TEXAS WATER DEVELOPMENT BOARD

REPORT 62

GROUND-WATER RESOURCES OF ELLIS COUNTY, TEXAS

By

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TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd.)

TABLES

TABLE OF CONTENTS (Cont'd.)

FIGURES

TABLE OF CONTENTS (Cont'd.)

Page

G R O U N D - W A T E R   R E S O U R C E S   O F

E L L I S   C O U N T Y ,   T E X A S

ABSTRACT

The principal water-bearing formations in Ellis County are the Hosston Formation, the Paluxy Sand, and the Woodbine Formation; the Quaternary alluvium is a minor but potentially useful aquifer for local irrigation near the Trinity River and other large streams in the county. The Woodbine is exposed in a small area in the northwestern part of the county; the alluvium occurs along the major streams; none of the other principal aquifers crop out in Ellis County.

With exception of the Hosston Formation, in which the water moves northward, and the alluvium, in which the water probably moves toward the streams, the ground water in Ellis County generally moves east-southeastward down the dip of the aquifers. The rate of ground-water movement varies from about 10 to 40 feet per year. The hydraulic gradient in most of the principal aquifers is about 10 to 18 feet per mile.

In 1964, about 4.8 mgd (million gallons per day), or 5,400 acre-feet, of ground water was used for public supply, industry, irrigation, rural domestic, and livestock needs combined.

Of the total amount of ground water used in 1964, about 3,500 acre-feet or 65 percent was from the Woodbine Formation, about 1,840 acre-feet or 34 percent from the Hosston Formation, about 40 acre-feet or 0.8 percent from the Quaternary alluvium, and about 8 acre-feet or 0.2 percent from the Paluxy Sand.

Estimates using the 1965 hydraulic gradient indicate that the Hosston Formation annually transmits about 2,670 acre-feet of ground water (2.4 mgd), and the Woodbine about 3,500 acre-feet (3.1 mgd). The Paluxy transmits somewhat less--perhaps on the order of 1,000 acre-feet per year (about 1 mgd).

Pumpage from the Hosston Formation and Paluxy Sand probably can be increased by about 1,000 acre-feet per year (1 mgd) from each. In 1964, pumpage from the Woodbine about equalled the amount transmitted, but considerable ground water (1,200,000 acre-feet) is available from storage in the Woodbine at depths less than 400 feet below the surface.

Not all of the available ground water in Ellis County meets the chemical quality standards established by the U.S. Public Health Service. Most of the water is high in sodium, bicarbonate, fluoride, and dissolved solids (99 percent of the analyzed samples exceeded 500 ppm and 81 percent exceeded 1,000 ppm). Most water, except that from the alluvium, is soft. No ground-water samples were of a quality desirable for sustained irrigation except that from the alluvium.

G R O U N D - W A T E R R E S O U R C E S O F
E L L I S C O U N T Y , T E X A S

INTRODUCTION

Purpose and Scope of the Investigation

Information on the ground-water resources of Ellis County and on the methods of deriving maximum benefits from the available supplies is presented in this report.

The scope of the investigation includes a determination of: the location and extent of important fresh water-bearing formations; the chemical quality of the water; the quantity of ground water being withdrawn; the hydraulic characteristics of the important water-bearing units; an estimate of the quantity of ground water available for development from each of the important aquifers; and a consideration of all significant ground-water problems in Ellis County.

Records of 220 water wells, springs, and test holes (Table 6), including 50 electrical logs of oil tests and water wells, and 54 drillers' logs (Table 7) were collected and studied. Water samples from 114 wells were collected and analyzed (Table 8). Present and past pumpage of ground water was inventoried, and pumping tests were made in eight wells to determine the hydraulic characteristics of the aquifers.

The technical terms used in discussing the ground-water resources of the county are defined and listed alphabetically in the section entitled "Definitions of Terms."

Location and Extent of the Area

Ellis County, an area of 951 square miles, is in the central part of northeastern Texas (Figure 1) between latitudes 32°03' and 32°33' N and longitudes 96°23' and 97°06' W. It is bordered on the northwest by Tarrant County, on the north by Dallas County, on the east by Kaufman and Henderson Counties, on the southeast by Navarro County, on the southwest by Hill County, and on the west by Johnson County. Waxahachie, the county seat, is in the central part of the county about 26 miles south of Dallas.

Climate

Ellis County has a dry to moist subhumid climate (Thornthwaite, 1952, fig. 30). Hot summers and mild winters generally provide a long growing season

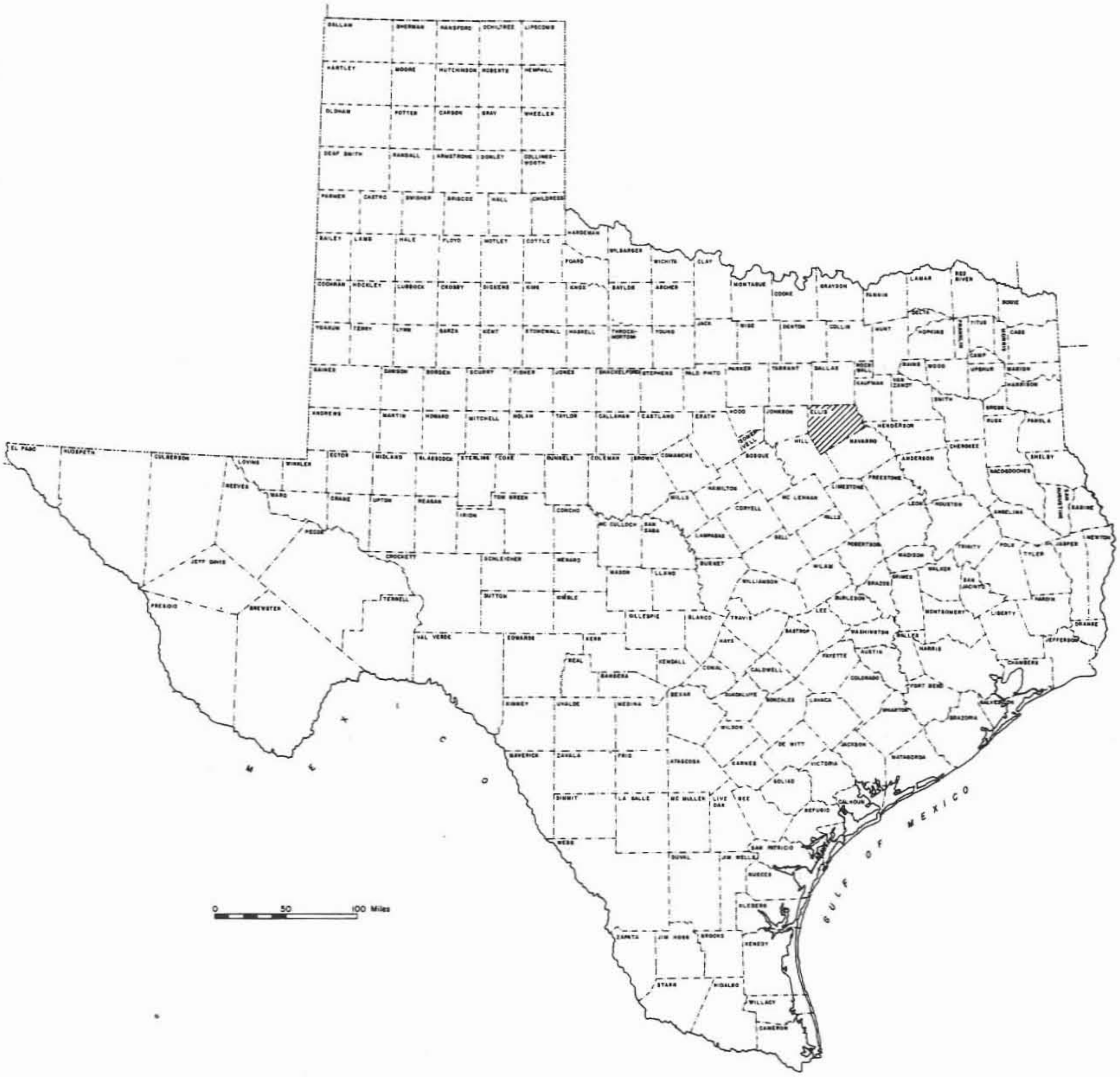

Figure 1

Location of Ellis County

U.S. Geological Survey in cooperation with the Texas Water Development Board

of approximately 246 days. The annual rainfall, which averages 34 inches in the western part of the county and 38 inches in the eastern part, is sufficient to sustain extensive agricultural development.

The average annual temperature at Waxahachie for the period 1931-65 was 66°F. The average annual precipitation was 34.44 inches during the same period, and the average annual gross lake surface evaporation for the county was 61.8 inches (Lowry, 1960, p. E-11).

The average monthly temperature, precipitation, and gross lake surface evaporation are listed in the following table:

Monthly Averages

Month	Temperature at Waxahachie, in °F	Precipitation at Waxahachie, in inches	Gross lake evaporation in Ellis County, in inches
January	45.7	2.56	2.3
February	49.2	2.97	2.6
March	55.3	2.42	3.7
April	65.0	3.97	4.2
May	73.2	4.53	5.2
June	81.3	3.53	6.6
July	85.1	1.99	8.1
August	85.2	1.79	8.9
September	78.2	3.28	7.2
October	67.6	2.69	5.9
November	55.2	2.70	4.2
December	47.5	2.74	3.0

Physiography and Drainage

Ellis County is in the northwestern part of the West Gulf Coastal Plain of Texas (Fenneman, 1938, p. 102-108; Deussen, 1924, fig. 2), and includes part of the White Rock escarpment (Austin Chalk) and the Black Prairie (Fenneman, 1938, pl. VII). Elevations in the county range from slightly less than 305 feet at the eastern tip of the county along the Trinity River channel to 898 feet on the escarpment about 3.5 miles south-southwest of Midlothian. The escarpment is a moderately dissected outcrop of the Austin Chalk, trending north-northeastward across the western quarter of Ellis County. Eastward from the escarpment, the topography is gently rolling, becoming nearly flat near the Trinity River.

Ellis County is totally within the drainage basin of the Trinity River (Peckham and others, 1963, fig. 1). The county has an extensive network of streams, but only 10 of the principal streams, including the bounding Trinity River, are perennial. The others flow intermittently. The perennial streams within the county are Red Oak Creek; Bear Creek; Village Creek; Cummins Creek; Waxahachie Creek and its upper tributaries, North Prong Creek and South Prong Creek; Chambers Creek; and South Fork Chambers Creek.

Economic Development

In 1965, the population of Ellis County was approximately 44,600, of which 73 percent lived in towns or villages of 50 or more inhabitants. The larger towns and villages, with their populations in 1960, are as follows: Waxahachie, 12,749; Ennis, 9,347; Ferris, 1,807; Midlothian, 1,800; Italy, 1,500; Palmer, 613; Milford, 590; Sonoma, 503; Red Oak, 415; Forreston, 350; and Maypearl, 350. Of the remaining communities, 9 had from 100 to 349 inhabitants, 5 had from 50 to 99, and 11 had from 10 to 49.

The larger towns and villages are served by rail lines, State and U.S. highways, and numerous farm-to-market roads.

The economy of Ellis County, prior to 1955, was based primarily upon agriculture. Since 1955, diversification to industry and livestock has reduced the relative economic importance of agriculture, especially that of cotton, which formerly provided about two-thirds of the county income. Cotton production in 1964 was approximately 49,000 bales. Other crops of economic importance in the county are sorghum, hay, corn, oats, wheat, barley, and soybeans. Livestock and poultry production include cattle, sheep, hogs, chickens, and turkeys.

Irrigation of cropland has not been practiced extensively in the county because of the high sodium content of most of the ground water. Recently, several shallow wells have been drilled in the alluvium along the Trinity River; these wells may provide additional water supplies suitable for irrigation.

The value of mineral products in the county has risen sharply in recent years because of the increased production of cement. Stone, clay, sand, and gravel are commercially abundant. Oil was discovered in southeastern Ellis County in 1953 in the Wolfe City Sand Member of the Taylor Marl at a depth of about 800 feet. This oil field was formerly called Rice field, but recently it was included in the Corsicana area and designated the Corsicana shallow field of Navarro and Ellis Counties. Total production in Ellis County prior to January 1, 1964, was 609,000 barrels of crude oil.

Previous Investigations

Prior to this investigation, little detailed study had been made of the ground-water resources of Ellis County. The first investigation was made by Hill (1901), who discussed the geology of the Black and Grand Prairies of Texas with special reference to artesian waters. Sundstrom, Hastings, and Broadhurst (1948) summarized the public water supplies in eastern Texas, including an inventory of municipal wells, well logs, chemical analyses of water samples, and estimates of water consumption and storage capacity for the principal municipalities in the county. Ellis County is included in a ground-water reconnaissance investigation of the Trinity River basin by Peckham and others (1963).

Various reports on regional geology in eastern and northern Texas describe the geologic formations common to Ellis County. For discussions of the general geology applying to areas in the vicinity of Ellis County, the reader is referred to various local county reports by Baker (1960), Grayson County; Dallas Geological Society (1965), Dallas County; Holloway (1961), McLennan County; Leggat (1957), Tarrant County; Hendricks (1957), Parker County; Scott (1930), Parker County; Shuler (1918), Dallas County; Stramel (1951), Parker County; and Winton and Scott (1922), Johnson County.

Well-Numbering System

The well-numbering system used in this report, based on the division of latitude and longitude, is the one adopted by the Texas Water Development Board for use throughout the State. Under this system, each 1-degree quadrangle in the State is given a number consisting of two digits, from 01 to 89. These are the first two digits appearing in the well number. Each 1-degree quadrangle is divided into 7-1/2 minute quadrangles which are given 2-digit numbers from 01 to 64. These are the third and fourth digits of the well number. Each 7-1/2 minute quadrangle is subdivided into 2-1/2 minute quadrangles given a single digit number from 1 to 9. This is the fifth digit of the well number. Finally, each well within a 2-1/2 minute quadrangle is given a 2-digit number in the order in which it is inventoried, starting with 01. These are the last two digits of the well number. In addition to the 7-digit well number, a 2-letter prefix is used to identify the county. The prefix for Ellis County is JK. Thus, well JK-33-44-401 (which supplies water for the city of Ennis) is in Ellis County (JK), in the 1-degree quadrangle 33, in the 7-1/2 minute quadrangle 44, in the 2-1/2 minute quadrangle 4. This was the first well (01) inventoried in that 2-1/2 minute quadrangle (Figure 2). The letter prefixes for those counties adjacent to Ellis County used in this report are: Dallas County, HR; Hill County, LW; Johnson County, PX; Kaufman County, RA; Navarro County, TY; Henderson County, LT; and Tarrant County, XU.

On the well-location map in this report (Figure 15), the 1-degree quadrangles are numbered in large bold numbers. The 7-1/2 minute quadrangles are numbered in the northwest corners. The 3-digit number shown with the well symbol contains the number of the 2-1/2 minute quadrangle in which the well is located and the number of the well within that quadrangle. For example, the city of Ennis well is numbered 401 in the quadrangle numbered 44.

Acknowledgments

The ground-water investigation of Ellis County, begun in February 1965, was conducted by the Water Resources Division of the U.S. Geological Survey in cooperation with the Texas Water Development Board.

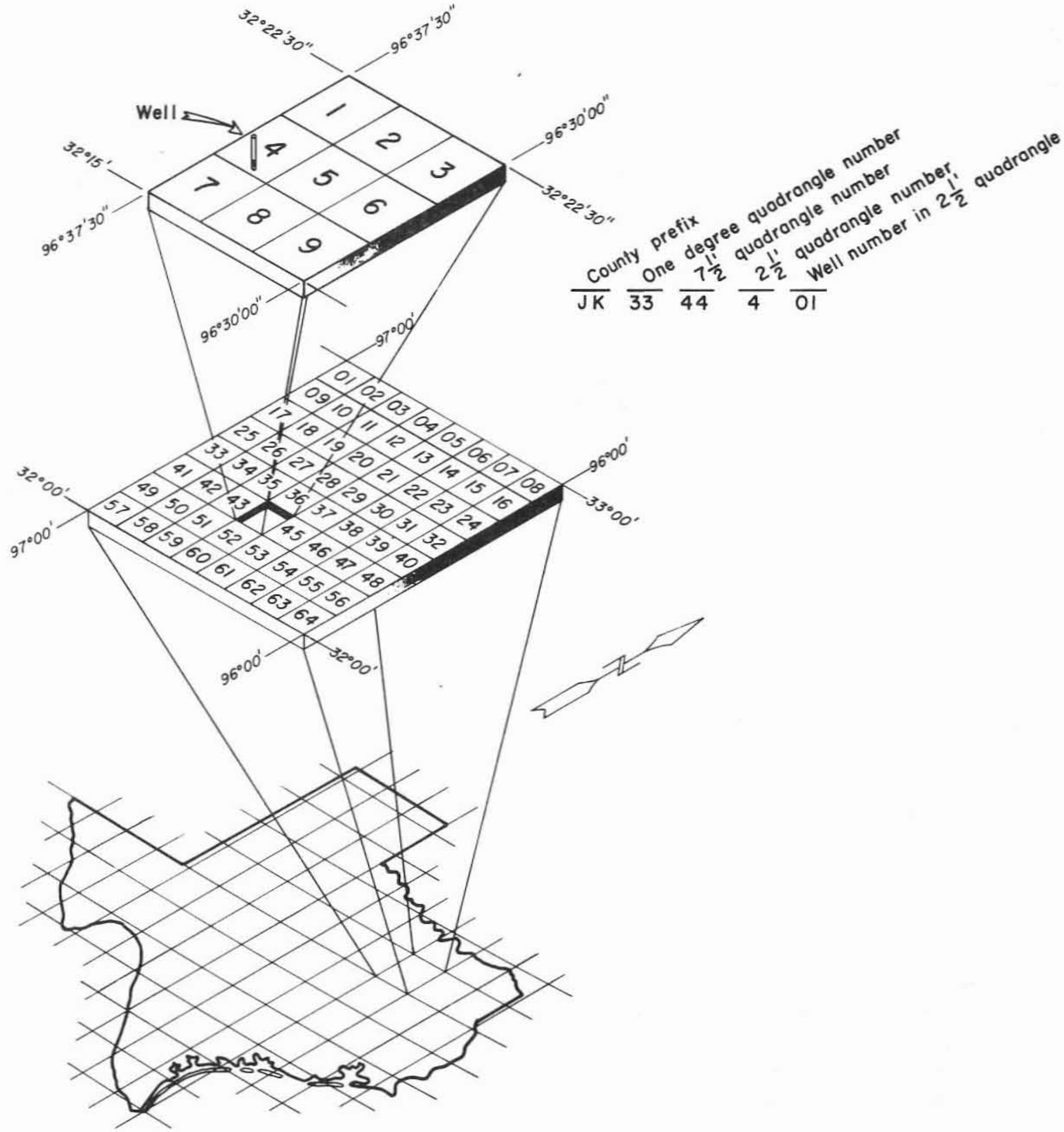

Figure 2

Well-Numbering System

U.S. Geological Survey in cooperation with the Texas Water Development Board

The author is indebted to the property owners in Ellis County for supplying information about their wells and for permitting access to their properties; to the local well drillers for information on water wells; and to all city officials and officials of independent water districts who supplied pumpage data and cooperated in pumping tests on public-supply wells. The cooperation of Federal and State agencies greatly facilitated completion of the report and project.

Appreciation is expressed to J. L. Myers' Sons, Dallas, Texas, for providing information on public-supply and domestic wells in Ellis County; and to Layne-Texas Co., Inc., Dallas, Texas, and C. M. Stoner Drilling Co., Keene, Texas, for supplying numerous logs and well locations.

GEOLOGY

General Stratigraphy and Structure

The geologic formations that contain fresh to slightly saline water in Ellis County are, from oldest to youngest: The Hosston Formation, Travis Peak Formation, Paluxy Sand, Woodbine Formation, and the Quaternary alluvial deposits. The aquifers are of Cretaceous age except for the alluvium which is Quaternary in age (Table 1). The areal geology of Ellis County is shown in Figure 3.

The thicknesses, lithologic characteristics, age, and water-bearing properties of the formations are summarized in Table 1. The maximum thicknesses for the geologic units as shown in this table were determined from interpretations of electrical and drillers' logs.

About 6,000 feet of limestone, shale, siltstone, sandstone, some anhydrite, and locally alluvium constitute the complete geologic section containing the aquifers.

The three principal aquifers in the county are water-bearing sandstone: (1) in the lowest part of the Cretaceous System, herein referred to as the Hosston Formation, (2) the Paluxy Sand, and (3) the Woodbine Formation. The upper part of the Travis Peak Formation includes about 20 to 60 feet of water-bearing sandstone, but no known wells in Ellis County obtain water from this section. Minor ground-water potential exists in the shallow alluvial deposits bordering the larger streams in the county.

The Cretaceous rocks unconformably overlie older, nearly impermeable rocks of the Ouachita folded belt which extends southwestward from Oklahoma through Ellis County. The pre-Cretaceous rocks, which are commonly crumpled, folded, and faulted (Sellards and others, 1932, p. 128-137), constitute a subsurface wedge of highly indurated sediments.

All formations of Cretaceous age generally trend north-northeastward and dip gently east-southeastward about 50 to 100 feet per mile. The angle of dip gradually increases with increased depth.

Faults probably do not greatly affect the water-bearing characteristics of the aquifers in Ellis County. Reaser (1961, p. 1759-1762) included the surface

Table 1.--Geologic units in Ellis County, their lithologic characteristics, and water-bearing properties

System	Series	Group	Geologic unit	Maximum thickness (ft)	Lithologic characteristics	Water-bearing properites
Quaternary	Recent		Alluvium	45±	Sand, gravel, clay and silt.	Small to moderate yields. Water satisfactory for irrigation.
Cretaceous	Gulf	Navarro		490±	Dark or greenish-gray calcareous clay, and fine-grained, firmly cemented, dark or greenish-gray sandstone.	Not known to yield water to wells in Ellis county.
			Taylor Marl	626	Medium-gray to bluish-black calcareous shale to fine-grained calcareous sand or sandy shale.	Yields small quantities of fresh to slightly saline water to shallow dug wells for domestic and livestock use.
			Wolfe City Sand Member (of the Taylor Marl)	80	Fine-grained, calcareous sandstone interbedded with thicker beds of sandy marl.	Yields small quantities of moderately mineralized hard water for domestic and livestock use.
			Austin Chalk	508	Chalk and marl interstratified with silty to sandy shale. Disseminated pyrite, marcasite concretions, and fossils occur commonly.	Not known to yield water in Ellis County.
			Eagle Ford Shale	467	Bluish-black shale containing thin beds of sandstone and limestone.	Yields only very small quantities of water to shallow wells for domestic and livestock use.
			Woodbine Formation	405	Thin- to massive-bedded sandstone interbedded with varying amounts of shale and sandy shale.	A principal aquifer in Ellis County. Water from upper part of formation contains more dissolved solids than water of lower part. Formation supplies most of ground water used in county. Wells yield small to moderate quantities of water for public supply, industry, domestic, and livestock use.
		(unconformity)				
	Comanche	Washita (undifferentiated)		543	Limestone, shale, and sandy to calcareous shale.	Not know to yield water to wells in Ellis County.
		Fredericksburg (undifferentiated)		271	Limestone, shale, and calcareous, silty to sandy shale; some shell agglomerate.	Do.
		Trinity	Paluxy Sand	160	Fine-grained, homogeneous, poorly consolidated sandstone containing varying amounts of clay, sandy clay, shale, lignite, and pyrite nodules.	Yields small to moderate quantities of slightly saline water for domestic and livestock use. Only a few wells tap the aquifer in Ellis County.
			Glen Rose Limestone	805	Medium- to thick-bedded limestone interbedded with some sandstone, sandy shale, shale, and anhydrite.	Not known to yield water to wells in Ellis County.

(Continued on next page)

Table 1.--Geologic units in Ellis County, their lithologic characteristics, and water-bearing properties--Continued

System	Series	Group	Geologic unit	Maximum thickness (ft)	Lithologic characteristics	Water-bearing properties
Cretaceous	Comanche	Trinity	Travis Peak Formation	510	Coarse- to fine-grained sandstone in upper and lower parts with limestone and some shale dominating middle part. The upper sandstone changes to shale downdip.	Small to moderate quantities of water may be available, but no known water wells tap the formation in Ellis County.
	Coahuila of Mexico	Nuevo León and Durango of Mexico	Hosston Formation	310	Massive sandstone containing sparse interbeds of siltstone, varigated red and green shale, sandy shale, marl, and limestone.	A principal aquifer underlying Ellis County. Yields up to 500 gpm for public supply, industrial, and some domestic and livestock use. Water quality is better than that in other principal aquifers.
			Major unconformity			
Pre-Cretaceous				?	Shale, quartzite, and indurated sandstone.	No wells have tested these rocks, but they are not a likely source of water.

faults that have been reported and mapped in central and northeastern Ellis County as part of the Balcones system, most of which have a projected stratigraphic displacement of 100 feet or less.

Physical Characteristics and Water-Bearing Properties of the Geologic Units

Pre-Cretaceous Rocks

The pre-Cretaceous rocks in Ellis County (Figures 16 and 17) are highly indurated, impermeable sediments, chiefly shale, quartzite, and sandstone of Pennsylvanian and Jurassic age. The Jurassic sandstones, which underlie the eastern half of the county, are below the base of the fresh to slightly saline water in the Hosston Formation and are not a likely source of ground-water supply. No known wells obtain water from any part of the pre-Cretaceous section.

Cretaceous System

Nuevo León and Durango Groups

The oldest basinward rocks of the Cretaceous System in Texas are probably stratigraphic equivalents of the Nuevo León and Durango Groups in northern Mexico and the Hosston and Sligo Formations in southern Arkansas (Figure 4). Imlay (1945) formally established the Nuevo León and Durango Groups in the Mexico-Texas region to include all rocks of the Cretaceous System older than the Trinity Group.

The rock equivalents of the Nuevo León and Durango Groups in Texas underlie the Trinity Group to form a subsurface wedge extending into east Texas from southern Arkansas and Louisiana. The approximate updip limit extends along the trend of the Balcones fault zone as far west as Maverick County, Texas, and northern Coahuila, Mexico.

Hosston Formation

The lowest and most important water-bearing formation in Ellis County is the Hosston Formation, or its stratigraphic equivalent, as identified in McLennan County by Holloway (1961) and Limestone County by Imlay (1944).

The Hosston equivalent in Ellis County may or may not be the lowest part of the Travis Peak Formation and the Trinity Group, but it is recognizably distinctive as a water-bearing unit, and in Ellis and Dallas Counties, drillers refer to the lower sandstone aquifer as the Trinity Sand. The Hosston Formation as used in this report includes much of the Travis Peak Formation of Tarrant County (Leggat, 1957) and the Trinity River basin (Peckham and others, 1963).

The Hosston Formation does not crop out in Ellis County, or in central and northeastern Texas, but forms an eastward-thickening subsurface wedge of predominantly clastic rock underlying the Trinity Group or Sligo Formation. The top of the Hosston ranges in depth from about 1,800 feet (Figure 5) in the northwest corner of Ellis County to a projected depth of about 4,900 feet in the extreme eastern part of the county. The dip ranges from 60 feet per mile in the western part of the county to about 110 feet per mile in the eastern part.

Lithologic logs of local wells (Table 7) indicate a thick sand section in the lower half of the formation with scattered interbeds of siltstone, sandy shale, red and green shale, marl, and limestone. The complete thickness of the Hosston Formation in Ellis County, as determined from electrical logs, ranges from about 90 feet in public-supply well JK-33-41-501 in the west-central part of the county to about 310 feet in test hole JK-33-27-701 in the north-central part. The unit averages more than 230 feet in thickness in the eastern and northeastern parts of the county.

Several public-supply wells for municipal and independent water districts tap the Hosston. Some of these wells can produce as much as 400 to 500 gpm (gallons per minute) from a 6- to 8-inch diameter screen 100 to 150 feet in length.

The measured dissolved-solids content of the water ranged from 673 to 1,368 ppm. The water is generally better in chemical quality than water from other aquifers in the county, but because of its high sodium content, the water is probably not desirable for prolonged use in irrigation.

Trinity Group

The Trinity Group includes, from oldest to youngest, the following formations: the Travis Peak Formation, the Glen Rose Limestone, and the Paluxy Sand. This group attains a maximum composite thickness of at least 1,475 feet (Table 1) in Ellis County. The group, in general, thickens eastward downdip.

Limestone, shale, and sandy shale predominate in the Trinity Group in Ellis County. At present, the Paluxy Sand is the only utilized aquifer of the group, but the upper sandstone section of the Travis Peak Formation is an aquifer in the northwestern half of the county. The sand percentages in both the Paluxy and the upper part of the Travis Peak decrease downdip.

Travis Peak Formation

The Travis Peak Formation was divided by Hill (1901, p. 142) into the Sycamore Sand Member, the Cow Creek Limestone Member, and the Hensell Sand Member, in ascending order. According to Hill (1901, p. 140), only the Sycamore and Hensell Members are present in Tarrant County, but electrical logs from Ellis County indicate that the Cow Creek Limestone Member, or an equivalent limestone, occurs in addition to the upper and lower sandstone units. The strata above the top of the Hosston Formation (Figures 16 and 17), but below the lowest massive limestone of the Glen Rose Limestone, are included in the Travis Peak Formation, which does not crop out in Ellis County. The Travis

Peak Formation, as used in this report, includes only the upper part of the Travis Peak as used by Leggat (1957) in Tarrant County and Peckham and others (1963) in the Trinity River basin.

The Travis Peak consists of coarse- to fine-grained sandstone in the upper and lower members, although the upper member becomes increasingly shaly in the downdip direction. The middle member consists of limestone and some shale.

The thickness of the Travis Peak Formation increases eastward, ranging from 210 feet just west of the county line in Johnson County in oil test PX-32-40-701 to 510 feet in JK-33-44-301. The formation averages about 360 feet in thickness. The depth below land surface to the top of the formation increases eastward, ranging from 1,525 feet at PX-32-40-701 in the west to a projected depth of about 4,450 feet at the intersection of Ellis, Henderson, and Navarro Counties. The eastward dip increases from about 40 feet per mile in the western part of the county to 90 feet per mile in the east.

No wells are known to obtain water from either the upper or lower sandstone sections in the Travis Peak. According to electrical-log interpretations, water in the lower sandstone appears to be better in quality than that in the upper section, but the thin interbedded shale in the lower section probably causes a lower permeability in that section. Small to moderate supplies of water may be available from the Travis Peak Formation, but the chemical quality is probably inferior to that of water from the Hosston Formation. No hydrologic information is available for the Travis Peak in Ellis County.

Glen Rose Limestone

The Glen Rose Limestone, which does not crop out in Ellis County, occurs at depths ranging from less than 980 feet below land surface in the northwestern part of the county (near well JK-32-32-802) to more than 3,100 feet just east of test well JK-33-44-301.

The Glen Rose consists primarily of medium- to thick-bedded limestone, but also contains some sandstone, sandy shale, shale, and anhydrite. The top of the formation is gradational with the Paluxy Sand, and, therefore, the contact between these two formations is arbitrary on some electrical logs. The uppermost part of the Glen Rose Limestone contains more sand and clay than the lower part. The lower part of the Glen Rose contains a massive bed of anhydrite, the Ferry Lake Anhydrite of Imlay (1944).

The Glen Rose Limestone in Ellis County thickens eastward about 10 feet per mile between oil test JK-32-40-302 in the northwest and JK-33-44-301 in the east. A complete section of the formation ranges in thickness from 470 feet in well JK-32-40-301 to at least 805 feet near well JK-33-44-301, averaging about 620 feet throughout the county.

Interpretations of electrical logs indicate that the Glen Rose is not a source of fresh to slightly saline water in Ellis County, and local drillers report that they have encountered only highly mineralized water in the formation. Well JK-33-34-711 (city of Waxahachie "mineral well") tapped the Glen Rose Limestone and produced moderately saline water. The well has been abandoned.

Paluxy Sand

The Paluxy Sand, which is present in the subsurface in Ellis County, crops out in northwestern Tarrant County (Leggat, 1957, p. 21) and in extreme west-central and southwestern Johnson County (Winton and Scott, 1922, p. 19). The top of the Paluxy (Figure 6) ranges in depth below land surface from about 830 feet in oil test JK-32-32-802 in the northwestern part of Ellis County to more than 2,950 feet east of well JK-33-44-301.

The formation consists predominantly of fine-grained, homogeneous, poorly consolidated sandstone and varying amounts of clay, sandy clay, shale, lignite, and pyrite nodules. The saturated sand containing fresh to slightly saline water in the formation ranges from as low as 25 percent of the formation in well JK-33-42-702 to as much as 75 percent in well JK-33-33-101; the average sand thickness is about 60 feet.

The thickness of the Paluxy Sand is irregular except that it generally thickens northward, ranging in thickness from 77 feet in test hole JK-33-50-601 in the south to 160 feet in well JK-33-27-701 in the north-northeast; the average thickness in the county is about 130 feet. The formation dips eastward about 42 feet per mile in the west, 50 feet per mile in the northwest, and 85 feet per mile in east-central Ellis County. Between oil tests PX-32-40-701 and JK-33-44-301, the average dip is about 66 feet per mile.

A few wells tap the water-bearing sandstone of the Paluxy in Ellis County. These wells yield small to moderate quantities of slightly saline water for domestic and livestock use. The Paluxy Sand is capable of increased development in the western half of the county, but eastward, the quality of the water deteriorates downdip and becomes moderately saline.

Fredericksburg Group

The Fredericksburg Group (Figures 16 and 17), which does not crop out in Ellis County, includes, from oldest to youngest, the Walnut Clay, the Goodland Limestone, and the Kiamichi Formation. The sedimentary rocks of this group are mainly limestone; shale; and calcareous, silty, and sandy shale.

The thickness of the group is moderately uniform. It ranges from 185 feet in test well JK-33-27-701 in the north-northeastern part of the county to 271 feet in well JK-33-50-601 in the southern part, averaging about 220 feet.

The Walnut Clay, referred to as a fossil lime or caprock by local drillers, consists mainly of a characteristic shell agglomerate of abundant *Gryphaea marcoui* and *Exogyra texana*. It also contains brown sandy clay, thinly-bedded fossiliferous clay, black fissile shale, and iron-stained earthy limestone.

The Goodland Limestone is equivalent to the Comanche Peak and Edwards Limestones of central Texas. It typically consists of chalky thin- to massive-bedded, fossiliferous limestone and blue to yellowish-brown marl.

The Kiamichi Formation is predominantly shale with some marl and thin limestone. The formation is an excellent stratigraphic index on electrical logs, and its thickness and lithology are remarkably uniform.

The Federicksburg Group is not a source of ground water in Ellis County.

Washita Group

The Washita Group in Ellis County consists of the following formations, from oldest to youngest: the Duck Creek Formation, the Fort Worth Limestone, the Denton Clay, the Weno Clay, the Pawpaw Formation, the Mainstreet Limestone, and Grayson Shale, and the Buda Limestone, which occurs only in the eastern part of the county. These formations constitute a sequence of interbedded limestone, shale, and sandy to calcareous shale.

The Washita Group ranges in thickness from 320 feet in oil test JK-33-49-101 to 543 feet in test JK-33-44-301; it averages about 400 feet in thickness. The group thickens eastward and dips eastward about 55 feet per mile.

The Washita Group is not a source of ground water in Ellis County.

Upper Cretaceous Rocks

Upper Cretaceous rocks in Ellis County, from oldest to youngest, are the Woodbine Formation, the Eagle Ford Shale, the Austin Chalk, the Taylor Marl, and the Navarro Group. These strata attain a maximum composite thickness of at least 2,496 feet (Table 1) in Ellis County.

Woodbine Formation

The Woodbine Formation crops out in the eastern third of Tarrant and Johnson Counties and in the northwestern part of Ellis County. In Ellis County the Woodbine is not formally separated into members, although the upper sandy part is informally distinguished from the lower part because of the distinctive difference in the quality of the water. The water in the upper part contains a higher amount of dissolved solids than that in the lower part. The top of the lower part of the Woodbine section is picked arbitrarily at the base of the thickest shale that underlies the uppermost sandstone strata in the formation. Most water wells obtaining water from the Woodbine exclude the upper part because of the poor quality of the water.

The Woodbine Formation crops out in the northwestern part of Ellis County and dips to the southeast. The top of the formation occurs at a depth of 1,986 feet in test well JK-33-45-401 in the southeastern part (Figure 7). In Ellis County, the top of the Woodbine is selected at the top of the first prominent water-bearing sandstone as shown by electrical logs (Figures 16 and 17).

The Woodbine consists predominantly of thin- to massive-bedded sandstone and varying amounts of interbedded shale and sandy shale. The sandstone is thicker in the lower part of the formation than in the upper part. Sand bodies within the Woodbine are irregular and discontinuous. Correlation of individual beds is difficult, but suites of rock strata grouped according to gross lithologic similarities are recognizable on electrical logs across the county. Everywhere within Ellis County the Woodbine lies unconformably upon rocks of the truncated Washita Group.

The upper part of the Woodbine contains much sandy clay interstratified with beds of lignite and gypsum; nodules of alunite are common in the uppermost strata. All these constituents contribute to the high mineral content of the ground water in the upper part of the formation.

The Woodbine Formation varies considerably in thickness in Ellis County. It ranges from 190 feet in public-supply well JK-33-57-202 at Milford (southwestern Ellis County) to 405 feet in thickness in test hole JK-33-44-301 in the east. The formation thickens eastward about 7.5 feet per mile. The average thickness of the Woodbine in Ellis County is about 295 feet. The formation dips east-southeastward at a rate ranging from 48 feet per mile in western Ellis County to about 80 feet per mile in the eastern part, averaging about 60 feet per mile.

The Woodbine Formation is not as deep as the other principal water-bearing formations in Ellis County. Therefore, a water well in the Woodbine is the least expensive for property owners who need only small to moderate supplies of water. Nearly all domestic and livestock wells in the county tap this formation, and most wells drilled into it since about 1955 obtain water only from the lower part because of the highly mineralized water in the upper part.

The lower part of the Woodbine is an important source of ground water for domestic, livestock, and public-supply use in the western three-quarters of Ellis County, but the quality of the water deteriorates downdip and becomes moderately saline in the eastern quarter of the county.

Eagle Ford Shale, Austin Chalk, and Taylor Marl

Strata of the Eagle Ford Shale, Austin Chalk, and Taylor Marl, most of which are non-water-bearing, crop out in belts that trend north-northeastward across Ellis County. Minor sand beds in the Eagle Ford Shale and in the Wolfe City Sand Member of the Taylor Marl are a source of small quantities of water to shallow wells.

The Eagle Ford Shale is a moderately fossiliferous, bluish-black shale containing thin beds of sandstone and limestone. The maximum observed thickness in Ellis County is 467 feet but the average is about 410 feet. The formation supplies very small quantities of bitter (gypsum) water to shallow dug wells and is not considered a source of fresh to slightly saline water in the county.

The Austin Chalk, which forms the White Rock Escarpment in Ellis County, consists of a lower chalk, middle marl, and upper chalk. The chalk is interstratified with soft silty to sandy shale. The formation has a maximum thickness of 508 feet and an average thickness of about 455 feet. The Austin is not an important source of ground water in Ellis County.

The Taylor Marl in Ellis County is divided into four members: A lower marl member, the Wolfe City Sand Member, the Pecan Gap Member, and an upper marl member. The full thickness of the Taylor reaches a maximum of 626 feet in Ellis County. Electrical logs in eastern Ellis County indicate that the Wolfe City Sand Member ranges in thickness from about 40 feet in test holes JK-33-37-701 and JK-33-45-403 to about 80 feet in JK-33-44-101. Pitkin (1958, p. 80) describes the Wolfe City Sand Member as consisting of "...thin beds of slabby fine-grained (calcareous) sandstone interbedded with thicker beds of sandy marl." A few domestic and livestock wells tap the Wolfe City, but they yield only small quantities of moderately mineralized hard water in a small area of eastern Ellis County.

The Taylor Marl yields small quantities of fresh to slightly saline hard water to shallow wells for domestic and livestock use.

Navarro Group

The basal, and probably some of the middle part of the Navarro Group, crops out in the eastern part of Ellis County. The basal Navarro consists generally of dark or greenish-gray, calcareous clay and marl containing scattered concretionary layers. The middle part consists of dark or greenish-gray, fine-grained, firmly-cemented sandstone. The maximum observed thickness of the Navarro in Ellis County is about 490 feet, but the full thickness of the group is not present in the county.

The Navarro Group is not a source of ground water in Ellis County.

Quaternary Alluvial Deposits

Alluvial deposits veneer the Cretaceous strata in Ellis County along the principal stream channels and on some of the upland stream divides. The upland alluvial deposits are thin and not a source of ground water.

The flood-plain alluvium along the stream channels consists of material eroded from outcropping strata within the drainage basin. The alluvium is generally a moderately- to well-sorted mixture of rounded or angular gravel, sand, silt, and clay. Generally, the coarsest material occurs at the base.

The alluvial deposits may be as much as 1.25 miles in width along the lower reaches of the principal streams in Ellis County and as much as 3 miles in width west of the main channel of the Trinity River.

Leggat (1957, p. 39) states that flood-plain deposits range up to about 45 feet in thickness in Tarrant County; similar thicknesses are probable along the Trinity River in Ellis County. Several large-diameter shallow wells were augered to depths of about 30 feet in the alluvium of the Trinity River near well JK-33-37-801 but none of them reached the bottom of the alluvium. These wells individually yield as much as 75 gpm of fresh water that is suitable for irrigation. Because they are used primarily for irrigation, their use is seasonal.

The flood-plain alluvial deposits along the principal streams can yield small to moderate supplies of fresh ground water that are suitable for domestic, livestock, and irrigation use. Wells should penetrate the entire thickness of the alluvium for the greatest yield. The quality of the water will vary locally, but the water from the alluvium is the only significant ground water produced in Ellis County that is suitable for sustained irrigation.

Source and Occurrence of Ground Water

The primary source of ground water in Ellis County is precipitation on the outcropping formations and drainage from the adjoining areas. A large part of the precipitation becomes surface runoff because it moves rapidly down the hill surfaces or across impermeable rocks. If the rain is intense, the proportion of surface runoff increases because the time available for absorption is inadequate even in very sandy areas. Much of the water evaporates at the land surface, is transpired by plants, or remains in the subsoil as a result of capillary forces. A small part of the precipitation infiltrates to the water table or zone of saturation. In the zone of saturation, the water fills all the intergranular spaces and becomes ground-water recharge to the water-bearing formations. The water then moves down the hydraulic gradient into the artesian sections of the aquifers.

Ground water occurs under either water-table or artesian conditions. Many publications describe the general principles of the occurrence of ground water in all kinds of rocks: Meinzer (1923a, p. 2-142; 1923b), Todd (1959, p. 14-114), and Baldwin and McGuinness (1963). Ground water in the outcrop area generally is unconfined and therefore under water-table conditions. Water under these conditions does not rise above the point where it is first encountered in a well. In most places, the configuration of the water table approximates the topography of the land surface.

Downdip from the outcrop, the aquifer may underlie a relatively impermeable layer of rock. The water in this part of the aquifer is confined under hydrostatic pressure and therefore under artesian conditions. The pressure is nearly equal to the weight of a column of water extending upward to the height of the water table in the area of outcrop of the aquifer. Where the altitude of the land surface is below the altitude of the outcrop of the aquifer, the hydrostatic pressure of the water may be sufficient to raise the water level in the well substantially--possibly even high enough for the well to flow.

The hydrostatic pressure in the Hosston Formation before 1930 was great enough for all wells tapping this aquifer to flow. In fact, the water level in some wells reached a height of 90 feet above ground level when the wells were initially drilled.

The static level to which water rises in wells in an artesian aquifer forms an imaginary surface of equal hydrostatic pressure, called the piezometric surface. The piezometric surface usually slopes downward from the area of outcrop, the degree of slope depending on the permeability of the water-bearing material and the quantity of water flowing through the material.

Recharge, Movement, and Discharge of Ground Water

The recharge of ground water to the aquifers in Ellis County is chiefly from precipitation on the outcrops of the aquifers in areas mostly west of the county. The average annual precipitation on the outcrops ranges from about 30 inches per year in the west to about 33 inches in the east. Only a small percentage of this precipitation becomes recharge, the quantity being determined by evapotranspiration and runoff which, in turn, are influenced by such factors as intensity of rainfall, absorbing character of the land surface, topographic slope, air temperature and humidity, depth of root penetration by various plants, and the depth of the water table. The quantity of recharge to the aquifers in Ellis County is not known but is estimated to be equivalent to about 0.5 inch of precipitation per year on the sandy parts of the outcrops of the aquifers.

The dominant direction of ground-water movement after initial infiltration is downward, under the force of gravity, through the zone of aeration to the water table or zone of saturation. In the zone of saturation, the movement of water generally has a nearly horizontal component in the direction of decreasing head or pressure. The rate of movement is rarely uniform, but is directly proportional to the hydraulic gradient, which tends to steepen near areas of natural discharge or pumping wells.

The piezometric map (Figure 8) for the lower part of the Woodbine Formation shows the altitude of water levels in wells in that aquifer. The map shows that the water moves east-southeastward and that the hydraulic gradient is about 10 to 20 feet per mile. The rate of movement in the Woodbine is about 10 to 40 feet per year. Data are not sufficient for the preparation of a piezometric map for the Hosston Formation; however, the few data available indicate that the movement of water is northward.

Water moves in the subsurface in response to differences in hydrostatic pressure in the aquifers. It may move vertically from one aquifer to another through overlying semi-confining beds and possibly along fault planes in the zones of faulting. Ground water may ultimately be discharged from the deeper formations to shallower, more permeable rocks.

Fresh to slightly saline water in the aquifers in Ellis County moves constantly toward areas of natural or artificial discharge. Most natural discharge is by springs, seepage to streams and marshes where the water table intersects the land surface, transpiration by vegetation, evaporation through the soil, and by underflow into other areas. Most of the natural discharge in Ellis County is by underflow into adjoining areas to the east and north.

Hydraulic Characteristics of the Aquifers

The value of an aquifer as a source of ground water depends principally upon the capacity of the aquifer to transmit and store water. The coefficients of transmissibility, permeability, and storage, which may be determined by aquifer tests, are the measurements of this capacity. The water-bearing characteristics of an aquifer may vary considerably in short distances, depending upon lithologic and structural changes within the aquifer. A single aquifer test can be used to measure the aquifer's coefficients in only a small part of the total aquifer.

The coefficients of transmissibility and storage may be used to predict the drawdown or decline in water levels caused by pumping from an aquifer. A pumping well forms a cone of depression in the piezometric surface or water table. Pumping from wells drilled close together may create cones of depression that intersect, thereby causing additional lowering of the piezometric surface or water table. The intersection of cones of depression, or interference between wells, results in lower pumping levels (and increased pumping costs) and can cause serious declines in yields of the wells. The proper spacing of wells, determined from aquifer-test data, minimizes interference between wells.

Aquifer tests were conducted at eight wells in Ellis County. The tests were made in wells which tapped the Hosston Formation at Waxahachie and Midlothian; the Paluxy Sand at Camp Hoblitzelle, about 6 miles south of Midlothian; and the Woodbine Formation at Ferris, Milford, Palmer, and Red Oak. (See Table 2.)

Some of the wells tested did not screen all of the water-bearing sand in the aquifers. Therefore, the coefficients of transmissibility determined from these tests represent only a part of the total thickness of saturated sand in the aquifers. To obtain estimates of the hydraulic characteristics of all the principal aquifers in Ellis County, the local tests were supplemented by data from tests in adjacent counties.

Aquifer tests were made in wells tapping the Hosston Formation in public-supply wells JK-33-34-702 and JK-33-34-703 at Waxahachie, and JK-33-33-101 at Midlothian. The coefficient of transmissibility at Waxahachie averaged 8,700 gpd (gallons per day) per foot, and the coefficient of storage was about 0.00008. At Midlothian, the coefficient of transmissibility was 6,400 gpd per foot, but the well penetrated only about 98 feet of saturated sand. The thickness of the saturated sand of the Hosston Formation averages about 110 feet in Ellis County and the coefficient of permeability is about 65 gpd per square foot; therefore, the average coefficient of transmissibility in the county is estimated to be about 7,000 gpd per foot. The specific capacities of three wells tapping the Hosston Formation in Ellis County ranged from 1.1 to 13.6 gpm (gallons per minute) per foot, averaging about 6 gpm per foot (Table 2).

The time-distance-drawdown curves for the Hosston Formation under artesian conditions (Figure 9) show that a Hosston well pumping continuously at a rate of 100 gpm for 1 year theoretically will lower the water level about 14 feet in other Hosston wells 1,000 feet from the pumped well, and about 7 feet at a distance of 10,000 feet. At the same pumping rate and distances, the water levels would be lowered about 18 feet and about 11 feet, respectively, after 10 years.

An aquifer test on the Paluxy Sand was made in public-supply well JK-32-40-901 at Camp Hoblitzelle, 6 miles south of Midlothian. The results of the test indicate that the coefficient of transmissibility at this site is 3,100 gpd per foot. The saturated sand thickness in the well is about 70 feet, which is about the average for the Paluxy in Ellis County; therefore, the average coefficient of transmissibility in the county is estimated to be about 3,000 gpd per foot. The average coefficient of permeability is about 45 gpd per square foot. The coefficient of storage was not determined in the test at Camp Hoblitzelle, but the results of four aquifer tests in Tarrant County (Leggat, 1957, p. 72) showed the average coefficient of storage in the Paluxy to be about 0.0001. This value is probably applicable to the Paluxy in Ellis County. The specific capacity of the tested well in Ellis County was 2.7 gpm per foot in 1965.

The time-distance-drawdown curves (Figure 9) for the Paluxy Sand under artesian conditions show the theoretical effects of pumping on the water levels in the aquifer.

Table 2.--Results of aquifer tests

Well tested	Water-bearing unit	Date of test	Pumping rate (gpm)	Coefficient of transmissibility (gpd/ft)	Coefficient of storage	Specific capacity (gpm/ft)	Remarks
JK-32-40-301	Hosston Formation	Jan. 5, 1960	330	--	--	3.6	Test by J. L. Myers.
JK-32-40-303	Woodbine Formation	June 14, 1963	240	--	--	2.1	Do.
JK-32-40-901	Paluxy Sand	June 2, 1965	79	3,100	--	2.7	Recovery in pumped well.
JK-33-26-802	Woodbine Formation	June 3, 1965	63	700	--	1.7	Do.
HR-33-27-602	do	June 1, 1965	170	4,600	--	4.2	Do.
JK-33-33-101	Hosston Formation	June 3, 1965	450	6,400	--	13.6	Average from drawdown and recovery in pumped well.
JK-33-34-702	do	Mar. 14, 1948	547	9,200	0.00008	--	Average from recovery and three interference tests.
JK-33-34-703	do	do	558	8,200	.00008	--	Average from recovery and two interference tests.
JK-33-35-503	Woodbine Formation	June 2, 1965	120	11,600	--	3.96	Recovery in pumped well.
JK-33-35-702	do	Sept. 3, 1964	100	--	--	1.8	Test by J. L. Myers.
JK-33-36-201	do	Feb. 26, 1960	40 100	-- --	-- --	5.7 1.9	Do.
JK-33-42-702	Hosston Formation	July 23, 1964	175	--	--	1.1	Do.
JK-33-57-202	Woodbine Formation	June 4, 1964 June 4, 1965	150 136	-- 1,400	-- --	.93 1.1	Do. Drawdown in pumped well.

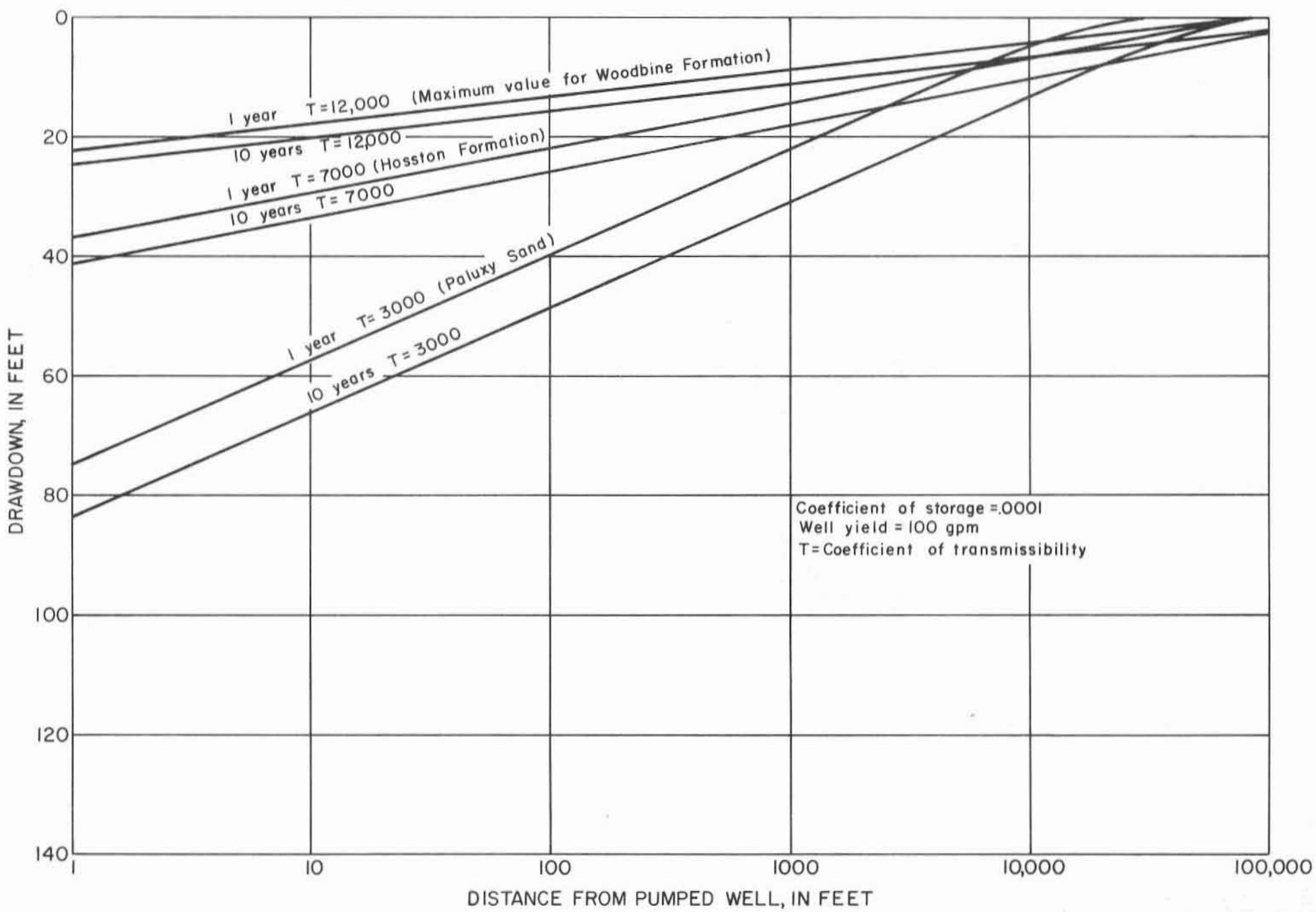

Figure 9

Relation of Drawdown to Distance and Time Caused by Pumping in an Infinite and Homogeneous Aquifer

U. S. Geological Survey in cooperation with the Texas Water Development Board

Aquifer tests were made in wells tapping the Woodbine Formation in public-supply wells JK-33-26-802 at Red Oak, HR-33-27-602 at Ferris, JK-33-35-503 at Palmer, and JK-33-57-202 at Milford. The coefficients of transmissibility ranged from about 700 gpd per foot at Red Oak to 11,600 gpd per foot at Palmer (Table 2). The coefficient of permeability ranged from about 10 gpd per square foot to about 180 gpd per square foot and averaged about 70. The coefficient of storage was not determined in these four tests, but Baker (1960, p. 54) reported coefficients of storage in Grayson County ranging from 0.00002 to 0.0002 and averaging 0.0001. The latter value is probably applicable to the Woodbine in Ellis County.

The thickness of the saturated sand in the Woodbine Formation in Ellis County averages about 135 feet. Based on this thickness, the average coefficient of transmissibility for the county is estimated to be about 9,500 gpd per foot. The coefficient of transmissibility may be as much as 12,000 gpd per foot where the sand in the Woodbine is thickest.

Use and Development of Ground Water

About 4.8 mgd (million gallons per day), or 5,400 acre-feet, of ground water was used in Ellis County during 1964 for public supply, industry, irrigation, rural domestic needs, and livestock (Table 3). Ground water is the major source of water supply in the county; however, surface water from reservoirs recently constructed is being used to augment water supplies for municipal and industrial use in central and eastern Ellis County.

Table 3.--Ground water used in Ellis County, 1964

Use	mgd	ac-ft/yr
Public supply	2.8	3,100
Industrial	.40	450
Irrigation	.04	40
Rural domestic	.98	1,100
Livestock	.59	660
Totals*	4.8	5,400

*Figures are rounded to two significant figures because some of the pumpage is estimated.

Records of 220 wells, springs, and test holes were obtained in Ellis County and adjacent areas (Table 6) during the ground-water investigation. The inventory included only a part of the total number of wells in the county. Locations of the inventoried wells, springs, and test holes are shown in Figure 15.

Public Supply

Ground water was used in 1964 for public supply in 20 localities in Ellis County, of which Waxahachie, Ennis, Ferris, and Midlothian used about 2.5 mgd (2,752 acre-feet), or about 89 percent. The pumpage of ground water for all public supply increased from about 2.6 mgd (2,900 acre-feet) in 1955 to about 2.8 mgd (3,100 acre-feet) in 1964. The increased use of water since 1955 is related to an increase in municipal population and the need for additional water-supply systems. The yearly fluctuation is related largely to the variation in local annual precipitation. Five newly-formed rural cooperative public-supply systems began operation during 1965 and much of the rural domestic ground water used in the county is now supplied by the cooperative systems.

The city of Waxahachie is the largest user of ground water for public supply in the county. Waxahachie used a total of about 1.4 mgd (1,574 acre-feet) during 1964, which was about 51 percent of all public supply used in the county that year, or about 29 percent of the total ground water used in the county in 1964 for all purposes (Table 3). Waxahachie obtains its ground water from four wells tapping the Hosston Formation at depths of about 2,950 feet.

Ennis is the second largest user of ground water for public supply. During 1964, Ennis used a total of about 0.74 mgd (829 acre-feet), which is about 27 percent of all public supply used in the county that year, or about 15 percent of the total of all ground water used. The water is pumped from three wells in the Woodbine Formation at depths of about 1,800 feet. Ennis also has a second complete water line system that distributes about 0.20 mgd (220 acre-feet) of untreated surface water for industry and lawn watering.

Ferris is the third largest user of ground water for public supply. During 1964, Ferris used a total of about 0.17 mgd (194 acre-feet), which is about 6 percent of all public supply used in the county that year, or about 4 percent of the total ground water used. Ferris obtains its water from three wells tapping the Woodbine Formation at a maximum depth of about 1,480 feet.

Midlothian is the fourth largest user of ground water for public supply. During 1964, Midlothian used a total of about 0.14 mgd (156 acre-feet), which is about 5 percent of all public supply used in the county that year, or about 3 percent of the total ground water used. More than 95 percent of the ground water was pumped from two wells in the Hosston Formation at a depth of about 2,300 feet. The remainder was pumped from one well in the Woodbine Formation at a depth of about 700 feet.

Other municipalities in Ellis County that used ground water for public supply in 1964 were: Italy, about 0.07 mgd (74 acre-feet) from the Woodbine; Milford, about 0.06 mgd (65 acre-feet) from the Hosston and Woodbine; Palmer, about 0.04 mgd (46 acre-feet) from the Woodbine; Bardwell, about 0.04 mgd (46 acre-feet) from the Woodbine; Maypearl, about 0.03 mgd (28 acre-feet) from the Woodbine; and Red Oak, about 0.02 mgd (27 acre-feet) from the Woodbine. The remaining public-supply systems used a total of about 0.07 mgd (77 acre-feet), or about 2 percent of all public supply used in the county in 1964.

Most of the water pumped for industrial use in Ellis County is provided by local public-supply systems. Texas Industries, Inc. near Midlothian has the only privately-owned system consisting of one well tapping the Hosston and two wells tapping the Woodbine. Texas Industries used 450 acre-feet of water in

1964 (Table 3); this was about 8 percent of the total ground water used in the county in 1964, and more than double the amount used for industry in 1960.

Irrigation

It was estimated that about 40 acre-feet of ground water was pumped for irrigation (Table 3) in Ellis County in 1964 from a few shallow wells in the alluvium of the Trinity River and Chambers Creek. The water was used to irrigate less than 100 acres of cropland.

Rural Domestic and Livestock

The average annual quantity of ground water used for rural domestic needs in Ellis County since 1955 was determined by four factors--a gradually declining rural population, a gradually increasing daily requirement of water per capita because of modernization of rural homes, an increase in the number of public-supply systems, and the annual fluctuations in local precipitation.

In 1955 the county's rural population of about 14,044 used an estimated 787 acre-feet (0.70 mgd) of ground water. By 1964 the rural population, probably about 9,000, used an estimated 1,100 acre-feet (0.98 mgd); this is about 20 percent of the total ground water used in the county in that year for all needs (Table 3).

The quantity of ground water used in 1964 for livestock was about 660 acre-feet (0.59 mgd). This is about 12 percent of all ground water used in the county in that year for all needs.

In summary, rural domestic and livestock needs required an estimated 1,760 acre-feet, or about 33 percent of all ground water used in the county in 1964. Of the domestic and livestock wells used, probably 95 percent tapped the Woodbine Formation.

Of the ground water pumped for all uses in Ellis County in 1964, about 3,500 acre-feet or 65 percent came from the Woodbine Formation, about 1,840 acre-feet or 34 percent came from the Hosston Formation, about 40 acre-feet or 0.8 percent came from the alluvium, and about 8 acre-feet or 0.2 percent came from the Paluxy Sand. An insignificant amount of water was pumped from the Taylor Marl--chiefly from the Wolfe City Sand Member.

Well Construction

Almost all the wells in Ellis County were installed since 1930 and the majority were completed after 1950. Most of the wells were drilled although some of the shallower wells were bored or dug.

Shallow dug wells constitute about 25 percent of all water wells in Ellis County. Some of these wells are very old having been completed prior to 1900. The dug wells are mostly less than 50 feet in depth and they range in diameter from 24 to at least 40 inches. The yields are small because the wells penetrate only a few feet of saturated material.

The bored wells, predominantly tile cased, range from 8 to 10 inches in diameter and from 40 to 130 feet in depth. The yields of the bored wells are small because the water enters the wells only through the small cross-sectional bottom areas which restrict the ground-water intake.

The drilled, predominantly metal-cased wells range from 2 to 20 inches in diameter; 4-inch diameters are common. Most of the larger yields are from drilled wells.

Many domestic and livestock wells drilled in the county in recent years are 4-inch diameter wells that penetrate several hundred feet of rock. These wells use 10 to 20 feet of slotted or perforated metal casing opposite the water-bearing material.

The industrial and public-supply wells, which generally are larger in diameter and deeper than the domestic and livestock wells, range from 4 to 20 inches in diameter and from 573 to 3,282 feet in depth. Figure 10 shows an example of well construction which is characteristic of many public-supply wells in the county. This construction eliminates or greatly reduces several problems and undesirable effects relating to dependability of the wells and water quality. Because a loose, very fine- to fine-grained sandy texture characterizes some aquifers, sand may be pumped with the water. This characteristic reduces the effective life of most pumps, especially submersible pumps. A properly gravel-packed well will greatly reduce the sand intake and thus lengthen pump life.

Changes in Water Levels

Water levels in wells continuously respond to natural and artificial influences which act on the aquifers. In general, the major influences that control water levels are the rates of recharge to and discharge from the aquifer. Relatively minor changes are due to variations in atmospheric pressure and other causes. Fluctuations are usually gradual, but in some wells the water levels may rise or fall several inches or several feet in a few minutes.

Water-level declines of considerable magnitude usually result from large withdrawals of water from wells. A lowering of the water table represents an actual dewatering of the aquifer; the lowering may reflect drought conditions or overpumping from the aquifer. Where artesian conditions prevail, a lowering of the water level represents a decrease in artesian pressure in the aquifer and the change in the quantity of water in storage may be small.

Long-term records of annual fluctuations of water levels in Ellis County are not available, but information on changes of water levels is afforded by several wells (under artesian conditions) in the county. The net change in water levels measured in several wells ranged from a decline of 263 feet from 1915 to 1965, averaging about 7.9 feet per year since 1946 in a well tapping the Hosston Formation, to a decline of 114 feet from 1936 to 1965, averaging 5.4 feet per year in well JK-32-48-601 tapping the Woodbine Formation. The immediate causes of these declines in water levels are not clearly known because of an inadequate number of water-level measurements for each well; however, the declines were undoubtedly caused by pumping either in Ellis County or, more probably, in Dallas County.

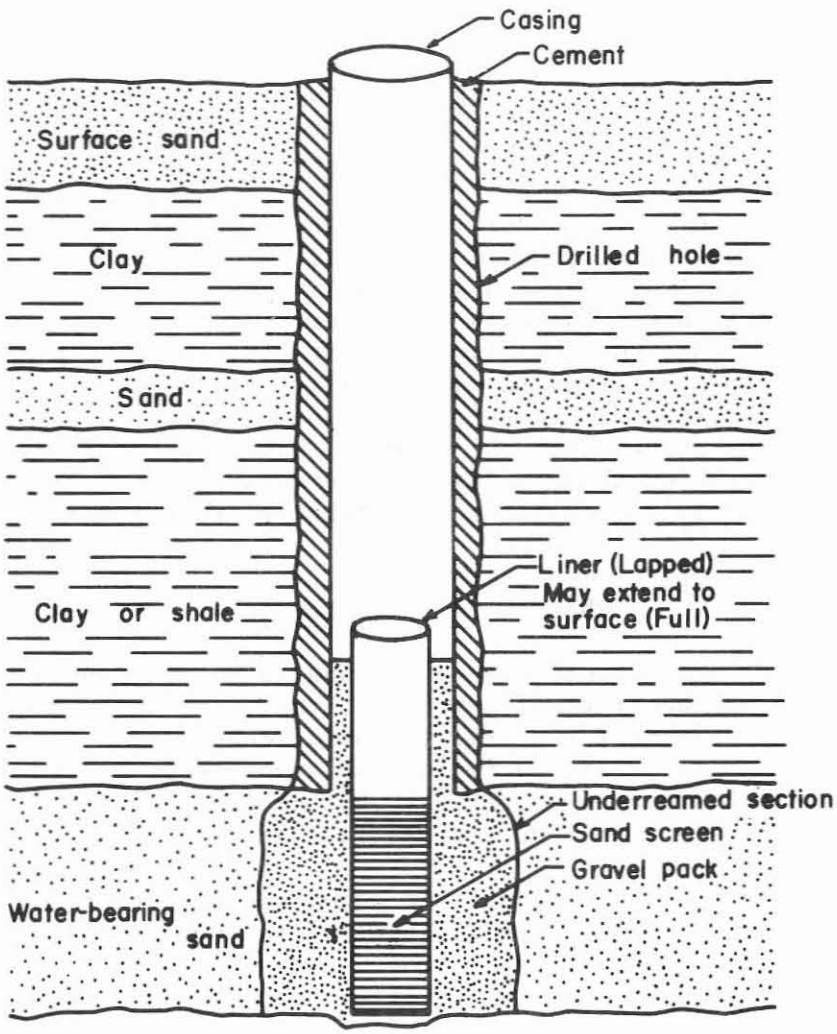

Figure 10

Construction of a Typical Public-Supply Well

U.S. Geological Survey in cooperation with the Texas Water Development Board

An example of a water-level decline that definitely is related to heavy local pumping is afforded by well JK-33-57-205, a domestic well near Milford. From 1962 to 1965 the water level in this well declined a reported 42 feet, a rate of about 14 feet per year. This well is about 4 miles west of the Neuhoff cattle feeder in Navarro County, where water from the Woodbine Formation is supplied to about 25,000 cattle that consume annually about 336 acre-feet of water. At this locality the coefficient of transmissibility is probably less than the average, and the cones of depression of five closely-spaced wells undoubtedly overlap, thus maximizing the local drawdown. The water levels in several recently drilled public-supply wells have declined at an average annual rate of 10 feet per year (JK-33-35-501 and JK-33-42-901) to as much as 23.5 feet per year (JK-33-43-301) and 35 feet per year (HR-33-27-602); the water level in public-supply well JK-33-35-702 near Boyce has declined 50 feet during the first year of use.

QUALITY OF GROUND WATER

The chemical constituents in the ground water in Ellis County are derived principally from solution of material in the soil and rocks through which the water has moved. The differences in the chemical quality of the water reflect, in a general way, the types of soil and rocks that have been in contact with the water. Usually, as the water moves deeper, its chemical content is increased by solution and by removal of salts held by molecular forces. The source and significance of the dissolved-mineral constituents and other properties of ground water are summarized in Table 4, which is modified from Doll and others (1963, p. 39-43). The chemical quality of ground water in Ellis County is summarized and compared with various standards of water quality in Table 5. The chemical analyses of water from 114 selected wells in Ellis County are given in Table 8.

Quality and Suitability of Water for Use

The suitability of a water supply depends upon the contemplated use of the water and its chemical quality, including the dissolved-mineral constituents, bacterial content, and other physical characteristics such as turbidity, color, odor, temperature, and radioactivity.

The dissolved solids or "total salts" content is a major limitation on the use of water for many purposes. The classification of water, based on the dissolved-solids content in ppm (parts per million), as used in this report is shown on page 44 (Winslow and Kister, 1956, p. 5).

Table 4.--Source and significance of dissolved-mineral constituents and properties of water
(from Doll and others, 1963, p. 39-43)

Constituent or property	Source or cause	Significance
Silica (SiO_2)	Dissolved from practically all rocks and soils, commonly less than 30 ppm. High concentrations, as much as 100 ppm, generally occur in highly alkaline waters.	Forms hard scale in pipes and boilers. Carried over in steam of high pressure boilers to form deposits on blades of turbines. Inhibits deterioration of zeolite-type water softeners.
Iron (Fe)	Dissolved from practically all rocks and soils. May also be derived from iron pipes, pumps, and other equipment.	On exposure to air, iron in ground water oxidizes to reddish-brown precipitate. More than about 0.3 ppm stains laundry and utensils reddish-brown. Objectionable for food processing, textile processing, beverages, ice manufacture, brewing, and other processes. USPHS (1962) drinking water standards state that iron should not exceed 0.3 ppm. Larger quantities cause unpleasant taste and favor growth of iron bacteria.
Calcium (Ca) and Magnesium (Mg)	Dissolved from practically all soils and rocks, but especially from limestone, dolomite, and gypsum. Calcium and magnesium are found in large quantities in some brines. Magnesium is present in large quantities in sea water.	Cause most of the hardness and scale-forming properties of water; soap consuming (see hardness). Waters low in calcium and magnesium desired in electroplating, tanning, dyeing, and in textile manufacturing.
Sodium (Na) and Potassium (K)	Dissolved from practically all rocks and soils. Found also in oil-field brines, sea water, industrial brines, and sewage.	Large amounts, in combination with chloride, give a salty taste. Moderate quantities have little effect on the usefulness of water for most purposes. Sodium salts may cause foaming in steam boilers and a high sodium content may limit the use of water for irrigation.
Bicarbonate (HCO_3) and Carbonate (CO_3)	Action of carbon dioxide in water on carbonate rocks such as limestone and dolomite.	Bicarbonate and carbonate produce alkalinity. Bicarbonates of calcium and magnesium decompose in steam boilers and hot water facilities to form scale and release corrosive carbon dioxide gas. In combination with calcium and magnesium, cause carbonate hardness.
Sulfate (SO_4)	Dissolved from rocks and soils containing gypsum, iron sulfides, and other sulfur compounds. Commonly present in some industrial wastes.	Sulfate in water containing calcium forms hard scale in steam boilers. In large amounts, sulfate in combination with other ions gives bitter taste to water. USPHS (1962) drinking water standards recommend that the sulfate content should not exceed 250 ppm.
Chloride (Cl)	Dissolved from rocks and soils. Present in sewage and found in large amounts in oil-field brines, sea water, and industrial brines.	In large amounts in combination with sodium, gives salty taste to drinking water. In large quantities, increases the corrosiveness of water. USPHS (1962) drinking water standards recommend that the chloride content should not exceed 250 ppm.
Fluoride (F)	Dissolved in small to minute quantities from most rocks and soils. Added to many waters by fluoridation of municipal supplies.	Fluoride in drinking water reduces the incidence of tooth decay when the water is consumed during the period of enamel calcification. However, it may cause mottling of the teeth, depending on the concentration of fluoride, the age of the child, amount of drinking water consumed, and susceptibility of the individual (Maier, 1950, p. 1120-1132).
Nitrate (NO_3)	Decaying organic matter, sewage, fertilizers, and nitrates in soil.	Concentration much greater than the local average may suggest pollution. USPHS (1962) drinking water standards suggest a limit of 45 ppm. Waters of high nitrate content have been reported to be the cause of methemoglobinemia (an often fatal disease in infants) and therefore should not be used in infant feeding (Maxcy, 1950, p. 271). Nitrate has been shown to be helpful in reducing inter-crystalline cracking of boiler steel. It encourages growth of algae and other organisms which produce undesirable tastes and odors.
Boron (B)	A minor constituent of rocks and of natural waters.	An excessive boron content will make water unsuitable for irrigation. Wilcox (1955, p. 11) indicated that a boron concentration of as much as 1.0 ppm is permissible for irrigating sensitive crops; as much as 2.0 ppm for semitolerant crops; and as much as 3.0 for tolerant crops. Crops sensitive to boron include most deciduous fruit and nut trees and navy beans; semitolerant crops include most small grains, potatoes and some other vegetables, and cotton; and tolerant crops include alfalfa, most root vegetables, and the date palm.
Dissolved solids	Chiefly mineral constituents dissolved from rocks and soils.	USPHS (1962) drinking water standards recommend that waters containing more than 500 ppm dissolved solids not be used if other less mineralized supplies are available. For many purposes the dissolved-solids content is a major limitation on the use of water. A general classification of water based on dissolved-solids content, in ppm, is as follows (Winslow and Kister, 1956, p. 5): Waters containing less than 1,000 ppm of dissolved solids are considered fresh; 1,000 to 3,000 ppm, slightly saline; 3,000 to 10,000 ppm, moderately saline; 10,000 to 35,000 ppm, very saline; and more than 35,000 ppm, brine.
Hardness as $CaCO_3$	In most waters nearly all the hardness is due to calcium and magnesium. All of the metallic cations other than the alkali metals also cause hardness.	Consumes soap before a lather will form. Deposits soap curd on bathtubs. Hard water forms scale in boilers, water heaters, and pipes. Hardness equivalent to the bicarbonate and carbonate is called carbonate hardness. Any hardness in excess of this is called non-carbonate hardness. Waters of hardness up to 60 ppm are considered soft; 61 to 120 ppm, moderately hard; 121 to 180 ppm, hard; more than 180 ppm, very hard.
Sodium-adsorption ratio (SAR)	Sodium in water.	A ratio for soil extracts and irrigation waters used to express the relative activity of sodium ions in exchange reactions with soil (U.S. Salinity Laboratory Staff, 1954, p. 72, 156). Defined by the following equation: $$SAR = \frac{Na^+}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}},$$ where Na^+, Ca^{++}, and Mg^{++} represent the concentrations in equivalents per million (epm) of the respective ions.
Residual sodium carbonate (RSC)	Sodium and carbonate or bicarbonate in water.	As calcium and magnesium precipitate as carbonates in the soil, the relative proportion of sodium in the water is increased (Eaton, 1950, p. 123-133). Defined by the following equation: $$RSC = (CO_3^{--} + HCO_3^-) - (Ca^{++} + Mg^{++}),$$ where CO_3^{--}, HCO_3^-, Ca^{++}, and Mg^{++} represent the concentrations in equivalents per million (epm) of the respective ions.
Specific conductance (micromhos at 25°C)	Mineral content of the water.	Indicates degree of mineralization. Specific conductance is a measure of the capacity of the water to conduct an electric current. Varies with concentration and degree of ionization of the constituents.
Hydrogen ion concentration (pH)	Acids, acid-generating salts, and free carbon dioxide lower the pH. Carbonates, bicarbonates, hydroxides, and phosphates, silicates, and borates raise the pH.	A pH of 7.0 indicates neutrality of a solution. Values higher than 7.0 denote increasing alkalinity; values lower than 7.0 indicate increasing acidity. pH is a measure of the activity of the hydrogen ions. Corrosiveness of water generally increases with decreasing pH. However, excessively alkaline waters may also attack metals.

Table 5.--Chemical quality of ground water in Ellis County as compared with various standards of water quality

Chemical constituents in parts per million (ppm)

	Criteria for public and domestic supply																	
	Silica (SiO_2)		Iron total[a] (Fe)		Sulfate (SO_4)		Chloride (Cl)		Fluoride (F)			Nitrate (NO_3)		Hardness as $CaCO_3$		Dissolved solids for fresh water		
Upper limits	20		0.3		250		250		1.0			45		60		500		
	Number of determinations																	
	Total	Over 20 ppm	Total	Over 0.3 ppm	Total	Over 250 ppm	Total	Over 250 ppm	Total	Over 1.0 ppm	Over 1.6 ppm	Total	Over 45 ppm	Total	Over 60 ppm	Total	Over 500 ppm	Over 1,000 ppm
All samples (total 141)	80	4	65	12	134	93	140	29	83	75	62	86	1	133	18	93	92	75
Hosston Formation	18	3	17	0	20	2	20	7	19	18	13	18	0	20	3	20	20	13
Glen Rose Limestone	1	0	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1
Paluxy Sand	1	0	2	0	1	1	2	0	1	1	1	1	0	2	0	1	1	1
Woodbine Formation	56	1	43	9	99	85	102	22	57	54	47	60	0	95	0	67	67	59
Wolfe City Sand Member of Taylor Marl	1	0	1	1	1	1	2	0	1	1	0	1	0	2	1	1	1	1
Taylor Marl (excluding Wolfe City)	1	0	0	0	7	2	7	0	1	0	0	2	0	7	7	1	1	0
Alluvium	2	0	1	1	5	1	6	0	3	0	0	3	1	6	6	2	1	0

[a] Includes field determinations.

Description	Dissolved-solids content (ppm)
Fresh	Less than 1,000
Slightly saline	1,000 to 3,000
Moderately saline	3,000 to 10,000
Very saline	10,000 to 35,000
Brine	More than 35,000

The U.S. Public Health Service has established and periodically revises the standards for drinking water used on common carriers engaged in interstate commerce. The standards are designed to protect the public and are used to evaluate public water supplies.

According to the standards, chemical substances should not exceed the listed concentrations whenever more suitable supplies are or can be made available. The major chemical standards adopted by the U.S. Public Health Service (1962, p. 7-8) are as follows:

Substance	Concentration (ppm)
Chloride (Cl)	250
Fluoride (F)	(*)
Iron (Fe)	.3
Manganese (Mn)	.05
Nitrate (NO_3)	45
Sulfate (SO_4)	250
Total dissolved solids	500

*The permissible concentration of fluoride is based upon the annual average of the maximum daily temperature. Using an average of 77.0°F (measured at Waxahachie for the period 1931-65), the fluoride concentration in drinking water in Ellis County should not exceed 1.0 ppm.

Not all of the ground water available in Ellis County meets the standards established by the U.S. Public Health Service, but wells generally yield water that is suitable for most uses except sustained irrigation (Figure 11).

The concentration of dissolved solids in 93 analyzed samples ranged from 444 ppm in water from well JK-33-37-805 tapping the Quaternary alluvium to 5,650 ppm in well JK-33-34-711 tapping the Glen Rose Limestone. About 99 percent of the analyzed samples (Table 5) exceeded the 500 ppm limit and about 81 percent exceeded 1,000 ppm. All samples from the Hosston Formation, Glen Rose Limestone, Paluxy Sand, Woodbine Formation, and Taylor Marl contained more than 500 ppm. Eighty-eight percent of the Woodbine samples and 65 percent of the Hosston samples exceeded 1,000 ppm.

Sodium bicarbonate is the most abundant of the dissolved solids (Table 8) in all aquifers except the alluvium. Figure 12 shows that the SAR (sodium adsorption ratio) is also very high in most ground water in Ellis County.

The sodium and sodium plus potassium determinations in water samples from Ellis County and adjoining areas ranged from 23 ppm in well JK-33-37-805 tapping the alluvium to 1,420 ppm in well JK-33-34-711 tapping the Glen Rose Limestone. The sodium concentration in water samples from the Woodbine Formation averaged 596 ppm; the concentration in samples from the Hosston Formation averaged 362 ppm.

Sulfate concentration in about 70 percent of all samples exceeded 250 ppm. The maximum was 3,680 ppm in well JK-33-34-711 in the Glen Rose Limestone, but most of the excesses were in water from the Woodbine Formation (Table 5).

The chloride concentration ranged from 2.4 ppm to 1,540 ppm. Most of the water samples with more than 250 ppm chloride were from wells in the Woodbine Formation.

Water containing an optimum fluoride content reduces the incidence of tooth decay when the water is used by children during the period of enamel calcification. Depending upon the age of the child, the amount of drinking water consumed, and the susceptibility of the individual, excessive concentrations of fluoride may cause mottling of the teeth (Maier, 1950, p. 1120-1132). The optimum fluoride level for a given area depends upon climatic conditions because the amount of drinking water consumed is influenced by the air temperature. Based on the annual average of the maximum daily temperature at Waxahachie of 77°F from 1931-65, the optimum fluoride content in drinking water in Ellis County is 0.8 ppm, and should not average more than 1.0 ppm. Concentrations greater than 1.6 ppm (twice the optimum) constitute grounds for rejection of a public water supply by the U.S. Public Health Service.

Of the 83 fluoride determinations (Table 5), 90 percent exceeded 1.0 ppm and 74 percent exceeded 1.6 ppm. In water samples from the Woodbine Formation, 95 percent exceeded 1.0 ppm and 82 percent exceeded 1.6 ppm. In water samples from the Hosston Formation, 95 percent exceeded 1.0 ppm and 68 percent exceeded 1.6 ppm. The maximum fluoride concentration measured was 7 ppm in the Ennis public-supply well JK-33-44-401 tapping the Woodbine Formation. In Ellis County, only the Taylor Marl and the alluvial deposits yield water with insignificant concentrations of fluoride.

The upper limit for nitrate concentration, according to the Public Health Service, is 45 ppm. The use of water containing nitrate in excess of 45 ppm has been related to infant cyanosis or "blue baby" disease (Maxcy, 1950, p. 271). The presence of more than several parts per million of nitrate in

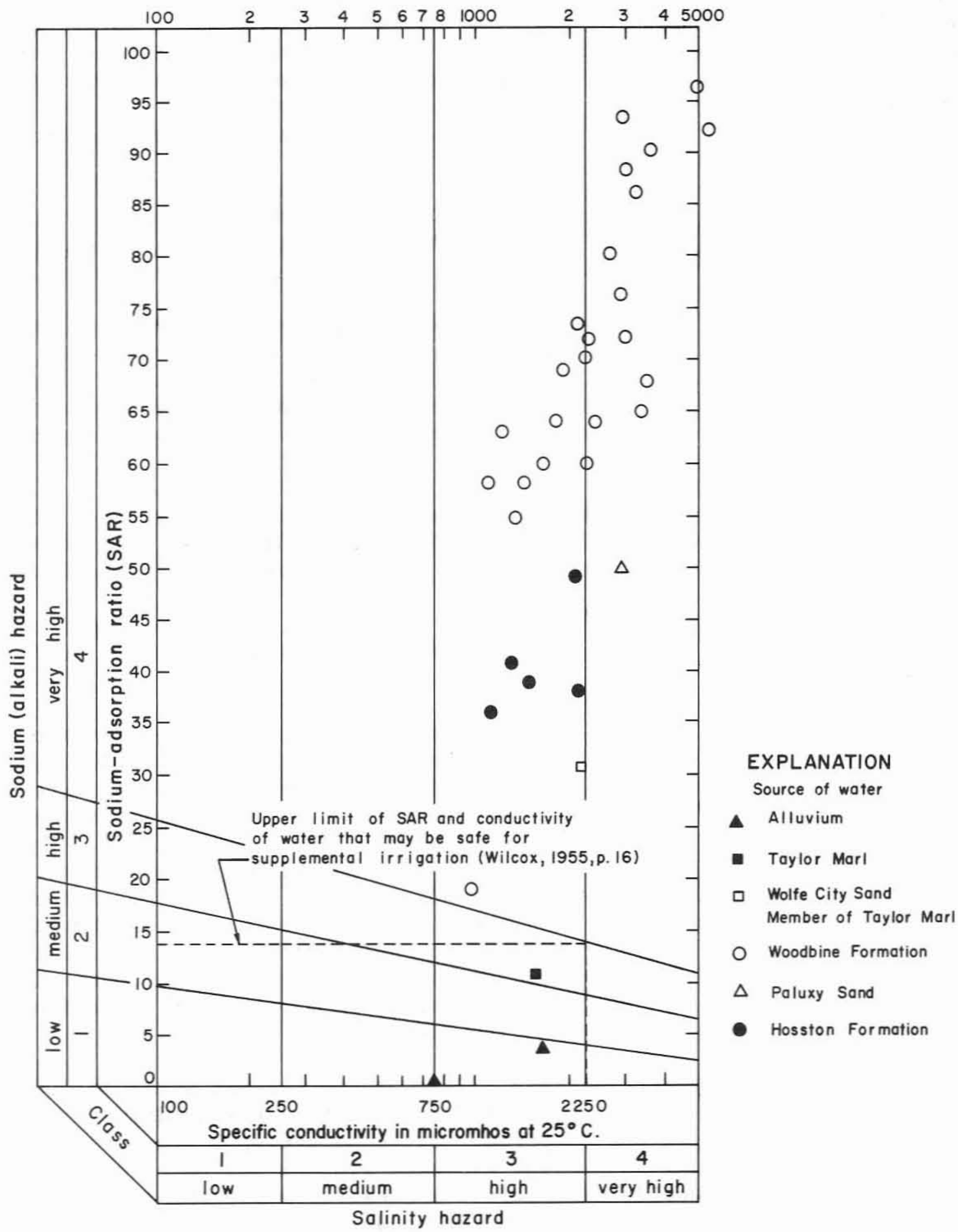

Figure 12

Classification of Irrigation Waters

U. S. Geological Survey in cooperation with the Texas Water Development Board water may indicate contamination by sewage or other organic matter (Lohr and Love, 1954, p. 10). Contamination is more likely in shallow dug wells than in deep wells.

Nitrate concentrations were low in most of the samples analyzed. Of 86 determinations, 19 contained no trace of nitrate, and most samples contained less than 5 ppm. Wells JK-33-43-501 (depth 32 feet) and JK-33-37-805 (depth 30 feet), both tapping the flood-plain alluvium, contained 54 and 35 ppm nitrate, respectively.

The hardness of water is caused principally by calcium and magnesium. Excessive hardness increases soap consumption and induces the formation of scale in hot water heaters and water pipes. Although no limits of concentration have been established by the Public Health Service, a commonly accepted classification of water hardness is as follows:

Hardness range (ppm)	Classification
60 or less	Soft
61 to 120	Moderately hard
121 to 180	Hard
More than 180	Very hard

Of 133 determinations of hardness, only 18 exceeded 60 ppm, none of which were for samples from the Woodbine or Paluxy, and only 3 were of samples from the Hosston.

The chemical characteristics of water that are of particular importance to its use for irrigation are SAR (sodium adsorption ration) in relation to the specific conductance, RSC (residual sodium carbonate), and boron concentration. Figure 12 shows that the SAR and specific conductance of water from most of the aquifers in Ellis County are not within the upper limits of SAR (14) and specific conductance (2,250 micromhos at 25°C); the water is, therefore, not desirable for either sustained or extensive supplemental irrigation. Only the water produced from the alluvium and Taylor Marl is of a chemical quality suitable for irrigation.

Most of the water is also unsuitable for irrigation because of the RSC content of the water. Wilcox (1955, p. 11) reports that water containing more than 2.5 epm (equivalents per million) RSC is undesirable for irrigation and that water containing 1.25 to 2.5 is marginal; water containing less than 1.25 is probably safe. RSC exceeded 2.5 epm in about 85 percent of all samples tested.

The boron content of water is also significant in the evaluation of irrigation water. Wilcox (1955, p. 11) suggests that a permissible boron concentration for water used in irrigating boron-sensitive crops can be as much as 1.0 ppm but for boron-tolerant crops as much as 3.0 ppm. Boron determinations were made for 27 samples in Ellis County; the boron content ranged in these samples from 0.1 to 6.2 ppm. Of the determinations made of water from the Hosston Formation, all but one were less than 1.0 ppm. Of 15 determinations made of Woodbine samples, the boron content ranged from 1.8 to 6.2 ppm, and in 9 of the samples, the content was more than 3.0 ppm.

The temperature of ground water may be an important consideration for certain industrial uses of water. The temperatures, as determined from water wells and oil tests in Ellis County, indicate that the temperature increases about 1.5°F for every 100 feet of increase in depth. The mean annual air temperature (about 66°F) approximates the temperature of the ground water near the land surface; therefore, the gradient of 1.5 degrees per 100 feet can be applied to this base to determine the approximate temperature at any given depth.

Contamination from Oil-Field Operations

Although oil-field operations are a potential source of contamination of shallow ground water in Ellis County, no contaminated wells were found in the area of the Ellis County extension of the Corsicana shallow field, the only field in the county. All oil-field brine produced in Ellis County is disposed of in open-surface pits. In 1961, the Ellis County field reported 10,151 barrels of brine production (Texas Water Commission and Texas Water Pollution Control Board, 1963).

At least in part, salt water placed in unlined open-surface pits seeps into the ground and can contaminate the shallow aquifers. Because ground water moves at a very slow rate, two important conditions exist in the aquifer. First, because salt water added to the ground water at one point may not affect the quality of the water in nearby wells for a long period of time, the contamination may not be immediately apparent. Second, when a well is finally contaminated, the salt water remains for a long period because purification by leaching and dilution requires more time than that of the original contamination.

Aquifers may also be contaminated through inadequately cased, improperly plugged, or unplugged oil and gas wells and test holes that allow migration of undesirable water up the bore hole into aquifers containing water of good quality. The Texas Railroad Commission requires that fresh-water strata be protected by surface casing and cement, or by alternate protection devices; however, no field rules regarding surface casing depths are specified for the Ellis County part of the Corsicana shallow field of Navarro and Ellis Counties. No evidence of contamination of this type was observed in Ellis County.

AVAILABILITY OF GROUND WATER

The principal water-bearing formations in Ellis County are the Hosston Formation, the Paluxy Sand, and the Woodbine Formation. The flood-plain alluvium is potentially important for local irrigation near the larger streams, especially the Trinity River. Other aquifers in the county are of minor importance and supply only small quantities of water.

The most favorable areas for development of ground water in Ellis County are where the thicknesses of saturated sand are greatest. Figures 13 and 14 show the thickness of saturated sands containing fresh to slightly saline water in the Hosston Formation, the Paluxy Sand, and the Woodbine Formation. The maps also show the extent of the fresh to slightly saline water-bearing portion of each aquifer.

Figure 13 shows that the greatest thickness of saturated sands in the Hosston Formation is in the eastern part of the county a few miles west of the downdip limit of fresh to slightly saline water. Assuming an efficiency of 70 percent, a properly constructed well in the Hosston might be expected to yield as much as 450 gpm with 250 feet of drawdown. Figure 13 also shows that the extent of fresh to slightly saline water-bearing sand in the Paluxy Sand is considerably less than in the Hosston. The greatest saturated thickness in the Paluxy is in the western part of the county where the thickness exceeds 100 feet in places. Yields of properly constructed wells in the Paluxy might be expected to be as much as 200 gpm with 250 feet of drawdown if the well efficiency is 70 percent.

Figure 14 shows the saturated thickness of fresh to slightly saline water-bearing sands in the Woodbine Formation. This figure shows that the greatest thickness (about 200 feet) is in the north-central part of the county near the Dallas County line. The figure also shows a large area extending throughout most of the central part of the county in which the thickness is a least 150 feet. Assuming well efficiencies of 70 percent, yields of as much as 600 gpm with 250 feet of drawdown might be expected in properly constructed wells in the Woodbine.

The amount of water that can be pumped perennially in Ellis County without depleting the ground-water supply depends on several factors, one of the most important of which is the average effective rate of recharge. This can be estimated by determining the amount of water that is moving through the aquifers. However, this method is valid only if the aquifers have not been affected by pumping. Since the water levels in wells have declined substantially over a period of many years and apparently are still declining, it is evident that the aquifers in Ellis County have been affected by pumping within the county itself, and, undoubtedly, by pumping in the Dallas and Fort Worth areas. The estimate of recharge can be computed using the formula $Q = TIL$, in which Q is the quantity of water in gallons per day moving through the aquifer, T is the coefficient of transmissibility in gallons per day per foot, I is the undisturbed or original hydraulic gradient of the piezometric surface or water table in feet per mile, and L is the length of the aquifer in miles normal to the hydraulic gradient. Data are not available to determine the undisturbed or original hydraulic gradient; however, computations can be made of the quantity of water moving through the county under the present hydraulic gradient.

Data are not available to determine the average hydraulic gradient in the Hosston Formation in Ellis County; however, sparse control points indicate that the gradient might be about 10 feet per mile. Based on this gradient and an average coefficient of transmissibility of about 7,000 gpd per foot, the amount of water moving through the county in the Hosston Formation is at least 2.4 mgd, or about 2,670 acre-feet per year. Since the gradient used in this calculation is not the original hydraulic gradient, the actual recharge figure is probably somewhat less than 2.4 mgd.

The quantity of water available from the Paluxy Sand cannot be estimated because data are not sufficient to determine the hydraulic gradient in the county. The results of the pumping tests and the thickness of the saturated sand indicate, however, that the quantity is less than that from either the Hosston or the Woodbine, perhaps about 1,000 acre-feet per year.

Estimates of the quantity of water flowing through the county in the Woodbine Formation can be made in a similar manner to those that were made for the Hosston. Based on the present hydraulic gradient of about 11 feet per mile and the coefficient of transmissibility of about 9,500 gpd per foot, the quantity of water flowing through the Woodbine is about 3.1 mgd, or 3,500 acre-feet per year. As stated above, water levels in the Woodbine Formation are declining and the gradient of 11 feet per mile is not the original or undisturbed gradient. Therefore, the figure of 3.1 mgd does not represent the amount of recharge to the formation. The recharge would be somewhat less but probably not much less.

Large quantities of water are in storage in all of the major aquifers in Ellis County. Most of this water occurs at great depth and under present economics of pumping it would be impracticable to pump the water from storage. However, in the Woodbine Formation at least a part of this large quantity of water is available for development. The aquifer occurs at a depth of less than 400 feet below the surface in a triangular-shaped area of about 95 square miles in the northwest part of the county. In this area, about 1,200,000 acre-feet of water is in storage at a depth of less than 400 feet. Much of this water could be pumped but because of the low coefficient of transmissibility, it would require a large number of wells.

The quantity of water available from the alluvium of the flood plains of the major streams of the county is not known; however, yields of properly constructed wells in the alluvium might be expected to be as much as 75 gpm.

In summary, it appears that small additional supplies of ground water are available in Ellis County without depleting the aquifers. The 1964 pumpage of 3,500 acre-feet from the Woodbine is probably slightly more than the average rate of replenishment to the Woodbine in the county. The pumpage from the Hosston (1,840 acre-feet in 1964) is probably somewhat less (about 1,000 acre-feet) than the average rate of replenishment. Small additional supplies of water are available from the Paluxy Sand, probably about 1,000 acre-feet per year, and smaller amounts are available from the other aquifers in the county. In addition to the perennial supplies, a large quantity of water (about 1,200,000 acre-feet) is available in storage in the Woodbine in the northwest part of the county.

The availability of water from the major aquifers in Ellis County depends to a large extent on the development in neighboring counties, especially in Dallas and Tarrant Counties and the counties to the west of Ellis County. Determinations of the availability of water should be made on a regional basis rather than on a county basis. The region should include Dallas and Tarrant Counties and at least the immediately adjoining counties. A program should be established in the region for the collection of basic hydrologic data. The program should include a network of observation wells in each of the aquifers not only in the areas of development but also extending to the areas of recharge. Records should be kept of the withdrawals of water from the aquifers, and a network of observation wells should be established to provide for resampling so as to record any changes in the chemical quality of the water. Such a program could be established in Ellis County on the basis of the results of the present investigation. Detailed studies should be made in Dallas and Tarrant Counties and the adjoining counties before an adequate program of observation can be established.

DEFINITIONS OF TERMS

Many of these definitions have been selected from reports by Meinzer (1923b), American Geological Institute (1960), Langbein and Iseri (1960), and Ferris and others (1962).

Acre-foot.--The volume of water required to cover 1 acre to a depth of 1 foot (43,560 cubic feet), or 325,851 gallons.

Acre-feet per year.--One ac-ft/yr equals 892.13 gallons per day.

Alluvial deposits.--See alluvium.

Alluvium.--Sediments deposited by streams; includes flood-plain deposits and stream-terrace deposits. Also called alluvial deposits.

Aquifer.--A formation, group of formations, or part of a formation that is water bearing.

Aquifer test, pumping test.--The test consists of the measurement at specific intervals of the discharge and water level of the well being pumped and the water levels in nearby observation wells. Formulas have been developed to show the relationship among the yield of a well, the shape and extent of the cone of depression, and the properties of the aquifer such as the specific yield, porosity, and coefficients of permeability, transmissibility, and storage.

Artesian aquifer, confined aquifer.--Artesian (confined) water occurs where an aquifer is overlain by rock of lower permeability (e.g., clay) that confines the water under pressure greater than atmospheric. The water level in an artesian well will rise above the top of the aquifer. The well may or may not flow.

Artesian well.--One in which the water level rises above the top of the aquifer, whether or not the water flows at the land surface.

Base flow of a stream.--Fair weather flow in a stream supplied by the ground-water discharge.

Cone of depression.--Depression of the water table or piezometric surface surrounding a discharging well, more or less the shape of an inverted cone.

Confining bed.--One which because of its position and its impermeability or low permeability relative to that of the aquifer keeps the water in the aquifer under artesian pressure.

Contact.--The place or surface where two different kinds of rock or geologic units come together, shown on both maps and cross sections.

Dip of rocks, attitude of beds.--The angle or amount of slope at which a bed is inclined from the horizontal; direction is also expressed (e.g., 1 degree, southeast; or 90 feet per mile, southeast).

Drawdown.--The lowering of the water table or piezometric surface caused by pumping (or artesian flow). In most instances, it is the difference, in feet, between the static level and the pumping level.

Electrical log.--A graph log showing the relation of the electrical properties of the rocks and their fluid contents penetrated in a well. The electrical properties are natural potentials and resistivities to induced electrical currents, some of which are modified by the presence of the drilling mud.

Equivalents per million (epm).--An expression of the concentration of chemical substances in terms of the reacting values of electrically charged particles, or ions, in solution. One epm of a positively charged ion (e.g., Na^+) will react with 1 epm of a negatively charged ion (e.g., Cl^-).

Evapotranspiration.--Water withdrawn by evaporation from a land area, a water surface, moist soil, or the water table, and the water consumed by transpiration of plants.

Fault.--A fracture or fracture zone along which there has been displacement of the two sides relative to one another parallel to the fracture.

Ferruginous.--Containing iron; usually ranging from pale yellow brown, through dark brown, to deep reddish brown in color depending on the amount of iron in the rock.

Formation.--A body of rock that is sufficiently homogeneous or distinctive to be regarded as a mappable unit, usually named from a locality where the formation is typical (e.g., Paluxy Sand, Hosston Formation, and Woodbine Formation).

Fresh water.--Water containing less than 1,000 ppm (parts per million) of dissolved solids (Winslow and Kister, 1956, p. 5). For dissolved solids, see Table 8.

Gallons per day (gpd).

Gallons per hour (gph).

Gallons per minute (gpm).

Ground water.--Water in the ground that is in the zone of saturation from which wells, springs, and seeps are supplied.

Head, or hydrostatic pressure.--Artesian pressure measured at the land surface reported in pounds per square inch or feet of water.

Hydraulic gradient.--The slope of the water table or piezometric surface, usually given in feet per mile.

Hydrologic cycle.--The complete cycle of phenomena through which water passes, commencing as atmospheric water vapor, passing into liquid or solid form as precipitation, thence along or into the ground, and finally again returning to the form of atmospheric water vapor by means of evaporation and transpiration.

Irrigation, supplemental.--The use of ground or surface water for irrigation in humid regions as a supplement to rainfall during periods of drought. Not a primary source of moisture as in arid and semiarid regions.

Lignite.--A brownish-black coal in which the alteration of vegetal material has proceeded further than in peat but not so far as subbituminous coal.

Lithology.--The description of rocks, usually from observation of hand specimen, or outcrop.

Marl.--A calcareous clay.

Million(s) gallons per day (mgd).--One mgd equals 3.068883 acre-feet per day or 1,120.91 acre-feet per year.

Mineral.--Any chemical element or compound occurring naturally as a product of inorganic processes.

Outcrop.--That part of a rock layer which appears at the land surface. On an areal geologic map a formation or other stratigraphic unit is shown as an area of outcrop where exposed and where covered by alluvial deposits (contacts below the alluvial deposits are shown on map by dotted lines).

Parts per million (ppm--weight).--One part per million represents 1 milligram of solute in 1 kilogram of solution. As commonly measured and used, parts per million is numerically equivalent to milligrams of a substance per liter of water.

Permeability of an aquifer.--The capacity of an aquifer for transmitting water under pressure.

Piezometric surface.--An imaginary surface that everywhere coincides with the static level of the water in the aquifer. The surface to which the water from a given aquifer will rise under its full head.

Porosity.--The ratio of the aggregate volume of interstices (openings) in a rock or soil to its total volume, usually stated as a percentage.

Recharge of ground water.--The process by which water is absorbed and is added to the zone of saturation. Also used to designate the quantity of water that is added to the zone of saturation, usually given in acre-feet per year or in million gallons per day.

Recharge, rejected.--The natural discharge of ground water in the recharge area of an aquifer by springs, seeps, and evapotranspiration, which occurs when the rate of recharge exceeds the rate of transmission in the aquifer.

Resistivity (electrical log).--The resistance of the rocks and their fluid contents penetrated in a well to induced electrical currents. Permeable rocks containing fresh water have high resistivities.

Salinity of water.--From a general classification of water based on dissolved-solids content by Winslow and Kister (1956, p. 5): fresh water, less than 1,000 ppm; slightly saline water, 1,000 to 3,000 ppm; moderately saline water, 3,000 to 10,000 ppm; very saline water, 10,000 to 35,000 ppm; and brine, more than 35,000 ppm.

Specific capacity.--The rate of yield of a well per unit of drawdown, usually expressed as gallons per minute per foot of drawdown. If the yield is 250 gpm and the drawdown is 10 feet, the specific capacity is 25 gpm/ft.

Specific yield.--The quantity of water that an aquifer will yield by gravity if it is first saturated and then allowed to drain; the ratio expressed in percentage of the volume of water drained to volume of the aquifer that is drained.

Storage.--The volume of water in an aquifer, usually given in acre-feet.

Storage, coefficient of.--The volume of water that an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in the component of head normal to that surface. Storage coefficients of artesian aquifers may range from about 0.00001 to 0.001; those of water-table aquifers may range from about 0.05 to 0.30.

Structural feature, geologic.-- The result of the deformation or dislocation (e.g., faulting) of the rocks in the earth's crust. In a structural basin, the rock layers dip toward the center or axis of the basin. The structural basin may or may not coincide with a topographic basin.

Surface water.--Water on the surface of the earth.

Transmissibility, coefficient of.--The rate of flow of water in gallons per day through a vertical strip of the aquifer 1 foot wide extending through the vertical thickness of the aquifer at a hydraulic gradient of 1 foot per foot and at the prevailing temperature of the water. The coefficient of transmissibility from a pumping test is reported for the part of the aquifer tapped by the well.

Transmission capacity of an aquifer.--The quantity of water that can be transmitted through a given width of an aquifer at a given hydraulic gradient, usually expressed in acre-feet per year or million gallons per day.

Transpiration.--The process by which water vapor escapes from a living plant, principally the leaves, and enters the atmosphere.

Water level.--Depth to water, in feet below the land surface, where the water occurs under water-table conditions (or depth to the top of the zone of saturation). Under artesian conditions the water level is a measure of the pressure on the aquifer, and the water level may be at, below, or above the land surface.

Water level, pumping.--The water level during pumping measured in feet below the land surface.

Water level, static.--The water level in an unpumped or nonflowing well measured in feet above or below the land surface or sea-level datum.

Water table.--The upper surface of a zone of saturation except where the surface is formed by an impermeable body of rock.

Water-table aquifer (unconfined aquifer).--An aquifer in which the water is unconfined; the upper surface of the zone of saturation is under atmospheric pressure only and the water is free to rise or fall in response to the changes in the volume of water in storage. A well penetrating an aquifer under water-table conditions becomes filled with water to the level of the water table.

Yield of a well.--The rate of discharge, commonly expressed as gallons per minute, gallons per day, or gallons per hour. In this report, yields are classified as small, less than 50 gpm (gallons per minute); moderate, 50 to 500 gpm; and large, more than 500 gpm.

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Table 6.--Records of wells and springs in Ellis and adjacent counties

All wells are drilled unless otherwise noted in remarks column.
Water level : Reported water levels are given in feet; measured water levels are given in feet and tenths.
Method of lift and type of power: B, bucket and rope; C, cylinder; E, electric; G, gasoline, butane, or Diesel engine; H, hand; J, jet; N, none; T, turbine; W, windmill. Number indicates horsepower.
Use of water : D, domestic; Ind, industrial; Irr, irrigation; N, none; P, public supply; S, livestock.
Water-bearing unit : Qal, Quaternary alluvium; Ktw, Wolfe City Sand Member of Taylor Marl; Kt, Taylor Marl; Ka, Austin Chalk; Kef, Eagle Ford Shale; Kwb, Woodbine Formation; Kp, Paluxy Sand; Kgr, Glen Rose Limestone; Kh, Hosston Formation.

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	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
							Ellis County					
*JK-32-32-801	J. B. Eldridge	C. M. Stoner	1962	300	4	Kwb	567	130 131.2	Dec. 1962 June 15, 1965	T,E, 1	S	Cased to bottom. Slotted from 265 ft to bottom. Temp. 72°F.
802	H. D. Nifong, well 1	C. E. Prince, et al	1954	1,161	--	--	550	--	--	--	--	Oil test.[2/]
901	Gifford Hill Cement Plant	J. L. Myers' Sons	1965	594	--	Kwb(?)	670	460	June 1965	T,E, 3	Ind	Cased to bottom. Screen from 567 to 588 ft.
* 902	A. W. Burnitt	C. M. Stoner	1964	530	4	Kwb	650	301.7	June 15, 1965	T,E, 2	D,S	Cased to bottom. Perforated from 520 ft to bottom. Temp. 77°F.[1/]
40-201	W. R. Miller	do	1963	458	4	Kwb	651	240	May 1963	T,E, 1-1/2	D,S	Cased to bottom. Perforated from 438 to 445 ft. Reported discharge 10 gpm.[1/]
301	Texas Industries, Inc., well 2	J. L. Myers' Sons	1960	2,249	12, 8	Kh	670	480 500	1960 1963	T,E, 100	Ind	Cased to bottom. Screen from 2,034 ft to 2,175 ft. Gravel-packed. Reported discharge 350 gpm. Temp. 98°F.[1/] [2/]
302	J. L. Rush well 1	Johnny Mitchell	1953	4,069	9	--	655	--	--	--	--	Oil test.[2/]
303	Texas Industries, Inc., well 3	J. L. Myers' Sons	1963	573	12	Kwb	668	250	June 1963	T,E	Ind	Used for cooling purposes. Gravel-packed with perforations from 446 to 477, 481 to 531, and 536 to 556 ft. Reported discharge 220 gpm. Temp. 81°F.
304	Texas Industries, Inc., well 1	do	1959	566	5	Kwb	680	250	Sept. 1959	T,E, 3	Ind	Cased to bottom. Perforated from 528 to 542 ft.
* 601	Bob Emerson	C. M. Stoner	1962	759	4	Kwb	852	450	Aug. 1962	T,E	S	Cased to bottom. Slotted from 709 ft to bottom. Temp. 81°F.[1/]
602	do	do	1963	756	7	Kwb	858	480	Oct. 1963	T,E, 10	S	Cased to bottom. Perforated from 695 to 730 ft. Reported discharge 40 gpm.
603	Edgar Seay	C. Glenn Wallen	1963	636	5, 4	Kwb	853	430	Nov. 1963	T,E, 2	D,S	Cased to bottom. Slotted from 520 to 530, 533 to 560, 563 to 566, 573 to 581, and 596 to 618 ft. Reported 15 ft of drawdown after 24 hours pumping at 10 gpm.
604	John Adamek	George Combs	1962	40	30	Kef(?)	832	6	Apr. 1962	--	D	Cased to 5 ft. Open hole from 5 ft to bottom.
605	J. V. Salter	C. M. Stoner	1964	669	4	Kwb	802	435	Jan. 1964	T,E, 1-1/2	D,S	Cased to bottom. Screen from 635 to 645 ft. Reported discharge 8 gpm.[1/]

See footnotes at end of table.

Table 6.--Records of wells and springs in Ellis and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	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
*JK-32-40-901	Salvation Army Camp Hoblitzelle	J. L. Myers' Sons	1955	1,359	8	Kp	742	323 350.8	Jan. 1955 June 2, 1965	T,E	P	Cased to bottom. Screen from 1,230 to 1,244, and 1,254 to 1,338 ft. Drawdown 28.97 ft after pumping 2 hours at 79 gpm.1/ 2/
902	R. J. Fryer	C. M. Stoner	1965	667	--	Kwb	745	415	June 1965	T,E, 5	D,S	Cased to bottom. Perforated from 515 to 530 and 532 to 547 ft.
903	Salvation Army Camp Hoblitzelle	--	--	Spring	--	Kef	720	+	--	Flows	D	Reported spring under house.
904	C. L. Blythe	C. Glenn Wallen	1963	582	4, 3	Kwb	790	365	May 1963	T,E, 1-1/2	D	Cased to bottom. Slotted from 500 ft to bottom. Reported drawdown 35 ft after 5 hours pumping at 8 gpm.
48-201	R. F. Smith	-- Walling	1925	240	--	Kwb	614	--	--	-,E, 1/2	D,S	Casing open end.
302	do	do	1946	261	--	Kwb	595	--	--	T,G	S	Reported pump set at 258 ft. Water level reported dropping continuously.
* 501	Herbert Donnell	C. M. Stoner	1963	367	4	Kwb	592	225 132.7	July 1963 June 22, 1965	T,E, 1	D,S	Cased to bottom. Perforated from 328 to 335 and 352 to 355 ft. Reported water level 225 ft while bailing. Temp. 75°F.1/
502	Otis L. White	do	1962	357	4	Kwb	582	200	Sept. 1962	T,E, 3/4	D,S	Cased to 337 ft. Perforated from 312 to 335 ft. Screen from 337 to bottom. Reported discharge 8 gpm.
* 503	W. J. Childers	do	1962	349	4	Kwb	584	130 135.0	Aug. 1962 June 22, 1965	T,E, 3/4	D,S	Cased to bottom. Slotted from 330 ft to bottom. Reported discharge 8 gpm. Temp. 74°F.
504	R. C. Smith	--	1910	220	--	Kwb	612	--	--	T,E, 1/2	D,S	Reported casing open end to bottom.
* 601	Maypearl City well 1	J. L. Myers' Sons	1936	507	8, 6	Kwb	527	21.4 24.8 135.2	May 17, 1936 May 19, 1936 June 18, 1965	T,E, 15	P	Reported discharge 75 gpm in 1961. Used as standby well only.1/
* 602	Maypearl City well 2	do	1956	410	7	Kwb	525	75	Aug. 1956	T,E, 15	P	Cased to bottom. Perforated from 365 to 405 ft.
603	A. T. Hill	C. M. Stoner	1963	378	4	Kwb	572	215	May 1963	T,E, 1	D	Cased to bottom. Perforated from 335 to 340 and 356 to 360 ft.
* 901	H. P. Irving	do	1965	384	4	Kwb	581	168.6	June 22, 1965	T,E, 3/4	D,S	Cased to bottom. Perforated from 355 to 365 ft. Reported discharge 10 gpm.
902	J. L. Ray	do	1962	375	4	Kwb	558	155	Oct. 1962	T,E	D,S	Cased to bottom. Slotted from 340 ft to bottom. Reported discharge 3 gpm.1/

See footnotes at end of table.

Table 6.--Records of wells and springs in Ellis and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	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
*JK-32-48-903	T. H. Kiker	C. M. Stoner	1964	430	4	Kwb	590	176.1	June 22, 1965	T,E, 1	D,S	Cased to bottom. Perforated from 384 to 394 ft. Reported discharge 5 gpm.[1]
904	Lloyd McCullough	do	1964	368	4	Kwb	582	210	July 1964	T,E, 1	D,S	Cased to bottom. Perforated from 336 to 346 ft. Reported discharge 10 gpm.
* 33-25-501	Bill Nutting	C. G. Wallen	1963	697	5, 4	Kwb	809	510	Dec. 1963	T,E, 2	D,S	Cased to bottom. Slotted from 662 ft to bottom. Drawdown 20 ft after pumping 8 gpm for 24 hours.[1]
701	J. R. Fryer	do	1962	664	6	Kwb	812	465	June 1962	T,E, 1-1/2	S	Cased to bottom. Slotted from 557 ft to bottom. Reported discharge 7 gpm.
* 702	R. J. Fryer	C. M. Stoner	1963	824	4	Kwb	812	500	Apr. 1963	T,E, 5	D,S	Cased to bottom. Perforated from 704 to 772 ft. Reported discharge 17 gpm.[1]
* 801	G. P. Massey	C. G. Wallen	1953	709	5	Kwb	748	300	1952	T,E, 1-1/2	S	Cased to bottom. Perforated from 558 ft to bottom.
* 901	Village of Ovillia	do	1952	735	8, 4	Kwb	630	348	Mar. 1959	T,E, 3	P	Cased to bottom. Reported discharge 11 gpm.
* 902	Sardis-Lone Elm Water Corp.	J. L. Myers' Sons	1964	2,763	10, 7, 6	Kh	769	625 659.1	Dec. 1964 June 24, 1965	T,E, 60	P	Reported discharge 250 gpm. Screen from 2,565-2,581, 2,592-2,617, 2,632-2,650, and 2,664-2,699 ft.[1] [2]
903	Bill Eaton	C. G. Wallen	1963	747	5, 4	Kwb	690	430	Oct. 1963	T,E, 1	D	Cased to bottom. Slotted from 725 ft to bottom. Reported discharge 4 gpm.
* 904	Bill Dennis	J. L. Myers' Sons	1963	688	4	Kwb	652	320	Sept. 1965	T,E, 2	D,S	Cased to 685 ft. Screen from 665 to 685 ft.
906	C. Guyness	do	1965	698	4	Kwb	625	320	1965	N	N	Cased to bottom. Perforated from 674 ft to bottom. Broken down; will not repair.
* 26-701	Lewis Williams, Jr.	do	1962	692	4	Kwb	642	360	1962	T,E, 2	D	Cased to bottom. Perforated from 677 to 692 ft. Temp. 82°F.
* 702	W. Ardizone	--	1955	900	4	Kwb	632	--	--	T,E, 2	D,S	
* 801	City of Red Oak well 1	J. L. Myers' Sons	1938	944	6, 5	Kwb	595	--	--	T,E, 10	P	
* 802	City of Red Oak well 2	do	1962	1,171	8	Kwb	620	370 421.3	1962 June 3, 1965	T,E, 20	P	Cased to 1,161 ft. Screen from 1,085-1,111, 1,117-1,125, and 1,135-1,161 ft. Reported discharge 75 gpm. Temp. 85°F.[1]
803	John W. Rushing	G. Combs	1962	50	30	--	628	--	--	N	N	Dry.[2]
804	L. O. Cooper	J. L. Myers' Sons	1959	867	--	Kwb	551	260	1959	T,E, 1-1/2	D,S	

See footnotes at end of table.

Table 6.--Records of wells and springs in Ellis and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	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
*JK-33-26-805	Community of Pleasant Grove	J. L. Myers' Sons	1952?	1,100	5	Kwb	651	--	--	T,E	P	Temp. 83°F.
* 901	Miss W. Langford	do	1961	950	4	Kwb	542	278.3	Aug. 4, 1965	T,E, 1	D	Cased to bottom. Temp. 82°F.
27-701	Curtis Hill well 1	Faulds Whitehead	1960	3,630	--	--	405	--	--	--	--	Oil test.[2]
* 801	Mrs. G. J. Keller	J. L. Myers' Sons	1954	1,447	--	Kwb	408	253.1	June 21, 1965	T,E, 1	D,S	Temp. 76°F.
* 901	City of Ferris well 2	do	1957	1,954	12	Kwb	465	208 200	1954 1960	T,E, 50	P	Reported discharge 250 gpm. Screen from 1,311-1,431 and 1,459-1,481 ft. Temp. 92°F.[2]
28-701	A. M. Sims well 1	W. E. Butler, et al.	1940	4,015	--	--	423	--	--	--	--	Oil test.[2]
* 702	W. M. Jones	-- Terrell?	1964	1,548	4	Kwb	450	40	1964	T,E, 1	D,S	Cased to bottom. Slotted from 1,528 ft to bottom.
* 801	A. A. Adams	Gregorio Material	1965	40	--	Qal	345	19	Aug. 1965	C,G	D,Irr	Dug well. Open gravel pit in Trinity Alluvium.
* 33-101	City of Midlothian well 3	J. L. Myers' Sons	1957	2,412	10, 7	Kh	746	536	June 1957	T,E, 150	P	Reported discharge 450 gpm. Screen from 2,175-2,226 and 2,235-2,335 ft. Temp. 102°F.[1] [2]
* 102	City of Midlothian well 2	WPA Administrators	1934	2,512	10, 6	Kh	753	358 600	1946 1965	T,E, 30	P	Temp. 102°F.[1] [2]
* 103	City of Midlothian well 1	Layne-Texas Co.	1940	699	10, 5, 4	Kwb	753	346 280 413 436.8	Oct. 1940 1940 Aug. 1955 Nov. 30, 1956	T,E	N	Reported discharge 70 gpm. Screen from 623 ft to bottom. Abandoned April 1965.[1]
104	G. C. & S. F. RR.	--	1913	698	--	Kwb	753	--	--	N	N	Capped. Caused boiler scale in engines. Never used.
* 201	J. B. Gaither	C. G. Wallen	1957	619	4	Kwb	726	250	1957	T,E, 1-1/2	D	Cased to bottom. Slotted from 599 ft to bottom. Temp. 78°F.
* 202	Webster & Dunn	C. M. Stoner	1963	754	4	Kwb	700	392.1	June 24, 1965	T,E, 1-1/2	D	Cased to bottom. Slotted from 718 ft to bottom. Reported discarge 8 gpm. Temp. 84°F.
* 302	L. J. Allen	-- Wilson	1935?	500?	4	Kwb	722	--	--	T,E	D,S	Estimated discharge 8 gpm.
* 401	Frank Tennery	C. G. Wallen	1963	642	4	Kwb	839	475	Aug. 1963	T,E, 3	D,S	Slotted from 540 ft to bottom. Reported discharge 9 gpm. Temp. 80°F.
402	Marvin Byrd	C. M. Stoner	1963	762	4	Kwb	815	480	Oct. 1963	T,E, 2	S	Cased to bottom. Perforated from 697-712 and 735-750 ft. Reported discharge 10 gpm.[1]
403	O. Ray Jobe	J. L. Myers' Sons	1963	786	4	Kwb	850	440	Sept. 1963	T,E, 2	D	Cased to bottom. Perforated from 751-756, 767-768, and 775-777 ft.[2]

See footnotes at end of table.

Table 6.--Records of wells and springs in Ellis and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	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
JK-33-33-502	J. P. Neill	J. L. Myers' Sons	1940	600	4	Kwb	639	160	1964	T,E, 2	D,S	
503	do	Morris Pollack	1954	550	4	Kwb	668	140	1954	C,W	S	
504	do	do	1954	550	4	Kwb	690	--	--	C,W	S	
* 701	Hi View Hereford Ranch	do	1955?	1,425	5, 4, 2	Kp	832	424 550	1955 1964	T,E, 10	D	Casing: 5-in. to 551 ft; 4-in. from 551 to 751 ft; and 2-in. from 751 to 1,181 ft. Reported slight sulfur taste. Supplies water for 3 families and swimming pool.
* 702	do	do	1955?	695	5	Kwb	835	433 500	1955 1965	T,E, 2	S	Cased to 648 ft. Measured discharge 23.5 gpm. Temp. 80°F.
703	do	do	1956	620	5	Kwb	835	436.4	Mar. 21, 1961	T,G, 25	S	Slight sulfur taste.
704	H. A. McAlpin	-- Walling	1946	750	--	Kwb	740	--	--	T,E	D,S	Perforated at 400 ft.
802	A. H. Bingham	G. Combs	1962	30	30	--	781	--	--	N	N	Bored well. Dry.
901	H. Woodward	do	1943	42	30	--	645	--	--	N	N	Do.
* 34-101	-- Dale	J. L. Myers' Sons	1957	902	4	Kwb	652	215	1956	T,E	D	Bottom 40 ft plugged. Sand in water. Temp. 79°F.
102	Stuckey's Candy Shop	C. M. Stoner	1963	922	4	Kwb	627	390	Mar. 1963	T,E, 3	Ind	Cased to bottom. Slotted from 909 ft to bottom. Temp. 79°F.[1]
201	T. C. Buie	--	1925	41	24	--	--	--	--	--	D	Dug well. Four interconnecting wells used at one time to water chicken farm.
* 202	E. K. Burks	C. M. Stoner	1962	1,000	4	Kwb	622	400 398.5	1962 July 22, 1965	T,E, 1-1/2	D,S	Cased to bottom. Slotted from 965 ft to bottom. Temp. 78°F.[1]
* 203	W. E. Couch	J. L. Myers' Sons	1945	940	4	Kwb	610	400	1945	T,E, 1-1/2	D,S	Cased to bottom. Slotted from 920 ft to bottom.
* 204	W. J. Byrne	do	1959	968	4	Kwb	638	350	June 1950	T,E, 2	D,S	Cased to bottom. Slotted from 948 ft to bottom. Temp. 77°F.
* 301	Rockett Water District well 1	do	1965	3,285	10, 7	Kh	525	310 321.1	Aug. 1965 Oct. 13, 1965	T,E, 60	P	Cased to 1,250 ft. Screen from 3,080 to 3,208 ft. Reported discharge 520 gpm. Temp. 109°F.[1] [2]
401	Naughton Nursery	G. Combs	1963	50	30	--	630	--	--	C,E	Irr	Bored well. One of several wells used seasonally.
* 402	Jack Howe	--	1960	997	4	Kwb	622	373.7	July 22, 1965	T,E, 1	D	Temp. 85°F.

See footnotes at end of table.

Table 6.--Records of wells and springs in Ellis and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land-surface (ft)	Water level		Method of lift	Use of water	Remarks
								Below land surface datum (ft)	Date of measurement			
JK-33-34-403	V. L. Herndon	J. L. Myers' Sons	1963	876	4	Kwb	632	415	May 1963	T,E, 2	D	Cased to bottom. Perforated from 841 to 863 ft.
* 404	Jack Coe Childrens' Home	-- Wilson	1950?	--	4	Kwb	625	--	--	T,E	P,D	
* 502	J. M. Edmondson	C. M. Stoner	1948	1,080	4	Kwb	558	--	--	T,E, 1/2	D,S	Cased to bottom. Reported water level dropping. Temp. 75°F.
* 601	C. W. Melton	do	1962	1,302	4	Kwb	530	290 313.3	1962 July 23, 1965	T,E, 3	D,S	Cased to bottom. Slotted from 1,252 ft to bottom. Temp. 76°F.1/
701	Waxahachie Ice Co.	--	1907	1,200	6	Kwb	559	--	--	N	N	Destroyed.
* 702	City of Waxahachie well 1	-- Dearing	1913	2,950	10, 6	Kh	525	90 125 112.6 155.2	1913 1947 Mar. 16, 1948 Feb. 18, 1953	T,E, 75	P	Cased to bottom. Reported discharge 500 gpm. Temp. 121°F.1/
* 703	City of Waxahachie well 3	Prince Bros.	1931	2,950	12, 8	Kh	540	+ 98 120.3	1931 1945 Mar. 16, 1948	Flows, T,E, 60	P	Reported discharge 400 gpm. Reported flowed slightly when drilled.1/
* 704	City of Waxahachie well 4	Layne-Texas Co.	1949	2,878	16, 8	Kh	551	135 282.9	Jan. 1948 Mar. 16, 1965	T,E	P	Screen from 2,581 to 2,770 ft. Plugged at 2,800 ft. Temp. 112°F.
706	W. H. Prather	C. G. Wallen	1963	839	4, 3	Kwb	615	350	1963	T,E	S	Cased to 832 ft. Slotted from 757 to 832 ft. Reported discharge 4 gpm.
* 711	City of Waxahachie (Mineral well)	--	1899	1,521	--	Kgr(?)	525	--	--	N	N	Originally a mineral well; abandoned and destroyed.1/
* 712	City of Waxahachie well 2	--	1919	2,907	8	Kh	535	+	1919	Flows, T,E,50	P	Estimated discharge in 1949 450 gpm. Stopped flowing in 1932. Temp. 121°F.1/
* 802	Ted Almand	C. M. Stoner	1955	1,180	--	Kwb	572	225	June 1955	T,E, 2	D,S	Perforated from 1,160 to 1,180 ft. Temp. 81°F.
* 803	M. G. Bennett	J. L. Myers' Sons	1954	1,091	4	Kwb	580	231 319.1	Feb. 1954 July 20, 1965	T,E, 2	D,S	
901	F. R. Muirhead	C. M. Stoner	1958	1,304	4	Kwb	532	260	1958	T,E, 1-1/2	D,S	Cased to bottom. Perforated from 1,229 ft to bottom.
* 35-401	Hart Farm	do	1952	1,295	4	Kwb	528	180	1952	T,E, 3/4	--	Cased to bottom. Reported discharge 25 gpm. Perforated from 708 to 800 ft. Temp. 85°F.
* 501	City of Palmer well 1	--	1928	1,472	8	Kwb	462	375 325	1959 1964	T,E, 15	N	Collapsed in 1965.

See footnotes at end of table.

Table 6.--Records of wells and springs in Ellis and adjacent counties--Continued

Well	Owner	Driller	Date com-plet-ed	Depth of well (ft)	Diam-eter of well (in.)	Water-bear-ing 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
JK-33-35-502	N. L. Everett	--	1940	24	--	--	458	--	--	C,E	D	Dug well. Reported insufficient supply for needs.
* 503	City of Palmer well 2	J. L. Myers' Sons	1964	1,522	8, 4	Kwb	467	340 336.6	Aug. 1964 July 6, 1965	T,E, 25	P	Cased to bottom. Screen from 1,330 to 1,390 ft. Reported discharge 120 gpm. Temp. 92°F.1/ 2/
601	Gober well 1	Hughey-Dent, Barron & Davis	1957	1,230	--	--	383	--	--	--	--	Oil test.2/
* 701	Boyce Co-op	J. L. Myers' Sons	1947	1,303	4	Kwb	525	117 180 318.7	Apr. 1947 1961 July 30, 1965	T,E, 10	--	Cased to bottom. Reported screen from 1,221-1,306 ft. Water level declined 4.5 ft/yr to 1961, but dropped 35 ft/yr since 1961. Temp. 88°F.
* 702	Boyce Water Dist. 1	do	1964	1,321	7, 3	Kwb	506	328 378.5	Sept. 1964 Aug. 10, 1965	T,E	P	Screen from 1,172-1,203, 1,210-1,231, 1,250-1,265, and 1,279-1,300 ft. Reported discharge 75 gpm. Temp. 89°F.1/
* 801	John & Stanley Macalik	--	--	18	30	--	460	--	--	C,E, 1/3	D,S	Dug well. Went dry in 1957. Temp. 81°F.
803	Barron Brick Co.	-- Pierce	--	--	--	Kwb(?)	452	148.8	June 21, 1965	T,E, 1	D,S	
* 902	Don L. Griffith	Chil Chilcoate	1963	140	4	Kt	538	80	1963	J,E, 1	D	Cased to bottom. Temp. 73°F.
36-101	McClain well 1	American Liberty Oil Co.	1954	4,270	--	--	391	--	--	--	--	Oil test.2/
* 201	City of Bristol well 1	J. L. Myers' Sons	1960	1,980	8, 4	Kwb	508	348	1960	T,E, 15	P	Reported discharge 50 gpm. Screen from 1,823-1,866 and 1,916-1,961 ft. Temp. 102°F.2/
203	Paul Harris well 1	Jack D. Orr	1959	1,753	--	--	471	--	--	--	--	Oil test.2/
* 401	E. O. Culbertson	G. Combs	1963	50	30	Kt	490	15.1	Aug. 3, 1965	C,E, 3/4	D	Reported family does not drink water from well. Cased to bottom. Temp. 77°F.
501	H. L. Jansen	-- Haney	1964	300	4	Ktw	427	8	1964	N	N	Abandoned. Too salty for use; drilled to Wolfe City Sand.
601	-- Willis	G. Combs	1963	30	30	Qal	332	15	Apr. 1963	T,G, 1/3	S	In Trinity River alluvium.
801	Adolph Novy	--	1920	168	5	Ktw	442	--	--	N	N	Abandoned in 1940. Reported salt water.
* 802	H. E. Jansen	Camino Oil Co.	1962	1,703	4	Kwb	468	275	1962	T,E, 3	D	Slotted from 1,497-1,671 ft. Temp. 87°F.2/

See footnotes at end of table.

Table 6.--Records of wells and springs in Ellis and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	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
*JK-33-37-401	J. Roy Glaspy	--	--	28	6	Qal	332	15.1	Mar. 7, 1965	C,E, 1	D,S	In Trinity River alluvium.
701	-- Kendall well 1	J. R. Gill	1961	807	--	Ktw	333	--	--	--	--	Oil test.2/
801	H. R. Strouby, Jr.	G. Combs	1963	30	30	Qal	323	12.2	Aug. 13, 1965	C,E, 2	Irr	Several shallow wells in Trinity River alluvium for seasonal use.
802	do	do	1963	30	30	Qal	323	12.2	do	C,E, 2	Irr	Do.
803	do	do	1963	30	30	Qal	323	12.2	do	C,E, 2	Irr	Do.
804	do	do	1965	26	--	Qal	323	10.1	do	C,E, 2	Irr	Do.
* 805	do	do	1963	30	--	Qal	323	12	Aug. 1965	C,E	Irr	Do.
806	do	do	1963	30	--	Qal	323	12	do	C,E	Irr	Do.
* 41-202	J. P. Hodges	C. M. Stoner	1964	727	4	Kwb	681	343.3	June 16, 1965	T,E, 1-1/2	D	Reported discharge 10 gpm. Perforated from 684-694 and 706-710 ft. Temp. 81°F.1/
* 401	Len Sullivan	do	1964	728	4	Kwb	721	380.4	do	T,E, 2	S	Cased to bottom. Perforated from 680-690 and 700-710 ft. Temp. 82°F.1/
402	E. C. Dawson	do	1962	690	4	Kwb	710	290	Oct. 1962	T,E, 1-1/2	D,S	Cased to bottom. Slotted from 648 ft to bottom.
* 501	Buena-Vista Water District well 1	J. L. Myers' Sons	1965	2,606	7	Kh	690	458.8	June 16, 1965	T,E	P	Cased to bottom. Screen from 2,450-2,456, 2,466-2,472, 2,480-2,489, 2,493-2,506, and 2,516-2,520 ft. Estimated discharge 150 gpm. Temp. 109°F.2/
* 802	Barron Kidd	C. M. Stoner	1963	632	4	Kwb	532	203.1	do	T,E, 1-1/2	S	Cased to bottom. Perforated from 610-617 ft. Temp. 79°F.
* 901	Five Points Coop Gin	C. G. Wallen	1954	620	4	Kwb	607	277.5	July 19, 1965	T,E, 3	D,S	Temp. 79°F.
* 42-104	C. O. Bigham	C. M. Stoner	1962	1,019	4	Kwb	585	302.6	do	T,E, 1-1/2	D,S	Cased to bottom. Slotted from 951 ft to bottom. Reported discharge 10 gpm.1/
* 201	J. I. King	C. A. Wilson	1962	1,285	4	Kwb	557	325.2	Aug. 12, 1965	T,E, 2	D,S	Temp. 84°F.
301	Frank Martin	G. Combs	1964	30	30	--	492	18	1964	C,E, 1/2	D,S	

See footnotes at end of table.

Table 6.--Records of wells and springs in Ellis and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	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
*JK-33-42-401	James Lewis	C. M. Stoner	1963	1,026	4	Kwb	622	357	1963	T,E, 1-1/2	D	Cased to bottom. Perforated from 1,010-1,017 ft. Reported discharge 8 gpm. Temp. 79°F.[1]
* 404	Warren West	C. G. Wallen	1950?	836	4	Kwb	662	--	--	T,E, 1	D,S	Estimated discharge 10 gpm. Temp. 73°F.
* 601	E. L. Hagler	-- Collins	1957	25	30	Qal	485	17.1	Aug. 10, 1965	J,E	D,S	Dug well. Waxahachie Creek alluvium. Temp. 71°F.
* 701	W. R. Elliott	C. G. Wallen	1950	940	4	Kwb	558	200	1961	T,E, 5	P	Originally city well of Forreston.
* 702	Nash-Forreston Water District no. 1	J. L. Myers' Sons	1964	2,850	7	Kh	550	225	1964	T,E	P	Cased to bottom. Perforated from 2,750-2,795 ft. Reported discharge 100 gpm. Temp. 115°F.[1]
704	J. A. Rudd	G. Combs	1963	36	30	Ka	621	9	June 1963	C,E	D	Cased to 10 ft.
706	Leland Calvert	do	1961	35	30	Ka	557	--	--	N	N	Dry hole.[1]
* 901	Howard Water Coop Co.	J. L. Myers' Sons	1953	1,238	5, 4	Kwb	513	226 297.2	1958 July 20, 1965	T,E, 5	P	Perforated from 1,137 to 1,236 ft.[1]
43-201	-- Christian well 1	-- Coefield	1950	3,478	--	--	481	--	--	--	--	Oil test.[2]
202	-- Christian well 2	T. M. Nowlin	1950	2,378	--	--	495	--	--	--	--	Oil test.[1]
203	-- Christian well 3	do	1950	2,878	--	--	470	--	--	--	--	Oil test. Temp. 110°F.[2]
* 301	City of Garrett	-- Stroube	1956	1,350	10	Kwb	555	300 394.2	1961 Aug. 10, 1965	T,E, 5	P	Perforated from 1,310-1,350 ft. Temp. 93°F.[2]
* 302	Guy Killough	-- Chilcoate	1963	230	6	Ktw	521	37.8	Mar. 17, 1965	J,E, 1	D	Cased to bottom. Screen from 70-75 ft. Gravel-packed from 70 ft to bottom.
* 401	Kervin Gin	C. M. Stoner	1950	1,350	8	Kwb	503	--	--	T,E, 3	Ind,D	Cased to bottom. Slotted from 1,330-1,350 ft. Reported discharge 150 gpm. Supplies water for 4 houses.
* 501	E. L. Hagler	-- Collins	1964	32	36	Qal	473	28.7	Aug. 10, 1965	J,E, 1/2	D	Dug well. Brick lined. Temp. 70°F.
601	Wesley Honza well 1	M. L. Richards	1956	1,742	8	--	444	--	--	--	--	Oil test. Temp. 107°F.[2]
* 602	City of Ennis well 3	J. L. Myers' Sons	1951	1,806	12, 10, 6	Kwb	510	525	Jan. 1964	T,E, 100	P	Screen from 1,623-1,750 ft. Temp. 116°F.[1] [2]
* 701	-- Lewis	C. M. Stoner	1954	1,240	5, 4	Kwb	513	263.1	Feb. 13, 1961	T,E, 2	P	Reported discharge 20 gpm. Water level declined 11 ft/yr since 1961.

See footnotes at end of table.

Table 6.--Records of wells and springs in Ellis and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	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
*JK-33-43-801	City of Bardwell well 1	J. L. Myers' Sons	1953	1,517	6, 4	Kwb	475	142	1953	T,E, 10	P	Screen to 1,153 ft. Pump lowered 3 times. Temp. 96°F.1/
* 901	Normand & Singleton Construction Co.	C. M. Stoner	1964	1,659	8	Kwb	446	320 333.2	1964 Aug. 11, 1965	T,E, 100	N	Perforated from 1,318-1,326, 1,372-1,377, 1,407-1,420, and 1,461-1,475 ft. Temp. 98°F.1/ 2/
902	J. L. Champion well 1	Austex Drilling Corp.	1964	4,253	8	--	464	--	--	--	--	Oil test. Temp. 135°F.2/
44-101	Alvin Nesuda well 1	Browining & Smith	1957	1,524	6	--	480	--	--	--	--	Oil test. Temp. 100°F.2/
202	-- Spaniel	--	1932	12	30	Kt	398	3	1964	T,-	D	Dug well. Reported will pump dry, but will fill up overnight.
301	L. Kirkpatrick well 1	Jackson & Griffith Bros.	1961	5,491	7	--	395	--	--	--	--	Oil test. Temp. 138°F.2/
303	-- Eues	--	1925	35?	40	Kt	388	--	--	T,E	D	Reported supply too small for domestic use.
* 401	City of Ennis well 1	-- Scott	1926	1,796	20	Kwb	528	258.2 380	Mar. 1949 June 1959	T,E, 100	P	Drilled to 3,560 ft; plugged back to 1,796 ft. Reported discharge 500 gpm. Temp. 105°F.1/
* 402	City of Ennis well 2	Layne-Texas Co.	1937	1,805	13	Kwb	528	162	1937	T,E, 100	P	Cased to 1,722 ft. Perforated from 1,722-1,805 ft. Reported discharge 370 gpm. Temp. 105°F.1/
* 403	T. J. Branton	-- Chilcoate	1960	165	7	Ktw(?)	488	15 23.1	1960 Aug. 12, 1965	J,E, 3/4	D,S	Cased to bottom. Slotted from 135 ft to bottom.
501	Frank Jelnik	G. Combs	1963	50	30	Kt	460	41	1963	--	D	Bored well.
701	L. Sellers	-- Chilcoate	1955	125	6	Kt	472	20	Sept. 1955	J,E, 3/4	D,S	Cased to bottom. Perforated at 50, 60, and 80 ft.
702	Chas. Newman	do	1964	121	6	Kt	440	18 27.9	1964 Aug. 12, 1965	J,E, 1/5	D	Perforated at 60 ft. Very slow to recover.
704	A. H. Little	A. H. Little	1959	1,126	--	--	472	--	--	N	N	Core test. Abandoned.
801	W. E. Smith well 1	J. B. Stoddard	1942	5,020	8	--	480	--	--	--	--	Oil test.2/
* 802	Joe Wright	-- Barlow	1955	45	36	Kt	472	15 18.6	1955 Aug. 12, 1965	J,E, 1/2	D	Dug well. Temp. 73°F.
901	Antone Vinkler	G. Combs	1963	40	30	Kt	438	8	1963	--	D	Bored well.
45-201	--	--	1960	23	--	--	335	18.0	Apr. 13, 1965	N	N	Dug well. Old gravel pit; still in operation.
401	O'Belle Gambling well 2	E. L. McNeill et al.	1956	2,121	6	--	445	--	--	--	--	Oil test.2/

See footnotes at end of table.

Table 6.--Records of wells and springs in Ellis and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	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
JK-33-45-403	-- Anthony well 1	Louis Howard	1952	680	4	--	388	--	--	--	--	Oil test. Temp. 90°F.2/
49-101	R. S. Le Sage	Lesco, Inc.	1944	2,898	8	--	710	--	--	--	--	Oil test.2/
* 102	Weldon Blair	C. M. Stoner	1964	719	4	Kwb	660	350	Aug. 1964	T,E	D,S	Cased to bottom. Perforated from 595-615, 623-625, and 704-711 ft. Temp. 77°F.1/
201	R. S. Le Sage	Lesco, Inc.	1944	2,559	8	Kp	525	--	--	--	--	Oil test; completed as water well. Cased to bottom. Perforated from 1,415-1,463 ft.2/
* 202	Le Sage Bell Branch Ranch	do	--	2,800	4	Kh (?)	620	--	--	T,E, 2	D,S	
205	Le Sage Lone Star Co.	C. M. Stoner	--	814	7	Kwb	625	186.7	June 8, 1965	T,E, --	D,S	
* 208	Barron Kidd	do	1963	668	4	Kwb	625	279.1	July 19, 1965	T,E, 1-1/2	D,S	Cased to bottom. Perforated from 644 to 650 ft. Reported discharge 8 gpm. Temp. 79°F.1/
* 402	Murr Hodges	do	1962	672	4	Kwb	715	400	Sept. 1962	T,E, 1-1/2	D,S	Cased to bottom. Perforated from 645 ft to bottom. Reported discharge 8 gpm.1/
* 601	City of Italy well 2	-- Dearing & Sons	1912	881	6	Kwb	558	90 282	Mar. 1949 1956	T,E, 20	P	Cased to 858 ft. Screen or open hole from 858 ft to bottom. Used only as standby well. Temp. 87°F.1/
* 602	City of Italy well 3	Layne-Texas Co.	1957	935	10	Kwb	558	254 375 392.1	May 1957 Apr. 1961 Aug. 1965	T,E, 40	P	Cased to bottom. Screen from 839-858, 862-883, and 909-929 ft. Reported discharge 199 gpm.2/
* 604	John Davis	C. M. Stoner	1964	903	7	Kwb	570	309.8	Apr. 29, 1965	T,E, 15	D,Ind	Cased to bottom. Perforated from 800-830 and 850-903 ft. Drilled for highway construction. Reported discharge 69 gpm. Temp. 86°F.1/
* 801	M. P. Loenard	C. G. Wallen	1953	680	4	Kwb	650	320	July 1965	T,E, 1-1/2	D,S	Temp. 79°F.
* 50-101	W. D. Price	C. M. Stoner	1959	1,050	4	Kwb	510	160	1958	T,E, 1-1/2	D,S	Cased to bottom. Perforated from 1,030 ft to bottom. Temp. 86°F.
201	B. U. Wakeland	-- Dearing & Sons	1915	1,000	--	Kwb	490	250	1950	--	D,S	
* 301	Max E. Griffith	Bob Feaster	1955	990	2	Kwb	500	--	--	T,E, 3/4	D,S	Cased to 300 ft. Reported discharge 4 gpm. Temp. 75°F.
* 401	D. L. Rollins	C. M. Stoner	1959	1,050	4	Kwb	500	200	1959	T,E, 5	D,S	Cased to bottom. Perforated from 1,005 ft to bottom. Temp. 75°F.
* 502	C. R. Youngblood well 2	J. L. Myers' Sons	1963	1,238	7	Kwb	540	320	1963	T,E, 10	P,D	Cased to bottom. Screen from 1,146-1,153, 1,153-1,163, and 1,212-1,233 ft. Supplies water for Avalon. Temp. 86°F.2/

See footnotes at end of table.

Table 6.--Records of wells and springs in Ellis and adjacent counties--Continued

Well	Owner	Driller	Date com-plet-ed	Depth of well (ft)	Diam-eter of well (in.)	Water-bear-ing 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
*JK-33-50-503	D. D. Betts	C. M. Stoner	1955	1,185	4	Kwb	460	258.5	June 29, 1965	T,E, 2-1/2	D,S	Temp. 75°F.
601	M. C. Feaster	Hughey & Carpenter	1946	3,007	7	--	435	--	--	--	--	Oil test.[2]
901	Jack Eastman well 1	L. H. Hughey	1949	860	7	--	435	--	--	--	--	Oil test. Temp. 85°F.[2]
* 51-203	H. L. Turner	--	1953	28	33	Kt	463	13.2	Aug. 11, 1965	J,E, 1/2	D,S	Dug well. Temp. 68°F.
* 302	Albert Valdez	--	1955	36	30	Kt	430	24.4	do	B,H	D	Dug well. Temp. 67°F.
* 501	J. S. Idlett	-- Angiln	1954	38	30	Kt	455	24.5	do	C,E, 1/2	D	Dug well. Temp. 69°F.
52-101	Clay and Walker Ledbetter well 1	Ware Drilling Co.	1965	1,700	10	Ktw(?)	385	--	--	--	--	Oil test. Gas bubbles and oily scum on water.
102	Clay and Walker Betts well 1	do	1964	1,700	--	--	381	--	--	--	--	Oil test.
* 103	R. M. Ledbetter	R. M. Ledbetter	--	18	36	Kt	398	10.3	Aug. 12, 1965	C,E, 1/2	D,S	Dug well. Cased to bottom. No sand or gravel. Temp. 76°F.
* 57-201	City of Milford well 1	R. H. Dearing & Son	1916	2,592	6, 4	Kh	650	90 62 173.1	1915 1946 Feb. 13, 1961	T,E, 30	P	Cased to bottom. Perforated at 2,470 ft. Reported when drilled well flowed 145,000 gpd or 101 gpm. Temp. 101°F.[1]
* 202	City of Milford well 2	J. L. Myers' Sons	1964	900	8, 4	Kwb	650	370 384.7	June 1964 June 4, 1965	T,E	P	Cased to bottom. Screen from 744-786, 789-803, and 824-845 ft. Reported discharge 136 gpd. Temp. 86°F.[1][2]
* 203	Joe W. Rosson	C. G. Wallen	1950	714	4	Kwb	560	185	1950	T,E, 1	S	Cased to bottom. Perforated 674 ft.
204	John R. Dishman	C. M. Stoner	1962	837	4	Kwb	600	300	Dec. 1962	T,E, 1-1/2	D,S	Cased to bottom. Slotted from 802 ft to bottom. Reported discharge 10 gpm.[1]
* 205	W. E. Borgers	J. L. Myers' Sons	1962	822	4	Kwb	592	250 292.1	Apr. 1962 July 14, 1965	T,E, 1-1/2	D	Cased to bottom. Perforated from 799 ft to bottom. Reported discharge 10 gpm. Temp. 80°F.
58-101	-- Bennett well 1	Geologic Enterprises	1962	1,900	--	--	505	--	--	--	--	Oil test.[2]

See footnotes at end of table.

Table 6.--Records of wells and springs in Ellis and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	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
							Dallas County					
HR-33-25-201	City of Cedar Hill well 2	J. L. Myers' Sons	1953	2,715	--	Kwb	832	--	--	--	P	Screen from 609-645, 653-663, 668-672, 675-678, 688-692, 702-704, 725-742, 759-762, 772-774, 779-781, 798-800, and 809-895 ft.2/
401	City of Cedar Hill well 4	do	1965	2,507	--	Kh	720	--	--	--	P	Screen from 2,248-2,311, 2,314-2,374, and 2,377-2,416 ft.2/
26-301	City of Lancaster well 3	Layne-Texas Co.	1952	3,230	8	Kh	512	--	--	T,E	P	Temp. 100°F.2/
* 27-501	Acme Brick Co.	--	1933	1,500	4	Kwb	405	155	1958	T,E	N	Near county line.
* 601	City of Ferris well 1 (Brick Co.)	Dearing & Sons	1914	1,343	6	Kwb	420	--	--	N	N	Well destroyed. Reported casing bent at surface.1/
* 602	City of Ferris well 3	J. L. Myers' Sons	1963	1,390	8, 5	Kwb	420	240	June 1963	T,E, 25	P	Cased to 1,352 ft. Screen from 1,288-1,318 and 1,322-1,352 ft. Reported discharge 170 gpm. Specific capacity 4.2. Temp. 92°F.1/
* 603	R. C. Graham	do	1964	1,360	4, 2	Kwb	442	277.6	May 3, 1965	T,E, 3	D	2/
604	Virginia Walker	do	1963	1,382	4	Kwb	442	285	Nov. 1963	T,E, 1-1/2	S	Cased to bottom. Reported discharge 7 gpm.2/
28-401	-- Moyer well 1	Guiberson & Lucey	1943	4,504	--	--	359	--	--	--	--	Oil test.2/
							Hill County					
LW-32-64-301	Clink Scales	C. M. Stoner	1963	670	7	Kwb	800	430	1964	T,E, 20	D,Ind	Cased to bottom. Reported discharge 110 gpm. For temporary use in highway construction.
							Johnson County					
PX-32-40-701	Haskell Dean well 1	Humble Oil & Refining Co.	1960	8,965	--	--	655	--	--	--	--	Oil test. Temp. 178°F.2/
							Kaufman County					
RA-33-29-901	S. D. Stanfield well 1	C. F. Carter	1942	3,300	--	--	419	--	--	--	--	Oil test.2/
							Navarro County					
TY-33-45-601	--Dickson	--	1928	26	36	Qal	323	22.3	Apr. 13, 1965	C,E, 1/2	D,S	Dug well. Cased to bottom.
701	R. M. Langham well 1	W. F. Garmon et al.	1956	2,423	6	--	458	--	--	--	--	Oil test.2/

See footnotes at end of table.

Table 6.--Records of wells and springs in Ellis and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	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
TY-33-52-201	-- Evarts	--	1956	42	11	Qal	366	--	--	C,G, 25	Irr	Reported deepest of 4 wells in Chambers Creek alluvium.
801	City of Emhouse well 1	-- Strouble	1955	1,795	4	Kwb	473	412.7	Aug. 26, 1965	T,E, 3	P	
53-301	L. P. Hodge Estate well 1	Oakland Corp.	1954	2,788	7	--	417	--	--	--	--	Oil test. Temp. 105°F.2/
58-501	Sheppard well 1	F. W. Wilson	1944	2,511	7	--	534	--	--	--	--	Oil test. Temp. 107°F.2/
							Tarrant County					
XU-32-31-605	City of Mansfield well 5	J. L. Myers' Sons	1955	1,733	--	Kh	593	423	Apr. 1955	T,E	P	Temp. 90°F.2/

* See Table 8 for chemical analyses of water from wells.
1/ See Table 7 for drillers' logs of wells.
2/ Electric log of well in files of Texas Water Development Board or U.S. Geological Survey, Austin, Texas.

Table 7.--Drillers' logs of wells in Ellis and adjacent counties

Ellis County

Well JK-32-32-902

Owner: A. W. Burnitt. Driller: C. M. Stoner.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	2	2	Shale and rock	48	405
Clay, yellow	33	35	Shale, sandy	75	480
Shale, blue	195	230	Sand	25	505
Shale, brown	85	315	Sandrock, brown	13	518
Shale, sandy	42	357	Shale, sandy	12	530

Well JK-32-40-201

Owner: W. R. Miller. Driller: C. M. Stoner.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	3	3	Sand, coarse	20	330
Clay, yellow	33	36	Shale, hard	6	336
Shale, blue	120	156	Shale, sandy	58	394
Shale, brown	100	256	Sand, coarse	5	399
Sand	22	278	Shale,	16	415
Shale, sandy	32	310	Sand, fine	43	458

Well JK-32-40-301

Owner: Texas Industries, Inc. well 2. Driller: J. L. Myers' Sons.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Dirt, black	2	2	Shale, sandy	24	414
Clay, yellow	38	40	Sand	11	425
Shale	260	300	Shale, sandy	103	328
Sand	22	322	Sand	14	542
Shale, sandy	60	382	Shale, sandy	18	560
Sand	8	390	Lime	90	650

(Continued on next page)

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well JK-32-40-301--Continued					
Lime and shale --------	94	744	Lime ------------------	16	1,308
Lime ------------------	156	900	Lime and shale ---------	87	1,395
Shale -----------------	30	930	Lime ------------------	330	1,725
Lime ------------------	97	1,027	Sand and shale ---------	135	1,860
Shale and sandy shale -	53	1,080	Lime ------------------	25	1,885
Lime ------------------	8	1,088	Shale -----------------	65	1,950
Sand ------------------	23	1,111	Sand and shale, broken -	50	2,000
Shale, sandy ----------	59	1,170	Sand and shale ---------	162	2,162
Sand ------------------	60	1,230	Shale and lime ---------	8	2,170
Lime ------------------	55	1,285	Lime ------------------	79	2,249
Sand ------------------	7	1,292			

Well JK-32-40-601

Owner: Bob Emerson. Driller: C. M. Stoner.

Topsoil ---------------	1	1	Shale -----------------	32	607
Chalk rock ------------	125	126	Sand, broken ----------	28	635
Shale, blue -----------	324	450	Shale, gray -----------	29	664
Shale, brown ----------	80	530	Sand ------------------	48	712
Shale, sandy ----------	6	536	Sand, good ------------	47	759
Sand ------------------	39	575			

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)

Well JK-32-40-605

Owner: J. V. Salter. Driller: C. M. Stoner.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil ---------------	6	6	Sandrock, hard ---------	8	485
Rock, white -----------	4	10	Sand -------------------	35	520
Rock, blue ------------	20	30	Shale, sandy -----------	40	560
Shale, blue -----------	320	350	Sand and shale, broken -	55	615
Shale, brown ----------	115	465	Sand -------------------	35	650
Sand ------------------	12	477	Shale, sandy -----------	19	669

Well JK-32-40-901

Owner: Salvation Army well 1 (Camp Hoblitzelle). Driller: J. L. Myers' Sons.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Chalk rock ------------	45	45	Lime -------------------	439	1,109
Shale -----------------	501	546	Lime, broken -----------	203	1,312
Sand ------------------	14	560	Sand -------------------	28	1,340
Sand and shale --------	110	670	Lime, broken -----------	19	1,359

Well JK-32-48-501

Owner: Herbert Donnell. Driller: C. M. Stoner.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil ---------------	3	3	Shale, sandy -----------	13	228
Clay, yellow ----------	15	18	Sand -------------------	10	238
Sand and gravel -------	17	35	Shale, gray ------------	20	258
Shale, blue -----------	135	170	Sand -------------------	9	267
Shale, sandy ----------	35	205	Shale, sandy -----------	3	270
Sand ------------------	10	215	Sand -------------------	8	278

(Continued on next page)

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

Well JK-32-48-501--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Shale, sandy	12	290	Shale, sandy	8	328
Sand	10	300	Sand	7	335
Shale, sandy	6	306	Shale, sand	17	352
Sand	8	314	Sand	3	355
Shale, sandy	2	316	Shale, green	10	365
Sand	4	320	Rock, white	2	367

Well JK-32-48-601

Owner: Maypearl City well 1. Driller: J. L. Myers' Sons

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	2	2	Sand	5	249
Clay	6	8	Lime	34	283
Clay, gravelly	5	13	Sand, water	11	294
Shale	92	105	Shale	62	356
Shale, brown	95	200	Sand, water	40	396
Sand, water	15	215	Shale	84	480
Shale, gray	29	244	Lime	27	507

Well JK-32-48-902

Owner: J. L. Ray. Driller: C. M. Stoner.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	3	3	Shale, blue	110	160
Clay, yellow	7	10	Shale, brown	80	240
Gravel, sandy	8	18	Sand	40	280
Sand	22	40	Shale, gray	30	310
Gravel	10	50	Sand	65	375

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)

Well JK-32-48-903

Owner: T. H. Kiker. Driller: C. M. Stoner.

Topsoil ---------------	3	3	Shale ------------------	4	347
Clay, yellow ----------	25	28	Sand -------------------	3	350
Shale, blue -----------	80	108	Shale ------------------	5	355
Shale, brown ----------	100	208	Sand -------------------	6	361
Sand ------------------	23	231	Sand, broken -----------	17	378
Shale, sandy, broken --	72	303	Sand -------------------	16	394
Sand and shale, broken	37	340	Shale, sandy -----------	36	430
Sand ------------------	3	343			

Well JK-33-25-501

Owner: Bill Nutting. Driller: C. G. Wallen.

Topsoil, black --------	1	1	Shale, brown, leathery -	20	650
Rock chunks -----------	4	5	Sand, water ------------	3	653
Chalk rock, white -----	176	181	Sand and shale, broken water ----------------	9	662
Shale -----------------	300	481	Sand, water ------------	34	696
Shale, black ----------	126	607	Shale, brown -----------	1	697
Shale, sandy ----------	23	630			

Well JK-33-25-702

Owner: R. J. Fryer. Driller: C. M. Stoner.

Topsoil ---------------	3	3	Shale, brown -----------	106	546
Rock, white -----------	109	112	Sand -------------------	16	562
Shale, blue -----------	328	440	Shale, sandy -----------	62	624

(Continued on next page)

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)

Well JK-33-25-702--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand ------------------	10	634	Sand -------------------	11	736
Shale, sandy ----------	20	654	Shale, sandy -----------	18	754
Sand ------------------	6	660	Sand -------------------	6	760
Sand, broken ----------	44	704	Shale ------------------	6	766
Sand ------------------	10	714	Sand -------------------	15	781
Shale, sandy ----------	11	725	Shale ------------------	43	824

Well JK-33-25-902

Owner: Sardis-Lone-Elm Water Corp. Driller: J. L. Myers' Sons.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface soil ----------	5	5	Lime -------------------	388	2,071
Chalk rock ------------	245	250	Lime, broken -----------	71	2,142
Shale -----------------	435	685	Lime and shale, broken -	150	2,292
Sand ------------------	10	695	Lime, broken -----------	147	2,439
Shale -----------------	30	725	Shale, sandy -----------	26	2,465
Sand and shale --------	175	900	Lime -------------------	46	2,511
Shale, sandy ----------	60	960	Shale, sandy -----------	8	2,519
Lime ------------------	618	1,578	Sand and lime, hard ----	38	2,557
Lime, broken ----------	22	1,600	Sand -------------------	148	2,705
Sand and shale, broken	83	1,683	Lime -------------------	58	2,763

Well JK-33-26-802

Owner: City of Red Oak well 2. Driller: J. L. Myers' Sons.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface soil ----------	3	3	Shale -----------------	442	842
Chalk rock ------------	397	400	Sand, broken -----------	13	855

(Continued on next page)

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--continued

Ellis County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)

Well JK-33-26-802--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand ------------------	35	890	Shale, sandy -----------	12	1,082
Shale -----------------	28	918	Sand -------------------	24	1,106
Sand, broken ----------	6	924	Shale, sandy -----------	7	1,113
Sand ------------------	19	943	Sand -------------------	7	1,120
Shale -----------------	20	963	Shale, sandy -----------	11	1,131
Sand, broken ----------	15	978	Sand -------------------	9	1,140
Shale -----------------	78	1,956	Shale ------------------	6	1,146
Shale, sandy ----------	7	1,063	Sand, broken -----------	15	1,161
Shale -----------------	7	1,070	Shale ------------------	10	1,171

Well JK-33-33-101

Owner: City of Midlothian. Driller: J. L. Myers' Sons.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Chalk rock ------------	12	12	Lime, broken -----------	68	1,763
Shale -----------------	628	640	Shale, sandy -----------	47	1,810
Sand ------------------	14	654	Lime and shale ---------	70	1,880
Shale -----------------	21	675	Lime and shale, sandy --	150	2,030
Lime, broken ----------	370	1,045	Shale, sandy -----------	205	2,235
Lime ------------------	180	1,225	Sand -------------------	104	2,339
Shale -----------------	145	1,370	Red beds and shale -----	73	2,412
Lime ------------------	325	1,695			

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)

Well JK-33-33-102

Owner: City of Midlothian well 2. Driller: WPA Administrators.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Chalk	60	60	Sand and broken lime shells	26	1,840
Chalk, broken	40	100	Sand and lime shells	14	1,854
Shale	296	396	Lime, hard	15	1,869
Shale, hard	54	450	Lime and shell	71	1,940
Woodbine Formation	274	724	Shale and lime shells, sandy	57	1,997
Lime	136	860	Lime, hard	16	2,013
Shale	4	864	Lime, broken	23	2,036
Lime	290	1,154	Lime and shale, broken	29	2,065
Lime, broken	189	1,343	Shale	15	2,080
Lime, broken, sandy	65	1,408	Lime, sandy	18	2,098
Lime, sandy	40	1,448	Shale, sandy, and broken lime	45	2,143
Lime, broken	40	1,488	Lime and shale, broken	10	2,153
Lime and shale, broken	33	1,521	Lime and shale, sandy	34	2,187
Shale and lime shells	15	1,536	Red beds and sand	18	2,205
Lime, sandy	4	1,540	Lime and sand, broken	3	2,208
Sand	4	1,544	Sand, water	32	2,240
Lime, hard	71	1,615	Red beds	40	2,280
Lime, broken	11	1,626	Sand	53	2,333
Shale and lime, sandy	20	1,646	Lime, broken, and green shale	5	2,338
Lime and shale, broken	52	1,698	Sand	7	2,345
Lime, gray	67	1,765			
Sand, gray	49	1,814			

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Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

Well JK-33-33-102--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand and shale --------	10	2,355	Sand and shale ---------	42	2,450
Red beds --------------	6	2,361	Shale -----------------	14	2,464
Sand ------------------	13	2,374	Sand ------------------	36	2,500
Sand, shale, and red beds, mixed ----------	10	2,384	Shale, black -----------	9	2,509
Sand ------------------	10	2,394	Lime ------------------	3	2,512
Red beds and sand -----	14	2,408			

Well JK-33-33-103

Owner: City of Midlothian well 1. Driller: Layne-Texas Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Chalk rock ------------	48	48	Layers, hard -----------	1	465
Shale -----------------	73	121	Sand, hard, fine -------	18	483
Rock ------------------	1	122	Layers, hard -----------	1	484
Shale -----------------	36	158	Sand ------------------	22	506
Shale, hard, sandy ----	34	192	Shale and sand layers --	7	513
Sand, hard ------------	9	201	Shale and sandy shale --	11	524
Shale -----------------	30	231	Rock ------------------	1	525
Shale, hard, and boulders ------------	4	235	Shale, hard, brittle ---	14	539
Shale, hard -----------	70	305	Shale, layers of sand --	30	569
Layers, hard ----------	1	306	Shale -----------------	27	596
Shale -----------------	14	320	Shale, sand and lignite	20	616
Layers, hard ----------	2	322	Sand, layers and shale -	83	699
Shale, hard -----------	142	464			

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)

Well JK-33-33-402

Owner: Marvin Byrd. Driller: C. M. Stoner.

Topsoil	6	6	Shale	15	582
Chalk	116	122	Sand	2	584
Shale, blue	328	450	Shale, sandy	108	692
Shale, brown	85	535	Sand	28	720
Sand	7	542	Shale, sandy	10	730
Shale	2	544	Sand	20	750
Sand	23	567	Rock, white	12	762

Well JK-33-34-102

Owner: Stuckey's Candy Shoppe. Driller: C. M. Stoner.

Topsoil	6	6	Shale, sandy	50	830
Rock, white	344	350	Sand	25	855
Shale, blue	220	570	Shale, gray, sandy	25	880
Shale, brown	210	780	Sand	72	922

Well JK-33-34-202

Owner: E. K. Burks. Driller: C. M. Stoner.

Topsoil	1	1	Shale, sandy	76	895
Chalk	369	370	Sand	34	929
Shale, blue	320	690	Shale, sandy	37	966
Shale, brown	117	807	Sand	34	1,000
Sand	12	819			

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well JK-33-34-301					
Owner: Rockett Water District well 1. Driller: J. L. Myers' Sons.					
Topsoil	6	6	Lime	307	2,036
Clay	39	45	Lime, sandy	245	2,281
Chalk rock	185	230	Lime	209	2,490
Shale	927	1,157	Lime, sandy	15	2,505
Sand and shale	150	1,307	Lime	336	2,841
Shale	70	1,377	Limestone and shale	220	3,061
Lime	230	1,607	Sand and shale, broken	129	3,190
Lime and shale	122	1,729	Lime	95	3,285
Well JK-33-34-601					
Owner: C. W. Melton. Driller: C. M. Stoner.					
Clay	8	8	Sand	50	960
Gravel	4	12	Shale, sandy	45	1,005
Clay	18	30	Sand	25	1,030
Chalk	490	520	Shale, sandy	140	1,170
Shale, blue	325	845	Sand	50	1,220
Shale, brown	55	900	Shale, sandy	30	1,250
Shale, sandy	10	910	Sand	52	1,302
Well JK-33-34-702					
Owner: City of Waxahachie well 1. Driller: -- Dearing.					
Surface soil	27	27	Shale, limestone, and sandstone	1,381	1,636
Chalk	228	255			

(Continued on next page)

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well JK-33-34-702--Continued					
Sand	24	1,660	Sand and shale	10	2,346
Shale	15	1,675	Shale	14	2,360
Sand	18	1,693	Sand	65	2,425
Shale and limestone	57	1,750	Gumbo	35	2,460
Sand	45	1,795	Shale	40	2,500
Sand and limestone	10	1,805	Limestone and shale	27	2,527
Limestone	55	1,860	Sand and limestone	35	2,562
Sand	7	1,867	Limestone and shale	12	2,574
Limestone	58	1,925	Sand	10	2,584
Gumbo	4	1,929	Limestone and shale	12	2,596
Sand and limestone	4	1,933	Sand	19	2,615
Limestone	72	2,005	Sand and shale	55	2,670
Sand	10	2,015	Sand	12	2,682
Sand and limestone	15	2,030	Sand and shale	8	2,690
Limestone	60	2,090	Sand	100	2,790
Shale	20	2,110	Red beds	20	2,810
Limestone	32	2,142	Sand	40	2,850
Sand	5	2,147	Red beds	100	2,950
Limestone, with sandy Shale and sand	189	2,336			

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

Well JK-33-34-703

Owner: City of Waxahachie well 3. Driller: Prince Bros.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface material ------	25	25	Lime ------------------	313	1,573
Chalk -----------------	230	255	Sand, shale, and lime --	50	1,623
Shale -----------------	390	645	Sand and lime ----------	15	1,638
Sand ------------------	5	650	Sand -------------------	22	1,660
Shale -----------------	90	740	Shale ------------------	15	1,675
Lime, sandy -----------	20	760	Sand -------------------	20	1,695
Shale -----------------	42	802	Sand and lime ----------	113	1,808
Sand ------------------	5	807	Lime -------------------	50	1,858
Shale, lime streaks ---	95	902	Sand -------------------	12	1,870
Sand ------------------	3	905	Lime -------------------	57	1,927
Shale -----------------	15	920	Gumbo ------------------	5	1,932
Sand ------------------	5	925	Sand -------------------	5	1,937
Shale -----------------	20	945	Lime -------------------	71	2,008
Sand ------------------	63	1,008	Sand, water ------------	22	2,030
Shale -----------------	12	1,020	Lime -------------------	60	2,090
Lime ------------------	20	1,040	Shale ------------------	22	2,112
Lime boulders ---------	40	1,080	Lime -------------------	30	2,142
Shale -----------------	5	1,085	Sand -------------------	5	2,147
Lime ------------------	140	1,225	Lime -------------------	168	2,315
Shale -----------------	10	1,235	Lime and shale ---------	23	2,338
Lime ------------------	20	1,255	Sand and shale ---------	7	2,345
Shale -----------------	5	1,260	Shale ------------------	15	2,360

(Continued on next page)

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well JK-33-34-703--Continued					
Sand ------------------	65	2,425	Sand and shale ---------	10	2,578
Gumbo -----------------	33	2,458	Sand -------------------	10	2,588
Shale -----------------	20	2,478	Lime and shale ---------	7	2,595
Lime ------------------	24	2,502	Sand and shale ---------	95	2,690
Shale -----------------	8	2,510	Sand, water ------------	100	2,790
Gumbo -----------------	18	2,528	Red beds ---------------	30	2,820
Sand and lime ---------	35	2,563	Sand, water ------------	50	2,870
Gumbo -----------------	5	2,568	Red beds ---------------	80	2,950

Well JK-33-34-711

Owner: City of Waxahachie (Mineral well). Driller: --

Soil and gravel -------	26	26	Sand, water-bearing ----	7	947
Limerock, white -------	316	342	Sandrock with water ----	15	962
Shale, blue -----------	346	688	Limerock, white --------	100	1,062
Sandrock --------------	75	763	Limerock, white, alternating with blue shale ----------------	165	1,227
Sand, water-bearing ---	9	772			
Sandrock --------------	100	872	Limestone, white -------	284	1,511
Limerock with fossils -	68	940	Limestone, blue --------	10	1,521

Well JK-33-34-712

Owner: City of Waxahachie well 2. Driller: --

Topsoil ---------------	26	26	Sand and rock, broken --	78	768
Rock, white -----------	319	345	Sand, water ------------	10	778
Shale and gumbo -------	345	690	Limestone and pyrites --	167	945

(Continued on next page)

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

Well JK-33-34-712--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand, water	55	1,000	Shale, red	34	2,404
Shale and boulders	155	1,155	Shale, red, and gumbo	36	2,440
Limestone	485	1,640	Shale, hard, and sand	20	2,460
Sand, water	120	1,760	Sand, mineral water	55	2,515
Limestone	60	1,820	Gumbo	10	2,525
Limestone and shale	80	1,900	Shale, red, and gumbo	75	2,600
Limestone	95	1,995	Sand, rock, and shale	80	2,680
Limestone, blue	235	2,230	Sandrock, hard	15	2,695
Gumbo	10	2,240	Shale, red	15	2,710
Sandrock, hard, and pyrites	20	2,260	Sandrock, hard	18	2,728
Rock, gypsum	16	2,276	Sand, water	146	2,874
Shale, red, and gumbo	14	2,290	Sandrock	15	2,889
Rock, hard	4	2,294	Shale, soft, fine	18	2,907
Sand, mineral water	76	2,370			

Well JK-33-35-503

Owner: City of Palma well 2. Driller: J. L. Myers' Sons.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface soil	4	4	Shale	162	1,344
Clay and gravel	60	64	Sand, broken	45	1,389
Shale	228	292	Shale	72	1,461
Rock, chalk	428	720	Sand	23	1,484
Shale	427	1,147	Shale	38	1,522
Sand, broken	35	1,182			

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

Well JK-33-35-702

Owner: Boyce Water District no. 1. Driller: J. L. Myers' Sons.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface soil	6	6	Shale	106	1,174
Clay	44	50	Sand	36	1,210
Shale	72	122	Sand, broken	13	1,223
Chalk rock	472	594	Shale	31	1,254
Shale	400	994	Sand	8	1,262
Sand, broken	20	1,014	Sand, broken	38	1,300
Sand	38	1,052	Shale	21	1,321
Sand, broken	16	1,068			

Well JK-33-41-202

Owner: J. P. Hodges. Driller: C. M. Stoner.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	3	3	Sand, broken, and shale	139	679
Sand and yellow clay	27	30	Sand	21	700
Rock, white	100	130	Shale	7	707
Shale, blue	310	440	Sand, dry	7	714
Shale, brown	77	517	Shale	13	727
Sand	23	540			

Well JK-33-41-401

Owner: Len Sullivan. Driller: C. M. Stoner.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Rock	132	132	Sand	52	562
Shale, blue	300	432	Shale	5	567
Shale, brown	78	510	Shale, sandy	21	588

(Continued on next page)

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

Well JK-33-41-401--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand	9	597	Sand	10	661
Shale	3	600	Shale, sandy	11	672
Sand	11	611	Sand	44	716
Shale	40	651	Shale, sandy	12	728

Well JK-33-41-802

Owner: Barron Kidd. Driller: C. M. Stoner.

Topsoil	2	2	Sand	8	470
Clay, yellow	5	7	Shale, sandy	7	477
Chalk rock	43	50	Sand	33	510
Shale, blue	170	220	Shale, sandy	27	537
Shale, brown	180	400	Sand	8	545
Shale, sandy	10	410	Sand, broken, and shale	13	558
Sand	32	442	Sand	10	568
Shale, sandy	8	450	Sand, broken and shale	9	577
Shale	12	462	Sand	55	632

Well JK-33-42-104

Owner: C. O. Bigham. Driller: C. M. Stoner.

Topsoil	4	4	Shale, sandy	81	834
Chalk	361	365	Sand	27	861
Shale, blue	270	635	Shale, sandy	90	951
Shale, brown	101	736	Sand	68	1,019
Sand	17	753			

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

Well JK-33-42-401

Owner: James H. Lewis. Driller: C. M. Stoner.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil ---------------	1	1	Sand -------------------	10	835
Chalk rock ------------	404	405	Sand, broken and shale -	25	860
Shale, blue -----------	95	500	Sand -------------------	40	900
Shale, brown ----------	290	790	Sand, good -------------	35	935
Sand ------------------	20	810	Sand, broken, and shale	25	960
Shale, sandy ----------	15	825	Sand -------------------	66	1,026

Well JK-33-42-702

Owner: Nash-Forreston Water District no. 1. Driller: J. L. Myers' Sons.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface soil ----------	3	3	Shale ------------------	136	1,656
Clay ------------------	6	9	Lime -------------------	107	1,763
Chalk rock ------------	341	350	Shale ------------------	72	1,835
Shale -----------------	390	740	Shale, sandy -----------	65	1,900
Sand ------------------	10	750	Lime and shale ---------	249	2,149
Shale -----------------	72	822	Lime -------------------	111	2,260
Sand ------------------	20	842	Sand, broken, and shale	162	2,422
Shale and sand --------	183	1,025	Sand and shale ---------	223	2,645
Lime ------------------	333	1,358	Sand -------------------	150	2,795
Lime and shale --------	162	1,520	Sand, broken, and shale	55	2,850

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

Well JK-33-42-901

Owner: Howard Water Corp. Co. Driller: J. L. Myers' Sons.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay	60	60	Shale	477	1,037
Shale	80	140	Shale and rock	100	1,137
Chalk rock	96	236	Sand	99	1,236
Rock	226	462	Rock, hard	2	1,238
Rock, soft	98	560			

Well JK-33-43-202

Owner: -- Christian well 2. Driller: T. M. Nowlin.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface clay	45	45	Sand	52	1,250
Shale	245	290	Lime and shale	20	1,270
Lime	4	294	Shale, sand, and lime	20	1,290
Shale	58	352	Shale and hard sand	55	1,345
Lime	9	361	Lime, hard	11	1,356
Marl	407	768	Shale and lime	14	1,370
Chalk	84	852	Lime, hard	7	1,377
Lime and shale	22	874	Sand and shale	28	1,405
Lime, hard	44	918	Limerock	23	1,428
Shale	224	1,142	Shale	34	1,462
Lime, hard	2	1,147	Lime, shale, and sand	26	1,488
Shale and lime	41	1,188	Sand, hard	6	1,494
Sand	9	1,197	State, hard, sandy	2	1,496
Lime, hard	1	1,198			

(Continued on next page)

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)

Well JK-33-43-202--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand, shale, and shells, hard --------	15	1,511	Lime and shale --------	43	1,951
Lime, hard ------------	7	1,518	Shale and lime ---------	74	2,025
Cored -----------------	50	1,568	Lime and shells --------	35	2,060
Shale and lime, sticky	19	1,587	Limerock ---------------	6	2,066
Cored, recovered 2 ft of lime, with streaks of hard sand --------	4	1,591	Shale ------------------	14	2,080
Lime, hard, sticky ----	13	1,604	Shale, sticky ----------	20	2,100
Shale -----------------	2	1,606	Shale and lime ---------	87	2,187
Lime ------------------	1	1,607	Shale, broken, and lime	18	2,205
Shale -----------------	9	1,616	Shale and lime ---------	28	2,233
Lime ------------------	5	1,621	Shale and lime, broken -	67	2,300
Shale -----------------	78	1,699	Shale and lime ---------	32	2,332
Lime, sticky ----------	4	1,703	Shale, hard ------------	14	2,346
Shale and lime --------	106	1,809	Shale, sandy -----------	10	2,356
Shale and lime --------	99	1,908	Shale and lime, sandy --	7	2,363
			Lime and shale ---------	15	2,378

Well JK-33-43-602

Owner: City of Ennis well 3. Driller: J. L. Myers' Sons.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface ---------------	7	7	Shale -----------------	115	1,375
Clay, streaks of rock -	23	30	Lime and shale ---------	76	1,451
Shale -----------------	542	572	Lime -------------------	19	1,470
Lime ------------------	286	858	Shale, sandy, and lime -	63	1,533
Shale with lime -------	402	1,260	Sand and shale ---------	27	1,560

(Continued on next page)

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well JK-33-43-602--Continued					
Lime, hard ------------	41	1,601	Sand, broken, and lime -	75	1,756
Lime ------------------	9	1,610	Sand -------------------	6	1,762
Sand ------------------	71	1,681	Lime -------------------	44	1,806

Well JK-33-43-801

Owner: City of Bardwell well 1. Driller: J. L. Myers' Sons.

Clay ------------------	38	38	Sand -------------------	12	1,270
Shale -----------------	312	350	Shale ------------------	50	1,320
Chalk rock ------------	100	450	Shale, sandy -----------	35	1,355
Rock ------------------	83	533	Sand -------------------	8	1,363
Chalk rock ------------	247	780	Rock -------------------	5	1,368
Shale -----------------	373	1,153	Sand -------------------	14	1,382
Rock, hard ------------	3	1,156	Rock -------------------	16	1,398
Shale and rock, broken	15	1,171	Sand -------------------	97	1,495
Shale -----------------	87	1,258	Shale ------------------	22	1,517

Well JK-33-43-901

Owner: Normand and Singleton Construction Co. Driller: C. M. Stoner.

Clay, yellow ----------	30	30	Sand -------------------	18	1,328
Shale, blue ------------	300	330	Shale, sandy -----------	32	1,360
Chalk rock ------------	580	910	Sand -------------------	10	1,370
Shale, blue -----------	290	1,200	Shale, sandy -----------	40	1,410
Shale, sandy ----------	70	1,270	Sand, hard, fine -------	65	1,475
Sand, broken, and shale	40	1,310	Shale, sandy -----------	35	1,510

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Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well JK-33-43-901--Continued					
Sand	50	1,560	Sand, hard	69	1,659
Shale, sandy	30	1,590			

Well JK-33-44-401

Owner: City of Ennis well 1. Driller -- Scott.

Soil and shale	100	100	Lime	6	1,840
Lime and shale	8	108	Shale	10	1,850
Shale, sandy	452	560	Shale, sticky	53	1,903
Chalk	487	1,047	Shale, hard	42	1,945
Shale	330	1,377	Lime	85	2,030
Shale, sticky	68	1,445	Gumbo	2	2,032
Sand	46	1,491	Lime	83	2,115
Shale	12	1,503	Shale	5	2,120
Shale, sticky	105	1,608	Limestone	316	2,436
Lime	2	1,610	Shale, hard	4	2,440
Shale, hard	82	1,692	Lime	6	2,446
Shale, sticky	7	1,699	Shale, hard	10	2,456
Sand	4	1,703	Lime	44	2,500
Sand, hard	4	1,707	Sand	5	2,505
Sand, hard, and shale	29	1,736	Shale, sandy	30	2,535
Sand, hard	60	1,796	Lime	14	2,549
Shale, sticky	24	1,820	Shale, hard, sandy	11	2,560
Shale, hard	14	1,834	Lime	13	2,573

(Continued on next page)

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well JK-33-44-401--Continued					
Shale, hard -----------	5	2,578	Lime ------------------	34	2,934
Lime ------------------	5	2,583	Lime, hard ------------	10	2,944
Lime, broken, and hard shale --------------	7	2,590	Lime ------------------	43	2,987
Lime ------------------	14	2,604	Shale, sticky ----------	5	2,992
Shale, soft -----------	10	2,614	Lime ------------------	20	3,012
Shale, sticky ---------	4	2,618	Lime, broken -----------	24	3,036
Lime, broken, and hard shale --------------	7	2,625	Lime ------------------	29	3,065
Lime, hard ------------	3	2,628	Lime, broken, and shale	115	3,180
Lime, broken, and hard shale ----------	17	2,645	Lime, broken -----------	20	3,200
Lime, broken, and shale	35	2,680	Lime, broken, and hard shale ---------------	10	3,210
Lime, hard ------------	7	2,687	Lime ------------------	110	3,320
Lime ------------------	20	2,707	Lime, broken -----------	58	3,378
Lime, sandy -----------	25	2,732	Shale, hard ------------	15	3,393
Lime and broken lime --	52	2,784	Sand ------------------	16	3,409
Shale -----------------	2	2,786	Shale, sandy -----------	15	3,424
Lime, broken ----------	6	2,792	Shale, hard ------------	2	3,426
Lime ------------------	6	2,798	Shale, hard, and sandy lime ----------------	20	3,446
Shale, sandy, and lime	8	2,806	Sand ------------------	14	3,460
Lime, broken ----------	44	2,850	Shale, sticky ----------	6	3,466
Lime and shale --------	8	2,858	Lime, sandy ------------	5	3,471
Lime, broken ----------	42	2,900	Shale, hard ------------	3	3,474

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Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well JK-33-44-401--Continued					
Shale, sticky ---------	10	3,484	Sand ------------------	8	3,517
Shale, sandy -----------	6	3,490	Shale, sandy -----------	20	3,537
Shale, sandy, and lime	7	3,497	Sand, hard, and shale --	5	3,542
Lime, hard ------------	3	3,500	Lime, sandy ------------	6	3,548
Shale, hard, and lime -	5	3,505	Shale, sandy -----------	4	3,552
Lime, sandy -----------	3	3,508	Sand, hard -------------	3	3,555
Lime ------------------	1	3,509	Sand -------------------	5	3,560

Well JK-33-44-402

Owner: City of Ennis well 2. Driller: Layne-Texas Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil and clay ------	15	15	Shale ------------------	352	555
Sand ------------------	10	25	Rock, white ------------	393	948
Clay ------------------	35	60	Rock, white, and shale -	67	1,015
Sand, black -----------	15	75	Shale, hard ------------	369	1,384
Clay and sand ---------	20	95	Shale with streaks of sand -----------------	40	1,424
Clay and shale --------	27	122	Sand -------------------	25	1,449
Rock ------------------	1	123	Lime -------------------	3	1,452
Shale, sticky ---------	13	136	Sand, hard -------------	13	1,465
Rock ------------------	1	137	Sand -------------------	13	1,478
Shale, sticky ---------	3	140	Shale, sticky ----------	40	1,518
Shale, sticky, sand and boulders --------	29	169	Shale, sandy -----------	10	1,528
Rock ------------------	1	170	Shale, hard ------------	32	1,560
Shale, sticky ---------	33	203	Lime -------------------	3	1,563

(Continued on next page)

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

Well JK-33-44-402--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Shale, hard, boulders and lime ------------	101	1,664	Sand -------------------	4	1,701
Shale, hard, sandy, and lignite ---------	18	1,682	Sand and sandy shale ---	31	1,732
Sand ------------------	13	1,695	Sand, hard, and sandrock -------------	52	1,784
Shale, hard -----------	2	1,697	Sand, hard, and shale --	21	1,805

Well JK-33-48-602

Owner: City of Maypearl well 2. Driller: J. L. Myers' Sons.

Surface soil ----------	4	4	Sand -------------------	18	224
Gravel ----------------	7	11	Shale ------------------	141	365
Sand ------------------	4	15	Sand -------------------	40	405
Shale -----------------	191	206	Shale ------------------	5	410

Well JK-33-49-102

Owner: Weldon Blair. Driller: C. M. Stoner.

Chalk -----------------	117	117	Sand -------------------	20	615
Shale, blue -----------	243	360	Shale, sandy -----------	10	625
Shale, brown ----------	125	485	Sand -------------------	8	633
Shale, sandy ----------	15	500	Sand, broken, and shale	71	704
Sand ------------------	10	510	Sand -------------------	7	711
Shale, sandy ----------	20	530	Shale, sandy, and white rock -----------	8	719
Sand ------------------	35	565			
Shale, sandy, and sand	30	595			

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)

Well JK-33-49-208

Owner: Barron Kidd. Driller: C. M. Stoner.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil ---------------	1	1	Shale, sandy -----------	21	536
Rock ------------------	87	88	Sand ------------------	3	539
Shale, blue -----------	298	386	Shale, sandy -----------	38	577
Shale, brown ----------	85	471	Sand ------------------	4	581
Sand, good ------------	12	483	Shale, sandy -----------	41	622
Shale, sandy, and lime	29	512	Sand ------------------	33	655
Sand ------------------	3	515	Shale and lime ---------	13	668

Well JK-33-49-402

Owner: Murr Hodges. Driller: C. M. Stoner.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Rock, white -----------	174	174	Sand ------------------	7	567
Shale, blue -------------	201	375	Shale, sandy -----------	53	620
Shale, brown -----------	165	540	Sand ------------------	8	628
Sand ------------------	10	550	Shale, sandy -----------	8	636
Shale, broken, sandy --	10	560	Sand ------------------	36	672

Well JK-33-49-601

Owner: City of Italy well 2. Driller: R. H. Dearing & Sons.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface soil ----------	8	8	Gumbo -----------------	35	470
Rock, white -----------	342	350	Rock ------------------	4	474
Shale -----------------	15	365	Shale -----------------	26	500
Rock ------------------	3	368	Gumbo with boulders about 4 ft apart -----	60	560
Shale -----------------	67	435			

(Continued on next page)

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

Well JK-33-49-601--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Shale ----------------	40	600	Shale -----------------	13	775
Soapstone ------------	20	620	Gumbo -----------------	10	785
Rock, very hard -------	6	626	Gumbo, red ------------	9	794
Shale and gumbo -------	74	700	Shale -----------------	26	820
Soapstone ------------	10	710	Sand, hard ------------	10	830
Rock, hard -----------	3	713	Gumbo -----------------	10	840
Shale ----------------	9	722	Shale and soapstone ----	18	858
Rock -----------------	3	725	Sandrock --------------	1	859
Sand, hard -----------	16	741	Sand ------------------	22	881
Soapstone ------------	5	746			
Soapstone with little hard pan ------------	16	762			

Well JK-33-49-604

Owner: John Davis. Driller: C. M. Stoner.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil --------------	2	2	Shale, sandy and sand --	52	745
Clay, yellow -----------	8	10	Sand ------------------	20	765
Chalk rock -----------	310	320	Shale -----------------	30	795
Shale, blue -----------	290	610	Sand ------------------	37	832
Shale, brown ----------	25	635	Shale -----------------	18	850
Shale, sandy, and sandrock ------------	45	680	Sand ------------------	20	870
Sand -----------------	13	693	Rock, white -----------	33	903

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

Well JK-33-57-201

Owner: City of Milford well 1. Driller: -- Dearing & Sons.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	3	3	Marl	55	1,620
Rock, white	307	310	Limestone, soft	30	1,650
Shale, blue	330	640	Limestone, hard	174	1,824
Sand	9	649	Marl, white	11	1,835
Shale	15	664	Limestone, hard	160	1,995
Sand	14	678	Marl	7	2,002
Shale	36	714	Limestone, hard	26	2,028
Sand	6	720	Limestone, soft	47	2,075
Shale	25	745	Soapstone	20	2,095
Sand	53	798	Limestone, hard	10	2,105
Shale	178	976	Sand, mineral	5	2,110
Limestone, hard	224	1,200	Limestone, hard	7	2,117
Marl, white	25	1,225	Soapstone	19	2,136
Limestone, hard	89	1,314	Sand, hard, mineral	9	2,145
Marl, white	56	1,370	No record	15	2,160
Limestone, hard	75	1,445	Sand, hard, mineral	8	2,168
Shale	10	1,455	Shale, blue	7	2,175
Sandrock, very hard	7	1,462	Sand, hard, mineral	32	2,207
Sand, good	23	1,485	Limestone, hard	43	2,250
Shale	7	1,492	Shale	25	2,275
Lime, hard	58	1,550	Limestone	10	2,285
Soapstone	15	1,565	Marl, red	19	2,304

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Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Ellis County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well JK-33-57-201--Continued					
Shale ----------------	36	2,340	Marl, red -------------	7	2,435
Marl, red ------------	25	2,365	Sand ------------------	15	2,450
Limestone ------------	35	2,400	Marl, red -------------	20	2,470
Marl, red ------------	18	2,418	Sand, good ------------	118	2,588
Sandrock -------------	10	2,428	Sandrock, very hard ----	4	2,592

Well JK-33-57-202

Owner: City of Milford well 2. Driller: J. L. Myers' Sons.

Surface soil ---------	4	4	Shale -----------------	4	767
Chalk, rock ----------	311	315	Sand ------------------	27	794
Shale ----------------	351	666	Sand, broken ----------	28	822
Sand -----------------	19	685	Sand ------------------	30	852
Shale ----------------	63	748	Sand and shale --------	8	860
Sand -----------------	15	763	Shale -----------------	40	900

Well JK-33-57-204

Owner: John R. Dishman. Driller: C. M. Stoner.

Topsoil --------------	3	3	Shale, sandy ----------	25	675
Chalk, rock ----------	337	340	Sand ------------------	80	755
Shale, blue ----------	200	540	Shale -----------------	25	780
Shale, brown ---------	110	650	Sand ------------------	57	837

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Dallas County

Well HR-33-27-601

Owner: City of Ferris well 1. Driller: -- Dearing & Sons.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay	18	18	Shale	27	1,050
Gravel	4	22	Gumbo	26	1,076
Shale	118	140	Shale, hard	24	1,100
Rock, white	425	565	Rock	1	1,101
Shale	25	590	Shale, hard, with sand	24	1,125
Pan, hard	10	600	Soapstone	5	1,130
Shale	85	685	Rock	1	1,131
Rock	1	686	Shale, hard	14	1,145
Shale	23	709	Soapstone	5	1,150
Gumbo	19	728	Rock	1	1,151
Shale	162	890	Sand	45	1,196
Pan, hard	8	898	Limerock, dirt	121	1,317
Shale	77	975	Sand	26	1,343
Gumbo	48	1,023			

Well HR-33-27-602

Owner: City of Ferris well 3. Driller: J. L. Myers' Sons.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface soil	3	3	Sand, broken	6	1,116
Clay	23	26	Shale	9	1,125
Shale	106	132	Sand	4	1,129
Chalk rock	520	652	Sand and shale	9	1,138
Shale	458	1,110	Shale	11	1,149

(Continued on next page)

Table 7.--Drillers' logs of wells in Ellis and adjacent counties--Continued

Dallas County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well HR-33-27-602--Continued					
Shale, sandy ----------	14	1,163	Sand -------------------	23	1,308
Sand ------------------	19	1,182	Sand, broken -----------	37	1,345
Shale -----------------	28	1,210	Shale ------------------	24	1,369
Sand ------------------	33	1,243	Sand -------------------	3	1,372
Shale -----------------	42	1,285	Shale ------------------	18	1,390

Table 8.--Chemical analyses of water from wells in Ellis and adjacent counties

(Analyses are in parts per million except specific conductance, pH, percent sodium, sodium adsorption ratio, and residual sodium carbonate.)

Water-bearing unit: Qal, Quaternary alluvium; Ktw, Wolfe City Sand Member of Taylor Marl; Kt, Taylor Marl; Ka, Austin Chalk; Kef, Eagle Ford Shale; Kwb, Woodbine Formation; Kp, Paluxy Sand; Kgr, Glen Rose Limestone; Kh, Hosston Formation.

Well	Depth of well (ft)	Date of collection	Water-bearing unit	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$	Percent sodium	Sodium adsorption ratio (SAR)	Residual sodium carbonate (RSC)	Specific conductance (micromhos at 25°C)	pH
Ellis County																									
JK-32-32-801	300	June 15, 1965	Kwb	11	**0.45	--	6.5	2.7	* 222	--	382	--	166	16	0.5	0.2	--	--	613	27	95	19	5.72	975	7.3
902	530	do	Kwb	12	--	--	1.8	.4	* 308	--	418	--	292	19	.7	.2	--	--	840	6	99	55	6.73	1,360	7.6
40-601	759	June 10, 1965	Kwb	--	--	--	--	--	--	--	456	--	250	19	--	--	--	--	--	7	--	--	7.33	1,270	7.8
901	1,359	June 2, 1965	Kp	14	.05	--	7.2	4.4	696	3.6	666	--	864	74	5.4	3.2	--	1.2	2,000	36	97	50	.2	2,970	8.0
48-501	367	June 22, 1965	Kwb	11	--	--	.5	.7	* 290	--	576	--	118	25	1.3	.2	--	--	730	4	99	63	9.36	1,200	8.2
503	349	do	Kwb	--	--	--	--	--	--	--	574	--	94	22	--	--	--	--	--	8	--	--	9.25	1,130	7.8
a/ 601	507	May 19, 1936	Kwb	--	--	--	--	--	--	--	--	--	123	42	--	--	--	--	916	--	--	--	--	--	7.8
602	410	Feb. 21, 1961	Kwb	12	--	--	1.0	.2	* 315	--	592	--	139	38	1.8	.0	--	--	821	4	99	68	9.63	1,310	8.1
901	384	June 22, 1965	Kwb	--	--	--	--	--	--	--	620	--	353	51	--	--	--	--	--	10	--	--	9.96	1,820	8.1
903	430	do	Kwb	--	--	--	--	--	--	--	606	--	106	24	--	--	--	--	--	5	--	--	9.83	1,180	8.0
33-25-501	697	June 10, 1965	Kwb	12	--	--	6.0	3.2	* 795	--	562	--	944	218	1.3	2.0	--	--	2,260	28	98	65	8.65	3,370	7.9
702	824	June 15, 1965	Kwb	12	** .4	--	25	1.2	* 467	--	546	--	470	59	2.1	.0	--	--	1,280	11	99	61	8.73	1,990	7.4
801	709	June 25, 1965	Kwb	--	--	--	--	--	--	--	818	--	510	299	--	--	--	--	--	19	--	--	13.0	3,100	8.1
901	735	June 10, 1965	Kwb	12	--	--	1.8	.9	* 363	--	528	--	278	50	1.1	3.0	--	--	970	8	99	56	8.49	1,540	8.0
b/ 902	2,763	Dec. 28, 1964	Kh	15	.1	--	4.0	1.9	* 312	--	520	24	98	91	1.7	.6	--	--	1,068	18	--	--	--	--	8.5
902	2,763	June 25, 1965	Kh	20	.04	0.00	2.2	1.1	300	1.8	552	--	97	84	1.6	.0	--	.62	779	10	98	41	8.85	1,310	8.1
904	688	July 27, 1965	Kwb	11	--	--	4.5	1.9	* 603	--	580	--	624	140	2.8	.2	--	--	1,670	19	99	60	9.13	2,670	8.0
26-701	692	Aug. 5, 1965	Kwb	13	--	--	3.5	1.8	* 565	--	588	--	532	144	2.2	.0	--	--	1,550	16	99	61	9.32	2,430	7.9
702	900	do	Kwb	12	--	--	5.2	3.2	* 803	--	766	--	544	408	--	3.0	--	--	2,160	26	99	68	12.0	3,440	7.8
801	944	Jan. 27, 1943	Kwb	11	.04	--	4.6	1.5	460	8.2	579	--	394	98	1.3	2.5	--	--	1,270	18	--	--	--	--	8.2
801	944	June 9, 1965	Kwb	12	.10	.01	3.0	1.8	496	1.8	572	--	398	159	1.8	1.5	0.33	2.4	1,360	15	98	56	9.08	2,180	7.9
c/ 802	1,171	Sept. 24, 1962	Kwb	--	.45	.05	2	1	* 460	--	604	--	386	80	2.0	2.0	--	--	1,230	9	--	--	--	2,145	8.1
802	1,171	June 3, 1965	Kwb	13	.05	.05	2.0	.7	448	2.1	608	--	380	74	1.9	.2	.02	2.0	1,220	8	99	69	9.81	1,930	8.0
805	1,100	Aug. 5, 1965	Kwb	13	.07	.00	2.0	1.7	473	1.7	562	--	450	91	1.7	.0	.01	2.4	1,310	12	99	59	8.97	2,080	8.0
901	950	Aug. 4, 1965	Kwb	13	--	--	2.2	1.1	* 520	--	628	--	414	134	2.4	.0	--	--	1,400	10	99	72	10.1	2,190	8.0
27-801	1,447	do	Kwb	--	--	--	--	--	--	--	738	--	416	146	--	--	--	--	--	10	--	--	11.9	2,390	8.0

See footnotes at end of table.

Table 8.--Chemical analyses of water from wells in Ellis and adjacent counties--Continued

Well	Depth of well (ft)	Date of collection	Water-bearing unit	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$	Percent sodium	Sodium adsorption ratio (SAR)	Residual sodium carbonate (RSC)	Specific conductance (micromhos at 25°C)	pH
c/ JK-33-27-901	1,954	Sept. 4, 1954	Kwb	20	0.02	--	3	3	* 580	--	744	30	371	167	3.5	0.4	--	--	1,515	25	--	--	--	--	--
c/ 901	1,954	July 24, 1963	Kwb	--	.08	--	3	1	* 580	--	780	11	383	173	4.1	< .4	--	--	1,940	14	--	--	--	2,794	8.4
28-702	1,548	June 9, 1965	Kwb	--	--	--	--	--	--	--	1,040	--	11	1,540	--	--	--	--	--	45	--	--	16.2	6,150	7.7
801	40	Aug. 3, 1965	Qal	14	--	--	156	12	* 178	--	296	--	234	240	.2	1.8	--	0.1	982	438	47	3.7	.00	1,640	6.8
b/ 33-101	2,412	June 11, 1957	Kh	10	--	--	4.0	--	* 278	--	449	26	79	84	--	--	--	--	933	10	--	--	--	--	8.4
101	2,412	June 3, 1965	Kh	18	.01	0.00	2.0	1.2	262	1.6	490	--	76	69	1.1	.2	0.00	.52	673	10	98	36	7.83	1,130	8.0
102	2,512	Jan. 27, 1943	Kh	15	.02	--	4.3	1.2	263	6.8	467	15	77	73	1.9	.0	--	--	681	16	--	--	--	--	8.2
103	699	do	Kwb	8.0	.04	--	4.5	1.3	378	6.8	408	39	368	45	.6	.0	--	--	1,050	16	--	--	--	--	8.4
201	619	June 24, 1965	Kwb	--	--	--	--	--	--	--	644	--	720	192	--	--	--	--	--	20	--	--	10.2	2,990	7.9
202	754	do	Kwb	--	--	--	--	--	--	--	472	--	188	19	--	--	--	--	--	6	--	--	7.62	1,160	7.8
302	500	June 17, 1965	Kwb	--	--	--	--	--	--	--	486	--	344	39	--	--	--	--	--	8	--	--	7.81	1,560	7.8
401	642	June 10, 1965	Kwb	--	--	--	--	--	--	--	552	8	550	101	--	--	--	--	--	14	--	--	9.75	2,310	8.3
701	1,425	Apr. 28, 1965	Kp	--	.17	--	--	--	--	--	628	83	--	56	--	--	--	--	--	24	--	--	12.6	2,260	9.1
702	695	Apr. 26, 1961	Kwb	--	** .65	--	3.5	1.0	* 537	--	560	--	572	82	2.3	4.2	--	--	1,490	12	99	67	8.93	2,240	7.9
34-101	902	July 22, 1965	Kwb	--	--	--	--	--	--	--	586	--	492	108	--	--	--	--	--	13	--	--	9.34	2,240	7.9
202	1,000	do	Kwb	--	--	--	--	--	--	--	612	--	416	79	--	--	--	--	--	10	--	--	9.83	2,020	7.8
203	940	Aug. 5, 1965	Kwb	--	--	--	--	--	--	--	616	--	404	88	--	--	--	--	--	11	--	--	9.88	2,050	8.0
204	968	July 22, 1965	Kwb	13	--	--	1.5	1.1	* 391	--	562	--	300	56	1.6	2.8	--	--	1,040	8	99	60	9.05	1,650	8.0
301	3,285	Dec. 17, 1965	Kh	20	.17	.00	4.8	1.7	493	3.3	646	--	142	275	3.0	.8	.01	1.1	1,260	1.9	98	49	10.2	2,070	8.0
402	997	July 22, 1965	Kwb	--	--	--	--	--	--	--	676	--	454	135	--	--	--	--	--	14	--	--	10.8	2,360	7.6
404	--	do	Kwb	14	.04	.00	2.5	1.9	547	1.8	682	--	440	142	3.2	3.2	.12	3.5	1,490	14	99	64	10.9	2,370	7.9
502	1,080	July 23, 1965	Kwb	--	--	--	--	--	--	--	734	--	394	140	--	--	--	--	--	14	--	--	11.8	2,320	8.0
601	1,302	do	Kwb	13	--	--	3.5	.4	* 529	--	668	--	464	84	3.2	2.8	--	--	1,430	10	99	73	10.8	2,100	8.1
702	2,950	Jan. --, 1943	Kh	21	.07	--	5.4	2.1	429	7.2	494	18	112	288	1.7	3.0	--	--	1,130	22	97	--	--	--	8.4
702	2,950	July 6, 1948	Kh	20	.10	--	4.8	1.7	427	4.8	492	24	112	275	2.0	.8	--	.87	1,110	19	97	--	--	1,920	8.1
702	2,950	Feb. 21, 1961	Kh	16	--	--	6.8	2.8	* 461	--	500	--	165	315	1.7	.0	--	--	1,210	28	97	38	7.63	2,100	7.9
703	2,950	June 4, 1948	Kh	20	.15	--	5.0	3.2	414	4.8	480	28	113	262	1.8	.8	--	--	1,090	26	97	--	--	1,890	8.5
704	2,878	Feb. 28, 1952	Kh	23	.01	.00	3.3	1.2	348	.8	563	--	109	132	1.8	.0	.0	.70	897	13	98	--	--	1,470	8.2
711	1,521	July 6, 1948	Kgr	12	5.8	--	229	106	1,420	20	168	--	3,680	95	2.8	.5	--	2.0	5,650	1,060	75	--	--	6,840	7.1
712	2,907	June 4, 1948	Kh	20	.15	--	4.2	3.1	436	4.8	476	26	121	292	1.8	.8	--	--	1,140	23	97	--	--	1,980	8.7
712	2,907	Mar. 24, 1949	Kh	22	.05	--	4.0	1.6	* 462	--	520	6	167	288	1.8	.0	--	.38	1,210	16	98	--	--	1,930	8.2

See footnotes at end of table.

Table 8.--Chemical analyses of water from wells in Ellis and adjacent counties--Continued

Well	Depth of well (ft)	Date of collection	Water-bearing unit	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$	Percent sodium	Sodium adsorption ratio (SAR)	Residual sodium carbonate (RSC)	Specific conductance (micromhos at 25°C)	pH
JK-33-34-802	1,180	July 23, 1965	Kwb	--	--	--	--	--	--	--	702	28	274	84	--	--	--	--	--	10	--	--	12.2	1,960	8.4
803	1,091	July 30, 1965	Kwb	--	--	--	--	--	--	--	732	--	240	70	--	--	--	--	--	8	--	--	11.8	1,800	7.9
35-401	1,295	Apr. 10, 1965	Kwb	--	0.11	--	--	--	--	--	728	94	--	115	--	--	--	--	--	11	--	--	14.8	2,260	9.1
401	1,295	Aug. 6, 1965	Kwb	14	.11	--	1.8	1.3	* 582	--	900	--	344	118	5.1	0.0	--	--	1,510	10	99	80	14.6	2,330	8.0
501	1,472	Jan. 27, 1943	Kwb	23	.00	--	5.5	2.3	782	7.6	874	30	293	454	4.8	10	--	--	2,050	23	--	--	--	--	8.2
501	1,472	Feb. 23, 1961	Kwb	14	--	--	3.0	1.8	* 765	--	904	--	284	448	3.9	.2	--	--	1,960	15	99	86	14.5	3,230	7.7
b/ 503	1,522	Aug. 24, 1964	Kwb	15	.28	--	3.2	1.2	* 528	--	778	24	300	120	--	--	--	--	1,770	13	--	--	--	--	8.3
503	1,522	Aug. 6, 1965	Kwb	15	.05	0.00	1.8	1.3	523	1.9	808	--	316	114	4.0	.0	0.00	4.8	1,380	10	99	72	13.0	2,190	8.0
701	1,303	July 30, 1965	Kwb	14	--	--	2.5	.7	* 532	--	822	--	320	105	4.3	.00	--	--	1,380	9	99	77	13.3	2,170	7.7
b/ 702	1,321	Sept. 5, 1964	Kwb	15	.2	--	3.2	1.0	* 508	--	754	18	324	114	3.2	--	--	--	1,738	12	--	--	--	--	8.5
702	1,321	July 30, 1965	Kwb	14	.10	.02	3.2	.7	537	2.1	818	--	352	105	3.6	.2	.10	4.4	1,420	11	99	70	13.2	2,240	8.0
801	18	Aug. 9, 1965	Qal	--	--	--	--	--	--	--	288	--	1,460	105	--	--	--	--	--	965	--	--	.00	3,120	7.2
902	140	Aug. 6, 1965	Kt	18	--	--	38	15	* 314	--	612	--	258	47	.5	2.0	--	--	994	156	81	11	6.90	1,550	7.2
b/ 36-201	1,980	Mar. 2, 1960	Kwb	15	.4	--	5.6	--	* 749	--	933	28	427	272	--	--	--	--	2,434	14	--	--	--	--	--
201	1,980	Aug. 3, 1965	Kwb	18	.15	.01	4.5	.5	729	2.7	944	--	427	234	3.8	.2	.01	5.5	1,910	13	99	88	15.2	2,990	7.9
401	50	do	Kt	--	--	--	--	--	--	--	778	--	684	135	--	3.0	--	--	--	610	--	--	.55	2,710	7.1
802	1,703	do	Kwb	17	--	--	6.5	2.7	*1,150	--	1,060	--	328	940	--	.8	--	--	2,970	27	99	96	16.8	4,990	7.8
37-401	28	Mar. 17, 1965	Qal	--	1.5	--	--	--	--	--	254	--	--	10	.1	--	--	--	--	236	--	--	.00	521	7.4
805	30	Aug. 13, 1965	Qal	13	--	--	128	5.5	23	1.4	384	--	41	8.2	.1	35	--	.38	444	342	13	.5	.00	742	7.1
41-202	727	June 16, 1965	Kwb	13	--	--	.5	.7	* 269	--	552	--	93	25	1.2	.2	--	--	674	4	99	58	8.97	1,100	8.0
401	728	do	Kwb	--	--	--	--	--	--	--	644	--	207	58	--	--	--	--	--	7	--	--	10.4	1,560	7.8
b/ 501	2,606	May 24, 1965	Kh	16	.15	--	2.4	1.5	* 303	--	510	29	86	76	1.0	--	--	--	1,032	12	--	--	--	--	8.5
501	2,606	June 25, 1965	Kh	20	.23	--	2.5	1.0	297	1.8	556	--	86	76	1.4	.0	.00	.66	759	10	98	41	8.91	1,270	8.0
802	632	June 16, 1965	Kwb	--	--	--	--	--	--	--	650	31	296	76	--	--	--	--	--	8	--	--	11.5	1,910	8.6
901	620	July 19, 1965	Kwb	--	--	--	--	--	--	--	660	--	656	151	--	--	--	--	--	15	--	--	1.05	2,740	7.9
42-104	1,019	July 17, 1965	Kwb	14	--	--	2.0	1.0	* 442	--	662	--	296	78	2.8	1.8	--	--	1,160	9	99	64	10.7	1,820	7.9
201	1,285	Aug. 10, 1965	Kwb	13	--	--	2.5	1.0	* 488	--	762	--	304	86	3.5	.2	--	--	1,270	10	99	67	12.3	1,990	7.8
401	1,026	July 17, 1965	Kwb	--	--	--	--	--	--	--	650	--	518	82	--	--	--	--	--	10	--	--	10.4	1,910	7.9
404	836	July 19, 1965	Kwb	--	--	--	--	--	--	--	636	--	340	532	--	--	--	--	--	30	--	--	9.82	3,210	7.9
601	25	Aug. 10, 1965	Qal	--	--	--	--	--	--	--	306	--	11	2.4	--	--	--	--	--	252	--	--	.00	518	7.2

See footnotes at end of table.

Table 8.--Chemical analyses of water from wells in Ellis and adjacent counties--Continued

Well	Depth of well (ft)	Date of collection	Water-bearing unit	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	otassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$	Percent sodium	Sodium adsorption ratio (SAR)	Residual sodium carbonate (RSC)	Specific conductance (micromhos at 25°C)	pH
JK-33-42-701	940	Jan. 27, 1943	Kwb	11	0.10	--	5.0	1.9	645	8.0	706	24	501	195	5.0	8.2	--	--	1,756	20	--	--	--	--	8.4
701	940	Feb. 23, 1961	Kwb	12	--	--	3.2	1.4	* 624	--	722	--	498	178	3.6	.8	--	--	1,680	14	99	73	11.6	2,650	7.8
d/ 702	2,850	July 24, 1964	Kh	--	.10	--	24	25	270	4.4	360	20	82	250	1.9	.75	0.205	--	1,172	61	--	--	--	--	8.4
901	1,238	July 20, 1965	Kwb	14	.04	0.00	2.8	1.7	644	2.4	900	--	426	164	4.7	3.5	.06	4.5	1,710	14	99	75	14.5	2,700	7.8
43-301	1,350	Aug. 9, 1965	Kwb	15	.03	.01	6.2	4.0	1,200	4.7	988	--	22	1,200	--	4.5	.02	--	3,040	32	99	92	15.6	5,420	7.7
302	230	Mar. 17, 1965	Ktw	--	--	3.6	--	--	--	--	486	--	--	34	--	--	--	--	--	270	--	--	2.57	816	7.2
401	1,350	Aug. 10, 1965	Kwb	--	--	--	--	--	--	--	924	--	340	157	--	--	--	--	--	10	--	--	14.9	2,480	8.0
501	32	do	Qal	--	--	--	--	--	--	--	306	--	34	16	--	54	--	--	--	316	--	--	.00	678	7.1
c/ 602	1,806	Sept. 30, 1954	Kwb	--	.02	--	--	--	* 775	--	--	--	473	270	5.5	--	--	--	2,141	--	--	--	--	--	--
602	1,806	Feb. 3, 1965	Kwb	--	--	--	--	--	* 770	--	--	--	487	266	--	--	--	--	2,510	--	--	--	--	--	--
701	1,240	July 15, 1965	Kwb	15	.12	--	3.0	2.1	696	2.5	976	--	432	210	5.9	.8	.02	--	1,850	16	99	76	15.7	2,890	8.0
801	1,517	Feb. 13, 1961	Kwb	16	--	--	2.2	1.3	* 712	--	944	--	418	239	5.1	.2	--	--	1,860	11	99	93	15.2	2,950	7.8
c/ 901	1,659	July 1964	Kwb	--	.37	--	--	--	--	--	--	--	442	400	--	--	--	--	2,340	--	--	--	--	--	7.4
901	1,659	Aug. 17, 1965	Kwb	15	--	--	4.0	1.9	* 881	--	1,060	--	480	400	--	1.2	--	--	2,300	18	99	90	17.0	3,600	8.1
44-401	1,796	Jan. 1943	Kwb	10	.06	--	4.5	2.1	* 785	--	958	16	488	277	5.6	.5	--	--	2,090	20	--	--	--	--	8.2
401	1,796	Mar. 21, 1949	Kwb	16	.00	--	3.8	2.4	* 807	--	1,020	--	503	280	7.0	.5	--	2.6	2,120	20	99	--	--	3,300	8.0
c/ 401	1,796	Feb. 23, 1965	Kwb	--	--	--	--	--	--	--	990	--	482	273	5.6	.4	--	--	2,250	--	--	--	--	--	--
402	1,805	Jan. 27, 1943	Kwb	11	.31	--	4.6	2.1	807	9.0	983	25	500	285	6.0	.8	--	--	2,140	20	98	--	--	--	8.4
402	1,805	Feb. 21, 1961	Kwb	15	--	--	3.2	1.6	* 792	--	1,010	--	488	275	4.8	.5	--	--	2,080	14	99	92	16.3	3,280	7.8
c/ 402	1,805	Feb. 23, 1965	Kwb	--	--	--	--	--	* 790	--	990	--	491	277	5.6	--	--	--	2,560	--	--	--	--	--	8.2
402	1,805	Aug. 25, 1965	Kwb	17	.01	.00	3.8	1.8	800	2.8	1,010	--	508	282	6.4	4.5	.02	6.2	2,130	17	99	84	16.2	3,310	7.9
403	165	Aug. 12, 1965	Ktw	12	--	--	12	3.4	* 477	--	686	--	276	162	1.5	.2	--	--	1,280	44	96	31	10.4	2,040	7.6
802	45	do	Kt	--	--	--	--	--	--	--	376	--	70	174	--	--	--	--	--	276	--	--	.64	1,260	7.4
49-102	719	June 17, 1965	Kwb	--	--	--	--	--	--	--	740	--	402	85	--	--	--	--	--	12	--	--	11.9	2,170	7.9
202	2,800	do	Kh	20	--	--	3.0	1.6	* 339	--	546	18	78	133	1.7	.0	--	--	862	14	98	39	8.67	1,470	8.4
208	668	July 19, 1965	Kwb	--	--	--	--	--	--	--	646	--	304	63	--	--	--	--	--	9	--	--	10.4	1,790	7.8
402	672	July 20, 1965	Kwb	--	--	--	--	--	--	--	592	--	620	104	--	--	--	--	--	16	--	--	9.38	2,490	7.8
601	881	Jan. 28, 1943	Kwb	14	.31	--	3.9	1.9	569	11	618	37	514	111	3.3	.2	--	--	1,570	18	--	--	--	--	8.4
601	881	Mar. 21, 1949	Kwb	14	.23	--	2.8	1.7	* 580	--	692	--	514	112	4.8	4.0	--	1.8	1,570	14	99	--	--	2,380	8.0
c/ 602	935	Jan. 28, 1963	Kwb	--	.08	--	4	--	* 556	--	668	--	470	103	3.0	4.9	--	--	1,810	--	--	--	--	2,662	8.4

See footnotes at end of table.

Table 8.--Chemical analyses of water from wells in Ellis and adjacent counties--Continued

Well	Depth of well (ft)	Date of collection	Water-bearing unit	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$	Percent sodium	Sodium adsorption ratio (SAR)	Residual sodium carbonate (RSC)	Specific conductance (micromhos at 25°C)	pH
JK-33-49-602	935	Aug. 24, 1965	Kwb	13	0.06	0.00	2.5	1.9	551	2.0	692	--	484	107	3.4	3.5	0.01	4.0	1,510	14	99	64	11.1	2,370	7.8
604	903	June 17, 1965	Kwb	--	** .2	--	--	--	--	--	672	--	480	108	--	--	--	--	--	13	--	--	10.8	2,350	7.8
801	680	July 21, 1965	Kwb	--	--	--	--	--	* 705	--	848	--	444	274	--	9.9	--	--	--	18	99	72	13.5	3,000	7.9
50-101	1,050	July 15, 1965	Kwb	--	--	--	--	--	--	--	890	--	388	118	--	--	--	--	--	12	--	--	14.4	2,410	7.9
301	990	do	Kwb	--	--	--	--	--	--	--	870	--	448	300	--	--	--	--	--	20	--	--	13.9	3,070	8.0
401	1,050	June 29, 1965	Kwb	--	**1.2	--	--	--	--	--	812	--	458	132	--	--	--	--	--	12	--	--	13.0	2,510	8.1
502	1,238	do	Kwb	14	.12	.00	3.2	1.7	693	2.5	952	--	498	172	5.7	.00	.00	5.4	1,860	15	99	78	5.3	2,920	8.0
503	1,185	do	Kwb	14	--	--	2.2	1.1	* 573	--	828	--	382	118	5.2	.2	--	--	1,500	10	99	79	13.4	2,370	8.0
51-203	28	Aug. 11, 1965	Kt	--	--	--	--	--	--	--	342	--	50	106	--	--	--	--	--	352	--	--	.00	983	7.3
302	36	do	Kt	--	--	--	--	--	--	--	360	--	25	24	--	--	--	--	--	292	--	--	.06	704	7.3
52-501	38	do	Kt	--	--	--	--	--	--	--	410	--	22	48	--	--	--	--	--	220	--	--	2.32	831	7.3
52-103	18	Aug. 12, 1965	Kt	--	--	--	--	--	--	--	314	--	16	12	--	--	--	--	--	284	--	--	.00	583	7.1
57-201	2,592	Jan. 1943	Kh	14	.04	--	13	5.2	358	7.8	439	42	245	110	1.2	.0	--	--	1,010	54	92	--	--	--	8.4
201	2,592	Mar. 21, 1949	Kh	20	.10	--	14	6.8	* 379	--	500	10	287	111	1.4	1.2	--	.78	1,080	63	93	--	--	1,690	8.4
c/ 201	2,592	Feb. 1, 1962	Kh	--	.06	--	26	11	* 415	--	473	--	440	98	2.0	.7	--	--	1,368	110	--	--	--	--	--
c/ 202	900	June 4, 1964	Kwb	--	.20	--	4	1	* 520	--	590	--	496	77	3.2	< .4	--	--	1,680	14	--	--	--	2,475	8.3
202	900	June 4, 1965	Kwb	12	.06	.00	3.0	1.6	514	2.0	612	--	516	79	2.0	.2	.01	2.5	1,430	14	99	60	9.75	2,250	8.2
203	714	May 27, 1951	Kwb	14	--	--	3.8	2.7	* 671	--	650	--	642	194	--	5.0	--	--	1,850	20	99	--	--	2,880	8.2
205	822	July 14, 1965	Kwb	14	--	--	1.5	.9	* 356	--	674	--	151	48	1.4	.2	--	--	904	7	99	58	10.9	1,450	8.2
Dallas County																									
HR-33-27-501	1,500	Apr. 15, 1965	Kwb	--	5.7	--	--	--	--	--	574	75	--	180	--	--	---	--	--	14	--	--	11.6	2,210	9.1
601	1,343	Jan. 27, 1943	Kwb	11	.08	--	3.1	1.7	519	6.6	714	--	337	126	3.0	0.0	--	--	1,380	14	98	--	--	--	8.4
602	1,390	June 1, 1965	Kwb	14	.04	0.00	2.8	1.2	554	1.8	764	--	352	158	3.3	.2	0.00	3.6	1,470	12	99	70	12.3	2,310	7.9
603	1,360	May 3, 1965	Kwb	--	.27	--	---	--	--	--	720	24	--	222	--	--	---	--	--	13	--	--	12.3	2,490	8.5

* Sodium and potassium calculated as sodium (Na).
** Field tests.
a/ Analyses by Southwestern Laboratories, Dallas, Texas.
b/ Analyses by Pope Testing Laboratories, Dallas, Texas.
c/ Analyses by Texas State Department of Health, Austin, Texas.
d/ Analyses by North Texas State University Water Research Laboratory, Denton, Texas.