Section 15 – Long Term Supply – Year 2050 – CRMWA II

Content

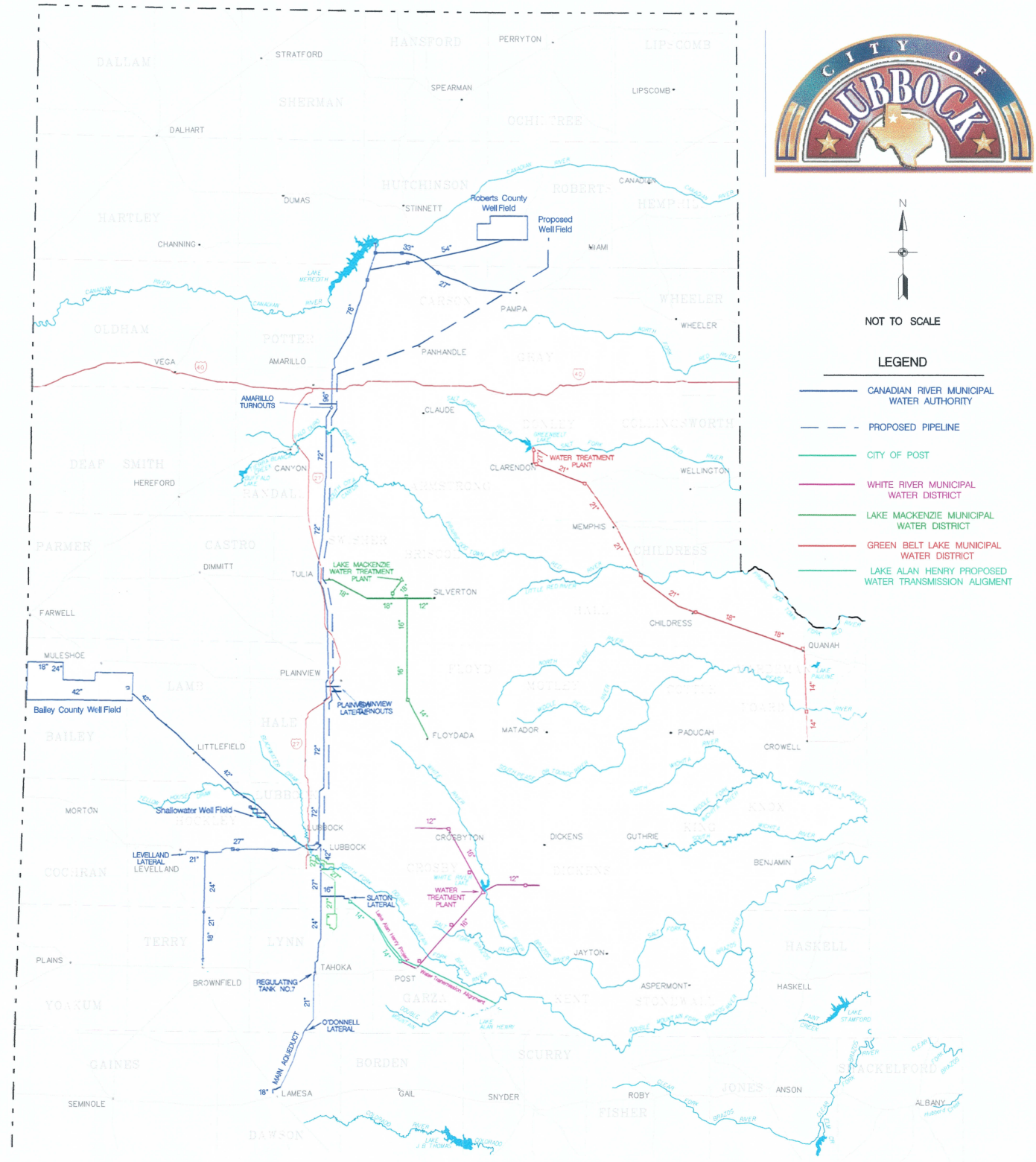
a. System Map

Summary

The Canadian River Municipal Water Authority is now preparing a long range water supply plan for its member cities. This report should be complete in the summer of 2007. The report will provide information on all member city water needs, and recommend ways in which member cities can work together on future water supply projects.

This is a significant project due to distance. Water transmission lines could reach 200 miles when considering well field lines as well as actual transmission lines. The project would also require well field infrastructure including wells, pumps, gathering lines, storage tanks, etc. In addition, additional water rights would need to be purchased to supply the increased demand.

The Region O Water Plan does not include the CRMWA II project, however, the report does mention the opportunity for additional supplies from CRMWA. With the completion of the CRMWA Water Plan, there will be an opportunity to have CRMWA plans included in regional plans.


CITY OF LUBBOCK
N
NOT TO SCALE
LEGEND
CANADIAN RIVER MUNICIPAL WATER AUTHORITY
PROPOSED PIPELINE
CITY OF POST
WHITE RIVER MUNICIPAL WATER DISTRICT
LAKE MACKENZIE MUNICIPAL WATER DISTRICT
GREEN BELT LAKE MUNICIPAL WATER DISTRICT
LAKE ALAN HENRY PROPOSED WATER TRANSMISSION ALIGMENT
Roberts County Well Field
Proposed Well Field
Bailey County Well Field
Shallowater Well Field
AMARILLO TURNOUTS
PLAINVIEW LATERAL TURNOUTS
LEVELLAND LATERAL
SLATON LATERAL
O'DONNELL LATERAL
MAIN AQUEDUCT
REGULATING TANK NO.7
WATER TREATMENT PLANT
LAKE MACKENZIE WATER TREATMENT PLANT
PERRYTON
STRATFORD
SPEARMAN
LIPSCOMB
DALHART
DUMAS
STINNETT
CANADIAN
CHANNING
MIAMI
PAMPA
WHEELER
VEGA
AMARILLO
PANHANDLE
CLAUDE
CANYON
HEREFORD
CLARENDON
WELLINGTON
MEMPHIS
DIMMITT
TULIA
SILVERTON
CHILDRESS
QUANAH
FARWELL
MULESHOE
PLAINVIEW
FLOYDADA
MATADOR
PADUCAH
CROWELL
LITTLEFIELD
MORTON
LUBBOCK
CROSBYTON
DICKENS
GUTHRIE
BENJAMIN
LEVELLAND
PLAINS
BROWNFIELD
TAHOKA
POST
JAYTON
ASPERMONT
HASKELL
SEMINOLE
LAMESA
GAIL
SNYDER
ROBY
ANSON
ALBANY

Section 16 – Long Term Supply – Docum/Santa Rosa Aquifer (brackish water)

Content

a. Feasibility Study – Texas Water Development Board

Summary

Under a significant expanse of the Texas pan handle, and under much of the Ogallala Aquifer, lies the Dockum Aquifer group, which includes the Santa Rosa Aquifer. Most of the water in the Dockum Aquifer is brackish (salty) and reverse osmosis would be required to treat the water prior to use. Portions of a Texas Water Development Board study on the Dockum Aquifer is included for your consideration.

Since the cost is significant, this alternative is not recommended as a priority in the near term. In addition, much of the Dockum is reported to not be productive and wells may not be very productive in some areas. Pilot tests might be helpful to determine where the Aquifer would be productive and where it might not.

Texas Water Development Board

Report 359

The Groundwater Resources of the Dockum Aquifer in Texas

by
Robert G. Bradley, P.G., and
Sanjeev Kalaswad, Ph.D., P.G.

December 2003

1.0 Executive Summary

The Dockum aquifer is a minor aquifer that underlies much of the Ogallala Formation in the Texas Panhandle and West Texas. Recoverable groundwater in the Dockum aquifer occurs within the many Upper Triassic sandstone and conglomerate beds that host the aquifer. The hydrogeologic properties of the aquifer vary widely. For example, well yields range from 0.5 to 2,500 gpm and transmissivity from 48 to 4,600 square feet per day. Generally, however, well yields and transmissivities are fairly low throughout much of the aquifer.

Precipitation recharges the aquifer where it is exposed at the land surface around the eastern and southern edges of the aquifer. The confined portions of the aquifer receive some recharge by leakage from overlying and underlying geologic units. We estimate that annual recharge to the aquifer is approximately 31,000 acre-feet. Discharge from the aquifer occurs from pumping wells, small springs, evapotranspiration and cross-formational flow.

Regional groundwater flow in the aquifer is generally to the east. Historical hydrographs of wells show that water levels in the northern and southern parts of the aquifer have declined in some areas and risen in others over the past 20 to 30 years. In the central part of the aquifer, water levels have generally risen over the same time period.

Groundwater in the Dockum aquifer is generally of poor quality. Water quality ranges from fresh in the outcrop areas to brine in the confined parts of the aquifer. It also tends to deteriorate with depth, and total dissolved solids (TDS) concentrations can exceed 60,000 mg/l in the deepest parts of the aquifer. Water in the Dockum aquifer is also typically hard with a mean hardness of about 470 mg/l. Radionuclides naturally derived from uranium minerals in the host rocks occur at concentrations above 5 pCi/l in widespread areas of the aquifer. Most counties in the study area also had at least one groundwater sample that contained sulfate or chloride at concentrations greater than the secondary standard of 250 mg/l. In contrast, fluoride concentrations were higher than the secondary standard in only a few samples collected from five counties. Much of the land overlying the Dockum aquifer is susceptible to salinity problems originating from the high concentrations of sodium in the groundwater. This problem is most prevalent over the confined areas of the aquifer and is less of a concern over the outcrops.

We estimate that the total amount of water in the entire Dockum aquifer in the study area is approximately 185 million acre-feet. Of this amount, approximately 109 million acre-feet contains TDS of less than 5,000 mg/l, about 27 million acre-feet between 5,000 and 10,000 mg/l, and 49 million acre-feet greater than 10,000 mg/l. However, not all of the water in the Dockum is readily available for withdrawal. In fact, measured aquifer parameters suggest that the aquifer can provide only small quantities of water. Furthermore, because the confined part of the aquifer (where water with the highest TDS concentrations is present) receives little recharge, any significant withdrawal of water from these areas will essentially mine or deplete the aquifer.

2.0 Introduction

The Upper Triassic Dockum Group extends over approximately 96,000 square miles in parts of Colorado, Kansas, Oklahoma, New Mexico and Texas (Figure 2-1). In Texas, sands of the Dockum Group produce small to moderate quantities of fresh to saline water and constitute the Dockum aquifer which is classified as a minor aquifer (Ashworth and Hopkins, 1995). As delineated by Ashworth and Hopkins (1995), the Dockum aquifer includes an area of the aquifer containing groundwater with less than 5,000 mg/l total dissolved solids (Figure 2-2). However, for the purposes of this report, we also include other areas of the aquifer that have total dissolved solids concentrations greater than 5,000 mg/l. In this report, the term "Dockum aquifer" is used loosely for all water-bearing strata of the Dockum Group regardless of their dissolved solids content.

Locally, the Dockum aquifer can be an important source of groundwater for irrigation, public supply, oil-field activity, livestock, and manufacturing. However, deep pumping depths, poor water quality, low yields, and declining water levels have discouraged its more widespread use. Nevertheless, the aquifer may become an important secondary source in the future, especially in areas where demand from the overlying Ogallala and Edwards-Trinity (Plateau) aquifers is high. It could also be considered for desalination in the future.

To date, only a few investigations have been conducted on the Dockum aquifer in Texas. One of the first regional studies was conducted by Gould (1907) in west Texas. Later, Galloway (1955) investigated Triassic artesian wells near Hereford, Texas, to evaluate the feasibility of obtaining water from similar types of wells in eastern New Mexico. Other studies of a local nature were conducted by Fink (1963) and Rayner (1965). Several county-level studies on the Dockum aquifer have also been conducted (see, for example, Garza and Wesselman, 1959; Ogilbee and others, 1962; Shamburger, 1967; White, 1971; Duffin, 1984; and Ashworth, 1986).

The aim of this study was to evaluate the groundwater resources of the Dockum aquifer (Figure 2-2). Specific goals of the investigation were to compile and evaluate existing geologic and hydrologic information on the area, determine the quality of groundwater in the Dockum aquifer, and estimate the approximate amount of groundwater in the aquifer. Much of the information presented in this report was obtained from previous literature and Texas Water Development Board (TWDB) records. We collected groundwater samples in 1995 and 1996 from all of the counties in the study area to assess the chemical quality of water in the aquifer.

3.0 Study Area

The study area (Figure 2-2) encompasses the total areal extent of the Dockum Group in Texas (approximately 42,000 square miles). The outcrop area of the Dockum Group is approximately 5,500 square miles, and extends as a north-south-trending belt paralleling the eastern escarpment of the Llano Estacado. The belt is narrow between Armstrong and Dickens counties in the north but broadens south of Dickens County to include most of Scurry and Mitchell counties.

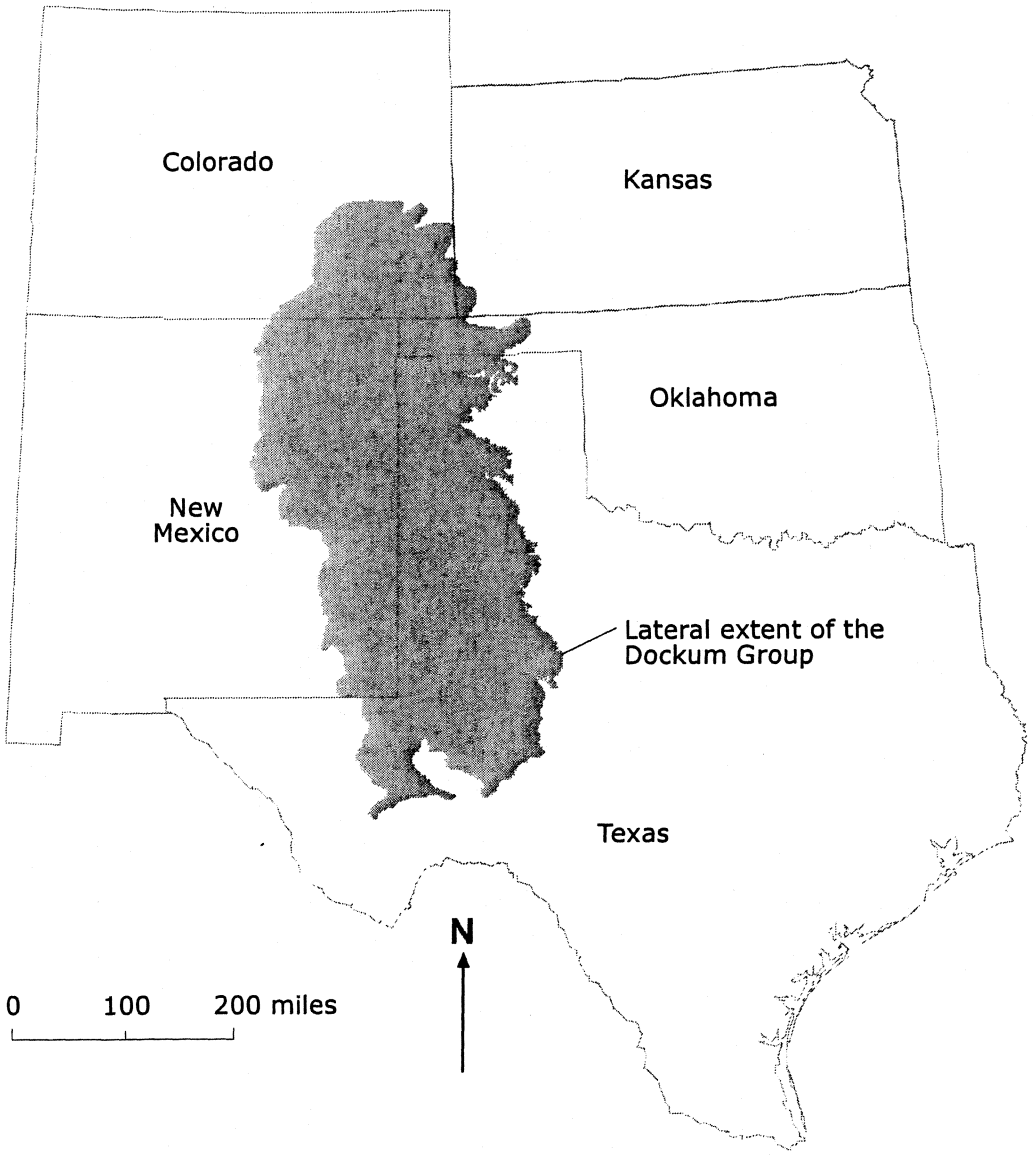


Figure 2-1. Lateral extent of the Dockum Group in southwestern United States (modified from McKee and others, 1959; Bureau of Economic Geology, 1967, 1968, 1969, 1974, and 1983; McGowen and others, 1977).

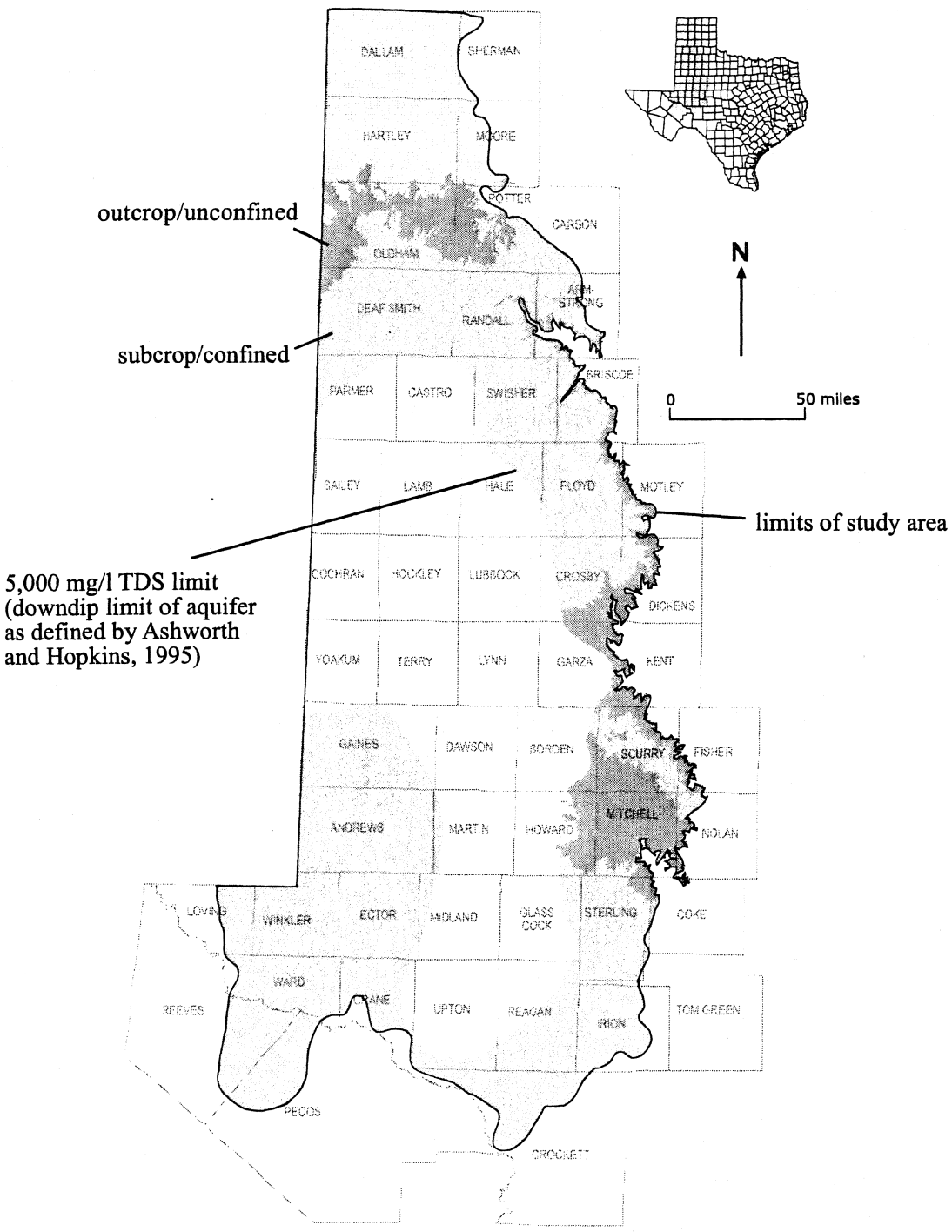


Figure 2-2. Areal extent of the study area and the Dockum aquifer in Texas.

Within the study area, the Dockum aquifer is exposed along the Canadian River in the north, along the east edge of the Caprock Escarpment in the east, and in parts of Borden, Fisher, Garza, Howard, Kent, Mitchell, Nolan, and Scurry counties in the south. Other small exposures are found in Coke, Crane, Ector, Loving, Martin, Sterling, and Ward counties. Covered outliers of the Dockum aquifer are present in Hansford, Hutchinson, and Ochiltree counties.

The Dockum aquifer in the study area overlies Permian-age units and is in turn overlain by Jurassic rocks in the northwest corner of the Texas Panhandle, by Cretaceous sediments in the southern High Plains and Edwards Plateau, and by the Ogallala Formation in the northern High Plains (Table 3-1). In the southwest part of the study area, the aquifer is overlain by the Cenozoic Pecos Alluvium.

3.1 Physiography

Much of the study area lies within the High Plains section of the Great Plains physiographic province which extends from the Pecos River in the south to the latitude of the Great Bear Lake in Canada (Thornbury, 1965). The High Plains section in Texas is a vast, monotonous flat surface underlain primarily by Tertiary sediments. The eastern edge of the section is marked by a pronounced escarpment called the Caprock Escarpment.

Smaller parts of the study area in the south lie within the Pecos Valley and the Edwards Plateau sections of the Great Plains physiographic province. The Pecos Valley section, which lies southwest of the High Plains section, consists of a broad north-south-trending topographic depression underlain by highly soluble Cretaceous rocks. To its east lies the Edwards Plateau section, characterized by low relief (except along major stream channels) in the west and higher relief in the east. The Edwards Plateau is underlain by carbonate rocks of Cretaceous age. A small part of the study area east of the Caprock Escarpment falls within the Osage section of the Central Lowlands province and is underlain by mainly Pennsylvanian or Permian rocks.

Five major river basins drain the study area, including the basins of the Canadian and Red rivers, which drain eastward, and the basins of the Brazos, Colorado, and Pecos rivers, which drain toward the southeast. A significant part of the Dockum Group outcrop is drained by the Canadian and Colorado rivers and their tributaries.

3.2 Climate

The climate over much of the northern and central parts of the study area is of a continental steppe type and is characterized by large variations in daily temperatures, relatively low humidity, and infrequent rainfall events (Larkin and Bomar, 1983). Average annual precipitation in these areas ranges from about 21 inches in the eastern parts of the study area to about 17 inches in the western parts (Figure 3-1). Historically, mean annual precipitation has ranged from 13.89 inches in the southern part of the study area (Figure 3-1c) to 22.23 inches in the central part (Figure 3-1b). Three-fourths of the precipitation in these areas typically occurs between early spring and early fall. May and September are usually the rainiest months. Snowfall is an important source of precipitation in the winter. Temperatures often exceed 100° F in the summer and drop below freezing in the winter.

Table 3-1. Geologic Formations in the Texas Panhandle and West Texas and Their Water-Bearing Characteristics (modified from Knowles and others, 1984; Lehman, 1994a and 1994b).

System	Series	Group	Formation	Physical Characteristics	Water-bearing Characteristics
Quaternary			Cenozoic Pecos Alluvium	Unconsolidated to partially consolidated sand, silt, gravel, clay, and caliche.	Yields small to large amounts of fresh to slightly saline water.
Tertiary	Late Miocene to Pliocene		Ogallala	Tan, yellow, and reddish-brown, silty to coarse-grained sand alternating with yellow to red silty clay and variable sized gravel.	Yields moderate to large amounts of water to well.
Cretaceous		Washita		Massive, fine to coarse grained, white, gray, or yellowish gray limestone and thick, dark greenish gray, gray, or yellow marl.	Yields small to large amounts of water to wells and springs.
		Fredericksburg	Kiamichi	Thinly laminated, sometimes sandy, gray to yellowish-brown shale with beds of thin, gray argillaceous limestone, and, thin, yellow limestone.	Yields small amounts of water locally to wells.
			Edwards	Light-gray to yellowish-gray, thick bedded to massive, fine- to coarse-grained limestone.	Yields small to large amounts of water to wells and springs.
			Comanche Peak	Light gray to yellowish-brown, irregularly bedded, argillaceous limestone, thin beds light-gray shale.	Yields small to large amounts of water to wells.
			Walnut	Light-gray to yellowish-brown, fine to medium-grained, sandstone, thin bedded, gray to grayish-yellow, calcareous shale; and light gray to grayish-yellow, argillaceous limestone.	Not known to yield water to wells.
		Trinity	Antlers	White, gray, yellowish-brown to purple, fine to medium-grained, loosely cemented sandstone and conglomerate, with beds of siltstone and clay.	Yields small to moderate amounts of water to wells.
Jurassic			Morrison	Variegated shale, sandstone, siltstone, and limestone.	Yields small amounts of fresh to slightly saline water.
			Exeter	Light-colored sandstone.	Yields small amounts of fresh to slightly saline water.
Triassic		Dockum	Cooper Canyon	Reddish-brown to orange siltstone and mudstone with lenses of sandstone, and conglomerate.	Yields small to large quantities of fresh to brine water to wells and springs.
			Trujillo	Gray, brown, greenish-gray, fine to coarse-grained sandstone and sandy conglomerate with thin gray and red shale interbeds.	
			Tecovas	Variegated, sometimes sandy mudstone with interbedded fine to medium-grained sandstones.	
			Santa Rosa	Red to reddish-brown sandstone and conglomerate.	
Permian	Ochoa		Dewey Lake	Red siltstone and shale.	Not known to yield water to wells.
			Rustler	Dolomite, anhydrite, sandstone, conglomerate, and variegated shale.	Yields small to large amounts of slightly to moderately saline water.
	Guadalupe	Undifferent-iated		Sandstone, shale, gypsum, anhydrite, dolomite, and selenite.	Yields small to large amounts of fresh to moderately saline water.

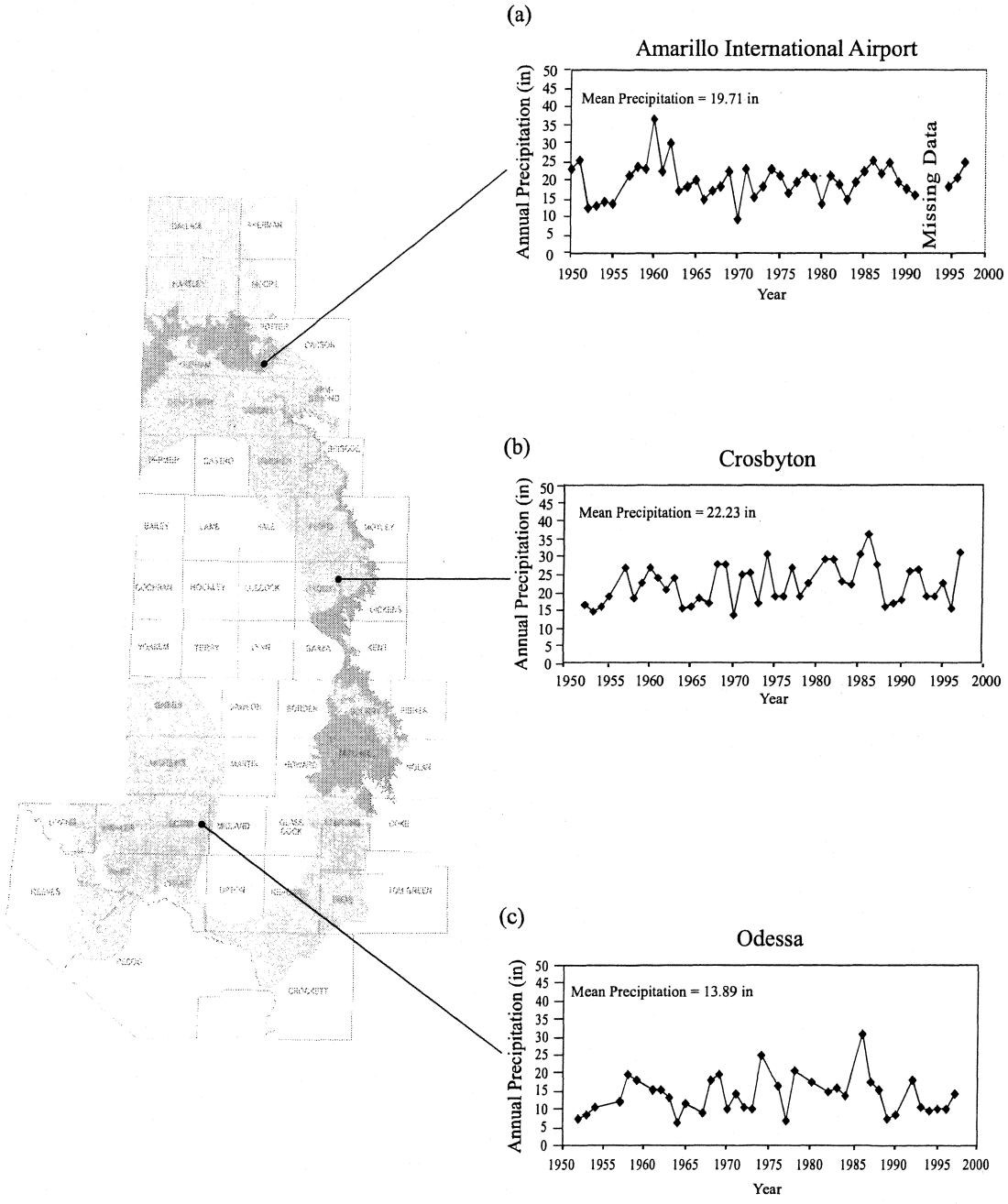


Figure 3-1. Historical annual precipitation recorded at (a) Amarillo International Airport, (b) Crosbyton, and (c) Odessa.

Evaporation in the northern and central parts of the study area is greatest in the summer months. The average annual evaporation potential for an open surface water body in Lubbock County is approximately three-and-half times the average annual precipitation (Knowles and others, 1984).

The southern part of the study area (Trans-Pecos) is semi-arid and is characterized by a wide range of temperatures, low rainfall, and high evaporation rates (Ashworth, 1990). Temperatures typically range from below freezing in winter to over 100° F during the summer. Average annual precipitation in the southern part of the study area ranges from 9 inches in the west to about 14 inches in the east with much of it occurring in April and October. Historical annual precipitation at the Odessa rain gage station has ranged from 6.2 inches to 30.8 inches (Figure 3-1c).

4.0 Geology

The Triassic sediments of the Dockum Group that form the Dockum aquifer consist of a series of alternating sandstones and shales (Cazeau, 1962). Individual sandstone units are light- to dark- or greenish-gray, buff and red, and range in thickness from a few feet to about 50 feet. They are often lens-shaped, partly conglomeratic, poorly sorted, friable, and micaceous. The red and maroon sandy shale units that separate the sandstones range in thickness from about 50 to 100 feet.

Recoverable groundwater in the Dockum aquifer is present within the many sandstone and conglomerate beds that occur throughout the sedimentary sequence. The coarse-grained deposits form the more porous and permeable water-bearing units of the Dockum Group, whereas the fine-grained sediments form impermeable aquitards in the group (Fallin, 1989). The more prolific parts of the aquifer are consequently developed in the lower and middle sections where the coarse-grained sediments predominate (Best Sandstone in Figure 4-1 through 4-10). Locally, any water-bearing sandstone within the Dockum Group is typically referred to as the Santa Rosa aquifer. In the Pecos River valley, the Dockum aquifer is usually known as the Allurosa aquifer (White, 1971).

The geologic setting of the Dockum Group, as well as information on aquifer properties, water levels, chemical quality of water in the aquifer, and recharge to and discharge from the aquifer are presented below.

4.1. Stratigraphy

Recent investigations of the Dockum Group have largely focused on stratigraphic nomenclature, and a fair amount of controversy has arisen over its rank as a group or formation (for an in-depth

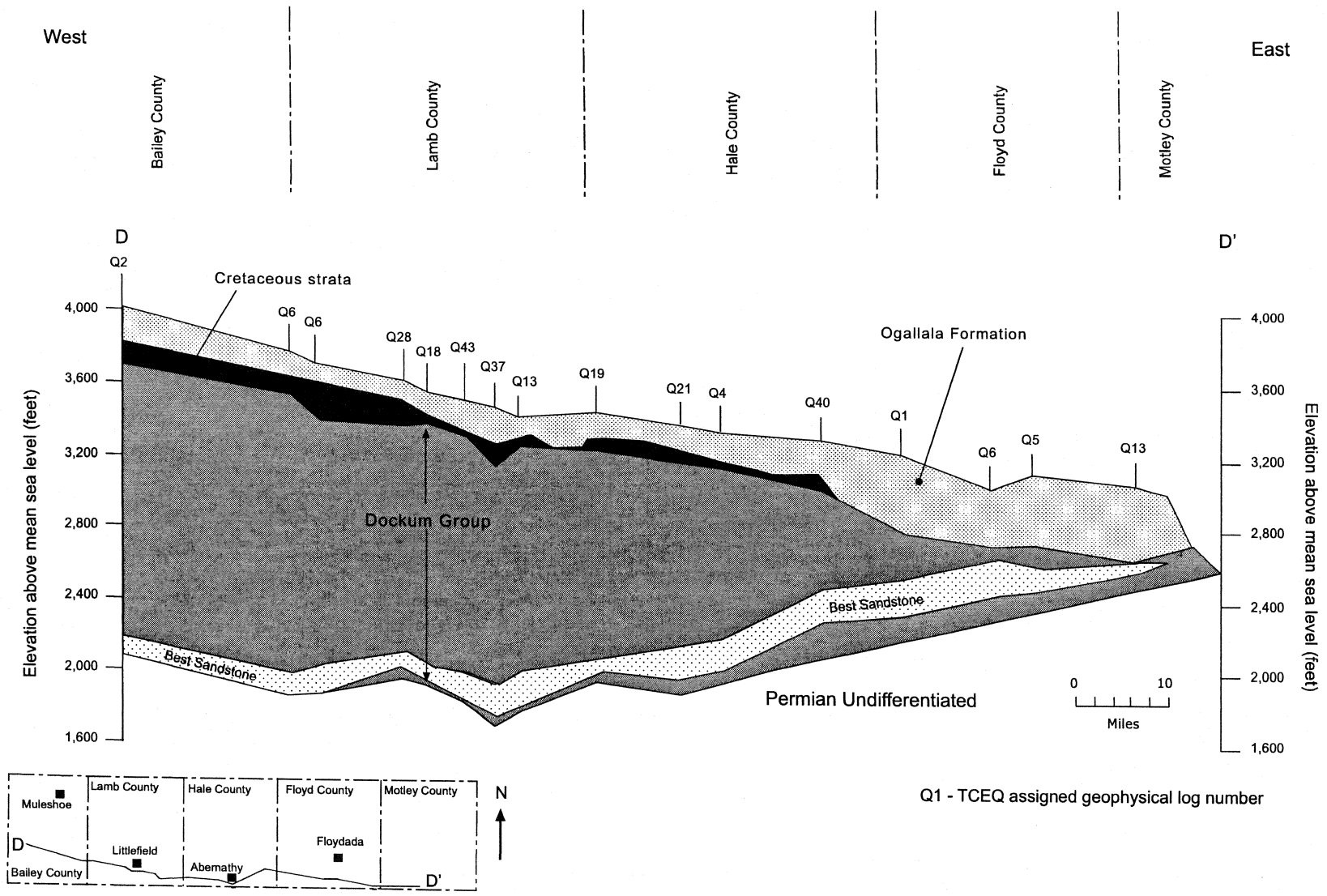


Figure 4-5 Geologic cross-section D-D'.

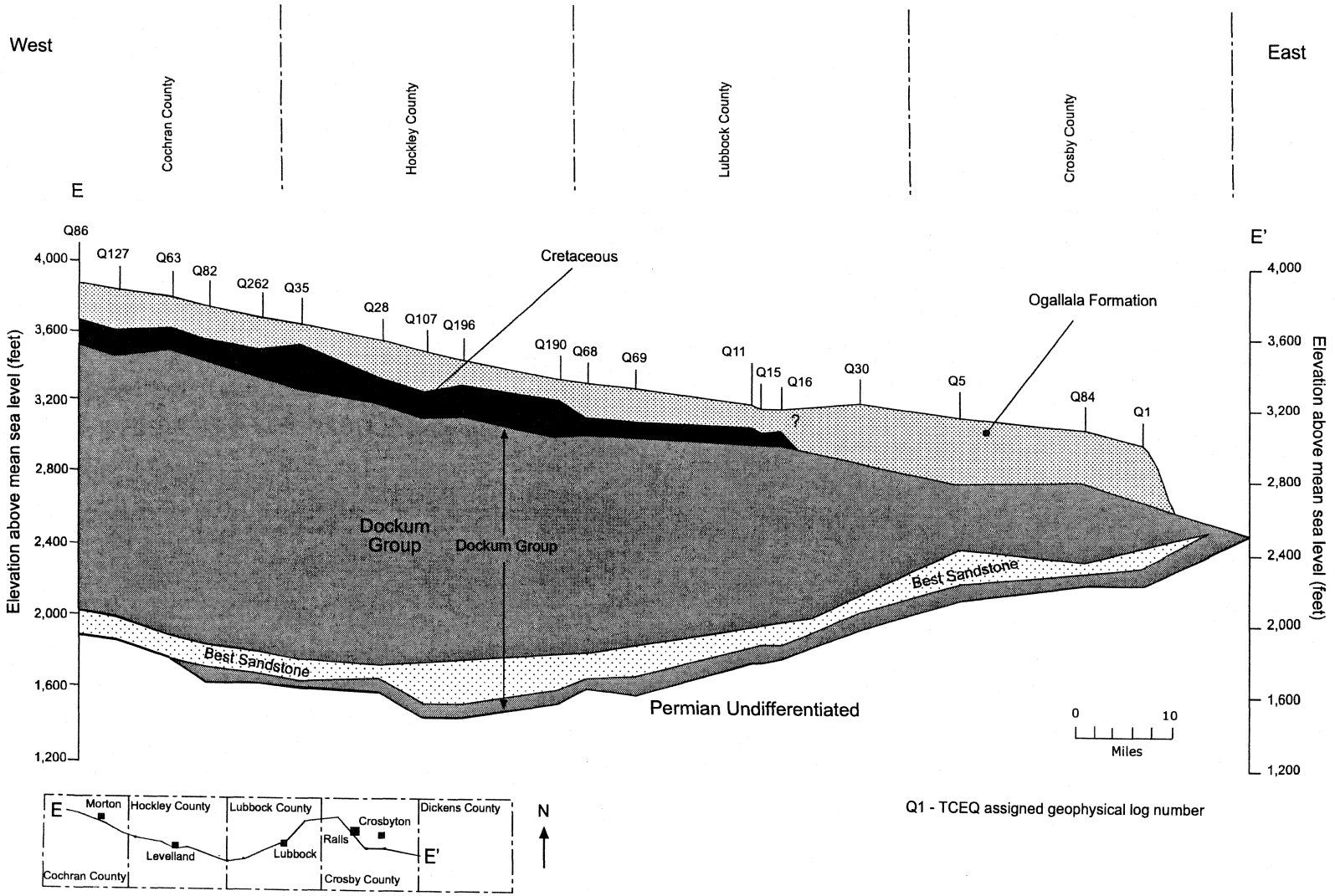


Figure 4-6 Geologic cross-section E-E'.

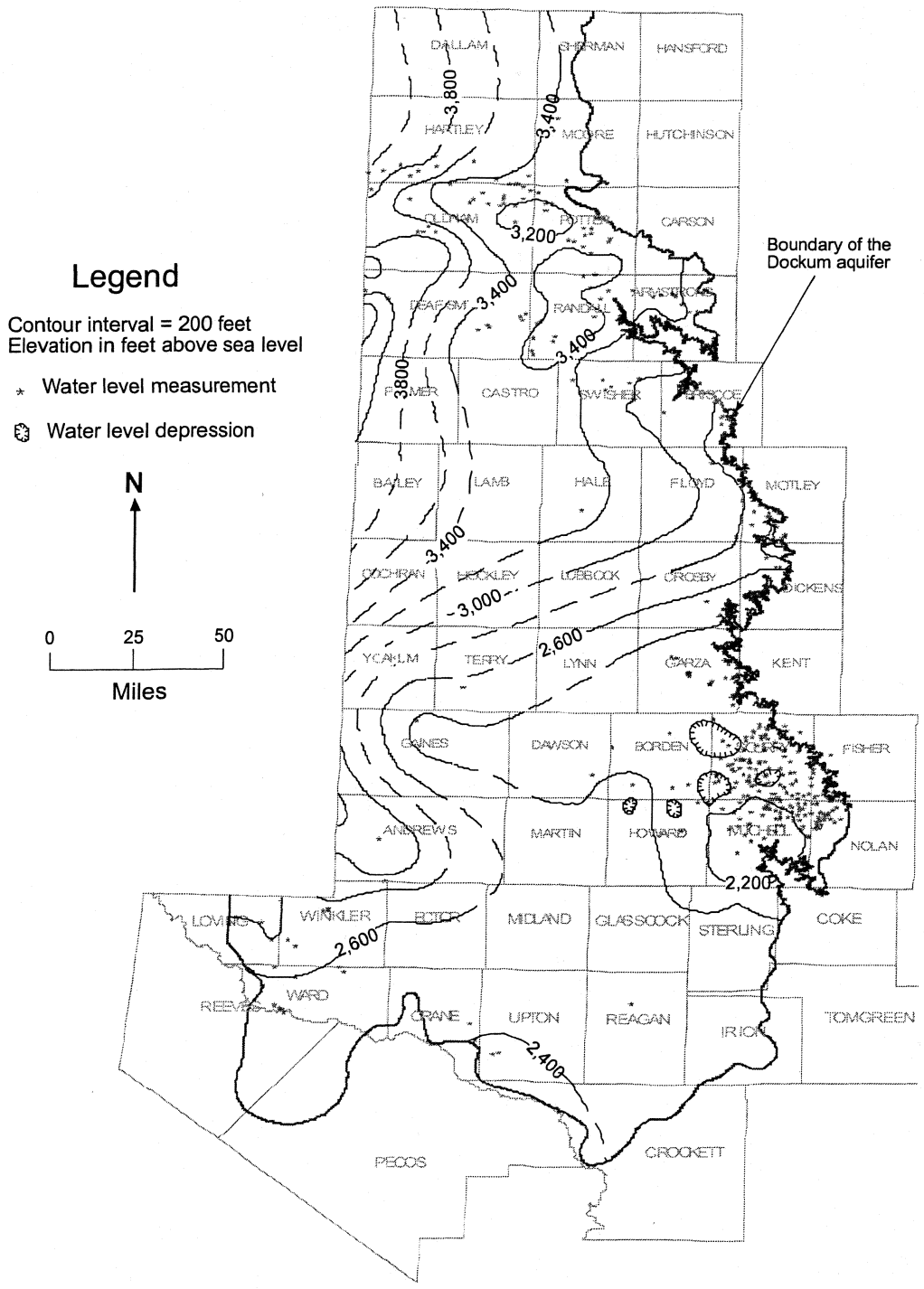


Figure 5-1. Approximate water level elevations in the Dockum aquifer, 1981 through 1996.