Sterling County Underground Water Conservation District

Groundwater Management Plan

2023 - 2028

Adopted: July 10, 2023

Sterling County Underground Water Conservation District

Physical Address:

612 4th Street
Sterling City, TX 76951

Mailing Address:

P.O. Box 873
Sterling City, TX 76951

Phone: 325-378-2704
Fax: 325-378-2624
Cell: 325-242-7329

Web Site:

http://www.sterlinguwcd.org

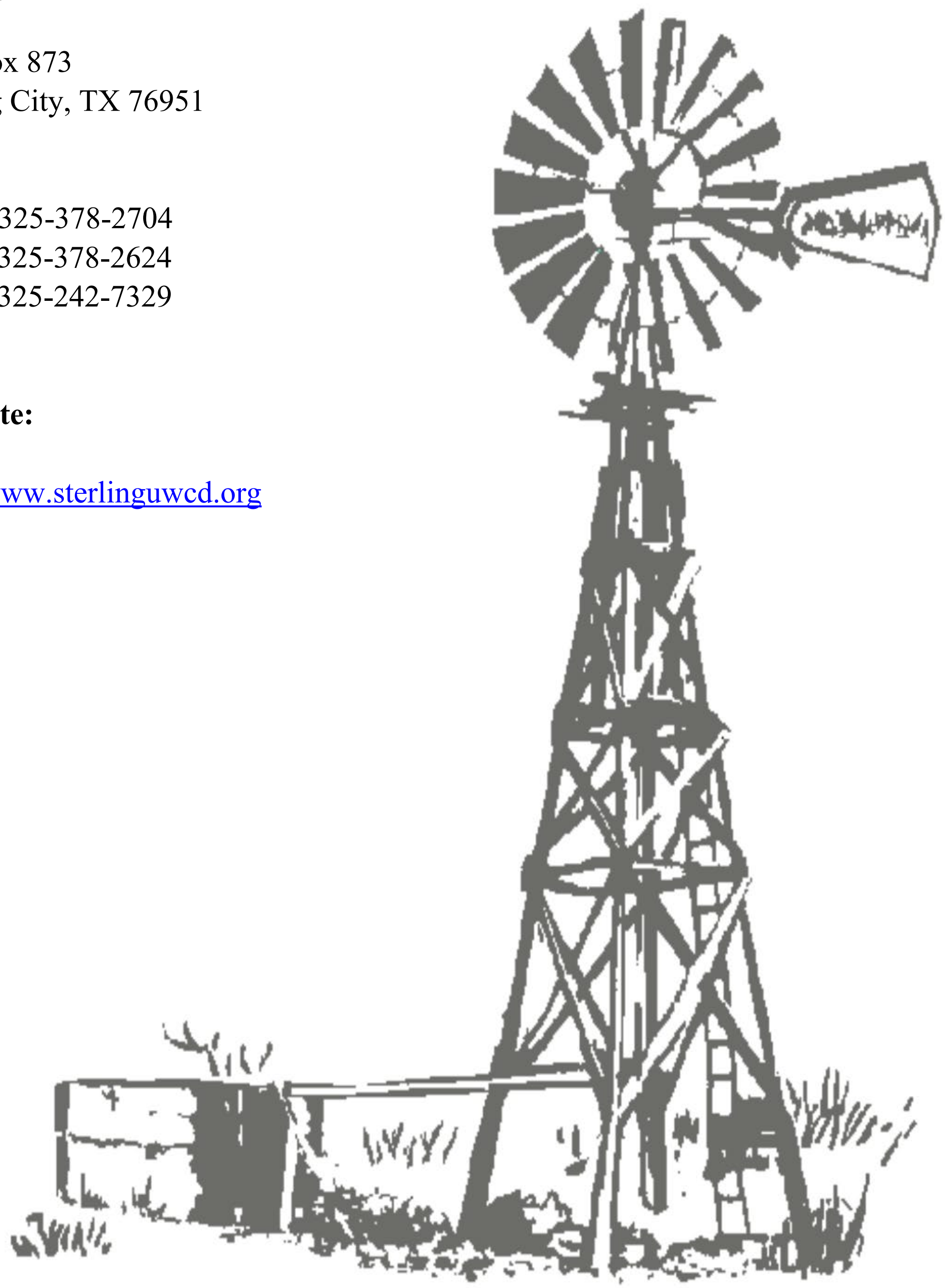


Table of Contents

District Mission 1

Purpose of Management Plan 2

Time Period for this Plan 2

Statement of Guiding Principles 2

General Description 3
- History 3
- Location and Extent 3
- Regional Cooperation and Coordination 3

Groundwater Resources 5
- Edwards-Trinity (Plateau) Aquifer 5
- Dockum Aquifer 5
- Lipan Aquifer 6

Technical District Information Required by Texas Administrative Code 6
- Modeled Available Groundwater in the District. 7
- Amount of Groundwater being Used within the District on an Annual Basis 7
- Annual Amount of Recharge from Precipitation to the Groundwater Resources within the District 7
- Annual Volume of Water that Discharges from the Aquifer to Springs and Surface Water Bodies 8
- Estimate of the Annual Volume of Flow into the District, out of the District and Between Aquifers in the District 8
- Projected Surface Water Supplies within the District 8
- Projected Total Demand for Water within the District 8
- Water Supply Needs 8
- Water Management Strategies 8

Management of Groundwater Supplies, and Actions, Procedures, Performance and Avoidance Necessary to Effectuate the Management Plan 9

Methodology for Tracking Progress 9

Goals, Management Objectives and Performance Standards 10
- Goal 1.0 - §36.1071(a)(1) Providing the Efficient Use of Groundwater 10
- Goal 2.0 - §36.1071(a)(2) Controlling and Preventing Waste of Groundwater 10
- Goal 3.0 - §36.1071(a)(5) Addressing Natural Resource Issues 10
- Goal 4.0 - §36.1071(a)(6) Addressing Drought Conditions 11
- Goal 5.0 - §36.1071(a)(7) Addressing Conservation and Precipitation Enhancement 11

Goal 6.0 - §36.1071(a)(8) Addressing the Desired Future Conditions established under §36.108 12

Management Goals Determined Not-Applicable 12
Goal 7.0 - §36.1071(a)(3) Controlling and Preventing Subsidence 12
Goal 8.0 - §36.1071(a)(4) Addressing Conjunctive Surface Water Management Issues 13
Goal 9.0 - §36.1071(a)(7) Addressing Recharge Enhancement 13
Goal 10.0 - §36.1071(a)(7) Addressing Rainwater Harvesting 13
Goal 11.0 - §36.1071(a)(7) Addressing Brush Control 13

Appendix A - GAM Run 21-012 MAG 15

Appendix B - Estimated Historical Groundwater Use and 2022 State Water Plan Datasets: Sterling County Underground Water Conservation District 68

Appendix C - GAM Run 17-012: Sterling County Underground Water Conservation District Management Plan 79

Appendix D - District Rules 106

Appendix E - Resolutions Adopting and Amending the Management Plan 107

Appendix F - Evidence of Notice and Hearing 109

Appendix G - Evidence of letters to Surface Water Entities and Region F 112

Sterling County Underground Water Conservation District
Groundwater Management Plan 2023-2028

The Sterling County Underground Water Conservation District (the "District") was created by the 69th Texas Legislature under the authority of Section 59, Article XVI, of the Texas Constitution, and in accordance with Chapter 51 and 52 of the Texas Water Code ("Water Code"), Acts of the 70th Legislature, Regular Session, 1987. In 1995, by Acts of the 74th Legislature, Chapter 52 of the Water Code was repealed and replaced with Chapter 36 of the Water Code effective September 1, 1995. In 2009, by Acts of the 81st Legislature, the enabling legislation for the District was recodified in Texas Special District Local Laws Code Ann. Ch. 8814 Sterling County Underground Water Conservation District.

The District is a governmental agency and a body politic and corporate. The District was created "to provide for the conservation, preservation, protection, recharge, and prevention of waste and pollution of the district's groundwater and surface water" consistent with the objectives set forth in Section 59, Article XVI, of the Texas Constitution, and Chapter 36, Water Code. The District is composed of the territory described by Section 1, Chapter 915, Acts of the 70th Legislature, Regular Session, 1987, and as that territory has been modified under Chapter 36, Water Code, or other law.

District Mission

The mission of the District is to develop, promote and implement water conservation and management strategies to:

a) conserve, preserve, and protect the groundwater supplies of the District,
b) protect and enhance recharge,
c) prevent waste and pollution, and
d) to effect the efficient, beneficial and wise use of water for the benefit of the citizens and economy of the District.

The District seeks to protect the groundwater quality and quantity within the District, pursuant to the powers and duties granted under Chapter 36, Subchapter D of the Texas Water Code. Any action taken by the District shall only be after full consideration and respect has been afforded to the individual property rights of all citizens of the District.

The District also seeks to maintain groundwater ownership and rights of the landowners and their lessees as provided in the Texas Water Code §36.002.

Purpose of Management Plan

The 75th Texas Legislature in 1997 enacted Senate Bill 1 ("SB 1") to establish a comprehensive statewide water planning process. In particular, SB 1 contained provisions that required groundwater conservation districts to prepare management plans to identify the water supply resources and water demands that will shape the decisions of each district. SB 1 designed the management plans to include management goals for each district to manage and conserve the groundwater resources within their boundaries. In 2001, the Texas Legislature enacted Senate Bill 2 ("SB 2") to build on the planning requirements of SB 1 and to further clarify the actions necessary for districts to manage and conserve the groundwater resources of the state of Texas.

The Texas Legislature enacted significant changes to the management of groundwater resources in Texas with the passage of House Bill 1763 (HB 1763) in 2005. HB 1763 created a long-term planning process in which groundwater conservation districts (GCDs) in each Groundwater Management Area (GMA) are required to meet and determine the Desired Future Conditions (DFCs) for the groundwater resources within their boundaries by September 1, 2010 and every five years thereafter. In addition, HB 1763 required GCDs, to share management plans with the other GCDs in the GMA for review by the other GCDs.

The Sterling County Underground Water Conservation District's management plan satisfies the statutory requirements of Chapter 36 of the Texas Water Code, and the administrative requirements of the Texas Water Development Board's (TWDB) rules.

Time Period for this Plan

This plan becomes effective upon adoption by the Board of Directors. The plan remains in effect for five years or until amendment or adoption of a new plan.

Statement of Guiding Principles

The District recognizes that groundwater resources are of the utmost importance for the economy for all groundwater users, first for the residents of the District, and then the region. Also recognized is the importance of understanding the aquifers and aquifer characteristics for proper management of these resources. Integrity and ownership of groundwater are also recognized as important for the management of this precious resource.

The primary goal of the District is to preserve the integrity of the groundwater in the district from all potential contamination sources, mainly oil and gas production and related activities. This is accomplished as the District sets objectives to provide for the conservation, preservation, protection, recharge, prevention of waste and pollution, and efficient use of water including:

a) acquiring additional hydrogeologic data for the aquifers within the District;

b) protecting the landowner's right to the beneficial use of groundwater resources beneath his land;

c) promulgating rules for the protection of all users while maintaining adequate future supplies and;

d) cooperation with other local GCD's to manage shared groundwater resources.

These objectives are best achieved through guidance from the locally elected board members who understand the local conditions and can manage the resource for the benefit of the residents of the district and region. The District shall seek to ensure that maximum groundwater withdrawals do not exceed amounts that would be significantly detrimental for future residents of the District.

General Description

History

The citizens of Sterling County, accepting the importance of protecting the integrity of groundwater from potential contamination from the vast amount of oil and gas production and associated activities and the necessity of local control of groundwater resources, introduced legislation in the 70th Regular Legislative Session (1987) for creation of the District. The District was confirmed the same year. Government of the District is by a five member locally elected board serving staggered four-year terms.

Location and Extent

The District has an areal extent of 616,101 acres (963 square miles) in Sterling and Tom Green Counties located in the west-central part of Texas. Elevation ranges from approximately 2,200 to 2,700 feet above mean sea level. The Us Census Bureau estimated 2021 population is 1,381 including the County Seat, Sterling City. Economy in the District consists of agriculture and oil and gas activities. Agriculture land use is mainly rangeland with limited crop land.

The majority of the District overlies the Edwards-Trinity (Plateau) Aquifer. Minor aquifers of Dockum and Lipan are also present. The District is included in the Upper Colorado Region of the Colorado River Basin, Region F Regional Water Planning Group and Groundwater Management Area 7.

Regional Cooperation and Coordination

<u>West Texas Regional Groundwater Alliance</u>

Since 1988 the District has been involved in coordination of district activities with other GCD's managing the Edwards-Trinity (Plateau) Aquifer. In 1988, four groundwater conservation districts; Coke County UWCD, Glasscock County UWCD, Irion County WCD, and Sterling

County UWCD signed an original Cooperative Agreement. As new districts were created, they too signed the Cooperative Agreement. In the fall of 1996, the original Cooperative Agreement was redrafted and the West Texas Regional Groundwater Alliance was created.
Today, the regional alliance consists of eighteen locally created and locally funded groundwater conservation districts covering all or part of twenty-six counties, that encompass approximately 18.2 million acres or 28,368 square miles of West Central Texas. This West Texas region is as diverse as the State of Texas. Due to the diversity of this region, each member district provides its own unique programs to best serve its constituents. Current member districts are:

Coke Co. UWCD	Crockett Co. GCD	Glasscock GCD
Hickory UWCD # 1	Hill Country UWCD	Irion Co. WCD
Kimble Co. GCD	Lipan-Kickapoo WCD	Lone Wolf GCD
Menard Co. UWD	Middle Pecos GCD	Permian Basin UWCD
Plateau UWC & SD	Reeves Co. GCD	Santa Rita UWCD
Sterling Co. UWCD	Sutton Co. UWCD	Wes-Tex GCD

This regional alliance was created because the local districts have a common objective: to facilitate the conservation, preservation and protection of groundwater supplies, protection and enhancement of recharge, prevention of waste and pollution, and beneficial use of water and related resources. Local districts monitor water-related activities which include but are not limited to the State's largest industries of farming, ranching and oil and gas production. The regional alliance provides coordination essential to the activities of these member districts as they monitor these activities in order to accomplish their objectives.

West Texas Weather Modification Association

In 1996, in response to the resident landowners of seven groundwater conservation districts, the West Texas Weather Modification Association (WTWMA) was formed for the purpose of providing weather modification (cloud seeding) for rainfall and recharge enhancement throughout the geographical region of its members. The target area of the WTWMA includes all of six counties and part of a 7^{th} for a total area of over 5.7 million acres or almost 9,000 square miles of West Central Texas.

Current membership includes:

City of San Angelo	Crockett Co GCD	Irion County WCD
Plateau UWC & SD	Santa Rita UWCD	Sterling County UWCD
Sutton County UWCD		

Recognizing the importance of rainfall in the region, the WTWMA was formed to provide benefits from enhanced rainfall which includes a reduction of groundwater withdrawals, increase in runoff, increase in agricultural productivity with the resulting economic impact for the region, provide additional recharge, and increase spring flow. These benefits are not only realized within the region but also downwind and downstream of the target area.

Regional Water Planning

The District has been active in the Region F, Regional Water Planning Group meetings to provide input in developing and adopting the 2001, 2006, 2011, 2016, and 2021 regional plans. As the regional planning group moves toward adopting future Regional Plans the District will continue to participate in the planning process.

Groundwater Management Area

Groundwater Management Area 7 covers all or part of thirty-three counties and includes twenty groundwater conservation districts. These GCD's manage groundwater resources at the local level in all or part of twenty-four counties within GMA 7 and surrounding areas. The District continues to actively participate in meetings and discussions to determine a feasible future desired condition of the aquifers within the management area and district.

Groundwater Resources

Edwards-Trinity (Plateau) Aquifer

Edwards-Trinity (Plateau) Aquifer is a major aquifer extending across much of the southwestern part of the state. The water-bearing units are composed predominantly of limestone and dolomite of the Edwards Group and sands of the Trinity Group. Although maximum saturated thickness of the aquifer is greater than 800 feet, freshwater saturated thickness averages 433 feet. Water quality ranges from fresh to slightly saline, with total dissolved solids ranging from 100 to 3,000 milligrams per liter, and water is characterized as hard within the Edwards Group. Water typically increases in salinity to the west within the Trinity Group. Elevated levels of fluoride in excess of primary drinking water standards occur within Glasscock and Irion counties. Springs occur along the northern, eastern, and southern margins of the aquifer primarily near the bases of the Edwards and Trinity groups where exposed at the surface. San Felipe Springs is the largest exposed spring along the southern margin. Of groundwater pumped from this aquifer, more than two-thirds is used for irrigation, with the remainder used for municipal and livestock supplies. Water levels have remained relatively stable because recharge has generally kept pace with the relatively low amounts of pumping over the extent of the aquifer.[1]

Dockum Aquifer

The Dockum Aquifer is a minor aquifer found in the northwest part of the state. It is defined stratigraphically by the Dockum Group and includes, from oldest to youngest, the Santa Rosa Formation, the Tecovas Formation, the Trujillo Sandstone, and the Cooper Canyon Formation.

[1] Texas Water Development Board, Report 380, Aquifers of Texas

The Dockum Group consists of gravel, sandstone, siltstone, mudstone, shale, and conglomerate. Groundwater located in the sandstone and conglomerate units is recoverable, the highest yields coming from the coarsest grained deposits located at the middle and base of the group. Typically, the water-bearing sandstones are locally referred to as the Santa Rosa Aquifer. The water quality in the aquifer is generally poor—with freshwater in outcrop areas in the east and brine in the western subsurface portions of the aquifer—and the water is very hard. Naturally occurring radioactivity from uranium present within the aquifer has resulted in gross alpha radiation in excess of the state's primary drinking water standard. Radium-226 and -228 also occur in amounts above acceptable standards. Groundwater from the aquifer is used for irrigation, municipal water supply, and oil field waterflooding operations, particularly in the southern High Plains. Water level declines and rises have occurred in different areas of the aquifer.[2]

Lipan Aquifer

The Lipan Aquifer is a minor aquifer found in parts of Coke, Concho, Glasscock, Irion, Runnels, Schleicher, Sterling, and Tom Green counties in west-central Texas. The aquifer includes water-bearing alluvium and the updip portions of older, underlying strata. The alluvium includes as much as 125 feet of saturated sediments of the Quaternary Leona Formation. These deposits consist mostly of gravels and conglomerates cemented with sandy lime and layers of clay. The formation generally fines upward with conglomerates existing mainly in locations of thicker alluvium. The underlying strata include the San Angelo Sandstone of the Pease River Group and the Choza Formation, Bullwagon Dolomite, Vale Formation, Standpipe Limestone, and Arroyo Formation of the Clear Fork Group. These units are predominantly limestones and shales. Groundwater in the alluvial deposits and the upper parts of the older rocks is hydraulically connected, and most wells in the area are completed in both units. Groundwater flow in the Lipan Aquifer does not appear to be structurally controlled. Higher production wells appear to correspond to alluvial deposits overlying the Choza, Bullwagon, and Vale formations. In these areas, thick alluvial deposits with conglomerates lie near the contact with the Permian. Groundwater in the alluvium ranges from fresh to slightly saline, containing between 350 and 3,000 milligrams per liter of total dissolved solids, and is very hard. Water in the underlying parts of the Choza Formation and Bullwagon Dolomite tends to be moderately saline with total dissolved solids in excess of 3,000 milligrams per liter. The aquifer is primarily used for irrigation but also supports livestock and municipal, domestic, and manufacturing uses. Because of drought and heavy irrigation pumping in the late 1990s, water levels decreased significantly in some areas, and the aquifer could not be pumped through the entire irrigation season. In other areas, however, the aquifer could be pumped, but only at a reduced rate.[3]

Technical District Information Required by Texas Administrative Code

Texas Water Code § 36.001 defines modeled available groundwater as "the amount of water that

[2] Ibid

[3] Ibid

the executive administrator determines may be produced on an average annual basis to achieve a desired future condition established under Section 36.108."

The joint planning process set forth in Texas Water Code § 36.108 must be collectively conducted by all groundwater conservation districts within the same GMA. The District is a member of GMA 7. GMA 7 declared the Dockum and Lipan Aquifers as not relevant for regional planning purposes in the Sterling County Underground Water Conservation District and adopted DFCs for the Edwards/Trinity (Plateau) Aquifer on August 19, 2021. The adopted DFCs were forwarded to the TWDB for development of the MAG calculations. The submittal package for the DFCs can be found here:
https://www.twdb.texas.gov/groundwater/management_areas/gma7.asp

A summary of the desired future conditions and the modeled available groundwater are summarized below.

Edwards/Trinity (Plateau) Aquifer: An average drawdown of 7 feet for the Edwards-Trinity (Plateau) aquifer based on the GMA 7 Technical Memorandum 18-01.

Dockum Aquifer: Not relevant for joint planning purposes within the boundaries of Sterling County Underground Water Conservation District.

Lipan Aquifer: Not relevant for joint planning purposes within the boundaries of Sterling County Underground Water Conservation District.

Estimated Modeled Available Groundwater in ac/ft for the Edwards/Trinity (Plateau) Aquifer by district from GAM Run 21-012 MAG.

	Year					
	2020	2030	2040	2050	2060	2070
Sterling County UWCD	2,495	2,495	2,495	2,495	2,495	2,495

Modeled Available Groundwater in the District.

Please refer to Appendix A

Amount of Groundwater being Used within the District on an Annual Basis

Please refer to Appendix B

Annual Amount of Recharge from Precipitation to the Groundwater Resources within the District

Please refer to Appendix C

Annual Volume of Water that Discharges from the Aquifer to Springs and Surface Water Bodies

Please Refer to Appendix C

Estimate of the Annual Volume of Flow into the District, out of the District and Between Aquifers in the District

Please refer to Appendix C

Projected Surface Water Supplies within the District

Please refer to Appendix B

Projected Total Demand for Water within the District

Projected water demands do not exceed projected available groundwater in Sterling County.

Please refer to Appendix B

Water Supply Needs

There are sufficient water supplies to meet all projected demands in Sterling County.

Projected water supply needs for Tom Green County are primarily municipal and include Concho Rural Water, Goodfellow Air Force Base, manufacturing, and San Angelo. The District's portion of Tom Green County consists of acreage owned within Sterling County that is contiguous with and spills across the county line in a rural part of Tom Green County. The District considered the water supply needs in Tom Green County and given the District's jurisdictional boundaries and the remote location compared to the listed water supply needs, the District considers this to be not relevant.

Please refer to Appendix B

Water Management Strategies

The District continues to encourage conservation, reuse, and weather modification (Goal 5.0 below) to meet the projected strategies in the 2021 Region F Water Plan.

Projected water management strategies for Tom Green County include Concho River Water Project indirect use, municipal conservation, subordination-San Angelo System and Mountain Creek Reservoir, irrigation conservation, weather modification, subordination-OH Ivie non system portion, water audits and leak-Millersview Doole WSC, mining conservation, brush control, Hickory well field expansion, and West Texas Water Partnership- Edwards-Trinity Plateau, Pecos Valley and Trinity Aquifers. The District's portion of Tom Green County consists of acreage owned within Sterling County that is contiguous with and spills across the county line in a rural part of Tom Green County. The District considered the water management strategies in Tom Green County and given the District's jurisdictional boundaries and the wide spread application of District efforts in conservation and weather modification (Goal 6.0 below), the District considers this to be not relevant for the many strategies outside of conservation and weather modification.

Please refer to Appendix B

Management of Groundwater Supplies, and Actions, Procedures, Performance, and Avoidance Necessary to Effectuate the Management Plan

The District will implement and utilize the provisions of this plan as a guide for determining the direction and/or priority for District activities. Operations of the District and all agreements entered into by the District will be consistent with the provisions of this plan.

The District has adopted rules for the management of groundwater resources and will amend those rules as necessary pursuant to TWC Chapter 36 and the provisions of this plan. The promulgation of the rules will be based on the best technical evidence available. Current rules are available at http://www.sterlinguwcd.org/rules.

The District shall treat all residents with equality. Residents may apply to the District for discretion in enforcement of the rules on grounds of adverse economic effect or unique local character. In granting discretion to any rule, the Board shall consider the potential for adverse effect on adjacent landowners. The exercise of said discretion by the Board shall not be construed as limiting the power of the Board. The District will seek cooperation in the implementation of this plan and the management of groundwater supplies within the District.

Methodology for Tracking Progress

The methodology that the District will use to track the progress in achieving the management goals will be as follows: the District holds a regular monthly Board Meeting for the purpose of conducting District business. Each month the Managers Report will reflect meetings attended, water samples collected and analyzed, water levels monitored, fluid injection permit applications, reports on any school or civic group programs, resulting action regarding potential contamination or remediation of actual contamination, and other matters of district importance. Additionally, the District General Manager will prepare and present an annual report to the Board regarding achievement of management plan goals and objectives for the preceding fiscal year.

Goals, Management Objectives and Performance Standards

Goal 1.0 - §36.1071(a)(1) Providing the Efficient Use of Groundwater

The District strives to gather groundwater data both to improve the understanding of the aquifers and their hydrogeologic properties and to quantify this resource for prudent planning and efficient use.

1.1. Management Objective
The District will measure, record, and accumulate a historic record of static water levels in the monitoring network quarterly.

1.1a. Performance Standard
Monitor network water level measurements will be reported quarterly at regularly scheduled board meetings.

Goal 2.0 - §36.1071(a)(2) Controlling and Preventing Waste of Groundwater

The District strives to minimize potential waste and contamination of the groundwater by monitoring the drilling, spacing, and completion of wells.

2.1. Management Objective
The District will register new wells drilled within the district in accordance with District Rules.

2.1a. Performance Standard
The District will maintain files including information on the drilling, spacing, and completion of all new wells drilled within the District. Newly registered wells will be reported quarterly at regularly scheduled board meetings.

Goal 3.0 - §36.1071(a)(5) Addressing Natural Resource Issues

The District recognizes the reliance of other natural resources on groundwater supplies.

3.1 Management Objective
The District will track the number of wells being permitted and drilled to support oil and gas drilling and production operations.

3.1a. Performance Standard
The District will report the number of tracked wells to the Board quarterly at regularly scheduled board meetings.

3.2 Management Objective

There is the opportunity to participate in discussions, planning, and education concerning the interrelationship of groundwater with other natural resource issues through GMA 7 and the water planning process.

3.2a. Performance Standard
A representative of the District will attend a minimum of 50% of the GMA 7 meetings annually.

Goal 4.0 - §36.1071(a)(6) Addressing Drought Conditions

The District's lack of surface water supplies and semi-arid climate conditions results in drought monitoring being an important component of informed management. The District strives to remain aware of ever changing climatic conditions.

4.1.Management Objective
The District will monitor the NOAA Climate Prediction Center, http://www.cpc.ncep.noaa.gov/ and the TWDB drought page, https://waterdatafortexas.org/drought/.

4.1a. Performance Standard
The drought index will be reported quarterly at regularly scheduled board meetings.

4.2 .Management Objective
The District will maintain a rainfall monitor network.

4.2a. Performance Standard
Data from the rainfall monitoring network will be reported quarterly at regularly scheduled board meetings.

Goal 5.0 - §36.1071(a)(7) Addressing Conservation and Precipitation Enhancement

The District strives to promote water management strategies recommended in the 2021 Region F Regional Water Plan that have the potential to promote local groundwater supplies and maintain financial responsibility.

5.1 Management Objective - Conservation
The District will continue to be a source for available informational materials and programs to improve public awareness of efficient use, wasteful practices and conservation measures.

5.1a. Performance Standard
The District will provide information to the public annually by participating in a

show, demonstration, education talk, or other community event.

5.2 Management Objective - Precipitation Enhancement
The District will continue to support and participate in the West Texas Weather Modification Association.

5.2a. Performance Standard
The District will stay current with membership assessment fees. A District representative will attend at least 50% of the regularly scheduled meetings.

Goal 6.0 - §36.1071(a)(8) Addressing the Desired Future Conditions established under §36.108

The District strives to gather groundwater data both to improve the understanding of the aquifers and their hydrogeologic properties and in the establishment and monitoring of achievement of desired future conditions.

6.1 Management Objective
The District will each year measure, record, and accumulate a historic record of static water levels in the well monitoring network.

6.1a. Performance Standard
The District will maintain files including number of water levels measured and static levels information on the well monitoring network. Water level measurements will be reported quarterly at regularly scheduled board meetings. Monitor wells tracked by the TWDB will have their measurements reported to the TWDB annually.

6.2 Management Objective
The District will in every fifth year utilize the historic record of static water levels in the well monitoring network to establish a cumulative water level trend to be compared to the adopted Desired Future Condition.

6.2a. Performance Standard
The District will complete an analysis on the cumulative water level trend every five years and present the evaluation to the Board at a regularly scheduled meeting.

Management Goals Determined Not-Applicable

Goal 7.0 - §36.1071(a)(3) Controlling and Preventing Subsidence

The rigid geologic framework of the region precludes significant subsidence from occurring, as identified in the *Identification of the Vulnerability of the Major and Minor Aquifers of Texas to Subsidence with Regard to Groundwater Pumping – TWDB Contract Number 1648302062* report. Table 1.4 on page 1-6 (pdf 28 of 434) summarizes the risk as low for the aquifer as a whole. The subsidence risk at well locations figure on page 4-32 (pdf 81 of 434) visually identifies the risk for Sterling County ranging from insufficient data to low subsidence risk, recognizing that risk is likely skewed due to drillers log descriptions of clay (page 4-31 or pdf 80 of 434). As a result, this management goal is not applicable to the operations of the District.

Goal 8.0 - §36.1071(a)(4) Addressing Conjunctive Surface Water Management Issues

There are no surface water management entities within the District. As recorded by the TCEQ Water Rights Viewer, there are a total of 5 water rights within the boundaries of the SCUWCD of which none have recorded diversions by the TCEQ (Texas Water Rights Viewer (arcgis.com)). The closest USGS data collection point is the N. Concho Rv Abv Sterling City, TX-08133250 gauge which records an average flow of 0.0 ft3/s (N Concho Rv Abv Sterling City, TX - USGS Water Data for the Nation). This management goal is not applicable to the operations of the District.

Goal 9.0 - §36.1071(a)(7) Addressing Recharge Enhancement

The diverse topography, and limited knowledge of any specific recharge sites makes any type of recharge enhancement project economically unfeasible. According to the TWDB Statewide Survey of ASR and AR Suitability, the Sterling County Underground Water Conservation District has a suitability rating that ranges from *neither excess water nor need* throughout most of the jurisdictional boundary to *less suitable* with a small area of *no outcropping aquifer* (https://arcg.is/0zPHir0). This management goal is not applicable to the operation of the District.

Goal 10.0 - §36.1071(a)(7) Addressing Rainwater Harvesting

The semiarid nature of the area within the District makes the cost of large-scale rainwater harvesting projects economically unfeasible. Educational material and programs on rainwater harvesting are provided by the experts at the Texas AgriLife Extension Service. This management goal is not applicable to the operations of the District.

Goal 11.0 - §36.1071(a)(7) Addressing Brush Control

The District recognizes the benefits of brush control through increased spring flows and the enhancement of native turf which limits runoff. However, most brush control projects within the District are carried out and funded through the experts at the Natural Resources Conservation Service (NRCS) and ample educational material and programs on brush control are provided by the Texas AgriLife Extension Service. This management goal is not applicable to the operations of the District.

Appendix A - GAM Run 21-012 MAG

Appendix B - Estimated Historical Groundwater Use and 2022 State Water Plan Datasets: Sterling County Underground Water Conservation District

Appendix C - GAM Run 17-012: Sterling County Underground Water Conservation District Management Plan

Appendix D - District Rules

Appendix E - Resolutions Adopting and Amending the Management Plan

Appendix F - Evidence of Notice and Hearing

Appendix G - Evidence of letters to Surface Water Entities and Region F

Appendix A

GAM RUN 21-012 MAG: MODELED AVAILABLE GROUNDWATER FOR THE AQUIFERS IN GROUNDWATER MANAGEMENT AREA 7

Ian C. Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-6641
August 12, 2022

This page is intentionally left blank.

GAM RUN 21-012 MAG: MODELED AVAILABLE GROUNDWATER FOR THE AQUIFERS IN GROUNDWATER MANAGEMENT AREA 7

Ian C. Jones, Ph.D., P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-6641
August 12, 2022

EXECUTIVE SUMMARY:

The Texas Water Development Board (TWDB) has prepared estimates of the modeled available groundwater for the relevant aquifers of Groundwater Management Area 7—the Capitan Reef Complex, Dockum, Edwards-Trinity (Plateau), Ellenburger-San Saba, Hickory, Ogallala, Pecos Valley, Rustler, and Trinity aquifers. The estimates are based on the desired future conditions for these aquifers adopted by the groundwater conservation districts in Groundwater Management Area 7 on August 19, 2021. The explanatory reports and other materials submitted to the TWDB were determined to be administratively complete on February 23, 2022.

The modeled available groundwater values are summarized by decade for the groundwater conservation districts (Tables 1, 3, 5, 7, 9, 11, 13) and for use in the regional water planning process (Tables 2, 4, 6, 8, 10, 12, 14). The modeled available groundwater estimates for each decade from 2020 through 2070 are:

- 26,164 acre-feet per year in the Capitan Reef Complex Aquifer,
- 2,324 acre-feet per year in the Dockum Aquifer,
- 6,570 to 7,925 acre-feet per year in the Ogallala Aquifer,
- 479,063 acre-feet per year in the undifferentiated Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers,
- 22,616 acre-feet per year in the Ellenburger-San Saba Aquifer,
- 49,936 acre-feet per year in the Hickory Aquifer, and
- 7,040 acre-feet per year in the Rustler Aquifer.

The modeled available groundwater estimates were extracted from results of model runs using the groundwater availability models for the Capitan Reef Complex Aquifer [Version

1.01] (Jones, 2016) for the Capitan Reef Complex Aquifer; the High Plains Aquifer System [Version 1.01] (Deeds and Jigmond, 2015) for the Dockum and Ogallala aquifers; the minor aquifers of the Llano Uplift Area [Version 1.01] (Shi and others, 2016) for the Ellenburger-San Saba and Hickory aquifers, and the Rustler Aquifer [Version 1.01] (Ewing and others, 2012) for the Rustler Aquifer. In addition, the alternative 1-layer model for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers (Hutchison and others, 2011a) was used for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers, except for Kinney and Val Verde counties. In these two counties, the alternative Kinney County model (Hutchison and others, 2011b) and the model associated with a hydrogeological study for Val Verde County and the City of Del Rio (EcoKai and Hutchison, 2014), respectively, were used to estimate modeled available groundwater.

REQUESTOR:

Ms. Meredith Allen, coordinator of Groundwater Management Area 7 districts.

DESCRIPTION OF REQUEST:

In an email dated August 28, 2021, Dr. William Hutchison on behalf of Groundwater Management Area 7 provided the TWDB with the desired future conditions for the Capitan, Dockum, Ellenburger-San Saba, Hickory, Ogallala, and Rustler aquifers, as well as for the undifferentiated Edwards-Trinity (Plateau), Pecos Valley and Trinity aquifers, in Groundwater Management Area 7. Groundwater Management Area 7 provided additional clarifications through an email to the TWDB on November 12, 2021, for the assumptions and model files to be used to calculate modeled available groundwater.

The final adopted desired future conditions as stated in signed resolutions for the aquifers in Groundwater Management Area 7 are as follows:

Capitan Reef Complex Aquifer *(Resolution #08-19-2021-2)*

a) Total net drawdown of the Capitan Reef Complex Aquifer not to exceed 56 feet in Pecos County (Middle Pecos GCD) in 2070 as compared with 2006 aquifer levels. **(Reference: Scenario 4, GMA 7 Technical Memorandum 16-03)*

b) The Capitan Reef Complex Aquifer is not relevant for joint planning purposes in all other areas of GMA 7.

Dockum and Ogallala aquifers *(Resolution #08-19-2021-5)*

Ogallala Aquifer:

a) Total net drawdown of the Ogallala Aquifer not to exceed **6 feet in Glasscock County** in 2070 as compared with 2010 aquifer levels.

Dockum Aquifer:

b) Total net drawdown of the Dockum Aquifer not to exceed **52 feet in Pecos County** in 2070 as compared with 2010 aquifer levels.

c) Total net drawdown of the Dockum Aquifer not to exceed **14 feet in Reagan County** in 2070 as compared with 2010 aquifer levels.

**(Reference items a) through c): Scenario 17, GMA 7 Technical Memorandum 16-01)*

d) The Ogallala and Dockum Aquifers are not relevant for joint planning purposes in all other areas of GMA 7.

Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers *(Resolution #08-19-2021-3)*

a) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **0 feet in Coke County** in 2070 as compared with 2010 aquifer levels.
b) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **10 feet in Crockett County** in 2070 as compared with 2010 aquifer levels.
c) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **4 feet in Ector County** in 2070 as compared with 2010 aquifer levels.
d) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **2 feet in Edwards County** in 2070 as compared with 2010 aquifer levels.
e) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **5 feet in Gillespie County** in 2070 as compared with 2010 aquifer levels.
f) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **42 feet in Glasscock County** in 2070 as compared with 2010 aquifer levels.
g) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **10 feet in Irion County** in 2070 as compared with 2010 aquifer levels.
h) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **1 foot in Kimble County** in 2070 as compared with 2010 aquifer levels.
i) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **1 foot in Menard County** in 2070 as compared with 2010 aquifer levels.
j) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **12 feet in Midland County** in 2070 as compared with 2010 aquifer levels.
k) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **14 feet in Pecos County** in 2070 as compared with 2010 aquifer levels.
l) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **42 feet in Reagan County** in 2070 as compared with 2010 aquifer levels.
m) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **4 feet in Real County** in 2070 as compared with 2010 aquifer levels.
n) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **8 feet in Schleicher County** in 2070 as compared with 2010 aquifer levels.
o) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **7 feet in Sterling County** in 2070 as compared with 2010 aquifer levels.
p) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **6 feet in Sutton County** in 2070 as compared with 2010 aquifer levels.
q) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **0 feet in Taylor County** in 2070 as compared with 2010 aquifer levels.
r) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **2 feet in Terrell County** in 2070 as compared with 2010 aquifer levels.
s) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **20 feet in Upton County** in 2070 as compared with 2010 aquifer levels.
t) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **2 feet in Uvalde County** in 2070 as compared with 2010 aquifer levels.
*(Reference items *a)* through *t)*: GMA 7 Technical Memorandum 18-01)

Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers *(continued)*

u) Total net drawdown in **Kinney County** in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an annual average flow of 23.9 cfs and an annual median flow of **23.9 cfs at Las Moras Springs.**
**(Reference: Groundwater Flow Model of the Kinney County Area by W.R. Hutchison and others, 2011).*

v) Total net drawdown in **Val Verde County** in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an average annual flow of **73-75 mgd at San Felipe Springs.**
**(Reference: EcoKai, 2014)*

w) The Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers are not relevant for joint planning purposes in all other areas of GMA 7.

Minor Aquifers of the Llano Uplift Area *(Resolution #08-19-2021-4)*

Ellenburger-San Saba Aquifer:

a) Total net drawdown of the Ellenburger-San Saba Aquifer not to exceed **8 feet in Gillespie County** in 2070 as compared with 2010 aquifer levels.

b) Total net drawdown of the Ellenburger-San Saba Aquifer not to exceed **18 foot in Kimble County** in 2070 as compared with 2010 aquifer levels.

c) Total net drawdown of the Ellenburger-San Saba Aquifer not to exceed **14 foot in Mason County** in 2070 as compared with 2010 aquifer levels.

d) Total net drawdown of the Ellenburger-San Saba Aquifer not to exceed **29 feet in McCulloch County** in 2070 as compared with 2010 aquifer levels.

e) Total net drawdown of the Ellenburger-San Saba Aquifer not to exceed **46 feet in Menard County** in 2070 as compared with 2010 aquifer levels.

f) Total net drawdown of the Ellenburger-San Saba Aquifer not to exceed **5 feet in San Saba County** in 2070 as compared with 2010 aquifer levels.

Hickory Aquifer:

g) Total net drawdown of the Hickory Aquifer not to exceed **53 feet in Concho County** in 2070 as compared with 2010 aquifer levels.

h) Total net drawdown of the Hickory Aquifer not to exceed **9 feet in Gillespie County** in 2070 as compared with 2010 aquifer levels.

i) Total net drawdown of the Hickory Aquifer not to exceed **18 feet in Kimble County** in 2070 as compared with 2010 aquifer levels.

j) Total net drawdown of the Hickory Aquifer not to exceed **17 feet in Mason County** in 2070 as compared with 2010 aquifer levels.

Minor Aquifers of the Llano Uplift Area *(continued)*

k) Total net drawdown of the Hickory Aquifer not to exceed **29 feet in McColloch County** in 2070 as compared with 2010 aquifer levels.
l) Total net drawdown of the Hickory Aquifer not to exceed **46 feet in Menard County** in 2070 as compared with 2010 aquifer levels.
m) Total net drawdown of the Hickory Aquifer not to exceed **6 feet in San Saba County** in 2070 as compared with 2010 aquifer levels.
**(Reference items a) through m): Scenario 3, GMA 7 Technical Memorandum 16-02)*
n) The Llano Uplift Region (Ellenburger-San Saba, Hickory, Marble Falls) Aquifers are not relevant for joint planning purposes in all other areas of GMA 7.

Rustler Aquifer *(Resolution #08-19-2021-6)*

a) Total net drawdown of the Rustler Aquifer not to exceed **94 feet in Pecos County** in 2070 as compared with 2010 aquifer levels.
**(Reference: Scenario 4, GMA 7 Technical Memorandum 15-05)*
b) The Rustler Aquifer not relevant for joint planning purposes in all other areas of GMA 7.

In addition to the non-relevant statements provided above in the individual resolutions, Groundwater Management Area 7 also provided additional non-relevant documentation dated August 27, 2021 and January 20, 2022 as part of their submittal to TWDB. The following aquifers or parts of aquifers are non-relevant for the purposes of joint planning:

- The entirety of the Blaine, Cross Timbers, Igneous, Lipan, Marble Falls, and Seymour aquifers.
- The Capitan Reef Complex Aquifer outside of the boundaries of the Middle Pecos Groundwater Conservation District.
- The Edwards-Trinity (Plateau) Aquifer in Concho, Mason, McCulloch, Nolan, and Tom Green counties.
- The Ellenburger-San Saba Aquifer in Coleman, Concho, and Mason counties.
- The Hickory Aquifer in Coleman and Llano counties.
- The Dockum Aquifer outside of Reagan and Pecos counties.
- The Ogallala Aquifer outside of Glasscock County.

CLARIFICATIONS:

In response to a request for clarifications from the TWDB in 2021, the Groundwater Management Area 7 Chair, Ms. Meredith Allen, and Groundwater Management Area 7 consultant, Dr. William R. Hutchison, provided the following clarifications regarding the definition of the desired future conditions. These clarifications were necessary for verifying that the desired future conditions of the aquifers were attainable and for confirming approval of the TWDB methodology to calculate modeled available groundwater volumes in Groundwater Management Area 7:

Capitan Reef Complex Aquifer

- The calculated modeled available groundwater values are based on the official TWDB aquifer boundary.
- The modeled available groundwater calculations are based on the desired future conditions with a one-foot tolerance (that is, modeled drawdown verifications within one foot of the desired future conditions are acceptable).
- Drawdown calculations used to define the desired future conditions value take into consideration the occurrence of “dry” cells, where water levels are below the base of the aquifer.

Dockum Aquifer

- The calculated modeled available groundwater values are based on the spatial extent of the Dockum Formation, as represented in the groundwater availability model for the High Plains Aquifer System, rather than the official TWDB aquifer boundary.
- Modeled available groundwater analysis excludes model pass-through cells.
- The modeled available groundwater calculations are based on the desired future conditions with a one-foot tolerance (that is, modeled drawdown verifications within one foot of the desired future conditions are acceptable).

Ogallala Aquifer

- The calculated modeled available groundwater values are based on the official TWDB aquifer boundary and use the same model assumptions used in Groundwater Management Area 7 Technical Memorandum 16-01 (Hutchison, 2016c).
- Drawdown calculations used to define the desired future conditions do not take into consideration the occurrence of “dry” cells, where water levels are below the base of the aquifer.

- The modeled available groundwater calculations are based on the desired future conditions with a one-foot tolerance (that is, modeled drawdown verifications within one foot of the desired future conditions are acceptable).

Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers

- The calculated modeled available groundwater values are based on the official TWDB aquifer boundaries.
- The modeled available groundwater calculations are based on the desired future conditions with a one-foot tolerance (that is, modeled drawdown verifications within one foot of the desired future conditions value are acceptable).
- Drawdown calculations used to define the desired future conditions include drawdowns for cells with water levels below the base elevation of the cell ("dry" cells).

Kinney County

- The modeled available groundwater values, model assumptions, and simulated springflow are from GAM Run 10-043 MAG Version 2 (Shi, 2012).

Val Verde County

- There is no associated drawdown as a desired future condition. The desired future condition is based solely on simulated spring flow conditions at San Felipe Spring of 73 to 75 million gallons per day. Pumping scenarios—50,000 acre-feet per year—in three well field locations and monthly hydrologic conditions for the historic period 1969 to 2012 meet the desired future conditions set by Groundwater Management Area 7 (EcoKai and Hutchison, 2014; Hutchison 2021).

Minor Aquifers of the Llano Uplift Area

- The calculated modeled available groundwater values are based on the full spatial extent of the Ellenburger-San Saba and Hickory formations in the groundwater availability model for the aquifers of the Llano Uplift Area rather than the official TWDB aquifer boundaries and use the same model assumptions used in Groundwater Management Area 7 Technical Memorandum 16-02 (Hutchison 2016b).
- The modeled available groundwater calculations are based on the desired future conditions with a one-foot tolerance (that is, modeled drawdown verifications within one foot of the desired future conditions value are acceptable).

- The drawdown calculations used to define desired future conditions did not include "dry" cells, where water levels are below the base of the aquifer.

Rustler Aquifer

- The model used to define desired future conditions and calculate modeled available groundwater assumes that the initial model heads represent the heads at the end of 2008 (the baseline for calculating desired future conditions drawdown values).
- Calculated modeled available groundwater values are based on the full spatial extent of the Rustler Formation, as represented in the groundwater availability model for the Rustler Aquifer, rather than the official TWDB aquifer boundary.
- The predictive model used to define desired future conditions and calculate modeled available groundwater uses the same model assumptions used in Groundwater Management Area 7 Technical Memorandum 15-05 (Hutchison, 2016d).
- The modeled available groundwater calculations are based on the desired future conditions with a one-foot tolerance (that is, modeled drawdown verifications within one foot of the desired future conditions value are acceptable).

METHODS:

As defined in Chapter 36 of the Texas Water Code (TWC, 2011), "modeled available groundwater" is the estimated average amount of water that may be produced annually to achieve a desired future condition. Groundwater conservation districts are required to consider modeled available groundwater, along with several other factors, when issuing permits to manage groundwater production to achieve the desired future condition(s). The other factors districts must consider include annual precipitation and production patterns, the estimated amount of pumping exempt from permitting, existing permits, and a reasonable estimate of actual groundwater production under existing permits.

For relevant aquifers with desired future conditions based on water-level drawdown, water levels simulated at the end of the predictive simulations were compared to the water levels in the baseline year. These baseline years are 2005 in the groundwater availability model for the Capitan Reef Complex Aquifer and the alternative model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers, 2012 in the groundwater availability model for the High Plains Aquifer System, 2010 in the groundwater availability model for the minor aquifers of the Llano Uplift Area, and 2008 in the groundwater availability model for the Rustler Aquifer. The predictive model runs used average pumping rates from the historical period for the respective model except in the aquifer or area of interest. In those areas, pumping rates are varied until they produce drawdowns consistent with the adopted desired future conditions. In most cases, these model runs were supplied by Groundwater Management Area 7 for review by TWDB staff before they were used to calculate the modeled available groundwater. Pumping rates or modeled available groundwater are reported in 10-year intervals.

Water-level drawdown averages were calculated for the relevant portions of each aquifer. Drawdown for model cells that became dry during the simulation—when the water level dropped below the base of the cell—were excluded from the averaging. In Groundwater Management Area 7, dry cells only occur during the predictive period in the Ogallala Aquifer of Glasscock County. Consequently, estimates of modeled available groundwater decrease over time as continued simulated pumping predicts the development of increasing numbers of dry model cells in areas of the Ogallala Aquifer in Glasscock County. The calculated water-level drawdown averages for all aquifers were compared with the desired future conditions to verify that the pumping scenario achieved the desired future conditions.

In Kinney and Val Verde counties, the desired future conditions are based on discharge from selected springs. In these cases, spring discharge was estimated based on simulated average spring discharge over a historical period, maintaining all historical hydrologic conditions—such as recharge and river stage—except pumping. In other words, we assume that past average hydrologic conditions—the range of fluctuation—will continue in the future. In the cases of Kinney and Val Verde counties, simulated spring discharge was based on hydrologic variations that took place over the periods 1950 through 2005 and 1968 through 2013, respectively. The desired future condition for the Edwards-Trinity (Plateau) Aquifer in Kinney County is similar to the one adopted in 2010 and the associated modeled available groundwater is based on a specific model run—GAM Run 10-043 (Shi, 2012).

Modeled available groundwater values for the Ellenburger-San Saba and Hickory aquifers were determined by extracting pumping rates by decade from the model results using ZONBUDUSG Version 1.01 (Panday and others, 2013). For the remaining relevant aquifers in Groundwater Management Area 7 modeled available groundwater values were determined by extracting pumping rates by decade from the model results using ZONEBUDGET Version 3.01 (Harbaugh, 2009). Decadal modeled available groundwater for the relevant aquifers is reported by groundwater conservation district and county (Figure 1; Tables 1, 3, 5, 7, 9, 11, 13), and by county, regional water planning area, and river basin (Figures 2 and 3; Tables 2, 4, 6, 8, 10, 12, 14).

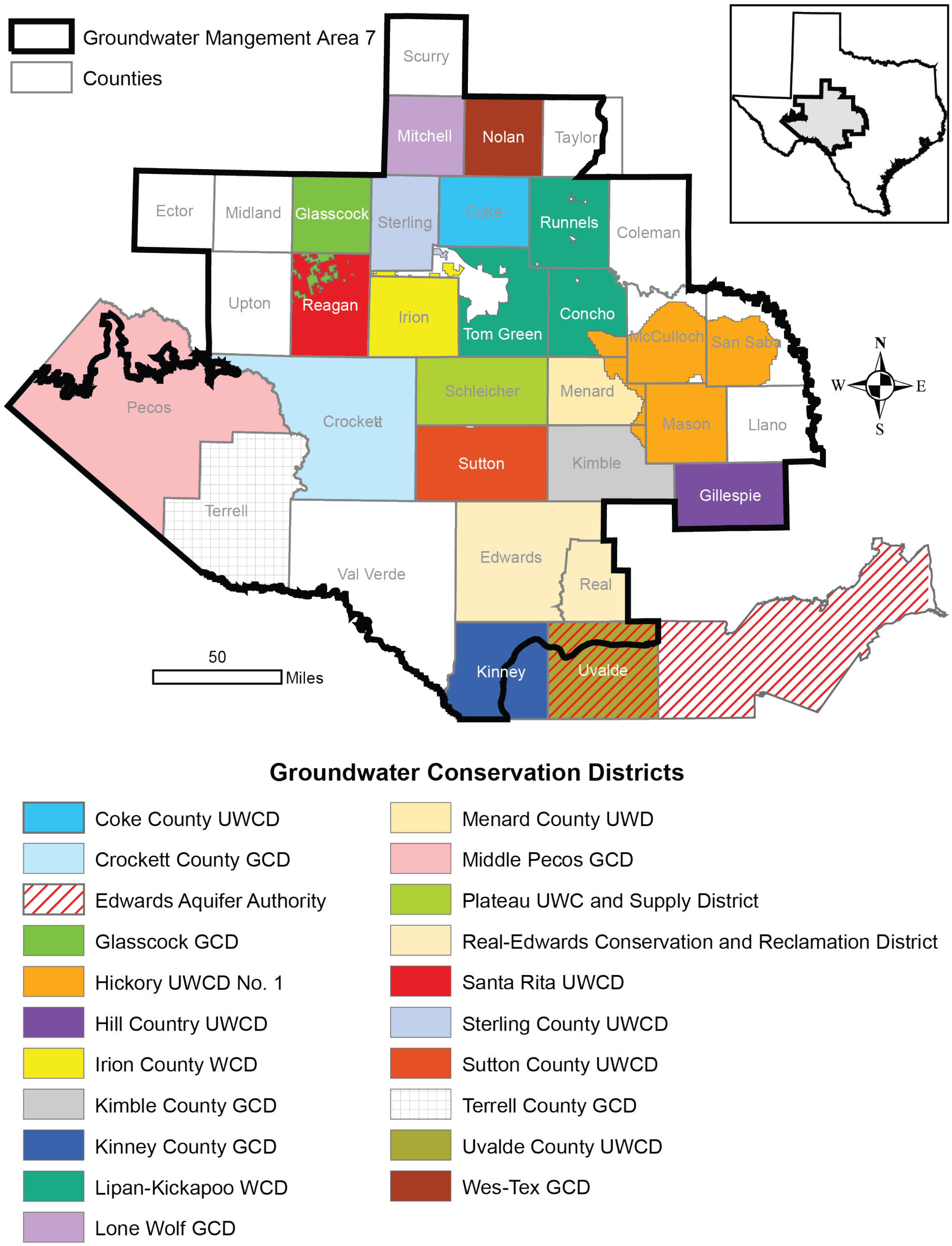


FIGURE 1. MAP SHOWING THE GROUNDWATER CONSERVATION DISTRICTS (GCD) IN GROUNDWATER MANAGEMENT AREA 7. NOTE: THE BOUNDARIES OF THE EDWARDS AQUIFER AUTHORITY OVERLAP WITH THE UVALDE COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (UWCD).

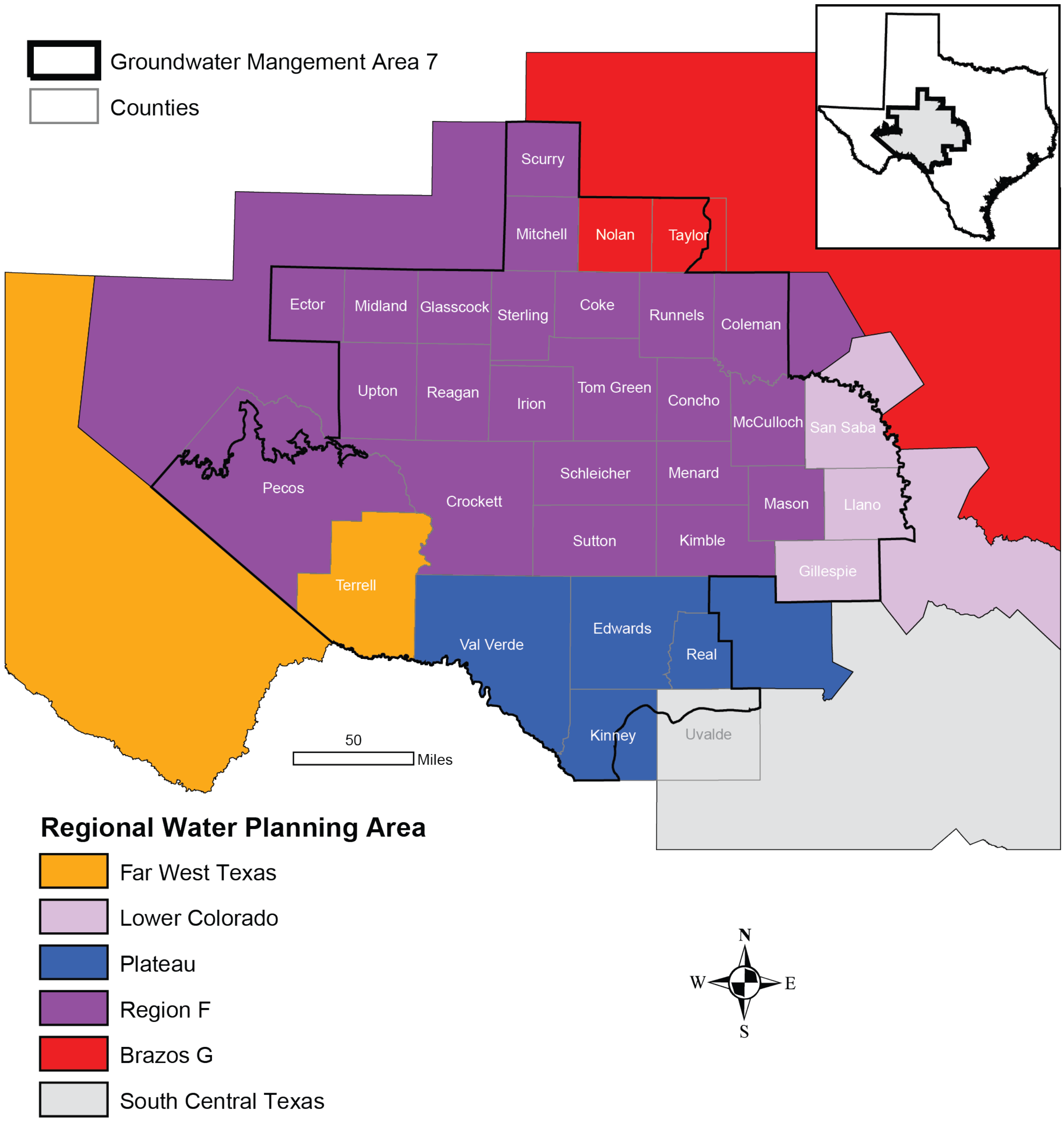


FIGURE 2. MAP SHOWING REGIONAL WATER PLANNING AREAS IN GROUNDWATER MANAGEMENT AREA 7.

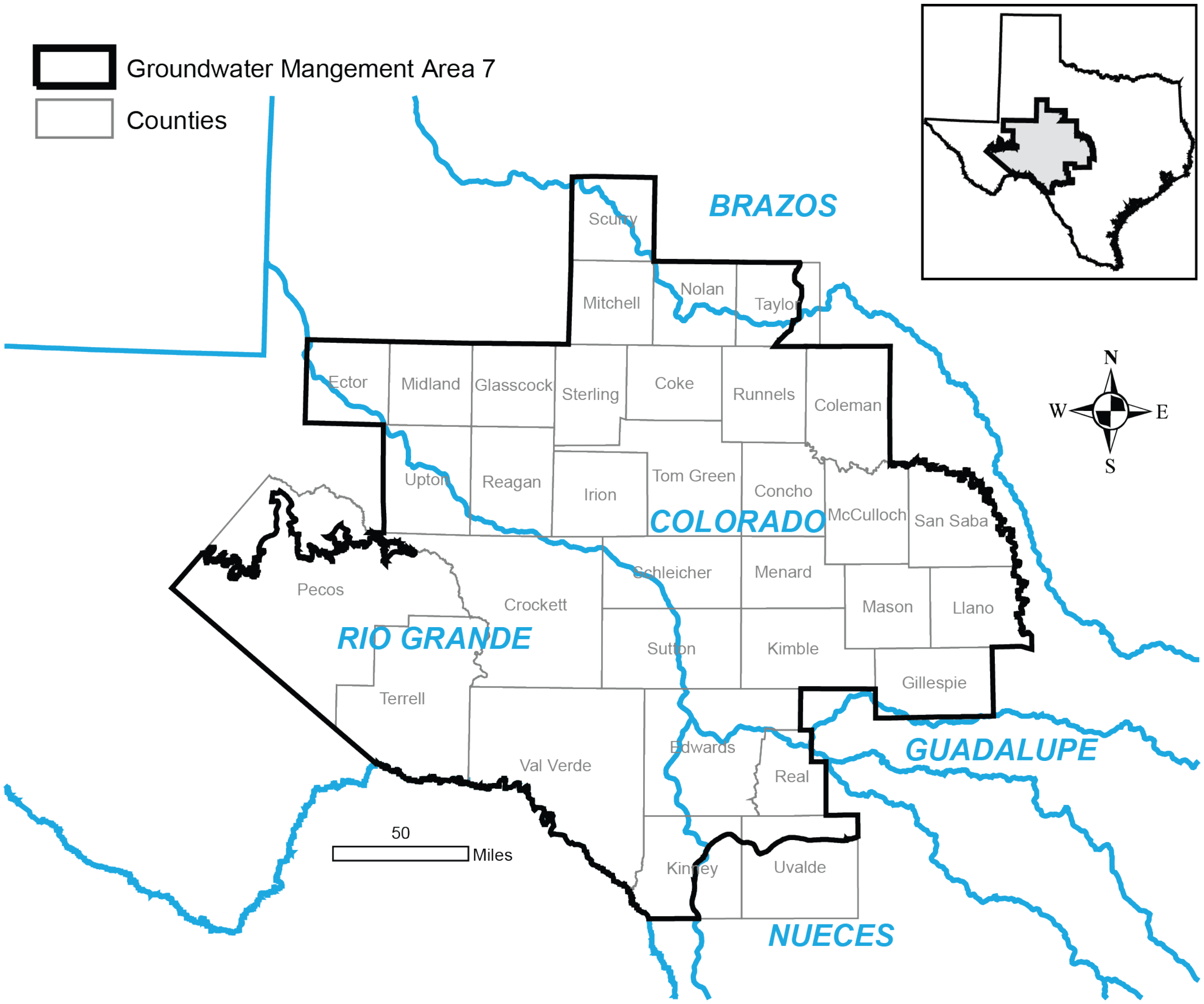


FIGURE 3. MAP SHOWING RIVER BASINS IN GROUNDWATER MANAGEMENT AREA 7. THESE INCLUDE PARTS OF THE BRAZOS, COLORADO, GUADALUPE, NUECES, AND RIO GRANDE RIVER BASINS.

PARAMETERS AND ASSUMPTIONS:

Capitan Reef Complex Aquifer

- Version 1.01 of the groundwater availability model of the eastern arm of the Capitan Reef Complex Aquifer was used. See Jones (2016) for assumptions and limitations of the groundwater availability model. See Hutchison (2016a) for details on the assumptions used for predictive simulations.
- The model has five layers: Layer 1, the Edwards-Trinity (Plateau) and Pecos Valley aquifers; Layer 2, the Dockum Aquifer and the Dewey Lake Formation; Layer 3, the Rustler Aquifer; Layer 4, a confining unit made up of the Salado and Castile formations, and the overlying portion of the Artesia Group; and Layer 5, the Capitan Reef Complex Aquifer, part of the Artesia Group, and the Delaware Mountain Group. Layers 1 through 4 are intended to act solely as boundary conditions facilitating groundwater inflow and outflow relative to the Capitan Reef Complex Aquifer (Layer 5).
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).
- The model was run for the interval 2006 through 2070 for a 64-year predictive simulation. Drawdowns were calculated by subtracting 2006 simulated water levels from 2070 simulated water levels, which were then averaged over the portion of the aquifer in Groundwater Management Area 7.
- During predictive simulations, there were no cells where water levels were below the base elevation of the cell ("dry" cells). Therefore, all drawdowns were included in the averaging.
- Drawdown averages and modeled available groundwater volumes are based on the official TWDB aquifer boundary within Groundwater Management Area 7.

Dockum and Ogallala Aquifers

- Version 1.01 of the groundwater availability model for the High Plains Aquifer System by Deeds and Jigmond (2015) was used to construct the predictive model simulation for this analysis. See Hutchison (2016c) for details of the initial assumptions.
- The model has four layers which represent the Ogallala and Pecos Valley Alluvium aquifers (Layer 1), the Edwards-Trinity (High Plains) and Edwards-Trinity (Plateau) aquifers (Layer 2), the Upper Dockum Aquifer (Layer 3), and the Lower Dockum Aquifer (Layer 4). Pass-through cells exist in layers 2 and 3 to hydraulically connect the Ogallala Aquifer to the Lower Dockum where the Edwards-Trinity (High Plains)

and Upper Dockum aquifers are absent. These pass-through cells were excluded from the calculations of drawdowns and modeled available groundwater.

- The model was run with MODFLOW-NWT (Niswonger and others, 2011). The model uses the Newton formulation and the upstream weighting package, which automatically reduces pumping as heads drop in a particular cell, as defined by the user. This feature may simulate the declining production of a well as saturated thickness decreases. Deeds and Jigmond (2015) modified the MODFLOW-NWT code to use a saturated thickness of 30 feet as the threshold—instead of percent of the saturated thickness—when pumping reductions occur during a simulation. Therefore, the groundwater management area should be aware that the modeled available groundwater values will be less than pumping input values if the modeled saturated thickness drops below that threshold.
- The model was run for the interval 2013 through 2070 for a 58-year predictive simulation. Drawdowns were calculated by subtracting initial water levels from 2070 simulated water levels, which were then averaged over the portion of the aquifer in Groundwater Management Area 7.
- During predictive simulations, there were no cells in the Dockum Aquifer where water levels were below the base elevation of the cell ("dry" cells). Therefore, all drawdowns were included in the averaging. However, in the Ogallala Aquifer, dry cells occurred during the predictive simulation. These dry cells were excluded from the modeled available groundwater calculations.
- Drawdown averages and modeled available groundwater volumes are based on the model boundary within Groundwater Management Area 7 for the Dockum Aquifer and the official TWDB aquifer boundary for the Ogallala Aquifer.

Pecos Valley, Edwards-Trinity (Plateau) and Trinity Aquifers

- The single-layer alternative groundwater flow model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers was used for this analysis. This model is an update to the previously developed groundwater availability model documented in Anaya and Jones (2009). See Hutchison and others (2011a) and Anaya and Jones (2009) for assumptions and limitations of the model. See Hutchison (2016e; 2018) for details on the assumptions used for predictive simulations.
- The groundwater model has one layer representing the Pecos Valley Aquifer and the Edwards-Trinity (Plateau) Aquifer. In the relatively narrow area where both aquifers are present, the model is a lumped representation of both aquifers.
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

- The model was run for the interval 2006 through 2070 for a 65-year predictive simulation. Drawdowns were calculated by subtracting 2010 simulated water levels from 2070 simulated water levels, which were then averaged over the portion of the aquifer in Groundwater Management Area 7.
- Because simulated water levels for the baseline year (2010) are not included in the original calibrated historical model, these water levels had to be verified against measured water levels to confirm that the predictive model satisfactorily matched real-world conditions. Comparison of 2010 simulated and measured water levels indicated a root mean squared error of 100 feet or 4 percent of the range in water-level elevations, which is within acceptable limits. Based on these results, we consider the predictive model an appropriate tool for evaluating the attainability of desired future conditions and for calculating modeled available groundwater.
- Drawdowns for cells with water levels below the base elevation of the cell ("dry" cells) were included in the averaging.
- Drawdown averages and modeled available groundwater volumes are based on the official TWDB aquifer boundaries within Groundwater Management Area 7.

Edwards-Trinity (Plateau) Aquifer of Kinney County

- All parameters and assumptions for the Edwards-Trinity (Plateau) Aquifer of Kinney County in Groundwater Management Area 7 are described in GAM Run 10-043 MAG Version 2 (Shi, 2012). This report assumes a planning period from 2010 to 2070.
- The Kinney County Groundwater Conservation District model developed by Hutchison and others (2011b) was used for this analysis. The model was calibrated to water level and spring flux collected from 1950 to 2005.
- The model has four layers representing the following hydrogeologic units (from top to bottom): Carrizo-Wilcox Aquifer (Layer 1), Upper Cretaceous Unit (Layer 2), Edwards (Balcones Fault Zone) Aquifer/Edwards portion of the Edwards-Trinity (Plateau) Aquifer (Layer 3), and Trinity portion of the Edwards-Trinity (Plateau) Aquifer (Layer 4).
- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).
- The model was run for 56 annual stress periods under the conditions set in Scenario 3 in Task 10-027 (Hutchison, 2011).
- Modeled available groundwater volumes are based on the official TWDB aquifer boundary within Groundwater Management Area 7 in Kinney County.

Edwards-Trinity (Plateau) Aquifer of Val Verde County

- The single-layer numerical groundwater flow model for the Edwards-Trinity (Plateau) Aquifer of Val Verde County was used for this analysis. This model is based on the previously developed alternative groundwater model of the Kinney County area documented in Hutchison and others (2011b). See EcoKai and Hutchison (2014) for assumptions and limitations of the model. See Hutchison (2016e; 2021) for details on the assumptions used for predictive simulations, including recharge and pumping assumptions.
- The groundwater model has one layer representing the Edwards-Trinity (Plateau) Aquifer of Val Verde County.
- The model was run with MODFLOW-2005 (Harbaugh, 2005).
- The model was run for a 45-year predictive simulation representing hydrologic conditions of the interval 1968 through 2013. Simulated spring discharge from San Felipe Springs was averaged over duration of the simulation. The resultant pumping rate that met the desired future conditions was applied to the predictive period—2010 through 2070—based on the assumption that average conditions over the predictive period are the same as those over the historic period represented by the model run.
- Modeled available groundwater volumes are based on the official TWDB aquifer boundary within Groundwater Management Area 7 in Val Verde County.

Minor aquifers of the Llano Uplift Area

- We used version 1.01 of the groundwater availability model for the minor aquifers in the Llano Uplift Area. See Shi and others (2016) for assumptions and limitations of the model. See Hutchison (2016b) for details of the initial assumptions.
- The model contains eight layers: Trinity Aquifer, Edwards-Trinity (Plateau) Aquifer, and younger alluvium deposits (Layer 1), confining units (Layer 2), Marble Falls Aquifer and equivalent units (Layer 3), confining units (Layer 4), Ellenburger-San Saba Aquifer and equivalent units (Layer 5), confining units (Layer 6), Hickory Aquifer and equivalent units (Layer 7), and Precambrian units (Layer 8).
- The model was run with MODFLOW-USG beta (development) version (Panday and others, 2013). Perennial rivers and reservoirs were simulated using the MODFLOW-USG river package. Springs were simulated using the MODFLOW-USG drain package.
- The model was run for the interval 2011 through 2070 for a 60-year predictive simulation. Drawdowns were calculated by subtracting initial water levels from

2070 simulated water levels, which were then averaged over the portion of the aquifer in Groundwater Management Area 7. During predictive simulations, there were no cells where water levels were below the base elevation of the cell ("dry" cells). Therefore, all drawdowns were included in the averaging.

- Drawdown averages and modeled available groundwater volumes are based on the model boundaries within Groundwater Management Area 7.

Rustler Aquifer

- Version 1.01 of the groundwater availability model for the Rustler Aquifer by Ewing and others (2012) was used to construct the predictive model simulation for this analysis. See Hutchison (2016d) for details of the initial assumptions, including recharge conditions.
- The model has two layers, the top one representing the Rustler Aquifer, and the other representing the Dewey Lake Formation and the Dockum Aquifer.
- The model was run with MODFLOW-NWT (Niswonger and others, 2011).
- The model was run for the interval 2009 through 2070 for a 61-year predictive simulation. Drawdowns were calculated by subtracting 2009 simulated water levels from 2070 simulated water levels, which were then averaged over the portion of the aquifer in Groundwater Management Area 7.
- The predictive model used to define desired future conditions uses 2008 recharge conditions throughout the predictive period.
- The predictive model used to define desired future conditions has general-head boundary heads that decline at a rate of 1.5 feet per year.
- During predictive simulations, there were no cells where water levels were below the base elevation of the cell ("dry" cells). Therefore, all drawdowns were included in the averaging.
- Drawdown averages and modeled available groundwater volumes are based on the model boundaries within Groundwater Management Area 7.

RESULTS:

The modeled available groundwater estimates for each decade from 2020 through 2070 are:

- 26,164 acre-feet per year in the Capitan Reef Complex Aquifer,
- 2,324 acre-feet per year in the Dockum Aquifer,

- 6,570 to 7,925 acre-feet per year in the Ogallala Aquifer,
- 479,063 acre-feet per year in the undifferentiated Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers,
- 22,616 acre-feet per year in the Ellenburger-San Saba Aquifer,
- 49,936 acre-feet per year in the Hickory Aquifer, and
- 7,040 acre-feet per year in the Rustler Aquifer.

The modeled available groundwater for the respective aquifers has been summarized by aquifer, county, and groundwater conservation district (Tables 1, 3, 5, 7, 9, 11, and 13). The modeled available groundwater is also summarized by county, regional water planning area, river basin, and aquifer for use in the regional water planning process (Tables 2, 4, 6, 8, 10, 12, and 14). The modeled available groundwater for the Ogallala Aquifer that achieves the desired future conditions adopted by districts in Groundwater Management Area 7 decreases from 7,925 to 6,570 acre-feet per year between 2020 and 2070 (Tables 5 and 6). This decline is attributable to the occurrence of increasing numbers of cells where water levels were below the base elevation of the cell ("dry" cells) in parts of Glasscock County. Please note that MODFLOW-NWT automatically reduces pumping as water levels decline.

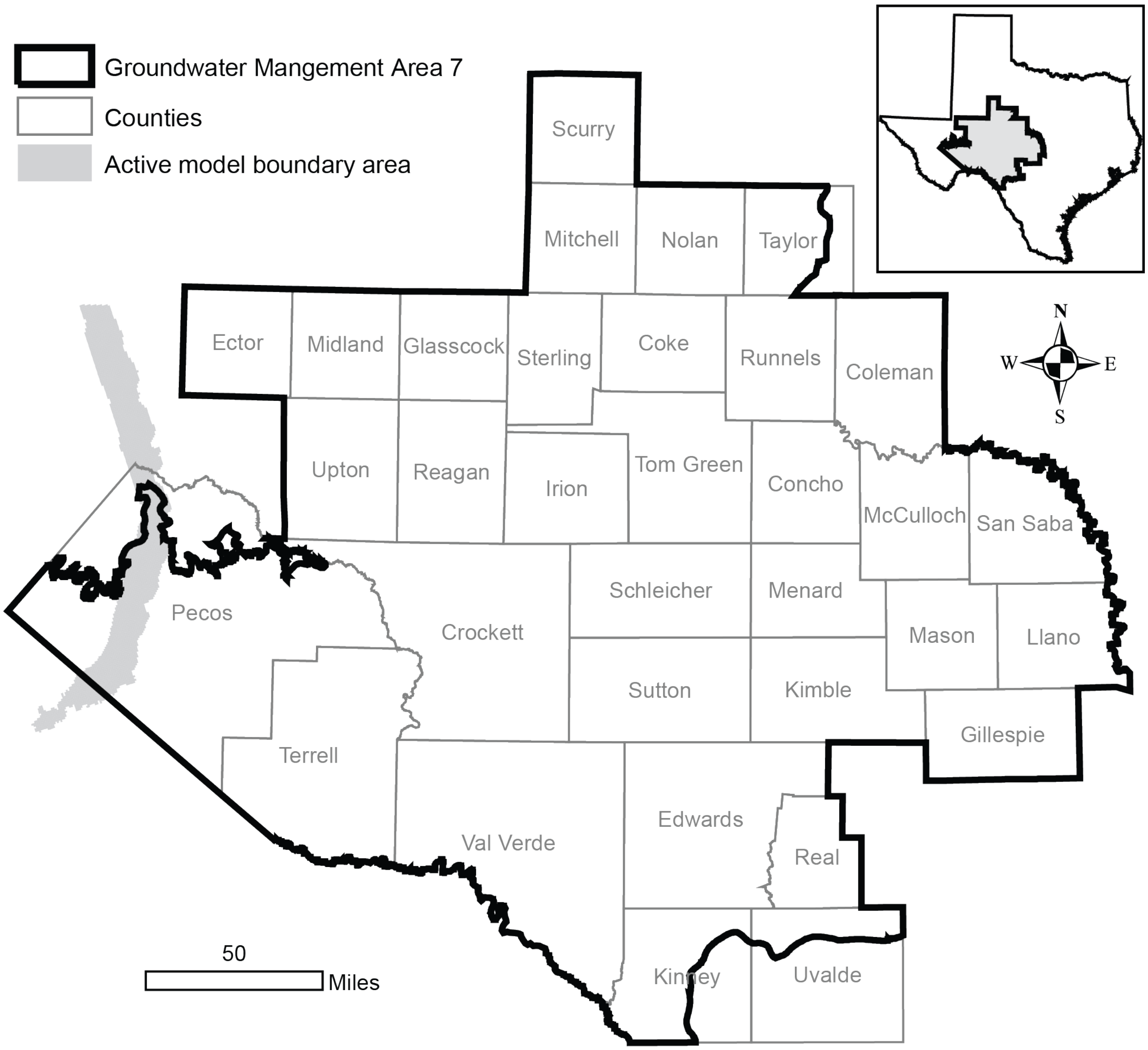


FIGURE 4. MAP SHOWING THE AREAS COVERED BY THE CAPITAN REEF COMPLEX AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE EASTERN ARM OF THE CAPITAN REEF COMPLEX AQUIFER IN GROUNDWATER MANAGEMENT AREA 7.

TABLE 1. MODELED AVAILABLE GROUNDWATER FOR THE CAPITAN REEF COMPLEX AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

District	County	Year					
		2020	2030	2040	2050	2060	2070
Middle Pecos GCD	Pecos	26,164	26,164	26,164	26,164	26,164	26,164
	Total	**26,164**	**26,164**	**26,164**	**26,164**	**26,164**	**26,164**
GMA 7		**26,164**	**26,164**	**26,164**	**26,164**	**26,164**	**26,164**

TABLE 2. MODELED AVAILABLE GROUNDWATER FOR THE CAPITAN REEF COMPLEX AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Pecos	F	Rio Grande	26,164	26,164	26,164	26,164	26,164
		Total	**26,164**	**26,164**	**26,164**	**26,164**	**26,164**
GMA 7			**26,164**	**26,164**	**26,164**	**26,164**	**26,164**

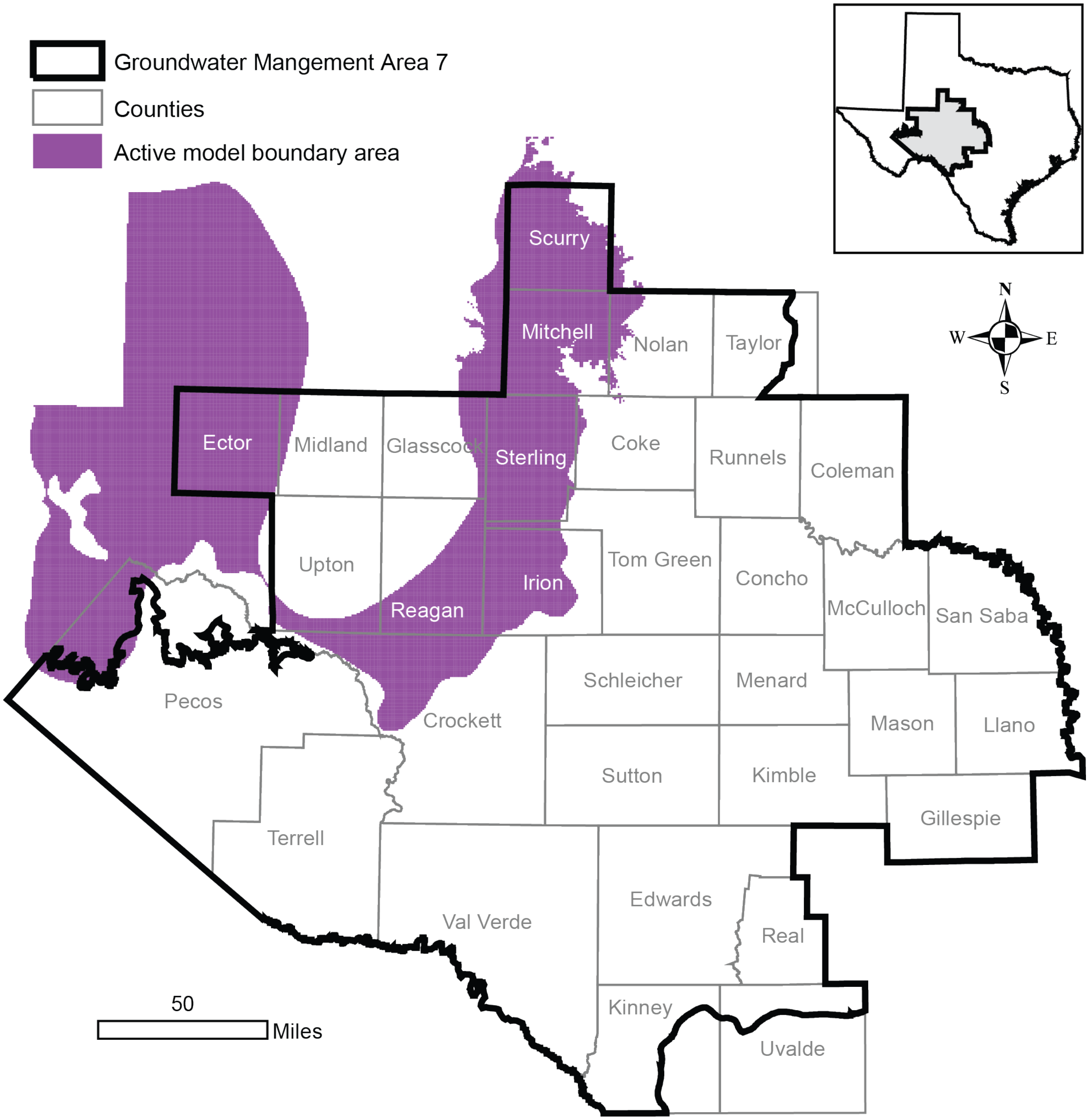


FIGURE 5. MAP SHOWING AREAS COVERED BY THE DOCKUM AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE HIGH PLAINS AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 7.

TABLE 3. MODELED AVAILABLE GROUNDWATER FOR THE DOCKUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR. GCD AND UWCD ARE THE ABBREVIATIONS FOR GROUNDWATER CONSERVATION DISTRICT AND UNDERGROUND WATER CONSERVATION DISTRICT, RESPECTIVELY.

District	County	Year					
		2020	2030	2040	2050	2060	2070
Middle Pecos GCD	Pecos	2,022	2,022	2,022	2,022	2,022	2,022
	Total	**2,022**	**2,022**	**2,022**	**2,022**	**2,022**	**2,022**
Santa Rita UWCD	Reagan	302	302	302	302	302	302
	Total	**302**	**302**	**302**	**302**	**302**	**302**
GMA 7		**2,324**	**2,324**	**2,324**	**2,324**	**2,324**	**2,324**

Note: The modeled available groundwater for Santa Rita Underground Water Conservation District excludes parts of Reagan County that fall within Glasscock Groundwater Conservation District.

TABLE 4. MODELED AVAILABLE GROUNDWATER FOR THE DOCKUM AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Pecos	F	Rio Grande	2,022	2,022	2,022	2,022	2,022
		Total	**2,022**	**2,022**	**2,022**	**2,022**	**2,022**
Reagan	F	Colorado	302	302	302	302	302
		Rio Grande	0	0	0	0	0
		Total	**302**	**302**	**302**	**302**	**302**
GMA 7			**2,324**	**2,324**	**2,324**	**2,324**	**2,324**
Note: The modeled available groundwater for Reagan County excludes parts of Reagan County that fall outside of Santa Rita Underground Water Conservation District.							

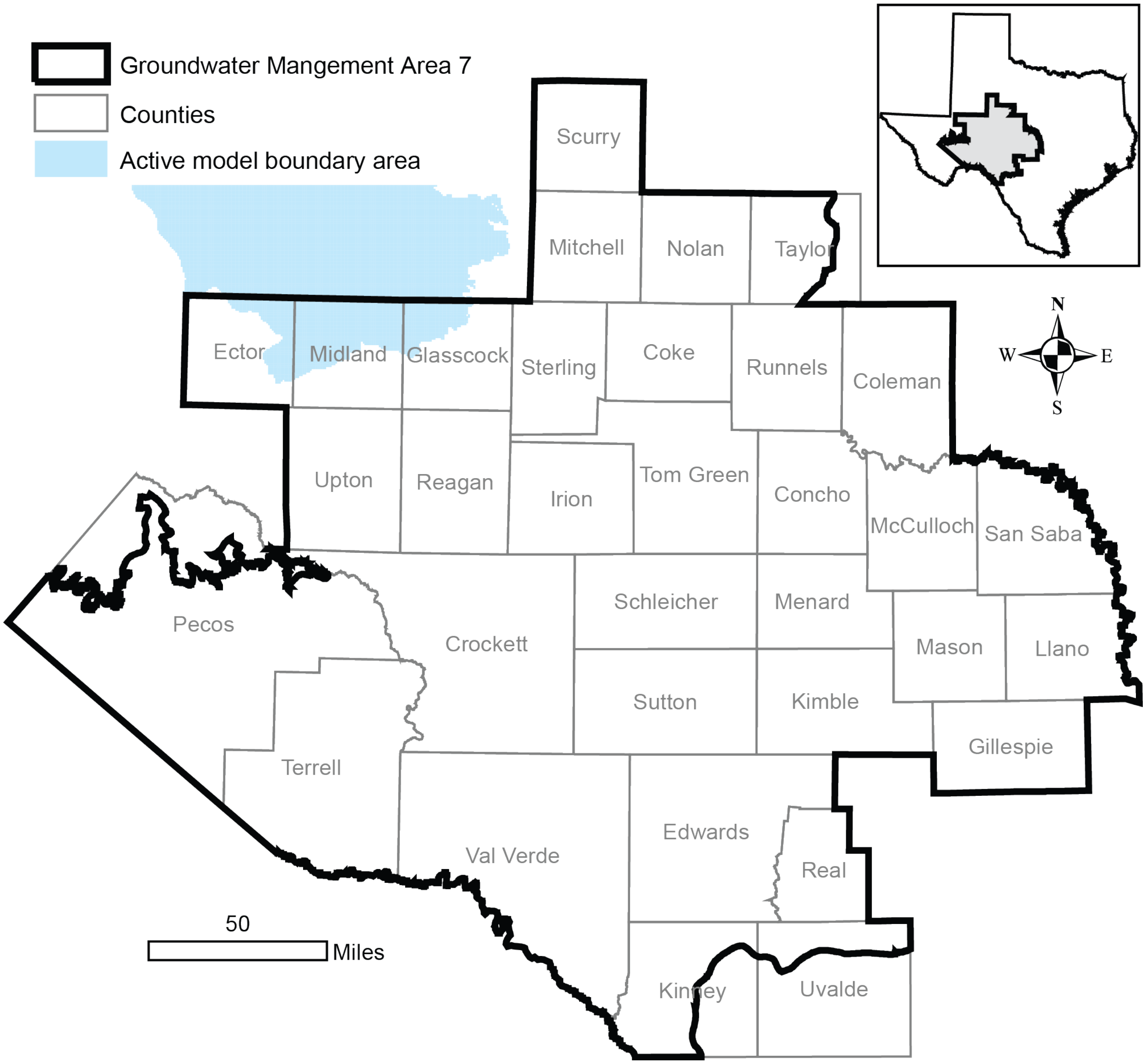


FIGURE 6. MAP SHOWING THE AREAS COVERED BY THE OGALLALA AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE HIGH PLAINS AQUIFER SYSTEM IN GROUNDWATER MANAGEMENT AREA 7.

TABLE 5. MODELED AVAILABLE GROUNDWATER FOR THE OGALLALA AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

District	County	Year					
		2020	2030	2040	2050	2060	2070
Glasscock GCD	Glasscock	7,925	7,673	7,372	7,058	6,803	6,570
	Total	**7,925**	**7,673**	**7,372**	**7,058**	**6,803**	**6,570**
GMA 7		**7,925**	**7,673**	**7,372**	**7,058**	**6,803**	**6,570**

TABLE 6. MODELED AVAILABLE GROUNDWATER FOR THE OGALLALA AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Glasscock	F	Colorado	7,673	7,372	7,058	6,803	6,570
		Total	**7,673**	**7,372**	**7,058**	**6,803**	**6,570**
GMA 7			**7,673**	**7,372**	**7,058**	**6,803**	**6,570**

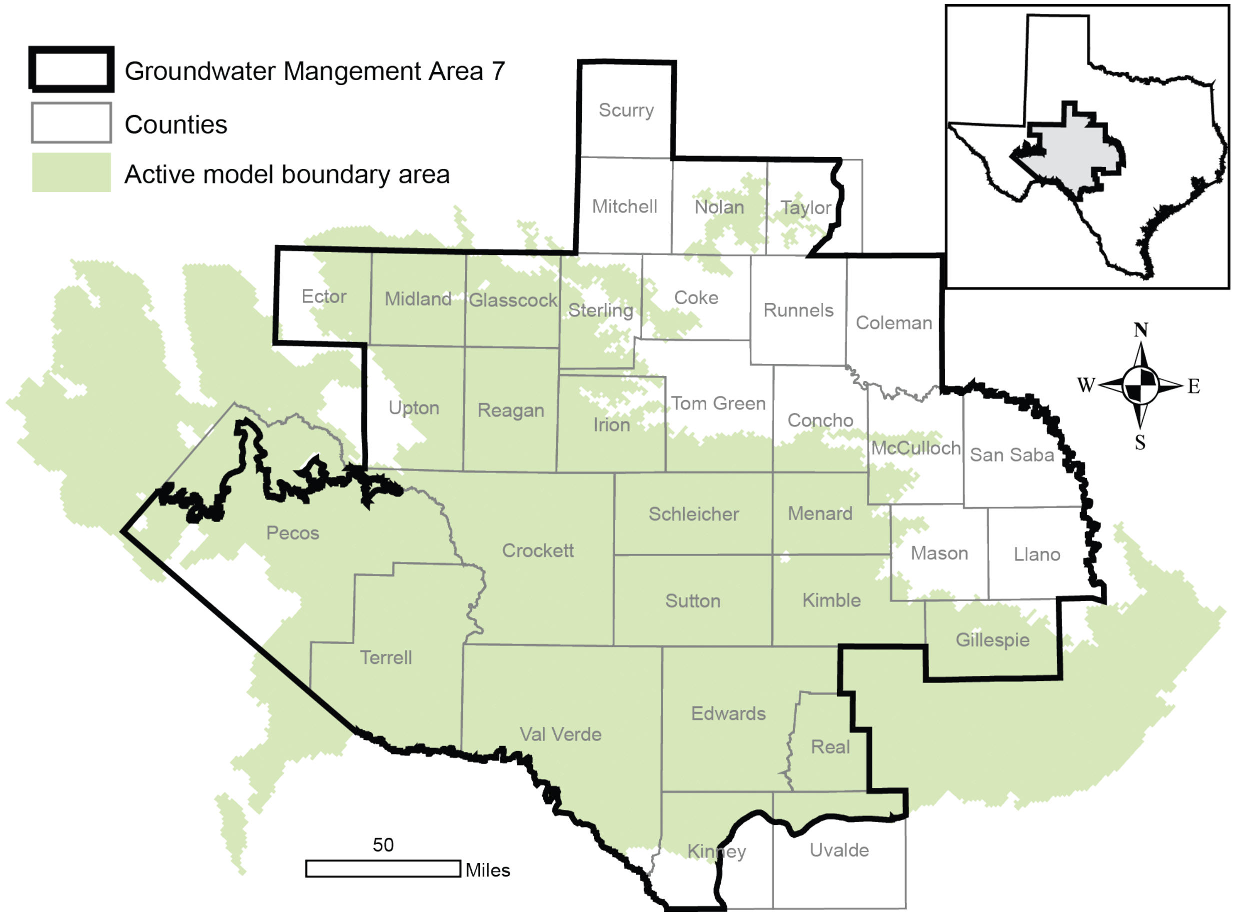


FIGURE 7. MAP SHOWING THE AREAS COVERED BY THE UNDIFFERENTIATED EDWARDS-TRINITY (PLATEAU), PECOS VALLEY, AND TRINITY AQUIFERS IN THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AND PECOS VALLEY AQUIFERS IN GROUNDWATER MANAGEMENT AREA 7.

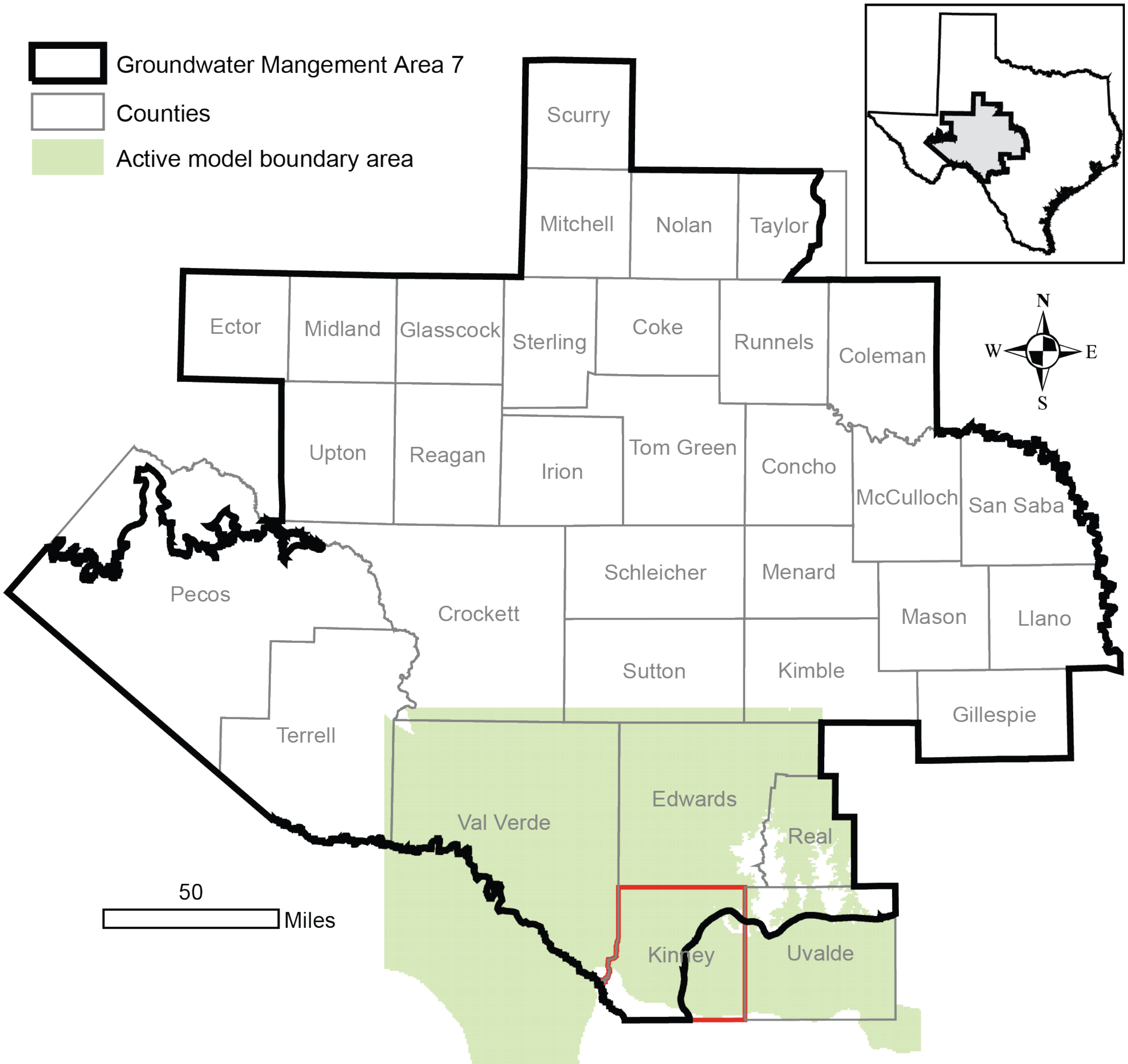


FIGURE 8. **MAP SHOWING THE AREAS COVERED BY THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN THE ALTERNATIVE MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN KINNEY COUNTY [HIGHLIGHTED IN RED].**

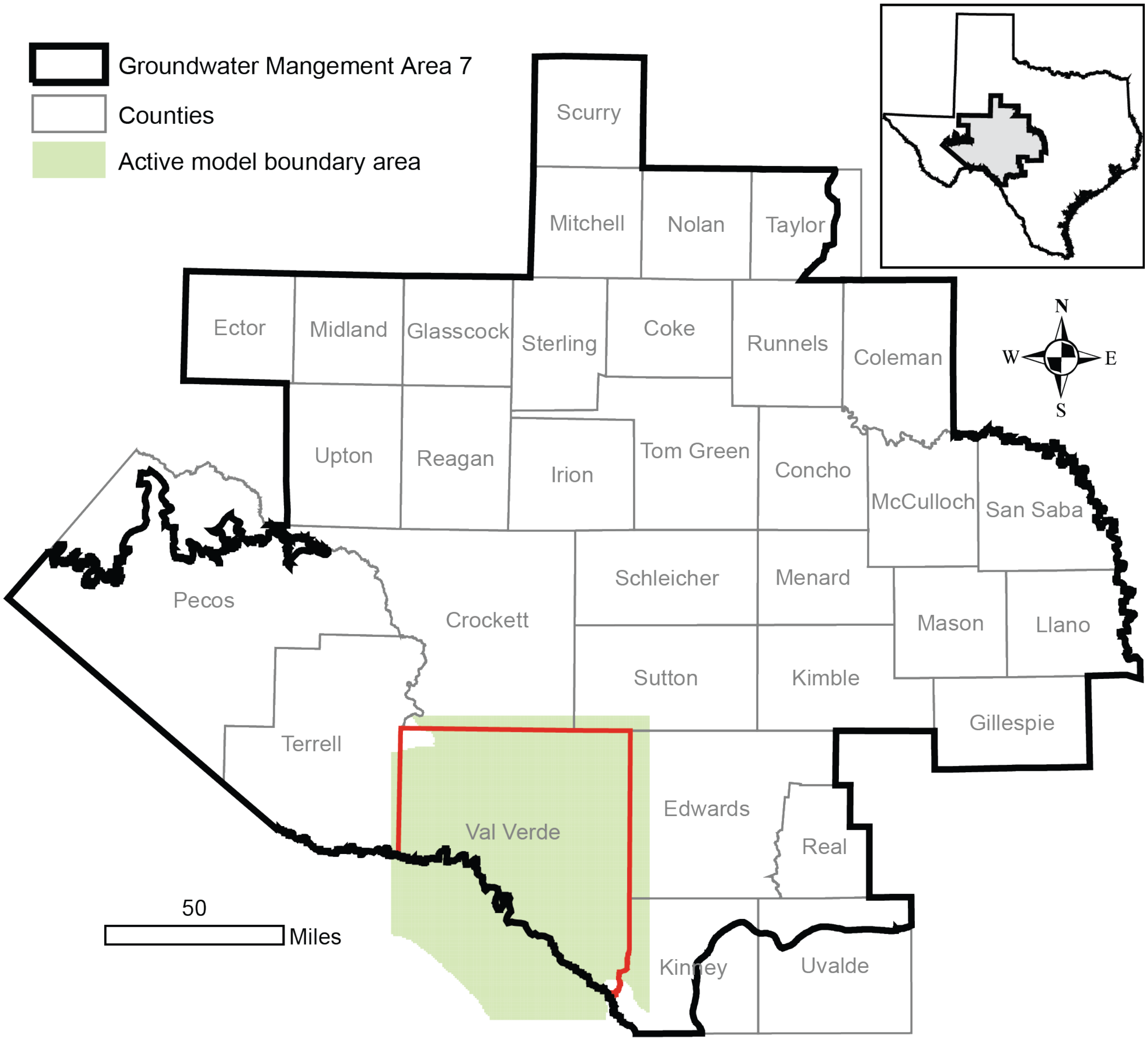


FIGURE 9. MAP SHOWING THE AREAS COVERED BY THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN THE GROUNDWATER FLOW MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER IN VAL VERDE COUNTY [HIGHLIGHTED IN RED].

TABLE 7. MODELED AVAILABLE GROUNDWATER FOR THE UNDIFFERENTIATED EDWARDS-TRINITY (PLATEAU), PECOS VALLEY, AND TRINITY AQUIFERS IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY, FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD IS ABBREVIATION FOR UNDERGROUND WATER CONSERVATION DISTRICT, WCD IS WATER CONSERVATION DISTRICT, UWD IS UNDERGROUND WATER DISTRICT, UWC IS UNDERGROUND WATER CONSERVATION, AND C AND R DISTRICT IS CONSERVATION AND RECLAMATION DISTRICT.

District	County	Year					
		2020	2030	2040	2050	2060	2070
Coke County UWCD	Coke	997	997	997	997	997	997
	Total	**997**	**997**	**997**	**997**	**997**	**997**
Crockett County GCD	Crockett	4,675	4,675	4,675	4,675	4,675	4,675
	Total	**4,675**	**4,675**	**4,675**	**4,675**	**4,675**	**4,675**
Glasscock GCD	Glasscock	65,186	65,186	65,186	65,186	65,186	65,186
	Reagan	40,835	40,835	40,835	40,835	40,835	40,835
	Total	**106,021**	**106,021**	**106,021**	**106,021**	**106,021**	**106,021**
Hickory UWCD No. 1	Kimble	104	104	104	104	104	104
	Menard	380	380	380	380	380	380
	Total	**484**	**484**	**484**	**484**	**484**	**484**
Hill Country UWCD	Gillespie	4,979	4,979	4,979	4,979	4,979	4,979
	Total	**4,979**	**4,979**	**4,979**	**4,979**	**4,979**	**4,979**
Irion County WCD	Irion	3,289	3,289	3,289	3,289	3,289	3,289
	Total	**3,289**	**3,289**	**3,289**	**3,289**	**3,289**	**3,289**
Kimble County GCD	Kimble	1,282	1,282	1,282	1,282	1,282	1,282
	Total	**1,282**	**1,282**	**1,282**	**1,282**	**1,282**	**1,282**

TABLE 7. (CONTINUED).

District	County	Year					
		2020	2030	2040	2050	2060	2070
Kinney County GCD	Kinney	70,341	70,341	70,341	70,341	70,341	70,341
	Total	**70,341**	**70,341**	**70,341**	**70,341**	**70,341**	**70,341**
Menard County UWD	Menard	2,217	2,217	2,217	2,217	2,217	2,217
	Total	**2,217**	**2,217**	**2,217**	**2,217**	**2,217**	**2,217**
Middle Pecos GCD	Pecos	117,309	117,309	117,309	117,309	117,309	117,309
	Total	**117,309**	**117,309**	**117,309**	**117,309**	**117,309**	**117,309**
Plateau UWC and Supply District	Schleicher	8,034	8,034	8,034	8,034	8,034	8,034
	Total	**8,034**	**8,034**	**8,034**	**8,034**	**8,034**	**8,034**
Real-Edwards C and R District	Edwards	5,676	5,676	5,676	5,676	5,676	5,676
	Real	7,523	7,523	7,523	7,523	7,523	7,523
	Total	**13,199**	**13,199**	**13,199**	**13,199**	**13,199**	**13,199**

TABLE 7. (CONTINUED).

District	County	Year					
		2020	**2030**	**2040**	**2050**	**2060**	**2070**
Santa Rita UWCD	Reagan	27,398	27,398	27,398	27,398	27,398	27,398
	Total	**27,398**	**27,398**	**27,398**	**27,398**	**27,398**	**27,398**
Sterling County UWCD	Sterling	2,495	2,495	2,495	2,495	2,495	2,495
	Total	**2,495**	**2,495**	**2,495**	**2,495**	**2,495**	**2,495**
Sutton County UWCD	Sutton	6,400	6,400	6,400	6,400	6,400	6,400
	Total	**6,400**	**6,400**	**6,400**	**6,400**	**6,400**	**6,400**
Terrell County GCD	Terrell	1,420	1,420	1,420	1,420	1,420	1,420
	Total	**1,420**	**1,420**	**1,420**	**1,420**	**1,420**	**1,420**
Uvalde County UWCD	Uvalde	1,993	1,993	1,993	1,993	1,993	1,993
	Total	**1,993**	**1,993**	**1,993**	**1,993**	**1,993**	**1,993**
No district		102,703	102,703	102,703	102,703	102,703	102,703
GMA 7		**475,236**	**475,236**	**475,236**	**475,236**	**475,236**	**475,236**

TABLE 8. MODELED AVAILABLE GROUNDWATER BY DECADE FOR THE UNDIFFERENTIATED EDWARDS-TRINITY (PLATEAU), PECOS VALLEY, AND TRINITY AQUIFERS IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Coke	F	Colorado	997	997	997	997	997
		Total	**997**	**997**	**997**	**997**	**997**
Crockett	F	Colorado	20	20	20	20	20
		Rio Grande	5,427	5,427	5,427	5,427	5,427
		Total	**5,447**	**5,447**	**5,447**	**5,447**	**5,447**
Ector	F	Colorado	4,925	4,925	4,925	4,925	4,925
		Rio Grande	617	617	617	617	617
		Total	**5,542**	**5,542**	**5,542**	**5,542**	**5,542**
Edwards	J	Colorado	2,305	2,305	2,305	2,305	2,305
		Nueces	1,631	1,631	1,631	1,631	1,631
		Rio Grande	1,740	1,740	1,740	1,740	1,740
		Total	**5,676**	**5,676**	**5,676**	**5,676**	**5,676**
Gillespie	K	Colorado	4,843	4,843	4,843	4,843	4,843
		Guadalupe	136	136	136	136	136
		Total	**4,979**	**4,979**	**4,979**	**4,979**	**4,979**
Glasscock	F	Colorado	65,186	65,186	65,186	65,186	65,186
		Total	**65,186**	**65,186**	**65,186**	**65,186**	**65,186**

TABLE 8. (CONTINUED).

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Irion	F	Colorado	3,289	3,289	3,289	3,289	3,289
		Total	**3,289**	**3,289**	**3,289**	**3,289**	**3,289**
Kimble	F	Colorado	1,386	1,386	1,386	1,386	1,386
		Total	**1,386**	**1,386**	**1,386**	**1,386**	**1,386**
Kinney	J	Nueces	12	12	12	12	12
		Rio Grande	70,329	70,329	70,329	70,329	70,329
		Total	**70,341**	**70,341**	**70,341**	**70,341**	**70,341**
Menard	F	Colorado	2,597	2,597	2,597	2,597	2,597
		Total	**2,597**	**2,597**	**2,597**	**2,597**	**2,597**
Midland	F	Colorado	23,233	23,233	23,233	23,233	23,233
		Total	**23,233**	**23,233**	**23,233**	**23,233**	**23,233**
Pecos	F	Rio Grande	117,309	117,309	117,309	117,309	117,309
		Total	**117,309**	**117,309**	**117,309**	**117,309**	**117,309**

TABLE 8. (CONTINUED).

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Reagan	F	Colorado	68,205	68,205	68,205	68,205	68,205
		Rio Grande	28	28	28	28	28
		Total	**68,233**	**68,233**	**68,233**	**68,233**	**68,233**
Real	J	Colorado	277	277	277	277	277
		Guadalupe	3	3	3	3	3
		Nueces	7,243	7,243	7,243	7,243	7,243
		Total	**7,523**	**7,523**	**7,523**	**7,523**	**7,523**
Schleicher	F	Colorado	6,403	6,403	6,403	6,403	6,403
		Rio Grande	1,631	1,631	1,631	1,631	1,631
		Total	**8,034**	**8,034**	**8,034**	**8,034**	**8,034**
Sterling	F	Colorado	2,495	2,495	2,495	2,495	2,495
		Total	**2,495**	**2,495**	**2,495**	**2,495**	**2,495**
Sutton	F	Colorado	388	388	388	388	388
		Rio Grande	6,022	6,022	6,022	6,022	6,022
		Total	**6,410**	**6,410**	**6,410**	**6,410**	**6,410**
Taylor	G	Brazos	331	331	331	331	331
		Colorado	158	158	158	158	158
		Total	**489**	**489**	**489**	**489**	**489**
Terrell	E	Rio Grande	1,420	1,420	1,420	1,420	1,420
		Total	**1,420**	**1,420**	**1,420**	**1,420**	**1,420**

TABLE 8. (CONTINUED).

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Upton	F	Colorado	21,243	21,243	21,243	21,243	21,243
		Rio Grande	1,126	1,126	1,126	1,126	1,126
		Total	**22,369**	**22,369**	**22,369**	**22,369**	**22,369**
Uvalde	L	Nueces	1,993	1,993	1,993	1,993	1,993
		Total	**1,993**	**1,993**	**1,993**	**1,993**	**1,993**
Val Verde	J	Rio Grande	50,000	50,000	50,000	50,000	50,000
		Total	**50,000**	**50,000**	**50,000**	**50,000**	**50,000**
GMA 7			**479,063**	**479,063**	**479,063**	**479,063**	**479,063**

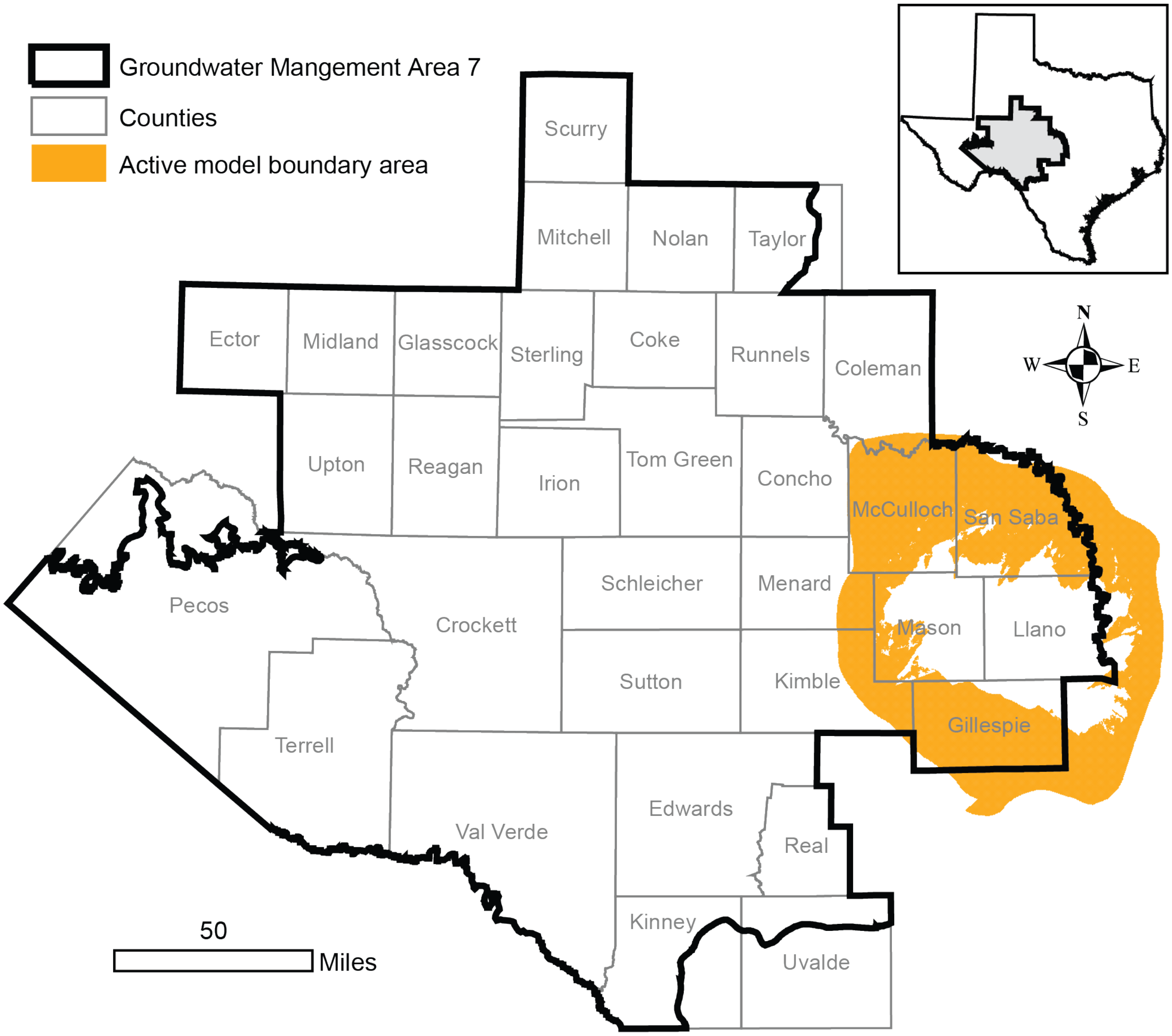


FIGURE 10. **MAP SHOWING THE AREAS COVERED BY THE ELLENBURGER-SAN SABA AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE MINOR AQUIFERS OF THE LLANO UPLIFT AREA IN GROUNDWATER MANAGEMENT AREA 7.**

TABLE 9. MODELED AVAILABLE GROUNDWATER FOR THE ELLENBURGER-SAN SABA AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD IS THE ABBREVIATION FOR UNDERGROUND WATER CONSERVATION DISTRICT AND UWD IS UNDERGROUND WATER DISTRICT.

District	County	Year					
		2020	2030	2030	2050	2060	2070
Hickory UWCD No. 1	Kimble	344	344	344	344	344	344
	Mason	3,237	3,237	3,237	3,237	3,237	3,237
	McCulloch	3,466	3,466	3,466	3,466	3,466	3,466
	Menard	282	282	282	282	282	282
	San Saba	5,559	5,559	5,559	5,559	5,559	5,559
	Total	**12,887**	**12,887**	**12,887**	**12,887**	**12,887**	**12,887**
Hill Country UWCD	Gillespie	6,294	6,294	6,294	6,294	6,294	6,294
	Total	**6,294**	**6,294**	**6,294**	**6,294**	**6,294**	**6,294**
Kimble County GCD	Kimble	178	178	178	178	178	178
	Total	**178**	**178**	**178**	**178**	**178**	**178**
Menard County UWD	Menard	27	27	27	27	27	27
	Total	**27**	**27**	**27**	**27**	**27**	**27**
No District	McCulloch	898	898	898	898	898	898
	San Saba	2,331	2,331	2,331	2,331	2,331	2,331
	Total	**3,229**	**3,229**	**3,229**	**3,229**	**3,229**	**3,229**
GMA 7		**22,615**	**22,615**	**22,615**	**22,615**	**22,615**	**22,615**

TABLE 10. MODELED AVAILABLE GROUNDWATER FOR THE ELLENBURGER-SAN SABA AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Gillespie	K	Colorado	6,294	6,294	6,294	6,294	6,294
		Total	**6,294**	**6,294**	**6,294**	**6,294**	**6,294**
Kimble	F	Colorado	521	521	521	521	521
		Total	**521**	**521**	**521**	**521**	**521**
Mason	F	Colorado	3,237	3,237	3,237	3,237	3,237
		Total	**3,237**	**3,237**	**3,237**	**3,237**	**3,237**
McCulloch	F	Colorado	4,364	4,364	4,364	4,364	4,364
		Total	**4,364**	**4,364**	**4,364**	**4,364**	**4,364**
Menard	F	Colorado	309	309	309	309	309
		Total	**309**	**309**	**309**	**309**	**309**
San Saba	K	Colorado	7,890	7,890	7,890	7,890	7,890
		Total	**7,890**	**7,890**	**7,890**	**7,890**	**7,890**
GMA 7			**22,615**	**22,615**	**22,615**	**22,615**	**22,615**

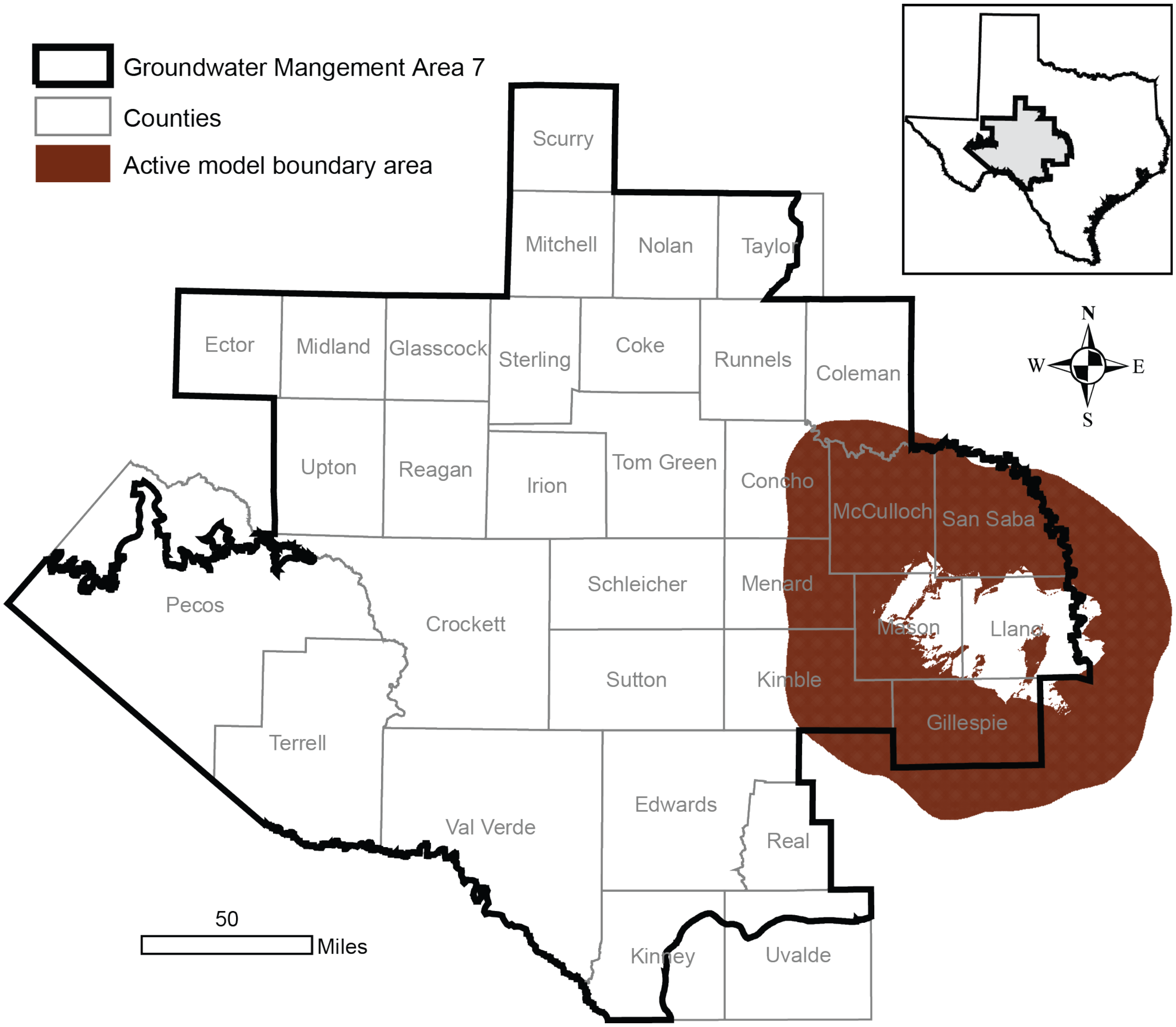


FIGURE 11. MAP SHOWING AREAS COVERED BY THE HICKORY AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE MINOR AQUIFERS OF THE LLANO UPLIFT AREA IN GROUNDWATER MANAGEMENT AREA 7.

TABLE 11. MODELED AVAILABLE GROUNDWATER FOR THE HICKORY AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD IS THE ABBREVIATION FOR UNDERGROUND WATER CONSERVATION DISTRICT AND UWD IS UNDERGROUND WATER DISTRICT.

District	County	Year					
		2020	2030	2040	2050	2060	2070
Hickory UWCD No. 1	Concho	13	13	13	13	13	13
	Kimble	42	42	42	42	42	42
	Mason	13,212	13,212	13,212	13,212	13,212	13,212
	McCulloch	21,950	21,950	21,950	21,950	21,950	21,950
	Menard	2,600	2,600	2,600	2,600	2,600	2,600
	San Saba	7,027	7,027	7,027	7,027	7,027	7,027
	Total	**44,843**	**44,843**	**44,843**	**44,843**	**44,843**	**44,843**
Hill Country UWCD	Gillespie	1,751	1,751	1,751	1,751	1,751	1,751
	Total	**1,751**	**1,751**	**1,751**	**1,751**	**1,751**	**1,751**
Kimble County GCD	Kimble	123	123	123	123	123	123
	Total	**123**	**123**	**123**	**123**	**123**	**123**
Lipan-Kickapoo WCD	Concho	13	13	13	13	13	13
	Total	**13**	**13**	**13**	**13**	**13**	**13**
Menard County UWD	Menard	126	126	126	126	126	126
	Total	**126**	**126**	**126**	**126**	**126**	**126**
No District	McCulloch	2,427	2,427	2,427	2,427	2,427	2,427
	San Saba	652	652	652	652	652	652
	Total	**3,080**	**3,080**	**3,080**	**3,080**	**3,080**	**3,080**
GMA 7		**49,937**	**49,937**	**49,937**	**49,937**	**49,937**	**49,937**

TABLE 12. MODELED AVAILABLE GROUNDWATER FOR THE HICKORY AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Concho	F	Colorado	27	27	27	27	27
		Total	**27**	**27**	**27**	**27**	**27**
Gillespie	K	Colorado	1,751	1,751	1,751	1,751	1,751
		Total	**1,751**	**1,751**	**1,751**	**1,751**	**1,751**
Kimble	F	Colorado	165	165	165	165	165
		Total	**165**	**165**	**165**	**165**	**165**
Mason	F	Colorado	13,212	13,212	13,212	13,212	13,212
		Total	**13,212**	**13,212**	**13,212**	**13,212**	**13,212**
McCulloch	F	Colorado	24,377	24,377	24,377	24,377	24,377
		Total	**24,377**	**24,377**	**24,377**	**24,377**	**24,377**
Menard	F	Colorado	2,725	2,725	2,725	2,725	2,725
		Total	**2,725**	**2,725**	**2,725**	**2,725**	**2,725**
San Saba	K	Colorado	7,680	7,680	7,680	7,680	7,680
		Total	**7,680**	**7,680**	**7,680**	**7,680**	**7,680**
GMA 7			**49,937**	**49,937**	**49,937**	**49,937**	**49,937**

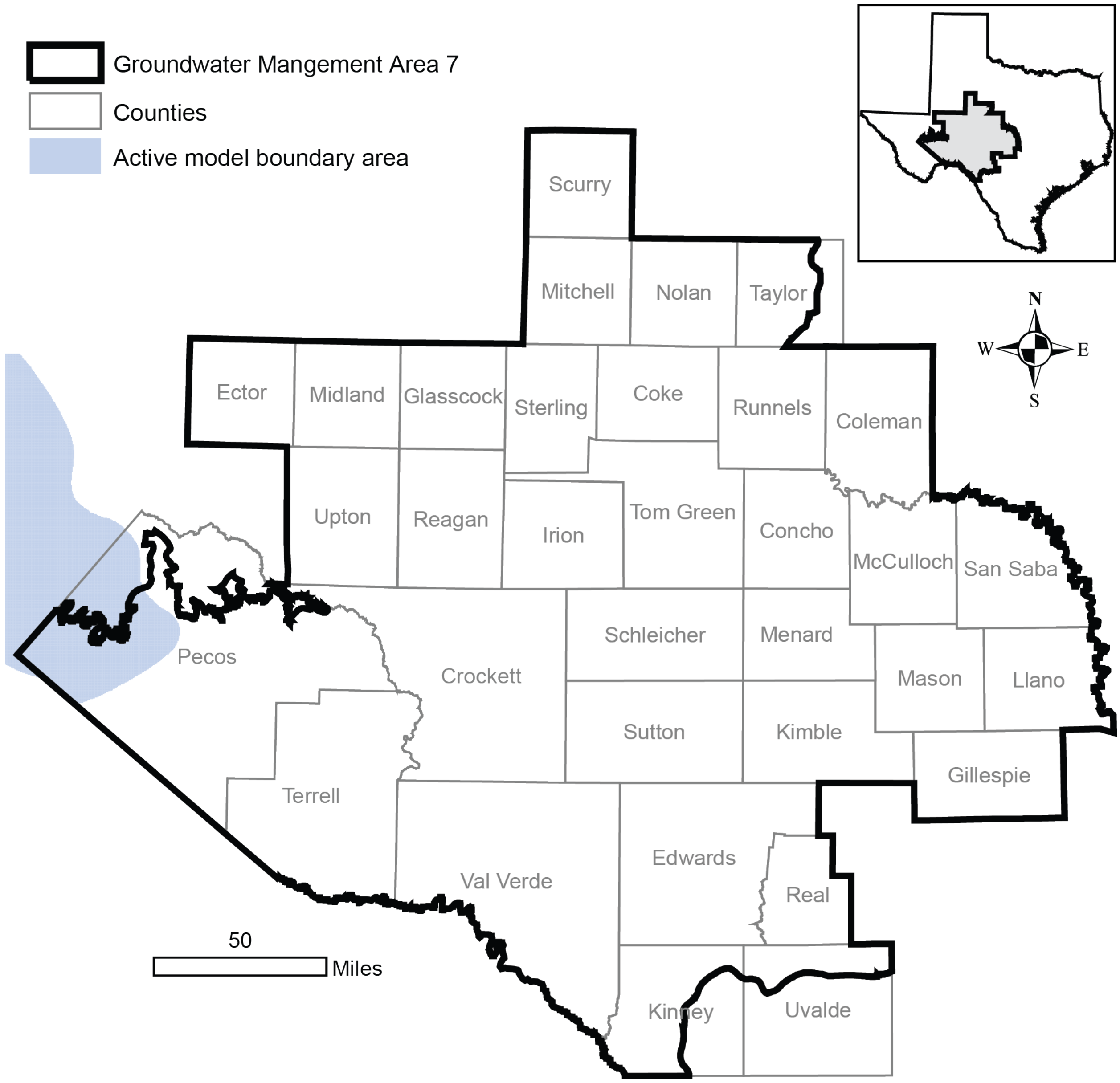


FIGURE 13. MAP SHOWING AREAS COVERED BY THE RUSTLER AQUIFER IN THE GROUNDWATER AVAILABILITY MODEL FOR THE RUSTLER AQUIFER IN GROUNDWATER MANAGEMENT AREA 7.

TABLE 13. MODELED AVAILABLE GROUNDWATER FOR THE RUSTLER AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY DISTRICT AND COUNTY FOR EACH DECADE BETWEEN 2020 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

District	County	Year					
		2020	2030	2040	2050	2060	2070
Middle Pecos GCD	Pecos	7,040	7,040	7,040	7,040	7,040	7,040
	Total	**7,040**	**7,040**	**7,040**	**7,040**	**7,040**	**7,040**

TABLE 14. MODELED AVAILABLE GROUNDWATER FOR THE RUSTLER AQUIFER IN GROUNDWATER MANAGEMENT AREA 7 SUMMARIZED BY COUNTY, REGIONAL WATER PLANNING AREA (RWPA), AND RIVER BASIN FOR EACH DECADE BETWEEN 2030 AND 2070. RESULTS ARE IN ACRE-FEET PER YEAR.

County	RWPA	River Basin	Year				
			2030	2040	2050	2060	2070
Pecos	F	Rio Grande	7,040	7,040	7,040	7,040	7,040
		Rio Grande	**7,040**	**7,040**	**7,040**	**7,040**	**7,040**

LIMITATIONS:

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

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

A key aspect of using the groundwater model to evaluate historical groundwater flow conditions includes the assumptions about the location in the aquifer where historic pumping was placed. Understanding the amount and location of historical 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 historical time period.

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

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

Model "Dry" Cells

In some cases, the predictive model run for this analysis could result in water levels in some model cells dropping below the base elevation of the cell during the simulation. In terms of water level, the cells have gone dry. However, as noted in the model assumptions the transmissivity of the cell remains constant and will produce water. This would mean that the modeled available groundwater would include imaginary "pumping" values that are coming from cells that are actually dry.

REFERENCES:

Anaya, R., and Jones, I. C., 2009, Groundwater Availability Model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas: Texas Water Development Board Report 373, 103p. http://www.twdb.texas.gov/groundwater/models/gam/eddt_p/ET-Plateau_Full.pdf

Deeds, N. E. and Jigmond, M., 2015, Numerical Model Report for the High Plains Aquifer System Groundwater Availability Model, Prepared by INTERA Incorporated for Texas Water Development Board, 640p. http://www.twdb.texas.gov/groundwater/models/gam/hpas/HPAS_GAM_Numerical_Report.pdf

EcoKai Environmental, Inc. and Hutchison, W. R., 2014, Hydrogeological Study for Val Verde and Del Rio, Texas: Prep. For Val Verde County and City of Del Rio, 167 p.

Ewing, J. E., Kelley, V. A., Jones, T. L., Yan, T., Singh, A., Powers, D. W., Holt, R. M., and Sharp, J. M., 2012, Final Groundwater Availability Model Report for the Rustler Aquifer, Prepared for the Texas Water Development Board, 460p. http://www.twdb.texas.gov/groundwater/models/gam/rslr/RSLR_GAM_Report.pdf

Harbaugh, A. W., 2005, MODFLOW-2005, The US Geological Survey Modular Groundwater-Model – the Ground-Water Flow Process. Chapter 16 of Book 6. Modeling techniques, Section A Ground Water: U.S. Geological Survey Techniques and Methods 6-A16. 253p.

Harbaugh, A. W., 2009, Zonebudget Version 3.01, A computer program for computing sub-regional water budgets for MODFLOW ground-water flow models: U.S. Geological Survey Groundwater Software.

Harbaugh, A. W., Banta, E. R., Hill, M. C., 2000, MODFLOW-2000, the U.S. Geological Survey Modular Ground-Water Model – User Guide to Modularization Concepts and the Ground-Water Flow Process: U.S. Geological Survey, Open-File Report 00-92, 121p.

Hutchison, W. R., Jones, I. C, and Anaya, R., 2011a, Update of the Groundwater Availability Model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas, Texas Water Development Board, 61 p. http://www.twdb.texas.gov/groundwater/models/alt/eddt_p_2011/ETP_PV_One_Layer_Model.pdf

Hutchison, W. R., Shi, J., and Jigmond, M., 2011b, Groundwater Flow Model of the Kinney County Area, Texas Water Development Board, 217 p. http://www.twdb.texas.gov/groundwater/models/alt/knny/Kinney_County_Model_Report.pdf

Hutchison, W. R., 2011, Draft GAM Task 10-027 (revised), 8 p.

Hutchison, W. R., 2016a, GMA 7 Technical Memorandum 16-03—Final, Capitan Reef Complex Aquifer: Initial Predictive Simulations with Draft GAM, 8 p.

Hutchison, W. R., 2016b, GMA 7 Technical Memorandum 16-02—Final, Llano Uplift Aquifers: Initial Predictive Simulations with Draft GAM, 24 p.

Hutchison, W. R., 2016c, GMA 7 Technical Memorandum 16-01—Final, Dockum and Ogallala Aquifers: Initial Predictive Simulations with HPAS, 29 p.

Hutchison, W. R., 2016d, GMA 7 Technical Memorandum 15-05—Final, Rustler Aquifer: Nine Factor Documentation and Predictive Simulation with Rustler GAM, 27 p.

Hutchison, W. R., 2016e, GMA 7 Technical Memorandum 15-06—Final, Edwards-Trinity (Plateau) and Pecos Valley Aquifers: Nine Factor Documentation and Predictive Simulation, 60 p.

Hutchison, W. R., 2018, GMA 7 Technical Memorandum 18-01—Final, Edwards-Trinity (Plateau) and Pecos Valley Aquifers: Update of Average Drawdown Calculations, 10 p.

Hutchison, W. R., 2021, GMA 7 Explanatory Report—Final, Edwards-Trinity, Pecos Valley and Trinity Aquifers: Prep. For Groundwater Management Area 7, 173 p.

Jones, I. C., 2016, Groundwater Availability Model: Eastern Arm of the Capitan Reef Complex Aquifer of Texas. Texas Water Development Board, March 2016, 488p. http://www.twdb.texas.gov/groundwater/models/gam/crcx/CapitanModelReportFinal.pdf

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., http://www.nap.edu/catalog.php?record_id=11972.

Niswonger, R.G., Panday, S., and Ibaraki, M., 2011, MODFLOW-NWT, a Newton formulation for MODFLOW-2005: United States Geological Survey, Techniques and Methods 6-A37, 44 p.

Panday, S., Langevin, C. D., Niswonger, R. G., Ibaraki, M., and Hughes, J. D., 2013, MODFLOW–USG version 1: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation: U.S. Geological Survey Techniques and Methods, book 6, chap. A45, 66 p.

Shi, J, 2012, GAM Run 10-043 MAG (Version 2): Modeled Available Groundwater for the Edwards-Trinity (Plateau), Trinity, and Pecos Valley aquifers in Groundwater Management Area 7, Texas Water Development Board GAM Run Report 10-043, 15 p. www.twdb.texas.gov/groundwater/docs/GAMruns/GR10-043_MAG_v2.pdf

Shi, J., Boghici, R., Kohlrenken, W., and Hutchison, W., 2016, Numerical model report: minor aquifers of the Llano Uplift Region of Texas (Marble Falls, Ellenburger-San Saba, and Hickory): Texas Water Development Board published report, 400 p. http://www.twdb.texas.gov/groundwater/models/gam/llano/Llano_Uplift_Numerical_Model_Report_Final.pdf

Texas Water Code, 2011, http://www.statutes.legis.state.tx.us/docs/WA/pdf/WA.36.pdf

Appendix B

Estimated Historical Groundwater Use And 2022 State Water Plan Datasets:

Sterling County Underground Water Conservation District

Texas Water Development Board
Groundwater Division
Groundwater Technical Assistance Section
stephen.allen@twdb.texas.gov
(512) 463-7317
January 17, 2023

GROUNDWATER MANAGEMENT PLAN DATA:

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

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

The five reports included in this part are:

1. Estimated Historical Groundwater Use (checklist item 2)

   from the TWDB Historical Water Use Survey (WUS)

2. Projected Surface Water Supplies (checklist item 6)
3. Projected Water Demands (checklist item 7)
4. Projected Water Supply Needs (checklist item 8)
5. Projected Water Management Strategies (checklist item 9)

   from the 2022 Texas State Water Plan (SWP)

Part 2 of the 2-part package is the groundwater availability model (GAM) report for the District (checklist items 3 through 5). The District should have received, or will receive, this report from the Groundwater Availability Modeling Section. Questions about the GAM can be directed to Grayson Dowlearn, grayson.dowlearn@twdb.texas.gov, (512) 475-1552.

DISCLAIMER:

The data presented in this report represents the most up to date WUS and 2022 SWP data available as of 1/17/2023. Although it does not happen frequently, either of these datasets are subject to change pending the availability of more accurate WUS data or an amendment to the 2022 SWP. District personnel must review these datasets and correct any discrepancies to ensure approval of their groundwater management plan.

The WUS dataset can be verified at this web address:

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

The 2022 SWP dataset can be verified by contacting Sabrina Anderson (sabrina.anderson@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 conditions within district boundaries. The multiplier used in 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 SWP 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 entity locations).

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

In the WUS 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 ideal 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 can add those data to the plan with an explanation of how the data were derived. Apportioning percentages that the TWDB used 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).

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

Groundwater and surface water historical use estimates are currently unavailable for calendar year 2020. TWDB staff anticipates the calculation and posting of these estimates at a later date.

STERLING COUNTY *100% (multiplier)* All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2019	GW	235	0	3	0	846	232	1,316
	SW	0	0	0	0	0	26	26
2018	GW	229	0	57	0	870	232	1,388
	SW	0	0	0	0	0	26	26
2017	GW	222	0	4	0	698	222	1,146
	SW	0	0	0	0	0	25	25
2016	GW	235	0	5	0	720	217	1,177
	SW	0	0	0	0	0	24	24
2015	GW	244	0	8	0	924	214	1,390
	SW	0	0	0	0	0	24	24
2014	GW	263	0	252	0	931	209	1,655
	SW	0	0	0	0	0	23	23
2013	GW	244	0	257	0	1,050	211	1,762
	SW	0	0	0	0	0	23	23
2012	GW	232	0	0	0	849	193	1,274
	SW	0	0	0	0	0	21	21
2011	GW	306	0	52	0	977	216	1,551
	SW	0	0	0	0	0	24	24
2010	GW	226	0	136	0	688	225	1,275
	SW	0	0	37	0	0	25	62
2009	GW	226	0	106	0	1,026	256	1,614
	SW	0	0	29	0	0	29	58
2008	GW	246	0	76	0	738	241	1,301
	SW	0	0	21	0	0	27	48
2007	GW	206	0	0	0	477	290	973
	SW	0	0	0	0	0	32	32
2006	GW	273	0	0	0	600	266	1,139
	SW	0	0	0	0	0	30	30
2005	GW	240	0	0	0	450	255	945
	SW	0	0	0	0	0	28	28
2004	GW	253	0	0	0	496	202	951
	SW	0	0	0	0	0	51	51

TOM GREEN COUNTY

0.82% (multiplier)

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2019	GW	34	4	0	0	434	7	479
	SW	103	1	0	0	30	2	136
2018	GW	32	5	0	0	424	7	468
	SW	108	1	0	0	25	2	136
2017	GW	36	5	0	0	411	7	459
	SW	99	1	0	0	26	2	128
2016	GW	35	5	0	0	324	4	368
	SW	95	1	0	0	21	1	118
2015	GW	37	4	0	0	393	4	438
	SW	106	2	0	0	21	1	130
2014	GW	30	4	0	0	346	4	384
	SW	115	2	0	0	25	1	143
2013	GW	33	3	0	0	279	4	319
	SW	114	2	0	0	25	1	142
2012	GW	32	3	0	0	433	9	477
	SW	124	2	0	0	24	2	152
2011	GW	39	4	0	0	65	10	118
	SW	149	3	0	0	23	3	178
2010	GW	31	3	4	0	310	9	357
	SW	137	2	4	0	54	2	199
2009	GW	21	4	4	0	547	9	585
	SW	134	2	4	0	33	2	175
2008	GW	13	4	4	0	704	10	735
	SW	129	3	4	0	0	3	139
2007	GW	13	4	0	0	564	7	588
	SW	122	2	0	0	44	2	170
2006	GW	13	3	0	0	271	11	298
	SW	142	2	0	0	132	3	279
2005	GW	13	3	0	0	228	10	254
	SW	123	2	0	0	107	3	235
2004	GW	11	3	0	0	200	1	215
	SW	121	3	0	0	108	11	243

Projected Surface Water Supplies
TWDB 2022 State Water Plan Data

STERLING COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
F	Irrigation, Sterling	Colorado	Colorado Run-of-River	30	30	30	30	30	30
F	Livestock, Sterling	Colorado	Colorado Livestock Local Supply	25	25	25	25	25	25
	Sum of Projected Surface Water Supplies (acre-feet)			**55**	**55**	**55**	**55**	**55**	**55**

TOM GREEN COUNTY

0.82% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
F	Concho Rural Water	Colorado	Mountain Creek Lake/Reservoir	0	0	0	0	0	0
F	Irrigation, Tom Green	Colorado	Colorado Run-of-River	14	14	14	14	14	14
F	Livestock, Tom Green	Colorado	Colorado Livestock Local Supply	3	3	3	3	3	3
F	Millersview-Doole WSC	Colorado	OH Ivie Lake/Reservoir Non-System Portion	235	263	269	274	275	254
F	Mining, Tom Green	Colorado	Mountain Creek Lake/Reservoir	0	0	0	0	0	0
F	San Angelo	Colorado	Colorado Run-of-River	214	214	214	214	214	214
F	San Angelo	Colorado	OH Ivie Lake/Reservoir Non-System Portion	5,020	4,850	4,679	4,509	4,338	4,168
F	San Angelo	Colorado	San Angelo Lakes Lake/Reservoir System	0	0	0	0	0	0
	Sum of Projected Surface Water Supplies (acre-feet)			**5,486**	**5,344**	**5,179**	**5,014**	**4,844**	**4,653**

Projected Water Demands
TWDB 2022 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.

STERLING COUNTY

100% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
F	County-Other, Sterling	Colorado	32	32	32	32	32	32
F	Irrigation, Sterling	Colorado	899	899	899	899	899	899
F	Livestock, Sterling	Colorado	234	234	234	234	234	234
F	Mining, Sterling	Colorado	780	953	812	522	270	140
F	Sterling City	Colorado	276	281	281	280	280	280
		Sum of Projected Water Demands (acre-feet)	**2,221**	**2,399**	**2,258**	**1,967**	**1,715**	**1,585**

TOM GREEN COUNTY

0.82% (multiplier)

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
F	Concho Rural Water	Colorado	560	576	588	604	624	646
F	County-Other, Tom Green	Colorado	8	8	9	9	9	9
F	DADS Supported Living Center	Colorado	109	108	108	107	107	107
F	Goodfellow Air Force Base	Colorado	513	568	596	629	666	707
F	Irrigation, Tom Green	Colorado	348	348	348	348	348	348
F	Livestock, Tom Green	Colorado	9	9	9	9	9	9
F	Manufacturing, Tom Green	Colorado	7	8	8	8	8	8
F	Millersview-Doole WSC	Colorado	263	271	276	283	293	302
F	Mining, Tom Green	Colorado	9	9	9	9	9	9
F	San Angelo	Colorado	17,924	19,657	20,494	21,556	22,847	24,250
F	Tom Green County FWSD 3	Colorado	131	142	147	154	162	172
		Sum of Projected Water Demands (acre-feet)	**19,881**	**21,704**	**22,592**	**23,716**	**25,082**	**26,567**

Projected Water Supply Needs
TWDB 2022 State Water Plan Data

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

STERLING COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
F	County-Other, Sterling	Colorado	0	0	0	0	0	0
F	Irrigation, Sterling	Colorado	0	0	0	0	0	0
F	Livestock, Sterling	Colorado	0	0	0	0	0	0
F	Mining, Sterling	Colorado	0	0	0	0	0	0
F	Sterling City	Colorado	0	0	0	0	0	0
		Sum of Projected Water Supply Needs (acre-feet)	**0**	**0**	**0**	**0**	**0**	**0**

TOM GREEN COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
F	Concho Rural Water	Colorado	8	0	-3	-6	-9	-13
F	County-Other, Tom Green	Colorado	264	252	208	173	140	112
F	DADS Supported Living Center	Colorado	0	0	0	0	0	0
F	Goodfellow Air Force Base	Colorado	-136	-191	-222	-258	-298	-345
F	Irrigation, Tom Green	Colorado	558	509	452	437	386	332
F	Livestock, Tom Green	Colorado	0	0	0	0	0	0
F	Manufacturing, Tom Green	Colorado	-38	-144	-159	-178	-198	-215
F	Millersview-Doole WSC	Colorado	58	80	83	82	75	46
F	Mining, Tom Green	Colorado	0	0	0	0	0	0
F	San Angelo	Colorado	-4,785	-6,658	-7,632	-8,824	-10,243	-11,775
F	Tom Green County FWSD 3	Colorado	0	0	0	0	0	0
		Sum of Projected Water Supply Needs (acre-feet)	**-4,959**	**-6,993**	**-8,016**	**-9,266**	**-10,748**	**-12,348**

Projected Water Management Strategies
TWDB 2022 State Water Plan Data

STERLING COUNTY

WUG, Basin (RWPG) All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Irrigation, Sterling, Colorado (F)							
Irrigation Conservation - Sterling County	DEMAND REDUCTION [Sterling]	45	90	135	135	135	135
Weather Modification	Weather Modification [Atmosphere]	48	48	48	48	48	48
		93	**138**	**183**	**183**	**183**	**183**
Mining, Sterling, Colorado (F)							
Mining Conservation - Sterling County	DEMAND REDUCTION [Sterling]	33	40	34	22	11	6
		33	**40**	**34**	**22**	**11**	**6**
Sterling City, Colorado (F)							
Municipal Conservation - Sterling City	DEMAND REDUCTION [Sterling]	3	3	3	3	3	3
		3	**3**	**3**	**3**	**3**	**3**
Sum of Projected Water Management Strategies (acre-feet)		**129**	**181**	**220**	**208**	**197**	**192**

TOM GREEN COUNTY

WUG, Basin (RWPG) All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
Concho Rural Water, Colorado (F)							
Concho River Water Project - San Angelo	Indirect Reuse [Tom Green]	74	83	86	91	95	98
Municipal Conservation - Concho Rural WSC	DEMAND REDUCTION [Tom Green]	20	21	22	23	24	24
Subordination - San Angelo System	San Angelo Lakes Lake/Reservoir System [Reservoir]	8	7	6	5	4	4
		102	**111**	**114**	**119**	**123**	**126**
County-Other, Tom Green, Colorado (F)							
Concho River Water Project - San Angelo	Indirect Reuse [Tom Green]	29	40	43	49	54	58
Subordination - Mountain Creek Reservoir	Mountain Creek Lake/Reservoir [Reservoir]	70	70	70	70	70	70
Subordination - San Angelo System	San Angelo Lakes Lake/Reservoir System [Reservoir]	22	18	17	15	13	11
		121	**128**	**130**	**134**	**137**	**139**
DADS Supported Living Center, Colorado (F)							

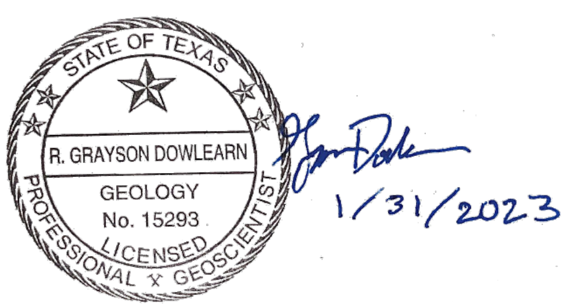
	Municipal Conservation - Dads Supported Living Center	DEMAND REDUCTION [Tom Green]	1	1	1	1	1	1
			1	**1**	**1**	**1**	**1**	**1**
Goodfellow Air Force Base, Colorado (F)								
	Concho River Water Project - San Angelo	Indirect Reuse [Tom Green]	85	141	173	210	253	301
	Municipal Conservation - Goodfellow Air Force Base	DEMAND REDUCTION [Tom Green]	8	9	9	10	10	11
	Subordination - San Angelo System	San Angelo Lakes Lake/Reservoir System [Reservoir]	44	42	40	38	35	33
			137	**192**	**222**	**258**	**298**	**345**
Irrigation, Tom Green, Colorado (F)								
	Irrigation Conservation - Tom Green County	DEMAND REDUCTION [Tom Green]	2,125	4,249	5,099	5,099	5,099	5,099
	Weather Modification	Weather Modification [Atmosphere]	2,007	2,007	2,007	2,007	2,007	2,007
			4,132	**6,256**	**7,106**	**7,106**	**7,106**	**7,106**
Manufacturing, Tom Green, Colorado (F)								
	Concho River Water Project - San Angelo	Indirect Reuse [Tom Green]	1	108	128	149	172	193
	Subordination - San Angelo System	San Angelo Lakes Lake/Reservoir System [Reservoir]	37	36	32	29	26	22
			38	**144**	**160**	**178**	**198**	**215**
Millersview-Doole WSC, Colorado (F)								
	Municipal Conservation - Millersview-Doole WSC	DEMAND REDUCTION [Tom Green]	6	7	7	7	7	7
	Subordination - OH Ivie Non System Portion	OH Ivie Lake/Reservoir Non-System Portion [Reservoir]	22	0	0	0	5	29
	Water Audits And Leak - Millersview-Doole WSC	DEMAND REDUCTION [Tom Green]	28	29	29	30	31	32
			56	**36**	**36**	**37**	**43**	**68**
Mining, Tom Green, Colorado (F)								
	Concho River Water Project - San Angelo	Indirect Reuse [Tom Green]	2	3	4	4	4	5
	Mining Conservation - Tom Green County	DEMAND REDUCTION [Tom Green]	44	45	47	47	48	49
			46	**48**	**51**	**51**	**52**	**54**
San Angelo, Colorado (F)								
	Brush Control - San Angelo	San Angelo Lakes Lake/Reservoir System [Reservoir]	90	90	90	90	90	90
	Concho River Water Project - San Angelo	Indirect Reuse [Tom Green]	7,723	7,518	7,447	7,365	7,277	7,187
	Hickory Well Field Expansion in McCulloch County - San Angelo	Hickory Aquifer [McCulloch]	0	1,040	3,040	3,040	3,040	3,040
	Municipal Conservation - San Angelo	DEMAND REDUCTION [Tom Green]	459	532	558	592	629	668
	Subordination - OH Ivie Non System Portion	OH Ivie Lake/Reservoir Non-System Portion [Reservoir]	329	0	0	0	0	0

Subordination - San Angelo System	San Angelo Lakes Lake/Reservoir System [Reservoir]	1,547	1,460	1,375	1,288	1,203	1,117
West Texas Water Partnership (Groundwater)	Edwards-Trinity-Plateau, Pecos Valley, and Trinity Aquifers [Pecos]	0	8,191	8,330	8,470	8,609	8,749
		10,148	**18,831**	**20,840**	**20,845**	**20,848**	**20,851**
Tom Green County FWSD 3, Colorado (F)							
Municipal Conservation - Tom Green County FWSD 3	DEMAND REDUCTION [Tom Green]	3	4	4	4	5	5
		3	**4**	**4**	**4**	**5**	**5**
Sum of Projected Water Management Strategies (acre-feet)		**14,784**	**25,751**	**28,664**	**28,733**	**28,811**	**28,910**

Appendix C

GAM RUN 22-016: STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT MANAGEMENT PLAN

Tim Cawthon, GIT and Grayson Dowlearn, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-5076
January 31, 2023



This page is intentionally blank

GAM RUN 22-016: STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT MANAGEMENT PLAN

Tim Cawthon, GIT and Grayson Dowlearn, P.G.
Texas Water Development Board
Groundwater Division
Groundwater Modeling Department
512-463-5076
January 31, 2023

EXECUTIVE SUMMARY:

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

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

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

The groundwater management plan for the Sterling County Underground Water Conservation District should be adopted by the district on or before March 29, 2023 and submitted to the executive administrator of the TWDB on or before April 28, 2023. The current management plan for the Sterling County Underground Water Conservation District expires on June 27, 2023.

This analysis used version 1.01 of the groundwater availability model for the High Plains Aquifer System (Deeds and Jigmond, 2015), version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) Aquifer (Anaya and Jones, 2009), and version 1.01 of the groundwater availability model for the Lipan Aquifer (Beach and others, 2004), to estimate the management plan information for the aquifers within the Sterling County Underground Water Conservation District.

This report replaces the results of GAM Run 17-012 (Jones, 2017). Values may differ from the previous report as a result of routine updates to the spatial grid files used to define county, groundwater conservation district, and aquifer boundaries, which can impact the calculated water budget values. Additionally, the approach used for analyzing model results is reviewed during each update and may have been refined to better delineate groundwater flows. Tables 1, 2, and 3 summarize the groundwater availability model data required by statute. Figures 1, 3, and 5 show the areas of the models from which the values in Tables 1, 2, and 3 were extracted. Figures 2, 4, and 6 provide generalized diagrams of the groundwater flow components provided in Tables 1, 2, and 3. Full water budgets for each aquifer within the district are provided in Appendix A. These budgets are included to assist the Sterling County Underground Water Conservation District in analyzing the effects of pumping and recharge on the aquifers within the district. If, after review of the figures, the Sterling County Underground Water Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB at your earliest convenience.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability models mentioned above were used to estimate information for the Sterling County Underground Water Conservation District management plan. Water budgets were extracted for the historical model periods for the Dockum Aquifer (1980 through 2012), Edwards-Trinity (Plateau) Aquifer (1981 through 2000), and Lipan Aquifer (1980 through 1998) using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The average annual water budget values for recharge, surface-water outflow, groundwater inflow to the district, groundwater outflow from the district, and the groundwater flow between aquifers within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Dockum Aquifer

- We used version 1.01 of the groundwater availability model for the High Plains Aquifer System to analyze the Dockum Aquifer. See Deeds and others (2015) and Deeds and Jigmond (2015) for assumptions and limitations of the model.
- The groundwater availability model for the High Plains Aquifer System contains the following four layers:
    - Layer 1 represents the Ogallala Aquifer,
    - Layer 2 represents the Rita Blanca, Edwards-Trinity (High Plains), and Edwards-Trinity (Plateau) aquifers where present,
    - Layer 3 represents the upper portion of the Dockum Aquifer and equivalent units, and
    - Layer 4 represents the lower portion of the Dockum Aquifer and equivalent units.
- Water budget values for the district were determined only for the Dockum Aquifer (Layers 3 and 4).
- The MODFLOW-NWT River (RIV) package was used to simulate rivers and general head boundaries within the district.
- Water budget terms were averaged for the historical calibration period 1980 to 2012 (stress periods 52 through 84).
- The model was run with MODFLOW-NWT (Niswonger and others, 2011).

Edwards-Trinity (Plateau) Aquifer

- We used version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers to analyze the Edwards-Trinity (Plateau) Aquifer. See Anaya and Jones (2009) for assumptions and limitations of the model.

- The groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers contains the following two layers within the Sterling County Underground Water Conservation District:
    - Layer 1 represents the Edwards Group and equivalent limestone hydrostratigraphic units of the Edwards-Trinity (Plateau) Aquifer, and
    - Layer 2 represents the undifferentiated Trinity Group hydrostratigraphic units or equivalent units of the Edwards-Trinity (Plateau) Aquifer.
- An individual water budget for the district was determined for the Edwards-Trinity (Plateau) Aquifer (Layers 1 and 2, combined). The Pecos Valley Aquifer does not occur within the Sterling County Underground Water Conservation District and therefore no groundwater budget values are included for it in this report.
- Seeps and springs were simulated with the MODFLOW Drain (DRN) package and streams were simulated with the MODFLOW Streamflow-Routing (SFR) package.
- Water budget terms were averaged for the period 1981 through 2000 (stress periods 2 through 21).
- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

Lipan Aquifer

- We used version 1.01 of the groundwater availability model for the Lipan Aquifer to analyze the Lipan Aquifer. See Beach and others (2004) for assumptions and limitations of the model.
- The groundwater availability model contains one layer with a constant thickness of 400 feet. The layer represents portions of the Quaternary Leona Formation, underlying Permian units, adjacent Permian units, and the Edwards-Trinity (Plateau) Aquifer.
- Water budget terms were averaged for the period of 1980 through 1998 (stress periods 2 through 20). The last stress period representing the year 1999 was not included because of incorrect pumping values.

- The model does not cover the entire Lipan Aquifer (Figure 5). Consequently, please contact Mr. Stephen Allen with the TWDB at (512) 463-7317 or stephen.allen@twdb.texas.gov for additional information on the aquifer in areas not covered by the groundwater availability model in the Sterling County Underground Water Conservation District.
- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the groundwater availability model results for the Dockum, Edwards-Trinity (Plateau), and Lipan aquifers located within the Sterling County Underground Water Conservation District and averaged over the historical calibration period, as shown in Tables 1, 2, and 3.

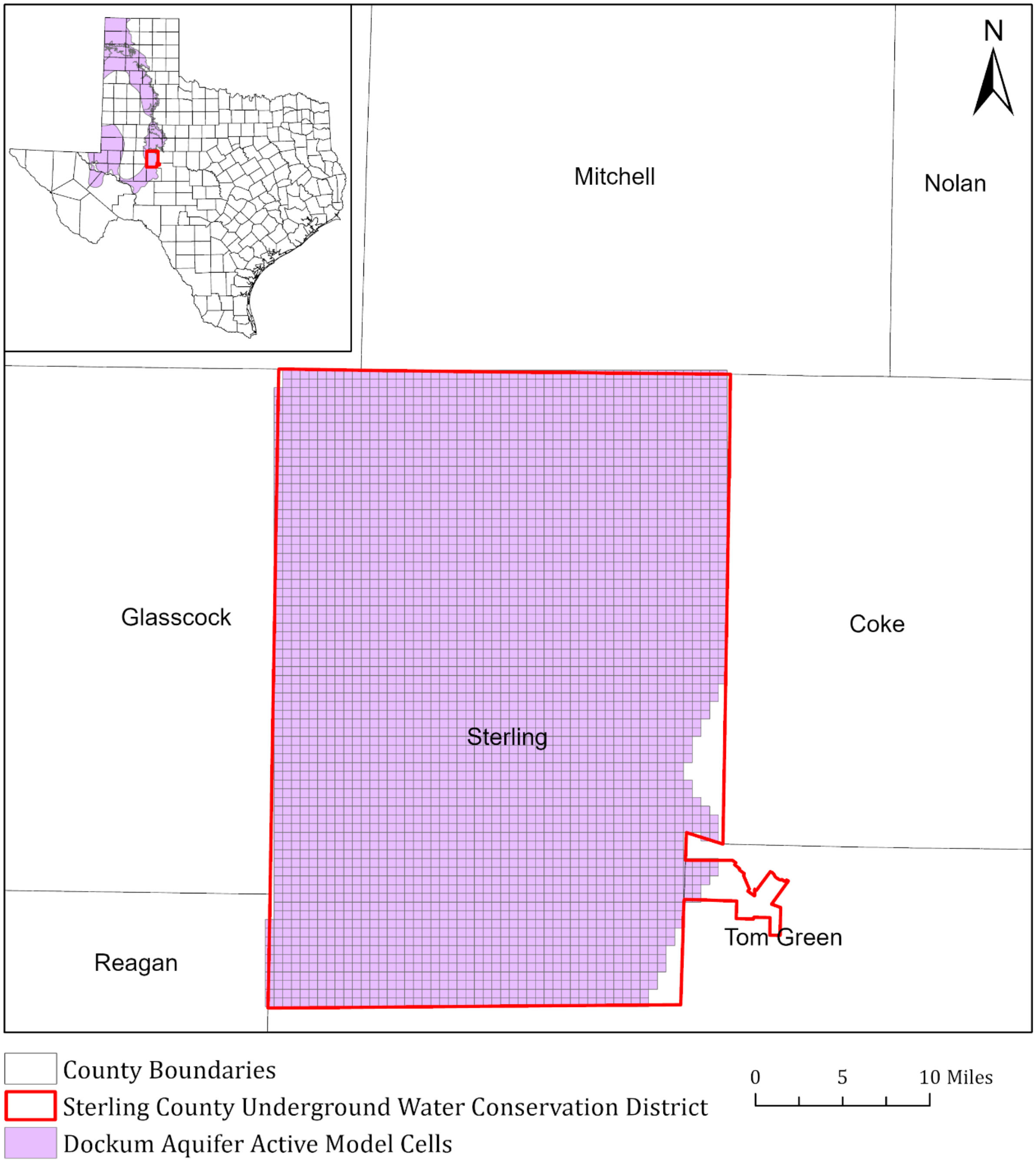
1. Precipitation recharge—the areally distributed recharge sourced from precipitation falling on the outcrop areas of the aquifers (where the aquifer is exposed at land surface) within the district.
2. Surface-water outflow—the total water discharging from the aquifer (outflow) to surface-water features such as streams, reservoirs, and springs.
3. Flow into and out of district—the lateral flow within the aquifer between the district and adjacent counties.
4. Flow between aquifers—the net vertical flow between the aquifer and adjacent aquifers or confining units. This flow is controlled by the relative water levels in each aquifer and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs.

The information needed for the district's management plan is summarized in Tables 1, 2, and 3. Figures 2, 4, and 6 provide generalized diagrams of the groundwater flow components provided in Tables 1, 2, and 3. Full water budgets for each aquifer within the district are provided in Appendix A. These budgets are included to assist the Sterling County Underground Water Conservation District in analyzing the effects of pumping and recharge on the aquifers within the district.

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

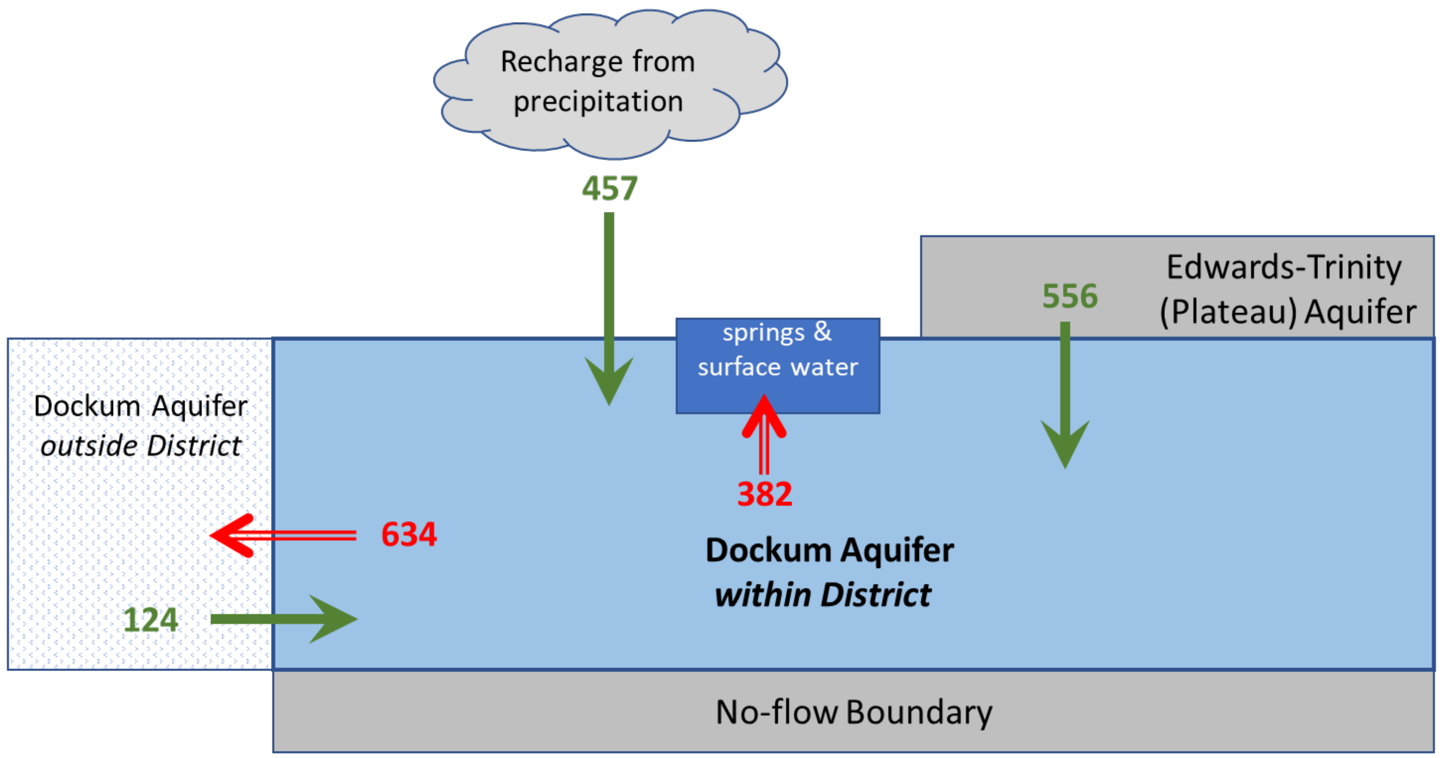
TABLE 1: SUMMARIZED INFORMATION FOR THE DOCKUM AQUIFER THAT IS NEEDED FOR THE STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Dockum Aquifer	457
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Dockum Aquifer	382
Estimated annual volume of flow into the district within each aquifer in the district	Dockum Aquifer	124
Estimated annual volume of flow out of the district within each aquifer in the district	Dockum Aquifer	634
Estimated net annual volume of flow between each aquifer in the district	To the Dockum Aquifer from the Edwards-Trinity (Plateau) Aquifer	556



gcd boundary date = 06.26.2020, county boundary date = 07.03.2019, hpas grid date = 01.06.2020

FIGURE 1: AREA OF THE HIGH PLAINS AQUIFER SYSTEM GROUNDWATER AVAILABILITY MODEL FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE DOCKUM AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

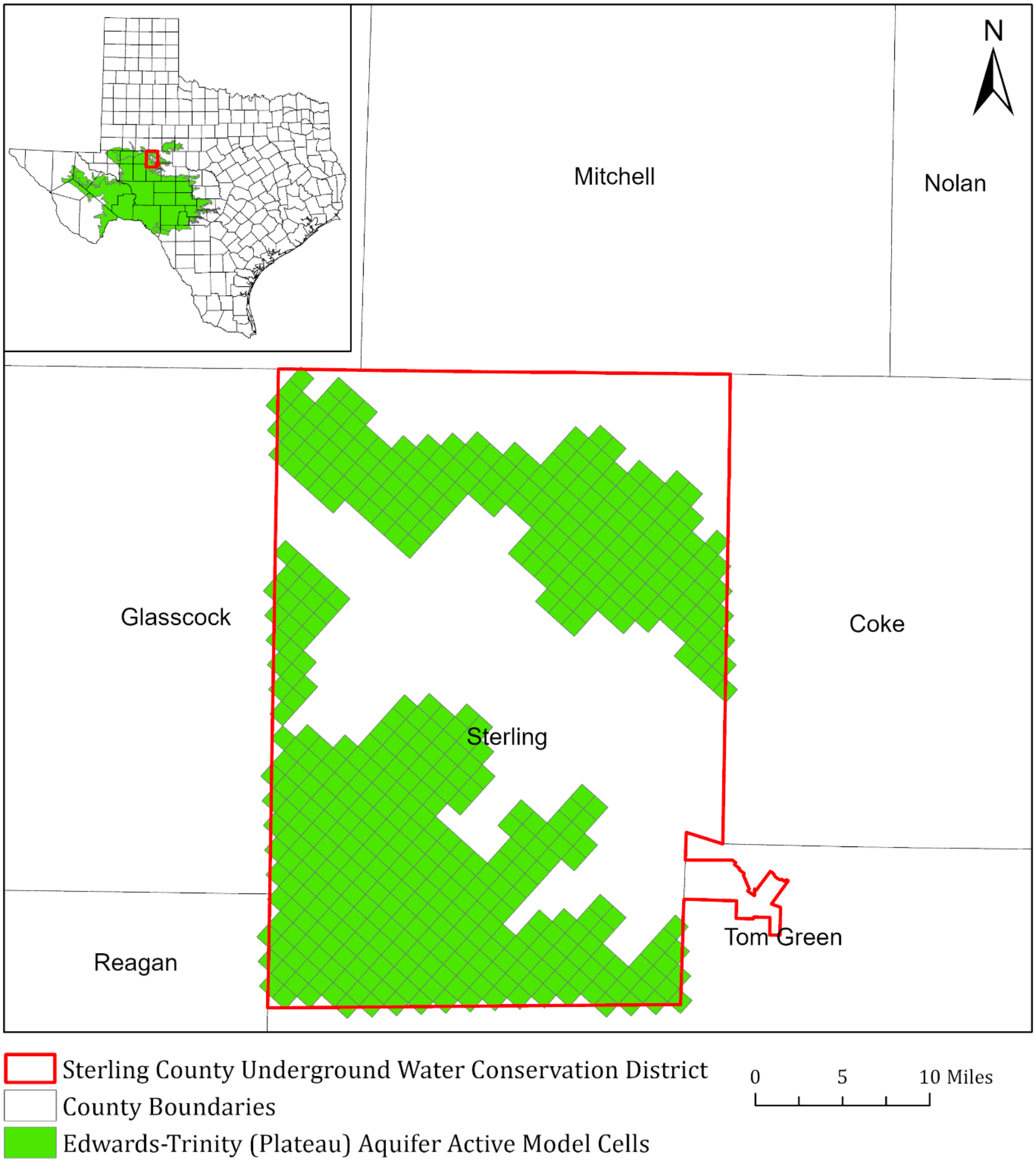


Caveat: This diagram only includes the water budget items provided in Table 1. A complete water budget would include additional inflows and outflows. Please see Appendix A for a full water budget.

FIGURE 2: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 1, REPRESENTING DIRECTIONS OF FLOW FOR THE DOCKUM AQUIFER WITHIN THE STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR.

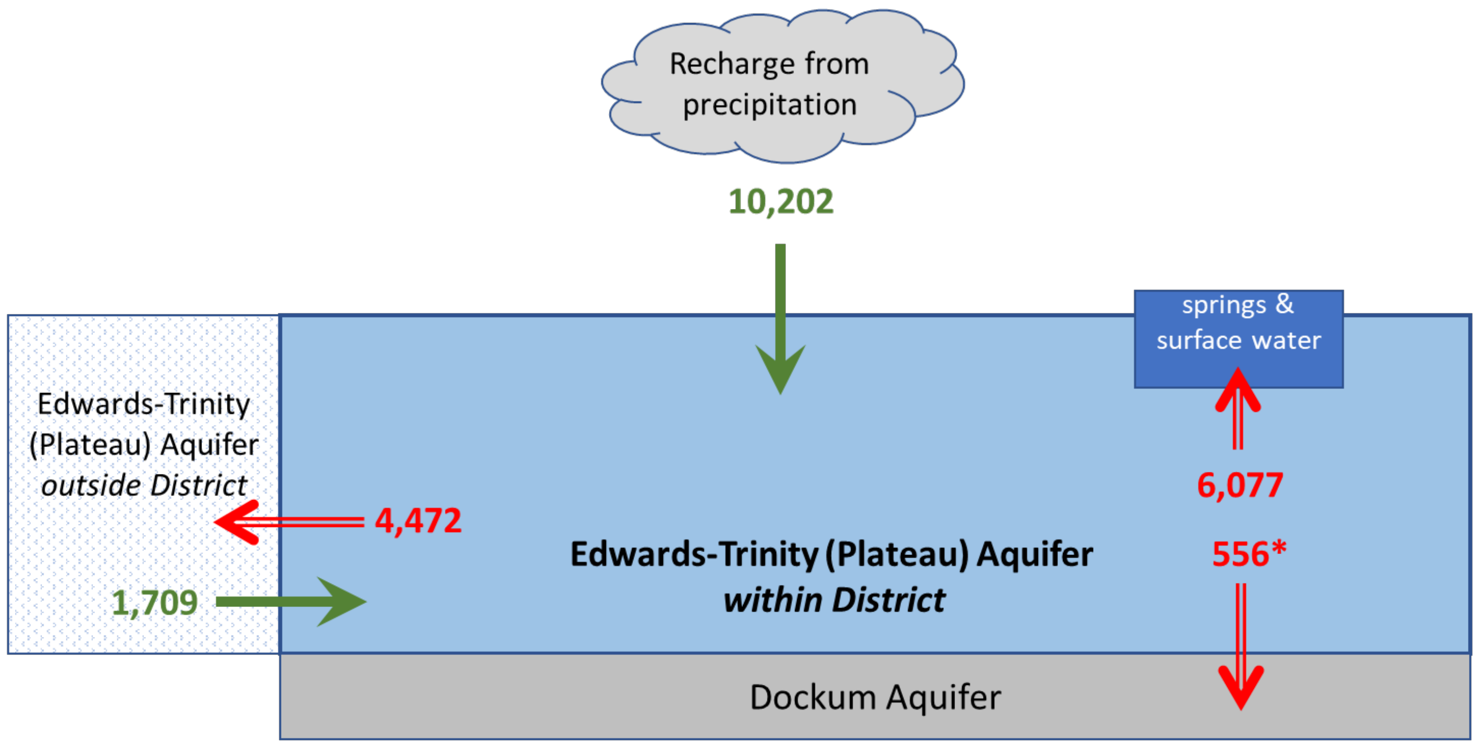
TABLE 2: SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER THAT IS NEEDED FOR THE STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Edwards-Trinity (Plateau) Aquifer	10,202
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Edwards-Trinity (Plateau) Aquifer	6,077
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	1,709
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	4,472
Estimated net annual volume of flow between each aquifer in the district	From the Edwards-Trinity (Plateau) to the Dockum Aquifer	556*
*Flow from the Edwards-Trinity (Plateau) Aquifer to the Dockum Aquifer is provided by the High Plains Aquifer System groundwater availability model.		



gcd boundary date = 06.26.2020, county boundary date = 07.03.2019, eddt_p grid date = 01.06.2020

FIGURE 3: AREA OF THE EDWARDS-TRINITY (PLATEAU) AND PECOS VALLEY AQUIFER GROUNDWATER AVAILABILITY MODEL FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE EDWARDS-TRINITY [PLATEAU] AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).



* Flow from the Edwards-Trinity (Plateau) Aquifer to the Dockum Aquifer is provided by the High Plains Aquifer System groundwater availability model.

Caveat: This diagram only includes the water budget items provided in Table 2. A complete water budget would include additional inflows and outflows. Please see Appendix A for a full water budget.

FIGURE 4: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 2, REPRESENTING DIRECTIONS OF FLOW FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER WITHIN THE STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR.

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

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Lipan Aquifer	105*
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Lipan Aquifer	0*
Estimated annual volume of flow into the district within each aquifer in the district	Lipan Aquifer	277*
Estimated annual volume of flow out of the district within each aquifer in the district	Lipan Aquifer	354*
Estimated net annual volume of flow between each aquifer in the district		Not applicable*
*The model was developed prior to the extension of the Lipan Aquifer along the North Concho River. The model does not cover the entire Lipan Aquifer as shown in Figure 5. Please contact Mr. Stephen Allen with the TWDB at 512-463-7317 or stephen.allen@twdb.texas.gov for additional information on the aquifer in areas not covered by the groundwater availability model in the Sterling County Underground Water Conservation District.		

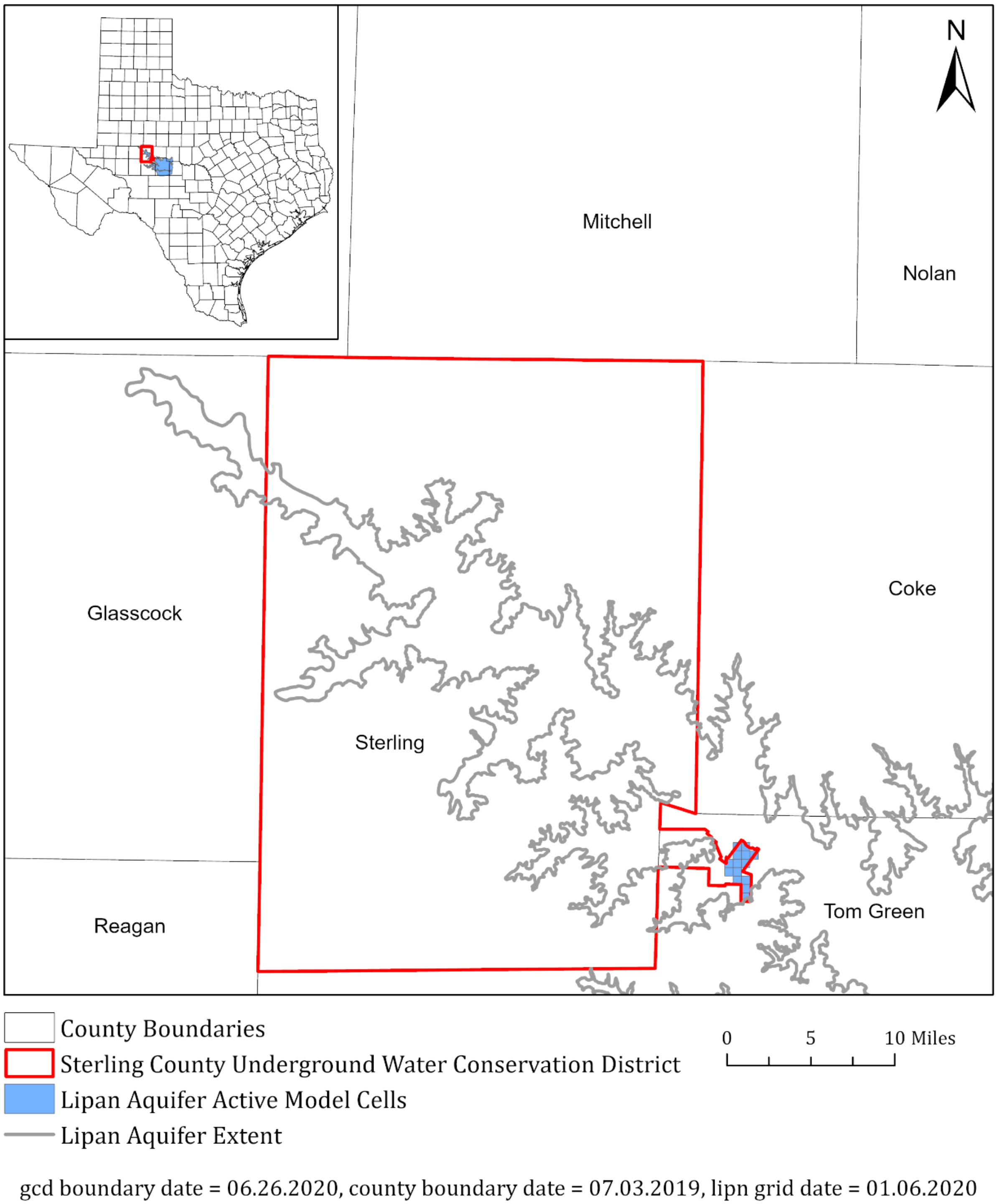
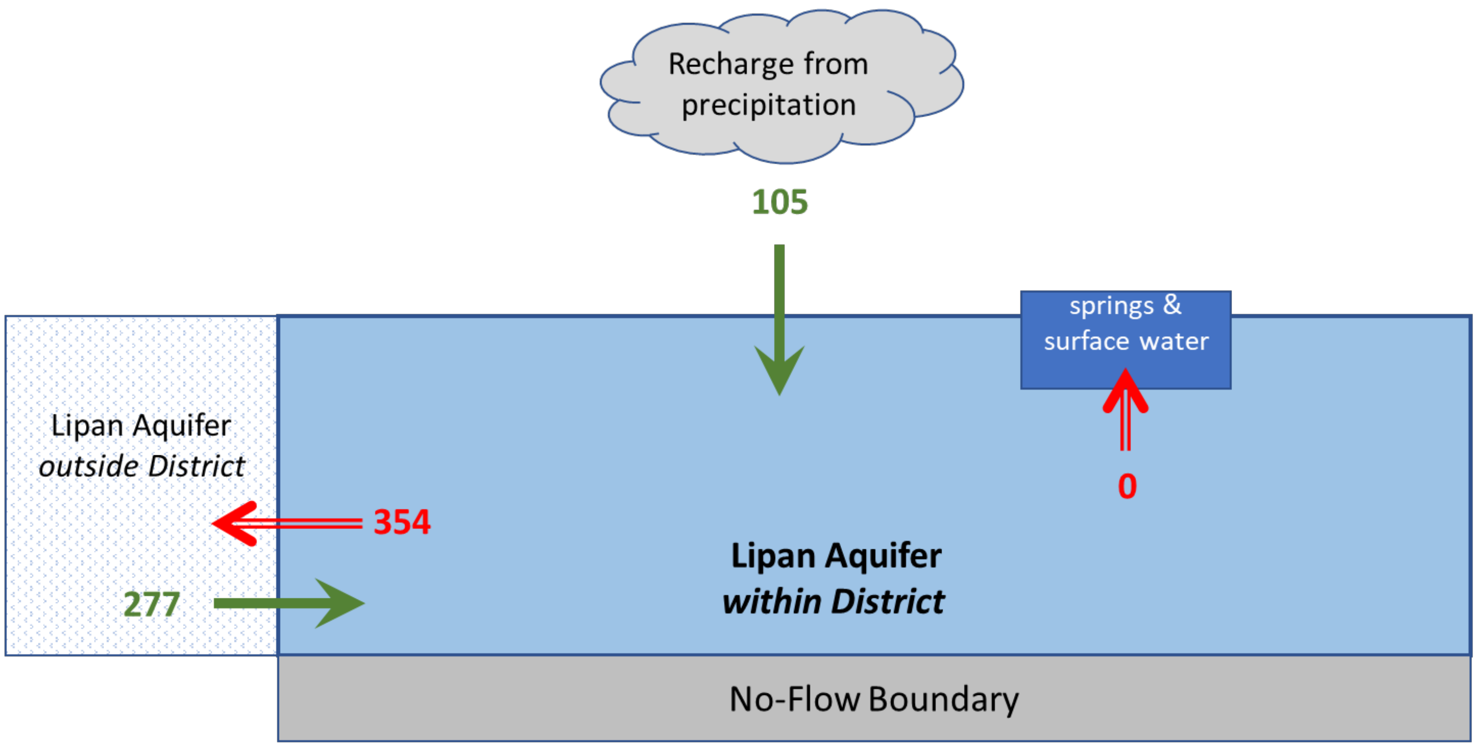


FIGURE 5: AREA OF THE LIPAN AQUIFER GROUNDWATER AVAILABILITY MODEL FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (THE LIPAN AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).



Caveat: This diagram only includes the water budget items provided in Table 3. A complete water budget would include additional inflows and outflows. Please see Appendix A for a full water budget.

FIGURE 6: GENERALIZED DIAGRAM OF THE SUMMARIZED BUDGET INFORMATION FROM TABLE 3, REPRESENTING DIRECTIONS OF FLOW FOR THE LIPAN AQUIFER WITHIN THE STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT. FLOW VALUES EXPRESSED IN ACRE-FEET PER YEAR.

LIMITATIONS:

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

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

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

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

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

REFERENCES:

Anaya, R., and Jones, I. C., 2009, Groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers of Texas: Texas Water Development Board Report 373, 103 p. http://www.twdb.texas.gov/groundwater/models/gam/eddt_p/ET-Plateau_Full.pdf.

Beach, J.A., Burton, S., and Kolarik, B., 2004, Groundwater availability model for the Lipan Aquifer in Texas: Final report prepared for the Texas Water Development Board by LBG-Guyton Associates, 246 p., https://www.twdb.texas.gov/groundwater/models/gam/lipn/LIPN_Model_Report.pdf.

Deeds, N. E., Harding, J. J., Jones, T. L., Singh, A., Hamlin, S. and Reedy, R. C., 2015, Final Conceptual Model Report for the High Plains Aquifer System Groundwater Availability Model, 590 p., https://www.twdb.texas.gov/groundwater/models/gam/hpas/HPAS_GAM_Conceptual_Report.pdf

Deeds, N. E. and Jigmond, M., 2015, Numerical Model Report for the High Plains Aquifer System Groundwater Availability Model, 640 p., https://www.twdb.texas.gov/groundwater/models/gam/hpas/HPAS_GAM_Numerical_Report.pdf?d=4324

Harbaugh, A. W., 2009, Zonebudget Version 3.01, A computer program for computing subregional water budgets for MODFLOW ground-water flow models, U.S. Geological Survey Groundwater Software.

Harbaugh, A. W., and McDonald, M. G., 1996, User's documentation for MODFLOW-96, an update to the U.S. Geological Survey modular finite-difference groundwater-water flow model: U.S. Geological Survey Open-File Report 96-485, 56 p.

Jones, I. C., 2017, GAM Run 17-012: Texas Water Development Board, GAM Run 17-012 Report, 14 p., https://www.twdb.texas.gov/groundwater/docs/GAMruns/GR17-012.pdf.

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., http://www.nap.edu/catalog.php?record_id=11972.

Niswonger, R.G., Panday, S., and Ibaraki, M., 2011, MODFLOW-NWT, a Newton formulation for MODFLOW-2005: USGS, Techniques and Methods 6-A37, 44 p.

Texas Water Code, 2011, http://www.statutes.legis.state.tx.us/docs/WA/pdf/WA.36.pdf

Appendix A – Full Groundwater Budget Diagrams

Full water budget diagrams presented in Figures A-1 through A-6 are included to assist the Sterling County Underground Water Conservation District in analyzing the effects of pumping and recharge on the aquifers within the district. These diagrams are intended to provide additional insight for groundwater conservation districts to better understand their aquifers and to provide more detailed information to inform groundwater management.

Figures A-1, A-3, and A-5 show the full water budgets for the years of minimum and maximum pumping within each aquifer in the district during the historical calibration periods described in the Parameters and Assumptions section. Figure A-2 shows the full water budget for the first and last years of the historical calibration period for the High Plains Aquifer System groundwater availability model. Years of minimum and maximum recharge are not included because the model keeps recharge constant for each stress period within the district during the historical calibration period. Figures A-4 and A-6 show the full water budgets for the years of minimum and maximum recharge of the historical calibration period for the Edwards-Trinity (Plateau) Aquifer and Lipan Aquifer groundwater availability models. Table A-1 lists each component and provides an explanation of each component contained in the full water budget diagrams.

TABLE A-1: EXPLANATION OF EACH BUDGET COMPONENT INCLUDED IN THE FULL WATER BUDGETS FOR THE STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT.

Full water budget component	**Explanation**
Recharge	Representative of recharge to the aquifer from areally distributed rainfall that reaches the water table of the aquifer.
Pumping	The amount of water pumped out of the aquifer through water wells located within the aquifer.
Natural Discharge	Represents the combination of water leaving the aquifer through ephemeral streams, evapotranspiration, springs, and free flowing wells. - Ephemeral streams are streams that do not flow year-round - Springs are locations where groundwater is directly connected to the ground surface and water leaves the aquifer

TABLE A-1: EXPLANATION OF EACH BUDGET COMPONENT INCLUDED IN THE FULL WATER BUDGETS FOR THE STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT.

Full water budget component	Explanation
	- Free flowing wells are wells which connect to the aquifer where the water level is above ground surface and water will flow without the need of pumping
River Leakage	Only representative of the net exchange of water between the rivers/reservoirs and the aquifer in the model
Evapotranspiration	Only represents the amount of water removed from the water table by vegetation or direct evaporation from the water table. This does not include total evapotranspiration for all plants or water features covering the modeled area
Groundwater Exchanges	The sum of the net exchange of groundwater between the aquifer of interest within the district and all geologic units within and outside of the district boundaries
Storage	Represents the difference from the previous year in the amount of water contained within the aquifer and indicates a relative water level rise (negative Storage value) or water level decline (positive Storage value). Change in storage (dS) is the difference between inflows and outflows (Equation 1). To solve the zero-sum budget over the volume of the aquifer within the district, the term dS must be subtracted from both sides of Equation 1 (Equation 2). If total inflows are greater than outflow, Storage will be negative. If total outflows are greater than total inflows, Storage will be positive. $dS = Inflows - Outflows$ **Equation 1** $0 = Inflows - Outflows - dS$ **Equation 2**

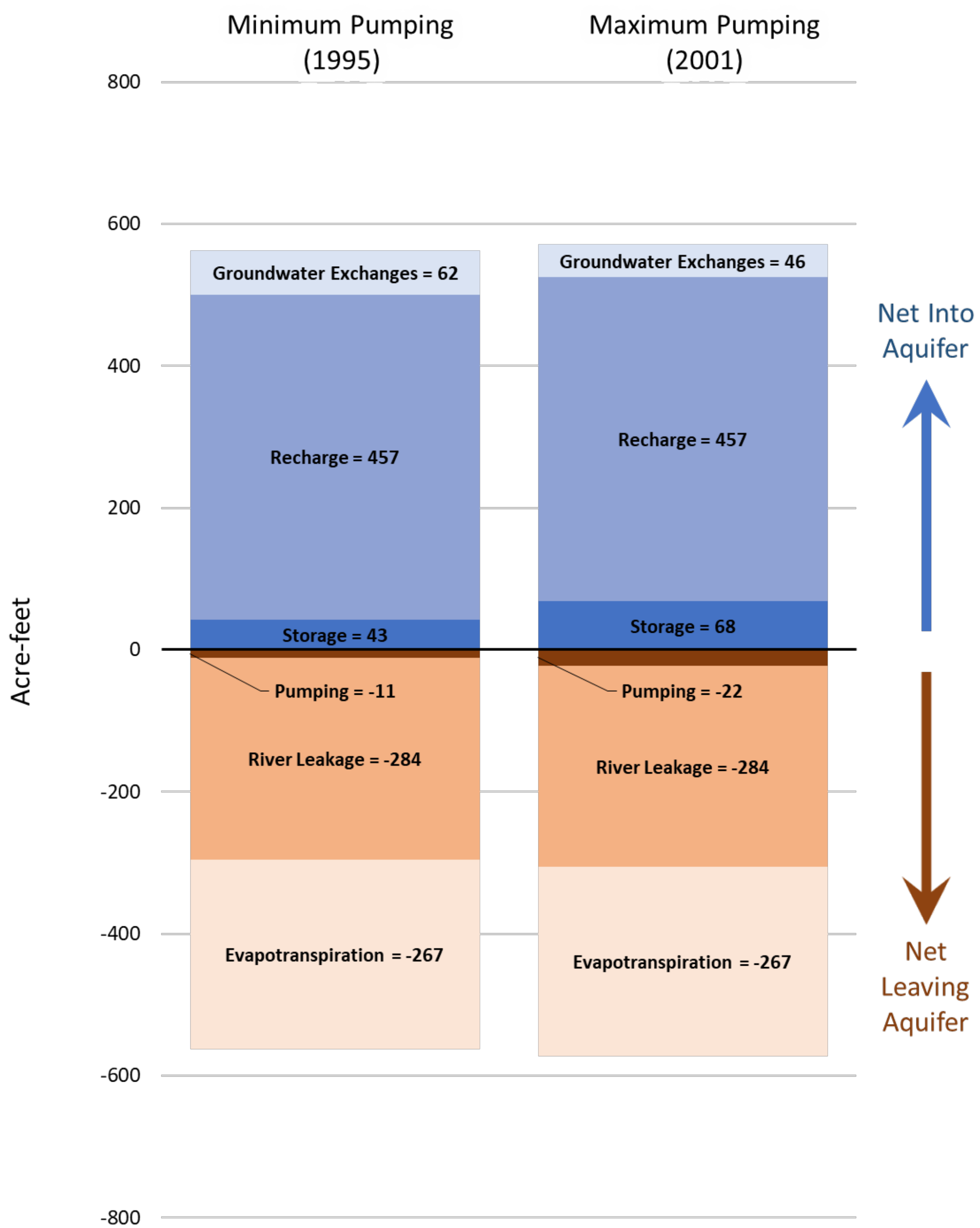


FIGURE A-1: FULL WATER BUDGETS FOR THE DOCKUM AQUIFER WITHIN THE STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT SHOWING THE YEAR OF MINIMUM PUMPING AND THE YEAR OF MAXIMUM PUMPING BETWEEN 1980 AND 2012.

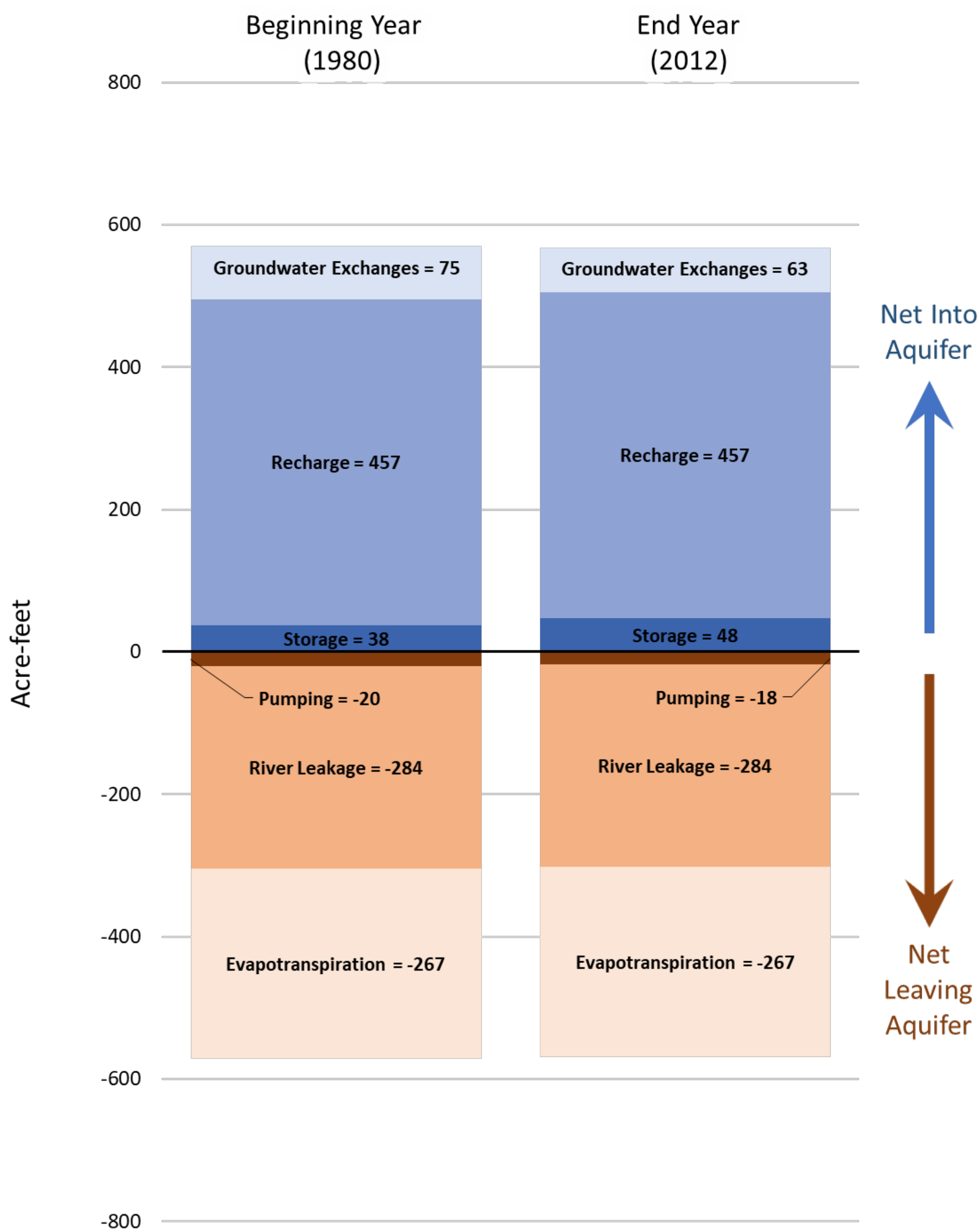


FIGURE A-2: FULL WATER BUDGETS FOR THE DOCKUM AQUIFER WITHIN THE STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT SHOWING THE FIRST AND LAST YEAR OF THE HISTORICAL TRANSIENT PERIOD BETWEEN 1980 AND 2012.

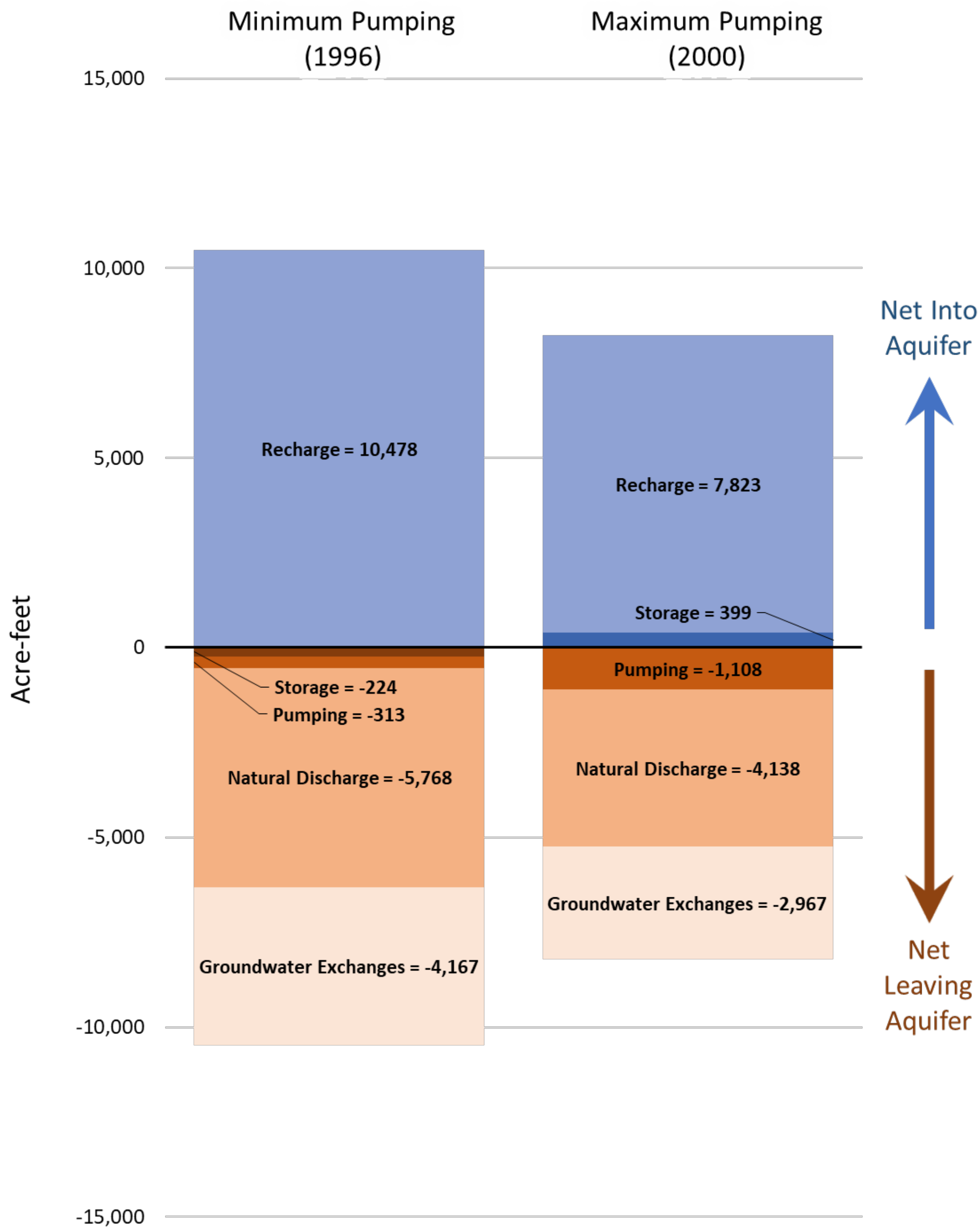


FIGURE A-3: FULL WATER BUDGETS FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER WITHIN THE STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT SHOWING THE YEAR OF MINIMUM PUMPING AND THE YEAR OF MAXIMUM PUMPING BETWEEN 1981 AND 2000.

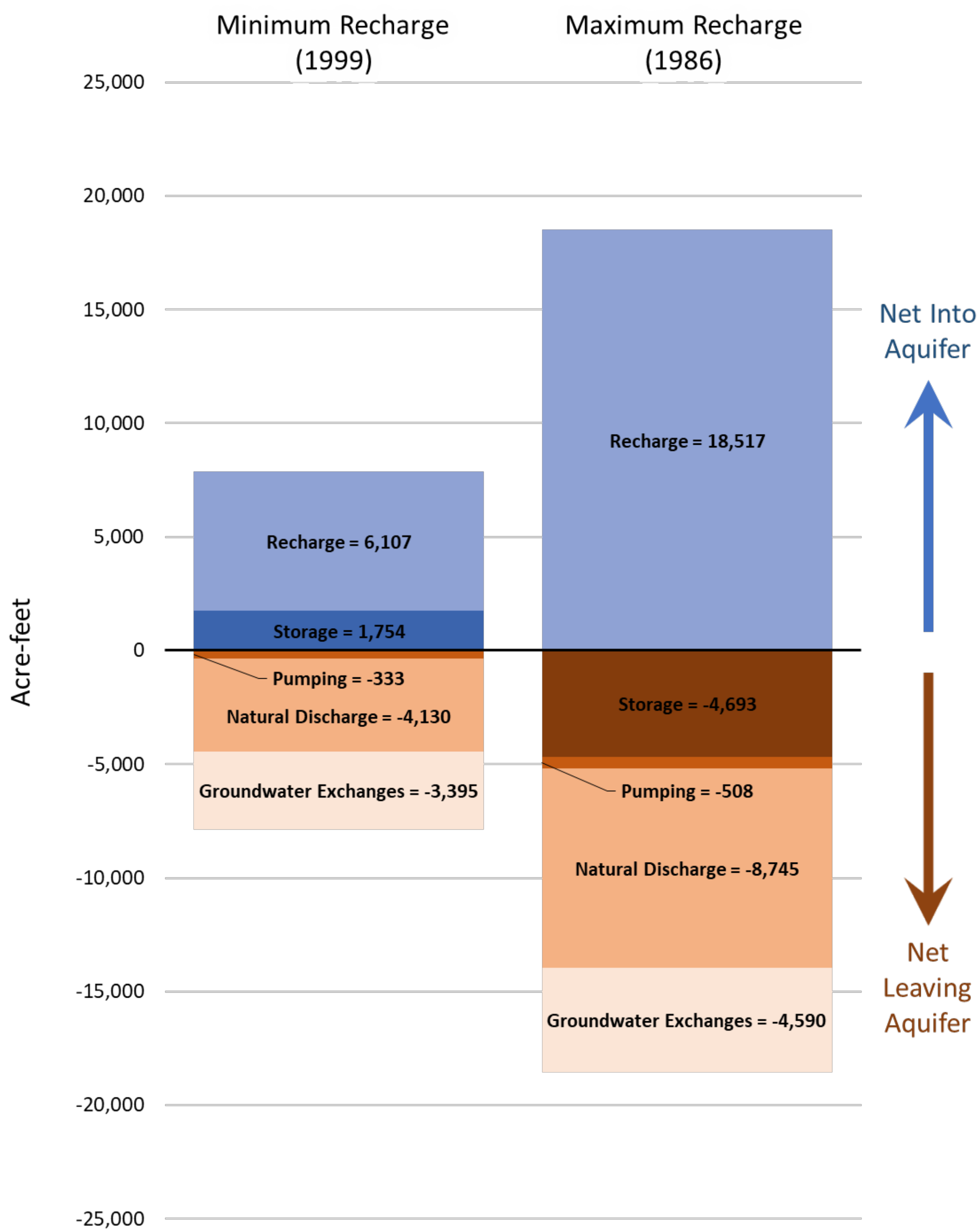


FIGURE A-4: FULL WATER BUDGETS FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER WITHIN THE STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT SHOWING THE YEAR OF MINIMUM RECHARGE AND THE YEAR OF MAXIMUM RECHARGE BETWEEN 1981 AND 2000.

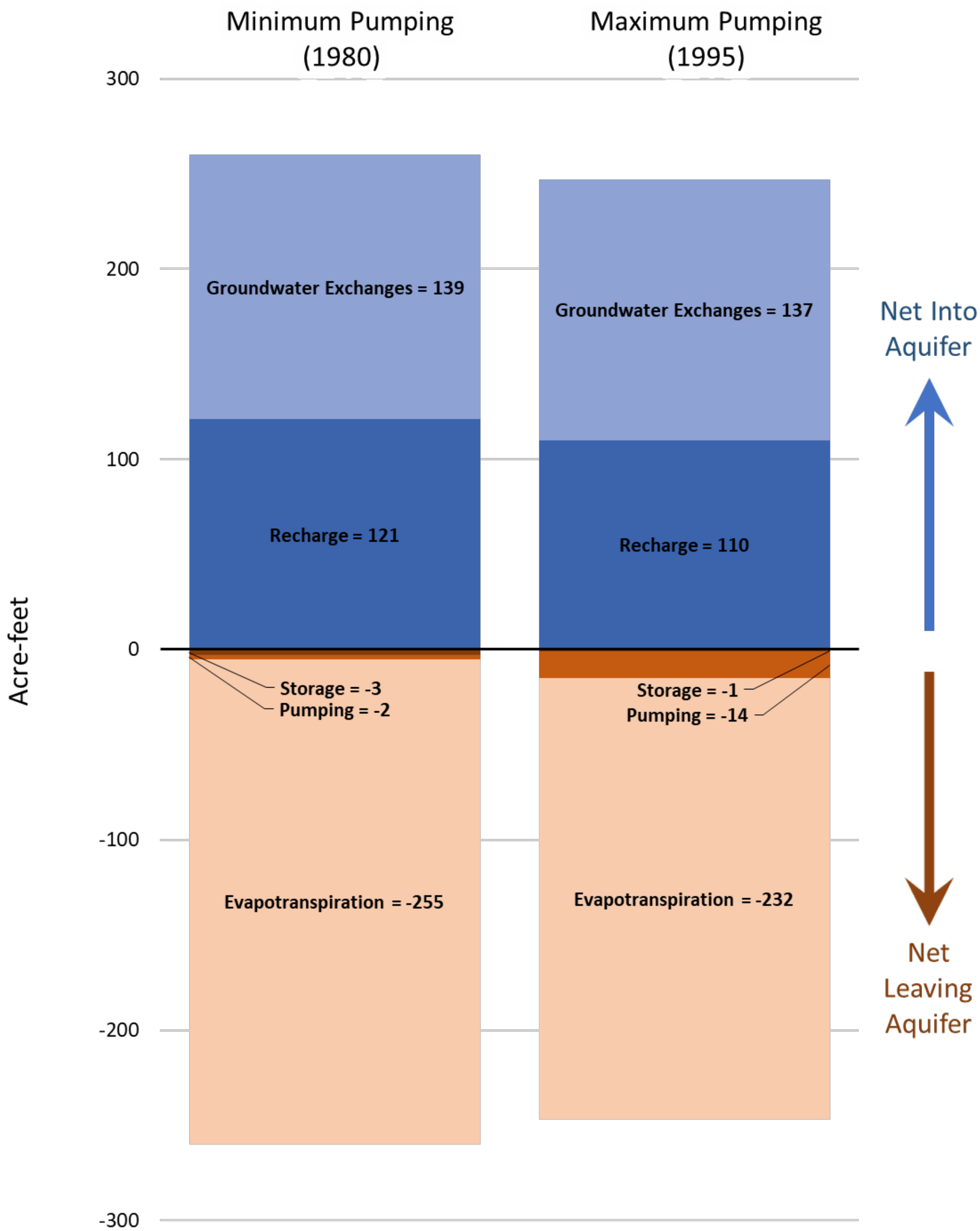


FIGURE A-5: FULL WATER BUDGETS FOR THE LIPAN AQUIFER WITHIN THE STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT SHOWING THE YEAR OF MINIMUM PUMPING AND THE YEAR OF MAXIMUM PUMPING BETWEEN 1980 AND 1998.

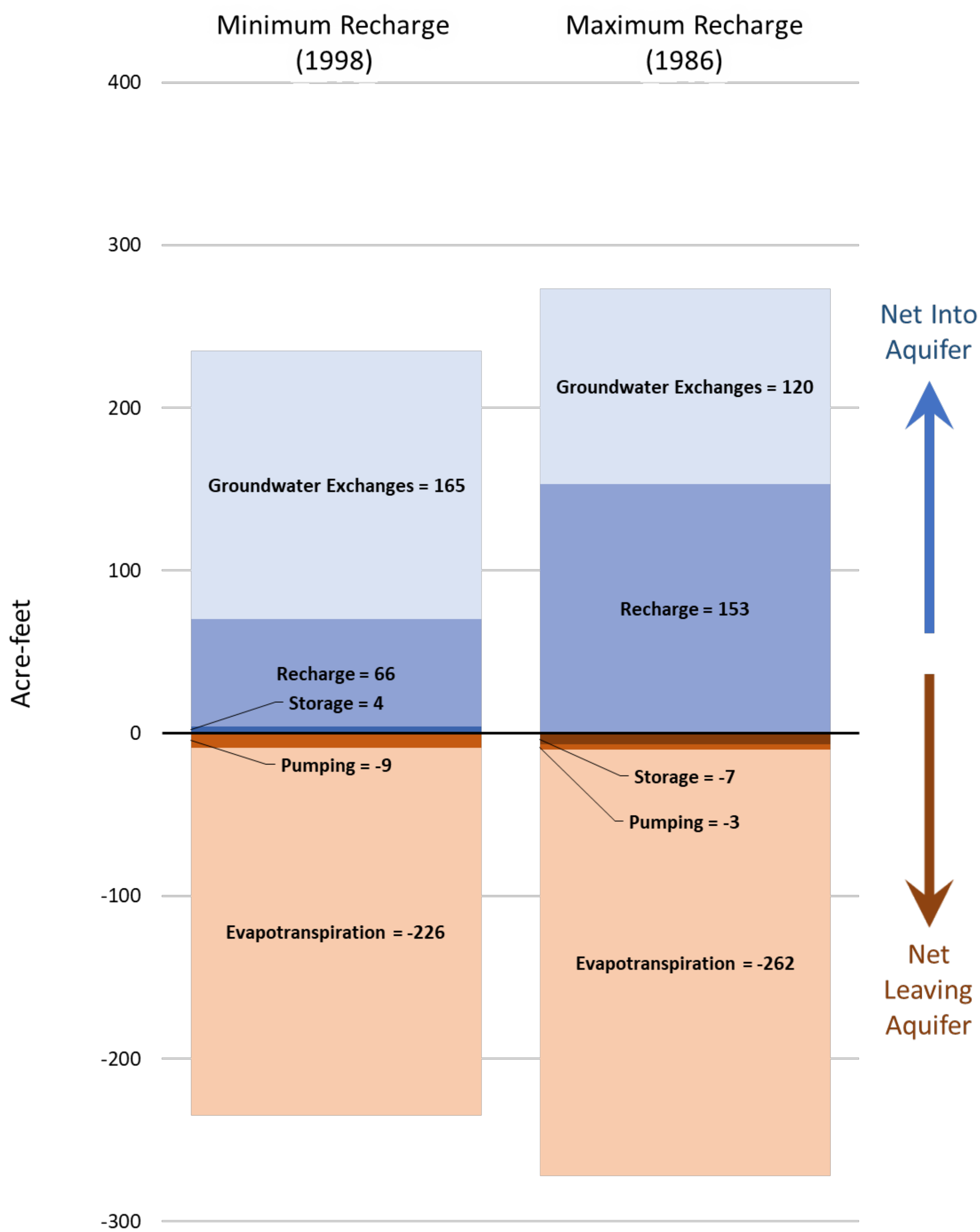


FIGURE A-6: FULL WATER BUDGETS FOR THE LIPAN AQUIFER WITHIN THE STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT SHOWING THE YEAR OF MINIMUM RECHARGE AND THE YEAR OF MAXIMUM RECHARGE BETWEEN 1980 AND 1998.

Appendix D

https://www.sterlinguwcd.org/rules

Appendix E

STERLING COUNTY
Underground Water
Conservation District

STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT

Office: (325) 378-2704 Fax: (325) 378-2624 E-Mail: scuwcd@verizon.net

Adoption of 2023-2028 SCUWCD Management Plan

WHEREAS, the Sterling County Underground Water Conservation District (the District) was created by Acts of the 70th Legislature (1987), H.B. 2587, in accordance with Article 16, Section 59 of the Constitution of Texas and Chapters 51 and 52 of the Texas Water Code, as amended; and

WHEREAS, H.B. 2587 was amended by Acts of the 78th Legislature (2003), H.B. 3556, in accordance with Chapters 36 and 49 of the Texas Water Code, as amended; and

WHEREAS, Acts of the 81st Legislature (2009), the enabling legislation for the District was recodified in Texas Special District Local Laws Code Ann. Ch. 8814 Sterling County Underground Water Conservation District.

WHEREAS, the District is required by Chapter 36, §36.1071 of the Texas Water Code to develop and adopt a Management Plan; and

WHEREAS, the District is required by Chapter 36, §36.1072 of the Texas Water Code to review and re-adopt the plan with or without revisions at least once every five years and to submit the adopted Management Plan the Executive Administrator of the Texas Water Development Board for review and approval; and

WHEREAS, the District's readopted revised Management Plan shall be approved by the Executive Administrator if the plan is administratively complete; and

WHEREAS, the District Board of Directors, after reviewing the existing Management Plan, has determined that this plan should be revised and replaced with a new five-year Management Plan expiring in 2028; and

WHEREAS, the District Board of Directors has determined that the five-year Management Plan addresses the requirements of Chapter 36, §36.1071.

NOW, THEREFORE, be it resolved, that the Board of Directors of the Sterling County Underground Water Conservation District, following notice and hearing, hereby adopts this five-year Management Plan; and

FURTHER, be it resolved, that this new Management Plan shall become effective immediately upon adoption.

Adopted this 10th day of July, 2023 by the Board of Directors of the Sterling County Underground Water Conservation District.

Attesting Signature

Presiding Officer

Appendix F

Standard-Times
PART OF THE USA TODAY NETWORK

PROOF OF PUBLICATION

STERLING COUNTY UWCD
PO BOX 873

STERLING CITY, TX 76951

State of Wisconsin, County of Brown

On **June 30, 2023**, personally appeared before me the undersigned, a Notary Public in and for said county and state, legal clerk of the **SAN ANGELO STANDARD-TIMES**, a daily newspaper published in San Angelo, County of TOM GREEN, State of Texas and of general circulation in the following counties: **Tom Green, Coke, Concho, Crockett, Irion, Kimble, Mason, McCulloch, Menard, Reagan, Runnels, Schleicher, Sterling, Sutton**. The attached advertisement, a true copy of which is hereto annexed, was published in said newspaper in its issues there of the issue(s) dated as follows:

06/30/2023

Subscribed and sworn to before me on June 30, 2023

Legal Clerk

Notary Public, State of WI, County of Brown

8-25-23

My commission expires

SHELLY HORA
Notary Public
State of Wisconsin

Publication Cost: $212.87
Ad No: 0005752799
Customer No: 1246762
PO #:
# of Affidavits 1

This is not an invoice

NOTICE OF PUBLIC HEARING AND MEETING OF THE STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (SCUWCD)

A PUBLIC HEARING and MEETING of the Board of Directors will convene at 1:00 PM on the 10th day of JULY, 2023, in the SCUWCD Office, 612 4th Street, Sterling City, Texas. The purpose of this hearing is to accept public comment on the proposed 2023-2028 SCUWCD Management Plan. Copies of the proposed 2023-2028 SCUWCD Management Plan can be found at the District homepage, at https://www.sterlinguwcd.org/ or can be obtained by contacting the District office at 325-378-2704 or scuwcd@verizon.net. Written comments will be received through July 7, 2023, by mail, email (scuwcd@verizon.net), or hand delivery. The mailing address is PO Box 873, Sterling City, TX, 76951. The physical address for hand delivery is 612 4th Street, Sterling City, TX. The public may provide oral comments at the July 10, 2023 public hearing.

#2155

NOTICE OF PUBLIC HEARING AND MEETING OF THE STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (SCUWCD)

A PUBLIC HEARING and MEETING of the Board of Directors will convene at 1:00 PM on the 10th day of JULY, 2023, in the Sterling County Underground Water Conservation District Office, 612 4th Street, Sterling City, Texas. The purpose of this hearing is to accept public comment on the proposed 2023-2028 SCUWCD Management Plan. Copies of the proposed 2023-2028 SCUWCD Management Plan can be found at the District homepage, at https://www.sterlinguwcd.org/ or can be obtained by contacting the District office at 325-378-2704 or scuwcd@verizon.net. Written comments will be received through July 7, 2023, by mail, email (scuwcd@verizon.net), or hand delivery. The mailing address is PO Box 873, Sterling City, TX, 76951. The physical address for hand delivery is 612 4th Street, Sterling City, TX. The public may provide oral comments at the July 10, 2023 public hearing.

Diana Thomas, General Manager
Ashley Masters, Technician

FILED June 29, 2023
AT 3:59 o'clock P M
JERRI McCUTCHEN
County Clerk, Sterling County, Texas
By ________, Deputy

CERTIFICATE

THE STATE OF TEXAS {}

COUNTY OF STERLING {}

I, Jerri McCutchen, Clerk of the County Court in and for Sterling County, Texas, hereby certify that the above and foregoing instrument is a true and correct copy of the original "Notice of Meeting" as filed by in my office on June 29, A.D. 2023

GIVEN UNDER MY HAND AND SEAL OF OFFICE, this the 29th day of June, A.D. 2023.

Jerri McCutchen, Clerk, County Court
Sterling County, Texas
By: ________ Deputy

COUNTY COURT OF STERLING COUNTY TEXAS

Appendix G

STERLING COUNTY
Underground Water
Conservation District

STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT
Office: (325) 378-2704 Fax: (325) 378-2624 E-Mail: scuwcd@verizon.net

July 12, 2023

Region F Water Planning Group
Colorado River Municipal Water District
400 E. 24th St.
Big Spring, TX 79720

RE: Sterling County Underground Water Conservation District Management Plan – Adopted July 10, 2023

Chapter 36, Texas Water Code, requires groundwater conservation districts to adopt a management plan addressing issues concerning groundwater management in coordination with surface water management entities and regional planning. Therefore, please go to https://www.sterlinguwcd.org/ for a copy of the newly adopted Sterling County Underground Water Conservation District 2023-2028 Management Plan for review.

If you have any questions or need further information on the management plan, please contact me at 325-378-2704 or scuwcd@verizon.net .

Thank you,

Diana Thomas
General Manager

STERLING COUNTY
Underground Water
Conservation District

STERLING COUNTY UNDERGROUND WATER CONSERVATION DISTRICT
Office: (325) 378-2704 Fax: (325) 378-2624 E-Mail: scuwcd@verizon.net

July 12, 2023

Upper Colorado River Authority
512 Orient
San Angelo, TX 76903

RE: Sterling County Underground Water Conservation District Management Plan – Adopted July 10, 2023

Chapter 36, Texas Water Code, requires groundwater conservation districts to adopt a management plan addressing issues concerning groundwater management in coordination with surface water management entities and regional planning. Therefore, please go to https://www.sterlinguwcd.org/ for a copy of the newly adopted Sterling County Underground Water Conservation District 2023-2028 Management Plan for review.

If you have any questions or need further information on the management plan, please contact me at 325-378-2704 or scuwcd@verizon.net .

Thank you,

Diana Thomas
General Manager