REPORT ON GROUND-WATER CONDITIONS IN THE VICINITY OF CHAMPION, SOUTHWEST OF SWEETWATER, NOLAN COUNTY, TEXAS

Prepared for

The City of Sweetwater
Sweetwater, Texas

By

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October 2, 1987

Mr. David Maddox
City Manager
City of Sweetwater
Post Office Box 450
Sweetwater, Texas 79556

Dear Mr. Maddox:

Attached is our report on the results of our study of ground-water conditions in the vicinity of Champion, southwest of the City of Sweetwater.

We wish to express our appreciation for the assistance we received from you and Mr. Mickey Rogers while the field work for the study was in progress.

If you have any questions concerning the report, we shall be glad to discuss them with you.

Sincerely yours,

WILLIAM F. GUYTON ASSOCIATES, INC.

Joseph K. Longacre

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enclosure

TABLE OF CONTENTS

	Page
CONCLUSIONS	i
INTRODUCTION	1
ACKNOWLEDGMENTS	2
GEOLOGY	3
RECORDS OF WATER WELLS	6
PUMPAGE FROM SANTA ROSA	9
WATER LEVELS IN WELLS	12
PUMPING TESTS	15
TEST HOLES	19
RECHARGE TO AND NATURAL DISCHARGE FROM THE SANTA ROSA	21
CHEMICAL QUALITY OF GROUND WATER	25
Dissolved Solids	25
Chloride and Sulfate	27
Nitrate	27
Iron and Manganese	31
Hardness	32
Heavy Metals	32
Organic Chemicals	33
Radionuclides	33
South Fork Champion Creek	34
WATER IN STORAGE	34
DEVELOPMENT OF WATER SUPPLY	36
Water Availability	36
Water Quality	39
Tentative Well Field	42
Well Construction	44
Pumping Levels	46
PLUGGING OF ABANDONED WELLS	47
EFFECT OF PUMPING ON OTHER WELLS	48

TABLE OF CONTENTS (Continued)

TABLES

Table 1. Records of Wells
Table 2. Results of Pumping Tests
Table 3. Results of Chemical Analyses of Ground Water from the Santa Rosa Formation
Table 4. Texas Department of Health's Maximum Constituent Levels for Public Water Systems
Table 5. Results of Analyses for Metals in Water from Wells and Distribution Systems of the Cities of Roscoe and Loraine
Table 6. Organic Chemicals
Table 7. Radiological Analyses of Water from Wells and Distribution Systems of the Cities of Roscoe and Loraine

FIGURES

Figure 1. Location of Study Area
Figure 2. Geologic Map
Figure 3. Depth to and Elevation of Base of Santa Rosa Formation
Figure 4. Well Location Map
Figure 5. Depth to and Elevation of the Water Table in the Santa Rosa Formation
Figure 6. Depths to Water in Selected Wells and Precipitation at Roscoe
Figure 7. Depths to Water in Selected Wells
Figure 8. Pumping Test of Well 29-44-111
Figure 9. Pumping Test of Well 29-44-4X8
Figure 10. Pumping Test of Well 29-44-1X2
Figure 11. Pumping Test of Well 29-44-112
Figure 12. Pumping Test Data
Figure 13. Chemical Quality of Ground Water in the Santa Rosa Formation
Figure 14. Relationship Between Dissolved Solids and Specific Conductance
Figure 15. Saturated Thickness Data
Figure 16. Tentative Locations for Wells in a Well Field
Figure 17. Typical Gravel Wall Well

APPENDICES

Appendix 1. Sample Logs of Test Holes
Appendix 2. Electric and Radioactivity Logs of Test Holes

CONCLUSIONS

1. The study area for this report is comprised of eight sections of land southwest of Sweetwater. It is shown on Figure 1 herein. The principal source of ground water in the study area is the Santa Rosa Formation of the Triassic Dockum Group. The Santa Rosa outcrops in the study area, but it is covered by thin layers of Pleistocene surficial and other deposits in places. The depth to the base of the Santa Rosa is about 150 to 200 feet in the study area. Nine test holes were drilled in or near the study area as part of this investigation.

2. The Santa Rosa is comprised of a dense, hard, well-cemented basal conglomerate overlain by alternating layers of sand, sandstone, sand and gravel, and clay. The net thickness of permeable unconsolidated sand or sand and gravel ranges from 0 to about 141 feet, and averages about 55 feet. The net thickness of sandstone or cemented sand and gravel ranges from 0 to about 102 feet, and averages about 34 feet. The thickness of the basal conglomerate ranges from a few feet to 30 to 40 feet. The most water productive zone in the Santa Rosa appears to be the sands, gravels, and sandstones in approximately the bottom 40 to 80 feet of the formation just above the basal conglomerate.

3. A large number of domestic, stock, and irrigation wells have been drilled in the study area and the surrounding area. Many of the domestic, stock, and irrigation wells are unused. In 1987, only 12 of the 67 irrigation wells inventoried in the study area and surrounding area, in a total area of 26 sections, were being used. Seventeen industrial wells have been drilled in this vicinity to obtain water for water flooding of oil reservoirs at some distance from the study area. Eight of these wells were unused in 1987.

4. A small amount of water was being produced in 1987 for irrigation of crops in the study area and the surrounding area. The pumpage for irrigation in 1987 probably will be less than about 200 acre-feet. Pumpage for irrigation in the study area and the surrounding area was much larger in the past. The pumpage for irrigation in the latter 1950's and early 1960's probably was as much as 2,000 to 2,100 acre-feet per year.

Pumpage by Texaco from its well field southeast of the study area averaged about 670 acre-feet per year from 1961 to 1979, and 660 acre-feet per year for the years 1980 through 1986. During the latter period, an average of 590 acre-feet per year was sold to the City of Sweetwater and the remainder was used for water flooding oil reservoirs. Records of

Texaco's pumpage indicate that all the water produced in 1986 was sold to the City of Sweetwater and none was used for water flooding.

5. Water levels in the Santa Rosa in the study area rose an average of about 20 feet from the early 1970's to 1987. The rise in water level probably is a result of water-level recovery caused by the reduction of pumpage for irrigation, terracing of fields to hold rainfall runoff, and slightly above-average precipitation during this time period. Depths to water levels in Santa Rosa wells in 1987 ranged from 8 to 12 feet below land surface at low elevations near South Fork Champion Creek to 87 feet below land surface at higher elevations in the study area.

6. The transmissivity of the water-bearing materials in the Santa Rosa was determined from pumping tests of 11 wells to range from about 1,400 to 12,200 gallons per day per foot. Specific capacities determined from tests of the wells range from 1.2 to 6.0 gallons per minute per foot of drawdown.

   The pumping tests show that the transmissivity is not uniform in the vicinity of many of the wells that were tested. The nonuniformity of the transmissivity results from the lack of homogeneity of the water-bearing materials in the Santa Rosa.

7. Part of the natural recharge to the Santa Rosa from precipitation on its outcrop is discharged locally as natural discharge by streamflow in South Fork Champion Creek and by evapotranspiration near the creek. The natural discharge as streamflow and by evapotranspiration is estimated to range from about 420 to 1,230 acre-feet per year.

8. The chemical quality of the water from most wells in the study area and surrounding area is reasonably good. The average dissolved solids for water that contains less than 1,000 milligrams per liter (mg/l) dissolved solids is 480 mg/l, the average chloride for water with less than 300 mg/l chloride is 82 mg/l, the average sulfate for water with less than 300 mg/l sulfate is 66 mg/l, and the average nitrate in water with less than 45 mg/l nitrate is 11 mg/l. Some poor quality exists in the area, however. The specific conductances of water from four wells indicate that dissolved solids in water from three of the wells probably is 1,700 to 2,000 mg/l, and dissolved solids in the fourth well probably is about 1,100 to 1,200 mg/l. Measured dissolved solids in water from a fifth well is 1,640 mg/l. Chloride and sulfate concentrations in water from four of these wells exceed the Texas Department of Health's (TDH) maximum level of 300 mg/l.

Nitrate concentrations in water from 15 of the 23 wells in the study area from which water samples were analyzed, range from 0 to 33 mg/l, and the nitrate concentrations in the water from the other eight wells range from 62 mg/l to 168 mg/l.

9. The ground-water discharge to South Fork Champion Creek is highly mineralized. The specific conductance, chloride, sulfate, and nitrate in a water sample from the creek were 3,500 micromhos per centimeter, 500 mg/l, 600 mg/l, and 75 mg/l, respectively. The quality of the water from the creek indicates that the ground water in the upper part of the Santa Rosa which feeds the creek probably is highly mineralized. Data from some wells also indicate that in some places the ground water in the upper part of the Santa Rosa is more highly mineralized than that in the lower part.

10. It is estimated that the amount of water available in storage in the Santa Rosa sands, sand and gravel, and sandstones underlying the study area is about 70,000 acre-feet. Approximately one-half to two-thirds of this water in storage probably could be produced before pumping rates of wells would decrease to the extent that continuing to pump would not be economical.

11. The estimated 70,000 acre-feet of water in storage would provide 1-1/2 million gallons per day (mgd) for 20 years if one-half of it is recoverable, or 2 mgd for 20 years if two-thirds of it is recoverable. If part of the natural discharge to South Fork Champion Creek is captured by pumping of wells, the water supply should last longer than 20 years.

12. The available chemical quality data indicate that the quality of water from wells in a well field might deteriorate in time. It seems likely that most of the poor quality ground water is in the upper part of the Santa Rosa. Examination of drillers' logs of wells in the study area and the logs of the test holes drilled for this study indicate that perhaps 31 percent of the water in storage in the Santa Rosa is in the upper part and 69 percent is in the lower part. Based on the available analyses, using this ratio, and assuming that all the water in the upper part of the formation is represented by the average of the analyses showing the poorer quality water and that all the water in the lower part of the formation is represented by the average of the analyses showing the better quality water, the movement of the highly mineralized water from the upper part of the formation to the lower part would not increase the dissolved solids, chloride, and nitrate concentrations beyond the TDH limits if the two waters should mix uniformly. It is calculated on the basis

of these assumptions that with uniform mixing dissolved solids would be about 950 mg/l, chloride would be about 190 mg/l, sulfate would be about 170 mg/l, and nitrate would be about 38 mg/l.

It is unlikely that mixing of the waters throughout the study area would occur uniformly. It appears possible, however, that deterioration of water quality to the extent that it would be unsatisfactory for public supply would not occur in all of the wells in a well field in the study area. Individual wells that might be affected probably could be abandoned and replaced with new wells as necessary at locations where the water quality is good.

Additional studies could be made to obtain more information and reduce the uncertainty, but probably not completely, with regard to possible deterioration of the water quality from wells in the study area. The studies would require drilling more test holes to obtain information on the quality of the water at various depths in the formation and the areal extent of the poor quality water. A comprehensive study would be required to determine the source of the nitrate. The test drilling is considered the more important of the studies, and drilling 20 to 25 test holes with air, using a shot-hole type of rig, to obtain water quality information would help to assess the risk of deterioration of the quality of water from a well field in the study area.

13. Based on the data obtained from this study it is believed that the pumping rates of wells which could be sustained at the end of 20 years of pumping would be about 80 gpm. Fourteen wells would be required to obtain 1-1/2 mgd and 18 wells would be required to obtain 2 mgd.

    Initially, pumping rates of the wells probably could be more than 80 gpm. With average pumping rates of 100 gpm, 11 wells would be required for 1-1/2 mgd and 14 wells would be required for 2 mgd. Additional wells would be required as pumping rates of the wells decline. Also, some wells might have to be replaced because of water quality deterioration.

14. Gravel-wall type wells should be constructed to produce the water to prevent pumping undesirable amounts of sand and to obtain the optimum yield. The wells should be constructed with 10-inch diameter casings and 6-inch diameter liner and screen. The depths to the bottoms of the casings probably would be below 100 feet, the water-bearing materials in the lower part of the formation would be screened in the wells, and the wells would be 150 to 200 feet deep.

15. The pump bowls on the pumps in the wells should be set near the bottoms of the wells, and pumping rates of the wells should be selected based on the characteristics of the individual wells to have pumping levels about 15 to 20 feet above the pump bowls. Estimated future pumping levels in the wells range from about 130 feet to 180 feet below land surface, and the average elevation of the pumping levels is estimated at about 2,180 feet above mean sea level.

16. Abandoned wells in the study area should be located and plugged in accordance with the rules of the Texas Water Commission if the City of Sweetwater decides to develop a well field in this area.

17. Pumping from a well field in the study area will lower water levels in domestic and stock wells, but it should not lower water levels deep enough to preclude obtaining water from those with casing large enough to lower the pumps to near the bottoms of the wells.

INTRODUCTION

This report presents the results of an investigation of ground-water conditions in the vicinity of Champion, in Nolan County, Texas. The study area, as shown on Figure 1, is located about 15 miles southwest of Sweetwater and eight miles southwest of Roscoe, and consists of eight sections of land in Block 24, Texas and Pacific Railroad Reservation Survey.

The objective of the study was to determine the availability of ground water in the Santa Rosa Formation, which is the primary aquifer in the study area. In this regard, this report includes information on: (1) the amount of permeable water-bearing material in the Santa Rosa Formation, (2) the hydraulic characteristics of the water-bearing zones in the Santa Rosa, (3) the amount of water that might be recovered from the Santa Rosa, the rate at which it might be recovered, and the longevity of the supply, and (4) the chemical quality of the water in the formation.

In order to accomplish the objectives listed above, the following data were collected and reviewed: (1) reports on geology and ground-water resources published by the Texas Water Development Board (or predecessor agencies), the University of Texas at Austin Bureau of Economic Geology, and our firm, (2) well records and drillers' logs of existing wells and test holes from the files of the Texas Water Commission, the U.S. Geological Survey, and local drillers and well owners, (3) electric logs of oil test holes from the records of the Texas Water Commission, and (4) chemical analyses, historical and current pumpage records, and historical and current water-level data from the files of the Texas Water Development Board.

In conjunction with collecting the data described above, field work for this study included: (1) an inventory of water wells in the study area, and within about one mile of the study area, (2) measurement of static water levels in wells where practicable, (3) making four pumping tests of existing wells in the study area, (4) collecting water samples for chemical analysis from selected wells in the area, and (5) observing the drilling and logging of nine test holes, and collecting drill cutting samples and water samples from the test holes for analysis.

Reports relating to ground water in western Nolan County and eastern Mitchell County that have been published by State water agencies and other references that were reviewed during this study are listed at the end of the text of this report.

ACKNOWLEDGMENTS

Appreciation is expressed to the many well owners in the Champion area who contributed data and made wells available for testing during this investigation.

Particular appreciation is expressed to the following: Texas Water Development Board for providing part of the funding for the investigation and for providing its drilling rig and crew for drilling test holes; the City of Sweetwater, particularly David Maddox and Mickey Rogers for their assistance during the study; and Texaco Oil Company for furnishing information on its water wells.

GEOLOGY

The geology of the study area has previously been described by Victor M. Shamburger, Jr., in Texas Water Development Board Report 50, titled "Ground-Water Resources of Mitchell and Western Nolan Counties, Texas", and is also shown on the Big Spring Sheet of the Geologic Atlas of Texas, published by the University of Texas at Austin Bureau of Economic Geology. The following discussion draws on information presented in these publications, supplemented by information obtained by study of drillers' logs of water wells in the area, and by data obtained from the drilling of nine test holes in the area.

The study area lies on the Eastern Platform of the Permian Basin of West Texas. Rocks exposed in the vicinity of the study area range from Permian to Quaternary in age. In order of ascending age, they include the Permian Whitehorse Sandstone and Quartermaster Formation, the Triassic Dockum Group, the Cretaceous

Antlers Sand and Edwards Group, the Tertiary Ogallala Formation, Pleistocene surficial and playa deposits, and Quaternary surficial and alluvial deposits. Figure 2 shows the outcrop geology of the area around Champion.

The only aquifers of importance in the study area and in the vicinity of it are the Santa Rosa Formation of the Triassic Dockum Group, and the Cretaceous Antlers Sand. The Antlers Sand yields sufficient quantities of water for domestic or stock use where it is present in the study area, but does not generally yield sufficient quantities of water for irrigation or public supply purposes. The water-bearing sands and sandstones of the Santa Rosa Formation are the strata in which the irrigation wells and other large-capacity wells in the Champion area are completed.

The Santa Rosa Formation is present throughout the study area, and crops out in the Champion Creek valley, although it is thinly mantled in places by Pleistocene surficial deposits. Around the margins of the valley, the Santa Rosa is overlain by the Antlers Sand or by alluvial deposits. Near Roscoe, the Santa Rosa is overlain by the Ogallala Formation.

The Santa Rosa Formation is terrestrial in origin, and consists of river channel and floodplain deposits laid down by streams flowing from the east and south into the Permian Basin. Figure 3 is a structure contour map of the base of the Santa Rosa Formation, compiled from data obtained from the test holes and other drillers' logs. Channeling of the Santa Rosa into the underlying Permian sediments is illustrated by the contour pattern. The Santa Rosa Formation dips to the west-northwest at about 25 to 30 feet per mile and ranges in thickness from about 150 to 200 feet in the study area.

The Santa Rosa Formation is composed of a basal conglomerate overlain by alternating layers of sand, sandstone, sand and gravel, and clay. The basal conglomerate ranges from a few feet thick to 30 or 40 feet thick. It is composed of pebble gravel in a matrix of poorly sorted sand, and is typically dense, hard, and well cemented. The sands are typically gray or yellow, and composed of subangular to subrounded, fine- to medium-grained quartz. Locally, layers or lenses of coarse-grained sand and granule to pebble gravel are interbedded with the deeper sands. Varying amounts of mica and dark mineral grains are present in the sands. The sands are typically loose to weakly cemented, although locally they are moderately or well cemented to sandstone. The clays interbedded with the sands are red or blue-gray in color, and locally contain thin beds of carbonaceous material resembling coal. Sample logs showing the materials encountered in the test holes are included as Appendix 1, and electric logs and radioactivity logs made in the test holes are included as Appendix 2.

Examination of the logs from the test holes and 37 other wells in or near the study area indicates that the net thickness of permeable unconsolidated sand, or sand and gravel, in the Santa Rosa ranges from 0 to 141 feet, and averages about 55 feet. The net thickness of consolidated or cemented sand, or sand and gravel, ranges from 0 to 102 feet, and averages about 34 feet. Large variations in the position and thickness of the sand and sandstone layers over relatively short distances indicate that these layers are highly lenticular. Observations of the amount of water produced from the test holes during drilling indicate that the major water-bearing zones in the Santa Rosa are the sands, gravels, and sandstones in the lower part of the formation -- generally the lower 40 to 80 feet of the formation above the top of the basal conglomerate, depending on the location of the test hole.

The Antlers Sand, also referred to as Trinity Sand or Paluxy Sand in the older geological literature, crops out in the sides of the bluffs or hills rising to the north, south, and east of the Champion Creek valley. It has been removed by erosion in much of the study area. The Antlers sand is principally composed of white to purplish, loosely to moderately consolidated, fine- to coarse-grained quartz sand, and ranges in thickness from about 70 to 80 feet near Champion.

RECORDS OF WATER WELLS

Records of water wells and test holes within the study area and within about one mile of the study area were compiled from data in published reports and the files of the Texas Water Development Board, the U.S. Geological Survey, and the Texas Water Commission (or predecessor agencies). A field inventory of water wells within the study area and the surrounding area was conducted in June and July of 1987. Two hundred and twenty-three water wells or water well test holes were identified in the 26-section area studied. The locations of these wells and test holes are shown on Figure 4. Data regarding the owner of record, driller, date drilled, depth and construction, aquifer, water levels, use of water, and relevant remarks are tabulated in Table 1.

Of the 223 wells identified, 85 of them were in the study area. The largest number of wells in both the study area and the overall area were either unused irrigation wells or domestic wells. The types of wells identified are summarized in the following table.

Summary of Wells by Aquifer and Use of Water

Use of Water	Eight-Section Study Area	Surrounding Area	Total
	Cretaceous Antlers Sand		
Domestic/Stock	2	11	13
Dom./Stock, Unused	2	7	9
Irrigation	0	1	1
Subtotal	4	19	23
	Triassic Santa Rosa Formation		
Domestic/Stock	23	34	57
Dom./Stock, Unused	13	28	41
Irrigation	8	4	12
Irrigation, Unused	29	26	55
Dom./Stock/Irrigation	2	4	6
Industrial	0	9	9
Industrial, Unused	0	8	8
Water Well Test Holes	6	6	12
Subtotal	81	119	199
Total	85	138	223

Thirty-seven of the 85 wells in the study area and 44 of the 138 wells in the surrounding area had previously been located in the field by personnel of the Texas Water Development Board (or predecessor agencies). Drillers' logs for an additional six wells in the study area and 22 wells in the surrounding area were on file with the Texas Water Commission, but had not yet been field located by State personnel. Field work for this study established the actual locations of these wells, which were primarily domestic wells. An additional 42 wells in the study area and 72 wells in the surrounding area for which no State records exist were field located during this study. All types of wells are represented in this group, but domestic and unused domestic wells predominate.

Wells that have been located by Texas Water Development Board personnel by field inventory are assigned a permanent "State" well number by the Board. Wells for which records are available in the Texas Water Commission files that have not been located by field inventory are assigned a temporary well number by the Board. The Board's permanent and temporary well numbers have been used in this report for identification of the wells that it has assigned numbers. For example, the permanent State well numbers in the tables in this report are 29-36-701, 29-43-302, etc., and the temporary State well numbers are 29-35-9B, 29-43-9A, etc. Wells inventoried by William F. Guyton Associates, Inc. during this ground-water study for which no State records exist were assigned numbers with the four-number prefix used by the Board followed by a suffix that would not be confused with those used by the Board. For example, 29-35-9X1, and 29-36-7X1, etc. On the illustrations in the report, only the last three digits of the well number are shown.

PUMPAGE FROM SANTA ROSA

Water is produced from Santa Rosa wells in the study area and the surrounding area for irrigation, water flooding oil reservoirs, and for municipal, stock, and domestic use.

Sixty-seven irrigation wells were inventoried in the study area and the surrounding area during this study. All but 12 of the irrigation wells are reported to be unused. Surveys of irrigation in western Nolan and eastern Mitchell Counties by the Texas Water Development Board show that a large amount of water from the Santa Rosa was used for irrigation in the past. The surveys also show that water used for irrigation in these areas has decreased substantially since 1964. Pumpage from the surveys is given in the following table.

	Pumpage in Acre-Feet	
	Nolan County	Mitchell County
1958	2,698	23,741
1964	2,884	23,291
1969	2,947	2,556
1974	2,706	4,204
1979	1,729	2,375
1984	1,629	2,739

The area in Nolan County that is included in the survey is much larger than the study area and the area surrounding it. It includes irrigation of land in western Nolan County that is generally west of Roscoe and Farm Road 608 (FM 608), south of Highway 84, and about three to four miles south of Champion. In eastern Mitchell County the area included in the survey is generally four to seven miles west of the Nolan-Mitchell County line, about three miles north of Loraine, and about four miles south of FM 2319.

Based on the data in the surveys, an estimate of the acre-feet of water pumped for irrigation within about two miles of the study area is as follows.

Pumpage in Acre-Feet

1958	1964	1969	1974	1979	1984
2,068	1,401	1,040	864	793	400

Very little irrigation of land was observed during this ground-water study, and the water used for irrigation in 1987 probably will be less than 200 acre-feet.

Texaco Oil Company (formerly Getty Oil Company) produces water from Santa Rosa wells in Sections 85, 95, and 96, Block 24, Texas and Pacific Railroad Reservation Survey, southwest of the study area. Getty Oil Company began producing water from the wells in 1961 or 1962 for water flooding of oil reservoirs. It is reported that about 11,300 acre-feet of water was pumped from the wells between 1962 and 1979, which amounts to an average withdrawal of about 670 acre-feet per year. The requirements for water flooding decreased, and in 1980 Texaco began selling water to the City of Sweetwater. From 1980 through 1986, the water received by the City ranged from 437 to 781 acre-feet per year and averaged about 590 acre-feet per year. The total water produced from the wells from 1980 through 1986 for the City and water flooding averaged about 660 acre-feet per year. Records of Texaco's pumpage indicate that all of the water produced in 1986 was sold to the City of Sweetwater and none was used for water flooding.

The City of Roscoe obtains its water supply from eight Santa Rosa wells near the City. Pumpage by Roscoe was about 269 acre-feet in 1985.

Pumpage of water for domestic and stock use in the study area and the surrounding area is small. It is estimated that the water produced from the 57 active domestic and stock wells inventoried probably is about 20 acre-feet per year.

WATER LEVELS IN WELLS

Water levels were measured in 83 private wells and seven test holes during the field work for this study. Water levels were found to be very shallow in the area along Champion Creek, ranging from about 6 to 30 feet below ground. At greater distances from the creek, at higher elevations, water levels were as much as 160 feet below ground. Figure 5 shows the elevation of the water table in the Santa Rosa Formation in the study and surrounding area. The water table generally slopes to the west-northwest at a gradient of about 20 to 30 feet per mile. The elevation of the bed of Champion Creek is also shown on Figure 5. Based on the relative elevation of the water table and the creek bed, the water table is higher than the creek bed, and ground water from the Santa Rosa Formation discharges into the creek.

Water levels measured in 1987 in 23 wells in which water levels had been measured by personnel of the Texas Water Development Board (or predecessor agencies) in 1963 and 1964 showed a rise in the water level between the earlier measurement and the current measurement, with the exception of three wells. The amount of the rise in water levels ranged from about 7 to 47 feet. Figures 6 and 7 show hydrographs of six wells in the study area and in the vicinity of the study area for which more detailed records of water levels are available. The hydrographs show that water levels in the wells have been rising since about 1971. The average rise of water levels in the study area from the early 1970's to 1987 was about 20 feet.

The rise in water levels in the wells is probably attributable to a combination of factors, including: (1) a recovery of water levels due to the decline in pumpage of water for irrigation, (2) a change in soil conservation practices, whereby many fields are now terraced to hold rainfall runoff, which percolates to the water table rather than flowing overland into surface drainage channels, and (3) unusually high rainfall in 1986. Precipitation at Roscoe is shown on Figure 6.

Of the three wells which did not show a rise in water levels, Well 29-44-208, which belongs to Texaco, showed a decline of about 17 feet since 1962, which is attributed to the proximity of this well to the center of industrial pumpage in Texaco Oil Company's

Nena Lucia Well Field. Well 29-44-409 showed a net decline of only one foot. Periodic water levels for this well are shown on a hydrograph on Figure 6. The hydrograph shows very little change in the water level in this well since 1962. This is probably due to the distance of this well from the areas of irrigation pumpage to the north and industrial pumpage to the east. Well 29-44-407 shows a net decline of about 55 feet since 1963, which is thought to be due primarily to an error in the earlier measurement, because the reported elevation of the 1963 water level in the well is about 40 to 50 feet higher than it should have been at that time.

Water levels measured in 11 wells completed in the Antlers Sand northwest, northeast, and southeast of the study area were found to be significantly higher in elevation than the regional water levels in the Santa Rosa Formation. The Antlers Sand is apparently separated from the water-bearing zones of the Santa Rosa Formation by impermeable clay beds in these areas. Thus, the water in the Antlers Sand is perched at a higher elevation than the water in the Santa Rosa Formation. However, the contact between the two formations is unconformable, and it is reported that in some areas sands of the two formations are in hydraulic communication.

PUMPING TESTS

Pumping tests were made of four existing wells in the study area in July 1987. The tests generally consisted of one to two hours of static water-level measurements prior to starting the pump, followed by a 24-hour pumping period during which the pumping rate was held constant and pumping water levels were measured, followed by six hours of water-level recovery measurements after the pump was shut off. On two of the tests water levels were measured in nearby observation wells during the test. The test of Well 29-44-4X8 had to be stopped and restarted because the pumping rate initially chosen for the test, 100 gallons per minute (gpm), was not sustainable and caused the pump to break suction after about one hour and 15 minutes. The test was restarted at a lower pumping rate after measuring the water-level recovery for two hours and 15 minutes.

The pumping-test data were analyzed to determine the hydraulic properties of the Santa Rosa in the vicinity of the wells. Plots of the water-level and pumping-rate measurements made during the four tests are shown on Figures 8 through 11.

Pumping tests of seven wells in the study area were made by City of Sweetwater personnel in March, April, and May 1986. The data from those tests were analyzed for the City of Sweetwater by William F. Guyton Associates, Inc. The results of the analyses of the tests were reported to Mr. Emmett Autrey (former Director of

Utilities) in letters dated April 22, 1986 and July 24, 1987. The information obtained from analysis of data from pumping tests of wells is the transmissivity of the aquifer from which the water is produced, the coefficient of storage of the aquifer, and the specific capacity of the pumped well. The transmissivity is the rate at which water is transmitted through a one-foot wide strip of the total thickness of the aquifer under a unit hydraulic gradient. The units for transmissivity used in this report are expressed as gallons per day per foot (gpd/ft). The coefficient of storage of the aquifer is the number of cubic feet of water released from or taken into storage in one square foot of the aquifer when the water level changes one foot. The storage coefficient is dimensionless. Storage coefficients of artesian aquifers are very small because they are a function of the compressibility of the water and the water-bearing materials in the aquifer and of leakage through confining beds. They may range from about 1×10^{-5} to 1×10^{-3}. Storage coefficients of water-table aquifers are approximately equal to the specific yield (or effective porosity) of the water-bearing materials, and they may range from about 0.1 to 0.3. The specific capacity of a well is a function of the transmissivity of the aquifer screened in the well, the diameter of the well, and the efficiency of the well.

The transmissivities and specific capacities determined from analysis of the four pumping tests made during this study and the seven pumping tests made by City of Sweetwater personnel are given in Table 2. The locations of the wells that were tested and the transmissivities and specific capacities are shown on Figure 12.

Transmissivities calculated from the pumping-test data range from 1,400 to 12,200 gpd/ft. The transmissivity of the water-bearing materials from which water was being withdrawn either increased or decreased during the tests of seven of the wells. The largest decreases of transmissivity occurred during the tests of Wells 29-44-116 and 29-44-125. The transmissivity from the first 2-1/2 hours of data for Well 29-44-116 was 10,500 gpd/ft, and the transmissivity from the last 49 hours of water-level recovery data was about 3,000 gpd/ft. The transmissivity from the first 11 hours of data for Well 29-44-125 was 6,900 gpd/ft and the transmissivity from the last 10 hours of data was about 1,400 gpd/ft. The largest increase of transmissivity occurred during the test of Well 29-44-111. The transmissivity from the first 1-1/2 hours of data was about 1,600 gpd/ft and the transmissivity from the last 22-1/2 hours of data was about 5,200 gpd/ft.

The decrease in transmissivity could be caused by unwatering of some of the water-bearing materials contributing water to the well during the test or to the cone of depression created by pumping from the well extending into an area in the vicinity of the well where the water-bearing materials are thinner, less permeable, or have pinched out. Conversely, the increase in transmissivity may have been caused by the cone of depression extending into an area in the vicinity of the well where the water-bearing materials are thicker or more permeable. The study of drillers' logs of water wells and the test holes drilled during this ground-water investigation indicate large variations in the position and thickness of the sand and sandstone beds in short distances. The changes in transmissivities would correspond with such variations in the water-bearing materials.

The transmissivity values from the pumping tests are about the same as transmissivity values determined from pumping tests at four locations in Mitchell County by personnel of the Texas Water Development Board during a ground-water study in western Nolan and eastern Mitchell Counties in 1962 and 1963. The transmissivities from those tests ranged from 5,856 to 12,300 gpd/ft.

Water levels were measured in a nearby observation well during the tests of Wells 29-36-708, 29-44-1X35, 29-44-1X36, 29-44-1A, 29-44-111, 29-44-125, and 29-44-1X2. The only useful results from the water-level measurements in the observation wells were from the tests of Wells 29-36-708 and 29-44-1X2. Well 29-44-126 was the observation well in both of the tests. The transmissivities determined from the water-level measurements in the observation well were 5,000 and 5,200 gpd/ft. The coefficients of storage calculated from the test data were 4×10^{-5} and 7×10^{-5}. The small coefficient of storage indicates that artesian conditions exist in the vicinity of these wells. Very small drawdowns, if any, were measured in the observation wells for the other tests, indicating that water-table conditions exist in the vicinities of those wells.

The specific capacities of the wells range from 1.2 to 6.0 gpm/ft. The specific capacity of a well is largely a function of the transmissivity of the water-bearing materials contributing water to the well, and, except for the specific capacities of Wells 29-36-708 and 29-44-1X2, the specific capacities of the wells appear to correspond with the transmissivities obtained from the tests of the wells. The specific capacities of Wells 29-36-708 and 29-44-1X2 appear to be low based on the transmissivities.

TEST HOLES

Nine test holes were drilled in or near the study area in July and August 1987. The drilling was done by the Texas Water Development Board drilling rig and crew. Electric logs and radioactivity logs were made in the drilled holes by the Water Development Board. Personnel of William F. Guyton Associates, Inc. observed the drilling and logging, described the materials penetrated, and collected samples of the drill cuttings and formation water for analysis. Sample logs of the materials penetrated in the test holes are included as Appendix 1, and the electric logs and radioactivity logs are included as Appendix 2.

The drilling rig used to drill the test holes was equipped to drill by either the mud rotary or air rotary method of drilling. It was decided that the air rotary method would be preferable in this case, since sample recovery of fine-grained sands and sandstones would be better, and it would also be possible to estimate the amount of water produced from the hole and collect water samples during drilling. Therefore, with the exception of Test Hole TH-1, Test Hole TH-2 below 204 feet, and Test Hole TH-6 below 190 feet, which were drilled with mud, all of the test holes were drilled with air. A 6-1/4-inch drill bit was used to drill the holes, and samples of sands penetrated by the drill bit below the static water table were collected and retained for sieve analysis. Cutting samples were collected for each successive 10-foot interval of sand penetrated. The holes were drilled through the basal conglomerate of the Santa Rosa Formation, and at least 10 to 20 feet into the underlying Permian beds. When the total depth was reached, the drill bit was pulled up to the bottom of the Santa Rosa, and a water sample was collected and the open hole water production was visually estimated while airlift pumping through the drill string. In Test Holes TH-5 and TH-6 water samples were also collected from water-bearing zones higher in the hole before the hole was drilled to its total depth.

Following collection of the water samples, the drill string was removed from the hole, and electric and radioactivity logs were made of the hole. The electric logs consist of a spontaneous potential (SP) log and a 16-inch and 64-inch (short and long) normal resistivity log. The radioactivity logs consist of a natural gamma ray log and a neutron density log. A caliper log was also run in Test Holes TH-5 and TH-8. Following the logging of the test holes, the holes were plugged by the driller in accordance with the Texas Water Commission's regulations.

Sieve analyses of the cutting samples were made by the Texas Water Development Board materials laboratory. The data were utilized in preparing the sample logs in Appendix 1. Water samples were analyzed in the field with portable test equipment by William F. Guyton Associates, Inc. The data are incorporated into the discussion of the chemical quality of the ground water.

RECHARGE TO AND NATURAL DISCHARGE FROM THE SANTA ROSA

Recharge to the Santa Rosa is from precipitation on areas where it outcrops on the land surface, and precipitation in the valley of South Fork Champion Creek where it is overlain by only a thin layer of Pleistocene surficial deposits. Streams crossing the outcrop probably contribute recharge to the Santa Rosa when water levels in the Santa Rosa are below the elevation of the stream beds. Leakage from the overlying Antlers and Ogallala Formations probably provides some recharge to the Santa Rosa.

The 51-year average annual precipitation at Roscoe is 23.35 inches. Part of the precipitation falling on the outcrop is consumed by evapotranspiration soon after it falls on the ground, part of it runs off to streams, and part of it infiltrates to the water table in the outcrop area and moves slowly downgradient from the recharge area to points or areas of discharge at lower altitudes.

As shown on Figure 5, the water table in the Santa Rosa slopes generally west-northwest at a hydraulic gradient of about 20 to 25 feet per mile. Regionally, the water in the Santa Rosa moves generally toward the Colorado River in central Mitchell County where it is discharged through seeps and springs and evapotranspiration.

Locally, some of the water in the Santa Rosa discharges to South Fork Champion Creek where the elevation of the water level in the Santa Rosa is above the elevation of the creek bed. The elevations of water levels measured in the Santa Rosa in 1987 are higher than the bed of South Fork Champion Creek, and water was observed discharging from the Santa Rosa to the creek during this study. The flow in the creek was estimated at the creek crossing on FM 1230 and three creek crossings at one-mile intervals east of FM 1230, and at a creek crossing on Mitchell County Road 424 about three miles west of FM 1230. The flow in South Fork Champion Creek at FM 1230 and at the three creek crossings east of FM 1230 was estimated to be about 200 to 300 gpm. The flow at the creek crossing three miles west of FM 1230 was estimated to be about 400 to 700 gpm. The flow in the creek at FM 1230 and two creek crossings at one-mile intervals east of FM 1230 was observed again on August 17, 1987. The flow on that date was about the same as the flow estimated in July.

In addition to the water discharged to South Fork Champion Creek as streamflow, water in the Santa Rosa is discharged to the atmosphere from the shallow water table in the vicinity of the creek by evapotranspiration. Estimates of the evapotranspiration rate along South Fork Champion Creek, using a procedure developed by Mahdi S. Hantush for solving the Thornthwaite formula to determine potential evapotranspiration, indicate that the potential evapotranspiration along the creek is about three feet per year. The potential evapotranspiration is the maximum evapotranspiration when water is plentiful enough to sustain it, which appears to be the case in 1987. Assuming that evapotranspiration occurs from a 100-foot wide strip adjacent to the creek, which may be too small, the water discharged by evapotranspiration would be about 36 acre-feet per year per mile of creek.

Local residents report that flow in the creek began only recently. Water levels have been measured periodically since 1946 in Well 29-44-106, which is about 0.1 mile north of the creek at FM 1230, and since 1961 in Well 29-44-205, which is about 3.5 miles upstream from FM 1230. Hydrographs of the water levels in these wells are shown on Figure 6. The elevation of the water level in Well 29-44-106 was about four feet below the elevation of the creek in 1946. The water level declined and in 1961 the elevation of the water level in the well was about 10 feet below the elevation of the creek. The elevation of the water level in Well 29-44-205 was about 12 feet below the elevation of the creek in 1961. The low water-level elevations in the wells resulted from pumping water from the Santa Rosa for irrigation. Water levels in both wells began to rise about 1971 owing to the reduction in pumpage for irrigation. Water levels measured in the wells in 1987 are the highest of record. In June 1987, the water-level elevation in Well 29-44-106 was about seven feet above the elevation of the creek, and the elevation of the water level in Well 29-44-205 was about the same as the elevation of the creek. The elevations of the water level in Well 29-44-106 would be about creek elevation when the depth to water in the well is about 18 feet below land surface. The water-level records show that the depth to water in the well was 17.76 feet below land surface in October 1981 and 17.02 feet below land surface in September 1982. The water level in the well was not measured again until June 1987, and at that time it was 11.3 feet below land surface. Thus, the elevation of the water level in the well rose above creek elevation at some time between 1982 and 1987. Precipitation at Roscoe was slightly below normal in 1983 and 1984, and the water level may not have risen above creek elevation until 1985.

The creek should continue to flow continuously or at least intermittently if heavy irrigation pumpage is not resumed and precipitation is near normal.

CHEMICAL QUALITY OF GROUND WATER

Results of chemical analyses of water samples from wells in the study area and the surrounding area are given in Table 3. The Texas Department of Health's (TDH) maximum levels for primary constituents and recommended levels for secondary constituents in water to be used for public supply are given in Table 4. These standards are the basis for evaluation of the suitability of the ground water for public supply.

Concentrations of dissolved solids, sulfate, chloride, and nitrate in water from wells in the study area and the surrounding area are shown on Figure 13. If the dissolved solids in the water was not determined, the specific conductance of the water is shown on Figure 13.

Dissolved Solids

The dissolved solids in water makes the water conductive and the conductance is related to the dissolved solids concentrations. Accordingly, a relationship between dissolved solids and specific conductance can be established with the results of chemical analyses that contain both. Figure 14 is a plot of dissolved solids concentrations in water samples from wells in the area versus the specific conductance of the samples. The graph shows that the relationship between specific conductance and dissolved solids is reasonably well defined for dissolved solids from about 200 to 850 milligrams per liter (mg/l), and that the relationship is poorly defined by the available analyses for dissolved solids greater than 850 mg/l. The graph indicates, however, that dissolved solids probably is more than 1,000 mg/l if the specific conductance is larger than about 1,650 micromhos per centimeter.

With a few exceptions, the analyses of water from the wells and test holes in the study area show that dissolved solids in water from the wells and test holes is less than 1,000 mg/l, and generally the dissolved solids in the water is less than 500 mg/l. The exceptions are discussed below.

The specific conductances of water from four wells in the study area indicate that dissolved solids in the water is more than the 1,000 mg/l level recommended by the TDH. They are Wells 29-44-1X2 and 29-44-1J in Section 70, Well 29-44-1X15 in Section 74, and Well 29-44-1X26 in Section 81. Except for Well 29-44-1X15, the dissolved solids in the water from the wells probably is about 1,700 to 2,000 mg/l. Dissolved solids in the water from Well 29-44-1X15 probably is about 1,100 to 1,200 mg/l. The measured dissolved solids in water from Well 29-44-111 in Section 75 is 1,640 mg/l. Neither dissolved solids nor specific conductance is available for the water from Well 29-36-708 near the north line of Section 71, but the sulfate, chloride, and nitrate concentrations in the water from the well indicate that dissolved solids in the water from the well probably is more than 1,000 mg/l.

Chloride and Sulfate

The chloride and sulfate in the water from most of the wells and test holes in the study area are less than the TDH recommended level of 300 mg/l each. For these wells and test holes the chloride in the water ranges from 26 to 257 mg/l, and it is generally less than 100 mg/l. The sulfate in the water from these wells and test holes ranges from 22 to 160 mg/l, and the sulfate in water from only three wells and one test hole is more than 100 mg/l.

The recommended levels for chloride and sulfate are exceeded in water from Wells 29-44-1X2 and 29-44-1J2 in Section 70, Well 29-44-111 in Section 75, and Well 29-44-116 in Section 81. The recommended level for chloride also is exceeded in the water from Well 29-44-106 in Section 75 and Well 29-44-1X26 in Section 81.

Nitrate

Nitrate is of concern in water used for public supply, and the TDH maximum limit for it is 10 mg/l as nitrogen or 45 mg/l as nitrate. The values given in Table 3 and on Figure 13 are for nitrate.

The nitrate in the water from wells in the study area, and adjacent to it, ranges from 0 to 168 mg/l. Water from 13 of the 23 wells in the study area, and adjacent to it, for which nitrate was determined contains nitrate concentrations which are less than 45 mg/l. For the water from the 13 wells with nitrate concentrations of less than 45 mg/l, the range is 0 to 33 mg/l. For the water from the 10 wells with nitrate concentrations that exceed 45 mg/l, the range is 62 to 168 mg/l.

Nitrate exceeds the TDH maximum limits in more wells than the dissolved solids, chloride, and sulfate exceed the TDH recommended limits. The water from all of the wells with high nitrate contents, however, also have sulfate and chloride contents that are at least somewhat higher than they are in water from wells in the study area with low nitrate.

Water samples from Well 29-44-116 were analyzed in 1963 and in 1986. The nitrate in the water from the well increased from 4.5 mg/l in 1963 to 62 mg/l in 1986. The 1963 and 1986 analyses of water from the well show that the chloride and sulfate in the water also increased from 1963 to 1986. The increase in chloride was from 62 to 375 mg/l, and the increase in sulfate was from 73 to 333 mg/l, which are proportionately smaller increases than the nitrate increase.

Water from Well 29-44-104 was analyzed in May 1963, June 1976, and July 20, 1978. The nitrate was 9 mg/l in 1963, 19 mg/l in 1976, and 16 mg/l in 1978. Dissolved solids in the water increased from 369 mg/l in 1963 to 451 in 1976, and 454 in 1978. The increases in nitrate and dissolved solids in water from this well were moderate.

A water sample was obtained when Test Hole 5 (Well 29-43-609) was 90 feet deep, and another water sample was obtained after the test hole was drilled to the base of the Santa Rosa at 185 feet. The nitrate in the water sample at 90 feet was 37 mg/l and the nitrate in the water sample at 185 feet was 6 mg/l, indicating that the nitrate content of the water probably decreases with depth at that test hole site. Water samples were collected from Test Hole 6 (Well 29-44-130) at depths of 120 and 160 feet. The nitrate content of the water when the test hole was 120 feet deep was 84 mg/l, and it was 86 mg/l when the test hole was 160 feet deep. The nitrate content of water from Well 29-44-1J, which is about 700 to 800 feet north of Test Hole 6, is 89 mg/l. This is about the same as the nitrate in the water from the test hole. The sulfate content of water from Well 29-44-1J, which is 125 feet deep, is 650 mg/l, whereas the sulfate content of the water from the test hole was 220 mg/l when it was 120 feet deep and 155 mg/l when it was 160 feet deep, which indicates that, although the nitrate concentrations of the water from the well and test hole are about the same, the chemical compositions of the two waters are very different.

The usual sources of nitrate in ground water are from contamination from septic tanks, barnyards, feedlots, industrial wastes, and fertilizers or from natural soil nitrate. Feedlots are not present in the area and industrial wastes are not generated in the area. Barnyards are scarce. Except possibly for Well 29-44-1J in Section 70 and Well 29-44-116 in Section 81, the wells producing water with high nitrate concentrations should not be subject to contamination from septic tanks. The nitrate content of water from Test Hole 7 which is near Well 29-44-1J is about the same as the nitrate content of the water from the well. The water from the test hole should not be subject to contamination from the septic tank, and the chloride and sulfate concentrations in the water from the well and test hole are different; therefore, the high nitrate at the test hole site is from some other source or it is a natural condition.

Fertilizers probably were applied to the land in the study area for dryland farming and when much of the land was irrigated. However, a history of the use of fertilizers in the area is not available. Studies made by R. W. Harden and Associates in Knox and Haskell Counties, Texas and by C. W. Kreitler and D. C. Jones, Bureau of Economic Geology, in Runnels County, Texas indicate that nitrate contamination of ground water from fertilizers probably does not occur to a large extent, and that high nitrate in ground water underlying these counties results from leaching of natural soil nitrate. Kreitler and Jones' study of the high nitrate in ground water in Runnels County indicated that the water table had risen, due to extensive land terracing, into a high soil nitrate zone and leached nitrate into the ground water.

The nitrate analyses for Wells 29-44-106 and 29-44-108 in 1946 show that the nitrate in water from the wells was 84 and 86 mg/l, respectively. Chloride and sulfate in the water from Well 29-44-106 were 328 and 120 mg/l, respectively, and 137 and 85 mg/l, respectively, in the water from Well 29-44-108. The wells are relatively shallow. Well 29-44-106 is 110 feet deep and Well 29-44-108 is 114 feet deep. Records of wells in Texas Water Development Board Report 50 indicate that almost all of the irrigation wells in the area were drilled after 1946; therefore, there probably was little irrigation, and fertilizers applied for dryland farming prior to 1946 probably would not have been leached to a great extent into the subsurface. This supports the likelihood that the high nitrate in the water from these wells was a natural occurrence.

Iron and Manganese

The available analyses show that iron concentrations in the water from wells in the study area are less than the TDH recommended level of 0.3 mg/l. Likewise, manganese concentrations in the water from the wells are less than the TDH recommended level of 0.05 mg/l.

Hardness

The water from the Santa Rosa is very hard. The hardness, as calcium carbonate, of water from wells in the study area ranges from 235 to 860 mg/l. The hardness in the water with dissolved solids less than 1,000 mg/l averages 327 mg/l.

Heavy Metals

A water sample from Well 29-44-111 was sent to the TDH by the City of Sweetwater for analysis for heavy metals. The water sample bottle was broken and a second sample was delivered to the TDH on September 11, 1987. The results of the analyses were not available as of September 28, 1987.

Analyses for arsenic in the water from Wells 29-44-1X2, 29-44-112, and 29-44-4X8 were made by Edna Wood Laboratories. The arsenic concentrations in the water samples in the three samples were less than 0.01 mg/l. The TDH maximum level for arsenic is 0.05 mg/l.

The Cities of Roscoe, northeast of the study area, and Loraine, northwest of the study area, obtain water supplies from Santa Rosa wells. Analyses for heavy metals in water from the Roscoe and Loraine wells and distribution systems that were made by TDH are given in Table 5. The analyses show that the TDH's maximum levels for the constituents are not exceeded except for selenium in the March 17, 1987 sample from Roscoe, and it is only 0.002 mg/l more than the maximum level of 0.01 mg/l. The selenium in the September 1984 sample from Roscoe was less than 0.01 mg/l.

Organic Chemicals

Three water samples were analyzed for organic chemicals, and the results of the analyses are given in Table 6. The wells are fairly evenly distributed throughout the study area. Well 29-44-1X2 is in Section 70 in the northern part of the area, Well 29-44-112 is in Section 83 in the central part of the area, and Well 29-44-4X8 is in Section 88 in the southern part of the area.

The TDH's maximum levels for the organic constituents are given in Table 4. The results of the analyses show that the maximum levels for the organic constituents are not exceeded in any of the analyses.

Radionuclides

The TDH's maximum levels for radiological constituents are given in Table 4.

A water sample from Well 29-44-111 was delivered to the TDH for radiological analysis. The results of complete analysis of the sample were not available as of September 28, 1987.

Analysis for gross alpha and gross beta have been made and they were 10.0±5 and 4.6±5.8, respectively. Analysis for radium-226 and radium-228 have not been completed. Based on the results of radiological analyses of water from the Santa Rosa that is used by the Cities of Roscoe and Loraine, which are given in Table 7, the gross alpha value of 10.0±5.0 indicates that total radium-226 and radium-228 probably does not exceed the TDH's maximum level of 5 picocuries per liter.

South Fork Champion Creek

The specific conductance of a water sample collected from South Fork Champion Creek, where it crosses the section line between Sections 82 and 83, on August 17, 1987 was 3,500 micromhos per centimeter. The chloride, sulfate, and nitrate concentrations in the water were 500, 600, and 75 mg/l, respectively. The water flowing in South Fork Champion Creek is ground water discharged from the Santa Rosa.

WATER IN STORAGE

The amount of ground water available from storage depends on the effective porosities (specific yields) of the sand, sand and gravel, and sandstone in the Santa Rosa. It is estimated from examination of the unconsolidated sand and sand and gravel samples from the test holes that the effective porosity of these materials probably is about 20 percent. Total porosities determined by the Texas Water Development Board of sections cut from sandstone cores from Test Hole 1 range from 24 to 31 percent. It is believed that these values do not represent the effective porosity of most of the sandstone underlying the study area. It is estimated that an average effective porosity of about 10 percent is more representative for the sandstone. The thickness of the basal conglomerate ranges from a few feet to 30 to 40 feet. The conglomerate penetrated in the test holes indicates that it is well cemented and dense and that its effective porosity is negligible.

Information on the saturated thickness of the Santa Rosa is shown on Figure 14 at locations where logs of wells or test holes are available. The data shown on Figure 14 are the estimated depth to the base of the Santa Rosa, total saturated thickness, saturated thickness of unconsolidated sand and sand and gravel, saturated thickness of sandstone, and the estimated feet of water stored in the saturated sand, sand and gravel, and sandstone. The estimated amount of water is based on an effective porosity of 20 percent for the unconsolidated sand and sand and gravel and an effective porosity of 10 percent for the sandstone. The thickness of the conglomerate is included in the depth to the base of the Santa Rosa and in the total saturated thickness, but it is not considered to be water bearing.

The data indicate that at many of the locations the sand and sand and gravel are the predominant saturated water-bearing material. At other locations such as Test Hole 1 (Well 29-44-212) there is only eight feet of saturated sand and sand and gravel and 74 feet of sandstone. At Test Holes 5 and 7 the thickness of the saturated sand and sand and gravel and the thickness of the saturated sandstone are about equal. The largest volumes of water are stored in the areas where sand and sand and gravel are the predominant water-bearing material. In the study area the largest amounts of water appear to be in storage beneath Sections 82 and 83. The amount of water in storage beneath each of the other sections appears to be about equal.

Based on the available data, it is estimated that approximately 70,000 acre-feet of water is available in storage in the saturated water-bearing materials beneath the study area. Approximately one-half to two-thirds of the water probably can be produced from wells before the pumping rates of the wells decline to the extent that it is no longer economically feasible to continue to pump them.

DEVELOPMENT OF WATER SUPPLY

Water Availability

Lowering of water levels by pumping from wells in the vicinity of South Fork Champion Creek should intercept some of the natural recharge that is being discharged naturally to the creek. As noted previously in this report, the flow in South Fork Champion Creek east of FM 1230 in July and August 1987 was estimated to be 200 to 300 gpm. This would be 320 to 480 acre-feet per year of natural discharge if the flow occurs on an annual basis. The flow in the creek three miles west of FM 1230 was estimated to be 400 to 700 gpm in July 1987, and this would be 640 to 1,130 acre-feet of natural discharge if sustained annually. In addition to the water discharged to the creek as streamflow, water is discharged from the shallow water table in the vicinity of the creek by evapotranspiration. It is estimated that the water discharged to the atmosphere by evapotranspiration could be about 36 acre-feet per year per mile of creek. Lowering water levels in the vicinity of the creek should salvage part or all of this discharge. The reduction of discharge by evapotranspiration along the three miles of creek in the study area would be about 100 acre-feet per year if all of the discharge by evapotranspiration could be salvaged. In summary, it appears that the natural discharge, streamflow in the creek, and evapotranspiration that might be intercepted could range from about 420 to 1,230 acre-feet per year.

As discussed in the previous section of this report, approximately 70,000 acre-feet of water is estimated to be available in storage in the sand, sand and gravel, and sandstone in the Santa Rosa beneath the study area. Approximately one-half to two-thirds of this water should be recoverable through wells. In addition to the water underlying the study area, water will move to this area from beneath adjacent lands when pumping from it begins. The amount of water available from underflow from adjacent lands probably is small. It should not be considered in determining the amount of water available to Sweetwater from the study area, because development of wells on the adjacent lands for irrigation in the future cannot be predicted.

The estimated 70,000 acre-feet of water beneath the study area would provide about 1.5 million gallons per day (mgd) annually for 20 years if one-half of it is recoverable and about 2.0 mgd annually if two-thirds of it is recoverable. These estimates do not take into consideration that at least part of the natural discharge to South Fork Champion Creek may be intercepted. If discharge is intercepted, it can serve as a safety factor if the estimated amount of water available in storage is less than the actual amount of water in storage, or if not needed for this purpose, it could sustain the pumpage for longer than 20 years.

If the City of Sweetwater decides to develop a water supply in the study area, it will be desirable to acquire exclusive water rights to all of the water beneath the eight sections to assure that none of it will be pumped by others for irrigation or other water intensive purposes. Pumpage for domestic and stock use does not need to be excluded, because pumpage for these uses is small.

Water Quality

The data indicate that, at present, the chemical quality of water from most properly constructed wells in the study area probably would be satisfactory for public supply, but the highly mineralized water from some of the existing wells and the highly mineralized water in South Fork Champion Creek indicate that the quality of water from wells in a well field might deteriorate in time.

The quality of the water in the creek indicates that water in the upper part of the Santa Rosa where it feeds the creek probably is highly mineralized. There also is some indication of this in some other parts of the area.

The existing water wells in the study area are poorly constructed. Most of the old wells were drilled with cable tool equipment. Some have casing to total depth and some have casing only in the upper part of the hole. Few, if any, have cement around the casing. If the water in the upper part of the Santa Rosa is highly mineralized, it may be moving from the upper part of the Santa Rosa to the deeper zones along the outside of the casings in the wells that produce water with high dissolved solids, sulfate, chloride, and nitrate.

An accurate quantitative evaluation of the effect that highly mineralized water in the upper part of the Santa Rosa would have on the chemical quality of the water pumped from wells cannot be made with the available data, but certain estimates as discussed below can be made.

Based on examination of the drillers' logs of the water wells in the study area and the logs of the nine test holes drilled during this study, the saturated water-bearing materials in the upper 100 feet of the Santa Rosa probably contain about 31 percent of the water in storage and the water-bearing materials in the lower part contain about 69 percent of the water in storage.

If the water-bearing materials in the upper 100 feet of the Santa Rosa in the entire study area contain highly mineralized water, which does not appear to be the case, and the water moves down to the lower part of the Santa Rosa and mixes uniformly with the water there, the ratio, based on the above estimate, would be one part of highly mineralized water to 2.2 parts of the water in the lower water-bearing materials.

Based on available data the maximum dissolved solids in the highly mineralized water appears to be about 2,000 mg/l. The average of the dissolved solids in water with less than 1,000 mg/l in the study area is about 480 mg/l. Mixing the two waters with the ratio given above would produce water with about 950 mg/l dissolved solids. With an average chloride of 432 mg/l in the water in the upper water-bearing materials and 82 mg/l in the lower, the mixed water would have a chloride content of about 190 mg/l. With an average sulfate of 408 mg/l in the water in the upper water-bearing materials and 66 mg/l in the lower, the mixed water would have a sulfate content of about 170 mg/l. The nitrate average for the wells with nitrate more than 45 mg/l is 98 mg/l and the average nitrate for the wells with nitrate less than 45 mg/l is 11 mg/l. Based on the ratio of 2.2 to 1 the nitrate in the mixed water would be about 38 mg/l.

It is unlikely that mixing of the waters throughout the study area would occur uniformly as discussed above. It appears possible, however, that deterioration of water quality to the extent that it would be unsatisfactory for public supply probably would not occur in all of the wells in a well field in the study area, and individual wells that might be affected could be abandoned and new wells drilled to replace them as necessary at locations where the water quality is good.

Additional studies, which were beyond the scope of this ground-water study, could be made to obtain more information on the extent of the highly mineralized water. The studies would reduce to some extent the uncertainty, but probably not completely, with regard to possible deterioration of the water quality from wells in the study area. Such a study would require drilling more test holes to obtain information on the quality of the water at various depths in the formation, and the source and areal extent of the poor quality water that is pumped from some of the wells in the study area. A comprehensive study of the source of the nitrate probably would require a study similar to that of Kreitler and Jones in Runnels County, where the source of nitrate was identified by correlating the natural nitrogen isotope ratios (N^{14}/N^{15}) of ground-water nitrate to the nitrate of soils in different land-use environments. Completing part or all of these studies should help to assess the risk involved with the future chemical quality of water from a well field.

Determining the depths to which the highly mineralized water extends in the formation and its areal extent are considered to be the most important of the suggested studies. It is estimated that about 20 to 25 additional test holes probably would be desirable to obtain the chemical-quality information that is needed. The holes could be drilled to obtain water samples from the top of the water table to total depth of the Santa Rosa, without spending the effort to take circulated sand samples or electric or radioactivity logs. They could be drilled relatively quickly with an air rotary rig of the shot-hole type, and it might be best to contract for the drilling on a time and materials basis.

Tentative Well Field

The available data indicate that conditions probably are favorable for obtaining 1-1/2 to 2 mgd of ground water from wells in the study area.

Pumping rates measured during tests of four irrigation wells in the study area as part of this ground-water study ranged from 60 to 131 gpm, and pumping rates measured during tests of seven irrigation wells by City of Sweetwater personnel in 1986 ranged from 155 to 208 gpm. These pumping rates are in accord with pumping rates reported for irrigation wells in the study and surrounding area by V. M. Shamburger, Jr. in Texas Water Development Board Report 50.

Based on the specific capacities of the wells and the transmissivities of the water-bearing materials in the Santa Rosa that were obtained from the tests, it is believed that the higher pumping rates could not be sustained for pumping 1-1/2 to 2 mgd for 20 years from a well field. The specific capacities of the wells and the transmissivities determined from the pumping tests of the wells indicate that, although initial pumping rates of the wells probably could be higher, sustained pumping rates of the wells for continuous pumping for 20 years probably would not average more than about 80 gpm.

At an average pumping rate of 80 gpm per well, 14 wells would be required to produce 1-1/2 mgd and 18 wells would be required to produce 2 mgd during the latter part of the 20 years of pumping. Tentative locations for 18 wells are shown on Figure 16. The wells are spaced throughout the study area to try to lower water levels in the area as uniformly as practicable to recover as much of the water in storage as practicable. Additionally, the areas where available data show high concentrations of nitrate in the water were avoided in selecting well locations.

Fewer wells probably could be used initally to produce 1-1/2 to 2 mgd because the pumping rates of the wells could be larger during the early years. With an average pumping rate of 100 gpm per well, 11 wells would be required for 1-1/2 mgd and 14 wells would be required for 2 mgd. Additional wells would have to be drilled as the pumping rates of the wells decline. Also wells might have to be moved because of chemical quality deterioration.

Well Construction

Most of the irrigation wells in the area were drilled with cable tool equipment. Some of the wells have casing and liner to the total depth of the well, but some of the older wells are cased only in the upper part of the hole.

The information obtained from this study and the test holes drilled during the study indicates that the unconsolidated sands and sands and gravels in the Santa Rosa yield most of the water to the better wells. Sieve analyses of sand samples from the test holes indicate that some of the sands are very fine grained. Therefore, it is believed that underreamed gravel-wall wells should be used in the well field to preclude producing undesirable amounts of sand and to obtain the largest practicable yield. An illustration of a typical gravel-wall well is shown on Figure 17.

The wells should be constructed with 10-inch diameter casing set and cemented to about 10 feet above the water-bearing materials screened in the well, 6-inch diameter liner extending from land surface to the bottom of the well, with screen opposite the water-bearing zones and blank pipe opposite the clays in the underreamed hole between the bottom of the casing and the bottom of the well, and gravel in the annular space between the liner and the underreamed hole and the liner and the casing. Based on the data obtained from the test holes, the casing depths probably will be below 100 feet, the water-bearing materials in the lower part of the formation will be screened in the wells, and the total depths of the wells probably will be about 150 to 200 feet.

The water-bearing materials in the Santa Rosa are not uniform throughout the study area. In some places, the water-bearing materials are composed mostly of sandstone and very little sand and sand and gravel. This study has indicated that the sandstone is not as productive as the sand and gravel. Thus, water-bearing materials underlying some of the tentative well locations may not be favorable for construction of a well. Also it may be found that the chemical quality of the water at a tentative location is unsatisfactory. Where either of these conditions is found, the location should be abandoned and the well constructed at another location which is favorable.

Evaluation of each tentative well location should be based on information obtained from a pilot hole drilled with air rotary drilling equipment. Drilling the pilot holes with air will provide information on the water-bearing materials at the site, the productivity of the water-bearing materials at the site, and also provide water samples to help assess the probable water quality at the site.

Pumping Levels

The pump bowls on the pumps should be set near the bottoms of the wells, and the pumping rates of the wells should be selected based on the characteristics of the individual wells to have pumping levels about 15 to 20 feet above the pump bowls.

Drawdowns for estimating pumping levels in the wells were calculated using the Theis nonequilibrium formula to see whether two mgd could be pumped without lowering pumping levels below the bottoms of the wells. A transmissivity of 4,000 gpd/ft and a water-table storage coefficient of 0.15 was selected for computing the drawdown. The well arrangement used for computing drawdowns is the one shown on Figure 16.

For the calculations, it was assumed that the average pumping rate per well would be about 80 gpm. The larger computed drawdowns are for wells near the center of the study area and the smaller computed drawdowns are for wells near the north and south boundaries of the study area. The estimated pumping level at the tentative well location in the southwest corner of Section 74 after 20 years of pumping about two mgd is about 130 feet below land surface (2,180 feet above mean sea level), and, for the same pumping rate and time, the estimated pumping level at the tentative well location near the east line of Section 88 is about 180 feet below land surface (about 2,190 feet above mean sea level). The calculated pumping levels appear to be at reasonable depths above the base of the water-bearing materials in the formation.

The estimated pumping levels do not include any drawdown that may be caused by pumping by others in the study area or the surrounding area. It has been assumed that the contracts which the City of Sweetwater executes to acquire water rights in the area will preclude pumping by others in the study area.

PLUGGING OF ABANDONED WELLS

If the City of Sweetwater decides to develop a well field in the study area, the abandoned irrigation, domestic, and stock wells should be located and plugged. This is a requirement of the Texas Department of Health as well as the Texas Water Commission.

Plugging and sealing of the abandoned wells should be in accordance with procedures and methods in the rules of the Texas Water Commission.

EFFECT OF PUMPING ON OTHER WELLS

Pumping from a well field in the study area would lower water levels in wells in the vicinity of the field. The drawdown effect would be largest in the City of Sweetwater's wells and diminish with distance from them.

As shown by the well inventory there are about 23 domestic and stock wells in the study area and 34 in the surrounding area that are being used. Pumping of water from the well field would lower water levels in the wells, and the drawdown of water levels in some of the wells might be large enough to make the wells useless if diameters of the casings are too small to permit lowering the pumps deeper in the wells to continue pumping at deeper water levels.

Based on the limiting factor of removal of only one-half to two-thirds of the water in storage by the City of Sweetwater, water levels in domestic and stock wells would not be lowered to the extent that water supplies for those purposes could not be obtained from wells in which pumps can be lowered or from new wells drilled to replace old wells in which the pumps cannot be lowered.

TABLE 1. RECORDS OF WELLS

Well Number	Owner	Driller	Blk	Sec	1/4	Date Drilled	Aquifer1/	Depth of Well,ft	Casing Dia,in	Casing Depth,ft	Ground Elev,ft	Static W.L.,ft	Date of SWL Meas	Yield GPM2/	Use of Water3/	Remarks
29-35-9B	Elmer Mahon	Sam H. Smith	24	69	SE	1970	Trdsr	154	5-1/2	154	2,327	43.0	12-70	---	D	Drillers' log on file with Texas Water Development Board; located in grid 29-44-1
29-35-9E	James Wells	Joe Whitworth	24	93	NE	1971	Trdsr	170	5-1/2	170	---	---	---	25r	D	Drillers' log on file with Texas Water Development Board; located in grid 29-44-4
29-35-9F	Edsel Bankhead	Thomas Steddum	24	64	SE	1977	Kca,Trdsr	125	5	125	2,435	55.0	7-77	---	D	Drillers' log on file with Texas Water Development Board; perforated 105 to 125 ft.
29-35-9J	Edsel Bankhead	Ira L. Craig	24	64	NE	1984	Kca,Trdsr	180	5	180	2,433	83.5	7-87	50r	D	Drillers' log on file with Texas Water Development Board; gravel packed 80 to 180 ft.
29-35-9K	Randall Bankhead	Ira L. Craig	24	64	NW	1984	Kca,Trdsr	121	5	121	2,421	65.4	7-87	25r	D	Drillers' log on file with Texas Water Development Board
29-35-9X 1	Don Richburg	---	24	57	SE	---	Trdsr,Kca	---	---	---	2,420	---	---	230r	Irr,U	
29-35-9X 2	---	---	24	64	NW	---	Kca	---	5	---	2,420	75.1	6-87	---	D,U	Old windmill
29-36-701	Jimmie Wright	O. R. House	24	62	NW	1956	Trdsr	360	6	200	2,455	195.4	1-64	88m	D	Open hole below 200 ft.
29-36-702	Jimmie Wright	Max Wright	24	62	NW	1955	Trdsr	300	16-12	220	2,450	188.6 146.2	1-64 6-87	98m	Irr	Open hole below 220 ft.
29-36-704	S. H. Garrett	-----	24	63	NW	----	Kca	100	5	---	2,434	62.4	2-63	3r	D,S,U	
29-36-707	Robert Wright	Hopkins Drig. Co.	24	62	SE	1963	Trdsr	217	---	---	2,392	95.0	5-63	68r	TH,U	Drillers' log on file with Texas Water Development Board
29-36-708	Eugene Fullwood	John Hanna	24	71	NW	1981	Trdsr	223	8	223	2,380	99.6	6-87	---	Irr	Drillers' log on file with Texas Water Development Board; perforated from 183 t0 223 ft.
29-36-709	Archie Hunter	James Ware	24	63	SE	1981	Trdsr	245	8	245	2,380	---	---	---	Irr,U	Drillers' log on file with Texas Water Development Board
29-36-7B	Dale Monroe	Ernest Robertson	24	63	SE	1980	Trdsr,Kca	244	---	---	2,415	128.6	6-87	---	D,S	
29-36-7G	Douglas Rotte	Ira L. Craig	24	63	SW	1984	Trdsr,Kca	195	5	195	2,380	---	---	25r	D,S	Drillers' log on file with Texas Water Development Board; gravel packed 50 to 195 ft.
29-36-7X 1	---	---	24	61	NW	---	Kca	---	5	---	2,450	56.4	6-87	---	D,U	Old windmill
29-36-7X 2	---	---	24	62	NE	---	Kca	---	---	---	---	---	---	---	S,U	Old windmill

TABLE 1. RECORDS OF WELLS

Well Number	Owner	Driller	Blk	Sec	1/4	Date Drilled	Aquifer1/	Depth of Well,ft	Casing Dia,in	Casing Depth,ft	Ground Elev,ft	Static W.L.,ft	Date of SWL Meas	Yield GPM2/	Use of Water3/	Remarks
29-36-7X 3	Jimmie Wright	---	24	62	NW	---	Trdsr,Kca	---	---	---	2,440	---	---	---	Irr,U	
29-36-7X 4	Jimmie Wright	---	24	62	NW	---	Trdsr,Kca	---	---	---	2,450	---	---	---	Irr,U	
29-36-7X 5	Robert Wright	---	24	62	SE	---	Trdsr,Kca	---	---	---	2,392	---	---	---	D	
29-36-7X 6	Robert Wright	---	24	62	SE	---	Kca	---	5	---	2,390	11.9	6-87	---	D,U	Old windmill
29-36-7X 7	Mrs. Orzac	---	24	63	NE	1947	Kca	---	---	---	2,440	---	---	---	D	Old windmill
29-36-7X 8	Jimmie Wright	---	24	63	NW	---	Kca,Trdsr	---	---	---	2,438	---	---	---	D	
29-36-7X 9	Mark Wright	---	24	63	NW	1984	Kca,Trdsr	280	6	---	2,435	84.0	7-87	---	Irr	
29-36-7X10	Thomas	---	24	63	SE	---	Kca,Trdsr	210	5	---	2,425	---	---	---	D,S	Owner reported static water level of about 50 feet, 7-87
29-36-7X11	F. Bradford	O. R. House	24	63	SW	1957	Trdsr,Kca	202	---	---	2,385	---	---	---	D	
29-36-7X12	Archie Hunter	Joe Whitworth	24	63	SE	---	Trdsr	190	6	---	2,385	---	---	---	D,Irr	
29-36-806	Chevron Pipeline Co.	---	24	60	SE	1927	Trdsr	254	8	215	2,421	144.8	1-64	15r	Ind,U	Open hole 215 to 254 ft; there are 2 similar wells at this facility - one is unused and one is currently used for domestic use only
29-36-810	J. B. Cooper	O. R. House	23	66	NW	----	Trdsr	185	6	---	2,425	108.0	11-60	27m	Irr,U	
29-36-811	Arlen Orman	Hopkins Drilling Co.		--		1961	Trdsr	240	8	---	---	157.4	1-64	58m	Irr	
29-36-814	L. S. Howard	O. R. House		--		1956	Trdsr	185	8	185	2,432	125.7	1-64	150r	Irr	
29-36-820	J. B. Cooper	O. R. House	23	66	NW	1960	Trdsr	200	8	---	2,426	137.9	1-64	---	Irr,U	
29-36-824	Ray Hendricks	Sam H. Smith	23	67	NW	1972	Trdsr	212	7	212	2,410	25.0	12-72	75m	Irr	
29-36-8B	Henry Parrott	Joe Whitworth	24	61	SE	1966	Kca,Trdsr	120	5-1/2	64	2,403	11.8	6-87	---	S	Open hole 64-120 ft.
29-36-8X 1	Clifford Wilson	---	23	67	NW	---	Trdsr	---	8	---	2,404	98.4	6-87	---	Irr	
29-36-8X 2	Chevron Pipeline Co.	---	24	60	SE	---	Trdsr,Kca	215	---	---	2,421	85.1	7-87	---	Ind,U	See 29-36-806
29-36-8X 3	---	---	24	72	NE	---	Trdsr,Kca	---	---	---	2,405	---	---	---	D,U	Old windmill
29-43-302	B. H. Johnson	Sam Smith	24	77	NE	1954	Trdsr	180	8	180	2,330	85.2 68.2	1-64 6-87	170r	Irr,U	

TABLE 1. RECORDS OF WELLS

Well Number	Owner	Driller	Blk	Sec	1/4	Date Drilled	Aquifer1/	Depth of Well,ft	Casing Dia,in	Casing Depth,ft	Ground Elev,ft	Static W.L.,ft	Date of SWL Meas	Yield GPM2/	Use of Water3/	Remarks
29-43-303	B. H. Johnson	Eulis Compton	24	77	SW	1953	Trdsr	150	12	100	2,260	26.8	1-64	170r	Irr,U	Open hole 100 to 150 ft.
29-43-306	---	---	24	64	SW	---	---	---	---	---	2,357	---	---	---	---	Oil Test
29-43-310	G. B. Tartt	---	24	64	SW	---	Trdsr	233	5-1/2	233	2,369	132.9	5-63	---	Ind,U	
29-43-311	B. H. Johnson	N. C. House	24	80	SE	1961	Trdsr	195	---	---	2,315	43.7	5-63	75r	TH,U	Drillers' log on file with Texas Water Development Board
29-43-312	E. O. Mahon	Hopkins Drig. Co.	24	78	SE	1963	Trdsr	180	6	180	2,298	71.3 61.5	5-63 6-87	130r	Irr,U	Drillers' log on file with Texas Water Development Board
29-43-314	City of Sweetwater	Texas Water Development Board	24	81	SW	1987	Trdsr	180	---	---	2,297	---	---	70e	TH,U	Test Hole 7; drillers' log, electric log, and radioactivity logs included in this report
29-43-3B	John Martin	Sam H. Smith	24	69	SW	1971	Trdsr	60	5	60	2,328	30	9-71	15	D	Drillers' log on file with Texas Water Development Board
29-43-3C	J. C. Brasuell	C. C. Justiss	24	68	SE	1972	Trdsr	165	6-5/8	165	2,338	88.0	5-72	---	D	Drillers' log on file with Texas Water Development Board; slotted 90 to 160 ft.
29-43-3D	Jackie Brasuell	C. C. Justiss	24	68	SE	1970	Trdsr	111	5-3/4	111	2,322	75.0	5-70	---	D	Drillers' log on file with Texas Water Development Board; slotted 80 to 109 ft.
29-43-3X 1	Don Martin	James Ware	24	69	NW	1985	Kca,Trdsr	103	5	103	2,410	---	---	10r	D	Drillers' log on file with Texas Water Development Board
29-43-3X 2	---	---	24	69	NE	---	Kca,Trdsr	---	---	---	2,380	---	---	---	S,U	Old windmill
29-43-3X 3	---	---	24	69	NW	---	Kca,Trdsr	---	6	---	2,365	33.3	7-87	---	S	
29-43-3X 4	M. A. Moore	---	24	69	SE	---	Trdsr	95	5	---	2,320	---	---	---	D	
29-43-3X 5	M. A. Moore	Robertson	24	69	SE	---	Trdsr	230	8-5/8	---	2,345	58.0	7-87	100e	S,Irr	
29-43-3X 6	John Martin	---	24	69	SW	---	Trdsr	---	---	---	2,322	---	---	---	Irr,U	
29-43-3X 7	Jimmie Burke	---	24	76	NW	---	Trdsr	135	---	---	2,332	---	---	---	D	
29-43-3X 8	Jimmie Burke	---	24	76	NW	---	Trdsr	165	8	---	2,332	66.8	6-87	95r	Irr	
29-43-3X 9	Smith and Cooper	---	24	76	NW	---	Trdsr	---	---	---	2,315	---	---	---	Irr,U	
29-43-3X10	Smith and Cooper	---	24	76	SW	---	Trdsr	---	---	---	2,291	---	---	---	Irr,U	

TABLE 1. RECORDS OF WELLS

Well Number	Owner	Driller	Blk	Sec	1/4	Date Drilled	Aquifer1/	Depth of Well,ft	Casing Dia,in	Casing Depth,ft	Ground Elev,ft	Static W.L.,ft	Date of SWL Meas	Yield GPM2/	Use of Water3/	Remarks
29-43-3X11	---	---	24	77	SW	---	Trdsr	---	---	---	2,312	---	---	---	D,U	Old windmill
29-43-3X12	---	---	24	78	SE	---	Trdsr	---	---	---	2,305	---	---	---	D,U	Old windmill
29-43-3X13	Edsel Bankhead	---	24	81	NW	---	Trdsr	155	7	---	2,288	19.8	7-87	20e	S	
29-43-601	B. H. Johnson	Sam Smith	24	80	SE	1960	Trdsr	150	8	150	2,295	49.1 34.8	1-64 7-87	88m	Irr,U	
29-43-602	Herman Aucutt	O. R. House	X	26	NW	1956	Trdsr,Kca	220	8	60	2,370	94.8	1-64	51m	Irr,U	Drillers' log on file with Texas Water Development Board; open hole 60 to 220 ft.
												47.7	6-87			
29-43-603	Georgia Institute of Technology	---	24	89	NW	---	Trdsr	133	5-1/2	---	2,328	97.1	12-61	---	D,U	
												83.4	6-87			
29-43-605	Alice Miles	---	24	92	NW	---	Trdsr	120	5-1/2	---	2,335	97.0	1-64	---	D,S,U	Old windmill
29-43-606	Herman Aucutt	O. R. House	X	26	NW	1962	Trdsr	210	6	210	2,375	---	---	---	D	
29-43-608	---	---	24	89	SE	---	---	---	---	---	2,332	---	---	---	---	Oil Test
29-43-609	City of Sweetwater	Texas Water Development Board	24	92	NE	1987	Trdsr	210	---	---	2,348	75.0	8-87	100e	TH,U	Test Hole 5; drillers' log, electric log, and radioactivity logs included in this report
29-43-610	Edsel Bankhead	---	24	81	SW	---	Trdsr	134	6-1/2	50	2,300	24.7	6-87	---	Irr,U	Radioactivity logs on file with Texas Water Development Board; open hole 50 to 134 ft.
29-43-611	Edsel Bankhead	---	24	81	SW	1961	Trdsr	142	6-1/2	60	2,305	27.7	6-87	---	Irr,U	Radioactivity logs on file with Texas Water Development Board; open hole 60 to 142 ft.
29-43-6X 1	---	---	24	79	SE	---	Trdsr	---	---	---	2,321	---	---	---	D	Old windmill
29-43-6X 4	---	---	24	88	NW	---	Trdsr	---	5	---	2,322	44.0	6-87	---	D,U	Old windmill
29-43-6X 5	---	---	24	90	NE	---	Trdsr	---	---	---	2,321	---	---	---	D,S,U	Old windmill
29-43-6X 6	Alice Miles	---	24	92	NE	---	Trdsr	176	5	---	2,345	86.9	7-87	15e	D	New well near Well 29-44-4C
29-43-6X 7	Alice Miles	---	24	92	NE	---	Trdsr	---	---	---	2,345	---	---	---	D,U	Old windmill
29-43-6X 8	Ken Miles	---	X	26	NE	---	Trdsr,Kca	---	---	---	2,400	---	---	---	S	Old windmill
29-43-6X 9	Ron Reedy	---	X	26	NW	---	Trdsr	100	---	---	2,362	---	---	---	D	Old windmill

TABLE 1. RECORDS OF WELLS

Well Number	Owner	Driller	Blk	Sec	1/4	Date Drilled	Aquifer1/	Depth of Well,ft	Casing Dia,in	Casing Depth,ft	Ground Elev,ft	Static W.L.,ft	Date of SWL Meas	Yield GPM2/	Use of Water3/	Remarks
29-43-6X10	Ron Reedy	---	X	26	NW	---	Trdsr	185	8	---	2,365	64.84	6-87	110r	Irr,U	
29-43-9A	Herman Aucutt	O. R. House	X	26	NW	1962	Trdsr	225	5	155	2,375	---	---	35r	D	Drillers' log on file with Texas Water Development Board; open hole 155 to 225 ft.; located in grid 29-43-6
29-43-9G	Herman Aucutt	O. R. House	X	26	NW	1962	Trdsr	218	5	155	2,375	---	---	35r	D	Drillers' log on file with Texas Water Development Board; open hole 155 to 218 ft.; located in grid 29-43-6
29-44-101	J. E. Collier	Grosshans Bros.	24	70	NE	1959	Trdsr	220	12	200	2,368	94.7	1-64	450m	Irr,U	Well is reported to have caved in
29-44-102	E. O. Mahon	N. C. House	24	70	SE	1960	Trdsr	215	7	---	2,340	52.3	1-64	59m	Irr,U	Drillers' log on file with Texas Water Development Board
												45.5	7-87			
29-44-103	E. O. Mahon	O. R. House	24	70	SE	1960	Trdsr	205	8	140	2,342	64.6	1-64	61m	Irr,U	Drillers' log on file with Texas Water Development Board; open hole 140 to 205 ft.
												45.4	7-87			
29-44-104	W. H. Cooper	O. R. House	24	74	SW	1953	Trdsr	150	10	80	2,323	27.7	1-64	220m	Irr,U	Drillers' log on file with Texas Water Development Board; open hole 80 to 150 ft.
												12.4	7-87			
29-44-105	Alfreda Gabler	---	24	75	SE	1954	Trdsr	152	10	60	2,313	13.2	6-87	230r	Irr,U	Open hole 60 to 152 ft.
29-44-106	E. A. Costephens	---	24	75	SW	---	Trdsr	110	8	---	2,298	27.2	2-62	---	Irr,U	
												11.3	6-87			
29-44-108	J. R. Hawkins	---	24	71	SE	1944	Trdsr	114	5	---	2,342	47.7	7-46	---	D,U	Old windmill
29-44-109	E. A. Costephens	---	24	75	NW	---	Trdsr	300	8-1/2	---	2,315	45.6	1-64	---	Irr,U	
												28.2	6-87			
29-44-110	O. L. Hawkins	O. R. House	24	71	SE	1956	Trdsr	179	8	92	2,345	51.1	1-64	156m	Irr,U	Drillers' log on file with Texas Water Development Board; open hole 92 to 179 ft.; well is reported to have caved in
												34.8	7-87			
29-44-111	Alfreda Gabler	Ed Gabler	24	75	SE	1953	Trdsr	150	10	60	2,320	28.7	1-64	108m	Irr,U	Drillers' log on file with Texas Water Development Board; open hole 60 to 150 ft.
												14.4	6-87			
29-44-112	R. Sanford	O. R. House	24	83	NW	1956	Trdsr	153	10	30	2,320	26.4	1-64	154m	Irr,U	Drillers' log on file with Texas Water Development Board; open hole 30 to 153 ft.
												12.5	6-87			

TABLE 1. RECORDS OF WELLS

Well Number	Owner	Driller	Blk Sec 1/4	Date Drilled	Aquifer1/	Depth of Well,ft	Casing Dia,in	Casing Depth,ft	Ground Elev,ft	Static W.L.,ft	Date of SWL Meas	Yield GPM2/	Use of Water3/	Remarks
29-44-113	O. A. Rannefeld	O. R. House	24 83 SE	1957	Trdsr	160	7	---	2,345	41.7 30.7	1-64 7-87	110r	Irr,U	
29-44-114	Edsel Bankhead	O. R. House	24 81 NE	1956	Trdsr	155	8	70	2,285	29.4 12.6	1-64 6-87	180r	Irr,U	Drillers' log on file with Texas Water Development Board; open hole 70 to 155 ft.
29-44-115	Edsel Bankhead	O. R. House	24 82 SW	1958	Trdsr	155	8	150	2,322	43.1	1-64	70m	Irr,U	Drillers' log on file with Texas Water Development Board
29-44-116	M. Z. Richburg	Olin House	24 82 SW	1952	Trdsr	145	10	120	2,300	15.6	6-87	225r	Irr	Drillers' log on file with Texas Water Development Board; open hole 120 to 145 ft.
29-44-117	Edsel Bankhead	O. R. House	24 82 SW	1953	Trdsr	150	8	150	2,320	34.2	6-87	70m	Irr,U	
29-44-118	O. A. Rannefeld	O. R. House	24 83 SW	1959	Trdsr	200	10	65	2,345	35.7	1-64	170r	Irr,U	Open hole 65 to 200 ft.
29-44-119	O. A. Rannefeld	O. R. House	24 83 SW	1960	Trdsr	155	6-1/2	50	2,335	---	---	65r	Irr,U	Open hole 50 to 155 ft.
29-44-120	O. A. Rannefeld	O. R. House	24 83 SW	1956	Trdsr	165	8	55	2,351	35.7	7-87	170r	Irr,U	
29-44-121	Morgan Wright	O. R. House	24 75 NE	1961	Trdsr	162	7	103	2,318	37.3 18.1	1-64 6-87	85r	Irr,U	Drillers' log on file with Texas Water Development Board; open hole 103 to 162 ft.
29-44-122	M. Z. Richburg	O. R. House	24 81 SE	1961	Trdsr	145	7	60	2,298	39.6	3-63	90r	Irr	Drillers' log on file with Texas Water Development Board; open hole 60 to 145 ft.
29-44-123	Eugene Fullwood	Sam Smith	24 74 NE	1970	Trdsr	168	8-5/8	168	2,348	45.3 37.5	12-81 6-87	220m	Irr	Drillers' log on file with Texas Water Development Board; Slotted from 120 to 168 ft.
29-44-125	M. Z. Richburg	John Hanna	24 81 SE	1974	Trdsr	146	8	140	2,290	45.0 10.3	6-74 6-87	45r	Irr	Drillers' log on file with Texas Water Development Board
29-44-126	Eugene Fullwood	John Hanna	24 71 NW	1981	Trdsr	215	8	215	2,365	81.8	6-87	---	Irr	Drillers' log on file with Texas Water Development Board; Perforated from 175 to 215 ft.
29-44-127	Weldon E. McDonald	Weldon E. McDonald	24 64 SE	1981	Kca	70	4	---	2,383	44.8	7-87	---	D	
29-44-128	City of Sweetwater	Texas Water Development Board	24 83 SE	1987	Trdsr	200	---	---	2,340	16.0	7-87	400e	TH,U	Test Hole 4; drillers' log, electric log and radioactivity logs included in this report

TABLE 1. RECORDS OF WELLS

Well Number	Owner	Driller	Blk Sec 1/4	Date Drilled	Aquifer1/	Depth of Well,ft	Casing Dia,in	Casing Depth,ft	Ground Elev,ft	Static W.L.,ft	Date of SWL Meas	Yield GPM2/	Use of Water3/	Remarks
29-44-129	City of Sweetwater	Texas Water Development Board	24 83 NW	1987	Trdsr	190	---	---	2,332	27.5	7-87	300e	TH,U	Test Hole 3; drillers' log, electric log and radioactivity logs included in this report
29-44-130	City of Sweetwater	Texas Water Development Board	24 70 NW	1987	Trdsr	240	---	---	2,348	---	---	125e	TH,U	Test Hole 6; drillers' log, electric log, and radioactivity logs included in this report
29-44-131	City of Sweetwater	Texas Water Development Board	24 76 NE	1987	Trdsr	180	---	---	2,290	6.0	8-87	400e	TH,U	Test Hole 8; drillers' log, electric log, and radioactivity logs included in this report
29-44-132	City of Sweetwater	Texas Water Development Board	24 71 SE	1987	Trdsr	210	---	---	2,357	56.0	8-87	400e	TH,U	Test Hole 9; drillers' log, electric log, and radioactivity logs included in this report
29-44-1A	Edsel Bankhead	O. R. House	24 82 NW	1961	Trdsr	150	7	119	2,330	38.1	6-87	---	Irr,U	Drillers' log on file with Texas Water Development Board; open hole 119 to 150 ft.
29-44-1B	Dr. Bruce Johnson	W. R. Justice	24 77 NE	1972	Trdsr	93	5	93	2,330	60.0	3-72	---	D,U	Drillers' log on file with Texas Water Development Board; located in grid 29-43-3; perforated 80 to 91 ft.
29-44-1C	Robbie Sanford	---	24 83 NW	1966	Trdsr	143	5	143	2,322	14.0	6-87	---	D,U	Drillers' log on file with Texas Water Development Board; perforated 90 to 143 ft.
29-44-1D	Mrs. Cooper	Joe Whitworth	24 74 SE	1971	Trdsr	155	5-1/2	155	2,351	---	---	---	D	Drillers' log on file with Texas Water Development Board
29-44-1E	Dale Wilson	Joe Whitworth	24 74 NW	1971	Trdsr	160	5	160	---	---	---	---	D	Drillers' log on file with Texas Water Development Board
29-44-1J1	Wendell Bankhead	Sam H. Smith	24 70 NW	1979	Kca,Trdsr	133	5	134	2,355	---	---	---	D,U	
29-44-1J2	Wendell Bankhead	James Ware	24 70 NW	1987	Kca,Trdsr	125	5	---	2,355	19.6	6-87	---	D	
29-44-1K	Brewster Hillis	Joe Whitworth	24 72 SE	1974	Trdsr,Kca	170	5-1/2	170	2,403	---	---	30r	D	Drillers' log on file with Texas Water Development Board; located in grid 29-44-2
29-44-1M	Gaines Price	Ira L. Craig	24 62 NW	1981	Trdsr,Kca	245	5	245	2,442	162.2	7-87	15r	D	Drillers' log on file with Texas Water Development Board; gravel packed 10 to 245 ft.; located in grid 29-36-7

TABLE 1. RECORDS OF WELLS

Well Number	Owner	Driller	Blk	Sec	1/4	Date Drilled	Aquifer1/	Depth of Well,ft	Casing Dia,in	Casing Depth,ft	Ground Elev,ft	Static W.L.,ft	Date of SWL Meas	Yield GPM2/	Use of Water3/	Remarks
29-44-1R	Kenneth Thomas	Ira L. Craig	24	82	SE	1983	Trdsr	174	5	174	2,375	---	---	20r	D	Drillers' log on file with Texas Water Development Board
29-44-1X 1	E. O. Mahon	---	24	69	SE	---	Trdsr	---	---	---	2,325	---	---	---	D,U	Old windmill
29-44-1X 2	Bud Collier	---	24	70	NE	---	Trdsr	210	---	---	2,365	86.72	6-87	91m	Irr	
29-44-1X 3	Bud Collier	---	24	70	NE	---	Trdsr	50	---	---	2,361	---	---	---	D,U	
29-44-1X 4	Moore	---	24	70	NW	---	Kca,Trdsr	---	---	---	2,392	---	---	---	D	
29-44-1X 5	Wendell Bankhead	---	24	70	NW	---	Kca,Trdsr	---	---	---	2,350	---	---	---	D,U	Old windmill
29-44-1X 6	Mahon	---	24	70	SE	---	Trdsr	---	---	---	2,342	---	---	---	D,S,U	Old windmill
29-44-1X 7	Mahon	---	24	70	SE	---	Trdsr	---	---	---	2,348	---	---	---	Irr,U	
29-44-1X 8	Hawkins	---	24	70	SW	---	Trdsr	---	---	---	2,335	---	---	---	D,U	
29-44-1X 9	P. W. Saunders, Jr.	---	24	70	SW	---	Trdsr	45	---	---	2,330	---	---	5r	D	
29-44-1X10	Hawkins	O. R. House	24	71	SE	1960	Trdsr	160	---	---	2,341	---	---	---	D	
29-44-1X11	---	---	24	71	SW	---	Trdsr	---	---	---	2,333	14.2	6-87	---	D,U	Old windmill
29-44-1X12	A. G. Furlow, Jr.	---	24	71	SW	---	Trdsr	42	---	---	2,355	---	---	---	D	
29-44-1X13	Bosworth	---	24	74	NE	---	Trdsr	---	---	---	2,355	---	---	---	D	Old windmill
29-44-1X14	Eugene Fullwood	---	24	74	NE	---	Trdsr	---	---	---	2,355	---	---	---	S,U	Old windmill
29-44-1X15	Eugene Fullwood	---	24	74	NE	---	Trdsr	176	6	---	2,370	62.6	6-87	30e	S	
29-44-1X16	Eugene Fullwood	---	24	74	NE	---	Trdsr	200	---	---	2,364	---	---	---	D	
29-44-1X17	Mrs. Cooper	---	24	74	SE	---	Trdsr	136	5	---	2,351	8.4	6-87	---	D,U	Old windmill
29-44-1X18	Cooper	---	24	74	SW	---	Trdsr	---	---	---	2,328	---	---	---	D	
29-44-1X19	Morgan Wright	---	24	75	NE	---	Trdsr	---	---	---	2,312	---	---	---	S,U	Old windmill
29-44-1X20	Morgan Wright	---	24	75	NE	---	Trdsr	---	---	---	2,325	---	---	---	D,U	Old windmill
29-44-1X21	Alfreda Gabler	---	24	75	SE	---	Trdsr	---	---	---	2,320	---	---	---	D	Old windmill
29-44-1X22	---	---	24	75	SW	---	Trdsr	---	---	---	2,295	---	---	---	D,U	Old windmill

TABLE 1. RECORDS OF WELLS

Well Number	Owner	Driller	Blk	Sec	1/4	Date Drilled	Aquifer1/	Depth of Well,ft	Casing Dia,in	Casing Depth,ft	Ground Elev,ft	Static W.L.,ft	Date of SWL Meas	Yield GPM2/	Use of Water3/	Remarks
29-44-1X23	Champion Baptist Church	---	24	76	NE	---	Trdsr	130	---	---	2,323	---	---	---	D,P	
29-44-1X24	Troy Bankhead	---	24	81	NE	---	Trdsr	---	---	---	2,300	---	---	---	D	
29-44-1X25	M. Z. Richburg	---	24	81	SE	---	Trdsr	150	---	---	2,308	---	---	---	D	
29-44-1X26	M. Z. Richburg	J. Miller	24	81	SE	1980	Trdsr	153	7	130	2,308	---	---	---	D	
29-44-1X27	M. Z. Richburg	J. Miller	24	81	SE	1980	Trdsr	130	7	153	2,308	---	---	---	D	
29-44-1X28	Archie Hunter	---	24	82	NE	---	Trdsr	140	---	---	2,323	23.8	7-87	100e	S,Irr	
29-44-1X29	Archie Hunter	---	24	82	NW	---	Trdsr	70	5	---	2,330	---	---	---	S	Old windmill
29-44-1X30	Malone	---	24	82	NW	---	Trdsr	---	---	---	2,306	---	---	---	D	
29-44-1X31	Jesse Fullwood	---	24	83	NE	---	Trdsr	---	---	---	2,332	---	---	---	Irr,U	
29-44-1X32	Jesse Fullwood	---	24	83	NE	---	Trdsr	---	---	---	2,345	---	---	---	Irr,U	
29-44-1X33	Robbie Sanford	---	24	83	NW	---	Trdsr	---	---	---	2,322	---	---	---	D,U	Old windmill
29-44-1X34	L. W. Davis	---	24	83	SE	---	Trdsr	---	8	---	2,361	43.2	6-87	---	Irr,U	
29-44-1X35	L. W. Davis	---	24	83	SE	---	Trdsr	160	8	---	2,350	31.7	6-87	---	Irr	
29-44-1X36	L. W. Davis	---	24	83	SE	---	Trdsr	160	8	---	2,363	48.2	6-87	165m	D,Irr	
29-44-1X37	Oscar Rannefeld	House	24	83	SW	---	Trdsr	150	---	---	2,357	---	---	230r	D	
29-44-1X38	R. Sanford	---	24	83	NW	---	Trdsr	---	10	---	2,320	12.4	6-87	---	Irr,U	Old well about 6 feet east of Well 29-44-112
29-44-201	J. L. Campbell	Max Wright	24	73	SW	1957	Trdsr	156	6	100	2,355	40.1 13.4	1-64 7-87	50r	Irr,U	Open hole 100 to 156 ft.
29-44-205	Kidd	---	23	79	SW	---	Trdsr	64	5-1/2	---	2,368	19.1 9.5	1-64 6-87	---	S,U	
29-44-207	---	---	24	73	SW	---	---	---		---	2,338	---	---	---	---	Oil Test
29-44-208	Texaco Oil Co.	O. R. House	24	85	NW	1962	Trdsr	205	8-1/2	205	2,410	72.5 89.7	7-62 7-87	123r	Ind,U	Nena Lucia Well 3; drillers' log on file with Texas Water Development Board
29-44-210	Morgan Wright	Hopkins Drlg. Co.	24	73	SE	---	Trdsr	---	5-1/2	---	2,392	74.5	3-63	---	D,U	

TABLE 1. RECORDS OF WELLS

Well Number	Owner	Driller	Blk	Sec	1/4	Date Drilled	Aquifer1/	Depth of Well,ft	Casing Dia,in	Casing Depth,ft	Ground Elev,ft	Static W.L.,ft	Date of SWL Meas	Yield GPM2/	Use of Water3/	Remarks
29-44-211	Newmont Oil Co.	Wylie Drilling Co.	23	67	SW	1966	Trdsr	265	8-5/8	224	2,420	107.2	10-81	91r	Ind,U	Drillers' log on file with Texas Water Development Board; perforated from 152 to 224 ft.
29-44-212	City of Sweetwater	Texas Water Development Board	24	73	NW	1987	Trdsr	220	---	---	2,368	46.5	7-87	---	TH,U	Test Hole 1; drillers' log, electric log, and radioactivity logs included in this report
29-44-2C	Lawrence Sims	Joe Whitworth	24	85	NE	1971	Trdsr,Kca	80	5-1/2	80	---	---	---	8r	S	Drillers' log on file with Texas Water Development Board
29-44-2G	Johnny Allen	Joe Whitworth	24	72	SE	1976	Trdsr,Kca	170	5	170	2,412	---	---	25r	D	Drillers' log on file with Texas Water Development Board
29-44-2X 1	---	---	24	72	SW	---	Trdsr,Kca	---	---	---	2,382	---	---	---	D,U	Old windmill
29-44-2X 2	Luke Wright	O. R. House	24	72	SW	1951	Trdsr	148	---	---	2,390	73.4	6-87	5r	D	
29-44-2X 3	Al Miller	Justis	24	73	NE	---	Trdsr	145	6	---	2,382	55.8	7-87	---	D	
29-44-2X 4	Morgan Wright	---	24	73	SE	1950	Trdsr	150	9	---	2,370	30.2	6-87	55r	Irr,U	
29-44-2X 5	Morgan Wright	---	24	73	SE	1963	Trdsr	175	---	---	2,392	---	---	---	TH,U	
29-44-2X 6	Morgan Wright	Joe Whitworth	24	73	SE	1981	Trdsr	130	4 - 5	---	2,395	54.1	6-87	---	D	
29-44-2X 7	J. L. Campbell	---	24	73	SW	1953	Trdsr	80	5 or 6	---	2,350	---	---	---	D	
29-44-2X 8	Jesse Fullwood	---	24	83	NE	---	Trdsr	200	---	---	2,338	13.7	6-87	---	D	
29-44-2X 9	Pullings	---	24	83	SE	---	Trdsr	150	6	---	2,340			---	D,S	Owner reported static water level of about 27 feet, 7-87
29-44-2X10	----	----	24	84	NW	----	Trdsr	---	---	---	2,340	---	---	----	D,U	Old Windmill
29-44-308	L. R. Wright	Hopkins Drilling Co.		--		1963	Trdsr	205	8	200	2,452	112.0	5-63	62m	Irr	
29-44-402	M. Z. Richburg	Olin House	24	81	SE	---	Trdsr	145	6	145	2,308	32.1 21.4	12-61 6-87	60m	Irr,U	
29-44-403	Alexander	O. R. House	24	86	NW	1956	Trdsr	215	10	212	2,387	---	---	170r	Irr,U	Drillers' log on file with Texas Water Development Board
29-44-404	Alexander	O. R. House	24	86	SW	1957	Trdsr	220	12	218	2,390	70.3	1-64	225r	Irr,U	Drillers' log on file with Texas Water Development Board
29-44-405	Sonny Brown	Compton	24	87	NW	1953	Trdsr	187	8	187	---	---	---	120m	S,U	Drillers' log on file with Texas Water Development Board

TABLE 1. RECORDS OF WELLS

Well Number	Owner	Driller	Blk	Sec	1/4	Date Drilled	Aquifer1/	Depth of Well,ft	Casing Dia,in	Casing Depth,ft	Ground Elev,ft	Static W.L.,ft	Date of SWL Meas	Yield GPM2/	Use of Water3/	Remarks
29-44-406	Texaco Oil Co.	O. R. House	24	95	NW	1955	Trdsr	225	7	225	---	---	---	90r	Irr,U	
29-44-407	Sam Jones	Huron Gist	24	87	SE	1956	Trdsr	203	7	203	2,405	41.2 96.6	3-63 7-87	40r	Irr,U	
29-44-409	A. A. Gabler	---	X	25	NW	---	Trdsr	220	6	---	2,403	113.2 114.2	1-64 7-87	50r	Irr,U	
29-44-410	Alexander	O. R. House	24	86	NE	1959	Trdsr	190	8	115	2,375	53.4	1-64	150r	Irr,U	Drillers' log on file with Texas Water Development Board; open hole 115 to 190 ft.
29-44-412	Sam Jones	O. R. House	24	87	SW	1963	Trdsr	160	6	---	2,355	66.4	2-63	---	D,U	
29-44-413	O. C. Gabler	O. C. Gabler	24	93	SW	1958	Trdsr	160	6	160	2,390	---	---	40r	D,U	
29-44-414	Alexander	Hopkins Drlg. Co.	24	86	NW	1963	Trdsr	210	10	---	2,387	---	---	100r	Irr,U	Drillers' log on file with Texas Water Development Board
29-44-416	---	---	24	94	NE	---	---	---	---	---	2,375	---	---	---	---	Oil Test
29-44-417	Sonny Brown	Joe Whitworth	24	87	NW	1963	Trdsr	145	6	145	2,325	33.2	6-87	50r	S,Irr	Drillers' log on file with Texas Water Development Board
29-44-418	Sam Jones	---		--		1968	Trdsr	130	5	---	2,352	70.9	5-85	---	S,D	
29-44-420	City of Sweetwater	Texas Water Development Board	24	88	NE	1987	Trdsr	254	---	---	2,370	---	---	100e	TH,U	Test Hole 2; drillers' log, electric log, and radioactivity logs included in this report
29-44-421	M. Z. Richburg	Jack Miller	24	81	SE	1983	Trdsr	156	8	156	2,303	18.9	6-87	180r	Irr,U	
29-44-422	Edsel Bankhead	---	24	81	SW	---	Trdsr	140	6-1/2	34	2,300	14.0	8-87	---	Irr,U	Radioactivity logs on file with Texas Water Development Board; open hole 34 to 140 ft.
29-44-4A	Sonny Brown	Joe Whitworth	24	87	NW	1963	Trdsr	141	5-1/2	141	2,345	61.3	6-87	---	S,U	Drillers' log on file with Texas Water Development Board
29-44-4C	Alice Miles	J. D. House	24	92	NE	1963	Trdsr	144	5	144	2,345	---	---	---	D,U	Drillers' log on file with Texas Water Development Board
29-44-4E	Sonny Brown	Joe Whitworth	24	87	NW	1974	Trdsr	150	6	150	2,355	58.5	6-87	---	Irr,U	Drillers' log on file with Texas Water Development Board; located in grid 29-43-6
29-44-4X 3	Sonny Brown	---	24	87	NW	---	Trdsr	---		---	2,370	---	---	---	S,U	
29-44-4X 4	Sonny Brown	---	24	87	NW	---	Trdsr	---	---	---	2,320	---	---	---	D	

TABLE 1. RECORDS OF WELLS

Well Number	Owner	Driller	Blk	Sec	1/4	Date Drilled	Aquifer1/	Depth of Well,ft	Casing Dia,in	Casing Depth,ft	Ground Elev,ft	Static W.L.,ft	Date of SWL Meas	Yield GPM2/	Use of Water3/	Remarks
29-44-4X 5	Roy Barrett	Sam Smith	24	87	SE	1970	Trdsr	240	6	---	2,455	---	---	---	D	Owner reported static water level of about 170 feet, 7-87
29-44-4X 6	Barbara Spears	James Ware	24	87	SW	1986	Trdsr	138	6	138	2,377	94.0	7-87	10r	D,U	Drillers' log on file with Texas Water Development Board
29-44-4X 7	John Massey	---	24	88	NE	---	Trdsr	160	---	---	2,360	80.3	6-87	20e	S	
29-44-4X 8	John Massey	---	24	88	NE	1962	Trdsr	127	8-5/8	---	2,328	44.0	6-87	60m	S	
29-44-4X 9	James Wells	M. D. Williams	24	93	NE	1968	Trdsr	165	8	---	2,342	58.8	7-87	150r	S,Irr	
29-44-4X10	Brown	---	24	93	SE	---	Trdsr	---	---	---	2,393	---	---	---	D	
29-44-4X11	Georgia Institute of Technology	---	24	93	SW	---	Trdsr	---	6	---	2,380	---	---	---	D,U	
29-44-4X12	Farmers Home Administration	---	24	94	NW	---	Trdsr,Kca	---	5	---	2,410	117.3	7-87	---	D,U	
29-44-4X13	---	---	24	94	SE	---	Trdsr,Kca	---	6	---	2,475	108.6	7-87	---	S	
29-44-4X14	Dave Smith	---	24	94	SE	---	Trdsr	---	8	---	2,448	81.9	7-87	---	Irr,U	
29-44-4X15	Dave Smith	---	24	94	SW	---	Trdsr,Kca	---	---	---	2,422	---	---	---	D	
29-44-4X16	Terry L. Clark	---	X	25	NE	---	Trdsr	---	---	---	2,397	---	---	---	D	
29-44-4X17	Terry L. Clark	---	X	25	NE	---	Trdsr	---	---	---	2,397	---	---	---	D,S,U	Old windmill
29-44-4X18	---	---	X	25	NW	---	Trdsr,Kca	---	---	---	2,395	---	---	---	D,S,U	
29-44-501	Texaco Oil Co.	O. R. House	24	95	NE	1957	Trdsr	215	12	215	2,405	72.2	3-63	150r	Ind	Nena Lucia Well 2; drillers' log on file with Texas Water Development Board
29-44-503	Texaco Oil Co.	O. R. House	24	96	NW	1962	Trdsr	225	10	225	2,425	---	---	285r	Ind	Nena Lucia Well 4; drillers' log on file with Texas Water Development Board
29-44-504	Texaco Oil Co.	O. R. House	24	85	SE	---	Trdsr	135	5	---	2,477	112.0	10-62	---	S,U	
29-44-505	Texaco Oil Co.	O. R. House	24	96	SE	1962	Trdsr	266	8-1/2	266	2,488	118.0	8-63	130r	Ind,U	Nena Lucia Well 5; drillers' log on file with Texas Water Development Board
29-44-506	Texaco Oil Co.	O. R. House	24	96	SE	1962	Trdsr	280	10-3/4	280	2,518	---	---	200r	Ind,U	Nena Lucia Well 6
29-44-507	---	---	24	96	NE	---	---	---	---	---	2,495	---	---	---	---	Oil Test

TABLE 1. RECORDS OF WELLS

Well Number	Owner	Driller	Blk	Sec	1/4	Date Drilled	Aquifer1/	Depth of Well,ft	Casing Dia,in	Casing Depth,ft	Ground Elev,ft	Static W.L.,ft	Date of SWL Meas	Yield GPM2/	Use of Water3/	Remarks
29-44-509	---	---	24	96	SE	---	---	---	---	---	2,505	---	---	---	---	Oil Test
29-44-510	Texaco Oil Co.	---	24	96	NW	---	Trdsr	130	5-1/2	---	2,535	104.9	12-63	---	S,U	
29-44-5E	Farmers Home Administration	Ira L. Craig	24	94	NE	1981	Kca,Trdsr	100	5	100	2,425	---	---	12r	S	Drillers' log on file with Texas Water Development Board; located in grid 29-44-4
29-44-5X 1	---	---	24	85	NW	---	Trdsr,Kca	---	5	---	2,402	---	---	---	S,U	Old windmill
29-44-5X 2	E. Fullwood	---	24	85	SW	1951	Kca,Trdsr	148	5-1/2	---	2,457	39.6	7-87	---	S,U	
29-44-5X 3	Texaco Oil Co.	---	24	85	SW	---	Trdsr	---	---	---	2,470	135.6	7-87	---	Ind	Nena Lucia Well 10
29-44-5X 4	Texaco Oil Co.	O. R. House	24	85	SW	---	Trdsr,Kca	---	10	---	2,455	99.7	7-87	---	Ind,U	Nena Lucia Well 7
29-44-5X 5	---	---	24	86	SE	---	Trdsr,Kca	---	---	---	2,410	---	---	---	S,U	Old windmill
29-44-5X 6	Texaco Oil Co.	---	24	95	SE	---	Trdsr	---	---	---	2,440	---	---	---	Ind	Nena Lucia Well 9
29-44-5X 7	Texaco Oil Co.	---	24	96	NW	---	Trdsr	253	---	---	2,492	---	---	---	Ind	Nena Lucia Well 11
29-44-5X 8	Texaco Oil Co.	---	24	96	SW	---	Trdsr	---	---	---	2,475	---	---	---	Ind	Nena Lucia Well 14
29-44-5X 9	Texaco Oil Co.	---	24	96	SW	---	Trdsr	262	---	---	2,480	---	---	---	Ind	Nena Lucia Well 12
29-44-5X10	Texaco Oil Co.	---	24	96	SW	---	Trdsr	---	---	---	2,480	---	---	---	Ind	Nena Lucia Well 13
29-44-5X11	Texaco Oil Co.	---	24	96	SW	---	Trdsr	---	---	---	2,510	---	---	---	Ind	Nena Lucia Well 8

Footnotes:

1/ Aquifer: Kca - Cretaceous Antlers Sand (Comanchean Series)
Trdsr - Triassic Santa Rosa Formation (Dockum Group)

2/ r - reported
m - measured

3/ Use of Water: D - Domestic
S - Stock
Irr - Irrigation
Ind - Industrial
P - Public Supply
TH - Test Hole
U - Unused or Abandoned

TABLE 2. RESULTS OF PUMPING TESTS

Pumped Well	Owner and Owner's Well No.	Observation Well	Date of Test	Length of Test (hours)	Pumping Rate (gpm)	Trans-missivity (gpd/ft)	Specific Capacity (gpm/ft)	Specific Capacity (hrs)	Remarks
29-44-1X35	L. W. Davis Well No. 2		3-86	6	208	7,000	3.6	6	
29-44-1X36	L. W. Davis Well No. 1		3-86	6	198	5,400	3.3	6	
29-44-123	E. R. Fullwood No. 1		5-86	13	190	8,100	4.3	13	
	E. R. Fullwood No. 1		5-86	48	190	8,400	4.3	13	Transmissivity is from first 12 hours of test. Transmissivity decreased to 5,200 gpd/ft from 12 hours to 48 hours.
29-36-708	E. R. Fullwood (Hillis No. 2)		5-86	48	165	6,200	2.0	24	
	E. R. Fullwood (Hillis No. 3)	29-44-126	5-86	48	165	5,000	-	-	Transmissivity from water-level recovery data in Fullwood (Hillis) Well 3 after Fullwood (Hillis) Well 2 turned off on 5-21-86.
29-44-125	M. Zane Richburg Well No. 7		5-86	48	170	6,900	4.8	24	Transmissivity is from first 11 hours of test. Transmissivity decreased to 3,200 gpd/ft from 11 hours to about 38 hours and to 1,400 gpd/ft from 38 hours to 48 hours.
29-44-116	M. Zane Richburg Well No. 5		5-86	48	168	10,500	3.4	24	Transmissivity from first 2-1/2 hours of test. Transmissivity decreased to about 5,000 gpd/ft from about 2-1/2 hours to about 8 hours and water-level recovery measurements indicate that the transmissivity decreased to about 3,000 gpd/ft from about 8 hours to 57 hours.
29-44-1A	Edsel Bankhead Well No. 1		5-86	48	155	12,200	6.0	24	
29-44-1X2	B. Collier		7-87	24	91	5,100	1.4	24	
	E. R. Fullwood (Hillis) No. 2	29-44-126	7-87	24	91	5,200	-	-	
29-44-111	Alfreda Gabler		7-87	24	131	5,200	1.8	24	Transmissivity from last 22-1/2 hours of test. Transmissivity from first 1-1/2 hours of test was about 1,600 gpd/ft.
29-44-112	R. Sanford		7-87	24	111	5,000	3.4	24	Transmissivity from last 22 hours of test. Transmissivity from first 2 hours of test was about 4,200 gpd/ft.
29-44-4X8	J. Massey		7-87	24	60	3,600	1.2	24	Transmissivity is from last 18 hours of test. Transmissivity from first 6 hours of test is about 2,600 gpd/ft.

TABLE 3.
RESULTS OF CHEMICAL ANALYSES OF GROUND WATER FROM THE SANTA ROSA FORMATION
(All results in milligrams per liter except Specific Conductance and pH)

Well No.	Well Owner	Depth of Well (ft)	Date of Collection	Analyst1/	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as ($CaCO_3$)	Specific conductance (micromhos 25°C)	pH
29-36-702	Jimmie Wright	300	7/24/63	TDH	12	---	---	68	21	24	---	268	32	36	0.7	2.0	327	259	585	7.9
29-36-708	Eugene Fullwood	223	5/19/86	SNPH	---	0.1	---	---	---	---	---	---	300	250	---	132	---	342	---	---
29-36-811		240	7/19/63	TDH	22	---	---	68	20	14	---	261	39	24	0.9	0.4	316	255	555	7.3
29-36-814		185	7/20/78	TDH	17	---	---	127	27	42	---	248	101	133	1.0	26	596	428	910	7.6
29-36-820		200	8/17/63	TDH	15	---	---	60	14	28	---	204	36	43	0.6	3.0	300	207	532	7.6
29-43-313	Danny Thompson	170	12/02/81	TDH	18	---	---	217	51	147	---	299	385	230	1.0	141	1,337	752	1,560	7.9
29-43-3X5	M. A. Moore	230	7/22/87	WFG	---	---	---	---	---	---	---	---	68	86	---	16	---	---	870	---
29-43-3X4	M. A. Moore	95	7/22/87	WFG	---	---	---	---	---	---	---	---	100	124	---	168	---	---	1,400	---
29-43-3X13	Edsel Bankhead	155	7/18/87	WFG	---	---	---	---	---	---	---	---	61	44	---	4	---	---	750	---
29-43-314	City of Sweetwater TH-7	160	8/12/87	WFG	---	---	---	---	---	---	---	---	30	27	---	3	---	---	600	---
29-43-602	Herman Aucutt	220	8/16/63	TDH	14	---	---	178	42	190	---	264	280	319	1.2	50	1,210	620	1,960	7.4
			6/29/76	TDH	19	---	---	296	59	401	---	278	540	660	2.9	171	2,285	980	3,290	7.7
29-43-606	Herman Aucutt	210	7/20/78	TDH	10	---	---	264	89	256	---	269	549	557	0.8	17	1,785	1,025	2,260	7.8
			9/13/82	TDH	10	---	---	220	86	284	---	254	501	538	0.8	8.9	1,890	903	2,090	8.0
29-43-6X6	Alice Miles	176	7/22/87	WFG	---	---	---	---	---	---	---	---	43	32	---	3	---	---	660	---
29-43-609	City of Sweetwater TH-5	90	8/02/87	WFG	---	---	---	---	---	---	---	---	84	77	---	37	---	---	980	---
		185	8/02/87	WFG	---	---	---	---	---	---	---	---	42	38	---	6	---	---	650	---
29-44-102	E. O. Mahon	215	5/05/60	USGS	15	---	---	61	30	27	---	296	36	36	---	1.2	355	276	616	7.4
29-44-104	W. H. Cooper	150	5/18/63	TDH	14	---	---	80	17	30	---	256	43	51	0.6	9	369	270	654	7.7
			6/29/76	TDH	13	---	---	94	15	44	---	262	65	71	0.6	19	451	296	739	7.6
			7/20/78	TDH	18	---	---	94	15	40	---	265	57	64	0.6	16	454	295	662	8.0
29-44-106	E. A. Costevens	110	7/ 5/46	USGS	---	---	---	---	---	---	---	292	120	328	---	84	---	---	675	---
29-44-108	J. R. Hawkins	114	6/28/46	USGS	---	---	---	---	---	---	---	405	85	137	---	96	---	---	652	---
29-44-111	Alfreda Gabler	150	7/07/87	TDH	---	---	---	98	105	324	---	317	402	468	4.3	81	1,640	676	3,276	---
29-44-112	Robbie Sanford	153	7/12/87	WFG	---	---	---	---	---	---	---	---	128	146	---	81	---	---	1,380	---
			7/12/87	EWL	---	0.06	0.01	---	---	---	---	---	154	144	---	89	---	390	1,400	7.4
29-44-116	M. Z. Richburg	145	3/11/63	TDH	15	---	---	98	16	37	---	272	62	73	0.3	4.5	439	311	762	7.8
			6/03/86	SNPH	---	0.1	---	---	---	---	---	---	375	333	---	61.6	---	684	---	---
29-44-125	M. Z. Richburg	146	7/21/83	TDH	14	---	---	71	14	23	2	203	62	39	0.6	10.3	352	235	533	7.9
			5/21/86	SNPH	---	0.1	---	---	---	---	---	---	125	61	---	13.2	---	325	---	---
29-44-1A	Bankhead	150	6/02/86	SNPH	---	0.1	---	---	---	---	---	---	125	91	---	17.6	---	342	---	---
29-44-1J2	Wendell Bankhead	125	7/18/87	WFG	---	---	---	---	---	---	---	---	650	345	---	89	---	---	3,400	---
29-44-1X2	John Collier	210	7/10/87	WFG	---	---	---	---	---	---	---	---	335	505	---	102	---	---	3,400	---
			7/10/87	EWL	---	0.06	0.01	---	---	---	---	---	422	478	---	168	---	860	3,000	7.4
29-44-1X16	Eugene Fullwood	200	7/28/87	WFG	---	---	---	---	---	---	---	---	33	67	---	6	---	---	770	---

TABLE 3.
RESULTS OF CHEMICAL ANALYSES OF GROUND WATER FROM THE SANTA ROSA FORMATION
(All results in milligrams per liter except Specific Conductance and pH)

Well No.	Well Owner	Depth of Well (ft)	Date of Collection	Analyst1/	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as ($CaCO_3$)	Specific conductance (micromhos 25°C)	pH
29-44-1X15	Eugene Fullwood	176	7/28/87	WFG	---	---	---	---	---	---	---	---	160	257	---	33	---	---	1,760	---
29-44-1X26	M. Z. Richburg	153	7/29/87	WFG	---	---	---	---	---	---	---	---	300	535	---	78	---	---	3,200	---
29-44-1X28	Archie Hunter	140	7/31/87	WFG	---	---	---	---	---	---	---	---	40	67	---	14	---	---	730	---
29-44-1X36	L. W. Davis	160	3/86 7/31/87	SNPH WFG	--- ---	0.1 ---	--- ---	--- ---	--- ---	--- ---	--- ---	--- ---	<25 44	150 92	--- ---	4.0 23	--- ---	342 ---	--- 840	--- ---
29-44-129	City of Sweetwater TH-3	175	7/29/87	WFG	---	---	---	---	---	---	---	---	19	38	---	12	---	---	580	---
29-44-128	City of Sweetwater TH-4	160	7/31/87	WFG	---	---	---	---	---	---	---	---	22	32	---	0	---	---	580	---
29-44-130	City of Sweetwater TH-6	120 160	8/04/87 8/04/87	WFG WFG	--- ---	--- ---	--- ---	--- ---	--- ---	--- ---	--- ---	--- ---	220 155	168 155	--- ---	84 86	--- ---	--- ---	1,580 1,480	--- ---
29-44-132	City of Sweetwater TH-9	187	8/19/87	WFG	---	---	---	---	---	---	---	---	22	30	---	3	---	---	600	---
29-44-131	City of Sweetwater TH-8	140	8/16/87	WFG	---	---	---	---	---	---	---	---	99	106	---	16	---	---	950	---
29-44-212	City of Sweetwater TH-1	220	7/19/87	WFG	---	---	---	---	---	---	---	---	35	60	---	7.5	---	---	750	---
29-44-308		205	8/07/63	TDH	12	---	---	43	7	15	---	149	15	16	0.5	3.5	185	136	335	7.7
29-44-417	Charles Brown	145	11/30/81	TDH	13	---	---	76	10	14	2	272	20	17	0.6	4.3	274	234	460	8.3
29-44-418	Sam Jones	130	5/22/85	TDH	13	---	---	78	19	21	2	303	37	27	0.8	< 0.1	302	272	552	8.3
29-44-4X7	John Massey	160	7/20/87	WFG	---	---	---	---	---	---	---	---	25	26	---	10	---	---	580	---
29-44-4X8	John Massey	127	7/09/87 7/09/87	WFG EWL	--- ---	--- 0.04	--- <0.01	--- ---	--- ---	--- ---	--- ---	--- ---	50 46	68 65	--- ---	7.5 8.4	--- ---	--- 316	825 800	--- 7.6
29-44-501	Texaco	215	5/01/62 8/ 3/81	TRWL SWL	8 ---	--- ---	--- ---	356 87	64 10	72 7	--- ---	--- 253	132 18	142 33	--- 0.7	--- 22	--- 308	420 255	860 ---	7.3 ---
29-44-5X7	Texaco	253	7/30/81	SWL	---	---	---	88	6	8	---	245	20	28	0.6	4.5	276	244	---	---
29-44-5X9	Texaco	262	3/27/80	ML	---	0.08	---	85	7	18	---	276	19	24	---	---	289	240	435	7.0

1/ Analyst:
- TDH - Texas State Department of Health
- SNPH - Sweetwater - Nolan County Public Health Laboratory
- WFG - William F. Guyton Associates, Inc.
- USGS - U. S. Geological Survey
- EWL - Edna Wood Laboratories, Inc.
- TRWL - Treat-Rite Water Laboratory
- SWL - Southwestern Laboratories
- ML - Martin Water Laboratories, Inc.
- USGS - U. S. Geological Survey

TABLE 4. TEXAS DEPARTMENT OF HEALTH'S MAXIMUM CONSTITUENT LEVELS FOR PUBLIC WATER SYSTEMS

Constituent	Maximum Level (mg/l, except as noted)	Constituent	Maximum Level (mg/l, except as noted)
Arsenic	0.05	Chloride	300
Barium	1	Color	15 color units
Cadmium	0.010	Copper	1.0
Chromium	0.05	Corrosivity	non-corrosive
Lead	0.05	Foaming Agents	0.5
Mercury	0.002	Hydrogen Sulfide	0.05
Nitrate (as N)	10	Iron	0.3
(as NO_3)	44.2	Manganese	0.05
Selenium	0.01	Odor	3 threshold Odor No.
Silver	0.05	pH	>7.0
Fluoride[1/]	2.0-4.0	Sulfate	300
		Total Dissolved Solid	1,000
		Zinc	5.0
Endrin	0.0002		
Lindane	0.004		
Methoxychlor	0.1		
Toxaphene	0.005		
2,4-D	0.1		
2,4,5-Tp	0.1		
Gross Alpha, pCi/l	15		
Combined radium-226 and Radium-228, pCi/l	5		
Gross Beta[2/]			

[1/] Fluoride concentrations up to 4.0 mg/l are acceptable. Customers must be notified if fluoride exceeds 2.0 mg/l.

[2/] The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any organ greater than 4 millirem (mrem)/year. Drinking water assumed to be in compliance if the average annual concentration of gross beta particle activity is less than 50 pCi/l and if the average annual concentration of tritium and strontium-90 are less than 20,000 pCi/l and 8 pCi/l, respectively.

TABLE 5. RESULTS OF ANALYSES FOR METALS IN WATER FROM WELLS AND DISTRIBUTION SYSTEMS OF THE CITIES OF ROSCOE AND LORAINE

(All results in milligrams per liter. All analyses by the Texas Department of Health)

	LORAINE			ROSCOE	
Date of Collection	7-28-83	8-22-84	3-13-85	9-84	3-17-87
Constituent					
Arsenic	<0.02	<0.01	<0.01	<0.01	<0.01
Barium	<0.05	<0.05	<0.5	<0.5	<0.50
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium	<0.02	<0.02	<0.02	<0.02	0.07
Copper	<0.02	<0.02	<0.02	<0.02	<0.02
Lead	<0.02	<0.02	<0.02	<0.02	<0.002
Mercury	<0.0002	0.0002	<0.002	<0.002	0.012
Selenium	<0.002	<0.002	<0.002	<0.002	<0.01
Silver	<0.01	<0.01	<0.01	<0.01	0.04
Zinc	0.09	1.20	0.36	0.02	

TABLE 6. ORGANIC CHEMICALS
(All results in milligrams per liter)

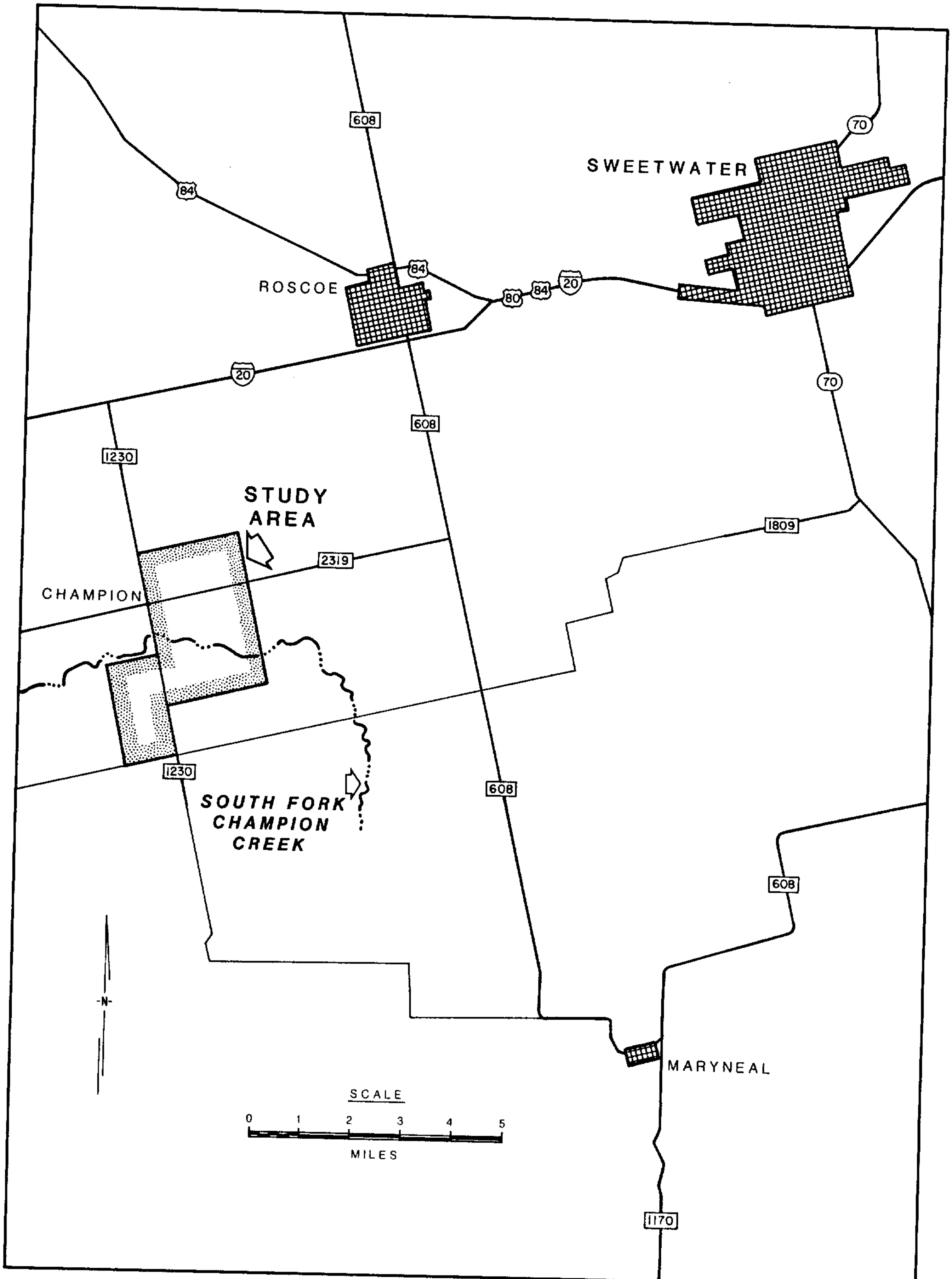
Well No.	Date of Collection	Constituent: Endrin	Lindane	Methoxychlor	Toxaphene	2,4-D	2,4,5-TP Silvex
29-44-1X2	7-10-87	<0.0002	<0.00003	<0.0005	<0.0050	<0.020	<0.005
29-44-112	7-12-87	<0.0002	<0.0001	<0.0003	<0.003	<0.005	<0.001
29-44-4X8	7-9-87	<0.0002	<0.00003	<0.0005	<0.0050	<0.020	<0.005

TABLE 7. RADIOLOGICAL ANALYSES OF WATER FROM WELLS AND DISTRIBUTION SYSTEMS OF THE CITIES OF ROSCOE AND LORAINE[1/].

(All results are in picocurries per liter)

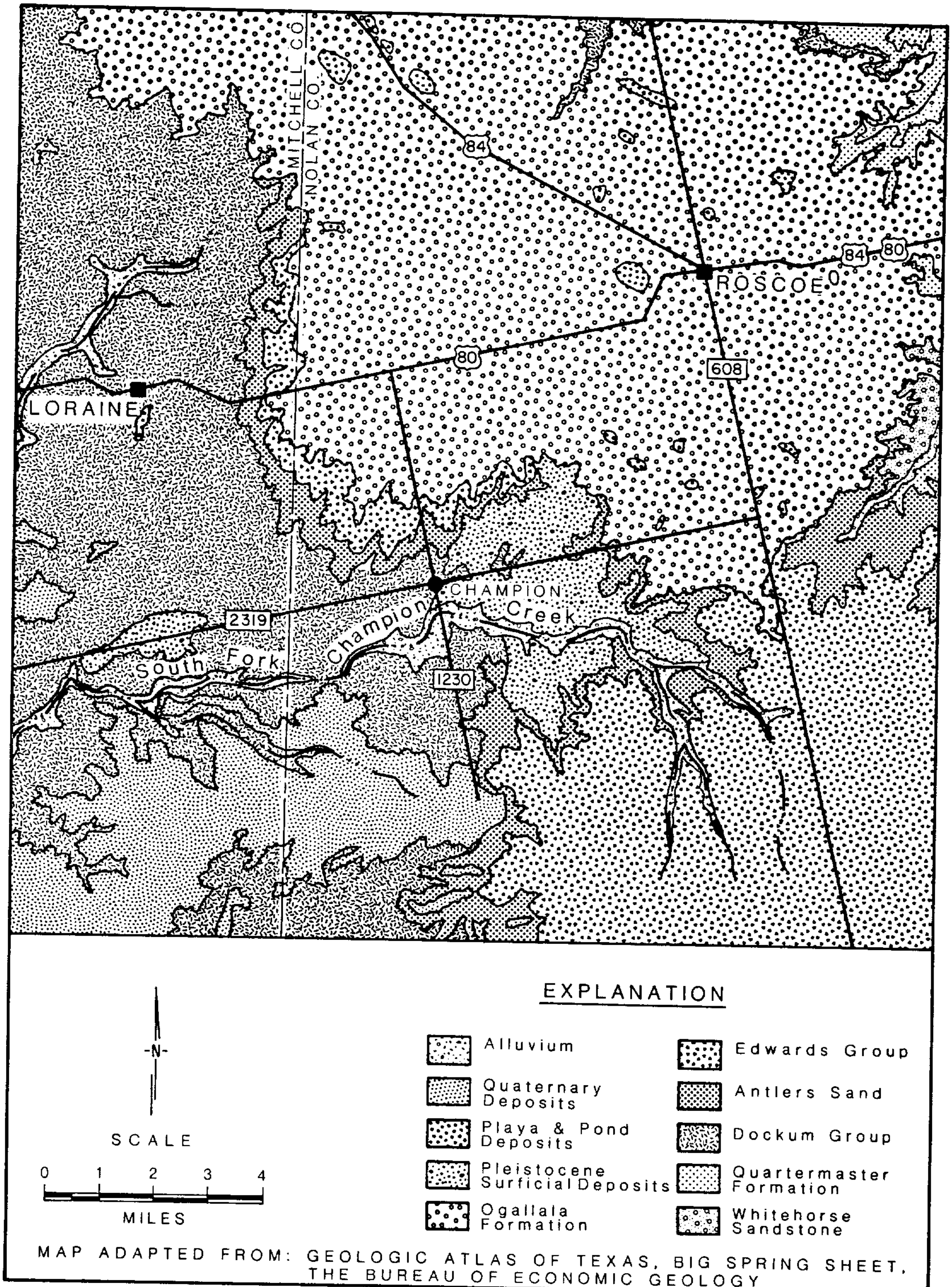
City	Date of Analysis	Gross Alpha	Total Radium	Radium -226	Radium -228	Total Uranium	Gross Beta
Roscoe	6-82	8.3±2.2	0.6±0.3	0.6±0.1	<1.0	---	8.9±4.4
Loraine	3-84	16±5	1.6±0.3	---	---	4.4±0.7	7.0±5.1
	1-85	15±5	1.7±0.4	1.3±0.1	<1.0	5.4	6.3±4.0
	8-85	9.2±3.2	1.5±0.4	---	---	---	6.7±4.6
	3-87	13.0±4.0	1.7±0.3	1.2±0.1	<1.0	3.1±0.7	10.0±5.0

1/ All analyses by Texas Department of Health



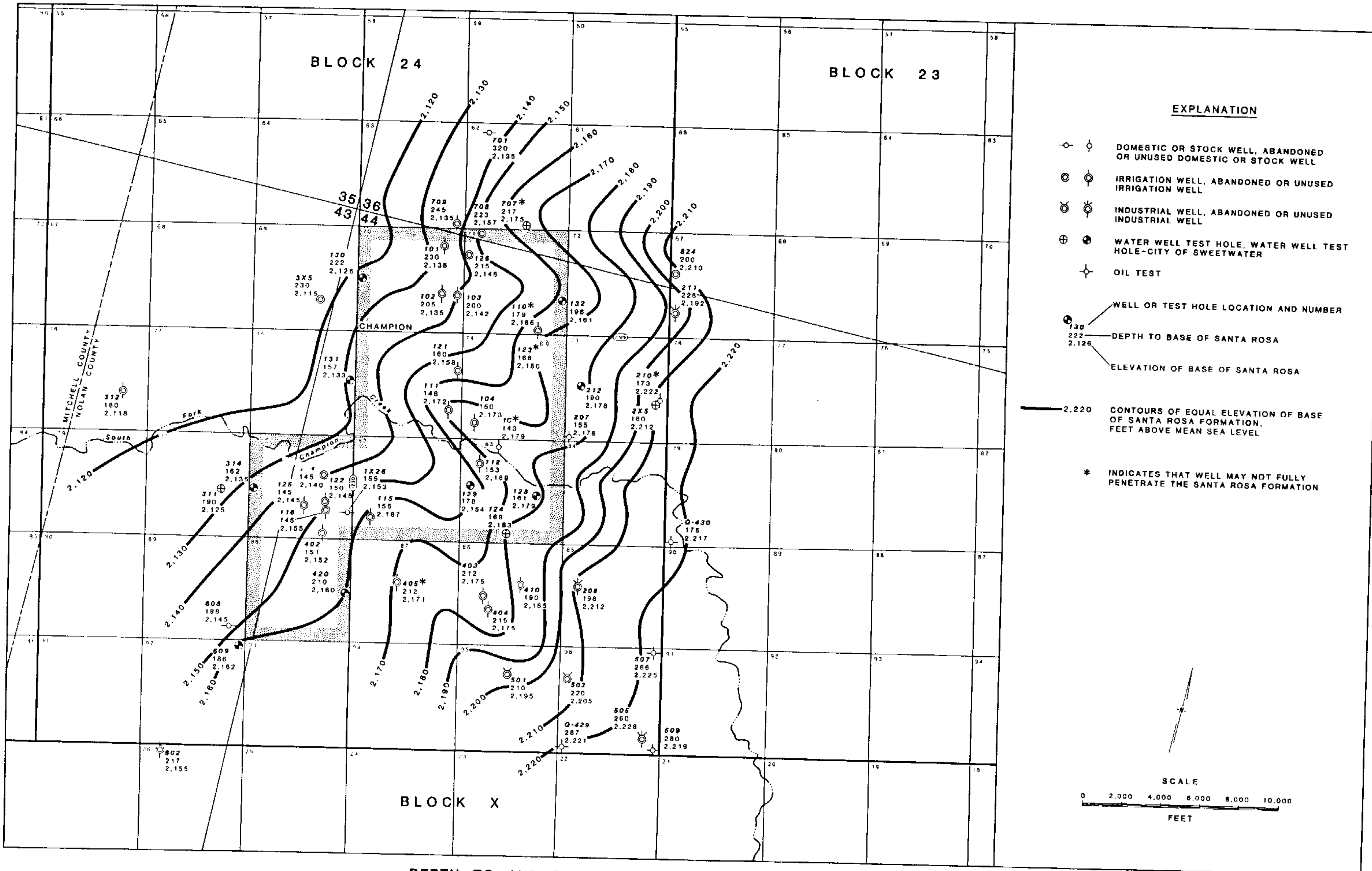
LOCATION OF STUDY AREA

Figure 1



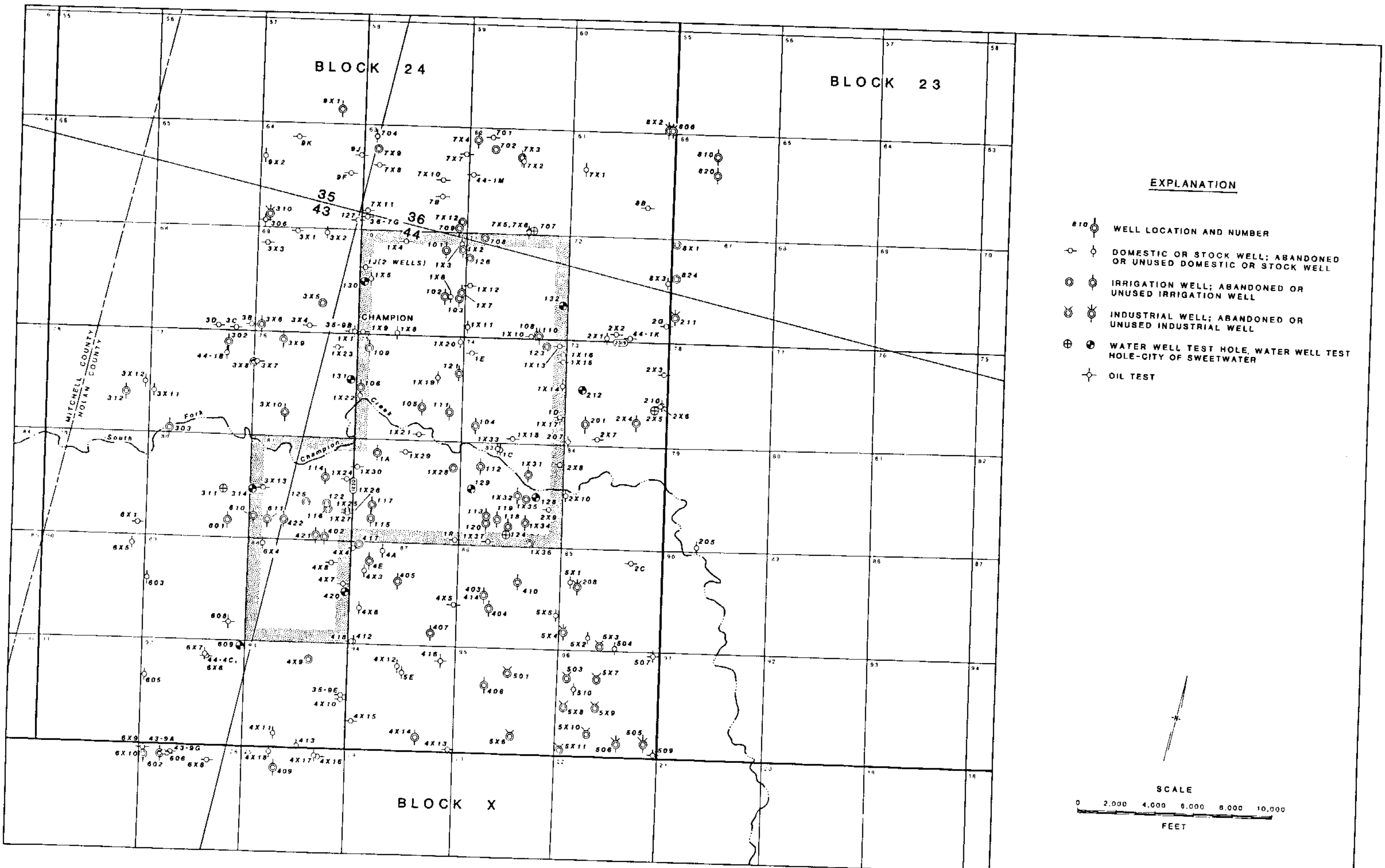
GEOLOGIC MAP

Figure 2



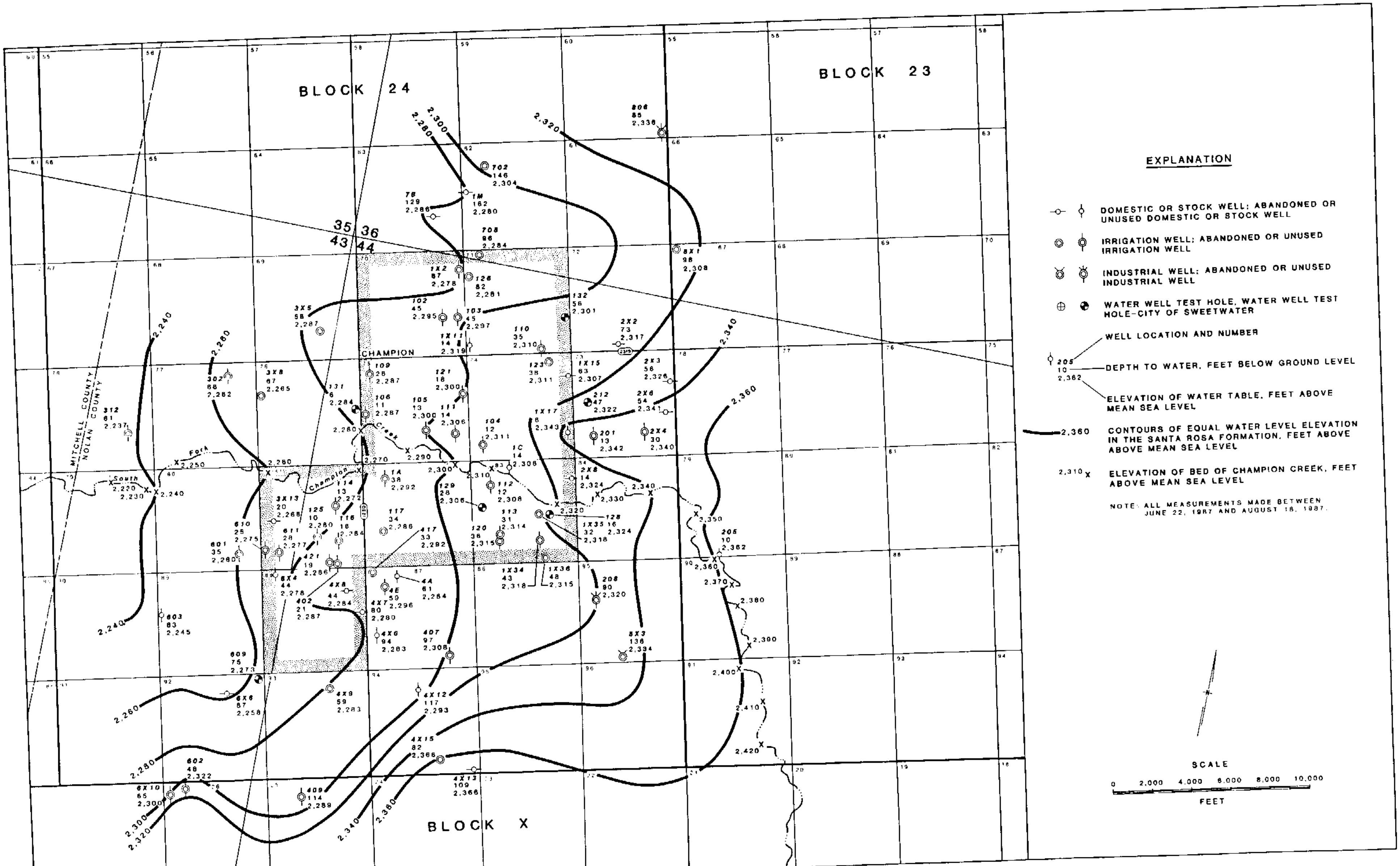
DEPTH TO AND ELEVATION OF BASE OF SANTA ROSA FORMATION

Figure 3



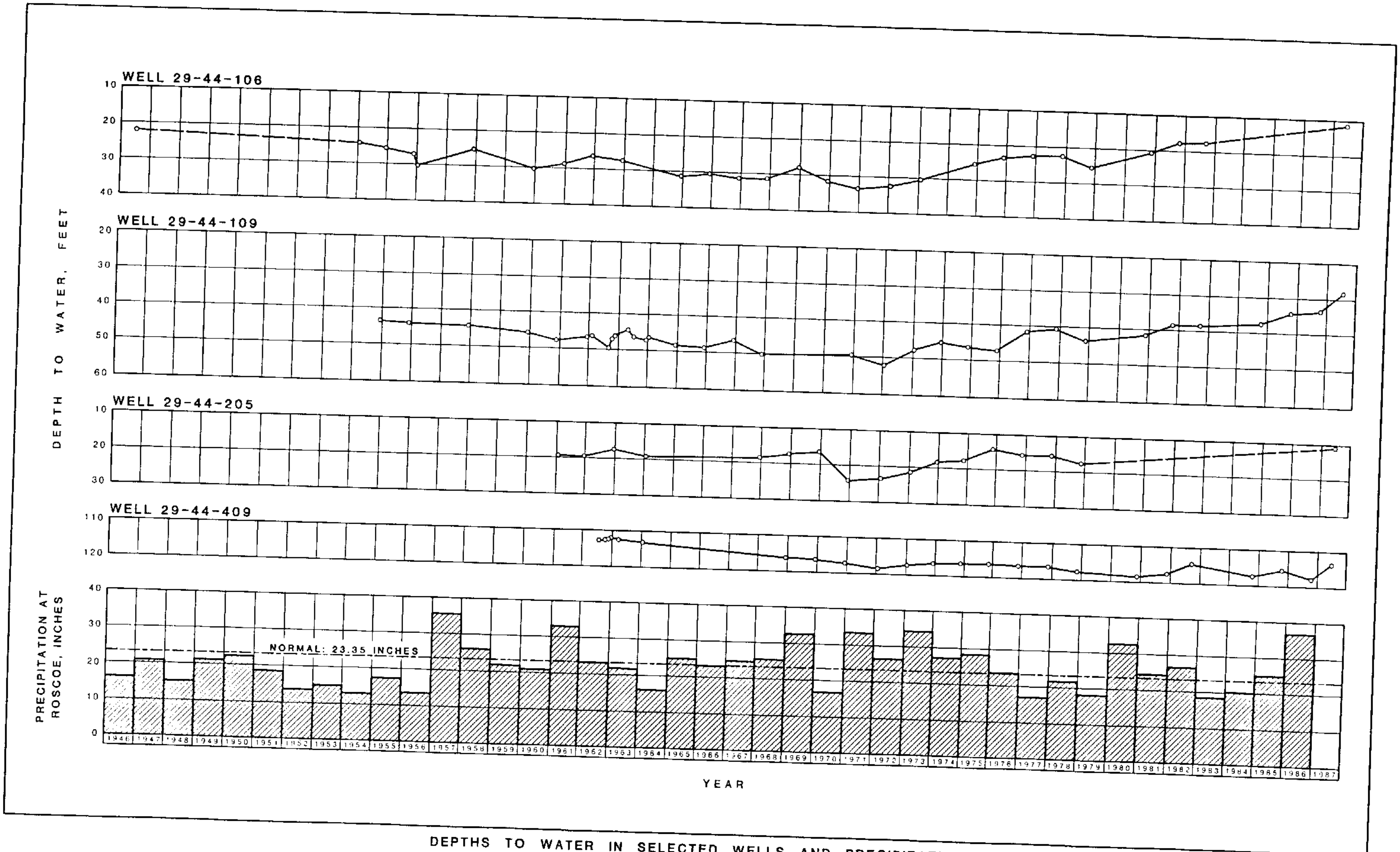
WELL LOCATION MAP

Figure 4



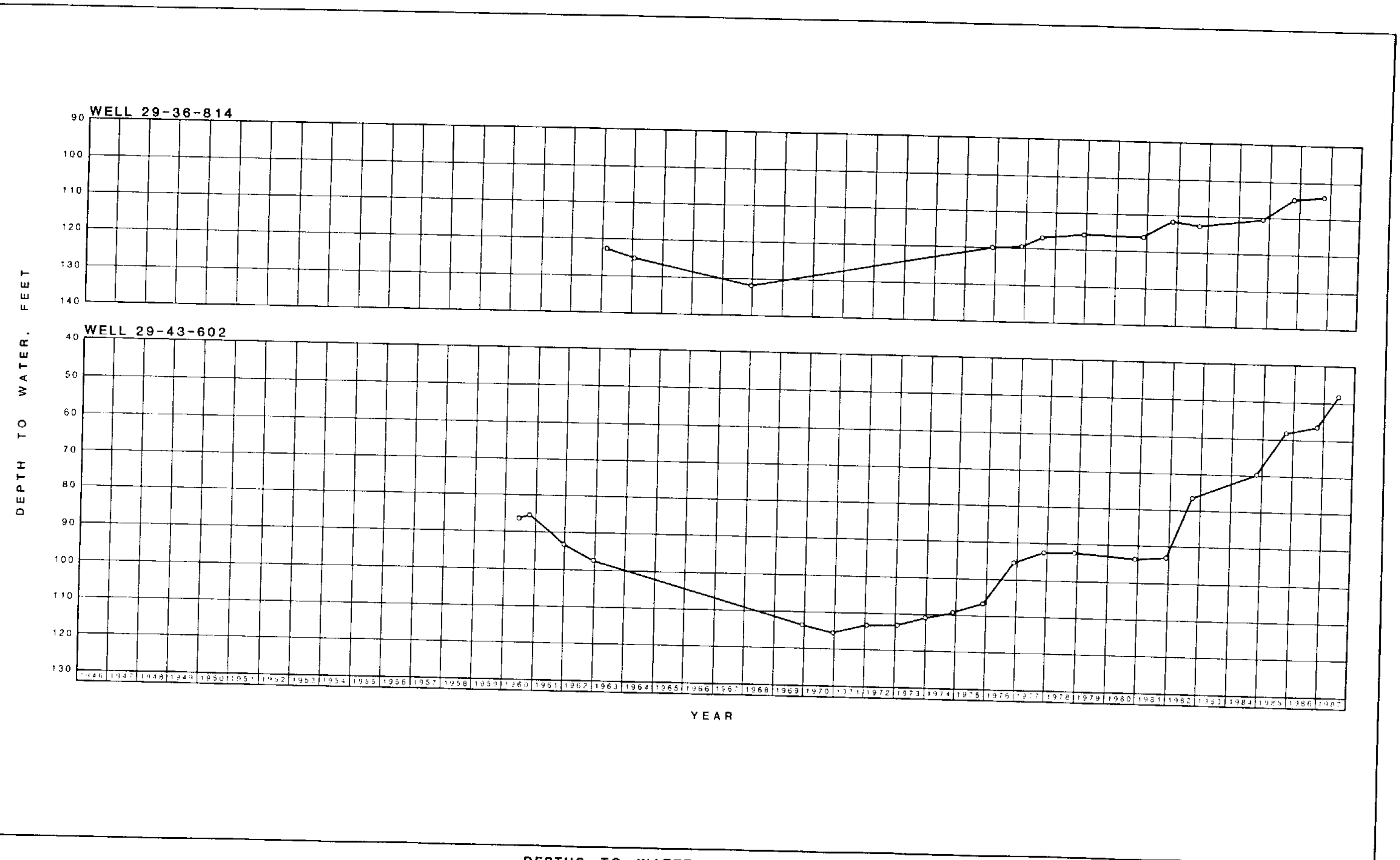
DEPTH TO AND ELEVATION OF THE WATER TABLE IN THE SANTA ROSA FORMATION

Figure 5



DEPTHS TO WATER IN SELECTED WELLS AND PRECIPITATION AT ROSCOE

Figure 6



DEPTHS TO WATER IN SELECTED WELLS

Figure 7

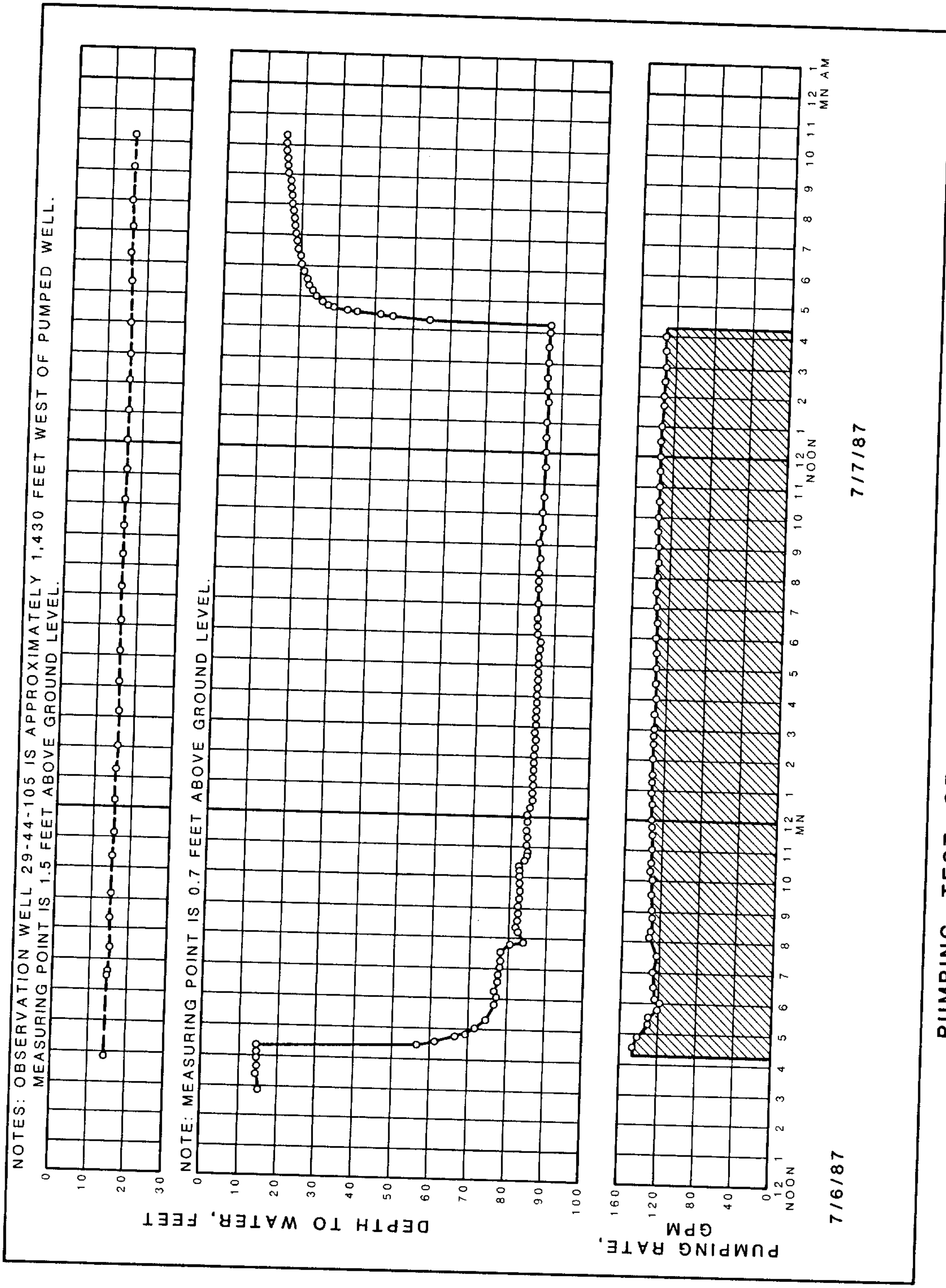
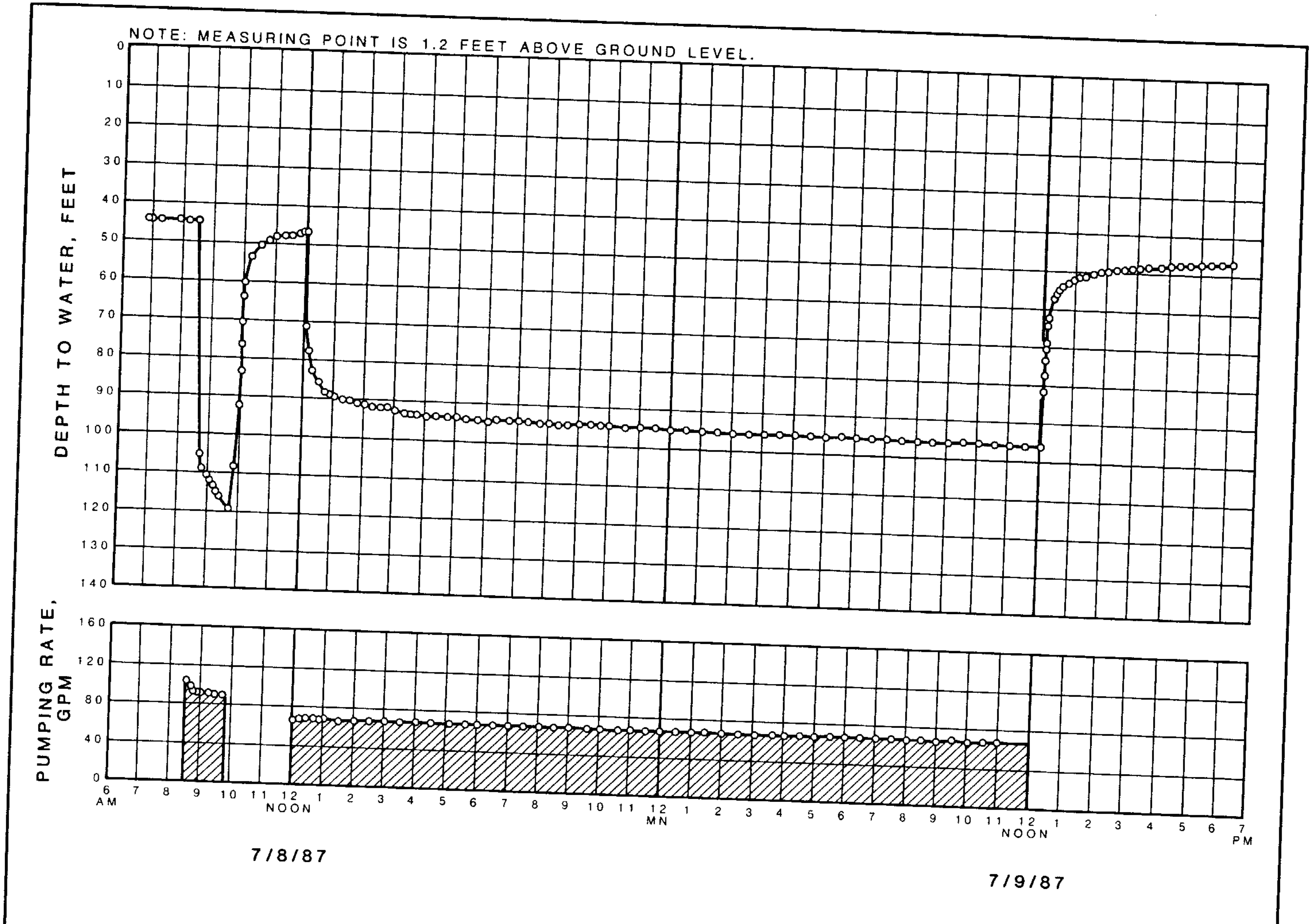
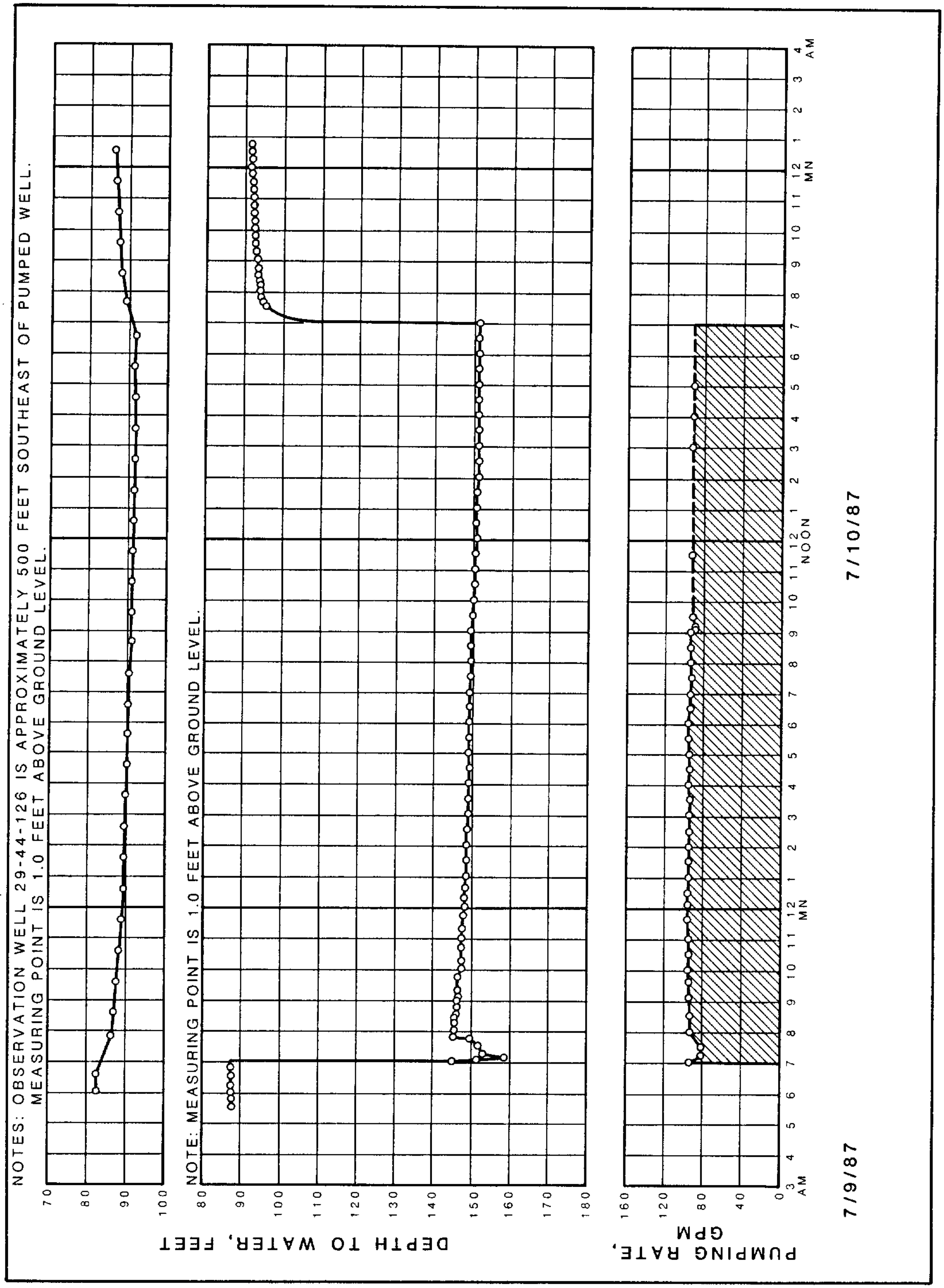

NOTES: OBSERVATION WELL 29-44-105 IS APPROXIMATELY 1,430 FEET WEST OF PUMPED WELL.
MEASURING POINT IS 1.5 FEET ABOVE GROUND LEVEL.
NOTE: MEASURING POINT IS 0.7 FEET ABOVE GROUND LEVEL.
DEPTH TO WATER, FEET
PUMPING RATE, GPM
12 NOON
MN
12 NOON
12 MN
1 AM
7/6/87
7/7/87
PUMPING TEST OF WELL 29-44-111 (GABLER WELL)

Figure 8



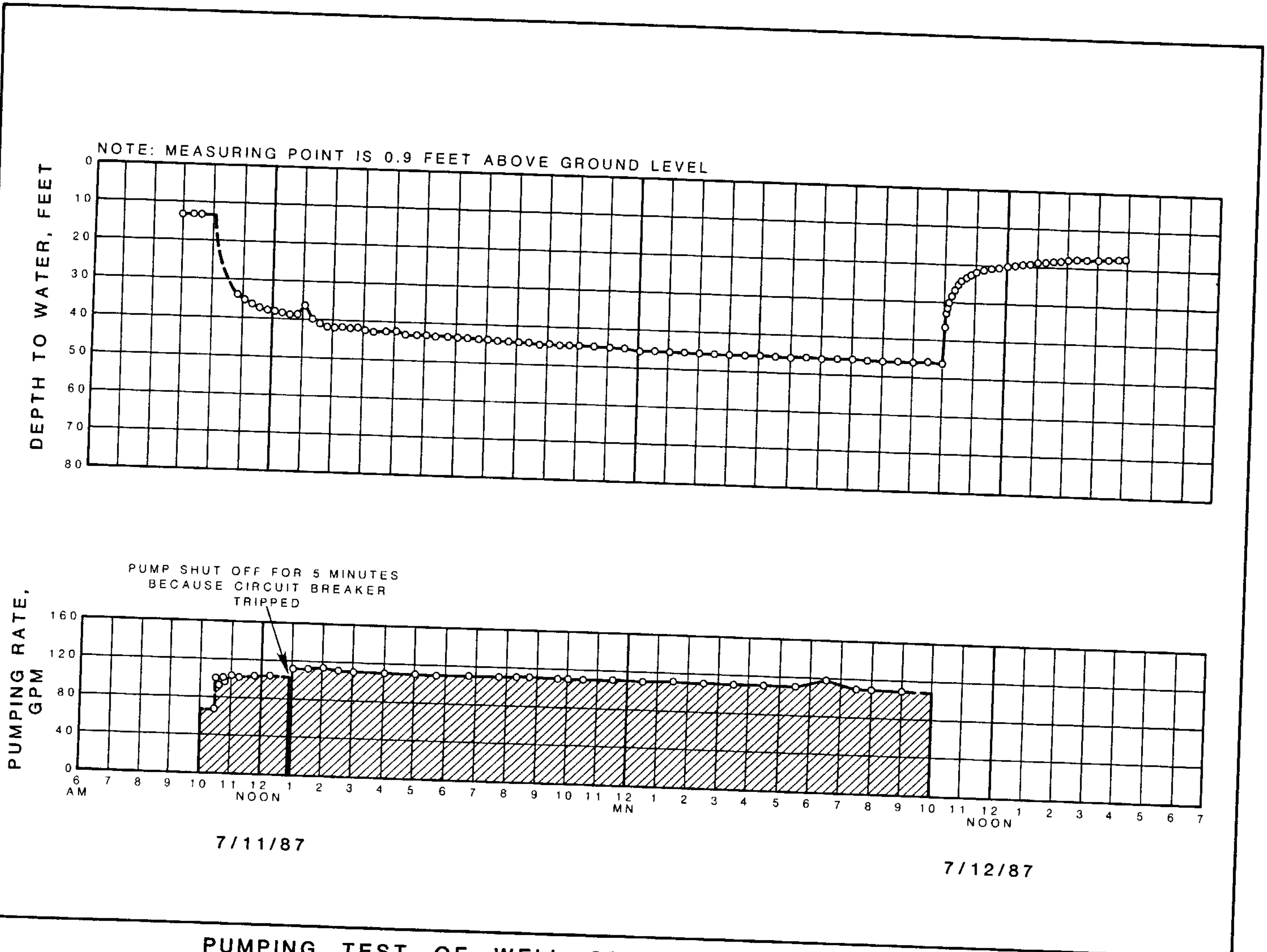
PUMPING TEST OF WELL 29-44-4X8 (MASSEY WELL)

Figure 9



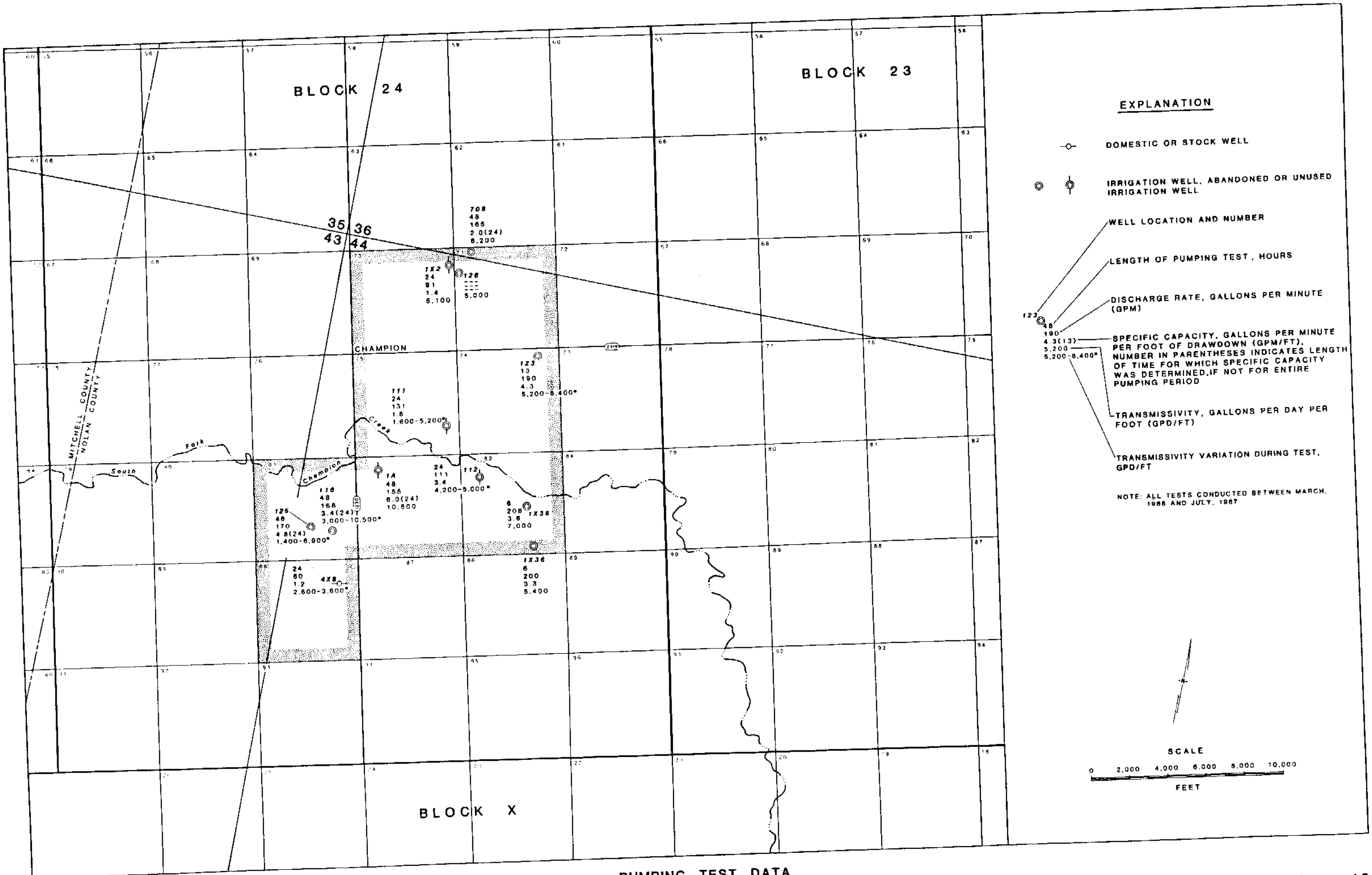
PUMPING TEST OF WELL 29-44-1X2 (COLLIER WELL)
NOTES: OBSERVATION WELL 29-44-126 IS APPROXIMATELY 500 FEET SOUTHEAST OF PUMPED WELL.
MEASURING POINT IS 1.0 FEET ABOVE GROUND LEVEL.
NOTE: MEASURING POINT IS 1.0 FEET ABOVE GROUND LEVEL.
DEPTH TO WATER, FEET
PUMPING RATE, GPM
7/9/87
7/10/87
AM
MN
NOON

Figure 10



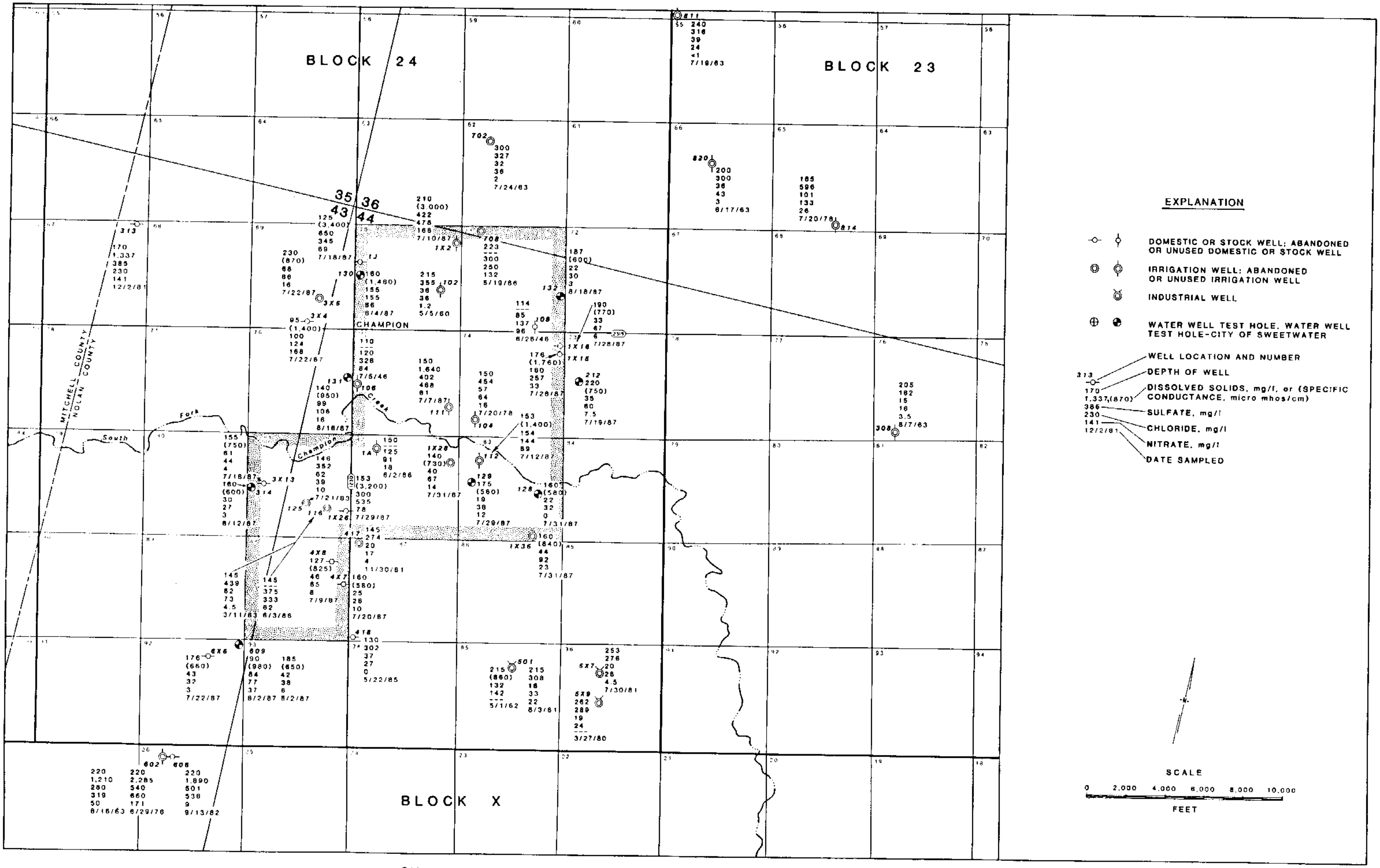
PUMPING TEST OF WELL 29-44-112 (SANFORD WELL)

Figure 11



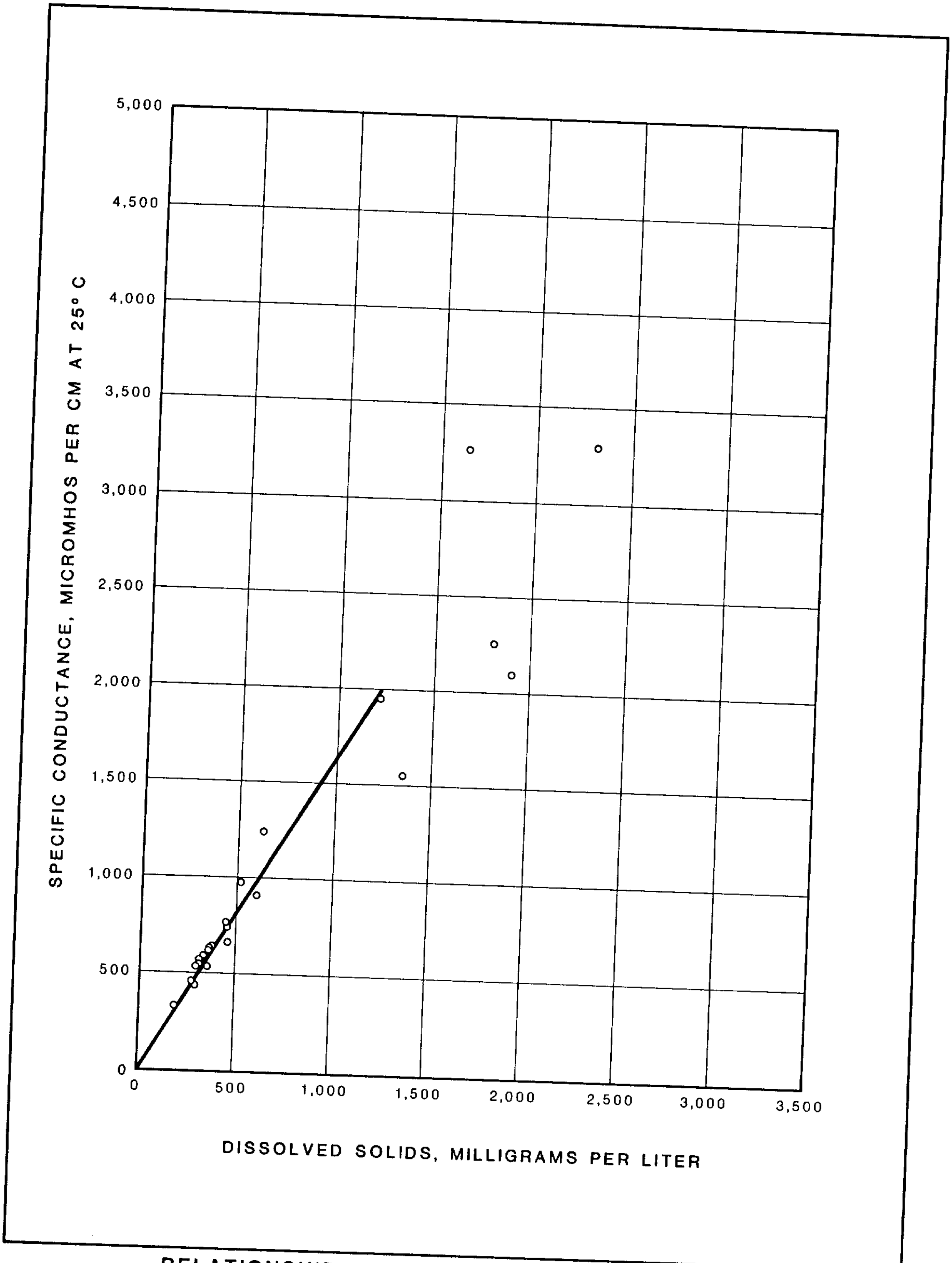
PUMPING TEST DATA

Figure 12



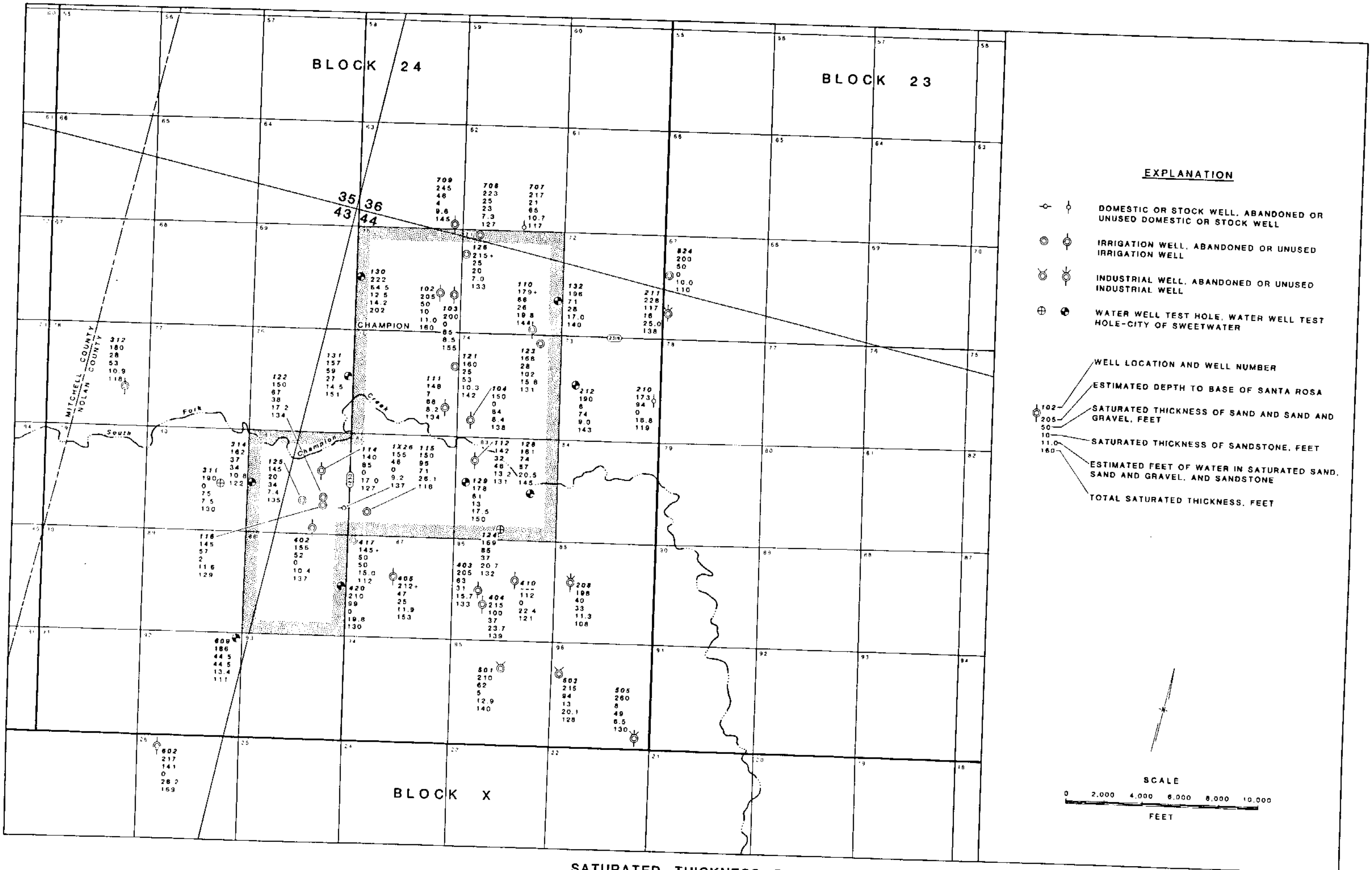
CHEMICAL QUALITY OF GROUND WATER IN THE SANTA ROSA FORMATION

Figure 13



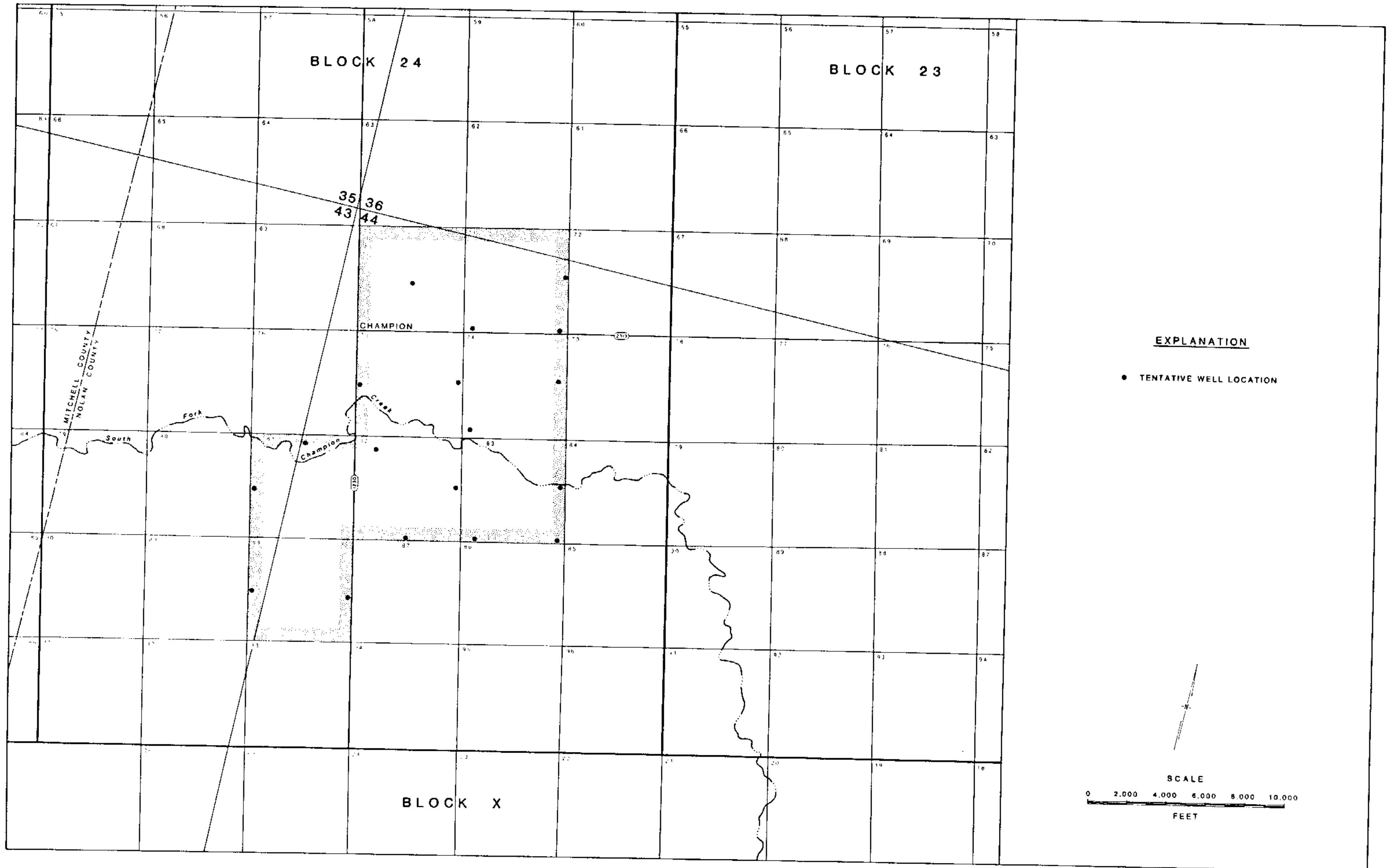
RELATIONSHIP BETWEEN DISSOLVED SOLIDS AND SPECIFIC CONDUCTANCE

Figure 14



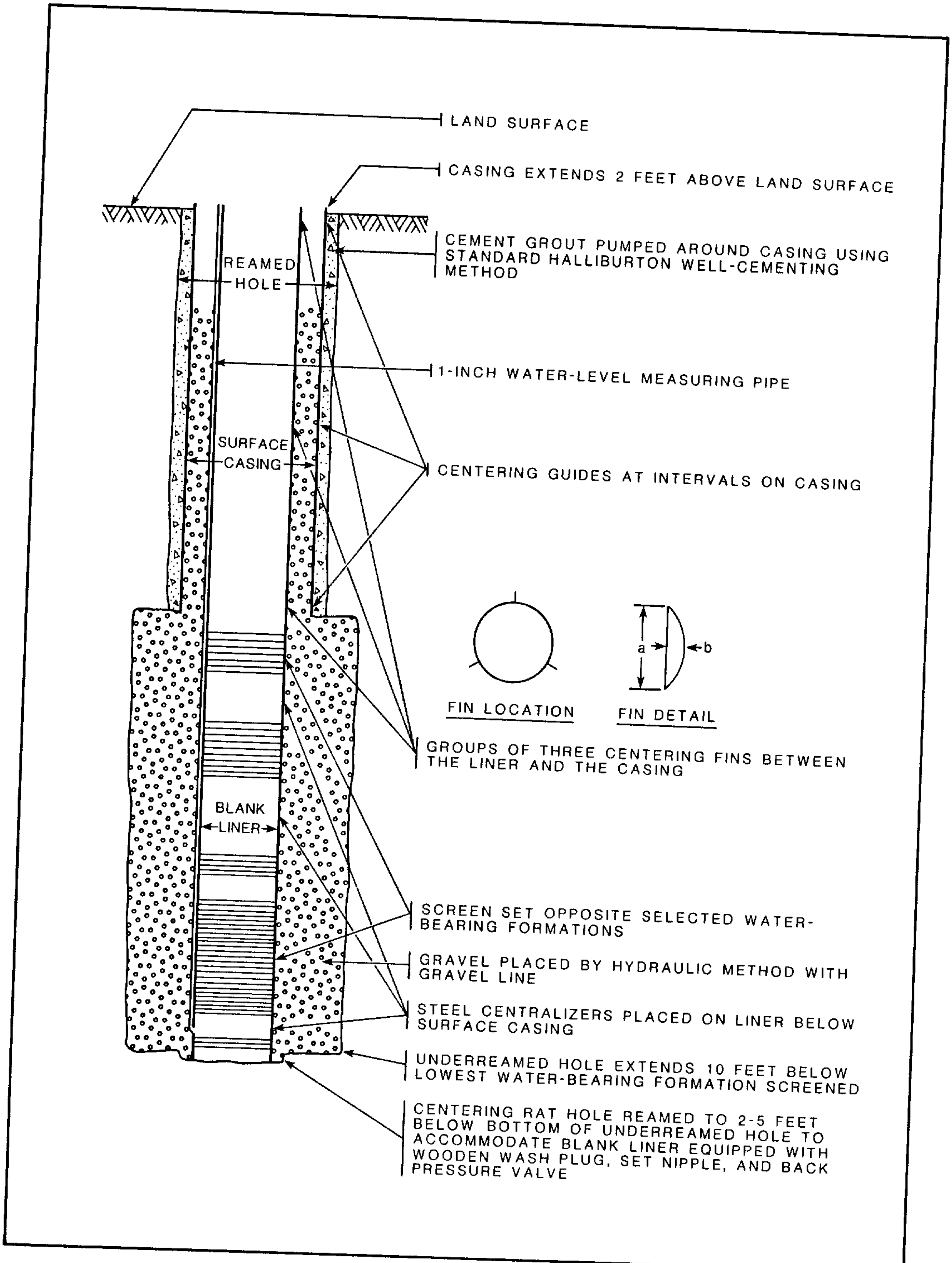
SATURATED THICKNESS DATA

Figure 15



TENTATIVE LOCATIONS FOR WELLS IN A WELL FIELD

Figure 16



TYPICAL GRAVEL WALL WELL

Figure 17

APPENDIX 1

SAMPLE LOGS OF TEST HOLES

CITY OF SWEETWATER

TEST HOLE TH-1

Well Number: UA-29-44-212
Location: SW 1/4 of NE 1/4 of Sec. 73, Blk. 24, T&PRRR Survey
Ground Level Elevation: 2368 ft. from topographic map
Drilling Method: Mud Rotary
Date Drilled: 7-16-87

Interval	Description of Materials	Thickness
0-27	Clay, red	27
27-36	Sandstone, red	9
36-52	Clay, with minor limestone and sandstone	16
52-62	Sandstone, red and gray, with mica and clay	10
62-103	Sandstone, gray, with some clay layers	41
103-108	Clay	5
108-119	Sandstone, gray	11
119-126	Clay, blue-gray	7
126-134	Sand	8
134-143	Clay, blue-gray	9
143-155	Sandstone, yellow-tan, with clay layers	12
155-173	Conglomerate, yellow-tan	18
173-180	Clay, red	7
180-190	Conglomerate and sandstone	10
190-220	Clay and siltstone, red	30

Depth to base of Santa Rosa Formation: 190 ft.
Static water level: About 46 ft. below ground level (BGL).
Major water-bearing zones: Unable to determine accurately with mud rotary drilling method.
Estimated open-hole water production: Unable to determine.

CITY OF SWEETWATER

TEST HOLE TH-2

Well Number: UA-29-44-420
Location: SE 1/4 of NE 1/4 of Sec. 88, Blk. 24, T&PRRR Survey
Ground Level Elevation: 2370 ft. from topographic map
Drilling Method: Air rotary / mud rotary
Date Drilled: 7-21-87

Interval	Description of Materials	Thickness
0-14	Soil, sandstone and caliche	14
14-79	Clay, red, with some blue clay	65
79-107	Sand, red and tan, fine- to medium-grained, with minor sandstone and granule to pebble gravel	28
107-126	Clay, brown	19
126-197	Sand, yellow-tan, fine- to medium-grained, with mica, some coarse-grained sand, and granule to pebble gravel	71
197-210	Conglomerate, gray, very hard	13
210-264	Sandstone, limestone and siltstone, red and yellow	54

Depth to base of Santa Rosa Formation: 210 ft.
Static water level: Not measured.
Major water-bearing zones: 154 to 196 ft.
Estimated open-hole water production: About 100 gallons per minute (GPM).

CITY OF SWEETWATER

TEST HOLE TH-3

Well Number: UA-29-44-129
Location: SW 1/4 of NW 1/4 of Sec. 83, Blk. 24, T&PRRR Survey
Ground Level Elevation: 2332 ft. from topographic map
Drilling Method: Air rotary
Date Drilled: 7-29-87

Interval	Description of Materials	Thickness
0-12	Soil, sandstone and caliche	12
12-54	Clay, red and blue	42
54-82	Sand and sandstone, red-brown and yellow-tan, fine- to coarse-grained	26
82-94	Clay, brown	10
94-123	Sand, tan, very fine- to fine-grained, with mica	29
123-125	Clay	2
125-164	Sand, tan, medium-grained, with some fine- and coarse-grained sand, and granule to pebble gravel	39
164-178	Conglomerate	14
178-190	Clay and siltstone, red, with yellow sandstone	12

Depth to base of Santa Rosa Formation: 178 ft.
Static water level: About 27 ft. BGL.
Major water-bearing zones: 120-170 ft.
Estimated open-hole water production: 200-300 GPM.

CITY OF SWEETWATER

TEST HOLE TH-4

Well Number: UA-29-44-128
Location: NW 1/4 of SE 1/4 of Sec. 83, Blk. 24, T&PRRR Survey
Ground Level Elevation: 2340 ft. from topographic map
Drilling Method: Air rotary
Date Drilled: 7-30-87

Interval	Description of Materials	Thickness
0-48	Sandstone, brown and tan, with minor clay layers	48
48-65	Sand, red	17
65-82	Sand, yellow-tan, fine- to coarse-grained, with granule to pebble gravel	17
82-92	Clay, gray	10
92-102	Sandstone, yellow-gray	10
102-125	Sand, yellow-gray, fine- to coarse-grained, with granule to pebble gravel	23
125-140	Sandstone and conglomerate, yellow-gray	15
140-157	Sand, and granule to pebble gravel, gray-tan	17
157-161	Conglomerate	4
161-200	Siltstone and clay, red, with some sandstone and limestone	39

Depth to base of Santa Rosa Formation: 161 ft.
Static water level: About 16 ft. BGL
Major water-bearing zones: 60-80 ft., 92-157 ft.
Estimated open-hole water production: 300-400 GPM

CITY OF SWEETWATER

TEST HOLE TH-5

Well Number: UA-29-43-609
Location: NE 1/4 of NE 1/4 of Sec. 92, Blk. 24, T&PRRR Survey
Ground Level Elevation: 2348 ft. from topographic map
Drilling Method: Air rotary
Date Drilled: 8-2-87

Interval	Description of Materials	Thickness
0-13	Soil, clay, caliche and sandstone	13
13-53	Clay, red	40
53-62	Sand and sandstone, gray	9
62-64	Clay, gray	2
64-93	Sandstone and sand, gray, medium- to coarse-grained, with granule to pebble gravel	29
93-113	Clay, gray	20
113-158	Sand and sandstone, gray, fine- to medium grained, with mica, and minor coarse-grained sand and granule gravel	45
158-160	Coal and clay, gray	2
160-186	Conglomerate and sandstone, gray, with sand and pebble gravel	26
186-210	Siltstone, red, with brown sand and sandstone	24

Depth to base of Santa Rosa Formation: 186 ft.
Static water level: About 75 ft. BGL
Major water-bearing zones: 75-90 ft., 131-185 ft.
Estimated open-hole water production: About 100 GPM

CITY OF SWEETWATER

TEST HOLE TH-6

Well Number: UA-29-44-130
Location: SW 1/4 of NW 1/4 of Sec. 70, Blk. 24, T&PRRR Survey
Ground Level Elevation: 2348 ft. from topographic map
Drilling Method: Air rotary / mud rotary
Date Drilled: 8-4-87

Interval	Description of Materials	Thickness
0-5	Soil	5
5-14	Caliche, limestone, and sandstone	9
14-32	Clay, red and blue	18
32-41	Sandstone and sand, yellow-gray	9
41-59	Clay, red	18
59-75	Sand and sandstone, red-brown, fine- to medium-grained	16
75-101	Clay, blue-gray and red-brown	26
101-109	Sand, brown, fine- to medium-grained	8
109-113	Clay	4
113-136	Sand, brown, medium- to coarse-grained, with mica, and granule to pebble gravel	23
136-157	Sand, yellow-gray, fine- to medium-grained, with mica	21
157-189	Sand and clay, brown	32
189-222	Conglomerate, red-gray	33
222-240	Clay and siltstone, red, with yellow limestone	18

Depth to base of Santa Rosa Formation: 222 ft.
Static water level: Not measured.
Major water-bearing zones: 60-75 ft., 110-160 ft.
Estimated open-hole water production: About 125 GPM above 190 ft.

CITY OF SWEETWATER

TEST HOLE TH-7

Well Number: UA-29-43-314
Location: NW 1/4 of SW 1/4 of Sec. 81, Blk. 24, T&PRRR Survey
Ground Level Elevation: 2297 ft. from topographic map
Drilling Method: Air rotary
Date Drilled: 8-12-87

Interval	Description of Materials	Thickness
0-4	Soil	4
4-26	Clay, red, minor white clay	22
26-51	Sand and sandstone, yellow, fine- to medium-grained, with mica	25
51-54	Clay, gray	3
54-59	Sandstone, gray, with granule to pebble gravel	5
59-60	Coal and clay, gray, with pyrite	1
60-80	Clay, gray and red, with minor pyrite	20
80-127	Sandstone and sand, gray, fine- to medium-grained, with mica, granule to pebble gravel, and minor clay	47
127-130	Clay	3
130-145	Conglomerate and sandstone	15
145-148	Sand, yellow	3
148-153	Conglomerate and sandstone	5
153-158	Sand, yellow	5
158-162	Conglomerate	4
162-180	Siltstone, sandstone and clay, red	18

Depth to base of Santa Rosa Formation: 162 ft.
Static water level: About 40 ft. BGL
Major water-bearing zones: 125-162 ft.
Estimated open-hole water production: 50-70 GPM

CITY OF SWEETWATER

TEST HOLE TH-8

Well Number: UA-29-44-131
Location: SE 1/4 of NE 1/4 of Sec. 76, Blk. 24, T&PRRR Survey
Ground Level Elevation: 2290 ft. from topographic map
Drilling Method: Air rotary
Date Drilled: 8-16-87

Interval	Description of Materials	Thickness
0-5	Soil	5
5-16	Pebble and cobble gravel (Alluvium)	11
16-64	Clay, gray and yellow, with minor sand lenses	48
64-74	Sandstone, gray, fine- to medium-grained, with some conglomerate	10
74-101	Sand, yellow-tan, fine- to medium-grained	27
101-123	Sandstone and sand, yellow-tan, fine- to medium-grained, with some granule to pebble gravel	22
123-136	Sand, yellow-tan, medium- to coarse-grained, and granule to pebble gravel	13
136-142	Sandstone and conglomerate, yellow-tan	6
142-150	Sand and granule to pebble gravel, yellow-gray	8
150-157	Conglomerate and sandstone, yellow-gray	7
157-180	Clay and siltstone, red	23

Depth to base of Santa Rosa Formation: 157 ft.
Static water level: About 6 ft. BGL
Major water-bearing zones: 6-16 ft., 76-150 ft.
Estimated open-hole water production: About 400 GPM

CITY OF SWEETWATER

TEST HOLE TH-9

Well Number: UA-29-44-132
Location: NE 1/4 of SE 1/4 of Sec. 71, Blk. 24, T&PRRR Survey
Ground Level Elevation: 2357 ft. from topographic map
Drilling Method: Air rotary
Date Drilled: 8-18-87

Interval	Description of Materials	Thickness
0-73	Clay, red-brown	73
73-97	Clay, red-brown, with minor sand lenses	24
97-130	Sand, yellow-brown, fine- to medium-grained, with minor clay layers	33
130-138	Pebble gravel, yellow-brown, with sand	8
138-168	Sand, yellow-brown, medium- to coarse-grained, with some conglomerate	30
168-196	Conglomerate and sandstone, yellow-gray, red-brown	28
196-210	Clay and siltstone, red	14

Depth to base of Santa Rosa Formation: 196 ft.
Static water level: About 56 ft. BGL
Major water-bearing zones: 97-180 ft.
Estimated open-hole water production: About 400 GPM

APPENDIX 2

ELECTRIC AND RADIOACTIVITY LOGS OF TEST HOLES

AUSTIN, TEXAS

PROJECT 6060

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS.

TYPES OF LOGS THIS DATE: [illegible] ; [illegible] ; [illegible] ; [illegible] ; ; ;

OPERATOR (S): [illegible] LOCATION: [illegible] OF I.H. 20 ON FM 608 AND 4.1 M. WEST ON FM [illegible] SOUTH ON CO. RD. [illegible] EAST OF CO. RD.

COUNTY: NOLAN NEAREST TOWN: ROSCOE DRILLER: [illegible]

OWNER: CITY OF SWEETWATER ADDRESS:

TYPE OF DRILL: MUD ROTARY BIT SIZE: [illegible] 1/4"

ALTITUDE OF LAND SURFACE: LOGGED DEPTH: [illegible] DRILLED DEPTH: 220'

FLUID LEVEL: [illegible] FLUID TYPE: [illegible] LOG REFERENCE POINT: GROUND LEVEL

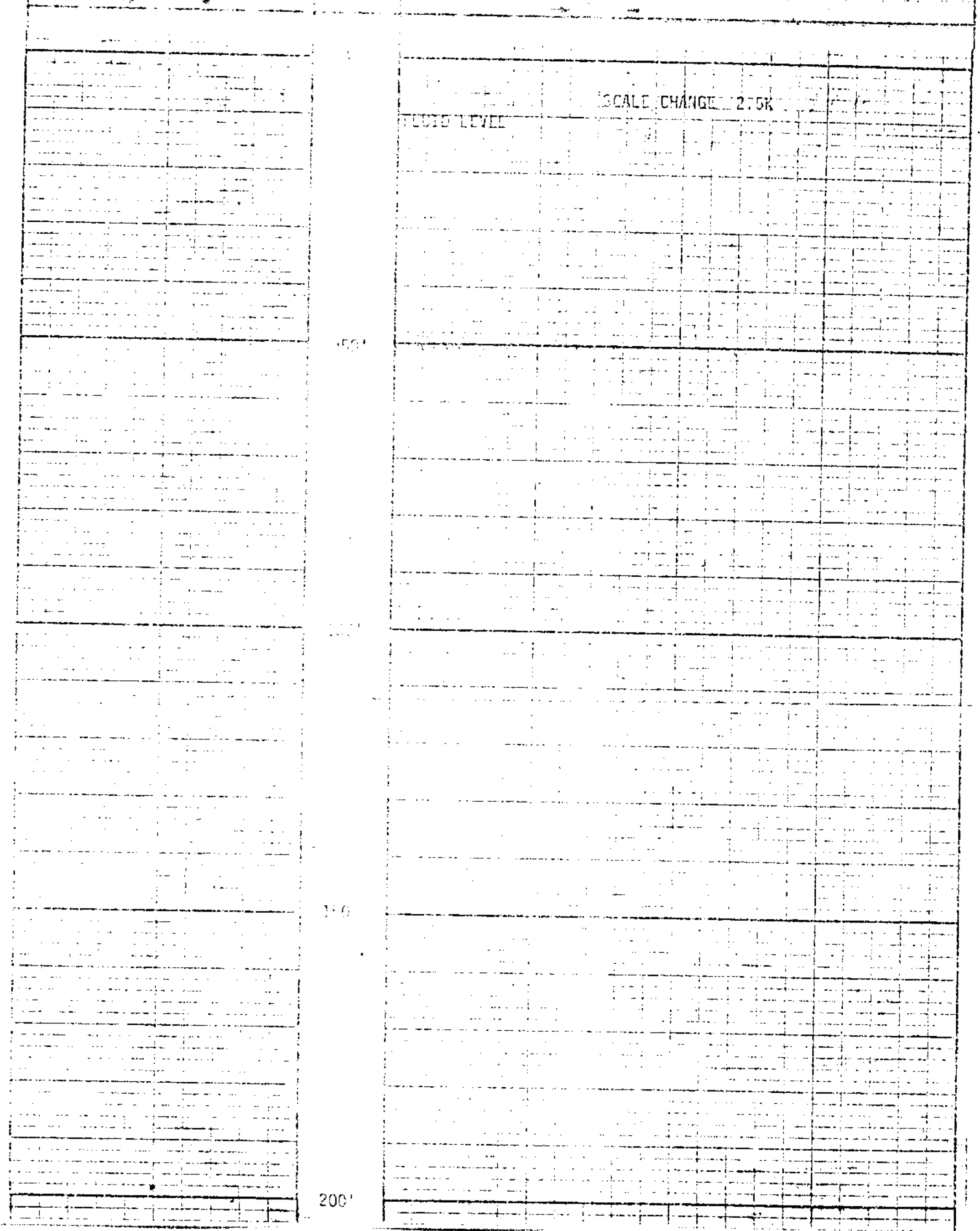
CASING DATA: NONE OPEN HOLE DIA.: 6 1/4"

CEMENTED FROM: NONE TO SCREEN: NONE TO AQUIFER: SANTA ROSA

FLUID RESISTIVITY: OHMS AT °F. REMARKS:

GAMMA RAY	NEUTRON
COUNTS PER SECOND [illegible]50	COUNTS PER SECOND 250
TIME CONSTANT 2	TIME CONSTANT [illegible] SPACING 21"

RADIATION INCREASES → COUNTS PER SECOND	DEPTH 1"=100'	RADIATION INCREASES → COUNTS PER SECOND



TWDB C-?

TEXAS WATER DEVELOPMENT BOARD
WATER AVAILABILITY DATA AND STUDIES SECTION
AUSTIN, TEXAS

STATE WELL NUMBER 67-52
FILE NUMBER
PROJECT 6050

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS.

TYPES OF LOGS THIS DATE: 7/21/[illegible] ; [illegible] ; GR ; [illegible] ; ; ; ;

OPERATOR (S) GRIM . LOCATION: [illegible] SEC. [illegible] BLK. 24

COUNTY: NOLAN NEAREST TOWN: [illegible] DRILLER: [illegible]

OWNER: CITY OF SWEETWATER ADDRESS:

TYPE OF DRILL: MUD ROTARY BIT SIZE: 6 1/4"

ALTITUDE OF LAND SURFACE: LOGGED DEPTH: 250' DRILLED DEPTH: 252'

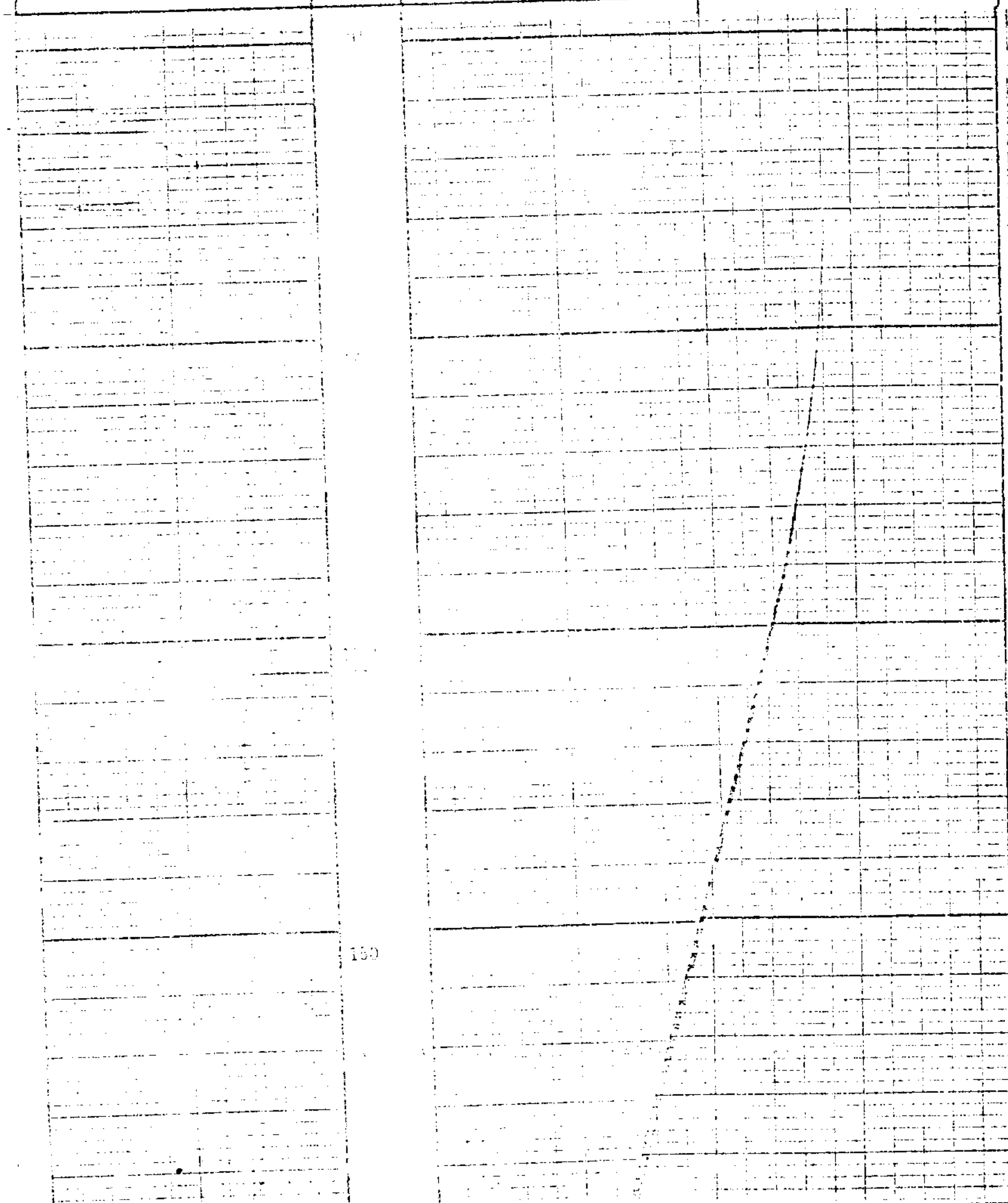
FLUID LEVEL: SURF. FLUID TYPE: QUIK GEL LOG REFERENCE POINT: GROUND LEVEL

CASING DATA: NONE OPEN HOLE DIA.: [illegible]

CEMENTED FROM: NONE TO SCREEN NONE TO AQUIFER: SANTA ROSA

FLUID RESISTIVITY: OHMS AT °F. REMARKS:

SELF POTENTIAL MILLIVOLTS	DEPTH 1"=100'	---RESISTIVITY----- OHMS M^2/M	
← →		16" NORMAL / 64" NORMAL	SINGLE POINT



TEXAS WATER DEVELOPMENT BOARD
WATER AVAILABILITY DATA AND STUDIES SECTION
AUSTIN, TEXAS

STATE WELL NUMBER
FILE NUMBER [illegible]
PROJECT 5060

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS.

TYPES OF LOGS: [illegible] DATE: [illegible]

OPERATOR(S): [illegible] LOCATION: [illegible]

COUNTY: [illegible] NEAREST TOWN: [illegible] DRILLER: [illegible]

OWNER: [illegible] ADDRESS:

TYPE OF DRILL: ROTARY BIT SIZE: [illegible]

ALTITUDE OF LAND SURFACE LOGGED DEPTH: [illegible] DRILLED DEPTH: 252'

FLUID LEVEL [illegible] FLUID TYPE: [illegible] LOG REFERENCE POINT: GROUND LEVEL

CASING DATA: [illegible] OPEN HOLE: [illegible]

CEMENTED FROM: [illegible] TO SCREEN: [illegible] TO AQUIFER: SANTA ROSA

FLUID RESISTIVITY: OHMS AT °F. REMARKS:

GAMMA RAY	NEUTRON
COUNTS PER SECOND [illegible]	COUNTS PER SECOND 500
TIME CONSTANT [illegible]	TIME CONSTANT [illegible] SPACING [illegible]

RADIATION INCREASES → COUNTS PER SECOND	DEPTH	RADIATION INCREASES → COUNTS PER SECOND

TEXAS WATER DEVELOPMENT BOARD
WATER AVAILABILITY DATA AND STUDIES SECTION
AUSTIN, TEXAS

FILE NUMBER
PROJECT

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS.

TYPES OF LOGS THIS DATE:

OPERATOR (S)

approx. 50yds. EAST OF ROAD.

COUNTY: NEAREST TOWN: DRILLER:

OWNER: ADDRESS:

TYPE OF DRILL: BIT SIZE:

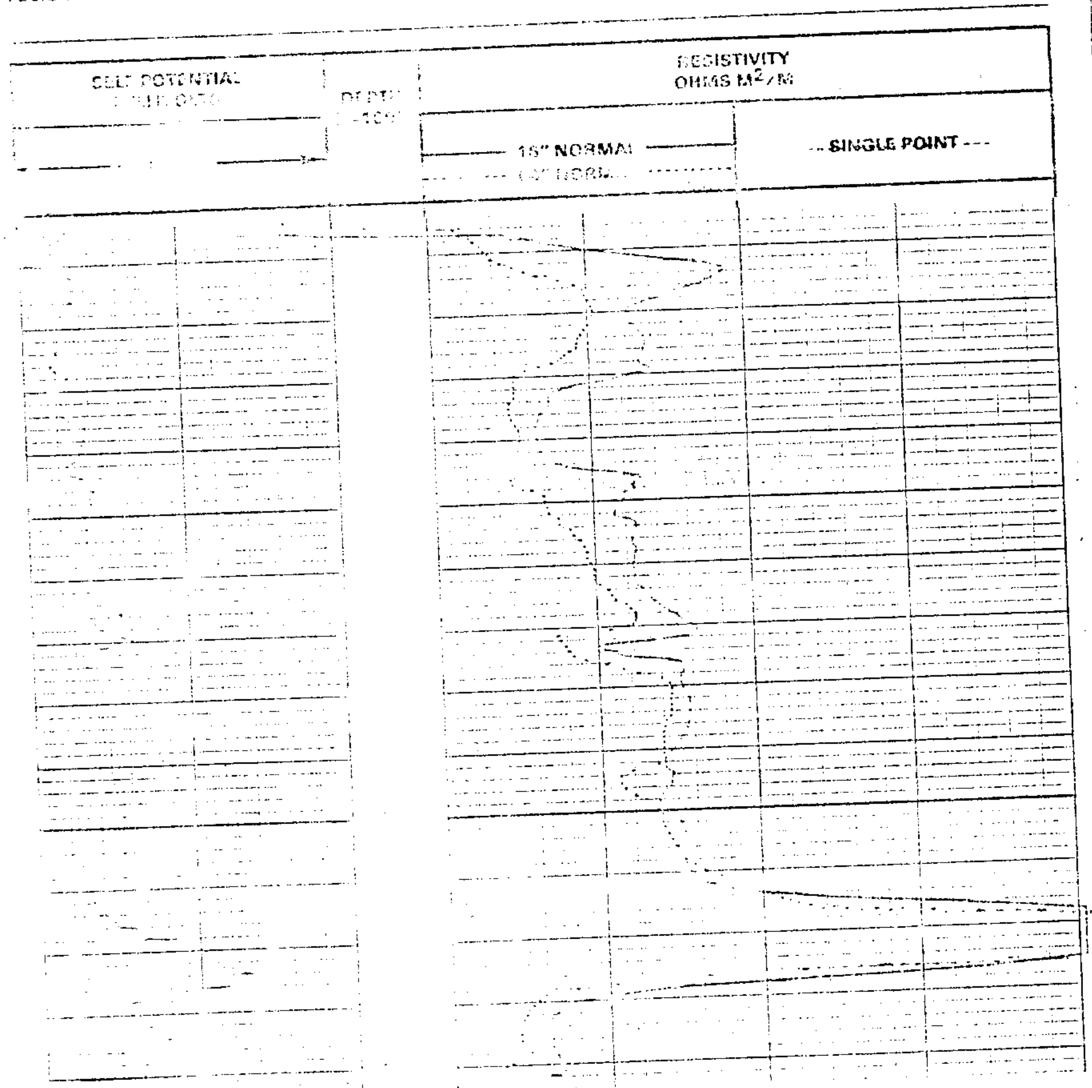
ALTITUDE OF LAND SURFACE: LOGGED DEPTH: 100' DRILLED DEPTH: 100'

FLUID LEVEL: FLUID TYPE: LOG REFERENCE POINT: GROUND LEVEL

CASING DATA: OPEN HOLE DIA.:

CEMENTED FROM TO SCREENED TO AQUIFER:

FLUID RESISTIVITY: OHMS AT °F. REMARKS:



TEXAS WATER DEVELOPMENT BOARD
WATER AVAILABILITY DATA AND STUDIES SECTION
AUSTIN, TEXAS

STATE WELL NUMBER ______
FILE NUMBER # 87-36
PROJECT 6060

GAMMA/NEUTRON

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS.

TYPES OF LOGS THIS DATE: [illegible]

OPERATOR (S): [illegible] LOCATION: [illegible] 20 ON FM 608 & 5MI WEST ON

FM 2319. [illegible] BOYDS, EAST OF ROAD

COUNTY: [illegible] NEAREST TOWN: [illegible] DRILLER: [illegible] BUELIN

OWNER: [illegible] ADDRESS: ______

TYPE OF DRILL: [illegible] ROTARY BIT SIZE: [illegible]

ALTITUDE OF LAND SURFACE: ______ LOGGED DEPTH: [illegible] DRILLED DEPTH: 120

FLUID LEVEL: [illegible] FLUID TYPE: [illegible] WATER LOG REFERENCE POINT: GROUND LEVEL

CASING DATA: [illegible] OPEN HOLE DIA: [illegible]

CEMENTED FROM: [illegible] TO ______ SCREEN: OPEN HOLE TO ______ AQUIFER: SANTA ROSA

FLUID RESISTIVITY: ______ OHMS AT ______ °F. REMARKS: ______

GAMMA RAY
COUNTS PER SECOND [illegible]
TIME CONSTANT [illegible]

NEUTRON
COUNTS PER SECOND 500
TIME CONSTANT ______ SPACING [illegible] "

RADIATION INCREASES
COUNTS PER SECOND

DEPTH
FEET

RADIATION INCREASES →
COUNTS PER SECOND

[illegible] WATER DEVELOPMENT BOARD
[illegible] DATA AND STUDIES SECTION
AUSTIN, [illegible]

STATE WELL NUMBER ______
FILE NUMBER [illegible]
PROJECT [illegible]

[illegible] THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS. ELECTRIC LOG

TYPES OF LOGS THIS DATE: [illegible] ; [illegible] ; ; ; ; .

OPERATOR (S) [illegible] LOCATION: [illegible] ... SE 1/4 SEC. 83, BLK 24

COUNTY: [illegible] NEAREST TOWN: [illegible] DRILLER: TWOR, BURKIN

OWNER: [illegible] ADDRESS:

[illegible] DRILLED: [illegible] BIT SIZE: [illegible]

ALTITUDE OF LAND SURFACE: [illegible] LOGGED DEPTH: 199.6' DRILLED DEPTH: 200'

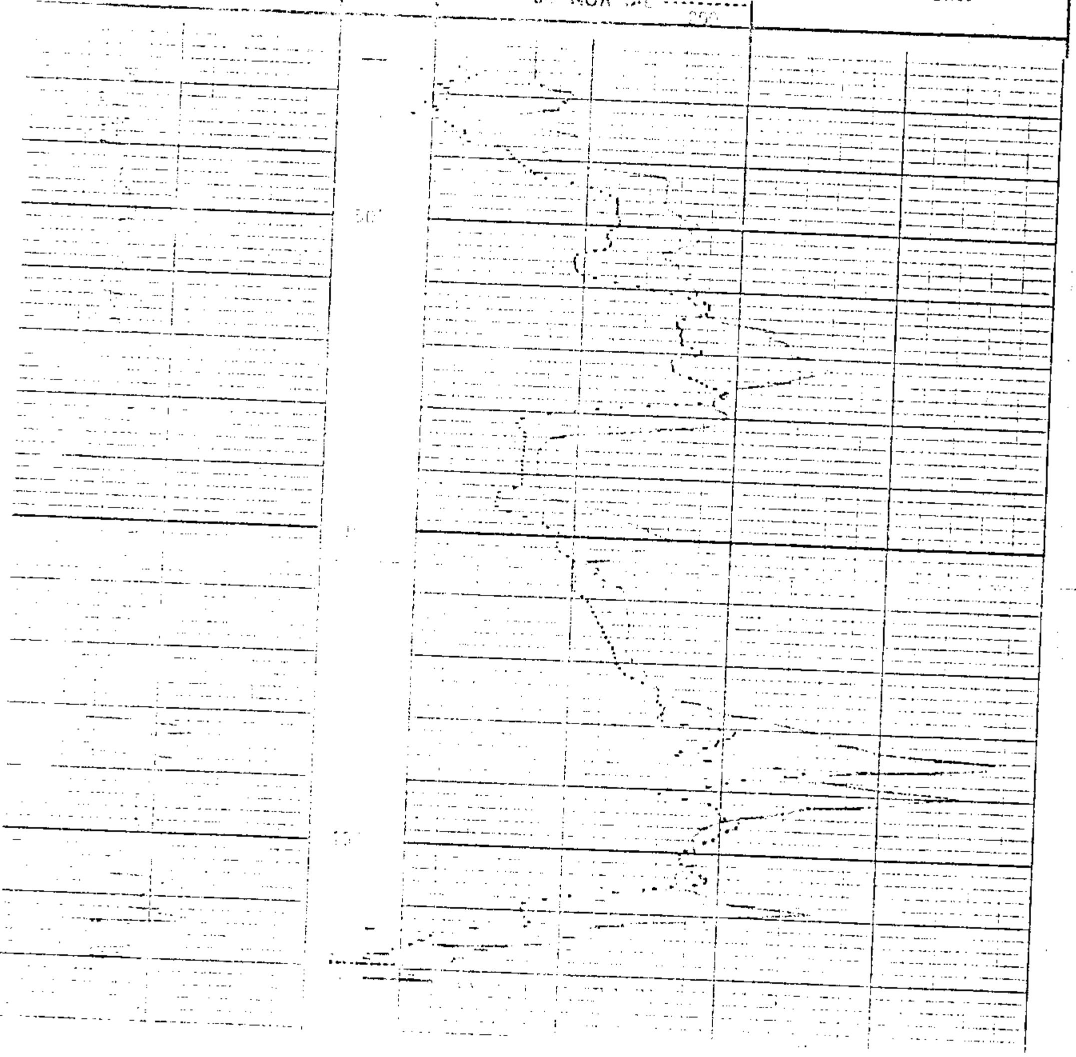
[illegible] FLUID TYPE: [illegible] LOG REFERENCE POINT: GROUND LEVEL

[illegible] DATA: [illegible] OPEN HOLE DIA.: 6 1/4"

CEMENTED FROM: [illegible] TO ______ SCREENED [illegible] TO ______ AQUIFER: SANTA ROSA

[illegible] OHMS AT [illegible] REMARKS:

SELF POTENTIAL MILLIVOLTS	DEPTH 1"=100'	RESISTIVITY OHMS M^2/M	
		16" NORMAL 64" NORMAL	~~SINGLE POINT~~



WATER AVAILABILITY DATA AND STUDIES SECTION
AUSTIN, TEXAS

STATE WELL NUMBER ____________
FILE NUMBER ____ 97-
PROJECT ____________

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTUAL OBLIGATIONS.

TYPES OF LOGS THIS DATE: ______ ; ______ ; ______ ; ______ ; ______ ; ______

OPERATOR (S) ______ LOCATION: ______

COUNTY: ______ NEAREST TOWN: ______ DRILLER: ______

OWNER: ______ ADDRESS: ______

TYPE OF DRILL: ______ BIT SIZE: ______

ALTITUDE OF LAND SURFACE: ______ LOGGED DEPTH: ______ DRILLED DEPTH: ______

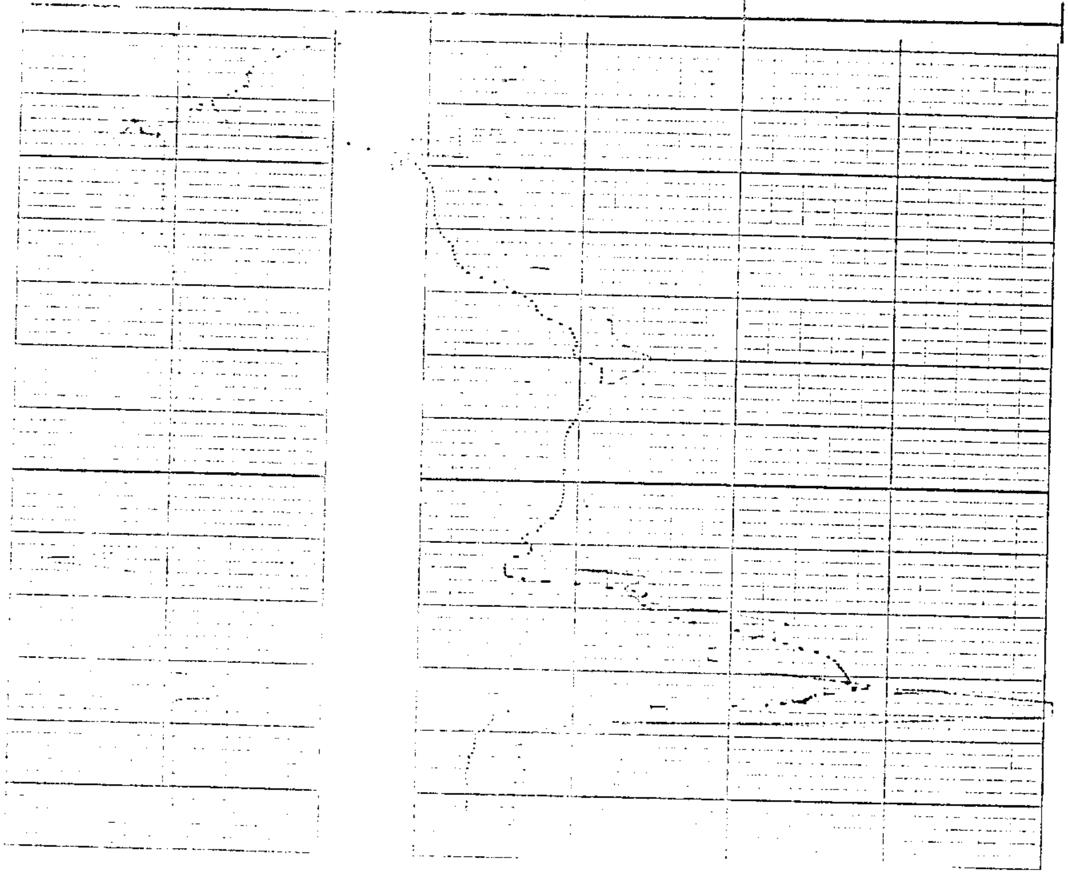
FLUID LEVEL: ______ FLUID TYPE: ______ LOG REFERENCE POINT: ______

CASING DATA: ______ OPEN HOLE DIA.: ______

CEMENTED FROM ______ TO ______ SCREEN: ______ TO ______ AQUIFER: ______

FLUID RESISTIVITY: ______ OHMS AT ______ °F. REMARKS: ______

SELF POTENTIAL MILLIVOLTS	DEPTH FEET	RESISTIVITY OHMS M²/M	
		——— 16" NORMAL ——— --------- 64" NORMAL ---------	- - - SINGLE-POINT-



TEXAS WATER DEVELOPMENT BOARD
WATER AVAILABILITY DATA AND STUDIES SECTION
AUSTIN, TEXAS

STATE WELL NUMBER ____
FILE NUMBER ____
PROJECT ____

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTUAL OBLIGATIONS.

TYPES OF LOGS THIS DATE: ____

OPERATOR (S) ____ LOCATION: ____

COUNTY: ____ NEAREST TOWN: ____ DRILLER: ____

OWNER: ____ ADDRESS: ____

TYPE OF DRILL: ____ BIT SIZE: ____

ALTITUDE OF LAND SURFACE: ____ LOGGED DEPTH: ____ DRILLED DEPTH: ____

FLUID LEVEL: ____ FLUID TYPE: ____ LOG REFERENCE POINT: ____

DRILLING DATE: ____ OPEN HOLE DIA.: ____

CEMENTED FROM: ____ TO ____ SCREEN: ____ TO ____ AQUIFER: ____

FLUID RESISTIVITY: ____ OHMS AT ____ °F. REMARKS: ____

GAMMA RAY
COUNTS PER SECOND ____
TIME CONSTANT ____

NEUTRON
COUNTS PER SECOND ____
TIME CONSTANT ____ SPACING ____ "

RADIATION INCREASES COUNTS PER SECOND →	DEPTH IN FEET	RADIATION INCREASES COUNTS PER SECOND →

TEXAS WATER DEVELOPMENT BOARD
WATER AVAILABILITY DATA AND STUDIES SECTION
AUSTIN, TEXAS

STATE WELL NUMBER ______
FILE NUMBER ______
PROJECT ______

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS.

TYPES OF LOGS THIS DATE: ______

OPERATOR (S) ______ LOCATION: ______

COUNTY: ______ NEAREST TOWN: ______ DRILLER: ______

OWNER: ______ ADDRESS: ______

TYPE OF DRILL: ______ BIT SIZE: ______

ALTITUDE OF LAND SURFACE: ______ LOGGED DEPTH: ______ DRILLED DEPTH: ______

FLUID LEVEL: ______ FLUID TYPE: ______ LOG REFERENCE POINT: ______

CASING DATA: ______ OPEN HOLE DIA.: ______

CEMENTED FROM: ______ TO ______ SCREEN: ______ TO ______ AQUIFER: ______

FLUID RESISTIVITY: ______ OHMS AT ______ ° F. REMARKS: ______

CALIPER
HOLE DIAMETER IN INCHES
FROM ______ " TO ______ "

GAMMA-GAMMA
COUNTS PER SECOND ______
TIME CONSTANT ______ SPACING ______ "

HOLE DIAM. INCREASE →	DEPTH	RADIATION INCREASES COUNTS PER SECOND →

WATER AVAILABILITY DATA AND STUDIES SECTION
AUSTIN, TEXAS

STATE WELL NUMBER
FILE NUMBER
PROJECT

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS.

TYPES OF LOGS THIS DATE

OPERATOR (S) LOCATION:

COUNTY: NEAREST TOWN: DRILLER:

OWNER: ADDRESS:

TYPE OF DRILL: BIT SIZE:

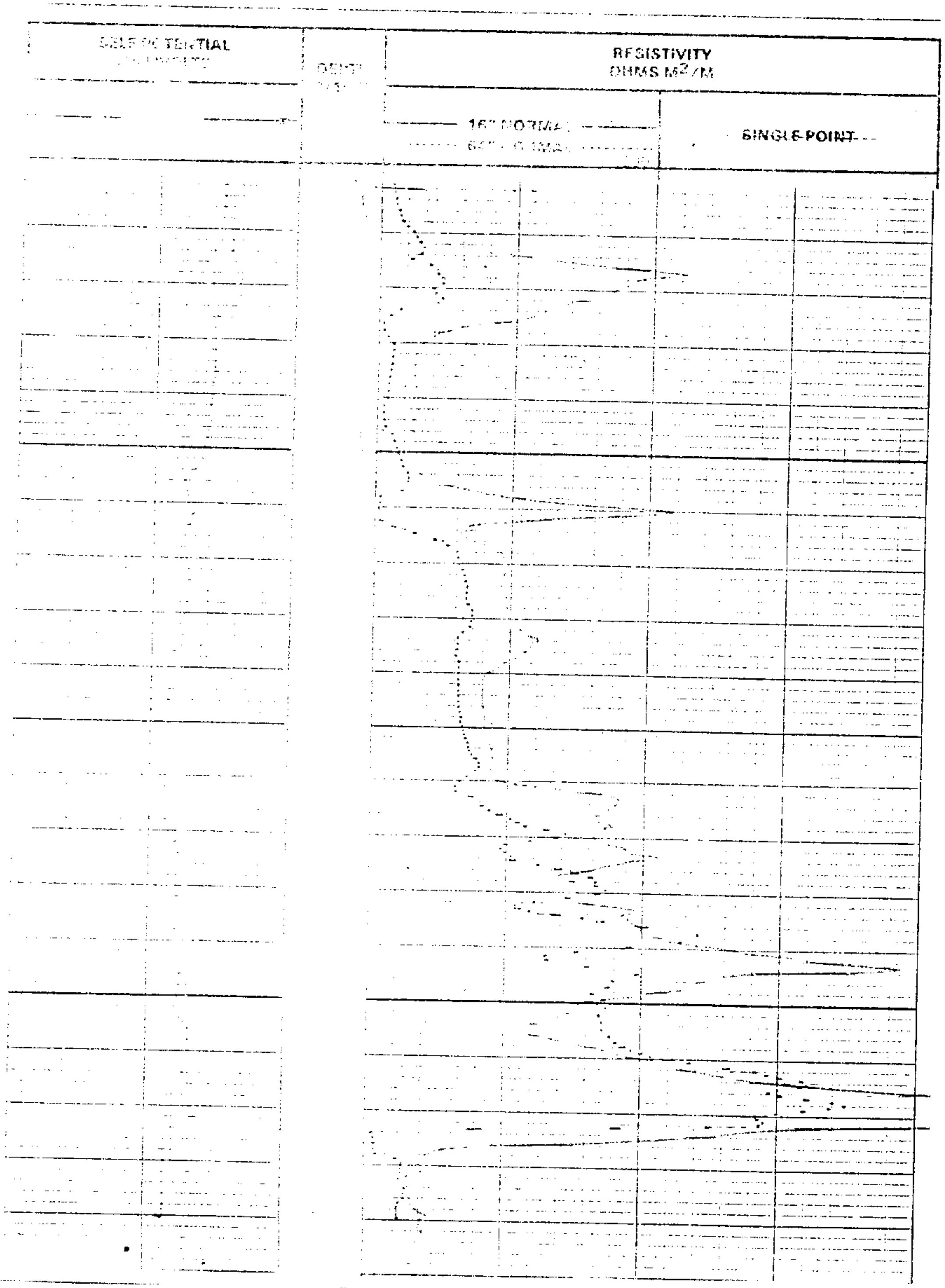
ALTITUDE OF LAND SURFACE: LOGGED DEPTH: DRILLED DEPTH:

FLUID LEVEL: FLUID TYPE: LOG REFERENCE POINT:

CASING DATA: OPEN HOLE DIA.

CEMENTED FROM TO SCREENED TO AQUIFER:

FLUID RESISTIVITY: OHMS AT °F. REMARKS:



TEXAS WATER DEVELOPMENT BOARD
WATER AVAILABILITY DATA AND STUDIES SECTION
AUSTIN, TEXAS

STATE WELL NUMBER ______
FILE NUMBER ______
PROJECT ______

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS.

TYPES OF LOGS THIS DATE: ______

OPERATOR (S) ______ LOCATION: ______

COUNTY: ______ NEAREST TOWN: ______ DRILLER: ______

OWNER: ______ ADDRESS: ______

TYPE OF DRILL: ______ BIT SIZE: ______

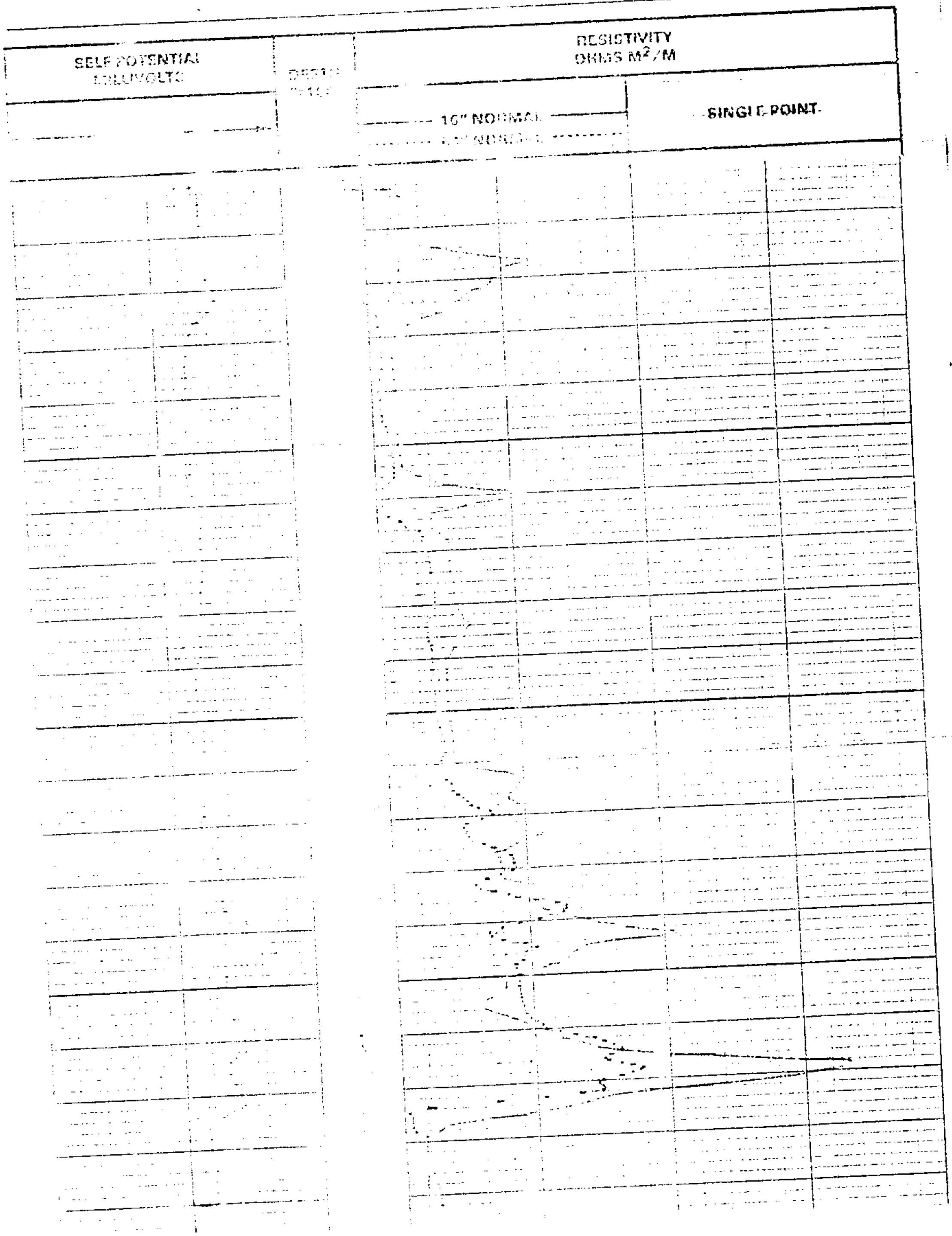
ALTITUDE OF LAND SURFACE: ______ LOGGED DEPTH: ______ DRILLED DEPTH: ______

FLUID LEVEL: ______ FLUID TYPE: ______ LOG REFERENCE POINT: GROUND LEVEL

CASING DATA: ______ OPEN HOLE DIA: ______

CEMENTED FROM ______ TO ______ SCREEN ______ AQUIFER: SANTA ROSA

FLUID RESISTIVITY ______ OHMS AT ______ °F REMARKS: ______



STATE WELL NUMBER
FILE NUMBER
PROJECT

... CONTRACTUAL OBLIGATIONS

TYPE OF LOG ... THIS DATE

OPERATOR(S)

COUNTY

DRILLER

ADDRESS

ALTITUDE OF LAND SURFACE

DRILLED DEPTH

FLUID LEVEL

FLUID TYPE

LOG REFERENCE POINT: GROUND LEVEL

CASING DATA

OPEN HOLE DIA

COMPUTED FROM ... TO

AQUIFER

FLUID RESISTIVITY: ... OHMS AT

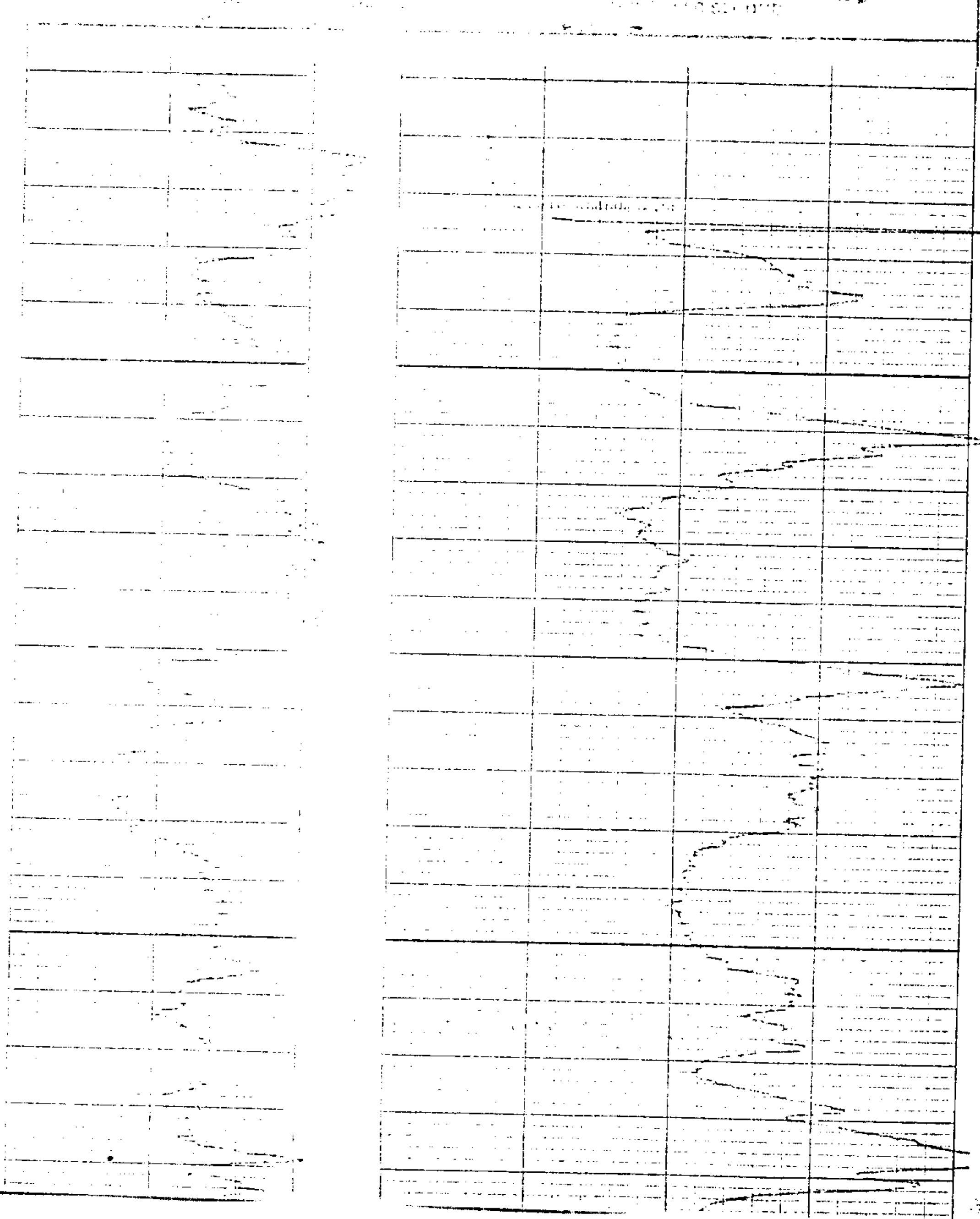
REMARKS:

GAMMA RAY
COUNTS PER SECOND
TIME CONSTANT

NEUTRON
COUNTS PER SECOND
TIME CONSTANT
SPACING

RADIATION INCREASES

RADIATION INCREASES



TEXAS WATER DEVELOPMENT BOARD
WATER AVAILABILITY DATA AND STUDIES SECTION
AUSTIN, TEXAS

STATE WELL NUMBER
FILE NUMBER # 27-[illegible]
PROJECT

TEST HOLE# 7
E-LOG

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS.

TYPES OF LOGS THIS DATE: [illegible] ; [illegible] ; [illegible] ; [illegible] ; ; ; ;

OPERATOR (C) [illegible] , LOCATION: [illegible] 1/4, [illegible] 1/4, [illegible] [illegible], BLK 24, [illegible] 1270

COUNTY: [illegible] NEAREST TOWN: [illegible] DRILLER: [illegible]

OWNER: [illegible] ADDRESS:

TYPE OF DRILL: [illegible] BIT SIZE: [illegible] 1/4"

ALTITUDE OF LAND SURFACE: [illegible] LOGGED DEPTH: [illegible] DRILLED DEPTH: [illegible]

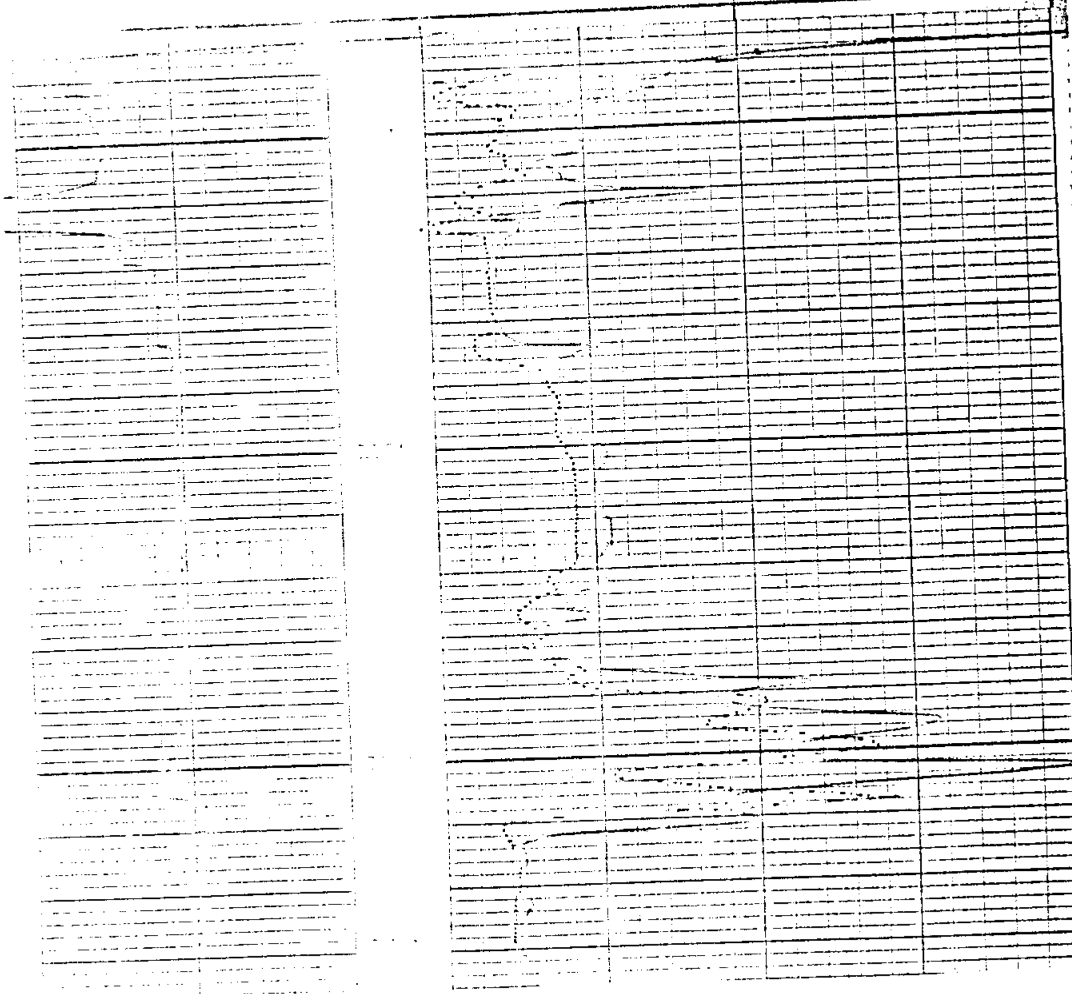
FLUID LEVEL: [illegible] FLUID TYPE: [illegible] LOG REFERENCE POINT: GROUND LEVEL

CASING DATA: OPEN HOLE DIA. : [illegible] 1/4"

CEMENTED FROM: TO SCREEN: [illegible] AQUIFER: SANTA ROSA

FLUID RESISTIVITY: OHMS AT ° F. REMARKS:

SELF POTENTIAL MILLIVOLTS	DEPTH 1"=100'	RESISTIVITY OHMS M2/M	
		16" NORMAL / 64" NORMAL	SINGLE POINT



TEXAS WATER DEVELOPMENT BOARD
WATER AVAILABILITY DATA AND STUDIES SECTION
AUSTIN, TEXAS

STATE WELL NUMBER ______
FILE NUMBER # 37-44
PROJECT 6060

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS.

TEST HOLE #7
GAMMA/NEUTRON

TYPES OF LOGS THIS DATE: [illegible] : [illegible] : [illegible] : ______ : ______ : ______ : ______ : ______.

OPERATOR (S) [illegible]. LOCATION: [illegible] 1/4, [illegible] 1/4, [illegible], [illegible], BLK 24 ON FM 1230,

[illegible] NORTH

COUNTY: [illegible] NEAREST TOWN: [illegible] DRILLER: [illegible]

OWNER: [illegible] ADDRESS: ______

TYPE OF DRILL: [illegible] BIT SIZE: 6 3/4"

ALTITUDE OF LAND SURFACE: [illegible] LOGGED DEPTH: [illegible] DRILLED DEPTH: 182'

FLUID LEVEL: [illegible] FLUID TYPE: [illegible] LOG REFERENCE POINT: [illegible]

CASING DATA: [illegible] OPEN HOLE DIA.: 6 3/4"

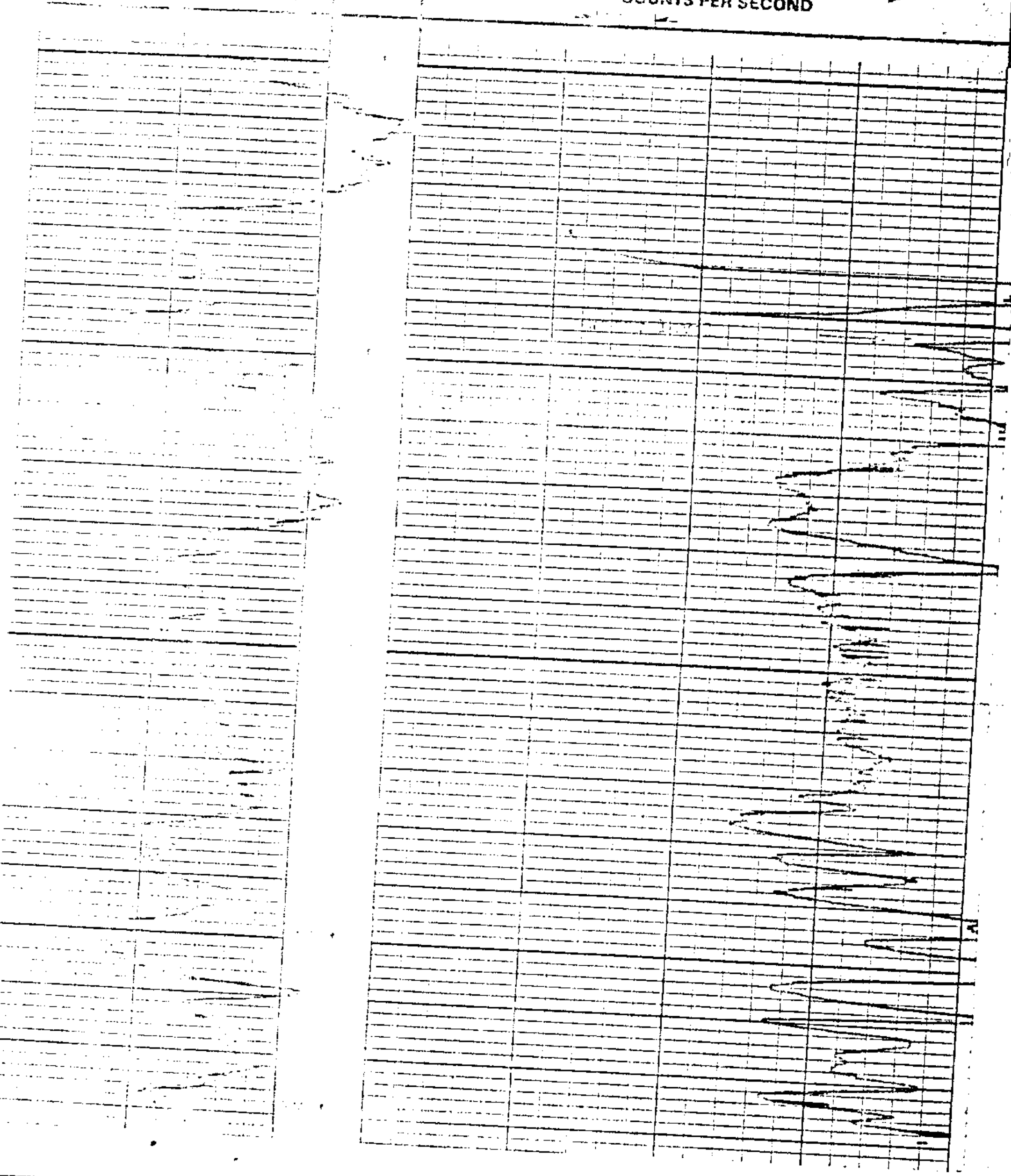
CEMENTED FROM: ______ TO ______ SCREEN: [illegible] TO ______ AQUIFER: SANTA ROSA

FLUID RESISTIVITY: ______ OHMS AT ______ °F, REMARKS: ______

GAMMA RAY
COUNTS PER SECOND ______
TIME CONSTANT ______

NEUTRON
COUNTS PER SECOND 100
TIME CONSTANT ______ SPACING 21"

RADIATION INCREASES → COUNTS PER SECOND	DEPTH "=100'	RADIATION INCREASES → COUNTS PER SECOND



WATER AVAILABILITY D... A AND STUDIES SECTION

STATE WELL NUMBER
FILE NUMBER
PROJECT

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS.

TYPES OF LOGS THIS DATE:

OPERATOR(S): LOCATION:

COUNTY: NEAREST TOWN: DRILLER:

OWNER: ADDRESS:

TYPE OF DRILL: BIT SIZE:

ALTITUDE OF LAND SURFACE: LOGGED DEPTH: DRILLED DEPTH:

FLUID LEVEL: FLUID TYPE: LOG REFERENCE POINT:

CASING DATA: OPEN HOLE DIA.:

CEMENTED FROM: TO SCREENED: TO AQUIFER:

FLUID RESISTIVITY: OHMS AT °F. REMARKS:

CALIPER
HOLE DIAMETER IN INCHES
FROM TO

~~BOREHOLE COMPENSATED SONIC VELOCITY~~
CALIBRATED FROM TO MICROSECONDS PER FOOT

DEPTH (FEET)

MICROSECONDS/FOOT
DELTA T

[illegible]XAS WATER DEV[illegible]OPMENT BOARD
[illegible]ATER AVAILAB[illegible] [illegible]A AND STUDIES SECTION
[illegible]USTIN, TEXAS

STATE WELL NUMBER ______
FILE NUMBER [illegible]
PROJECT [illegible]

[illegible]OTE: THESE LOGS [illegible] NOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS. [illegible] RUN #2 [illegible] T.E.# 3

TYPES OF LOGS THIS DATE: [illegible] : [illegible] : [illegible] : [illegible] : [illegible] : ___ : ___ : ___.

[illegible]PERATOR (S) [illegible] . LOCATION: [illegible] SOUTH [illegible] 2319 ON [illegible] AND APPROX.
[illegible]

COUNTY: [illegible] NEAREST TOWN: [illegible] DRILLER: [illegible]

OWNER: [illegible] ADDRESS: ______

TYPE OF DRILL: [illegible] BIT SIZE: [illegible]/4"

ALTITUDE OF LAND SURFACE: [illegible] LOGGED DEPTH: [illegible] DRILLED DEPTH: [illegible]

[illegible]LUID LEVEL: [illegible] FLUID TYPE: [illegible] LOG REFERENCE POINT: GROUND LEVEL

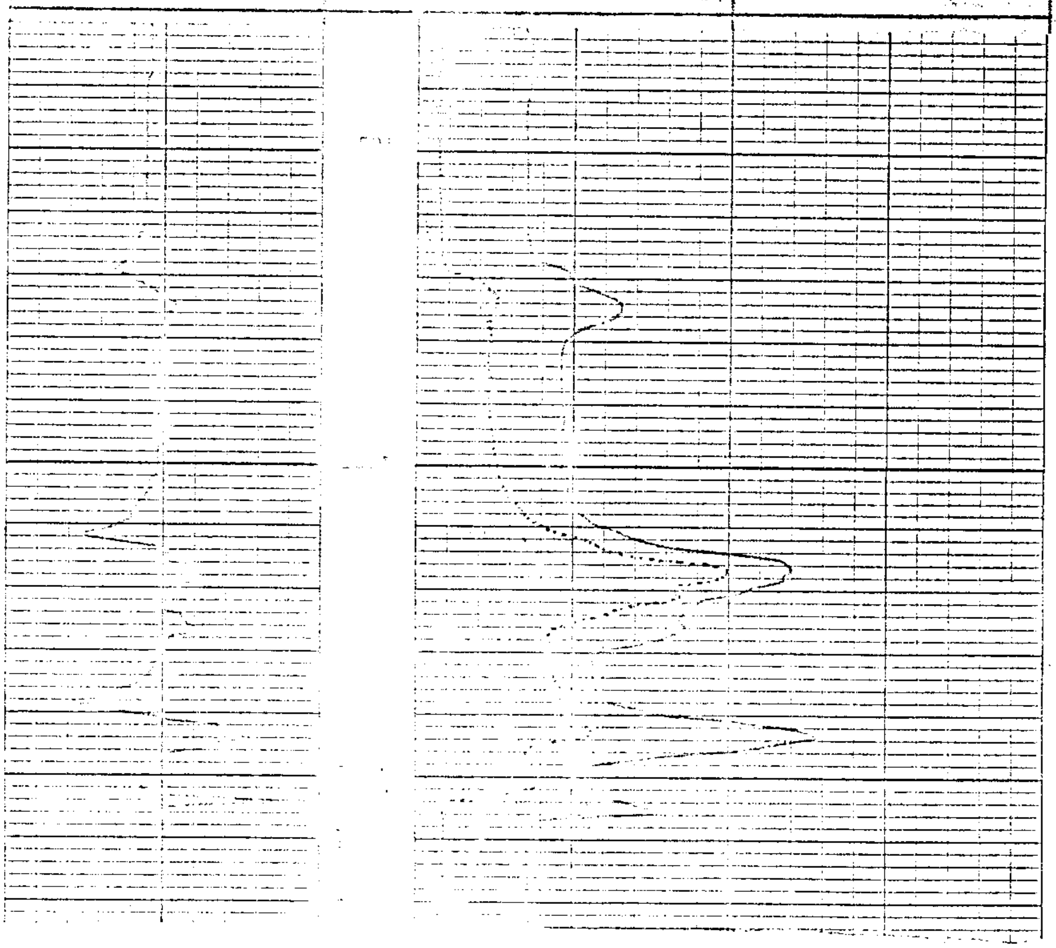
CASING DATA: [illegible] OPEN HOLE DIA.: [illegible]

CEMENTED FROM: [illegible] TO ______ SCREEN: [illegible] TO ______ AQUIFER: SANTA ROSA

[illegible] 950 @ 23[illegible]

FLUID RESISTIVITY: ______ OHMS AT ______ ° F. REMARKS: ______

SELF POTENTIAL MILLIVOLTS	DEPTH 1"=100'	RESISTIVITY OHMS M²/M	
[illegible]		16" NORMAL / 64" NORMAL	SINGLE POINT



TEXAS WATER DEVELOPMENT BOARD
WATER AVAILABILITY DATA AND STUDIES SECTION
AUSTIN, TEXAS

STATE WELL NUMBER
FILE NUMBER 57-45
PROJECT [illegible]

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS. [illegible] T.H. #2

TYPES OF LOGS THIS DATE: [illegible]

9319

OPERATOR (S) [illegible] LOCATION: [illegible]

COUNTY: [illegible] NEAREST TOWN: [illegible] DRILLER: [illegible]

OWNER: [illegible] ADDRESS:

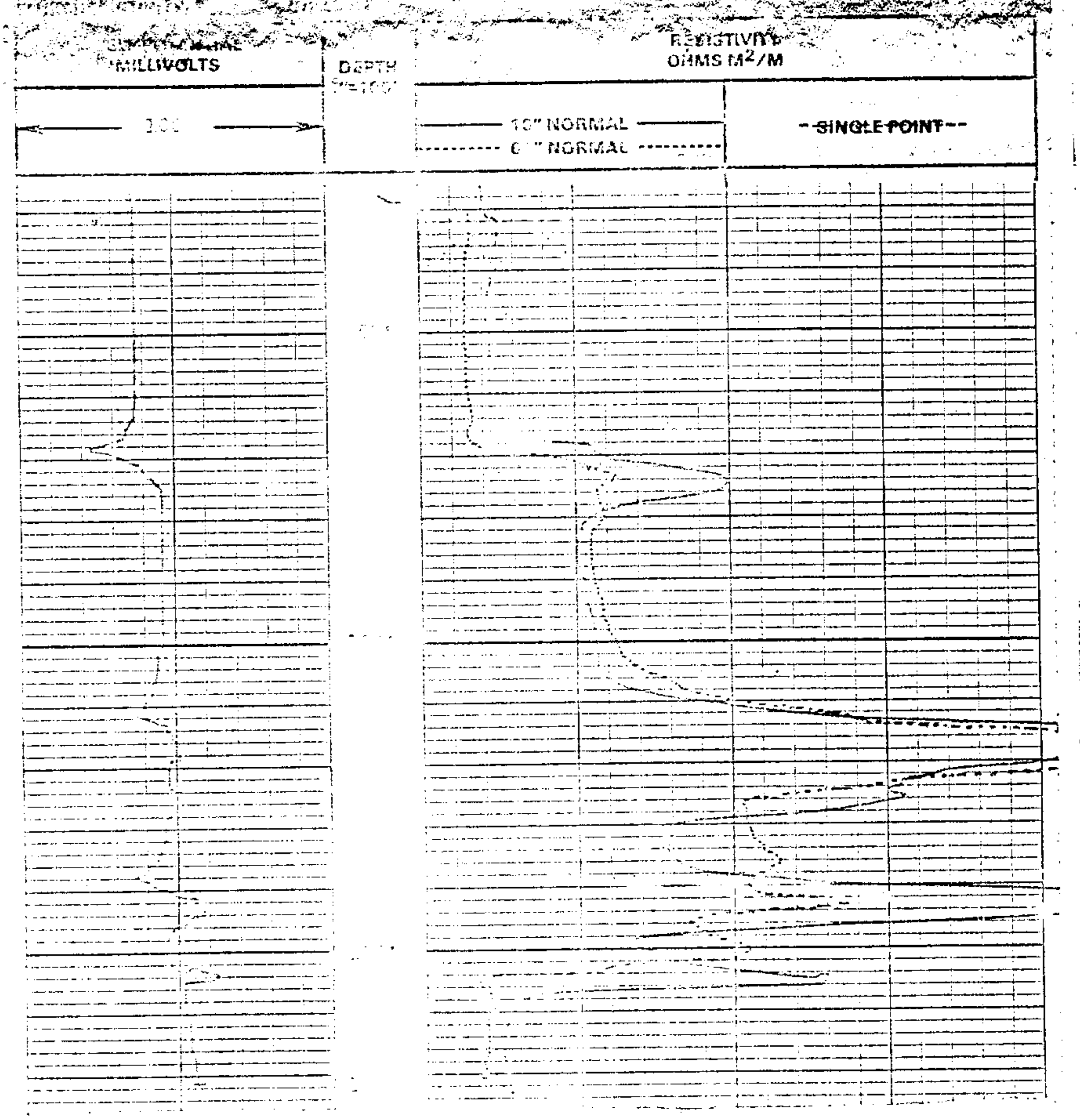
TYPE OF DRILL: AIR ROTARY BIT SIZE: [illegible]

ALTITUDE OF LAND SURFACE: [illegible] LOGGED DEPTH: [illegible] DRILLED DEPTH: [illegible]

FLUID LEVEL: [illegible] FLUID TYPE: [illegible] LOG REFERENCE POINT: GROUND LEVEL

CASING DATA: [illegible] OF HOLE DIA.: [illegible]

CEMENTED FROM: [illegible] TO [illegible] SCREEN: [illegible] AQUIFER: [illegible]



[illegible] BOARD
WATER AVAILABILITY DATA AND STUDIES SECTION
AUSTIN, TEXAS

STATE WELL NUMBER
FILE NUMBER F 87-45
PROJECT 6060

[illegible] FULFILL CONTRACTURAL OBLIGATIONS.

GAMMA RAY/ NEUTRON
TEST HOLE #9

TYPES OF LOGS THIS DATE: [illegible] ; [illegible] ; GR ; N ; ; ; ;

OPERATOR(S): [illegible] . LOCATION: 1.5MILES EAST OF FM 1230 ON FM 2319 AND 0.5 MILES NORTH.
[illegible]

COUNTY: [illegible] NEAREST TOWN: ROSCOE DRILLER: TWDB, BUFKIN

OWNER: CITY OF SWEETWATER ADDRESS:

TYPE OF DRILL: AIR ROTARY BIT SIZE: 6 1/4"

[illegible] OF LAND SURFACE: [illegible] LOGGED DEPTH: [illegible] DRILLED DEPTH: 210'

FLUID LEVEL: [illegible] FLUID TYPE: WATER LOG REFERENCE POINT: GROUND LEVEL

[illegible] OPEN HOLE DIA.: 6 1/4"

CEMENTED FROM: [illegible] TO SCREEN: OPEN TO AQUIFER SANTA ROSA
[illegible]
FLUID RESISTIVITY: O [illegible] AT °F. REMARKS:

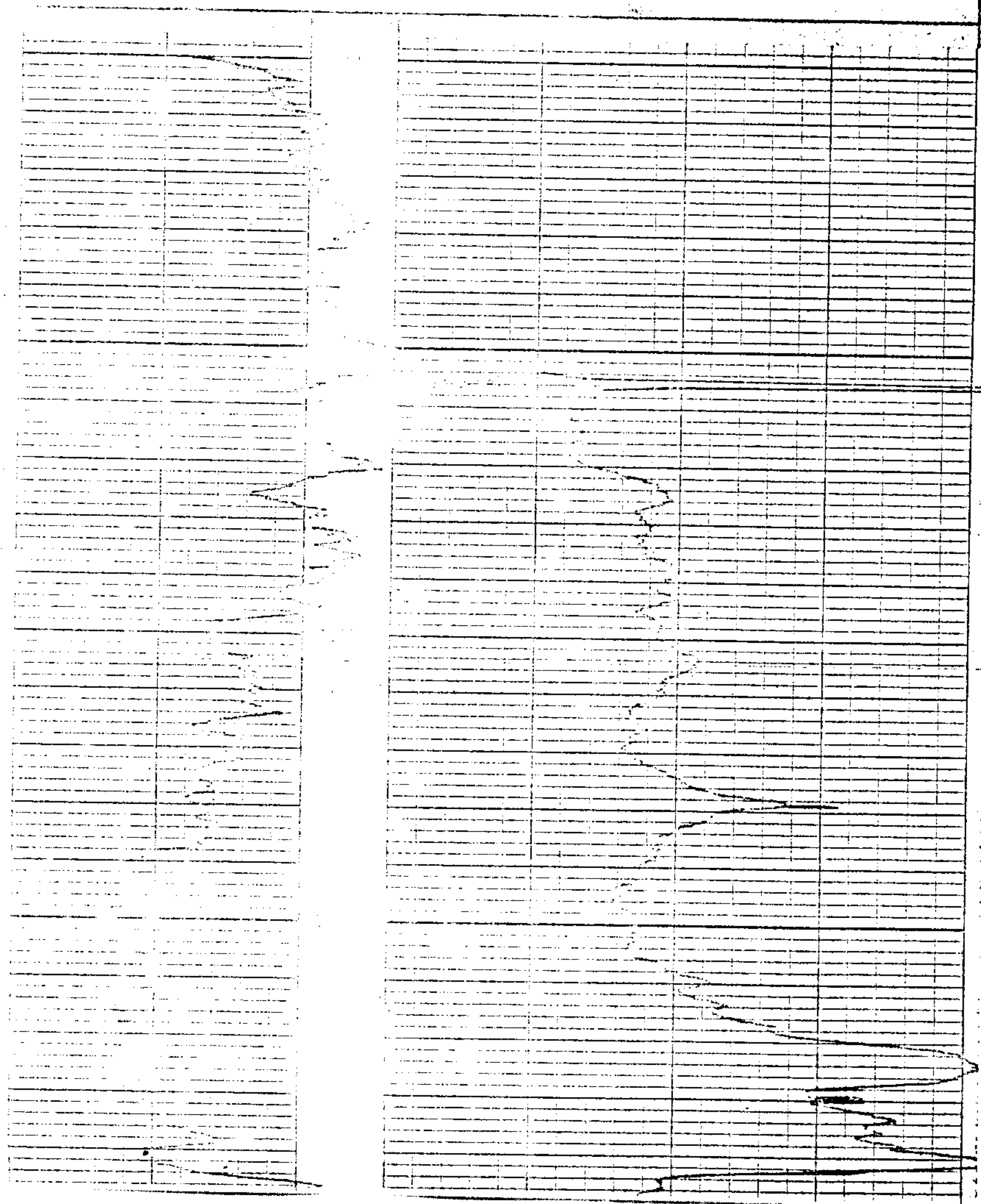
GAMMA RAY
COUNTS PER SECOND 50
TIME CONSTANT [illegible]

NEUTRON
COUNTS PER SECOND 250
TIME CONSTANT [illegible] SPACING 21 "

RADIATION INCREASES →
COUNTS PER SECOND

DEPTH
[illegible]

RADIATION INCREASES →
COUNTS PER SECOND



TEXAS WATER DEVELOPMENT BOARD
WATER AVAILABILITY DATA AND STUDIES SECTION
AUSTIN, TEXAS

STATE WELL NUMBER ______
FILE NUMBER # 87-45
PROJECT 6060

NOTE: THESE LOGS CANNOT BE USED TO FULFILL CONTRACTURAL OBLIGATIONS. E-LECTRIC LOG

TEST HOLE# 9

TYPES OF LOGS THIS DATE: [illegible] ; E-[illegible] ; [illegible] ; [illegible] ; ; ; ; .

OPERATOR (S) [illegible] . LOCATION: 1.5MILES EAST OF FM 1230 ON FM 2319 AND 0.5 MILES NORTH [illegible]

COUNTY: NOLAN NEAREST TOWN: ROSCOE DRILLER: TWDB, RUFKIN

OWNER: CITY OF [illegible] WATER ADDRESS:

TYPE OF DRILL: AIR ROTARY BIT SIZE: [illegible] 1/4"

ALTITUDE OF LAND SURFACE: 2357' LOGGED DEPTH: 210' DRILLED DEPTH: 210'

FLUID LEVEL: [illegible] FLUID TYPE: [illegible] LOG REFERENCE POINT: GROUND LEVEL

CASING DATA: [illegible] OPEN HOLE DIA.: 6 1/4"

CEMENTED FROM: [illegible] TO ______ SCREEN: OPEN TO ______ AQUIFER: SANTA ROSA

FLUID COND [illegible] 23° C
FLUID RESISTIVITY: ______ OHMS AT ______ °F. REMARKS:

SELF POTENTIAL MILLIVOLTS	DEPTH	RESISTIVITY OHMS M²/M	
← 20 →	[illegible]	16" NORMAL / 64" NORMAL	SINGLE POINT