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

Dear Mr. Patteson,

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 July 16, 2015, 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 July 16,2015, 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 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, Edward Pawlik , and Bill Appelt, 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 GR14-014.

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 is 11,434 ac-ft/year from 2020-2060. The source of the data is GAM run 10-047 MAG.

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

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. 001-2015

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_16th day of July 2015.

_____ Attest by:_____

Scott Bledsoe III, President Lonnie Stewart, Secretary

Appendix A

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-fee/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
	Sum of Projected Surface Water Supplies (acre-feet/year)			**5,461**	**5,459**	**5,458**	**5,459**	**5,462**	**5,465**

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
	Sum of Projected Water Demands (acre-feet/year)		**12,535**	**12,956**	**13,084**	**13,073**	**12,939**	**12,858**

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
	Sum of Projected Water Supply Needs (acre-feet/year)		**-1,028**	**-1,562**	**-2,045**	**-2,327**	**-2,577**	**-2,892**

Projected Water Management Strategies
TWDB 2012 State Water Plan Data

LIVE OAK COUNTY

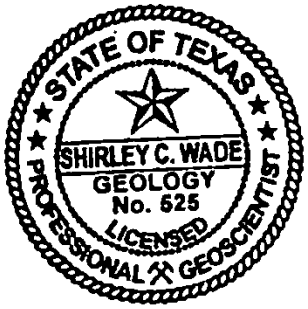
WUG, Basin (RWPG)

All values are in acre-feet/year

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

GAM Run 14-014: Live Oak Underground Water Conservation District Management Plan

by Shirley C. Wade, Ph.D., P.G.
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 936-0883
December 12, 2014



Shirley C. Wade, 12/12/14

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GAM RUN 14-014: LIVE OAK UNDERGROUND WATER CONSERVATION DISTRICT MANAGEMENT PLAN

by Shirley C. Wade, Ph.D., P.G.
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 936-0883
December 12, 2014

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. Information derived from groundwater availability models that shall be included in the groundwater management plan includes:

- the annual amount of recharge from precipitation to the groundwater resources within the district, if any;
- 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
- the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

This report—Part 2 of a two-part package of information from the TWDB to the Live Oak Underground Water Conservation District—fulfills the requirements noted above. Part 1 of the two-part package is the Estimated Historical Water Use/State Water Plan data report. The District will receive this data report from the TWDB Groundwater Technical Assistance Section. Questions about the data report can be directed to Mr. Stephen Allen, stephen.allen@twdb.texas.gov, (512) 463-7317.

The groundwater management plan for the Live Oak Underground Water Conservation District should be adopted by the district on or before August 12, 2015 and submitted to the executive administrator of the TWDB on or before September 11, 2015. The current management plan for the Live Oak Underground Water Conservation District expires on November 10, 2015.

This report discusses the methods, assumptions, and results from model runs using the groundwater availability models for the southern Carrizo-Wilcox, Queen City, and Sparta aquifers (Kelley and others, 2004), the Yegua-Jackson Aquifer (Deeds and others, 2010), and the central portion of the Gulf Coast Aquifer System(Chowdhury and others, 2004). This model run replaces the results of GAM Run 10-010 (Hassan, 2010). GAM Run 14-014 meets current standards set after the release of GAM Run 10-010. Tables 1 through 3 summarize the groundwater availability model data required by statute, and Figures 1 through 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 for the southern Carrizo-Wilcox, Queen City, and Sparta aquifers (Kelley and others, 2004), the Yegua-Jackson Aquifer (Deeds and others, 2010), and the central portion of the Gulf Coast Aquifer System (Chowdhury and others, 2004) were run for this analysis. Live Oak Underground Water Conservation District water budgets were extracted for the historical model period (1980 through 1999) using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The average annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district, net inter-aquifer flow (upper), and net inter-aquifer flow (lower) for the portion of the aquifer located within the district is summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Carrizo-Wilcox, Queen City, and Sparta aquifers

- 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 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).

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 duration of the calibration and verification portion of the model run in the district, as shown in Tables 1, 2, and 3.

- 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.

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

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

- 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 or confining unit and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs. “Inflow” to an aquifer from an overlying or underlying aquifer will always equal the “Outflow” from the other aquifer.

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	1,366
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
	From the Carrizo-Wilcox Aquifer to the overlying Reklaw Confining Unit	70

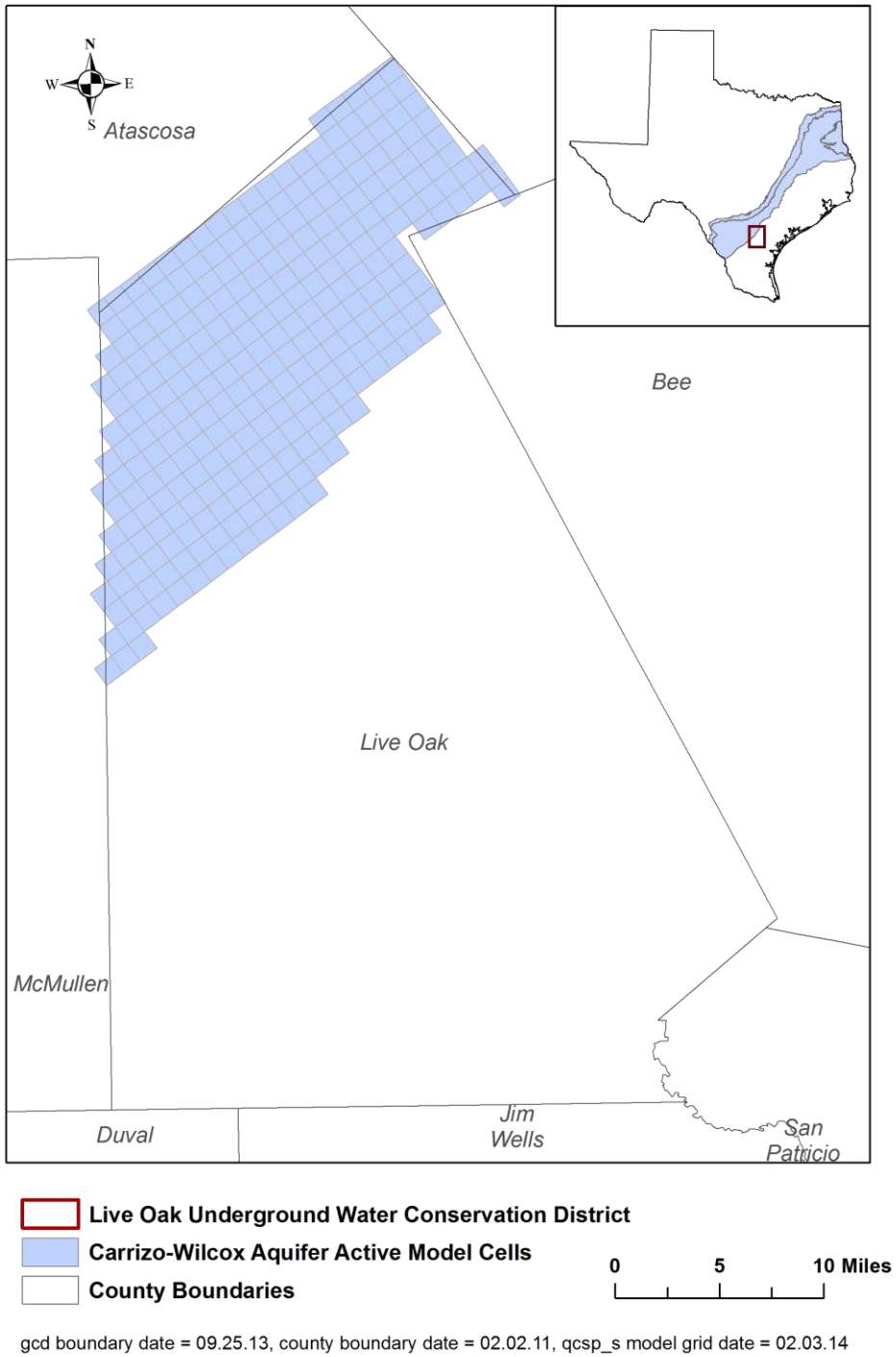

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE CARRIZO-WILCOX AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

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	496
Estimated net annual volume of flow between each aquifer in the district	From the Yegua-Jackson Aquifer to the confined portion of the Yegua and Jackson groups	88

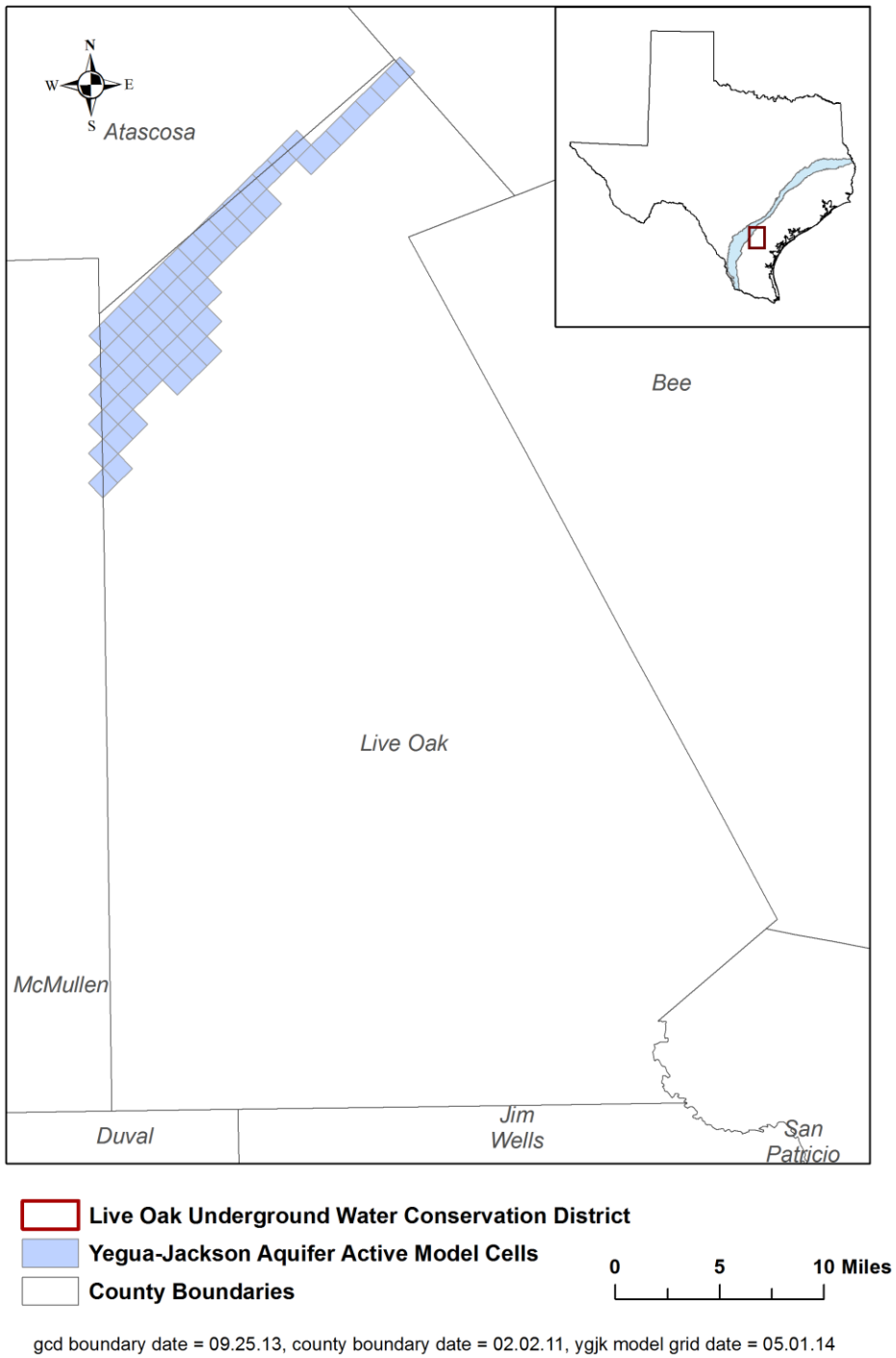

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE YEGUA-JACKSON AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE YEGUA-JACKSON AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

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	To the Gulf Coast Aquifer System from underlying units[1]	273

[1] Estimated from Layer 1 of the Groundwater Availability Model for the Yegua-Jackson Aquifer

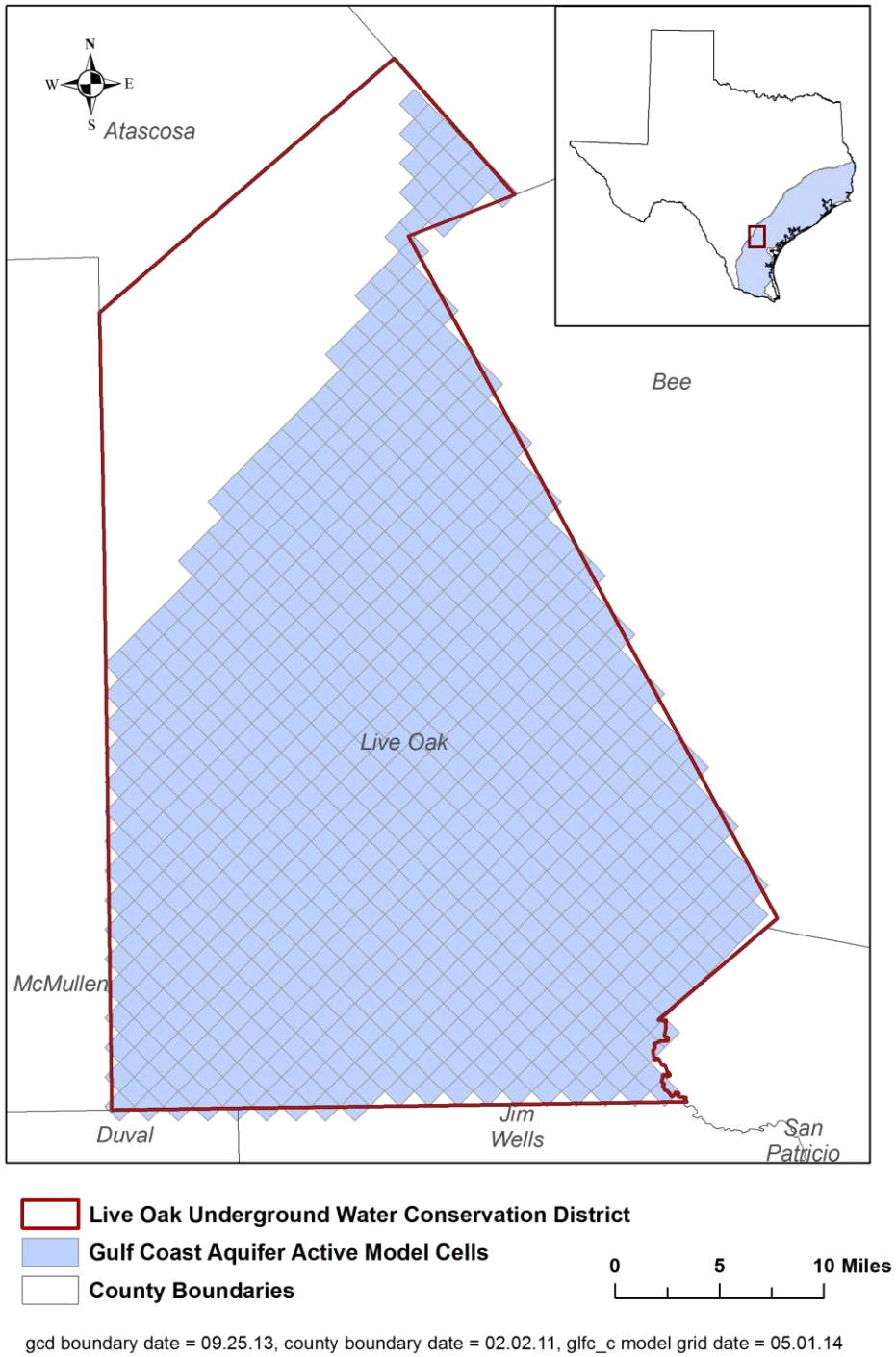

FIGURE 3: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE GULF COAST AQUIFER SYSTEM FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (THE GULF COAST AQUIFER SYSTEM EXTENT WITHIN THE DISTRICT BOUNDARY).

LIMITATIONS:

The groundwater model(s) used in completing this analysis is the best available scientific tool that can be used to meet the stated objective(s). 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.

Because the application of the groundwater models was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations related 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 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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