# 3.0 OVERVIEW OF HUECO BOLSON

The Hueco Bolson covers about 2,500 square miles, or 1.6 million acres in New Mexico, Texas, and Chihuahua (Figure 3-1). In Texas, the Hueco overlies portions of El Paso and Hudspeth Counties. The Tularosa Basin in New Mexico bounds the Hueco on the north. The boundary between the Tularosa and the Hueco is not a geologic or hydrologic boundary, and groundwater flows from the Tularosa into the Hueco. EPWU wells in the Hueco are limited to a relatively small portion of the basin as shown in Figure 3-2.

Heywood and Yager (2003, pg. 2) describe the geology of the Hueco Bolson as follows:

> *"The Hueco Bolson is a fault-bounded structural depression associated with the Rio Grande Rift. At the inception of Rio Grande rifting about 26 million years ago (Chapin and Seager, 1975), normal faults accommodated regional extension, resulting in downdropped structural grabens. Igneous rocks of Precambrian age and sedimentary rocks of Paleozoic and Mesozoic age surround and underlie the Hueco Bolson. Unconsolidated to poorly consolidated deposits of Tertiary and Quaternary age consisting primarily of gravel, sand, silt, and clay have filled the basin. These deposits compose the alluvial-aquifer system known as the Hueco Bolson."*

Rio Grande alluvium overlies Hueco Bolson deposits in the valley portions of the area. The approximate extent of the alluvium is shown in Figure 3-3. The alluvium is relatively thin (about 200 feet).

In cross-section (Figure 3-4), it can be seen that the Hueco is a deep basin that is bounded by faults along the Franklin and Hueco Mountains. Note that the cross-section also provides a generalized view of the occurrence of fresh and brackish groundwater. Fresh groundwater is limited to a relatively thin lens on the western side of the Hueco. The Hueco is a deep basin, but groundwater at depth has high salinity.

The Rio Grande and the associated ditches and drains interact with the groundwater in the Hueco depending on the relative elevations of the surface water and groundwater. Conceptual diagrams of the relationship are presented in Figure 3-5. In condition (a), groundwater elevations are higher than the elevation of the surface water. This was the case prior to high pumping, and the result was a gaining stream that was fed by groundwater discharge.

In condition (b), groundwater elevations are lower than the surface water elevation due to pumping, but the water table is still connected to the surface water. The surface water in this condition acts as a source of recharge (referred to as induced inflow). The rate of induced inflow increases as pumping increases until condition (c) is reached. In this situation, the groundwater table has dropped to below the bottom of the surface water (disconnected), and the rate of induced inflow is at its effective maximum, and varies only as a function of the depth of water in the stream.

Lippincott (1921, pg i) was apparently the first to discuss the interaction of the Rio Grande and the Hueco Bolson. After reviewing the history of groundwater level declines and water quality changes in the Mesa wellfield, Lippincott (1921, pg. i) concluded that the wells were being fed, in part, from the Rio Grande. The location of the Mesa wellfield that was investigated is presented in Figure 3-6. Lippincott (1921, pg, h), however, was not able to quantify the supply of the wellfield ("(t)his water supply is unmeasureable and speculative").

As pumping continued, more data were collected, and the science of hydrogeology improved over the decades, the understanding of the interaction also improved. In a report by the Texas Board of Water Engineers (a predecessor agency of the Texas Water Development Board), Smith (1956, pg. 11) provided one of the earliest qualitative discussions:

> *"The only apparent feature in the district that would account for retarded development of the cone of depression is the area of natural discharge in the Rio Grande Valley. The coarse alluvial fill in the valley (shallow aquifer) and the underlying bolson deposits (deep aquifer) may be considered two separate aquifers, although they are hydraulically connected by material of irregular thickness and relatively low permeability. Prior to the development of groundwater resources in the area, the head in the deep aquifer exceeded the head in the shallow aquifer and water was discharged from the deep aquifer to the shallow aquifer. As pumping causes the head in the deep aquifer to decrease, discharge to the shallow aquifer decreases, and, in places where the head in the deep aquifer is below the head in the shallow aquifer, the flow is reversed."*
>
> *"The recharge-discharge relationship between the two aquifers has changed progressively because the head has decreased in the deep aquifer more rapidly than in the shallow aquifer. The progressive difference between the pumping rates and depletion rates previously mentioned probably are directly related to the changing recharge-discharge relationship in the valley."*

In 1976, a US Geological Survey investigation presented a quantitative estimate of the interaction between groundwater and surface water. Meyer (1976, pg. 24) recognized that the Rio Grande was a gaining stream until the mid-1930s, after which the Rio Grande began to lose water at a rate that increased as pumping increased. The deeper pumping induced this recharge from the Rio Grande, and the water first recharged the shallow alluvium prior to recharging the bolson. Meyer (1976, pg. 24) summarized the results of a groundwater flow model in the context of the history of the impact of the pumping:

> *"Since 1903, slightly more than 2 million acre-feet of water has been pumped from the bolson aquifer. The model shows that of this amount, about 50 percent was removed from storage in the water table part of the bolson aquifer, 25 percent was contributed by leakage from the alluvium, and the rest was derived from natural recharge".*

It can be seen that from 1921 to 1976, the understanding of the groundwater in the El Paso area evolved from considering the groundwater resources of the Hueco "unmeasureable and speculative" to a quantitative understanding of the relationships between pumping, storage decline, natural recharge and leakage from the alluvium. After 1976, data continued to be collected and studies and interpretations of those data continued. Many of these more recent studies are described in more detail in this report.

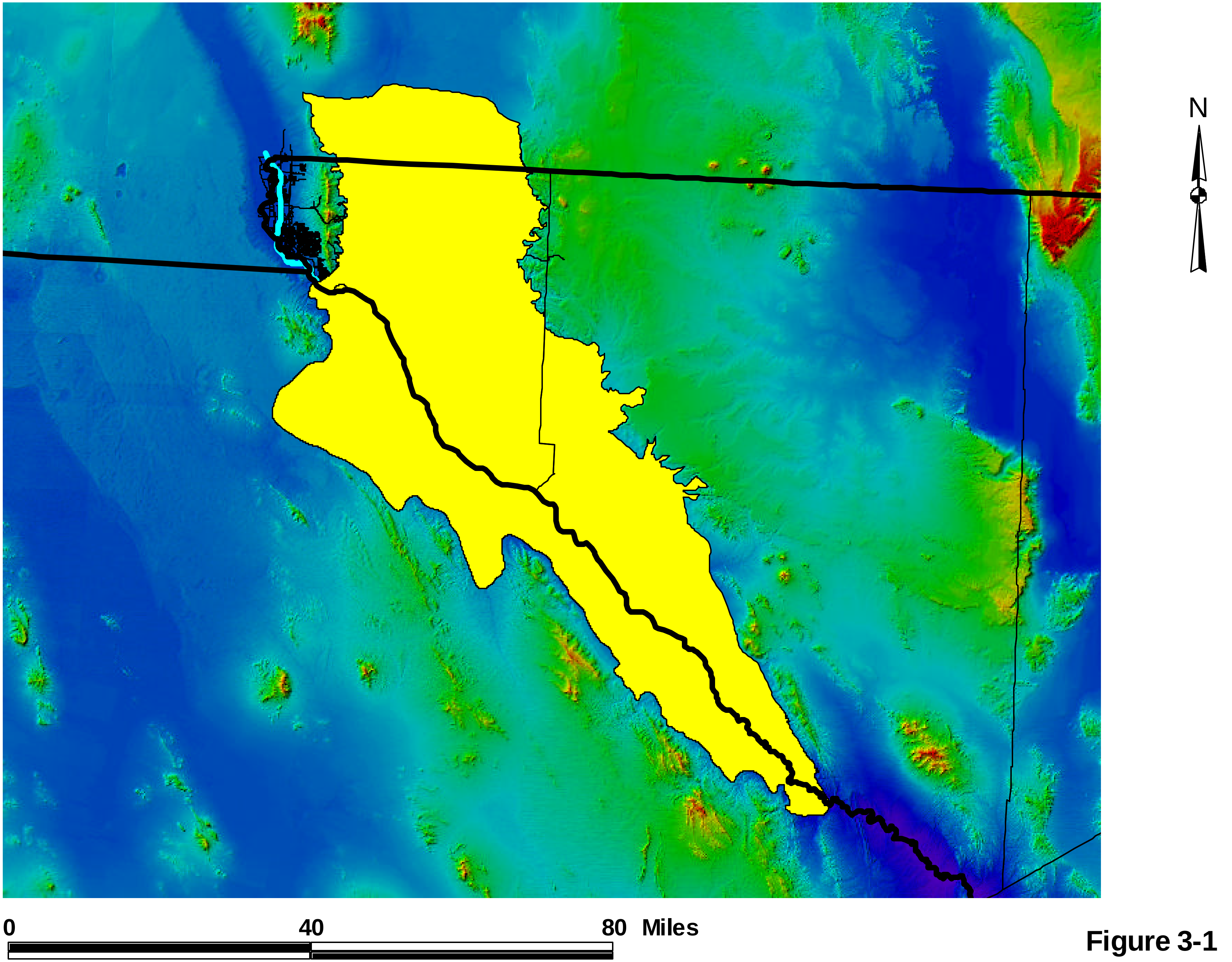



**Figure 3-1**
**Hueco Bolson**

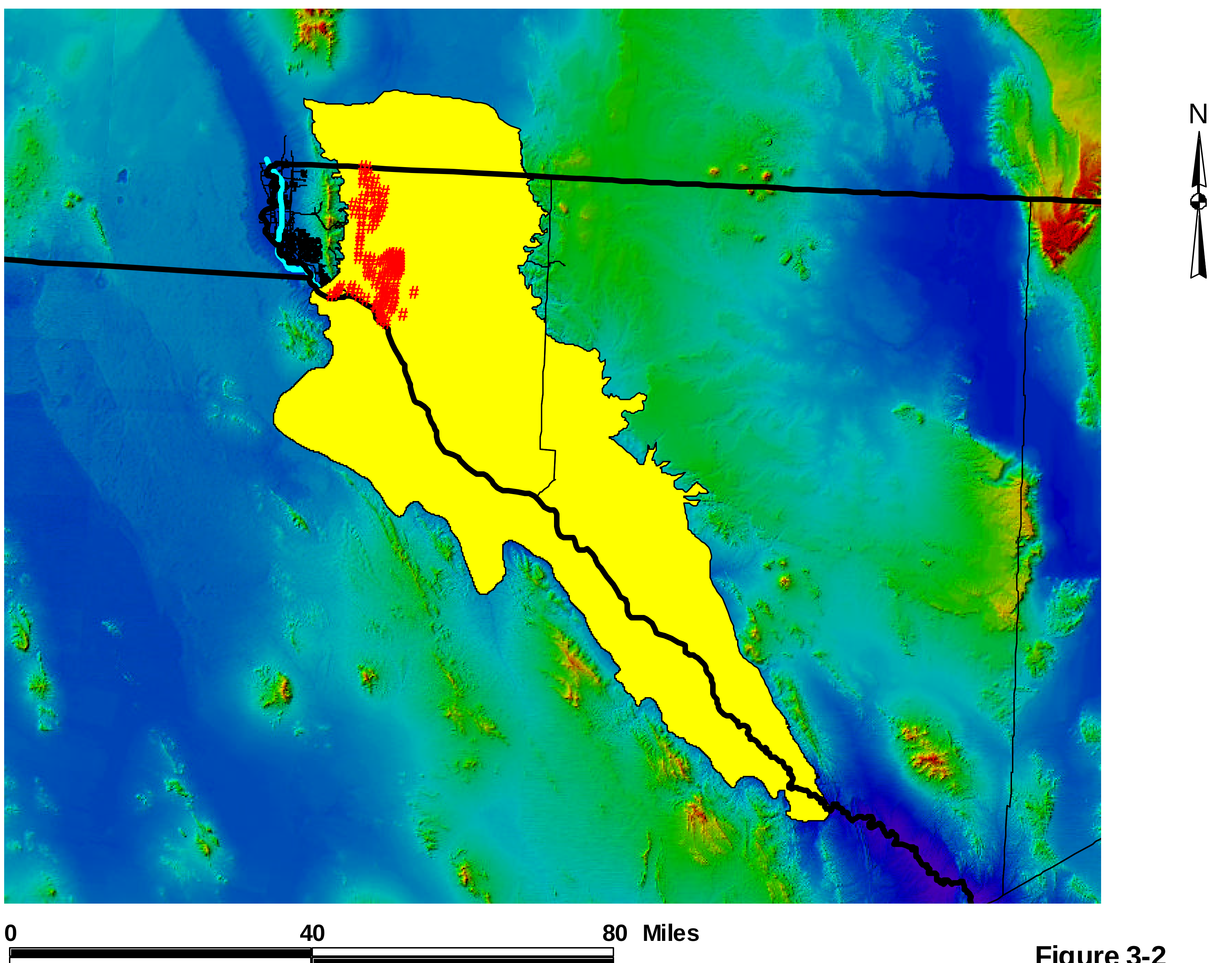



**Figure 3-2**
**Hueco Bolson with EPWU Wells**

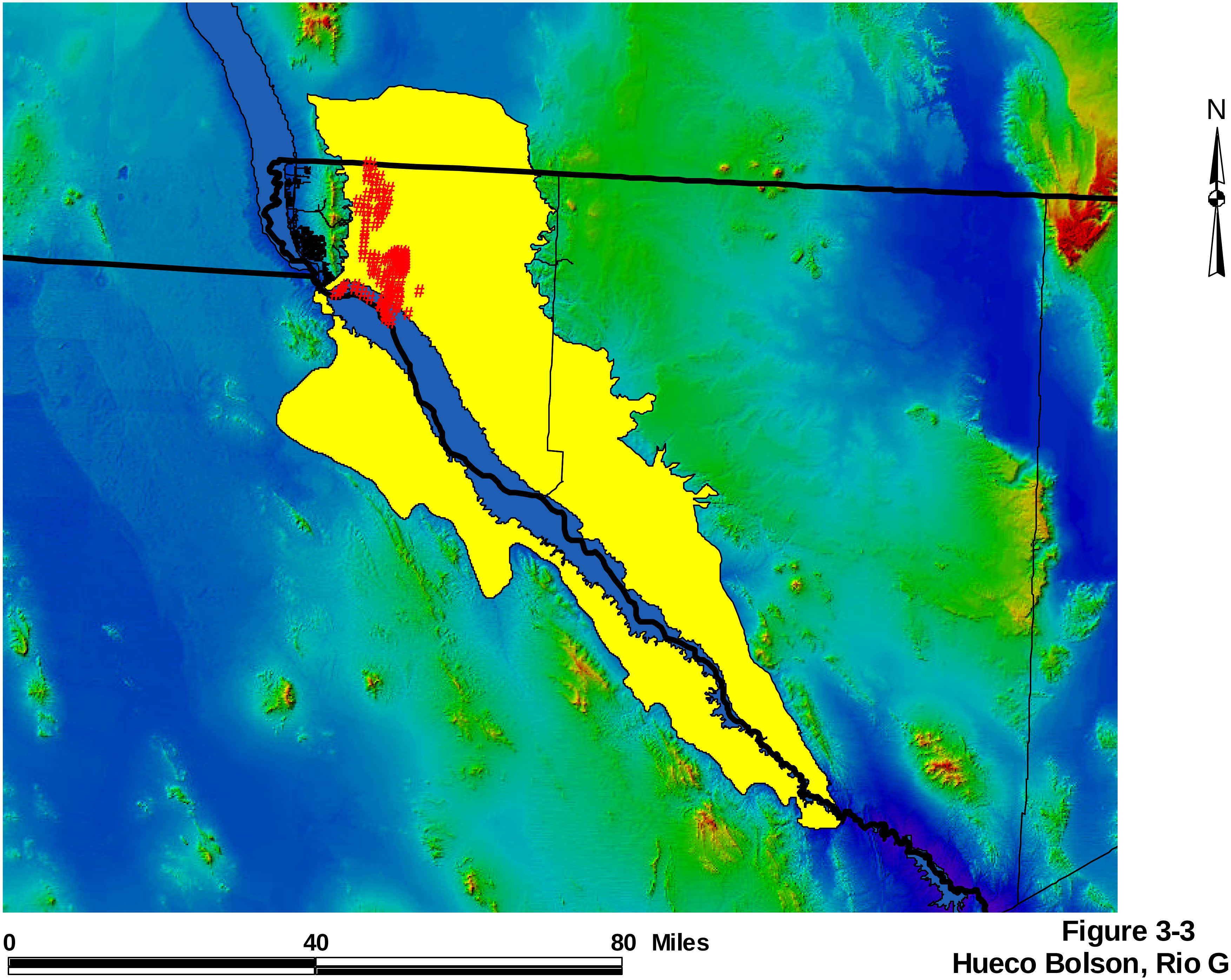



**Figure 3-3**
**Hueco Bolson, Rio Grande Alluvium with EPWU Wells**

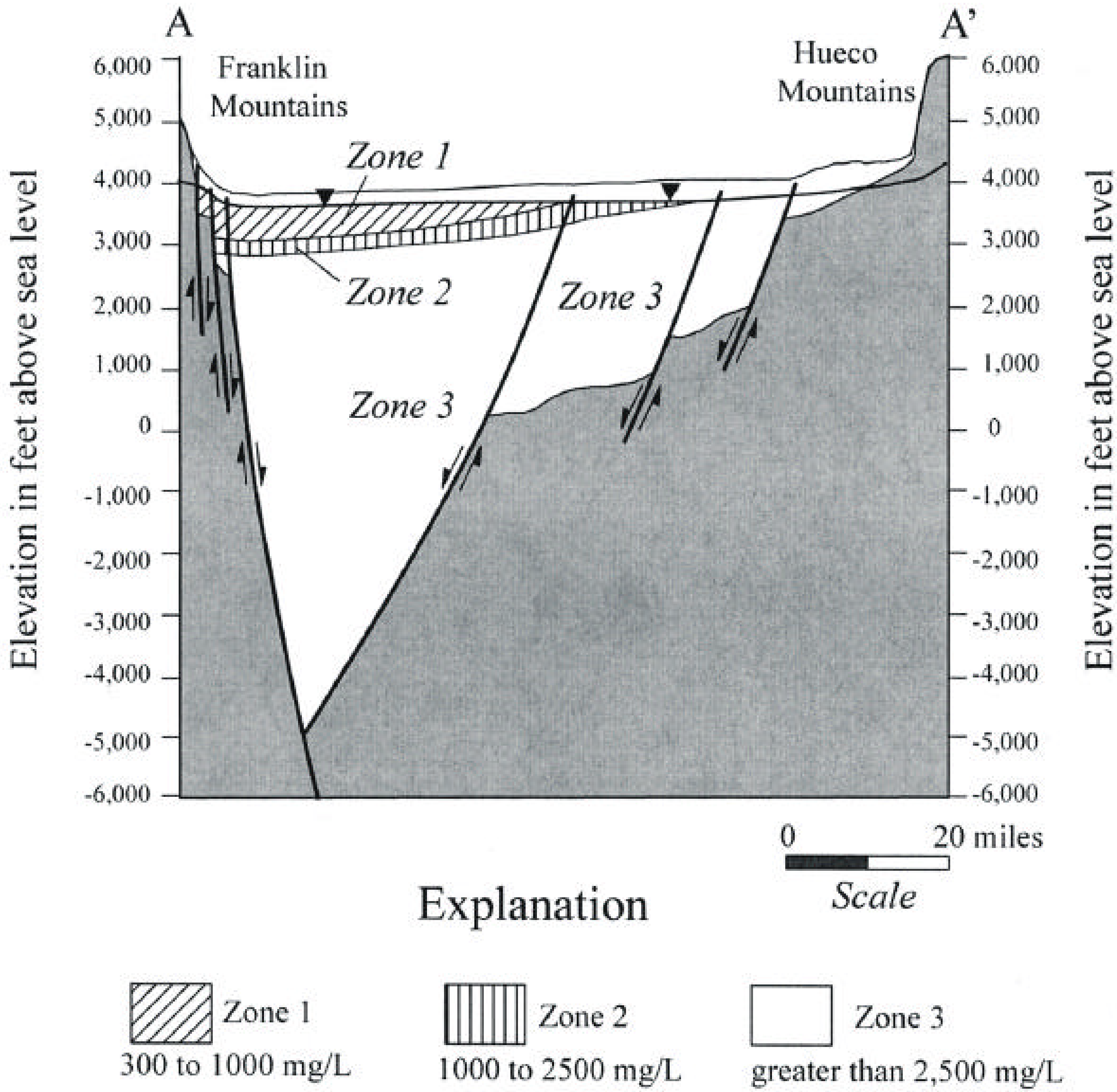
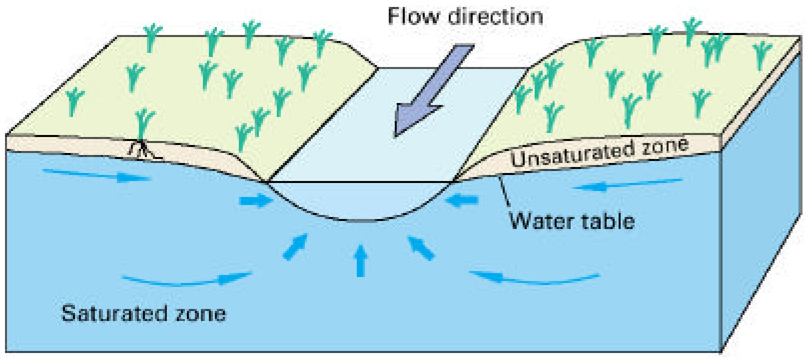
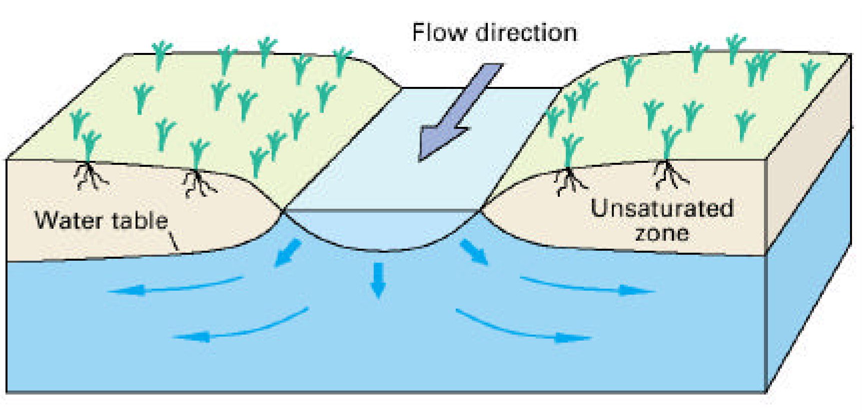



Figure 3-4
Hueco Cross Section

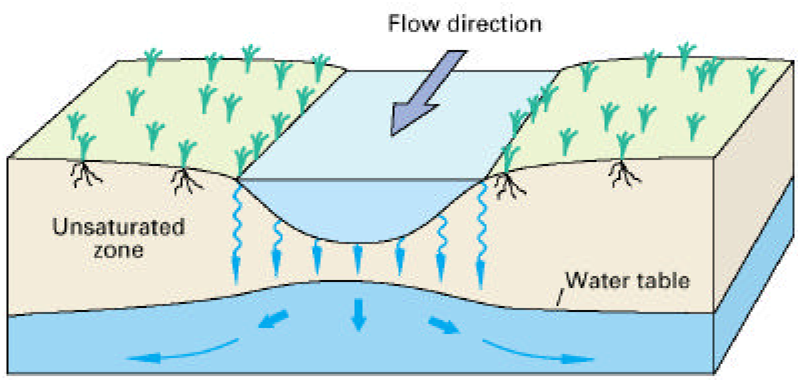
**Figure 3-5**
**Surface Water/Groundwater Interaction**




**(a) Gaining Stream**




**(b) Losing Stream**




**(c) Losing Stream with Disconnected Water Table**

Diagrams from Alley and others (1999, pg.31)

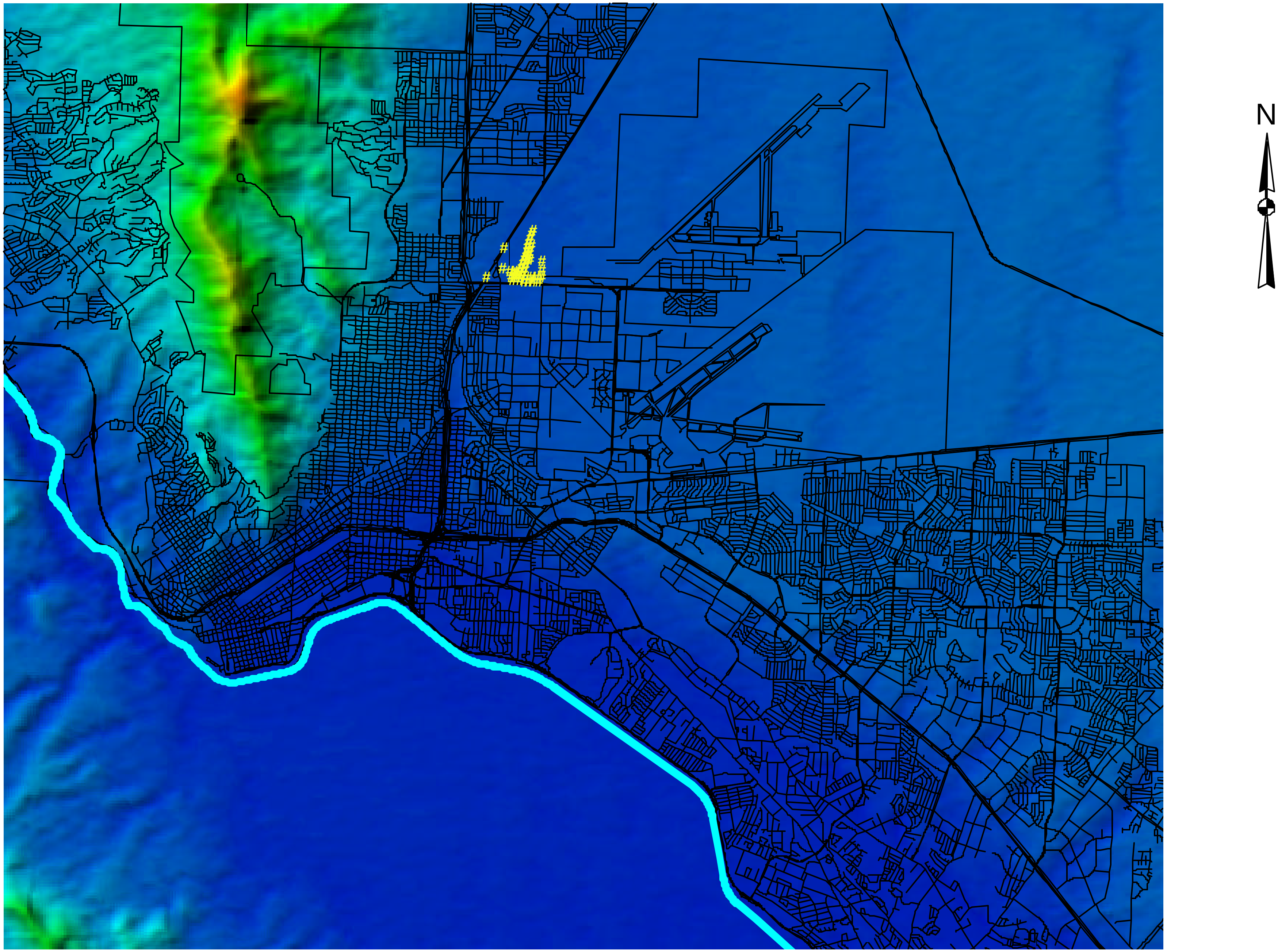



**Figure 3-6**
**Location of Mesa Wellfield**
**Discussed by Lippincott (1921)**