2021 JOINT PLANNING
DESIRED FUTURE CONDITIONS
EXPLANATORY REPORT

Prepared by:

Groundwater Management Area 15
Joint Planning Committee

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{DATE}

Geoscientist Seals and Contributors

Groundwater Management Area 15 contracted with LRE Water, a licensed professional geoscientist firm (Texas License No. 50516) to provide technical support related to the development and adoption of desired future conditions for managed aquifers. This report documents the work of the following licensed professional geoscientists in the State of Texas:

Michael Keester, P.G.

Mr. Keester was the technical lead responsible for performing modeling and developing information to support the members of Groundwater Management Area 15 in their development of desired future conditions for relevant aquifers. Mr. Keester is also the principal author of the explanatory report.

_____ _____
Signature Date

Velma Danielson

Ms. Danielson provided technical support associated with assessment of water management strategies, socioeconomic impacts, and private property rights relative to proposed desired future conditions. Ms. Danielson is also a co-author of the explanatory report.

_____ _____
Signature Date

Andrew C. A. Donnelly, P.G.

Mr. Donnelly provided technical support associated with modeling and in the development of relevant information for the discussion of factors relative to the proposed desired future conditions. Mr. Donnelly is also a co-author of the explanatory report.

_____ _____
Signature Date

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SECTION 1: INTRODUCTION

The Texas Legislature created Groundwater Management Areas (GMAs) "in order 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, consistent with the objectives of Section 59, Article XVI, Texas Constitution..." (Texas Water Code 35.001). The responsibility for GMA delineation was delegated to the Texas Water Development Board (TWDB) per Texas Water Code 35.004. The TWDB adopted the initial GMA delineations December 15, 2002 and has modified them when necessary according to agency rules. There are 16 GMAs in Texas Figure 1 shows the boundaries of these 16 GMAs, including GMA 15.

1.1 GROUNDWATER MANAGEMENT AREA 15

Figure 2 shows the location of the 13 Groundwater Conservation Districts (GCDs) that are contained wholly or in part within the boundary of GMA 15. These 13 GCDs are the Bee GCD, Calhoun County GCD, Coastal Bend GCD, Coastal Plains GCD, Colorado County GCD, Corpus Christi Aquifer Storage & Recovery Conservation District (ASRCD), Evergreen Underground Water Conservation District (UWCD), Fayette County GCD, Goliad County GCD, Pecan Valley GCD, Refugio GCD, Texana GCD, and Victoria County GCD. The Aransas County GCD was previously included in GMA 15. However, an election to confirm this GCD and their ad valorem tax rate failed on May 7, 2016. The following is an excerpt from an article in The Rockport Pilot on May 11, 2016 summarizing the results of this election (Martinez, 2016):

> "Aransas County voters said no to the creation of an Aransas County Groundwater Conservation District with an overwhelming majority by those who cast ballots. Only 10.71 percent of voters said yes to the district, while 89.29 percent voted no. The total number of voters, however, was only 11.37 percent of registered voters in the county."

Therefore, the Aransas County GCD did not participate in the 2021 joint planning cycle and is no longer a part of GMA 15.

In GMA 15, the TWDB recognizes two major aquifers and three minor aquifers. Figure 3 shows the footprints of the two major aquifers, namely, the Gulf Coast Aquifer System and the Carrizo-Wilcox Aquifer. The Carrizo-Wilcox occurs only as a subcrop in the four most up-dip counties, De Witt, Karnes, Lavaca, and Fayette counties. Figure 4 shows the footprints of the minor aquifers, which are the Yegua-Jackson, the Sparta, and the Queen City aquifers. These three minor aquifers only occur as subcrops in Fayette County. Table 1 provides the hydrogeologic units present within GMA 15 with the order representing each unit's position in the subsurface relative to the other units.

The Gulf Coast Aquifer System is divided into four major hydrogeologic units, which are shown in Table 1. These four units are, from youngest to oldest, the Chicot Aquifer, the Evangeline Aquifer, the Burkeville Confining Unit, and the Jasper Aquifer. There are fourteen counties in GMA 15. Table 2 lists the fourteen counties and their area and population projects. In 2010, the fourteen

counties had a population of 369,500 people, and the county with the largest population was Victoria County with 86,800 people. The population of the fourteen counties is expected to grow to 473,000 people in 2070, with Victoria expanding to a population of 116,500 people. These population projections for GMA 15 remain unchanged from the 2016 joint planning.

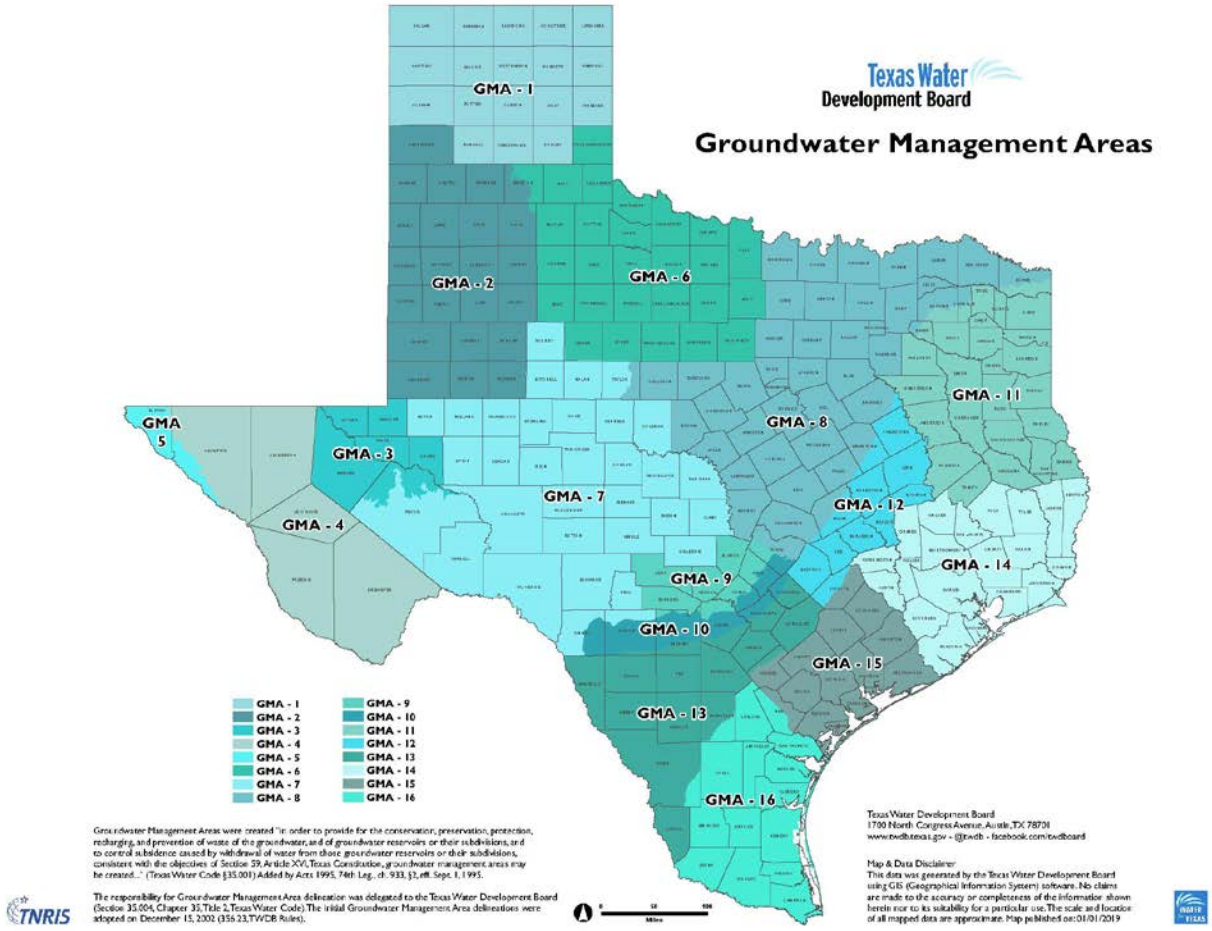

Figure 1. Delineation of 16 groundwater management zones in Texas
(obtained from https://www.tnris.org/maps/ on March 8, 2021).

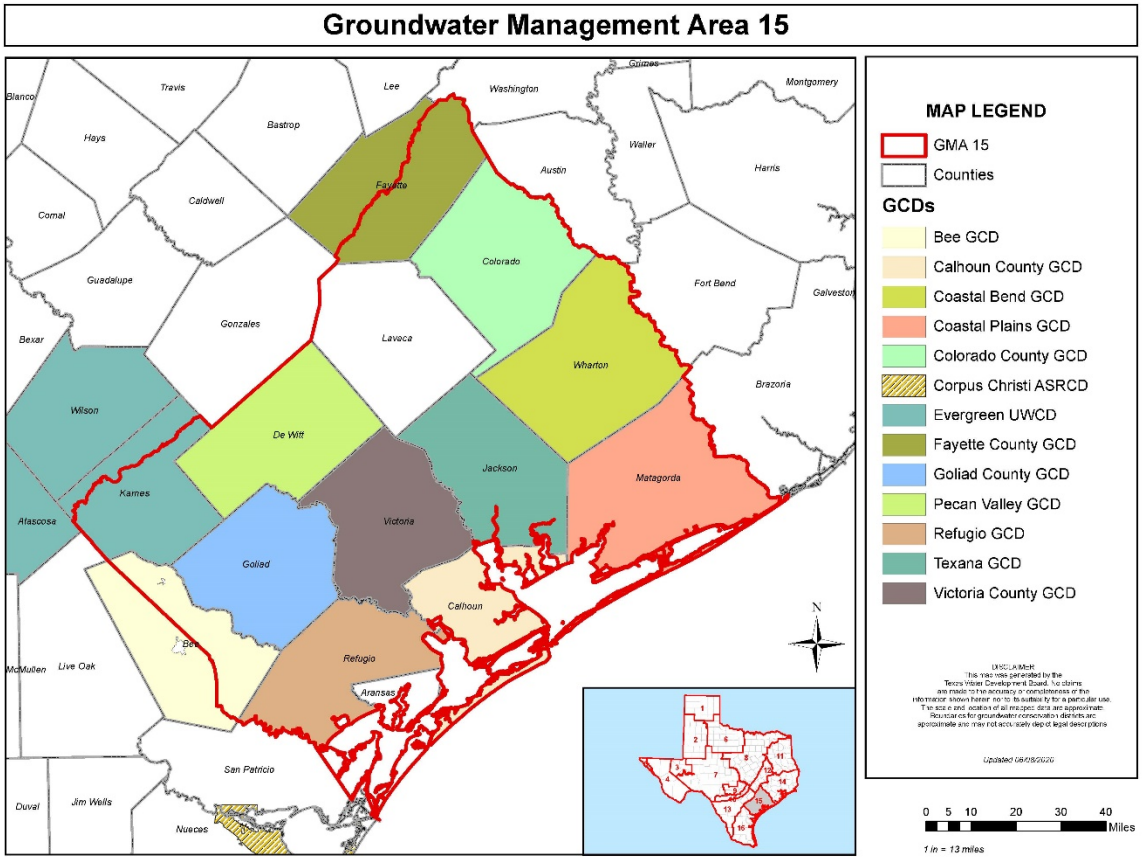

Figure 2. Delineation of GMA 15 showing locations of GCDs
(obtained from http://www.twdb.texas.gov/groundwater/management_areas/maps/GMA15_GCD.pdf).

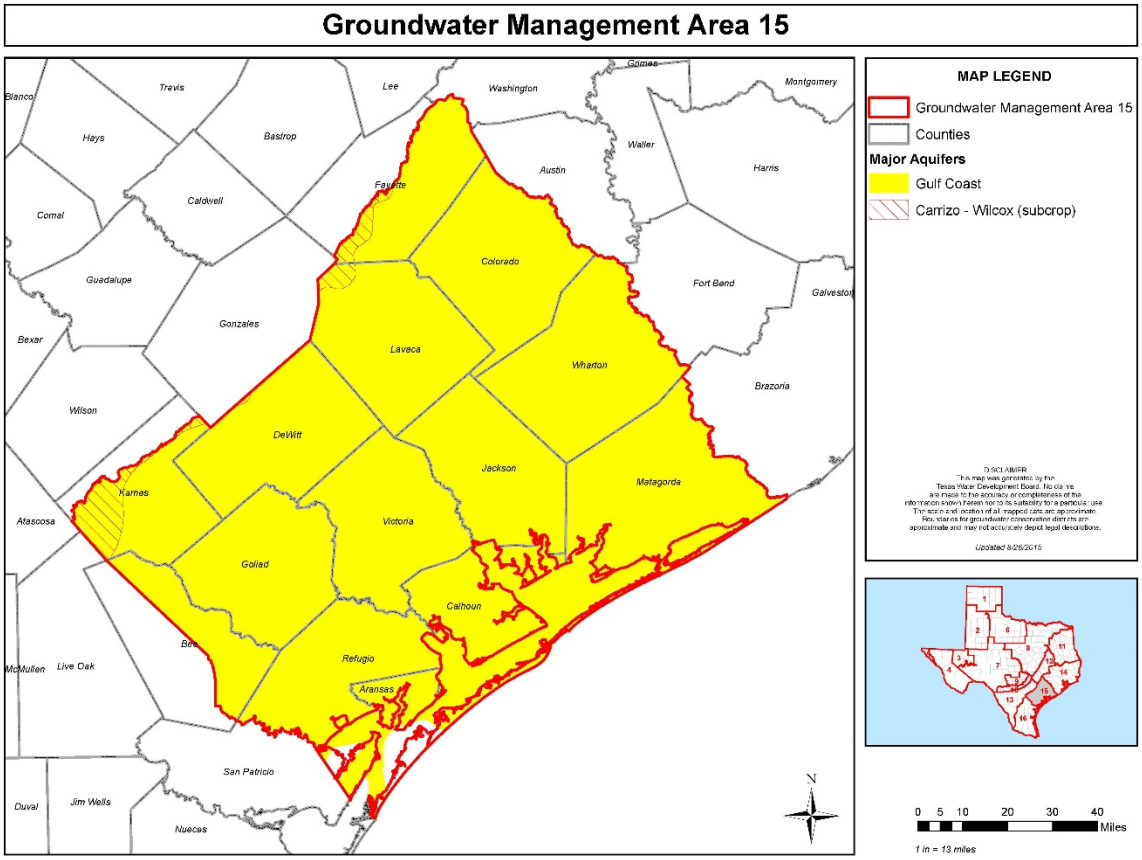

Figure 3. **Map of GMA 15 major aquifer boundaries.**
(obtained from http://www.twdb.texas.gov/groundwater/management_areas/maps/GMA15_MajorAquifer.pdf).

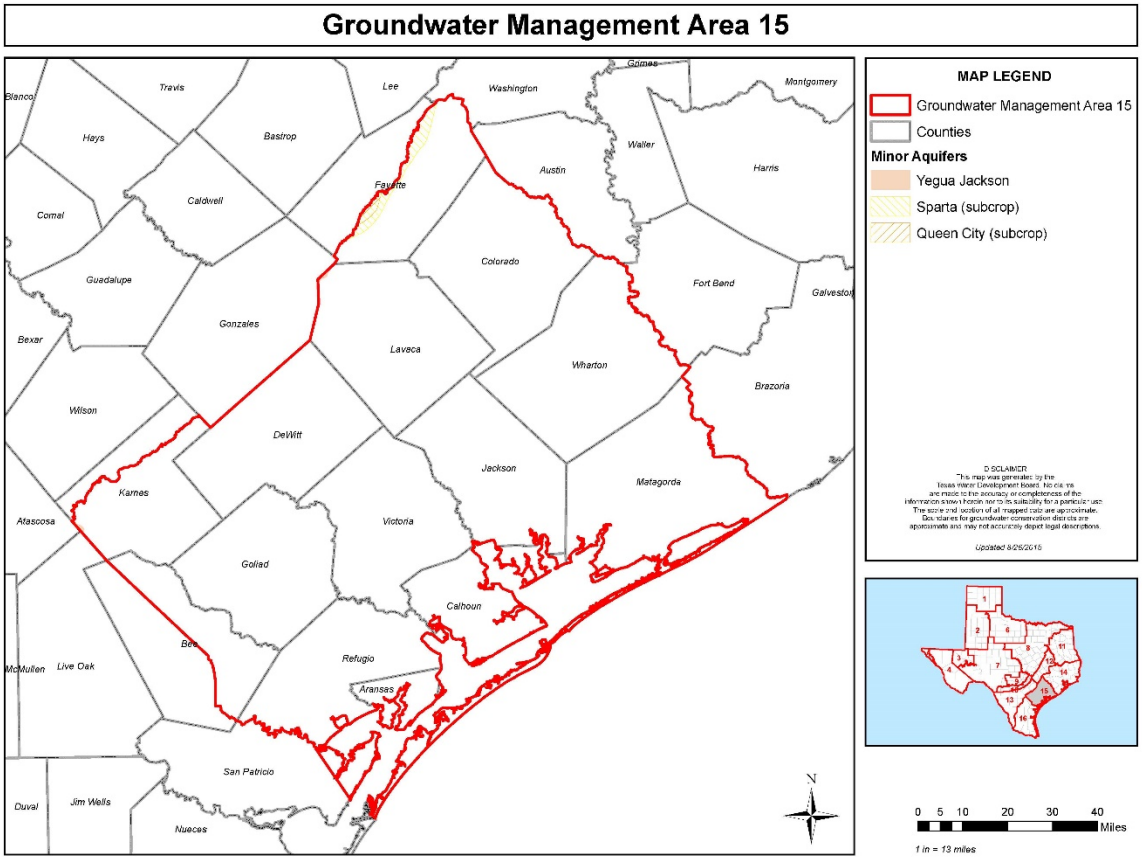

Figure 4. **Map of GMA 15 minor aquifer boundaries.**
(obtained from http://www.twdb.texas.gov/groundwater/management_areas/maps/GMA15_MinorAquifer.pdf).

Table 1. Hydrogeologic units in GMA 15.
Modified from Shi and others (2020), Deeds and others (2010), and Young and others (2018).

Geologic Unit		Hydrogeologic Unit
Alluvium and Eolian Sand		Alluvium/Eolian Aquifer
Beaumont		Chicot Aquifer
Lissie		
Willis		
Goliad		Evangeline Aquifer
Upper Fleming		
Middle Fleming		Burkeville Confining Unit
Lower Fleming		Jasper Aquifer
Oakville		
Catahoula		
Jackson Group	Whitsett	Yegua-Jackson Aquifer
	Manning	
	Wellborn	
	Caddell	
Claiborne Group	Yegua	
	Cook Mountain	Aquitard
	Sparta	Sparta Aquifer
	Weches	Aquitard
	Queen City	Queen City Aquifer
	Reklaw	Aquitard
	Carrizo	Carrizo-Wilcox Aquifer
Wilcox Group	Upper	
	Middle	
	Lower	

Table 2. Population projections from 2021 Regional Water Planning.

County	Area (mi^2)*	2010**	2020	2030	2040	2050	2060	2070
Aransas	252	23,158	24,463	24,991	24,937	25,102	25,103	25,104
Bee***	880	31,861	33,478	34,879	35,487	35,545	35,579	35,590
Calhoun	506	21,381	24,037	26,866	29,622	32,276	34,906	37,454
Colorado	960	20,874	21,884	22,836	23,544	24,582	25,449	26,293
De Witt	909	20,097	20,855	21,555	21,900	22,216	22,425	22,572
Fayette***	950	24,554	28,373	32,384	35,108	37,351	39,119	40,476
Goliad	852	7,210	8,427	9,519	10,239	10,545	10,759	10,884
Jackson	829	14,075	14,606	15,119	15,336	15,515	15,627	15,699
Karnes***	747	14,824	15,456	15,938	15,968	15,968	15,968	15,968
Lavaca	970	19,263	19,263	19,263	19,263	19,263	19,263	19,263
Matagorda	1,100	36,702	39,166	41,226	42,548	43,570	44,296	44,815
Refugio	770	7,383	7,687	7,929	7,985	8,119	8,175	8,213
Victoria	882	86,793	93,857	100,260	105,298	109,785	113,470	116,522
Wharton	1,086	41,280	43,804	46,614	48,860	50,804	52,599	54,189
GMA 15* **		**369,455**	**395,356**	**419,379**	**436,095**	**450,641**	**462,738**	**473,042**

*****Source of county areas is https://www.indexmundi.com/facts/united-states/quick-facts/texas/land-area#table
******2010 is based on the United States Census
***Values represent the populations projections for whole county and not just the portion within GMA 15

1.2 DESIRED FUTURE CONDITION JOINT PLANNING PROCESS

Texas Water Code Chapter 36 includes requirements for annual and Desired Future Conditions (DFC) joint planning by two or more GCDs located within the same GMA boundaries. For DFC joint planning, Texas Water Code Section 36.108(d) specifically requires GCDs to propose DFCs for adoption for all relevant aquifers in the GMA by no later than May 1, 2021 and every five years thereafter. DFCs are defined in Texas Water Code 36.001(30) as the "quantitative description, adopted in accordance with Section 36.108, of the desired condition of the groundwater resources in a management area at one or more specified future times." The specified future time extends through at least the period that includes the current planning period for the development of regional water plans pursuant to Texas Water Code 16.053, or in perpetuity, as defined by participating districts within a GMA as part of the joint planning process. DFCs have to be physically possible, individually and collectively, if different DFCs are stated for different geographic areas overlying an aquifer or subdivision of an aquifer.

The more substantive elements of the DFC joint planning process include:

(1) An explanatory report which is developed and submitted at the conclusion of the joint-planning process to document that certain required factors for consideration have been addressed;
(2) Modeled available groundwater (MAG), including the process for addressing exempt use, amounts, which are developed after final DFCs are adopted by the GMA;
(3) A minimum 90-day public comment period during which each GCD holds a public hearing on proposed DFCs before final adoption by at least two thirds of the GCD representatives in the GMA;
(4) Following GMA adoption of the DFCs required information is to be submitted to the Texas Water Development Board (TWDB) to determine administrative completeness of the DFC submission packet; and,
(5) As soon as possible after the TWDB determination of administrative completeness, individual GCDS then finally adopt the DFCs. Pursuant to Texas Water Code Section 36.108(d-3), GMAs must approve by resolution the adoption of the final DFCs no later than January 5, 2022.

Prior to adopting proposed DFCS, the districts must jointly consider technical and other information to determine the DFCs for the management area and, in doing so, are required to consider the nine following factors (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;
(2) The water supply needs and water management strategies included in the state water plan;
(3) Hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage 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;
(8) The feasibility of achieving the DFC; and
(9) Any other information relevant to the specific DFCs.

After final DFCs are adopted by a GMA, the TWDB calculates the MAG amounts based on those DFCs. A MAG is defined in the Texas Water Code 36.001(25) as “the amount of water that the executive administrator determines may be produced on an average annual basis to achieve a desired future condition established by Section 36.108.” The MAG amounts are then given to the GCDs within the GMA, and to the applicable Regional Water Planning Groups.

1.3 GMA 15 DFC JOINT PLANNING PROCESS

The DFC joint-planning process as outlined in Texas Water Code 36.108 is a public, transparent process, where all planning decisions are made in open, publicly-noticed meetings in accordance with provisions contained in Texas Water Code Chapter 36. From 2017 to 2021, GMA 15 convened 15 times within the boundary of the GMA at the dates listed in Table 3. All of the meetings were open to the public. All meeting notices were posted at least 10 days in advance of the meeting and included an invite to submit comments, questions, and requests for additional information to Tim Andruss of the Victoria County GCD by mail at 2805 N. Navarro St. Suite 210, Victoria, TX 77901, by email at admin@vcgcd.org, or by phone at (361) 579-6863. Table 3 lists the dates and the major discussion topics of the GMA 15 joint planning meetings held during 2021 joint planning.

Table 3. List of meetings convened by GMA 15 from May 17, 2017 through _____, 2021.

Meeting	Quorum	Major Discussion Topics
May 11, 2017	Yes	Memorandum to GCDs regarding the sequence and timeline of DFC adoption. MAG values between draft GAM Run Report GR-16-025 and the baseline model. Joint planning, management plan review, the conservation and protection of groundwater, and the achievement of DFCs.
October 12, 2017	Yes	Water level study for Goliad County. Calhoun County GCD adoption of management plan and rules. Region P RWPG review of water demand projections. Joint planning, summary of permitting activities and a well field project in Goliad County GCD. Administrative and organizational matters for GMA 15.
January 11, 2018	Yes	Concerns over the GAM for Goliad County, new TWDB project improving GAM for Central and Southern Gulf Coast. Joint planning, and review of management, and joint planning committee officer election. Adopted draft revisions of administrative procedures, approved draft revisions of bylaws and cost sharing agreement.
April 12, 2018	Yes	Report by DBS&A on the groundwater resources of Goliad County. Passed motion to request that TWDB evaluate the “impact of erroneous recharge data used for Goliad County”. Project to improve GAMS for Central/Southern Gulf coast and updates to rules in chapter 356 to reflect DFC adoption requirements.
July 12, 2018	Yes	Response from TWDB over request to review Goliad County GCD GAM report. Joint planning including proposals for professional services regarding the development and adoption of DFCs. LRE Water designated as preferred respondent to the proposal with INTERA as the alternate.

Table 3 (cont.). List of meetings convened by GMA 15 from May 17, 2017 through _____, 2021.

Meeting	Quorum	Major Discussion Topics
October 11, 2018	Yes	Agreement between LRE Water and Pecan Valley GCD (on behalf of GMA 15). Joint planning cost-sharing agreement. TWDB processing management plans. USGS study assessing groundwater availability in aquifers near the gulf, including those in GMA 15. Joint planning discussion included reviewing revised management plans from Calhoun, Goliad, Refugio and Victoria County GCDs. Determination that management plans have a positive impact on groundwater resources and result in the achievement of DFCs. LRE Water's pumping distribution maps and pumping charts from the GMA 15 MAG run.
January 10, 2019	Yes	Various studies including the Goliad GCDs recharge study, Victoria County's water level study, and the Brackish Characterization study. TWDB's plans to develop GAMs for irrelevant aquifers. Discussed joint planning schedule and the pumping distributions and amounts from previous round of joint planning and expectations for current round that was provided by LRE.
April 11, 2019	Yes	Report regarding recent/future activities of VCGCD. Development of activities at TWDB. LRE Water modeling results of two pumping scenarios. Approved management plans for Bee, Coastal Bend, Colorado, and Fayette County GCDs and determined their positive impact on water planning and the DFCs.
October 10, 2019	Yes	Financial report of joint planning funds. Refugio GCD notice of a petition filed on behalf of GCDs in GMA 16 to TCEQ regarding the failure of Starr County GCD to participate in joint planning and adopt DFCs. LRE Water's summary of memos sent earlier that covered uses and conditions, modeling results, and an updated schedule for the DFC adoption process.
November 14, 2019	Yes	Joint planning, future modeling efforts, the use of the baseline reference year for new DFCs. Pumping scenario to use as the baseline for evaluating the nine factors. GAM issues. Letter submitted by Goliad GCD.
January 9, 2020	Yes	Efforts of Goliad GCD to study groundwater recharge. Activities at TWDB. LRE Water memorandum regarding water supply needs and water management strategies to the members of GMA 15.

Table 3 (cont.). List of meetings convened by GMA 15 from May 17, 2017 through _____, 2021

Meeting	Quorum	Major Discussion Topics
June 11, 2020	Yes	TWDB's report with the initial projections of exempt use for each county within GMA 15. LRE Water's provided memos regarding hydrogeological conditions, environmental conditions, and subsidence impacts. Memos were accepted.
October 8, 2020	Yes	Groundwater joint planning including: TWDB's new guidance documents for desired future conditions. LRE Water's memos regarding socioeconomic impacts, impacts on private property, and DFC feasibility. Notification to GCDs within GMA 15 and GMA 16 of a stakeholder meeting regarding TWDB's effort to develop a new GAM for central/southern Gulf Coast Aquifer.
January 14, 2021	Yes	Additional discussion regarding socioeconomic impacts, impacts on private property, and DFC feasibility. Discussion and adoption of the Carrizo-Wilcox, Queen City, Sparta, and Yegua-Jackson aquifers as non-relevant for joint planning purposes. Summary of the modeling results.
April 8, 2021	Yes	Proposing of DFCs for adoption.

Appendix 1 contains the meeting notices and the minutes for the meetings. In July 2018, GMA 15 selected LRE Water, LLC, Daniel B. Stephens & Associates, Inc., and Blanton & Associates, Inc. (collectively referred to as the LRE Water Team) to be their technical consultant. The LRE Water Team performed the groundwater availability model (GAM) simulations for GMA 15, provided technical guidance, and supported the preparation of this explanatory report.

During the GMA 15 meeting on April 8, 2021, GMA 15 designated the draft Groundwater Management Area 15 Desired Future Conditions language, with modification, as the Proposed Desired Future Conditions of Groundwater Management Area 15. As required by Texas Water Code Section 36.108(d-2), the proposed DFCs were subsequently distributed to the individual districts in GMA 15. A period of not less than 90 days was provided to allow for public comments on the proposed DFCs; during this comment period, each district held a public hearing on the proposed DFCs. Table 4 lists the date that each district conducted a public hearing on the proposed DFCs.

Table 4. GCD public hearings regarding the GMA 15 proposed DFCs.

District	Public Hearing Date
Bee GCD	_____, 2021
Calhoun County GCD	_____, 2021
Coastal Bend GCD	_____, 2021
Coastal Plains GCD	_____, 2021
Colorado County GCD	_____, 2021
Corpus Christi ASRCD	_____, 2021
Evergreen UWCD	_____, 2021
Fayette County GCD	_____, 2021
Goliad County GCD	_____, 2021
Pecan Valley GCD	_____, 2021
Refugio GCD	_____, 2021
Texana GCD	_____, 2021
Victoria County GCD	_____, 2021

SECTION 2: GMA 15 DESIRED FUTURE CONDITIONS

Texas Water Code 36.001 defines a desired future condition (DFC) as a quantitative description of the desired condition of the groundwater resources in a management area at one or more specified future times. The following provides the DFCs adopted by GMA 15 members in accordance with Texas Water Code 36.108.

2.1 GULF COAST AQUIFER SYSTEM

For the Gulf Coast Aquifer System, the aquifers of interest are the Chicot, Evangeline, and Jasper. As shown in Table 1, the Burkeville Confining Unit separates the Evangeline and the Jasper aquifers. GMA 15 used the Central Gulf Coast Groundwater Availability Model (Chowdhury and others, 2004) to establish DFCs. GMA 15 used the zone delineations by Anaya and Hardwick (2020) to define the areas representing each of the counties and aquifers.

On _____, GMA 15 Representatives approved resolution _____ titled Resolution to Adopt the Desired Future Conditions for Groundwater Management Area 15 (Appendix 2). The adopted DFCs are expressed as average drawdown for each county and the entire groundwater management area from January 1, 2000 through December 31, 2080. The DFC for GMA 15 shall not exceed an average drawdown of 13 feet (±3 feet) for the Gulf Coast Aquifer System. DFCs for each county within the groundwater management area shall not exceed the values specified in Table 5.

Table 5. Adopted DFCs for each county in GMA 15 expressed as average drawdown from January 1, 2000 through December 31, 2080.

County	Aquifer	DFC
Aransas	Gulf Coast Aquifer System	0 (±3 feet)
Bee	Gulf Coast Aquifer System	7 (±3 feet)
Calhoun	Gulf Coast Aquifer System	5 (±3 feet)
Colorado	Chicot & Evangeline	17 (±3 feet)
	Jasper	25 (±3 feet)
De Witt	Gulf Coast Aquifer System	17 (±3 feet)
Fayette	Gulf Coast Aquifer System	44 (±3 feet)
Goliad	Chicot	-4 (±5 feet)
	Evangeline	-2 (±5 feet)
	Burkeville	7 (±5 feet)
	Jasper	14 (±5 feet)
Jackson	Gulf Coast Aquifer System	15 (±3 feet)
Karnes	Gulf Coast Aquifer System	22 (±3 feet)
Lavaca	Gulf Coast Aquifer System	18 (±3 feet)
Matagorda	Chicot & Evangeline	11 (±3 feet)
Refugio	Gulf Coast Aquifer System	5 (±3 feet)
Victoria	Gulf Coast Aquifer System	5 (±3 feet)
Wharton	Chicot & Evangeline	15 (±3 feet)

2.2 CARRIZO-WILCOX AQUIFER

GMA 15 considers the portion of the Carrizo-Wilcox Aquifer within its boundary non-relevant for joint planning purposes. The Carrizo-Wilcox Aquifer footprint extends into Bee, De Witt, Fayette, Karnes, and Lavaca counties within GMA15. The portion of this aquifer within GMA 15 is relatively small and only present at great depths. Figure 3 illustrates the location of the aquifer within GMA 15.

As shown on Table 6, the Carrizo-Wilcox Aquifer is separated from the Gulf Coast Aquifer System by several aquitards making the hydraulic connection between the aquifers negligible. Use and projected demands from the Carrizo-Wilcox Aquifer within GMA 15 are negligible to non-existent. The total estimated recoverable storage (TERS) for the Carrizo-Wilcox Aquifer within GMA 15 is 69,900,000 acre-feet. Table 6 provides the TERS values for the aquifer within GMA 15 as calculated by Wade and Anaya (2014).

Table 6. Carrizo-Wilcox Aquifer total estimated recoverable storage within GMA 15 (Wade and Anaya, 2014).

County	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
De Witt	1,200,000	300,000	900,000
Fayette	16,000,000	4,000,000	12,000,000
Karnes	43,000,000	10,750,000	32,250,000
Lavaca	9,700,000	2,425,000	7,275,000
GMA 15	69,900,000	17,475,000	52,425,000

The portion of the aquifer in Fayette and Karnes counties is managed by Fayette County Groundwater Conservation District and Evergreen Underground Water Conservation District, respectively. Each of these districts participate in joint planning within other groundwater management areas where the Carrizo-Wilcox Aquifer is more prevalent and where management of the resource is addressed. The limited extent and use of the Carrizo-Wilcox Aquifer within GMA 15, its hydraulic separation from the relevant aquifer system, and planning occurring for portions of the aquifer within other management areas, support GMA 15's decision to classify the aquifer as non-relevant for joint planning purposes within their boundary.

2.3 QUEEN CITY AQUIFER

GMA 15 considers the portion of the Queen City Aquifer within its boundary non-relevant for joint planning purposes. The Queen City Aquifer footprint extends into Fayette County within GMA15. The portion of this aquifer within GMA 15 is relatively small and only present at great depths. Figure 4 illustrates the location of the aquifer within GMA 15.

As shown on Table 7, the Queen City Aquifer is separated from the Gulf Coast Aquifer System by several geologic layers making the hydraulic connection between the aquifers negligible. Use

and projected demands from the Queen City Aquifer within GMA 15 are negligible to non-existent. The TERS for the Queen City Aquifer within GMA 15 is 640,000 acre-feet. Table 6 provides the TERS values for the aquifer within GMA 15 as calculated by Wade and Anaya (2014).

Table 7. Queen City Aquifer total estimated recoverable storage within GMA 15 (Wade and Anaya, 2014).

County	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Fayette	640,000	160,000	480,000
GMA 15	640,000	160,000	480,000

The portion of the aquifer in Fayette County is managed by Fayette County Groundwater Conservation District. Fayette County Groundwater Conservation District participates in joint planning within GMA 12 where the Queen City Aquifer is more prevalent and where management of the resource is addressed. The limited extent and use of the Queen City Aquifer within GMA 15, its hydraulic separation from the relevant aquifer system, and planning occurring for portions of the aquifer within other management areas, support GMA 15's decision to classify the aquifer as non-relevant for joint planning purposes within their boundary.

2.4 SPARTA AQUIFER

GMA 15 considers the portion of the Sparta Aquifer within its boundary non-relevant for joint planning purposes. The Sparta Aquifer footprint extends into Fayette County within GMA15. The portion of this aquifer within GMA 15 is relatively small and only present at great depths. Figure 4 illustrates the location of the aquifer within GMA 15.

As shown on Table 8, the Sparta Aquifer is separated from the Gulf Coast Aquifer System by several geologic layers making the hydraulic connection between the aquifers negligible. Use and projected demands from the Sparta Aquifer within GMA 15 are negligible to non-existent. The TERS for the Sparta Aquifer within GMA 15 is 2,900,000 acre-feet. Table 6 provides the TERS values for the aquifer within GMA 15 as calculated by Wade and Anaya (2014).

Table 8. Sparta Aquifer total estimated recoverable storage within GMA 15 (Wade and Anaya, 2014).

County	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Fayette	2,900,000	725,000	2,175,000
GMA 15	2,900,000	725,000	2,175,000

The portion of the aquifer in Fayette County is managed by Fayette County Groundwater Conservation District. Fayette County Groundwater Conservation District participates in joint

planning within GMA 12 where the Sparta Aquifer is more prevalent and where management of the resource is addressed. The limited extent and use of the Sparta Aquifer within GMA 15, its hydraulic separation from the relevant aquifer system, and planning occurring for portions of the aquifer within other management areas, support GMA 15's decision to classify the aquifer as non-relevant for joint planning purposes within their boundary.

2.5 YEGUA-JACKSON AQUIFER

GMA 15 considers the portion of the Yegua-Jackson Aquifer within its boundary non-relevant for joint planning purposes. The Yegua-Jackson Aquifer footprint extends into Karnes and Lavaca counties within GMA15. The portion of this aquifer within GMA 15 is relatively small. Figure 4 illustrates the location of the aquifer within GMA 15.

As shown on Table 9, the Yegua-Jackson Aquifer is separated from the Gulf Coast Aquifer System by an aquitard making the hydraulic connection between the aquifers negligible. Use and projected demands from the Yegua-Jackson Aquifer within GMA 15 are negligible to non-existent. The TERS for the Yegua-Jackson Aquifer within GMA 15 is 810,000 acre-feet. Table 6 provides the TERS values for the aquifer within GMA 15 as calculated by Wade and Anaya (2014).

Table 9. Yegua-Jackson Aquifer total estimated recoverable storage within GMA 15 (Wade and Anaya, 2014).

County	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Lavaca	620,000	155,000	465,000
Karnes	190,000	47,500	142,500
GMA 15	810,000	202,500	607,500

The portion of the aquifer in Karnes County is managed by Evergreen Underground Water Conservation District. Evergreen Underground Water Conservation District participates in joint planning within GMA 13 where the Yegua-Jackson Aquifer is more prevalent and where management of the resource is addressed. The limited extent and use of the Yegua-Jackson Aquifer within GMA 15, its hydraulic separation from the relevant aquifer system, and planning occurring for portions of the aquifer within other management areas, support GMA 15's decision to classify the aquifer as non-relevant for joint planning purposes within their boundary.

SECTION 3: POLICY JUSTIFICATION

The adoption of DFCs by GCDs, pursuant to the requirements and procedures set forth in Texas Water Code Chapter 36 is an important policy-making function. DFCs are planning goals that state a desired condition of the groundwater resources in the future in order to promote better long-term management of those resources. GCDs are authorized to utilize different approaches in developing and adopting DFCs based on local conditions and consider other statutory criteria as set forth in Texas Water Code 36.108.

GMA 15 and each of its member GCDs evaluated DFCs with regard to the nine factors required by Texas Water Code 36.108(d). In addition to these nine factors, GMA 15 and the individual districts evaluated DFCs with regard to providing a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, and recharging, and prevention of waste of groundwater in GMA 15.

In evaluating the DFCs, GMA 15 and the individual GCDs recognize that: 1) the production capability of the relevant aquifer varies across GMA 15; 2) historical groundwater production is different across GMA 15; and 3) the importance of groundwater production to the socioeconomic livelihood of an area varies among the GCDs. As a result, a key GMA 15 policy decision was to allow districts to set different DFCs for portions of the aquifer or hydrostratigraphic units within their boundaries, as long as the different DFCs could be modeled with the TWDB-approved GAM.

The allowance of different DFCs among the districts is justified for several reasons. One reason is that Texas Water Code 36.108(d)(1) provides for the adoption of different DFCs for different geographic areas over the same aquifer based on the boundaries of political subdivisions. The statute expressly and specifically allows districts "to consider uses or conditions of an aquifer within the management area, including conditions that differ substantially from one geographic area to another" when developing and adopting DFCs for:

1. each aquifer, subdivision of an aquifer, or geologic strata located in whole or in part within the boundaries of the management area; or

2. each geographic area overlying an aquifer in whole or in part or subdivision of an aquifer within the boundaries of the management area.

The Legislature's addition of the phrase "in whole or in part" makes it clear that GCDs may establish a "different" DFC for a geographic area that does not cover the entire aquifer but only part of that aquifer. Moreover, the plain meaning of the term "geographic area" in this context clearly includes an area defined by political boundaries, such as those of a GCD or a county.

Each GCD in GMA 15 submitted a summary of the public comment period and public hearing regarding the proposed DFCs inclusive of all relevant comments received during the public comment period from April 29, 2021 through _____, 2021 (### days) regarding the proposed DFCs, any suggested revisions to the proposed DFCs, and the basis for the revisions. The summaries are provided in Appendix C. GMA 15 Representatives reviewed the summary

submittals during a meeting held on _____, 2021. The DFCs that GMA 15 considered and proposed for final adoption specify acceptable drawdown levels in the Gulf Coast Aquifer System on a county-by-county basis and across the entire GMA 15.

SECTION 4: TECHNICAL JUSTIFICATION

GMA 15 adopted DFCs based on evaluations conducted using the Central Gulf Coast Groundwater Availability Model (GAM) developed by Waterstone (2003) and Chowdhury and others (2004). The GAM represents the Gulf Coast Aquifer System with four layers representing, from top to bottom, the Chicot, Evangeline, Burkeville, and Jasper hydrostratigraphic units. Figure 5 illustrates the extent of the GAM.

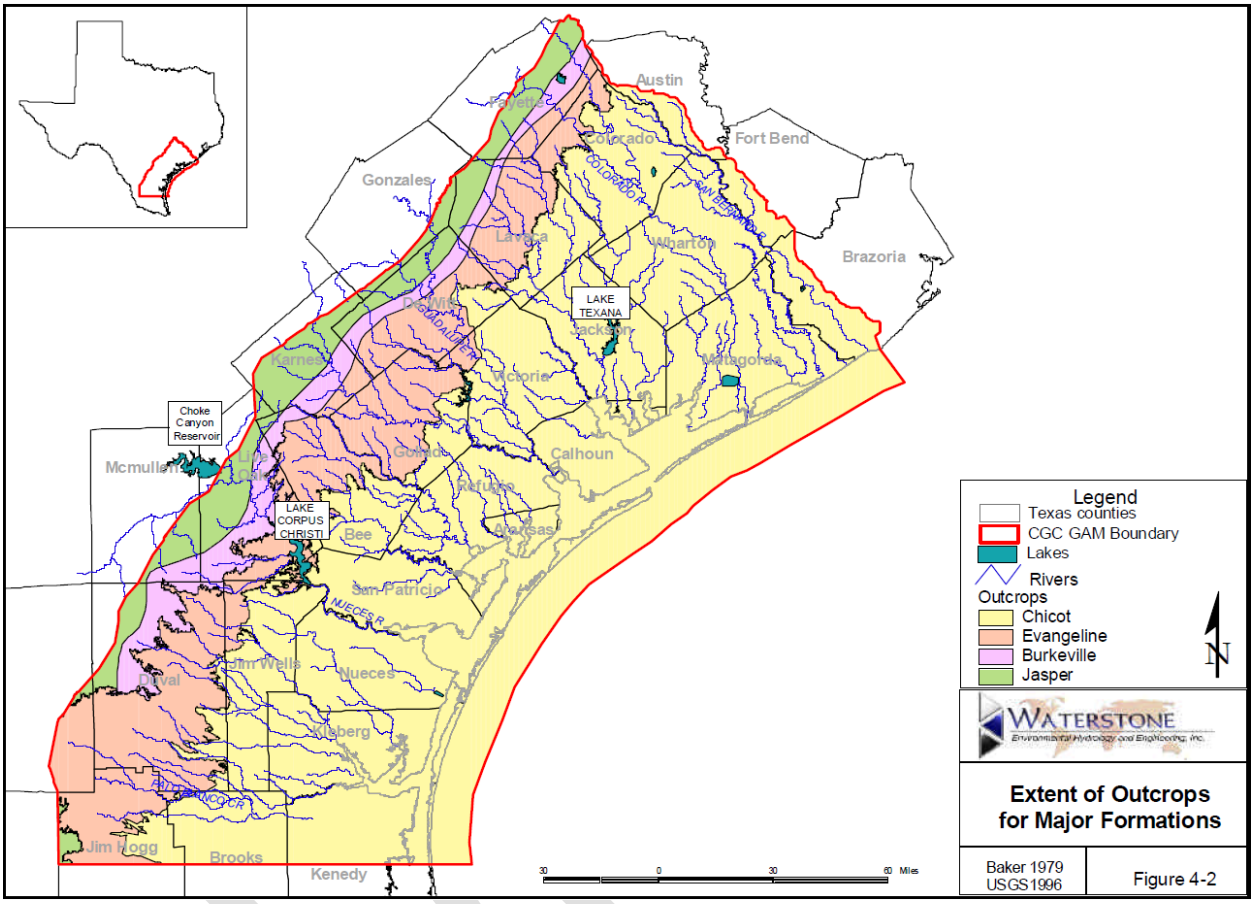

Figure 5. Extent of the Central Gulf Coast GAM (Waterstone, 2003).

Chowdhury and others (2004) calibrated the GAM through the end of 1999. The predictive period of the GAM begins with the year 2000 and extends through 2080. During 2016 joint planning, the predictive period ended in 2070 (Young, 2016) and GMA 15 elected to extend the GAM input values for 2070 through 2080 so the end of the predictive period would coincide with regional water planning. In addition, GMA 15 updated the pumping input values for 2000-2016 to more accurately reflect estimated actual pumping during those years (see

Appendix 3).

Chowdhury and others (2004) calibrated the GAM with the objective of matching available data as best as possible. By matching the available data, they deemed the GAM to reasonable represent groundwater flow through the modeled hydrostratigraphic units. However, as discussed by Young (2016) there are several studies demonstrating the error and uncertainty with the GAM. During the 2021 joint planning, Goliad County Groundwater Conservation District added to the available research through projects focused on the improving the state of the science within Goliad County.

One project focused on improving their understanding of local recharge to the aquifer. Results of their investigations suggest the GAM inflow values are higher than data indicate (McLendon and others, 2016; Rainwater and Coldren, 2019; Rainwater and Coldren, 2020). Another project involved a local recalibration of the GAM to improve the ability of the model to simulate measured water levels. Observation of water levels over the last 15 years has shown the GAM is not capable of reasonably reflecting the measured water levels as the GAM predicts rising or relatively stable water levels, but the measured water levels are decline by one foot per year or more. Results of the recalibration demonstrated the uncertainty in the GAM results within Goliad County (Keester, 2020). Appendix 4 contains copies of the Rainwater and Coldren (2020) and Keester (2020) reports provided to GMA 15.

While there is uncertainty in the results from this GAM, it is important to remember that any model will have some level of uncertainty. One way GMA 15 considered uncertainty was through the evaluation of many model scenarios with variations in pumping and recharge. In addition, GMA 15 reviewed the results from the scenarios with varying baseline dates for calculating the average drawdown. Appendix 3 contains a technical memorandum summarizing the results from the various scenarios. After discussion and consideration of the various modeling scenarios, on November 15, 2019 GMA 15 selected the scenario titled “GMA15_2019_001_v1” as the baseline pumping file for moving forward through the joint planning process.

SECTION 5: FACTOR CONSIDERATION

Texas Water Code 36.108(d) identifies factors districts must consider before voting on proposed DFCs. GMA 15 considered each of the required factors during open meetings. Table 10 lists the factors in Texas Water Code 36.108(d) and the meeting during which GMA 15 members considered each factor.

Table 10. GMA 15 meetings during which members considered factors enumerated in Texas Water Code 36.108(d) prior to voting on proposed DFCs.

Texas Water Code 36.108(d)	Consideration	Meeting Date
(1)	Aquifer uses/condition	10/10/2019
(2)	Water needs/strategies	01/09/2020
(3)	Hydrological conditions	06/11/2020
(4)	Environmental conditions	06/11/2020
(5)	Subsidence	06/11/2020
(6)	Socioeconomic impacts	10/08/2020
(7)	Private property	10/08/2020
(8)	DFC feasibility	10/08/2020
(9)	Other information	01/14/2021

Consideration of each factor included the preparation of a technical memorandum and a presentation during the GMA 15 meeting. Appendix 5 contains copies of the technical memoranda and presentations associated with each consideration. The following provides a brief summary of the information provided in each memorandum.

5.1 AQUIFER USES OR CONDITIONS

Appendix 5.1 provides detailed information regarding GMA 15's consideration of "aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another" (Texas Water Code 36.108(d)(1)). Most of the pumping from the Gulf Coast Aquifer System occurs in the northeast part of GMA 15. Total groundwater use in GMA 15 averaged just over 350,000 acre-feet per year from 2011 through 2016. Of the total use, irrigation was the dominant groundwater use within GMA 15 accounting for 83 percent of the average total annual use. Municipal or Public Supply was the second most common use followed by exempt use (combined domestic and livestock use).

5.2 WATER SUPPLY NEEDS AND WATER MANAGEMENT STRATEGIES

Appendix 5.3 provides detailed information regarding GMA 15's consideration of "the water supply needs and water management strategies included in the state water plan" (Texas Water Code 36.108(d)(2)). GMA 15 covers parts of Regional Water Planning Areas K, L, N, and P. According to the 2017 State Water Plan the projected demand for the counties (including the portion of Bee County in GMA 16) within GMA 15 is 1,225,528 acre-feet in 2020 and increases to 1,271,026 acre-feet in 2070. Review of the adopted demand projections for the 2021 regional plans and

2022 State Water Plan shows a projected demand for the counties within GMA 15 is 1,123,946 acre-feet in 2020 and decreases to 1,060,450 acre-feet in 2070. Most of the projected water demand is in the northeast portion of GMA 15 which is generally consistent with the distribution of pumping within the GMA.

5.3 HYDROLOGICAL CONDITIONS

Appendix 5.5 provides detailed information regarding GMA 15's consideration of "hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator, and the average annual recharge, inflows, and discharge" (Texas Water Code 36.108(d)(3)). The total estimated recoverable storage for the Gulf Coast Aquifer System in GMA 15 is 368,800,000 acre-feet (Wade and Anaya, 2014). The most significant source of outflow from the aquifer is pumping with significant inflows to the model from captured streamflow though the values are relative since the GAM is not designed to provide a robust simulation of the stream/aquifer interaction. Scanlon and others (2012) calculated the average annual recharge to the Gulf Coast Aquifer System to be 0.51 inches per year within GMA 15 while the GAM uses a recharge value of 0.36 inches per year within GMA 15.

While the recharge values in the GAM are lower than the best estimates of actual recharge, based on review of the total estimated recoverable storage, inflows, and outflows it does not appear that pumping associated with the DFCs would have a negative impact on the overall hydrological conditions within GMA 15. The greatest simulated impact is an increase in captured streamflow, but the simulated impact should not be considered quantitative as the GAM was not designed to provide a robust simulation of the stream/aquifer interaction.

5.4 ENVIRONMENTAL IMPACTS

Appendix 5.7 provides detailed information regarding GMA 15's consideration of "other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water" (Texas Water Code 36.108(d)(4)). The primary environmental factor of interest in GMA 15 is the impact of pumping on baseflows in rivers and streams. Anaya and others (2016) identified that for the for the counties in GMA 15, average annual groundwater discharge from the Gulf Coast Aquifer System to surface water is about 650,000 acre-feet; however, the GAM simulates water primarily inflowing from the streams. While there may be some diminishment in groundwater contribution to streamflow due to declining water levels associated with pumping, the adopted DFCs are unlikely to have a measureable impact.

5.5 SUBSIDENCE IMPACTS

Appendix 5.9 provides detailed information regarding GMA 15's consideration of "impacts on subsidence" (Texas Water Code 36.108(d)(5)). Land subsidence has occurred within GMA 15 and will likely continue to occur. Young (2016) describes that much of GMA 15 has experienced at least two feet of subsidence since 1950. Ratzlaff (1982) documented regional subsidence of more than one foot in Jackson and Matagorda counties due to groundwater withdrawals for rice irrigation. With continued utilization of the groundwater resources, subsidence will likely continue to occur.

Clay thickness within the Gulf Coast Aquifer System commonly exceeds 300 feet and is characterized as an easily deformed plastic clay (Furnans and others, 2018). When water levels in the aquifers decline it causes a depressurization of the aquifer which releases water slowly from the clay layers. The slow dewatering of these clay layers causes the reorientation of the clay grains perpendicular to the vertical load causing aquifer compaction and land surface subsidence (Kasmarek, 2013). Much of GMA 15 has a medium to high risk for subsidence associated with groundwater pumping. However, based on historical subsidence, aquifer characteristics, and predicted water-level declines, expected future subsidence within GMA 15 is less than one foot through the end of 2080.

5.6 SOCIOECONOMIC IMPACTS

Appendix 5.11 provides detailed information regarding GMA 15's consideration of "socioeconomic impacts reasonably expected to occur" (Texas Water Code 36.108(d)(6)). Regional and state water planning in Texas considers socioeconomic impacts as required by statute. To carry out this requirement, the TWDB staff prepares regional water planning analyses of social and economic impacts based on water supply needs from the regional water plans. The TWDB prepared information for use by all regional water planning groups for the 2021 regional water plans, including Regions K, L, N, and P, the four regional water planning groups that cover some portion of GMA 15. However, these analyses **do not** evaluate socioeconomic impacts of DFCs at the GMA level.

During 2016 joint planning, GMA 15 had qualitative discussions to consider the impacts that may occur due to DFCs. The result of the discussion was that GMA 15 did not anticipate that the adoption of the DFCs would have adverse socioeconomic impacts in GMA 15 during the planning horizon. They also concluded that the DFCs would provide a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharge and prevention of waste of groundwater, and control of subsidence in the management area. These qualitative considerations remain applicable during the 2021 joint planning.

5.7 PRIVATE PROPERTY RIGHTS

Appendix 5.13 provides detailed information regarding GMA 15's consideration of "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 as recognized under [Texas Water Code] Section 36.002" (Texas Water Code 36.108(d)(7)). Per Texas Water Code 36.002, "a landowner owns the groundwater below the surface of the landowner's land as real property." While a landowner owns the groundwater under the statute, the Texas Water Code does not entitle the landowner the right to capture a specific amount of groundwater.

The GMA 15 members recognize that the primary vehicle by which private property rights are protected is each GCD's Management Plan and Rules. With regard to private property rights and the ownership of groundwater, the DFCs adopted by GMA 15 do not appear to create a restriction on a landowner's ability to produce their groundwater to meet projected beneficial use demands.

With the DFCs being based on the model results using pumping scenarios that includes projected demands, it does not appear that there would be any significant impact on private property rights.

5.8 ACHIEVEMENT FEASIBILITY

Appendix 5.15 provides detailed information regarding GMA 15's consideration of "the feasibility of achieving the desired future condition." (Texas Water Code 36.108(d)(8)). In practice the test for the reasonableness or feasibility of DFCs was whether or not they could be modeled with the TWDB adopted GAM for the aquifer (Young, 2016). However, the feasibility of achieving the DFCs could also be considered relative to measured water levels.

In a well calibrated model, the trends between measured and simulated water levels should be similar. Evaluation of the measured water level trends compared to the modeled water level trends, since January 1, 2000, confirmed a variance on the model results is needed. To address the uncertainty in the GAM, GMA 15 adopted a variance of +/- 3.5 feet (+/- 5.0 feet for Goliad County) to be associated with the DFCs.

5.9 OTHER INFORMATION

As discussed in Section 4, Goliad County GCD submitted information to GMA 15 to support evaluation of the DFCs (see Appendix 4). The GMA 15 members considered the information provided and supported Goliad County GCD's approach for adopting DFCs for Goliad County that were consistent with other DFCs throughout the management area.

SECTION 6: OTHER DESIRED FUTURE CONDITIONS CONSIDERED

To be completed based on information received during the public comment period on the proposed DFCs.

SECTION 7: DISCUSSION OF OTHER RECOMMENDATIONS

To be completed based on information received during the public comment period on the proposed DFCs.

SECTION 8: REFERENCES

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APPENDIX 1 —
2021 JOINT PLANNING MEETING NOTICES AND MINUTES

APPENDIX 2 —
RESOLUTION TO ADOPT THE DESIRED FUTURE CONDITIONS FOR GROUNDWATER MANAGEMENT AREA 15

APPENDIX 3 —
SUMMARY OF MODELING AND PUMPING UPDATES

Appendix 3.1 —
January 10, 2019 Discussion of Modeling Updates

Appendix 3.2 —
April 11, 2019 Discussion of Modeling Updates

Appendix 3.3 —
October 8, 2019 Discussion of Modeling Updates

Appendix 3.4 —
October 8, 2019 Presentation of Modeling Results

APPENDIX 4 —
ADDITIONAL INFORMATION PROVIDED BY
GOLIAD COUNTY GROUNDWATER CONSERVATION DISTRICT

Appendix 4.1 —
Goliad County Recharge Evaluation

Appendix 4.2 —
GAM Recalibration Focusing on Goliad County

APPENDIX 5 —
TECHNICAL MEMORANDA AND PRESENTATIONS ASSOCIATED WITH CONSIDERTION OF FACTORS ENUMERATED IN TEXAS WATER CODE 36.108(d)

Appendix 5.1 —
Discussion of Aquifer Uses and Conditions

Appendix 5.2 —
Presentation Regarding Aquifer Uses and Conditions

Appendix 5.3 —
Discussion of Water Supply Needs and Water Management Strategies

Appendix 5.4 —
Presentation Regarding Water Supply Needs and Water Management Strategies

Appendix 5.5 —
Discussion of Hydrological Conditions

Appendix 5.6 —
Presentation Regarding Hydrological Conditions

Appendix 5.7 —
Discussion of Environmental Impacts

Appendix 5.8 —
Presentation Regarding Environmental Impacts

Appendix 5.9 —
Discussion of Subsidence Impacts

Appendix 5.10 —
Presentation Regarding Subsidence Impacts

Appendix 5.11 —
Discussion of Socioeconomic Impacts

Appendix 5.12 —
Presentation Regarding Socioeconomic Impacts

Appendix 5.13 —
Discussion of the Impacts of Desired Future Conditions on the Interests and Rights in Private Property

Appendix 5.14 —
Presentation Regarding Impacts of Desired Future Conditions on the Interests and Rights in Private Property

Appendix 5.15 —
Discussion of Feasibility of Achieving the DFCs

Appendix 5.16 —
Presentation Regarding Feasibility of Achieving the DFCs

Appendix 5.17 —
Presentation Regarding Potentially Non-Relevant Aquifers for GMA 15 Joint Planning