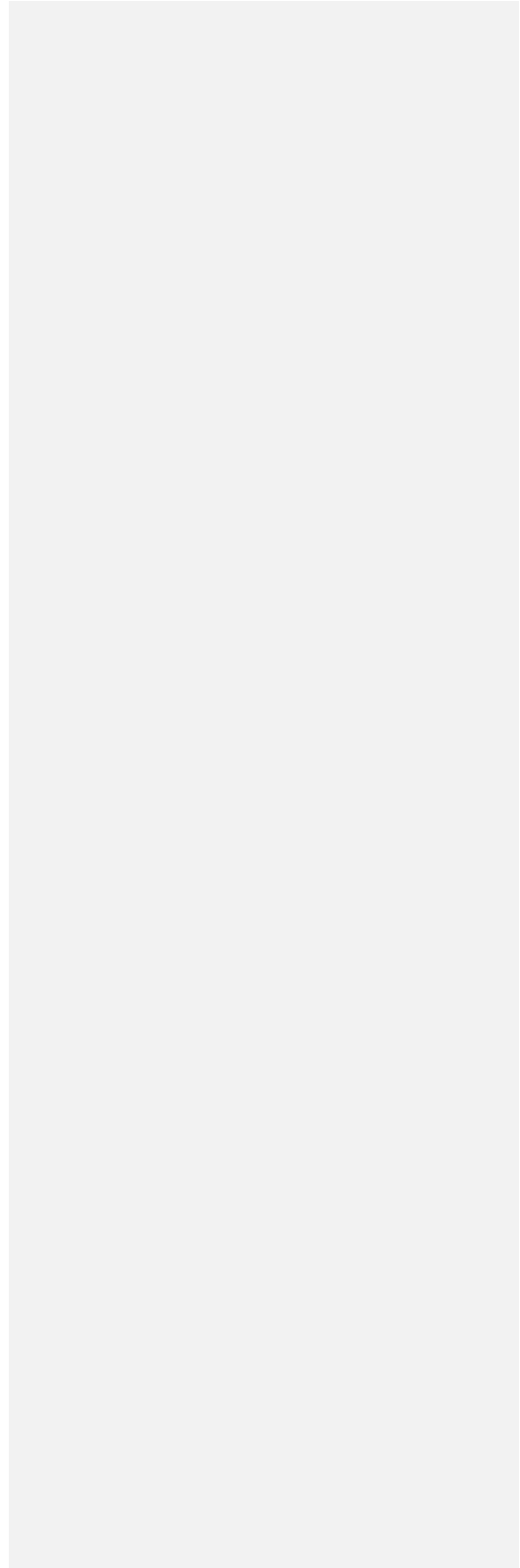


CHAPTER 1

FAR WEST TEXAS DESCRIPTION

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1 FAR WEST TEXAS

Far West Texas encompasses the most arid region of the State of Texas (Figure 1-1). Residents of this expansive desert environment recognize that water is a scarce and valuable resource that must be developed and managed with great care to ensure the area’s long-term viability. The Region’s economic health and quality of life are dependent on a sustainable water supply that is equitably managed.

Chapter 1 presents a broad descriptive overview of Far West Texas including currently existing water management facilities and international water issues. This chapter also summarizes specific planning components that are presented in more detail elsewhere in this *2026 Far West Texas Water Plan*, such as projected population and water demand and available water-supply sources to meet these anticipated demands. Also provided in this chapter is a listing of State and Federal agencies, universities, and private organizations that are involved in various aspects of water supply issues.

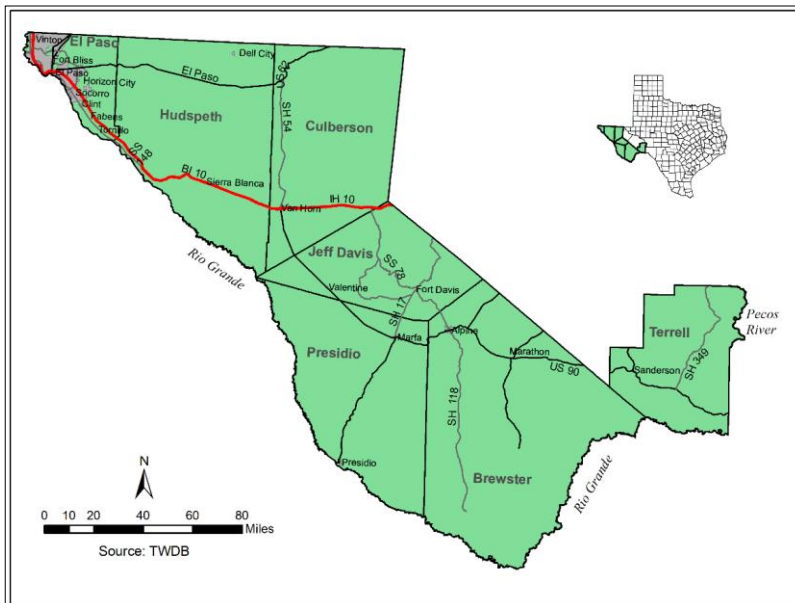


Figure 1-1. Location of Far West Texas

1.1 WATER PLANNING AND MANAGEMENT

Regional Water Planning

The *2026 Plan* follows an identical format as the plans prepared by the other 15 water planning regions in the State as mandated by the Texas Legislature and overseen by the Texas Water Development Board (TWDB). This *Plan* provides an evaluation of current and future water demands for all water-use categories and water supplies available during drought-of-record conditions to meet those demands. Where future water demands exceed an entity's ability to supply that need, alternative strategies are considered to meet the potential water shortages. Water management strategies are also presented that reflect an entity's desire to upgrade their water supply system. In all cases, conservation practices are first considered in managing water supplies.

In January of ~~2016~~ 2021, the ~~fourth~~ fifth round of regional water planning was concluded with the adoption of the ~~2016~~ 2021 *Far West Texas Water Plan*. It is understood that this *Plan* was not a static plan, but rather is intended to be revised as conditions change. For this reason, the current ~~2021~~ 2026 *Plan* put forth in this document is not a new plan, but rather an evolutionary modification of the preceding ~~2016~~ 2021 *Plan*. Only those parts of the previous *Plan* that require updating, and there are many, have been revised.

The purpose of the ~~2021~~2026 *Far West Texas Water Plan* is to provide a document that water planners and users can reference for long and short-term water management recommendations. Equally important, this *Plan* serves as an educational tool to inform all citizens of the importance of properly managing and conserving the delicate water resources of this desert community.

~~During the fifth round of regional water planning, the Previous regional-2021 regional water plans and state-2022 State Water Plan water plans were modified to be aligned with water utility service areas, rather than political boundaries, such as city limits. This was due to TWDB rule revisions, that now have been aligned with political boundaries, such as city limits rather than water utility service areas. Recent TWDB rule changes now define a municipal water user group (WUG) as being utility based. Some cities that were once included in the 2016 and older regional water plans are not represented in the 2021 and 2026 Plans because they do not have their own water and therefore no longer meet the TWDB WUG definition. For these entities, their population is represented through: (1) utility WUGs who provide water for them and meet the new WUG definition, or (2) county-other WUGs as aggregated rural population, and thus the emphasis of the development of population and municipal water demands for the 2021 regional water plans transition from political boundaries to utility service area boundaries.~~

Because our understanding of current and future water demand and supply sources is constantly changing, it is intended for this *Plan* to be revised every five years or sooner if deemed necessary. This *Plan* fully recognizes and protects existing water rights, water contracts, and option agreements. There are no known conflicts between this *Plan* and plans prepared for other regions. Publicly available water plans of major agricultural, municipal and commercial water users were considered in the development of this *Plan*, primarily as they relate to Chapter 5 ~~Chapters 5~~ and ~~Chapter 7~~ Chapter 7.

The Far West Texas Water Planning Group (FWTWP) is a voluntary association comprised of voting and non-voting members who represent a minimum of 11 water use categories. Since 1997, the planning group has been involved in a wide range of projects, programs and the development of the Regional

Water Plan. All meetings and activities of the FWTWPG met all requirements under the Texas Open Meetings Act.

Water supply availability under drought-of-record conditions is considered in the planning process to ensure that water demands can be met under the most challenging hydrologic circumstances. For surface water supplies, drought-of-record conditions relate to the quantity of water available to meet existing permits from the Rio Grande and the Pecos River as estimated by the TCEQ Rio Grande [Full Authorization Run \(Run 3\)](#) Water Availability Model (WAM). [For this Plan, the assessment of surface water availability reflects updates to new water right permits and current operating policies and/or contractual agreements.](#) The ~~2024~~2026 Plan has no impact on navigation on these surface water courses.

The availability of groundwater during drought-of-record conditions is based on the Modeled Available Groundwater (MAG) volumes that may be produced on an average annual basis to achieve a Desired Future Condition (DFC) as adopted by Groundwater Management Areas (GMAs) (per Texas Water Code §36.001). Groundwater availability volumes for parts of the Region where MAGs are not determined by the TWDB are calculated separately. Chapter 3 contains a detailed analysis of water-supply availability in the Region.

Since the completion of the ~~2016~~2021 Far West Texas Water Plan, several changed conditions have occurred in the Region, which warrant this ~~2024~~2026 updated water Plan. The latest census (~~2010~~2020) is the baseline for estimates of population and municipal/rural water demand projections. [During this cycle of regional water planning, the TWDB also established several key changes to the population projection methodology. This is outlined in more detail in Section 2.1.1.](#) Groundwater and surface water availability models (GAMs and WAMs) have been ~~developed~~updated and ~~as~~serve as tools for use in evaluating water-supply source availability.

This current Plan continues to rely on environmental data on the more prominent watercourses in the Region as contributed by the Texas Parks & Wildlife Department, the National Parks Service, and the Texas Nature Conservancy. This data was useful in the assessment and consideration of environmental flow needs, springs, and ecologically unique stream segments.

The FWTWPG strongly encourages all entities to participate in the planning process so that their specific concerns can be recognized and addressed. The Group also encourages the participation of Groundwater Conservation Districts (GCDs) and recognizes their management plans and rules. District management plans are specifically respected when establishing groundwater availability estimates.

Water quality is recognized as an important component in this 50-year water plan. Water supplies can be diminished or made costlier to prepare for distribution if water quality is compromised (Section 1.8). To ensure that this Plan fully considers water quality, the Federal Clean Water Act and the State Clean Rivers Program were reviewed and considered when developing water-supply availability estimates (Chapter 3), water management strategies' water quality impacts (Chapter 5), and recommendations (Chapter 8).

Interim Regional Water Supply Research Projects

Previous planning periods included research projects that provided important scientific data or water strategy analysis that was beyond the normal range of regional planning activities but provided important insight and accuracy to the overall planning process. Reports of the results of these studies listed below

are available at the Rio Grande Council of Governments website (<http://westtexaswaterplanning.org/>) or from the TWDB website (<http://www.twdb.texas.gov/publications/reports/index.asp>). Information gained from these projects is also incorporated in specific water-supply management strategies discussed in Chapter 5.

- Igneous Aquifer System of Brewster, Jeff Davis and Presidio Counties, Texas (2001)
- West Texas Bolsons and Igneous Aquifer System Groundwater Availability Model Data Collection (2003)
- Conceptual Evaluation of Surface Water Storage in El Paso County (2008)
- Far West Texas Climate Change Conference (2008)
- Groundwater Data Acquisition in Far West Texas (2009)
- Evaluation of Irrigation Efficiency Strategies for Far West Texas: Feasibility, Water Savings and Cost Considerations (2009)
- Water Conservation Conference for Far West Texas Water Plan Region E (2009)
- Groundwater Data Acquisition and Analysis for the Marathon and Edwards-Trinity (Plateau) Aquifers (2010)

State Water Plan

The Texas Water Development Board adopted [Water for Texas 2022](#) ~~Water for Texas 2017~~ as the latest official Texas State Water Plan. The Texas Water Code directs the TWDB to periodically update this comprehensive water plan, which is used as a guide to State water policy. The ~~2017~~ 2022 State Water Plan is the ~~fourth~~ fifth water plan to incorporate water management and policy decisions made at the regional level as expressed in the 16 approved regional water plans.

Groundwater Conservation Districts

The Texas Legislature has established a process for local management of groundwater resources through Groundwater Conservation Districts (GCDs). GCDs are charged to manage groundwater by providing for the conservation, preservation, protection, recharging and prevention of waste of groundwater within their jurisdictions. An elected or appointed board governs these districts and establishes rules, programs and activities specifically designed to address local problems and opportunities. Texas Water Code §36.0015 states, in part, “Groundwater Conservation Districts created as provided by this chapter are the State’s preferred method of groundwater management.” Six districts are currently in operation within Far West Texas (Figure 1-2) and their management goals are discussed in further detail in Chapter 6.

- Brewster County Groundwater Conservation District
- Culberson County Groundwater Conservation District
- Hudspeth County Underground Water Conservation District #1
- Jeff Davis County Underground Water Conservation District
- Presidio County Underground Water Conservation District

| Far West Texas Water Plan

January ~~2024~~2026

- Terrell County Groundwater Conservation District

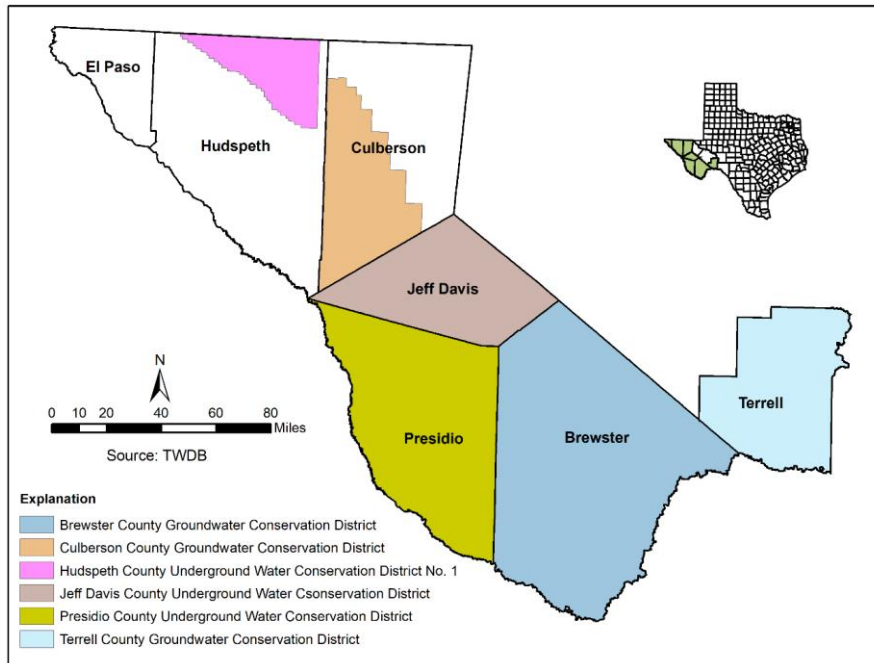


Figure 1-2. Groundwater Conservation Districts

Groundwater Management Areas

In ~~recent~~ previous sessions, the Texas Legislature has redefined the manner in which groundwater is to be managed (http://www.twdb.texas.gov/groundwater/management_areas/index.asp). Senate Bill 2 of the 77th Texas Legislature (2001) authorized:

- The Texas Water Development Board (TWDB) to designate Groundwater Management Areas that would include all major and minor aquifers of the State.
- The requirement of Groundwater Conservation Districts to share groundwater plans with other districts in the Groundwater Management Area.
- A Groundwater Conservation District to call for joint planning among districts in a Groundwater Management Area.

The objective was to delineate areas considered suitable for management of groundwater resources. A Groundwater Management Area (GMA) should ideally coincide with the boundaries of a groundwater reservoir (aquifer) or a subdivision of a groundwater reservoir, but it may also be defined by other factors, including the boundaries of political subdivisions. In December 2002, the TWDB designated 16 GMAs covering the entire State (<https://geographic.texas.gov/maps>). (<http://www.twdb.texas.gov/mapping/maps.asp>).

In 2005, the Legislature once again changed the direction of groundwater management. The new requirements, codified in Texas Water Code Chapter 36.108, required joint planning in management areas among Groundwater Conservation Districts. The new requirements indicate that,

“Not later than September 1, 2010, and every five years thereafter, the districts shall consider groundwater availability models and other data or information for the management area and shall establish desired future conditions for the relevant aquifers within the management area.”

DFCs, as described in Title 31, Part 10, §356.10 (6) of the Texas Administrative Code are “the desired, quantified condition of groundwater resources (such as water levels, spring flows, or volumes) within a management area at one or more specified future times as defined by participating groundwater conservation districts within a groundwater management area as part of the joint planning process.” ~~are a description of the aquifers at some time in the future.~~ This description is a precursor to developing a volumetric number called Modeled Available Groundwater (MAG). The TWDB is responsible for providing each Groundwater Conservation District and regional water planning group, located wholly or partly in the management area, with MAG volumes. Once the MAG is determined, the districts begin issuing groundwater withdrawal permits to support the DFC of the aquifer up to the total amount of the MAG. These permits express DFCs by only allowing withdrawals that will support the conditions established by the groundwater management area. Regional water plans must also incorporate the MAG for each aquifer within their regions. The counties of Far West Texas are included in three Groundwater Management Areas:

- GMA 4 includes Brewster, Culberson, part of Hudspeth, Jeff Davis and Presidio
- GMA 5 includes El Paso and part of Hudspeth
- GMA 7 includes Terrell

This ~~2021~~2026 *Far West Texas Water Plan* includes a significant revision to groundwater source availability estimates based on MAG volumes. MAG volumes for the use of this *Plan* have increased by nine percent from those used within the previous regional water plan. Total groundwater availability is the sum of both the MAG and non-MAG volumes for a particular aquifer, generated from the GMA process for those aquifers that are managed by the Groundwater Conservation Districts.

El Paso Water as the Declared Regional Water Supply Planner

In 1995, the Texas Legislature passed Senate Bill 450 designating the El Paso Water Utilities/Public Service Board (now El Paso Water, or EPW) as the regional water and wastewater planner for El Paso County. The purpose of the Bill is to improve regional water and wastewater planning for El Paso County and encourage increased consultation, coordination, and cooperation in the management of regional water resources. The City of El Paso serves a pivotal role in all future planning and expansion projects. The City, through El Paso Water, receives priority consideration for public funding for the planning, design, and construction of water-supply and wastewater systems within the County. The intent of Senate Bill 450 is to address regional planning issues by the following seven actions:

- Coordinate water and wastewater management on a regional watershed basis
- Address water quality and quantity conditions adversely affecting the public health and the environment

- Provide efficient planning and management of water resources to mitigate existing and avoid future negative colonia conditions
- Participate in water and wastewater planning with adjacent counties and the border states of New Mexico and Chihuahua, Mexico, to address transboundary water issues
- Encourage conjunctive management for the protection and preservation of the limited surface water and groundwater resources
- Maximize the amounts and provide for the efficient use of public funding to implement the purposes of Senate Bill 450
- Provide intergovernmental cooperation with water utilities to encourage their planning to be consistent with the regional plan

El Paso County Priority Groundwater Management Area

In 1985, the 69th Texas Legislature recognized that certain areas of the State were experiencing or were expected to experience critical groundwater problems. House Bill 2 directed the Texas Department of Water Resources (later to become the Texas Water Commission (TWC) and the TWDB) to identify the “critical” groundwater areas in the State, to conduct studies in those areas, and to make recommendations on whether a GCD should be established in critical areas. Senate Bill 1 changed the name of “Critical Area” to “Priority Groundwater Management Area” (PGMA) and mandated that the Texas Natural Resource Conservation Commission (TNRCC - successor agency to the TWC and later to be named TCEQ) complete reviews of all pending PGMA studies.

The PGMA process is initiated by TCEQ, who designates a PGMA when an area is experiencing critical groundwater problems or is expected to do so within 25 years. These problems include shortages of surface water or groundwater, land subsidence resulting from groundwater withdrawal, or contamination of groundwater supplies. Once an area is designated a PGMA, landowners have two years to create a GCD. Otherwise, the TCEQ is required to create a GCD or to recommend that the area be added to an existing district. The TWDB works with the TCEQ to produce a legislative report every two years on the status of PGMA in the State. The PGMA process is completely independent of the current Groundwater Management Area process as each process has different goals. The goal of the PGMA process is to establish GCDs in these designated areas so that there will be a regulating entity to address the identified groundwater issues. PGMA are still relevant if there remain portions within these designated areas without GCDs. A statewide map of the declared PGMA areas is available at:

https://www.twdb.texas.gov/waterplanning/rwp/img/pgma_areas.pdf

<https://www.teeq.texas.gov/groundwater/pgma.html>

The TWC and TWDB evaluated groundwater supply conditions in El Paso County in 1990 as part of the PGMA program. An overview evaluation (TWDB Report 324) recognized that the Hueco Bolson Aquifer had a long history of water level decline and water quality deterioration, and the expected life of the aquifer, under then current understanding, was about 60 years at best. However, rather than declaring the area “Critical,” the TWC placed a moratorium over the declaration until after the completion of a 50-year City of El Paso water management plan.

The TNRCC requested a technical update study of El Paso County, which was completed in the spring of 1998 (TWDB Open-File Report, Preston, 1998; and TPWD Report, El-Hage and Moulton, 1998). The

TWDB report concluded that water level declines and quality deterioration are still present in the Hueco Bolson but did not address El Paso's plans to remedy the problems and provide long-term management. The TPWD reported no known effect on wildlife as a result of water level declines in the Hueco Bolson Aquifer. TNRCC staff then completed their analysis and recommended to their Commissioners that the area identified by the TWDB as the Hueco Bolson Aquifer in El Paso County be declared a PGMA (TNRCC File Report, Musick, 1998). The Commissioners, subsequently, declared "the area of El Paso County overlying the Hueco Bolson Aquifer, including its subcrops and outcrops" as a PGMA. However, the Commissioners stated that,

"El Paso has clearly demonstrated a significant effort toward regional cooperation, planning, and voluntary implementation of actions to address water supply problems" and that "it is not clear that creating a groundwater conservation district for the area of El Paso County overlying the Hueco Bolson Aquifer would be in the public interest, meet a public need, or benefit the property therein at this time."

(TNRCC Docket No. 98-0999-MLM, SOAH Docket No. 582-98-1540).

Since the conclusion of this action, El Paso County Commissioner's Court has not promulgated any water availability requirements within the County.

Hudspeth County Priority Groundwater Management Area Consideration

In March 2005, Texas Commission on Environmental Quality (TCEQ) released a report titled "Evaluation for the Hudspeth County Priority Groundwater Management Study Area." The purpose of this evaluation was to determine if the Hudspeth County area is experiencing or is expected to experience within the next 25 years, critical groundwater problems, and whether a GCD should be created to address such problems. The study area included all of Hudspeth County; however only the area outside of the Hudspeth County Underground Water Conservation District No. 1 was considered for PGMA designation.

For this report, TCEQ staff considered comments, data, and information provided by several different sources including water stakeholders from within the study area, the TWDB, the TPWD, the FWTWPG, and independent research by the staff. The report discusses the available authority and management practices of existing groundwater management entities within and adjacent to the study area and makes recommendations on appropriate strategies needed to conserve and protect local groundwater resources.

The water supply problems identified in the study area include widespread total dissolved solids concentrations in groundwater and the lack of firm alternative supplies for irrigation use in the Rio Grande Valley during drought-of-record conditions. Groundwater concerns expressed by area stakeholders included sustainability, water quality, availability, access to alternative water supplies, and the possibility of water exportation.

The TCEQ concluded that the identified water supply and water quality issues are not presently critical problems and are not anticipated to be critical during the next 25-year planning horizon, and that the Hudspeth County study area should not be designated as a PGMA at this time. However, the TCEQ also acknowledges that the creation of a GCD is a feasible and practicable groundwater management option for citizens of the study area to consider.

1.2 FAR WEST TEXAS GEOGRAPHIC SETTING

Located in the westernmost region of the State, Far West Texas is bounded on the north by New Mexico, on the south and west by the Rio Grande and the United Mexican States, and on the east by the Pecos River; and incorporates the counties of Brewster, Culberson, El Paso, Hudspeth, Jeff Davis, Presidio and Terrell. These counties claim some of the most impressive topography and scenic beauty in Texas. The Region is home to the Guadalupe Mountains National Park, Big Bend National Park, and the contiguous Big Bend Ranch State Park. El Paso, the largest city in the Region, is also the Nation's largest city on the U.S.-Mexico border. Ciudad Juarez, with an estimated population of over 1.5 million, is located across the Rio Grande from the City of El Paso and shares the same water sources with El Paso.

All seven counties that comprise the planning Region lie solely within the Rio Grande River Basin. While the entire planning Region falls within the Rio Grande River Basin, the Region is occupied by several internally drained closed basins (bolsons). The Rio Grande not only forms the border between the United States and Mexico but is also a vital water-supply source for communities, industries, and agricultural activities adjacent to the River. Above Fort Quitman, use of water from the Rio Grande is controlled primarily by the operations of the Rio Grande Project, which was established to supply agricultural water in southern New Mexico and Far West Texas. Other than along the Rio Grande corridor, the Region is dependent on groundwater resources derived from several aquifer systems.

The counties of Far West Texas are among the largest in the State, occupying 24,069 square miles (mi²), or nine percent of the total State area. Ranked by total area, the counties that make up the Region are Brewster (6,193 mi²), Hudspeth (4,572 mi²), Presidio (3,856 mi²), Culberson (3,813 mi²), Terrell (2,358mi²), Jeff Davis (2,264 mi²), and El Paso (1,013 mi²).

Physiography

Far West Texas is in a topographically distinct area of North America known as the Basin and Range Physiographic Province and is characterized by higher elevations and greater local relief than is observed anywhere else in the State. Traversed from north to south by an eastern range of the Rocky Mountains, the Region contains all of Texas' true mountains (Figure 1-3). Widely spaced mountain ranges rise from 1,000 to more than 3,000 feet above the intervening basin lowlands.

Although most of Texas is generally flat and less than 2,500 feet above mean sea level, the floors of most of the basins in Far West Texas are at elevations greater than 3,000 feet. The basins (or bolsons) are filled with sediments eroded from the surrounding mountains. At the deepest points of the basins, deposits of basin-fill range in thickness from less than 1,000 feet to more than 9,000 feet. Except for the Rio Grande and its tributaries, the Rio Conchos (Chihuahua, Mexico) and the Pecos River (Texas), all surface water in the Region drains toward the lowest elevation within each basin. "Salt Flats" occur in northeastern Hudspeth and northwestern Culberson Counties where water, upwelling from shallow aquifers and collecting from rainfall runoff, rapidly evaporates leaving behind accumulations of mineral deposits. These lakes are dry during periods of low rainfall, exposing salt-incrusted basin flats. For years, this area was a source of commercial salt extraction.

Highest of the mountain ranges are the Guadalupe Mountains, which straddle the Texas-New Mexico state line. The highest elevations in the range are Guadalupe Peak (the highest surface elevation in Texas at 8,751 feet) and El Capitan, which overlook the Salt Basin to the west and south. Lying west of the Salt Basin and extending to the Hueco Mountains a short distance east of El Paso is the Diablo Plateau.

Other mountain ranges, including the Eagle, Quitman, Carrizo, Delaware, and Sierra Vieja Mountains, are located south and east of the Diablo Plateau in Culberson, Hudspeth, Jeff Davis, and Presidio Counties. These mountains overlook several intermountain basins from which there is no external drainage (e.g., Eagle Flat, Ryan Flat, Michigan Flat, and Wild Horse Flat). Two other basins, Red Light Draw and Green River Valley, are dissected by and drain to the Rio Grande.

The Davis Mountains are principally in Jeff Davis County; however, igneous rocks originating from volcanic vents that formed the Davis Mountains extend into Brewster, Hudspeth, and Presidio Counties. The Davis Mountains contain peaks with elevations greater than 7,000 feet, including Mount Livermore, which at 8,206 feet is one of the highest peaks in Texas. Mount Locke at 6,809 feet is home to the University of Texas McDonald Observatory. These peaks intercept moisture bearing winds and receive more precipitation than other locations in West Texas. The Davis Mountains are greener than other mountains of the Region with the growth of grass and forest trees.

The Big Bend country, which lies southeast of the Davis Mountains, is bounded on three sides by a great eastward swing of the Rio Grande, which gives it its name. It is a sparsely populated mountainous country with scant rainfall. Its principal mountains, the Chisos, rise to an elevation of 7,825 feet. Along the Rio Grande are the Santa Elena, Mariscal, and Boquillas Canyons, with rim elevations of 3,500 feet to 3,775 feet. Because of its remarkable topography and plant and animal life, the southern part of this Region along the Rio Grande is home to Big Bend National Park and Big Bend Ranch State Park.

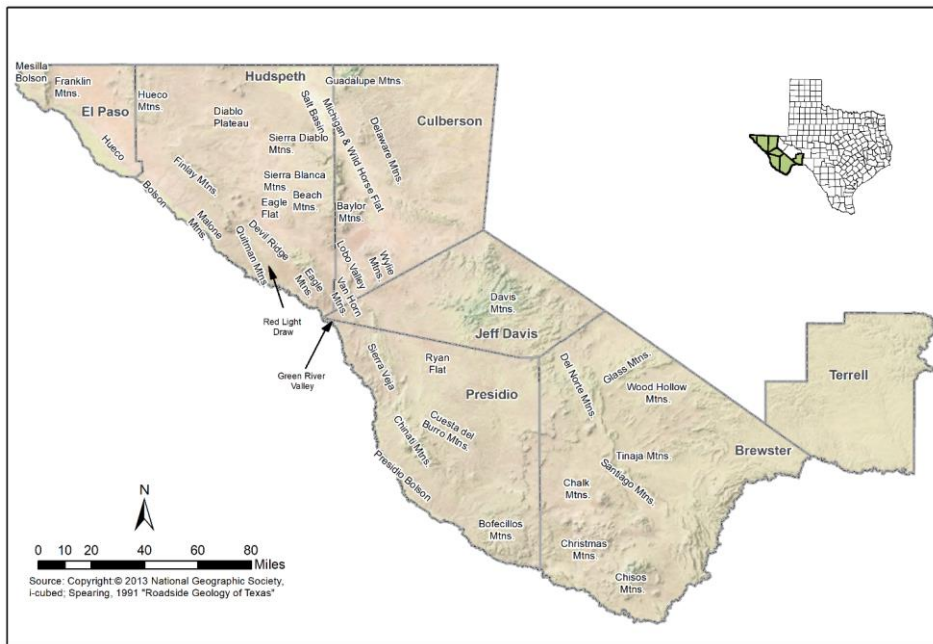


Figure 1-3 Mountains and Basins

In El Paso County, the Franklin Mountains rise 3,000 feet above the adjacent Rio Grande valley floor to an elevation of 7,192 feet and separate the “Upper and Lower Valleys” of the Rio Grande, as well as the Mesilla and Hueco Bolsons. The historic towns and missions of Ysleta, Socorro and San Elizario are located along the Lower Valley.

Population and Regional Economy

Apart from El Paso County, the counties of Far West Texas are among the least populated in the State. In the year ~~2020~~ 2030, approximately ~~97.98~~ percent (~~925,565~~ 999,348) of the Region’s ~~954,035~~ 1,022,933 residents are projected to reside in El Paso County, where the population density is 914 persons per square mile (

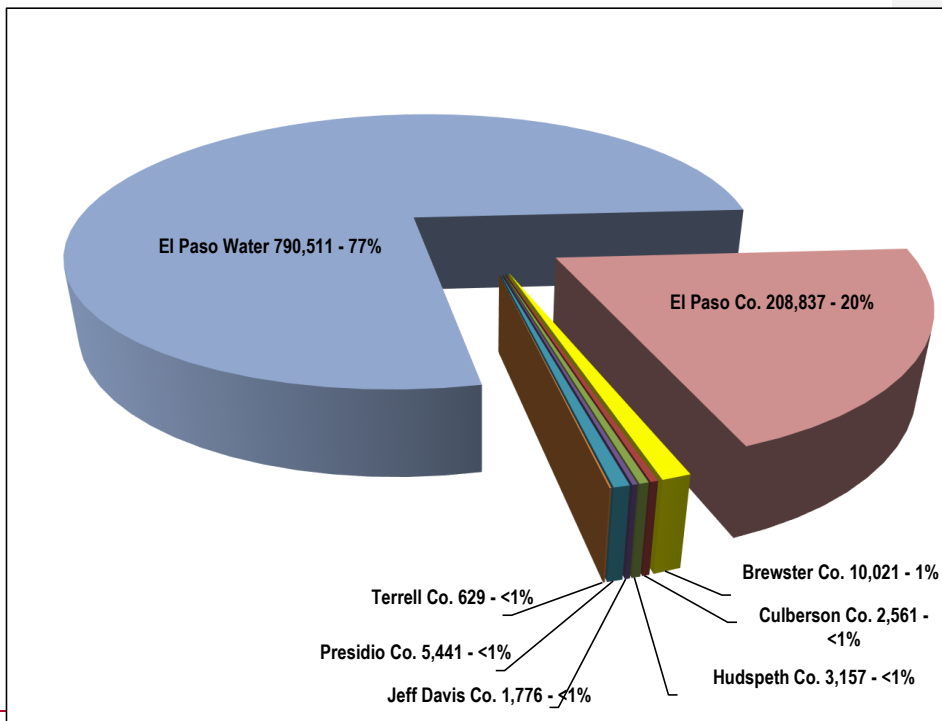


Figure 1-4). The population density of the six rural counties is approximately one person per square mile. Approximately 75 percent of the residents in the Region are Hispanic or Latinos.

The City of El Paso, one of the fastest growing cities in Texas, is the largest city in the Region, with a year ~~2020~~ 2030 projected population of ~~734,034~~ 790,511. This is 79 percent of the total population of El Paso County and 77 percent of the Region’s total population.

The year ~~2020~~ 2030 projected populations of cities in the six rural counties are as follows: Alpine, Brewster County (~~6,066~~ 7,129); Van Horn, Culberson County (~~2,319~~ 2,312); Sierra Blanca, Hudspeth County (~~620~~ 1,663); Fort Davis, Jeff Davis County (~~4,264~~ 945); Marfa, Presidio County (~~2,203~~ 2,814); Presidio, Presidio County (~~4,867~~ 2,279); Sanderson, Terrell County (~~889~~ 477). Population of other

smaller communities such as Fort Hancock, Del City, Marathon and Valentine are included in the "county-other" (rural) population of each county. The "county-other" rural population of the Region, projected in 2030 is ~~48,664~~ 6,421, or ~~five~~one percent of the total Regional population. The current and projected population growth in Far West Texas is further discussed in Chapter 2.

The regional economy is predominantly comprised of agriculture, agribusiness, manufacturing, tourism, wholesale and retail trade, government, and military. According to TWDB's socio-economic analysis (provided in Appendix 6A), the Far West Texas Regional economy generates about \$35 billion in gross state product for Texas and supports roughly 435,000 jobs.

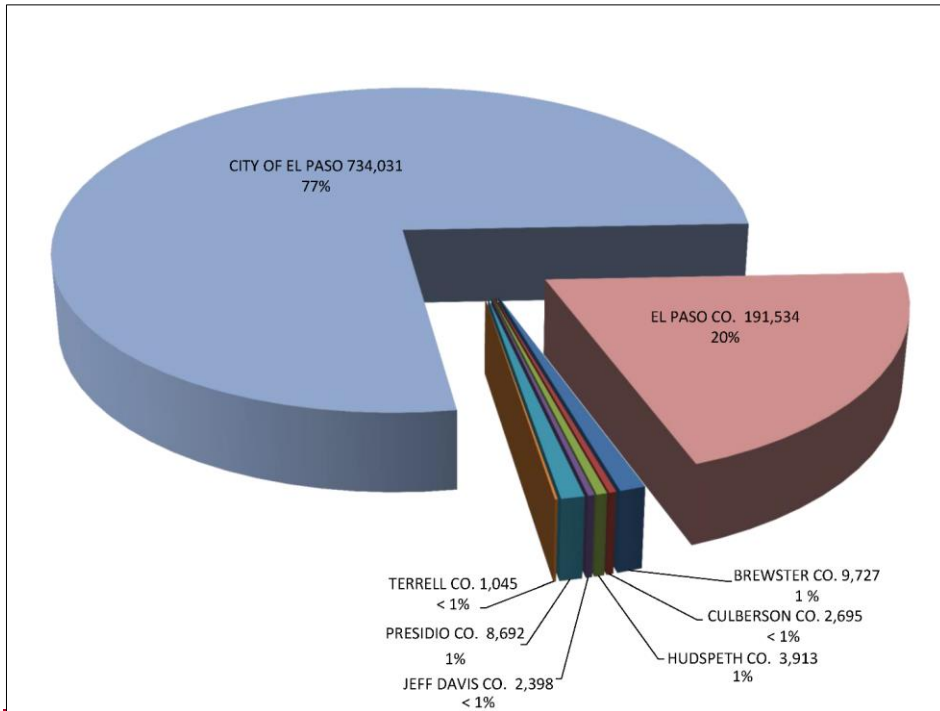
The dominant commercial land use throughout the rural areas of the Region is extensive cattle grazing. Aridity and historic land-tenure practices have combined to produce large ranches and low animal densities. Dairy operations in El Paso County represent the largest proportion of the market valuation for livestock, as El Paso County traditionally ranks in the top five dairy-production counties in Texas. Floodplain-irrigated agriculture is found along the Rio Grande extending above and below El Paso and into southern Hudspeth County. A much smaller irrigated strip also occurs along the River near Presidio. Currently, irrigated agriculture based on groundwater pumping is essentially limited to Dell Valley in northeastern Hudspeth County, Diablo Farms in northwestern Culberson County, and Wild Horse and Lobo Flats near Van Horn.

An innovative agricultural industry has developed in Jeff Davis and Presidio Counties where large greenhouse facilities have been constructed and successfully operated to produce hydroponically grown tomatoes. The Jeff Davis County and Presidio County Underground Water Conservation Districts permit well use for these two facilities and thus have records of their annual groundwater use. Although small compared to large-scale farming operations elsewhere in the Region, the Districts do strive to ensure that this innovative industry is recognized in the Regional Water Plan.

The Tornillo-Guadalupe International Bridge border crossing in El Paso County was completed in 2014 and replaces the existing Fabens-Caseta International Bridge. The crossing, capable of handling modern day commercial, automobile and pedestrian traffic, supports the expansion of trade and economic growth on both sides of the border. In the El Paso area, the crossing allows continued expansion of jobs in related industries such as trucking, warehousing, transshipping, and manufacturing; and according to the border economic plan for El Paso County also allows expansion of employment opportunities along IH-10 near the intersection of traffic from Tornillo and Fabens. In Mexico, the project provides an additional crossing that accommodates the expansion of maquiladora plants eastward from Juarez. By 2025, total annual vehicle crossings, both north and south, are expected to be over 900 thousand. Commercial truck traffic that previously traveled through downtown El Paso and Juarez is now able to move through the crossing beyond the congested urban core, thus reducing air and noise pollution.

The Barnett Shale play has become the largest natural gas play in the State of Texas. This productive geologic formation has equivalent rock units (Woodford) that extend into West Texas. Although gas production from these formations in West Texas have not generally proven to be as prolific as those in the Fort Worth area, exploration interest has caused water planners to pay attention to an industry with potential high-water needs. In a concerted effort to derive meaningful water use estimates for all mining applications, including the oil and gas industry, a TWDB report, "Current and Projected Water Use in the Texas Mining and Oil and Gas Industry, 2011 and 2012," estimates water use for mining, (which includes water used for drilling operations such as rig supply), water flooding, and fracking in two reports. These

estimates determined a water use volume per oil and gas well. Estimates from these reports indicate that Culberson and Terrell Counties had the greatest demand by the oil and gas industry within the Far West Texas Region. None of the other counties in the Region have reported any significant usage by the industry.



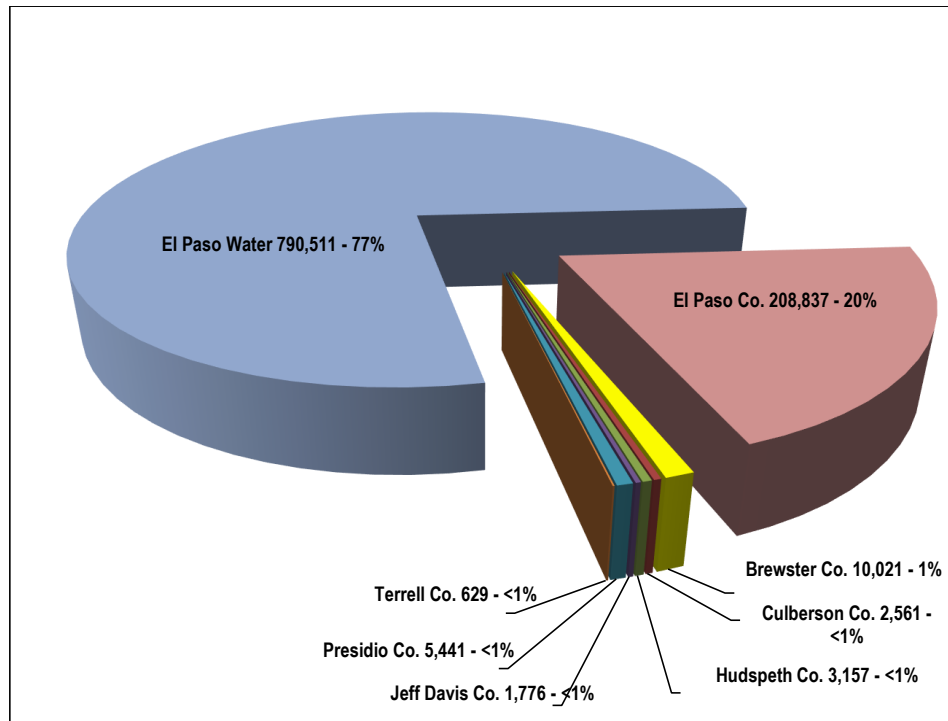


Figure 1-4. Year ~~2020~~ 2030 Projected Population

Land Use

Land use in the seven-county Region, as illustrated in Figure 1-5, is described here in terms of six categories:

- Urban (or developed)
- Cultivated agricultural
- Rangeland
- Forest
- Waterways and Wetlands
- Barren

Urban lands make up less than one percent of the total land area in Far West Texas. The largest concentration of urban land is in El Paso County, where ~~97~~ 98 percent of the Region’s residents live. Cultivated agricultural lands are identified as areas that support the cultivation of crops and occupy less than one percent of the total land area of the Region. These lands generally require access to high

volumes of groundwater or surface water. Together, urban and cultivated agricultural lands comprise the two most significant water consumptive land use areas.

Rangeland is defined as all areas that are either associated with or are suitable for livestock production. Although this is the largest category of land use in the Region, rangeland accounts for one of the smallest sources of water demand. Forestland occurs where topography and climate support the growth of native trees. These are limited to highlands, such as the Davis, Guadalupe and Chisos Mountains. Forestlands rely exclusively on rainfall as a source of moisture.

Areas designated as either water or wetlands are mostly associated with the Rio Grande and the Pecos River and their tributaries. The Rio Grande is also a major source of irrigation water for agricultural lands in El Paso, Hudspeth and Presidio Counties. Most all other streams in the Region are ephemeral. In addition to the two rivers, wetlands formed by desert springs (ciénegas) provide critical wildlife habitat. Finally, barren lands are defined as undeveloped areas with little potential for use for agriculture, rangeland, or forests.

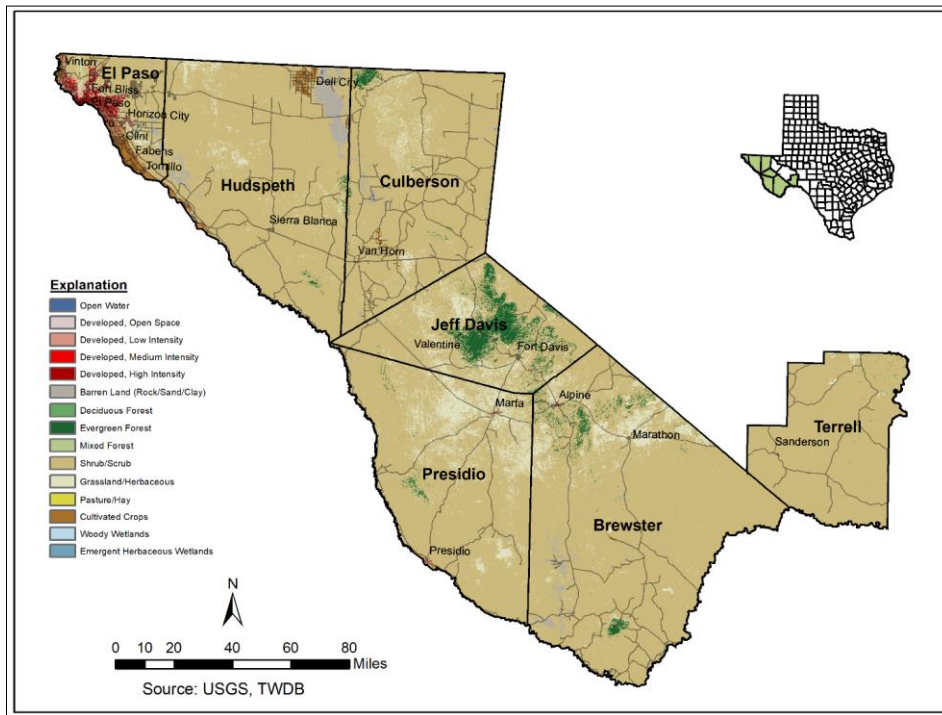


Figure 1-5. Land Use

Climate

Far West Texas, the most arid region in the State, is positioned in the northern part of the Chihuahuan Desert, a large arid zone that extends southward into Mexico. Only the highest altitudes occurring in the eastern part of the Region receive sufficient precipitation to be considered semiarid, rather than true desert.

The mean annual temperature of the Region is approximately 65°F. The average annual low temperature ranges between 45° F and 54° F, and the average high is 77°F to 80°F. During summer months, afternoon temperatures often exceed 100°F. In the winter, lows in the mountains and high desert plateaus can plummet to less than 10°F.

The Region usually reports the lowest annual precipitation (the regional average is ~~11.0 inches~~ ~~42.9 inches~~) and the highest lake-surface evaporation (the regional average is 70 inches) in Texas (Figure 1-6 and Figure 1-7). The combination of low rainfall and high evaporation creates what would be considered drought conditions in any other part of the State.

Past climatic precipitation data was collected from <https://www.ncei.noaa.gov/past-weather>, for the purposes of calculating average monthly rainfall (1993-2023), for a total of 11 weather stations within the Region. These selected stations not only meet the 30-year record of service requirement, but accurately represent the average monthly rainfall amounts for each county. Tables 1-1 through 1-7 present monthly rainfall amounts by county, in inches based on these 31-year averages. From highest to lowest values, average annual rainfall by county is reported as follows:

- Jeff Davis County = 18.2 in
 - Mount Locke, TX – USC004164104 (1993-2023) (~~20.8 in~~)
- Brewster County = 13.3 in
 - Alpine, TX – USC00410174 (1993-2008) (~~16.9 in~~)
 - Alpine 7 NW, TX – USC00410176 (2009-2023)
- Terrell County = 12.2 in
 - Sanderson, TX – USC00418022 (1993-2012)
~~Sanderson, Terrell County (14.3 in.)~~
 - Dryden Terrell CO Airport, TX - USW00003032 (2013-2023)
- Culberson County = 8.8 in
 - Van Horn, TX – USC000419295 (1993-2023)
~~Van Horn, Culberson County (13.1 in)~~
- El Paso County = 8.6 in
 - El Paso International Airport, TX – USW00023044 (1993-2023)
~~City of El Paso, El Paso County (8.8 in)~~
- Presidio County = 8.3 in

- Marfa 2, TX – USC00415596 (1993-2008)
- Presidio 2, TX – USC00417264 (2009-2017)
- Presidio Lely International Airport, TX – USW00000471 (2018-2023)

~~Marfa, Presidio County (15.9 in)~~

- Fort Hancock 8 SSE, TX – USC00413266 (1993-2023)

~~Hudspeth County (10 in)~~

Figure 1-8). Rainfall during the spring and summer months is dominated by widely scattered thunderstorms. Because of the convective nature of thunderstorms, the amount of spring and summer precipitation in the Region increases with elevation.

Table 1-1. Brewster County Monthly Rainfall (1993-2023)
(inches)

Station Name	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Average Annual Rainfall
Alpine, TX (USC00410174)	1993	0.83	0.04	0.08	0.47	1.55	1.08	7.30	2.50	0.53	0.39	0.00	0.95	
	1994	0.60	0.20	0.92	0.25	0.91	0.25	0.61	1.41	2.60	1.12	0.00	0.08	
	1995	0.11	0.20	0.21	n/a	n/a	2.51	0.28	0.66	4.98	1.66	0.35	0.71	
	1996	0.24	0.14	0.00	0.38	0.54	2.91	2.66	4.02	4.71	0.29	0.45	0.04	
	1997	0.32	1.99	0.10	1.01	1.88	4.00	3.13	2.50	1.33	0.40	0.63	0.9	
	1998	0.00	0.10	0.24	0.11	0.20	1.18	1.36	2.00	0.72	3.40	0.29	0.33	
	1999	0.00	0.00	1.35	0.02	1.04	4.39	6.15	1.36	0.93	0.22	0.00	0.21	
	2000	0.01	0.10	0.00	0.09	0.07	4.77	1.04	3.00	0.24	4.02	0.53	0.12	
	2001	0.50	0.70	0.26	0.16	0.57	0.46	2.04	1.37	1.84	0.02	1.08	0.19	
	2002	0.04	0.86	0.25	0.46	0.33	1.95	2.55	2.87	0.07	1.83	0.27	0.54	
	2003	0.00	1.16	0.30	0.00	0.85	3.40	1.79	n/a	0.77	2.21	0.06	0.00	
	2004	1.36	0.58	1.76	1.72	0.35	4.61	2.38	4.32	4.80	0.72	2.58	0.09	
	2005	0.33	1.64	0.19	0.03	0.91	1.52	n/a	6.21	0.1	n/a	n/a	0.08	
	2006	0.00	0.04	n/a	n/a	0.33	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
2007	n/a	n/a	n/a	n/a	2.18	6.68	1.52	0.99	n/a	n/a	n/a	n/a		
2008	n/a	n/a	n/a	n/a	n/a	n/a	3.95	5.85	4.41	0.41	0.02	0.10		
Alpine 7 NW, TX (USC00410176)	2009	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1.34	1.43	0.68	0.25	
	2010	1.47	0.54	0.06	0.30	0.15	2.60	5.65	3.59	1.16	0.02	0.00	0.00	
	2011	0.07	0.06	0.00	0.00	0.00	0.00	0.41	2.27	2.48	0.05	0.02	0.65	
	2012	0.33	0.28	0.00	0.50	2.29	1.59	6.16	2.29	3.11	0.78	0.46	0.10	
	2013	2.97	0.00	0.00	0.13	0.47	2.30	1.29	1.32	2.03	0.61	0.72	1.20	
	2014	0.00	0.08	0.35	0.21	0.01	2.68	1.49	4.54	5.44	1.04	2.91	0.38	
	2015	1.11	1.43	2.28	0.84	1.40	1.60	3.22	2.19	0.89	3.53	3.40	0.68	
	2016	0.37	0.04	0.02	0.25	2.14	0.85	2.88	4.05	1.46	0.29	0.46	0.70	
	2017	1.06	0.00	0.30	1.20	0.09	1.88	7.97	3.04	2.31	0.03	0.08	1.24	
	2018	0.02	0.06	0.05	0.02	1.33	1.67	2.42	1.90	2.83	3.49	0.06	0.53	
	2019	0.38	0.32	0.23	1.51	1.43	3.92	1.01	1.57	3.23	0.50	0.72	1.17	
	2020	0.53	1.31	0.38	0.00	0.29	0.04	0.20	0.29	2.22	0.11	0.00	1.41	
	2021	0.33	0.59	0.00	0.39	0.70	1.69	1.15	n/a	0.59	0.18	0.16	0.02	
	2022	0.18	0.08	0.00	0.01	0.29	1.92	2.83	7.57	2.75	2.39	0.71	0.16	
	2023	0.02	1.00	0.76	0.01	1.65	0.66	2.36	2.72	3.10	0.46	1.75		
Total Average Monthly Rainfall		0.43	0.44	0.33	0.32	0.77	2.04	2.45	2.46	2.03	1.02	0.59	0.41	13.29

Note: N/A represents no data was recorded.

**Table 1-2. Culberson County Monthly Rainfall (1993-2023)
(inches)**

Station Name	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Average Annual Rainfall
Van Horn, TX (USC00419295)	1993	1.22	0.32	0.10	0.08	0.08	0.46	n/a	1.40	1.34	0.72	0.00	0.62	
	1994	0.07	0.05	0.07	0.16	1.67	0.46	0.40	0.38	1.49	0.81	0.49	0.69	
	1995	0.36	0.73	0.19	0.00	0.60	2.18	1.14	n/a	2.01	0.66	0.14	0.07	
	1996	n/a	0.00	0.00	0.53	0.00	5.62	2.34	4.83	2.41	0.03	0.26	0.00	
	1997	0.34	1.29	0.09	0.66	0.77	1.59	2.05	2.57	0.57	0.43	0.63	1.38	
	1998	0.06	0.12	0.11	0.00	0.08	0.42	3.57	1.63	0.65	1.71	0.42	0.42	
	1999	0.12	0.00	0.31	0.17	0.29	1.30	1.38	1.16	0.96	0.16	0.00	0.34	
	2000	0.00	0.09	0.00	0.00	0.00	2.63	n/a	n/a	0.00	1.39	0.60	0.28	
	2001	0.53	0.37	0.24	0.00	0.19	0.49	1.85	0.68	0.32	0.06	0.83	0.31	
	2002	0.17	1.15	0.19	0.12	0.08	1.95	1.84	1.23	0.42	1.56	0.27	0.68	
	2003	0.00	1.02	0.01	0.00	0.27	0.74	0.87	0.79	0.39	2.78	0.44	0.00	
	2004	0.56	0.19	0.46	1.35	0.30	0.96	0.85	4.22	3.25	3.21	3.22	0.31	
	2005	0.37	1.82	0.07	0.25	1.05	0.07	0.53	2.14	1.52	2.52	0.00	0.00	
	2006	0.00	0.25	0.50	0.00	0.11	0.20	3.15	n/a	2.77	1.07	0.08	0.35	
	2007	n/a	0.12	0.71	0.54	0.99	0.65	2.36	2.26	n/a	0.09	0.54	0.72	
	2008	n/a	0.02	0.03	0.00	0.40	0.02	1.93	1.30	2.56	0.00	0.00	0.28	
	2009	0.05	n/a	0.25	0.00	0.51	1.03	2.32	1.86	0.00	0.10	0.19	0.85	
	2010	1.59	1.65	0.10	1.22	0.00	0.17	4.68	2.23	1.45	0.08	0.00	0.00	
	2011	0.02	0.03	0.00	0.00	0.00	0.14	0.71	1.12	0.36	0.11	0.04	0.49	
	2012	0.61	0.11	0.24	0.00	0.77	0.10	1.51	1.14	1.74	0.00	0.03	0.00	
	2013	0.65	0.18	0.00	0.45	0.18	0.37	3.50	0.60	2.38	0.45	0.13	1.20	
	2014	0.00	0.06	0.31	0.26	0.01	1.54	1.42	4.04	2.34	0.91	0.44	0.40	
	2015	0.51	0.12	1.65	0.19	1.36	1.17	1.13	0.55	1.78	2.13	0.77	0.40	
	2016	0.05	0.00	0.02	0.05	0.80	1.98	0.91	4.53	1.20	1.31	0.27	0.79	
	2017	0.69	0.13	0.00	0.27	0.00	1.54	1.84	1.52	1.79	0.18	0.00	0.77	
2018	0.00	0.04	0.04	0.00	0.18	0.06	1.02	1.38	1.03	0.89	0.32	0.40		
2019	0.20	0.04	0.30	0.55	0.45	1.32	0.89	2.24	1.72	2.00	0.25	0.31		
2020	0.02	0.77	1.37	0.00	0.43	0.25	1.02	0.56	1.02	0.00	0.00	0.18		
2021	0.08	0.39	0.00	0.02	0.18	1.90	0.64	2.68	0.01	0.03	0.11	0.00		
2022	0.20	0.25	0.00	0.06	0.03	0.88	1.65	3.77	0.84	1.23	0.60	0.02		
2023	0.24	0.07	0.00	0.00	0.01	1.09	0.67	1.98	0.41	0.38	0.31	0.17		
Total Average Monthly Rainfall		0.28	0.37	0.24	0.22	0.38	1.07	1.55	1.77	1.25	0.87	0.37	0.40	8.77

Note: N/A represents no data was recorded.

**Table 1-3. El Paso County Monthly Rainfall (1993-2023)
(inches)**

Station Name	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Average Annual Rainfall
El Paso International Airport, TX (USW00023044)	1993	1.34	0.32	0.01	0.12	0.00	1.47	0.95	2.73	1.32	0.17	0.49	0.71	
	1994	0.03	0.23	0.37	0.65	0.80	0.67	0.18	0.02	0.03	0.35	0.54	1.61	
	1995	0.26	0.88	0.42	0.04	0.01	1.74	0.28	0.76	3.18	0.00	0.26	0.23	
	1996	0.11	0.19	0.00	0.49	0.00	2.36	1.97	1.87	1.24	0.00	0.16	0.00	
	1997	0.38	0.29	0.64	0.43	0.52	1.11	0.91	1.41	1.55	0.19	0.79	1.41	
	1998	0.05	0.15	0.18	0.04	0.00	0.27	2.07	0.53	0.66	2.14	0.34	0.34	
	1999	0.10	0.00	0.04	0.00	0.02	1.44	2.00	1.43	1.94	0.56	0.00	0.63	
	2000	0.00	0.03	0.06	0.28	0.00	2.45	1.59	0.70	0.00	0.82	1.06	0.42	
	2001	0.06	0.24	0.40	0.00	0.18	0.30	0.36	1.72	0.30	0.00	0.60	0.13	
	2002	0.00	1.22	0.00	0.00	0.00	0.35	1.34	0.76	0.48	1.09	0.00	1.65	
	2003	0.00	1.37	0.18	0.02	0.00	0.49	0.55	0.66	0.08	0.33	0.52	0.01	
	2004	0.36	0.05	0.80	1.06	0.50	0.93	1.70	3.04	0.89	0.39	2.01	0.36	
	2005	0.66	1.92	0.08	0.14	0.93	0.00	0.66	4.35	2.77	1.36	0.00	0.00	
	2006	0.02	0.28	0.00	0.01	0.89	0.27	3.17	6.85	4.99	0.92	0.06	0.05	
	2007	1.81	0.19	0.02	0.31	1.30	0.51	2.08	0.57	1.71	0.09	1.07	0.46	
	2008	0.14	0.15	0.00	0.00	0.03	0.48	4.34	2.61	1.52	0.15	0.17	0.27	
	2009	0.01	0.00	0.06	0.01	0.77	2.24	0.49	0.59	2.50	0.21	0.96	0.84	
	2010	0.66	1.43	0.02	0.13	0.01	1.08	1.07	0.31	1.62	0.18	0.00	0.16	
	2011	0.00	0.11	0.00	0.00	0.00	0.05	2.59	1.11	0.43	0.01	0.23	0.74	
	2012	0.66	0.02	0.08	0.09	0.53	0.00	2.39	0.65	1.41	0.10	0.02	0.09	
	2013	0.30	0.41	0.00	0.00	0.18	0.16	3.13	1.12	3.85	0.00	0.10	0.26	
	2014	0.00	0.00	0.18	0.45	0.01	0.01	0.69	1.79	4.23	0.98	0.11	0.12	
	2015	0.85	0.03	0.61	0.24	0.81	0.18	2.88	1.55	0.33	3.24	0.28	1.08	
	2016	0.46	0.07	0.01	0.04	0.06	0.33	0.24	4.76	2.12	0.00	0.39	0.86	
	2017	1.05	0.16	0.00	0.14	0.03	1.16	3.37	2.01	1.16	0.05	0.28	0.68	
	2018	0.10	0.67	0.21	0.00	0.41	0.37	1.36	1.16	1.21	2.44	0.01	0.43	
	2019	0.10	0.12	0.25	0.08	0.16	0.97	0.18	0.89	1.54	1.34	1.73	0.72	
	2020	0.27	0.78	2.02	0.00	0.21	0.25	1.47	0.05	0.59	0.18	0.00	0.02	
	2021	0.18	0.40	0.00	0.24	0.18	2.37	4.8	2.46	0.47	0.00	0.34	0.59	
2022	0.03	0.40	0.15	0.00	0.00	1.24	0.24	2.84	1.65	1.91	0.12	0.34		
2023	0.23	0.41	0.05	0.00	0.11	0.03	0.30	1.44	0.95	0.35	0.27	0.20		
Total Average Monthly Rainfall	0.33	0.40	0.22	0.16	0.28	0.82	1.59	1.70	1.51	0.63	0.42	0.50	8.55	

Note: N/A represents no data was recorded.

**Table 1-4. Hudspeth County Monthly Rainfall (1993-2023)
(inches)**

Station Name	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Average Annual Rainfall
Fort Hancock 8 SSE, TX (USC00413266)	1993	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.18	0.42	0.16	1.25	
	1994	0.00	0.00	0.59	0.00	0.50	0.00	0.31	0.65	1.40	n/a	0.34	0.00	
	1995	0.10	0.55	0.03	0.00	0.00	0.30	0.10	0.60	2.30	0.00	0.00	0.00	
	1996	0.10	0.00	0.00	0.42	0.00	1.40	0.55	1.73	0.90	0.00	0.00	0.00	
	1997	0.00	0.00	0.00	0.22	0.35	1.63	1.22	0.00	0.30	0.30	0.46	1.36	
	1998	0.00	0.24	0.00	0.00	0.44	0.23	1.36	0.44	0.05	1.53	0.00	0.00	
	1999	0.20	n/a	n/a	n/a	0.10	2.16	2.26	1.66	0.64	0.31	0.00	0.40	
	2000	0.00	0.08	0.00	0.10	0.00	2.12	0.98	1.12	0.00	1.58	1.25	0.19	
	2001	0.53	0.12	0.27	0.02	0.00	0.66	2.21	1.22	0.46	0.00	0.06	0.17	
	2002	0.17	1.20	0.00	0.00	0.10	0.73	0.48	0.21	0.42	1.31	0.00	0.85	
	2003	0.00	0.94	0.10	0.00	0.00	n/a	1.21	0.93	0.60	0.82	0.01	0.00	
	2004	0.95	0.78	0.85	1.49	0.49	1.95	1.37	1.86	2.03	1.80	2.51	0.18	
	2005	0.62	1.13	0.00	0.30	2.03	0.00	1.78	2.29	0.66	3.54	0.00	0.00	
	2006	0.00	0.09	0.19	0.00	0.00	0.09	2.95	3.16	1.25	1.50	0.04	0.15	
	2007	1.91	0.24	0.14	1.70	0.40	1.54	2.13	1.01	1.97	0.35	0.77	0.75	
	2008	0.00	0.00	0.00	0.00	0.30	0.06	3.88	2.18	1.79	0.70	0.00	0.00	
	2009	0.02	0.00	0.01	0.00	0.48	0.24	1.70	2.01	0.80	0.56	0.22	1.88	
	2010	0.67	0.99	0.00	0.97	0.00	0.40	2.22	1.60	0.66	0.33	0.00	0.06	
	2011	0.00	0.00	0.00	0.00	0.00	0.18	0.53	1.45	0.05	0.17	0.14	0.41	
	2012	0.67	0.03	0.66	0.33	0.45	0.00	2.33	1.73	0.74	0.00	0.11	0.01	
	2013	0.53	0.23	0.00	0.02	0.07	0.89	2.61	0.23	2.23	0.00	0.29	0.65	
	2014	0.00	0.07	0.00	0.78	0.00	0.58	2.47	2.05	0.98	0.55	1.16	0.40	
	2015	0.59	0.00	1.04	0.35	1.17	0.94	1.35	0.68	0.81	1.55	0.81	0.44	
	2016	0.24	0.00	0.00	0.28	0.85	0.46	0.54	3.30	1.61	1.85	0.00	0.75	
2017	0.23	0.00	0.00	0.10	0.00	1.17	1.96	1.83	1.52	0.11	0.23	0.65		
2018	0.03	0.15	0.22	0.00	0.02	1.83	0.81	0.97	1.30	2.18	0.48	0.76		
2019	0.05	0.00	0.15	0.17	0.35	0.91	1.89	0.40	2.02	2.34	1.01	0.44		
2020	0.05	0.45	1.76	0.00	0.11	0.43	1.78	0.00	0.97	0.01	0.00	0.20		
2021	0.31	0.21	0.00	0.14	0.05	0.70	1.39	4.36	2.52	0.16	0.09	0.00		
2022	0.43	0.17	0.00	0.00	0.00	2.17	1.49	6.70	0.54	1.58	0.28	0.15		
2023	0.05	0.25	0.00	0.00	0.35	0.57	0.60	2.56	0.05	0.58	0.27	0.12		
Total Average Monthly Rainfall		0.27	0.26	0.19	0.24	0.28	0.79	1.50	1.58	1.02	0.84	0.34	0.39	7.71

Note: N/A represents no data was recorded.

**Table 1-5. Jeff Davis County Monthly Rainfall (1993-2023)
(inches)**

Station Name	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Average Annual Rainfall
Mount Locke, TX (USC00416104)	1993	0.86	0.21	0.56	0.49	1.22	3.18	6.31	3.83	0.49	0.36	0.01	0.88	
	1994	0.47	0.19	0.62	0.27	3.27	1.01	2.48	1.66	2.40	1.06	0.07	0.47	
	1995	0.10	0.73	0.32	1.43	0.87	2.83	0.67	0.91	5.20	0.99	0.85	0.42	
	1996	0.52	0.17	0.10	0.09	0.14	1.46	2.98	4.05	6.95	0.31	0.91	0.04	
	1997	0.31	0.95	0.05	1.57	2.44	3.40	3.19	3.35	3.82	1.36	0.46	1.52	
	1998	0.00	0.04	0.06	0.06	0.58	0.25	3.70	3.36	0.12	2.19	0.33	0.39	
	1999	0.09	0.00	0.24	0.02	2.64	5.29	2.75	2.95	2.71	0.12	0.00	0.61	
	2000	0.04	0.16	0.00	0.29	0.13	7.38	0.96	1.80	0.00	2.66	0.64	0.04	
	2001	0.55	0.55	0.12	0.95	0.59	2.47	3.80	4.14	1.43	0.13	1.89	0.21	
	2002	0.17	1.21	0.38	0.28	0.01	1.86	5.43	3.86	1.13	2.70	0.35	0.23	
	2003	0.10	1.13	0.68	0.00	0.96	2.40	5.70	2.37	1.14	2.60	0.00	0.00	
	2004	1.54	n/a	1.88	3.00	1.90	2.33	3.58	5.74	6.10	3.58	4.78	0.25	
	2005	0.44	2.27	0.14	0.12	0.22	0.25	2.78	5.23	1.55	4.56	0.00	0.00	
	2006	0.00	0.07	0.20	0.00	0.23	1.16	3.00	n/a	1.90	2.01	0.04	0.77	
	2007	2.27	0.11	1.45	0.25	4.59	3.11	2.28	3.61	2.27	0.64	0.38	0.16	
	2008	0.20	0.03	0.09	0.00	0.16	2.82	5.53	3.92	4.23	0.59	0.00	n/a	
	2009	0.00	n/a	0.16	0.00	3.89	2.57	2.32	2.47	0.76	1.95	0.09	1.16	
	2010	1.77	0.72	0.23	1.10	0.50	3.61	7.93	4.74	3.82	0.00	0.00	0.00	
	2011	0.01	0.10	0.00	0.00	0.00	0.01	1.68	2.73	1.39	0.28	0.05	0.59	
	2012	0.54	0.17	0.59	0.28	2.64	1.63	3.96	3.80	3.55	0.30	0.03	0.10	
	2013	2.36	0.00	0.00	0.05	0.76	3.56	4.24	0.84	3.10	0.62	0.39	1.24	
	2014	0.00	0.00	0.68	0.71	0.00	3.03	3.84	3.51	4.02	1.26	1.44	0.44	
	2015	2.49	0.53	1.13	1.26	2.69	4.00	2.23	3.11	1.92	6.18	2.89	0.92	
	2016	0.12	0.00	0.06	0.19	2.08	2.99	1.16	7.80	2.51	0.71	1.21	0.39	
2017	1.39	0.00	0.28	0.90	0.02	1.79	12.27	5.86	2.94	0.92	0.15	1.77		
2018	0.00	0.02	0.05	0.09	1.38	1.97	5.55	2.74	3.44	2.84	0.00	0.66		
2019	0.23	0.27	0.46	0.45	1.00	2.14	3.13	1.85	7.76	0.74	1.24	0.45		
2020	0.92	0.95	1.22	0.02	0.84	2.50	2.30	1.26	1.62	0.00	0.00	0.6		
2021	0.24	0.37	0.00	0.20	1.25	5.73	2.04	6.00	1.29	1.32	0.12	0.05		
2022	0.25	0.33	0.02	0.00	0.05	2.28	5.44	6.94	3.12	3.63	0.44	0.28		
2023	0.08	0.47	0.31	0.04	1.36	0.93	0.68	3.37	3.25	1.15	1.28	0.00		
Total Average Monthly Rainfall		0.58	0.38	0.39	0.46	1.24	2.58	3.67	3.48	2.77	1.54	0.65	0.47	18.21

Note: N/A represents no data was recorded.

**Table 1-6. Presidio County Monthly Rainfall (1993-2023)
(inches)**

Station Name	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Average Annual Rainfall
Marfa 2, TX (USC00415596)	1993	0.93	0.16	0.23	0.44	0.37	1.46	2.89	1.68	0.86	0.49	0.00	0.78	
	1994	1.38	0.16	1.10	0.10	2.66	0.63	0.91	1.74	0.79	0.82	0.02	0.50	
	1995	0.10	0.27	0.04	1.28	0.49	1.75	2.54	2.56	4.18	0.65	0.11	0.48	
	1996	0.14	0.20	0.07	0.00	0.12	1.37	2.33	5.52	6.00	0.10	0.61	0.03	
	1997	0.09	2.08	0.12	1.56	2.66	0.90	6.28	2.44	1.07	0.16	0.68	0.96	
	1998	0.03	0.12	0.20	n/a	n/a	0.07	2.79	2.80	1.04	1.77	0.22	0.11	
	1999	0.00	0.00	0.20	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	2000	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	2001	n/a	n/a	n/a	n/a	1.56	0.43	5.03	2.22	1.01	0.09	0.98	0.14	
	2002	0.03	0.81	0.23	0.67	0.64	1.55	3.43	3.57	0.55	2.02	0.57	0.34	
	2003	0.00	0.98	0.34	0.00	0.32	2.95	n/a	1.16	0.88	1.65	0.02	0.00	
	2004	1.80	0.30	2.12	1.16	0.53	3.17	3.16	4.26	4.07	0.93	3.79	0.28	
	2005	0.48	1.41	0.02	0.03	0.66	0.85	2.34	3.86	2.50	3.80	0.00	0.08	
2006	0.01	n/a	0.00	n/a	0.02	0.54	1.46	n/a	3.26	n/a	0.00	n/a		
2007	0.24	0.23	n/a	0.40	2.19	n/a	1.35	0.44	n/a	n/a	n/a	n/a		
2008	n/a	n/a	0.00	n/a	n/a	n/a	n/a	n/a	n/a	0.00	n/a	n/a		
Presidio 2, TX (USC00417264)	2009	0.00	n/a	1.13	0.00	2.01	2.06	1.20	2.99	0.68	0.91	0.02	0.46	
	2010	0.95	0.95	0.08	1.75	0.25	0.32	1.37	1.43	1.41	0.00	0.00	0.00	
	2011	0.00	0.00	0.00	0.00	0.00	1.40	0.33	0.30	0.49	0.32	0.00	0.07	
	2012	0.00	0.18	0.00	0.30	1.83	0.69	0.79	0.41	2.09	0.50	0.27	0.00	
	2013	0.20	0.00	0.00	0.00	0.56	3.65	3.22	0.39	2.33	0.08	0.71	0.44	
	2014	0.00	0.03	0.00	0.17	0.00	0.71	0.67	3.50	5.19	0.28	2.04	0.00	
	2015	1.64	0.00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	2016	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
2017	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		
Presidio Lely International Airport, TX (USW00000471)	2018	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1.56	0.00	0.62	
	2019	0.39	0.04	0.02	0.01	0.05	1.01	n/a	1.18	2.86	0.57	0.45	0.42	
	2020	0.17	0.22	0.16	0.09	0.12	0.01	0.38	0.01	2.18	0.07	n/a	0.43	
	2021	0.19	0.33	0.02	0.62	1.61	1.39	1.32	2.15	0.32	n/a	0.14	n/a	
	2022	0.01	n/a	n/a	n/a	0.09	0.75	1.15	5.89	0.13	1.37	0.03	0.10	
2023	n/a	0.44	0.34	n/a	2.45	0.06	0.01	0.43	0.58	0.12	0.39	0.07		
Average Monthly Rainfall	0.28	0.29	0.21	0.28	0.68	0.89	1.45	1.64	1.43	0.59	0.36	0.20	8.31	

Note: N/A represents no data was recorded.

**Table 1-7. Terrell County Monthly Rainfall (1993-2023)
(inches)**

Station Name	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Average Annual Rainfall
Sanderson, TX (USC00418022)	1993	0.59	0.39	0.15	1.00	2.84	0.90	1.44	3.60	1.40	0.22	0.15	0.99	12.21
	1994	1.21	0.41	1.07	0.70	0.21	0.42	1.01	0.82	1.66	0.98	0.21	n/a	
	1995	0.19	1.16	0.07	0.91	2.92	3.44	1.09	0.95	4.64	0.78	1.68	n/a	
	1996	n/a	0.23	n/a	0.76	0.73	0.50	0.31	3.81	3.27	0.59	1.11	0.05	
	1997	0.22	1.00	3.00	0.94	2.13	4.11	0.61	1.36	2.30	1.08	0.34	0.68	
	1998	0.16	0.27	0.08	n/a	0.20	2.72	0.02	4.63	0.08	1.74	1.29	4.11	
	1999	n/a	n/a	0.68	0.15	3.40	5.75	4.44	0.49	0.26	0.11	n/a	0.15	
	2000	0.04	0.33	0.01	0.17	n/a	2.57	1.15	0.01	0.20	5.25	2.55	0.23	
	2001	0.74	0.39	0.45	0.20	0.38	0.18	n/a	2.02	0.08	0.19	4.95	0.03	
	2002	n/a	0.41	0.20	1.91	0.44	0.25	3.30	0.42	0.91	3.04	0.13	0.90	
	2003	0.05	0.98	0.39	0.08	0.65	1.06	2.27	2.03	1.16	2.57	0.10	n/a	
	2004	0.81	0.98	3.42	2.91	0.44	4.51	6.63	1.11	2.23	0.66	2.86	0.08	
	2005	0.55	1.15	0.51	0.07	3.63	0.84	n/a	n/a	0.04	3.12	n/a	0.36	
	2006	0.04	0.38	0.05	n/a	0.09	1.64	0.13	n/a	n/a	1.17	n/a	n/a	
	2007	n/a	n/a	2.66	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
	2008	0.33	n/a	0.05	0.05	0.38	4.12	1.89	2.69	4.59	0.74	0.02	0.23	
2009	n/a	n/a	1.90	0.02	1.90	3.25	1.38	0.09	0.58	1.65	0.09	2.71		
2010	1.63	1.79	0.20	0.98	2.81	0.10	11.28	0.16	1.24	n/a	n/a	0.02		
2011	0.37	0.06	n/a	0.11	0.03	n/a	0.03	0.28	0.35	1.07	0.05	0.52		
2012	n/a	0.57	1.02	0.43	3.97	0.24	2.12	1.61	1.32	0.31	0.09	0.02		
Dryden Terrell CO Airport, TX (USW00003032)	2013	3.54	n/a	n/a	0.39	0.31	1.10	1.47	0.08	4.33	0.52	1.08	0.20	
	2014	n/a	0.02	n/a	0.34	0.30	1.64	0.07	0.70	1.74	0.70	0.26	0.06	
	2015	1.50	0.33	2.57	1.74	1.14	2.76	1.58	0.18	n/a	2.43	0.47	0.52	
	2016	0.24	0.52	1.87	0.33	2.22	0.62	0.33	3.30	0.45	0.05	0.55	0.57	
	2017	0.49	0.96	0.07	0.97	0.13	1.42	3.27	3.28	2.93	0.15	0.03	1.46	
	2018	n/a	0.02	1.40	n/a	1.17	0.21	0.55	2.56	5.35	2.71	n/a	1.23	
	2019	0.41	0.01	0.18	1.11	0.52	4.38	n/a	0.12	1.32	0.33	0.59	0.62	
	2020	0.23	0.70	0.37	0.02	1.10	0.88	n/a	0.01	0.41	n/a	n/a	1.15	
	2021	0.52	0.08	n/a	0.10	3.46	0.64	1.27	0.86	0.89	0.02	n/a	0.24	
	2022	0.13	0.39	n/a	0.03	0.54	0.05	n/a	7.94	0.86	3.17	0.53	0.21	
	2023	0.10	0.32	0.63	0.04	0.74	2.49	0.12	5.78	0.46	1.44	1.86	0.80	
Total Average Monthly Rainfall		0.45	0.45	0.74	0.53	1.25	1.70	1.54	1.64	1.45	1.19	0.68	0.59	12.21

Note: N/A represents no data was recorded.

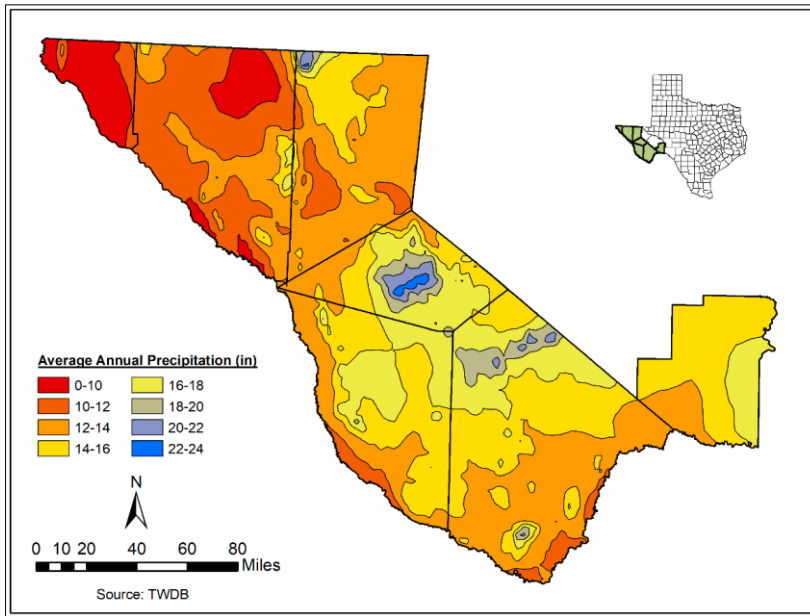


Figure 1-6. Variation of Precipitation

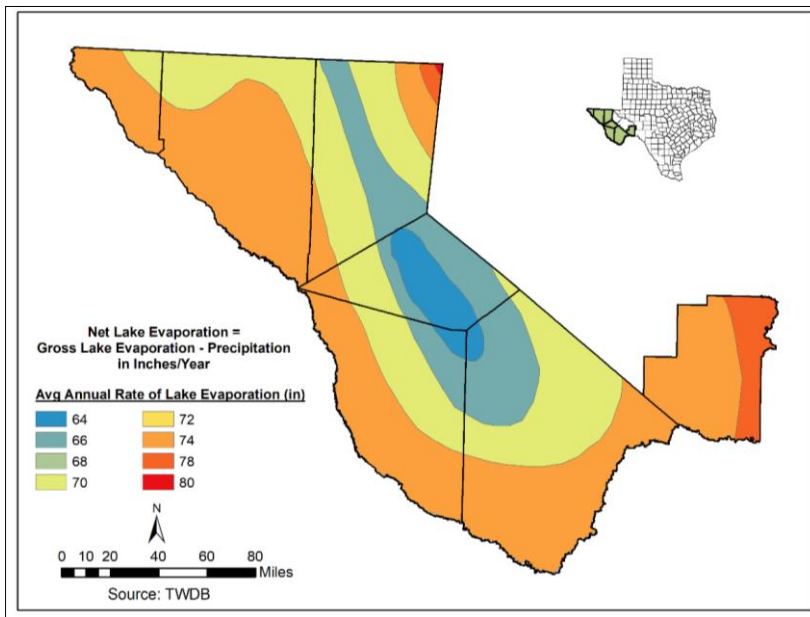


Figure 1-7. Net Lake Evaporation

Figure 1-8. Average Monthly Rainfall for Selected Stations
Source: NCEI

Far West Texas Climate Change Conference

Far West Texas, like much of the western United States, has historically relied on large-scale infrastructure to store and deliver surface water supplies. These surface water supplies are particularly vulnerable to changes in weather patterns. With the realization that the regional climate may have been more variable in the past than indicated by the historical record and may be even harsher and more variable in the future, several western states have taken on initiatives to address the potential impacts of climate change on their natural resources.

Because of these and other considerations, State Senator Eliot Shapleigh authored Senate Bill 1762 during the 80th Texas Legislative Session. The bill directed the TWDB, in coordination with the FWTWPG, to conduct a study regarding the possible impact of climate change on surface water supplies from the portion of the Rio Grande in Texas subject to the Rio Grande Compact. Because of this legislation, the TWDB hosted the Far West Texas Climate Change Conference June 17, 2008, at the Carlos M. Ramirez

Water Resources Learning Center in El Paso. Along with other related issues, conference participants reviewed:

- Current analyses of potential impacts of climate change on surface water resources in Texas and other Western states; and
- Recommendations for incorporating potential impacts of climate change into the Far West Texas Water Plan, including potential impacts to the Rio Grande in Texas subject to the Rio Grande Compact, and identifying feasible water management strategies to offset any potential impacts.

The entire report "Far West Texas Climate Change Conference – Study Findings and Conference Proceedings" can be accessed at http://www.twdb.texas.gov/publications/reports/special_legislative_reports/doc/climatechange.pdf.

Drought

Drought conditions are assumed in the planning process to ensure that adequate infrastructure and planning is in place under severe water shortage conditions and is discussed in detail in Chapter 7 of this *Plan*. Drought in Far West Texas can be defined in the following operational definitions:

Meteorologic drought is an interval of time, usually over a period of months or years, during which precipitation cumulatively falls short of the expected supply.

Agricultural drought is that condition when rainfall and soil moisture are insufficient to support the healthy growth of crops and to prevent extreme crop stress. It may also be defined as a deficiency in the amount of precipitation required to support livestock and other farming or ranching operations.

Hydrologic drought is a long-term condition of abnormally dry weather that ultimately leads to the depletion of surface water and groundwater supplies, the drying up of lakes and reservoirs, and the reduction or cessation of spring flow or streamflow.

Although agricultural drought and hydrologic drought are consequences of meteorologic drought, the occurrence of meteorologic drought does not guarantee that either one or both of the others will develop. Regarding the upper segment of the Rio Grande, drought is more significantly influenced by the amount of snowmelt in southern Colorado and northern New Mexico that affects the amount of water in storage in Elephant Butte Reservoir shown in Figure 1-9 [[historical data \(1915-2020\)](#)] provided by U.S. Department of Interior, Bureau of Reclamation found here: <https://www.usbr.gov/rsvr/Water/HistoricalApp.html>]. For Far West Texas and particularly those who rely on the Rio Grande, an operational drought definition is more appropriate.

The westernmost part of Texas, as well as the headwaters of the Rio Grande in Colorado and New Mexico, has been experiencing drought conditions for much of the past two decades, with only 1997, 2005 and 2008 experiencing above average spring runoff into Elephant Butte reservoir. According to the U.S. Bureau of Reclamation El Paso Office, July 2013 Elephant Butte reservoir was at only three percent of capacity. 2013 was the shortest irrigation season (less than six weeks) and supplied the least amount of water in the almost 100-year history of the Rio Grande Project. After a short period of recovery, the reservoir was again back down to 3.3 percent of capacity by October 2018. Per the TWDB Water Data for Texas (<http://www.waterdatafortexas.org/>), in ~~April 2019~~ May 2024 Elephant Butte Reservoir is 14.23 percent of a full reservoir. Approximately one-fourth of the water currently in storage is Rio Grande

Compact Credit water, which is owned by upstream users and is not available for use in southern New Mexico, Texas, or Mexico.

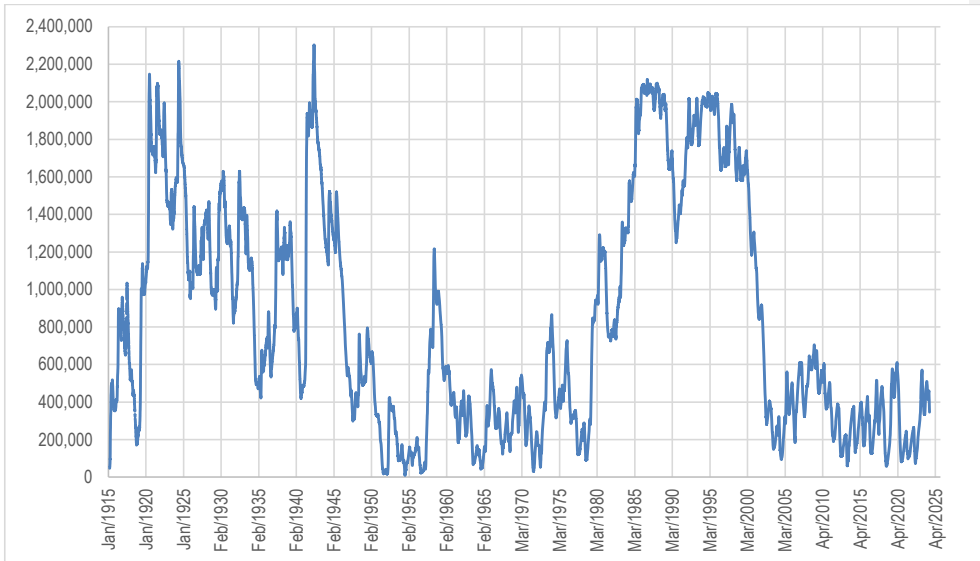


Figure 1-9. Elephant Butte Reservoir Storage in Acre-Feet
 Source: U.S. Bureau of Reclamation

River drought above Fort Quitman is a period when the Rio Grande and its storage facilities (reservoirs) have reached a stage where water deliveries are less than full allocation. There may be a drought in all other definitions, but if there is adequate storage in the local reservoir (Elephant Butte), there is no “river drought” and no reduction in surface water deliveries.

River drought below confluence of Rio Conchos may be defined as any time the combined flows of the Rio Grande and Rio Conchos falls below 250 cubic feet per second (cfs) for more than 90 consecutive days.

Consistent flows of less than 250 cfs below Presidio have reduced to bare remnants an agricultural economy on land that has been continuously cultivated longer than anywhere else in Texas. Consistent low water flow threatens important wildlife habitat and river recreation resources that are essential building blocks for rural economies downstream of El Paso.

The 1950s drought-of-record and the ~~current-2011~~ drought can be compared using historic precipitation, stream flow records, spring discharges and water level measurements in wells for locations that have accumulated data measurements since the 1940s. This is discussed further in Chapter 7. For this planning cycle, the drought of the 1950s is declared the drought-of-record. However, it is the intent of the current

~~2021-2026 Plan, to illustrate in Chapter 7 that although the 1950s drought is the historic drought-of-record, drought is a recurrent phenomenon in the region. Drought is a recurrent phenomenon in the region.~~

Far West Texas is perennially under drought or near-drought conditions compared with more humid areas of Texas. Although residents of the Region are generally accustomed to these conditions, the low rainfall and the accompanying high levels of evaporation underscore the necessity of developing plans that respond to potential disruptions in the supply of groundwater and surface water caused by drought conditions. Those entities that rely on surface water are most vulnerable to the impact of drought. Irrigators along the Rio Grande rely on projected allocations provided by the U.S. Bureau of Reclamation to anticipate their crop potential each year. El Paso Water has developed a conjunctive use plan in which it can shift supply emphasis to groundwater sources during periods of low surface water availability. Water management and drought contingency plans for regional entities are discussed in detail in Chapter 7.

Native Vegetation and Ecology

Vegetation native to the arid Chihuahuan Desert is closely tied to the Region's precipitation and evaporation potential. This area typically receives most of its precipitation in the summer in the form of convective storms, which are typically characterized by intense rainfall concentrated in small areas. When it occurs, winter precipitation comes from frontal systems, which are generally soaking rains covering larger areas. Due to their nature, the summer precipitation generally wets only the shallow subsurface soil layer, whereas, winter rains are more likely to percolate deeper into the subsurface.

According to the Chihuahuan Desert Research Institute, vegetation native to Far West Texas can be classified into two groups: intensive water users and extensive water users. Intensive water users include short grasses and cacti, which have short root systems and respond quickly to small amounts of moisture that is available in the soil profile for only a limited time. Extensive water users have both shallow roots capable of capturing soil moisture as well as deep roots that penetrate further downward in the subsurface. Thus, summer rainfall favors grasslands, while winter rainfall favors scrubs. Although a shift in predominate precipitation patterns from summer to winter has not been clearly recognized, local observations indicate that scrubs are becoming more predominate. Likewise, it is becoming increasingly clear that ongoing drought conditions in Far West Texas are placing a serious strain on vegetation, especially the oak and conifer woodlands in the higher elevations.

Agricultural Resources

Agriculture, including both the beef industry and irrigated farming, is the most significant economic activity in Far West Texas. The raising of beef cattle occurs in all seven counties, with Brewster County accounting for the greatest number of range cattle. The dairy industry primarily operates in El Paso County.

With an average annual rainfall of ~~less than 13~~ 11 inches, the raising of crops in this Region requires irrigation. Most irrigated farming occurs along the flood plains of the Rio Grande in El Paso, Hudspeth, and Presidio Counties, where water is diverted from the River to grow vegetables, cotton, various grain crops, and orchards. Inland, groundwater sources are pumped to the surface to irrigate crops and pastures primarily in Hudspeth (Dell Valley), Culberson (Diablo Farms, Wild Horse Flat, and Lobo Flat), and Jeff Davis (Ryan Flat and Lobo Flat) Counties.

Agricultural activities in the Region that rely on surface water are designed to accommodate the intermittent nature of the supply. In some cases, this means that agricultural water supply needs will be supplemented by groundwater sources, or that irrigation activities will cease until river supplies are replenished.

The only potential impacts to agricultural are identified with the possible change in water rights use from agricultural use to municipal use of Rio Grande water in El Paso County and groundwater in the Dell City and Diablo Farms areas of Hudspeth and Culberson Counties. As these strategies only potentially change the use of the water and not the volume of diversion, there is no significant impact to natural resources.

Natural Resources

Far West Texas boasts the highest and most scenic desert communities in Texas. The natural resources of the Region include the surface water and groundwater sources described in Sections 1.4 and 1.5 of this chapter, and in Chapter 3. Terrestrial and aquatic habitats that provide beautiful vistas, recreational opportunities, and unique wildlife habitats are also natural resources. Understandably, both residents and tourists make use of these resources in their enjoyment of the numerous public parks within the Region. Big Bend National Park, Guadalupe Mountains National Park, and Big Bend Ranch State Park are three of the largest protected areas in the Region.

Natural resources also include the great diversity of plant and animal wildlife that inhabit these environments. Texas Parks and Wildlife Department's Natural Diversity Database is a comprehensive source of information on species by county that are Federally listed, proposed to be Federally listed, have Federal candidate status, are state listed, or carry a global conservation status indicating a species is critically imperiled, very rare, vulnerable to extirpation, or uncommon. TPWD suggests that due to continuing updates that readers access the most current listing at http://www.tpwd.state.tx.us/landwater/land/maps/gis/ris/endangered_species.

Both plant and animal species endemic to Far West Texas have developed a tolerance for the intermittent nature of surface water availability; however, significantly long drought conditions can have a severe effect on these species. Riparian water needs for birding habitat are particularly critical. Springs (ciénegas) emanating from shallow groundwater sources often provide the most constant water supply available for aquatic habitat. "Major Springs" in the Region are listed in Section 1.6 of this chapter and are described in more detail in Appendix 1A, while "ecologically unique river and stream segments" are described in Chapter 8 of this ~~2021~~ 2026 Plan.

Of recognized importance to the water planning process is the concern of the effect that future development of water supplies might have on the diversity of species in the Region. Water supply deficit strategies developed in Chapter 5 of this Plan include an evaluation of each strategy's potential impact on the environment and natural resources.

1.3 REGIONAL WATER DEMAND

Major Demand Centers

Total projected year ~~2020~~ 2030 water consumptive use in Far West Texas is ~~480,424~~ 598,338 acre-feet. The largest category of use is irrigation (~~310,403~~ 404,049 acre-feet), followed by municipalities and county-other (~~142,507~~ 162,873 acre-feet), ~~mining (11,922 acre-feet)~~, steam-electric ~~cooling power (10,545~~ 8,880 acre-feet), manufacturing (~~7,033~~ 7,920 acre-feet), ~~mining (7,835 acre-feet)~~, and livestock (~~2,101~~ 2,694 acre-feet) (

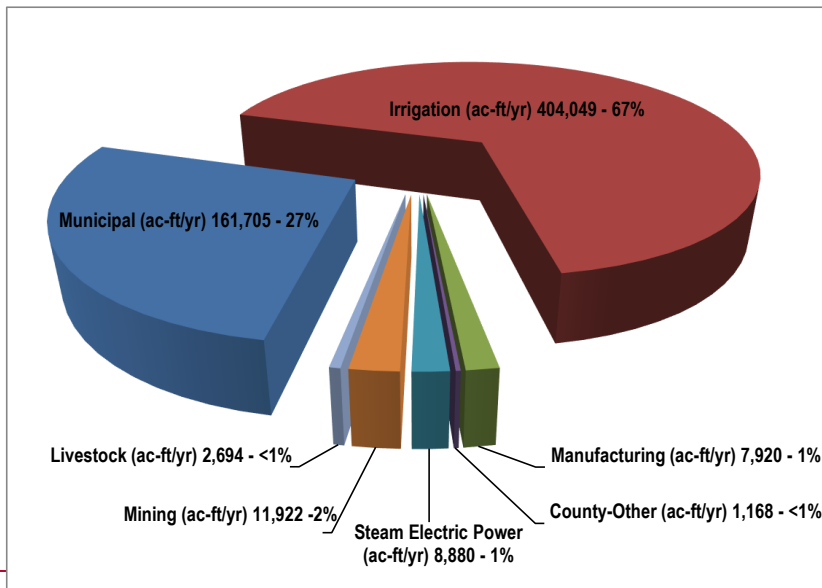


Figure 1-10). Sixty-five ~~seven~~ percent of water used in the Region is by the agricultural sector in support of irrigation. ~~Thirty percent~~ ~~Twenty seven percent~~ is used by municipalities and county-other, and the remaining ~~5.6~~ percent supports manufacturing, steam-electric power generation, livestock, and mining. Current and projected water demand for all water-use types are discussed in detail in Chapter 2.

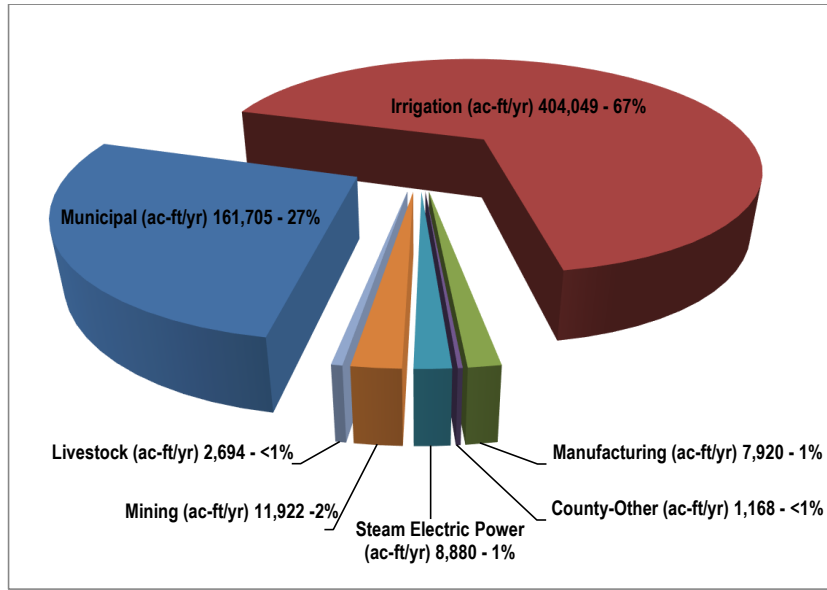


Figure 1-10. Year 2030 Projected Water Demand by Water-Use Category

Agriculture

The cultural and physical landscape of Far West Texas has more in common with the desert southwest than with other areas of Texas. The dominant commercial land use throughout the rural areas of the Region is extensive cattle grazing. Aridity and historic land-tenure practices have combined to produce large ranches and low animal densities. The projected total volume of water used in livestock production in the Region in the year ~~2020~~ 2030 is ~~2,101~~ 2,694 acre-feet. Livestock water demand in ~~2020~~ 2030 ranges from a high of ~~437~~ 533 acre-feet in Hudspeth County to a low of ~~154~~ 183 acre-feet in Terrell County. The reduction of concentrated dairy farms has significantly reduced livestock water consumption in El Paso County. Cow and calf operations dominate the livestock industry in every county except Terrell, where sheep and goats predominate. In addition to livestock, many of the ranches supplement revenue through hunting leases.

There is virtually no rain-fed agriculture (dry-land farming) in Far West Texas, and even irrigated agriculture is confined to a small fraction of the Region. Floodplain-irrigated agriculture is found along the Rio Grande extending above and below El Paso (EPCWID#1) and into southern Hudspeth County (HCCRD#1). A much smaller irrigated strip also occurs along the Rio Grande near Presidio from Candelaria to Redford.

Currently, irrigated agriculture based on groundwater pumping is essentially limited to Dell Valley in northeastern Hudspeth County, Diablo Farms in northwestern Culberson County, and Wild Horse and Lobo Flats near Van Horn. High quality cotton, pecans, alfalfa, and vegetables such as tomatoes, onions, and chilies are the major crops of the Region.

Total projected irrigation use in the Region in the year ~~2020~~ 2030 is ~~310,403~~ 404,049 acre-feet. El Paso and Hudspeth Counties accounted for the greatest amount of irrigation with ~~149,570~~ 193,990 and ~~115,542~~ 143,072 acre-feet of use, respectively. Along the Rio Grande corridor in these two counties, irrigation water is diverted from the River, except during years when flow is significantly below normal. In northeastern Hudspeth County, the Dell Valley farming area irrigates cropland with groundwater pumped from the underlying Bone Spring-Victorio Peak Aquifer.

Irrigation in El Paso and Hudspeth Counties represents ~~85~~ 83 percent of total irrigation water use in the Region. Most of the remaining ~~15~~ 17 percent of irrigation demand is centered in Culberson County, where ~~37,863~~ 55,482 acre-feet is projected to be used in ~~2020~~ 2030 to support irrigated agriculture. Greenhouse farming operations near Fort Davis and Marfa have the highest crop (tomatoes) yield per volume of water applied.

The area of land irrigated in the El Paso County Water Improvement District #1 in any given year varies from 40,000 to 50,000 acres. The total water rights acreage in the District, however, is 69,010. The City of El Paso currently owns or leases 13,075 acres of land within the District with water rights.

Crop production in Far West Texas is not sustainable without a source of irrigation water. A reduction in the quantity of water available for irrigation will cause a reduction in the number of acres that can be irrigated profitably. Similarly, cutbacks in the supply of water for livestock will cause a reduction in herd size. As water supplies are depleted, modifications will be required to use the available rangeland resource, and water hauling within a given ranch may be required to better distribute water to livestock.

Although drought-like conditions are a relative constant in the Region, extended periods of below normal rainfall can have significant and long-lasting harmful effects on the rangeland resource. Reduction of livestock numbers because of drought usually lags the impact of drought on the range-grass ecosystem. Extended periods of drought can lead to the depletion of grass species and to an increase in shrub species. This leads to a decrease in soil cover and increases the potential for erosion by water and wind.

A decrease in water quality has a greater impact on crop production than on livestock output. As the salinity of irrigation water increases, the amount of irrigation water applied must also increase. This satisfies the leaching requirement and keeps the root zone salinity at levels that allow for economic crop production. If salinity levels increase, the mixture of crops may change to include crops with greater tolerance to soil salinity.

Groundwater use for irrigated farming principally occurs in Dell Valley, Diablo Farms, and along the various flats that comprise the Salt Basin bolson valley. Principal aquifers from which irrigation water is withdrawn include the Rio Grande Alluvium, Bone Spring-Victorio Peak, Capitan Reef, and the Wild Horse/Michigan, Lobo, and Ryan Flats of the West Texas Bolson Aquifers. Characteristics of these aquifers are described in Chapter 3.

Future availability of water for agricultural use from these aquifers varies. During times of insufficient river flow farmers may use groundwater from the Rio Grande Alluvium to sustain crops. However, because of its high mineral content, this water can only be used on a short-term basis. In Dell Valley, groundwater from the Bone Spring-Victorio Peak Aquifer has deteriorated in quality, particularly in the central part of the valley as a result of repeated irrigation water return flow. The aquifer should remain viable in the future as the Hudspeth County Underground Water District #1 limits permitted withdrawals

Commented [JJ1]: Sent email to Scott and Lisa requesting confirmation that this statement is still true.

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to 101,400 acre-feet or less annually (MAG aquifer limit). Water levels have declined in the past in most parts of the Salt Basin aquifers but have generally recovered due to a decrease in pumpage in recent years.

Municipal and County-Other

The municipal and county-other category of demand consists of both urban residential, rural-domestic, and commercial water uses. Commercial water consumption includes business establishments, public offices, and institutions, but does not include industrial water use. Residential and commercial uses are categorized together because they are similar types of uses, i.e.; they both use water primarily for drinking, cleaning, sanitation, air conditioning, and landscape watering. Total projected municipal and county-other water demand in the seven counties in the year ~~2020~~ 2030 is projected to be ~~142,507~~ 162,873 acre-feet.

The City of El Paso, with a projected water use of ~~110,572~~ 120,789 acre-feet in the year ~~2020~~ 2030, represents ~~78.74~~ percent of the total municipal and county-other water use in the Region. The City's water demand has remained in check over the last several years due to diligent enforcement of conservation measures. Total projected municipal and county-other water use in El Paso County (~~136,508~~ 155,088 acre-feet in ~~2020~~ 2030), which includes the City of El Paso, other communities, and rural domestic supply, represents ~~96.95~~ percent of the Regional total.

EPW which serves the City of El Paso, obtains approximately half of its water from the Rio Grande in full river water supply allocation conditions. The remainder is groundwater pumped from wellfields in the Mesilla Bolson and Hueco Bolson Aquifers. The Utility also supplies water to other incorporated areas and to businesses within El Paso County. Other entities in El Paso County not served by EPW rely exclusively on groundwater resources. All the cities and unincorporated areas of the six rural counties likewise depend entirely on groundwater resources from aquifers located in their respective areas.

Following necessary treatment, water supplies developed for municipal consumption are expected to meet "primary" and "secondary" safe drinking water standards mandated by the U.S. Environmental Protection Agency and the Texas Commission on Environmental Quality. "Primary standards" address dissolved particulates (e.g., heavy metals and organic contaminants) that are known to have adverse effects on human health. "Secondary standards" address factors that affect the aesthetic quality (e.g., taste and odor) of drinking water.

Water quality varies widely within the Region. In much of the rural counties, groundwater is of sufficient quality that only chlorination is required as a means of treatment. In other areas, various methods of treatment are required to bring the water into compliance with primary and secondary standards. For example, Dell City, El Paso, and Horizon Regional MUD operate desalination plants or wellhead facilities to reduce the concentration of total dissolved solids (TDS) in groundwater extracted from local aquifers.

EPW actively treats available water supplies to meet drinking water standards. These operations include the blending of fresh water with marginally elevated TDS water to increase available supplies, and the tertiary treatment of wastewater to generate supplies for reuse. EPW has updated its treatment facilities to accommodate the arsenic concentration standard. EPW and Fort Bliss have jointly constructed the Kay Bailey Hutchison Desalination Facility, a 27.5 MGD desalination plant that makes use of brackish groundwater in the Hueco Bolson Aquifer, thus preserving fresh water in the aquifer for drought protection and emergency use.

County-other is an aggregation of residential, commercial, and institutional water users in cities with less than 500 people or non-city utilities that provide less than 100 acre-feet per year, an average of 250,000 gallons per day, as well as unincorporated rural areas in each county. The ~~2020~~ 2030 county-other total water demand for the Region is ~~3,266~~ 1,168 acre-feet/year (Figure 1-10).

Major Water Providers

A major water provider is defined as a significant public or private WUG or wholesale water provider (WWP) whose significance is determined by the RWPG and provides water for any water use category in a regional water planning area. Entities meeting this definition and entities to which they contract are as follows:

El Paso County Water Improvement District #1

- El Paso Water

El Paso Water

- City of El Paso
- Lower Valley Water District
- Fort Bliss and East Biggs
- Vinton Hills
- Paseo Del Este MUD#1
- East Montana Water System
- Haciendas Del Norte WID
- County-Other
- El Paso Steam Electric
- Manufacturing
- Mining

Lower Valley Water District

- Socorro
- San Elizario
- Clint

Horizon Regional MUD

- Horizon City
- County Other

The El Paso County Water Improvement District #1 primarily delivers water from the Rio Grande to irrigators in El Paso County and sells water to El Paso Water. EPW obtains raw surface water from the El Paso County Water Improvement District #1 and groundwater from its own wells in the Hueco and

Mesilla Bolson Aquifers. While most of this water is used within the City of El Paso, significant volumes are also provided to manufacturing and power generating entities, as well as other public suppliers outside of the city. The Lower Valley Water District is a significant supplier of water to Socorro, San Elizario, Clint, and other retail customers and receives all its supply from EPW. Horizon Regional MUD supplies water to Horizon City and other local retail customers.

Industrial, Manufacturing, Electric Power Generation, and Mining

Industrial and manufacturing companies, which represent a significant component of the economy of Far West Texas, are mostly located in El Paso County where all but ~~56.5~~ acre-feet of the total ~~7,033-7,920~~ acre-feet of water projected to be used in the Region in the year ~~2020~~ 2030 is used in El Paso County. The industrial, manufacturing and power generation sectors purchase water from EPW, or are self-supplied by water wells. In some cases, companies use treated wastewater provided by EPW through the Utility's purple-pipe program.

El Paso Electric Company, located in El Paso County, is the only facility within the Region that uses water in the form of steam to generate electricity (~~40,545-8,880~~ acre-feet in ~~2020~~ 2030). Anticipated local population growth, as well as increasing commercial and manufacturing power needs, means that the quantity of water needed to produce electricity will likewise increase. El Paso Electric currently purchases most of its water supply from EPW.

Chemical quality standards for water used for industrial purposes vary greatly with the type of industry utilizing the water. The primary concern with many industries is that the water does not contain constituents that are corrosive or scale forming. Also of concern are those minerals that affect color, odor, and taste; therefore, water with a high concentration of dissolved solids is avoided in many manufacturing processes.

The ~~mining-livestock~~ sector accounts for the smallest area of demand, with ~~7,835-2,694~~ acre-feet of projected total use in the Region in ~~2020~~ 2030.

Environmental and Recreational Water Needs

Environmental and recreational water use in Far West Texas is recognized as being an important consideration as it relates to the natural community in which the residents of this Region share and appreciate. In addition, for rural counties, tourism activities based on natural resources offer perhaps the best hope for modest economic growth ~~to areas that have seen a long decline in traditional economic activities such as agriculture and mining.~~

Natural and environmental resources are often overlooked when considering the consequences of prolonged drought conditions. All living organisms require water. The amount and quality of water required to maintain a viable population, whether it be plant or animal, is highly variable. As water supplies diminish during drought periods, the balance between both human and environmental water requirements becomes increasingly competitive. A goal of this *Plan* is to provide for the health, safety, and welfare of the human community, with as little detrimental effect to the environment as possible. To accomplish this goal, the evaluation of strategies to meet future water needs includes a distinct consideration of the impact that each implemented strategy might have on the environment.

Recreation activities involve human interaction with the outdoor environment. Many of these activities are directly dependent on water resources such as fishing, swimming, and boating; while a healthy

environment enhances many others, such as hiking and bird watching. Thus, it is recognized that the maintenance of the regional environmental community's water supply needs serves to enhance the lives of citizens of Far West Texas as well as the tens of thousands of annual visitors to this Region. Environmental and recreational water needs are further discussed throughout the *Plan*.

1.4 SURFACE WATER SUPPLY SOURCES

Rio Grande

The Rio Grande originates in southwestern Colorado and northern New Mexico, where it derives its headwaters from snowmelt in the Rocky Mountains (Figure 1-11). The Elephant Butte Dam and Reservoir in New Mexico is approximately 125 miles north of El Paso and can store over two million acre-feet of water. Water in the reservoir is stored to meet irrigation demands in the Rincon, Mesilla, El Paso, and Juarez Valleys and is released in a pattern for power generation. Above El Paso, flow in the River is largely controlled by releases from Caballo Reservoir located below Elephant Butte; while downstream from El Paso to Fort Quitman, flow ~~consists of treated~~ is dominated by treated municipal wastewater from El Paso, untreated municipal wastewater from Juarez, and irrigation return flow. Below the El Paso-Hudspeth County line, flow consists mostly of return flow and occasional floodwater and runoff from adjacent areas. Channel losses are significant enough that the Rio Grande is often dry from below Fort Quitman to the confluence with ~~the Mexican river~~, the Rio Conchos, which is entirely in Mexico and joins the Rio Grande upstream of Presidio. The Rio Conchos is the only significant perennial tributary in the 350 miles between Elephant Butte Reservoir and Presidio.

The Rio Grande is unique in its complexity of distribution management. Because the waters of the River must be shared between three U.S. states (Colorado, New Mexico and Texas) and the nation of Mexico, a system of Federal, State and local programs has been developed to oversee the ~~equitable~~ distribution of water. The compacts, treaties and projects that currently provide the River's management framework are discussed in Chapter 3.

Pecos River

The Pecos River forms the eastern boundary of Far West Texas only for a short distance at the northeast corner of Terrell County (Figure 1-11). As a major tributary to the Rio Grande, the headwaters of the Pecos River originate as snowmelt east of Santa Fe, New Mexico in the Sangre de Cristo Mountains. The River flows southward through eastern New Mexico, to where Red Bluff Lake impounds it at the Texas-New Mexico border. The Pecos River Compact ~~provides defines~~ the apportionment ~~and division~~ of Pecos River waters between New Mexico and Texas and is administered by the Pecos River Compact Commission. Although Pecos River water in Texas is typically too salty for human consumption, it has been a source for irrigation in Pecos, Reeves and Ward Counties. Downstream in Terrell County, water in the Pecos is mostly relegated to livestock use.

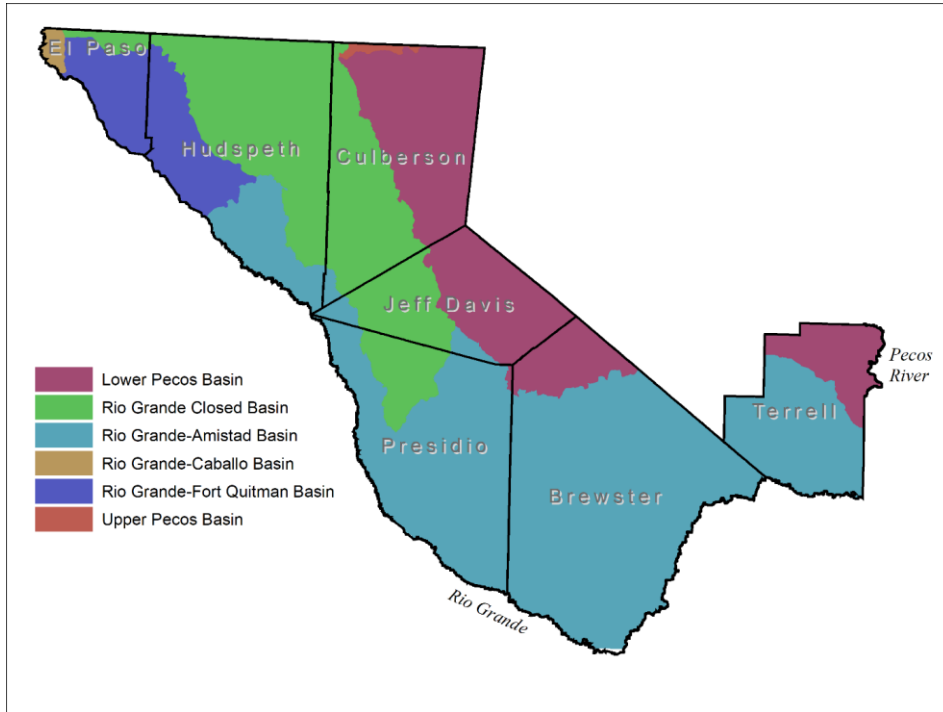


Figure 1-11. Rio Grande Drainage Basins Above Amistad Reservoir

Ecologically Unique River and Stream Segments

~~As part of the planning process, regional water planning groups may include recommendations of ecologically unique river and stream segments in their adopted regional water plans. As a part of the planning process, regional planning groups may include recommendations of ecologically unique river and stream segments in their adopted regional water plans (31 TAC 357.8), but only the Texas Legislature may designate a river or stream segment of unique ecological value based on the recommendations of a regional water planning group. The Texas Legislature may designate a river or stream segment of unique ecological value following the recommendations of a regional water planning group.~~ As per §16.051(f) of the Texas Water Code, this designation solely means that a state agency or political subdivision of the State may not finance the actual construction of a reservoir in a specific river or stream segment designated by the legislature under this subsection.

The FWTWPG chooses to respect the privacy of private lands and therefore recommends as “Ecologically Unique River and Stream Segments” (Figure 1-12) three streams that lie within the boundaries of state-managed properties, four within National Park boundaries, and specified streams managed by the Texas Nature Conservancy and the Trans Pecos Water Trust. All the streams previously designated by the FWTWPG have been adopted by the Texas Legislature. These stream and river segments are described in Chapter 8.

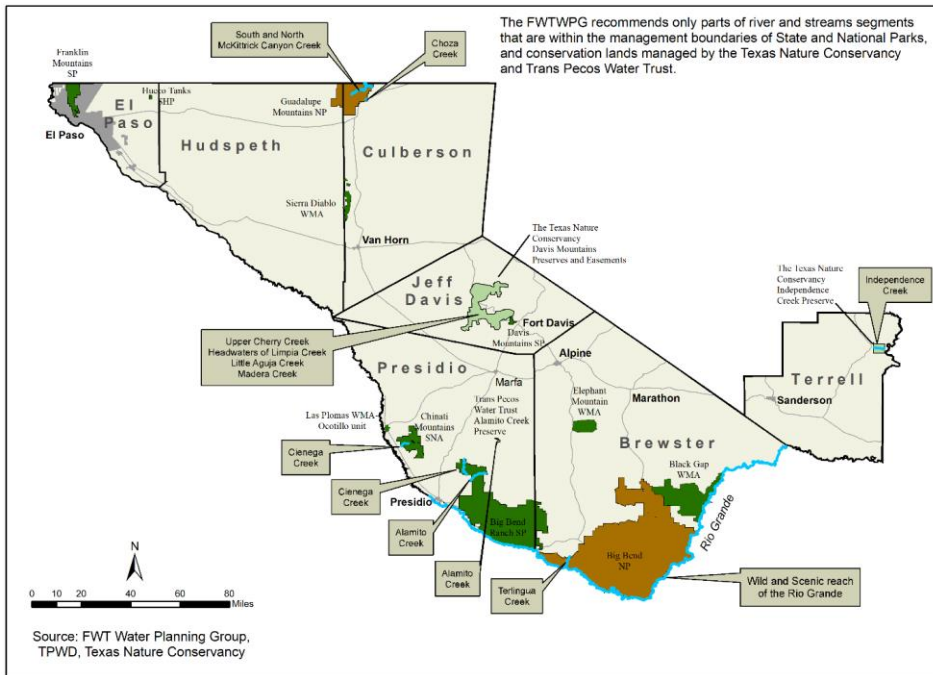


Figure 1-12. Recommended Ecologically Unique River and Stream Segments

1.5 GROUNDWATER SUPPLY SOURCES

Outside of the Rio Grande corridor, almost all water supply needs are met with groundwater withdrawn from numerous aquifers in the Region (Figure 1-13). Depth to water, well yields, and chemical quality dictate how these resources are used. A more thorough discussion of the aquifers, especially as it relates to water supply availability, can be found in Chapter 3. Aquifers recognized in the Region include the following:

- Hueco and Mesilla Bolson
- West Texas Bolsons
 - Salt Basin
 - Upper Salt Basin
 - Wild Horse and Michigan Flats
 - Lobo Flat
 - Ryan Flat
 - Presidio / Redford
 - Green River Valley
 - Red Light Draw
 - Eagle Flat
- Bone Spring-Victorio Peak
- Igneous (Davis Mountains Igneous)
- Edwards-Trinity (Plateau)
- Capitan Reef Complex
- Marathon
- Rustler
- Pecos Valley (Balmorhea Alluvium)

Other locally recognized groundwater sources:

- Rio Grande Alluvium
- Edwards-Trinity of Brewster County (Brewster Cretaceous)
- Diablo Plateau

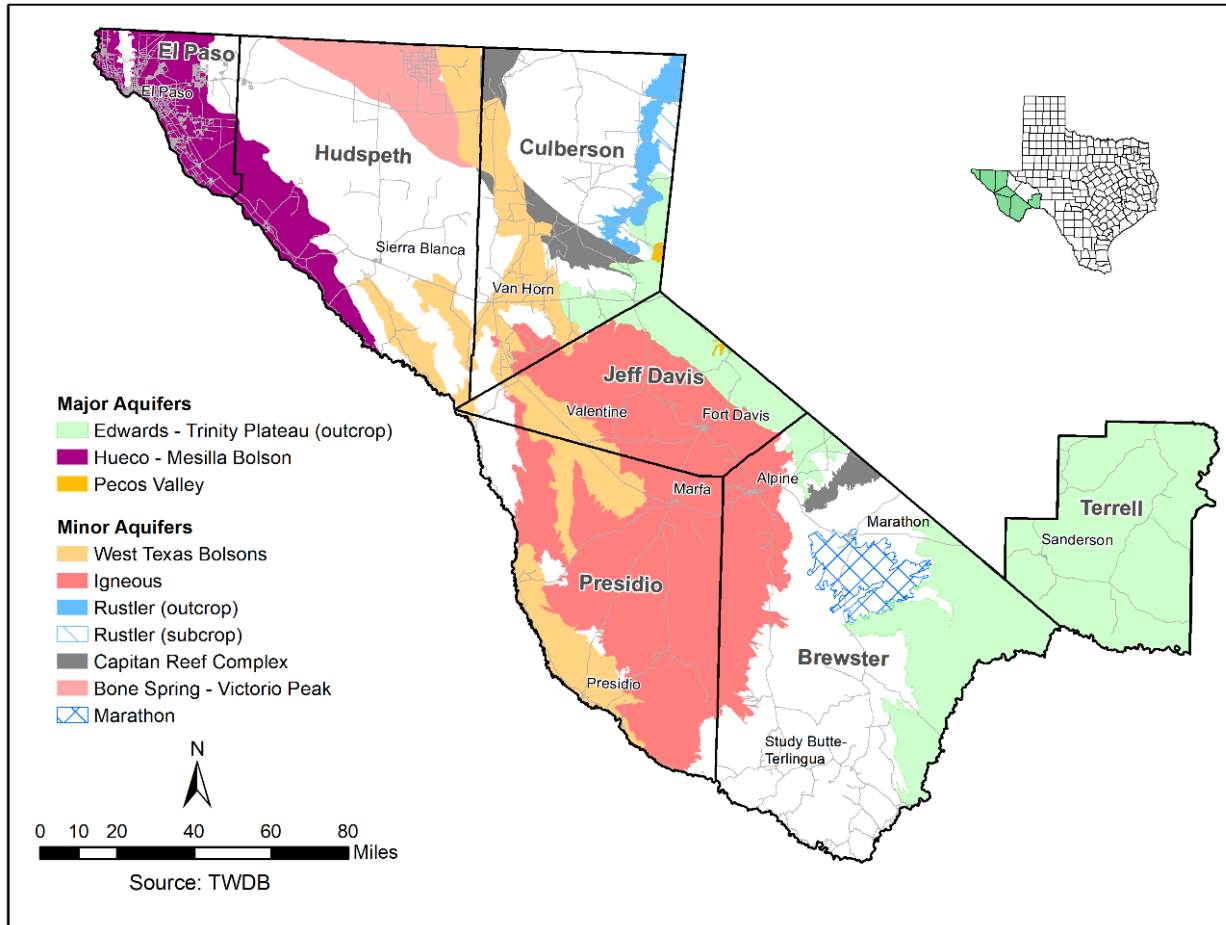


Figure 1-13. Major and Minor Aquifers of Far West Texas

Hueco and Mesilla Bolson Aquifers

The Hueco Bolson Aquifer extends from east of the Franklin Mountains in El Paso County southeastward into southern Hudspeth County, and continues a short distance north into New Mexico and south into Mexico. The Hueco Bolson along with the Mesilla Bolson Aquifer provides approximately half of the municipal supply for the City of El Paso and is the principal source of municipal supply for Ciudad Juarez, Mexico.

The Mesilla Bolson Aquifer lies in the Upper Rio Grande Valley west of the Franklin Mountains and extends to the north into New Mexico where it is primarily used for agricultural and public supply purposes. In Texas, the agricultural use of this aquifer is much less than in New Mexico. EPW's Canutillo Wellfield is located in the Mesilla Bolson.

West Texas Bolsons Aquifer

Several deep bolsons, or basins, filled with sediments eroded from the surrounding highlands underlie Far West Texas. In places, the bolsons contain significant quantities of groundwater. These bolsons are referred to as Red Light Draw, Eagle Flat, Green River Valley, Presidio-Redford, and the Salt Basin. The Salt Basin is subdivided from north to south into the Upper Salt Basin and Wild Horse, Michigan, Lobo, Ryan Flats. The bolson aquifers provide variable amounts of water for irrigation and municipal water supplies in parts of Culberson, Hudspeth, Jeff Davis and Presidio Counties. The communities of Presidio, Sierra Blanca, Valentine and Van Horn rely on the bolson aquifers for municipal water supplies.

Bone Spring-Victorio Peak Aquifer

The Bone Spring-Victorio Peak Aquifer is in northeast Hudspeth County along the eastern edge of the Diablo Plateau, west of the Guadalupe Mountains, and extends northward into the Crow Flats area of New Mexico. The aquifer is used primarily as a source of irrigation water. Dell City is the only municipality that relies on the aquifer as a source of public supply; however, the City must filter the water through a desalination process to render the water supply potable. The Hudspeth County Underground Water Conservation District #1 regulates the quantity of water withdrawn from the aquifer. The boundary of the district was recently extended to include the TWDB revised extent of the aquifer. EPW is in the process of purchasing properties overlying this aquifer as a potential future water-supply source (see EPW strategies in Chapter 5).

Commented [JJ3]: This sentence might need to be updated based on EPW's feedback on WMS.

Igneous Aquifer

The Igneous Aquifer occurs in the Davis Mountains of Jeff Davis County and extends outward into Brewster and Presidio Counties. The Cities of Alpine, Fort Davis and Marfa rely on the aquifer as a source of municipal supply.

Edwards-Trinity (Plateau) Aquifer

The Edwards-Trinity (Plateau) Aquifer underlies the Edwards Plateau east of the Pecos River and the Stockton Plateau west of the Pecos River, and provides water to all or parts of 38 Texas counties. The aquifer extends from the Hill Country of Central Texas to the Trans-Pecos region of Far West Texas, where it is a source of water in Brewster, Culberson, Jeff Davis and Terrell Counties. There is relatively little pumpage from the aquifer over most of its extent in Far West Texas, with the City of Sanderson in

Terrell County being the only municipality in the Region that pumps water from the State-designated portion of this aquifer.

Capitan Reef Aquifer

The Capitan Reef Aquifer is contained within a relatively narrow strip of limestone formations (10 to 14 miles wide) that formed along the shelf edge of the ancestral Permian Sea. In Texas, the reef formations are exposed in the Guadalupe, Apache, and Glass Mountains and trend northward into New Mexico, where the aquifer is a source of abundant fresh water for the City of Carlsbad. Within Far West Texas, the aquifer underlies sections of Culberson County and a small area of northern Brewster County. EPW owns approximately 29,000 acres overlying the Capitan Reef aquifer in northwestern Culberson County and may tap this aquifer for future needs (see EPW strategies in Chapter 5).

Commented [JJ4]: This sentence may need to be updated based on the outcome of updating EPW WMSs with Scott.

Marathon Aquifer

The Marathon Aquifer is located entirely within north-central Brewster County and is used primarily as a municipal water supply by the Community of Marathon and for rural domestic and livestock purposes.

Rustler Aquifer

The Rustler Formation is exposed in eastern Culberson County and plunges eastward into the subsurface of adjacent counties. The aquifer is principally located beneath Loving, Pecos, Reeves and Ward Counties, where it yields water for irrigation, livestock and water-flooding operations in oil-producing areas. No communities in Far West Texas rely on this aquifer as large concentrations of dissolved solids render the water unsuitable for human consumption.

Pecos Valley (Balmorhea Alluvium) Aquifer

The Pecos Valley Aquifer, locally referred to as the Balmorhea Alluvium Aquifer, is located in a small area along the Jeff Davis and Reeves county line and is composed of a relatively shallow layer of gravel that overlies Cretaceous limestone. The Balmorhea Alluvium Aquifer is recognized in this *Plan* due to its use as a municipal supply source for the City of Balmorhea and the Madera Valley WSC, both located in Reeves County in the adjacent Region F [water planning area](#).

Other Groundwater Resources

Also shown in Figure 1-13 are large areas of Far West Texas that are not underlain by designated major or minor aquifers. The map, however, should not be interpreted as an indication that such areas are devoid of groundwater, but rather as a reflection of the current level of understanding of the extent of known groundwater resources in the Region.

Rio Grande Alluvium Aquifer

The Rio Grande Alluvium Aquifer consists of Quaternary floodplain sediments laid down by the Rio Grande as the river cut into the surface of the Hueco Bolson. The floodplain forms a narrow valley within the topographically lowest part of the Hueco Bolson and extends nearly 90 miles from El Paso to Fort Quitman, where the valley is constricted between the Sierra de la Cienguilla of Chihuahua and the Quitman Mountains of Hudspeth County. The aquifer is hydrologically connected with the underlying

Hueco Bolson and is occasionally a source of irrigation water for farms in El Paso and Hudspeth Counties.

Edwards-Trinity (Plateau) Aquifer of Brewster County

In southern Brewster County, the communities of Lajitas, Study Butte, and Terlingua, as well as much of Big Bend National Park, withdraw their municipal supplies from Cretaceous limestone aquifers that are equivalent to the Edwards-Trinity (Plateau) Aquifer. Further evaluation is needed to arrive at a better understanding of the water resource development potential in these areas.

Diablo Plateau Aquifer

Thick limestone beds that make up the subsurface of the Diablo Plateau of central and northern Hudspeth County (west of Dell City) may have significant volumes of groundwater in storage. Although relatively few exploration wells have been drilled on the Plateau, the aquifer likely contains sufficient water to be considered as a potential source of groundwater.

1.6 MAJOR SPRINGS

Springs and seeps are found in all seven of the Far West Texas counties and have played an important role in the development of the Region. Springs were important sources of water for Native Americans as indicated by the artifacts and petroglyphs found near many of the springs. In the 18th and 19th centuries, locations of transportation routes including supply and stagecoach lines, railroads, military outposts, and early settlements and ranches were largely determined by the occurrence of springs that issued from locations in the mountains and along mountain fronts. Figure 1-14 shows the regional distribution of documented springs in the Region that are currently in existence or are of historical significance.

Springs contribute to the esthetic and recreational value of private land and parkland in Far West Texas, especially in the Big Bend area where thermal springs discharge along the banks of the Rio Grande. Springs are significant sources of water for both aquatic and terrestrial wildlife as they form small wetlands that attract migratory birds and other fowl that inhabit the Region throughout the year. As documented by the Texas Parks and Wildlife Department, springs also provide habitat for threatened and endangered species of fish (such as the Pecos and the Big Bend Gambusia).

The FWTWPG recognizes the importance of all springs in this desert community for their contribution as a water supply source and as natural habitat. However, the FWTWPG chooses to respect the privacy of private lands and therefore specifically identifies the following “Major Springs” occurring only on State, Federal, or privately owned conservation managed lands (Figure 1-15). Many of these springs also are the primary source of flow to the “ecologically unique river and stream segments” described in Chapter 8. Descriptions of these springs are provided in Appendix 1A of this *Plan*.

La Baviza Spring, Chinati Mountains State Natural Area – Presidio County

Big Bend National Park / Rio Grande Wild and Scenic River Springs – Brewster County

- Gambusia Hot Springs Complex
- Outlaw Flats Spring Complex
- Las Palmas Spring Complex
- Madison Fold Spring Complex

Guadalupe Mountains National Park – Culberson County

- Bone Spring
- Dog Canyon Spring
- Frijole Spring
- Goat Seep
- Guadalupe Spring
- Juniper Spring
- Manzanita Spring

- Smith Spring
- Upper Pine Spring

Texas Nature Conservancy – Independence Creek Preserve – Terrell County

- Caroline Spring

Texas Nature Conservancy – Davis Mountains Preserve – Jeff Davis County

- Tobe Spring
- Bridge Spring
- Pine Spring
- Limpia Spring

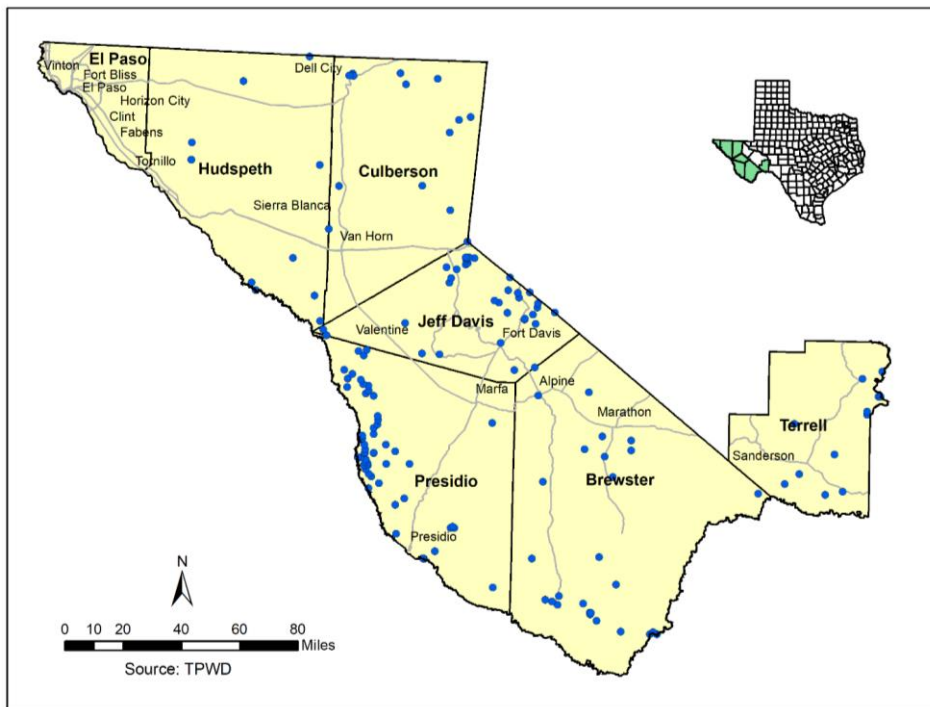


Figure 1-14. Location of Documented Springs

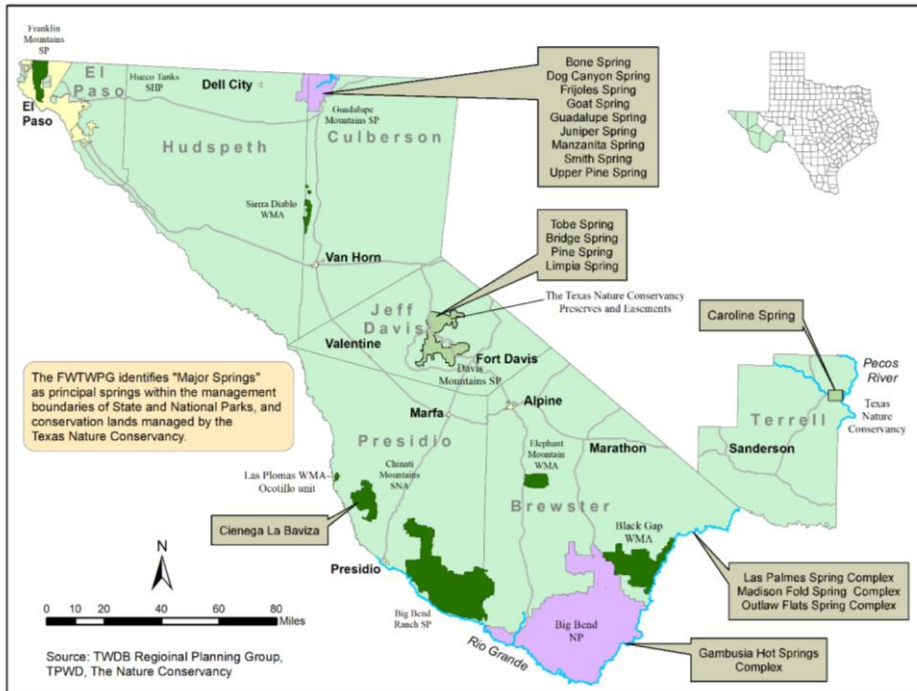


Figure 1-15. Location of Identified Major Springs

1.7 REUSE

El Paso water has nearly 40 miles of reclaimed-water (purple) pipelines throughout all areas of the City. Reclaimed (non-potable) water serves the landscape irrigation demand of golf courses, parks, schools, and cemeteries, and provides water supplies for steam-electric plants and industries within the City. EPW does not plan on extending or growing the purple pipe infrastructure but will focus on maintaining existing purple pipe customers and work towards increasing the use of reclaimed water through additional purified water projects. EPW also develops direct reuse supplies through its advanced water purification process producing potable public supply water. The City of Alpine in Brewster County is also reusing treated wastewater to irrigate city-owned park land.

Indirect reuse of treated non-potable municipal wastewater discharged into the Rio Grande occurs in El Paso and Hudspeth Counties where it is reapplied for irrigation use by the El Paso County Water Improvement District No.1 and the Hudspeth County Conservation and Reclamation District No.1.

1.8 IDENTIFIED WATER QUALITY PROBLEMS

Water quality plays an important role in determining the availability of water supplies to meet current and future water needs in the Region. The quality of groundwater and surface water is evaluated to help determine the suitability of each source for use and the potential impacts on these sources that might result from the implementation of recommended water management strategies.

Water Quality Issues

Groundwater quality issues in the Region are generally related to naturally high concentrations of total dissolved solids (TDS) or to the occurrence of elevated concentrations of individual dissolved constituents. High concentrations of TDS are primarily the result of the lack of sufficient recharge and restricted circulation. Together, these retard the flushing action of fresh water moving through the aquifers. Some aquifers, however, have a low TDS but may contain individual constituent levels that exceed safe drinking water standards. For example, some wells in the Davis Mountains Igneous Aquifer have exceptionally low TDS but contain unsatisfactory levels of fluoride. Also, freshwater wells in the Study Butte-Terlingua- Lajitas area have elevated levels of radioactivity.

Groundwater quality changes are often the result of human activities. In agricultural areas, aquifers such as the Bone Spring-Victorio Peak have increased in TDS. Irrigation water applied on the fields percolates back to the aquifer carrying salts leached from the soil. Beneath El Paso and Ciudad Juarez, the average concentration of dissolved solids in the Hueco Bolson Aquifer has increased as the fresher water in the aquifer is being consumed. Although local instances of groundwater quality degradation have occurred in the Region, there are no major trends that suggest a widespread water quality problem due to the downward percolation of surface contaminants.

~~Arsenic is a costly problem in El Paso County. Municipal utilities have been required to upgrade their treatment facilities in the last 20 years to meet the arsenic maximum contaminant level of 10 ppd. Arsenic is a costly problem in El Paso County. With the lowering of the maximum contaminant level to 10 ppd, municipal utilities have been required to upgrade their treatment facilities to meet the new standard.~~

The Rio Grande and the Pecos River are the principal surface water sources in Far West Texas. Unlike groundwater, surface water quality can vary significantly depending on the amount of flow in the streambed and the rate and source of runoff from adjacent lands. Salinity is an issue associated with the Rio Grande, especially during drought conditions. River flows arriving at El Paso contain a substantial salinity contribution from irrigation return flow and municipal wastewater return in New Mexico. Under current conditions, approximately 25 percent of the applied irrigation water is needed to move through the project in El Paso County to keep the salt loading at reasonable and manageable levels given average surface flow rates. Studies have shown that salinities in the Rio Grande can increase to over 1,000 mg/l during May and September, depending on actual irrigation demands and releases from reservoirs. Prolonged low flow increase salt storage in riverbanks and riparian zones, which can then be flushed out during high flows.

Downstream from El Paso, most of the flow consists of irrigation return flow and small amounts of treated and untreated municipal wastewater. Heavy metals and pesticides have been identified along this segment of the Rio Grande. Flow is intermittent downstream to Presidio, where the Rio Conchos augments flow. Fresh water springs contribute to the Rio Grande flow in the Big Bend and enhance the overall quality of the River through this reach.

The Pecos River is not a source of drinking water for communities in Far West Texas; however, it is the most prominent tributary to the Rio Grande on the Texas side of the River above Amistad Reservoir. Per IBWC data, the Pecos River contributes an average of 11 percent of the annual stream flow in the Rio Grande above the Reservoir and ~~29~~ 29.5 percent of the annual salt load. Independence Creek’s contribution in Terrell County increases the Pecos River water volume by ~~42~~ about 50 percent at the confluence ~~with consistently fresh water, and significantly reduces the total suspended solids,~~ thus improving both water quantity and quality (Basnet et al., 2023).

Commented [JJ5]: Need to add the following reference to a footnote: Basnet, Nabin et al: *TRI301 Pecos River Water Quality Data Analysis and Dissolved Oxygen Modeling*, prepared for Texas State Soil and Water Conservation Board, Texas Institute for Applied Environmental Research, Tarleton State University, Stephenville, TX, December 2023.

Supply Source Protection

According to the 1996 Safe Drinking Water Act Amendments, the Texas Commission on Environmental Quality (TCEQ) is required to assess every public drinking water source for susceptibility to certain chemical constituents. The Source Water Protection Program is a voluntary program designed to help public water systems identify and implement measures that will protect their sources of water from potential contamination. Assessment reports are provided to the public water systems and are often used to implement local source water protection projects. Table 1-8 lists Far West Texas public water systems that have historically been ~~currently~~ involved in the TCEQ’s Source Water Protection Program. Public water systems that are interested in learning about the Source Water Protection Program, can access more detailed information here: <https://www.tceq.texas.gov/drinkingwater/SWAP>.

Table 1-1.8. Far West Texas Source Water Protection Participants

Utility Name	County	Report Date
Castolon Paint Area BBNP	Brewster	5/30/2000
Panther Junction PLT	Brewster	7/30/2000
Rio Grande Village BBNP	Brewster	5/31/2000
Big Bend National Park Chisos Basin Water	Brewster	5/31/2000
City of Van Horn	Culberson	7/31/1994
El Paso Water Utilities Public Service Board	El Paso	5/31/1990
El Paso County WCID 4 Fabens	El Paso	7/31/1999
El Paso County Tornillo WID	El Paso	7/31/1999
Fort Bliss Main Post Area	El Paso	7/31/1990
Dell City	Hudspeth	7/31/1994
Fort Davis WSC	Jeff Davis	7/31/1994
City of Marfa	Presidio	1/31/1995

Water Supply Source Vulnerability

Following the events of September 11th 2001, Congress passed the Bio-Terrorism Preparedness and Response Act. Drinking water utilities serving more than 3,300 people were required and have completed vulnerability preparedness assessments and response plans for their water, wastewater, and stormwater facilities. The U.S. Environmental Protection Agency (EPA) funded the development of three voluntary guidance documents, which provide practical advice on improving security in new and existing facilities of all sizes. The documents include:

- *Interim Voluntary Security Guidance for Water Utilities* www.awwa.org
- *Interim Voluntary Security Guidance for Wastewater/Stormwater Utilities* www.wef.org

- *Interim Voluntary Guidelines for Designing an Online Contaminant Monitoring System*
www.asce.org

1.9 WATER LOSS AUDITS

In 2003, the 78th Texas Legislature, Regular Session, enacted House Bill 3338 to help conserve the State’s water resources by reducing water loss occurring in the systems of drinking water utilities. This statute requires that retail public utilities providing water within Texas file a standardized water audit once every five years with the Texas Water Development Board (TWDB). In response to the mandates of House Bill 3338, TWDB developed a water audit methodology for utilities that measures efficiency, encourages water accountability, quantifies water losses, and standardizes water loss reporting across the State. This standardized approach to auditing water loss provides utilities with a reliable means to analyze their water loss performance. By reducing water loss, utilities can increase their efficiency, improve their financial status, minimize their need for additional water resources, and assist long-term water sustainability.

Any retail water supplier that has a system with more than 3,300 connections or an active financial obligation with the TWDB ~~is~~ are required to submit a water loss audit annually. ~~Additionally, retail water suppliers with more than 3,300 connections are now required to submit an audit annually. In addition, All other retail public water suppliers are required to submit a water loss audit once every five years. The next five year required submittal is due by May 1, 2026 for the 2025 audit year. It is strongly encouraged that all retail public water suppliers complete an audit annually to better track water loss and identify issues that need immediate addressing.~~

Utilizing a methodology derived from the American Water Works Association (AWWA) and the International Water Association (IWA), the TWDB has published a manual that outlines the process of completing a water loss audit: “Water Loss Audit Manual for Texas Utilities” – TWDB Report 367 (2008), which can be viewed at http://www.twdb.texas.gov/publications/brochures/conservation/doc/WaterLossManual_2008.pdf.

~~Table 1-2~~ Table 1-9 provides a listing of reported utility audits performed in Far West Texas that reported a loss of more than 10 percent (note: No utilities reported more than a 10 percent loss in 2017). The link provided below accesses a more detailed water loss audit report maintained by the TWDB (<http://www.twdb.texas.gov/conservation/municipal/waterloss/index.asp>).

Commented [JJ6]: Waiting for Heather Rose and Daniel Rice to provide guidance based on new methodology.

Table 1-29. Far West Texas 2015-2016 Public Water System Real Water Loss Report for Utilities with Greater than a 10 Percent Loss (gallons per year)

PWS Name	Report Year	Reported Breaks Leaks	Unreported Loss	Total Real Losses	Cost of Real Losses (\$)	Total Loss Percent
City of Presidio	2015	5,000,000	26,854,879	31,854,879	31,855	21.5
East Montana Water System	2016	2,385,000	48,009,515	50394515	349,688	19.2
Haciendas Del Norte WID	2015	5,000,000	3,689,434	8,689,434	14,772	20.5
Horizon Regional MUD	2015	0	224,268,829	224,268,829	201,842	14.9
Lajitas On The Rio Grande	2016	0	31,774,172	31,774,172	63,548	60.3
Marathon WSC	2016	150,000	6,140,301	6,290,301	1,635	27.7
Study Butte Terlingua Water System	2015	1,370,000	8,797,639	10,167,639	17,285	51.3

Commented [JJ7]: American Water Works Association (AWWA) recommends entities with more than 10% water loss take corrective action.

1.10 COLONIAS

Far West Texas Colonias

Colonias represent a special and growing subset of municipal water demand in the Region and present a challenge to water suppliers. While some colonias in the Region are centuries-old historic settlements, most are substandard subdivisions in unincorporated areas located along the United States/Mexico international border that have been illegally subdivided into small parcels characterized by a lack of basic services. These small parcels do not have a drinking water supply, wastewater services, paved roads, or proper drainage, and are typically sold to individuals of modest means who may be unaware of the negative consequences of purchasing illegally subdivided property. Public health problems are often associated with these colonias.

The office of the Attorney General of Texas [created and maintains an extensive Colonia Geographic Database, which](https://www.texasattorneygeneral.gov/divisions/colonias) recognizes 312 subdivisions that qualify as colonias in the counties that make up the Far West Texas region (Table 1-~~310~~). Of these 312 colonias, 292 are concentrated in El Paso County (<https://www.texasattorneygeneral.gov/divisions/colonias>).

Table 1-~~310~~. Far West Texas Colonias

Brewster County	Culberson County	El Paso County	Hudspeth County	Jeff Davis County	Presidio County	Terrell County
Marathon	Ranch Estates	292 Individual Colonias	Acala	Valentine	Candelaria	Dryden
Study Butte	Van Horn		Sierra Blanca		Pueblo Nuevo	Sanderson
Terlingua			Fort Hancock East		Shafter	
			Villa Alegre		Las Pamps	
			Loma Linda Estates		Redford	
					Loma Pelona	
					Ruidosa	

TWDB Economically Distressed Area Program

The Economically Distressed Area Program (EDAP) was created by the Texas Legislature in 1989 and is administered by the TWDB. The intent of the program is to provide local governments with financial assistance for bringing water supply and wastewater services to the colonias. An economically distressed area is defined as one in which water supply or wastewater systems are not adequate to meet minimal State standards, financial resources are inadequate to provide services to meet those needs, and there was an established residential subdivision on June 1, 2005. Affected areas are counties adjacent to the Texas/Mexico border, or that have per capita income 25 percent below the State median and unemployment rates 25 percent above the State average for the most recent three consecutive years for which statistics are available. Additional information pertaining to eligibility and requirements for this program are available on the TWDB website <http://www.twdb.texas.gov/financial/programs/EDAP/index.asp>.

In 2019, the 86th Texas Legislature made changes to the program with the passage of Senate Bill 2452, which directed the TWDB to develop a system for prioritizing EDAP projects and consider projects that will have a “substantial effect.” This includes projects serving areas determined to have a nuisance dangerous to public health and safety resulting from water supply and sanitation problems and projects for applicants subject to an enforcement action related to water supply or sewer service violations. EDAP projects in Far West Texas are in Brewster, El Paso, Hudspeth, ~~Presidio~~ and Terrell Counties and are described in ~~Table 1-44~~ Table 1-11. There is a total of two active projects and 22 completed projects within the Region.

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Data pertaining to all EDAP projects in the State can be found within the SFY 2023 EDAP Annual Report, which can be accessed through the TWDB website <http://www.twdb.texas.gov/publications/reports/edap-reports/doc/Status.pdf> <https://www.twdb.texas.gov/financial/programs/EDAP/index.asp>.

Table 1-411. Economically Distressed Area Program Projects (~~February 28, 2019~~ August 31, 2023)

County	Sponsor	Project	EDAP Funding (\$)	Other TWDB Funding (\$)	Status
Brewster	City of Alpine	Collection Systems Improvements	277,973.68		Completed
El Paso	City of El Paso	Canutillo Project	7,432,879.60		Completed
	City of El Paso	Colonia Assistance & Management Support	213,250.00		Completed
	City of El Paso	East Montana Water System (Phase 0)	441,941.88		Completed
	City of El Paso	Westway II	5,459,674.06	102,500.00	Completed
	City of El Paso	Westway Water Supply	1,437,540.80		Completed
	El Paso County	Colonia Plumbing Fixtures	1,368,392.29		Completed
	El Paso County	East Montana Water (Phase 2 & 3)	10,653,496.39	150,000.00	Completed
	El Paso County	Tornillo Wastewater System	13,157,652.21		Completed
	El Paso Water	Canutillo Area Water & Wastewater	412,730.00		Completed
	El Paso Water	Montana Vista Wastewater System	44,633,112.00		Active
	El Paso Water	Canutillo Norma & Georgia	90,000.00		Completed
	El Paso Water	Turf Estates Water Line	895,919.70		Completed
	Homestead MUD #1	East Montana Water System (Phase 1)	6,321,453.00	1,700,000.00	Completed
	Lower Valley Water District	Cultural Resource Management - Socorro	1,200.00		Completed
	Lower Valley Water District	Las Azaleas Planning	50,000.00		Completed
	Lower Valley Water District	LVWD Phase I - Bauman Water Project	1,800,608.00		Completed
	Lower Valley Water District	LVWD Phase II - Socorro	17,793,361.00	3,857,000.00	Completed
	Lower Valley Water District	LVWD Phase III - San Elizario	44,726,710.66	8,245,000.00	Completed
	Vinton	Water & Wastewater Planning	39,100.00		Completed
	Hudspeth	Fort Hancock WCID	Water Well & RO Treatment Facility	3,012,989.88	
Hudspeth County WCID #1		Sierra Blanca Wastewater System	2,146,966.16		Completed
Presidio	Presidio County	Presidio County Water & Wastewater Improvements	4,600,000.00		Active
Terrell	Terrell County WCID #1	Sanderson Wastewater System	4,232,175.00		Completed

County	Sponsor	Project	Cost	Status
Brewster	City of Alpine	Collection System Improvements	\$290,000	Completed
El Paso	City of El Paso	Canutillo Project	\$7,432,879	Completed Facility Planning and Construction
El Paso	City of El Paso	Westway Water Supply	\$1,437,540	Completed Facility Planning and Construction
El Paso	City of El Paso	Montana Vista Wastewater Planning	\$15,703,016	Active Planning
El Paso	El Paso County	East Montana Water System (Phase 1)	\$6,321,453*	Completed Construction
El Paso	El Paso County	East Montana Water System (Phase 2&3)	\$10,653,496*	Completed Construction
El Paso	El Paso County	Turf Estates Water Line	\$895,919	Completed Facility Planning and Construction
El Paso	El Paso County	Canutillo Area Water & Wastewater	\$412,730	Completed PAD
El Paso	El Paso County	Canutillo Water (Norma & Georgia)	\$90,000	Completed PAD
El Paso	El Paso County	Colonia Plumbing Fixtures	\$1,368,392	Completed Construction
El Paso	El Paso County	Colonia Assistance & Management Support	\$213,250	Completed Facility Planning
El Paso	El Paso WCID	Westway II	\$5,459,674*	Completed Construction
El Paso	Lower Valley Water District	Phase 1 – Bauman Water Project	\$1,800,608	Completed Construction
El Paso	Lower Valley Water District	Phase 2 – Socorro	\$17,793,361*	Completed Facility Planning and Construction
El Paso	Lower Valley Water District	Phase 3 – San Elizario	\$88,947,685*	Completed Facility Planning and Construction
El Paso	Lower Valley Water District	Las Azuleas Planning	\$50,000	Completed Facility Plan
El Paso	Lower Valley Water District	Cultural Resource Management – Socorro	\$1,200	Completed Construction
El Paso	Vinton	Water & Wastewater Planning	\$39,100	Completed Facility Planning
El Paso	El Paso County Tornillo WID	Tornillo Wastewater System	\$13,157,652	Completed Facility Planning and Construction
Hudspeth	Hudspeth County WCID #1	Sierra Blanca Wastewater System	\$2,146,966	Completed PAD and Construction
Hudspeth	El Hancoek WCID	Water Well and RO Treatment Facility	\$3,012,989	Completed Construction
Terrell	Terrell County WCID #1	Sanderson Wastewater System	\$4,232,175	Completed Facility Planning and Construction

*Cost * – Projects also receiving other TWDB funds.*

El Paso County Colonias

Over the past two decades, EPW has served as a program manager to assist outlying water districts in applying for funding, master planning, design, and construction management. As regional water planner for El Paso County, EPW continues to work with various water districts and colonia residents to consolidate efforts in securing adequate water supplies and to capitalize on economies of scale. Efforts to provide water service to outlying areas have resulted in approximately 97 percent of the population within El Paso County having access to clean potable water.

Projects shown in ~~Table 1-4~~ [Table 1-11](#) are in different stages of consideration. Funding has, and continues to be, the greatest challenge in moving forward with these projects. Given the limited number of residents (connections) and the large construction costs associated with each project, there are many areas where it is simply not feasible to construct needed facilities until either an increased number of connections are made and/or most importantly, increased amounts of State and Federal grant funding are available. In certain areas, it may be feasible to consider small onsite treatment systems, such as wellhead reverse osmosis systems. Such systems could be less expensive and allow for residents to obtain water until a more direct municipal supply is available. EPW continues to take the lead in identifying funding and in managing the projects within and/or on behalf of El Paso County. Title 30, Texas Administrative Code, Chapter 285 and the Texas Health and Safety Code, Chapter 366, §366.032 requires residents in rural areas of the county who do not have piped sewer infrastructure to comply with septic tank installation standards and receive a certificate of compliance prior to receiving water, gas, and electric utility service. Known as the On-Site Septic Facility (OSSF) program, this program is intended to prevent unhealthy conditions and protect underground water and is enforced by the El Paso City/County Health and Environmental District.

1.11 INTERNATIONAL WATER ISSUES

Ciudad Juarez

Ciudad Juarez is located across the Rio Grande from the City of El Paso and currently is 100 percent dependent on the Hueco Bolson and Conejos Medanos Aquifers to satisfy all its municipal and industrial demands. Pumping from the Hueco by Ciudad Juarez since 2000 is summarized in ~~Table 1-5~~, ~~Table 1-12~~.

~~Table 1-5~~ **Table 1-12. Ciudad Juarez Hueco Groundwater Pumping (Acre-Feet/Year)**

Year	Groundwater Pumping
2000	126,172
2001	124,735
2002	124,676
2003	125,144
2004	119,234
2005	122,315
2006	126,655
2007	129,193
2008	132,889
2009	130,735
2010	131,055
2011	119,137
2012	117,709
2013	122,596
2014	128,823
2015	132,899
2016	135,844
2017	137,286
2018	141,896

Commented [JJ8]: Sent an email to Scott asking for data from 2019-2023.

Pumping continues to increase each year in response to the population rise. However, water conservation efforts in Ciudad Juarez have somewhat offset increased population and service connections. With a growing population that is currently estimated to be over 1.5 million, Ciudad Juarez recognizes the limitations of the Hueco Bolson to supply future demands. Future supplies are anticipated from the following “imported” groundwater sources:

- Bismark Mine (26,000 acre-feet/year)
- Mesilla (26,000 acre-feet/year)
- Somero (28,000 acre-feet/year)
- Profundo (31,000 acre-feet/year)

In addition, plans are also being developed to convert 38,000 acre-feet/year of surface water from the Rio Grande (Rio Bravo) for use as municipal supply. Currently, Mexico’s allocation from the Rio Grande Project of 60,000 acre-feet/year is used for irrigated agriculture. The conversion would involve supplying wastewater effluent to farmers in exchange for surface water.

City of El Paso

The City of El Paso, through their water utility, El Paso Water, manages groundwater from the Hueco and Mesilla Bolson Aquifers as a drought supply. When surface water is not available (typically the winter and spring months) the Hueco Bolson Aquifer specifically is heavily pumped, becoming a major source of water for the east side of El Paso. However, when surface water is available, pumping from the Hueco decreases.

EPW has consistently decreased its groundwater dependence on the Hueco Bolson with its increased use of surface water (Rio Grande), reclaimed water, and water conservation. However, during periods of severe river drought, groundwater pumpage from the Hueco Bolson including the KBH desalination plant will be increased dramatically to offset the limited river supply.

In 2013, surface water availability was only 10,000 acre-feet (from the Rio Grande) due to severe drought conditions. As a result, the Hueco production was maximized. Although drought conditions have improved, surface water is limited, causing the Hueco Bolson Aquifer, along with the Mesilla Bolson Aquifer, to remain a critical groundwater supply source.

Transboundary Effects of Groundwater Pumpage

Prior to 1960, up to 5,000 acre-feet/year of groundwater flowed underground from Mexico to Texas as a result of higher pumping in El Paso than in Ciudad Juarez. However, since 1960, groundwater has generally flowed from Texas into Mexico due to increases in Ciudad Juarez pumping. The rate of flow has been about 33,000 acre-feet/year over the last decade. With continuous pumping from both Ciudad Juarez and El Paso, both cities have experienced extensive water level drawdowns and water quality degradation due to lateral brackish water intrusion into the freshwater zones. Brackish water intrusion from irrigation return flow drains continues to expand laterally and vertically, and to degrade water quality in the shallow alluvium along the Rio Grande.

Transboundary Aquifer Assessment Program

The Transboundary Aquifer Assessment Program (TAAP) is a joint effort between Mexico and the United States to evaluate shared priority aquifers is the product of US Public Law 109-448 (United States-Mexico Transboundary Aquifer Assessment Act of 2006). Parties involved included the International Boundary and Water Commission (IBWC/CILA), the Mexican National Water Commission (CONAGUA), the US Geological Survey (USGS), New Mexico State University and the Universities of Sonora, Texas, and Arizona. Project and research management in the Far West Texas region is conducted by Texas A&M AgriLife of El Paso.

The overall goal of the Program includes:

- Develop binational information and shared databases on groundwater quantity and quality;
- Identify and delineate transboundary aquifers of importance;
- Develop binational criteria for determination of priority transboundary aquifers;
- Assess the extent, availability, and movement of water in transboundary aquifers and the interaction with surface water;
- Develop and improve groundwater-flow information for binational aquifers to facilitate water-resource assessment and planning;
- Analyze trends in groundwater quality, including salinity and nutrients;

- Apply new data, models, and information to evaluate strategies to protect water quality and enhance supplies; and
- Provide useful information to decision makers, including assessments of groundwater management institutions and policies.

Fifteen transboundary aquifers have been identified between Mexico and Texas, though the mechanisms for hydrogeologic connection across the international boundary are known only for five. The transboundary groundwater resources shared by the two countries are largely uncharacterized due to lack of data, differences in aquifer boundary delineations and methodologies, and the limited cooperation and coordination among Federal, State, and local agencies within and between these countries to address groundwater issues from a binational perspective.

Four identified transboundary aquifers are categorized as priority aquifers: Hueco Bolson/Valle de Juarez, Mesilla/Conejos- Medanos, Santa Cruz, and San Pedro. In the general area of Far West Texas, the region of the bolsons (aquifers located southeast of the Conejos-Medanos/Mesilla Bolson, Valle de Juarez/Hueco-Tularosa Bolson Aquifer in northern Chihuahua, in southern New Mexico and western Texas) appear to be the most important areas for transboundary aquifer development.

Overall, the hydrogeological units along the Texas-Mexico border cover around 182,000 km² (approximately 110,000 km² on the Texas side and 72,000 km² on the Mexico side) (Sanchez et al. 2018). The total area considered to have good aquifer potential (defined as the favorable lithological properties that allow sustained and significant rates of pumpage) as well as good water quality ranges between 50 percent and 60 percent (60 percent of this in Texas). Some 20 to 25 percent of the hydrogeological units that cross the border area are considered to have poor aquifer potential and poor water quality, with the proportion of land being approximately equal on both sides of the border.

1.12 STATE AND FEDERAL AGENCIES WITH WATER RESPONSIBILITIES

1.12.1 Texas Water Development Board (TWDB)

The TWDB (<http://www.twdb.texas.gov/>), especially the Water Resources Planning and Information Division, is at the center of the Senate Bill 1 regional water planning effort. The agency has been given the responsibility of directing the effort to ensure consistency and to guarantee that all regions of the State submit plans in a timely manner. Results of the 16 regional water plans are then incorporated by the TWDB into a State Water Plan. The TWDB also administers financial grant and loan programs that provide funding for water research and facility planning projects.

1.12.2 Texas Commission on Environmental Quality (TCEQ)

The TCEQ (<http://www.tceq.texas.gov/>) strives to protect the State's natural resources, consistent with a policy of sustainable economic development. TCEQ's goal is clean air, clean water, and the safe management of waste, with an emphasis on pollution prevention. The TCEQ is the major State agency with regulatory authority over State waters in Texas. The TCEQ is also responsible for ensuring that all public drinking water systems are in compliance with the strict requirements of the State of Texas.

1.12.3 Texas Parks and Wildlife Department (TPWD)

The TPWD (<http://www.tpwd.state.tx.us/>) mission is to manage and conserve the natural and cultural resources of Texas and to provide hunting, fishing and outdoor recreation opportunities for the use and enjoyment of present and future generations. The agency currently has six program divisions: Wildlife, Coastal Fisheries, Inland Fisheries, Law Enforcement, State Parks, and Infrastructure.

1.12.4 Texas Department of Agriculture (TDA)

The TDA (<http://www.texasagriculture.gov/Home.aspx>) was established by the Texas Legislature in 1907. The TDA has marketing and regulatory responsibilities and administers more than 50 separate laws. The current duties of the department include: (1) promoting agricultural products locally, nationally, and internationally; (2) assisting in the development of the agribusiness in Texas; (3) regulating the sale, use and disposal of pesticides and herbicides; (4) controlling destructive plant pests and diseases; and (5) ensuring the accuracy of all weighing or measuring devices used in commercial transactions. The department also collects and reports statistics on all activities related to the agricultural industry in Texas.

1.12.5 Texas State Soil and Water Conservation Board (TSSWCB)

The TSSWCB (<http://www.tsswcb.texas.gov/>) is charged with the overall responsibility for administering the coordination of the State's soil and water conservation program with the State's soil and water conservation districts. The agency is responsible for planning, implementing, and managing programs and practices for abating agricultural and forest nonpoint source pollution. Currently, the agricultural/forest nonpoint source management program includes problem assessment, management program development and implementation, monitoring, education, and coordination.

1.12.6 International Boundary and Water Commission (IBWC) and Comisión Internacional de Límites y Aguas (CILA)

The IBWC (<http://ibwc.state.gov/>) and CILA provide binational solutions to issues that arise during the application of United States – Mexico treaties regarding boundary demarcation, national ownership of waters, sanitation, water quality, and flood control in the border region; the treaties are discussed in Chapter 3.

1.12.7 United States Bureau of Reclamation (USBR)

The stretch of the Rio Grande from Elephant Butte Dam (approximately 100 miles north of El Paso) to Fort Quitman, Texas, is within a Federal reclamation project known as the Rio Grande Project. The Bureau of Reclamation (<http://www.usbr.gov/>) manages the Elephant Butte Dam and the Caballo Reservoir in New Mexico, and determines the amount and timing of all water releases to Texas, with the input of the El Paso County Water Improvement District #1. The Bureau is guided by the terms of the Rio Grande Compact. The Bureau has asserted title to all the water in the Project in a lawsuit styled United States v. EBID, et al., which is currently being litigated.

1.12.8 United States Geological Survey (USGS)

The USGS (<http://www.usgs.gov/>) is responsible for fulfilling the Nation's needs for reliable, impartial scientific information to describe and understand the Earth. This information is used to minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect the quality of life. The USGS is the Federal Government's principal civilian map-making agency; the primary source of its data on the quality and quantity of the Nation's water resources; the Nation's primary provider of earth-science information on natural hazards, mineral and energy resources, and the environment; and the major partner in developing the Nation's understanding of the status and trends of biological resources and the ecological factors affecting living resources.

1.12.9 United States Environmental Protection Agency (EPA)

The mission of the EPA (<http://www.epa.gov/>) is to protect human health and the environment. Programs of the EPA are designed to (1) promote national efforts to reduce environmental risk, based on the best available scientific information; (2) ensure that Federal laws protecting human health and the environment are enforced fairly and effectively; (3) guarantee that all parts of society have access to accurate information sufficient to manage human health and environmental risks; and (4) guarantee that environmental protection contributes to making communities and ecosystems diverse, sustainable and economically productive.

1.12.10 United States Fish and Wildlife Service (USFWS)

The USFWS (<http://www.fws.gov/>) enforces Federal wildlife laws, manages migratory bird populations, restores nationally significant fisheries, conserves and restores vital wildlife habitat, protects and recovers endangered species, and helps other governments with conservation efforts. It also administers a Federal aid program that distributes money for fish and wildlife restoration, hunter education, and related projects across the country.

1.13 LOCAL ORGANIZATIONS AND UNIVERSITIES

The public and even those involved in water planning and management find it difficult to know about or keep track of the large number and wide array of organizations involved with water resource issues in Far West Texas. Following is a list of many of these organizations. Because of the hydrologic, cultural and economic connections of Far West Texas with Southern New Mexico and Mexico, this list includes water organizations in this expanded region. The list is likely incomplete as there are certainly other organizations deserving of being included.

- Alliance for the Rio Grande Heritage
- Border Environmental Cooperation Commission
- City of El Paso
 - Water Conservation Advisory Board
 - Rio Grande Riverpark Task Force
 - El Paso Water – Consortium for Hi-Technology Investigations in Water and Wastewater
 - El Paso water – TecH2O Learning Center
- City of Las Cruces
- Rio Grande Riparian Ecological Corridor Project
- Consortium for Hi-Technology Investigations in Water and Waste Water
- Environmental Defense
- Forest Guardians
- Hudspeth Directive for Conservation
- New Mexico State University
- New Mexico Lower Rio Grande Regional Water Users Organization
- New Mexico Water Conservation Alliance
- New Mexico Water Resources Research Institute
- New Mexico Water Task Force
- New Mexico Water Trust Board
- New Mexico-Texas Water Commission
- North American Commission for Environmental Cooperation
- North American Development Bank
- Paso Del Norte Watershed Council
- Paso Del Norte Water Task Force
- Project Del Rio
- Rio Grande/Rio Bravo Basin Coalition
- Rio Grande Council of Governments
- Rio Grande Institute
- Rio Grande Watershed Federal Coordinating Committee
- Southwest Environmental Center
- The Texas A&M University System
 - Texas AgriLife Research Center in El Paso
 - Transboundary Aquifer Assessment Program
 - Texas Cooperative Extension

- Rio Grande Basin Initiative
- Texas Water Resources Institute
- Texas State University System
 - Sustainable Agricultural Water Conservation in the Rio Grande Basin Project
- Texas Water Matters
 - Lone Star Chapter of the Sierra Club
 - National Wildlife Federation
 - Environmental Defense
- Tularosa Basin National Desalination Research Facility
- University of Texas at El Paso
 - Center for Environmental Resource Management
 - Rio Bosque Wetlands Park
 - Southwest Consortium for Environmental Research and Policy of the Southwest
- U. S. Mexico Border Coalition of Resource Conservation and Development Councils
- WERC: A Consortium for Environmental Education and Technology Development
- World Wildlife Fund – Chihuahuan Desert Program

APPENDIX 1A

MAJOR SPRINGS

MAJOR SPRINGS

The Far West Texas Water Planning Group recognizes the following “Major Springs” occurring on State, Federal, or privately-owned conservation-managed lands for their importance for natural resource protection.

CHINATI MOUNTAINS STATE NATURAL AREA – CIENEGA LA BAVIZA SPRING

Cienega Creek flows downstream from the spring-fed spring, La Baviza, in the 38,187-acre Chinati Mountains State Natural Area in west-central Presidio County. The spring (cienega) forms a fresh to slightly saline marsh with waters that are slightly geothermal. The habitat supports an intact, diverse marsh with saline grasses, rushes, sedges, and perennials. A high diversity of desert bats also use the area for feeding and watering. The adjacent Cienega Creek has very good examples of saline marsh and cottonwood gallery woodlands. It is an important wildlife area and is in the low Chihuahuan Desert where intact wetlands and riparian habitat are quite rare. Cienega Creek is recommended as an “Ecologically Unique River or Stream Segment” in Chapter 8.

BIG BEND NATIONAL PARK / RIO GRANDE WILD AND SCENIC RIVER SPRING COMPLEXES

River regulation, agricultural and municipal withdrawals and drought have diminished and altered the discharge patterns for the lower Rio Grande in Far West Texas. The physical and ecological system, once adapted to large and rapid fluctuations in flow, is now adapted to lower and more constant flows. The 250-mile reach of the Rio Grande managed by the National Park Service is the only free flowing reach in the lower Rio Grande. A significant portion of the base flows are provided by groundwater contributions from four spring complexes located in Big Bend National Park and along the Rio Grande Wild and Scenic River. Management Plans for both NPS entities list the protection of springs as critical management concerns. A portion of the Rio Grande Wild and Scenic River is recommended by the planning group as an “Ecologically Unique River and Stream Segment” and is discussed in Chapter 8. NPS staff has identified the following four spring complexes.

Gambusia Hot Springs Complex

River miles	804	814
UTM Coordinates N	3233835	3226468
UTM Coordinates E	702647	694388
Zone 13		

This reach includes hot springs between Mariscal Canyon and Boquillas Canyon. Easily delineated orifices with significant flow include: Gravel Pit, Langford Hot Springs, Lower Hot Springs (a.k.a. VD Springs or Leper Springs), Rio Grande Village Springs 3 and 4, and numerous unnamed springs. Springs on the Mexican side include Ojo Caliente and Boquillas Hot Springs. These springs issue from the upper Cretaceous rock units, the Boquillas and Santa Elena Limestones. Rio Grande Village currently gets its water supply from one of these springs. In addition, this same spring and another nearby spring feed two ponds that contain the world’s only population of *Gambusia gaigei*.

Outlaw Flats Spring Complex

River miles	748	762
UTM Coordinates N	3292773	3296392
UTM Coordinates E	725582	716672
Zone 13		

Springs issue from the Glen Rose Limestone. Although generally of low volume, there is evidence of historical use at a spring on the Texas side near the confluence with Big Canyon. Historical use includes the remains of a spring box.

Las Palmas Spring Complex

River miles	735	742
UTM Coordinates N	3293228	3293608
UTM Coordinates E	737565	732013
Zone 13		

Large volume springs in Del Carmen Limestone. Historical use at Asa Jones waterworks, a withdrawal and distribution system for a candelilla wax camp located on the canyon rim east of Silver Canyon. The system includes pumps, piping, and several rock tanks, one of which is located over a spring emanating from a rock joint. Park Service personnel estimated the spring discharge at 300 gpm. This joint can be followed in both directions beyond the rock walls where additional water discharges. Water enters the river on both sides along a reach approximately 200 feet long. Undocumented Mexican emigrants use this area frequently, as indicated by the presence of discarded clothing and bedrolls. Directly below the Asa Jones Waterworks, on the Texas side is Spigot Spring. River runners use this spring as a water source. Two miles downstream on the Coahuila Mexico, side is Hot Springs, a very popular river camp due to the presence of several warm pools. A road on the Mexican side provides access to the area for the Mexican Army (reports from River District Ranger). Another spring below and on the Texas side is commonly used as a water source for river runners.

Madison Fold Spring Complex

River miles	720	723
UTM Coordinates N	3298065	3296092
UTM Coordinates E	753147	751786
Zone	13	

Low volume springs discharging from the Del Carmen Limestone and the Maxon Sandstone. As these are the last discharges along the river, river runners commonly use the spring on the Texas side and below Lower Madison Falls as a water source.

GUADALUPE MOUNTAINS NATIONAL PARK SPRINGS COMPLEX

Springs in the Guadalupe Mountains National Park are crucial for maintenance of ecological stability and wildlife health within the Chihuahuan Desert environment. Loss or failure of any of these springs would cause significant environmental stress, even though discharge rates of most are relatively small. Most springs are also historic areas used by pioneers, early ranchers, and settlers. Remains of their homesteads and structures used to manage spring outflow and direct water usage are still visible in and near the springs. The National Park Service is directed to preserve these historic elements and cultural landscapes against unnatural impacts from continued human use, as well as to protect the spring’s water quality and quantity from human induced impairment. Specific major natural resource springs are listed in the following table:

SPRINGS IN GUADALUPE MOUNTAINS NATIONAL PARK				
Name	Discharge (gpm)	State Well Number	Position NAD 1927 Conus UTM 13 N northing	Position NAD 1927 Conus UTM 13 N easting
Bone Spring	2-3	-	3527444	512087
Dog Canyon Spring	<1	-	3537770	514918
Frijole Spring	6-13	47-02-801	3530009	518842
Goat Spring	1	-	3529611	511370
Guadalupe Spring	6-10	47-02-701	3526606	514633
Juniper Spring	<1	47-02-502	3531081	519488
Manzanita Spring	10-38	47-02-802	3530317	519111
Smith Spring	13-55	47-02-501	3531248	518287
Upper Pine Spring	8-13	47-02-803	3529514	517274

TEXAS NATURE CONSERVANCY INDEPENDENCE CREEK PRESERVE – CAROLINE SPRING

Caroline Spring is located at the Texas Nature Conservancy’s Independence Creek Preserve headquarters in northeastern Terrell County. The spring produces 3,000 to 5,000 gallons per minute and comprises about 25 percent of the creek’s flow. Downstream, Independence Creek’s contribution increases the Pecos River water volume by 42 percent and reduces the total dissolved solids by 50 percent, thus improving water quantity and quality. The preserve hosts a variety of bird and fish species, some of which are extremely rare. Caroline Spring, along with the entirety of the Independence Creek Preserve (19,740 acres), is a significant piece of West Texas natural heritage.

TEXAS NATURE CONSERVANCY DAVIS MOUNTAINS PRESERVE – TOBE, BRIDGE, PINE AND LIMPIA SPRINGS

The wild and remote Davis Mountains is considered one of the most scenic and biologically diverse areas in Texas. Rising above the Chihuahuan desert, the range forms a unique “sky island” surrounded by the lowland desert. Animals and plants living above 5,000 feet are isolated from other similar mountain ranges by vast distances. The Texas Nature Conservancy has established the 32,000-acre Davis Mountains Preserve (with conservation easements on 65,830 acres of adjoining property) in the heart of this Region. Tobe, Bridge, Pine and Limpia springs form critical wetland habitat and establish base flow to the downstream creeks.

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