Report 356

edited by
Robert E. Mace
William F. Mullican III
Edward S. Angle

Texas Water Development Board

P.O. Box 13231, Capitol Station
Austin, Texas 78711-3231

December 2001

.

Texas Water Development Board

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Aquifers of West Texas

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Craig D. Pedersen, Executive Administrator

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Preface

On behalf of the Texas Water Development Board, I want to welcome you to Alpine for the Aquifers of West Texas Conference. The Texas Water Development Board, along with our co-sponsors, Sul Ross State University and the University of Texas at El Paso, Center for Environmental Resource Management, hope that you will benefit greatly from the presentations made at the conference and during the field trip, as well as from the technical papers compiled in this document, Report 356, Aquifers of West Texas.

As a West Texas landowner, I keenly recognize the critical value of the precious water resources in our beautiful, productive, but arid lands. One of the most positive aspects of Senate Bill 1, passed by the 1997 Texas Legislature, was the regional water planning process. This process significantly improved our understanding of our water resources and their availability to meet future needs. There is still, however, so much more to be known about the hydrogeology of our West Texas aquifers. The Aquifers of West Texas Conference is, in large part, a compilation of much of the hydrogeologic information available regarding our groundwater resources. I believe that the valuable hydrogeologic information included in Report 356, along with the technical interaction and exchange of ideas to occur throughout this conference, will have a positive impact on our understanding of the water resources of Texas for many years to come.

Increasing the hydrogeologic science about our West Texas aquifers and enhancing public understanding about these underground water resources are vital to the future policy decision made about use of this water.

On behalf of the citizens of West Texas, we thank you for your participation in this most important effort.

Kathleen Hartnett White
Member
Texas Water Development Board

Note from the Editors:

The start of regional water planning, the pressures of drought, and the challenges facing growing urban centers have catalyzed interest in the water resources of West Texas. Therefore, when one of our board members, Ms. Kathleen Hartnett White, approached staff in late 2000 with the concept of holding a conference focusing on the science of aquifers in West Texas, we thought it was a great idea. Many water-resource issues in West Texas are controversial, and reliable scientific information is needed to help address many of the issues. Therefore, the purpose of the conference was to (1) review what is known about the aquifers of West Texas and (2) identify what needs to be done to better understand the aquifers.

When we organized the conference, we first identified the topics we wanted addressed and then identified potential speakers to invite to discuss each of the topics. After preparing an outline of the topics, we realized we had the skeleton of a good book about the aquifers of West Texas. Therefore, we asked speakers to also prepare a chapter to include in the volume you are now holding. This volume is meant to be a stand-alone document as well as a proceedings of the conference held in Alpine December 4th through 6th, 2001, including a field trip.

Orchestrating the conference and this document was a great task, and we are thankful for the assistance of many people. First, we thank our co-conveners for the conference, Sul Ross State University (David Rohr and Kevin Urbanczyk, Department of Earth and Physical Sciences) and the Center for Environmental Resource Management at The University of Texas at El Paso (Ed Hamlyn). We are also thankful to Barbara Kauffman (Rio Grande Council of Governments), Janet Adams (Jeff Davis County Underground Water Conservation District), Kate Hoskins (Culberson County Groundwater Conservation District), and Carla Daws (TWDB) for publicizing the conference.

We thank the authors for sharing their time and knowledge in preparing these papers. We are particularly thankful to Ian Jones, Sanjeev Kalaswad, and Zhuping Sheng for producing their papers with short notice. We thank the groundwater conservation districts for participating in the conference. We are grateful to Lana Dieterich of the Bureau of Economic Geology for her review of the document and Mike McCathern and Zelphia Bloodworth for final formatting and production work. We also thank our executive administrator, Craig Pedersen, and our deputy executive administrator, Dr. Tommy Knowles, for their reviews and support. We also thank our board member, Ms. Kathleen Hartnett White, for the initial idea and support throughout this effort.

Robert E. Mace
William F. Mullican III
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Table of Contents

Chapter 1

Aquifers of West Texas: An Overview

Robert E. Mace[1]

Introduction

Water is essential to the social, economic, and environmental well-being of Texas, especially in the arid areas of the west part of the state, where water is scarce and highly valued. Drought and increasing demand, primarily because of a growing urban population, have heightened concerns over water resources in the area. The cities of Ciudad Juarez, Mexico, and El Paso, USA, are quickly depleting their fresh groundwater resources. Juarez, it is estimated, will pump the last of its fresh groundwater beneath the city by 2005, and El Paso by 2020 (Washington and Perez, 2001). International and State boundaries complicate water policy in the area. Pumping in Juarez has drawn groundwater flow from Texas into Mexico, and pumping in Juarez and El Paso has drawn groundwater flow from New Mexico into Texas.

As local water resources and options decline, large urban areas such as El Paso and Ciudad Juarez are looking elsewhere for water. El Paso is considering desalination of local, poorer quality water as another possible water source. El Paso is also looking north and east for other groundwater resources (Brown and Caldwell, 2001a,b,c; FWTPG, 2001; HBC, 2001). Continuing and increasing urban demands can affect other elements of the local economy as well, such as agriculture and ranching, water supplies to smaller communities, and flow to springs that may harbor endangered and threatened species or have aesthetic and recreational value.

Although West Texas has not been graced by many major aquifers, it is home to many minor aquifers of varying water quality, yields, and geology. El Paso and its surrounding urban area currently rely on groundwater for about half of its water supply, and Ciudad Juarez relies entirely on groundwater from the Hueco Bolson aquifer. All of the towns and rural areas in West Texas rely entirely on groundwater, and total groundwater usage in the area has ranged from 320,000 to 720,000 acre-ft/yr over the past 20 yr. A better understanding of these aquifers is important for us to know how to best manage the scarce water resources that do exist in West Texas. The purpose of this paper is to present a general overview of the aquifers of West Texas and recent scientific and planning activities concerning these aquifers. Additional chapters in this report discuss the aquifers and some of the issues in far greater detail.

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[1] Texas Water Development Board

Location, Physiography, and Climate

We focus on the part of West Texas that includes Brewster, Culberson, El Paso, Hudspeth, Jeff Davis, Loving, Pecos, Reeves, Ward, and Winkler Counties (fig. 1-1). All of the counties in the area have fewer than 16,000 people, with the exception of El Paso County, which had about 680,000 people in 1997 (table 1-1). The population in the area has grown by nearly 500,000 people since 1950, with 98 percent of that growth occurring in El Paso County (table 1-1). In 1997, Brewster, Culberson, Pecos, Reeves, and Winkler Counties received more than 90 percent of their water from aquifers (table 1-1).

West Texas is primarily located in the Basin and Range Physiographic Province (Thornbury, 1965), which is characterized by asymmetric ridges or mountains and broad intervening basins (Bates and Jackson, 1984). Basins in the area have land-surface elevations of about 3,000 ft, with mountain ranges rising several thousand feet higher. Mountain ranges in the area include the Guadalupe Mountains (8,751 ft), Eagle Mountains (7,484 ft), the Quitman Mountains (5,200 ft), the Carrizo Mountains (5,200 ft), the Sierra Blanca Peaks (6,800 ft), the Davis Mountains (8,206 ft), and the Chisos Mountains (7,825 ft). The Diablo Plateau lies in the north–to-central part of Hudspeth County.

The Rio Grande and Pecos River are the major rivers than cut through the West Texas area (fig. 1-1). Upstream of El Paso, flow in the Rio Grande is primarily controlled by releases from Caballo Reservoir, located downstream of Elephant Butte. Downstream of El Paso, flow in the river consists of treated municipal wastewater from El Paso, untreated municipal wastewater from Ciudad Juarez, irrigation return-flow, and occasional floodwater and runoff. So much water leaks from the river into the ground that the river is often dry between southern Hudspeth County and Presidio, where Rio Conchos joins the Rio Grande.

The Pecos River is a major tributary to the Rio Grande that originates in New Mexico. The river is impounded in Red Bluff Lake in Loving County and is used for irrigation in Pecos, Reeves, and Ward Counties.

Most of the study area is in the mountain and subtropical arid climate regions of Texas (Larkin and Bomar, 1983) and lies in the north part of the Chihuahuan Desert (Schmidt, 1979). The Guadalupe, Davis, and Chisos Mountains of the Trans-Pecos region of Texas are in the mountain climate region, characterized by cooler temperatures, lower relative humidity, and moderate amounts of irregular rainfall. The rest of the study area is primarily in the subtropical arid climate region, influenced by the flow of air from the Gulf of Mexico that is disturbed by intermittent seasonal intrusions of continental air.

West Texas is the most arid region of the state, and, because of its low rainfall and high evaporation, is in drought during all or part of most years (Bomar, 1995). Average annual precipitation ranges from 8 inches in the El Paso area to more than 18 inches in the Davis Mountains (fig. 1-2a). In general, mountainous areas receive more rainfall than the surrounding valleys. Average annual gross lake-surface evaporation rates range from less

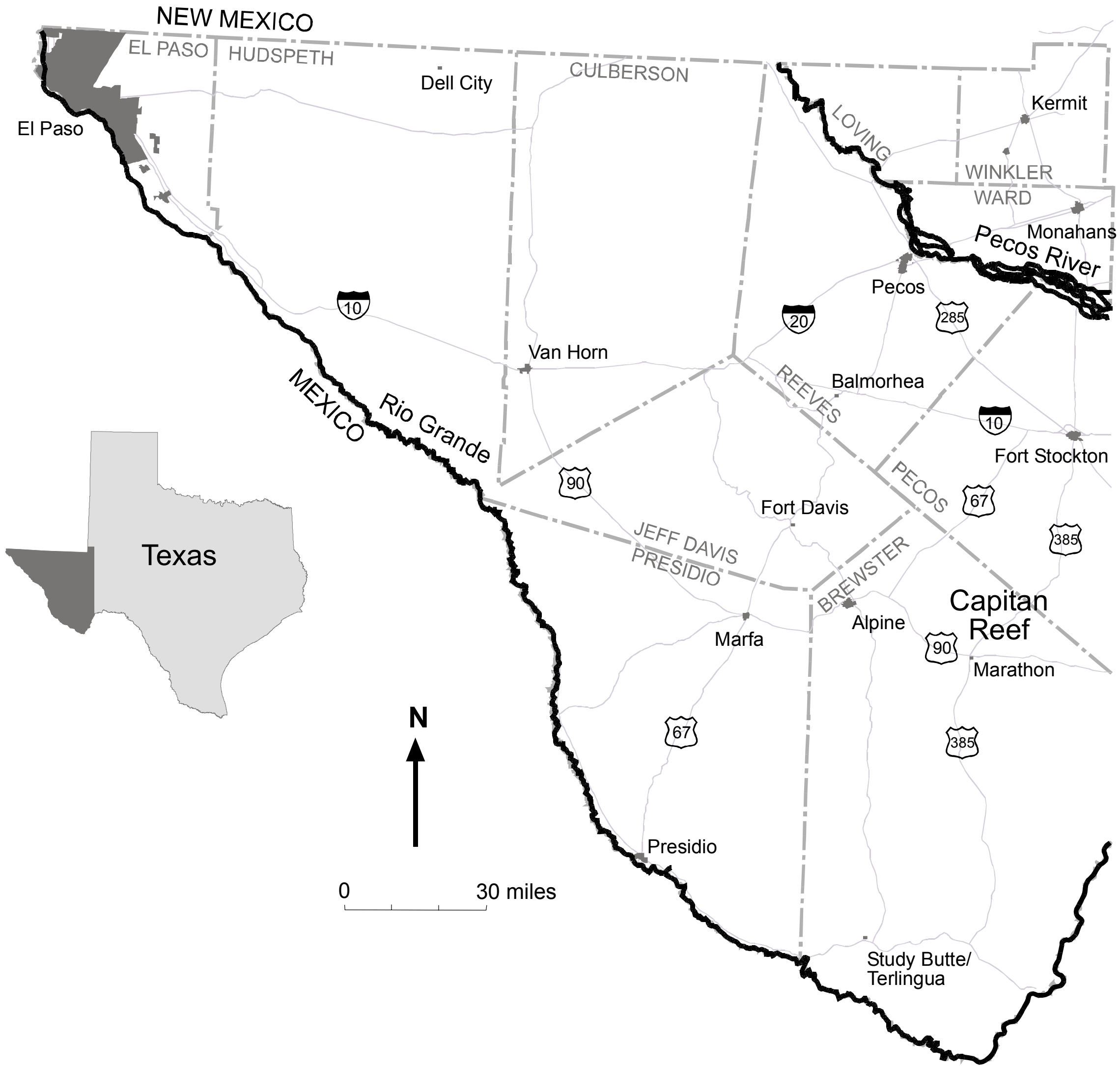

Figure 1-1: Location of the study area in West Texas.

than 80 inches in Loving and Winkler Counties to over 95 inches in southern Presidio County near the Rio Grande (fig. 1-2b).

Aquifers of West Texas

The West Texas area includes all or parts of 12 aquifers recognized by the State (fig. 1-3). Three major aquifers, the Hueco-Mesilla Bolson, the Cenozoic Pecos Alluvium, and the Edwards-Trinity (Plateau), are found in the area. Nine minor aquifers are also located in the area, including the Bone Spring-Victorio Peak, Capitan Reef, Dockum, Igneous, Marathon, Rustler, and West Texas Bolsons aquifers. The Texas Water Development Board (TWDB) assigns a major and minor status to the state's aquifers on the basis of the quantity of water supplied by each aquifer (Ashworth and Hopkins, 1995). In addition to

Table 1-1: Population and groundwater use in Far West Texas counties for selected years.

County	Population 1950	Population 1980	Population 1990	Population 1997	Groundwater use (acre-ft) 1980	Groundwater use (acre-ft) 1990	Groundwater use (acre-ft) 1997	%GW
Brewster	7,309	7,573	8,681	9,279	3,126	2,551	3,664	93.0
Culberson	1,825	3,315	3,407	3,299	76,119	12,580	9,773	99.9
El Paso	194,968	479,899	591,610	683,657	99,923	118,330	97,734	36.6
Hudspeth	4,298	2,728	2,915	3,397	141,649	51,526	132,327	66.6
Jeff Davis	2,090	1,647	1,946	2,028	26,872	3,767	898	85.7
Loving	227	91	107	95	64	44	70	10.5
Pecos	9,939	14,618	14,675	15,883	111,250	67,552	82,865	96.6
Presidio	7,354	5,188	6,637	7,484	14,200	7,027	4,977	19.0
Reeves	11,745	15,801	15,852	15,329	120,524	40,117	106,136	91.5
Ward	13,346	13,976	13,115	12,797	33,311	10,670	10,821	55.8
Winkler	10,064	9,944	8,626	8,335	8,356	3,171	3,647	99.9
Total:	263,165	554,780	667,571	761,583	635,394	317,335	452,912	62.3

% GW = percent of total water use in 1997 that was met with groundwater.
Population and groundwater use for all of Brewster and Pecos Counties are included.

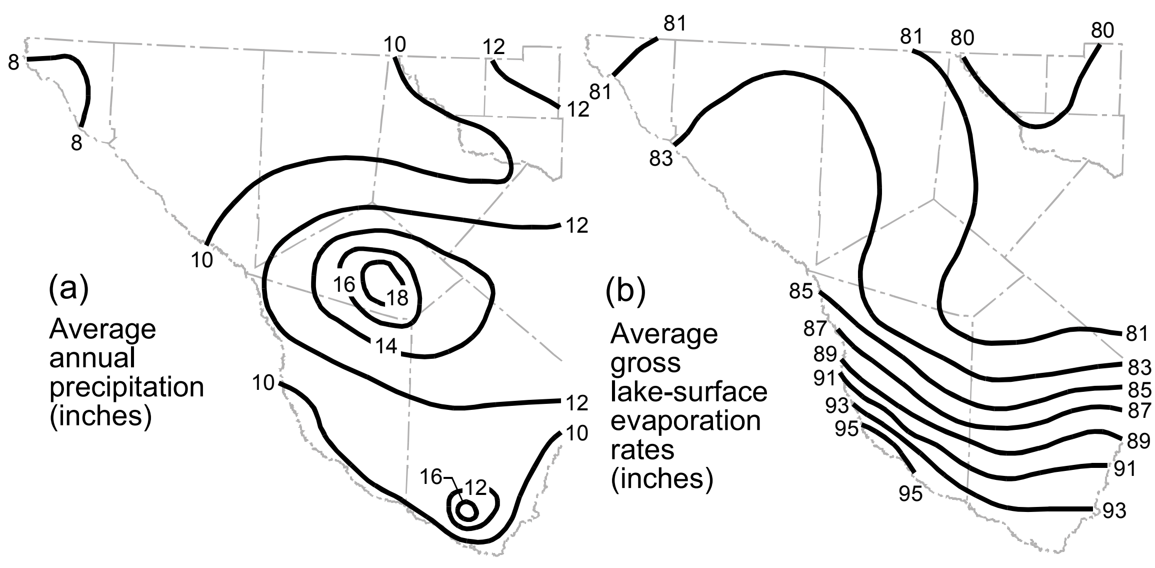

Figure 1-2: Amount of (a) average annual precipitation and (b) average gross lake-surface evaporation in the Far West Texas area (after Larkin and Bomar, 1983).

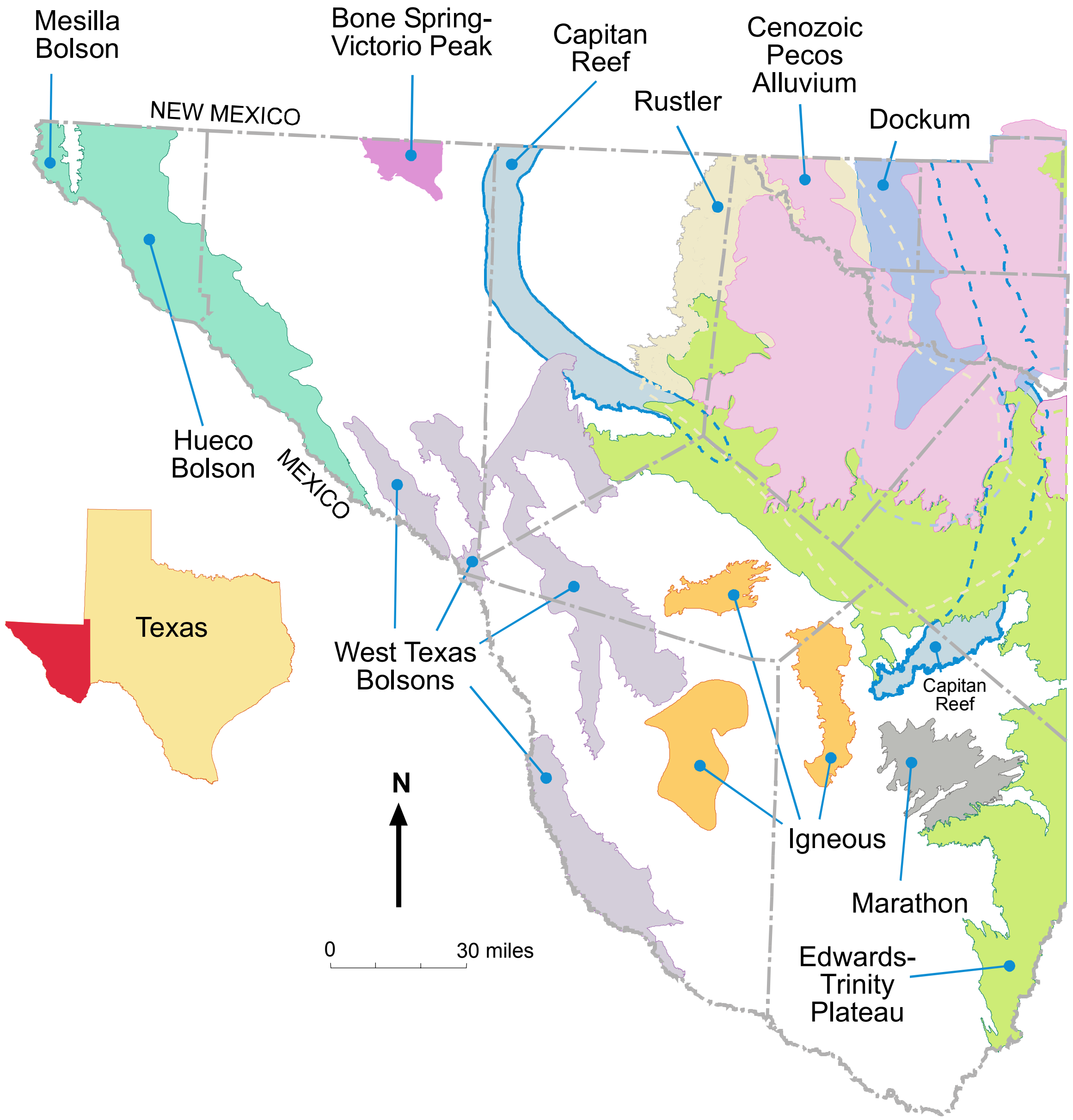

Figure 1-3: Location of recognized aquifers in Far West Texas.

the aquifers recognized by the TWDB, there are several other geologic formations that locally produce water.

Several of the aquifers (Hueco-Mesilla Bolson, the Cenozoic Pecos Alluvium, the Edwards-Trinity [Plateau], Bone Spring-Victorio Peak) have had a number of scientific studies done on them, especially the Hueco-Mesilla Bolson aquifer. However, several others (Capitan Reef, Dockum, Igneous, Marathon, Rustler, and West Texas Bolsons) have had few to almost no groundwater studies done on them.

Although we show the aquifers as separate entities, many are hydraulically connected to each other. For example, some of the West Texas Bolsons are connected to the Igneous and Capitan Reef aquifers (Angle, this volume; Brown and Caldwell, 2001c; Chastain-Howley, this volume). Brown and Caldwell (2001c) showed that much of the water produced from wells in the Ryan Flat Bolson aquifer at Antelope Valley Farm is sourced from igneous rocks underlying the bolson deposits. The Cenozoic Pecos Alluvium, Edwards-Trinity (Plateau), Dockum, Rustler, and Capitan Reef aquifers also hydraulically intermingle with each other in different areas. Fault systems and other flow paths can allow groundwater to move across areas without recognized aquifers (Sharp, this volume). Flow systems in West Texas can be very complex.

Much of the general information presented next is from Aquifers of Texas (Ashworth and Hopkins, 1995), the Far West Texas Regional Water Plan (FWTPG, 2001), water-use information from TWDB surveys and estimates, and selected publications.

Hueco-Mesilla Bolson aquifer

The Hueco-Mesilla Bolson aquifer consists of two bolsons: the Hueco and the Mesilla Bolsons (fig. 1-3). The Hueco Bolson is in El Paso and Hudspeth Counties, Texas, extends into Mexico south of the Rio Grande, and extends north of El Paso County, Texas, into New Mexico (fig. 1-3). A small part of the Mesilla Bolson extends into El Paso County (fig. 1-3), with most of the aquifer in New Mexico to the north. The Hueco Bolson is about 9,000 ft thick and consists of silt, sand, and gravel in the upper part and silt and clay in the lower part. The Mesilla Bolson is about 2,000 ft thick and consists of clay, silt, sand, and gravel. Pumping by El Paso and Ciudad Juarez have caused large water-level declines, changing groundwater flow directions, flow rates, and water quality and causing a minor amount of land subsidence. Pumping from the aquifer in Texas over the past 20 yr has ranged from about 96,000 to about 138,000 acre-ft/yr (table 1-2). The Hueco and Mesilla Bolsons are discussed in more detail by Sheng and others in chapter 6 and by Hawley and others in chapter 7, respectively.

Edwards-Trinity (Plateau) aquifer

The Edwards-Trinity (Plateau) aquifer, in the east part of the area in Brewster, Culberson, Jeff Davis, Pecos, Reeves, and Winkler Counties (fig. 1-3), extends eastward to the Hill Country of Texas. The Edwards-Trinity (Plateau) aquifer consists of rocks of the Comanche Peak, Edwards, and Georgetown Formations and the Trinity Group. The Trinity Group consists primarily of sands (Antlers and Maxim sands) and limestones. The Comanche Peak, Edwards, and Georgetown Formations consist primarily of limestones and dolomites. Pumping from the aquifer in the counties in the study area over the past 20 yr has ranged from about 52,000 to about 95,000 acre-ft/yr (table 1-2). The Edwards-Trinity (Plateau) aquifer is discussed in more detail by Anaya in chapter 8.

Table 1-2: Groundwater use for the different aquifers in the Far West Texas area (acre-ft).

	Year						
Aquifer	**1980** **1990** **1997**	**1984** **1991**	**1985** **1992**	**1986** **1993**	**1987** **1994**	**1988** **1995**	**1989** **1996**
Bone Spring-Victorio Peak	132,891 48,091 129,592	100,667 49,719	91,757 38,452	42,803 113,041	46,316 173,046	52,749 137,625	92,364 128,964
Capitan Reef	15,264 690 2,129	952 559	844 438	165 145	809 2,832	791 2,257	811 2,118
Cenozoic Pecos Alluvium	196,423 68,414 147,711	120,469 66,193	99,691 62,452	91,153 386,754	72,175 149,972	75,479 157,070	103,674 147,845
Dockum	5,336 3,547 4,411	5,488 3,871	5,178 5,226	3,866 5,900	3,657 5,598	4,003 4,582	3,857 4,445
Edwards-Trinity	74,085 59,265 55,821	91,346 56,432	77,047 55,844	64,836 95,457	58,845 52,024	58,572 58,926	64,257 55,009
Hueco-Mesilla Bolson	103,952 121,518 95,633	114,176 111,200	113,301 108,631	114,274 104,540	125,636 97,257	124,353 96,556	138,203 103,505
Igneous	6,826 3,338 4,821	3,953 3,582	4,010 3,618	3,915 3,620	3,154 4,291	3,863 4,266	3,435 4,167
Marathon	119 98 130	85 100	78 93	80 120	80 117	90 121	92 126
Rustler	286 173 1,532	351 168	252 183	235 598	220 1,405	175 1,593	207 1,491
West Texas Bolsons	91,033 17,538 12,839	25,363 12,985	28,093 17,019	22,566 10,568	21,263 10,957	24,569 11,330	20,418 11,625
Other aquifers	12,063 3,374 890	5,347 3,323	5,117 2,722	3,841 1,937	4,868 1,202	4,690 1,028	4,440 913

Cenozoic Pecos Alluvium aquifer

The Cenozoic Pecos Alluvium aquifer, located in Jeff Davis, Loving, Pecos, Reeves, Ward, and Winkler Counties in West Texas (fig. 1-3), extends to the east in Texas and to the north into New Mexico. The aquifer consists of sands, gravels, and clays of ancient river deposits that can be up to 1,500 ft thick. The aquifer is connected to the Dockum and Edwards-Trinity (Plateau) aquifers where they exist underneath the alluvium. Water quality is naturally highly variable and has also been locally impacted by past activities of the petroleum industry. Water levels have declined more than 200 ft in south-central Reeves and northwest Pecos Counties but have remained somewhat steady since the 1970's, with a decrease in irrigation. Lowered water levels have decreased base flow to the Pecos River and, in some cases, now cause the river to lose water to the aquifer. Pumping from the aquifer over the past 20 yr has ranged from about 62,000 to about 138,000 acre-ft/yr (table 1-2). Reeves County has been the largest user of groundwater from the aquifer, using 67 percent of the total water pumped in 1997. The Cenozoic Pecos Alluvium aquifer is discussed in more detail by Jones in chapter 9.

Bone Spring-Victorio Peak aquifer

The Bone-Spring Victorio Peak aquifer, located in Hudspeth County (fig. 1-3), extends northward into the Crow Flats area of New Mexico. The aquifer consists of about 2,000 ft of limestone beds of the Bone Spring and Victorio Peak Formations, with water occurring in fractures and solution cavities. The aquifer is primarily used for irrigation, although Dell City relies on the aquifer for municipal supply. Water levels have historically declined in the aquifer but have remained relatively steady since the late 1970's. Pumping from the aquifer in Texas over the past 20 yr has ranged from about 38,000 to about 170,000 acre-ft/yr (table 1-2). The Bone-Spring Victorio Peak aquifer is discussed in more detail by Ashworth in chapter 10.

Capitan Reef aquifer

The Capitan Reef aquifer consists of two strips located in Culberson, Hudspeth, Jeff Davis, Pecos, Reeves, Ward, and Winkler Counties (fig. 1-3) and extends northward into New Mexico. The aquifer is an ancient reef consisting of 2,360 ft of dolomite and limestone, and, in Texas, generally has poor water quality except in the exposed areas of the aquifer. Most of the water pumped from the aquifer is in Ward and Winkler Counties for water-flooding operations in oil-producing areas. A small amount of water is used for irrigation in Pecos and Culberson Counties. Carlsbad, New Mexico, relies on the aquifer for municipal use. Pumping from the aquifer in Texas over the past 20 yr has ranged from about 150 to about 15,000 acre-ft/yr (table 1-2). Recent pumping has been about 2,100 acre-ft/yr. The Capitan Reef aquifer is discussed in more detail by Uliana in chapter 11.

Dockum aquifer

The Dockum aquifer, located in Loving, Pecos, Reeves, Ward, and Winkler Counties in West Texas (fig. 1-3), extends to the east and northeast beneath the Ogallala and Edwards-Trinity (Plateau) aquifers and to the north into New Mexico. The Dockum aquifer consists of up to 700 ft of sand and conglomerate, with layers of silt and shale of the Dockum Group. Water quality is variable and is used for water-flooding operations in oil-producing areas of the southern High Plains. Pumping from the aquifer in the counties in the study area over the past 20 yr has ranged from about 3,900 to about 5,900 acre-ft/yr (table 1-2). The Dockum aquifer is discussed in more detail by Bradley and Kalaswad in chapter 12.

Igneous aquifer

The Igneous aquifer is currently represented on TWDB maps in three separate pieces in Brewster, Jeff Davis, and Presidio Counties near Alpine, Fort Davis, and Marfa, respectively (fig. 1-3). Recent work by the Far West Texas Planning Group, included in part in chapter 13 and summarized by LBG-Guyton (2001), suggests that the aquifer has a much greater extent coincident with the general occurrence of igneous (or volcanic) rocks in the area. Groundwater in the Igneous aquifer occurs primarily in the fractures of tuffs and other volcanic rocks in the aquifer, with thicknesses of about 900 to 1,000 ft. Alpine, Fort Davis, and Marfa rely on the aquifer as a source of municipal water. Pumping from the aquifer over the past 20 yr has ranged from about 3,100 to about 6,800 acre-ft/yr (table 1-2). The Igneous aquifer is discussed in more detail by Chastain-Howley in chapter 13.

Marathon aquifer

The Marathon aquifer is located in North-Central Brewster County in the vicinity of Marathon (fig. 1-3). Groundwater occurs in fractures and solution cavities at depths between 350 and 900 ft. Many shallow wells in the area produce from alluvial deposits that overlie the Marathon aquifer. Pumping from the aquifer over the past 20 yr has ranged from about 90 to about 130 acre-ft/yr (table 1-2). The Marathon aquifer is discussed in more detail by Smith in chapter 14.

Rustler aquifer

The Rustler aquifer is located in Culberson, Jeff Davis, Loving, Pecos, Reeves, and Ward Counties (fig. 1-3). Groundwater occurs in the partly dissolved dolomite, limestone, and gypsum beds of the Rustler Formation. The poor-quality water is used primarily for irrigation, livestock, and for waterflooding operations in oil-producing areas. Pumping from the aquifer in the counties in the study area over the past 20 yr has ranged from about 170 to about 1,600 acre-ft/yr(table 1-2). The Rustler aquifer is discussed in more detail by Boghici and Van Broekhoven in chapter 15.

West Texas Bolsons aquifers

The West Texas Bolsons aquifers, located in Culberson, Hudspeth, Jeff Davis, and Presidio Counties (fig. 1-3), are part of the Red Light Draw, Eagle Flat, Green River Valley, and Presidio-Redford Bolsons, as well as the Salt Basin. The Salt Basin is divided into the Wild Horse, Michigan, Lobo, and Ryan Flats. Composition of the bolson aquifers depends on the rock types of the nearby eroded mountains and ranges from coarse-grained volcanic rocks and limestones to fine-grained silt and clay lake deposits. Groundwater from the bolson aquifers is used for irrigation and municipal supply in parts of Culberson, Hudspeth, Jeff Davis, and Presidio Counties. Presidio, Sierra Blanca, Valentine, and Van Horn rely on the bolson aquifers for municipal water. Pumping from the aquifer over the past 20 yr has ranged from about 10,000 to about 91,000 acre-ft/yr (table 1-2). Pumping in recent years has been about 12,000 acre-ft/yr. The West Texas Bolsons aquifers are discussed by Angle in chapter 16 and Darling and Hibbs in chapter 17.

Other aquifers

Large areas of West Texas do not have a TWDB-recognized major or minor aquifer beneath them (see white areas in fig. 1-3). This does not mean, however, that there are no groundwater resources in these areas. The Diablo Plateau area in northern Hudspeth County has the potential to produce large amounts of water (see chapter 18 by Mullican and Mace), and the Igneous aquifer probably has a greater extent than previously realized (see chapter 13 of this report). Other areas may have small, local aquifers that can supply water for limited purposes. According to TWDB information, about 900 to as much as 12,000 acre-ft/yr has been pumped from other aquifers in the area (table 1-2). Further study and evaluation of these areas will increase our knowledge of water resources in these areas.

Springs

The many springs and seeps in the West Texas area have played an important part in the area's history. Native Americans relied on the springs as sources of water, as did later settlers. The path of the Old Spanish Trail through the area was largely determined by the occurrence of springs in and along mountains (Brune, 1981).

Springs in the area currently provide water to ranches and small communities, such as the village of Kent in southeastern Culberson County. Farmers use the flow from Balmorhea Springs to irrigate crops in Reeves County. A number of springs are valued for aesthetic and recreational uses, such as the pool at Balmorhea Springs and the hot springs in Big Bend. The springs are sources of water to wild game and habitats of threatened and endangered species. A number of springs have stopped flowing because of lowered water tables or drought (Brune, 1981), including Kokernot Springs in Alpine, Davis Spring in Fort Davis, and, recently, Phantom Lake Springs near Balmorhea. Several species that relied on spring flow are now extinct, and others are in danger in the West Texas area (Garrett and Edwards, this volume).

Comanche Springs in Fort Stockton went dry and resulted in a landmark legal case between the Pecos County Water Control District No. 1 and Clayton Williams (Brown, 2001). The springs, first noted in 1684 (Brune, 1975), supplied water to irrigate 6,000 acres and stopped flowing after Mr. Williams installed and started pumping from a well field upgradient of the springs during the drought of the 1950's. The courts decided that the rule of capture applied and that the water district had no recourse.

Groundwater Conservation Districts

Groundwater in Texas is governed by the common-law rule of capture unless there is a groundwater conservation district. Rule of capture allows a landowner to produce as much groundwater as the landowner chooses, absent malice or willful waste, without liability to neighbors who may claim that pumping has depleted their wells. The Legislature enabled the regulation of groundwater by creating groundwater conservation districts, the first of which was created in 1949 (High Plains Underground Water Conservation District No. 1). Groundwater conservation districts have broad regulatory authority and are recognized by the Legislature as the State's preferred method of managing groundwater resources.

West Texas is home to four confirmed groundwater conservation districts: the Hudspeth County Underground Water Conservation District No. 1, the Culberson County Groundwater Conservation District, the Jeff Davis County Underground Water Conservation District, and the Presidio County Underground Water Conservation District (fig. 1-4a). The 2001 Legislature created two additional districts in the area: the Brewster County Groundwater Conservation District and the Middle Pecos Groundwater Conservation District (fig. 1-4a). As of fall 2001, these two districts were awaiting confirmation elections.

Although not a groundwater conservation district, the El Paso Water Utilities−Public Service Board (EPWU) is an important manager of groundwater resources in the area. EPWU manages and operates the water and wastewater system for El Paso and operates 105 wells in the Hueco-Mesilla Bolson aquifer.

Regional Water Planning

Through Senate Bill 1, the 1997 Legislature enacted comprehensive water management to plan for drought and meet increasing demands as population grows (Hubert, 1999). Senate Bill 1 is a "bottom up" water-planning process that allows individuals representing different interest groups to serve as members of Regional Water Planning Groups. The interest groups include the public and representatives of counties, municipalities, industries, agriculture, environmental, small business, steam-electric power generating utilities, river authorities, water districts, water utilities, and others

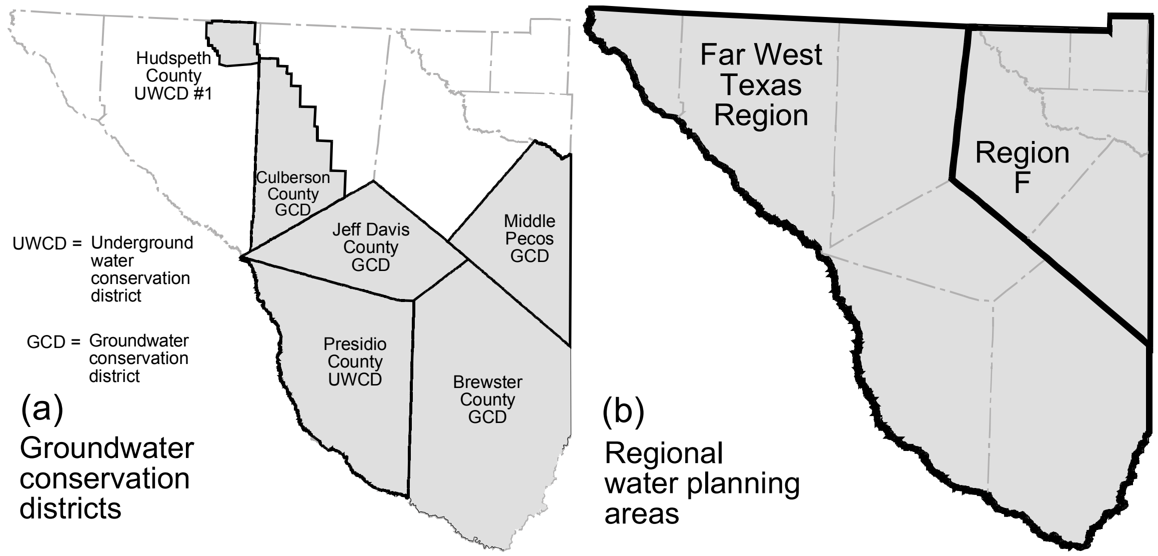

Figure 1-4: Location of (a) confirmed and created groundwater conservation districts and (b) regional water planning areas in the Far West Texas area. Note that both regions extend farther to the east.

selected by the Planning Groups. A total of 16 Planning Groups cover the state, which are charged with preparing regional water plans for their respective planning areas. These plans will show, for each planning area, how to conserve water, meet future water needs, and respond to future droughts.

Each Planning Group submitted its plan in January 2001. The TWDB is assembling the individual plans into a comprehensive State Water Plan for delivery on January 5, 2002. After January 5, 2002, the TWDB will provide financial assistance only to those projects that are consistent with the regional water plans, and the Texas Natural Resource Conservation Commission will issue water right permits only for purposes consistent with the plan. These water plans will be updated every 5 yr.

The West Texas area includes all of the Far West Texas Region and part of Region F (fig. 1-4b). The regional water plan for the Far West Texas Region shows that the region has some real challenges in meeting its future water needs, especially during a drought of record. The Planning Group showed that freshwater resources in the part of the Hueco-Mesilla Bolson aquifer available to El Paso will be greatly depleted by 2030. Furthermore, the Rio Grande will not be available for use during severe droughts.

The Far West Texas Planning Group recommended a number of strategies to meet future needs for water, including:

- conservation of surface water used for irrigation,
- purchase of irrigation rights,
- reuse of treated wastewater,

- desalination of brackish groundwater, and
- purchase and use of groundwater from outside El Paso County.

Expanded use of groundwater is intended as an emergency supply of water during times of drought.

Even with these strategies to supply more water, however, the region will be unable to meet all needs for water after 2030. Municipalities in El Paso County are projected to have water needs of over 200,000 acre-ft/yr in 2050.

Water plans for these regions can be found on the TWDB Web page (www.twdb.state.tx.us). In early 2002, a new version of the State Water Plan, which includes a statewide summary of the regional water plans, will be available from the TWDB.

Groundwater Availability Modeling

Texas is developing new, state-of-the-art computer models of groundwater resources. In 1999, the Legislature provided initial funding for development of groundwater availability models for the major aquifers. And in 2001, the Legislature directed the TWDB to develop groundwater availability models for the minor aquifers.

There are several ongoing modeling projects in West Texas. The U.S. Geological Survey (USGS) expects to release a report in late 2001 on a model it developed of the Hueco Bolson aquifer. Sheng and others (2001) reported on how the USGS model has been used to evaluate management of the bolson aquifer in the El Paso area. TWDB is working on a model of the Edwards-Trinity Plateau aquifer (see Anaya, this volume) and expects to be completed by the end of 2002. A model of the Cenozoic Pecos Alluvium aquifer will also be done by the TWDB and its contractors by the end of 2004. The Beldon Foundation is funding work on a model of the bolson aquifer in Wild Horse Valley (CCGCD, 2001; Finch and Armour, 2001). Models of these aquifers will be useful tools for assessing the possible impacts of increased pumping on water levels and spring flows.

Several scientific models of some of the minor aquifers have been developed (e.g., Bone-Spring/Victorio Peak: Mayer and Sharp, 1998; Red Light Draw and Eagle Flat: Darling and others, 1994, and Hibbs, 1996; Wildhorse Flat: Nielson and Sharp, 1985; Diablo Plateau: Mullican and Senger, 1990, 1992). The challenge for future modeling of these minor aquifers will be availability of enough information on the aquifers and an adequate understanding of the flow.

Final reports, models, and aquifer information will be posted on the TWDB GAM Web page (www.twdb.state.tx.us/gam).

Summary

Although the west part of Texas has been blessed with many aquifers, it faces many challenges with its desert climate and growing metropolis. Because of the arid climate, recharge to many of the aquifers is minimal. As a result of minimal recharge, large volumes of pumping cause water levels to decline. The resulting water-level declines cause reductions in the volume of fresh water, flow to springs, and water quality. El Paso is particularly susceptible to drought: the Rio Grande will not offer any water in a severe drought, and fresh groundwater resources in the Hueco-Mesilla Bolson are expected to be depleted by 2020.

Groundwater conservation districts, regional water planning groups, and groundwater availability modeling are helping to further our understanding of the aquifers and the options for meeting future water needs. However, additional study is needed, particularly on the less-studied minor aquifers in the area.

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