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 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 August 19, 2020, by unanimous consent. In addition, a certified copy of the LOUWCD Board of Directors resolution adopting the plan is also attached. This plan was adopted at the regular meeting of the LOUWCD August 19, 2020, 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 TWC 36.1071 (a) and 31 TAC 356. Documentation of this coordinated effort is included in the packet for your review.

The rules of LOUWCD are available at our website which is www.louwcd.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, Stanley Schilling , and James Pawlik, 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 not estimated 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 brackish in quality for municipal, industrial, and irrigation uses. However, because better water is not available in most areas in the county, brackish 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 streams, 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, the Choke Canyon reservoir 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 from the latest version of the TWDB Estimated Historical Water Use/2017 State Water Plan, estimates of the projected total demand, projected surface water supply, water supply needs, and water management strategies from the 2017 State Water Plan. (See Appendix A) The District considered the water supply needs and water management strategies included in the state water plan. There are not any projected water supply needs identified for Live Oak County. The District considered the demand reduction for the municipalities. For additional information see Appendix A

Groundwater Availability Modeling Information

This information came from the TWDB GAM run 19-019. The TWDB GAM run 19-019 report is included in Appendix A and presents estimated data values for recharge, discharge, and volume of flow into the district, out of the district, and between aquifers.

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 Texas Water Code 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, 2020. 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 January 17, 2017, and declared all of the other aquifers non-relevant. The desired future condition is 62 feet of drawdown as an average for the entire GMA 16. The desired future condition for Live Oak UWCD is 34 feet of drawdown within the district. The modeled available groundwater, GAM Run 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 District has reviewed the report: Identification of the Vulnerability of the Major and Minor Aquifers in Texas to Subsidence with regard to Groundwater Pumping – TWDB Contract Number 1648302062 by LRE Water: http://www.twdb.texas.gov/groundwater/models/research/subsidence/subsidence.asp. Due to the amount of current pumping, subsidence is not expected to occur. This management goal is not applicable to the operations of the District.

Goal 4.0: Addressing Conjunctive surface water management issues

Management Objective:

The District will participate in the regional planning process by attending the Region N regional water planning group meetings to encourage the development of surface water supplies to meet the needs of water user groups within the District. A representative of the District will attend, at least, one meeting of the Region N regional water planning group.

Performance Standard:

The District will attend one meeting of the Region N regional water planning group in , and include the attendee's name in the Annual Report to the Board.

Goal 5.0: Addressing Natural Resource Issues

Management Objective:

The District will investigate issues related to environmental and other concerns that may be affected by a district's groundwater management plan and rules, such as impacts on endangered species, soils, oil and gas production, mining, air and water quality degradation, agriculture, and plant and animal life.

Performance Standard:

The District will discuss any issues concerning the above in the Annual Report to the Board once per year.

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

Performance Standard:

A report of the Palmer Drought Severity Index will be presented to the District board on an annual basis. The link to the Drought index is www.waterdatafortexas.org/drought

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 annually measure the water levels in at least three monitoring wells within the District and will determine the five-year water level averages based on the measurements are 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 measured 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 measurements 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.

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.

RESOLUTION NO. 001-2020

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 19 day of August, 2020.

________________________ Attest by:________________________

Scott Bledsoe III, President Lonnie Stewart, Secretary

Appendix A

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

STATE OF TEXAS
ROHIT R. GOSWAMI
123986
LICENSED
PROFESSIONAL ENGINEER

Goswami
05/19/2017

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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.

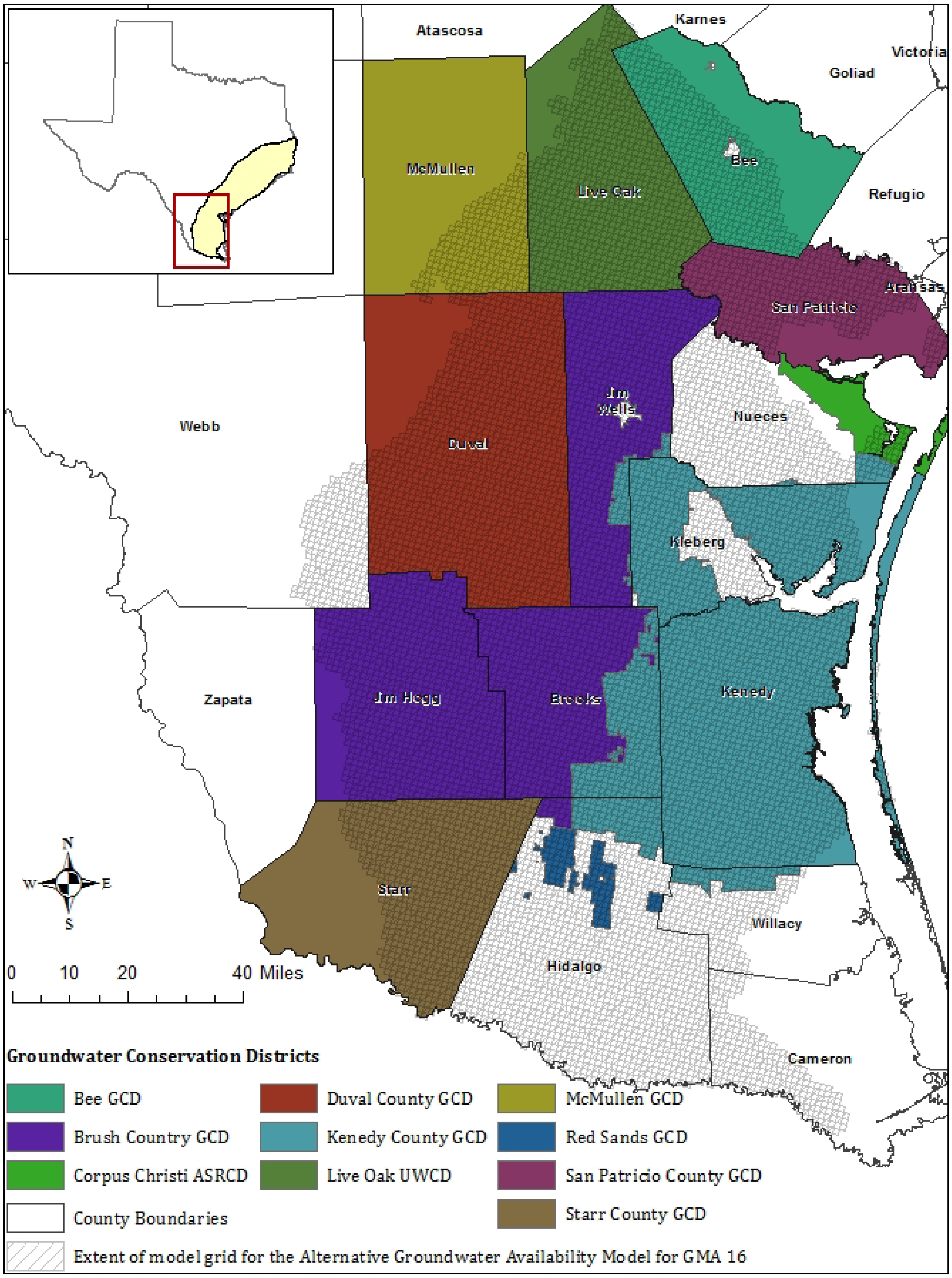

FIGURE 1. MAP SHOWING GROUNDWATER CONSERVATION DISTRICTS (GCDS), COUNTIES, AND GULF COAST AQUIFER SYSTEM EXTENT IN GROUNDWATER MANAGEMENT AREA 16 OVERLAIN ON THE EXTENT OF THE ALTERNATIVE GROUNDWATER AVAILABILITY MODEL FOR GROUNDWATER MANAGEMENT AREA 16.

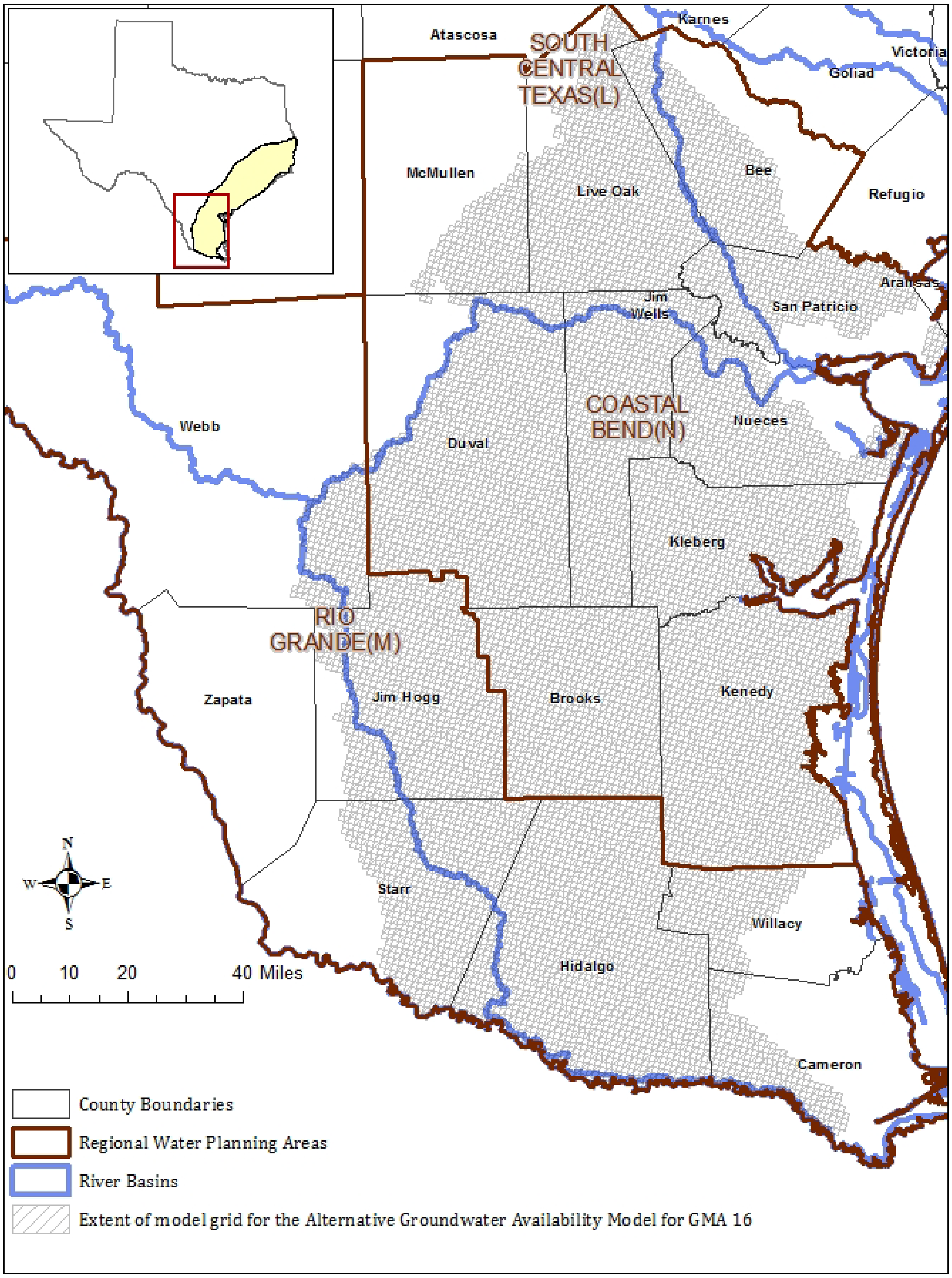

FIGURE 2. **MAP SHOWING THE EXTENT OF THE GULF COAST AQUIFER SYSTEM, REGIONAL WATER PLANNING AREAS, COUNTIES, AND RIVER BASINS IN GROUNDWATER MANAGEMENT AREA 16 OVERLAIN ON THE EXTENT OF THE ALTERNATIVE GROUNDWATER AVAILABILITY MODEL FOR GROUNDWATER MANAGEMENT AREA 16.**

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.

Groundwater Conservation District (GCD)	County	Aquifer	2010	2020	2030	2040	2050	2060
Bee GCD	**Bee**	**Gulf Coast Aquifer System**	**7,689**	**8,971**	**10,396**	**11,061**	**11,392**	**11,584**
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
Brush Country GCD		**Gulf Coast Aquifer System**	**14,182**	**18,672**	**19,037**	**19,365**	**19,730**	**20,022**
Corpus Christi ASRCD	**Nueces**	**Gulf Coast Aquifer System**	**328**	**342**	**356**	**370**	**384**	**398**
Duval County GCD	**Duval**	**Gulf Coast Aquifer System**	**18,973**	**20,571**	**22,169**	**23,764**	**25,363**	**26,963**
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
Kenedy County GCD		**Gulf Coast Aquifer System**	**13,989**	**23,314**	**32,637**	**41,964**	**51,289**	**51,289**
Live Oak UWCD	**Live Oak**	**Gulf Coast Aquifer System**	**6,556**	**8,338**	**9,343**	**8,564**	**8,441**	**8,441**
McMullen GCD	**McMullen**	**Gulf Coast Aquifer System**	**510**	**510**	**510**	**510**	**510**	**510**
Red Sands GCD	**Hidalgo**	**Gulf Coast Aquifer System**	**1,368**	**1,667**	**1,966**	**2,265**	**2,563**	**2,863**
San Patricio County GCD	**San Patricio**	**Gulf Coast Aquifer System**	**14,201**	**43,611**	**45,016**	**46,422**	**47,828**	**49,234**
Starr County GCD	**Starr**	**Gulf Coast Aquifer System**	**2,742**	**3,722**	**4,701**	**5,681**	**6,659**	**7,639**
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

Groundwater Conservation District (GCD)	County	Aquifer	2010	2020	2030	2040	2050	2060
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
No District-Total		**Gulf Coast Aquifer System**	**31,890**	**103,653**	**110,961**	**118,273**	**125,578**	**132,887**
GMA 16 Total		**Gulf Coast Aquifer System**	**112,428**	**233,371**	**257,092**	**278,239**	**299,737**	**311,830**

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

County	RWPA	River Basin	Aquifer	2020	2030	2040	2050	2060
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
GMA 16-Total			**Gulf Coast Aquifer System**	**233,371**	**257,092**	**278,239**	**299,737**	**311,830**

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).

Average water levels in Groundwater Management Area 16 (in feet above mean sea level)		
	Year 2000	**Year 2010**
Field measurements (GWDB)	114.1	114.4
Model estimated	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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GAM Run 19-019: Live Oak Underground Water Conservation District Management Plan

By Andrew Denham and Shirley C. Wade, Ph.D., P.G.
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September 4, 2019

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Cynthia K. Ridgeway is the manager of the Groundwater Availability Department and is responsible for the oversight of work performed by Andrew Denham under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on September 4, 2019.

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GAM RUN 19-019: LIVE OAK UNDERGROUND WATER CONSERVATION DISTRICT MANAGEMENT PLAN

By Andrew Denham and Shirley C. Wade, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
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(512) 936-0883
September 4, 2019

EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h) (Texas Water Code, 2011), states that, in developing its groundwater management plan, a groundwater conservation district shall use groundwater availability modeling information provided by the Executive Administrator of the Texas Water Development Board (TWDB) in conjunction with any available site-specific information provided by the district for review and comment to the Executive Administrator.

The TWDB provides data and information to the Live Oak Underground Water Conservation District in two parts. Part 1 is the Estimated Historical Water Use/State Water Plan dataset report, which will be provided to you separately by the TWDB Groundwater Technical Assistance Department. Please direct questions about the water data report to Mr. Stephen Allen at 512-463-7317 or stephen.allen@twdb.texas.gov. Part 2 is the required groundwater availability modeling information and this information includes:

1. the annual amount of recharge from precipitation, if any, to the groundwater resources within the district;
2. for each aquifer within the district, the annual volume of water that discharges from the aquifer to springs and any surface-water bodies, including lakes, streams, and rivers; and
3. the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

The groundwater management plan for the Live Oak Underground Water Conservation District should be adopted by the district on or before June 17, 2020 and submitted to the executive administrator of the TWDB on or before July 17, 2020. The current management plan for the Live Oak Underground Water Conservation District expires on September 15, 2020.

We used three groundwater availability models to estimate the management plan information for the aquifers within the Live Oak Underground Water Conservation District. Information for the Carrizo-Wilcox Aquifer is from version 2.01 of the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers (Kelley and others, 2004). Information for the Yegua-Jackson Aquifer is from version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer (Deeds and others, 2010). Information for the Gulf Coast Aquifer System is from version 1.01 of the groundwater availability model for the central portion of the Gulf Coast Aquifer System (Chowdhury and others, 2004).

This report replaces the results of GAM Run 14-014 (Wade, 2014), as the approach used for analyzing model results has been since refined to more accurately delineate flows between hydraulically connected units. Tables 1, 2, and 3 summarize the groundwater availability model data required by statute and Figures 1, 2, and 3 show the area of the models from which the values in the tables were extracted. If, after review of the figures, the Live Oak Underground Water Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB at your earliest convenience.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability models mentioned above were used to estimate information for the Live Oak Underground Water Conservation District management plan. Water budgets were extracted for the Carrizo-Wilcox Aquifer (1980-1999), Yegua-Jackson Aquifer (1980-1997), and Gulf Coast Aquifer System (1981-1999). We used ZONEBUDGET Version 3.01 (Harbaugh, 2009) to extract water budgets from the model results. The average annual water budget values for recharge, surface-water outflow, inflow to the district, and outflow from the district for the aquifers within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Carrizo-Wilcox Aquifer

- We used version 2.01 of the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers. See Deeds and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers.

- This groundwater availability model includes eight layers which generally represent the Sparta Aquifer (Layer 1), the Weches Confining Unit (Layer 2), the Queen City Aquifer (Layer 3), the Reklaw Confining Unit (Layer 4), the Carrizo Aquifer (Layer 5), the Upper Wilcox (Layer 6), the Middle Wilcox (Layer 7), and the Lower Wilcox (Layer 8). The Sparta Aquifer (Layer 1), and Queen City Aquifer (Layer 3) are not present in Live Oak Underground Water Conservation District. Water budgets were extracted collectively for the Carrizo-Wilcox Aquifer (Layer 5 through Layer 8).

- Groundwater in the Carrizo-Wilcox, Queen City, and Sparta aquifers ranges from fresh to brackish in composition (Kelley and others, 2004). Groundwater with total dissolved solids of less than 1,000 milligrams per liter are considered fresh and total dissolved solids of 1,000 to 10,000 milligrams per liter are considered brackish.

- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

Yegua-Jackson Aquifer

- We used version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer. See Deeds and others (2010) for assumptions and limitations of the groundwater availability model.

- This groundwater availability model includes five layers which represent the outcrop section for the Yegua-Jackson Aquifer and younger overlying units (Layer 1), the upper portion of the Jackson Group (Layer 2), the lower portion of the Jackson Group (Layer 3), the upper portion of the Yegua Group (Layer 4), and the lower portion of the Yegua Group (Layer 5).

- An overall water budget for the District was determined for the Yegua-Jackson Aquifer (Layer 1 through Layer 5 collectively for the portions of the model that represent the Yegua-Jackson Aquifer). The net flow between aquifers within the district were determined by separating Layer 1 from the combined Layers of 2 through 5 from portions outside of the Yegua-Jackson Aquifer outcrop areas.

- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

Gulf Coast Aquifer System

- We used version 1.01 of the groundwater availability model for the central portion of the Gulf Coast Aquifer for this analysis. See Chowdhury and others (2004) and Waterstone and others (2003) for assumptions and limitations of the groundwater availability model.

- The model for the central portion of the Gulf Coast Aquifer assumes partially penetrating wells in the Evangeline Aquifer due to a lack of data for aquifer properties in the deeper section of the aquifer located closer to the Gulf of Mexico.

- This groundwater availability model includes four layers, which generally represent the Chicot Aquifer (Layer 1), the Evangeline Aquifer (Layer 2), the Burkeville Confining Unit (Layer 3), and the Jasper Aquifer including parts of the Catahoula Formation (Layer 4).

- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

- Because this model assumes a no-flow boundary condition at the base of the Gulf Coast Aquifer System, we used version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer to investigate groundwater flows between parts of the Catahoula Formation in direct hydrologic communication with the Gulf Coast Aquifer System and the Yegua-Jackson Aquifer and its equivalent downdip Yegua-Jackson confined units. See Deeds and others (2010) for assumptions and limitations of the groundwater availability model for the Yegua-Jackson Aquifer.

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the model results for the aquifers located within the district and averaged over the historical calibration periods, as shown in Tables 1, 2, and 3.

1. Precipitation recharge—the areally distributed recharge sourced from precipitation falling on the outcrop areas of the aquifers (where the aquifer is exposed at land surface) within the district.

2. Surface-water outflow—the total water discharging from the aquifer (outflow) to surface-water features such as streams, reservoirs, and springs.

3. Flow into and out of district—the lateral flow within the aquifer between the district and adjacent counties.

4. Flow between aquifers—the net vertical flow between the aquifer and adjacent aquifers or confining units. This flow is controlled by the relative water levels in each aquifer and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs.

The information needed for the district's management plan is summarized in Tables 1, 2, and 3. It is important to note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double accounting, a model cell that straddles a political boundary, such as a district or county boundary, is assigned to one side of the boundary based on the location of the centroid of the model cell. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located.

TABLE 1: SUMMARIZED INFORMATION FOR THE CARRIZO-WILCOX AQUIFER THAT IS NEEDED FOR THE LIVE OAK UNDERGROUND WATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Carrizo-Wilcox Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Carrizo-Wilcox Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Carrizo-Wilcox Aquifer	1,390
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo-Wilcox Aquifer	1,367
Estimated net annual volume of flow between each aquifer in the district	To the Carrizo-Wilcox Aquifer from the down-dip portions of the equivalent formations	33
	To the Reklaw confining unit from the Carrizo-Wilcox Aquifer	70

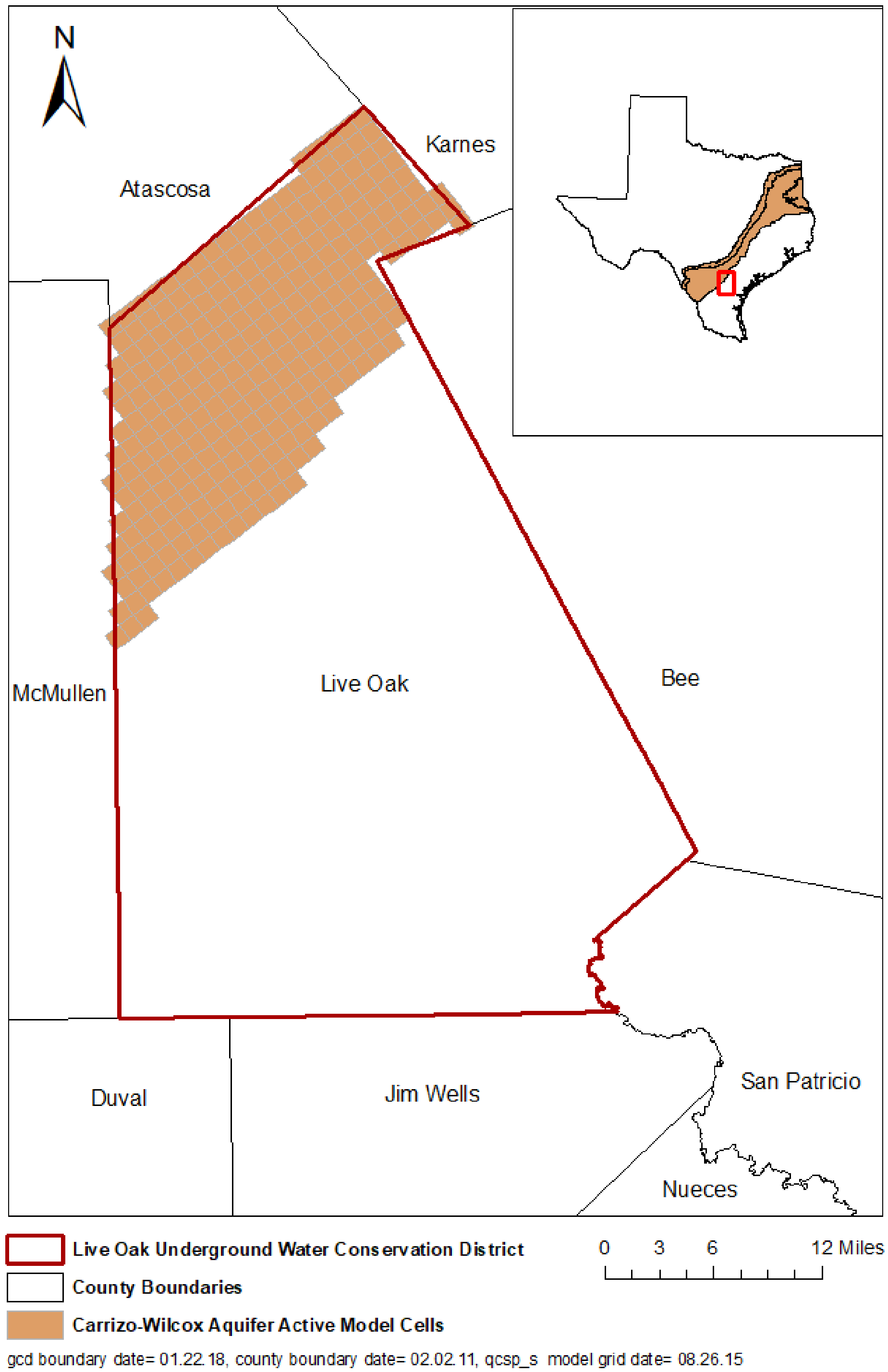

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE CARRIZO-WILCOX AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE YEGUA-JACKSON AQUIFER THAT IS NEEDED FOR THE LIVE OAK UNDERGROUND WATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Yegua-Jackson Aquifer	618
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Yegua-Jackson Aquifer	859
Estimated annual volume of flow into the district within each aquifer in the district	Yegua-Jackson Aquifer	798
Estimated annual volume of flow out of the district within each aquifer in the district	Yegua-Jackson Aquifer	585
Estimated net annual volume of flow between each aquifer in the district	Into the confined Yegua-Jackson units from the Yegua-Jackson Aquifer	13
	Into Yegua-Jackson Aquifer from the Catahoula Formation[1]	7
	Into the Catahoula Formation from the confined Yegua-Jackson units[2]	273

[1] The Catahoula Formation within and near its outcrop is considered part of the Gulf Coast Aquifer System by the TWDB. Flow values from the Catahoula Formation outcrop portion of the Gulf Coast Aquifer System into the Yegua-Jackson Aquifer were extracted from the groundwater availability model for the Yegua-Jackson Aquifer.

[2] Deeper parts of the Catahoula Formation in direct hydrologic communication with the Gulf Coast Aquifer System provide a semi-confined boundary between the Gulf Coast Aquifer system and the underlying confined Yegua-Jackson units (not considered part of the Yegua-Jackson Aquifer by the TWDB). Flow values from the Catahoula Formation in direct hydrologic communication with the Gulf Coast Aquifer System and into the confined Yegua-Jackson units were extracted from the groundwater availability model for the Yegua-Jackson Aquifer.

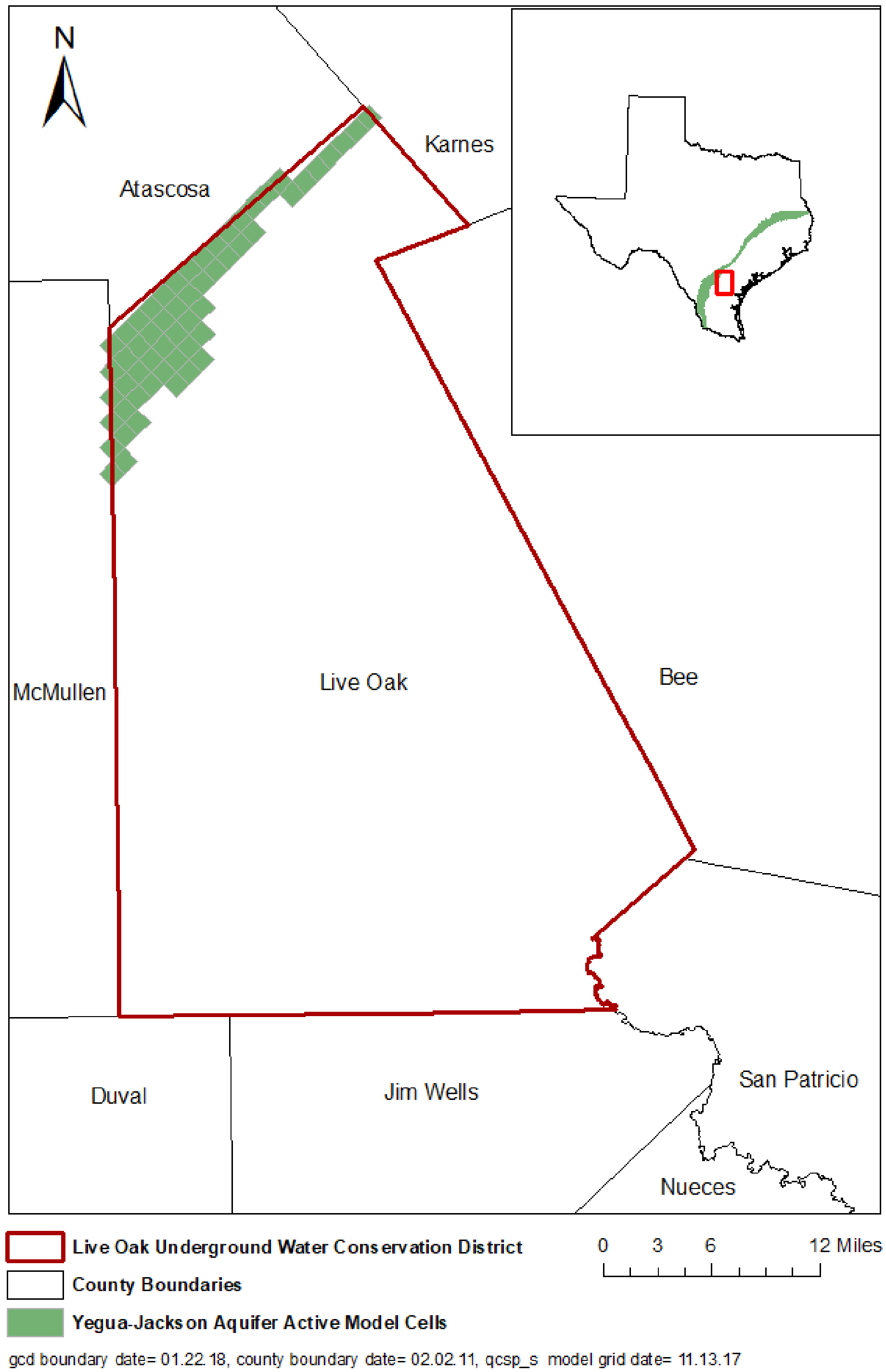

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE YEGUA-JACKSON AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE YEGUA-JACKSON AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 3: SUMMARIZED INFORMATION FOR THE GULF COAST AQUIFER SYSTEM THAT IS NEEDED FOR THE LIVE OAK UNDERGROUND WATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Gulf Coast Aquifer System	5,487
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Gulf Coast Aquifer System	10,378
Estimated annual volume of flow into the district within each aquifer in the district	Gulf Coast Aquifer System	4,124
Estimated annual volume of flow out of the district within each aquifer in the district	Gulf Coast Aquifer System	1,572
Estimated net annual volume of flow between each aquifer in the district	From the Catahoula Formation into Yegua-Jackson Aquifer[1]	7
	From the confined Yegua-Jackson units into the Catahoula Formation[2]	273

[1] The Catahoula Formation within and near its outcrop is considered part of the Gulf Coast Aquifer System by the TWDB. Flow values from the Catahoula Formation outcrop portion of the Gulf Coast Aquifer System into the Yegua-Jackson Aquifer were extracted from the groundwater availability model for the Yegua-Jackson Aquifer.

[2] Deeper parts of the Catahoula Formation in direct hydrologic communication with the Gulf Coast Aquifer System provide a semi-confined boundary between the Gulf Coast Aquifer System and the underlying confined Yegua-Jackson units (not considered part of the Yegua-Jackson Aquifer by the TWDB). Flow values from the Catahoula Formation in direct hydrologic communication with the Gulf Coast Aquifer System and into the confined Yegua-Jackson units were extracted from the groundwater availability model for the Yegua-Jackson Aquifer.

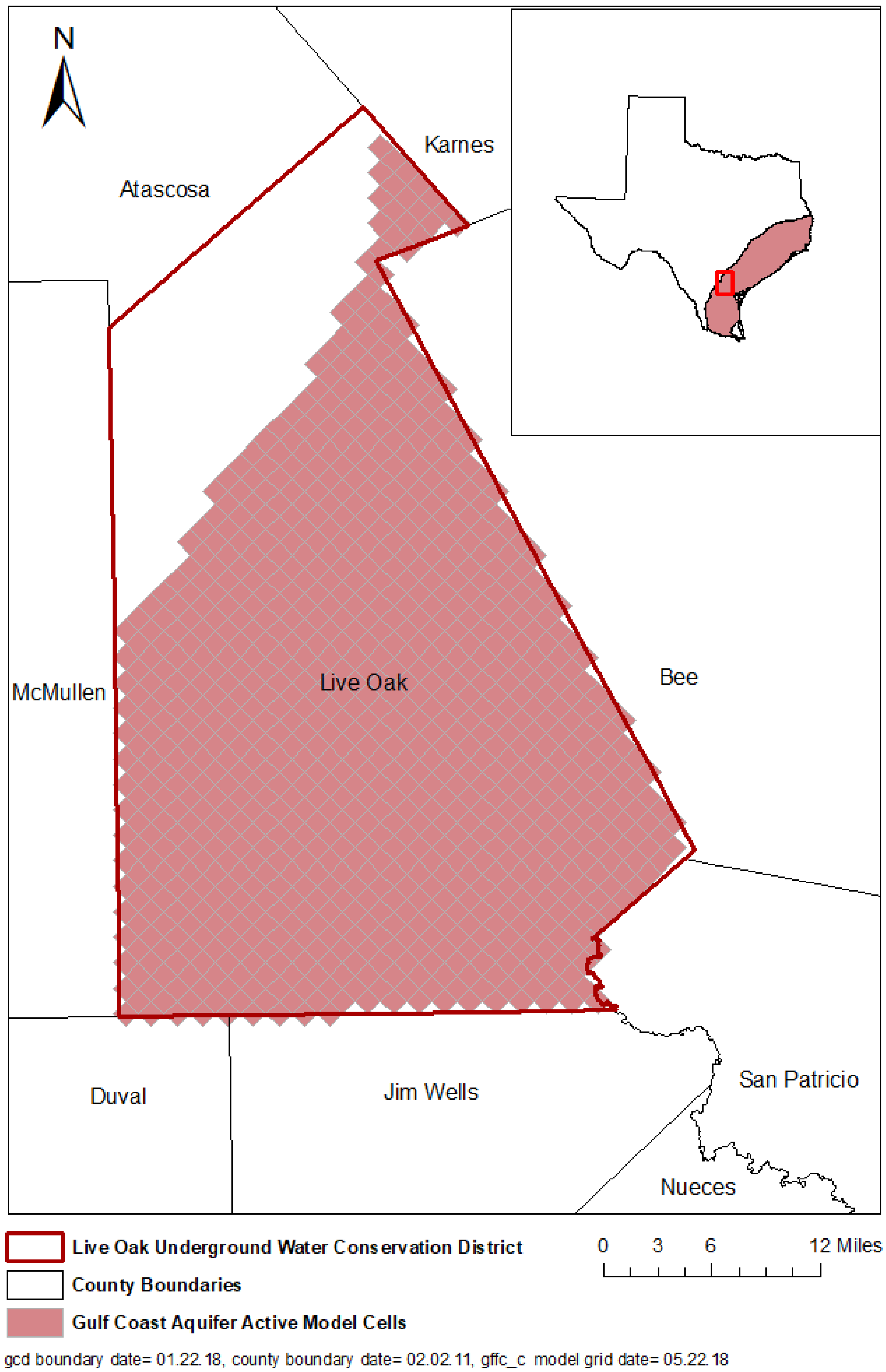

FIGURE 3: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PORTION OF THE GULF COAST AQUIFER SYSTEM FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (THE GULF COAST AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

LIMITATIONS:

The groundwater models 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 interaction with streams are specific to particular historic time periods.

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It is important for groundwater conservation districts to monitor groundwater pumping and overall conditions of 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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Estimated Historical Water Use And 2017 State Water Plan Datasets:

Live Oak Underground Water Conservation District

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May 15, 2020

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 this part 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)

   from the 2017 Texas State Water Plan (SWP)

Part 2 of the 2-part package is the groundwater availability model (GAM) report for the District (checklist items 3 through 5). 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 2017 SWP data available as of 5/15/2020. Although it does not happen frequently, either of these datasets are subject to change pending the availability of more accurate WUS data or an amendment to the 2017 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 2017 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).

Estimated Historical Water Use
TWDB Historical Water Use Survey (WUS) Data

Groundwater and surface water historical use estimates are currently unavailable for calendar year 2018. TWDB staff anticipates the calculation and posting of these estimates at a later date.

LIVE OAK COUNTY

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2017	GW	921	1,312	763	0	696	428	4,120
	SW	929	878	85	0	0	183	2,075
2016	GW	905	947	593	0	695	459	3,599
	SW	842	1,332	66	0	369	197	2,806
2015	GW	1,156	912	904	0	301	530	3,803
	SW	917	1,231	100	0	658	227	3,133
2014	GW	1,291	896	1,615	0	651	573	5,026
	SW	553	1,256	179	0	507	246	2,741
2013	GW	1,042	965	1,433	0	806	451	4,697
	SW	508	1,309	159	0	520	193	2,689
2012	GW	1,073	904	1,604	0	841	476	4,898
	SW	631	1,335	178	0	579	204	2,927
2011	GW	1,106	619	16	0	1,146	545	3,432
	SW	582	1,364	2	0	484	234	2,666
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

Projected Surface Water Supplies
TWDB 2017 State Water Plan Data

LIVE OAK COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
N	LIVESTOCK, LIVE OAK	NUECES	NUECES LIVESTOCK LOCAL SUPPLY	252	252	252	252	252	252
N	MANUFACTURING, LIVE OAK	NUECES	CORPUS CHRISTI-CHOKE CANYON LAKE/RESERVOIR SYSTEM	3,363	3,363	3,363	3,363	3,363	3,363
N	MANUFACTURING, LIVE OAK	NUECES	NUECES RUN-OF-RIVER	800	800	800	800	800	800
N	THREE RIVERS	NUECES	NUECES RUN-OF-RIVER	700	700	700	700	700	700
	Sum of Projected Surface Water Supplies (acre-feet)			**5,115**	**5,115**	**5,115**	**5,115**	**5,115**	**5,115**

Projected Water Demands
TWDB 2017 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

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
N	COUNTY-OTHER, LIVE OAK	NUECES	802	783	768	760	758	758
N	EL OSO WSC	NUECES	143	139	137	135	129	129
N	GEORGE WEST	NUECES	454	443	433	429	428	428
N	IRRIGATION, LIVE OAK	NUECES	2,200	2,310	2,426	2,547	2,674	2,808
N	LIVESTOCK, LIVE OAK	NUECES	933	933	933	933	933	933
N	MANUFACTURING, LIVE OAK	NUECES	2,024	2,058	2,089	2,114	2,221	2,333
N	MCCOY WSC	NUECES	22	21	21	20	20	20
N	MINING, LIVE OAK	NUECES	814	917	907	729	492	332
N	THREE RIVERS	NUECES	325	316	309	305	305	305
		Sum of Projected Water Demands (acre-feet)	**7,717**	**7,920**	**8,023**	**7,972**	**7,960**	**8,046**

Projected Water Supply Needs
TWDB 2017 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

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
N	COUNTY-OTHER, LIVE OAK	NUECES	200	219	234	242	244	244
N	EL OSO WSC	NUECES	308	312	314	316	322	322
N	GEORGE WEST	NUECES	423	434	444	448	449	449
N	IRRIGATION, LIVE OAK	NUECES	700	590	474	353	226	92
N	LIVESTOCK, LIVE OAK	NUECES	0	0	0	0	0	0
N	MANUFACTURING, LIVE OAK	NUECES	3,030	2,996	2,965	2,940	2,833	2,721
N	MCCOY WSC	NUECES	8	9	9	10	10	10
N	MINING, LIVE OAK	NUECES	106	3	13	191	428	588
N	THREE RIVERS	NUECES	824	833	840	844	844	844
	Sum of Projected Water Supply Needs (acre-feet)		**0**	**0**	**0**	**0**	**0**	**0**

Projected Water Management Strategies
TWDB 2017 State Water Plan Data

LIVE OAK COUNTY

WUG, Basin (RWPG)

All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
EL OSO WSC, NUECES (N)							
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [LIVE OAK]	11	21	28	29	26	28
		11	**21**	**28**	**29**	**26**	**28**
GEORGE WEST, NUECES (N)							
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [LIVE OAK]	15	46	44	40	39	39
		15	**46**	**44**	**40**	**39**	**39**
THREE RIVERS, NUECES (N)							
MUNICIPAL WATER CONSERVATION (RURAL)	DEMAND REDUCTION [LIVE OAK]	11	22	15	15	14	15
		11	**22**	**15**	**15**	**14**	**15**
Sum of Projected Water Management Strategies (acre-feet)		**37**	**89**	**87**	**84**	**79**	**82**