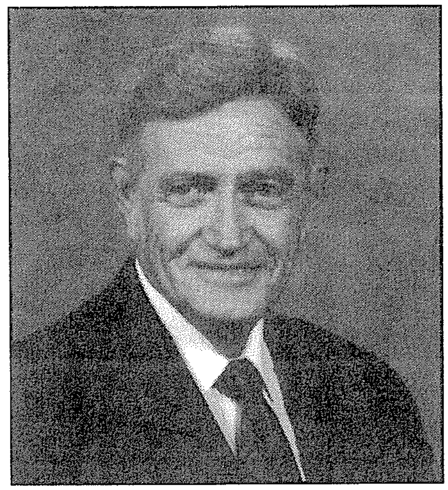
Tom Cliett graduated from Texas Western College in 1958 with a B.S. in geology. After graduating, he began a 32-year tenure as a groundwater geologist for El Paso Water Utilities. For the past six years, Tom has been a private consultant in the areas of groundwater exploration, well design and wellfield design.



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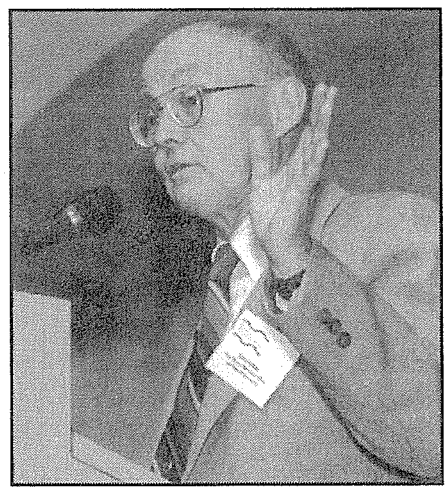

GENERAL GEOLOGY AND GROUNDWATER OCCURRENCE OF THE EL PASO AREA

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INTRODUCTION

Local groundwater resources available to the City of El Paso occur in two middle-late Tertiary age structural basins: the Hueco Bolson, lying east of the Franklin-Organ Mountains chain and the Mesilla Bolson, lying to the west of the chain.

Types of sedimentary sequences in the basins are similar within the aquifer systems but vary mostly in the zones below the potable groundwater deposits and the lower bedrock. Materials that make up the aquifer systems are de rived from the same or similar sources.

HUECO BOLSON

The Hueco Bolson is a northwest/southwest trending intermontane basin located in eastern El Paso County and western Hudspeth County, Texas, a short distance into south-central New Mexico and into the northern part of the state of Chihuahua, Mexico.

Structurally the basin is a graben bounded by the Franklin and Organ Mountains on the west, and the Sierra de Juárez, Sierra del Presidio, and Sierra de Amargosa ranges on the southwest in Mexico. The eastern margin is the west boundary of the Diablo Plateau and includes the Hueco and Quitman Mountains in Texas (Figure 1).

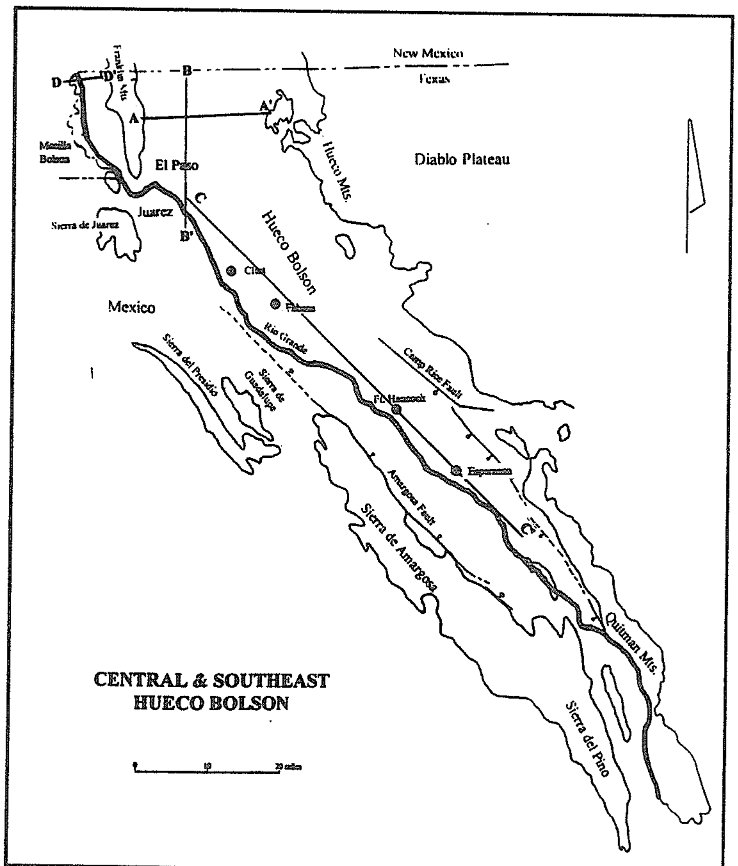

Figure 1. Central and southeast Hueco Bolson.

The top of the graben, between the Franklin and Hueco Mountains, is the base of the basin sedimentary units that include the aquifer systems of the Hueco Bolson (Figure 2, AA′). Graben bedrock consists mostly of Paleozoic limestones which dip westward toward the Franklin Mountains in the central part of the basin, but in the southeastern portion bedrock is made up of Cretaceous limestone and older carbonates.

Collins and Raney (1991) have shown that the bounding faults in the southwestern part of the Hueco Bolson near the Fort Hancock, Texas area are the Diablo Plateau fault scarp, including the Camp Rice Fault, and the Amargosa Fault of the Sierra de Amargosa in Chihuahua, Mexico (Figure 1).

The basin is partially filled with Tertiary to Recent age sediments consisting of fluvial, lacustrine and eolian deposits that exceed 10,000 feet in thickness in the central part of the basin. Portions of the basin fill were transported and deposited by fluvial action of the ancestral Rio Grande from areas at considerable distances from the basin and represent an important part of the aquifer systems. Most of the basin facies, however, are lacustrine deposits of clay, silt and lenses of fine sand (Cliett 1969).

Basin deposits are divided into two units based upon interpretations of seismic data (Figure 3, CC′). A reflector bed included in the deeper central basin is used as a marker separating the units and have been designated as the Lower basin fill unit and Upper basin fill unit (Collins and Raney 1991).

Near Fort Hancock the Lower Unit, overlying pre-Tertiary bedrock, is about 3,000 feet thick but thins to 0 about 15 miles southeast of Fort Hancock. The Upper unit is about 2,000 feet thick and thins to a few feet near the Quitman Mountains which appear to mark the southeastern terminus of the Hueco Bolson.

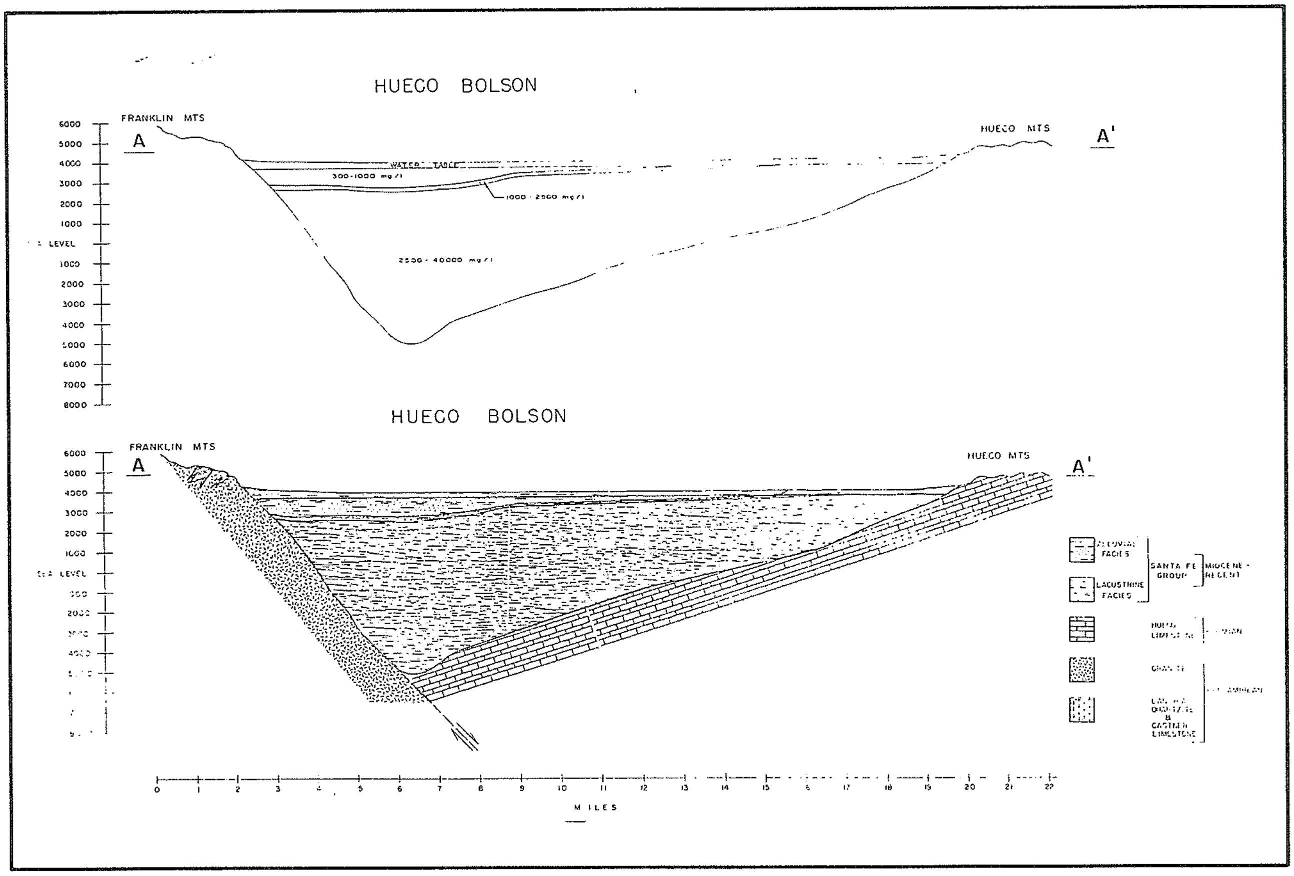

Figure 2. Groundwater quality and general geology of the Hueco Bolson.

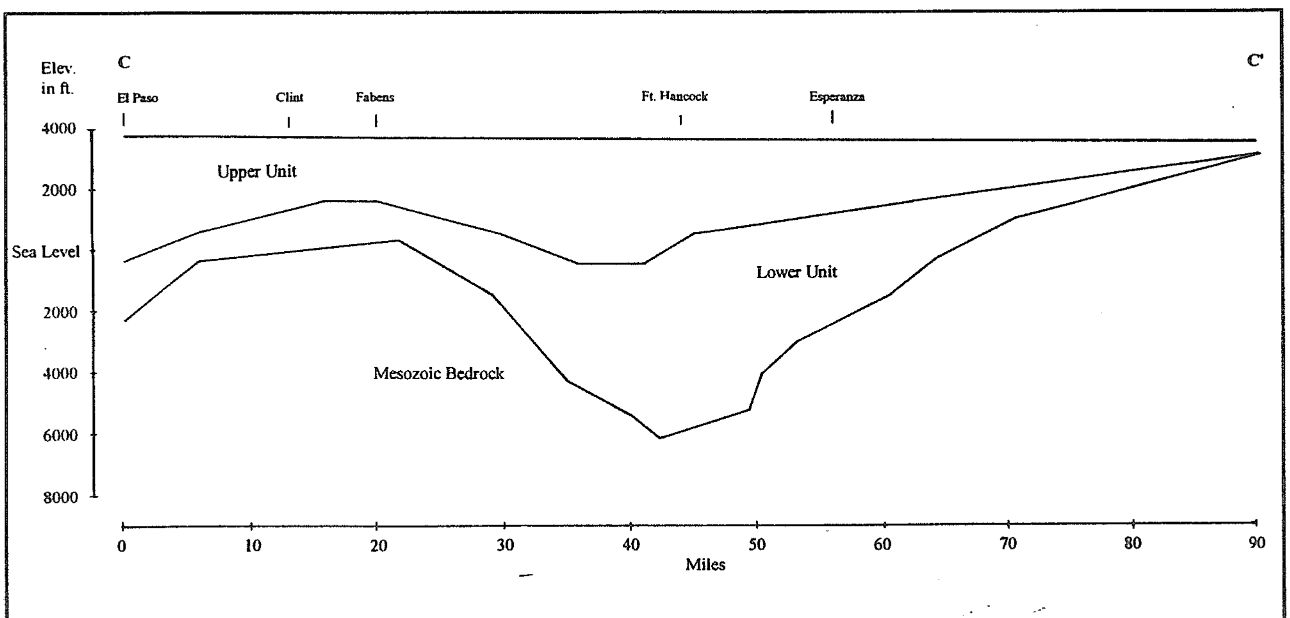

Figure 3. Cenozoic basin fill units of the central-southeast Hueco Bolson.

Aquifer systems in the Hueco Bolson are made up of the unconsolidated sand, gravel, clay and silt lenses of the Fort Hancock Formation, Camp Rice Formation and Rio Grande Alluvium. The Fort Hancock and Camp Rice formations are included in the Santa Fe Group deposits ranging in age from early Miocene to late Pleistocene. The Rio Grande Alluvium, which is superimposed on the older basin deposits in the Rio Grande Valley, is of recent age related to fluvial actions of the present day Rio Grande. A distinction between formations is not made in the cross sections of this report but Figure 2 (AA′) defines the Santa Fe Group in the central Hueco Bolson.

Groundwater Occurrence

Groundwater occurs under both unconfined and confined conditions in the Hueco Bolson. In the valley area near downtown El Paso two water tables are identified. Shallow water levels, ranging from 5 to 15 feet below ground level near the Rio Grande to 30 to 40 feet near the northern edge of the floodplain, define the unconfined water table of the Rio Grande Alluvium. The lower water levels, ranging from about 180 feet near downtown El Paso to 40 feet near Ysleta, mark the piezometric surface of the confined groundwater system.

The confined groundwater in the valley aquifer system becomes unconfined above the valley escarpment and throughout the mesa area of the Hueco Bolson where the Rio Grande Alluvium is absent.

Groundwater Quality

Groundwater quality varies widely throughout the Hueco Bolson, ranging from fresh water in the Camp Rice Formation to brine in the Fort Hancock Formation. Quality designations used in this report are in accordance with the U.S. Geological Survey classification of water which is based upon total dissolved solids (TDS) content. The classifications are as follows:

Classification	TDS (mg/l)
Fresh	< 1,000
Slightly Saline	1,000-3,000
Moderately Saline	3,000-10,000
Very Saline	10,000-35,000
Brine	> 35,000

The thickest sections of fresh groundwater in the Hueco Bolson occur in the central part of the basin with almost 1,000 feet of fresh water occurring in the upper Santa Fe Group (Figure 2). Fresh water thins south of the central basin to the Rio Grande Valley where it occurs below the Rio Grande Alluvium (Figure 4, BB′). It also thins to the east where large volumes of slightly saline water occur in the upper part of the Fort Hancock Formation and where there is an absence of the Camp Rice Formation, both of which are in the upper Santa Fe Group (Figure 2, AA′).

Groundwater quality contained in the Rio Grande Alluvium also varies but is mostly slightly saline to moderately saline. TDS values range from 1,000 mg/l to 5,000 mg/l or more in the valley area near downtown El Paso to the southeastern end of the basin. Generally groundwater mineralization is higher in areas where crop irrigation once occurred but have now been urbanized.

MESILLA BOLSON

The Mesilla Bolson is a structural basin occurring on the southern end of a series of structural basins that lie along the Rio Grande Rift extending from south-central Colorado through central New Mexico. The basin covers almost 1,000 square miles from the Robledo-Doña Ana Uplift on the north extending south into northern Mexico (Wilson et al. 1981). Only a minor portion of the Mesilla Bolson occurs in Texas (Figure 1).

Tectonic processes that formed the basin include pronounced volcanic activity and crustal rifting that have caused extensive blocks within the basin to sink relative to the bounding mountain ranges (Hawley and Lozinsky 1992).

The basin has been partially filled with alluvium derived from surrounding mountain ranges and include lacustrine, fluvial and eolian deposits. Thicknesses of the fill material throughout the basin range from 1,500 feet to 2,500 feet with the Santa Fe Group being the dominant units. Below the Santa Fe Group is a thick section of lower to middle Tertiary volcanics and lower Tertiary sedimentary rocks.

Hawley and Lozinsky (1992) have subdivided the Santa Fe Group into lower, middle and upper lithostratigraphic units with the lower and middle generally correlated with the Fort Hancock. However, the

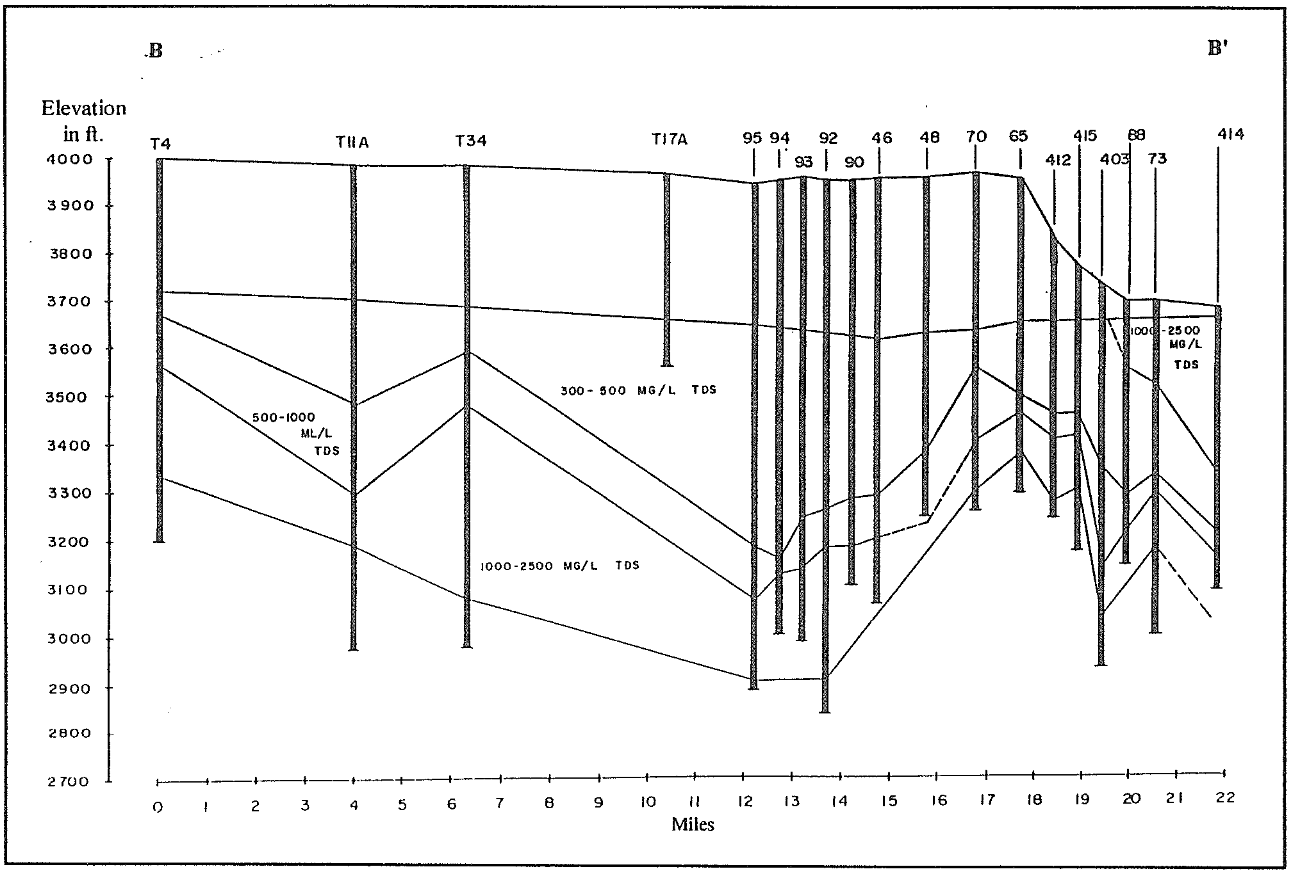

Figure 4. Groundwater quality of the Hueco Bolson system.

basin fill above the lower Tertiary units has two basic hydrologic components which they have termed the Santa Fe Group basin fill and the Rio Grande Valley fill.

Groundwater Occurrence

Groundwater occurs under water table conditions (unconfined) in the Rio Grande Valley fill within the river valley system and is correlatable in age with the Rio Grande Alluvium in the Hueco Bolson. Static levels may range from 3 feet near the Rio Grande to 20 feet near the boundaries of the valley and will vary seasonally with irrigation applications, river flow, drain flow and precipitation.

Artesian conditions (confined water table) occur in the Santa Fe Group which have been recorded throughout the El Paso Water Utilities' Cañutillo wellfield since the early 1950s. Production zones within the Cañutillo wellfield are divided into deep, intermediate and shallow with the deep and intermediate occurring in the Santa Fe Group and the shallow in the Rio Grande Valley fill (Figure 5, DD').

Groundwater Quality

Typical ranges of TDS in groundwater in the deep and intermediate zones can be seen in Figure 5 (DD'). The cross section shows vertical and horizontal variances within each zone, but in general the deep zone contains water less than 500 mg/l TDS throughout the largest portion of the field and the intermediate quality will average about 500 mg/l. Quality deteriorates to the east and south of the field in both the deep and intermediate.

Quality of water in the shallow zone varies sometimes widely from well to well ranging from 600 mg/l to about 2,500 mg/l within the Cañutillo wellfield. However, in the southern end of the basin, TDS content may exceed 15,000 mg/l TDS where shallow bedrock creates a barrier and impedes groundwater movement from the valley groundwater system.

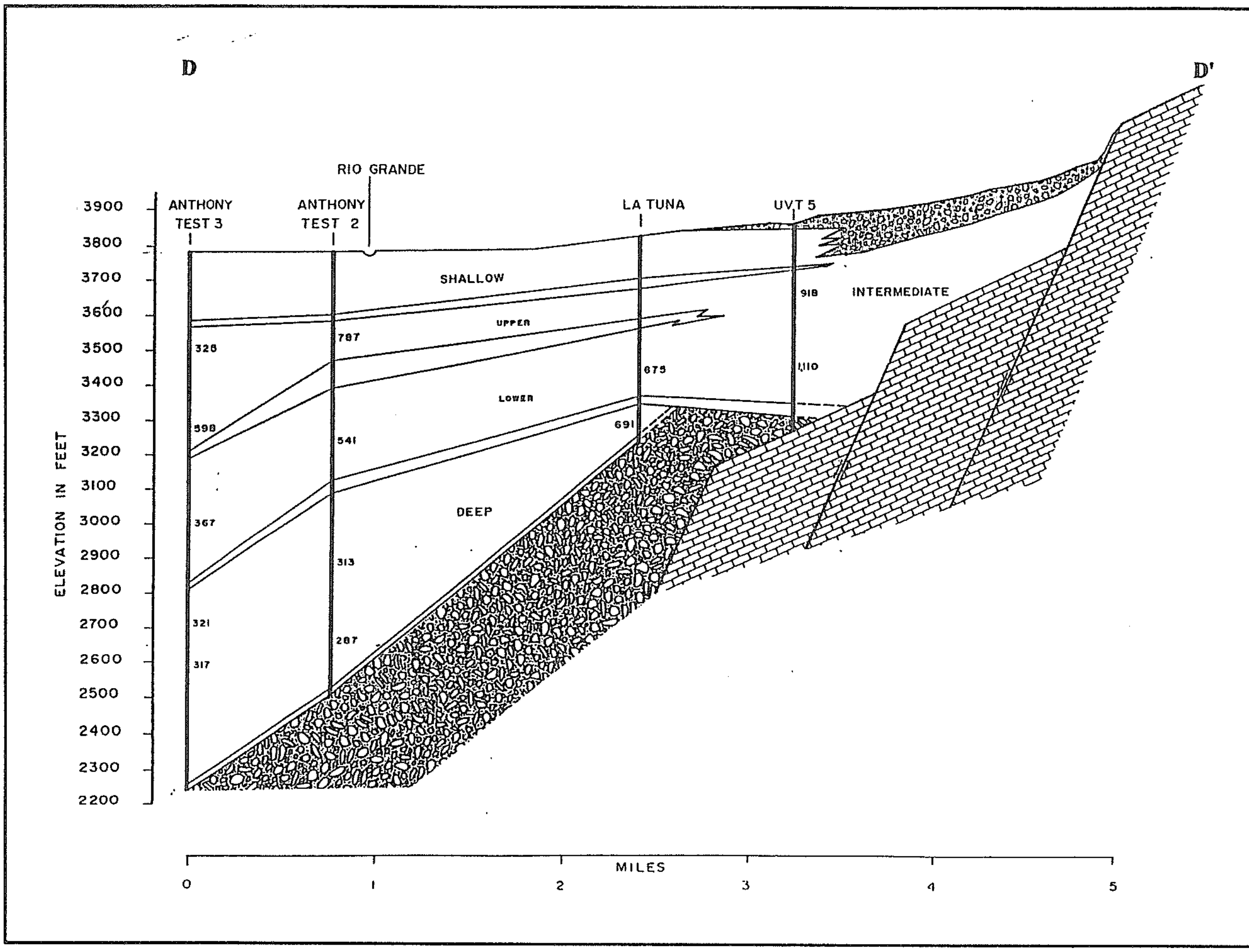

Figure 5. Groundwater quality of the Mesilla Valley system.

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