

Mr. Jeff Walker  
Executive Administrator  
Texas Water Development Board  
1700 N. Congress  
PO Box 13231  
Austin, Texas 78711-3231

Dear Mr. Walker,

The Live Oak Underground Water Conservation District (LOUWCD) is pleased to submit to the Texas Water Development Board (TWDB) a copy of our amended and adopted Management Plan in accordance with chapter 36.1073. The Live Oak Underground Water Conservation District Management Plan (LOUWCDMP) was adopted by the LOUWCD Board of Directors at their quarterly meeting on March 11, 2019, by unanimous consent. In addition, a certified copy of the LOUWCD Board of Directors resolution adopting the plan is also attached. This plan was revised at the regular meeting of the LOUWCD March 11, 2019, by unanimous vote of all directors.

The LOUWCD, established in 1991, has historically had an excellent working relationship with the TWDB and it is our hope that we can count on your support as we implement the enclosed plan, it is the intent of our Board of Directors that we will begin implementation of this plan immediately to facilitate the success of our efforts.

The LOUWCDMP was developed during open meetings of the Board of Directors in accordance with all notice and hearing requirements stated in the District's procedures. Documentation that notice and hearing requirements were followed is presented in a separate attachment.

During preparation of the LOUWCD Management Plan, (LOUWCD MP) all planning efforts were coordinated with the Nueces River Authority, as mandated by 36.1071 (a) and TAC 356.6(a)(4). Documentation of this coordinated effort is included in the packet for your review.

The rules of LOUWCD are available at our website which is [lowcd.org](http://lowcd.org). The LOUWCDMP will be in force for 5 years from the date of approval. If there is any other documentation we can provide to the TWDB that will ensure the prompt approval of the Live Oak Underground Water Conservation District Management Plan, please do not hesitate to call me or my staff. I look forward to working with you and your staff throughout the process.  
Sincerely,

Scott Bledsoe III, President

## **DISTRICT MISSION**

The Live Oak Underground Water Conservation District will strive to develop, promote, and implement water conservation, augmentation, and management strategies to protect water resources for the benefit of the citizens, economy, and environment of the district.

## **TIME PERIOD FOR THIS PLAN**

This plan becomes effective upon approval by the Texas Water Development Board and remains in effect until a revised plan is approved or five years, whichever is earlier.

## **STATEMENT OF GUIDING PRINCIPLES**

The district recognizes that the groundwater resources of the region are of vital importance. The preservation of this most valuable resource can be managed in a prudent and cost effective manner through regulation and permitting. This management document is intended as a tool to focus the thoughts and actions of those given the responsibility for the execution of district activities.

## **General Description**

The District was created by the citizens of Live Oak County through election, November, 1989. The current Board of Directors are Scott Bledsoe III - Chairman, Mark Katzfey - Vice-Chairman, Harriet Lamm, Edward Pawlik, and James Palik, Live Oak Underground Water Conservation District (LOUWCD) has the same areal extent as that of Live Oak County. The county has a vibrant economy dominated by agriculture and petroleum. The agriculture income is derived primarily from beef cattle production, wheat, corn, sorghum, and cotton, with some sheep and goat ranching.

## **Location and Extent**

Live Oak County, consisting of 1,072 square miles, is located in South Texas. The county is bounded on the east by Bee, San Patricio, and Karnes counties, on the north by Atascosa county, on the west by McMullen County, and on the south by Jim Wells and Duval County. George West, which is centrally located in the county, is the county seat. Three Rivers, the only other municipality in the county, is located in the northern portion of the county.

## **Topography , Drainage and Groundwater Resources of Live Oak County**

Live Oak County is on the Gulf Coastal Plain in southern Texas. Most the 1,072 square miles of the county are devoted to farming and ranching which provide the principal income for the 9,000 inhabitants. The production of oil is also an important industry.

The principal water-bearing formations underlying the county are the Carrizo Sand, Oakville Sandstone, Lagarto Clay, and Goliad Sand, and range in age from Eocene to Pliocene. The formations dip toward the coast at rates ranging from less than 20 to about 140 feet to the mile.

Some irrigation, municipal, and stock supplies are obtained from surface-water sources. In Live Oak County the water-bearing sands above a depth of 2,000 feet contain approximately 20 million acre-feet of fresh and slightly saline water. Even though it may be impractical to recover much of the stored water, the rate of withdrawal could be increased several times more than the 1999 rate without appreciably depleting the water available from storage for many decades. A large but unestimated amount of fresh to slightly saline water occurs in the Carrizo Sand in the northern and northwestern parts of the county at depths as much as 6,000 feet. Most of the water in the Carrizo sand in Live Oak County is more than 4,000 feet below land surface and therefore is too deeply buried to be economically developed for most uses.

Most of the ground water in Live Oak County is substandard in quality for municipal, industrial, and irrigation uses. However, because better water is not available in most areas in the county, substandard water has been used successfully by users of all three categories. Generally the Goliad sand contains water of better quality than that in any formation except the Carrizo Sand. In favorable areas properly constructed wells in the Carrizo, Oakville, Lagarto, and Goliad may yield 1,000 gallons per minute or more. Yields from wells tapping the other water-bearing formations generally are small and the water commonly is suitable only for stock.

Most of Live Oak County is rolling to moderately hilly, although some areas are nearly flat. The altitude ranges from about 460 feet in the southwestern part of the county to about 90 feet near Lake Corpus Christi. The county is drained by the Nueces River and its tributaries, the Frio and Atascosa Rivers, with the exception of a small, elongated area near the Bee County line which is drained by tributaries of the Aransas River.

The water-bearing formations in Live Oak County are continually recharged by the infiltration of a small part of the precipitation, which falls on the more permeable strata.

However, most of the precipitation that falls in the county runs off in steams, evaporates, or is transpired by plants. The remaining water, probably less than five percent, may reach the zone of saturation where it moves slowly toward an area of discharge such as a well, natural outlet, or, under artesian pressure, it may seep or percolate slowly upward into overlying beds. Recharge could be enhanced by several methods: brush control, additional precipitation, and additional tanks to catch runoff from excessive precipitation.

### **Surface Water Resource of Live Oak County**

There are two surface impoundments used to supply water other than for livestock consumption, Choke Canyon and Lake Corpus Christi. The average annual supply from these impoundments is 241,000 acre-feet, however, the calculated firm yield is 206,000 acre-feet. For planning calculations the impoundments will be assumed to supply 162,500 acre-feet per year by the year 2050. These figures came from the City of Corpus Christi. The owners and operators are the Nueces River Authority and the City of Corpus Christi within all reaches of the Nueces River in Live Oak County. The City of Corpus Christi is the major user of surface water in Live Oak County along with the City of Three Rivers and the petrochemical plant, Valero.

For additional information see Appendix A

### **Estimate of the amount of groundwater used, estimate of the projected total demand, water supply needs from the state water plan, water management strategies from the adopted state water plan**

For additional information see Appendix A

### **Groundwater Availability Modeling Information**

This information came from the TWDB GAM run GR17-025.

For additional information see Appendix A

### **Actions, Procedures, Performance and Avoidance for Plan Implementation**

The District will implement the provisions of this plan and will utilize the provisions of this plan as a guidepost for determining the direction or priority for all District activities. All operations of the District, all agreements entered into by the District and any additional planning efforts in which the District may participate will be consistent with the provisions of this plan.

The rules adopted by the District shall be pursuant to TWC Chapter 36 and the provisions of this plan. All rules will be adhered to and enforced. The promulgation and enforcement of the rules will be based on the best technical evidence available. The rules can be downloaded at <http://www.louwcd.org/approved-rules.html> under the tab "District Rules".

### **Methodology for Tracking the District's Progress in Achieving Management Goals**

The District manager will prepare and present an annual report to the Board of Directors on District performance in regards to achieving management goals and objectives. The presentation of the report will occur during the last monthly Board meeting each fiscal year, beginning December 31, 2015. The report will include the number of instances in which each of the activities specified in the District's management objectives was engaged in during the fiscal year. The Board will maintain the report on file, for public inspection at the District's offices upon adoption. This methodology will apply to all management goals contained within this plan.

### **Management of Groundwater Supplies**

The District will manage the supply of groundwater within the District in order to conserve the resource while seeking to maintain the economic viability of all resource user groups, public and private. In consideration of the economic and cultural activities occurring within the District, the District will identify and engage in such activities and practices that, if implemented, would result in a reduction of groundwater use. A monitor well observation network shall be established and maintained in order to evaluate changing conditions of groundwater supplies (water in storage) within the District. The District will make a regular assessment of water supply and groundwater storage conditions and will report those conditions to the Board and to the public. The District will undertake, as necessary and cooperate with investigations of the groundwater resources within the District and will make the results of investigations available to the public upon adoption by the Board.

The District has adopted rules to regulate groundwater withdrawals by means of well spacing and production limits. The District may deny a well construction permit or limit groundwater withdrawals in accordance with the guidelines stated in the rules of the District. In making a determination to deny a permit or limit groundwater withdrawals, the District will consider the public benefit against individual hardship after considering all appropriate testimony.

In pursuit of the Districts mission of protecting the resource, the District may require reduction of groundwater withdrawals to amounts, which will not cause harm to the aquifer. To achieve this purpose, the District may, at the Boards discretion, amend or revoke any permits after notice and hearing. The determination to seek the amendment or revocation of a permit by the District will be based on aquifer conditions observed by the District. The District will enforce the terms and conditions of permits and the rules of the District by enjoining the permit holder in a court of competent jurisdiction as provided for in Texas Water Code (TWC) 36.102.

#### **Desired Future Condition and Modeled Available Groundwater**

GMA 16 adopted a desired future condition for the Gulf Coast Aquifer on August 30, 2010, and declared all of the other aquifers non-relevant. The desired future condition is 94 feet of drawdown as an average for the entire GMA 16. The desired future condition for Live Oak UWCD is 25 feet of drawdown within the district. The modeled available groundwater, GAM 17-025 MAG, is in Appendix A.

# **LIVE OAK UNDERGROUND WATER CONSERVATION DISTRICT MANAGEMENT PLAN**

## **MISSION STATEMENT**

The mission of the Live Oak Underground Water Conservation District is to protect and assure a sufficient quantity and quality of groundwater for our constituents use.

We value:

- \*Collection and maintenance of data on water quantity and quality
- \*Efficient use of groundwater
- \*Conjunctive water management issues
- \*Development and enforcement of water district rules concerning conservation of ground water.

## **Management Goals, Objectives, and Performance Standards Resource Goals**

### **Goal 1.0: Providing the most efficient use of groundwater**

#### **Management Objective:**

Each year the District will provide education materials concerning the efficient use of groundwater.

#### **Performance standard:**

Provide educational materials to at least one school annually.

### **Goal 2.0: Controlling and preventing waste of groundwater**

#### **Management Objective:**

Measure water levels from the land surface on strategic wells on an annual basis and report waste to the District Board.

#### **Performance standard:**

- (a) Report to the District Board annually the water level measurements for three wells.

- (b) The District will investigate all reports of waste within 7 working days. The number of reports of waste as well as the investigation findings will be reported to the District Board annually.

### **Goal 3.0: Controlling and preventing subsidence**

The geologic framework of the District Area precludes any significant subsidence from occurring. This management goal is not applicable to the operations of the District.

### **Goal 4.0: Addressing Conjunctive surface water management issues**

Except as provided in Chapter 36 of the Texas Water Code, the District has no jurisdiction over surface water. The District shall consider the effects of surface water resources as required by Section 36.113 and other state law. This goal is not applicable at this time.

### **Goal 5.0: Addressing Natural Resource Issues**

#### **Management Objective:**

The District will cooperate with other interested parties and appropriate agencies to develop additional information on natural resource issues.

#### **Performance Standard:**

A representative of the District will attend a meeting annually with interested parties and appropriate agencies.

### **Goal 6.0: Addressing Drought Conditions**

#### **Management Objective:**

The District will monitor the Palmer Drought Severity Index (PDSI). The link to the Drought index is [www.waterdatafortexas.org/drought](http://www.waterdatafortexas.org/drought)

#### **Performance Standard:**

A report of the Palmer Drought Severity Index will be presented to the District board on an annual basis.



## **Goal 7.0: Addressing Conservation**

### **Management Objective:**

Each year the District will provide educational material to the public promoting conservation methods and concepts.

### **Performance Standard:**

The District will make at least one educational brochure available per year through service organizations, and on a continuing basis at the District office.

## **Goal 8.0: Addressing Precipitation Enhancement**

The District has determined that this goal is not financially feasible at this time.

## **Goal 9.0: Recharge Enhancement**

This goal is not applicable to the District because, at the current time, it is cost prohibitive.

## **Goal 10.0: Addressing Rainwater Harvesting**

This goal is not applicable to the District because, at the current time, it is cost prohibitive.

## **Goal 11.0: Addressing Brush Control**

This goal is not applicable to the District because, at the current time, it is cost prohibitive.

**Goal 12.0: Addressing the desired future conditions of the groundwater resource in the District.**

**Management Objective:**

The District will review and calculate its permit and well registration totals in light of the Desired Future Conditions of the groundwater resources within the boundaries of the District to assess whether the District is on target to meet the Desired Future Conditions estimates submitted to the TWDB.

**Performance Standard:**

The District's Annual Report will include a discussion of the District's permit and well registration totals and will evaluate the District's progress in achieving the Desired Future Conditions of the groundwater resources within the boundaries of the District and whether the District is on track to maintain the Desired Future Conditions estimates over the 50-year planning period.

**Management Objective:**

The District will annually sample the water levels in at least three monitoring wells within the District and will determine the five-year water level averages based on the samples taken.

The District will compare the five-year water level averages to the corresponding five-year increment of its Desired Future Conditions in order to track its progress in achieving the Desired Future Conditions.

**Performance Standard:**

The District's Annual Report will include the water level samples taken each year for the purpose of measuring water levels to assess the District's progress towards achieving its Desired Future Conditions. Once the District has obtained water level samples for five consecutive years and is able to calculate water level averages over five-year periods thereafter, the District will include a discussion of its comparison of water level averages to the corresponding five-year increment of its Desired Future Conditions in order to track its progress in achieving its Desired Future Conditions.

**RESOLUTION NO. 001-2019**

Whereas, the Live Oak Underground Water Conservation District has held the appropriate public hearings, and;

Whereas, the District has presented the management plan to the county officials and the Nueces River Authority.

Whereas, the District has followed the rules set forth by SB 1 and the TWDB.

Now, Therefore be it Resolved, that the Live Oak Underground Water Conservation District voted to pass the District management plan.

In favor \_\_\_\_\_ Against \_\_\_\_\_

Passed and Approved this the 11<sup>th</sup> day of March, 2019.

\_\_\_\_\_  
Scott Bledsoe III, President

Attest by: \_\_\_\_\_  
Lonnie Stewart, Secretary

## Appendix A

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# Estimated Historical Water Use And 2012 State Water Plan Datasets: Live Oak Underground Water Conservation District

by Stephen Allen  
Texas Water Development Board  
Groundwater Resources Division  
Groundwater Technical Assistance Section  
stephen.allen@twdb.texas.gov  
(512) 463-7317  
July 7, 2015

## **GROUNDWATER MANAGEMENT PLAN DATA:**

This package of water data reports (part 1 of a 2-part package of information) is being provided to groundwater conservation districts to help them meet the requirements for approval of their five-year groundwater management plan. Each report in the package addresses a specific numbered requirement in the Texas Water Development Board's groundwater management plan checklist. The checklist can be viewed and downloaded from this web address:

<http://www.twdb.texas.gov/groundwater/docs/GCD/GMPChecklist0113.pdf>

The five reports included in part 1 are:

1. Estimated Historical Water Use (checklist Item 2)  
from the TWDB Historical Water Use Survey (WUS)
2. Projected Surface Water Supplies (checklist Item 6)
3. Projected Water Demands (checklist Item 7)
4. Projected Water Supply Needs (checklist Item 8)
5. Projected Water Management Strategies (checklist Item 9)  
reports 2-5 are from the 2012 Texas State Water Plan (SWP)

Part 2 of the 2-part package is the groundwater availability model (GAM) report. The District should have received, or will receive, this report from the Groundwater Availability Modeling Section. Questions about the GAM can be directed to Dr. Shirley Wade, shirley.wade@twdb.texas.gov, (512) 936-0883.

## **DISCLAIMER:**

The data presented in this report represents the most up-to-date WUS and 2012 SWP data available as of 7/7/2015. Although it does not happen frequently, neither of these datasets are static so they are subject to change pending the availability of more accurate WUS data or an amendment to the 2012 SWP. District personnel must review these datasets and correct any discrepancies in order to ensure approval of their groundwater management plan.

The WUS dataset can be verified at this web address:

<http://www.twdb.texas.gov/waterplanning/waterusesurvey/estimates/>

The 2012 SWP dataset can be verified by contacting Sabrina Anderson (sabrina.anderson@twdb.texas.gov or 512-936-0886).

For additional questions regarding this data, please contact Stephen Allen (stephen.allen@twdb.texas.gov or 512-463-7317) or Rima Petrossian (rima.petrossian@twdb.texas.gov or 512-936-2420).

# Estimated Historical Water Use

## TWDB Historical Water Use Survey (WUS) Data

Groundwater and surface water historical use estimates are currently unavailable for calendar year 2014. TWDB staff anticipates the calculation and posting of these estimates at a later date.

### LIVE OAK COUNTY

All values are in acre-feet/year

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2013	GW	1,042	965	1,432	0	806	451	4,696
	SW	624	1,309	159	0	520	193	2,805
2012	GW	1,073	904	1,141	0	841	476	4,435
	SW	631	1,335	94	0	579	204	2,843
2011	GW	1,106	619	875	0	1,146	545	4,291
	SW	582	1,364	127	0	484	234	2,791
2010	GW	1,102	875	103	0	700	545	3,325
	SW	547	1,249	15	0	0	234	2,045
2009	GW	1,282	798	67	0	1,978	655	4,780
	SW	669	1,154	10	0	0	281	2,114
2008	GW	1,281	697	32	0	1,934	587	4,531
	SW	692	1,359	5	0	0	251	2,307
2007	GW	1,344	858	0	0	1,154	738	4,094
	SW	750	1,015	0	0	0	316	2,081
2006	GW	1,424	876	0	0	2,231	609	5,140
	SW	718	1,102	0	0	0	261	2,081
2005	GW	1,501	851	0	0	1,513	679	4,544
	SW	557	1,114	0	0	0	291	1,962
2004	GW	1,706	863	3	0	921	452	3,945
	SW	484	916	0	0	0	452	1,852
2003	GW	1,508	869	3	0	709	444	3,533
	SW	424	975	0	0	1,326	444	3,169
2002	GW	1,851	891	3	0	2,164	386	5,295
	SW	466	933	0	0	721	386	2,506
2001	GW	1,707	820	0	0	1,757	315	4,599
	SW	413	954	0	0	586	315	2,268
2000	GW	1,707	809	3	0	2,649	416	5,584
	SW	452	958	0	0	890	416	2,716

# Projected Surface Water Supplies

## TWDB 2012 State Water Plan Data

### LIVE OAK COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	Source Name	2010	2020	2030	2040	2050	2060
N	CHOKE CANYON WS	NUECES	CORPUS CHRISTI- CHOKE CANYON LAKE/RESERVOIR SYSTEM	227	256	266	254	221	187
N	IRRIGATION	NUECES	NUECES RIVER COMBINED RUN-OF- RIVER IRRIGATION	200	200	200	200	200	200
N	LIVESTOCK	NUECES	LIVESTOCK LOCAL SUPPLY	416	416	416	416	416	416
N	MANUFACTURING	NUECES	NUECES RIVER RUN- OF-RIVER	800	800	800	800	800	800
N	THREE RIVERS	NUECES	CORPUS CHRISTI- CHOKE CANYON LAKE/RESERVOIR SYSTEM	3,118	3,087	3,076	3,089	3,125	3,162
N	THREE RIVERS	NUECES	NUECES RIVER RUN- OF-RIVER	700	700	700	700	700	700
<b>Sum of Projected Surface Water Supplies (acre-feet/year)</b>				<b>5,461</b>	<b>5,459</b>	<b>5,458</b>	<b>5,459</b>	<b>5,462</b>	<b>5,465</b>



# Projected Water Demands

## TWDB 2012 State Water Plan Data

Please note that the demand numbers presented here include the plumbing code savings found in the Regional and State Water Plans.

### LIVE OAK COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
N	COUNTY-OTHER	NUECES	748	796	808	778	709	638
N	CHOKE CANYON WS	NUECES	397	425	435	421	384	346
N	EL OSO WSC	NUECES	206	220	223	215	196	176
N	MCCOY WSC	NUECES	54	57	58	56	51	46
N	IRRIGATION	NUECES	3,289	3,056	2,840	2,639	2,451	2,277
N	LIVESTOCK	NUECES	833	833	833	833	833	833
N	MANUFACTURING	NUECES	1,946	1,998	2,032	2,063	2,088	2,194
N	THREE RIVERS	NUECES	465	498	505	485	444	399
N	MINING	NUECES	3,894	4,319	4,583	4,845	5,108	5,341
N	GEORGE WEST	NUECES	703	754	767	738	675	608
<b>Sum of Projected Water Demands (acre-feet/year)</b>			<b>12,535</b>	<b>12,956</b>	<b>13,084</b>	<b>13,073</b>	<b>12,939</b>	<b>12,858</b>

# Projected Water Supply Needs

## TWDB 2012 State Water Plan Data

Negative values (in red) reflect a projected water supply need, positive values a surplus.

### LIVE OAK COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
N	CHOKE CANYON WS	NUECES	9	5	2	1	2	4
N	COUNTY-OTHER	NUECES	0	-32	-44	-14	0	0
N	EL OSO WSC	NUECES	0	0	0	0	0	0
N	GEORGE WEST	NUECES	0	0	0	0	0	0
N	IRRIGATION	NUECES	-627	-569	-514	-464	-416	-373
N	LIVESTOCK	NUECES	0	0	0	0	0	0
N	MANUFACTURING	NUECES	-337	-483	-559	-615	-657	-764
N	MCCOY WSC	NUECES	6	3	2	4	9	14
N	MINING	NUECES	-64	-478	-928	-1,234	-1,504	-1,755
N	THREE RIVERS	NUECES	3,353	3,289	3,271	3,304	3,381	3,463
<b>Sum of Projected Water Supply Needs (acre-feet/year)</b>			<b>-1,028</b>	<b>-1,562</b>	<b>-2,045</b>	<b>-2,327</b>	<b>-2,577</b>	<b>-2,892</b>

# Projected Water Management Strategies

## TWDB 2012 State Water Plan Data

### LIVE OAK COUNTY

WUG, Basin (RWPG)

All values are in acre-feet/year

Water Management Strategy	Source Name [Origin]	2010	2020	2030	2040	2050	2060
<b>COUNTY-OTHER, NUECES (N)</b>							
GULF COAST AQUIFER SUPPLIES	GULF COAST AQUIFER [LIVE OAK]	0	80	80	80	80	80
<b>GEORGE WEST, NUECES (N)</b>							
MUNICIPAL WATER CONSERVATION	CONSERVATION [LIVE OAK]	5	14	25	33	45	57
<b>IRRIGATION, NUECES (N)</b>							
GULF COAST AQUIFER SUPPLIES	GULF COAST AQUIFER [LIVE OAK]	1,210	1,210	1,210	1,210	1,210	1,210
IRRIGATION WATER CONSERVATION	CONSERVATION [LIVE OAK]	17	52	103	169	248	342
<b>MANUFACTURING, NUECES (N)</b>							
VOLUNTARY REDISTRIBUTION	CORPUS CHRISTI-CHOKE CANYON LAKE/RESERVOIR SYSTEM [RESERVOIR]	337	483	559	615	657	764
<b>MINING, NUECES (N)</b>							
MINING WATER CONSERVATION	CONSERVATION [LIVE OAK]	97	216	344	485	639	801
<b>THREE RIVERS, NUECES (N)</b>							
MUNICIPAL WATER CONSERVATION	CONSERVATION [LIVE OAK]	3	8	14	18	27	34
<b>Sum of Projected Water Management Strategies (acre-feet/year)</b>		<b>1,669</b>	<b>2,063</b>	<b>2,335</b>	<b>2,610</b>	<b>2,906</b>	<b>3,288</b>

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# GAM RUN 17-025 MAG: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 16

Rohit Raj Goswami, Ph.D., P.E.  
Texas Water Development Board  
Groundwater Division  
Groundwater Availability Modeling Section  
(512) 463-0495  
May 19, 2017



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# **GAM RUN 17-025 MAG: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 16**

Rohit Raj Goswami, Ph.D., P.E.  
Texas Water Development Board  
Groundwater Division  
Groundwater Availability Modeling Section  
(512) 463-0495  
May 19, 2017

## ***EXECUTIVE SUMMARY:***

The modeled available groundwater for Groundwater Management Area 16 (Figure 1) for the Gulf Coast Aquifer System is summarized by decade for the groundwater conservation districts and counties (Table 1) and for use in the regional water planning process (Table 2). The modeled available groundwater estimates range from approximately 233,000 acre-feet per year in 2020 to 312,000 acre-feet per year in 2060 (Tables 1 and 2). The estimates were extracted from results of a model run using the alternative groundwater availability model for Groundwater Management Area 16 (version 1.01). The model run files, which meet the desired future conditions of Groundwater Management Area 16, were submitted to the Texas Water Development Board (TWDB) as part of the Desired Future Conditions Explanatory Report for Groundwater Management Area 16. The explanatory report and other materials submitted to the TWDB were determined to be administratively complete on April 19, 2017.

## ***REQUESTOR:***

Mr. David O'Rourke, consultant for Groundwater Management Area 16.

## ***DESCRIPTION OF REQUEST:***

In a letter dated January 25, 2017, Mr. David O'Rourke, consultant for Groundwater Management Area 16, provided the TWDB with the desired future conditions of the Gulf Coast Aquifer System adopted by the groundwater conservation district representatives in Groundwater Management Area 16. All other aquifers in Groundwater Management Area 16 (Carrizo-Wilcox and Yegua-Jackson) were declared non-relevant for joint planning purposes. The Gulf Coast Aquifer System includes the Chicot Aquifer, Evangeline Aquifer, and the Jasper Aquifer. Clarifications to the submitted materials were received by TWDB on April 4, 2017. The desired future conditions for the Gulf Coast Aquifer System, as described

in Resolution No. 2017-01 and adopted January 17, 2017, by the groundwater conservation districts within Groundwater Management Area 16, are described below:

**Groundwater Management Area 16 [all counties]**

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 62 feet in December 2060 from estimated year 2010 conditions.

**Bee Groundwater Conservation District**

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 76 feet in December 2060 from estimated year 2010 conditions.

**Live Oak Underground Water Conservation District**

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 34 feet in December 2060 from estimated year 2010 conditions.

**McMullen Groundwater Conservation District**

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 9 feet in December 2060 from estimated year 2010 conditions.

**Red Sands Groundwater Conservation District**

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 40 feet in December 2060 from estimated year 2010 conditions.

**Kenedy County Groundwater Conservation District**

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 40 feet in December 2060 from estimated year 2010 conditions.

**Brush Country Groundwater Conservation District**

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 69 feet in December 2060 from estimated year 2010 conditions.

**Duval County Groundwater Conservation District**

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 104 feet in December 2060 from estimated year 2010 conditions.

### **San Patricio County Groundwater Conservation District**

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 48 feet in December 2060 from estimated year 2010 conditions.

### **Starr County Groundwater Conservation District**

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 69 feet in December 2060 from estimated year 2010 conditions.

### **No District - Cameron County**

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 70 feet in December 2060 from estimated year 2010 conditions.

### **No District - Hidalgo County**

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 118 feet in December 2060 from estimated year 2010 conditions.

### **No District - Kleberg County**

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 28 feet in December 2060 from estimated year 2010 conditions.

### **No District - Nueces County**

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 21 feet in December 2060 from estimated year 2010 conditions.

### **No District - Webb County**

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 113 feet in December 2060 from estimated year 2010 conditions.

### **No District - Willacy County**

Drawdown of the Gulf Coast Aquifer System shall not exceed an average of 40 feet in December 2060 from estimated year 2010 conditions.

### ***METHODS:***

The alternative groundwater availability model for Groundwater Management Area 16 (Hutchison and others, 2011) was run using the model files submitted with the explanatory report (O'Rourke, 2017). Model-calculated water levels were extracted for the years 2010



and 2060, and drawdown was calculated as the difference between water levels at the beginning of 2010 and water levels at the end of 2060. Drawdown averages were calculated for the Gulf Coast Aquifer System by county, groundwater conservation districts, and the entire groundwater management area. As specified in the explanatory report (O'Rourke, 2017), drawdown for model cells that became dry during the simulation (water level dropped below the base of the cell) were excluded from the averaging. The calculated drawdown averages were compared with the desired future conditions to verify that the pumping scenario specified by the district representatives achieved the desired future conditions within a one-foot variance.

The modeled available groundwater values were determined by extracting pumping rates by decade from the model results using ZONEBUDGET Version 3.01 (Harbaugh, 2009). Table 1 presents the annual pumping rates by county and groundwater conservation district, subtotaled by groundwater conservation district, and then summed for Groundwater Management Area 16. Table 2 presents the annual pumping rates by county, river basin, regional water planning area, and groundwater conservation district within Groundwater Management Area 16.

### **Modeled Available Groundwater and Permitting**

As defined in Chapter 36 of the Texas Water Code, "modeled available groundwater" is the estimated average amount of water that may be produced annually to achieve a desired future condition. Groundwater conservation districts must consider modeled available groundwater when issuing permits in order to manage groundwater production to achieve the desired future condition(s). Districts must also consider annual precipitation and production patterns, the estimated amount of pumping exempt from permitting, existing permits, and a reasonable estimate of actual groundwater production under existing permits.

### ***PARAMETERS AND ASSUMPTIONS:***

The parameters and assumptions for the groundwater availability are described below:

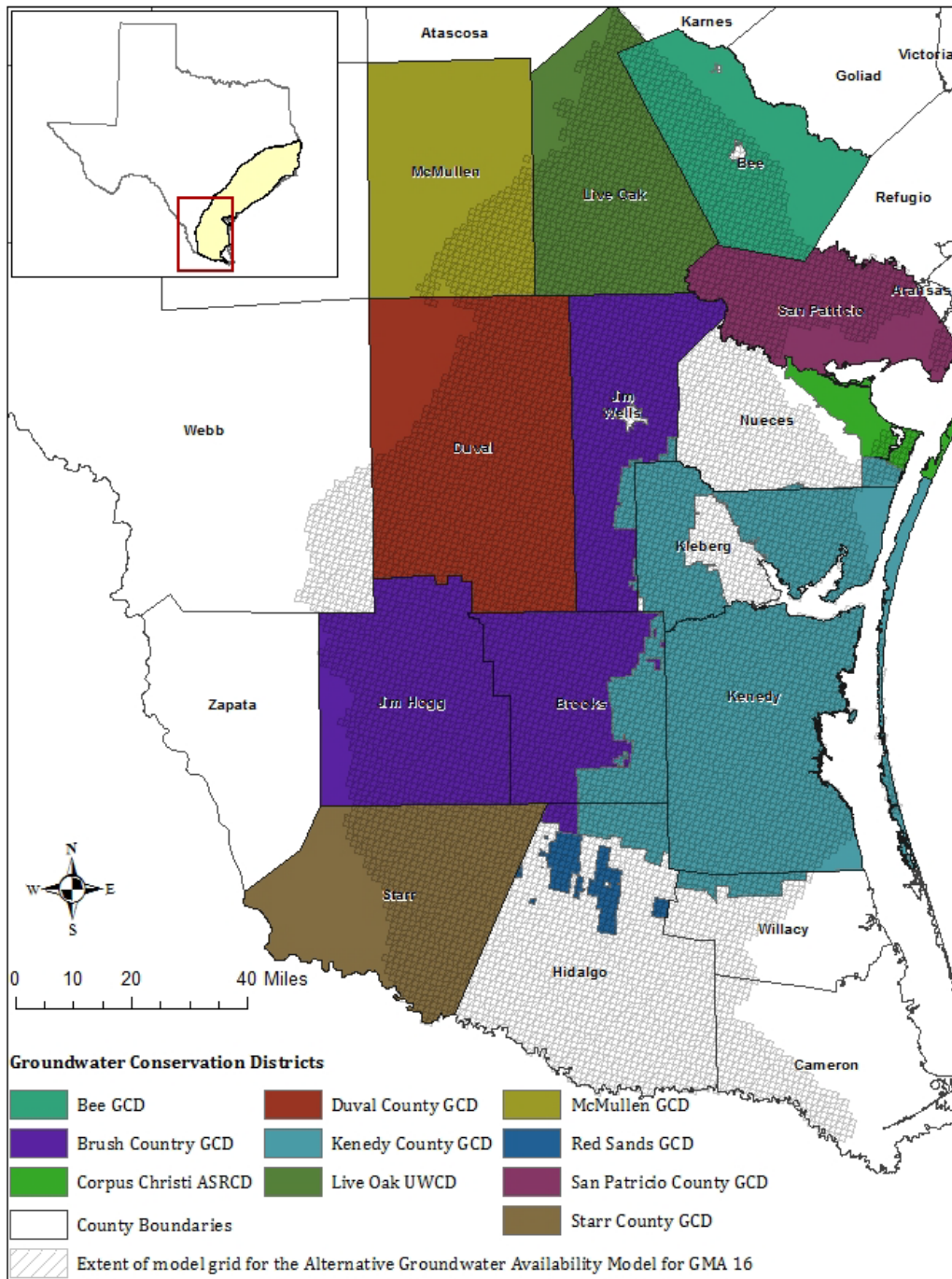
- The analysis used version 1.01 of the alternate groundwater availability model for Groundwater Management Area 16. See Hutchison and others (2011) for assumptions and limitations of the model.
- The model has six layers that represent the Chicot Aquifer (Layer 1), the Evangeline Aquifer (Layer 2), the Burkeville Confining Unit (Layer 3), the Jasper Aquifer (Layer 4), the Yegua-Jackson Aquifer (Layer 5), and the Queen-City, Sparta and Carrizo-Wilcox Aquifer System (Layer 6).
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

- Groundwater Division checked the validity of the assertion that starting water levels in the model were comparable to the measured water-level conditions at the end of year 2010. Water-level values were averaged over the entire area of Groundwater Management Area 16 for the measured and modeled conditions between the years 2000 and 2010. These averaged water-level values are reported in Table 3. As presented in Table 3, the average water-levels indicate that conditions in the field did not change significantly, however, model estimated values differ significantly (by over 12 feet). Such a difference in the model estimates can be explained by the difference in values of pumping and recharge used in the model and those occurring in the field for the period between the years 2000 and 2010. It is important to note here that the groundwater availability model for Groundwater Management Area 16 was constructed using the confined aquifer assumption (and LAYCON=0 option) available within MODFLOW-96. Such an assumption leads to an almost linear response between pumping and drawdown. The Groundwater Division checked and verified the validity of the assumption by taking out the pumping input in the model from the years 2000 to 2010 and obtaining equivalent drawdown values in the year 2060. Based on the analysis, we conclude that the submitted model files are acceptable for developing estimates of modeled available groundwater. Please note that the confined aquifer assumption may also lead to physically unrealistic conditions with pumping in a model cell continuing even when water levels have dropped below the base of the model cell.
- Drawdown averages and modeled available groundwater values are based on official aquifer boundaries (Figures 1 and 2).
- Drawdown values for cells with water levels below the base elevation of the cell ("dry" cells) were excluded from the averaging. However, pumping values from those cells were included in the calculation of modeled available groundwater.
- Estimates of modeled available groundwater from the model simulation were rounded to whole numbers.
- Average drawdown per county may include some model cells that represent portions of surface water such as bays, reservoirs, and the Gulf of Mexico.

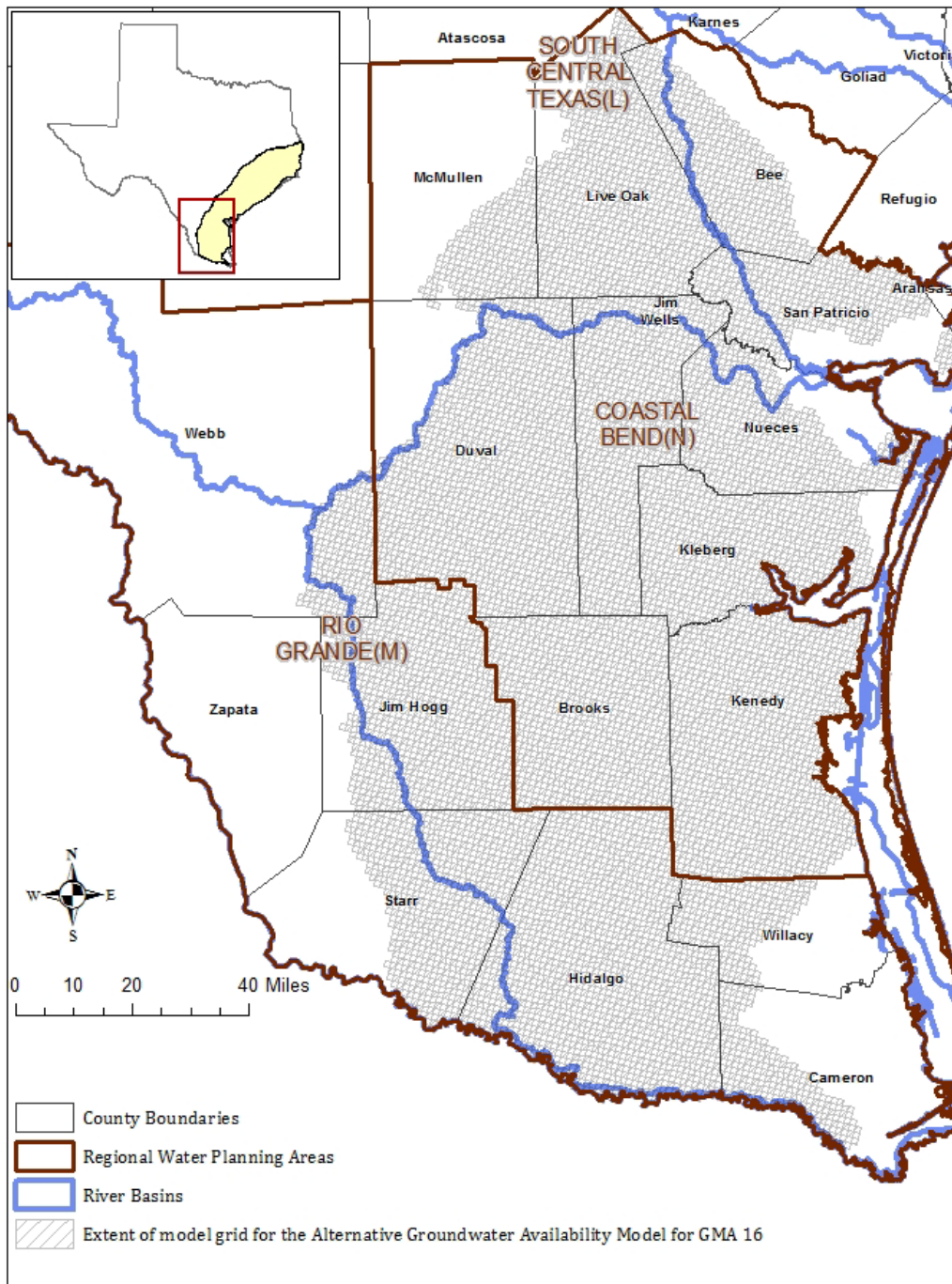
## ***RESULTS:***

The modeled available groundwater for the Gulf Coast Aquifer System that achieves the desired future conditions adopted by Groundwater Management Area 16 increases from approximately 233,000 acre-feet per year in 2020 to 312,000 acre-feet per year in 2060 (Tables 1 and 2). The modeled available groundwater is summarized by groundwater conservation district and county (Table 1) and by county, river basin, and regional water

planning area for use in the regional water planning process (Table 2). Small differences of values between table summaries are due to rounding errors.



**FIGURE 1. MAP SHOWING GROUNDWATER CONSERVATION DISTRICTS (GCDs), COUNTIES, AND GULF COAST AQUIFER SYSTEM EXTENT IN GROUNDWATER MANAGEMENT AREA 16 OVERLAIN ON THE EXTENT OF THE ALTERNATIVE GROUNDWATER AVAILABILITY MODEL FOR GROUNDWATER MANAGEMENT AREA 16.**



**FIGURE 2. MAP SHOWING THE EXTENT OF THE GULF COAST AQUIFER SYSTEM, REGIONAL WATER PLANNING AREAS, COUNTIES, AND RIVER BASINS IN GROUNDWATER MANAGEMENT AREA 16 OVERLAIN ON THE EXTENT OF THE ALTERNATIVE GROUNDWATER AVAILABILITY MODEL FOR GROUNDWATER MANAGEMENT AREA 16.**

**TABLE 1. MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 16  
 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2010 AND 2060.  
 VALUES ARE IN ACRE-FEET PER YEAR.**

<b>Groundwater Conservation District (GCD)</b>	<b>County</b>	<b>Aquifer</b>	<b>2010</b>	<b>2020</b>	<b>2030</b>	<b>2040</b>	<b>2050</b>	<b>2060</b>
<b>Bee GCD</b>	<b>Bee</b>	<b>Gulf Coast Aquifer System</b>	<b>7,689</b>	<b>8,971</b>	<b>10,396</b>	<b>11,061</b>	<b>11,392</b>	<b>11,584</b>
Brush Country GCD	Brooks	Gulf Coast Aquifer System	3,657	3,657	3,657	3,657	3,657	3,657
Brush Country GCD	Hidalgo	Gulf Coast Aquifer System	131	131	131	131	131	131
Brush Country GCD	Jim Hogg	Gulf Coast Aquifer System	6,174	6,174	6,174	6,174	6,174	6,174
Brush Country GCD	Jim Wells	Gulf Coast Aquifer System	4,220	8,710	9,075	9,403	9,768	10,060
<b>Brush Country GCD</b>		<b>Gulf Coast Aquifer System</b>	<b>14,182</b>	<b>18,672</b>	<b>19,037</b>	<b>19,365</b>	<b>19,730</b>	<b>20,022</b>
<b>Corpus Christi ASRCD</b>	<b>Nueces</b>	<b>Gulf Coast Aquifer System</b>	<b>328</b>	<b>342</b>	<b>356</b>	<b>370</b>	<b>384</b>	<b>398</b>
<b>Duval County GCD</b>	<b>Duval</b>	<b>Gulf Coast Aquifer System</b>	<b>18,973</b>	<b>20,571</b>	<b>22,169</b>	<b>23,764</b>	<b>25,363</b>	<b>26,963</b>
Kenedy County GCD	Brooks	Gulf Coast Aquifer System	1,155	1,925	2,695	3,465	4,235	4,235
Kenedy County GCD	Willacy	Gulf Coast Aquifer System	289	482	674	867	1,060	1,060
Kenedy County GCD	Hidalgo	Gulf Coast Aquifer System	364	607	849	1,092	1,335	1,335
Kenedy County GCD	Jim Wells	Gulf Coast Aquifer System	261	434	608	783	957	957
Kenedy County GCD	Nueces	Gulf Coast Aquifer System	151	251	351	452	552	552
Kenedy County GCD	Kenedy	Gulf Coast Aquifer System	7,981	13,301	18,621	23,941	29,261	29,261
Kenedy County GCD	Kleberg	Gulf Coast Aquifer System	3,788	6,314	8,839	11,364	13,889	13,889
<b>Kenedy County GCD</b>		<b>Gulf Coast Aquifer System</b>	<b>13,989</b>	<b>23,314</b>	<b>32,637</b>	<b>41,964</b>	<b>51,289</b>	<b>51,289</b>
<b>Live Oak UWCD</b>	<b>Live Oak</b>	<b>Gulf Coast Aquifer System</b>	<b>6,556</b>	<b>8,338</b>	<b>9,343</b>	<b>8,564</b>	<b>8,441</b>	<b>8,441</b>
<b>McMullen GCD</b>	<b>McMullen</b>	<b>Gulf Coast Aquifer System</b>	<b>510</b>	<b>510</b>	<b>510</b>	<b>510</b>	<b>510</b>	<b>510</b>
<b>Red Sands GCD</b>	<b>Hidalgo</b>	<b>Gulf Coast Aquifer System</b>	<b>1,368</b>	<b>1,667</b>	<b>1,966</b>	<b>2,265</b>	<b>2,563</b>	<b>2,863</b>
<b>San Patricio County GCD</b>	<b>San Patricio</b>	<b>Gulf Coast Aquifer System</b>	<b>14,201</b>	<b>43,611</b>	<b>45,016</b>	<b>46,422</b>	<b>47,828</b>	<b>49,234</b>
<b>Starr County GCD</b>	<b>Starr</b>	<b>Gulf Coast Aquifer System</b>	<b>2,742</b>	<b>3,722</b>	<b>4,701</b>	<b>5,681</b>	<b>6,659</b>	<b>7,639</b>
No District-Bee	Bee	Gulf Coast Aquifer System	0	0	0	0	0	0
No District-Cameron	Cameron	Gulf Coast Aquifer System	5,378	6,688	7,999	9,311	10,620	11,932
No District-Hidalgo	Hidalgo	Gulf Coast Aquifer System	15,908	85,634	90,905	96,175	101,445	106,715

<b>Groundwater Conservation District (GCD)</b>	<b>County</b>	<b>Aquifer</b>	<b>2010</b>	<b>2020</b>	<b>2030</b>	<b>2040</b>	<b>2050</b>	<b>2060</b>
No District-Jim Wells	Jim Wells	Gulf Coast Aquifer System	0	0	0	0	0	0
No District-Kleberg	Kleberg	Gulf Coast Aquifer System	3,857	4,051	4,243	4,436	4,629	4,822
No District-Nueces	Nueces	Gulf Coast Aquifer System	5,753	5,996	6,240	6,487	6,731	6,974
No District-Webb	Webb	Gulf Coast Aquifer System	450	620	789	959	1,129	1,299
No District-Willacy	Willacy	Gulf Coast Aquifer System	544	664	785	905	1,024	1,145
<b>No District-Total</b>		<b>Gulf Coast Aquifer System</b>	<b>31,890</b>	<b>103,653</b>	<b>110,961</b>	<b>118,273</b>	<b>125,578</b>	<b>132,887</b>
<b>GMA 16 Total</b>		<b>Gulf Coast Aquifer System</b>	<b>112,428</b>	<b>233,371</b>	<b>257,092</b>	<b>278,239</b>	<b>299,737</b>	<b>311,830</b>

**TABLE 2. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE GULF COAST AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 16. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), RIVER BASIN, AND AQUIFER.**

County	RWPA	River Basin	Aquifer	2020	2030	2040	2050	2060
Bee	N	Nueces	Gulf Coast Aquifer System	770	893	949	978	995
Bee	N	San Antonio-Nueces	Gulf Coast Aquifer System	8,201	9,503	10,112	10,414	10,589
Brooks	N	Nueces-Rio Grande	Gulf Coast Aquifer System	5,582	6,352	7,122	7,892	7,892
Cameron	M	Nueces-Rio Grande	Gulf Coast Aquifer System	6,301	7,536	8,771	10,005	11,241
Cameron	M	Rio Grande	Gulf Coast Aquifer System	387	463	540	615	691
Duval	N	Nueces	Gulf Coast Aquifer System	326	351	376	401	428
Duval	N	Nueces-Rio Grande	Gulf Coast Aquifer System	20,245	21,818	23,388	24,962	26,535
Hidalgo	M	Nueces-Rio Grande	Gulf Coast Aquifer System	86,405	91,810	97,216	102,620	107,784
Hidalgo	M	Rio Grande	Gulf Coast Aquifer System	1,634	2,041	2,447	2,854	3,260
Jim Hogg	M	Nueces-Rio Grande	Gulf Coast Aquifer System	5,236	5,236	5,236	5,236	5,236
Jim Hogg	M	Rio Grande	Gulf Coast Aquifer System	938	938	938	938	938
Jim Wells	N	Nueces	Gulf Coast Aquifer System	593	593	593	593	593
Jim Wells	N	Nueces-Rio Grande	Gulf Coast Aquifer System	8,551	9,090	9,593	10,132	10,424
Kenedy	N	Nueces-Rio Grande	Gulf Coast Aquifer System	13,301	18,621	23,941	29,261	29,261
Kleberg	N	Nueces-Rio Grande	Gulf Coast Aquifer System	10,365	13,082	15,800	18,518	18,711
Live Oak	N	Nueces	Gulf Coast Aquifer System	8,297	9,297	8,522	8,400	8,400
Live Oak	N	San Antonio-Nueces	Gulf Coast Aquifer System	41	46	42	41	41
McMullen	N	Nueces	Gulf Coast Aquifer System	510	510	510	510	510
Nueces	N	Nueces-Rio Grande	Gulf Coast Aquifer System	5,862	6,191	6,522	6,851	7,079
Nueces	N	Nueces	Gulf Coast Aquifer System	727	756	787	816	845
Nueces	N	San Antonio-Nueces	Gulf Coast Aquifer System	0	0	0	0	0
San Patricio	N	Nueces	Gulf Coast Aquifer System	4,130	4,502	4,874	5,247	5,619
San Patricio	N	San Antonio-Nueces	Gulf Coast Aquifer System	39,481	40,514	41,548	42,581	43,615
Starr	M	Nueces-Rio Grande	Gulf Coast Aquifer System	1,497	1,891	2,285	2,678	3,072



<b>County</b>	<b>RWPA</b>	<b>River Basin</b>	<b>Aquifer</b>	<b>2020</b>	<b>2030</b>	<b>2040</b>	<b>2050</b>	<b>2060</b>
Starr	M	Rio Grande	Gulf Coast Aquifer System	2,225	2,810	3,396	3,981	4,567
Webb	M	Rio Grande	Gulf Coast Aquifer System	98	125	152	179	206
Webb	M	Nueces	Gulf Coast Aquifer System	18	22	27	32	37
Webb	M	Nueces-Rio Grande	Gulf Coast Aquifer System	504	642	780	918	1,056
Willacy	M	Nueces-Rio Grande	Gulf Coast Aquifer System	1,146	1,459	1,772	2,084	2,205
<b>GMA 16-Total</b>			<b>Gulf Coast Aquifer System</b>	<b>233,371</b>	<b>257,092</b>	<b>278,239</b>	<b>299,737</b>	<b>311,830</b>

**TABLE 3. COMPARISON OF MEASURED AND MODELED WATER-LEVELS AVERAGED OVER GROUNDWATER MANAGEMENT AREA 16 FROM THE DECADAL YEARS 2000 AND 2010. VALUES OF FIELD MEASURED WATER-LEVELS WERE OBTAINED FROM THE TWDB GROUNDWATER DATABASE (GWDB).**

<b>Average water levels in Groundwater Management Area 16 (in feet above mean sea level)</b>		
	<b>Year 2000</b>	<b>Year 2010</b>
<b>Field measurements (GWDB)</b>	114.1	114.4
<b>Model estimated</b>	119.5	107.1

### ***LIMITATIONS:***

The groundwater model used in completing this analysis is the best available scientific tool that can be used to meet the stated objectives. To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

“Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results.”

A key aspect of using the groundwater model to evaluate historic groundwater flow conditions includes the assumptions about the location in the aquifer where historic pumping was placed. Understanding the amount and location of historic pumping is as important as evaluating the volume of groundwater flow into and out of the district, between aquifers within the district (as applicable), interactions with surface water (as applicable), recharge to the aquifer system (as applicable), and other metrics that describe the impacts of that pumping. In addition, assumptions regarding precipitation, recharge, and streamflow are specific to a particular historic time period.

Because the application of the groundwater model was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations relating to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor groundwater pumping and groundwater levels in the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

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