Explanatory Report for Adopted Desired Future Conditions of the Trinity Aquifer in Groundwater Management Area 10

Table of Contents

List of Appendices

FIGURES

TABLES

Abbreviations

DFC	Desired Future Conditions
GCD	Groundwater Conservation District
GMA	Groundwater Management Area
RWPG	Regional Water Planning Group
MAG	Modeled Available Groundwater
TERS	Total Estimated Recoverable Storage
TWDB	Texas Water Development Board

1. Description of Groundwater Management Area 10

Groundwater Conservation Districts (GCDs, or districts) were created, typically by legislative action, to provide for the conservation, preservation, protection, recharging, and prevention of waste of the groundwater, and of groundwater reservoirs or their subdivisions, and to control subsidence caused by withdrawal of water from those groundwater reservoirs or their subdivisions. The individual GCDs overlying each of the major aquifers or, for some aquifers, their geographic subdivisions were aggregated by the Texas Water Development Board (TWDB) acting under legislative mandate to form Groundwater Management Areas (GMAs). Each GMA is charged with facilitating joint planning efforts for all aquifers wholly or partially within its GMA boundaries that are considered relevant to joint regional planning.

GMA 10 was delineated based primarily on the extents of the San Antonio and Barton Springs segments of the Fresh Edwards (Balcones Fault Zone) Aquifer, but it also includes the underlying down-dip Trinity Aquifer. Other aquifers in GMA 10 include the Leona Gravel, Buda Limestone, Austin Chalk, and the Saline Edwards (Balcones Fault Zone) aquifers. The planning area of GMA 10 includes all or parts of Bexar, Caldwell, Comal, Guadalupe, Hays, Kinney, Medina, Travis, and Uvalde counties (Figure 1). GCDs in Groundwater Management Area 10 include Barton Springs/Edwards Aquifer Conservation District (BSEACD), Comal Trinity GCD, Edwards Aquifer Authority, Kinney County GCD, Medina County GCD, Plum Creek Conservation District, Uvalde County Underground Water Conservation District, and Southwestern Travis County Groundwater Conservation District SWTCGCD (Figure 1).

As mandated in Texas Water Code § 36.108, districts in a GMA are required to submit Desired Future Conditions (DFCs) of the groundwater resources in their GMA to the executive administrator of the TWDB, unless that aquifer is deemed to be non-relevant for the purposes of joint planning. According to Texas Water Code § 36.108 (d-3), the district representatives shall produce a Desired Future Conditions Explanatory Report for the management area and submit to the TWDB a copy of the Explanatory Report.

GMA 10 has designated the Trinity Aquifer as a relevant aquifer (excluding Plum Greek Conservation District) for purposes of joint planning. This document is the preliminary Explanatory Report for this aquifer.

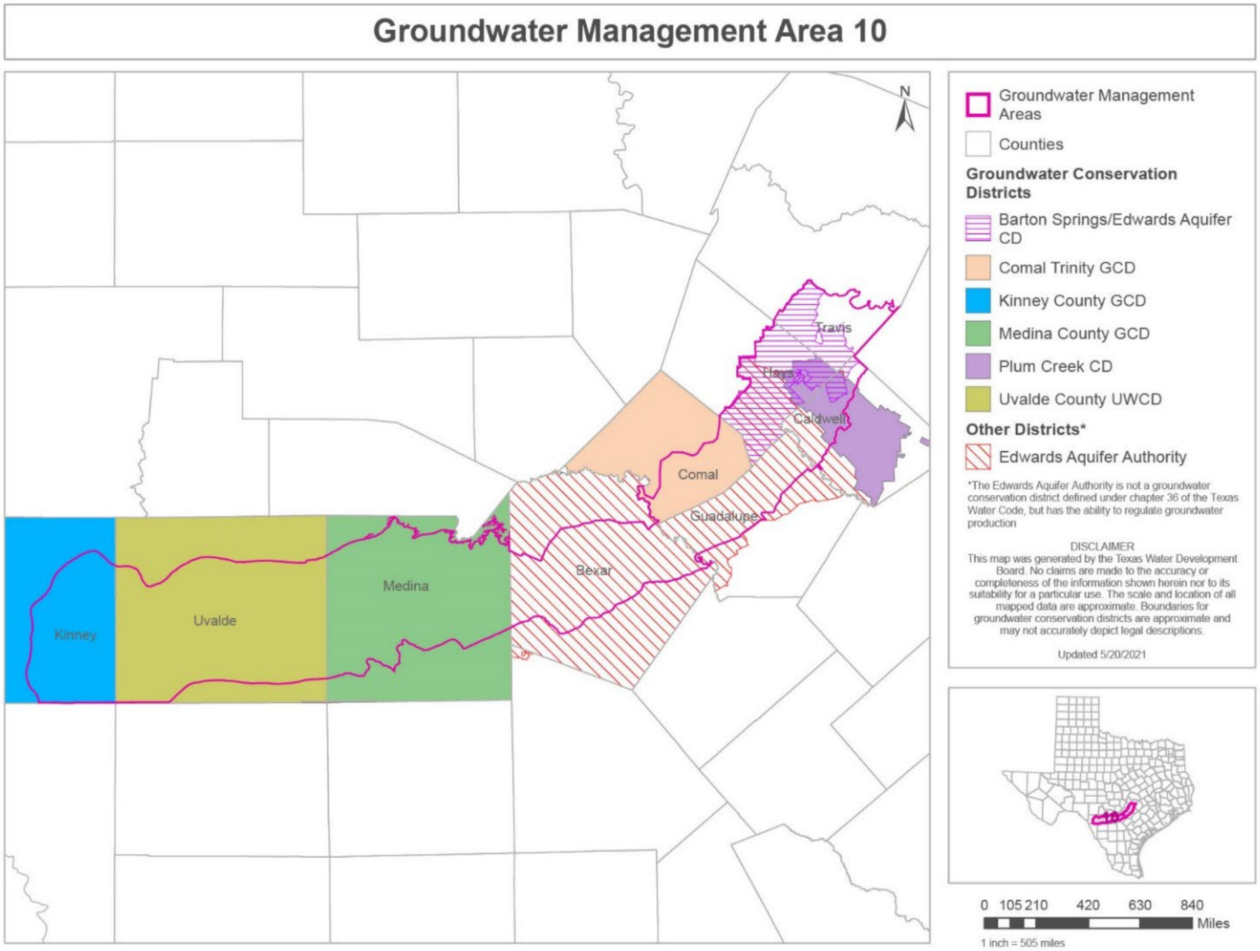

Figure 1. Map of the administrative boundaries of GMA 10 designated for joint-planning purposes and the GCDs in the GMA (From Texas Water Development Board website).

2. Aquifer Description

The Trinity Aquifer consists of Cretaceous-age formations of varying viability as water sources. The Upper Trinity Aquifer (comprising the upper Glen Rose Limestone) generally has low yields and poor water quality due to its evaporite beds; but in some localities domestic and public water supply wells have produced better yields and water quality. In some localities the upper most zones of the Upper Trinity Aquifer appear to be vertically connected with the Edwards Aquifer (Smith and Hunt, 2011). However, the Upper Trinity and Edwards Aquifer are generally hydraulically distinct over most of GMA 10. The Middle Trinity Aquifer (comprising the lower Glen Rose Limestone, the Hensel Sand, and Cow Creek Limestone) is the most widely used portion ofthe aquifer. The Lower Trinity Aquifer (comprising the Hosston Sand and Sligo Limestone) is not as widely used due to its depth and water quality (SCTRWPG, 2010). The Trinity Aquifer outcrops very little within GMA 10 and exists as a confined aquifer underlying the Edwards (Balcones Fault Zone) Aquifer. It is currently used as a minor source of groundwater in Uvalde, Medina, Bexar, Comal, Guadalupe, Hays, and Travis counties, but is increasingly becoming a major source due to rapid development and increased water demands.

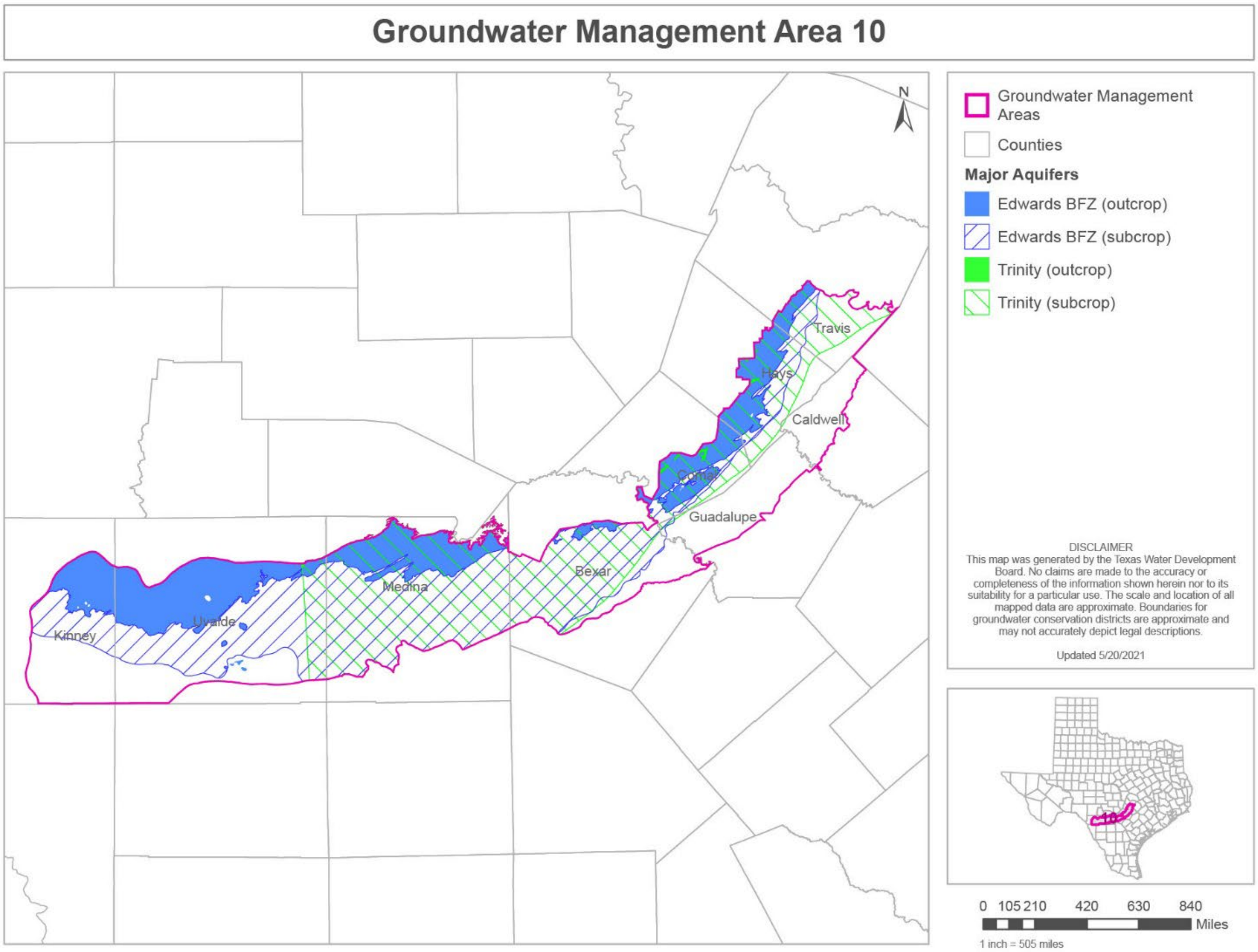

Figure 2. Map showing the extent of the Trinity Aquifer in GMA 10 (From Texas Water Development Board website)

3. Desired Future Conditions

The desired future conditions (DFC) adopted on 6/26/2017 for the Trinity Aquifer are as follows: Outside of Uvalde and Bexar Counties: Average regional well drawdown not exceeding 25 feet during average recharge conditions (including exempt and non-exempt use); within Uvalde County: No (zero) regional well drawdown (including exempt and non-exempt use).

GMA 10 has proposed to maintain the same DFCs in the third round as in the first round for this aquifer, with the exception of Hays-Trinity GCD, which is no longer in GMA 10. This third round of proposed DFCs was approved at the GMA 10 meeting on April 20, 2021 to be available for consideration during the 90-day public comment period and a public hearing held by each GCD. After the comment period and public hearings, the proposed DFCs were adopted at the GMA 10 meeting on October 26, 2021.

4. Policy Justification

The DFCs in the Trinity Aquifer within GMA 10 were adopted after considering the following factors specified in Texas Water Code §36.108 (d):

1. Aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another;
   a. for each aquifer, subdivision of an aquifer, or geologic strata; and
   b. for each geographic area overlying an aquifer
2. The water supply needs and water management strategies included in the state waterplan;
3. Hydrological conditions, including for each aquifer in the management area the TERS as provided by the executive administrator, and the average annual recharge, inflows, and discharge;
4. Other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water;
5. The impact on subsidence;
6. Socioeconomic impacts reasonably expected to occur;
7. The impact on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater asrecognized under Section 36.002;
8. The feasibility of achieving the DFC; and
9. Any other information relevant to the specific DFCs.

These factors and their relevance to establishing the DFCs are discussed in detail in corresponding sections and subsections of this Explanatory Report.

5. Technical Justification

The TWDB developed a method described in GTA Aquifer Assessment 10-06 (Thorkildsen and Backhouse, 2010) that uses an analytical solution to estimate modeled available groundwater for various drawdown scenarios. The same methods used by Thorkildsen and Backhouse (2010) were later used by Bradley and Radu (2018) in GAM Run 16-033 to recalculate modeled available groundwater for the Trinity Aquifer to reflect boundary changes in GMA 10 and groundwater conservation districts.

The proposed DFC is an expression of average drawdown of the potentiometric surface. Table 1 is anestimate of modeled available groundwater using the analytical approach used by TWDB. As described in Thorkildsen and Backhouse (2010), the modeled available groundwater (MAG) is estimated by multiplying the average drawdown by the storage coefficient and the area and then adding in estimated lateral inflow. As other inflows and outflows are considered to be negligible(described later in this report), this approach treats the aquifer as a closed system.

Table 1. Estimation of Modeled Available Groundwater (MAG) by County and GCD values are in acre-ft per year (Trinity).

Groundwater Conservation District	County	MAG
BSEACD	Hays	3,854
	Travis	341
Comal Trinity GCD	Comal	33,554
Medina County GCD	Medina	6,661
Uvalde County UWCD	Uvalde	40
Plum Creek Conservation District	Hays	276
Kinney County GCD**	Kinney	70,341
Non-District Areas	Caldwell	10
	Guadalupe	660
	Travis	239
Total		115,976

Estimated amounts from TWDB Report GAM Run 16-033
** Kinney County MAG number is based on information from GMA 7 and the undifferentiated Edwards-Trinity Plateau. This number is for the whole county and not specific for the GMA 10 Area. There is no MAG specifically for the Trinity within Kinney County.

6. Consideration of Designated Factors

In accordance with Texas Water Code § 36.108 (d-3), the district representatives shall produce a Desired Future Condition Explanatory Report. The report must include documentation of how nine factors identified in Texas Water Code §36.108(d) were considered and how the proposed DFC impacts each factor. The following sections of the Explanatory Report summarize the information that the GCDs used in their deliberations and discussions.

6.1 Aquifer Uses or Conditions

6.1.1 Description of Factors for the Trinity Aquifer in GMA 10

The Trinity Aquifer does not serve as the primary source of water for counties in GMA 10. However, given restrictions on groundwater withdrawals from the Edwards Aquifer, withdrawals from the Trinity Aquifer have been growing. The aquifer is stressed due to increasing numbers of wells to supply rapidly developing areas of central Texas. In addition, wells that were poorly cased through evaporite beds in the Upper Trinity formation have diminished the water quality in parts of the Middle Trinity Aquifer (SCTRWPG, 2010). Another concern is potential movement of the “bad water line” (where total dissolved solids concentrations exceed 1,000 milligrams per liter) due to increased groundwater withdrawal. Water quality becomes progressively poorer in the downdip sections of the Trinity Aquifer, with the “bad water line” stretching east-west through southern Uvalde and Medina counties, and then southeast-northwest through central Bexar, and along the southeastern edge of Comal and Hays counties (SCTRWPG, 2010).

The TWDB provides historical groundwater pumpage values by county and aquifer. Table 3 provides the estimated actual amount of groundwater in acre-feet supplied by the Trinity Aquifer for the period 2000-2018. Values reported by TWDB are county-based. In cases where a GCD only covers a portion of one or more counties, such as BSEACD and Plum Creek Conservation District, the data values are modified using a multiplier that more accurately represent the GCD. The multiplier is based on land area of GCD in county divided by the land area of county. BSEACD annexed additional portions of Hays County in 2015, prior to 2016 the percentage in Hays or appropriating multiplier was 15.5%.

Table 2 Areal Distribution of BSEACD and Plum Creek Conservation District by County.

County	BSEACD Total Acres in County	BSEACD Acres in District	Plum Creek Conservation District Acres in District	Percent in BSEACD prior to 2015	Percent in Plum Creek	Total percent or apportioning multiplier
Travis	656,348	74,311	NA	11.5%	NA	11.5%
Hays	433,248	184,513	39,425	42.5%	9.1%	51.6%
Caldwell	350,498	16,777	180,611	4.5%	51.53%	56.03%

The Trinity Aquifer does not provide the majority of groundwater in any county, although the Trinity Aquifer share has increased from 2000 in all counties. Variability in annual pumpage values could be attributed to factors such as climate conditions and precipitation. The TWDB does not report any pumping from the Trinity Aquifer in Caldwell or Kinney counties.

Table 3. Total groundwater pumpage values by county from the Trinity Aquifer in acre-ft/yr. Note that pumping estimates for Hays and Travis Counties are modified using a multiplier from Table 2. Prior to 2016 the BSEACD multiplier was (15.5%) and Plum Creek Conservation District was (9.1%) therefore a total of 24.6% was used.

County	**Bexar**	**Comal**	**Guadalupe**	**Hays***	**Medina**	**Travis***	**Uvalde**
2000	7,974	2,895	0	550	42	215	49
2001	8,761	2,422	0	600	33	226	46
2002	9,425	2,229	0	544	35	224	45
2003	8,681	2,169	0	520	36	224	43
2004	9,301	5,642	0	498	35	202	40
2005	11,579	5,404	0	553	186	222	61
2006	11,353	6,916	4	860	248	413	96
2007	8,698	6,896	4	939	242	326	91
2008	10,020	4,270	4	903	220	398	170
2009	11,675	4,166	6	1,048	248	528	163

2010	15,475	2,456	9	1,226	356	1,012	246
2011	18,530	4,678	6	1,503	479	1,192	257
2012	17,854	7,119	8	1,300	338	878	195
2013	14,763	4,180	7	1,245	332	1,013	180
2014	12,558	7,844	9	809	298	718	191
2015	26,309	6,964	9	685	308	737	201
2016	36,146	5,683	7	1,472	305	837	134
2017	27,344	6,503	5	1,550	323	742	110
2018	21,527	8,695	3	1,499	880	618	119

Values from https://www.twdb.texas.gov/waterplanning/waterusesurvey/historical-pumpage.asp

District-level water use numbers compiled by two GCDs in the GMA 10 area are also available, dating back to 2007,. Uvalde County UWCD values are sourced from their annual water use report database and provided in Table 4. Although these numbers were higher than the county-wide values provided by the TWDB, pre-2011, in recent years the districts reporting is below the county-wide values.

Table 4. Total groundwater pumpage values for the Trinity Aquifer in Uvalde County, according to the UCUWCD (2021)in acre-ft/yr.

Aquifer	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Trinity	228	267	1,667	908	117	108	120	120	140	138	106	114	106

The Barton Springs Edwards Aquifer Conservation District (BSEACD) values are based on meter readings from non-exempt district wells and include the Middle Trinity and Lower Trinity within a portion of Hays County and Travis and are provided in Table 4. The numbers are smaller than the county-wide numbers given by TWDB because the BSEACD only covers a portion of Travis County and Hays County. However, Trinity Aquifer permitted and actual pumpage values have significantly increased since 2007 within BSEACD. Furthermore, in 2015, BSEACD's jurisdictional area was expanded to include the portion of Hays County located within the boundaries of the Edwards Aquifer Authority (EAA) that excludes the Edwards Aquifer but includes the underlying Trinity and values from 2016 to 2019 reflect that expansion.

Table 5. Total actual groundwater pumpage values for the Trinity Aquifer in Travis and Hays County within BSEACD (acre-ft/yr). Values from BSEACD.

Aquifer	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Trinity	10.7	27.9	17.8	19.7	49.1	165.9	149.2	185.4	160.6	405.7	651.5	671.6	614.7

6.1.2 DFC Considerations

The Trinity Aquifer in GMA 10 is not the primary water source for much of the area. However, pressure on the freshwater Edwards (Balcones Fault Zone) Aquifer and population growth has led to the need for all viable water supplies. The current DFCs allow for a modeled available groundwater that is above the current use of the aquifer and allows room for development of the aquifer as a supply while protecting existing groundwater supplies. However rapid population growth along, particularly along the I-35 corridor, will increase demand for the Trinity Aquifer.

Table 6. MAG vs Permitted and Actual Pumpage

GCD	County	MAG	2019 Permitted Pumpage	2019 Actual Pumpage	2019 Exempt Pumpage Estimate
BSEACD	Hays and Travis	4,195	1,892	614.7	369.4
Uvalde County UWCD	Uvalde	795	30	106	20
Medina County GCD	Medina	6,661	11,763	1,129	N/A
Plum Creek Conservation District	Hays	276	0	0	0
Comal Trinity GCD	Comal	29,284	N/A	7,580	N/A
Kinney GCD	Kinney**	N/A	N/A	N/A	N/A

** Please see ** in table 1 for Kinney County GCD explanation

6.2 Water-Supply Needs

6.2.1 Description of Factors for the Trinity Aquifer in GMA 10

For estimating projected water-supply needs (i.e., water demand vs. supply), the districts used data extracted from the 2022 State Water Plan and provided by the TWDB. The TWDB provides water-supply needs estimates by decade as well as by county. A summary of the projected water-supply needs is provided in Table 7 by decade in acre-ft/yr. Also shown in Table 7 are demands, existing supplies, and water-supply strategies. Note that these are county totals, not just the portions of each county in GMA 10.

As in prior plans, some of the water-demand deficits in the area in the out-years (the later years in the planning period) include numerous contractual shortages.

These contractual shortages will be addressed on an *ad-hoc* basis, through the renewal and expansion of contracts with wholesale water suppliers and the contractual reallocation of existingsupplies in order to address the projected water demands for these and other area water-user groups. But even so, it is projected that there will be unmet needs under drought-of-record conditions and in the out-years.

6.2.2 DFC Considerations

Population growth throughout GMA 10 is creating demand for additional water supplies from all sources. The DFCs allow for drawdown of the Trinity Aquifer to allow for its use in the future as water supply of growing importance to the region.

Table 7. 2022 State Water Plan information for counties in GMA 10 containing the Trinity Aquifer. All values are in acre-ft/yr. Note that these are county totals and are not limited to the portion of each county in GMA 10.

County	Category	2020	2030	2040	2050	2060	2070
Bexar	Demands	344,503	270,868	395,122	420,879	446,877`	471,297
	Existing Supplies	350,128	352,726	356,461	360,814	364,601	366,478
	Needs	12,387	27,016	47,872	68,266	90,218	112,499
	Strategy Supplies	47,631	186,674	265,999	294,951	371,856	404,066
Caldwell	Demands	7,719	8,765	9,862	10,998	12,205	13,415
	Existing Supplies	12,791	12,800	12,770	12,737	12,692	12,655
	Needs	140	290	588	1,367	2,215	3,060
	Strategy Supplies	3,651	4,421	4,981	5,772	6,259	7,055
Comal	Demands	42,052	51,191	59,458	67,595	76,204	84,763
	Existing Supplies	44,176	44,353	44,611	44,792	45,014	46,603
	Needs	8,307	15,421	21,459	27,434	33,874	39,952
	Strategy Supplies	36,887	48,133	53,873	57,496	61,001	63,748
Guadalupe	Demands	40,989	47,698	52,552	57,475	62,659	67,827
	Existing Supplies	56,481	57,901	59,203	59,251	59,315	59,482
	Needs	43	480	2,379	6,552	10,906	14,765
	Strategy Supplies	13,806	24,193	33,761	34,397	36,464	37,631
Hays	Demands	40,729	50,453	61,476	72,555	89,124	107,760
	Existing Supplies	54,630	54,727	56,157	57,587	61,082	62,497
	Needs	626	4,079	10,390	18,751	31,337	48,349
	Strategy Supplies	19,698	35,543	55,564	65,714	78,368	90,058
Medina	Demands	70826,	71,745	72,527	73,276	74,069	74,822
	Existing Supplies	37,751	37,814	38,202	38,181	38,353	37,643
	Needs	36,808	37,544	37,831	38,489	39,053	40,481
	Strategy Supplies	1,779	2,126	2,519	2,918	3,293	3,726
Travis	Demands	267,501	308,104	348,116	377,848	402,586	430,760
	Existing Supplies	419,733	417,640	417,290	414,772	411,540	407,170
	Needs	3,102	6,867	20,254	25,866	31,463	43,787
	Strategy Supplies	31,385	63,916	121,452	153,681	183,330	241,184
Uvalde	Demands	73,467	74,152	74,647	75,323	76,062	76,818
	Existing Supplies	30,700	30,749	30,813	30,867	30,928	30,988
	Needs	43,173	43,773	44,193	44,779	45,420	46,079
	Strategy Supplies	2,881	3,257	3,613	3,992	4,376	4,738
Total	**Demands**	**887,786**	**882,976**	**1,073,760**	**1,155,949**	**1,239,786**	**1,327,462**
	Existing Supplies	**1,006,390**	**1,008,710**	**1,015,507**	**1,019,001**	1,023,525	**1,023,516**
	Needs	**104,586**	**135,470**	**184,988**	**231,504**	**284,486**	**348,972**
	Strategy Supplies	**157,718**	**368,263**	**541,762**	**618,921**	**744,947**	**852,206**

6.3 Water-Management Strategies

6.3.1 Description of Factors for the Trinity Aquifer in GMA 10

Both Regional Water Planning Groups K and L plan to further develop the Trinity Aquifer as part of their water management strategies to cover future water needs. Table 8-provides the proposed Trinity Aquifer Groundwater Wells and Other Water Management Strategies (WMS) developed by Regional Water Planning Groups K and L for the 2022 State Water Plan (in units of acre-feet per year). Groundwater WMSs values listed in Tables 8came from the 2022 Texas State Water Plan. The apportioning multipliers shown in Table 2 were used for Hays and Travis Counties. No WMS values for the Trinity Aquifer were listed to be sourced from Caldwell, or Kinney counties.

Table 8. Proposed Trinity Aquifer Water Management Strategy Values

Groundwater Wells and Other Water Management Strategy for Trinity Aquifer (acre/ft)								
County	**Regional Planning**		**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
		Existing Supplies	16,577	16,602	16,639	16,662	16,864	18,468
		Strategy Supplies	6,118	10,997	13,191	14,907	16,468	17,169
Comal	L	**Total**	**22,695**	**27,599**	**29,830**	**31,569**	**33,332**	**35,637**
		Existing Supplies	5,367	5,367	5,367	5,371	5,373	5,375
		Strategy Supplies	0	94	346	604	728	831
Hays	K and L	**Total**	**5,367**	**5,461**	**5,713**	**5,975**	**6,101**	**6,206**
		Existing Supplies	1,333	1,333	1,332	1,331	1,330	1,329
		Strategy Supplies	0	28	74	75	78	544
Travis	K	**Total**	**1,333**	**1,362**	**1,407**	**1,407**	**1,408**	**1,873**
		Existing Supplies	7,030	6,828	7,028	6,828	6,778	5,828
		Strategy Supplies	0	0	0	0	0	0
Medin a	L	**Total**	**7,030**	**6,828**	**7,028**	**6,828**	**6,778**	**5,828**
		Existing Supplies	795	795	795	795	795	795
		Strategy Supplies	0	0	0	0	0	0
Uvalde	L	**Total**						

			795	**795**	**795**	**795**	**795**	**795**
		Total for Decades	**37,220**	**42,045**	**44,772**	**46,574**	**48,415**	**50,339**

WMSs for Comal County from 2020 to 2070.

6.3.2 DFC Considerations

The proposed DFCs allow for development of the Trinity Aquifer in GMA 10 as contemplated inthe water management strategies in the 2022 State Water Plan.

6.4. Hydrological Conditions

6.4.1 Description of Factors for the Trinity Aquifer in GMA 10

6.4.1.1 Total Estimated Recoverable Storage

Texas statute requires that the TERS of relevant aquifers be determined (Texas Water Code § 36.108) by the TWDB. Texas Administrative Code Rule §356.10 (Texas Administrative Code, 2011) defines the TERS as the estimated amount of groundwater within an aquifer that accounts for hypothetical recovery scenarios that range between 25 percent and 75 percent of the porosity-adjusted aquifer volume.

TERS values may include a mixture of water-quality types, including fresh, brackish, and saline groundwater, because the available data and the existing Groundwater Availability Models do not permit the differentiation between different water- quality types. The TERS values do not take into account the effects of land surface subsidence, degradation of water quality, or any changes to surface- water/groundwater interaction that may occur due to pumping.

Table 9 provides the TERS values for the Trinity Aquifer in GMA 10. The percentage values for the 25 percent of total storage and 75 percent total storage shown here were rounded within one percent of the total.

Table 9. Total estimate of recoverable storage by county for the Trinity Aquifer within the GMA 10 jurisdiction (Values in acre-ft)(Jones et al., 2013)

County	Total Storage	25 percent of Total Storage	75 percent of Total Storage
Bexar	5,500,000	1,375,000	4,125,000
Caldwell	24,000	6,000	18,000
Comal	2,300,000	575,000	1,725,000
Guadalupe	43,000	10,750	32,250
Hays	2,400,000	600,000	1,800,000
Medina	11,000,000	2,750,000	8,250,000
Travis	690,000	172,500	517,500
Uvalde	1,100,000	275,000	825,000
Total	**23,057,000**	**5,764,250**	**17,292,750**

6.4.1.2 Average Annual Recharge

The Trinity Aquifer is confined throughout most of the extent of GMA 10; therefore, it does not receive direct recharge in this area. Rather the aquifer is recharged in the Trinity Aquifer outcrop area located in GMA 9 where the aquifer is not confined. The GMA 10 area is located south and east of GMA 9. Recharge estimates from previous studies varied from 1.5 to 11 percent of the annual rainfall falling on Trinity Aquifer outcrop areas. Recharge also occurs from losing streams crossing the aquifer outcrop (Jones et al., 2009). Table 10 includes recharge values calculated for the Medina County Groundwater Conservation District. Note that this district includes some Trinity Aquifer outcrop area that falls outside the GMA 10 boundary and this recharge occurs in that area, rather than within the GMA 10 extent. As shown in TWDB Aquifer Assessment 10-06 (Thorkildsen and Backhouse, 2010), there are small outcrop areas within GMA 10. In this assessment, TWDB estimates recharge to the aquifer to be approximately 4 percent of precipitation.

6.4.1.3 Inflows

Lateral Inflow Table 11 provides the estimated annual volume of flow into the Trinity Aquifer inGMA 10 from the Hill Country portion of the Trinity Aquifer across the Balcones Fault Zone (from Thorkildsen and Backhouse, 2010).

6.4.1.4 Discharge

Cross-formational flow: There is some evidence of vertical leakage from the Edwards Aquifer into the Trinity Aquifer in some locations, but this input is likely limited to the top 100 feet of the Upper Trinity Aquifer, as the bottom portion of the Upper Trinity Aquifer acts as an aquitard and prevents leakage from reaching the Middle Trinity Aquifer (BSEACD, 2013; Smith and Hunt, 2011). While this vertical leakage may be classified as cross-formational flow in a geologic sense, the upper portion of the Upper Trinity Aquifer appears to be hydraulically connected to and thus part of the Edwards Aquifer where vertical leakage was observed. In general, cross- formational flow is out of, not into, the Trinity Aquifer in GMA 10. Jones et al. (2011) estimated that cross-formational discharge from the Hill Country portion of the Trinity Aquifer to the Barton Springs and San Antonio segments of the Edwards Aquifer were 660 acre-ft/yr per mile of aquifer boundary in Uvalde and Medina counties; 2,400 in Bexar and Comal counties; and 350 in Hays and Travis counties. Table 12 provides estimated cross-formational flow from the Trinity Aquifer to the Edwards Aquifer within the Edwards Aquifer Authority (EAA).

Table 10. Recharge values for the Trinity Aquifer provided by the Medina County Groundwater Conservation District (acre-ft) and TWDB Aquifer Assessment 10-06. Note MCGCD recharge estimate reflects large amount of area occurring in the contributing zone outside of GMA 10 while the other estimates presented in this table only reflect estimated recharge within GMA 10 boundaries.

Area	Source	Aquifer	Estimated annual amount of recharge from precipitation to the district

MCGCD	GAM Run 20-003	Trinity Aquifer	6,918
Uvalde Co. UWCD	TWDB Aquifer Assessment 10-06	Trinity Aquifer	36
Comal County	TWDB Aquifer Assessment 10-06	Trinity Aquifer	206
Hays County	TWDB Aquifer Assessment 10-06	Trinity Aquifer	107

Natural Discharge: Since the Trinity Aquifer is confined in the GMA 10 study area, no direct discharge from the aquifer to surface springs is expected. Trinity Aquifer spring discharge occurs in the outcrop areas, north and northwest of GMA 10, where springs flow from the Trinity Aquifer and streams are net gaining from Trinity Aquifer discharge (Jones et al., 2009). No major springs issue from the Trinity Aquifer itself within GMA 10. However, it is possible that pumping from the Middle Trinity Aquifer within GMA 10 could impact flow to upgradient springs outside of GMA 10. The Blanco River Aquifer Assessment Tool is a numerical model currently in development designed to simulate some of these potential impacts (Martin et al., 2019). BSEACD (2013) does mention that some Upper Trinity Aquifer water may flow laterally or vertically into the Edwards Aquifer and thus, indirectly, feed Edwards Aquifer springs, such as Barton Springs. However, Middle Trinity Aquifer does not appear to discharge in the Balcones Fault Zone.

6.4.1.5 Other Environmental Impacts Including Springflow and Groundwater/Surface Water Interaction

As described in previous sections relating to inflows and discharges, the Trinity Aquifer in GMA 10 is confined and largely separated from surficial processes and the overlying Edwards Aquifer except the upper portion of the Upper Trinity Aquifer. While the current conceptualization of the aquifer includes flow from the Hill Country portion of the Trinity Aquifer (GMA 9) into the Trinity Aquifer in GMA 10, it is possible that large-scale development in GMA 10 could impact up-dip areas outside the GMA. There is not currently a groundwater availability model to evaluate the extent to which these impacts could occur.

Table 11. Lateral inflow to the Trinity Aquifer in GMA 10 (all values in acre-ft).

Aquifer	County	Lateral Inflow from Hill Country Trinity
Upper Trinity	Bexar	8,530
Upper Trinity	Caldwell	0
Upper Trinity	Comal	15,346
Upper Trinity	Guadalupe	0
Upper Trinity	Hays	2,512
Upper Trinity	Medina	1,576
Upper Trinity	Travis	267
Upper Trinity	Uvalde	176
Middle Trinity	Bexar	11,560

Middle Trinity	Caldwell	0
Middle Trinity	Comal	13,678
Middle Trinity	Guadalupe	0
Middle Trinity	Hays	913
Middle Trinity	Medina	3,751
Middle Trinity	Travis	374
Middle Trinity	Uvalde	417
Total		**59,100**

Table 12. Estimated value of cross-formational flow from the Trinity Aquifer to the Edwards Aquifer (acre-ft).

District	Source	Aquifer	Estimated net annual volume of flow between each aquifer in the district
EAA	GAM Run 15-009	from Trinity Aquifer to Edwards and associated limestones	13,658

6.4.2 DFC Considerations

Analysis of the hydrological conditions of the Trinity Aquifer in GMA 10 indicates that the aquifer can continue to serve as an alternative water supply to the freshwater Edwards (Balcones Fault Zone) Aquifer. However, since it has not seen large development historically in many areas of GMA 10, there is limited information on how the aquifer will respond to significant pumping. Two BSEACD permit applicants in Hays County provide recent examples of the potential impacts of large-scale pumping in the confined portion of the Trinity Aquifer within GMA 10: Electro Purification and Needmore Water LLC (See appendix C). In both cases, modeled drawdown based on aquifer test data analysis significantly exceeded the proposed DFC in less than 10 years at a distance of two miles from the high-capacity pumping wells.

7. Subsidence Impacts

Subsidence has historically not been an issue with the Trinity Aquifer in GMA 10. The aquifer matrix in the northern subdivision is well-indurated and the amount of pumping does not create compaction of the host rock and/or subsidence of the land surface. Hence, the proposed DFCs are not affected by and do not affect land-surface subsidence or compaction of the aquifer.

Additionally, LRE Water LLC hydrologists have built a Subsidence Prediction Tool (SPT) that takes individual well characteristics and calculates a potential subsidence risk in a localized area.

GMA 10 recognizes that the general reports from the SPT indicate that subsidence is not a concern for GMA 10 at this time.

8. Socioeconomic Impacts Reasonably Expected to Occur

8.1 Description of Factors for the Trinity Aquifer in GMA 10

Administrative rules require that regional water planning groups evaluate the impacts of not meeting water needs as part of the regional water planning process. The executive administrator shall provide available technical assistance to the regional water planning groups, upon request, on water supply and demand analysis, including methods to evaluate the social and economic impacts of not meeting needs [§357.7 (4)]. Staff of the TWDB's Water Resources Planning Division designed and conducted a report in support of the South Central Texas Regional Water Planning Group (Region L) and also the Lower Colorado Regional Water Planning Group (Region K). The report "Socioeconomic Impacts of Projected Water Shortages for the South Central Texas Regional Water Planning Area (Region L)" was prepared by the TWDB in support of the 2021 South Central Texas Regional Water Plan and is illustrative of these types of analyses.

The report on socioeconomic impacts summarizes the results of the TWDB analysis and discusses the methodology used to generate the results for Regions L. The socioeconomic impact reports for Water Planning Group J, K, and L are included in Appendix A. These reports are supportive of a cost-benefit assessment of the water management strategies and the socioeconomic impact of not promulgating those strategies.

8.2 DFC Considerations

The proposed DFC allows for development of the Trinity Aquifer above what is called for in the water-management strategies in the 2022 State Water Plan. For this reason, the proposed DFC will not have a socioeconomic impact associated with an unmet water need.

9. Private Property Impacts

9.1 Description of Factors for the Trinity Aquifer in GMA 10

The interests and rights in private property, including ownership and the rights of GMA 10 landowners and their lessees and assigns in groundwater, are recognized under Texas Water Code Section 36.002. The legislature affirmed that a landowner owns the groundwater below the surface of the landowner's land as real property. Joint planning must take into account the impacts on those rights in the process of establishing DFCs, including the property rights of both existing and future groundwater users. Nothing should be construed as granting the authority to deprive or divest a landowner, including a landowner's lessees, heirs, or assigns, of the groundwater ownership and rights described by this section. At the same time, the law holds that no landowner is guaranteed a certain amount of such groundwater below the surface of his/her land.

Texas Water Code Section 36.002 does not: (1) prohibit a district from limiting or prohibiting the drilling of a well by a landowner for failure or inability to comply with minimum well spacing or tract size requirements adopted by the district; (2) affect the ability of a district to regulate groundwater production as authorized under Section 36.113, 36.116, or 36.122 or otherwise under this chapter or a special law governing a district; or (3) require that a rule adopted by a district allocate to each landowner a proportionate share of available groundwater for production from the aquifer based on the number of acres owned by the landowner.

9.2 DFC Considerations

The DFC is designed to allow for additional development of the Trinity Aquifer as an alternative water supply in a manner that does not harm other property owners. The DFC does not prevent use of the groundwater by landowners either now or in the future, although ultimately total use of the groundwater in the aquifer is restricted by the aquifer condition, and that may affect the amount of water that any one landowner could use, either at particular times or all of the time.

10. Feasibility of Achieving the DFCs

The feasibility of achieving a DFC directly relates to the ability of the GCDs to manage the Trinity Aquifer to achieve the DFC, including promulgating and enforcing rules and other board actions that support the DFC. The feasibility of achieving this goal is limited by (1) the finite nature of the resource and how it responds to drought; and (2) the pressures placed on this resource by the high level of economic and population growth within the area served by this resource.

Texas state law provides Groundwater Conservation Districts with the responsibility and authority to conserve, preserve, and protect these resources and to ensure the recharge and prevention of waste of groundwater and control of subsidence in the management area. State law also provides that GMAs assist in that endeavor by joint regional planning that balances aquifer protection and highest practicable production of groundwater. The feasibility of achieving these goals could be altered if state law is revised or interpreted differently than is currently the case.

The caveats above notwithstanding, there are no current hydrological or regulatory conditions that call into question the feasibility of achieving the DFC.

11. Discussion of Other DFCs Considered

No other expression of DFC of the Trinity Aquifer in GMA 10 was considered. GMA 10 evaluated alternative amounts of drawdown for the DFC expression, including larger amounts of drawdown. The proposed DFC specifies an amount of drawdown that is not unreasonably large or small, and that should be readily achieved based on currently known information about the aquifer.

12. Discussion of Other Recommendations

12.1 Advisory Committees

An Advisory Committee for GMA10 has not been established.

12.2 Public Comments

GMA 10 approved its proposed DFCs on April 20, 2021. In accordance with requirements in Chapter 36.108(d-2), each GCD then had 90 days to hold a public meeting at which stakeholder input was documented. This input was submitted by the GCD to the GMA within this 90-day period. The dates on which each GCD held its public meeting is summarized in Table 14. Public comments for GMA 10 are included in Appendix B.

Table 13. Dates on which each GCD held a public meeting allowing for stakeholder input on the DFCs.

GCD	Date
Barton Springs/Edwards Aquifer Conservation District	June 10, 2021
Comal Trinity GCD	May 17, 2021
Kinney County GCD	June 10, 2021
Medina County GCD	June 16, 2021
Plum Creek Conservation District	June 30, 2021
Uvalde County UWCD	May 19, 2021

Under Texas Water Code, Ch. 36.108(d-3)(5), GMA 10 is required to "discuss reasons why recommendations made by advisory committees and relevant public comments were or were not incorporated into the desired future conditions" in each DFC Explanatory Report.

- The Trinity Aquifer is a confined aquifer in GMA 10 and its use does not appreciably affect the surface water systems there, including springs, seeps, and base flow of streams,which has been identified as a benefit of zero-drawdown approaches elsewhere, in other GMAs.
- Zero-drawdown is inconsistent with achieving the required balance between aquifer protection and maximum feasible groundwater production.
- Zero-drawdown does not protect private property rights and property values.
- Zero-drawdown is inimical to future municipal, commercial, and other economic interests.

13. Any Other Information Relevant to the Specific DFCs

During the process of DFC development, the GCDs in GMA 10 reviewed and evaluated the potential impacts of a planned development of the Cow Creek formation of the Middle Trinity Aquifer in central Hays County. The evaluation focused on 1) the potential for drawdown impacts within the Cow Creek to propagate to other portions of the Trinity and Edwards aquifers, and 2) the viability of production over the 50-year planning period at a wide range of pumping rates. This evaluation is documented in Appendix C.

14. Provide a Balance Between the Highest Practicable Level of Groundwater Production and the Conservation, Preservation, Protection, Recharging, and Prevention of Waste of Groundwater and Control of Subsidence in the Management Area

The "DFC Considerations" discussed in previous sections (especially 6.x.2, 8.2, 9.2, 10, and 11) provide the context in which the balancing factor is being addressed. But the TWDB has not developed guidance on how to approach this factor. It is up to the GCDs to determine how to approach it for each relevant aquifer, whether in a qualitative, quantitative, or combination manner. In addition, the GCDs need to include stakeholder input so that this factor can be more confidently addressed. GCD management plans will also be used to complete this requirement.

This DFC is designed to balance the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in the management area. This balance is demonstrated in (a) how GMA 10 has assessed and incorporated each of the nine factors used to establish the DFC, as described in Chapter 6 of this Explanatory Report, and (b) how GMA 10 responded to certain public comments and concerns expressed in timely public meetings that followed proposing the DFC, as described more specifically in Appendix B of this Explanatory Report. Further, this approved DFC will enable current and future Management Plans and regulations of those GMA 10 GCDs charged with achieving this DFC to balance specific local risks arising from protecting the aquifer while maximizing groundwater production.

15. References

Barton Springs Edwards Aquifer Conservation District (BSEACD). 2013. District Management Plan. Approved by Texas Water Development Board, January 7, 2013. Website: http://www.bseacd.org/uploads/Financials/MP_FINAL_TWDB-approved_1_7_2013_Body.pdf

Bradley, R. G. and R. Boghici. 2018. GAM Run 16-033 MAG: Modeled Available Groundwater for the Aquifers in Groundwater Management Area 10, Texas Water Development Board, 32 p.Website: http://www.twdb.texas.gov/groundwater/docs/GAMruns/GR16-033_MAG.pdf

Jones, I. C., J. Shi, and R. Bradley. 2013. GAM Task 13-033: Total Estimated Recoverable Storage for Aquifers in Groundwater Management Area 10. August, 2013.

Jones, I. C., R. Anaya, and S.Wade. 2009. Groundwater Availability Model for the Hill Country Portion of the Trinity Aquifer System, Texas. Prepared for the Texas Water Development Board. Website: http://www.twdb.texas.gov/groundwater/models/gam/trnt_h/TRNT_H_2009_Update_Model_Report.pdf

Jones, I.C. 2011. Interaction between the Hill Country Portion of the Trinity and Edwards Aquifers: Model Results included in Interconnection of the Trinity (Glen Rose) and Edwards Aquifers along the Balcones Fault Zone and Related Topics. Karst Conservation Initiative February 17, 2011 Meeting Proceedings. Austin, TX. Website: http://www.bseacd.org/uploads/AquiferScience/Proceedings_Edwards_Trinity_final.pdf

Lower Colorado Regional Water Planning Group (LCRWPG). 2010. 2011 Region K Water Plan: Volume I. Prepared for the Texas Water Development Board, July 2010.

Mace, R., A. Chowdhury, R. Anaya, and S. Way. 2000, Groundwater Availability of the Trinity Aquifer, Hill Country Area, Texas: Numerical Simulations through 2050: Texas Water Development Board, Report 353, 117 p.

Martin, N. D., R. T. Green, K. Nicholaides, S. B. Fratesi, R. R. Nunu, and M. E. Flores. 2019. Blanco River Aquifer Assessment Tool: A Tool to Assess How the Blanco River Interacts with its Aquifers: Creating the Conceptual Model, Technical Report prepared for the Meadows Center for Water and the Environment, Texas State University. 128 p. + appendices.

Smith, B. A. and Hunt, B. B. 2011, Potential for Vertical Flow Between the Edwards and Trinity Aquifer. Barton Springs Segment of the Edwards Aquifer, Interconnection of the Trinity (Glen Rose) and Edwards Aquifer along the Balcones Fault Zone, Karst Conservation Initiative February 17, 2011 Meeting Proceedings, 46p. https://bseacd.org/uploads/Proceedings_Edwards_Trinity_final.pdf

South Central Texas Regional Water Planning Group (SCTRWPG). 2010. South Central Texas Regional Water Planning Area 2011 Regional Water Plan Volume I: Executive Summary and Regional Water Plan. September 2010. http://www.twdb.texas.gov/waterplanning/rwp/plans/2011/L/Region_L_2011_RWPV1.pdf

Thorkildsen, D. and Backhouse, S., 2010, GTA Aquifer Assessment 10-06: Groundwater Management Area 10 Trinity Aquifer Draft Managed Available Groundwater estimates, Texas Water Development Board, 20 p. http://www.twdb.texas.gov/groundwater/docs/AA/AA10-06.pdf

Texas Water Development Board (TWDB). 2015. Summary of Desired Future Conditions for GMA 10, website: http://www.twdb.texas.gov/groundwater/management_areas/dfc_mag/GMA_10_DFC.pdf

Uvalde County Underground Water Conservation District (UCUWCD). 2011. Management Plan 2011-2021. Adopted July 26, 2011. Website: http://www.twdb.texas.gov/groundwater/docs/GCD/ucuwcd/ucuwcd_mgmt_plan2011.pdf.