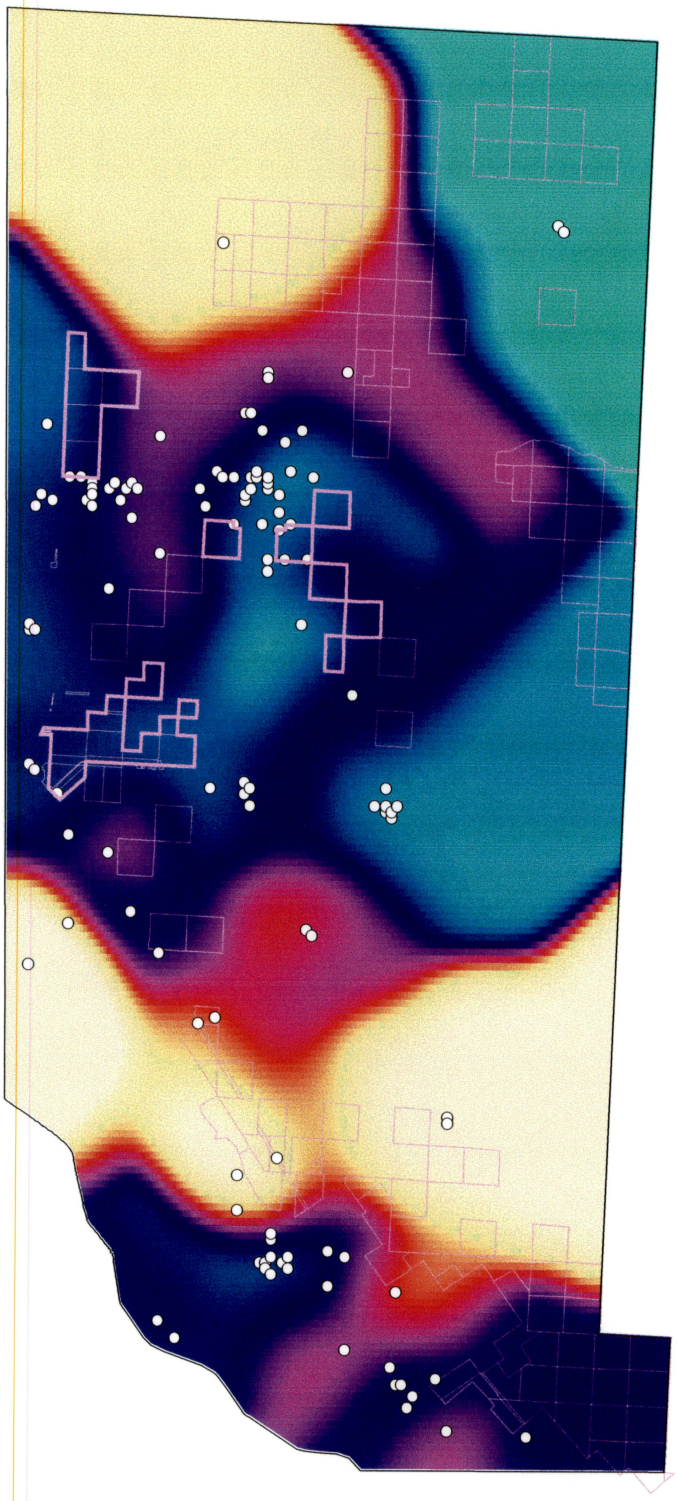
REEVALUATION OF GROUND-WATER RESOURCES ON STATE LANDS IN EASTERN EL PASO COUNTY



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William F. Mullican III,
Alan R. Dutton,
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Topical Report
Results of a Pilot Study

Prepared for the
Texas General Land Office
under Contract 96-204 R

Bureau of Economic Geology
Noel Tyler, Director
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CONTENTS

TABLES

FIGURES

EXECUTIVE SUMMARY

A reevaluation of the ground-water resources on State (Permanent School Fund) lands in eastern El Paso County, Texas, has resulted in the delineation of three areas where further hydrogeologic investigations are justified. The three areas were delineated on the basis of water chemistry and depth to ground water. In this re-evaluation, the three areas delineated all had total dissolved solids of less than 1,000 mg L^{-1} and a depth to ground water between 200 and 400 feet. On the basis of projected and reported consumption rates in other areas of the El Paso region, a range in cumulative production rates from 120 to 1,200 gallons per minute from 2 to 10 wells would meet local water needs. It is noted, however, that this reevaluation is based solely on readily available hydrologic and hydrochemical data. This reevaluation does not include any analysis concerning sustainable yield for the delineated areas based on site-specific hydraulic conductivity and specific storage data. The investigations described in the proposed scope of work will be required to provide these data, address sustainable yield, and target optimal drilling sites for water-supply wells.

INTRODUCTION

The potential for future economic development on State (Permanent School Fund) lands in eastern El Paso County and Hudspeth County in West Texas will depend in part on the location and delineation of additional ground-water reserves and resources in the local area. In this report, ground-water reserves are defined as identified potable supplies that can be economically

pumped and transported with existing technology and under current economic conditions, whereas ground-water resources are reserves plus all other supplies that might eventually become available, that is, known supplies that under present conditions do not have acceptable quality or cannot be developed economically. Historically, attempts to locate and secure water reserves and resources for future use in the greater El Paso area have been restricted to local areas where the quality and quantity of water available is great enough to satisfy a significant part of the long-term regional water requirements. The region has seen a rapid increase in population and demand for water over the last three decades. Attempts to find additional large volumes of good quality ground-water reserves near El Paso, however, have been unsuccessful.

Current plans for meeting these future needs include the development of large well fields located 100 to 150 miles southeast of El Paso in the areas of Van Horn and Valentine. This option obviously will be quite expensive, however, because of the length and energy requirements of the proposed pipeline. Additional reserves are available to the north in the Mesilla Bolson in New Mexico, but, to date, attempts to obtain these water rights have been unsuccessful because of legal problems.

Economic development on the various State lands in eastern El Paso County and Hudspeth County might not justify the capital investment of such large-scale water importation projects. This fact has been documented in several water resource investigations of the El Paso area (for example, Lee Wilson and Associates, 1981). However, if only the water needs of the State lands to be

developed are considered, instead of the much larger needs of the greater El Paso area, then local, economic sources of acceptable-quality ground water may be available for development.

This smaller, more localized ground-water resource goal represents a significant shift from the approach of searching for new large-scale ground-water resources in El Paso County during previous efforts. White (1987) reported an average per capita use of water to be approximately 200 gallons per day, which equates to approximately 22.5 acre-feet of water per year for every 100 people. Therefore, the projected water demand for a development of 1,000 people in the El Paso area would be 225 acre-feet.

The proposed El Paso County Municipal Utilities Districts 1 and 2 (located in eastern El Paso County and within the study area of this report) are projected together to require as much as 2,100 gallons per minute (or a maximum of 3,400 acre-feet of water per year) during peak consumption periods (Rust Lichliter/Jameson, 1994). It should be noted that the peak demand requirements may at least in part be met by local surface-water storage facilities (for example, above ground storage tanks) so that the actual sustained ground-water yield requirements might be somewhat lower than the peak demand of 2,100 gallons per minute. If this type of development is the goal of future endeavors on State lands, then perhaps the objective might be to locate and obtain the water rights to a local area where the sustainable yield would approach the 3,400 acre-feet of ground water required by the new El Paso County Municipal Utilities Districts. Reported consumption rates for rural communities in the region such as

Anthony, Clint, and Fabens range from 200 to 700 acre-feet per year (Ashworth, 1990). Therefore, the range in sustained yield hypothetically required to meet the typical municipal and industrial needs in this region for future development on State lands may, at least initially, be from a few hundred to a few thousand acre-feet per year. To meet a sustained yield requirement in this range, as few as 5 to 10 low-capacity water wells (with a range in sustained yield from 25 to 200 gallons per minute) would be sufficient.

This pilot study is designed to (1) identify and inventory hydrologic, geologic, and engineering data sets applicable to the question of whether there are sufficient ground-water reserves and resources available for future development of State lands, (2) compile these data for eastern El Paso County where significant State lands are present, (3) reevaluate the water-resource potential in the pilot study area, and (4) prepare a scope of work for the next phase of this reevaluation.

DATA INVENTORY

The collection and reporting of hydrologic data in the El Paso area dates back to Slichter (1905). With the significant increase in the rate of population growth experienced since the early 1950's, there has been a commensurate increase not only in the demand for water but also in the quantity of hydrologic data collected. In El Paso County, the primary sources for hydrologic data have been the El Paso County Water Utilities Public Service Board, the Texas Water Development Board (TWDB), and the United States Geological Survey (USGS).

A significant portion of these data has been integrated into the Texas Natural Resources Information Service's (TNRIS) ground-water data base and can now be easily accessed through the Internet. Table 1 below summarizes the amount and type of data available for El Paso County and for the portion of eastern El Paso investigated in this pilot study.

Table 1. Hydrologic data accessed from the TNRIS data base

Parameter	El Paso County	Eastern El Paso Study Area
Number of water wells with data	1,761	267
Water wells with at least one water-level measurement	1,375	168
Total number of water-level measurements	32,147	933
Water wells with at least one chemical analysis	761	149
Total number of chemical analyses	3,962	410

The hydrologic data summarized in table 1 illustrates three facts. First, there is a tremendous wealth of both historical and current hydrologic data available for El Paso County. Second, as would be expected, the majority of these data are located in the existing and historical well fields of El Paso County and also along the Rio Grande. Third, both the amount of available data and the number of ground-water resource investigations that have been conducted in eastern El Paso County are quite limited.

There are many sources of published hydrologic data available for the areas of El Paso County where well fields have been located, and also along the Rio Grande, in addition to the data base summarized above. For example, Davis

and Leggat (1965) published a reconnaissance investigation of ground-water resources along the entire extent of the Rio Grande in Texas. Information provided in their report is for all of El Paso County and includes both physical and chemical data. Chemical data presented for the eastern portion of El Paso County in Davis and Leggat (1965) appear to be consistent with the data compiled for this reevaluation, indicating that there are areas with inferior water quality but also areas with water quality that would be acceptable for municipal and industrial purposes. Davis and Leggat (1965) hypothesized that the inferior-quality water was localized in areas with finer grained sediments (silts and clays).

Myers (1969) provided the results of aquifer tests performed in 66 water wells in El Paso County. None of the 66 wells with pump test results are located within the pilot study area of eastern El Paso County.

Meyer and Gordon (1972) reviewed the development of ground water in the El Paso area from 1963 through 1970 and identified ground-water issues such as declining water levels in the main well fields and elevated chloride levels in a few of the municipal supply wells. Alvarez and Buckner (1980) provided an extensive compilation of hydrologic data in the El Paso area that was restricted to the immediate vicinity of the Rio Grande Valley. Their report provided only limited data in the area of interest of this pilot study north of Interstate 10. Gates and others (1980) conducted a water resource evaluation for a large portion of West Texas including the Hueco Bolson. A significant portion of this effort focused on electrical sounding profiles conducted to evaluate the presence and thickness of basin sediments saturated with fresh water. It is interesting to note

that on their profile A-A´, sounding locations 4 and 7 record a saturated thickness of 300 feet. These two locations are near the areas delineated during this pilot study as potentially containing locally significant volumes of quality ground water.

White (1987) reviewed the status of ground-water resources in El Paso County with an almost exclusive focus on existing and historical well fields. Only a few of the data points presented in White (1987) lie in the study area of this report. In a companion report to White (1987), Rees (1987) provided an extensive compilation of data on water levels, production rates, and chemical analyses from wells throughout the Trans-Pecos region of Texas including Hudspeth County. Rees (1987) focused on the major areas of ground-water withdrawal outside of El Paso County.

Other recent reports addressing the problems of water-level declines and deteriorating water quality in and around the major municipal well fields in El Paso County include Groschen (1994), Brock and others (1994), and Buszka and others (1994). These reports have all focused on various different hydrologic elements of the Hueco Bolson Recharge Project located in northern El Paso County east of the Franklin Mountains.

DATA COMPILATION

In order to conduct a preliminary reevaluation of the water-resource potential in the area of the State lands in eastern El Paso County, hydrologic data were compiled and analyzed to look for local areas where ground water is

present with acceptable chemical qualities and at suitable production depths. The study area for this pilot project is bounded on the east by the El Paso–Hudspeth county line, on the north by the Texas–New Mexico state line, on the south by Interstate 10, and on the west by a line chosen specifically to include all of the State lands in the eastern half of El Paso County (see figure 1).

There are many different hydrologic parameters presented in published reports and data bases that can be used to evaluate or reevaluate the ground-water resource potential within the pilot study area. In addition to the TNRIS data base, the following reports were reviewed for data availability and to evaluate current conceptual models for the area.

Although there have been a number of reports addressing the ground-water resources of the El Paso area, from Sayre and Livingston (1945) through Ashworth and Hopkins (1995), there has been almost no emphasis put on the development of marginal water resources within the pilot study area. The primary source of water for the El Paso area is the Hueco Bolson aquifer. According to Ashworth and Hopkins (1995), municipal water supply consumes 87 percent of the water pumped from the Hueco Bolson, located east of the Franklin Mountains, and the Mesilla Bolson aquifer, located to the west. Significant ground-water production from the Hueco Bolson aquifer has occurred in Texas, New Mexico, and Mexico. In the area roughly parallel to and east of the Franklin Mountains, sediments of the Hueco Bolson are reported to be up to 9,000-feet thick (Davis and Leggat, 1967; Mattick, 1967; Gates and others, 1978).

Ashworth (1990) provided the most current regional evaluation of the water resources for El Paso County from the TWDB perspective. Ashworth (1990) estimated that ground-water production in the area of the municipal well fields, which produce from the Hueco Bolson and Mesilla Bolson aquifers, exceeds the rate of recharge by approximately 83,000 acre-feet per year. This overdrafting or mining of ground water has resulted in local water-level declines as great as 150 feet. In the Texas portion of the Hueco Bolson aquifer, there remained an estimated 9.7 million acre-feet of theoretically recoverable ground water in 1989 (Ashworth, 1990).

The chemical quality of ground water produced from the Hueco Bolson aquifer can be quite variable. The average total dissolved solids in the El Paso area typically ranges from 500 to 1,500 mg L^{-1} with an average value of 642 mg L^{-1} (White, 1987). Water-level declines have coincided with a significant deterioration in the quality of ground water produced in the areas of the major municipal well fields.

Rust Lichliter/Jameson (1994) prepared a feasibility study for the creation of a municipal utility district immediately east of Horizon City. Basically, this was a proposal to develop an additional area west of Horizon City by using water from the Wheeler well field. In order to meet water-quality requirements, a reverse-osmosis plant was planned.

Geraghty & Miller, Inc. (1995), reported on (1) the quantity and quality of ground water remaining in the four principal well fields in the vicinity of El Paso (Wheeler, Desert, University Block L, and Fabens WCID well fields, which lie

west and southwest of the eastern El Paso County pilot study area), and (2) the potential for additional well fields in the region. According to Geraghty & Miller, Inc. (1995), the University Block L and Fabens WCID well fields do not meet minimum standards for chlorides, sulfate, and total dissolved solids. Wheeler is marginal, and Desert is locally acceptable. All of the present water-supply needs for Horizon City are being met by the three wells from the Wheeler well field and the seven wells in the Desert well field (Geraghty & Miller, Inc., 1995).

REEVALUATION OF WATER RESOURCE POTENTIAL IN EASTERN EL PASO COUNTY

This reevaluation of the water resource potential for the eastern portion of El Paso County selected for this pilot study differs from previous efforts because of the dramatic difference in scale. For example, Ashworth (1990, p. 22) summarized the potential for additional ground-water development in El Paso County with the following statement, " . . . undeveloped sources of fresh ground water *of significant quantity* (our italics) probably do not occur within the county." Ashworth (1990) and other previous studies had the objective of meeting all of El Paso's water-supply needs throughout the 21st Century. This study, however, has the objective of identifying sustainable ground-water resources for localized development. On the basis of current water usage statistics, a reasonable goal for sustainable yield on any particular tract of State lands selected for development is probably between a few hundred to a few thousand acre-feet per year.

This pilot study focused on two primary criteria to evaluate whether additional hydrologic investigations in the study area are justified. These criteria are water quality and depth to water. Published and accessible site-specific data (water wells located on State lands) were limited to only 10 water wells. The location of these wells and the years they were drilled are illustrated in figures 1 through 3. This limited amount of data clearly is neither sufficient nor of the type needed to make definitive recommendations about specific areas where additional ground-water resources may exist. The regional hydrologic data available in the study area, however, indicate areas where further investigation is warranted. Sufficient water wells are present to justify the extrapolation of regional trends in water quality and depth to water.

Three primary areas were identified where collection of additional hydrologic data is justified. These areas are outlined in bold on figures 1 and 3. These areas were selected on the basis of four technical criteria. First, the extrapolation of regional chemical data into these areas suggests that ground-water quality has total dissolved solids of less than 1,000 mg L^{-1} (figure 1). Second, the depth to the water table in the identified areas is between 200 to 400 foot, which is within the acceptable range for pumping lifts in this region (figure 3). Third, according to the regional work of White (1987) and Ashworth (1990) these areas are outside of known areas of water-level declines due to production from current or historical well fields. Finally, these areas warrant further investigation because of the significant difference in sustained yields desired from this effort versus yields targeted during previous evaluations.

If the estimated requirement for local sustainable yield is between 200 and 2,000 acre-feet per year, based on measured and estimated production rates of other similar areas, then the following production rates on a per-well basis would be required. A yield of 200 to 2,000 acre-feet per year equates to a pumping rate of 124 to 1,240 gallons per minute (gpm). Under this scenario, anticipated needs on specific blocks of State lands might be met by as few as 2 to as many as 10 low-capacity production wells evenly spaced within a 2- to 3-square-mile area. On the basis of previous work in the extension of the Hueco Bolson in Hudspeth County (Mullican and Senger, 1992), this level of sustained yield probably is most achievable for wells completed in saturated, coarse-grained sediments. Such drilling targets might be identified using surface geophysical methods. The following scope of work has been developed to further evaluate the potential for water resources in the three areas that meet the specified goals of water quantity and quality, and to prove up drilling targets for a well field.

PHASE I SCOPE OF WORK

This section describes the proposed Phase I scope of work. A Phase II scope of work (for example, extending the reevaluation to include additional State lands in Hudspeth County or conducting test drilling) might be designed on the basis of the results of the Phase I study. The cost involved in drilling and testing water-supply wells, especially in areas where the depth to water is considerable, may be very high. Therefore, it is very important to understand the

hydrologic system as well as possible prior to the drilling and installation of the water-supply wells by completing the following tasks:

1. Hydrologic data in the three identified target areas must be collected and inventoried. This effort would include field visits to survey and locate wells not currently included in available ground-water data bases, interviews with well owners to obtain information about well construction and performance, and collection of data on level measurements and chemical analyses. All data to be collected will be programmed into a geographic information system (GIS) for data analysis in a similar manner as was accomplished for this pilot study (maps of total dissolved solids and depth to ground water). The data will be organized in GIS look-up tables and maps. In areas where spatial location data are determined to be inadequate, global positioning system (GPS) surveys will be conducted so as to improve the coordinate registration of all items critical to the analysis (primarily water wells).
2. The absence of aquifer test data in the pilot study area is one of the most significant data deficiencies that should be addressed in order to determine the sustained yield potential for the area. Therefore, we will conduct pumping tests in existing wells in eastern El Paso County to better define the hydrogeologic properties of those areas delineated for further study. These data will then be integrated into the GIS data base as a discrete layer and used in the analysis of potential sustained yield for the three areas in question.

3. Although many water wells have been drilled in the pilot study area, detailed subsurface geologic data are sparse. As discussed earlier, the delineation of local areas with saturated, coarse-grained sediments has proven to be critical for providing quantities of ground water in the range deemed necessary in this pilot study. Shallow seismic reflection methods will be evaluated and optimized to delineate subsurface channels at depths of 200 to 600 feet. Field testing of seismic sources and acquisition parameters will be followed by 2-dimensional production surveys. These production surveys will cover the three sites that have been chosen for further ground-water resource evaluation.

4. Detailed hydrogeologic maps and data files will be prepared to serve as the fundamental basis for water-resource assessment. The types of maps to be prepared include but are not limited to potentiometric surfaces, well inventory, aquifer yield, water quality (total dissolved solids, chlorides, nitrates, sulfates), hydrogeologic properties such as hydraulic conductivity, sand/shale content, and geophysical attributes. These maps can be used, for example, to define the lateral and vertical extent of the Hueco Bolson aquifer, which meets the hydrologic criteria required for local water-resource needs. A map of the depth to water will be used to predict well construction and operation costs for each of the three delineated areas. The combination of aquifer geometry maps and water quality maps will be used to determine the volume of potable and marginal-quality water available for the delineated areas.

5. Perform analysis of the short- and long-term water resource potential of the delineated areas using computerized numerical ground-water flow models. This task will be achieved using the hydrogeologic data assembled in the tasks described above.

6. Make recommendations for the location and specifics of a test drilling program for the pilot study area.

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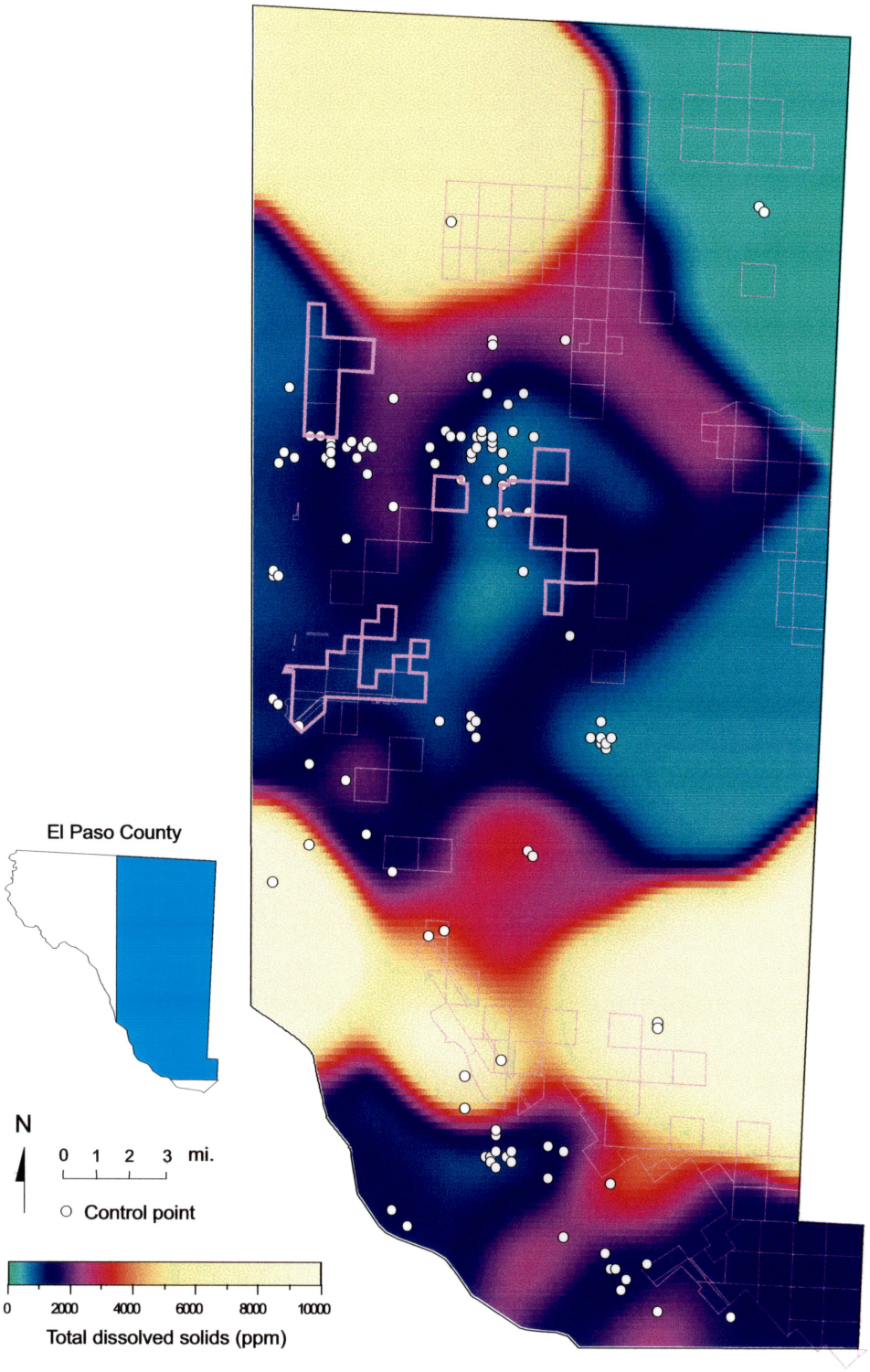
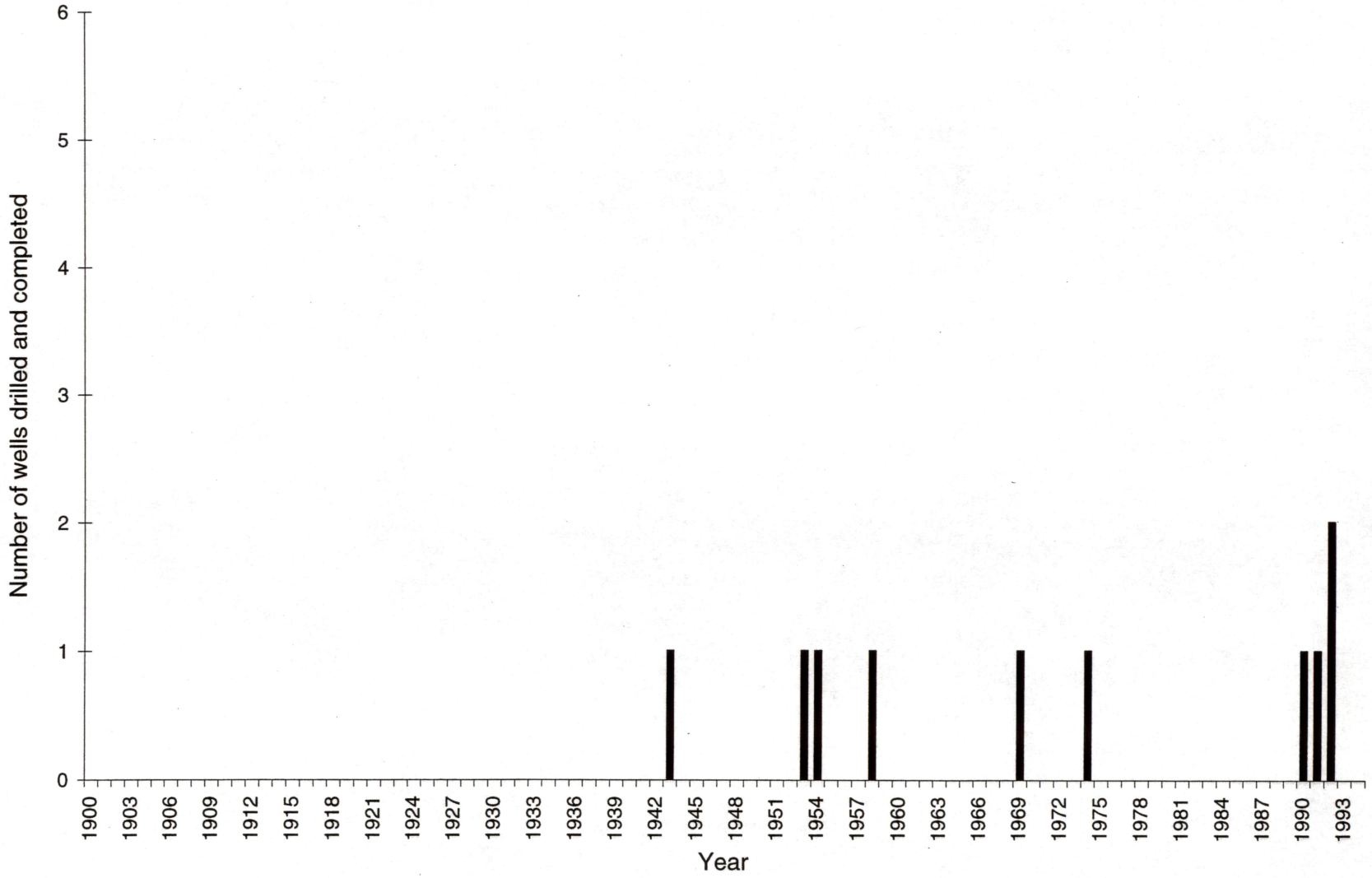


Figure 1. Map of study area in eastern El Paso County illustrating (1) location of water wells for which chemistry data was available, (2) location of State Lands, (3) location of areas delineated for more in-depth study (highlighted in bold), and (4) levels of total dissolved solids in ground-water samples collected in the area.

Figure 2. Graph illustrating the number of wells and years they were drilled on State lands in eastern El Paso County, Texas



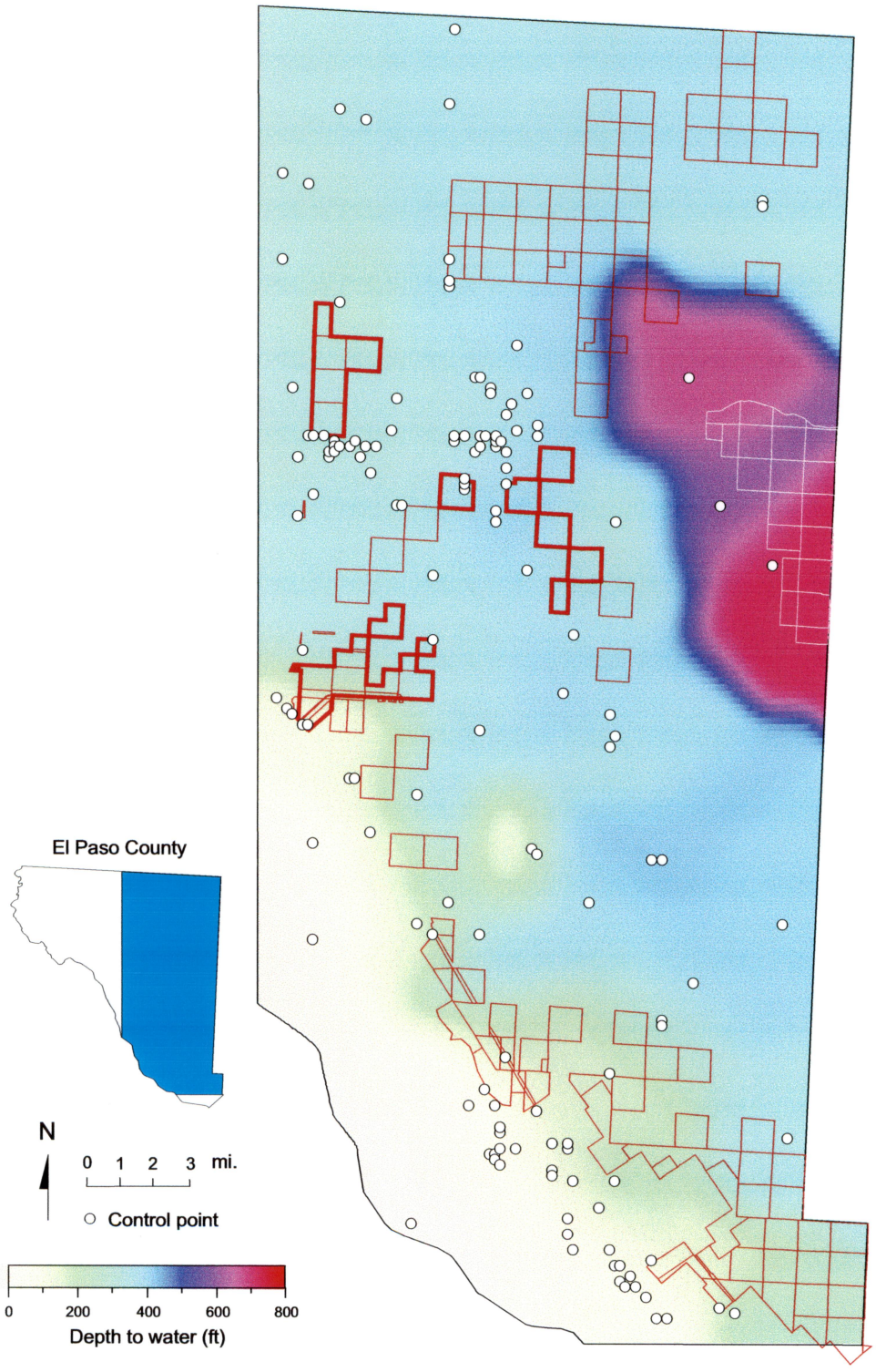


Figure 3. Map of study area in eastern El Paso County illustrating (1) location of water wells for which water-level data were available, (2) location of State Lands, (3) location of areas delineated for more in-depth study (highlighted in bold), and (4) depth to the water table.