A REVIEW AND EVALUATION OF THE AVAILABLE HYDROLOGIC DATA ON THE GROUNDWATER RESOURCES UNDER THE EL PASO COUNTY WATER AUTHORITY AND FABENS WCID LEASES

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Prepared for

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Geraghty & Miller, Inc. is submitting this report to HDR Engineering and the El Paso County Water Authority on the groundwater resources review of the EPCWA and Fabens WCID leases. The report was prepared in conformance with Geraghty & Miller's strict quality assurance/quality control procedures to ensure that the report meets the highest standards in terms of the methods used and the information presented. If you have questions or comments concerning this report, please contact one of the individuals listed below.

Respectfully submitted,

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A REVIEW AND EVALUATION OF THE AVAILABLE HYDROLOGIC DATA ON THE GROUNDWATER RESOURCES UNDER THE EL PASO COUNTY WATER AUTHORITY AND FABENS WCID LEASES

INTRODUCTION

Two well fields are currently utilized by the El Paso County Water Authority (EPCWA) in El Paso County, Texas. These well fields are the Wheeler well field and the Desert well field (Figure 1). The EPCWA has a long-term groundwater rights lease for the University Block L well field but does not currently utilize this well field for water supply. One well field is currently utilized by the El Paso County Water Control Improvement District No. 4 (Fabens WCID). An evaluation of the available groundwater reserves and quality in the four fields is necessary to determine whether the future water demands of the EPCWA and Fabens WCID can be met from these fields. The EPCWA owns the water rights for the Wheeler well field and has easements for groundwater rights in the Desert well field. The Fabens WCID owns the water rights to their well field.

The purpose of this study was to perform an assessment of groundwater resources under the EPCWA and Fabens WCID leases. In addition, recommendations were prepared from the available groundwater information identifying the potential for well field expansion and new well field locations. A program was prepared to further explore the groundwater resources in the undeveloped parts of the fields.

This study utilized reports from the EPCWA, El Paso Public Service Board (EPPSB), the University of Texas at El Paso (UTEP), the Bureau of Economic Geology (BEG), the United States Geological Survey (USGS), the Texas Natural Resources Conservation Commission (TNRCC) and the Texas Water Development Board (TWDB).

GENERAL GEOLOGY

The four well fields lie within a geologic basin called the Hueco Bolson. The Hueco Bolson is situated in the southeastern part of the Basin and Range physiographic province. It was formed by normal faulting of Tertiary- and Quaternary-age rocks which resulted in alternating structurally high mountain blocks and structurally low basins. The consolidated sedimentary and igneous rocks of the mountain and upland regions have been weathered, eroded and redeposited in the Hueco basin as unconsolidated sediments. These sediments consist of clays, silts, sands and gravels.

The basin is bordered on the north by the Organ Mountains, on the west by the Franklin Mountains and the east by the Hueco Mountains. The basin extends into Mexico to the south.

At least three main lithologic sequences are recognized in the Hueco Bolson: the unconsolidated alluvium deposits, the unconsolidated bolson deposits and the consolidated igneous and sedimentary deposits. Each of these three sequences exhibits different hydrologic characteristics and will be discussed later in the Hydrology Section. The geology of the three lithologic sequences is discussed below.

RIO GRANDE ALLUVIUM

The alluvium sediments, which form the floodplains of the Rio Grande, overlie the bolson deposits in the upper and lower El Paso Valley and are composed of unconsolidated gravel, sand, silt and clay. The alluvium was in part derived from the erosion and redeposition of bolson deposits. The aerial extent of the Rio Grande alluvium is illustrated in Figure 2. The individual layers and lenses of the various sediments are non-uniform in character, thickness and aerial extent and cannot be correlated from one location to another. These sediments are of Recent age and are reported to have a thickness of up to 200 feet in some areas.

HUECO BOLSON

The Hueco Bolson deposits consist of alternating layers of clay, silt, sand and gravel ranging in thickness from a fraction of an inch to nearly one hundred feet. The sediments in many places contain nearly as much sand as clay, and the sand is composed of fragments of chert, granite and porphyry. Sands and gravels associated with the bolson deposits are, for the most part, restricted to the upper few hundred feet of the formation. The thickest and coarsest portions of the bolson deposits are near the Franklin mountains; the material (sediments) in the bolson become generally finer and thinner to the east. Caliche is also found in some areas beneath the surface of the bolson deposits.

Like the Rio Grande alluvium, the layers encountered in the Hueco Bolson are not correlatable from well to well. Not only do the individual beds thicken and thin and pinchout from place to place, but the whole section may change within a short distance and the percentage of sand and gravel in relation to clays and silts may vary within wide limits.

The total thickness of the bolson deposits under the EPCWA and Fabens WCID properties is not known with any degree of certainty. State observation well No. 49-40-512, located near the southeastern end of the University Block L property, has a reported total depth of 1,018 feet and was completed in the bolson deposits. The thickest section of basin fill occurs along the Franklin Mountains where as much as 9,000 feet of sediments have been projected from seismic-refraction and resistivity data. In the southeastern portion of the bolson, the basin fill is from 1,000 to 3,000 feet thick.

SEDIMENTARY AND IGNEOUS DEPOSITS

Consolidated rocks of sedimentary and igneous origin crop out in the mountains and upland areas and underlie the bolson deposits. The igneous rocks are exposed in relatively large areas in the Franklin Mountains and in isolated areas in the southern part of the Hueco Mountains. The consolidated sedimentary rocks consist of limestone, quartzite, sandstone and shale. The limestone deposits range in age from Devonian to Permian and are at least 3,450 feet thick.

GENERAL HYDROLOGY

Groundwater in the vicinity of the EPCWA and Fabens WCID properties occurs in the Hueco Bolson deposits which consist of alternating beds of clay, silt, sand and gravel and the overlying Rio Grande alluvium which also consists of clay, silt, sand and gravel. Because no regional impermeable geologic layer is known to separate the bolson deposits from the river alluvium, they are believed to be hydraulically connected. Under these conditions, groundwater may move from one layer to the other in response to hydraulic pressure. Water quality associated with these aquifers is fresh to slightly saline. Groundwater also occurs in the deeper consolidated limestone and sandstone formations. However, it is usually very highly mineralized and generally unacceptable for municipal purposes.

Groundwater recharge to the northern Hueco Bolson, which includes areas in New Mexico, Texas and Ciudad Juarez, Mexico, amounts to about 5,640 acre-feet per year (Meyer, 1967) and occurs principally from precipitation, runoff and infiltration along the Organ and Franklin Mountains in New Mexico and Texas and the Sierra Juarez Mountains in Mexico. The runoff enters the Hueco Bolson through sands and gravels located near the base of the mountains. Discharge from the Bolson occurs from both pumpage and naturally from seepage into the upper alluvium.

RIO GRANDE ALLUVIUM AQUIFER

The groundwater associated with the Rio Grande alluvium is hydraulically connected to the unlined portion of the Rio Grande River. The alluvium is recharged by the Rio Grande River during periods of pumping from wells in the valley and by infiltration from precipitation and irrigation return flow. A study was performed in an area southeast of El Paso where the Rio Grande was lined with concrete. The reduction in the water levels of wells in the vicinity of the lined portion of the river implies that the Rio Grande discharged into the upper alluvium in this area prior to lining. The quality of water in the Rio Grande River is poor which, during periods of recharge into the alluvium, could have an adverse effect on the quality of the alluvium aquifer.

Groundwater in the Rio Grande alluvium occurs under water table conditions. Recent water level data was not available for this study. Regional water level data reported in 1980 (Texas Water Development Board, Report 300) indicated a southerly movement of the groundwater. However, the extensive groundwater withdrawal in the lower valley for irrigation and water supply has locally affected the gradient of the groundwater.

The Rio Grande alluvium is present in the Fabens WCID well field, the University Block L well field and the Wheeler well field but appears to be absent in the majority of the Desert well field.

The lithologic characteristic of the alluvium and bolson deposits are very similar and difficult to distinguish since the upper alluvium is a product of the erosion and redeposition of the bolson deposits. Water quality is the primary method of distinguishing between the two formations. The quality of the groundwater in the alluvium is generally poorer than the quality of the groundwater in the bolson deposits.

HUECO BOLSON AQUIFER

The Hueco Bolson Aquifer exhibits artesian conditions within the valley area but water table conditions in the mesa portion of the bolson. As the water moves through the mesa portion of the bolson, it passes under aquitards or restrictive layers which retard upward movement of the bolson water into the Rio Grande alluvium in the vicinity of the lower valley. The water then demonstrates artesian pressure exerted by the higher elevation of the water surface underlying the mesa.

SEDIMENTARY AQUIFER

Groundwater associated with the lower sedimentary aquifer occurs in limestone and sandstone formations. The occurrence of groundwater in these formations is controlled largely by the physical character and structure of the rocks. The porosity of the rocks has been formed by earth movement and solution (secondary porosity). The porous and permeable zones in the rocks are not uniform and gradually disappear with depth. The groundwater associated with the limestone formations appears to be confined. The water level rose several hundred feet above the point where the water was first encountered in wells which penetrated the limestone formation. Tests associated with the limestone formations have shown that even though extensive fracturing exists, the limestone exhibits very low production rates.

GENERAL GROUNDWATER QUALITY

RIO GRANDE ALLUVIUM AND HUECO BOLSON AQUIFER QUALITY

The water quality of the alluvium aquifer is generally poorer than that of the bolson aquifer. This can be attributed, in part, to the poor quality water that enters the alluvium through recharge from the Rio Grande River and through infiltration of irrigation water. In areas where the alluvium aquifer overlies the bolson aquifer, the alluvium can have an adverse effect on the water quality of the bolson aquifer.

Under static water table conditions, the greater density of the alluvium water compared to that in the bolson aquifer quality is apparently not great enough to induce significant commingling of the aquifers. Both the alluvium and bolson deposits contain lenses and layers of clay and silt which impede the downward migration of water and further reduce commingling of the aquifers.

Degradation of the fresher bolson aquifer can occur, however, through production of groundwater. The removal of water from the bolson deposits forces the groundwater in the alluvium to migrate downward due to a reduction of head in the bolson relative to the alluvium. When groundwater is withdrawn from the bolson aquifer and hydraulic head in the bolson becomes less than that in the overlying alluvium, downward water movement through the alluvium is impeded by clay and silt lenses. Once these lenses are encountered, the groundwater flows laterally until the lenses thin or pinch out, at which point downward migration is once again resumed. Degradation of the bolson aquifer can also be attributed to poor water quality which can be present at the base of bolson deposits. The degree of degradation of the groundwater quality in the bolson by the poorer quality in the alluvium aquifer and base of the bolson aquifer is influenced by the duration and amount of water pumped from the bolson aquifer, the extent of the clay and silt lenses, and the limited amount of fresh water recharge.

The quality of the Bolson aquifer is characteristically better in areas where the alluvium aquifer is absent and does not appear to be adversely affected by the production of groundwater in the bolson. However, water quality in the bolson aquifer varies with location as well as depth. Recent wells constructed in the Desert well field by the EPCWA indicate that in some areas, the base of the bolson aquifer contains poor quality water.

Caliche lenses encountered in the subsurface may have an effect on the quality of water found in the aquifers. The caliche occurs at depths of 2 to 4 feet below the surface of the bolson and is composed primarily of calcium carbonate. Rainwater coming in contact with the caliche through infiltration causes calcium carbonate to be dissolved in the water which is then transported to the aquifer.

SEDIMENTARY AQUIFER QUALITY

Wells completed in the lower sedimentary formations below the bolson do not yield moderate or large quantities of water, and therefore, are not suitable for municipal purposes.

<u>UNIVERSITY BLOCK L AND FABENS WCID WELL FIELDS</u>

THE UNIVERSITY BLOCK L AND FABENS WCID WELL FIELDS GEOLOGY

The University Block L and Fabens WCID well fields are located in the Rio Grande Floodplain of the Hueco Bolson. The geology of the two well fields are very similar. The Rio Grande Alluvium is the uppermost unit in the well fields and is derived from the erosion and redeposition of the bolson deposits. The Rio Grande Alluvium consists of unconsolidated sand, gravel, clay and silt. These deposits are reported to have a thickness of up to 200 feet in some areas. The Rio Grande Alluvium is underlain by the bolson deposits. The bolson deposits consist of alternating layers of clay, silt, sand and gravel. The bolson deposits are underlain by consolidated rocks of both igneous and sedimentary origin. The sedimentary rocks consist of thick sections of limestone, sandstone, and shale which yield small quantities of highly mineralized water.

UNIVERSITY BLOCK L AND FABENS WCID WELL FIELD HYDROLOGY

Groundwater under the properties occurs in the alluvium sediments of the Rio Grande floodplain, the Hueco Bolson, and the deeper limestone and sandstone formations. The groundwater in the deeper and older formations is usually very highly mineralized and is generally unacceptable for municipal purposes. The bolson and alluvium deposits contain large quantities of producible groundwater which in some instances may be moderately mineralized and may require treatment before it can be used for municipal purposes.

UNIVERSITY BLOCK L AND FABENS WCID WATER LEVELS

Groundwater in the alluvium occurs under water table conditions while slightly artesian conditions exist in the bolson deposits. A head difference between the two aquifers is not readily discernible given the available water level data. Both aquifers may be in hydraulic continuity in which case there would be little or no head difference. The available water level data indicate a southeasterly movement of the groundwater which agrees generally with the regional direction of movement.

UNIVERSITY BLOCK L AND FABENS WCID WELL FIELD GROUNDWATER QUALITY

The quality of the groundwater under the properties is highly variable with depth as well as location. The wells completed in the alluvium deposits of the Rio Grande floodplain show slightly elevated chloride and sulfate ion concentrations and total dissolved solids (TDS) which generally do not meet TNRCC or federal standards for municipal water supplies. The TNRCC standards for municipal water use recommend chloride and sulfate ion concentrations of 300 mg/L and TDS concentrations of 1,000 mg/L. The poor quality of the water in the Rio Grande alluvium may be the result of the concentration of salts through evapotranspiration of the shallow groundwater. Furthermore, irrigation in the valley has increased the concentration of salts in the water through irrigation water return flow and leaching of accumulated salts in the soil to the groundwater system.

The upper portion of the bolson aquifer generally contains better quality water than the alluvium aquifer. However, the bolson aquifer typically degrades with depth. Furthermore, there is no impermeable geologic layer separating the two aquifers and they are believed to be hydraulically connected. Without this impermeable layer, water can move relatively unrestricted from one aquifer to the other.

Clay lenses which exhibit limited lateral extent in the bolson and alluvial deposits along with the slightly artesian pressure found in the bolson aquifer minimizes the movement of the poor quality water from the alluvium aquifer to the bolson aquifer. However, degradation of the bolson aquifer has been observed in areas of pumping. Degradation rates appear to be dependent on the quality of the alluvium aquifer, the extent of the clay lenses and most importantly, the amount of water removed from the bolson aquifer through pumping.

University Block L

Recent water quality data was unavailable for the University Block L well field. Early tests indicated a relatively fresh water zone was present in areas of the Block L well field. However, pumpage of the groundwater over time appears to have degraded the groundwater in the areas where there are existing supply wells.

From a recent study performed by Tom Cliett & Associates, Inc. (January 5, 1993), relatively fresh water zones (<1000 mg/L TDS) were observed in the vicinity of State Well No. 49-40-412 (southern portion of the well field) and in the vicinity of State Wells 49-39-346 and 49-40-110 (northern portion of the well field). Generally, the northeastern side of the well field exhibited slightly saline groundwater quality (>1000 mg/L TDS). These distinct areas of water quality in the Hueco Bolson aquifer of the University Block L well field were based on chemical analysis data ranging in age from 3/6/61 to 10/9/90.

Fabens WCID

The two main supply wells for the Fabens WCID are the 10th Street and Golf Course wells. These water supply wells exhibit chloride, sulfate and TDS concentrations which meet the state drinking water standard. A third well, the CC Camp well, was also used for primary water supply but contained TDS concentrations of approximately 2,400 mg/L. Consequently, the production from the CC Camp well has been limited to times when the 10th Street well and the Golf Course well can not meet the demand. Elevated TDS concentrations in the CC Camp well may be attributed to the continued pumping and degradation of the bolson aquifer by both the lower portion of the bolson aquifer and the upper alluvium aquifer. Recent water quality information collected from this well indicated that the TDS concentrations had improved to 1,000 mg/L. With limited usage, this well might remain a viable water supply well which meets the state drinking water standards.

In June 1994, two additional wells were drilled in the Fabens WCID well field (Well Numbers 4 and 5). Interval samples were collected from these two wells. The results of the samples indicate that a zone of relatively fresh water (TDS concentrations of approximately 650 mg/L) exists in the bolson aquifer. Screened intervals were established to take advantage of this fresh zone and minimize the immigration (from above and below) of poorer quality water. These wells are scheduled to be incorporated into the water supply system.

UNIVERSITY BLOCK L AND FABENS WCID WELL FIELD PUMP TEST RESULTS

As reported by Reed & Associates in 1981, the El Paso County Water Authority conducted 72-hour simultaneous pumping tests on both the Fabens 10th street well and the WSW Number 1 well. The water levels were monitored in the pumping wells and two observation wells located near the pumping wells. Values of storage coefficients and transmissivity were determined from the pumping test data.

The storage coefficient of an aquifer is the volume of water released from or taken into storage, per unit of surface area of the aquifer per unit change in head. For water table aquifers, the storage coefficient is the same as the specific yield of the aquifer. The specific yield is defined as the volume of water which can be drained from a unit volume of the aquifer expressed as a percentage of the unit volume. The values for storage coefficient varied between the two tests from 0.002 to 3.84 x 10^{-5}. The storage coefficient of 0.002 was considered more representative of early average storage conditions which exist in the aquifer in its slightly artesian state. However, under long term production, the aquifers can be expected to function as an unconfined aquifer with a specific yield of about 15 percent.

The coefficient of transmissivity indicates the ability of the aquifer to transmit water through the entire thickness of the aquifer one-foot wide and under unit hydraulic gradient. The higher the value of this coefficient, the greater the transmitting capacity of the aquifer. The coefficient of transmissivity was estimated from the drawdown data of both the Fabens 10th Street well and WSW-1 at 32,757 gpd/ft and 32,492 gallons per day per foot (gpd/ft), respectively.

Tom Cliett & Associates, Inc. conducted a 36-hour pump test in December of 1992 on Well 49-40-111 in the University Block L well field. This well was pumped at an average of 814 gpm and a maximum drawdown of 77.75 feet was observed. The water level was observed for the first 2.5 hours of recovery. The fluid level recovered in the well to within one percent of the static water level 2.5 hours after terminating the drawdown test.

Tom Cliett & Associates, Inc. also conducted 36-hour pump tests in June and August of 1994 on wells 4 and 5 in the Fabens WCID well field. These wells were tested separately and the response of nearby wells were not recorded.

Well Number 4 was pumped for 36-hours at an average rate of 800 gpm. The water levels were observed in the pumping well during the test. A maximum drawdown of 91.25 feet was observed toward the end of the test. The water level in the well was observed for the first six hours of recovery. The fluid level recovered in the well to within 4 percent of the static water level six hours after terminating the drawdown test.

Well Number 5 was also pumped for 36-hours at an average rate of 965 gpm. A maximum drawdown of 59.08 feet was observed at the end of the test. The water level in the well was observed for the first six hours of recovery. The fluid level recovered in the well to within 13 percent of the static water level six hours after terminating the drawdown test.

Estimates of the aquifer coefficients of transmissivity have been determined for these locations. However, since no observation wells were monitored during these tests, an estimate of storage coefficient was not obtained.

The calculated transmissivity value for Well Number 4 was 13,626 gpd/ft and the calculated transmissivity value for well Number 5 was 65,323 gpd/ft (Cliett, 1994).

Since no observation well data was available for these pump tests, a value for the specific yield was not determined. A value of 0.15 was used for the bolson deposits. This value is reasonable considering that clean Ogallala deposits exhibit a specific yield of 0.15 to 0.20.

UNIVERSITY BLOCK L GROUNDWATER RESERVES

It is difficult to estimate the volume of fresh water (less than 1,000 mg/L TDS) in the University Block L well field due to the limited amount of recent data. However, based on the data presented by Tom Cliett & Associates, the total volume of fresh to slightly saline water under the property (4730 acres) was estimated. Based on 8 wells in the well field, an average gross saturated thickness of the fresh to slightly saline water under the property was estimate to be approximately 280 feet. Using a 15 percent specific yield and a recovery factor of 70 percent, the volume of economically producible reserves under the 4730 acres of land is estimated at 139,062 acre-feet.

FABENS WCID GROUNDWATER RESERVES

The volume of fresh water (less than 1,000 mg/L TDS) is difficult to estimate in the Fabens WCID well field due to the limited amount of available data for much of the area, the inconsistent water quality, and the demonstrated degradation of the bolson aquifer. For purposes of projection, assumptions regarding the hydraulic gradient, quality and quantity of the groundwater in the well field were made based on available data.

The total volume of fresh to slightly saline water present under the property (832.5 acres) to a depth of 350 feet was estimated. Based on the existing 5 wells in the well field, an average gross saturated thickness of the fresh to slightly saline water bearing zone under the property was estimated to be approximately 115 feet. Using a 15 percent specific yield and a recovery factor of 70 percent, the volume of economically producible reserves under the 832.5 acres of land is estimated at 10,052 acre feet (approximately 3.3 billion gallons).

PRESENT FABENS WCID WELL FIELD REQUIREMENTS

Based on the available data, the current peak water demand for the Fabens WCID is approximately 2,000,000 gallons per day (gpd). Three wells currently supply all of the water for the district. However, two existing wells are planned for incorporation into the water supply system. Including these two wells for supply and excluding the CC Camp well, the district is currently able to provide approximately 3.1 million gallons of water per day which meets the state drinking water standard.

FABENS WCID WELL FIELD EXPANSION

Currently, the Fabens WCID owns the groundwater rights to 832.5 acres of property. Five wells located within the property currently supply water to the district. A long term production rate of the wells within the Fabens WCID district is estimated at 550 gpm per well. These production rates are approximately 60 percent of the maximum capacity of the wells. If the production rate of these wells are increased, they may meet future demands of the district, but that could increase the quality degradation rate of the bolson aquifer.

The current well field could be expanded within the existing property. However, over-development of the existing property may also accelerate degradation of the bolson aquifer. Since the degradation rate of the bolson aquifer has not been well studied, an estimate of the optimum production rate from the field can not be determined. Acquisition and development of additional property may be advisable in order to meet future demands of the district and still meet state drinking water standards.

WHEELER WELL FIELD

WHEELER WELL FIELD GEOLOGY

The Wheeler well field is located in the Rio Grande Floodplain of the Hueco Bolson as are the University Block L and Fabens well field. The Rio Grande Alluvium overlies the bolson deposits which overlies the consolidated rocks of igneous and sedimentary origin.

WHEELER WELL FIELD HYDROLOGY

Groundwater in the Wheeler well field occurs in the alluvium sediments of the Rio Grande floodplain, the bolson deposits and the deeper limestone and sandstone formations.

WHEELER WELL FIELD WATER QUALITY

Historical water quality data from the Wheeler well field indicate that the wells were completed in a relatively fresh groundwater zone of the bolson aquifer. Interval sampling performed on Well Number 1 by December 1, 1969 indicated chloride and TDS concentrations below the state drinking water standard. On July 11, 1974, the water quality in the Wheeler No. 1 well had declined with a reported TDS concentration of 1,280 ppm. Water quality tests performed on other Wheeler well field wells in 1974 showed TDS concentrations above the state drinking water standard.

Recent water quality data was unavailable for individual wells in the Wheeler well field. However, chemical analysis data was available for above ground storage tank number 1, which collects groundwater pumped from all three of the active wells in the Wheeler well field. Based on the water quality analysis for Tank 1 in 1993, the average chloride, sulfate and TDS concentrations of the water produced from the Wheeler well field is approximately 478 mg/L, 392 mg/L and 1,450 mg/L, respectively.

WHEELER WELL FIELD PUMP TEST DATA

No pump test data was available for evaluation for any of the Wheeler well field wells. However, the hydraulic properties of the Wheeler well field are considered similar to the hydraulic properties of the University Block L and the Fabens WCID well field because of their similar geology and hydrology.

WHEELER WELL FIELD GROUNDWATER RESERVES

The total volume of slightly saline water under the property to a depth of 300 feet for the 450 acres was estimated. Based on the existing 3 wells in the well field, an average gross saturated thickness of the slightly saline water bearing zone under the property was estimated to be approximately 120 feet. Using a 15 percent specific yield and an economic recovery factor of 70 percent, the volume of economically producible reserves under the acreage is estimated at 5,670 acre-feet (approximately 1.8 billion gallons).

PRESENT WHEELER WELL FIELD REQUIREMENTS

The water quality in the Wheeler well field has deteriorated over time such that the current water quality does not meet the state drinking water standard. The well field is utilized during times when the wells in the Desert well field cannot meet the water demand of the district.

FUTURE WHEELER WELL FIELD EXPANSION

Three supply wells are currently completed in the Wheeler well field. These wells are located on the southwestern and downgradient portion of the well field. As mentioned above, the water quality of the Wheeler well field has deteriorated over time. The water quality in wells located approximately six miles upgradient of the well field indicate that the Wheeler supply wells may deteriorate further with continued pumping. Additional wells may be completed within the field, however, water quality data indicates that the water produced from these wells may be above the drinking water standard.

DESERT WELL FIELD

DESERT WELL FIELD GEOLOGY

Figure 1 shows the properties leased by the EPCWA. The Desert well field encompasses an area of approximately 121 sections with only three sections in the southern portion of the well field developed for a groundwater supply. Most of the Desert well field is located on the mesa portion of the Hueco Bolson. The Rio Grande alluvium material is predominantly absent in this area. The bolson deposits consist of alternating layers of sands, clays and silts with some caliche near the surface. Individual beds are generally not uniform in lithology and may pinch out or grade laterally or vertically into finer or coarser material. As mentioned earlier, the thickness of the bolson deposits under the property is not known with any degree of certainty.

Previous studies indicate that the sands become finer towards the eastern portion of the area. These sediments were derived from weathering and erosion associated with the Franklin and Hueco mountains. During the period of deposition, some areas on the mesa contained small closed lakes which were later filled with alternating layers of sands, silts and clays. This, in part, accounts for the occurrence of some of the silt and clay lenses which can only be traced over very short distances. Drillers logs from wells constructed in the developed portion of the Desert well field in April 1994 depict alternating layers of brown shale and fine sand with caliche near the surface.

DESERT WELL FIELD HYDROLOGY

Groundwater in the Desert well field occurs in the bolson deposits and in the deeper limestone and sandstone formation. The water in the deeper limestone and sandstone formations is usually very highly mineralized and is generally unacceptable for municipal purposes.

Groundwater in the Desert well field flows from areas of recharge to points of discharge. The hydraulic gradient and amount of groundwater flow under the Desert well field was based on 1980 water table conditions. Figure 3 shows that the general direction of groundwater flow in the Hueco Bolson was southerly in 1980. However, individual pumping centers have locally altered the hydraulic gradient.

Using an estimated hydraulic gradient (from the 1980 water table map) of approximately 3 ft/mi through a section of the aquifer about 170 feet in gross saturation, the normal groundwater flow under the Desert well field was estimated at approximately 109 acre-feet per year. It is assumed that approximately one-half of this volume of water can be intercepted by production wells when the well field is fully developed. Thus, about 55 acre-feet of recoverable recharge can be realized once the well field is brought into full operation.

DESERT WELL FIELD WATER LEVELS

Groundwater in the bolson aquifer under the Desert well field occurs under normal water table conditions. Recharge to the bolson aquifer occurs from precipitation and infiltration on the alluvial fan areas along the mountains which flank the basin. Precipitation and infiltration on the property accounts for a small portion of the recharge to the aquifer.

DESERT WELL FIELD QUALITY

The bolson deposits of the Desert well field exhibit highly variable qualities with depth as well as location (Table 1). The groundwater quality exceeds the TNRCC drinking water standards in some areas of the Desert well field (Figure 4). However, the central portion of the property from north to south contains an area of fresh to slightly saline water. Much of this area contains groundwater which meets the TNRCC standards in terms of the constituents analyzed.

Well 49-24-603, completed in the eastern portion of the property and various wells located in the western portion of the property show elevated levels of chloride and TDS which do not meet TNRCC or federal requirements for municipal water supply. The poor quality of the groundwater in the western portion of the Desert well field may be attributed to its proximity to the Rio Grande Alluvium.

The groundwater associated with the Desert well field is predominantly good quality throughout the upper portion of the aquifer although some areas of slightly saline water do exist. Degradation of quality resulting from production of the aquifer appears to be less where the Rio Grande Alluvium is absent than in the areas where the Rio Grande Alluvium is present. However, the base of the bolson aquifer may contain poorer quality water. This was determined during the construction of Well 15-36. Near the base of the well, a significant deterioration of water quality was observed. This may be attributed to the proximity of the Hueco Bolson aquifer to the lower sedimentary aquifer.

The available chemical analysis data indicate that the best quality water that can be produced from the developed portion of the Desert well field will have a chloride range from 65 mg/L to 340 mg/L and a TDS range from 470 mg/L to 920 mg/L. Water quality of this range appears to be limited to a general area which trends from north to south and is located in the central portion of the property.

DESERT WELL FIELD PUMPING TEST RESULTS

James B. Kelly, an independent consultant geologist, conducted 36-hour pump tests on wells 14-36, 1A-32 and 6A-36 located in the developed portion of the Desert well field. These wells were tested separately and the response of nearby observation wells was not recorded during the tests. Pump test data for these three wells are included in Appendix A.

Well 14-36 was pumped for a period of 36 hours at an average rate of 198 gpm. The water levels were observed in the pumping well during the test. A maximum drawdown of 188 feet occurred in the well towards the end of the 36-hour test. Well 1A-32 was pumped for a period of 36-hours at an average rate of 202 gpm. The water levels were observed in the pumping well during the test, and a maximum drawdown of 97 feet occurred at the end of the test. Well 6A-36 was pumped for a period of 36 hours at a rate of 185 gpm. The water levels were observed in this well during the test, and a maximum drawdown of 155 feet occurred at the end of the test.

Estimates of the aquifer coefficients of transmissivity have been determined for these locations. However, since no observation wells were monitored during these tests, an estimate of storage coefficient was not obtained.

Averaging the greatest transmissivity values calculated from the three pump tests gave a transmissivity of 2,191 gpd/ft. Averaging all of the transmissivity values calculated from the three pump tests gave a transmissivity of 2,038 gpd/ft.

Since no observation well data was available for these pump tests, a value for the specific yield was not determined. A value of 0.12 was used for the bolson deposits in the Desert well field instead of the above mentioned 0.15 for the other well fields since the lithology of the bolson material under the Desert well field demonstrates finer material containing more clay and silt than that seen in the Wheeler, University Block L and Fabens WCID well fields.

DESERT WELL FIELD GROUNDWATER RESERVES

The volume of fresh groundwater reserves (less than 1,000 mg/L TDS) under the property is difficult to estimate due to the limited amount of available data for much of the area. Local areas with existing development have been extensively evaluated through test holes resulting in a better understanding of the quantity and quality of the groundwater. However, large areas of the Desert well field have not been investigated, and the aquifer properties and conditions are not well defined. For purposes of projection, assumptions regarding the quality and quantity of the groundwater in the well field were made based on the available data.

As mentioned earlier, existing data for the well field has shown that the groundwater quality in the eastern and western portions of the Desert well field exceeds the TNRCC standard for municipal purposes in terms of chlorides, sulfates and TDS concentrations. An area in the central part of the Desert well field (approximately 4 sections wide from north to south) exhibits water quality which meets or is believed to meet the TNRCC standards. Areas in the Desert well field which appear to have good potential for future development were determined by including only those areas where the groundwater quality meets or is slightly above the TNRCC drinking water standard and the hydraulic properties appear to be sufficient for economical recovery of the groundwater. Of the 121 available sections in the Desert well field, 35 sections were believed to contain a sufficient quantity and quality of groundwater for future development (Figure 4). This includes 30 sections where the groundwater quality appears to be well below the TNRCC drinking water standard and 5 sections where the groundwater appears to be at or slightly above the TNRCC standard. The in-place groundwater reserves were determined only for these 35 sections.

The total volume of fresh water under the property to a depth of 640 feet for the 30 sections was estimated. Based on 13 existing wells in the well field, an average gross saturated thickness under the 30 sections was estimated to be approximately 170 feet. Using a 12 percent specific yield and a recovery factor of 70 percent, the volume of economically producible reserves under 30 sections of land is estimated at 274,200 acre-feet (approximately 90 billion gallons). Using an average daily production rate of 0.857 mgd for 1994 and a projected rate of 4.7 mgd for 2012, the total water requirement for this period (1994 to 2012) is estimated to be approximately 59,150 acre-feet (19.27 billion gallons). This is approximately 22 percent of the estimated in-place reserves in the field. With the additional 5 sections of marginal water quality added to the available reserves, approximately 18 percent of the estimated in-place reserves would be used by the year 2012.

The above estimates of the recoverable resources is based on what is available in-place under the property and does not include recharge to the aquifer or potential drainage from adjoining lands. Any recharge or captured drainage would add to the economical life of the well field. Since the amount of potential drainage which can be captured depends on the degree of development of the Desert well field as well as the adjoining properties, future planning should not be based on drainage estimates.

PRESENT WELL FIELD REQUIREMENTS

Based on available water usage records for July 1994, the current peak water demand for the EPCWA is 2,400,000 gpd. Seven wells completed in the developed portion of the Desert well field and three wells completed in the Wheeler well field are currently supplying all the water for the EPCWA in the Horizon City area. The production from these wells is collected in three existing storage tanks: production from the Wheeler well field is collected in Tank 1, production from two wells (1A-32 and 2-32) in the developed portion of the Desert well field is collected in

Tank 2 and production from the remaining five wells in the developed portion of the Desert well field is collected in Tank 3.

Chemical analysis data for November 1993 for each of the three tanks indicate that water produced from the Wheeler well field contained concentrations of chlorides, sulfates and TDS that exceeded the TNRCC standards for municipal water use. Fluorides and nitrates as nitrogen were found below the drinking water standard. However, water from the developed portion of the Desert well field meets the TNRCC standard. Therefore, blending water from the Desert and Wheeler well fields will be necessary to provide a water supply which meets the TNRCC standards.

The following factors were considered in determining the quantity of water required from each of the two well fields to meet TNRCC drinking water standards and to meet the current peak flow requirements:

1. The average daily flow rate from the Desert well field.

   An average flow rate of 116 gpm per well was determined from three of the wells located in the developed portion of the Desert well field (6A-36, 1A-32, and 14-36) using pump test data collected in April 1994 by James B. Kelly. No pump test data was available for the remaining four wells in the field, but the present pump designs for the wells reflect an average flow rate of 145 gpm per well. However, based on the available test data for three wells and pumping water level data for the remaining wells, it appears that the current available rate of 145 gpm is too high for long-term purposes since it would result in excessive drawdown in the field. Consequently, a conservative long-term flow rate of 125 gpm for each of these four wells was estimated. This means that the overall average long-term production rate for wells in the developed portion of the Desert well field is approximately 120 gpm per well.

2. The production capacity of the Wheeler well field.

Each of the three wells completed in the Wheeler well field were equipped with pumps to produce approximately 1,000 gallons per minute for a total capacity of 3,000 gallons per minute from the well field. Groundwater produced from the Wheeler well field is collected in Tank 1.

3. The average quality of groundwater from the developed portion of the Desert and Wheeler well fields in terms of chlorides, sulfates and TDS.

The quality of the groundwater in the developed portion of the Desert well field was determined by calculating a weighted average of the groundwater quality in tanks 1 and 2 (tank chemical analysis data in 1993) using an estimated flow rate per well of 120 gpm. The average concentrations of chloride, sulfate and TDS from the groundwater in the developed portion of the Desert well field was calculated to be 157 mg/L, 142 mg/L and 630 mg/L, respectively. Based on the water quality reports for Tank 1 in 1993, the average chloride, sulfate and TDS concentrations of the water produced from the Wheeler well field is approximately 478 mg/L, 392 mg/L and 1,450 mg/L, respectively.

Calculations were also performed to determine the overall water quality when groundwater produced from the developed portion of the Desert well field and Wheeler well field are blended. Assuming that the developed portion of the Desert well field produces a maximum daily rate of 1.21 mgd (seven wells at 120 gpm) and the Wheeler wells would make up the difference to attain the daily peak flow demand of 2.4 million gallons per day (mgd), chloride and TDS concentrations would exceed the TNRCC standards for municipal water use (Table 2a). By adding one well to the Desert well field at 120 gpm, the chloride and TDS levels would be reduced, thereby meeting the TNRCC standards. Table 2a also shows the affects of the blended water quality by adding two wells to the Desert well field which produce 120 gpm per well.

By adding wells to the developed portion of the Desert well field, less water would be required from the Wheeler well field which historically has had poorer quality water than the Desert field. Reducing the amount of flow required from the Wheeler well field could have a positive long-term effect on overall water quality and the rate of degradation of the bolson aquifer in the Wheeler field since, historically, degradation of the bolson aquifer in the Wheeler well field has occurred through heavy production.

Using a more conservative approach, Table 2b shows the affects on the overall blended quality when an average flow rate of 110 gpm per well is used for the developed portion of the Desert well field. This would require that two wells be added in order to obtain chloride and TDS levels which meet the TNRCC drinking water standard.

FUTURE WELL FIELD REQUIREMENTS

The average daily flow rate for the year 2012 has been projected to be 4.7 mgd. The peak daily production demand for the year 2012 is estimated by multiplying the projected average daily production of 4.7 mgd by the peak production factor of 2.05 for a peak production in the year 2012 of 9.635 mgd. Based on an average daily flow rate of 120 gpm per well in the developed portion of the Desert well field and a maximum production of 3,000 gpm from the Wheeler well field, a total of 31 wells would be needed in the Desert well field to meet the peak demand for the year 2012. Accounting for the seven existing wells in the developed portion of the Desert well field, the EPCWA would need to add an average of 1.33 wells per year in the Desert well field while increasing the production of the Wheeler well field incrementally over the same time frame in order to maintain the projected growth and TNRCC water quality standards.

The water quality of the alluvial aquifer deteriorates over time through pumping. This is evident in the Wheeler well field. However, historical data indicates that the water quality in the Desert field is minimally affected by the production of the aquifer (Table 1). It is difficult to predict what the degree of degradation of the Wheeler and Desert well field will be over time. Therefore, the blended quality of the water in 2012 can only be estimated using current water quality data. Based on the current water quality data and including the addition of 31 wells to the Desert well field required to meet the projected demands, the blended water will meet the TNRCC standard in 2012 in terms of chlorides and TDS. Since the other constituents such as sulfate, fluoride and nitrate currently meet the TNRCC standards in the two well fields, this should also be the case in the future.

WELL FIELD EXPANSION

Much of the Desert well field has not been explored from the standpoint of available quantity and quality of groundwater. The northeastern, eastern and southern untested portions of the field may contain economical quantities of groundwater and quality required to meet TNRCC drinking water standards. Based on the results of Well 3-37 and information obtained on state observation wells in the area, the southeastern portion of Block 78, TSP-3 and the southwest portion of Block 77, TSP-3 appear to be favorable areas for well field expansion. These areas would be the most economical for expansion since they are located near the existing transmission line. Developing these areas first is also recommended because it will allow for the capture of underflow which would otherwise discharge from the site.

Another area for potential well field expansion is located in the vicinity of Section 9, Block 78, TSP-3. A water sample collected from State Observation Well Number 47-15-901 in 1954 contained chloride, sulfate and TDS levels well below the TNRCC standards. Several other wells in the vicinity of this section had favorable water quality. This area may be restrictive from the standpoint of location; a transmission line five miles long would be required to connect this area with the existing system.

Based on trends associated with the available data, the central portion of the Desert well field appears to contain a sufficient quantity and quality of groundwater for future expansion of the well field. After additional investigations of the groundwater resources of the central portion of the well field have been performed and once the development of the southern boundary is complete, well field expansion is recommended to the north through the central portion of the well field.

PROGRAM FOR GROUNDWATER EXPLORATION OF UNDEVELOPED AREAS IN THE DESERT WELL FIELD

This study has summarized the groundwater resources in the Desert well field area. However, the conclusions in this report are based on a limited amount of available hydrogeologic data. A program for groundwater resources exploration of the Desert well field is necessary in order to obtain a greater understanding of the groundwater resources in the district and to obtain a more precise delineation of the following items:

- The amount of producible groundwater reserves in the bolson deposits under the properties of interest;

- The areas under the Desert well field where the groundwater quality is suitable for municipal purposes;

- The productivity of the bolson aquifer in the area;

- The optimum well designs and well field layout for expansion of the well field and a cost estimate for the project and

- The long-term utility of the expanded well field in this area based on the projected future water requirements of the district in terms of quantity and quality and the coordinated utilization with the existing well fields.

The exploration for groundwater resources in the Desert well field should include the following programs:

- Sampling of existing wells in the Desert well field to obtain a greater understanding of the groundwater quality of the Bolson Aquifer.

- Collection of water levels and total depths on the existing Desert well field to update and define water table conditions, hydraulic gradient and saturated thickness.

- Construction of eight test holes across the undeveloped area (Figure 4) to determine the lithology of the bolson deposits, the water levels and groundwater quality. This would provide a broad picture of the groundwater resources in the area. Additional test holes may be necessary to better evaluate certain areas.

- Construction, development and flow testing of two test production wells (Figure 4) in the area to determine the productivity of the bolson deposits and the hydraulic characteristics of the aquifer.

- Collection of groundwater samples from the test holes and test production wells and analysis of the samples for constituents pertinent to the use of the water for municipal purposes. The samples should be collected at varying depths in order to evaluate vertical differences in groundwater quality.

- Preparation of a water table map. Maps will also be prepared of the base of the fresh water zone of the bolson deposits and the gross saturated thickness of fresh water zone of the bolson, if sufficient data is available. In addition, an estimate of the amount of producible groundwater reserves in the aquifer will be determined.

- Preparation of plans for the design of the water supply wells and the layout of the well field.

- Review of projections of the future water requirements of the district and determination of the life of the well field expansion based on these projections and conjunctive use of the existing well fields.

- Preparation of a comprehensive report containing the results, conclusions and recommendations of the investigation.

The number of test holes and test wells to be constructed in the Desert well field area may be limited by the amount of funds that the district has available for exploration. At a minimum, eight test wells and two test production wells are recommended in order to provide a broad evaluation of the untested areas of the lease. Figure 4 depicts the layout of the eight proposed test holes and the two test production wells. The locations of the test production wells may be changed depending on the results obtained from the test holes. The outlined exploration program will provide a broad evaluation of the development potential of the lease. However, a more extensive investigation consisting of more test holes may be required in certain areas of the lease, depending on the results obtained from the eight test holes and two test production wells. Also, additional test holes will likely be required for the development phase to determine suitable locations for the water supply wells.

It is recommended that the eight test holes be completed as monitor wells (with casing, gravel pack, etc.) for the following reasons:

- To verify the suitability of the location in terms of lithology, saturated thickness and groundwater quality. The test hole may also provide some information of the productivity of the aquifer.

- Some of the test holes would serve as observation wells during the flow testing of the test production wells. The observation well is important from the standpoint of determining the aquifer characteristics of transmissivity and storage coefficient and evaluating the performance of the water supply well. The test holes would also be useful for subsequent monitoring of water levels in the well field.

We do not recommend the use of uncompleted pilot holes instead of test holes for the exploration of groundwater resources in the Desert well field for the following reasons:

- It may be difficult to obtain a good groundwater sample from the location if circulation is lost during drilling or if mud is required to keep the formation from collapsing. Both of these situations are likely to be encountered in the Desert well field area.

- The pilot hole would not be available as an observation well during the flow testing of the test production wells or for use in subsequent monitoring of water levels in the well field.

- A pilot hole may not necessarily cost less than a test hole. When the additional time required in attempting to retrieve a good groundwater sample is considered plus the additional cost of logging the hole, the cost may be quite close or even be higher for the pilot hole.

- The cost of logging the pilot hole would be significantly higher than for logging the test holes. This is because several test holes can be logged in a day whereas only one pilot hole would be available for logging at any given time. Standby and mobilization time for the logging company would significantly increase the cost per hole.

The design of the future water supply wells during the development phase will be based primarily on the range of flow capacities which are anticipated and the experience of having constructed and flow tested the two production test wells as part of the exploration program.

Development of the Desert well field consists of determining suitable locations for the water supply wells, construction and testing of the wells, equipping the wells with pumping equipment for long-term production, and construction of storage, collection and transmission facilities.

SUMMARY

The study area lies within a geological basin called the Hueco Bolson. Erosion of the structurally high mountain blocks which surround the basin resulted in the deposition of unconsolidated sediments in the basin known as bolson deposits. These sediments are composed primarily of clays, silts sands and gravels. The Rio Grande Alluvium deposits lie on top of the bolson deposits and are the result of erosion and redeposition of bolson deposits. Since the sediments of the alluvium deposits are derived from sediments of the bolson deposits and therefore similar in composition, they are distinguished primarily through water quality; the groundwater of the upper alluvium is generally poorer quality than that of the bolson. There is no impermeable geologic layer separating the two aquifers and they are believed to be hydraulically connected.

Groundwater in the Fabens WCID, University Block L and Wheeler well field occurs in the alluvium and bolson deposits which consist of sands and gravels with lenses of clay and silt. Groundwater in the Desert well field area occurs primarily in the bolson deposits which consist of alternating layers of fine sand, silt and clay. The groundwater occurs under normal water table conditions although it may exhibit artesian conditions initially. Water quality varies in the well fields both laterally and vertically. The water quality of the central portion of the Desert well field and specific zones of the bolson deposits in the Fabens WCID well field generally meets TNRCC standards for municipal purposes. The base of the bolson aquifer tends to contain poorer quality water than that found at shallower depths. Groundwater flow is generally in a southerly direction, however, pumping centers have affected the gradient locally.

Groundwater recharge to the northern portion of the Hueco Bolson, which includes areas in New Mexico, Texas and Ciudad Juarez, Mexico, is approximately 5,640 acre-feet per year (Meyer, 1967) principally from precipitation, runoff and infiltration along the Organ and Franklin Mountains in New Mexico and Texas and the Sierra Juarez Mountains in Mexico. Recharge to the bolson deposits in the Desert well field based on the transmissivity of the sediments, the gradient of the water table in 1980 and the horizontal section of the well field under which the groundwater flows is estimated to be 109 acre-feet per year.

Pump tests were performed by Cliett and Associates in June and August of 1994 on wells 4 and 5 in the Fabens WCID well field. These wells tested at rates of 800 gpm and 965 gpm, respectively. Long-term recommended production rates for the field, however, are estimated at an average of approximately 550 gpm per well.

Pump tests were also performed by James B. Kelly on three existing production wells in the developed portion of the Desert well field in April 1994. These wells were tested at rates ranging from 185 to 202 gpm. Long-term recommended production rates for the field are estimated at approximately 110 to 120 gpm per well.

An estimate of the in-place reserves was made for the Fabens WCID, University Block L, and the Wheeler well fields. Based on 832.5 acres in the Fabens WCID, and average gross saturated thickness of 115 feet, a specific yield of 15 percent and a recovery factor of 70 percent, the total volume of economically producible reserves is estimated at 10,052 acre feet. The Fabens WCID is currently able to provide approximately 3.1 million gallons of water per day which meets the state drinking water standard.

Although current data is limited on the University Block L well field, estimates were made of the in-place reserves. Based on 4,730 acres of available property, an average gross saturated thickness of 280 feet, a specific yield of 15 percent and a recovery factor of 70 percent, the total volume of fresh to slightly saline water under the property is estimated at 139,062 acre-feet.

Based on 450 acres in the Wheeler well field, an average gross saturated thickness of 120 feet, a specific yield of 15 percent and a recovery factor of 70 percent, the total volume of economically producible reserves under the average is estimated at 5, 670 acre feet. The existing wells in the Wheeler well field can produce approximately 4.3 mgd of slightly saline water which does not meet the state drinking water standard.

Although existing data is limited on the quantity and quality of groundwater in the Desert well field area, estimates were made of the in-place reserves. Based on 30 sections of available property, an average gross saturated thickness of 170 feet, a specific yield of 12 percent and a recovery factor of 70 percent, the total volume of fresh water under the property is estimated at

274,200 acre-feet. Including the 5 sections of marginal groundwater quality would add approximately 45,700 acre-feet of reserves.

If each of the production wells in the developed portion of the Desert well field produces an average of 120 gpm and accounting for a production rate of 3,000 gpm from the Wheeler well field, a total of 31 wells will be required in the Desert well field to meet the projected peak production in the year 2012. Accounting for the existing seven wells in the developed portion of the Desert well field, the EPCWA would need to add an average of 1.33 wells per year (starting in 1995) in order to meet the annual increase in production requirements.

By blending water produced from the Wheeler well field with water produced from the Desert well field, an overall water quality can be achieved which will meet the TNRCC standard for municipal purposes. However, long-term production rates of the seven existing wells in the Desert field will not produce enough water to meet current peak production demands and blended quality requirements. An additional one to two wells will be required in the Desert well field to obtain a peak flow of 2.4 million gallons per day. The addition of the well(s) will reduce the production requirements of the Wheeler well field and improve the blended quality of the water supply to meet the TNRCC standard for municipal purposes. In the period between 1994 and 2012, if the groundwater quality of the Desert field does not degrade significantly, the additional 1.33 wells per year constructed in the Desert field will be required only to meet production and not to lower the blended quality to meet the TNRCC drinking water standard.

The initial area for well field expansion in the Desert well field is recommended to be near the southern boundary of the district area (south of the existing development of the Desert well field). The groundwater quality in this area is well below the TNRCC drinking water standard and production rates appear to be comparable to other wells in the field. Another area for well field expansion is located north of the developed portion of the Desert well field. Approximately

26 sections north of the field appear to contain adequate hydrological properties for development and have not been extensively developed.

The acquisition of additional property is recommended for the future demands of the Fabens WCID. This should assist in extending the life of the current well field by limiting the production rate from the field and thereby minimizing the degradation rate of the fresh water bearing zone. The nearby University Block L well field expansion.

A program has been developed for further exploration of groundwater resources in the Desert well field area. This program includes the construction of eight test wells and two test production wells. Information obtained from the construction and testing of these wells will be used to define the amount of producible groundwater reserves in the study area, define areas of groundwater quality suitable for municipal purposes, determine the productivity of the bolson aquifer in the area, determine the optimum well design and well field layout and evaluate long-term utilization of the aquifer in the well field.

Information is limited on portions of the Desert well field, therefore a clear understanding of the available quality and quantity of groundwater can only be determined through the implementation of the groundwater exploration program.

RECOMMENDATIONS

FABENS WCID WELL FIELD

- Maintain the proposed average production rate of 550 gpm per well from the Fabens WCID well field. Utilize the CC Camp well when necessary but monitor the water quality from this well to determine if the degradation of the aquifer continues.

- Investigate the availability of additional property in the vicinity of the Fabens WCID well field for acquisition and future development.

UNIVERSITY BLOCK L WELL FIELD

- No recent water quality information was available on wells located in the University Block L well field. Previous studies have indicated that the fresh water bearing zone is subject to degradation through pumpage. The EPCWA and Fabens WCID are not using this well field for water supply. Water quality sampling should be performed in the University Block L well field and in the surrounding area to determine current water quality conditions.

WHEELER WELL FIELD

- Continue to utilize the Wheeler well field for emergency supply demands. However, since it appears that the water quality of the well field will not improve, and in fact, may continue to degrade, utilize the well field only when the Desert well field cannot supply the demand and the blended water quality from both fields meets the state drinking water standard.

DESERT WELL FIELD

- The addition of two wells to the Desert well field is recommended in order to obtain a blended quality of water which meets both the TNRCC drinking water standards and the present peak demand of 2.4 mgd.

- The current spacing of the wells located in the developed portion of the Desert well field appears to be too close and results in excessive drawdown and interference in the aquifer. A minimum spacing of 2,000 to 2,500 feet for future production wells is recommended in order to minimize interference but at the same time effectively drain the aquifer.

- A routine well field data collection program is recommended in order to evaluate the performance of the well field (and target future growth potential and restrictions). This program, should at a minimum, include the collection of static water levels during the winter and pumping water levels, production rates and water quality samples during the summer. Static water level data are useful in evaluating the status of reserves in the well field. Pumping water levels are useful in evaluating the performance of the well field under maximum stress.

In addition, a database management system is recommended to allow for storage and management of collected data. This database management system would assist in organizing information collected for the well fields and assist in evaluating the data.

- Development of the Desert well field should not be so intensive as to encourage encroachment of poor quality water.

- The available groundwater resources appear to be sufficient for meeting the water supply demands beyond the year 2012. However, a large portion of the Desert well field has not been explored. Implementation of the groundwater exploration program is imperative in order to determine its suitability for future development and for meeting future water supply requirements.

TABLES

Table 1
El Paso County Water Authority
Dessert Well Field and State Observation Well Data

Well No.	Water Level Measurement Date	Aquifer	Depth to Water (ft bgs)	Measuring Point Elev. (ft amsl)	Water Level Elevation (ft amsl)	Total Depth (ft bgs)	Saturated Thickness (ft)	Chloride (mg/L)	Sulfate (mg/L)	Total Dissolved Solids (TDS) (mg/L)	Chemical Analysis Date	Remarks
Dessert Well Field												
1A-32	4/5/94	Bolson	357.00	--	--	500	.143.00	290	162	908	1/17/68	
	--	--	--	--	--	--	--	226	120	780	3/20/67	
	--	--	--	--	--	--	--	340	82	830	4/8/94	
2-32	--	Bolson	--	--	--	--	--	265	134	865	1/17/68	
	--	--	--	--	--	--	--	315	143	920	6/16/72	
4-36	--	Bolson	--	--	--	--	--	99	149	620	7/15/61	
	--	--	--	--	--	--	--	93	151	630	6/16/72	
6A-36	3/21/94	Bolson	395.00	--	--	630	235.00	96	206	740	10/20/94	
	--	--	--	--	--	--	--	89	123	610	3/16/67	
	--	--	--	--	--	--	--	80	123	590	6/16/72	
	--	--	--	--	--	--	--	79	120	470	5/9/94	
12-36	--	Bolson	--	--	--	--	--	190	80	592	11/14/73	
14-36	3/23/94	Bolson	391.00	--	--	650	259.00	76	170	490	1/19/94	Collected at 544'-534' bgl
	--	--	--	--	--	--	--	140	160	610	1/19/94	Collected at app. 650' bgl
	--	--	--	--	--	--	--	65	97	470	4/8/94	
3-37	--	Bolson	--	--	--	--	--	85	81	484	7/12/74	
State Obs. Wells												
49-15-701	5/6/72	Bolson	349.70	4023	3,673.00	596	246.30	376	--	1872	5/15/68	
49-15-702	3/7/72	Bolson	346.00	4024	3,678.00	638	292.00	369	855	2013	8/15/69	
49-15-802	3/8/73	Bolson	420.00	4053	3,633.00	640	220.00	122	79	520	8/15/73	
49-15-803	10/1/73	Bolson	392.20	4054	3,661.80	552	159.80	56	73	401	8/17/72	
49-15-804	--	--	--	4058	--	629	--	--	--	--	--	
49-15-901	2/6/54	Bolson	379.35	4057	3,677.65	440	60.65	60	77	372	3/18/54	
49-15-902	--	--	700.00	4075	3,375.00	1100	400.00	--	--	--	--	Not Potable
49-15-903	--	--	--	4065	--	565	--	--	--	--	--	
49-15-904	--	--	--	4075	--	551	--	--	--	--	--	
49-23-201	9/6/56	Bolson	357.82	4026	3,668.18	440	82.18	675	219	1520	12/8/52	
49-23-501	2/6/54	Bolson	370.65	4021	3,650.35	500	129.35	370	146	958	12/8/52	
49-23-502	--	--	--	4029	--	560	--	307	97	840	2/2/62	
49-23-503	--	--	--	4030	--	983	--	--	--	--	--	
49-23-504	--	Bolson	370 est	4016	--	530	160 est	209	162	908	1/17/68	
49-23-505	--	Bolson	370 est	4029	--	558	188 est	315	109	880	1/17/68	
49-23-506	--	Bolson	--	4015	--	495	--	950	180	2151	2/9/68	
49-23-507	--	Bolson	--	4027	--	520	--	--	--	2140	7/31/68	
49-23-508	--	--	--	4023	--	628	--	--	--	--	--	
49-23-509	--	--	--	4028	--	615	--	443	84	1100	1/13/62	
49-23-601	8/1/53	--	397.20	4048	3,650.80	1100	702.80	520	65	1050	8/1/53	
49-23-602	--	--	--	4025	--	560	--	--	--	--	--	
49-23-801	2/3/54	Bolson	373.81	4010	3,636.19	500	126.19	1530	--	--	--	
49-23-901	--	Bolson	430.00	4012	3,582.00	540	110.00	--	--	--	--	
49-23-902	--	Bolson	--	4012	--	560	--	1220	165	2310	5/16/74	

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Table 1
El Paso County Water Authority
Dessert Well Field and State Observation Well Data

49-24-401	4/18/05	Bolson	362.00	4015	3,653.00	460	98.00	83	122	574	3/18/54	
49-24-402	2/1/60	--	340.00	4018	3,678.00	1189	849.00	--	--	--	--	
49-24-403	--	--	--	4016	--	600+	--	--	--	--	--	
49-24-404	--	Bolson	--	4016	--	652	--	--	--	--	--	
49-24-405	--	Bolson	340 est	4018	--	515	175 est	70	132	477	1/17/68	
49-24-406	--	Bolson	340 est	4022	--	521	181 est	85	153	574	1/17/68	
49-24-407	--	Bolson	--	4023	--	605	--	85	148	575	1/17/68	
49-24-408	--	Bolson	--	4020	--	535	--	99	149	620	7/15/61	
49-24-409	--	--	--	4016	--	590	--	150	85	570	9/18/61	
49-24-410	--	Bolson	--	4018	--	550	--	89	123	610	3/20/67	
49-24-411	--	Bolson	--	4017	--	500	--	220	156	720	9/13/68	
49-24-412	--	--	--	4027	--	574	--	205	127	640	9/13/68	
49-24-413	--	Bolson	--	4033	--	605	--	--	--	--	--	
49-24-414	--	--	--	4035	--	592	--	--	--	--	--	
49-24-415	5/5/69	Bolson	392.00	4035	3,643.00	595	203.00	--	--	--	--	
49-24-416	--	Bolson	--	4037	--	652	--	--	--	--	--	
49-24-417	--	--	--	4037	--	652	--	--	--	--	--	
49-24-602	--	--	--	4050	--	673	--	--	--	--	--	
49-24-603	--	Bolson	--	4048	--	--	--	534	221	1821	10/4/71	

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Table 2a. Calculations of blended quality assuming an average production from the Desert Well Field of 120 gpm per well and Wheeler wells making up the difference for combined peak flow of 2.4 mgpd.

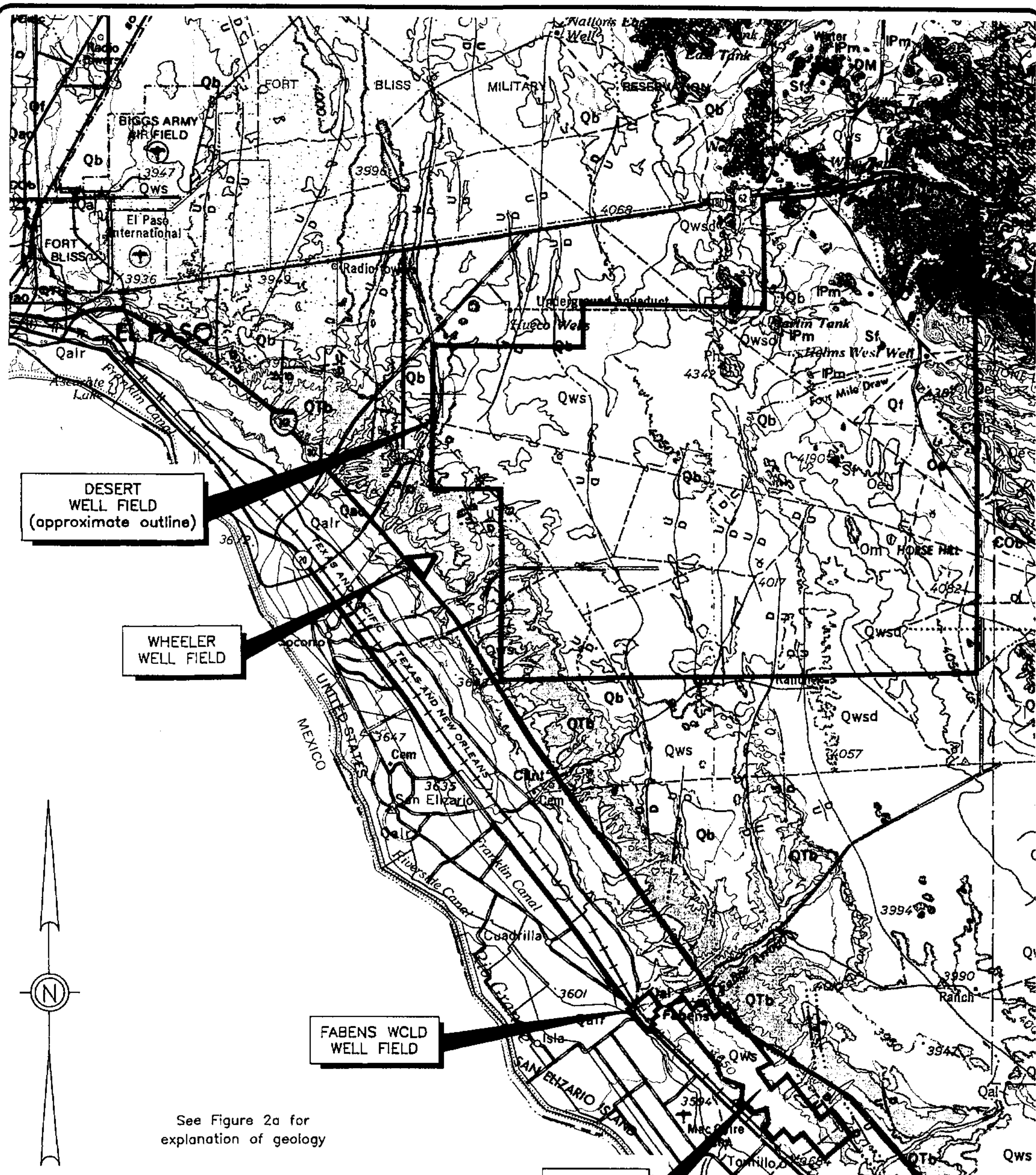
Number of Additional Wells in Desert Field	Average Chloride (mg/L)	Average Sulfate (mg/L)	Average TDS (mg/L)
0	316	266	1037
1	293	248	978
2	270	230	919
TNRCC State Drinking Water Standard	300	300	1000

Table 2b. Calculations of blended quality assuming an average production from the Desert Well Field of 110 gpm per well and Wheeler wells making up the difference for combined peak flow of 2.4 mgpd.

Number of Additional Wells in Desert Field	Average Chloride (mg/L)	Average Sulfate (mg/L)	Average TDS (mg/L)
1	309	260	1017
2	287	244	963
3	266	227	909
TNRCC State Drinking Water Standard	300	300	1000

FIGURES

DWG DATE: 07OCT94 | PRJCT NO.: MT0333.001 | FILE: HDR | DRAWING: MT33301A.DWG | CHECKED: D. REED | APPROVED: D. REED | DRAFTER: H. CLARDY



Reference: Geologic Atlas of Texas, Van Horn—El Paso Sheet, The University of Texas at Austin, Bureau of Economic Geology, published 1955 and 1962, revised 1983.

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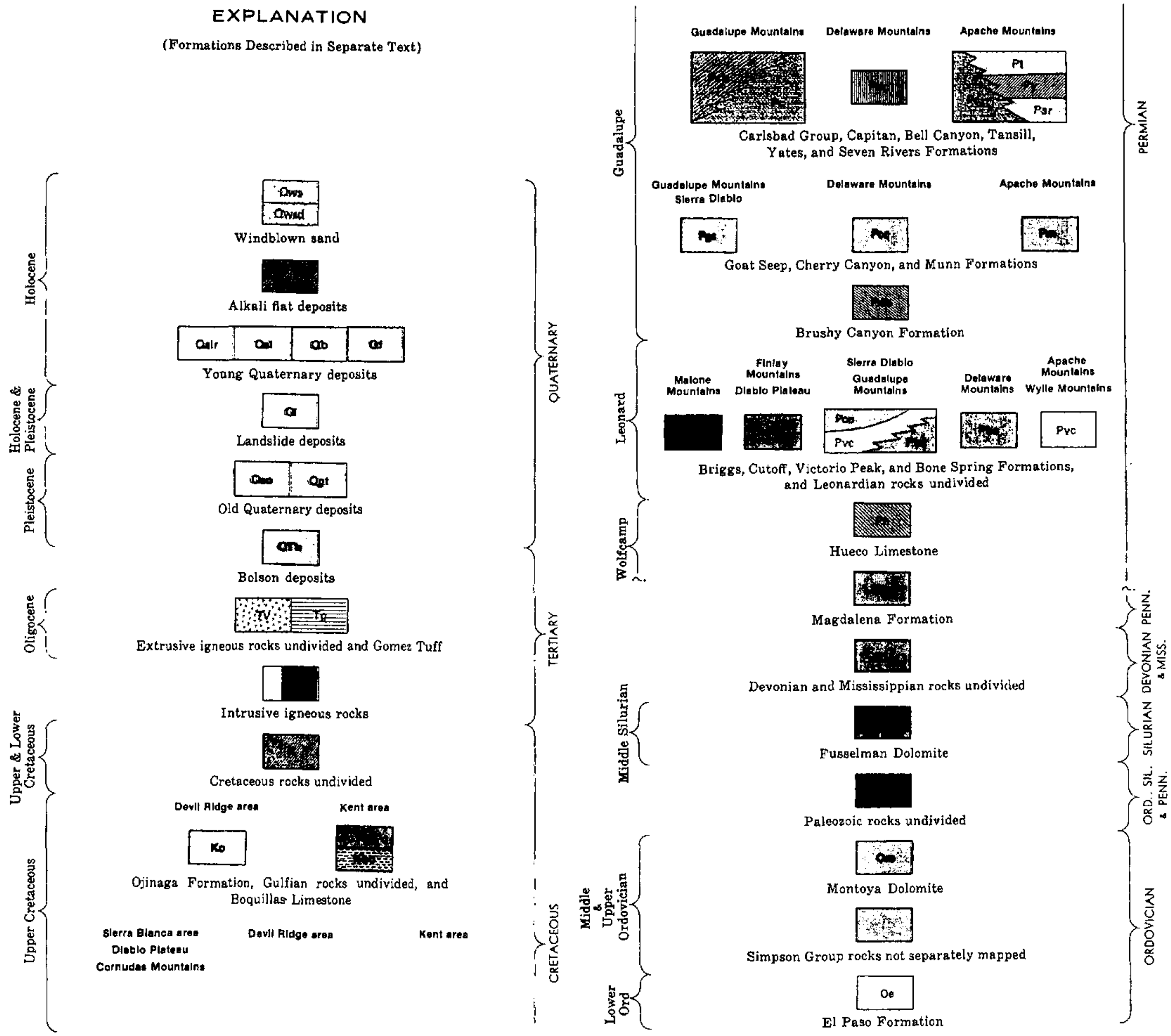
0 4 Miles

GEOLOGIC MAP

EL PASO COUNTY, TEXAS

FIGURE 2



Reference: Geologic Atlas of Texas, Van Horn–El Paso Sheet, The University of Texas at Austin, Bureau of Economic Geology, published 1955 and 1962, revised 1983.

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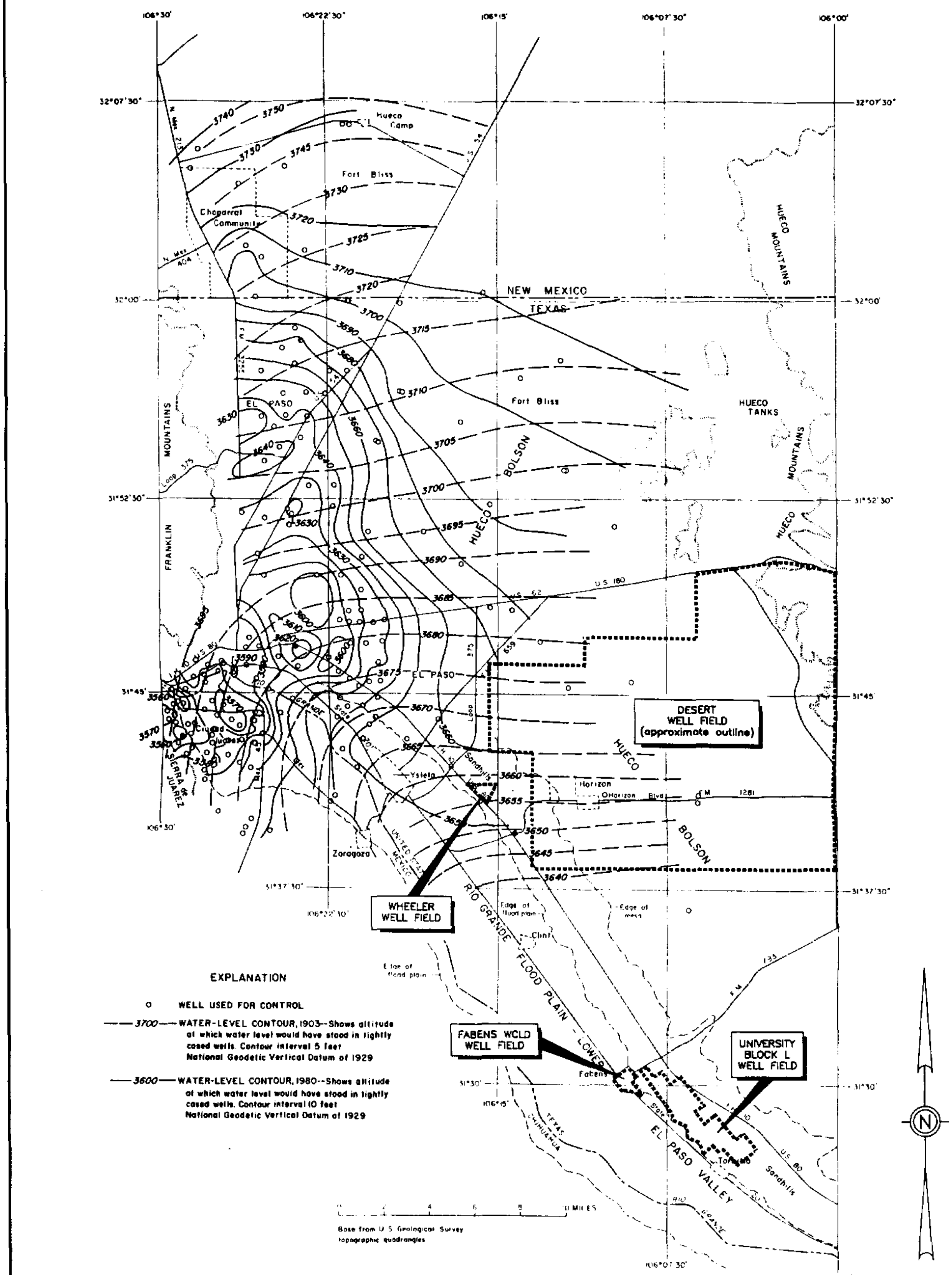
EXPLANATION FOR GEOLOGIC MAP

EL PASO COUNTY, TEXAS

FIGURE
2a

DWG DATE: 07OCT94 | PRJCT NO.: MT0333.001 | FILE: HDR | DRAWING: MT33301B.DWG | CHECKED: D. REED | APPROVED: D. REED | DRAFTER: H. CLARDY

DWG DATE: 13OCT94	PRJCT NO.: MT0333.001	FILE: HDR	DRAWING: MT33301E.DWG	COMPILER: D. REED	APPROVED: D. REED	DRAFTER: H. CLARDY



Reference: Texas Water Development Board, Summary of Hydrologic Information in the El Paso, Texas, Area, With Emphasis on Ground-Water Studies, 1903–80, Report 300, August, 1987.

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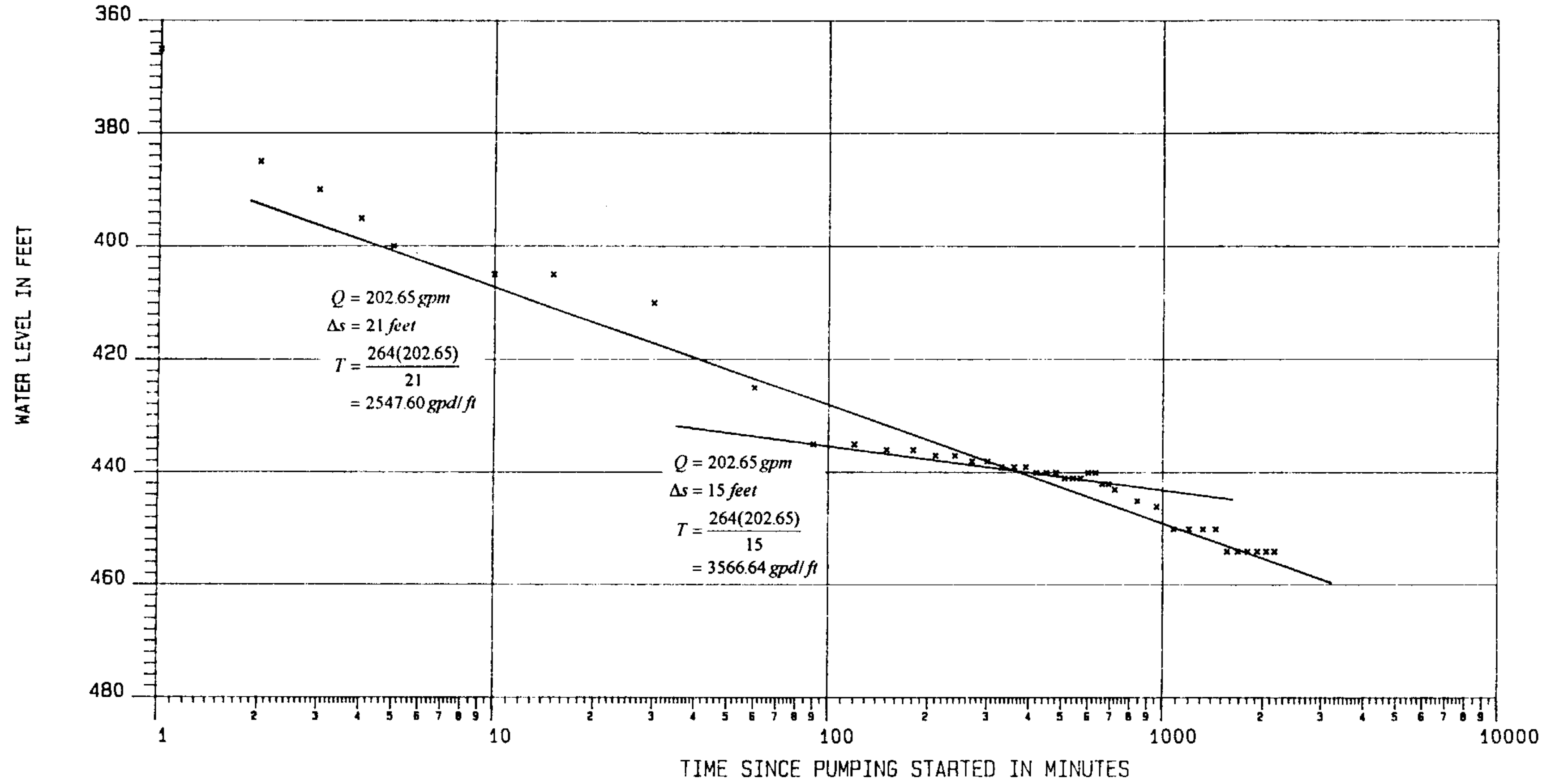
FIGURE 3

WATER TABLE - 1980

EL PASO COUNTY, TEXAS

APPENDIX A



HDR - EL PASO

EPCMWA
EL PASO COUNTY, TEXAS
DRAWDOWN OF WELL 1A-32

Date: 09-20-1994 Figure:

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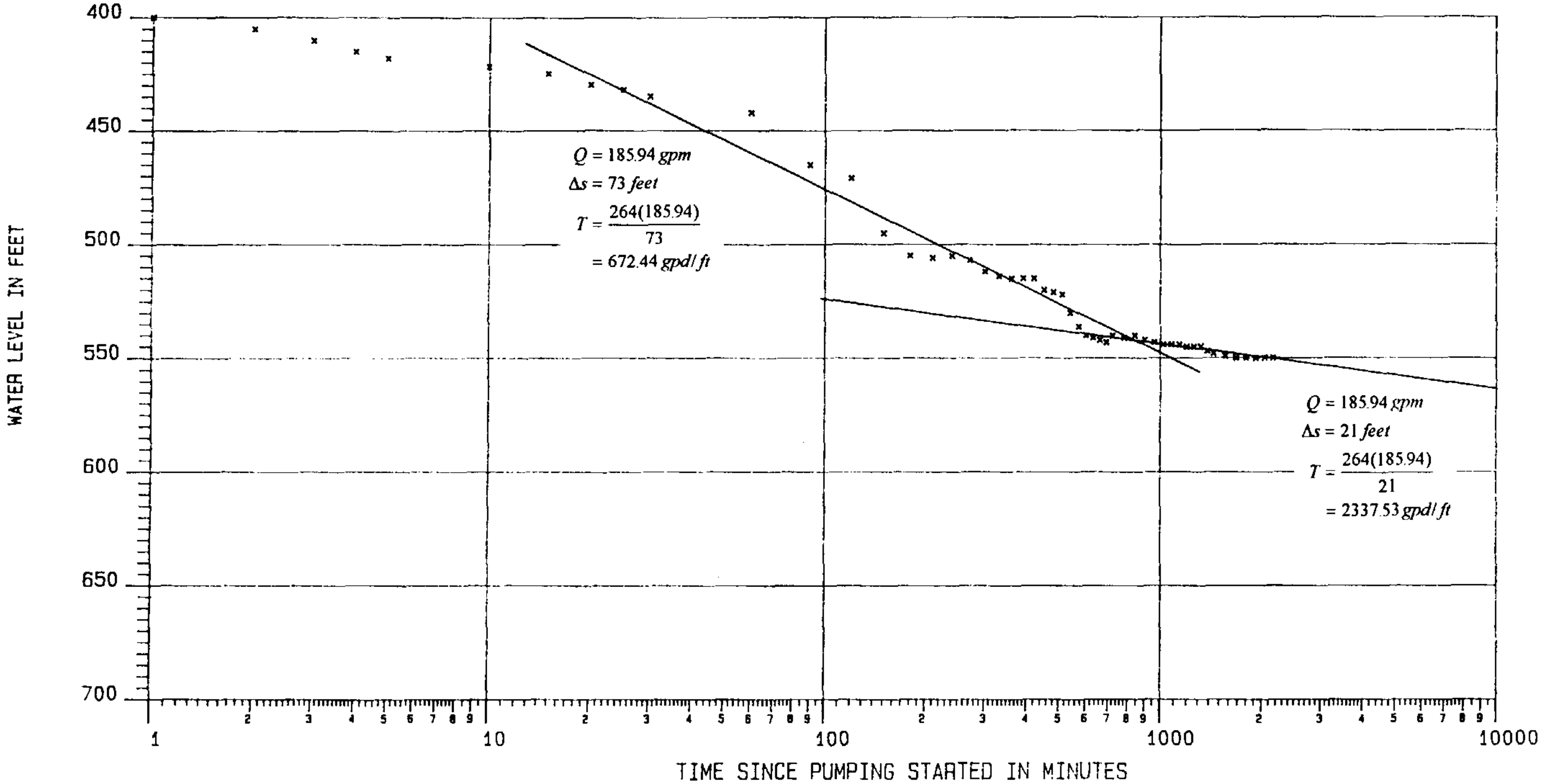
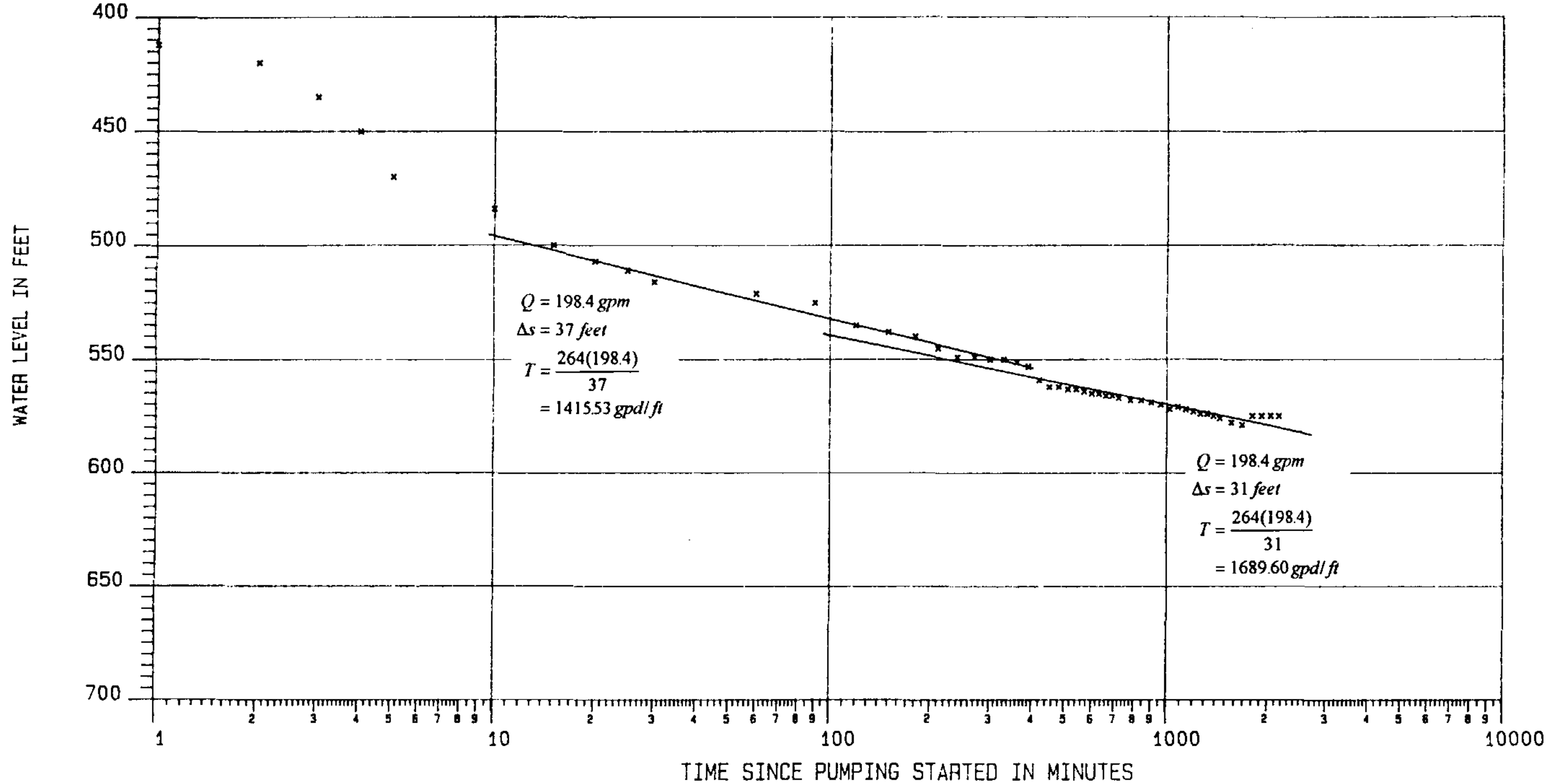


HDR - EL PASO

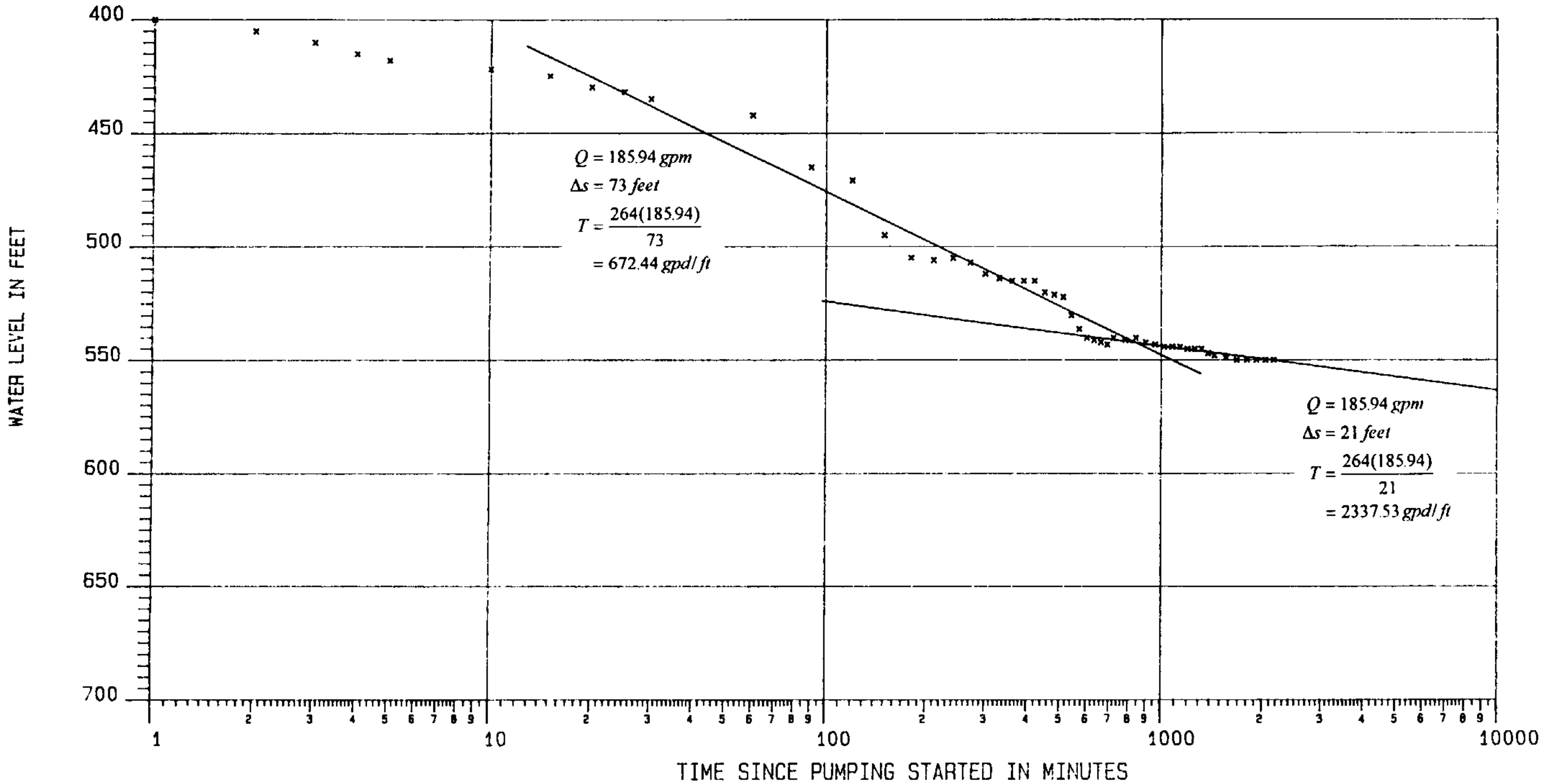
EPCMWA
EL PASO COUNTY, TEXAS
DRAWDOWN OF WELL 6A-36

Date: 09-20-1994 Figure:

GERAGHTY & MILLER, INC.



HDR - EL PASO
EPCMWA EL PASO COUNTY, TEXAS DRAWDOWN OF WELL 14-36
Date: 09-20-1994 Figure:
GERAGHTY & MILLER, INC.



HDR - EL PASO

EPCMWA
EL PASO COUNTY, TEXAS
DRAWDOWN OF WELL 6A-36

Date: 09-20-1994 Figure:

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A Review and Evaluation Of The
Available
Hydrologic Data On The
Groundwater Resources Under
The El Paso County Water
Authority And Fabens WCID Leases
Contract No. 94-483-049

The follow map is not attached to this report. Due to its size, it can not Be copied. The map will be located in the official file and may be copied upon request.

Groundwater Quality Figure 4

El Paso County, Texas

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