Sandy Land Underground Water Conservation District

Management Plan

2009-2014

Effective May 2009

Sandy Land Underground Water Conservation District

Groundwater Management Plan

Adopted 1998
Amended 2003
Amended 2009

Sandy Land UWCD Management Plan

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District Mission

The Sandy Land Underground Water Conservation District will provide technical assistance and develop, promote and implement management strategies to provide for the conservation, preservation, protection, recharging and prevention of waste of the groundwater reservoir, thereby extending the quantity and quality of the Ogallala and the Edwards-Trinity (High Plains) aquifers in Yoakum County.

Time Period of This Plan

This plan will become effective upon adoption by the Sandy Land Underground Water Conservation District Board of Directors and once approved as administratively complete by the Texas Water Development Board. The plan will remain in effect for five years from the date of approval (on or around June 2014) or until a revised plan is adopted and approved.

Statement of Guiding Principles

The Sandy Land Underground Water Conservation District recognized that the groundwater resources of the region are of vital importance to the continued vitality of the citizens, economy and environment within the District. The preservation of the groundwater resources can be managed in the most prudent and cost effective manner through the regulation of production as effected by the District's production limits, well permitting, and well spacing rules. This management plan is intended as a tool to focus the thoughts and actions of those individuals charged with the responsibility for the execution of District activities.

General Description

The Sandy Land Underground Water Conservation District (The District) was created in November, 1989 by authority of SB 1777 of the 71st Texas Legislature. The District has the same areal extent as Yoakum County, Texas and contains 510,540 upland acres. The District is bounded on the west by the State of New Mexico and by Cochran, Terry and Gaines Counties on the north, east and south, respectively. *(Figure 1)*

The economy of Yoakum County is primarily driven by two different industries; oil production and agriculture. The dominant crops produced in the District are irrigated cotton and peanuts. Additionally, watermelons, grain sorghum, sunflowers, soybeans, corn and hay are all grown both on irrigated and dry land acres.

Note: Data for the following has been pulled from the Texas Water Development Board's (TWDB) 2007 State Water Plan, along with the Groundwater Availability Model Run 09-05 (GAM 09-05). A copy of GAM 09-05 is attached in appendix as figure 3.

Groundwater Resources

The Ogallala aquifer is the primary source of water for Yoakum County. *(Figure 2)* The Ogallala aquifer yields water from interfingered sands, gravels and silts of the Ogallala Formation which is of Pliocene age. These sediments represent deposits eroded from the ancestral Rocky Mountains to the west. Within the District, groundwater in the Ogallala aquifer is under water table or unconfined conditions. In this portion of the Southern High Plains, the Ogallala Formation is predominantly covered by dune sands of Quaternary age. Underlying the Ogallala aquifer are sandstones and limestones of the Edwards-Trinity aquifer. These sediments were deposited during Cretaceous time upon an eroded surface and were in turn eroded before being covered by deposition of Ogallala Formation. The result is that the Edwards-Trinity aquifer within the District is highly variable in thickness and depth of occurrence and represents a minor source of groundwater in the District.

The Llano Estacado Regional Water Plan records that in 2004, the total amount of groundwater used in the District was 126,533 acre-feet. The projected irrigation demand for Yoakum County in 2010 is 120,979 acre-feet, down from 122,409 acre-feet in 2000. Texas Water Development Board (TWDB) estimates that annual recharge into the Ogallala Aquifer within the District is approximately 40,506 acre-feet and accounts for zero acre-feet of recharge into the Edwards and Comanche Peak and the Antler Sand formations (GAM 09-05). Natural recharge in the District is mostly through direct infiltration of precipitation into the coarse wind-blown sandy and silty surficial sediments. This is different from the more northern portions of the Southern High Plains where natural recharge is focused through the floors of the thousands of playas.

In order to increase the amount of recharge, which occurs within the District each year, the District has been a part of a regional weather modification program since 1997 to increase the amount of annual precipitation. In the fall of 2001, Sandy Land Underground Water Conservation District withdrew from that regional program and created a weather modification program with two other counties: Terry and Gaines. The TWDB has determined that recharge from rainfall is over 40,000 acre-feet per year, which is one third of the estimated irrigation demand for 2010. Terry and Gaines Counties each have much more recharge due to rainfall. The benefits of even a slight increase in precipitation can be two-fold. First, with any increase in precipitation during the growing season, one can reasonably expect a corresponding decrease in pumping or mining of the aquifer. Second, due to the coarse nature of surficial sediments in the District, the infiltration of precipitation below the effective zone of evapotranspiration may be significant. Initial estimates by outside analysis indicate an increase of .12 inches of rainfall per seeded cloud. Clouds available for seeding are highly variable from year to year, but based on years 2002 and 2003, which were extremely dry with below average rainfall, an increase of .30

inch attributed to precipitation enhancement over the county equates to 14,400 acre feet of water on the ground. One final activity that, while not technically meeting the definition of natural or enhanced recharge, which may significantly impact the overall supply of groundwater in the District is that of circulating irrigation water. Clearly not all irrigation water applied in the District is lost to evapotranspiration; rather some as yet unquantified volume of groundwater produced actually infiltrates back to the Ogallala aquifer and is thus available for pumping again.

Managed Available Groundwater (MAG)

The Desired Future Conditions (DFC's) have not been established for our District. We are working with the Groundwater Management Area 2 to establish these figures; therefore they are not available at the time. Once the desired future conditions have been adopted by GMA 2, an estimate of the managed available groundwater will be determined. The District will amend the management plan at that time.

Estimated Amount of Groundwater Used Annually

The amount of groundwater being used within the District on an annual basis has varied from a low of 121,554 acre-feet to a high of 144,210 acre-feet, over the last five years of available record. The figures for 2003 and 2004 were derived from TWDB Water Uses Survey-Historical Water Usage. The 2005, 2006, and 2007 computations are derived from The District's usage data.

Year	Groundwater Used
2003	141,076 acre-feet
2004	135,001 acre-feet
2005	121,554 acre-feet
2006	144,210 acre-feet
2007	126,085 acre-feet

Total Projected Groundwater Supplies of the District

The water supply estimates in this plan have been extracted from the 2006 Region O-Regional Water Plan. The total water supplies within the District are projected to be:

Year	Groundwater Supply
2010	103,958 acre-feet
2020	99,734 acre-feet
2030	95,204 acre-feet
2040	91,342 acre-feet
2050	88,062 acre-feet
2060	85,269 acre-feet

Total Projected Surface Water Supplies

Although the GAM 09-05 states that the District has no surface water, the 2007 State Water Plan does allow for projected supplies in the Livestock user group. These figures are as follows:

Year	Surface Water Supply
2010	218 acre-feet
2020	273 acre-feet
2030	278 acre-feet
2040	282 acre-feet
2050	288 acre-feet
2060	293 acre-feet

Total Projected Water Demands within the District

The water demand estimates in this plan have been extracted from the 2007 State Water Plan. With normal rainfall and the advent of expected conservation measures, total water demands within the District are projected to be:

Year	Total Water Demands
2010	127,955 acre-feet
2020	122,581 acre-feet
2030	116,958 acre-feet
2040	112,056 acre-feet
2050	107,784 acre-feet
2060	104,047 acre-feet

Annual Volume of Groundwater that Discharges to Surface Water Bodies

The District has no surface water available. As stated in GAM 09-05, the model does not include any major springs, lakes, streams, or rivers within the District; therefore, the estimated annual volume of water that discharges from the Ogallala Aquifer and the Edwards, Comanche Peak and the Antlers Sand Formations of the Edwards Trinity (High Plains) Aquifer to springs and any surface water body including lakes, streams, and rivers is reported as zero acre-feet.

Total Projected Water Needs

The total projected water needs for the District have been compiled from the 2007 State Water Plan. A positive value would reflect a water surplus; the negative values below reflect a water need.

Year	Projected Water Needs
2010	-23,779 acre-feet
2020	-23,192 acre-feet
2030	-23,508 acre-feet
2040	-22,261 acre-feet
2050	-21,088 acre-feet
2060	-20,083 acre-feet

Estimated Annual Volume of Flow through the District

The estimated annual volume of flow into and out of the district within the Ogallala Aquifer in this table below have been extracted from the Groundwater Availability Model Run 09-05 provided by the Texas Water Development Board.

	Aquifer or Confining Unit	Acre-feet
Estimated annual volume of flow into the district	Ogallala Aquifer	1,398 acre-feet
	Edwards & Comanche Peak Formations	392 acre-feet
	Antlers Sand Formation	486 acre-feet
Estimated annual volume of flow out of the district	Ogallala Aquifer	1,877 acre-feet
	Edwards & Comanche Peak Formations	390 acre-feet
	Antlers Sand Formation	387 acre-feet
Estimated net annual volume of flow between each aquifer in district	From Ogallala Aquifer to underlying units	940 acre-feet
	From overlying Ogallala Aquifer & Cretaceous shale into Edwards & Comanche Peak Formations	1,008 acre-feet
	From Edwards & Comanche Peak formations into Antlers Sand Formation	1,041 acre-feet

Total Projected Water Management Strategies (acre-feet per year)

The following table has been taken form the TWDB 2007 State Water Plan.

Water User Group	Water Management Strategy	Source Name	2010	2020	2030	2040	2050	2060
Denver City	Municipal Water Conservation	Conservation	77	169	179	171	160	155
Denver City	Local Groundwater	Ogallala Aquifer	0	0	1,476	1,328	1,195	1,076
Plains	Municipal Water Conservation	Conservation	33	68	106	107	102	98
Plains	Local Groundwater	Ogallala Aquifer	0	618	556	501	451	405
Irrigation	Irrigation Water Conservation	Conservation	1,074	966	870	783	704	634
Total Projected Water Management Strategies (acre-feet per year)=			**1,184**	**1,821**	**3,187**	**2,890**	**2,612**	**2,368**

Management of Groundwater Supplies

The District will manage the supply of groundwater within the District in order to conserve the resource while seeking to maintain the economic viability of all resource user groups, public and private. In consideration of the economic and cultural activities occurring within the District, the District will identify and engage in such activities and practices that, if implemented, would result in a reduction of groundwater use. A monitor well observation network shall be established and maintained in order to evaluate changing conditions of groundwater supplies (water in storage) within the District. The District will make a regular assessment of water supply and groundwater storage conditions and will report those conditions to the Board and to the public. The District will undertake, as necessary, and cooperate with investigations of the groundwater resources within the District and will make the results of investigations available to the public upon adoption by the Board.

The District has adopted rules to regulate groundwater withdrawals by production limits and well spacing. The District may deny a well construction permit or limit groundwater withdrawals in accordance with the guidelines stated in the rules of the District. In making a determination to deny a permit or limit groundwater withdrawals, the District will consider the public benefit against individual hardship after considering all appropriate testimony.

The relevant factors to be considered in making a determination to deny a permit or limit groundwater withdrawals will include:

1) The purpose of the rules of the District

2) The equitable distribution of the resource
3) The economic hardship resulting from grant or denial of a permit or the terms prescribed by the permit.

In pursuit of the District's mission of protecting the resource, the District may require reduction of groundwater withdrawals to amounts that will not cause harm to the aquifer. To achieve this purpose, the District may, at the Boards discretion, amend or revoke any permits after notice and hearing. The determination to seek the amendment or revocation of a permit by the District will be based on aquifer conditions observed by the District. The District will enforce the terms and conditions of permits and the rules of the District by enjoining the permit holder in a court of competent jurisdiction as provided for in Texas Water Code (TWC) §36.102.

The District will employ all technical resources at its disposal to evaluate the resources available within the District and to determine the effectiveness of regulatory or conservation measures. A public or private user may appeal to the Board for discretion in enforcement of the provisions of the water supply deficit contingency plan on grounds of adverse economic hardship or unique local conditions. The exercise of said discretion by the Board shall not be construed as limiting the power of the Board.

Drought Contingency Plan

There essentially can be no drought contingency plan for Sandy Land Underground Water Conservation District (Yoakum County) because under any standards drought is a constant. Rainfall averages for the year may seem somewhat adequate, but the need, during the growing season, is only a fraction of the total yearly rainfall. Irrigation wells cannot be turned off, or the amount of water pumped by them reduced, because of the crops that are growing.

What we have seen in many cases are half circles being irrigated instead of full circles. Those that pump the most, agricultural users, have been educated by the aquifer itself and the regulation it bestows on all users.

It is our belief that we will not make anymore groundwater. We have no surface water available to those located in Yoakum County and therefore our reliance on rainfall becomes even greater in the years ahead. Our most significant drought contingency plan is focused on increased rainfall through weather modification. The Texas Water Development Board has provided data that 40,506 acre-feet of recharge was supplied into the Ogallala Aquifer, in Yoakum County, from rainfall.

Actions, Procedures, Performance and Avoidance for Plan Implementation

The District will implement the provisions of this plan and will utilize the provisions of this plan as a guidepost for determining the direction or priority for all District activities. All operations of the District, all agreements entered into by the District and any additional planning efforts in which the District may participate will be consistent with the provisions of this plan.

The District will adopt rules relating to the permitting of wells and the production of groundwater. The rules adopted by the District shall be pursuant to TWC Chapter 36 and the provisions of this plan. All rules will be adhered to and enforced. The promulgation and enforcement of the rules will be based on the best technical evidence available.

The District shall treat all citizens with equality. Citizens may apply to the District for discretion in enforcement of the rules on grounds of adverse economic effect or unique local conditions. In granting of 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 the cooperation in the implementation of this plan and the management of groundwater supplies within the District. All activities of the District will be undertaken in cooperation and coordinated with the appropriate state, regional or local water management entity.

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

The District manager will prepare and present an annual report to the Board of Directors on District performance in regards to achieving management goals and objectives. The presentation of the report will occur during the last monthly Board meeting each fiscal year, beginning September 1, 1999. The report will include the number of instances in which each of the activities specified in the District's management objectives was engaged in during the fiscal year. Each activity will be referenced to the estimated expenditure of staff time and budget in accomplishment of the activity. The notations of activity frequency, staff time and budget will be referenced to the appropriate performance standard for each management objective describing the activity, so that the effectiveness and efficiency of the Districts operations may evaluated. The Board will maintain the report on file, for public inspection at the District's offices upon adoption. This methodology will apply to all management goals contained within this plan.

The District will actively enforce all rules and regulations necessary for conserving, preserving, protecting, recharging and prevention of waste of water from the Ogallala aquifer in Yoakum County. To accomplish this goal, the District will continue to develop and enforce rules and regulations, and modify as necessary, to carry out the duties as provided by Chapter 36 of the Texas Water code to effectively manage the Ogallala aquifer.

Goals, Management Objectives and Performance Standards

Goal

1.0 Provide for the most efficient use of groundwater within the District.

Management Objective

(a) Annually conduct irrigation well efficiency tests for 100 percent of requests within 10 days of the property owner request.

Performance Standard

(a1) Percentage of irrigation well efficiency test requests conducted annually within 10 days of request.

Management Objective

(b) There are currently 90 water wells in the District's water level monitoring network. The objective is to annually measure water levels in 80 percent of the District's monitor well network.

Performance Standard

(b1) Percentage of monitor wells in monitor well network in which water levels were measured.

Management Objective

(c) By January 1 of each year, prepare a map for the Internal Revenue Service documenting changes in water table elevations (the District Depletion Map) in the Ogallala aquifer within the District.

Performance Standard

(c1) A map submitted to the Internal Revenue Service by January 1 of each year.

Goal

2.0 Control and prevent waste of groundwater within the District.

Management Objective

(a) Each year, the District will sample the water quality in at least one selected well(s) in order to monitor water quality trends and prevent the waste of groundwater by contamination. The District will also sample for water quality analysis on 100 percent of other wells which the owner requests to be sampled each year.

Performance Standard
(a1) Number of wells sampled for water quality analysis by the District to monitor water quality trends each year.

Performance Standard
(a2) Percent of wells sampled for water quality analysis by the District upon request each year.

Management Objective
(b) Each year, the District will enforce District spacing and production limitation rules requiring the permitting of all new wells to prevent the waste of groundwater. The District will issue temporary permits for 100 percent of the application requests that meet the District's rigorous rules for spacing within 30 days of the receipt of the application.

Performance Standard
(b1) Number of temporary permits issued by the District for new wells in compliance with spacing and production limits each year.

(b2) Percent of temporary permits issued to applications that meet the District's rigorous rules for spacing within 30 days of receipt of application.

Management Objective
(c) The District newsletter will include articles on the district's activities and water conservation to encourage a reduction of water use. This information may be made available by direct mail, website or local newspaper.

Performance Standard
(c1) Number of articles on water conservation presented by the District each year.

Goal
3.0 Conservation of Groundwater within the District.

Management Objective
(a) Each year the District will participate in the TWDB Agricultural Conservation Loan program as a lender district and make loans available to all qualified applicants for the purchase of water conserving irrigation apparatus, up to the maximum amount of the loan commitment made to the District by TWDB.

Performance Standard
(a1) Number of Agricultural Conservation loan applications received by the District from qualified applicants each year.

(a2) Number of Agricultural Conservation loans made by the District to qualified applicants each year.

Management Objective
(b) Each year, the District will award scholarships to at least four (4) high school students graduating from a high school within the District to facilitate study of water conservation topics.

Performance Standard
(b1) Number of scholarships awarded to students graduating high school within the District to facilitate study of water conservation topics, each year.

Management Objective
(c) Each year, the District will make available a water conservation video to each elementary level school within the District.

Performance Standard
(c1) Number of water conservation videos made available to elementary level schools within the District, each year.

Goal
4.0 Precipitation Enhancement.

Management Objective
(a) The District will conduct at least one weather modification activity during five months (April, May, June, July and August) of each year to increase rainfall.

Performance Standard
(a1) Number of months that weather modification activities took place.

Goal
5.0 Addressing in a Quantitative Manner Desired Future the Conditions.
Although the District is currently involved in establishing the DFCs for the Ogallala Aquifer, the DFC has not been approved. Therefore, this goal is not applicable at this time.

Goal
6.0 Drought Conditions.
The District is under a constant state of drought; therefore this goal is not applicable.

Goal
7.0 Recharge Enhancement.
A review of past work conducted by others indicates this goal is not appropriate at present; therefore this goal is not applicable.

Goal

8.0 Rainwater Harvesting.

A review of past work conducted by others indicates this goal is not appropriate at present; therefore this goal is not applicable.

Goal

9.0 Brush Control.

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

<u>Goals identified in Chapter 36, Texas Water Code, not applicable to the District</u>

The following goals referenced in Chapter 36, Texas Water Code, have been determined not applicable to the District.

§36.1071(a)(3) The goal of controlling and preventing subsidence is not applicable to the District.

§36.1071(a)(4) The goal for addressing conjunctive surface water management issues is not applicable to the District due to the absence of any surface water features and hence, any surface water management issues.

§36.1071(a)(5) The goal for addressing natural resource issues that impact the use and availability of groundwater or are impacted by the use of groundwater within the District is not applicable.

Sandy Land UWCD

Groundwater Management Plan

Appendix

Figure 1
Groundwater Conservation Districts in Texas

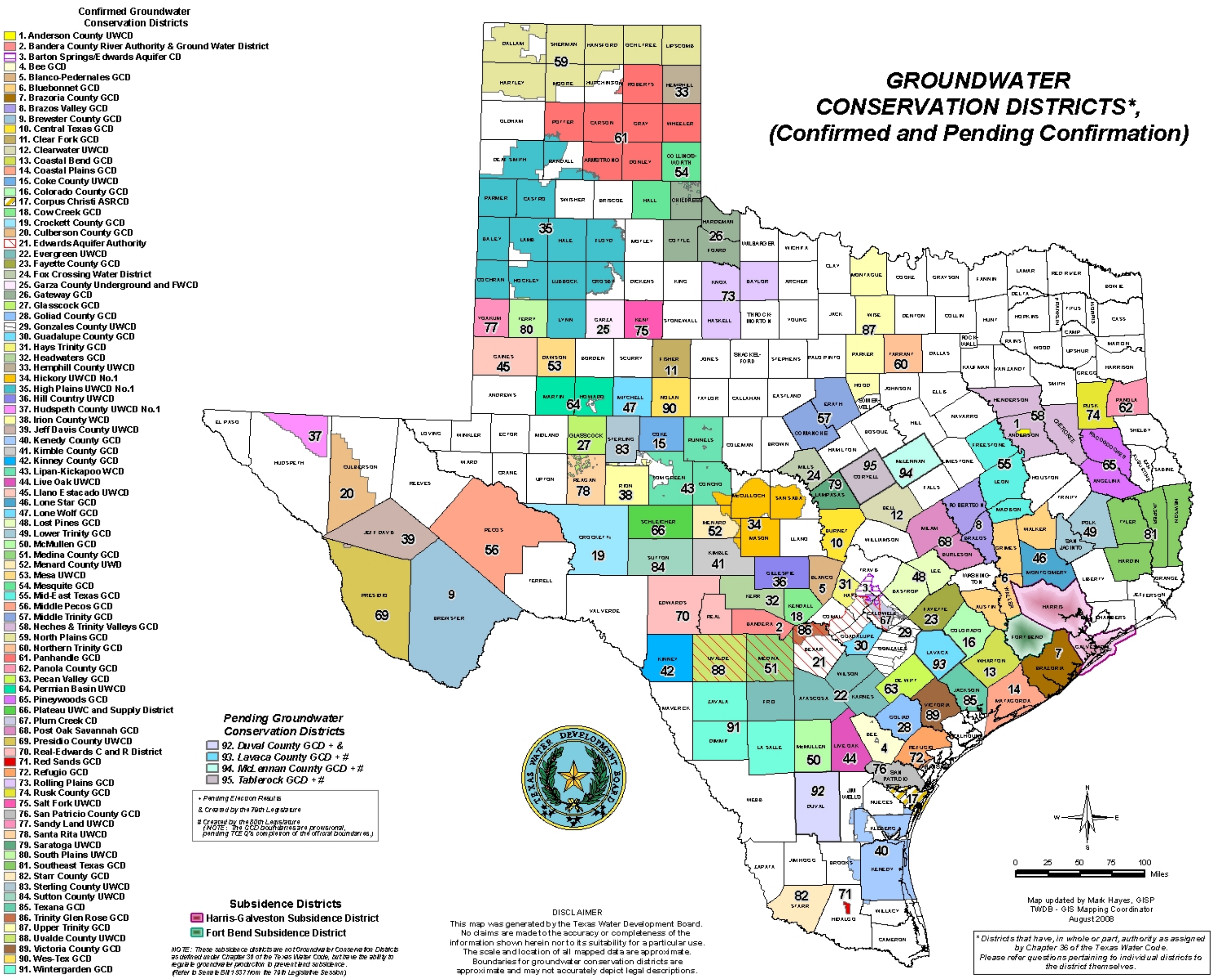
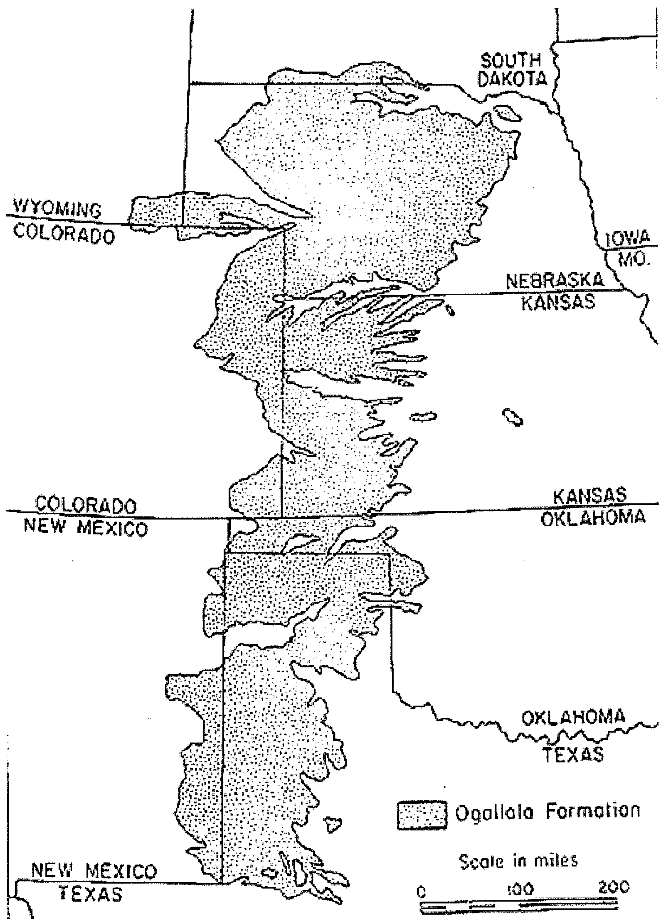


Figure 2

The Ogallala Aquifer



GAM Run 09-05

by Mr. Wade Oliver
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(512) 463-3132
March 17, 2009

EXECUTIVE SUMMARY:

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

(1) the annual amount of recharge from precipitation to the groundwater resources within the district, if any;
(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 purpose of this model run is to provide additional information to Sandy Land Underground Water Conservation District for its groundwater management plan. This modeling information, based on the newly approved groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer, is to be used in place of the results presented in Groundwater Availability Model Run 08-47 (Oliver, 2008) in development of the district's groundwater management plan. The groundwater management plan for Sandy Land Underground Water Conservation District is due for approval by the Executive Administrator of the Texas Water Development Board before February 25, 2009.

This report discusses the methods, assumptions, and results from model runs using the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer. Table 1 summarizes the groundwater availability model data required by statute for Sandy Land Underground Water Conservation District's groundwater management plan. Figure 1 shows the area of the model from which the values in Table 1 were extracted.

METHODS:

We ran the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer and (1) extracted water budgets for each year of the 1980 through 2000 period and (2) averaged the annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district, net inter-aquifer flow (upper), and net inter-aquifer flow (lower) for the portions of the aquifers located within the district.

PARAMETERS AND ASSUMPTIONS:

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

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

- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) for the Ogallala Aquifer in 2000 is 33 feet. The mean absolute error for the Edwards-Trinity (High Plains) Aquifer in 1997 is 25 feet (Blandford and others, 2008). This represents 1.8 and 3.0 percent of the hydraulic head drop across the model area for each aquifer, respectively.

- Irrigation return flow was accounted for in the groundwater availability model by a direct reduction in agricultural pumping as described in Blandford and others (2003).

- We used Groundwater Vistas version 5.30 Build 10 (Environmental Simulations, Inc., 2007) as the interface to process model output.

RESULTS:

A groundwater budget summarizes the water entering and leaving the aquifer according to the groundwater availability model. The model is based on the U.S. Geological Survey's MODFLOW 2000 groundwater modeling code (Harbaugh and others, 2000). Selected components were extracted from the groundwater budget for the aquifers located within the district and averaged over the duration of the calibrated portion of the model run (1980 to 2000) in the district, as shown in Table 1. The components of the modified budgets shown in Table 1 include:

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

- Surface water outflow—This is the total water exiting the aquifer (outflow) to surface water features such as streams, reservoirs, and drains (springs).

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

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

The information needed for the district's management plan is summarized in Table 1. 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 model cell's centroid. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located.

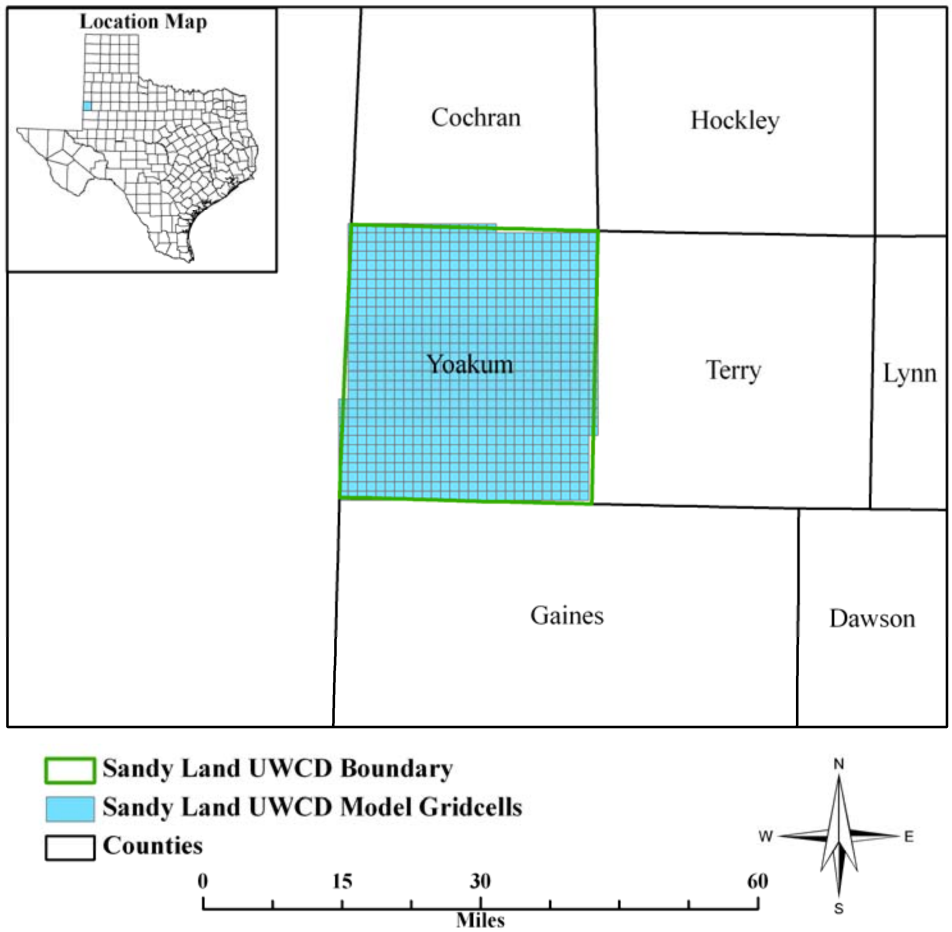
Table 1: Summarized information needed for the groundwater management plan for Sandy Land Underground Water Conservation District. All values are reported in acre-feet per year. All numbers are rounded to the nearest 1 acre-foot.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Ogallala Aquifer	40,506[a]
	Edwards and Comanche Peak formations	0
	Antlers Sand Formation	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Ogallala Aquifer	0[b]
	Edwards and Comanche Peak formations	0[b]
	Antlers Sand Formation	0[b]
Estimated annual volume of flow into the district within each aquifer in the district	Ogallala Aquifer	1,398
	Edwards and Comanche Peak formations	392
	Antlers Sand Formation	486
Estimated annual volume of flow out of the district within each aquifer in the district	Ogallala Aquifer	1,877
	Edwards and Comanche Peak formations	390
	Antlers Sand Formation	387
Estimated net annual volume of flow between each aquifer in the district	From Ogallala Aquifer to underlying units	940
	From overlying Ogallala Aquifer and Cretaceous shale into Edwards and Comanche Peak formations	1,008
	From Edwards and Comanche Peak formations into Antlers Sand Formation	1,041

[a] Irrigation return flow was accounted for in the model by a direct reduction in agricultural pumping as described in Blandford and others (2003). This value is higher than what was reported in Groundwater Availability Model Run 08-47 (Oliver, 2008) due to the correction associated with irrigation return flow.

[b] The model does not include any major springs, lakes, streams, or rivers within the district.

Figure 1: Area of the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer from which the information in Table 1 was extracted. Note that model grid cells that straddle a political boundary were assigned to one side of the boundary based on the centroid of the model cell.



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Cynthia K. Ridgeway is Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by employees under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G., on March 17, 2009.