# Chapter 12

# The Dockum Aquifer in West Texas

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## Introduction

The Dockum aquifer, classified as a minor aquifer by the Texas Water Development Board (TWDB), extends over approximately 42,000 $mi^2$ primarily in the Panhandle region of north Texas (figs. 12-1, 12-2). A portion of the southern tip of the aquifer extends into Crane, Ector, Loving, Pecos, Reeves, Ward and Winkler Counties in West Texas. Although the Dockum aquifer can be an important source of groundwater for irrigation, public supply, oil-field activity, livestock and manufacturing purposes, deep pumping depths, poor water quality, low yields, and declining water levels have generally discouraged its use except locally.

The purpose of this article is to present a summary of the characteristics of the Dockum aquifer in West Texas. Much of the information presented in the article was obtained from previous literature and from TWDB records.

## Physiography and Climate

The area overlying the Dockum aquifer in West Texas is generally flat with a gentle slope toward the southeast-flowing Pecos River, which drains much of the region. Drainage north and east of the Pecos River typically is closed, with runoff collecting in swales, sinks and playas (Ashworth, 1990). The climate of the region is semiarid, with hot summers and mild winters (Larkin and Bomar, 1983). Mean annual precipitation in the Pecos River Valley is approximately 10 inches, and lake surface evaporation about 80 inches/yr. (Larkin and Bomar, 1983).

## Geologic Setting

The approximately 2,000-ft-thick 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 ft. The red and maroon sandy shale units that separate the sandstones range in thickness from about 50 to 100 ft.

[1] Texas Water Development Board

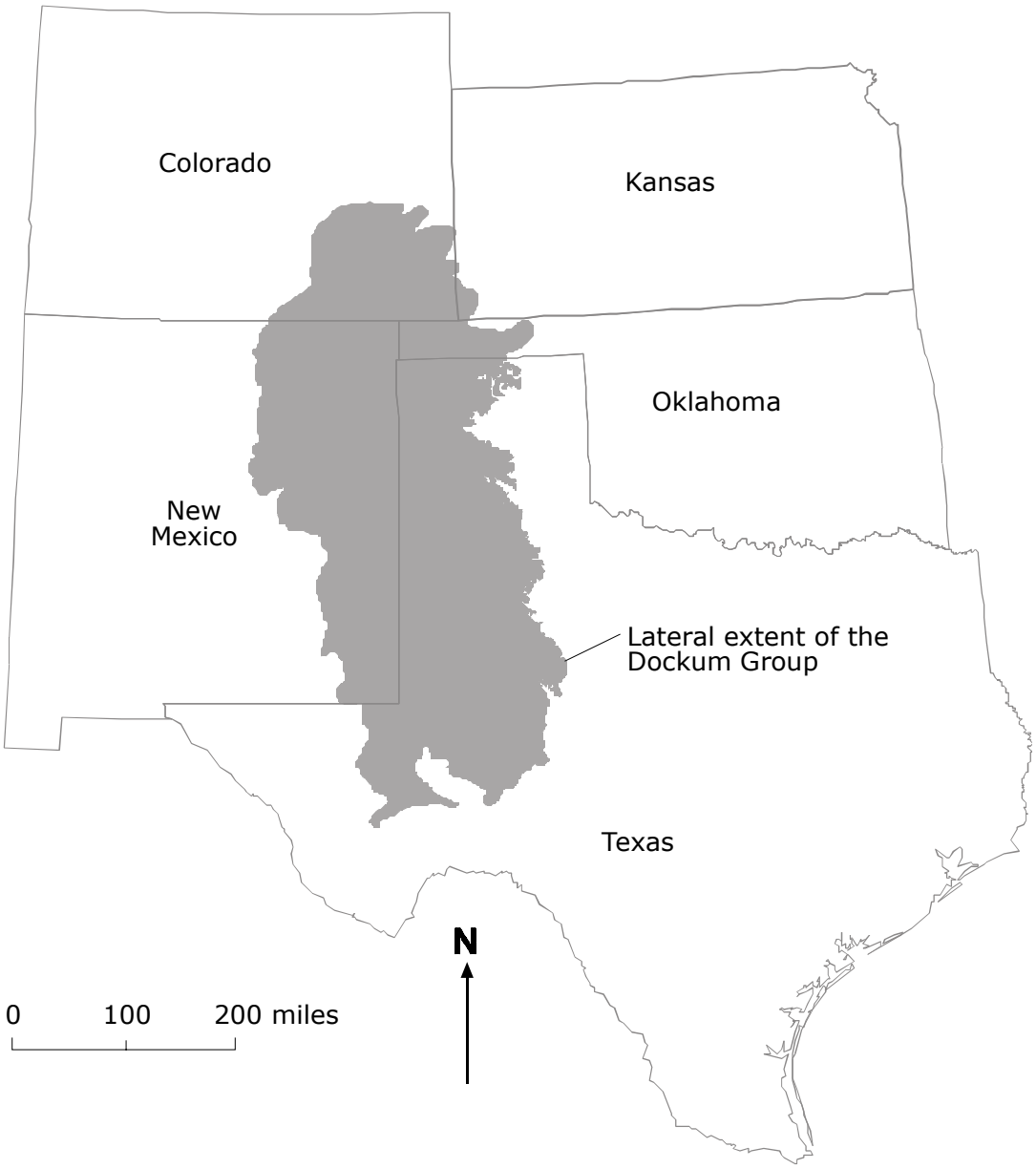


Figure 12-1: Location of the Dockum Group in Texas, New Mexico, Colorado, Kansas, and Oklahoma.

The formations within the Dockum Group (in ascending stratigraphic order) are: Santa Rosa Formation, Tecovas Formation, Trujillo Sandstone, and Cooper Canyon Formation. Locally the term *Santa Rosa* has been applied to the lower sandstone zones in the Dockum Group that may include all units of the Dockum Group except the upper mudstone.

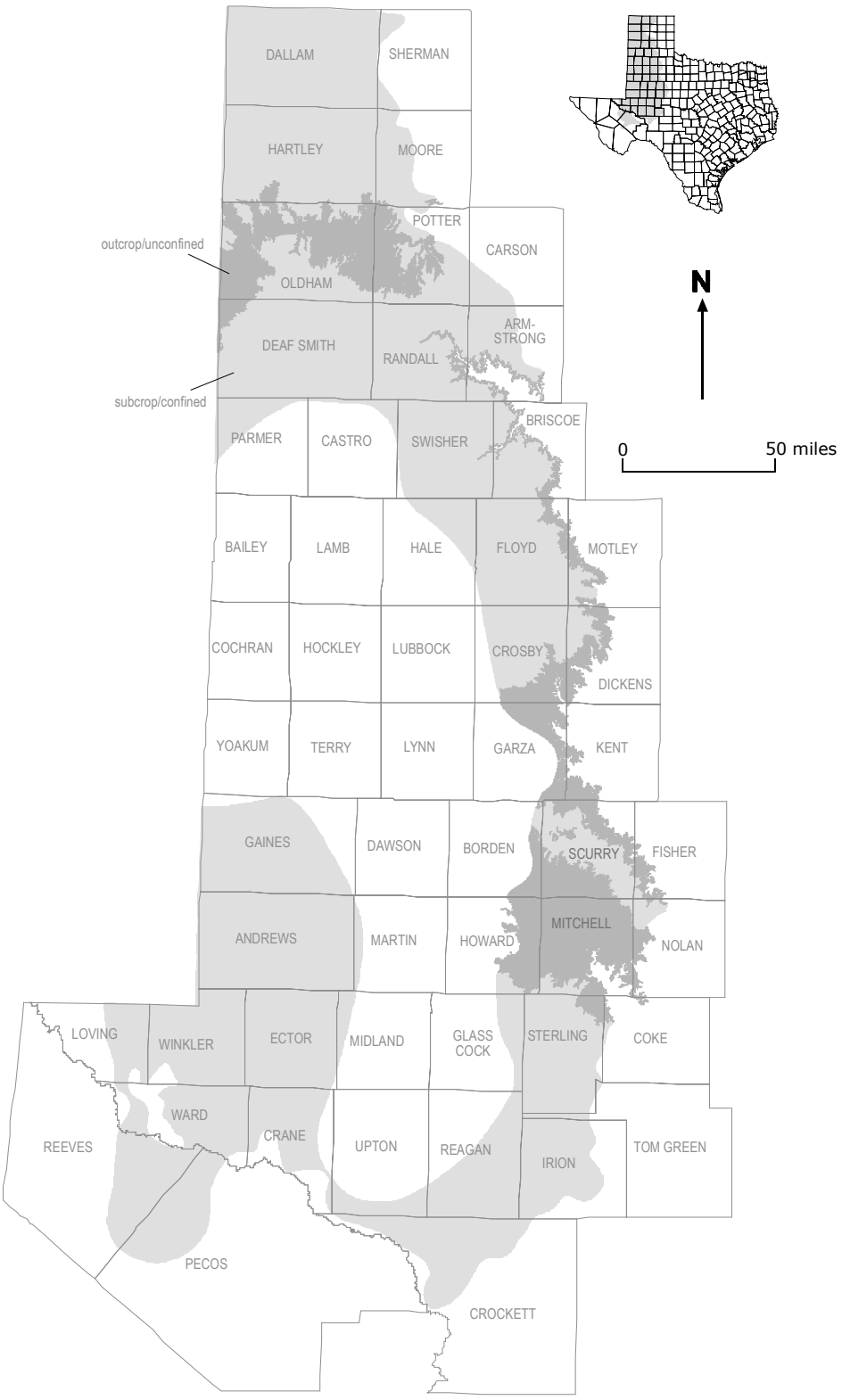


Figure 12-2: Location of the Dockum aquifer in Texas.

The basal unit, called the Santa Rosa Formation, rests unconformably on Upper Permian red beds and can be up to 130 ft thick (Lehman and others, 1992; Lehman, 1994a, b; Riggs and others, 1996). The Santa Rosa Formation is overlain by variegated mudstones and siltstones of the Tecovas Formation (Gould, 1907), which in turn is disconformably overlain by the 250-ft-thick Trujillo Formation composed of massive, crossbedded sandstones and conglomerates (Lehman, 1994a, b). The Cooper Canyon Formation consists of reddish-brown to orange mudstone, with some siltstone, sandstone and conglomerate (Lehman and others, 1992).

The Dockum Group is generally considered to represent sediments deposited in fluvial, deltaic, and lacustrine environments within a closed continental basin (McGowen and others, 1977, 1979; Granata 1981). The basin apparently received sediments from all directions, although in West Texas the source areas were primarily to the south and southwest (Fallin, 1989).

The beds of the Dockum Group are essentially horizontal, with very gentle dips toward the center of the main basin, whose axis trends approximately north-south. The dip varies considerably from location to location but is approximately 30 ft/mi (Rayner, 1963). In West Texas, the primary structural features are the Central Basin Platform in the east and the Delaware Basin in the west (Fallin, 1989).

The top of the Dockum Group is relatively flat and reflects the final filling of the Dockum Basin and the effects of postdepositional erosion. The opening of the Gulf of Mexico in the Cenozoic Period tilted the entire region toward the southeast.

# Hydrogeology

Recoverable groundwater in the Dockum aquifer is contained within the many sandstone and conglomerate beds that are present throughout the sedimentary sequence. The coarse-grained deposits form the more porous and permeable water-bearing units, whereas the fine-grained sediments form impermeable aquitards (Fallin, 1989). Consequently, the better groundwater flow zones are developed in the lower and middle sections of the stratigraphic sequence, where the coarse-grained sediments predominate. 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).

In West Texas, the Dockum aquifer overlies Permian-age beds and is overlain by the Cenozoic Pecos Alluvium. The aquifer typically is under confined or partially confined conditions where Dockum Group sandstones are in contact with the Cenozoic Pecos Alluvium.

## Water Levels and Groundwater Flow

Potentiometric maps drawn from water levels measured by the TWDB between 1981 and 1996 indicate that groundwater flow in the Dockum aquifer in West Texas is generally to

the southeast. Hydrographs of wells located in Crane, Ector, Loving, Reeves, Ward and Winkler Counties show a variety of water-level fluctuations. In Loving, Ector and Reeves Counties, the water table appears to have declined markedly whereas in Ward and Winkler Counties, it has remained relatively stable or has declined only slightly. The most significant water-level decline (almost 85 ft) was recorded in well 28-39-401 in Ector County. The decline presumably was the result of pumping in a nearby municipal water-supply well.

## Recharge

The Dockum aquifer is recharged by precipitation over areas where Dockum Group sediments are exposed at the land surface. Groundwater in the confined portions of the Dockum aquifer most likely originated as precipitation that fell on outcrops in eastern New Mexico. This recharge ceased when the Pecos and Canadian River Valleys were incised during the Pleistocene between the present-day Dockum aquifer in Texas and the paleo-recharge areas to the west (Dutton and Simpkins, 1986).

The Dockum aquifer is also recharged by upward leakage from the underlying Permian aquifer (Bassett and others, 1981; Bentley, 1981; Wirojanagud and others, 1984; Orr and others, 1985). Downward leakage into the Dockum aquifer occurs from the overlying Cenozoic Pecos Alluvium as a result of hydraulic-head differences between the aquifers (Dutton and Simpkins, 1986; Nativ and Gutierrez, 1988). Estimated annual recharge for outcrop areas and other areas in contact with overlying aquifers for the entire Dockum aquifer in Texas is approximately 31,000 acre-ft.

## Aquifer Properties

The hydraulic properties of the Dockum aquifer vary considerably from location to location. In West Texas, well yields measured by the TWDB ranged from approximately 23 gallons per minute (gpm) in Crane County to 353 gpm in Reeves County. Similarly, specific capacity ranged from 5.3 (Wink County) to 25 (Reeves County).

An aquifer test conducted on City of Kermit wells (Winkler County) by the TWDB in 1957 yielded an average transmissivity of 4,600 $ft^2$/day. These wells are completed in the Santa Rosa Sandstone that was described by Garza and Wesselman (1959) as a massive sandstone unit of limited areal extent. The storage coefficient was approximately $2.5\times10^{-4}$, which suggests that the aquifer in the test area is confined to partially confined.

## Groundwater Quality

Groundwater in the Dockum aquifer generally is of poor quality. It is characterized by decreasing quality with depth, mixed types of water, concentrations of total dissolved solids (TDS) and other constituents that exceed secondary drinking water standards over most of the area, and high sodium levels that may be damaging to irrigated land.

The chemical quality of water in the Dockum aquifer in West Texas ranges from fresh (TDS <1,000 milligrams per liter [mg/L]) in outcrop areas to moderately saline (TDS between 3,000 and 10,000 mg/L). Fresh water generally is present only at the edges of the Dockum basin, especially in outcrop areas where the aquifer is recharged. TDS ranges from 473 mg/L (Winkler County) to 4,040 mg/L (Reeves County). Water from the Dockum aquifer is typically hard, with $CaCO_3$ concentrations ranging from 203 mg/L (Ector County) to 1,394 mg/L (Crane County).

Where overlain by the Cenozoic Pecos Alluvium, groundwater in the Dockum aquifer is characterized by Ca-$SO_4$-mixed-anion-type waters. Groundwater samples collected from Ector County had gross alpha particle concentrations of 6 to 23 picocuries per liter (piC/L). The MCL established by the Texas Natural Resource Conservation Commission for gross alpha particle activity limit is 15 piC/L. Groundwater samples from Crane County had maximum radium-226 and radium-228 concentrations of 6.8 piC/L and 5 piC/L, respectively. The MCL for combined radium-226 and radium-228 is 5 piC/L. The occurrence of uranium in the Dockum Group has been known for years (McGowen and others, 1977) and is the source of the high concentrations of radium-226 and radium-228 detected in the groundwater samples.

Sodium in groundwater is a constituent that has neither an MCL nor a secondary standard but is still a concern where the water is used for irrigation purposes. Sodium adsorption ratios higher than 18 (which typically result in excess sodium in the soils) were detected only in groundwater samples from Ector County. These same samples also had residual sodium carbonate (RSC) values greater than 2.5 meq/L, suggesting that the water was not suitable for irrigation.

## Discharge

Discharge of groundwater from the Dockum aquifer occurs at pumping wells, small springs that contribute to stream base flow in the outcrop, evapotranspiration, and cross-formational flow. The greatest amount of discharge occurs from the pumping of wells installed in the aquifer.

Irrigation and public supply use is limited to areas of the Dockum aquifer where the water quality is acceptable, depth to water is shallow, and a sufficient thickness of sandstone exists to make the aquifer productive. Municipal users of Dockum aquifer water include the cities of Barstow, Kermit and Pecos. The Colorado River Municipal Water Authority also uses water from the Dockum aquifer.

Springs occur in areas where the Dockum sediments intersect the water table. Brune (1981) described springs issuing from the Dockum aquifer along the Pecos River Valley. Many of these springs are now dry or have lower flows than they did in the past.

# Conclusions

The Dockum aquifer in West Texas occupies a relatively small area and is only locally important where sufficient sandstone thickness and acceptable water quality are present. High TDS concentrations and salinity limit its use for many purposes.

Recharge of the Dockum aquifer only occurs in areas where the sandstone units are exposed at the surface or are in contact with overlying aquifers. However, since much of the Dockum aquifer in West Texas is confined, it receives little recharge so any water withdrawn from it is not immediately replenished.

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