South Plains Underground Water Conservation District

South Plains UWCD

Management Plan

2013-2018

Effective

December 3, 2013

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District Mission Statement

The South Plains Underground Water Conservation District (the District) will develop, promote, and implement management strategies to provide for the conservation, preservation, protection, recharging and prevention of waste of the groundwater resources, over which it has jurisdictional authority, for the benefit of the people that the District serves.

Time Period for this Plan

This plan becomes effective December 3, 2013, upon adoption by the Board of Directors (the Board) of the District and remains in effect until a revised plan is approved or until December 2, 2018, whichever is earlier.

Guiding Principles

The District was formed, and has been operated from its inception, with the guiding belief that the ownership and production of groundwater is a private property right. It is understood that, without the District, there is no protection of private property rights. The methods of protecting private property rights in groundwater are implemented using the policies adopted by the locally elected board members.

The Board understands the responsibilities of the District, and creates programs necessary for meeting them. The Board believes that the District should be more knowledgeable of its groundwater resources than any other entity.

Additionally, the Board realizes that the aquifer extends beyond the District's boundaries, and the sharing of information, programs and ideas with neighboring districts is important. As a result, the District will consider the joint administration of certain programs when practical.

This management plan is a tool which provides continuity in the management of the District. The District staff uses this guide to insure that the goals of the District are met. The Board uses it for planning, as well as measuring the performance of the staff.

Conditions change over time which requires that the Board modify this document. The dynamic nature of this plan shall be maintained such that the District continues serving the needs of the constituents. At the very least, the Board will review and readopt this plan every five years, or as specified by Chapter 36, Texas Water Code.

In the opinion of the Board, the goals, management objectives, and performance standards in this planning document have been set at a reasonable level considering existing and future fiscal and technical resources. Evolving conditions may change the management objectives defined to reach the stated goals. Whatever the future holds, the following guidelines are used to insure the management objectives are set at a sufficient level to be realistic and effective:

- The District's constituents will determine if the District's goals are set at a level that is both meaningful and attainable; through their voting right, the public will appraise the District's overall performance in the process of electing or re-electing Board members.
- The duly elected Board will guide and direct the District staff and will gauge the achievement of the goals set forth in this document.
- The interests and needs of the District's constituents shall control the direction of the management of the District.
- The Board will maintain local control of the privately owned resource over which the District has jurisdictional authority, as provided by Chapter 36, Texas Water Code.
- The Board will evaluate District activities on a fiscal year basis. That is, the District budgets operations on a September 1 – August 31 fiscal year. When considering stated goals, management objectives, and performance standards, any reference to the terms annual, annually, or yearly will refer to the fiscal year of the District.

General Description, Location and Extent

The District was created by HB 281 (72nd Legislature) during 1991. The District was confirmed by voter approval, the initial Board elected, and an ad valorem tax rate cap of $0.025/$100 valuation was set in an election held in August 1992. Table 1 lists the current Board of Directors, office held, occupation, and term.

Table 1: Board of Directors of the South Plains Underground Water Conservation District

Office	Name	Occupation	Term Ends
President	Scott Hamm	Active Farmer	May 2014
Vice-President	Matt Hogue	Active Farmer	May 2014
Secretary	Larry Yowell	Agri-Business	May 2016
Member	Dan A. Day, Jr.	Active Farmer/Rancher	May 2016
Member	David Swaringen	Agri-Business	May 2016

Originally, the jurisdictional extent of the District was the same as Terry County, Texas. However, in 1994 the District annexed about 1,500 acres of Hockley County from individual landowner petitions. As a result, the District includes about .26% of the land area in Hockley County.

The District now covers approximately 902 square miles of the Southern High Plains of Texas (Figure 1). Brownfield, the Terry county seat, is the largest municipality in the District, having a population of about 9,488. Meadow (pop. 658) and Wellman (pop. 245) are the other two incorporated communities in the District.

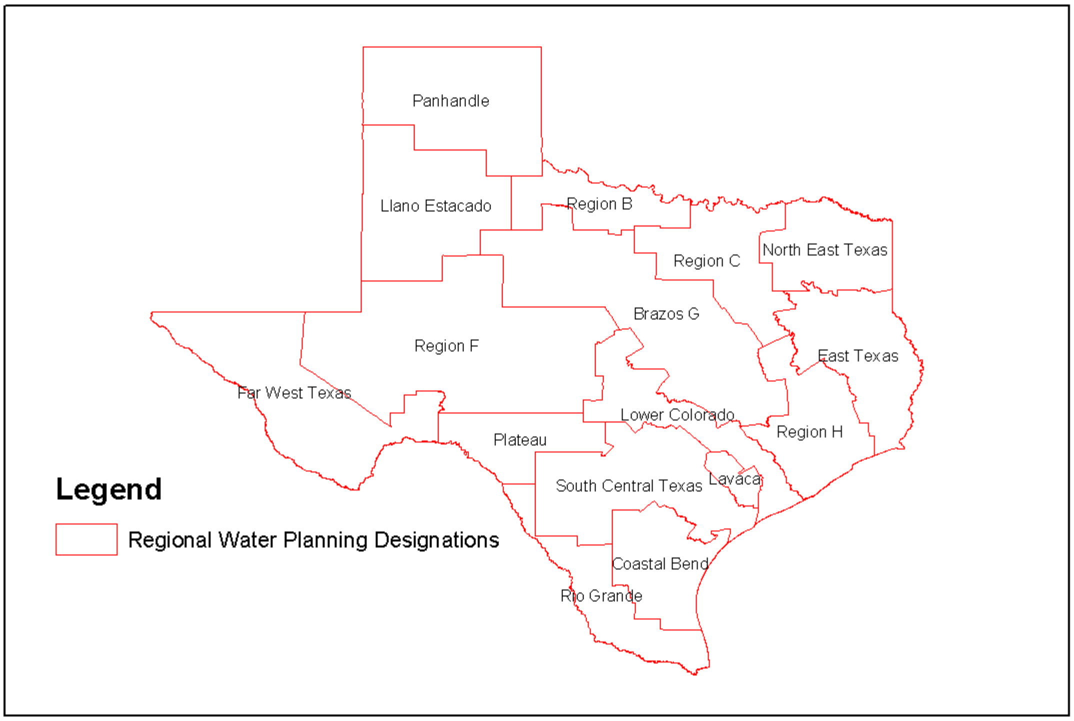
Four other groundwater districts border the South Plains Underground Water Conservation District. These include High Plains UWCD #1, Llano Estacado UWCD, Mesa UWCD and the Sandy Land UWCD.

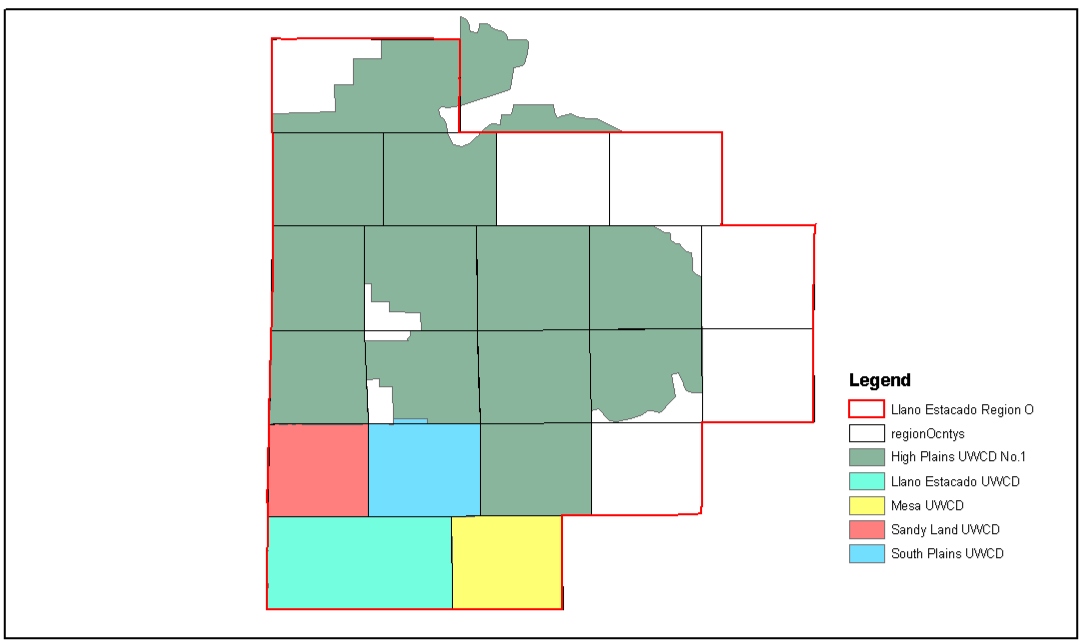
The economy of the District is supported predominately by row crop agriculture. The 150,000 plus acres of irrigated cropland (out of total row crop acreage of 500,000) affords economic stability to the area covered by the District. The major crops cultivated within the District include: cotton, peanuts, grain sorghum and wheat and, to a lesser extent, grapes, watermelons, sunflowers, alfalfa, guar and hay crops.

Recently, the dairy industry has also shown interest here. This has resulted in the building of two facilities, each milking about 2,000 cows. It is not expected there will be much more expansion within the District.

As oil prices have risen, the petroleum industry has again gained prominence in local economies. The production of low volume wells is more feasible at this time due to this recent trend. A significant portion of the District's tax-based revenues are generated by mineral valuation.

Figure 1: Location of the South Plains Underground Water Conservation District





Topography and Drainage

The land surface in the District is a nearly level to very gently undulating constructional plain that has little dissection. The northwestern part of the District is the most undulating, largely because eolian deposits of sand have been shifted and reworked by wind.

The elevation ranges from about 3150 feet above sea level in the southeastern part of the District to 3600 feet in the northwestern part. Brownfield, which is near the center of the District, has an approximate elevation of 3300 feet. There is a general slope of about 10 feet per mile from the northwest to southeast.

Two relic drainage ways, Sulfur Springs Draw and Lost Draw, cross the District from northwest to southeast. These draws are shallow and are usually dry; they seldom carry runoff water.

Rick Lake and Mound Lake are the largest salt lakes in the District. Around these lakes is the sharpest topographical relief. The eolian hills that border the east sides of these lakes are sometimes 100 feet or more higher than the lakebeds.

Playas, or shallow lakes, are more common in the northeastern part of the district. Playas are not prevalent in the sandier areas. The playas range in size from 2 to 40 acres and provide the only surface drainage in many areas. Aquifer recharge occurs through these playa basins during and after significant rainfall events. Recharge is limited once the clays in the basins swell and effectively stop percolation of groundwater (Sanders, 1961).

Groundwater Resources

The District has jurisdictional authority over all groundwater that lies within the District's boundaries. Three aquifers, the Ogallala, the Cretaceous, and the Dockum occur within the District. The following is a description of these formations that may be beneficial to District constituents by providing useable quantities of groundwater.

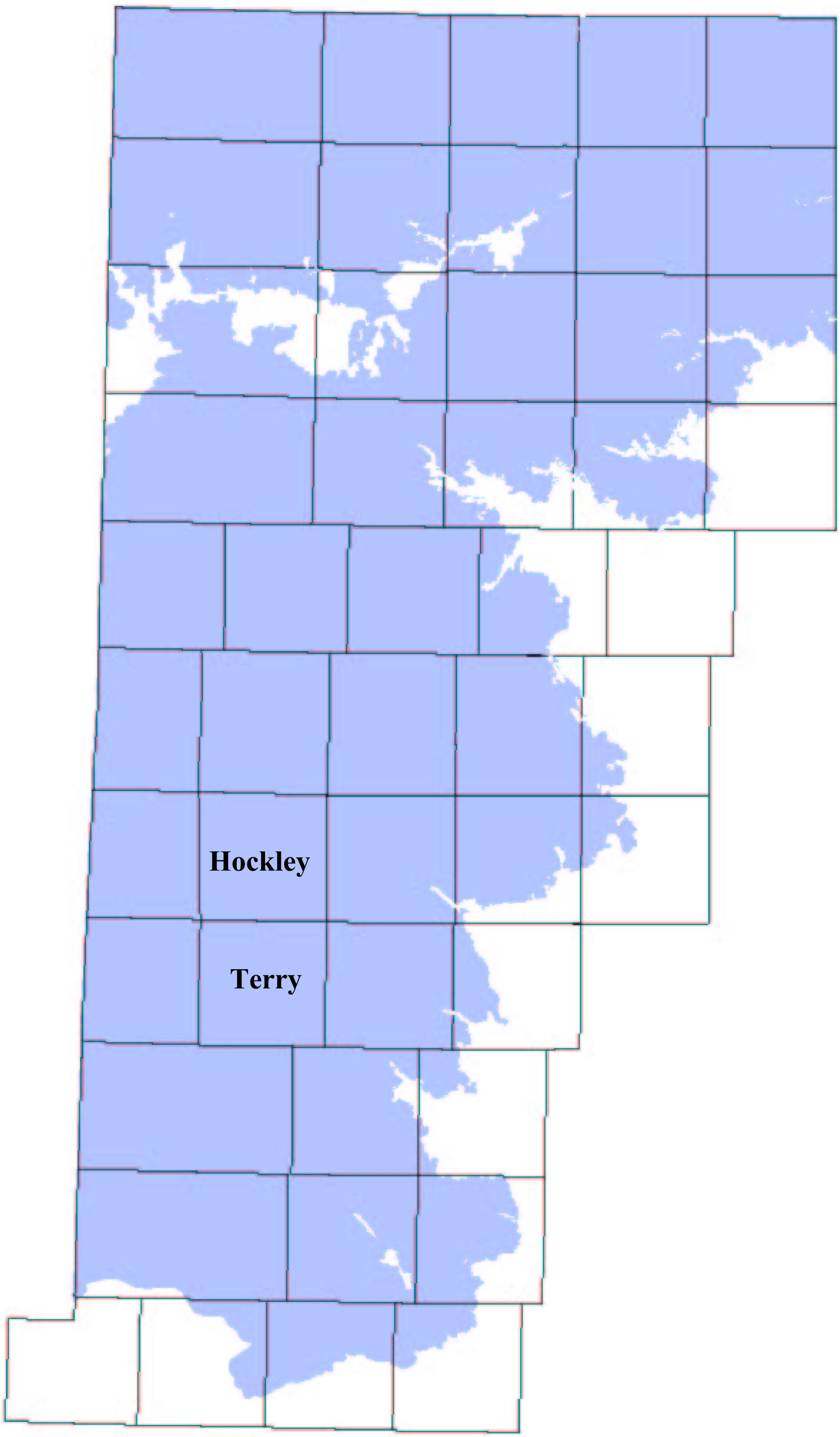
Ogallala Aquifer

The Ogallala Aquifer is the primary source of groundwater in the District (Figure 2). The aquifer extends from the ground surface downward, ranging in thickness from 80 feet to more than 200 feet in the area covered by the District.

The formation consists of heterogeneous sequences of clay, silt, sand and gravel. These sediments are thought to have been deposited by eastward flowing aggrading streams that filled and buried valleys eroded into pre-Ogallala rocks. A resistant layer of calcium carbonate-cemented caliche known locally as the "caprock" occurs near the surface of much of the area. (Ashworth and Hopkins, 1995).

Water levels in the Ogallala Aquifer are influenced by the rate of recharge and discharge. Recharge occurs primarily by infiltration of precipitation. GAM studies show that recharge is

Figure 2: Extent of the Ogallala Aquifer in Texas
(Adapted from Ashworth and Hopkins, 1995)



greater beneath irrigated lands. To a lesser extent, recharge may also occur by upward leakage from underlying Cretaceous units that, in places, have a higher water table elevation than the Ogallala. Generally, only a small percentage of water from precipitation actually reaches the water table due to a combination of limited annual precipitation (17.59 inches per year), high evaporation rate (60-70 inches per year), and slow infiltration rate. However, where deep sands are prevalent and the water table is shallow, precipitation may affect recharge rather quickly.

Groundwater in the aquifer generally flows from northwest to southeast, normally at right angles to water level contours. Velocities of less than one foot per day are typical, but higher velocities may occur along filled erosional valleys where coarser grained deposits have greater permeability.

Discharge from the Ogallala aquifer within the District primarily occurs through the pumping of irrigation wells. Groundwater usage typically exceeds recharge and results in water-level declines (Ashworth and Hopkins, 1995).

The chemical quality of Ogallala groundwater varies greatly across the District. Electrical conductance (EC) varies from less than 1.0 dS/m to over 4.0 dS/m. Generally, groundwater in the eastern and southeastern parts of the District exhibits the highest EC. Isolated occurrences of high EC values elsewhere in the District may be due to pollution through oil field salt water disposal pits or upward leakage and mixing from the underlying Cretaceous aquifer.

The suitability of groundwater for irrigation purposes is largely dependent on the chemical composition of the water and is determined primarily by the total concentration of soluble salts. Some farm acreage in the District is already limited to certain varieties of salt tolerant crops due to limiting or damaging total salt levels.

Cretaceous Aquifer

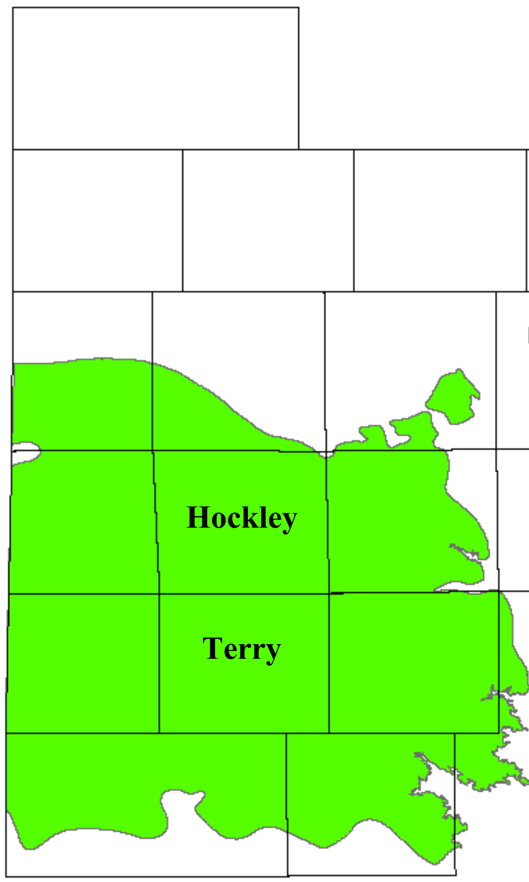
The Edwards-Trinity (High Plains) Aquifer, commonly referred to as the Cretaceous Aquifer, underlies the Ogallala Aquifer throughout the District (Figure 3). In some areas of the District, the Cretaceous and Ogallala Aquifers may be hydrologically connected. Groundwater in the Cretaceous is generally fresh to slightly saline. Water quality deteriorates where Cretaceous formations are overlain by saline lakes.

Studies performed by the District suggest that water quality in Cretaceous units is generally similar to that of the Ogallala. However, there are some instances where it has been discovered that lower Cretaceous units have poor quality water. This work is a continual investigation, and limited by the sparse locations of Cretaceous water wells. Further work should provide additional understanding of this issue.

As Ogallala water levels decline, it is expected that there will be greater interest in this minor aquifer. The District is implementing a water level measurement program for this minor aquifer, and is committing additional resources to the study of Cretaceous units.

Recharge of the Cretaceous occurs directly from the bounding Ogallala formation. Some upward movement of groundwater from the underlying Triassic Dockum formation may also occur, affecting recharge of the Cretaceous (Ashworth and Hopkins, 1995). As mentioned earlier, in some places the potentiometric surface elevation of the Cretaceous Aquifer is higher than the water table elevation of the Ogallala Aquifer, resulting in the upward leakage from the Cretaceous Aquifer. Movement of water in the Cretaceous is generally east to southeast.

Figure 3: Extent of the Edwards-Trinity (High Plains) Aquifer in Texas
(Adapted from Ashworth and Hopkins, 1995)



Dockum Aquifer
The Dockum Aquifer underlies the Cretaceous and Ogallala formations throughout the District. The primary water-bearing zone in the Dockum group, commonly called the "Santa Rosa", consists of up to 700 feet of sand and conglomerate interbedded with layers of silt and shale (Ashworth and Hopkins, 1995). Aquifer permeability is typically low and well yields normally do not exceed 300 gpm.

Water quality in the Dockum is the main limiting factor when considering its use within the District (Ashworth and Hopkins, 1995). EC values for Dockum groundwater range from 15.0 dS/m to over 50.0 dS/m. Even the most salt tolerant row crops grown cannot withstand such levels of salinity.

Currently, it seems the only practical use of Dockum groundwater may be for make-up water in secondary recovery operations of crude oil. By using water from this aquifer, oil companies could reduce their use of Ogallala and/or Cretaceous groundwater, thereby relieving some pressure from the freshwater sources.

At some point, it may be feasible to treat Dockum water for use as municipal supply. As desalination technology evolves, this process might be feasible for meeting some needs within the District. However, due to the limited productivity of this aquifer, it is likely best suited (using this scenario) for stock or municipal supply. These uses permit a storage system for water that is not available for agricultural irrigation usage.

Surface Water Resources

The only fresh surface water in the District exists as playa lakes. The playas play an important role in aquifer recharge and support some wildlife when rainfall accumulates in these naturally occurring depressions. Playas are rarely, if ever, used to support irrigation activities.

As previously mentioned, Rich Lake and Mound Lake are naturally occurring salt lakes within the District. Each of these naturally occurring impoundments support limited wildlife populations, primarily migratory waterfowl and opportunistic predators.

Perhaps the most significant surface water resource of benefit to the District is Lake Meredith located on the Canadian River in the Texas Panhandle. The lake is managed by the Canadian River Municipal Water Authority and provides water to the City of Brownfield, and starting 2009, the City of Meadow.

1. Estimates of Modeled Available Groundwater

The District adopted Desired Future Conditions for relevant aquifers in August 2010. The relevant aquifers are the Ogallala and Edwards-Trinity (High Plains) Aquifers. The Board decided that the Dockum Aquifer is not a relevant aquifer for the South Plains UWCD at this time.

During the joint planning process, this District and five other gcds along the southern end of GMA#2 adopted DFCs for the Ogallala and Edwards-Trinity (High Plains) based on an allowable amount of drawdown. The allowable drawdown is based on the average change during the 10-year period 1998-2007. For the South Plains UWCD, that number is -1.15 ft/year. Based on the 50 year planning horizon, GAM Task 10-023 Model Run Report Scenario 3, predicts the cumulative drawdown to be 42 feet for the District. For Estimated Pumping Values for the South Plains UWCD, refer to *GAM Run 10-030 MAG, Table 7, Appendix C.*

2. Estimated Historical Annual Groundwater Usage

The estimated Historical Water Use from the TWDB Estimated Historical Water Use Survey (WUS) are estimations of the historical quantity of groundwater used in the area served by the District. It will be used as a guide to estimate future demands on the resource in the District. I should be emphasized that the quantities shown are estimates.

Refer to Estimated Historical Groundwater Use and 2012 State Water Plan Data Sets, Appendix B

3. Estimates of Annual Groundwater Recharge from Precipitation

Refer to GAM Run 12-006, Appendix A

4. Estimates of Annual Groundwater Discharge to Springs/Surface Water Bodies

Refer to GAM Run 12-006, Appendix A

5. Estimates of Annual Groundwater Flow Into/Out of the District for the Ogallala; estimates of annual groundwater flow between aquifers in the District

Refer to GAM Run 12-006, Appendix A

6. Estimates of Projected Surface Water Supply

Currently, there are two towns within the District that use surface water. The Canadian River Municipal Water Authority supplies some water to Brownfield. Recently, the town of Meadow negotiated the purchase of some CRMWA water with Brownfield. The purchase was necessary for blending the higher quality CRMWA supply with the town's groundwater wells; several of which have elevated arsenic and fluoride.

As Lake Meredith has declined, CRMWA has purchased groundwater in Roberts County as a supplement.

Refer to Estimated Historical Groundwater Use and 2012 State Water Plan Data Sets, Appendix B

7. Estimates of Projected Total Demand for Water in the District

Projecting water demand is a challenging task. Some user group projections are more accurate than others. This is an inherent part of the process. Of particular difficulty is the projection of irrigation water demand. Rainfall, commodity prices, water level changes, and federal farm policy are a few of the factors that complicate the matter.

Refer to Estimated Historical Groundwater Use and 2012 State Water Plan Data Sets, Appendix B

8. Water Supply Needs and Water Management Strategies

It is required that the District Management Plan consider the water supply needs and water management strategies included in the 2012 State Water Plan (TWC 36.1071(e)(4)).

Refer to Estimated Historical Groundwater Use and 2012 State Water Plan Data Sets, Appendix B

Now, it seems necessary that the issue of irrigation needs be discussed. While the District understands that there is need for more irrigation supply than is currently available, the demand figures are not indicative of the average usage. Consequently, the unmet needs, while real, are not as great as shown.

Actions, Procedures, Performance and Avoidance for Plan Implementation

The District currently employs a set of rules governing the spacing and production of wells, as well as production limitations based on tract size. It is expected that this approach will remain the foundation of the Board's strategies for groundwater management. As conditions dictate, and as the DFC process is completed, it may require that the specific provisions within the existing rules be modified. The District's Board of Directors is responsible for that determination. The District's rules are available on the District web site: http://www.spuwcd.org/Rules_Mgt_Plan.html.

Additional water management strategies the District may consider, when applicable, are listed below.

A. Conversion to Dryland Farming—As water supplies decline, there are some landowners that may exercise this option. There are incentive payments available through the USDA NRCS for those interested in this option. The District supports the use of these incentive payments to help those landowners interested in this program.

B. Increased study of Minor Aquifers—Some future needs may be addressed using the two minor aquifers within the District. At this time, it is uncertain what additional amount of water may be available from minor aquifers. The District supports the continued and further investigation of these resources, and is committed to the monitoring and study of them.
C. Conservation Programs—The implementation of educational programs and resources regarding conservation remains top priority for the District. The Board supports the expansion of resources pertaining to those programs, which include, but are not limited to: maximizing crop water use efficiency, minimizing irrigation water evaporative losses, rainwater harvesting, use of water wise plants and drought tolerant landscaping, wise water use, and device give-aways.

Drought Contingency Plan

Drought is a normal, recurrent feature of climate, although many erroneously consider it a rare and random event. Drought is also a temporary aberration, and differs from aridity, which is restricted to low rainfall regions and is a permanent feature of climate ("What is Drought?" National Drought Mitigation Center). The South Plains Underground Water Conservation District is in a semi-arid region that also experiences drought. However, even in the midst of a drought, rainfall at crucial times of the growing season may significantly reduce irrigation water demand.

Drought response conservation measures typically used in other regions of Texas (i.e. rationing) cannot and are not used in this region due to extreme economic impact potential. In the District, groundwater conservation is stressed at all times. The Board recognizes that irrigated agriculture provides the economic stability to the communities within the District. Therefore, through the notice and hearing provisions required in the development and adoption of this management plan, the Board adopts the official position that, in times of precipitation shortage, irrigated agricultural producers will not be limited to any less usage of groundwater than is provided for by District rules.
In order to treat all other groundwater user groups fairly and equally, the District will encourage more stringent conservation measures, where practical, but likewise, will not limit groundwater use in any way not already provided for by District rules.

Regional Water Planning

The Board of Directors recognizes the regional water plan requirements listed in Ch. 36, TWC, §36.1071. Namely, the District's management plan must be forwarded to the regional water planning group for their consideration in their planning process, and the plan must address water supply needs such that there is no conflict with the approved regional water plan. It is the Board's belief that no such conflict exists.

The Board agrees that the regional water plan should include the District's best data. The Board also recognizes that the regional water planning process provides a necessary overview of the region's water supply and needs. However, the Board also believes it is the duty of the District to develop the best and most accurate information concerning groundwater within the District.

Goals, Management Objectives and Performance Standards

Method for Tracking the District's Progress in Achieving Management Goals

The District Manager will prepare an annual report of the District's performance achieving management goals and objectives. The report will be prepared in a format that will be reflective of the performance standards listed following each management objective. The report will be presented to the Board within 60 days of the end of each fiscal year. The report will be maintained on file in the open records of the District.

The District will actively enforce all rules of the District in order to conserve, preserve, protect and prevent the waste of the groundwater resources over which the District has jurisdictional authority. The Board may periodically review the District's rules, and may modify the rules, with public approval, to better manage the groundwater resources within the District and to carry out the duties prescribed in Chapter 36, Texas Water Code.

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

Management Objective—Water Level Monitoring

1.01 Measure the depth to water in the District's water level monitoring network; record measurements and/or observations; enter measurements into District's computer data base; maintain a network of measurement wells of 100 or more wells.

Performance Standards

1.01a Number of water level monitoring wells for which measurements were recorded each year

1.01b Number of water level monitoring wells for which field notes were written describing reason for inability to obtain measurements each year

1.01c Number of data records entered into District's data base each year

1.01d Number of wells in the water level measurement network each year

1.01e Number of wells added to the network, if required, each year

Management Objective—Technical Field Services

1.02 Provide technical field services including, but not limited to: flow testing, draw down measurement, sprinkler pattern efficiency testing, and water management strategy consultation. Record any observations, measurements, etc. in field log. Enter recorded information in District's database.

Performance Standards

1.02a Number of field services tests performed, as evidenced by field log, each year

1.02b Number of records entered into District's computer database each year

Management Objective—Laboratory Services

1.03 Provide basic water quality testing services. Maintain a record of tests performed by entering the results in the District's computer database. Communicate results of analyses to well owners.

Performance Standards

1.03a Number of laboratory service tests.

1.03b Number of records entered into District's computer database each year

1.03c Number of results communicated to well owners

Management Objective—Irrigation Monitoring

1.04 Monitor seasonal irrigation applications using a network of cooperative producers. Prepare monthly reports for cooperators that include the seasonal irrigation applications. Acquire yield data and analyze crop water use efficiency.

Performance Standards

1.04a Number of irrigation systems in the cooperative program

1.04b Number and type of crops monitored

1.04c Average irrigation application by crop

Management Objective—Center Pivot Inventory

1.05 Beginning in 2003, and again every five years thereafter, perform a physical inventory of the center pivot irrigation systems in the District. Note which center pivot irrigation systems have Low Energy Precision Application (LEPA) spaced nozzles as a measure of adoption of more efficient irrigation technology. Enter data in District's data base file by block and section.

Performance Standards

1.05a Number of irrigation systems recorded each documenting period

1.05b Percentage of center pivot irrigation systems with LEPA spaced nozzles each documenting period

1.05c Number of active irrigation systems by type in District's database

Goal 2.0 Controlling and preventing waste of groundwater

Management Objective—Well Permitting and Well Completion

2.01 Issue temporary water well drilling permits for the drilling and completion of non-exempt water wells, and well registrations for the drilling of exempt water wells. Inspect all well sites to be assured that the District's completion and spacing standards are met. Send written notification to the well owner if the well initially fails to meet standards. The Board will vote on final approval of the permit at the next regularly scheduled meeting after the well site has been inspected and District well standards have been met.

Performance Standards

2.01a Number of water well drilling permits issued each year

2.01b Number of well sites inspected after well completion each year

2.01c Number of well sites that initially fail to meet the standards of the District each year

<u>Management Objective</u>—Open, Deteriorated or Uncovered Wells

2.02 If an open, deteriorated or uncovered well is found, the District will insure that the open hole is properly closed according to District rules and, in so doing, prevent potential contamination of the groundwater resource. The reports shall be filed on forms provided by the District in order to track the progress of the closure process. The District will contact the party responsible for the open, deteriorated or uncovered well within 30 days of same being reported. The site will be inspected after notification to insure the well closure process occurs within 60 days of the initial contact with the responsible party. If the well is not closed by the end of the 60-day period, the District will pursue the available options at its disposal and remedy the well violation.

Performance Standards

2.02a Number of open, deteriorated or uncovered wells

2.02b Number of initial inspections accomplished each year

2.02c Average number of days required to make initial contact with responsible party each year

2.02d Average number of days required to complete closure of open or uncovered wells each year

2.02e Number of wells remaining open or uncovered after 60 day period that are closed in accordance with District rules each year

<u>Management Objective</u>—Maximum Allowable Production

2.03 The District will investigate reports of usage of groundwater in excess of the maximum production allowable under the District's rules. Investigation of each occurrence shall occur within 30 days of receiving the report. Each case will be remedied in accordance with District rules.

Performance Standards

2.03a Number of reports

2.03b Average amount of time taken to investigate reports each year

2.03c Number of incidences where violations occurred and violators were required to change operations to be in compliance with District rules each year.

<u>Management Objective</u>—Water Quality Monitoring

2.04 Conduct a District-wide water quality testing program. The results of the tests will be entered into the District's computer database and will be made available to the public.

Performance Standards

2.04a Number of samples collected and analyzed each year

2.04b Percent of previously sampled wells that were sampled in the current testing year

2.04c Number of analyses entered into District's computer database each year

<u>Goal 3.0</u> Controlling and preventing subsidence

(not applicable)

Goal 4.0 **Conjunctive surface water management issues**
(not applicable)

Goal 5.0 **Natural resource issues**
(not applicable)

Goal 6.0 **Drought Conditions**

Management Objective—Rain Gages

6.01 Maintain a network of rain gages in the District. Publish monthly and yearly rainfall totals on the District's web site

Performance Standards

6.01a Number of rain gages in the network

Goal 7.0 **Conservation**

Management Objective—Classroom Education

7.01 The District will make water conservation education curriculum available to 4^{th} grade schools within the District.

Performance Standards

7.01a Number of 4^{th} grade schools where water conservation curriculum is made available each year

Management Objective—Newsletter

7.02 The District will produce a minimum of two newsletter editions. Newsletters will be distributed to District constituents and other interested parties. At a minimum, two articles per year will be included that address methods of enhancing and protecting the quantity of useable quality groundwater within the District.

Performance Standards

7.02a Number of newsletter editions published each year

7.02b Number of newsletters distributed each year

7.02c Number of articles that address methods of enhancing and protecting the quantity of useable quality groundwater each year

Management Objective—News Releases

7.03 District staff will prepare a minimum of two news releases addressing groundwater protection and/or conservation.

Performance Standards

7.03a Number of news releases prepared for publication in local newspapers.

Management Objective—Public Speaking Engagements

7.04 The District staff and/or directors shall present a minimum of four programs concerning groundwater protection and/or conservation.

Performance Standards
7.04a Number of programs.

<u>Management Objective</u>**—Printed Material Resource Center and Technical File**
7.05 Maintain a self-service printed material resource center in the District office. Conduct an annual inventory of these items. Through the inventory process, determine the number and type of materials obtained by the public each year. Maintain a technical filing system of resource materials and annually record the number of copies obtained by the public

Performance Standards
7.05a Number of items, by type, obtained by the public from the resource center each year
7.05b Number of items copied and given to the public from the technical file each year

<u>Management Objective</u>**—Saturated Thickness Maps**
7.06 Every 7 years, beginning 2010, provide saturated thickness maps that show the varying thickness of groundwater remaining in storage.

Performance Standards
7.06a Number of saturated thickness maps displayed and/or printed at the District office

<u>Management Objective</u>**—Conservation Literature**
7.07 Maintain a portion of the District's material resource center devoted to water conservation. Stock this portion with conservation tips for both home water conservation and agricultural irrigation conservation.

Performance Standards
7.07a Number of brochures/periodicals dedicated to conservation
7.07b Number of conservation brochures/periodicals obtained by the public

<u>**Goal 8.0**</u> **Recharge Enhancement**
8.01 A review of past work conducted by others indicates this goal is not appropriate at present. Therefore this goal is not applicable.

<u>**Goal 9.0**</u> **Rainwater Harvesting**
<u>Management Objective</u>**—Public Awareness Program**
9.01 The District will conduct an educational program for this conservation strategy at least once a year.

Performance Standards
9.01a Document the type of program conducted (i.e. newsletter article, public presentation)

Goal 10.0 **Precipitation Enhancement**

10.01 While the District did participate in this program for eleven years, the Board has since determined it is not cost-effective. Therefore this goal is not applicable.

Goal 11.0 **Brush Control**

11.01 Existing programs administered by the USDA-NRCS are sufficient for addressing this goal. The Board does not believe that this activity is cost-effective and applicable for the District at this time. Therefore this goal is not applicable.

Goal 12.0 **Desired future condition of the aquifers**

The District adopted Desired Future Conditions for relevant aquifers in August 2010. The relevant aquifers are the Ogallala and Edwards-Trinity (High Plains) Aquifers. The Board decided that the Dockum Aquifer is not a relevant aquifer for the South Plains UWCD at this time.

During the joint planning process, this District and five other gcds along the southern end of GMA#2 adopted DFCs for the Ogllala and Edwards-Trinity (High Plains) based on an allowable amount of drawdown. The allowable drawdown is based on the average change during the 10-year period 1998-2007. For the South Plains UWCD, that number is -1.15 ft/year. Based on the 50 year planning horizon, the Southern Ogallala GAM predicts the cumulative drawdown to be 42 feet for the District. However, for the purposes of this management plan, the District proposes to evaluate the cumulative drawdown in 5 year increments, which will gage our attainment of the DFC in shorter increments, and allow us to make any changes accordingly.

It is our belief that no additional rules changes are needed at this time in order to meet the adopted DFC. Our proposal may be altered if, at the end of the current 5 year period, our cumulative annual drawdown differs significantly from what is calculated to keep us on track for DFC attainment.

Management Objective—Calculate Annual Drawdown

12.01 The District will calculate the average annual drawdown using the results of annual water level measurements each winter.

Performance Standards

12.01a Present the average drawdown results to the District Board each year.

12.01b Publish the average drawdown results in the District newsletter each year.

<u>Management Objective</u>—Calculate Cumulative Annual Drawdown

12.02 The District will calculate the cumulative average annual drawdown beginning with the 2012 year. The District will calculate the remaining allowable drawdown (based on the DFC) for the remaining years of the 2012-2017 period.

Performance Standards

12.02a Present the cumulative average annual drawdown results to the District Board each year.

12.02b Publish the cumulative average annual drawdown results in the District newsletter each year.

References

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Appendix A

GAM Run 12-006: South Plains Underground Water Conservation District Management Plan

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April 20, 2012

EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h), states that, in developing its groundwater management plan, groundwater conservation districts 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 from the Texas Water Development Board to South Plains Underground Water Conservation District management plan to fulfill the requirements noted above. The groundwater management plan for South Plains Underground Water Conservation District is due for approval by the Executive Administrator of the Texas Water Development Board before November 10, 2013.

This report discusses the method, assumptions, and results from model runs using the groundwater availability model for the southern portion of the Ogallala Aquifer, which includes the Edwards-Trinity (High Plains) Aquifer. Tables 1 and 2 summarize the groundwater availability model data required by the statute, and Figure 1 shows the area of the model from which the values in the tables were extracted. This model run replaces the results of GAM Run 08-18. GAM Run 12-006 meets current standards set after the release of GAM Run 08-18 and includes model results from the updated model for the southern portion of the Ogallala Aquifer, which now includes the Edwards-Trinity (High Plains) Aquifer. If after review of the figure, South Plains Underground Water 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:

The groundwater availability model for the southern portion of the Ogallala Aquifer, which includes the Edwards-Trinity (High Plains) Aquifer, was run for this analysis. Water budgets for each year of 1980 through 2000 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:

Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer

- Version 2.01 of the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer was used for this analysis. This model is an expansion on and update to the previously developed groundwater availability model for the southern portion of the Ogallala Aquifer described in Blandford and others (2003). See Blandford and others (2008) and Blandford and others (2003) for assumptions and limitations of the model.

- The model includes four layers representing the southern portion of the Ogallala and Edwards-Trinity (High Plains) aquifers. The units comprising the Edwards-Trinity (High Plains) Aquifer (primarily Edwards, Comanche Peak, and Antlers Sand formations) are separated from the overlying Ogallala Aquifer by a layer of Cretaceous shale, where present. Water budgets for the district have been determined for the Ogallala Aquifer (Layer 1), as well as the Edwards-Trinity (High Plains) Aquifer (Layer 2 through Layer 4, collectively).

- The mean absolute error (a measure of the difference between simulated and actual water levels during model calibration) for the Ogallala Aquifer in 2000 is 33 feet. The mean absolute error for the Edwards-Trinity (High Plains) Aquifer in 1997 is 25 feet

(Blandford and others, 2008). This represents 1.8 and 3.0 percent of the hydraulic head drop across the model area for each aquifer, respectively.

- Irrigation return flow was accounted for in the groundwater availability model by a direct reduction in agricultural pumping as described in Blandford and others (2003).
- Groundwater Vistas Version 5 (Environmental Simulations, Inc. 2007) was used as the interface to process model output.

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected components were extracted from the groundwater budget 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, as shown in Tables 1 and 2. The components of the modified budget shown in Tables 1 and 2 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 net 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 and 2. 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 (Figure 1).

TABLE 1: SUMMARIZED INFORMATION FOR THE OGALLALA AQUIFER THAT IS NEEDED FOR SOUTH PLAINS 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. THESE FLOWS INCLUDE BRACKISH WATERS.

Management Plan requirement	*Aquifer or confining unit*	*Results*
Estimated annual amount of recharge from precipitation to the district	Ogallala Aquifer	71,103
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Ogallala Aquifer	933
Estimated annual volume of flow into the district within each aquifer in the district	Ogallala Aquifer	2,113
Estimated annual volume of flow out of the district within each aquifer in the district	Ogallala Aquifer	4,871
Estimated net annual volume of flow between each aquifer in the district	From the Ogallala Aquifer into the Edwards-Trinity (High Plains) Aquifer and adjacent underlying areas	854

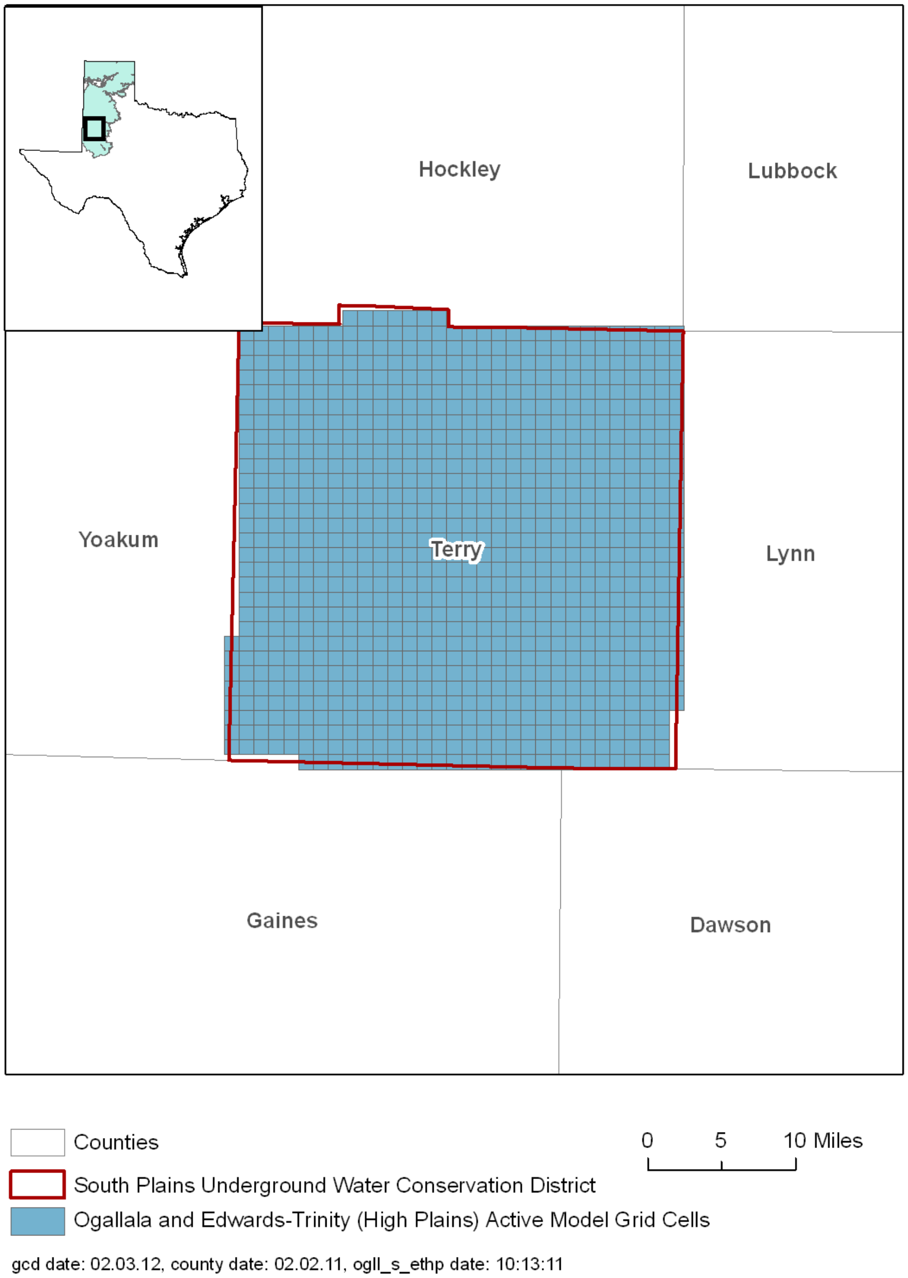

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE SOUTHERN PORTION OF THE OGALLALA AQUIFER FROM WHICH THE INFORMATION IN TABLES 1 AND 2 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (HIGH PLAINS) AQUIFER THAT IS NEEDED FOR SOUTH PLAINS 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. THESE FLOWS MAY INCLUDE FRESH AND BRACKISH WATERS.

Management Plan requirement	*Aquifer or confining unit*	*Results*
Estimated annual amount of recharge from precipitation to the district	Edwards-Trinity (High Plains) Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Edwards-Trinity (High Plains) Aquifer	3
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (High Plains) Aquifer	714
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (High Plains) Aquifer	962
Estimated net annual volume of flow between each aquifer in the district	From the Ogallala Aquifer and overlying units and into the Edwards-Trinity (High Plains) Aquifer	854

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 model 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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Appendix B

Estimated Historical Groundwater Use And 2012 State Water Plan Datasets:

South Plains Underground Water Conservation District

by Stephen Allen
Texas Water Development Board
Groundwater Resources Division
Groundwater Technical Assistance Section
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August 26, 2013

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:

DISCLAIMER:

The data presented in this report represents the most updated Historical Groundwater Use and 2012 State Water Planning data available as of 2/12/2013. 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 Survey 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).

The values presented in the data tables of this report are county-based. In cases where groundwater conservation districts cover only a portion of one or more counties the data values are modified with an apportioning multiplier to create new values that more accurately represent district conditions. The multiplier used as part of the following formula is a land area ratio: (data value * (land area of district in county / land area of county)). For two of the four State Water Plan tables (Projected Surface Water Supplies and Projected Water Demands) only the county-wide water user group (WUG) data values (county other, manufacturing, steam electric power, irrigation, mining and livestock) are modified using the multiplier. WUG values for municipalities, water supply corporations, and utility districts are not apportioned; instead, their full values are retained when they are located within the district, and eliminated when they are located outside (we ask each district to identify these locations).

The two other SWP tables (Projected Water Supply Needs and Projected Water Management Strategies) are not apportioned because district-specific values are not statutorily required. Each district needs only "consider" the county values in those tables.

In the Historical Groundwater Use table every category of water use (including municipal) is apportioned. Staff determined that breaking down the annual municipal values into individual WUGs was too complex.

TWDB recognizes that the apportioning formula used is not perfect but it is the best available process with respect to time and staffing constraints. If a district believes it has data that is more accurate it has the option of including those data in the plan with an explanation of how the data were derived. Apportioning percentages are listed above each applicable table.

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 Groundwater Use
TWDB Historical Water Use Survey (WUS) Data

Groundwater historical use estimates are currently unavailable for calendar years 2005, 2011 and 2012. TWDB staff anticipates the calculation and posting of these estimates at a later date.

HOCKLEY COUNTY *1.00 % (multiplier)* All values are in acre-feet/year

Year	Source	Municipal	Manufacturing	Steam Electric	Irrigation	Mining	Livestock	Total
1974	GW	16	1	0	3,455	167	4	3,643
1980	GW	20	2	0	1,354	101	4	1,481
1984	GW	20	1	0	1,009	44	4	1,078
1985	GW	18	1	0	831	42	5	897
1986	GW	14	1	0	645	45	4	709
1987	GW	17	0	0	503	40	4	564
1988	GW	15	0	0	535	41	2	593
1989	GW	16	0	0	924	36	2	978
1990	GW	17	0	0	920	36	3	976
1991	GW	17	0	0	910	37	3	967
1992	GW	15	0	0	1,126	35	7	1,183
1993	GW	18	0	0	1,352	34	7	1,411
1994	GW	19	0	0	1,685	34	5	1,743
1995	GW	20	0	0	1,691	67	5	1,783
1996	GW	19	0	0	1,689	67	5	1,780
1997	GW	17	0	0	1,691	67	4	1,779
1998	GW	20	0	0	1,608	61	6	1,695
1999	GW	17	0	0	1,913	61	6	1,997
2000	GW	18	0	0	1,744	61	5	1,828
2001	GW	16	0	0	1,867	30	4	1,917
2002	GW	16	0	0	1,649	34	4	1,703
2003	GW	15	0	0	1,901	40	3	1,959
2004	GW	15	0	0	1,856	40	2	1,913
2006	GW	13	0	0	1,089	4	5	1,111
2007	GW	20	0	0	1,975	5	3	2,003
2008	GW	14	0	0	1,297	4	4	1,319
2009	GW	14	0	0	1,504	13	3	1,534
2010	GW	14	0	0	989	6	4	1,013

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

Groundwater historical use estimates are currently unavailable for calendar years 2005, 2011 and 2012. TWDB staff anticipates the calculation and posting of these estimates at a later date.

TERRY COUNTY *100.00 % (multiplier)* All values are in acre-feet/year

Year	Source	Municipal	Manufacturing	Steam Electric	Irrigation	Mining	Livestock	Total
1974	GW	914	11	0	145,490	1,493	203	148,111
1980	GW	1,192	161	0	134,439	1,496	156	137,444
1984	GW	568	162	0	65,322	1,189	136	67,377
1985	GW	593	113	0	86,475	1,112	136	88,429
1986	GW	608	59	0	50,440	1,049	109	52,265
1987	GW	863	40	0	35,405	991	177	37,476
1988	GW	625	16	0	39,718	873	191	41,423
1989	GW	576	0	0	152,317	822	188	153,903
1990	GW	581	0	0	131,901	822	185	133,489
1991	GW	507	0	0	126,910	798	190	128,405
1992	GW	501	0	0	89,866	796	92	91,255
1993	GW	825	3	0	180,849	772	101	182,550
1994	GW	900	7	0	166,810	775	91	168,583
1995	GW	1,075	5	0	154,738	276	78	156,172
1996	GW	1,148	4	0	148,061	276	90	149,579
1997	GW	1,136	6	0	154,095	263	96	155,596
1998	GW	967	1	0	253,812	263	93	255,136
1999	GW	660	1	0	165,233	263	112	166,269
2000	GW	528	1	0	202,815	263	92	203,699
2001	GW	1,619	2	0	183,691	263	92	185,667
2002	GW	1,097	2	0	204,008	263	91	205,461
2003	GW	1,227	0	0	162,245	263	93	163,828
2004	GW	946	1	0	115,286	263	80	116,576
2006	GW	487	2	0	176,587	0	182	177,258
2007	GW	640	2	0	98,195	0	245	99,082
2008	GW	673	2	0	158,840	0	169	159,684
2009	GW	587	2	0	183,056	98	288	184,031
2010	GW	558	2	0	137,221	100	208	138,089

Projected Surface Water Supplies
TWDB 2012 State Water Plan Data

HOCKLEY COUNTY

1.00 % (multiplier)

All values are in acre-feet/year

RWPG	WUG	WUG Basin	Source Name	2010	2020	2030	2040	2050	2060
O	LEVELLAND	BRAZOS	MEREDITH LAKE/RESERVOIR						
O	LIVESTOCK	BRAZOS	LIVESTOCK LOCAL SUPPLY	2	3	3	3	3	3
O	LIVESTOCK	COLORADO	LIVESTOCK LOCAL SUPPLY	0	1	1	1	1	1
	Sum of Projected Surface Water Supplies (acre-feet/year)			**2**	**4**	**4**	**4**	**4**	**4**

TERRY COUNTY

100.00 % (multiplier)

All values are in acre-feet/year

RWPG	WUG	WUG Basin	Source Name	2010	2020	2030	2040	2050	2060
O	BROWNFIELD	COLORADO	MEREDITH LAKE/RESERVOIR	850	1,071	1,071	1,071	1,071	1,071
O	LIVESTOCK	BRAZOS	LIVESTOCK LOCAL SUPPLY	7	10	8	12	10	7
O	LIVESTOCK	COLORADO	LIVESTOCK LOCAL SUPPLY	115	114	118	118	125	130
	Sum of Projected Surface Water Supplies (acre-feet/year)			**972**	**1,195**	**1,197**	**1,201**	**1,206**	**1,208**

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.

HOCKLEY COUNTY

1.00 % (multiplier)

All values are in acre-feet/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
O	ANTON	BRAZOS						
O	LEVELLAND	BRAZOS						
O	COUNTY-OTHER	BRAZOS	8	9	9	8	8	8
O	MANUFACTURING	BRAZOS	12	12	12	12	12	12
O	MINING	BRAZOS	24	15	10	4	0	0
O	IRRIGATION	BRAZOS	1,513	1,454	1,397	1,343	1,290	1,240
O	LIVESTOCK	BRAZOS	6	7	8	8	9	9
O	ROPESVILLE	BRAZOS						
O	SMYER	BRAZOS						
O	LIVESTOCK	COLORADO	0	1	1	1	1	1
O	COUNTY-OTHER	COLORADO	0	0	0	0	0	0
O	SUNDOWN	COLORADO						
O	MINING	COLORADO	8	5	3	1	0	0
O	IRRIGATION	COLORADO						
	Sum of Projected Water Demands (acre-feet/year)		**1,571**	**1,503**	**1,440**	**1,377**	**1,320**	**1,270**

TERRY COUNTY

100.00 % (multiplier)

All values are in acre-feet/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
O	LIVESTOCK	BRAZOS	7	10	8	12	10	7
O	IRRIGATION	BRAZOS	9,636	9,142	8,674	8,229	7,807	7,407
O	COUNTY-OTHER	BRAZOS	14	14	15	16	15	15
O	MEADOW	COLORADO	73	75	78	80	79	79
O	COUNTY-OTHER	COLORADO	376	393	407	419	418	415
O	IRRIGATION	COLORADO	183,089	173,702	164,797	156,348	148,332	140,726
O	MINING	COLORADO	554	266	155	66	0	0
O	LIVESTOCK	COLORADO	227	264	284	301	326	353
O	MANUFACTURING	COLORADO	1	1	1	1	1	1
O	BROWNFIELD	COLORADO	2,747	2,905	3,047	3,181	3,185	3,167
	Sum of Projected Water Demands (acre-feet/year)		**196,724**	**186,772**	**177,466**	**168,653**	**160,173**	**152,170**

Projected Water Supply Needs
TWDB 2012 State Water Plan Data

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

HOCKLEY COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
O	ANTON	BRAZOS	-263	-270	-272	-268	-256	-243
O	COUNTY-OTHER	BRAZOS	0	0	0	0	0	0
O	COUNTY-OTHER	COLORADO	0	0	0	0	0	0
O	IRRIGATION	BRAZOS	-58,612	-69,394	-75,360	-80,580	-76,844	-75,268
O	IRRIGATION	COLORADO	-5,070	-6,281	-7,499	-7,251	-6,993	-6,376
O	LEVELLAND	BRAZOS	926	874	867	914	592	701
O	LIVESTOCK	BRAZOS	0	0	0	0	0	1
O	LIVESTOCK	COLORADO	0	0	0	0	0	0
O	MANUFACTURING	BRAZOS	0	0	0	0	0	0
O	MINING	BRAZOS	0	0	0	0	0	0
O	MINING	COLORADO	0	0	0	0	0	0
O	ROPESVILLE	BRAZOS	0	0	-91	-89	-85	-81
O	SMYER	BRAZOS	0	0	0	0	0	-62
O	SUNDOWN	COLORADO	0	-350	-353	-347	-332	-316
	Sum of Projected Water Supply Needs (acre-feet/year)		**-63,945**	**-76,295**	**-83,575**	**-88,535**	**-84,510**	**-82,346**

TERRY COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
O	BROWNFIELD	COLORADO	69	-115	-280	-435	-458	-457
O	COUNTY-OTHER	BRAZOS	0	0	0	0	0	0
O	COUNTY-OTHER	COLORADO	0	0	0	0	0	0
O	IRRIGATION	BRAZOS	-3,581	-3,400	-3,228	-3,541	-3,109	-2,703
O	IRRIGATION	COLORADO	-71,307	-88,577	-97,839	-102,699	-94,640	-87,052
O	LIVESTOCK	BRAZOS	0	0	0	0	0	0
O	LIVESTOCK	COLORADO	0	0	0	0	1	0
O	MANUFACTURING	COLORADO	0	0	0	0	0	0
O	MEADOW	COLORADO	0	0	0	0	0	0
O	MINING	COLORADO	0	0	0	0	0	0
	Sum of Projected Water Supply Needs (acre-feet/year)		**-74,888**	**-92,092**	**-101,347**	**-106,675**	**-98,207**	**-90,212**

Projected Water Management Strategies
TWDB 2012 State Water Plan Data

HOCKLEY COUNTY

WUG, Basin (RWPG)

All values are in acre-feet/year

Water Management Strategy	Source Name [Origin]	2010	2020	2030	2040	2050	2060
ANTON, BRAZOS (O)							
LOCAL GROUNDWATER DEVELOPMENT	OGALLALA AQUIFER [HOCKLEY]	569	569	512	461	415	373
MUNICIPAL WATER CONSERVATION	CONSERVATION [HOCKLEY]	14	11	6	2	0	0
IRRIGATION, BRAZOS (O)							
IRRIGATION WATER CONSERVATION	CONSERVATION [HOCKLEY]	25,809	23,227	20,905	18,814	16,933	15,240
IRRIGATION, COLORADO (O)							
IRRIGATION WATER CONSERVATION	CONSERVATION [HOCKLEY]	2,244	2,020	1,818	1,636	1,472	1,325
ROPESVILLE, BRAZOS (O)							
LOCAL GROUNDWATER DEVELOPMENT	OGALLALA AQUIFER [HOCKLEY]	0	0	91	89	85	81
SMYER, BRAZOS (O)							
LOCAL GROUNDWATER DEVELOPMENT	OGALLALA AQUIFER [HOCKLEY]	0	0	0	0	0	193
SUNDOWN, COLORADO (O)							
LOCAL GROUNDWATER DEVELOPMENT	OGALLALA AQUIFER [HOCKLEY]	0	412	569	512	461	415
MUNICIPAL WATER CONSERVATION	CONSERVATION [HOCKLEY]	24	25	19	14	11	11
Sum of Projected Water Management Strategies (acre-feet/year)		**28,660**	**26,264**	**23,920**	**21,528**	**19,377**	**17,638**

TERRY COUNTY

WUG, Basin (RWPG)

All values are in acre-feet/year

Water Management Strategy	Source Name [Origin]	2010	2020	2030	2040	2050	2060
BROWNFIELD, COLORADO (O)							
MUNICIPAL WATER CONSERVATION	CONSERVATION [TERRY]	211	448	687	802	793	788
IRRIGATION, BRAZOS (O)							
IRRIGATION WATER CONSERVATION	CONSERVATION [TERRY]	399	359	323	291	261	235

WUG, Basin (RWPG)

All values are in acre-feet/year

Water Management Strategy	Source Name [Origin]	2010	2020	2030	2040	2050	2060
IRRIGATION, COLORADO (O)							
IRRIGATION WATER CONSERVATION	CONSERVATION [TERRY]	12,886	11,597	10,437	9,393	8,455	7,609
Sum of Projected Water Management Strategies (acre-feet/year)		**13,496**	**12,404**	**11,447**	**10,486**		

Appendix C

GAM Run 10-030 MAG

by Mr. Wade Oliver

Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-3132
June 22, 2011

Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by employees under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on June 22, 2011.

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EXECUTIVE SUMMARY:

The estimated total pumping from the Ogallala Aquifer that achieves the desired future conditions adopted by the members of Groundwater Management Area 2 declines from approximately 2,367,000 acre-feet per year to 1,307,000 acre-feet per year between 2010 and 2060. This is summarized by county, regional water planning area, and river basin as shown in Table 2. The corresponding total pumping from the Edwards-Trinity (High Plains) Aquifer declines from approximately 96,000 acre-feet per year to 23,000 acre-feet per year over the same time period (Table 3). The estimated managed available groundwater, the amount available for permitting, for the groundwater conservation districts within Groundwater Management Area 2 for the Ogallala and Edwards-Trinity (High Plains) aquifers declines from approximately 2,368,000 acre-feet per year to 1,266,000 acre-feet per year between 2010 and 2060 (Table 9). The pumping estimates were extracted from Groundwater Availability Modeling Task 10-023, Scenario 3, which Groundwater Management Area 2 used as the basis for developing their desired future conditions.

REQUESTOR:

Mr. Jason Coleman of South Plains Underground Water Conservation District on behalf of Groundwater Management Area 2

DESCRIPTION OF REQUEST:

In a letter dated August 10, 2010 and received August 13, 2010, Mr. Jason Coleman provided the Texas Water Development Board (TWDB) with the desired future conditions of the Ogallala and Edwards-Trinity (High Plains) aquifers adopted by the members of Groundwater Management Area 2. Below are the desired future conditions for the Ogallala and Edwards-Trinity (High Plains) aquifers in the northern portion of the management area as described in Resolution No. 2010-01 and adopted August 5, 2010:

> [T]he *members of* [Groundwater Management Area] *#2 adopt the desired future condition of 50 percent of the saturated thickness remaining after 50 years for the Northern Portion of* [Groundwater Management Area] *#2, based on GAM Run 10-023, Scenario 3…*

As described in Resolution No. 2010-01, the northern portion of Groundwater Management Area 2 consists of Bailey, Briscoe, Castro, Cochran, Crosby, Deaf Smith, Floyd, Hale, Hockley, Lamb, Lubbock, Lynn, Parmer, and Swisher counties.

For the southern portion of Groundwater Management Area 2, desired future conditions for the Ogallala and Edwards-Trinity (High Plains) aquifers were stated as average water-level declines (drawdowns) over the same time period. The average drawdowns specified as desired future conditions for the southern portion of Groundwater Management Area 2 are: Andrews–6 feet, Bordon–3 feet, Dawson–74 feet, Gaines–70 feet, Garza–40 feet, Howard–1 foot, Martin–8 feet, Terry–42 feet, and Yoakum–18 feet.

In response to receiving the adopted desired future conditions, the Texas Water Development Board has estimated the managed available groundwater for each of the groundwater conservation districts within Groundwater Management Area 2 for the Ogallala and Edwards-Trinity (High Plains) aquifers.

Although not explicitly stated in the adopted desired future conditions statement, drawdown estimates for the Edwards-Trinity (High Plains) Aquifer associated with Scenario 3 of GAM Task 10-023 are shown in Table 1 below.

Table 1. Average drawdown in feet in the Edwards-Trinity (High Plains) Aquifer by county in Scenario 3 of GAM Task 10-023.

County	Average drawdown (feet)					
	2010	2020	2030	2040	2050	2060
Bailey	0	1	2	4	4	5
Borden	0	1	1	2	3	4
Cochran	-1	0	3	6	9	11
Dawson	3	21	37	50	60	67
Floyd	3	16	29	41	52	61
Gaines	6	28	42	53	61	67
Garza	2	10	18	26	33	40
Hale	1	8	15	22	29	36
Hockley	1	7	13	19	24	28
Lamb	0	1	1	2	3	3
Lubbock	1	8	14	20	25	29
Lynn	0	7	14	21	27	32
Terry	2	14	25	32	37	40
Yoakum	1	6	10	13	15	17

For purposes of developing total pumping and managed available groundwater numbers, it was assumed that by referencing Scenario 3 of GAM Task 10-023, the groundwater conservation districts in Groundwater Management Area 2 intended to fully incorporate the drawdown and pumping estimates of the Edwards-Trinity (High Plains) Aquifer. Thus, this analysis included those pumping numbers.

METHODS:

Groundwater Management Area 2, located in the Texas Panhandle, contains a portion of the Ogallala Aquifer and the entire Edwards-Trinity (High Plains) Aquifer. The location of Groundwater Management Area 2, the Ogallala and Edwards-Trinity (High Plains) aquifers, and the groundwater availability model cells that represent the aquifers are shown in Figure 1.

The Texas Water Development Board previously completed several predictive groundwater availability model simulations of the Ogallala and Edwards-Trinity (High Plains) aquifers to assist the members of Groundwater Management Area 2 in developing desired future conditions. As stated in Resolution No. 2010-01 and the narrative of the methods used for developing desired future conditions provided by Groundwater Management Area 2, the simulation on which the desired future conditions above are based is Scenario 3 of GAM Task 10-023 (Oliver, 2010). The estimated pumping for Groundwater Management Area 2 presented here, taken directly from the above scenario, has been divided by county, regional water planning area, river basin, and groundwater conservation district. These areas are shown in Figure 2.

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the model run using the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer are described below:

- The results presented in this report are based on "Scenario 3" in GAM Task 10-023 (Oliver, 2010). See GAM Task 10-023 for a full description of the methods, assumptions, and results for the groundwater availability model run.

- Version 2.01 of the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer (Blandford and others, 2008) was used for this analysis. This model is an expansion on and update to the previously developed groundwater availability model for the southern portion of the Ogallala Aquifer described in Blandford and others (2003). See Blandford and others (2008) and Blandford and others (2003) for assumptions and limitations of the groundwater availability model.

- The model includes four layers representing the southern portion of the Ogallala and Edwards-Trinity (High Plains) aquifers. The units comprising the Edwards-Trinity (High Plains) Aquifer (primarily Edwards, Comanche Peak, and Antlers Sand formations) are separated from the overlying Ogallala Aquifer by a layer of Cretaceous shale, where present.

- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) for the Ogallala Aquifer in 2000 is 33 feet. The mean absolute error for the Edwards-Trinity (High Plains) Aquifer in 1997 is 25 feet (Blandford and others, 2008).

- Cells were assigned to individual counties, river basins, regional water planning areas, and groundwater conservation districts as shown in the August 3, 2010 version of the file that associates the model grid to political and natural boundaries for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer. Note that some minor corrections were made to the file to better reflect the relationship of model cells to political boundaries.

- The recharge used for the model run represents average recharge as described in Blandford and others (2003).

Determining Managed Available Groundwater

As defined in Chapter 36 of the Texas Water Code, “managed available groundwater” is the amount of water that may be permitted. The pumping output from groundwater availability models, however, represents the total amount of pumping from the aquifer. The total pumping includes uses of water both subject to permitting and exempt from permitting. Examples of exempt uses include domestic, livestock, and oil and gas exploration. Each district may also exempt additional uses as defined by its rules or enabling legislation.

Since exempt uses are not available for permitting, it is necessary to account for them when determining managed available groundwater. To do this, the Texas Water Development Board developed a standardized method for estimating exempt use for domestic and livestock purposes based on projected changes in population and the distribution of domestic and livestock wells in the area. Because other exempt uses can vary significantly from district to district, and there is much higher uncertainty associated with estimating use due to oil and gas exploration, estimates of exempt pumping outside domestic and livestock uses have not been included. The districts were also encouraged to evaluate the estimates of exempt pumping and, if desired, provide updated estimates. Once established, the estimates of exempt pumping were subtracted from the total pumping output from the groundwater availability model to yield the estimated managed available groundwater for permitting purposes.

RESULTS:

The estimated total pumping from the Ogallala Aquifer in Groundwater Management Area 2 that achieves the above desired future conditions declines from approximately 2,367,000 acre-feet per year in 2010 to 1,307,000 acre-feet per year in 2060. This pumping has been divided by county, regional water planning area, and river basin for each decade between 2010 and 2060 for use in the regional water planning process (Table 2). The corresponding estimated total pumping from the Edwards-Trinity (High Plains) Aquifer declines from approximately 96,000 acre-feet per year to 23,000 acre-feet per year over the same time period (Table 3).

The total pumping estimates for the combined Ogallala and Edwards-Trinity (High Plains) aquifers are also summarized by county, regional water planning area, river basin, and groundwater conservation district as shown in tables 4, 5, 6, and 7, respectively. In Table 7, the total pumping both excluding and including areas outside of a groundwater conservation district is shown. Table 8 contains the estimates of exempt pumping for the Ogallala and Edwards-Trinity (High Plains) aquifers by groundwater conservation district. The managed available groundwater, the difference between the total pumping in the districts (Table 7, excluding areas outside of a district) and the estimated exempt use (Table 8) is shown in Table 9. The total managed available groundwater for the Ogallala and Edwards-Trinity (High Plains) aquifers in Groundwater Management Area 2 declines from approximately 2,368,000 acre-feet per year to 1,266,000 acre-feet per year between 2010 and 2060.

LIMITATIONS:

Managed available groundwater numbers included in this report are the result of subtracting the estimated future exempt use from the estimated total pumping that would achieve the desired future condition adopted by the groundwater conservation districts in the groundwater management area. These numbers, therefore, are the result of (1) running the groundwater model to estimate the total pumping required to achieve the desired future condition and (2) estimating the future exempt use in the area.

The groundwater model used in developing estimates of total pumping is the best available scientific tool that can be used to estimate the pumping that will achieve the desired future condition. Although the groundwater model used in this analysis is the best available scientific tool for this purpose, it, like all models, has limitations. 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 develop estimates of total pumping is the need to make assumptions about the location in the aquifer where future pumping will occur. As actual pumping changes in the future, it will be necessary to evaluate the amount of that pumping as well as its location in the context of the assumptions associated with this analysis. Evaluating the amount and location of future pumping is as important as evaluating the changes in groundwater levels, spring flows, and other metrics that describe the condition of the groundwater resources in the area that relate to the adopted desired future condition.

In addition, certain assumptions have been made regarding future precipitation, recharge, and streamflow in developing these total pumping estimates. Those assumptions also need to be considered and compared to actual future data when evaluating compliance with the desired future condition.

In the case of TWDB's estimates of future exempt use, key assumptions were made as to the pattern of population growth relative to the need for domestic wells or supplied water, per capita use from domestic wells, and livestock uses of water. In the case of district estimates of future exempt use, including exempt use associated with the exploration of oil and gas, the assumptions are specific to that district. In either case, these assumptions need to be considered when reviewing future data related to exempt use.

Given these limitations, users of this information are cautioned that the total pumping numbers should not be considered a definitive, permanent description of the amount of groundwater that can be pumped to meet the adopted desired future condition. 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 future groundwater pumping as well as whether or not they are achieving their desired future conditions. 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 these managed available groundwater numbers given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future.

REFERENCES:

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Blandford, T.N., Kuchanur, M., Standen, A., Ruggiero, R., Calhoun, K.C., Kirby, P., and Shah, G., 2008, Groundwater availability model of the Edwards-Trinity (High Plains) Aquifer in Texas and New Mexico: Final report prepared for the Texas Water Development Board by Daniel B. Stephens & Associates, Inc., 176 p.

National Research Council, 2007. Models in Environmental Regulatory Decision Making. Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p.

Oliver, W., 2010, GAM Task 10-023: Texas Water Development Board, GAM Task 10-023 Report, 27 p.

Texas Water Development Board, 2007, Water for Texas – 2007—Volumes I-III; Texas Water Development Board Document No. GP-8-1, 392 p.

Table 2. Estimated total annual pumping for the Ogallala Aquifer in Groundwater Management Area 2. Results are in acre-feet per year and are divided by county, regional water planning area, and river basin.

County	Region	Basin	Year					
			2010	2020	2030	2040	2050	2060
Andrews	F	Colorado	17,584	15,085	13,678	12,014	10,016	7,377
		Rio Grande	54	50	41	41	41	41
Bailey	O	Brazos	62,538	41,283	34,907	30,064	24,021	21,429
Borden	F	Brazos	292	292	292	292	292	292
		Colorado	107	107	107	107	107	107
Briscoe	O	Red	33,622	26,457	19,722	14,220	13,037	11,933
Castro	O	Brazos	90,367	90,367	90,367	90,367	88,630	84,458
		Red	37,055	36,936	36,141	35,449	34,650	33,540
Cochran	O	Brazos	16,324	7,707	6,556	4,770	4,410	4,179
		Colorado	32,021	28,501	27,085	25,926	23,674	21,192
Crosby	O	Brazos	133,239	133,058	133,058	133,058	133,058	133,058
		Red	1,624	1,624	1,624	1,624	1,624	1,624
Dawson	O	Brazos	5,350	5,350	5,350	5,138	4,075	1,099
		Colorado	196,260	192,758	180,531	156,477	131,379	92,681
Deaf Smith	O	Red	129,167	118,166	106,868	97,057	80,382	65,931
Floyd	O	Brazos	95,488	93,749	92,041	90,930	86,458	84,300
		Red	59,482	55,617	53,320	47,453	43,351	40,061
Gaines	O	Colorado	350,369	240,110	175,175	130,951	97,498	71,544
Garza	O	Brazos	19,203	19,073	18,942	18,812	18,032	17,121
Hale	O	Brazos	130,097	129,291	127,492	125,488	119,612	111,734
		Red	525	525	525	525	525	525
Hockley	O	Brazos	87,712	84,378	80,285	76,847	69,445	60,771
		Colorado	8,256	8,004	8,004	7,571	7,324	7,009
Howard	F	Colorado	3,075	3,075	2,731	2,731	2,731	2,703
Lamb	O	Brazos	147,368	137,304	125,466	111,509	95,696	85,190
Lubbock	O	Brazos	124,519	120,044	115,348	108,699	100,762	91,073
Lynn	O	Brazos	98,003	97,740	96,954	94,600	86,945	78,543
		Colorado	6,020	6,020	6,020	6,020	6,020	5,925
Martin	F	Colorado	13,570	13,570	13,570	13,140	12,299	12,277
Parmer	O	Brazos	50,258	45,572	39,624	35,624	29,978	27,692
		Red	18,436	17,493	16,960	16,525	15,642	13,289
Swisher	O	Brazos	28,248	28,248	26,603	19,889	14,084	8,304
		Red	82,677	79,158	74,399	64,929	59,764	55,994
Terry	O	Brazos	13,342	13,342	13,342	9,793	5,348	4,092
		Colorado	192,317	182,880	121,267	77,305	48,557	29,555
Yoakum	O	Colorado	82,297	59,745	43,575	33,882	26,717	20,040
Total			**2,366,866**	**2,132,679**	**1,907,970**	**1,699,827**	**1,496,184**	**1,306,683**

Table 3. Estimated total annual pumping for the Edwards-Trinity (High Plains) Aquifer in Groundwater Management Area 2. Results are in acre-feet per year and are divided by county, regional water planning area, and river basin.

County	Region	Basin	Year					
			2010	2020	2030	2040	2050	2060
Bailey	O	Brazos	279	279	279	279	279	279
Borden	F	Brazos	65	65	65	65	65	65
		Colorado	41	41	41	41	41	41
Cochran	O	Brazos	137	137	137	137	137	137
		Colorado	127	127	127	127	127	127
Dawson	O	Brazos	0	0	0	0	0	0
		Colorado	1,103	1,103	1,103	1,103	1,103	1,103
Floyd	O	Brazos	521	521	521	518	505	499
		Red	695	695	695	695	695	683
Gaines	O	Colorado	85,058	46,202	30,316	22,997	16,523	12,904
Garza	O	Brazos	18	18	18	18	18	18
		Colorado	0	0	0	0	0	0
Hale	O	Brazos	3,523	3,523	3,523	3,523	3,523	3,419
Hockley	O	Brazos	96	96	96	96	96	96
		Colorado	0	0	0	0	0	0
Lamb	O	Brazos	164	164	164	164	164	164
Lubbock	O	Brazos	690	690	690	690	690	690
Lynn	O	Brazos	221	221	221	221	221	221
		Colorado	9	9	9	9	9	9
Terry	O	Brazos	23	23	23	23	23	23
		Colorado	959	959	922	922	922	922
Yoakum	O	Colorado	2,532	1,893	1,757	1,642	1,642	1,524
Total			**96,261**	**56,766**	**40,707**	**33,270**	**26,783**	**22,924**

Table 4. Estimated total annual pumping for the Ogallala and Edwards-Trinity (High Plains) aquifers summarized by county in Groundwater Management Area 2 for each decade between 2010 and 2060. Results are in acre-feet per year.

County	Year					
	2010	2020	2030	2040	2050	2060
Andrews	17,638	15,135	13,719	12,055	10,057	7,418
Bailey	62,817	41,562	35,186	30,343	24,300	21,708
Borden	505	505	505	505	505	505
Briscoe	33,622	26,457	19,722	14,220	13,037	11,933
Castro	127,422	127,303	126,508	125,816	123,280	117,998
Cochran	48,609	36,472	33,905	30,960	28,348	25,635
Crosby	134,863	134,682	134,682	134,682	134,682	134,682
Dawson	202,713	199,211	186,984	162,718	136,557	94,883
Deaf Smith	129,167	118,166	106,868	97,057	80,382	65,931
Floyd	156,186	150,582	146,577	139,596	131,009	125,543
Gaines	435,427	286,312	205,491	153,948	114,021	84,448
Garza	19,221	19,091	18,960	18,830	18,050	17,139
Hale	134,145	133,339	131,540	129,536	123,660	115,678
Hockley	96,064	92,478	88,385	84,514	76,865	67,876
Howard	3,075	3,075	2,731	2,731	2,731	2,703
Lamb	147,532	137,468	125,630	111,673	95,860	85,354
Lubbock	125,209	120,734	116,038	109,389	101,452	91,763
Lynn	104,253	103,990	103,204	100,850	93,195	84,698
Martin	13,570	13,570	13,570	13,140	12,299	12,277
Parmer	68,694	63,065	56,584	52,149	45,620	40,981
Swisher	110,925	107,406	101,002	84,818	73,848	64,298
Terry	206,641	197,204	135,554	88,043	54,850	34,592
Yoakum	84,829	61,638	45,332	35,524	28,359	21,564
Total	**2,463,127**	**2,189,445**	**1,948,677**	**1,733,097**	**1,522,967**	**1,329,607**

Table 5. Estimated total annual pumping for the Ogallala and Edwards-Trinity (High Plains) aquifers summarized by regional water planning area in Groundwater Management Area 2 for each decade between 2010 and 2060. Results are in acre-feet per year.

Regional Water Planning Area	Year					
	2010	2020	2030	2040	2050	2060
F	34,788	32,285	30,525	28,431	25,592	22,903
O	2,428,339	2,157,160	1,918,152	1,704,666	1,497,375	1,306,704
Total	**2,463,127**	**2,189,445**	**1,948,677**	**1,733,097**	**1,522,967**	**1,329,607**

Table 6. Estimated total annual pumping for the Ogallala and Edwards-Trinity (High Plains) aquifers summarized by river basin in Groundwater Management Area 2 for each decade between 2010 and 2060. Results are in acre-feet per year.

Basin	Year					
	2010	2020	2030	2040	2050	2060
Brazos	1,108,085	1,052,535	1,012,364	961,614	886,567	818,946
Colorado	991,705	800,189	626,018	492,965	386,689	287,040
Red	363,283	336,671	310,254	278,477	249,670	223,580
Rio Grande	54	50	41	41	41	41
Total	**2,463,127**	**2,189,445**	**1,948,677**	**1,733,097**	**1,522,967**	**1,329,607**

Table 7. Estimated total annual pumping for the Ogallala and Edwards-Trinity (High Plains) aquifers summarized by groundwater conservation district (GCD) in Groundwater Management Area 2 for each decade between 2010 and 2060. Results are in acre-feet per year. UWCD refers to Underground Water Conservation District.

Groundwater Conservation District	Year					
	2010	2020	2030	2040	2050	2060
Garza County UWCD	19,221	19,091	18,960	18,830	18,050	17,139
High Plains UWCD No. 1	1,421,975	1,343,554	1,282,656	1,208,126	1,109,582	1,019,597
Llano Estacado UWCD	435,427	286,312	205,491	153,948	114,021	84,448
Mesa UWCD	202,713	199,211	186,984	162,718	136,557	94,883
Permian Basin UWCD	16,403	16,403	16,099	15,669	14,828	14,795
Sandy Land UWCD	84,829	61,638	45,332	35,524	28,359	21,564
South Plains UWCD	207,257	197,820	136,170	88,659	55,466	35,208
Total (excluding non-district areas)	**2,387,825**	**2,124,029**	**1,891,692**	**1,683,474**	**1,476,863**	**1,287,634**
No District	75,302	65,416	56,985	49,623	46,104	41,973
Total (including non-district areas)	**2,463,127**	**2,189,445**	**1,948,677**	**1,733,097**	**1,522,967**	**1,329,607**

Table 8. Estimates of annual exempt use for the Ogallala and Edwards-Trinity (High Plains) aquifers in Groundwater Management Area 2 by groundwater conservation district (GCD) for each decade between 2010 and 2060. Results are in acre-feet per year. UWCD refers to Underground Water Conservation District.

Groundwater Conservation District	Source	Year					
		2010	2020	2030	2040	2050	2060
Garza County UWCD	TA	68	71	69	67	64	59
High Plains UWCD No. 1	D	15,482	16,253	16,712	16,925	17,087	17,043
Llano Estacado UWCD	D	2,242	2,332	2,397	2,443	2,435	2,420
Mesa UWCD	TA	542	558	573	582	566	545
Permian Basin UWCD	TA	575	596	605	608	605	599
Sandy Land UWCD	TA	366	402	424	448	436	422
South Plains UWCD	TA	502	537	569	601	603	599
Total		**19,777**	**20,749**	**21,349**	**21,674**	**21,796**	**21,687**

TA = Estimated exempt use calculated by TWDB and accepted by the district
D = Estimated exempt use calculated by the district

Table 9. Estimates of managed available groundwater for the Ogallala and Edwards-Trinity (High Plains) aquifers in Groundwater Management Area 2 by groundwater conservation district (GCD) for each decade between 2010 and 2060. Results are in acre-feet per year. UWCD refers to Underground Water Conservation District.

Groundwater Conservation District	Year					
	2010	2020	2030	2040	2050	2060
Garza County UWCD	19,153	19,020	18,891	18,763	17,986	17,080
High Plains UWCD No. 1	1,406,493	1,327,301	1,265,944	1,191,201	1,092,495	1,002,554
Llano Estacado UWCD	433,185	283,980	203,094	151,505	111,586	82,028
Mesa UWCD	202,171	198,653	186,411	162,136	135,991	94,338
Permian Basin UWCD	15,828	15,807	15,494	15,061	14,223	14,196
Sandy Land UWCD	84,463	61,236	44,908	35,076	27,923	21,142
South Plains UWCD	206,755	197,283	135,601	88,058	54,863	34,609
Total	**2,368,048**	**2,103,280**	**1,870,343**	**1,661,800**	**1,455,067**	**1,265,947**

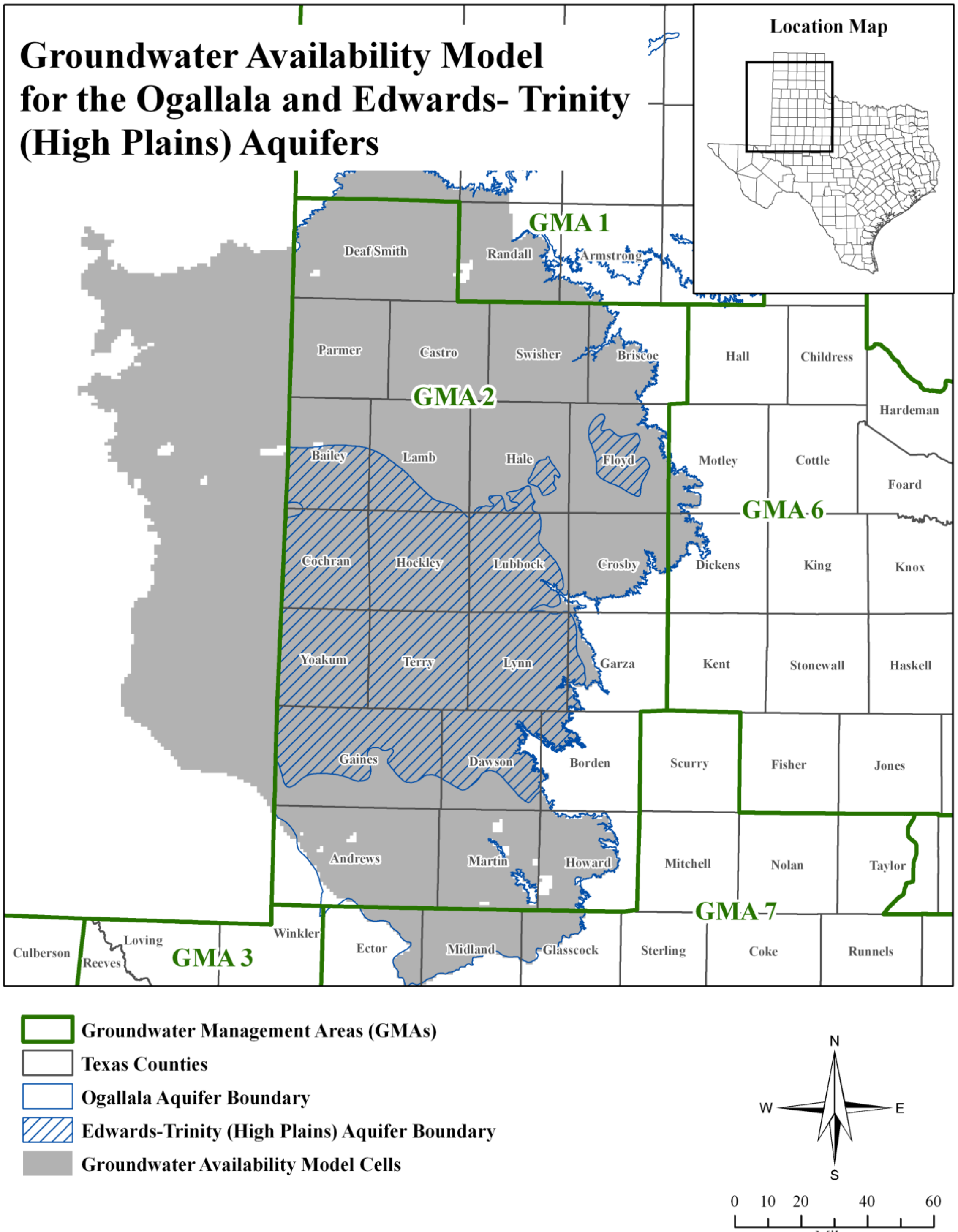

Figure 1. Map showing the areas covered by the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer.

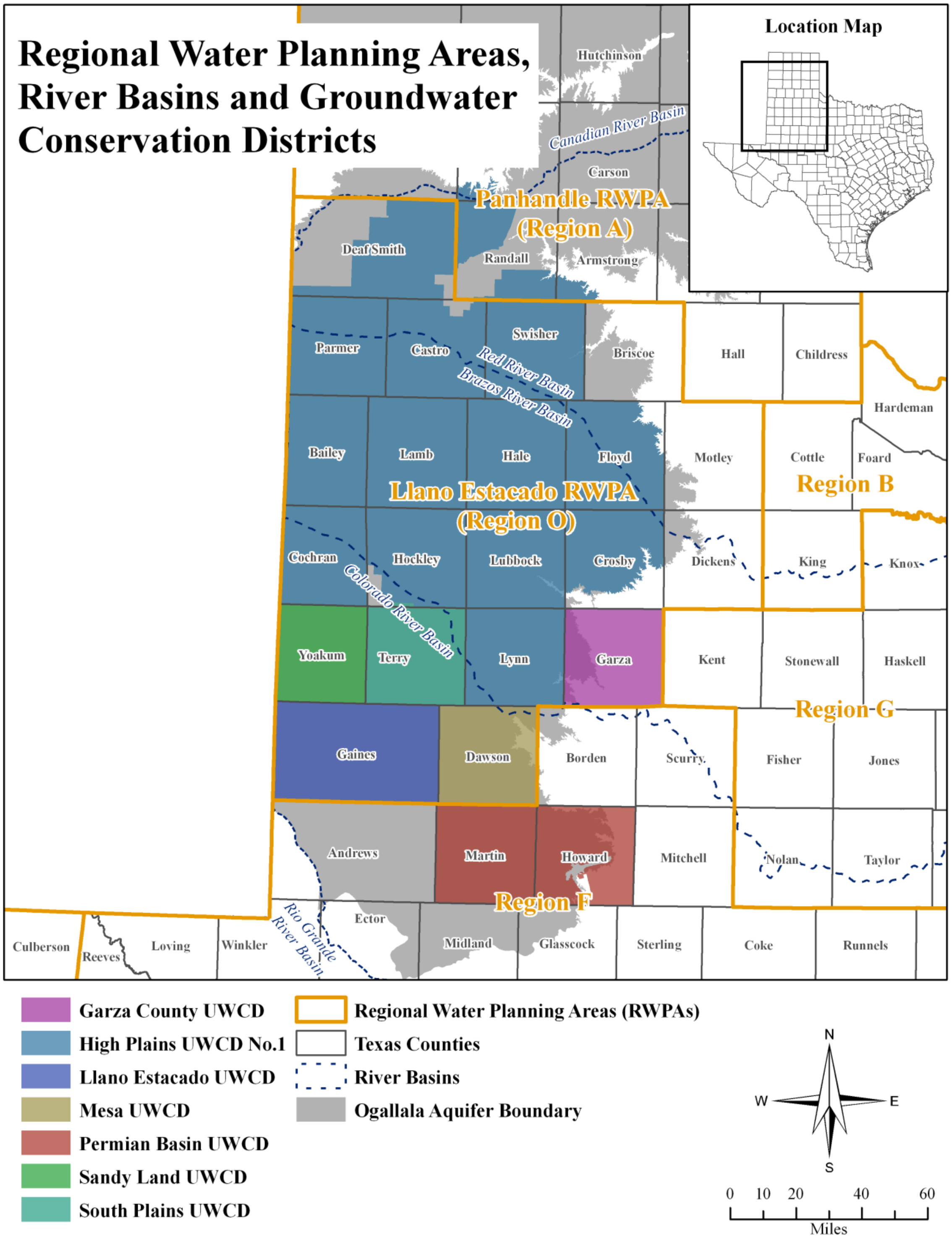
Regional Water Planning Areas, River Basins and Groundwater Conservation Districts
Location Map
Hutchinson
Canadian River Basin
Carson
Panhandle RWPA (Region A)
Deaf Smith
Randall
Armstrong
Parmer
Castro
Swisher
Red River Basin
Brazos River Basin
Briscoe
Hall
Childress
Hardeman
Bailey
Lamb
Hale
Floyd
Motley
Cottle
Foard
Region B
Llano Estacado RWPA (Region O)
Cochran
Hockley
Lubbock
Crosby
Dickens
King
Knox
Colorado River Basin
Yoakum
Terry
Lynn
Garza
Kent
Stonewall
Haskell
Region G
Gaines
Dawson
Borden
Scurry
Fisher
Jones
Andrews
Martin
Howard
Mitchell
Nolan
Taylor
Region F
Culberson
Reeves
Loving
Winkler
Rio Grande River Basin
Ector
Midland
Glasscock
Sterling
Coke
Runnels
Garza County UWCD
High Plains UWCD No.1
Llano Estacado UWCD
Mesa UWCD
Permian Basin UWCD
Sandy Land UWCD
South Plains UWCD
Regional Water Planning Areas (RWPAs)
Texas Counties
River Basins
Ogallala Aquifer Boundary
N
W
E
S
0 10 20 40 60
Miles

Figure 2. Map showing regional water planning areas (RWPAs), groundwater conservation districts (GCDs), counties, and river basins in Groundwater Management Area 2. UWCD refers to Underground Water Conservation District.