80
6	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	33
7	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	Hays Trinity GCD	10	Northern Subdivision	n/a	7
8	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Hays Trinity GCD	10	Northern Subdivision	n/a	7
9	Lower Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	112
10	Lower Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	75
11	Lower Trinity (> 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	29
12	Lower Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	103
13	Lower Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	48
14	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	BSEACD	10	Northern Subdivision	n/a	26
15	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	8
16	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	28
17	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	none	10	Northern Subdivision	n/a	15
18	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	none	10	Northern Subdivision	n/a	36

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MAG = Managed available groundwater in units of acre-feet per year

Table 11. Estimates of draft managed available groundwater for water level declines of 50 feet in the lower Trinity Aquifer (see Figure 1).

Map Key	Aquifer	County	RWPA	River Basin	GCD	GMA	GeoArea	Year	Draft MAG (ac-ft/yr)
1	Lower Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	388
2	Lower Trinity (≤ 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	389
3	Lower Trinity (≤ 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	9
4	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	BSEACD	10	Northern Subdivision	n/a	247
5	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	82
6	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	34
7	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	K	Colorado	Hays Trinity GCD	10	Northern Subdivision	n/a	7
8	Lower Trinity (≤ 3,000 mg/l TDS)	Hays	L	Guadalupe	Hays Trinity GCD	10	Northern Subdivision	n/a	7
9	Lower Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	none	10	Northern Subdivision	n/a	115
10	Lower Trinity (> 3,000 mg/l TDS)	Travis	K	Colorado	BSEACD	10	Northern Subdivision	n/a	78
11	Lower Trinity (> 3,000 mg/l TDS)	Travis	K	Guadalupe	BSEACD	10	Northern Subdivision	n/a	30
12	Lower Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	105
13	Lower Trinity (> 3,000 mg/l TDS)	Hays	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	50
14	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	BSEACD	10	Northern Subdivision	n/a	27
15	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	BSEACD	10	Northern Subdivision	n/a	8
16	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	Plum Creek CD	10	Northern Subdivision	n/a	29
17	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Guadalupe	none	10	Northern Subdivision	n/a	15
18	Lower Trinity (> 3,000 mg/l TDS)	Caldwell	L	Colorado	none	10	Northern Subdivision	n/a	37

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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

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 middle and lower Trinity Aquifer may not behave in a uniform manner. The analysis further assumes that aquifer recharge from direct precipitation is zero.

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.

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