McMULLEN GROUNDWATER

CONSERVATION DISTRICT

DISTRICT MANAGEMENT

PLAN

MCMULLEN GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN
Adopted July 10, 2013

District Mission

The McMullen Groundwater 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 July, 10, 2023, which ever is earlier. The planning period for the management plan is ten (10) years, but the plan must be updated and approved every five (5) years.

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 McMullen County through an election, January 2001. The current Board of Directors are Harold Jambers, Jr. - Chairman, J.E. Wheeler, Jr.- Vice-Chairman, David Longan – Secretary-Treasurer, Scott Dilworth, and Larry Miles, McMullen Groundwater Conservation District (MGCD) has the same aerial extent as that of McMullen County. The county has a vibrant economy dominated by agriculture and petroleum. The agriculture income is derived primarily from McMullen County is cattle production, wheat, corn, sorghum, and some sheep and goat ranching.

Location and Extent

McMullen County, consisting of 1,159 square miles, is located in South Texas. The county is bounded on the east by Live Oak County, on the north by Atascosa County, on the west by La Salle County, and on the south by Duval County. Tilden, which is centrally located in the county, is the county seat.

Topography, Drainage and Groundwater Recharge

McMullen County is on the Gulf Coastal Plain in southern Texas. Most the 1,159 square miles of the county are devoted to farming and ranching, which provide the principal income for the 851 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, Queen City, and the Sparta Aquifers.
Some livestock supplies were obtained from surface-water sources. Most of McMullen 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 the south end of the county. The county is drained by the Nueces River and the Frio River.
Recharge could be enhanced by several methods: brush control, more precipitation, and more tanks to catch runoff from excessive precipitation.
Surface Water Resources of McMullen County
Limited surface water rights are available within the county, mainly on the Nueces and Frio Rivers. The remaining surface water is impounded in stock tanks for livestock and domestic use.

The Desired Future Conditions for the aquifers in GMA 13 is an average drawdown of 30 feet and modeled available groundwater of 2,045 Ac/Ft. according to GAM run 10-012 MAG. The MAG for Yegua-Jackson is 179 Ac/Ft according to GAM run 10-041 MAG. The Desired Future Condition for the aquifers in GMA 16 is an average drawdown of 10 feet and a modeled available groundwater of 510 Ac/Ft. according to GAM run 10-047 MAG.

The District rules are available at our website: www.mcmullengcd.org.

The groundwater management plan data is provided in Appendix A.
The McMullen Groundwater Conservation District Management Plan data is provided in Appendix A.

Methodology for Tracking the District's Progress in Achieving Management Goals
The District manager will prepare and present an annual report to the District 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 District Board of directors meeting each fiscal year. 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 District 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 District 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 District 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.

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 District adopted rules relating to the permitting of wells and the production of groundwater and are on the website www.mcmullengcd.org. 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.

McMULLEN GROUNDWATER CONSERVATION DISTRICT
MANAGEMENT GOALS AND OBJECTIVES

MISSION STATEMENT

The mission of the McMullen Groundwater 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 number of water level measurements.
(b) The District will investigate all reports of waste of groundwater within five working days. The number of reports of waste as well as the investigation findings will be reported to the District Board in the annual report.

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: 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 for the District.

Goal 5.0: Natural Resource Issues

Management Objective:

The District will cooperate with other interested parties and appropriate agencies to develop additional information on aquifer recharge.

Performance Standard:

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

Goal 6.0: Drought Conditions

Management Objective:

The District will monitor the Palmer Drought Severity Index (PDSI).

Performance Standard:

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

Goal 7.0: Conservation

Management Objective:

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

Performance Objective:

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: Precipitation Enhancement

Management Objective:

The District will participate in the South Texas Weather Modification Program.

Performance Standard:

A district representative will attend a meeting of the South Texas Weather Modification Assn. annually.

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: Rainwater Harvesting

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

Goal 11.0: Brush Control

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

Goal 12.0: Desired future condition of the groundwater resource

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 07/10/2013

Whereas, the McMullen Groundwater 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 the by the statutes in Chapter 36 of the Texas Water Code and the TWDB.

Now, Therefore be it Resolved, that the McMullen Groundwater Conservation District has approved the District management plan.

In favor____ Against_____ Not Present _______

Passed and Approved the 10th day of July, 2013.

________________________ Attest by :________________________

Harold Jambers Jr., President David Longan, Secretary

Appendix A

Estimated Historical Water Use And 2012 State Water Plan Datasets:

McMullen Groundwater Conservation District

by Stephen Allen
Texas Water Development Board
Groundwater Resources Division
Groundwater Technical Assistance Section
stephen.allen@twdb.texas.gov
(512) 463-7317
October 15, 2012

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/GMPchecklist0911.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 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 updated Historical Water Use and 2012 State Water Planning data available as of 10/15/2012. Although it does not happen frequently, neither of these datasets are static and are subject to change pending the availability of more accurate data (Historical Water Use data) or an amendment to the 2012 State Water Plan (2012 State Water Planning data). District personnel must review these datasets and correct any discrepancies in order to ensure approval of their groundwater management plan.

The Historical Water Use dataset can be verified at this web address:

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

The 2012 State Water Planning dataset can be verified by contacting Wendy Barron (wendy.barron@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 use estimates are currently unavailable for 2005 and 2010. TWDB staff anticipates the calculation and posting of these estimates at a later date.

MCMULLEN COUNTY

All values are in acre-feet/year

Year	Source	Municipal	Manufacturing	Steam Electric	Irrigation	Mining	Livestock	Total
1974	GW	100	0	0	0	9	925	1,034
	SW	0	0	0	0	0	103	103
1980	GW	88	0	0	0	446	90	624
	SW	0	0	0	0	0	808	808
1984	GW	138	0	0	0	664	52	854
	SW	0	0	0	0	0	475	475
1985	GW	142	0	0	0	229	42	413
	SW	0	0	0	0	0	384	384
1986	GW	131	0	0	0	0	44	175
	SW	0	0	0	0	0	399	399
1987	GW	149	0	0	93	266	46	554
	SW	0	0	0	7	0	414	421
1988	GW	155	0	0	116	268	49	588
	SW	0	0	0	9	0	448	457
1989	GW	116	0	0	0	239	49	404
	SW	0	0	0	0	0	442	442
1990	GW	109	0	0	0	239	48	396
	SW	0	0	0	0	0	436	436
1991	GW	166	0	0	0	391	49	606
	SW	12	0	0	0	0	444	456
1992	GW	178	0	0	0	399	32	609
	SW	269	0	0	0	0	292	561
1993	GW	178	0	0	0	390	29	597
	SW	284	0	0	0	0	261	545
1994	GW	205	0	0	0	390	47	642
	SW	214	0	0	0	0	427	641
1995	GW	255	0	0	0	390	46	691
	SW	136	0	0	0	0	412	548
1996	GW	195	0	0	0	390	71	656
	SW	0	0	0	0	0	639	639
1997	GW	408	0	0	0	399	51	858
	SW	0	0	0	0	0	458	458

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

Groundwater and surface water use estimates are currently unavailable for 2005 and 2010. TWDB staff anticipates the calculation and posting of these estimates at a later date.

Year	Source	Municipal	Manufacturing	Steam Electric	Irrigation	Mining	Livestock	Total
1998	GW	411	0	0	0	399	47	857
	SW	0	0	0	0	0	421	421
1999	GW	449	0	0	0	399	50	898
	SW	0	0	0	0	0	450	450
2000	GW	470	0	0	0	845	25	1,340
	SW	0	0	0	0	0	224	224
2001	GW	632	0	0	0	176	82	890
	SW	0	0	0	0	0	738	738
2002	GW	244	0	0	0	385	48	677
	SW	0	0	0	0	0	431	431
2003	GW	412	0	0	0	385	48	845
	SW	0	0	0	0	0	431	431
2004	GW	273	0	0	0	385	48	706
	SW	0	0	0	0	0	431	431
2006	GW	114	0	0	0	219	89	422
	SW	0	0	0	0	0	357	357
2007	GW	114	0	0	0	219	89	422
	SW	0	0	0	0	0	357	357
2008	GW	173	0	0	0	219	79	471
	SW	0	0	0	0	0	316	316
2009	GW	164	0	0	0	417	82	663
	SW	0	0	0	0	66	329	395
2010	GW	156	219	0	0	330	93	798
	SW	0	0	0	0	110	371	481

Projected Surface Water Supplies
TWDB 2012 State Water Plan Data

MCMULLEN 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	18	20	21	20	16	13
N	LIVESTOCK	NUECES	LIVESTOCK LOCAL SUPPLY	593	593	593	593	593	593
	Sum of Projected Surface Water Supplies (acre-feet/year)			611	613	614	613	609	606

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.

MCMULLEN COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
N	COUNTY-OTHER	NUECES	143	146	138	129	123	117
N	MINING	NUECES	195	203	207	211	215	218
N	LIVESTOCK	NUECES	659	659	659	659	659	659
N	CHOKE CANYON WS	NUECES	43	44	42	39	37	35
	Sum of Projected Water Demands (acre-feet/year)		1,040	1,052	1,046	1,038	1,034	1,029

Projected Water Supply Needs
TWDB 2012 State Water Plan Data

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

MCMULLEN COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
N	CHOKE CANYON WS	NUECES	9	10	13	15	13	12
N	COUNTY-OTHER	NUECES	26	23	31	40	46	52
N	LIVESTOCK	NUECES	0	0	0	0	0	0
N	MINING	NUECES	0	0	0	0	0	0
	Sum of Projected Water Supply Needs (acre-feet/year)		0	0	0	0	0	0

Projected Water Management Strategies
TWDB 2012 State Water Plan Data

MCMULLEN 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)							
MUNICIPAL WATER CONSERVATION	CONSERVATION [MCMULLEN]	1	2	3	5	7	10
Sum of Projected Water Management Strategies (acre-feet/year)		1	2	3	5	7	10

GAM RUN 12-011: MCMULLEN GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

by William Kohlrenken
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-8279
June 25, 2012

Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by William Kohlrenken under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on June 25, 2012.

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GAM Run 12-011: McMullen Groundwater Conservation District Management Plan

by William Kohlrenken
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-8279
June 25, 2012

EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h), 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.

The purpose of this report is to provide Part 2 of a two-part package of information to McMullen Groundwater Conservation District for its groundwater management plan. The groundwater management plan for the McMullen Groundwater Conservation District is due for approval by the executive administrator of the TWDB before September 25, 2013.

This report discusses the method, assumptions, and results from GAM run 12-011 using the groundwater availability models for the central portion of the Gulf Coast Aquifer; the southern portion of the Queen City and Sparta aquifers, which includes the Carrizo-Wilcox Aquifer; and the Yegua Jackson Aquifer. Tables 1 through 5 summarize the groundwater availability model data required by the statute, and figures 1 through 5 show the area of each model from which the values in the respective tables were extracted. This model run replaces the results of GAM Run 08-02. GAM Run 12-011 meets current standards set after the release of GAM Run 08-02 and includes model results for the Yegua-Jackson Aquifer. Slight differences in the results of the two model runs for the Gulf Coast, Queen City, Sparta, and Carrizo-Wilcox aquifers are due to differences in the methods of extracting the data from the models. If after review of the figures, the McMullen Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the Texas Water Development Board immediately.

METHODS:

Groundwater availability models for the central portion of the Gulf Coast Aquifer (1981 through 1999); the Queen City and Sparta aquifers, which includes the Carrizo-Wilcox Aquifer (1980 through 1999); and the Yegua Jackson Aquifer (1980 through 1997) were run for this analysis. Water budgets for each year of the transient model period were extracted and 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 portions of the aquifers located within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Gulf Coast Aquifer

- Version 1.01 of the groundwater availability model for the central section of the Gulf Coast Aquifer was used 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 section of the Gulf Coast Aquifer assumes partially penetrating wells in the Evangeline Aquifer due to a lack of data for aquifer properties in the lower section of the aquifer.
- This groundwater availability model includes four layers, which generally correspond to (from top to bottom):

    1. the Chicot Aquifer,
    2. the Evangeline Aquifer,
    3. the Burkeville Confining Unit, and

4. the Jasper Aquifer including parts of the Catahoula Formation.

- The mean absolute error (a measure of the difference between simulated and measured water levels) in the entire model for 1999 is 26 feet, which is 4.6 percent of the hydraulic head drop across the model area (Chowdhury and others, 2004).

- Processing Modflow for Windows (PMWIN) version 5.3 (Chiang and Kinzelbach, 2001) was used as the interface to process model output.

Carrizo-Wilcox, Queen City, and Sparta Aquifers

- Version 2.01 of the groundwater availability model for the southern part of the Carrizo-Wilcox, Queen City, and Sparta aquifers was used for this analysis. 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 correspond to (from top to bottom):

    1. the Sparta Aquifer,
    2. the Weches Confining Unit,
    3. the Queen City Aquifer,
    4. the Reklaw Confining Unit,
    5. the Carrizo Aquifer,
    6. the Upper Wilcox Aquifer,
    7. the Middle Wilcox Aquifer, and
    8. the Lower Wilcox Aquifer.

- Of the eight layers listed above, individual water budgets for the district were determined for the Sparta Aquifer (Layer 1), the Queen City Aquifer (Layer 3), and the combined layers of the Carrizo-Wilcox Aquifer (Layers 5 through 8).

- The root mean square error (a measure of the difference between simulated and actual water levels during model calibration) in the groundwater availability model is 23 feet for the Sparta Aquifer, 18 feet for the Queen City Aquifer, and 33 feet for the Carrizo-Wilcox Aquifer for the calibration period (1980 to 1990). The root mean square error is 19 feet for the Sparta Aquifer, 22 feet for the Queen City Aquifer, and 48 feet for the Carrizo-Wilcox Aquifer in the verification period (1991 to 1999) (Kelley and others, 2004). These root mean square errors are between seven and ten percent of the range of measured water levels (Kelley and others, 2004).

- 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 concentrations of less than 1,000 milligrams per liter (mg/l) are considered fresh and total dissolved solids concentrations of 1,000 to 10,000 mg/l are considered brackish.

Yegua Jackson Aquifer

- Version 1.01 of the groundwater availability model for the Yegua Jackson Aquifer was used for this analysis. See Deeds and others (2010) for assumptions and limitations of the groundwater availability model.

- This groundwater availability model includes five layers, which generally correspond to (from top to bottom):

    1. the outcrop section of the Yegua Jackson Aquifer and younger overlying units,
    2. the upper portion of the Jackson Group,
    3. the lower portion of the Jackson Group,
    4. the upper portion of the Yegua Group, and
    5. the lower portion of the Yegua Group.

- An overall water budget for the district was determined for the Yegua Jackson Aquifer (Layer 1 through Layer 5 collectively for the portions that represent the Yegua Jackson Aquifer).

- As reported in Deeds and others (2010), the mean absolute errors (a measure of the difference between simulated and measured water levels during model calibration) for the Jackson Group (combined upper and lower Jackson units), Upper Yegua, and Lower Yegua portions of the Yegua Jackson Aquifer for the historical-calibration period of the model are 31.1, 23.9, and 24.5 feet, respectively. These represent 10.3, 5.7 and 6.3 percent of the hydraulic head drop across each model area, respectively.

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 runs in the district. The components of the modified budget shown in tables 1 through 5 include:

- 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 drains (springs).
- Flow into and out of district—The lateral flow within the aquifer between the district and adjacent counties.
- Flow between aquifers—The vertical flow between 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.

The information needed for the district’s management plan is summarized in tables 1 through 5. 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 district or county boundaries, 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 (see figures 1 through 5).

TABLE 1: SUMMARIZED INFORMATION FOR THE GULF COAST AQUIFER THAT IS NEEDED FOR MCMULLEN GROUNDWATER 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	243
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	809
Estimated annual volume of flow into the district within each aquifer in the district	Gulf Coast Aquifer	242
Estimated annual volume of flow out of the district within each aquifer in the district	Gulf Coast Aquifer	594
Estimated net annual volume of flow between each aquifer in the district	Not Applicable	Not Applicable

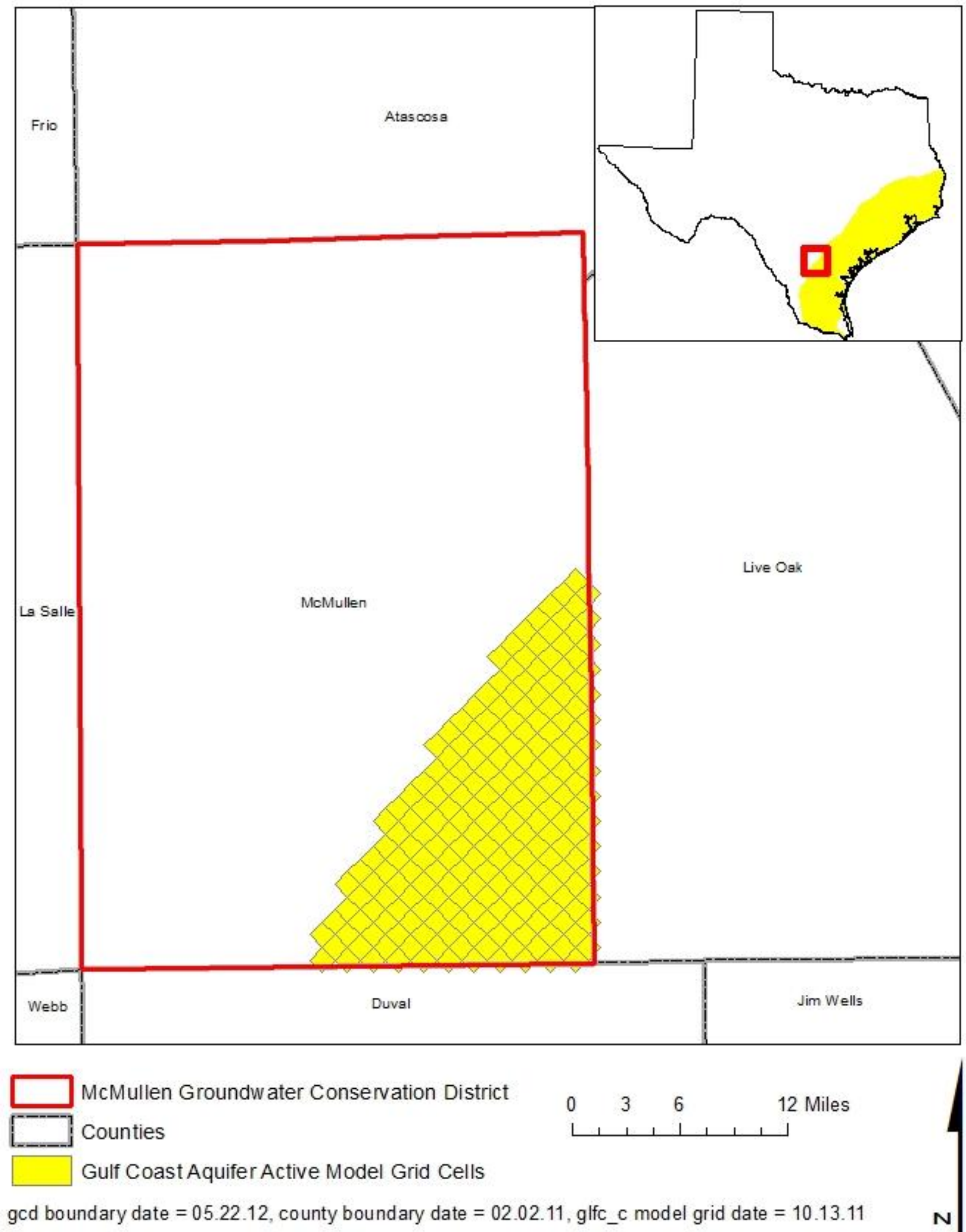

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CENTRAL PORTION OF THE GULF COAST AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE CARRIZO-WILCOX AQUIFER THAT IS NEEDED FOR MCMULLEN GROUNDWATER 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	3,833
Estimated annual volume of flow out of the district within each aquifer in the district	Carrizo-Wilcox Aquifer	3,089
Estimated net annual volume of flow between each aquifer in the district	From Reklaw Confining Unit into Carrizo-Wilcox Aquifer	688

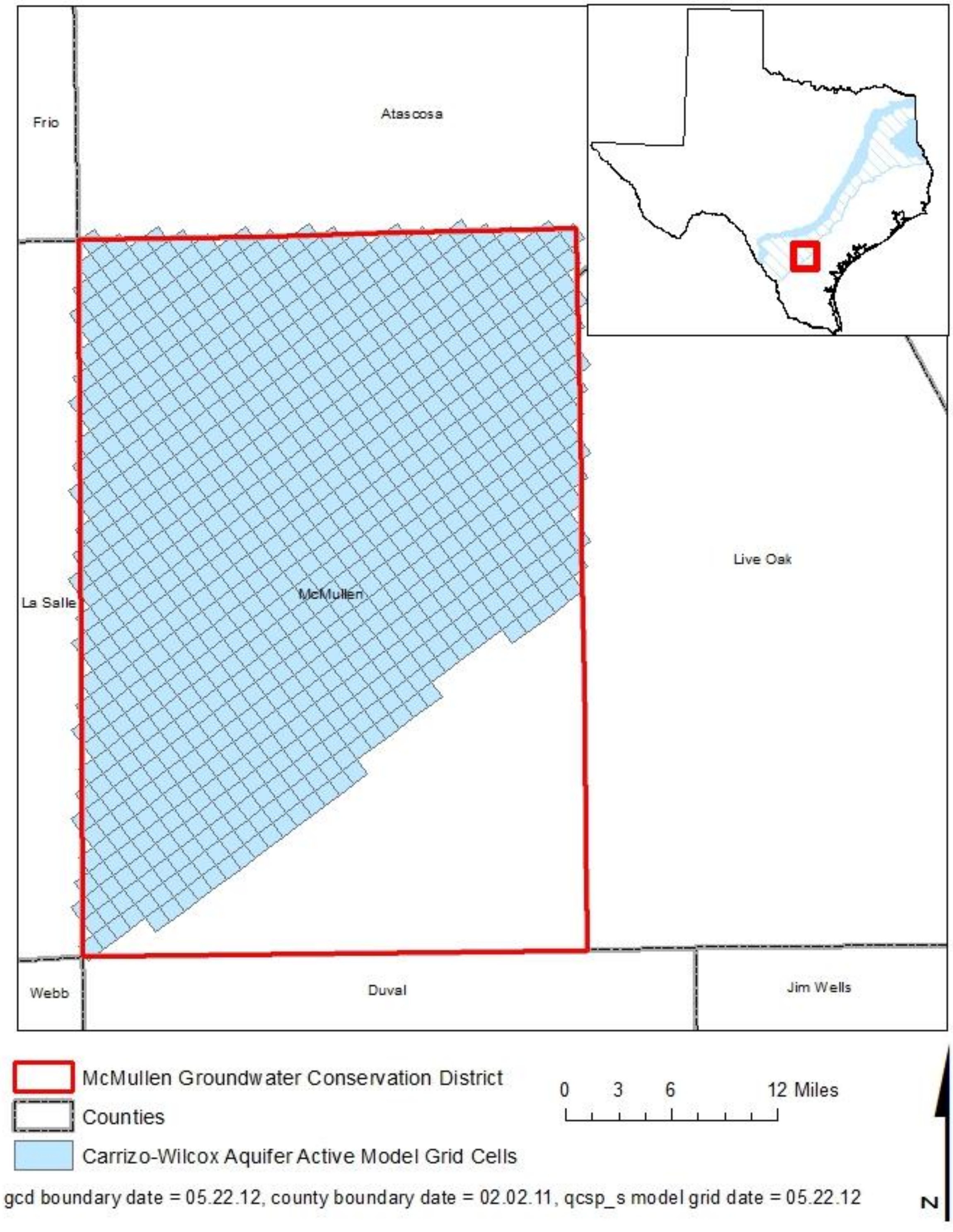

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE AQUIFER EXTENT OF THE CARRIZO-WILCOX AQUIFER WITHIN THE DISTRICT BOUNDARY).

TABLE 3: SUMMARIZED INFORMATION FOR THE QUEEN CITY AQUIFER THAT IS NEEDED FOR MCMULLEN GROUNDWATER 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	Queen City Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Queen City Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Queen City Aquifer	719
Estimated annual volume of flow out of the district within each aquifer in the district	Queen City Aquifer	191
Estimated net annual volume of flow between each aquifer in the district	From Queen City Aquifer into the Weches Confining Unit	917
	From the Queen City Aquifer into the Reklaw Confining Unit	135

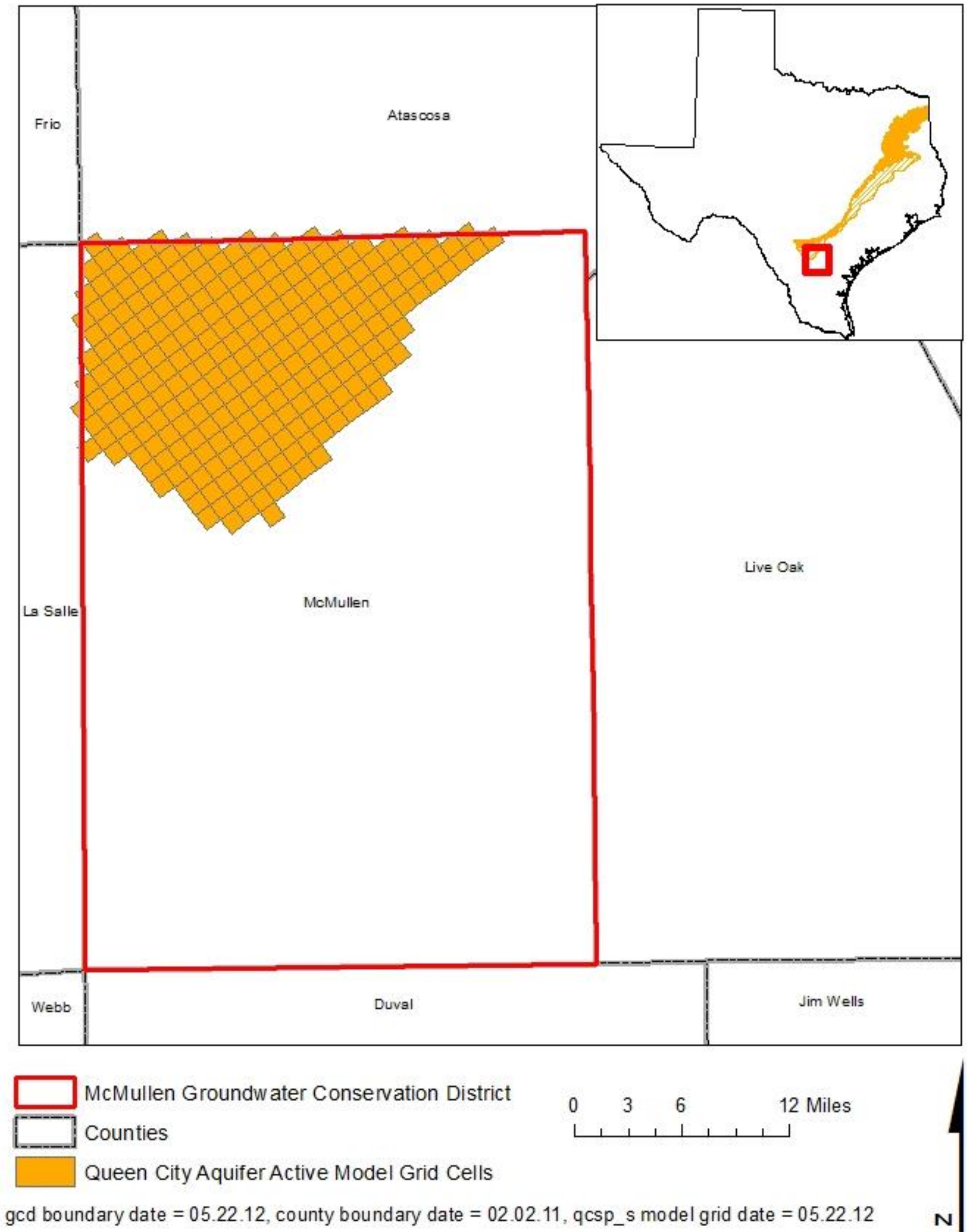

FIGURE 3: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (THE AQUIFER EXTENT OF THE QUEEN CITY AQUIFER WITHIN THE DISTRICT BOUNDARY).

TABLE 4: SUMMARIZED INFORMATION FOR THE SPARTA AQUIFER THAT IS NEEDED FOR MCMULLEN GROUNDWATER 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*	*Results*
Estimated annual amount of recharge from precipitation to the district	Sparta Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Sparta Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Sparta Aquifer	246
Estimated annual volume of flow out of the district within each aquifer in the district	Sparta Aquifer	268
Estimated net annual volume of flow between each aquifer in the district	From overlying units into the Sparta Aquifer	107
	From Weches Confining Unit into the Sparta Aquifer	101

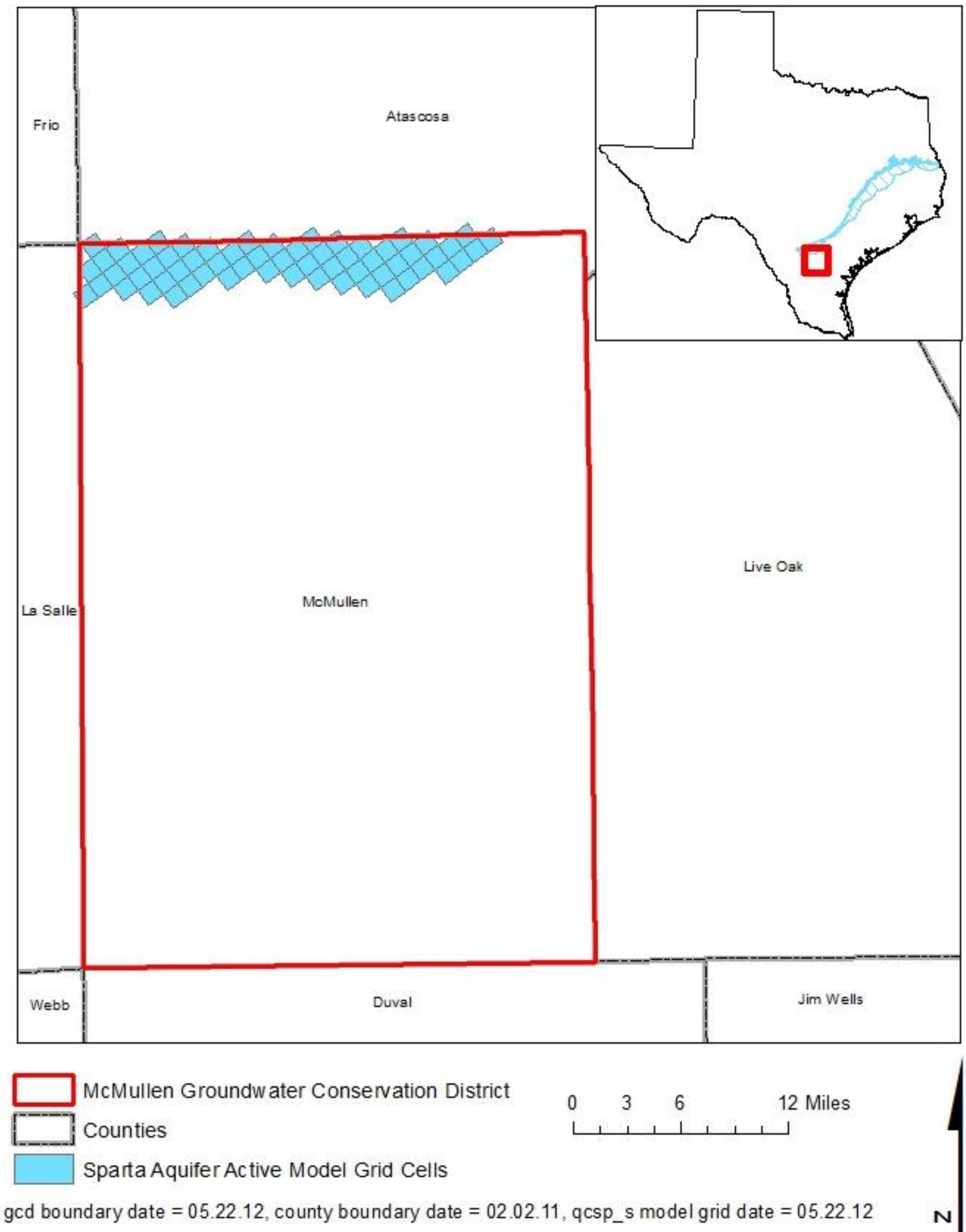

FIGURE 4: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS FROM WHICH THE INFORMATION IN TABLE 4 WAS EXTRACTED (THE AQUIFER EXTENT OF THE SPARTA AQUIFER WITHIN THE DISTRICT BOUNDARY).

TABLE 5: SUMMARIZED INFORMATION FOR THE YEGUA JACKSON AQUIFER THAT IS NEEDED FOR MCMULLEN GROUNDWATER 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	7,034
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	13,081
Estimated annual volume of flow into the district within each aquifer in the district	Yegua Jackson Aquifer	6,762
Estimated annual volume of flow out of the district within each aquifer in the district	Yegua Jackson Aquifer	4,577
Estimated net annual volume of flow between each aquifer in the district	From the Catahoula Formation into the Yegua Jackson Aquifer	243

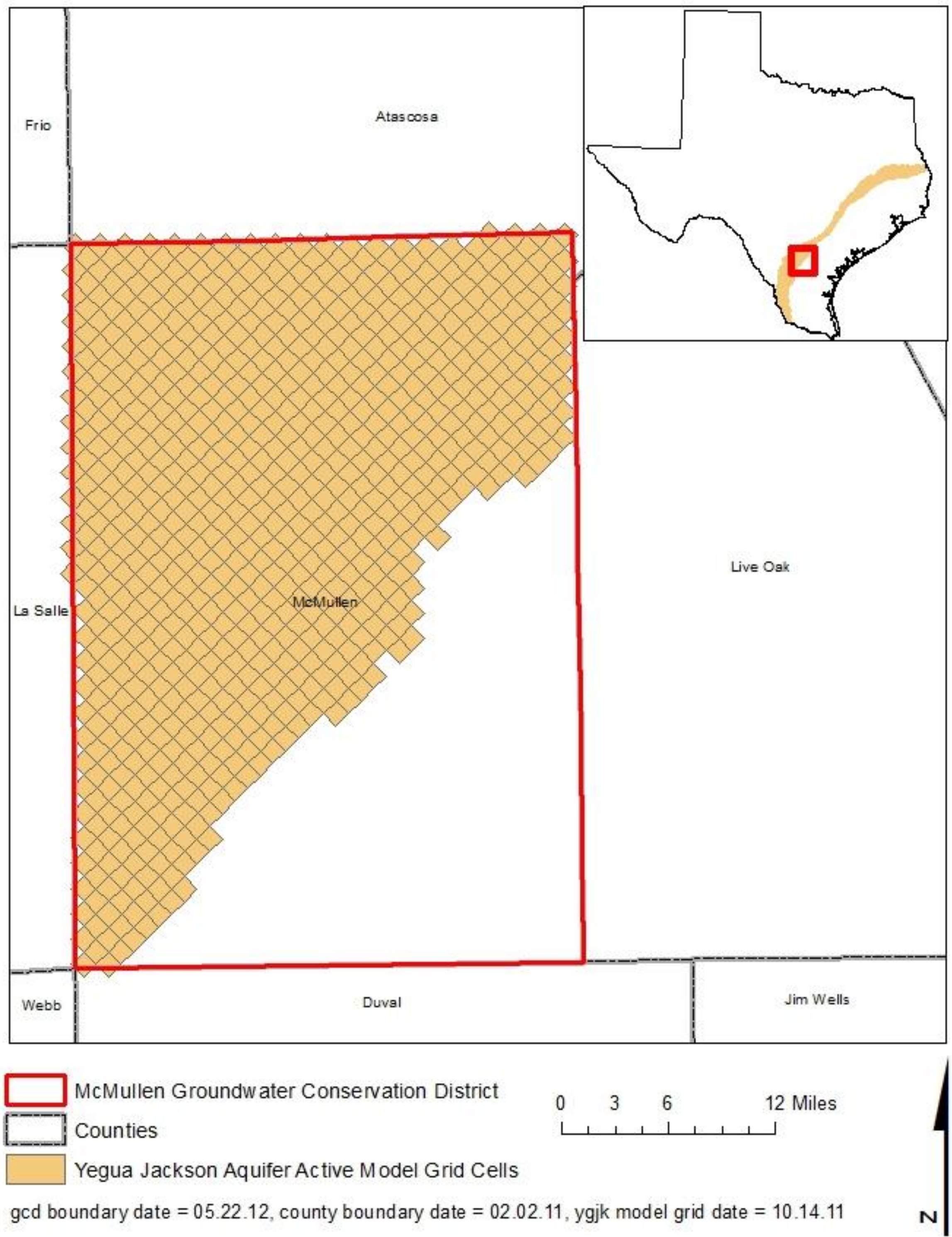

FIGURE 5: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE YEGUA JACKSON AQUIFER FROM WHICH THE INFORMATION IN TABLE 5 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

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 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 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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