Texas Department of Water Resources

GROUND-WATER CONDITIONS IN THE VICINITY OF JACKSBORO, JACK COUNTY, TEXAS

By

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FOREWORD

Effective September 1, 1977, Texas' three water resources agencies, the Texas Water Rights Commission, the Texas Water Quality Board, and the Texas Water Development Board, were consolidated to form the Texas Department of Water Resources. A number of publications prepared under the auspices of the predecessor agencies are being published by the TDWR. To effect as little delay as possible in production of these publications, references to these predecessor agencies will not be altered except on their covers and title pages.

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CONCLUSIONS AND RECOMMENDATIONS

Minor but important amounts of usable quality ground water occurs within erratic discontinuous sandstone and possibly limestone units of the near-surface rocks in the vicinity of Jacksboro. Geologically, these rocks are part of the Canyon and Cisco Groups of Pennsylvanian age.

Generally, ground-water quality deteriorates rapidly with depth in the area, and very poor quality water may be found locally at very shallow depths. However, fresh-to-slightly saline ground water (maximum total dissolved solids concentration of 2,924 milligrams per liter) is known to occur at least down to a depth of 391 feet in test hole number 1 (State Well Number 20-55-219) and in test hole number 2 (State Well Number 20-55-220) water containing only 1,097 milligrams per liter total dissolved solids was found at 284-305 feet. These tests are located just northwest of Jacksboro. Ground water northwest of the City of Jacksboro is of very good quality down to depths of 320 feet, but this is a very local condition; at most other known localities it generally occurs above 200 feet. Most wells in this area produce water containing total dissolved solids concentrations of less than 1,000 milligrams per liter.

Ground-water supplies in the Jacksboro area are not large; however they are used fairly extensively for both domestic and livestock purposes. Yields to wells are low and they are usually less than 25 gallons per minute.

Based on data assembled during this investigation, the recommended depth to which ground water should be protected in the Jacksboro area should correspond to the depths shown on the three geologic cross sections accompanying this report.

Protection should definitely extend to approximately 50 feet below the base of the zone containing beds with water having less than approximately 1,500 mg/l total dissolved solids. The base of this zone ranges from 170 to 320 feet with an average depth of about 200 feet or less at most localities. Additionally, protection should be given to beds containing water with a total dissolved solids content of less than 3,000 mg/l, but only at those localities where such beds are known to exist or can reasonably be expected to occur. This zone, as seen on the three accompanying geologic cross sections, has a maximum depth of approximately 410 feet in test well number 1 but it occurs at a shallower depth at many locations.

INTRODUCTION

During the summer of 1975, the Texas Railroad Commission, the Texas Water Quality Board, and the Texas Water Development Board all received correspondence from numerous individuals in Jacksboro, Jack County, Texas. These individuals expressed complaints about the adequacy of surface-casing recommendations for oil and gas wells in the immediate vicinity of the city. Additionally, there were several letters, memoranda, telephone calls, and personal conversations between personnel of these agencies concerning the problem.

As a result of the first of these complaints, personnel of the Surface Casing Section, Protection Branch, Ground Water Division, Texas Water Development Board made an office review of all available data which is normally used as criteria in making recommendations for the protection of ground water; electric logs of oil and gas tests, drillers' logs of water wells, and related geological data. In addition, the field investigator for the Texas Water Well Drillers Board visited Jacksboro and talked with a local water well driller, seeking additional ground-water data. Since no evidence was found indicating usable quality water below the current recommendations of 250 and 300 feet, the recommendations were not changed at that time.

Subsequently, additional letters were received from the concerned citizens of Jacksboro, including one from State Senator Tom Creighton of Mineral Wells.

These were still very insistent that ground-water resources were not being adequately protected. Therefore, in November, 1975, a special study of ground-water occurrence and quality in the immediate vicinity of Jacksboro was initiated by the Texas Water Development Board in connection with the Texas Water Quality Board.

For those readers interested in using the metric system, the English units used in this report may be converted to metric equivalents using the following conversion factors.

Unit	Abbreviation	MULTIPLY BY	To Obtain Unit	To Obtain Abbreviation
barrel	b	0.1590	cubic meter	m^3
cubic feet	ft^3	0.02832	cubic meter	m^3
feet	ft	0.3048	meter	m
feet per day	ft/day	0.3048	meter per day	m/day
gallon	gal	3.785	liter	l
gallons per minute	gpm	3.785	liters per minute	l/m
inch	in	2.54	centimeter	cm
mile	mi	1.609	kilometers	km
square mile	mi^2	2.590	square kilometer	km^2

Purpose

The major purpose of this study was to determine, as accurately as possible, the depth-to or altitude-of the base of usable-quality water in the Jacksboro area.

Location and Extent

The study included the City of Jacksboro and an area of less than 100 square miles around the city. Jacksboro, the county seat of Jack County, is located in the approximate center of the county in north Texas; about 60 miles northwest of Fort Worth and 60 miles south-southeast of Wichita Falls (Figure 1). The estimated 1973 population of Jacksboro was 3,676; that of Jack County 6,000. Jack County is bounded on the east by Wise and Montague Counties, on the north by Clay County, on the west by Archer and Young Counties, and on the south by Palo Pinto and Parker Counties.

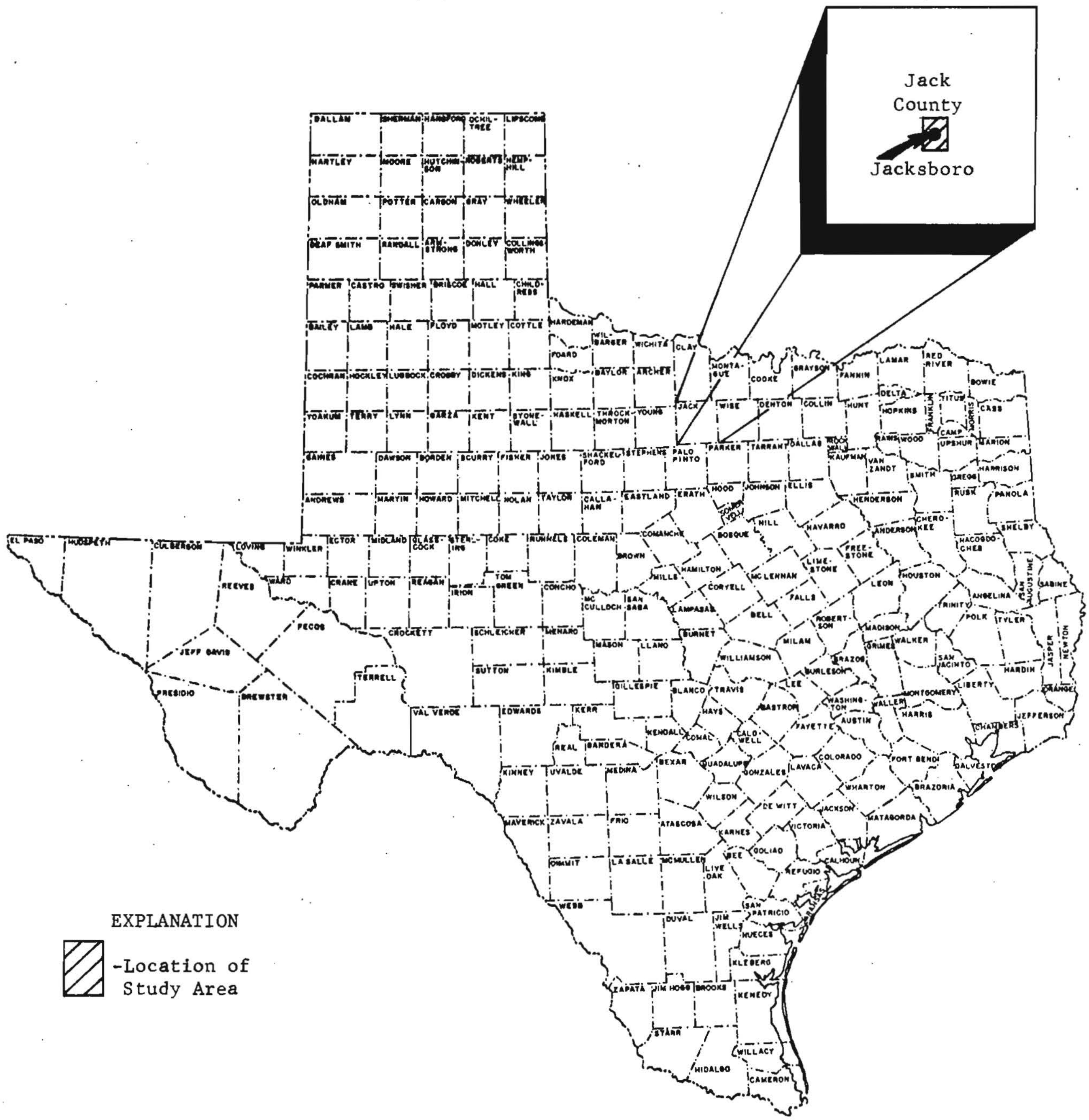

Figure 1

Map of Texas Showing Location of Jack County
Texas Water Development Board

Climate

The mean annual temperature at Jacksboro is about 65° Fahrenheit (F) with a mean maximum in July of 97°F and a mean minimum in January of 32°F. The growing season averages 218 days with the last killing frost on April 20 and the first on October 24. The record high temperature was 112°F and the record low was -3°F.

The average annual rainfall is 29.78 inches with April-May and September-October being the periods of highest rainfall.

Economy

The economy of the area is mainly dependent on petroleum and livestock production, but there is some manufacturing and farming. In addition, tourism is becoming an increasingly important factor, especially in association with the recent development of Fort Richardson State Park located on the south edge of Jacksboro.

The production of oil and gas and its related industries is probably the most important factor in the economics of not only the study area, but of Jack County and much of the north Texas area. Oil was discovered in Jack County in March 1913 and the industry has expanded throughout the county, with at least 2,000 tests drilled for oil and gas.

Oil and gas is now, or has been in the past, produced from rocks ranging in age from the Ellenburger Group of Ordovician to near surface rocks of the Cisco Group of the Pennsylvanian. The numerous producing horizons include rocks of the Ellenburger Group, Mississippian limestones, the Bend Conglomerate, the Marble Falls Limestone, and Strawn, Canyon, and Cisco sandstones and limestones.

A total of 147,250,081 barrels of crude oil was produced in Jack County through 1974. The 1974 production of crude oil was 2,103,256 barrels. Significant amounts of natural gas are also produced. In 1975, the production of petroleum products within the county included 17,750,844 million cubic feet of natural gas from gas wells, 84,317 barrels of condenstate, 1,964,046 barrels of crude oil, and 5,577,796 million cubic feet of casinghead gas.

Mineral production in Jack County had a total dollar value of $13,600,000 in 1972 and $14,771,000 in 1973, from petroleum, natural gas, stone, and natural gas liquids.

During the recent and continuing series of oil and gas "shortages," the Jack County area has undergone an upsurge of drilling activity, with an increase of about one-third in 1975 over 1974. In fact, it was this recent drilling in the immediate vicinity of Jacksboro which indirectly led to this study.

Previous Investigations

There have been no detailed studies of ground-water occurrence and availability in Jacksboro County. Texas Water Commission Bulletin 6309, Reconnaissance Investigation of the Ground-Water Resources of the Trinity River Basin, Texas included Jack County, but only in a very general way. Several complaints, by local landowners, of reported pollution or contamination of ground water have led to investigations by Texas Water Development Board personnel in the vicinity of Post Oak, Jermyn, and Bryson. Records of these studies are included in the Board's Central Records files. There are many reports covering various aspects of the geology of the North Texas area which includes Jack County. Several of these, which were used in the preparation of this report, are included in the References Section.

Well-Numbering System

In order to facilitate the location of wells and to avoid duplication of well numbers in present and future ground-water studies, the Texas Water Development Board has adopted a statewide well-numbering system. This system is based on the division of the State into quadrangles formed by degrees of latitude and longitude and the repeated division of these quadrangles into smaller ones.

The Jacksboro area which was the subject of this study and report is located within the 1-degree quadrangle assigned the number 20. The study area is included on the 7 1/2-minute quadrangles numbered 47, 48, 55, and 56. Each of the 7 1/2-minute quadrangles is divided into nine 2 1/2-minute quadrangles. Therefore, a complete well number includes the number of the well within the 2 1/2-minute quadrangle, the number of the 7 1/2-minute quadrangle, and the number of the 1-degree quadrangle. The well number is often preceded by an alphabetic code for the county. This code for Jack County is PL. Therefore, the complete state well number for test hole number 1, drilled as a part of the Jacksboro study is 20-55-219.

Acknowledgements

Numerous people helped in many ways in the completion of this study, and each individual's contribution of time, aid, and information is greatly appreciated. Especial thanks are due, however, to the following:

Mr. Bob Price, Texas Water Development Board, who made many useful suggestions concerning the illustrations and conclusions contained within the report, and also for his review and editing of the manuscript.

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The late George Horton, who drilled most of the recent water wells in Jack County, was a source not only of information on existing wells but invaluable general knowledge of the hydrology and geology of the area.

Mr. R. H. Tate, the City Manager of Jacksboro, who provided detailed data on the abandoned city wells, general information and help on the area, and arranged for water from the city for drilling the test holes.

Max Poyner, John Armstrong, and Pete Grace; who allowed test holes to be drilled on their property.

In addition, valuable help and cooperation were received from all of city, county, state, and federal employees with whom we had contact in the course of the study.

APPROACH AND PROCEDURE

Methods of Investigation

The steps of the study included:

(1) Several meetings were held. These included representatives not only of the Texas Water Development Board but of the Texas Water Quality Board as well. These meetings were used to plan and discuss progress on the various parts of the study.

(2) A reconnaissance investigation of Jack County and the study area was carried out for familiarization with the geology, topography, geography; and to meet with city and county officials and other local citizens who had written letters regarding the surface casing problem. This allowed a more exact evaluation of the problem and its extent.

(3) An examination and evaluation was made of both published and unpublished information on the hydrology, geology, and oil and gas exploration and production, not only in Jack County, but the entire north Texas area in general. This included work in the Library, Central Records files, and Surface Casing Section electric log files of the Texas Water Development Board; as well as the Texas Railroad Commission files on oil and gas well completion and plugging.

(4) An inventory was made of selected water wells and springs, with the collection of data including (where possible): (a) owner, (b) driller, (c) date drilled, (d) well depth, (e) producing interval, (f) water use, and (g) other pertinent data. Depths to water were measured where possible.

(5) Three test holes were drilled and cored. Selected core samples of the sand intervals were tested at the Texas Water Development Board Sample Laboratory for porosity, vertical and horizontal permeability, bulk density, and percent absorption. Sieve analyses were run on selected samples.

(6) Water samples for chemical analysis were collected from selected water wells. Samples were also collected from significant producing horizons in each of the three test holes. Each sample was analyzed by the Texas State Department of Health Resources.

(7) Data from the water well inventory, the chemical analyses of water from wells, and other sources were tabulated and various maps and charts were constructed using the data. The data from the chemical analyses was computerized and several tables and plots were generated by the computer. These included stick plots: maximum, minimum, and mean concentrations of various constituents.

(8) A suite of geophysical logs was run on each of the three test holes drilled. These included electric, gamma ray, neutron, gamma-gamma (density), and caliper logs.

(9) An evaluation was made of the chemical quality of the water in various sandstone and limestone units as shown on electric logs of oil and gas tests using a computer program.

(10) Preparation of a report outlining the situation, the results of the study, and recommendations.

Well Inventory

A total of 118 wells and springs were inventoried as a part of the study. This includes 19 wells which were formerly used to supply the City of Jacksboro, but which were abandoned with most of the wells plugged about 1950 when the city built Lake Jackson. These abandoned city wells were not given regular state well numbers. The location of those 99 water wells and springs which were given state well numbers is shown on Figure 3. Figure 2 shows the approximate location of abandoned city wells. The results of the water well inventory are included in Table 1. Drillers' logs of selected wells with state well numbers are included in Table 3. Drillers' logs of some of the abandoned city wells are in Table 4. Depth of the water wells inventoried ranged from about 20 to 338 feet. However, most were between 150 and 200 feet in depth.

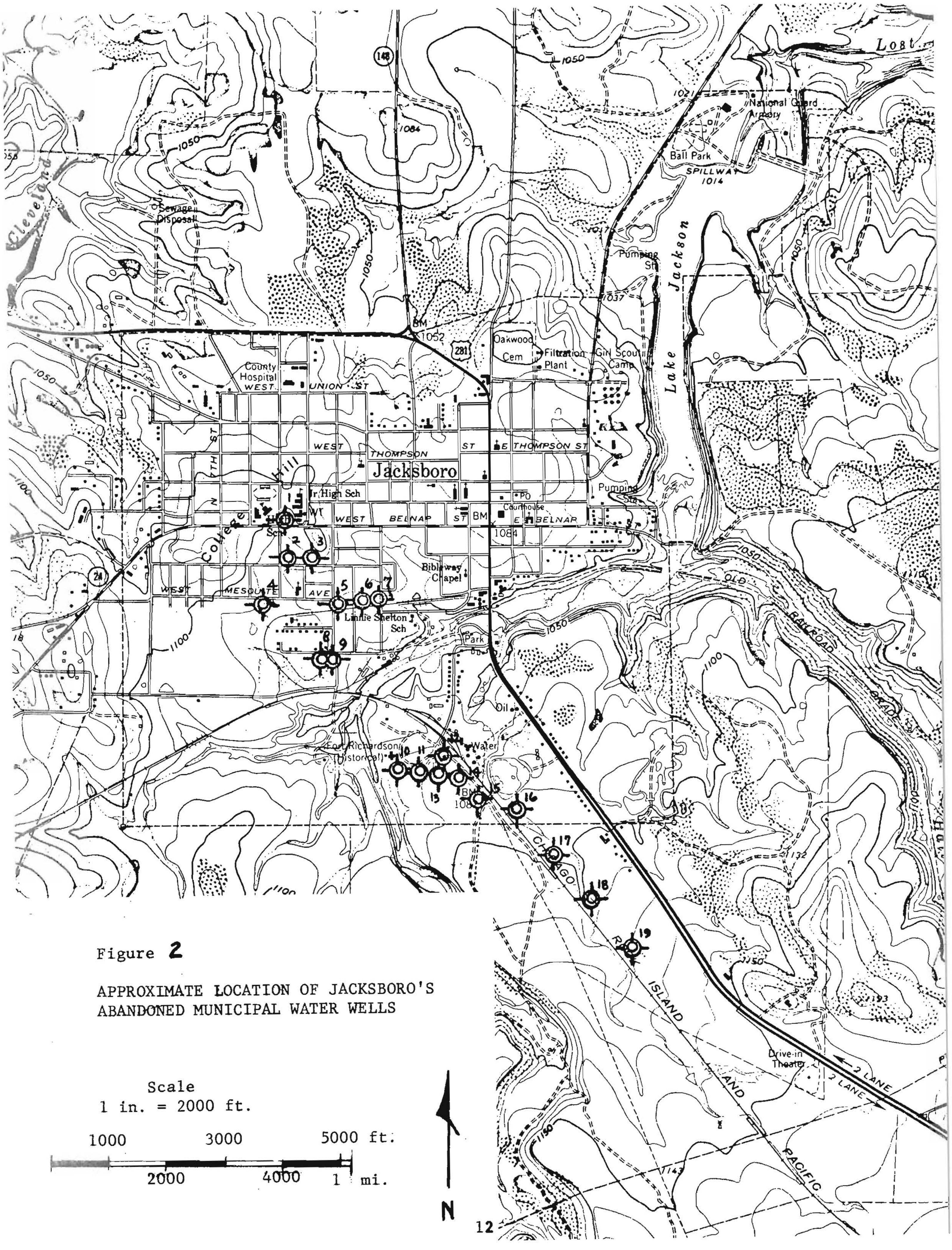

Figure 2

APPROXIMATE LOCATION OF JACKSBORO'S ABANDONED MUNICIPAL WATER WELLS

Scale
1 in. = 2000 ft.

1000 3000 5000 ft.
2000 4000 1 mi.

ell capacities are generally quite low, ranging from less than 5 to a maximum of about 20 gallons per minute. These maximum yields were achieved in the City of Jacksboro wells equipped with graded screens with large slots following acid treatment. Most of the wells are equipped with small electric submersible or cylinder pumps; however, several have windmills. Measured water levels ranged from 11.7 to 119.3 feet below the land surface with no real pattern to be seen.

Water Sampling

Water samples were collected from 40 wells. An additional seven samples were collected from various sand intervals in the test holes drilled as a part of the study. A total of 47 samples were collected and sent to the Texas State Department of Health Resources laboratory for chemical analysis.

Forty samples were analyzed which were produced from wells developed in rocks of the Canyon Group of the Pennsylvanian System. Total dissolved solids in these analyses ranged from 327 to 13,699 milligrams per liter with an average of 1,702 milligrams per liter. Concentrations of individual chemical constituents varied as follows (all in milligrams per liter):

	Minimum	Maximum		Minimum	Maximum
Silica	4	24	Bicarbonate	307	820
Calcium	1	950	Sulfate	19	9,900
Magnesium	1	1,620	Chloride	13	2,610
Sodium	55	1,770	Fluoride	0.2	5.3
			Nitrate	0.4	9

The pH of the samples ranged from 7.2 to 9.3 with an average of 8.2

Seven samples were analyzed which were produced by wells producing from rocks of the Cisco Group of the Pennsylvanian System. Concentrations of total dissolved solids in these analyses ranged from 410 to 2,557 milligrams per liter.

The ranges of concentration for the various individual chemical constituents (all in milligrams per liter) were as follows:

	Minimum	Maximum		Minimum	Maximum
Silica	14	19	Bicarbonate	153	381
Calcium	74	113	Sulfate	31	322
Magnesium	12	35	Chloride	25	940
Sodium	34	680	Fluoride	0.3	0.7
			Nitrate	0.4	36

The average concentration of total dissolved solids was 890 milligrams per liter. The pH of these samples ranged from 7.5 to 8.3 with an average of 7.7.

These analyses of water samples seem to indicate a native water quality of the sodium-calcium bicarbonate type. Over a wide range of total dissolved solids concentration there is generally at least a slightly higher concentration of sulfate than chloride. Therefore, the few wells with high chlorides which do not show a significant increase in sulfates may possibly be contaminated with brine from oil field operations.

The presence of natural gas was reported in several wells, especially in the area 1 1/2 to 3 miles southeast of Jacksboro.

The complete chemical analysis of each of the samples is summarized in Table 2. Figure 8 shows stick-plot diagrams of selected analyses.

Test Holes

Three test holes were completed as a part of this study. A modified Failing 1500 drilling rig operated by the Texas Water Development Board was used to drill the test holes. Additional equipment consisted of a 900 gallon water truck, 3 fourteen foot drill collars (4 1/2 inch diameter), 2 3/4 inch drill pipe, 3 inch steel casing, one 21 foot section of 3 inch perforated pipe, and one inch galvanized pipe used for an air line. Drilling was accomplished with conventional tri-cone rock bits. Cores of rock formations were obtained by use of a 6 1/8 inch double-walled core barrel equipped with a diamond-tipped bit capable of retrieving a four inch diameter core 10 feet in length.

The three test holes were drilled on private land during January, February, March, and April of 1976. Test hole number 1, state well number 20-55-219, was drilled to a depth of 164 feet. Samples of the cuttings were collected for each five foot interval of drilling and a drillers' log and sample log were made. The well was then cored from 164 feet to a total depth of 495.5 feet.

Test holes number 2 and 3 (state well numbers 20-55-220 and 20-55-311, respectively) were drilled to total depths of 491.5 and 541.5 feet. Selected intervals were cored in each well, generally when the drill cuttings indicated sandstone was being penetrated. After describing the lithology of the rocks cored, the cores were sent to the Texas Water Development Board's Sample Laboratory for testing of selected intervals of core. The results of core tests are shown in Tables 5 and 6.

A suite of geophysical logs was run on each of the three test holes using the Board's Logging Unit. These logs, along with the drillers' logs, sample logs, and the description of the cores were used to select the intervals to be tested in an attempt to collect samples of formation water for chemical analysis. Copies of the electric logs of the three test holes are used in the geologic cross sections, Figures 5, 6, and 7. The sample logs are included in Table 3.

In test hole number 1, several sand intervals were selected for testing. These included intervals from 461 to 482 feet, 370 to 391 feet, and 168 to 189 feet in depth. An attempt was made to pump a sample of water from each of these horizons using a submersible pump and packer system developed and used by the United States Geological Survey Office in San Antonio. This method was unsuccessful, however, probably because of the low permeability and production capacity of the thin sands encountered.

Water samples were obtained from the test holes by using a gravel-pack method of selected interval sampling rather than the conventional packer system. The gravel pack sampling method has been developed and utilized in the last few years by the Layne-Texas Company, local El Paso drillers, and the El Paso Water Utilities (EPWU). It is uncertain who first developed the method; Tom Cliett, EPWU geologist, in oral communication stated that he heard about it from the Layne-Texas Company and decided to try it as an alternative to the inefficient packer system of sampling in unconsolidated sediments. In essence, the gravel-pack method of sampling is as follows: First, a test hole of approximately eight inches in diameter is drilled to a total depth which will include all of the zones to be tested in the aquifer (Figure 9). Next, the borehole and mud are conditioned for geophysical logging; this procedure usually consists of adding fresh water to the drilling mud to lower the viscosity to approximately 35 Centipoises and help settle out any fine cuttings being carried in suspension, and also circulating the mud until a uniform consistence is obtained. This step is very important because if the mud is not uniform, it could result in discrepancies in the electric log (ie. possible faulty resistivity readings). Next, a suite of geophysical logs are run in the borehole; these usually consist of the short normal and long normal resistivity curves which are recorded in the right-hand track on the log paper. Simultaneously, a spontaneous potential is recorded in the left-hand track on the log paper. The SP curve is an indicator of permeability and porosity while the resistivity curves are indicators of lithology and quality of formation water.

After logging is completed, the logs are evaluated in order to determine which zones should be sampled. When the deepest zone to be sampled is determined, a screen or perforated pipe approximately 20 feet in length is attached to a string of 3-inch tubing or drill stem and run in the borehole until the screen

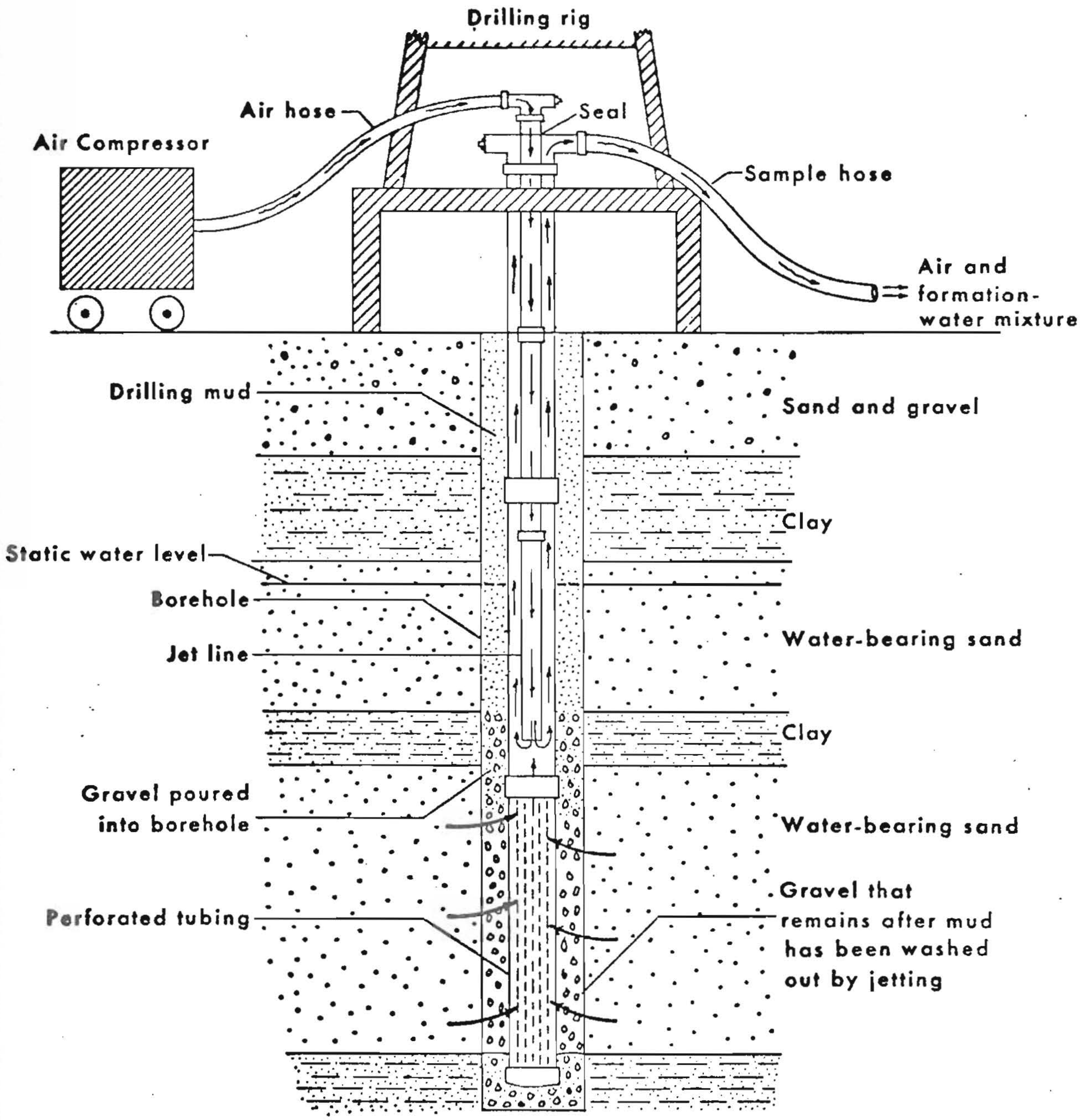

FIGURE 9

Diagram Showing Gravel Pack Method of Water Sampling is opposite the zone to be sampled (Figure 9). A relatively fine gravel (2 to 6 mm in diameter) is placed in the mud-filled borehole. If the borehole depth is 400 feet or less, it can be filled to the land surface. However, if the borehole is deeper than 400 feet, gravel should be placed no more than 100 feet above the zone to be sampled in order to prevent sticking the tubing in the borehole. Following sample collection, the screen should be raised to the next zone to be sampled, more gravel placed in the borehole (about 100 feet above zone to be sampled) and sample collected. This process should continue until all selected zones have been sampled. After the gravel has been placed in the borehole to the proper depth, a "T" connection is placed on the tubing and an airline, 1¼ to 1½-inch in diameter is run into the tubing. An air hose is connected to the "T" connection and to an air compressor, another line is connected to the "T" connection for discharge of jetted fluid. Air from the compressor is forced down the airline and up the tubing which creates a suction or jetting action on the screened section of the formation. This jetting causes water to enter the tubing through the screen and is forced up the tubing to the surface (Figure 9).

When jetting is commenced the airline should be lowered into the tubing at 150-foot increments to remove drilling mud from the tubing until the airline is from 1/3 to 1/2 below the static water-level depth.

The principle behind this method of sampling is that the formation water will follow the path of least resistance, and it will move laterally from the formation into the sample pipe rather than up the borehole through the mixture of mud and gravel. Gates and White (1976, p.21) state, "Contamination of the water by mud moving upward or downward through the gravel pack is minimal because the hydraulic conductivity of the gravel with respect to the mud is about 5 percent of the hydraulic conductivity of the gravel with respect to water. The hydraulic conductivity of a material is inversely proportional to the viscosity of the fluid moving through it, and drilling mud commonly has a viscosity about 20 times greater than the viscosity of water."

When jetting of fluid is commenced, drilling mud that has invaded the water-bearing formation and in the gravel opposite the screened section is removed, followed by water. When water has cleared of drilling mud and any fine particles it is considered to be formation water. This is substantiated by the constant level of the mud column in the borehole during jetting.

Utilizing this method of sampling, the hole is drilled to the desired depth, logged, and all the formations encountered evaluated before testing. In contrast, the packer method involves sampling "blindly" without the benefit of geophysical logs. The gravel-pack method also works much better than packers in unconsolidated clay, sand, and gravel because washouts, heaving sands and hole-size variation makes it difficult if not impossible to set formation packers.

An additional advantage, which was especially important in the Jacksboro study, was that the gravel-pack method was more efficient in "developing" the thin sands having relatively low permeabilities which occur in much of the Pennsylvanian rocks in the North Texas area. The submersible pump used with the U.S. Geological Survey's packer test tool would not "develop" these sands.

Water samples were obtained by the gravel-pack method from two zones in test hole number 1, from 461 to 482 feet and 370 to 391 feet. An attempt to obtain a sample from a third zone, 168 to 189 feet, was unsuccessful. This test failure points up the variation in permeability from place to place in this sand since it is known to yield water in nearby wells.

Samples were jetted from two intervals in each of the other two test holes; from 246 to 267 feet and 284 to 305 feet in test hole number 2, and from 123 to 144 feet and 496 to 517 feet in test hole number 3. Attempts to obtain water samples from several other intervals in these wells failed, apparently due to the low permeability in these sands. Figure 4 indicates the quality of water from the previously mentioned intervals.

The three test holes were plugged after the completion of the testing.

GENERAL GEOLOGY AND OCCURRENCE OF GROUND WATER

The area of Jacksboro and vicinity is underlain by rocks of the Paleozoic and Pre-Cambrian Eras. Exposed at the surface are rocks of the Pennsylvanian System. Below these Pennsylvanian rocks are, at successively greater depths and age, rocks of the Mississippian, Ordovician, and Cambrian systems and the Pre-cambrian Era.

Usable ground water is known to occur (in the immediate vicinity of Jacksboro) within near-surface sandstones and possibly in limestone beds of the Cisco and Canyon Groups of Pennsylvanian age. The contact between these two groups (as indicated on Figure 4) runs from southwest to northeast through the City of Jacksboro, with Cisco rocks outcropping to the northwest and Canyon rocks outcropping on the southeast. These rocks, as well as the underlying rocks of the Strawn Group of Pennsylvanian age and the aforementioned older rocks generally dip to the west and northwest at about 50 feet per mile (See Figure 5). Most of the water wells in the study area produce from sandstones in the upper part of the Canyon Group. However, electric log data suggests that minor amounts of ground water may also be present in permeable beds of the Ranger Limestone.

The Canyon Group consists of a thick sequence composed primarily of shales interbedded with thin to massive limestones. Within the shales and often replacing the limestones are numerous sinuous discontinuous sandstone bodies or channel sands. The geologic cross sections (Figures 5, 6, and 7) show the inter-relationships of the various beds within the upper part of the Canyon sequence. These sediments represent a cyclic deposition of fluvial, deltaic, and shallow near-shore marine deposits at the edge of the shelf. Throughout Canyon deposition, sediments derived from the east and northeast were deposited along a migrating shoreline controlled both by subsidence and a changing sea level.

The discontinuous nature of the sandstone deposits within the Canyon control, to a large extent, the occurrence and availability of usable quality ground water. The sands are generally fine grained and often contain thin layers of clay or silt which reduce the permeability of the sandstone beds. This not only restricts the amount of water that can move through the sandstones, and therefore the amount yielded to wells, but slows the movement of recharge in the sandstones which allows the ground water more contact time to dissolve minerals from the sediments. The complex interconnection, or lack of interconnection, between many of the individual sandstone or limestone beds additionally complicates the prediction of both the occurrence and quality of ground water at any individual location. Often there is little apparent correlation between sandstone beds in wells drilled quite close together.

Rocks of the Cisco Group are similar to those of the Canyon Group, but contain much more sandstone. They reach a maximum thickness of only about 200 feet in the study area, but are thicker to the west and northwest. Ground water in the Cisco occurs under similar conditions and restrictions as ground water occurs in the Canyon Group.

As indicated by the results of laboratory tests of the cores recovered in drilling the test holes, the porosity of sandstone units in the Canyon Group in the Jacksboro area probably ranges from 20 to 25 percent (Tables 5 and 6). Because the sand grains are generally fine to very fine and the sand generally is laminated with thin beds of clay and silt, the permeabilities are usually quite low (laboratory horizontal permeabilities ranged from 0.03 to 39.24 gallons per day per square foot). The sandstone beds range in thickness from 10 to 20 feet, with a few rarely approaching 50 feet, therefore transmissibilities are usually very low. It is therefore not surprising that the highest reported maximum yield for a well in the area is less than 25 gallons per minute.

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Table 1.--Records of Selected Water Wells, Test Holes, and Springs in the Vicinity of Jacksboro, Jack County, Texas

Water-bearing units : PNCS, Cisco Group; PNC, Canyon Group
Method of lift and type of power: C, cylinder; E, electric; J, jet; N, none; S, submersible; W, wind
Use of Water : D, domestic; S, livestock; Irr, irrigation; N, none

Well	Owner	Driller	Date completed	Depth of Well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
20-47-401	O. S. Hodge	George Horton	1973	100	5 1/2	100	PNCS	1049	--	--	S,E	D	
* 402	L. O. Shook	do	1973	120	5 1/2	120	PNCS	1050	34.6	Feb. 26, 1976	S,E	D,S	
403	O. S. Hodge	--	old	78	6	78	PNCS	1052	--	--	C,W	N	
* 701	Precinct 4, Jack County	Mack Roberts	1968	187	5 1/2	187	PNCS	1050	--	--	S,E	D	Not used for drinking water.
702	Archie Middlebrook	do	1965	137	5	137	PNCS	1050	--	--	J,E	D	
* 703	L. C. Whitsitt	George Horton	1971	200	5	200	PNC	1020	30	June 5, 1971	S,E	D	
704	do	--	1910	130	6	130	PNCS	1020	--	--	C,W	D,S	
* 705	W. L. Lowrance	--	1971	280	5	280	PNC	1009	40.0	Nov. 25, 1975	S,E	S	Drilled to 320 feet, plugged back to 280 feet.
* 706	do	--	old	110	6	110	PNCS	1011	--	--	J,E	D	
707	do	--	old	110	6	110	PNCS	988	--	--	C,W	S	
708	Ralph Conway	Mack Roberts	1969	201	5 1/2	201	PNC	1024	--	--	S,E	D	
709	do	--	1888	132	4	132	PNCS	1023	--	--	C,W	N	
* 710	Ira Whitsitt	--	1972	180	5	180	PNC	1027	42.1	Dec. 4, 1975	S,E	D	
* 801	Warren Rummage	George Horton	1972	100	5	100	PNCS	955	117.5	Nov. 20, 1975	S,E	D,S	
* 901	Sam Graves	Lindzie Hart	1954	110	5	110	PNC	1059	--	--	C,E	D	
902	D. N. Christian	do	1958	105	10	100	PNC	1062	--	--	J,E	D,S	
903	J. R. Bowen	--	old	100	4 1/2	100	PNC	1054	75.0	Nov. 19, 1975	C,E	S	
* 904	Jackie Worthington	George Horton	1973	240	8	240	PNC	934	--	--	S,E	D,S	

See footnotes at end of table.

TWDBE-GW-59 d

Table 1.--Records of Selected Water Wells, Test Holes, and Springs in the Vicinity of Jacksboro, Jack County, Texas--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
* 20-48-801	Ed Henry Stewart	Don Marley	1950	60	5	60	PNC	946	17.0	Dec. 5, 1975	S,E	D,S	
* 55-101	G. Van Baale	--	old	138	4	126	PNCS	1059	63.4	Nov. 24, 1975	C,E	D	
* 102	J. T. Rummage	Mack Roberts	1968	190	5 1/2	190	PNC	1091	--	--	S,E	D	
103	do	--	old	100	5	100	PNCS	1091	--	--	C,E	N	
* 104	Ronnie Smith	George Horton	1975	120	5	120	PNCS	1068	43.8	Nov. 26, 1975	S,E	D	Drilled to 200 feet, but produced salt water. Plugged back to 120 feet.
105	P. C. Lively	--	old	100	4	100	PNCS	1192	--	--	C,W	D	
106	Earnest Easter	Wake Winn	1939	114	5	114	PNCS	1071	60	Nov. 25, 1975	S,E	D,S	
107	E. B. Tanner	-- White	1960	180	5	180	PNC	1052	74.9	Nov. 21, 1975	S,E	D	
108	John W. Pursley	George Horton	1971	180	5	180	PNC	1059	40	Aug. 24, 1971	S,E	D	Drilled to 320 feet. Plugged back to 180 feet.
109	Gerald Moore	do	1968	180	5	180	PNC	1016	--	--	S,E	S	
110	Claude Rummage	--	1901	100	5	100	PNCS	1011	--	--	C,W	N	
* 201	John Armstrong	--	old	135	5	135	PNC	1039	35	Nov. 21, 1975	C,W	D	
* 202	W. R. Johnson	--	1954	250	5	250	PNC	1059	--	--	C,E	D	
* 203	Billie Smith	--	old	190	4	190	PNC	1102	80.6	Nov. 26, 1975	S,E	D	
* 204	George Horton	George Horton	1975	253	5	253	PNC	1092	71.0	do	S,E	D	Mostly used for yard, garage, and garden.
205	W. R. Johnson	--	1950	250	5	250	PNC	1064	--	--	S,E	D,S	
206	H. H. Bailey	--	1940	200	4	200	PNC	1035	--	--	C,W	N	
207	Gear Tank Truck	Lindzie Hart	1965	212	5	212	PNC	1045	--	--	J,E	D	
208	do	--	1950	90	4	90	PNC	1045	--	--	C,E	D	
209	do	Lindzie Hart	old	212	4	212	PNC	1030	--	--	J,E	D	
* 210	J. B. Owen	Mr. Cullers	1960	320	5	320	PNC	1038	63.5	Feb. 12, 1976	J,E	D	Well produces from sand at 305 to 320 feet. Well reported not drilled completely through sand bed.
* 211	H. S. Shields	Jackson	1965	200	5	200	PNC	1030	31.2	Dec. 4, 1975	S,E	D	Set up as yearly water level observation well.
212	J. C. Isbell	George Horton	1971	200	5	200	PNC	1028	57.6	do	S,E	D	
213	Jacksboro Independent School District	--	1950	220	-	-	PNC	1095	--	--	C,E	Irr.	

See footnotes at end of table.

TWOBS-SI-28b

Table 1.--Records of Selected Water Wells, Test Holes, and Springs in the Vicinity of Jacksboro, Jack County, Texas—Continued

	Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
*	20-55-214	M. L. Stewart	Tommy Hart	1945	350	6	--	PNC	1091	--	--	S,E	D,S	Reported to produce from about 150 feet.
*	215	S. V. Stark	George Horton	1972	220	5	--	PNC	1095	83.8	Mar. 30, 1976	S,E	D	Set up as yearly water level observation well.
*	217	W. F. Wiggington	George Horton	1974	230	5		PNC	1135	110.6	Nov. 23, 1975	S,E	D	
	218	John Armstrong	--	1971	338	10	338	PNC	1041	--	--	N	N	Abandoned oil test. May eventually use as water well.
*	219	Max Poyner	Texas Water Development Board	1976	500	--	--	PNC	1116	94.4	Feb. 13, 1976	N	N	Drilled test hole #1 for this study. Water samples collected from two intervals (370 to 391 feet and 461 to 482 feet). Complete set of logs available.
*	220	W. R. Johnson, Estate	do	1976	492	--	--	PNC	--	--	--	N	N	Drilled as test hole #2 for this study. Water samples collected from two intervals (246 to 267 feet and 284 to 305 feet). Complete set of logs available.
*	301	Jacksboro Municipal Golf Club	Lindsie Smith	1962	210	5	210	PNC	1061	40.0	Nov. 25, 1975	C,E	D	Used for manager's house and club house.
*	302	Mrs. Worth Nelson	George Horton	1975	250	5	250	PNC	1052	120	Oct. 1975	S,E	D,S	Drilled to 270 feet, plugged back to 250 feet.
*	303	Joy Fowler	--	1950	200	4	200	PNC	1050	--	--	C,E	D	
*	304	Royce King	Ed Thomas	1962	200	5	200	PNC	1042	119.3	Nov. 20, 1975	S,E	D	Set up as yearly water-level observation well.
*	305	Billie Craft	Lindsie Smith	1952	204	5 1/2	204	PNC	1090	65	Nov. 26, 1975	S,E	S	
	306	George Brownlee	--	1945	268	5	268	PNC	1042	--	--	S,E	D	
	307	E. B. Hill	--	old	130	5	130	PNC	1062	20.7	Dec. 4, 1975	S,E	D	
	308	Bill Fowler	--	old	130	5	130	PNC	1064	22.8	do	N	N	
	309	McConnell (Spring)	--	--	--	--	--	PNC	1050	+	Nov. 11, 1975	N	N	Spring. Flows into Lost Creek just south of downtown Jacksboro.
	310	B. B. Davis	--	old	100	5	100	PNC	1104	--	--	C,W	S	
*	311	Pete Grace	Texas Water Development Board	1976	542	--	--	PNC	--	--	--	N	N	Drilled as test hole #3 for this study. Water samples collected from two intervals (123 to 144 feet and 496 to 517 feet). Complete set of logs available.
*	401	William Rogers	George Horton	--	70	5	--	PNCS	1180	21.3	Nov. 24, 1975	S,E	D,S	
*	402	J. W. Swan	--	old	20	--	--	PNCS	1200	--	--	J,E	D,S	
	501	Henry J. Richards	George Horton	1971	240	5	240	PNC	1135	81.4	Dec. 3, 1975	S,E	S	

See footnotes at end of table.

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Table 1.--Records of Selected Water Wells, Test Holes, and Springs in the Vicinity of Jacksbor, Jack County, Texas—Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
* 20-55-502	Fort Richardson	--	old	180	4 1/2	--	PNC	1072	--	--	C,E	D	
* 503	Olen Bates	George Horton	1975	220	5	--	PNC	1142	--	--	S,E	D	
* 504	Billy Plaster	do	1971	220	5	--	PNC	1100	75.4 80.4	Nov. 20, 1975 Mar. 31, 1975	S,E	D,S	Set up as yearly water level observation well.
* 601	John Panky	do	1973	160	5	160	PNC	1135	75.2	Nov. 21, 1975	S,E	D	Set up as yearly water level observation well.
602	J. H. Ferrel	--	1951	150	6	110	PNC	1160	60	Nov. 21, 1975	C,E	D	
603	do	--	1908	80	4	80	PNC	1150	20	do	C,W	S	
604	B. B. Davis	Lindzie Hart	1936	100	5	100	PNC	1120	--	--	C,W	S	
605	Fort Richardson State Park	--	--	--	--	--	--	1060	--	--	--	--	Roaring Springs. Reported to flow almost continuously. This spring was producing drilling mud in 1975 (summer) investigated by Railroad Commission.
* 701	John Matlock	--	1964	37	5	--	PNCS	1269	31.6	Dec. 25, 1975	J,E	D,S	Several old dug wells nearby, all shallow.
56-101	J. D. Hunter	George Horton	1973	240	5	240	PNC	970	14.8	Dec. 5, 1975	S,E	S	Drilled to 280 feet, completed at 240 feet.
* 201	Ed Henry Stewart	do	1971	180	5	180	PNC	1090	120	1971	C,W	S	
202	do	--	1950	80	5	80	PNC	989	40.4	Dec. 5, 1975	S,E	D,S	
401	Charles Curtis	George Horton	1972	160	5	160	PNC	1192	116.3	Nov. 17, 1975	S,E	D	
* 402	do	do	1973	160	5	160	PNC	1190	115.8	Nov. 19, 1975	S,E	D	
403	H. D. Hurd	--	1918	113	5	113	PNC	1196	--	--	C,W	S	
404	R. W. Massengale	Lindzie Hart	1959	54	5	54	PNC	1096	--	--	J,E	D	
405	do	--	old	125	5	125	PNC	1075	11.7	Nov. 22, 1975	N	N	
406	Carl Massengale	George Horton	1975	148	5	148	PNC	1090	25	do	J,E	D	Drilled to 152 feet, completed at 148 feet.
407	Roy D. Quigley	do	1974	105	5 1/2	105	PNC	1129	--	--	S,E	D	
408	do	--	1920	140	6		PNC	1128	--	--	S,E	D	
409	H. D. Jackson	--	1966	105	5	105	PNC	1109	--	--	J,E	D	Mr. Jackson's well #1.
* 410	do	George Horton	1970	105	5	105	PNC	1100	--	--	S,E	D	Mr. Jackson's well #2.
411	do	do	1970	105	5	105	PNC	1090	20	Nov. 22, 1975	S,E	D	Mr. Jackson's well #3.

See footnotes at end of table.

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Table 1.--Records of Selected Water Wells, Test Holes, and Springs in the Vicinity of Jacksboro, Jack County, Texas—Continued

	Well	Owner	Driller	Date completed	Depth of well (ft)	Casing		Water-bearing unit	Altitude of land surface (ft)	Water level		Method of lift	Use of water	Remarks
						Diameter (in.)	Depth (ft)			Below land-surface datum (ft)	Date of measurement			
	20-56-412	H. H. Flowers	--	old	100	5	100	PNC	1184	--	--	C,W	S	Mr. Flower's well #1.
	413	do	--	old	100	5	100	PNC	1186	--	--	C,W	S	Mr. Flower's well #2.
	414	T. L. Ranch	Lindzie Hart	1931	310	5	310	PNC	1132	80	Nov. 24, 1975	C,E	D,S	
	415	do	--	old	240	4	240	PNC	1045	100	do	C,E	D	Drilled to 243 feet, completed at 240 feet.
	416	J. R. Ramsey	--	1971	155	5	155	PNC	1159	70.2	Nov. 23, 1975	C,W	D	
	417	do	--	old	110	4	110	PNC	1158	53.8	Nov. 24, 1975	N	N	
*	418	do	George Horton	1969	100	5	100	PNC	1150	48.6	do	S,E	S	
*	419	G. H. King	--	1950	195	--	--	PNC	1158	--	--	S,E	D	
*	701	Henry J. Richards	George Horton	1973	200	5	200	PNC	1204	40	Jan. 17, 1973	S,E	D,S	
	702	do	--	1940	200	5	200	PNC	1203	16.0	Nov. 25, 1975	N	N	

*Chemical analysis of water shown on Table 2.

See footnotes at end of table.

TWDBS-SI-28b

Table 2.--Chemical Analyses of Water from Selected Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas

(Analyses given in milligrams per liter,except percent sodium, sodium-adsorption ratio (SAR), residual sodium carbonate (RSC), specific conductance, and pH)
Water-bearing Unit: PNCS, Cisco Group; PNC, Canyon Group

State Well Number	Aquifer Unit	Depth of Well	Date of Sample	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	* Dissolved Solids	Total Hardness as $CaCO_3$	Specific conductance Micro-Mhos/Cm^3	pH	Percent sodium	SAR	RSC
20-47-402	PNCS	120	02-26-76	17	--	97	18	34	--	381	31	25	0.5	0.4	410	315	681	7.5	18.96	0.8	0.0
20-47-701	PNCS	187	11-21-75	7	--	950	1,620	840	--	317	9,900	224	0.4	1.5	13,699	9,000	9,000	7.3	16.82	3.8	0.0
20-47-703	PNC	200	11-20-75	13	--	58	28	630	--	700	372	455	3.5	2.5	1,906	261	2,850	8.0	84.05	17.0	6.2
20-47-705	PNC	280	11-25-75	9	--	16	7	860	--	580	254	810	3.1	6.0	2,250	69	3,350	8.2	96.45	44.1	8.1
20-47-706	PNCS	110	11-25-75	9	--	11	3	640	--	690	208	432	3.9	4.3	1,650	41	2,500	8.2	97.22	44.1	10.5
20-47-710	PNC	180	12-04-75	10	--	9	3	640	--	700	195	443	3.6	0.8	1,649	34	2,570	8.3	97.56	47.2	10.7
20-47-801	PNCS	100	11-20-75	14	1.7	113	35	680	--	295	322	940	0.7	5.1	2,257	427	3,510	7.5	77.64	14.3	0.0
20-47-901	PNC	110	11-19-75	17	6.8	159	74	81	--	417	316	131	0.3	1.3	991	700	1,470	7.3	20.08	1.3	0.0
20-47-904	PNC	240	11-19-75	10	0.1	24	9	720	5.0	440	550	550	1.4	8.0	2,094	97	3,080	8.0	93.81	31.8	5.2
20-48-801	PNC	60	12-05-75	15	--	75	53	170	--	600	207	55	1.7	0.4	872	406	1,280	8.3	47.72	3.6	1.7
20-55-101	PNCS	138	12-03-75	9	--	4	3	405	--	590	181	163	2.9	3.0	1,063	24	1,650	8.4	97.52	37.3	9.2
20-55-102	PNC	190	11-21-75	10	--	10	6	334	--	530	145	129	2.4	2.1	899	50	1,450	8.1	93.60	20.6	7.6
20-55-104	PNCS	120	11-26-75	19	--	89	28	176	--	373	125	192	0.7	2.1	815	339	1,300	7.6	53.16	4.1	0.0
20-55-201	PNC	135	11-21-75	8	--	15	11	449	--	530	298	206	4.2	3.7	1,255	83	1,900	8.2	92.19	21.4	7.0
20-55-202	PNC	250	11-20-75	12	--	11	6	345	--	530	186	115	3.3	3.3	942	52	1,490	8.1	93.50	20.7	7.6
20-55-203	PNC	190	11-26-75	10	--	2	1	207	--	459	37	26	0.8	1.3	511	12	819	8.7	98.01	29.8	7.3
20-55-204	PNC	253	11-26-75	8	--	3	1	332	--	700	48	62	3.8	1.6	804	11	1,300	8.6	98.41	42.4	11.2
20-55-210	PNC	320	02-11-76	15	--	23	16	327	--	520	192	153	1.5	1.2	984	122	1,590	8.0	85.23	12.8	6.0
20-55-211	PNC	200	12-04-75	11	--	36	5	223	--	530	74	56	1.1	8.0	674	113	1,079	8.5	81.46	9.2	6.4
20-55-214	PNC	350	11-19-75	10	--	1	1	188	--	420	28	27	0.8	0.9	463	5	769	8.6	98.41	31.8	6.7
20-55-215	PNC	220	11-19-75	10	0.0	2	1	244	--	510	63	34	1.1	0.4	606	9	986	8.6	98.31	35.1	8.1
20-55-217	PNC	230	11-22-75	10	--	3	1	265	--	540	73	32	1.6	2.2	653	11	1,056	8.7	98.02	33.8	8.6
20-55-219 1/	PNC	500	02-19-76	6	0.2	33	10	1,410	--	438	106	1,990	1.8	0.4	3,773	124	6,000	8.2	96.13	55.2	4.7
20-55-219 2/	PNC	500	02-20-76	4	3.0	27	8	1,110	--	355	95	1,500	1.8	0.4	2,924	103	4,790	8.6	96.01	48.2	3.8
20-55-220 3/	PNC	492	03-25-76	--	12.9	3	1	530	7.0	690	225	156	4.0	5.0	1,283	11	2,140	9.3	98.24	67.7	11.0
20-55-220 4/	PNC	492	03-26-76	--	7.9	2	1	463	6.0	610	178	133	3.6	2.2	1,097	9	1,850	9.3	98.36	66.7	9.8
20-55-301	PNC	210	11-25-75	8	--	48	19	1,270	--	489	920	1,140	2.8	7.0	3,655	200	4,450	8.0	93.31	39.2	4.0
20-55-302	PNC	250	11-20-75	10	0.1	29	11	1,290	--	500	252	1,530	3.3	9.0	3,380	117	5,150	7.8	95.97	51.7	5.8
20-55-303	PNC	200	11-19-75	10	--	21	8	1,030	--	540	252	1,160	3.6	0.4	2,751	85	4,250	7.8	96.33	48.5	7.1
20-55-304	PNC	200	11-20-75	10	--	12	4	640	--	700	339	337	4.5	4.4	1,695	48	2,570	8.0	96.77	40.8	10.5

See footnotes at end of table.

Table 2.--Chemical Analyses of Water from Selected Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

State Well Number	Aquifer Unit	Depth of Well	Date of Sample	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	* Dissolved Solids	Total Hardness as $CaCO_3$	Specific conductance Micro-Mhos/Cm^3	pH	Percent sodium	SAR	RSC
20-55-305	PNC	204	11-26-75	12	--	4	2	398	--	660	132	124	3.6	1.7	1,002	17	1,600	8.4	97.94	40.5	10.4
20-55-311 5/	PNC	542	04-27-76	9	0.3	47	13	1,770	13.0	400	66	2,610	1.3	0.4	4,727	169	7,250	8.5	95.35	58.9	3.1
20-55-311 6/	PNC	542	04-28-76	11	0.6	9	1	156	4.0	307	50	38	0.9	0.5	421	29	692	8.5	91.46	13.1	4.5
20-55-311 7/	PNC	542	04-29-76	12	1.0	7	1	149	4.0	310	30	46	0.4	0.4	403	22	662	8.5	92.39	13.9	4.6
20-55-401	PNCS	70	11-24-75	14	1.7	100	28	142	--	399	142	138	0.5	0.4	762	366	1,198	8.3	45.85	3.2	0.0
20-55-402	PNCS	20	11-24-75	17	--	74	24	44	--	153	194	37	0.3	7.0	473	284	704	7.6	25.24	1.1	0.0
20-55-502	PNC	180	11-19-75	13	0.2	4	2	145	--	346	24	18	0.3	2.1	379	17	617	8.5	94.54	14.7	5.3
20-55-503	PNC	220	11-19-75	9	0.0	3	1	299	--	570	98	49	2.3	2.1	744	13	1,196	8.6	98.24	38.1	9.1
20-55-504	PNC	220	11-20-75	9	--	12	5	670	--	580	670	236	4.1	0.4	1,892	52	2,770	8.3	96.65	41.0	8.4
20-55-601	PNC	160	11-21-75	19	0.3	56	9	55	--	311	19	13	0.3	2.0	327	176	521	7.7	40.36	1.7	1.5
20-55-701	PNCS	37	11-25-75	17	--	81	12	76	--	244	71	82	0.3	36.0	495	251	803	8.3	39.66	2.0	0.0
20-56-201	PNC	180	12-05-75	13	--	55	20	89	--	318	77	50	0.7	1.6	463	221	765	8.0	46.86	2.6	0.8
20-56-402	PNC	160	11-20-75	22	--	127	44	89	--	540	163	60	0.3	0.4	771	500	1,150	7.5	27.99	1.7	0.0
20-56-410	PNC	105	11-22-75	24	10.0	431	128	183	--	428	990	415	0.2	0.4	2,392	1,600	2,920	7.2	19.90	1.9	0.0
20-56-418	PNC	100	12-03-75	20	--	65	17	86	--	332	53	60	0.5	1.7	466	230	762	8.0	44.62	2.4	0.7
20-56-419	PNC	195	11-24-75	10	--	9	5	640	--	820	200	363	5.3	4.5	1,640	45	2,520	8.5	97.00	42.4	12.5
20-56-701	PNC	200	11-25-75	17	--	32	16	167	--	314	75	124	0.4	1.6	587	143	975	8.2	71.38	6.0	2.2

1/This sampled collected from the interval at 461-482 feet.
2/This sample collected from the interval at 370-391 feet.
3/This sample collected from the interval at 284-305 feet.
4/This sample collected from the interval at 246-267 feet.
5/This sample collected from the interval at 496-517 feet.
6/This sample collected from the interval at 123-144 feet after one hour of jetting.
7/This sample collected from the interval at 123-144 feet after four hours of jetting.

*The bicarbonate reported in this analysis is converted by computation (multiplying by 0.4917) to an equivalent amount of carbonate, and the carbonate figure is used in the computation of this sum.

Analyses performed by the Texas Department of Health.

Table 3 .--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-47-701		
Owner: Precinct 4, Jack County Driller: Mack Roberts		
Topsoil	1	1
Blue shale	37	38
Sandy Lime rock	6	44
Blue shale	6	50
Hard sand	5	55
Blue shale	53	108
Lime rock	1	109
Grey sandy shale	25	134
Water sand (broken)	24	158
Grey shale	4	162
Lime rock	4	166
Grey shale	4	170
Water sand-lime (broken)	9	179
Blue shale	8	187
Well PL-20-47-702		
Owner: Archie Middlebrook Driller: Mack Roberts		
Topsoil	1	1
Rocky clay	5	6
Shale, lime and sand rock	14	20
Shale, blue and grey	58	78

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-47-702 --Continued		
Sandy shell	2	80
Shale, grey	12	92
Hard sand and lime shells	13	105
Shale	12	117
Water sand	11	128
Lime, rock	2	130
Water sand	7	137
Well PL-20-47-703		
Owner: L. C. Whitsitt Driller: George Horton		
Surface clay	2	2
Sandstone and clay	14	16
Shale with sandstone streaks	50	66
Sandstone and shale	32	98
Shale	20	118
Shaley sand	7	125
Sandy lime	3	128
Sandstone (medium, soft)	20	148
Shale	3	151
(Tight) sandstone	5	156
Sandstone (medium, soft)	8	164
(Tight) sandy lime	3	167
Sandstone (medium soft)	10	177
Shale	3	200

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-47-708		
Owner: Ralph Conway		
Driller: Mack Roberts		
Topsoil	3	3
Limerock	2	5
Sandrock	5	10
Clay and shale, yellow, blue and grey shale	68	78
Lime shells and sand streaks	16	94
Grey shale	24	118
Sandy shale, lime shells	6	124
Grey shale	4	128
Sandy shale	3	131
Water sand	7	138
Blue and grey shale	13	151
Water sand	16	167
Grey and blue shale	34	201
Well PL 20-47-710		
Owner: Ira Whitsitt		
Driller: George Horton		
Surface clay	3	3
Sandstone	2	5
Clay	19	24
Shale	45	69
Shale with streaks lime and sandstone	13	82

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-47-710--Continued		
Sandstone	7	89
Shale and sandstone	10	99
Shale	21	120
Shale with streaks sandy lime	11	131
Sandstone (medium soft)	9	140
Well PL-20-47-801		
Owner: Warren W. Rummage Driller: George Horton		
Surface	4	4
Clay with streaks sandstone	37	41
Shale	11	52
Shale with streaks sandstone	16	68
Sandstone	2	70
Sandstone medium soft and shale	11	81
Sandstone medium soft	9	90
Shale	6	96
Limey sandstone	2	98
Shale streaks limey sandstone	2	100
Well PL-20-55-102		
Owner: J. T. Rummage Driller: Mac Roberts		
Topsoil	1	1
Brown Clay	2	3
Lime rock	3	6

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-55-102--Continued		
Yellow clay	12	18
Grey clay	36	54
Grey sandy shale	13	67
Broken lime and sand	13	80
Grey shale	8	88
Sandy lime rock	14	102
Grey shale	9	111
Sandy lime rock	8	119
Blue shale	6	125
Water sand	9	134
Blue shale	7	141
Sandy lime rock	4	145
Water sand	4	149
Shale	41	190
Well PL-20-55-104		
Owner: Ronnie Smith Driller: George Horton		
Clay	1	1
Clay and sandstone	2	3
Clay	15	18
Tight sandstone	2	20
Clay with sandstone	11	31
Shale with lime streaks	19	50
Sand	14	64

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-55-104--Continued		
Shale and sand	7	71
Shale with streaks sandstone	48	119
Limestone	16	135
Shale with lime streaks	15	150
Well PL-20-55-108 Owner: John W. Pursley Driller: George Horton		
Surface	1	1
Lime broken and clay	6	7
Shale	17	24
Shale with streaks sandstone	38	62
Sandstone (medium soft)	8	70
Limestone	3	73
Redbed	52	125
Shale and sandstone	15	140
Sand	35	175
Shale with sand and sandstone	45	220
Well PL-20-55-204 Owner: George Horton Driller: George Horton		
Surface	0	2
Sandstone	7	9
Clay	31	40
Shale	15	55

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-55-204--Continued		
Shale and sandstone	7	62
Sandstone (broken)	8	70
Shale	8	78
Lime	24	102
Shale	20	122
Shale and limey sandstone	6	128
Shale and sandstone	7	135
Well PL-20-55-212		
Owner: J. C. Isbell Driller: George Horton		
Surface clay	11	11
Sandstone	6	17
Shale	10	27
Sandstone (medium soft)	4	31
Shale	5	36
Sandstone (Hard)	1	37
Shale	8	45
Limestone	25	70
Shale	21	91
Sandstone	7	98
Shale with streaks sandstone	40	138
Limestone	7	145
Shale	16	161
Sand	39	200

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
WELL PL-20-55-215		
Owner: S. V. Staris, Sr.		
Driller: George Horton		
Surface clay	0	7
Clay with streaks sandstone	27	34
Sandstone	6	40
Shale with streaks sand and sandstone	14	54
Lime	24	78
Black shale	23	101
Hard sand	10	111
Shale	10	121
Shale with streaks sandstone and lime	25	146
Lime	6	152
Shale with sandstone and lime	22	174
Sand	29	205
Shale with lime streaks	15	220
Well PL-20-55-217		
Owner: W. F. Wigington		
Driller: George Horton		
Surface	0	2
Clay	14	16
Sandstone	23	39
Shale	12	51
(Tight) sandstone broken with shale	6	57
Shale	8	65

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-55-217--Continued		
Lime	6	164
Sandstone and shale	11	175
Sandstone	4	179
Well PL-20-55-219		
Owner: Max Poyner Driller: Lewis Barnes, T.W.D.B.		
Topsoil-red brown to yellow sandy clay	2	2
Interbedded siltstone and very fine grained sandstone-gray, tan, yellow, and green with a few thin streaks of clay	18	20
Gray shale,drills hard,turning black at 26 feet and getting harder	12	32
Hard grey sand with limey streaks, sand very thin grained,soft streak at 36-37 feet	8	40
Softer grey sand,broken,with streaks of grey shale	10.5	50.5
Very hard crystalline limestone,fossil hash with crystalline matrix,black and brown	9.5	60
Hard white to light grey limestone,fossiliferous, turning darker towards the bottom	15	75
Hard dark grey to black limestone,very fossiliferous	2	77
Alternating hard and soft shale,black and dark grey,some streaks of fine grey sand at 95-110 feet	63	140
Broken shale and limestone,dark grey to white and tan	5	145
Very hard white-tan-grey and brown fossiliferous limestone,a few thin streaks of dark grey calcareous shale,fossils(mostly brachiopods and crinoid fragments)	8	154

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-55-219--Continued		
Black fissile shale,very fossiliferous oxidation rings,shale lighter in color at end with a few thin streaks of fine grained-cross-bedded tan to blue-grey sandstone	15	169
Grey to blue fine-to very fine-grained sandstone with thin streaks and isolated lumps of blue shale(non-fossiliferous non calcareous)	10	179
Broken dark grey shale and thin beds of cross-bedded fine-grained light grey sandstone-non calcareous	6	185
Black and dark grey shale,non calcareous,no apparent fossils except a few imprints of fusilinids at 233-243 feet,waxy to about 223,silty after that	68	253
Black and dark-grey silty shale,with a few thin streaks of tan siltstone or shale,non calcareous silty streaks appear coarser grained toward bottom	50	303
Hard white crystalline limestone,many fossils and fossil fragments,limestone styolitic with pyrite crystals in stylolite breaks	9	312
White, light-grey, and blue shale,calcareous in upper part,highly contorted bedding with a few streaks of gold to brown siltstone or very fine sandstone	24	336
Hard, white to grey limestone,very fossiliferous, fossil hash cross-bedded in last 2 feet	7	343
Black to dark grey fissil shale,noncalcareous	2	345
Light grey to white limestone,interbedded hard crystalline limestone and softer mottled vuggy limestone-vugs filled with silty-graining limestone,very fossiliferous-Bryzoans, Crinoids Brachiopods. Broken in lower part with very thin beds of calcareous shale	25	370
Light to medium grey limestone,cross-bedded,bioherm structure,high fossiliferous-mostly Crinoid and Brachipods,calcareous shaley streaks dark grey bands in lower part with increasing sand in last foot	16	386

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-55-219--Continued		
Very fine-grained medium grey to blue and green sandstone,with streaks of dark grey-bedding highly deformed,cross-bedded,some streaks of black sandstone,one foot of medium-grained sandstone at 390-400 feet,interbedded with thin beds of dark grey shale at bottom		403
Interbedded black to dark grey shale and sandy shale with thin streaks of very fine-grained sandstone, sandstone is usually calcareous shale calcareous in streaks,few fossils,some carbonized plant fragments in dark shale 1/	45	448
Hard white to grey limestone 1/	7	455
Dark grey shale 1/	7	462
Hard grey sandstone-with dark grey shale 1/	32.5	494.5
Well PL-20-55-220		
Owner: W. R. Johnson, Estate Driller: Lewis Barnes, T.W.D.B.		
Red top soil-with chunks of yellow sandstone clay streaks	3	3
Medium hard sandstone,variegated colors-yellow, brown, red, grey,some thin beds of shale and siltstone, sandstone fine-grained	22	25
Soft tan to grey shale,streaks of green-red shale at 34 feet,tan at 35.5 feet	13	38
Hard light gray limestone,grainy	4	42
Light grey silty shale interbedded with soft very fine sandstone,some thin streaks of gray plastic shale,some green and yellow shale	10.5	52.5

1/Very poor samples below 435.

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-55-200--Continued		
Interbedded hard light gray to white limestone and gray shale,possibly thin streaks of vary fine sand at 55-60 feet,limestones are very fossiliferous, shales non-calcareous	22.5	75
Hard dark gray to black fossiliferous limestones, gets lighter in color with depth,turns tan to white at 40 feet,some thin streaks of grey shale	36.5	111.5
Soft dark grey shale non-calcareous drilled mushy some green streaks	29.5	141
Hard green-grey-yellow shale with some hard limestone streaks,some white grainy limestone streaks, soft shale at 145 feet still a few hard streaks (drills like sandstone)	41	182
Hard, white--brown fossiliferous limestone fossils and fossil fragments in crystalline matrix,many crinoid pieces	11	193
Grey and green shale,medium soft-very soft in streaks, black streaks at 210-230 feet, possibly carbonized plant fragments	37	230
Interbedded tan and grey shale and fine-grained sandstone,thin bedded,sandstone increases with depth turns grey-blue,cross-bedded with small (1 to 2 inch) oxidation circles and small lumps of grey clay,drills relatively soft	66	296
Hard,white to light grey sandstone with a few black spots,sand slightly coarser but still very fine grained,a few streaks of multicolored shale	14	310
Hard and soft layers of shale,grey-yellow-green, possibly a few thin layers of fine grained grey sandstone	20	330
Interbedded shale and sandstone,grey colored, sand very fine grained,less sand 355-359 feet	29	359
Interbedded sandstone, shale, and limestone, multicolored,hard limestone at 367-371 feet,drills rough	11	370

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL 20-55-220--Continued		
Grey to blue green shale and sandstone, hard, white to light grey limestone,very fossiliferous-Crinoids-Brachipods,a few very thin streaks of gray shale, 1 1/2 feet of dark grey shale at 397 feet	20	390
Very thin streaks of gray shale 1 1/2 feet of dark grey shale at 397 feet,white algal limestone 400-409 feet with thin grey shale breaks	65	445
Hard and soft layers of grey shale,possibly a few thin streaks of limestone	20	465
Hard white limestone,sandy at bottom	12	477
Gray shale	7	485
Hard white limestone	7	492
Well PL-20-55-302		
Owner: Mrs. Worth Nelson Driller: George Horton		
Surface sandy clay	2	2
Clay	11	13
Sandstone	17	30
Clay	12	42
Shale	22	64
Clay sandstone streaks and shale	11	75
Lime	17	92
Shale with lime streaks	58	150
Shale with sandstone (medium soft)	16	166
Shale	16	182
Lime	6	188

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-55-302--Continued		
Shale with lime streaks	15	203
Shale	29	232
Shale with limey sandstone	6	238
Sand	18	256
Limey sandstone and sand	6	262
Shale	8	270
Well PL-20-55-311		
Owner: Pete Grace Driller: Lewis Barnes, T.W.D.B.		
Red sandy soil	1	1
Hard red-brown to white limestone,fossiliferous	25	26
Dark grey to black shale,soft 26 to 51 feet,soft and hard streaks,multicolored	59	85
Medium hard grey very-fine grained sandstone	4	89
Soft grey shale	2	91
Hard,white and brown,fossiliferous limestone	9	100
Broken sandstone and shale,sand white fine-grained, shale multicolored	20	120
Fine to medium grained sandstone-white to light grey-crossbedded with thin black sand streaks with some plant remains,a few thin beds of blue-grey shale	40	160
Interbedded sandstone and shale,grey,silty	8	168
Grey silty shale with thin breaks of limestone, rough drilling	13	181
Grey,silty shale	29	210

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas--Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-55-311--Continued		
Interbedded shale, limestone, and sandstone;shale multicolored, sand grey-fine-grained, limestone brown and yellow	33	243
Dark grey shale with some white and grey sandstone	34	281
Very hard,white to tan,fossiliferous limestone	15	296
Light to medium grey shale and sandstone black specks in sample,sand very fine	15	311
Hard white to tan,fossiliferous limestone,rough drilling in spots,nodular limestone,some thin beds of sandstone and shale , many color changes in limestone ,crinoids and brachipods mostly,more shale near base	54	365
Interbedded,grey to white,fine-grained,sandstone and gray to black shale,black streaks of plant material in sand, less sand toward bottom	62	427
Hard,white to grey and brown ,limestone ,fossiliferous, some softer limestone and shale breaks	17	444
White to light grey,fine-grained sandstone interbedded with grey clay,a few hard streaks possibly limestone	74	518
Grey shale	17	535
Hard white and brown limestone,fossiliferous	5	540
Well PL-20-55-501		
Owner: Henry J. Richards Driller: George Horton		
Surface	1	1
Lime	24	25
Shale	16	41
Sandstone	5	46

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-55-501--Continued		
Shale	38	84
Lime	6	90
Shale	7	97
Sandstone (Medium soft)	42	139
Tight sandstone	4	143
Shale with streaks sandstone	40	183
Sandstone (broken) with shale	57	240
Well PL-20-55-503		
Owner: Olen Bates Driller: George Horton		
Clay	0	3
Sandstone	12	15
Clay and shale	8	23
Sandy, lime	2	25
Shale	6	31
Shale and sandy lime	6	37
Sandy lime	1	38
Shale	2	40
Lime	35	75
Shale	17	92
Sandstone	5	97

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-55-504		
Owner: Billy Plaster Driller: George Horton		
Surface clay with sandstone	0	12
Sandstone	7	19
Clay	7	26
Lime	33	59
Shale	15	74
(Tight) sandy lime	2	76
Sandstone and shale	5	81
Sandstone (medium soft)	7	81
Shale	28	122
Lime	7	129
Shale with lime streaks	18	147
Well PL-20-55-601		
Owner: John Panky Driller: George Horton		
Surface clay	0	2
Lime	16	18
Shale	39	57
Sandstone	5	62
Shale with streaks sandstone	16	78
Lime	5	83
Shale	8	91

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-55-601--Continued		
Shale with sand and sandstone	7	141
Sand and sandstone	13	154
Shale with sand and sandstone	6	160
Well PL-20-56-101		
Owner: J. D. Hunter Driller: George Horton		
Surface	4	4
Sandy clay	23	29
Shale with streaks sandstone	22	49
Limey sandstone	1	50
(Medium soft) sandstone and shale	5	55
Shale with streaks sandstone	48	103
Lime	6	109
Shale and redbed	13	122
Lime	29	151
Lime and shale with sandy shale	26	177
Shale with (medium soft) sandstone	29	206
Shale	11	217
Sandstone	4	221
Shale with streaks sandstone	15	236
Lime	10	246
Shale with streaks lime and sandstone	14	280

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-56-201		
Surface clay	3	3
Sandstone	3	6
Clay with sandstone	12	18
Shale with sandstone	4	22
Sandstone	3	25
Shale with streaks sandstone	74	99
Sandstone and sand	19	118
Shale with sand and sandstone	16	134
Sandstone and sand	22	156
Sandstone limey and sand	10	166
Shale and sandy lime	14	180
Well PL-20-56-401 Owner: Charles W. Curtis Driller: George Horton		
Surface	3	3
Lime	6	9
Clay	30	39
Shale	12	51
Sandy lime	8	59
Shale with streaks sandstone	28	87
Lime borken	2	89
Shale with streaks sandstone	15	104

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-56-401--Continued		
Sand	26	130
Shale and sand with sandstone	8	138
Sandstone	3	141
Shale with streaks sandstone	19	160
Well PL-20-56-416		
Surface	3	3
Clay and sandy clay	22	25
Shale with streaks sandstone	5	30
Lime	6	36
Shale	7	43
Sandstone (medium soft)	22	65
Brown sand	17	82
Shale with streaks sandstone	129	211
Lime	10	221
Shale with streaks redbed and clay	23	244
Lime	3	247
Shale	11	258
Lime	35	293
Shale with lime streaks	27	320

Table 3.--Drillers' Logs of Wells and Test Holes in the Vicinity of Jacksboro, Jack County, Texas—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PL-20-56-701		
Surface	3	3
Sandstone and clay	27	30
Shale with streaks sandstone	32	62
Lime	8	70
Shale with streaks sandstone	31	101
Sandstone and shale	21	122
Sandstone (medium soft)	20	142
Lime and shale	5	147
Shale with streaks sandstone	22	169
Sandstone (medium soft)	11	180
Shale	20	200

Table 4.--Data on Abandoned Jacksboro City Wells

June 1945 Pumpage Rates (Measured by City)

Well Number	Pumpage (GPM)	Well Number	Pumpage (GPM)
1	8.240	10	14.818
2	7.161	11	8.343
3	6.699	12	8.034
4	6.984	13	20.638
5	7.547	14	11.124
6	9.933	16	9.933
7	9.933	17	10.197
8	10.506	18	14.190
9	9.240	19	9.933

TOTAL (from 18 wells)
August 18, 1945 = 263.303 gallons per minute

DEPTHS

Well Number	Depth (feet)	Well Number	Depth (feet)
1	189		
3	174	12	163
4	200	13	152
5	182	14	152
6	169	16	233
7	172	17	270
8	173	18	251
10	163	19	188
11	180		

DRILLER'S LOGS

Well Number 13	Thickness (feet)	Depth (feet)
Surface	5	5
Lime	26	31
Dark Shale	29	60
Light shale	35	95
Lime	7	102
Blue shale	2	104
Red bed	2	106
Water sand	46	152

Table 4.--Data on Abandoned Jacksboro City Wells--Continued.

Well Number 16	Thickness (feet)	Depth (feet)
Lime rock	20	20
Black shale	30	50
Gray shale	17	67
Lime rock	2	69
Shale	6	75
Lime	5	80
Shale	2	82
Lime rock	7	89
Gray shale	12	101
Water sand	55	156
Black shale	22	178
Shale and rock	55	233

Well Number 17		
Broken lime	5	5
Black shale	45	50
Gray shale	10	60
Lime rock	2	62
Red shale	6	68
Lime rock	2	70
Gray shale	6	76
Hard lime rock	6	82
Black shale	12	94
Water sand	47	141
Shale	4	145
Dark water sand	15	160
Sandy shale	8	168
Gray shale	8	176
Sticky shale	8	184
Gray shale	8	192
Sandy lime	4	196
Black sticky shale	4	200
Dark water sand	20	220
Black sticky shale	10	230
Broken lime rock	5	235
Sticky shale	35	270
Hard lime rock	8	278
Sandy lime	2	280
Gravel and shale	2	282
Sticky shale	19	301
Brown lime rock	4	305
Sticky shale	7	312
Lime rock	8	320
Sandy lime	2	322

Table 4.--Data on Abandoned Jacksboro City Wells--Continued

Well Number 17--Continued	Thickness (feet)	Depth (feet)
Lime	3	325
Lime rock	18	343
Shale	4	347
Lime	2	349
Sandy shale	6	355
Lime	3	358
Shale	4	362
Cap rock for sand	4	366
Water sand (no good)	11	377
Sandy shale	7	384
Shale	13	397
Well Number 18		
Lime	14	14
Black shale	33	47
Gray shale	25	72
Black shale	13	85
Lime rock	4	89
Cleaky (Sic)	7	96
Gray shale	12	108
Water sand	8	116
Sandy shale	3	119
Water sand	42	161
Sandy shale	19	180
Black shale	4	184
Sandy shale	10	194
Heavy shale	4	198
Light sandy shale	7	205
Heavy sandy shale	5	210
Sand rock	11	221
Shale	5	225
Sand rock	2	227
Lime shells	2	229
Black sticky shale	11	240
Well Number 19		
Lime	4	4
Shale	66	70
Lime	9	79
Sandy shale	11	90
Black shale	4	94
Hard sand	2	96
Sandy shale	3	99

Table 4.--Data on Abandoned Jacksboro City Wells--Continued

	Thickness (feet)	Depth (feet)
Hard sand, water	21	120
Soft sand	15	135
Hard sand	2	137
Black shale and coal	2	139
Sand	5	144
Sandy shale	11	155
Broken sand	5	160
Sand	8	168
Sandy shale	7	175
Sand	10	185
Sandy shale	3	188

General Data

Well Number	Date Drilled	Driller
12	1947	-
13	May, 1937	Westley Preston
15	June 16, 1947	-
16	September, 1944	Olin Patton
17	August, 1944	Olin Patton
18	September, 1944	Olin Patton
19	July 20, 1945	Olin Patton

Table 5.--Results of Analysis of Cores from Test Holes

Depth ft.	Bulk Density gm/cc	Vertical Permeability (4-in. core) gpd/ft^2	Horizontal Permeability (2-in. core) gpd/ft^2	Percent Porosity	Percent Absorption
			Test Hole 1		
170-171	2.33	.99	19.48	26.3	8.73
171-172	2.28	Imp.	22.68	20.2	8.28
172-173	2.33	4.19	2.65	35.9	10.59
173-174	2.25	1.21	10.34	34.3	10.60
174-175	2.23	3.54	20.14	30.3	10.17
175-176	2.28	1.75	3.65	22.1	9.05
176-177	2.28	.03	.37	22.3	8.23
177-178	2.28	.07	3.71	19.4	9.09
178-179	2.27	.97	.86	15.8	7.18
179-180	2.29	.05	6.57	18.1	8.19
			Test Hole 2		
260-261	2.15	.60	.03	21.5	9.95
263-264	2.14	.08	--	24.9	11.42
265-266	2.16	.07	--	22.5	11.27
268-269	2.16	2.48	--	19.6	9.46
270-271	2.11	1.53	4.46	18.5	8.57
273-274	2.15	.87	--	20.7	10.19
275-276	2.15	.04	--	21.2	10.75
278-279	2.15	2.16	--	20.7	10.31
			Test Hole 3		
129-130	2.23	46.46	92.98	28.6	12.85
133-134	2.22	1.35	--	24.6	12.50
134-135	2.22	12.53	--	21.9	12.17
138-139	2.19	8.20	24.60	21.5	9.09
140-141	2.24	6.07	--	26.6	12.21
143-144	2.20	13.95	33.19	24.9	13.05
146-147	2.18	13.27	39.24	26.7	13.74
149-150	2.20	4.50	35.99	28.8	13.52

JACK COUNTY STUDY
Test Hole #1

Depth	Sieve Size	Percent Retained
170'-171'	#40 (0.420 mm)	4.5
	#50 (0.297 mm)	47.7
	#70 (0.210 mm)	82.2
	#100 (0.149 mm)	90.9
	#140 (0.105 mm)	94.4
	#200 (0.075 mm)	97.5
171'-172'	#40 (0.420 mm)	1.0
	#50 (0.297 mm)	44.2
	#70 (0.210 mm)	80.2
	#100 (0.149 mm)	90.7
	#140 (0.105 mm)	94.0
	#200 (0.075 mm)	97.0
172'-173'	#40 (0.420 mm)	6.5
	#50 (0.297 mm)	31.7
	#70 (0.210 mm)	63.5
	#100 (0.149 mm)	80.2
	#140 (0.105 mm)	88.5
	#200 (0.075 mm)	95.0
174'-175'	#40 (0.420 mm)	.5
	#50 (0.297 mm)	11.5
	#70 (0.210 mm)	55.7
	#100 (0.149 mm)	81.0
	#140 (0.105 mm)	92.5
	#200 (0.075 mm)	96.7

Table 6.--Results of Sieve Analysis of
Cores from Test Holes

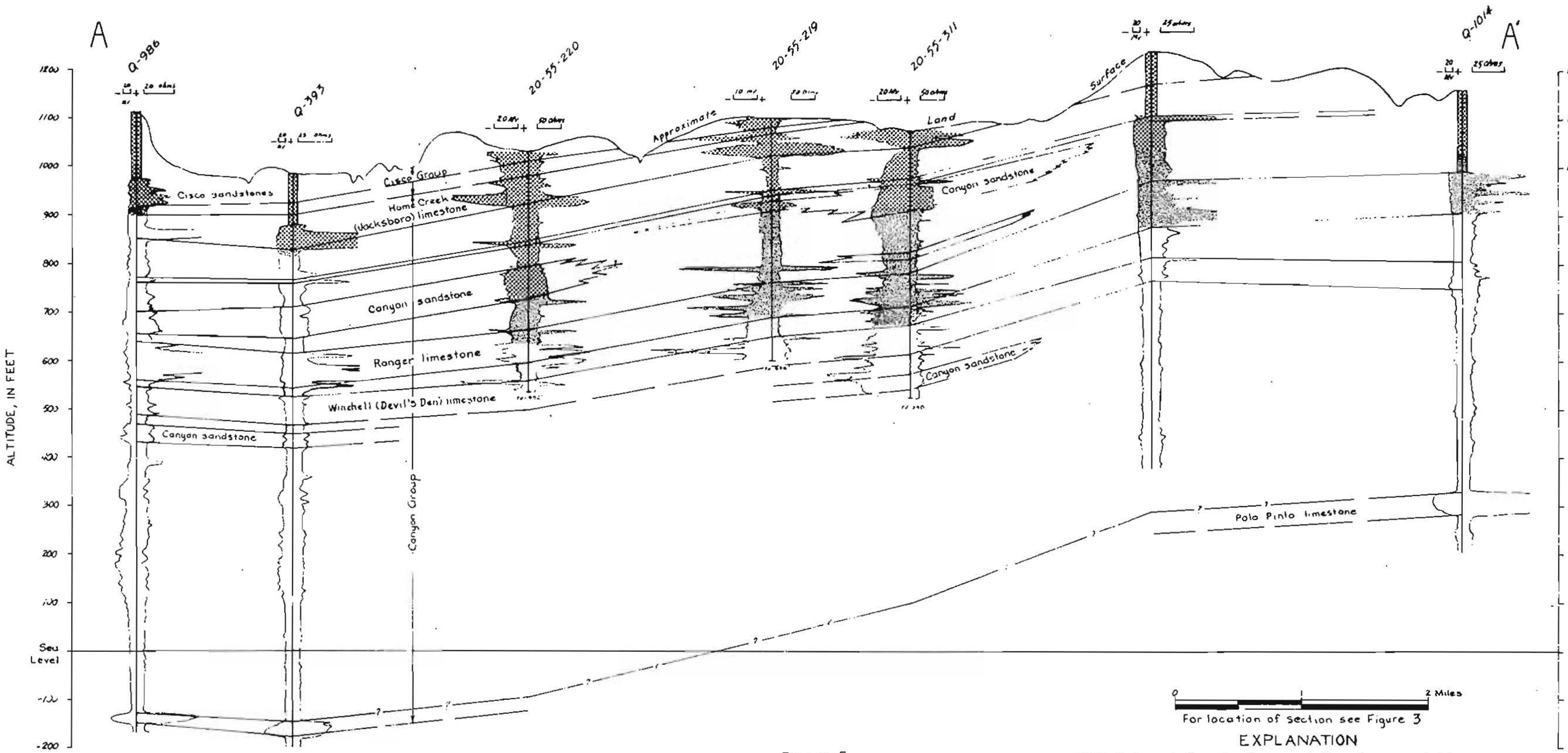
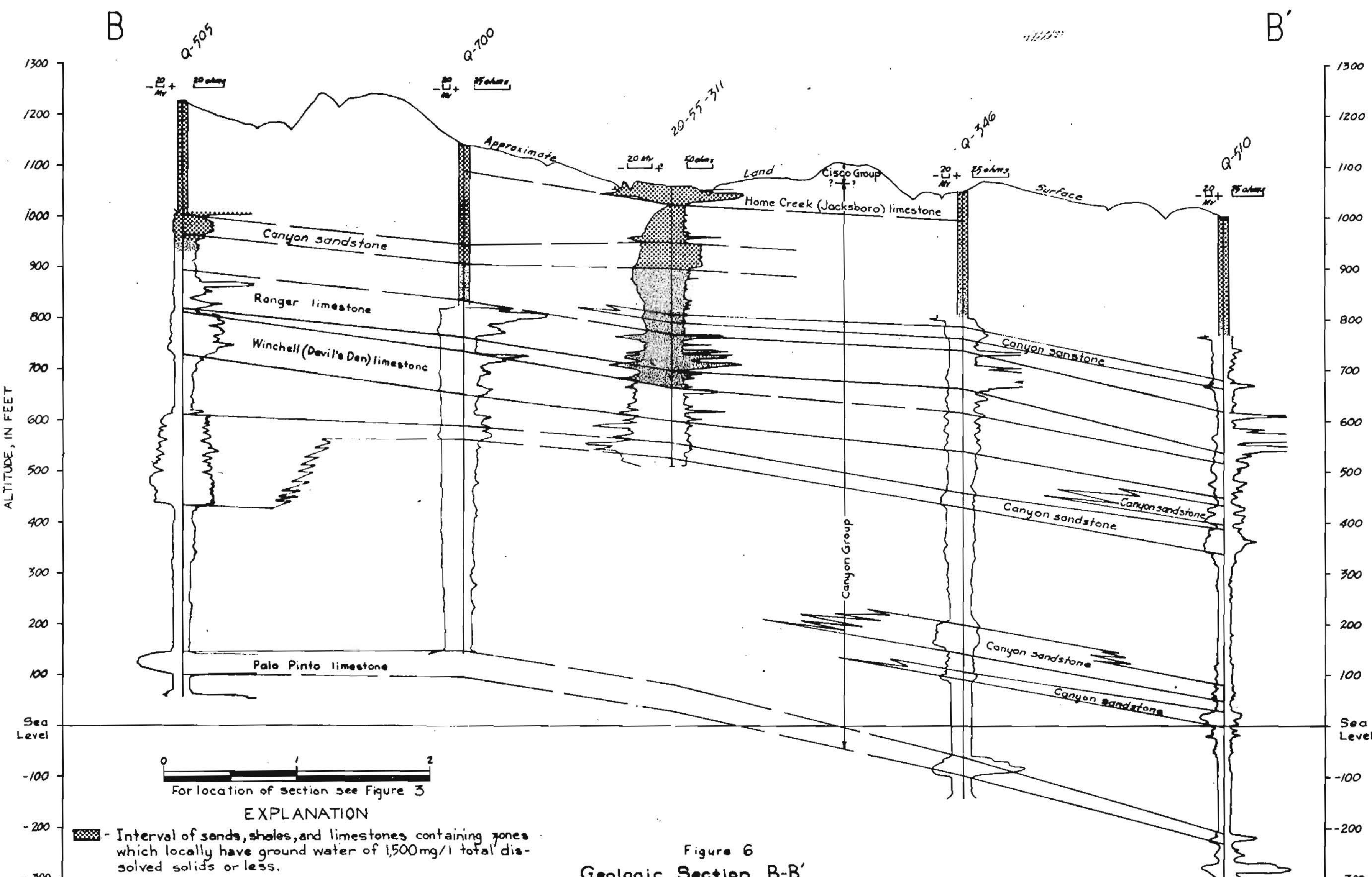


Figure 5
Geologic Section A-A'

EXPLANATION

- Interval of sands, shales, and limestones containing zones which locally have ground water of 1,500 mg/l total dissolved solids or less.
- Interval of sands, shales, and limestones which may locally contain thin zones having ground water ranging from 1,500 to 3,000 mg/l total dissolved solids.



EXPLANATION

- Interval of sands, shales, and limestones containing zones which locally have ground water of 1,500 mg/l total dissolved solids or less.
- Interval of sands, shales, and limestones which may locally contain thin zones having ground water ranging from 1,500 to 3,000 mg/l total dissolved solids.

Figure 6

Geologic Section B-B′

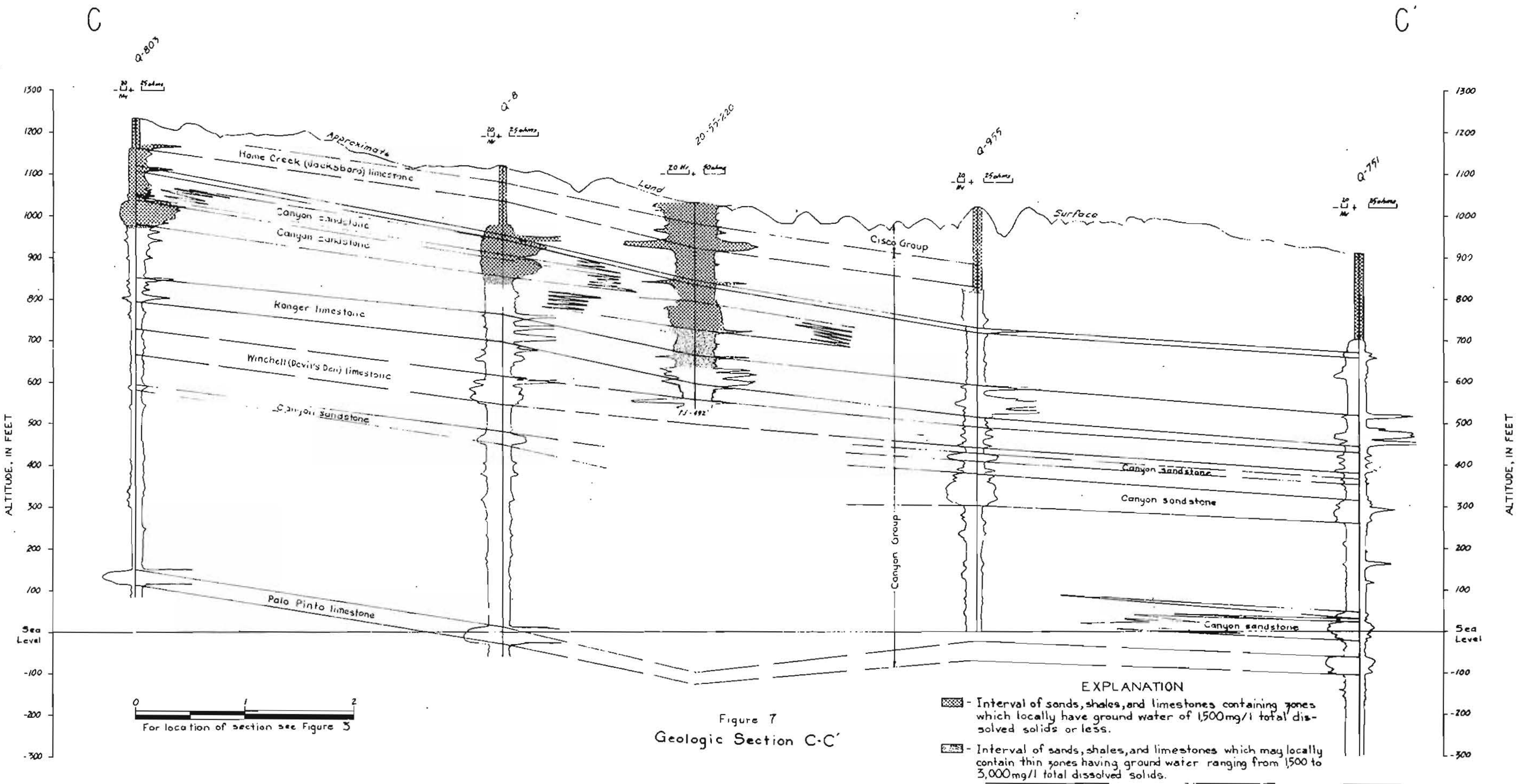


Figure 7
Geologic Section C-C′