TEXAS WATER DEVELOPMENT BOARD

REPORT 94

GROUND-WATER RESOURCES OF JOHNSON COUNTY, TEXAS

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ABSTRACT

Johnson County, an area of 740 square miles, is in the central part of northeastern Texas. Cleburne, the county seat, is about 27 miles south of Fort Worth. The county has a dry subhumid climate. The annual rainfall, which averages 31 inches in the western part of the county and 34 inches in the eastern part, is sufficient to sustain extensive agricultural development. The use of ground water for irrigation is limited by the low yield of most of the wells and the high sodium content of most of the ground water.

In 1965, the population of Johnson County was about 40,100. The economy of the county is based primarily on agriculture and some manufacturing. About 3.2 mgd (million gallons per day), or 3,600 acre-feet annually, of ground water was used in the county in 1966 for public supply (1.2 mgd), rural domestic (0.98 mgd), livestock (0.89 mgd), and industrial (0.17 mgd) needs. Part of the water for public supply and industrial uses in the central part of the county is surface water obtained from recently constructed reservoirs.

The principal water-bearing formations in the county and the approximate quantity of water supplied in 1966 are, as follows: Hosston Formation, 580 acre-feet; Travis Peak Formation, 360 acre-feet; Paluxy Sand, 2,000 acre-feet; Woodbine Formation, 680 acre-feet; and a small quantity from the Quaternary alluvial deposits. About half of the water now being withdrawn from the Paluxy comes from storage; the Paluxy transmits about 1,000 acre-feet per year (about 1 mgd) less than the quantity currently being pumped in the county. In 1966, pumpage from the Woodbine was less than half of the amount transmitted. Also, there is available from storage in the Woodbine in the eastern part of the county about 2,100,000 acre-feet of water.

GROUND-WATER RESOURCES OF JOHNSON COUNTY, TEXAS

INTRODUCTION

Purpose and Scope of Investigation

Information on the ground-water resources of Johnson County and on the methods of deriving maximum benefits from the available supplies are presented in this report. The investigation was begun in March 1966 by the Water Resources Division of the U.S. Geological Survey in cooperation with the Texas Water Development Board.

The scope of the investigation included the determination of: the location and extent of important aquifers; 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 Johnson County.

Records of 308 water wells, springs, and test holes (Table 6), including 50 electrical logs of oil tests and water wells and 50 drillers' logs, were collected and studied. Locations of wells are shown in Figure 15. Water samples from 119 wells were collected and analyzed (Table 8). Present and past pumpage of ground water was inventoried, and pumping tests were made in nine wells to determine the hydraulic characteristics of the aquifers.

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

Location and Extent of Area

Johnson County, an area of 740 square miles, is in the central part of northeastern Texas (Figure 1) between latitudes 32°08′ and 32°32′ N and longitudes 97°05′ and 97°37′ W. It is bordered on the northwest by Parker County, on the north by Tarrant County, on the east by Ellis County, on the south by Hill County, on the southwest by Bosque County, and on the west by Somervell and Hood Counties. The Brazos River is the boundary with Bosque County. Cleburne, the county seat, is in the central part of the county about 27 miles south of Fort Worth.

Figure 1.—Location of Johnson County

Climate

Johnson County has a dry subhumid climate (Thornthwaite, 1952, fig. 30). Hot summers and mild winters generally provide a long growing season of approximately 233 days. The annual rainfall, which averages 31 inches in the western part of the county and 34 inches in the eastern part, is sufficient to sustain extensive agricultural development.

The average annual temperature at Cleburne for the period 1931-60 was 66.5°F. The average annual precipitation at Cleburne was 33.2 inches during the same period, and the average annual gross lake surface evaporation for the county from 1940 through 1965 was 70.6 inches (Kane, 1967, table E-10).

The average monthly temperature, precipitation, and gross lake surface evaporation are listed in Table 1.

Table 1.—Average Monthly Temperature and Precipitation at Cleburne, and Average Monthly Gross Lake Surface Evaporation in Johnson County

MONTH	TEMPERATURE AT CLEBURNE (°F)	PRECIPITATION AT CLEBURNE (INCHES)	GROSS LAKE SURFACE EVAPORATION IN JOHNSON COUNTY (INCHES)
January	47.2	2.04	2.4
February	50.6	2.64	2.6
March	57.5	2.35	3.9
April	66.1	3.79	4.6
May	73.1	4.46	5.3
June	81.3	2.92	7.6
July	84.8	2.17	9.8
August	85.1	2.25	10.8
September	78.3	2.78	8.9
October	68.4	2.94	6.8
November	56.0	2.28	4.7
December	49.3	2.58	3.2

Physiography and Drainage

Johnson County is in the northwestern part of the West Gulf Coastal Plain of Texas (Fenneman, 1938, p. 100-107; Deussen, 1924, fig. 2), and includes from west to east: part of the Western Cross Timbers, the Grand Prairie, the Eastern Cross Timbers, and the edge of the Black Prairie (Fenneman, 1938, pl. VII). Elevations range from about 520 feet in the southwestern part of the county along the Brazos River channel to about 1,050 feet in the northwestern part of the county. The Western Cross Timbers, underlain by the Walnut Clay and Paluxy Sand, is in the western margin of the county. The Grand Prairie, which is the most extensively developed physiographic feature, overlies alternating beds of limestone and shale of the Washita Group that produce a series of terraces or cuestas. The surface of the Grand Prairie slopes gently eastward. The Eastern Cross Timbers coincides with the outcrop of the Woodbine Formation. The Black Prairie, underlain by the Eagle Ford Shale, is a flat surface that slopes gently to the east.

The eastern half of Johnson County is in the drainage basin of the Trinity River, and the western half is mostly in the drainage basin of the Brazos River. The county has an extensive network of streams, the most important of which are: Brazos River, Nolands River, Buffalo Creek, Village Creek, Rock Creek, and Mustang Creek.

Economic Development

In 1965, the population of Johnson County was about 40,100, of which 70 percent lived in cities or towns of 50 or more inhabitants. The larger cities and towns, with their population in 1960, are as follows: Cleburne, 15,381; Burleson, 2,345; Alvarado, 1,907; Keene, 1,532; Grandview, 961; Joshua, 764; Godley, 401; Venus, 324; Rio Vista, 284; Lillian, 150; and Egan, 50.

The economy of Johnson County is based primarily upon agriculture and some manufacturing. Diversification to industry and livestock production has reduced the relative economic importance of farming, especially that of cotton. Eighty percent of farm income now comes from livestock, dairying, and poultry. Cotton production in 1964 was approximately 11,000 bales. Other crops of economic importance in the county are sorghum, hay, corn, oats, wheat, and peanuts. Livestock and poultry production includes cattle, sheep, hogs, chickens, and turkeys.

Irrigation is not extensively practiced in the county because of the low yields of most wells and high sodium content of most of the ground water.

The value of mineral products in the county doubled from 1954 to 1961 and continues to increase because of the increased production of cement. Stone, silica sand, and gravel are commercially abundant.

Previous Investigations

Prior to this investigation, little detailed study had been made of the ground-water resources of Johnson 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, Broadhurst, and Dwyer (1947) included in their inventory of the public water supplies in central and north-central Texas the records of public-supply wells, well logs, chemical analyses of water samples, and estimates of water consumption and storage capacity for the principal municipalities in the county. Northeastern Johnson County is included in a ground-water reconnaissance investigation of the Trinity River basin by Peckham and others (1963), and southwestern Johnson County is in the ground-water reconnaissance of the Brazos River basin by Cronin and others (1963).

Several reports on regional geology in eastern and northern Texas describe the geologic formations in areas in the vicinity of Johnson County. The following reports describe the geology and ground-water resources of counties in the general area: Baker (1960), Grayson County; Dallas Geological Society (1965), Dallas County; Hendricks (1957), Parker County; Holloway (1961), McLennan County; Leggat (1957), Tarrant County; Scott (1930), Parker County; Shuler (1918), Dallas County; Stramel (1951), Parker County; Thompson (1967), Ellis County; and Winton and Scott (1922), Johnson County.

Well-Numbering System

The well-numbering system used in this report is based on the divisions of latitude and longitude and is the one adopted by the Texas Water Development Board for use throughout the State (Figure 2). 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 of the well number. Each 1-degree quadrangle is divided into 7½-minute quadrangles which are given 2-digit numbers from 01 to 64. These are the third and fourth digits of the well number. Each 7½-minute quadrangle is subdivided into 2½-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 2½-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 Johnson County is PX. Thus, well PX-32-45-601 (which supplies water for the city of Cleburne) is in Johnson County (PX), in the 1-degree quadrangle 32, in the 7½-minute quadrangle 45, in the 2½-minute quadrangle 6, and was the first well (01) inventoried in that 2½-minute quadrangle.

The letter prefixes for the counties near Johnson County are: Dallas County, HR; Hill County, LW; Ellis County, JK; Navarro County, TY; Tarrant County, XU; Bosque County, BB; Somervell County, XJ; Hood County, LY; and Parker County, UP.

All of Johnson County falls within the 1-degree quadrangle 32. On the well location map of this report (Figure 15), the 7½-minute quadrangles are numbered in their northwest corners. The 3-digit number shown with the well symbol contains the number of the 2½-minute quadrangle in which the well is located and the number of the well within that quadrangle.

Acknowledgments

The author is indebted to the property owners in Johnson 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 the city officials and officials of the water districts who supplied pumpage data and cooperated in pumping tests on their wells. The cooperation of federal and state agencies greatly facilitated completion of the project and the report.

Appreciation is expressed to J. L. Myers' Sons and Layne-Texas Co., Inc., Dallas, Texas, for providing information on public-supply and domestic wells; and to C. M. Stoner Drilling Co. and C. G. Wallen, 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 Johnson 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 with the exception of the alluvium which is Quaternary in age. The areal geology of Johnson County is shown in Figure 3.

The thicknesses, lithologic characteristics, age, and water-bearing properties of the formations are summarized in Table 2. The maximum thicknesses of the geologic units given in this table were determined from interpretations of electrical and drillers' logs.

About 2,000 feet of limestone, shale, siltstone, sandstone, some anhydrite, and the alluvium in local areas constitute the geologic section that contains the aquifers.

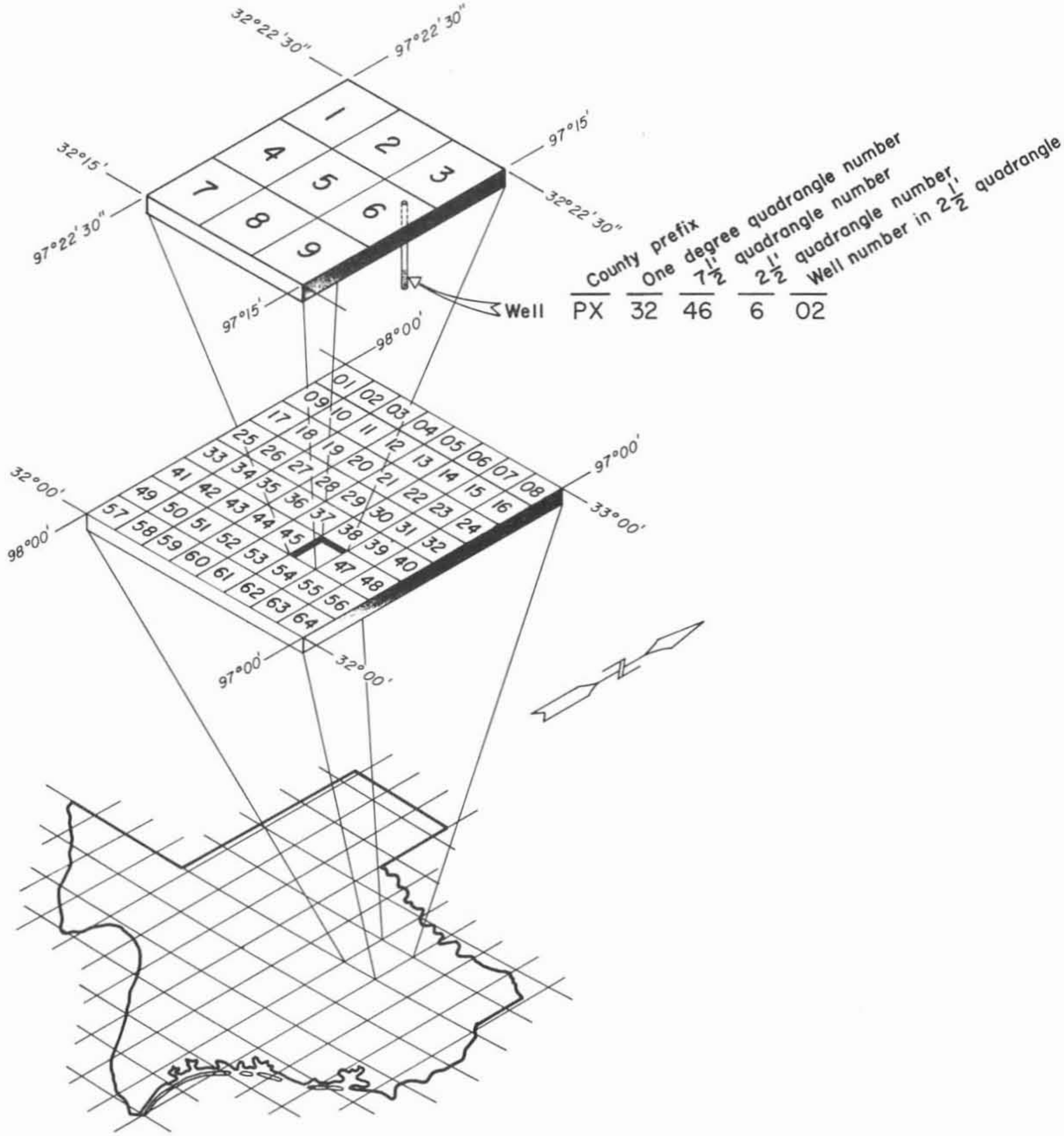

Figure 2
Well-Numbering System

The Cretaceous rocks unconformably overlie older, westward-dipping, highly indurated sediments of Pennsylvanian age that are probably part of the Strawn Group (Leggat, 1957, p. 15).

All formations of Cretaceous age generally trend or strike north-northeastward and dip gently east-southeastward about 25 to 55 feet per mile. The angle of dip gradually increases with increased depth.

Faults do not greatly affect the water-bearing characteristics of the aquifers in Johnson County. Reaser (1961, p. 1759-1762) reported that the nearest surface faults are in central and northeastern Ellis County and are part of the Balcones system.

Physical Characteristics and Water-Bearing Properties of the Geologic Units

Pre-Cretaceous Rocks

The pre-Cretaceous rocks in Johnson County (Figure 4) are highly indurated impermeable sediments, chiefly shale, quartzite, and sandstone of Pennsylvanian age. No known wells obtain water from any part of the pre-Cretaceous rocks in Johnson County, although Stramel (1951, p. 5-6) and Hendricks (1957, p. 59) report some water wells are on or near the Pennsylvanian outcrop in Parker County.

Cretaceous System

Hosston Formation

The oldest 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 Arkansa. Imlay (1945) included all rocks of the Cretaceous System older than the Trinity Group in the Nuevo León and Durango Groups in the Mexico-Texas region. The rock equivalents of the Nuevo León and Durango Groups in Texas underlie the Trinity Group as a subsurface sandstone wedge that extends from southern Arkansas and Louisiana into east Texas.

The lowest and most important water-bearing formation in Johnson County is the Hosston Formation (Table 2), or its stratigraphic equivalent, as identified in McLennan County by Holloway (1961) and in Limestone County by Imlay (1944).

The Hosston in Johnson County underlies the lowest part of the Travis Peak Formation and is a recognizably distinctive water-bearing unit. In Johnson, Ellis, and Dallas Counties, drillers refer to the Hosston as the Trinity Sand or the second Trinity.

In Tarrant County, Leggat (1957) did not recognize the Hosston Formation and arbitrarily assigned the sediments between the lowest limestone in the Trinity Group and the Pennsylvanian rocks to the Travis Peak Formation. In the Brazos River basin, Cronin and others (1963) and in the Trinity River basin, Peckham and others (1963) also included the sediments equivalent to the Hosston Formation, if any, in the Travis Peak. The Hosston Formation, as used in this report, includes the lower part of the Travis Peak Formation of Tarrant County (Leggat, 1957), of the Trinity River basin (Peckham and others, 1963), and of the Brazos River basin (Cronin and others, 1963).

The Hosston Formation, as defined by Imlay (1945), does not crop out in Johnson County or in central and northeastern Texas, but forms an eastward-thickening subsurface wedge of predominantly clastic rocks underlying the Trinity Group or Sligo Formation. The top of the Hosston ranges in depth from less than 1,000 feet (Figure 5) in the western part of Johnson County to more than 1,700 feet in the eastern part. The dip ranges from 30 feet per mile in the western part of the coutny to about 55 feet per mile in the eastern part.

Drillers' logs of several 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, calcareous silty shale, and limestone. The complete thickness of the Hosston Formation in Johnson County, as determined from electrical logs, ranges from about 50 feet in oil test PX-32-37-402 in the northwestern part of the county to about 145 feet in the southeast. The formation averages more than 120 feet in thickness in the eastern part of the county.

Several wells supplying independent water districts tap the Hosston. Some of these wells could produce as much as 350 gpm (gallons per minute) using 8- to 10-inch diameter screens 150 feet in length.

Trinity Group

The Trinity Group includes from oldest to youngest: the Travis Peak Formation, the Glen Rose Limestone, and the Paluxy Sand. This group attains a maximum composite thickness of at least 870 feet in Johnson County (Table 2). The group, in general, thickens eastward downdip.

Limestone, shale, and sandy shale predominate in the Trinity Group in Johnson County. The Paluxy Sand and sandstone beds in the Travis Peak Formation are the aquifers of the group. The percentage of sand in both the Paluxy and the Travis Peak decreases downdip.

Table 2.--Lithologic Characteristics and Water-Bearing Properties of the Geologic Units

SYSTEM	SERIES	GROUP	GEOLOGIC UNIT	MAXIMUM THICKNESS (FEET)	LITHOLOGICAL CHARACTER OF UNITS	WATER-BEARING PROPERTIES
Quaternary	Holocene and Pleistocene		Alluvial deposits	30±	Sand, gravel, clay, and silt.	Yields small quantities of water to shallow wells, and is considered a minor potential source of fresh water for livestock and for possible limited areal irrigation.
Cretaceous	Gulf		Eagle Ford Shale	115±	Bluish-black shale containing thin beds of sandstone and limestone.	Yields only very small quantities of water to shallow wells, and is not considered a source of fresh to slightly saline water in Johnson County.
			Woodbine Formation	230	Thin- to massive-bedded sandstone interbedded with varying amounts of shale and sandy shale. Upper part of formation contains lignite, gypsum, and nodules of alunite.	A principal aquifer in eastern third of Johnson County. Water from upper part of formation is more mineralized than water from lower part. Formation supplies nearly one-fifth of ground water used in county. Wells yield small to moderate supplies of water for public supply, industry, domestic, and livestock use. Suitable quality from less than 250-foot depth for minor irrigation.
		(unconformity)				
	Comanche	Washita (undifferentiated)		329	Limestone, shale, and sandy to calcareous shale.	Except for a few shallow dug wells, group is not a source of ground water in Johnson County.
		Fredericksburg (undifferentiated)		277	Limestone, shale, and calcareous silty to sandy shale; some shell agglomerate.	Do.
		Trinity	Paluxy Sand	146	Fine-grained, homogeneous, poorly consolidated sandstone containing varying amounts of clay, sandy clay, shale, lignite, and nodules of pyrite.	A principal aquifer in Johnson County. Yields small to moderate quantities of fresh to slightly saline water for public supply, industry, domestic, and livestock use. Supplies about 56 percent of ground water pumped in county.
			Glen Rose Limestone	470	Medium- to thick-bedded limestone interbedded with some sandstone, sandy shale, shale, and anhydrite.	Not a source of ground water in Johnson County.

(Continued on next page)

Table 2.--Lithologic Characteristics and Water-Bearing Properties of the Geologic Units--Continued

SYSTEM	SERIES	GROUP	GEOLOGIC UNIT	MAXIMUM THICKNESS (FEET)	LITHOLOGICAL CHARACTER OF UNITS	WATER-BEARING PROPERTIES
	Comanche	Trinity	Travis Peak Formation	255	Coarse- to fine-grained sandstone in upper and lower parts, and interbeds of sandstone, shale, and minor limestone in the middle part. Shale beds increase in middle part downdip.	Yields small to moderate quantities of fresh to slightly saline water for public supply, industrial, and some domestic and livestock use.
	Coahuila		Hosston Formation (Major unconformity)	145	Moderately massive, coarse- to fine- fine-grained sandstone containing sparse interbeds of siltstone, sandy sandy shale, varigated red and green shale, calcareous silty shale shale, and thin limestone.	Yields up to 200 gpm for public supply and industrial.use.
Pre-Cretaceous				?	Shale, quartzite, limestone, and indurated sandstone.	No wells have tested these rocks, but they are not a likely source of ground water.

Travis Peak Formation

The Travis Peak Formation, which crops out west of Johnson County, 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. Only the Sycamore and Hensell Members are present in Johnson and Tarrant Counties, but electrical logs of wells in Ellis County indicate that the Cow Creek Limestone Member occurs there in addition to the upper and lower sandstone units. The Travis Peak Formation, as used in this report, includes the rocks above the massive sandstone of the Hosston and below the lowest massive limestone of the overlying Glen Rose.

Generally, the Travis Peak consists of coarse- to fine-grained sandstone in the upper and lower parts and interbeds of sandstone, shale, and some limestone in the middle part. However, the limestone in the middle part of the Travis Peak is found only locally in the eastern part of Johnson County.

The thickness of the Travis Peak Formation increases eastward, ranging from 182 feet in well PX-32-52-202 to a maximum of 255 feet in well PX-32-40-701. The average thickness in the county is about 225 feet. The depth to the top of the formation also increases eastward, ranging from more than 500 feet in well PX-32-52-901 to 1,480 feet in well PX-32-40-701. The dip of the Travis Peak is eastward and ranges from about 30 feet per mile in the western part of the county to 50 feet per mile in the eastern part (Figure 6).

Only a few public-supply wells in the county are known to obtain water from the Travis Peak. Small to moderate supplies of water are available, but the chemical quality is probably slightly inferior to that of water from the Hosston Formation.

Glen Rose Limestone

The Glen Rose Limestone crops out in the valley of the Brazos River in the extreme west-central part of Johnson County (Figure 3). Generally, it occurs at depths ranging from less than 520 feet below land surface in the western part of the county to at least 925 feet in test well LW-32-47-902 in Hill County.

The Glen Rose consists primarily of medium- to thick-bedded limestone, but contains some sandstone, sandy shale, shale, and anhydrite. Because the top of the formation is gradational with the overlying Paluxy Sand, the contact between these two formations is arbitrarily picked on some electrical logs. The uppermost part of the Glen Rose contains more sand and clay than the lower part.

The Glen Rose Limestone thickens eastward in Johnson County. A complete section of the formation ranges in thickness from 260 feet in well PX-32-37-402 to at least 470 feet in well PX-32-40-701, averaging about 400 feet in the county.

Interpretation of electrical logs indicates that the Glen Rose is not a source of fresh or slightly saline water in the county, and local drillers report that they have encountered only highly mineralized water in the formation.

Paluxy Sand

The Paluxy Sand crops out along the Brazos River in the extreme west-central and southwestern parts of the county as shown in Figure 3 (Winton and Scott, 1922, p. 19). The top of the Paluxy (Figure 7) ranges from the land surface to a depth of 878 feet in oil test PX-32-40-701.

The formation consists predominantly of fine-grained, poorly consolidated sandstone with varying amounts of clay, sandy clay, shale, lignite, and pyrite nodules.

The thickness of the Paluxy Sand is irregular, but it generally thickens northward, ranging from 80 feet in well PX-32-54-101 in the south to 146 feet in oil test PX-32-37-402 in the north-northwest part of the county; the average thickness is about 120 feet of which about 50 percent is sand. The formation dips eastward at about 30 to 35 feet per mile.

Most domestic and livestock wells in Johnson County tap the water-bearing sandstone of the Paluxy. These wells yield small to moderate quantities of fresh to slightly saline water.

Fredericksburg Group

The Fredericksburg Group, which crops out mainly in the west-central and southwestern parts of Johnson County (Figure 3), includes, from oldest to youngest: the Walnut Clay, the Goodland Limestone, and the Kiamichi Formation. The rocks of this group are mainly shale; calcareous, silty, and sandy shale; and limestone.

The thickness of the group ranges from 222 feet in well PX-32-30-501 in the north-central part of the county to 277 feet in well PX-32-47-802 in the southeastern part, averaging about 240 feet.

The Walnut Clay, referred to as a fossil lime or caprock by local drillers, consists mainly of a characteristic shell agglomerate composed mostly of the fossils

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 typically consists of chalky, thin- to massive-bedded, fossiliferous limestone, and blue to yellowish-brown calcareous shale and siltstone. It is equivalent to the Comanche Peak and Edwards Limestone of central Texas.

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

The Fredericksburg Group is not a source of ground water in Johnson County, except for a few shallow dug wells (not inventoried during this investigation) that yield small quantities of fresh water for domestic and livestock uses.

Washita Group

The Washita Group, which crops out in most of the western half of Johnson County (Figure 3), 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 Main Street Limestone, and the Grayson Shale. These formations constitute a sequence of interbedded limestone, shale, and sandy to calcareous shale.

The complete thickness of the Washita Group ranges from 278 feet in oil test PX-32-47-603 to 329 feet in test PX-32-40-701 and averages about 300 feet. The group thickens generally eastward and dips eastward about 40 feet per mile.

Except for a few shallow dug wells (not inventoried), the Washita Group is not a source of ground water in Johnson County.

Upper Cretaceous Rocks

Upper Cretaceous rocks in Johnson County, from oldest to youngest, are the Woodbine Formation and the Eagle Ford Shale. These strata attain a maximum composite thickness of at least 345 feet in the county (Table 2).

Woodbine Formation

The Woodbine Formation crops out in much of the eastern half of Johnson County (Figure 3). It is not formally separated into members, although the upper sandy part is distinguished from the lower part because of the distinctive difference in the quality of the water. The water in the upper part contains a larger amount of dissolved solids than in the lower part. The top of the Woodbine is picked at the top of the highest prominent water-bearing sandstone on the electrical logs (Figures 16 and 17). The top of the lower Woodbine section is picked arbitrarily at the base of the thickest shale that underlies the uppermost sandstone strata in the formation.

The Woodbine Formation dips to the east-southeast at about 25 feet per mile in the southeastern part of the county and about 30 feet per mile in the eastern part. The top of the formation ranges from the land surface to a depth of 93 feet in well PX-32-48-703 in the southeastern part of the county.

The Woodbine consists predominantly of thin- to massive-bedded sandstone and varying amounts of interbedded shale and sandy shale. The sandstone is usually thicker in the lower part of the formation than in the upper part. Sand bodies within the Woodbine are irregular and discontinuous, and correlation of individual beds is difficult. However, parts of the Woodbine have similar electrical characteristics that are recognizable on electrical logs and can be traced across the county. Everywhere within Johnson County the Woodbine lies unconformably upon the truncated rocks of the Washita Group.

The upper part of the Woodbine contains much sandy clay interstratified with beds of lignite. Gypsum and alunite nodules, which contribute to the high mineral content of the ground water, are common in the uppermost part of this unit.

A complete section of the Woodbine ranges in thickness from about 140 feet in public-supply well PX-32-47-802 to 230 feet in test hole PX-32-40-701. The formation thickens east-northeastward about 8.5 feet per mile. The average total thickness of the Woodbine in Johnson County is about 185 feet.

The Woodbine Formation is not as deep in eastern Johnson County as the other principal water-bearing formations. Consequently, a water well in the Woodbine in this area is the least expensive for property owners who need only small to moderate supplies of water. Most of the wells drilled into the Woodbine since 1955 usually obtain water from the lower part of the formation because the upper part contains highly mineralized water.

The lower Woodbine is an important source of ground water for domestic use, livestock, and public supply in the eastern third of the county. The iron content of the water is high in many updip wells, and the sodium content increases relative to an increase in depth of the water-producing section. Most wells in the lower Woodbine that yield water from depths less than 250 feet can be used for irrigation of lawns and small garden plots.

Eagle Ford Shale

Strata of the Eagle Ford Shale, most of which are not water bearing, crop out in an irregularly shaped area in eastern Johnson County (Figure 3). The Eagle Ford Shale is a fossiliferous, bluish-black shale containing thin beds of sandstone and limestone. The maximum observed thickness in Johnson County is about 115 feet at the Ellis County line east of well PX-32-48-702. Minor sand beds in the Eagle Ford Shale are a source of small quantities of bitter (gypsum) water to shallow dug wells.

Quaternary Alluvial Deposits

Alluvial deposits of Quaternary age veneer the Cretaceous strata in Johnson County along the principal stream channels and on some upland divides (not shown in Figure 3). The alluvial deposits on the divides are thin and not a source of ground water.

The alluvial deposits along the stream channels consist of a mixture of gravel, sand, silt, and clay that may be as much as 30 feet thick. Generally, the coarsest material occurs at the base. These deposits may be as much as 1 mile in width along the lower reaches of the principal streams in Johnson County and in a local area west of the Brazos River at De Cordova Bend.

The floodplain alluvial deposits along the principal streams can yield small supplies of fresh ground water suitable for domestic, livestock, and irrigation uses. Wells should penetrate the entire thickness of the deposits and screen mainly the lower half for the greatest yield. The quality of the water varies locally, but the water is suitable for sustained irrigation.

GROUND-WATER HYDROLOGY

Source and Occurrence of Ground Water

The primary source of ground water in Johnson County is the infiltration of precipitation, either directly in the outcrop areas or indirectly as seepage of streamflow. 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. 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 in the rocks 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 areas of the formations and in the alluvial deposits generally is unconfined and 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 is under artesian conditions. The pressure is nearly equal to the weight of a column of water extending upward to the altitude of the water table in the area of outcrop of the aquifer. Where the altitude of the land surface at the well 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 to an altitude substantially above the top of the aquifer—possibly high enough for the well to flow.

Before 1930, the hydrostatic pressure in the Hosston Formation, Travis Peak Formation, and Paluxy Sand was great enough for many wells tapping these aquifers to flow.

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

Recharge, Movement, and Discharge of Ground Water

The recharge of ground water to the aquifers in Johnson County is chiefly from precipitation on the outcrops of the aquifers in and west of the county. The average annual precipitation ranges from about 30 inches per year west of Johnson County to about 33 inches in the northeastern part of the county. Only a small percentage of this precipitation becomes recharge. The quantity of recharge to the aquifers in Johnson County 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 Paluxy Sand shows the altitude of water levels in wells tapping that aquifer. The map shows that the water moves generally eastward into the county, but east of Cleburne, water movement is northeastward. The hydraulic gradient ranges from 11 to 40 feet per mile and averages about 20 feet per mile. The velocity of movement in the Paluxy Sand is about 10 to 40 feet per year.

The piezometric map (Figure 9) for the Woodbine indicates that the water in this formation moves eastward at an average gradient of 20 feet per mile with only moderate variations. Data are not sufficient for the preparation of a piezometric map for the Hosston and Travis Peak Formations; however, the few data available indicate that the movement of water in both formations is generally northeastward toward the Fort Worth-Dallas area of large withdrawals.

Water in the subsurface moves in response to differences in hydrostatic pressure within an aquifer, but it may move vertically from one aquifer to another through overlying semiconfining beds or along fault planes. Ground water may ultimately move from the deeper formations to shallower, more permeable rocks.

Fresh to slightly saline water in the aquifers in Johnson 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, and evaporation from the soil. Most of the ground water in the county moves through the aquifers into adjoining areas to the east and northeast where there may be heavy withdrawals.

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 to 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. Consequently, 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, therby 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 14 wells in Johnson County although only 9 yielded information on the hydraulic properties of the aquifers. The tests were made in wells that tapped the Hosston Formation at Rio Vista; the Paluxy Sand at Burleson; the Woodbine Formation at Grandview; the combined Travis Peak and Hosston Formations at Cleburne; and the combined Paluxy Sand, Travis Peak, and Hosston Formations at Alvarado (Table 3).

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 Johnson County, the local tests were supplemented by data from tests in adjacent counties.

The results of an aquifer test made in well PX-32-54-101, which screens 108 feet of the Hosston Formation at Rio Vista, indicated a coefficient of transmissibility of 3,100 gpd (gallons per day) per foot. On the basis of the 108 feet of sand screens in the well, the coefficient of permeability is about 29 gpd per square foot, which is considerably less than the average of 65 gpd per square foot estimated for the Hosston in Ellis County. A comparison of the electrical and drillers' logs in the two counties indicates that the average coefficient of permeability for the Hosston in Johnson County probably is on the order of 35 gpd per square foot. If the thickness of sand in the Hosston in Johnson County averages about 75 feet, the average coefficient of transmissibility would amount to 2,600 gpd per foot. The coefficient of storage for the Hosston Formation could not be determined from the aquifer test but it probably is similar to that determined for the Hosston in Ellis County—about 0.00008 (Thompson, 1967, p. 33). The specific capacities determined from tests of two wells in the Hosston in Johnson County ranged from 0.6 to 1.8 gpm per foot, averaging about 1.2 gpm per foot (Table 3).

No aquifer tests were made in wells tapping only the Travis Peak Formation, but four wells, PX-32-37-901, PX-32-45-302, PX-32-45-304, and PX-32-45-601 that screened both the Travis Peak and Hosston Formations were tested. One public-supply well, PX-32-39-702, that was screened in the Paluxy, the Travis Peak, and the Hosston was tested in Alvarado.

Table 3.-Results of Aquifer Tests

WELL	WATER-BEARING UNIT(S)	DATE OF TEST	PUMPING RATE (GPM)	COEFFICIENT OF TRANSMISSIBILITY (GPD/FT)	SPECIFIC CAPACITY (GPM/FT)	REMARKS
PX-32-47-806 and PX-32-47-803	Woodbine Formation	Nov. 16, 1966	47	1,600 and 1,100	1.03	Coefficient of storage: 0.00007. Adjusted recovery in pumped well. Adjusted interference test.
PX-32-30-502	Paluxy Sand	May 10, 1960	134	2,400	1.4	Test by H. C. Millican, drawdown in pumped well.
PX-32-36-501	do	Sept. 11, 1942	55	--	1.0	Test by Wiegand Bros., drawdown in pumped well.
PX-32-37-311	do	Nov. 27, 1961	98	--	1.3	Test by J. L. Meyers.
PX-32-47-802	do	Mar. 24, 1955	84	--	1.7	Test by C. M. Stoner, drawdown in pumped well.
PX-32-36-501	Travis Peak and Hosston Formations	Sept. 29, 1942	133	--	2.0	Test by Wiegand Bros., drawdown in pumped well.
PX-32-37-901	do	Apr. 21, 1958	423	4,600	1.7	Test by Layne Texas Co., drawdown in pumped well.
PX-32-45-302	do	Feb. 19, 1945	472	4,300	2.6	Test by Layne Texas Co., residual recovery in pumped well.
PX-32-45-304	do	Jan. 25, 1938	464 and 416	2,500	1.9	Test by Layne Texas Co., drawdown in pumped well. Other wells probably pumping.
PX-32-45-601	do	Apr. 12, 1955	560	7,700	2.8	Test by Layne Texas Co., drawdown in pumped well.
PX-32-38-901	Hosston Formation	Oct. 5, 1964	100	--	.57	Test by J. L. Myers.
PX-32-54-101	do	Dec. 6, 1966	168	3,100	1.8	Average of adjusted recovery and drawdown in pumped well.
PX-32-39-702	Paluxy Sand, Travis Peak, and Hosston Formations	May 4, 1947	296	4,900	2.8	Test by Layne Texas Co. Perforated a total of 190 feet. Average of drawdown and recovery in pumped well.

Except in well PX-32-45-601 at Cleburne, the coefficients of the Travis Peak and the Hosston averaged only a little higher than the values determined for the Hosston Formation in the aquifer test in well PX-32-54-101 at Rio Vista (Table 3). At Cleburne, public-supply well PX-32-45-601, the Travis Peak and Hosston together had a coefficient of transmissibility of about 7,700 gpd per foot and an average permeability of 42 gpd per square foot for a total saturated-sand section of 184 feet out of a 250-foot screened interval.

Of the 184 feet of sand, 65 feet is in the Hosston and 119 feet is in the Travis Peak. Assuming that the average coefficient of permeability of the Hosston in the county is 35 gpd per square foot, the calculated coefficient of transmissibility of the Hosston at this site is about 2,300 gpd per foot. On this basis, the Travis Peak at this site has a coefficient of transmissibility of about 5,400 gpd per foot and an average coefficient of permeability of 45 gpd per square foot.

The average saturated sand thickness of the Travis Peak is 88 feet in Johnson County. If the thickness is applied to an average permeability of 45 gpd per square foot, the estimated coefficient of transmissibility is about 4,000 gpd per foot. The coefficient of storage is assumed to average 0.0001.

The Hosston and Travis Peak Formations are separate aquifers in Johnson County, but are considered together to obtain the effects of pumpage from both aquifers tapped by the same well.

The time-distance-drawdown curves for the Hosston and Travis Peak Formations (Figure 10) show that the assumed average coefficient of transmissibility is 5,000 gpd per foot, and the average combined saturated sand thickness for both formations is about 160 feet. On this basis, the drawdown curves show that a well pumping continuously at the rate of 100 gpm for 1 year theoretically will lower the water level about 20 feet in other Hosston and Travis Peak wells 1,000 feet from the pumped well and about 9 feet at a distance of 10,000 feet. At the same pumping rate and distances, the water levels would be lowered about 25 feet and about 14 feet, respectively, after 10 years.

An aquifer test on the Paluxy Sand was made in public-supply well PX-32-30-502 at Burleson. The results of the test indicate that the coefficient of transmissibility at this site is about 2,400 gpd per foot. The saturated sand thickness in the well is about 85 feet, which is greater than the 65-foot average for the Paluxy in Johnson County; therefore, the average coefficient of transmissibility in the county is estimated to be about

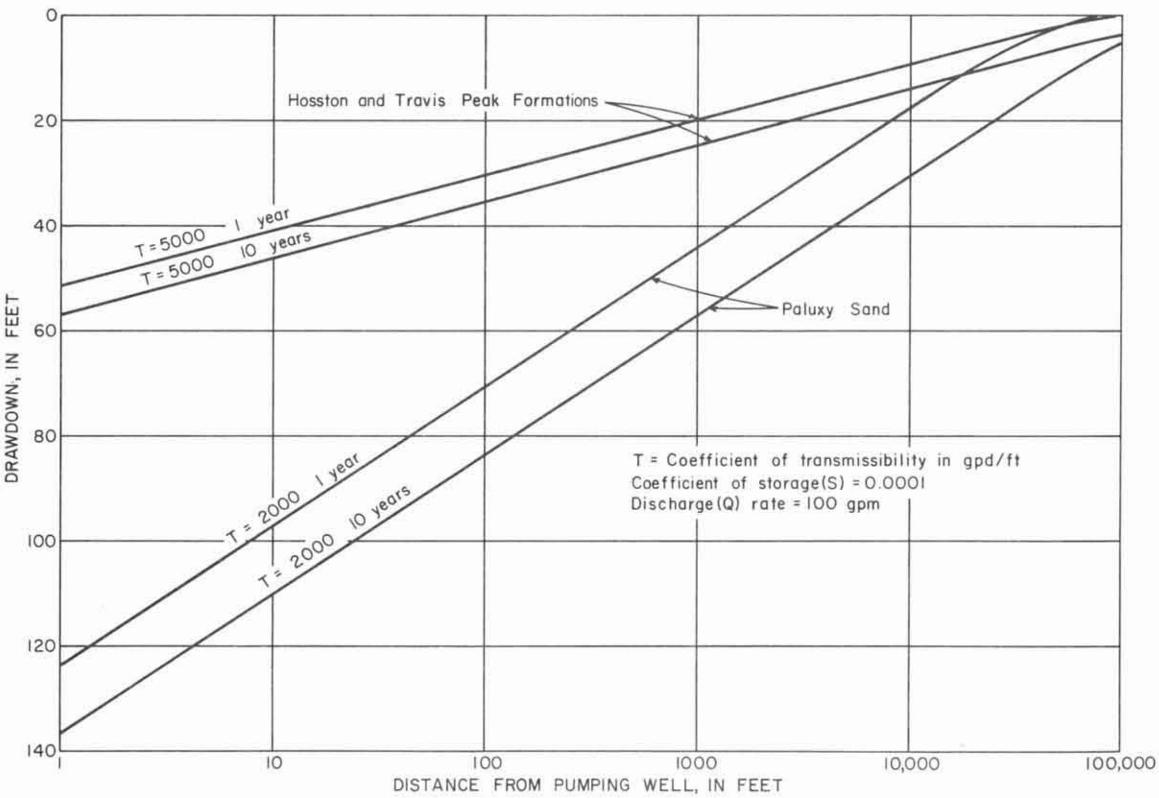

Figure 10.—Relation of Drawdown to Distance and Time in Pumped Aquifers

2,000 gpd per foot. The average coefficient of permeability is about 30 gpd per square foot. The coefficient of storage was not determined in the test at Burleson, 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 Johnson County. The specific capacity of the tested wells in Johnson County ranged from 1 to 1.7 gpm per foot and averaged 1.4 gpm per foot.

The time-distance-drawdown curves (Figure 10) for the Paluxy Sand under artesian conditions show the theoretical effects of pumping on the water levels in the aquifer.

Aquifer tests were made in wells tapping the Woodbine Formation in public-supply well PX-32-47-806 and observation well PX-32-47-803 at Grandview. The coefficients of transmissibility from a recovery test and an interference test averaged about 1,400 gpd per foot (Table 3). The coefficient of permeability from these wells was 56 gpd per square foot. The coefficient of storage from these tests was 7 x 10^{-5} (0.00007). No aquifer tests were conducted in the outcrop area where water-table conditions prevail.

The thickness of the saturated sand in the complete Woodbine Formation in Johnson County averages about 88 feet (135 feet in Ellis County). Based on this thickness and assuming an average permeability of 45 gpd per square foot for the county, the average coefficient of transmissibility for the Woodbine in the county is about 4,000 gpd per foot. This compares to 9,250 gpd per foot in Ellis County where the aquifer is thicker and more permeable.

Artesian aquifer characteristics in the Woodbine Formation (average coefficient of transmissibility is about 4,000 gpd per foot) are similar to those shown for the average of the combined Travis Peak and Hosston Formations (5,000 gpd per foot). Drawdowns in wells in the Woodbine would be greater than those shown in Figure 10 for the Travis Peak and Hosston combined. The outcrop of the Woodbine is closer to the wells in Johnson County than the outcrop of the Travis Peak; therefore, after long intervals of continuous pumping from wells in the Woodbine Formation, water levels will stabilize sooner than in wells tapping the Travis Peak and Hosston Formations.

Use and Development of Ground Water

About 3.2 mgd (million gallons per day), or 3,600 acre-feet annually, of ground water was used in Johnson County during 1966 for public supply, industry, rural domestic needs, and livestock (Table 4). 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 uses in central Johnson County.

Records of 308 wells, springs, and test holes were obtained in Johnson 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.

Table 4.—Use of Ground Water From the Principal Aquifers in Johnson County in 1966

AQUIFER	PUBLIC SUPPLY		INDUSTRIAL		RURAL DOMESTIC		LIVESTOCK		TOTALS 3/	
	MGD 1/	AC-FT 2/	MGD	AC-FT	MGD	AC-FT	MGD	AC-FT	MGD	AC-FT
Woodbine Formation	0.10	113	0	0	0.26	297	0.24	270	0.60	680
Paluxy Sand	.44	489	.04	50.00	.70	781	.63	710	1.80	2,000
Travis Peak Formation	.28	318	--	.46	.02	22	.02	20	.32	360
Hosston Formation	.39	440	.13	140	0	0	0	0	.52	580
Totals 3/	1.20	1,400	0.17	190	0.98	1,100	0.89	1,000	3.2	3,600

1/ mgd—million gallons per day.

2/ ac-ft—acre-feet per year.

3/ Figures are rounded to two significant figures because some pumpage was estimated.

Of the 3,600 acre-feet of ground water pumped for all uses in Johnson County in 1966, about 2,000 acre-feet or 55.7 percent came from the Paluxy Sand, about 680 acre-feet or 18.6 percent came from the Woodbine Formation, about 580 acre-feet or 16 percent came from the Hosston Formation, and about 360 acre-feet or 9.8 percent came from the Travis Peak Formation. An insignificant amount of water was pumped from the alluvium.

Public Supply

Ground water was used in 1966 for public supply in 15 municipalities or water districts in Johnson County, of which Burleson, Alvarado, Cleburne, and the Bethesda Water Supply Corporation used about 0.8 mgd (870 acre-feet), or about 62 percent. The pumpage of ground water for all public supply uses decreased from about 2.3 mgd (2,600 acre-feet) in 1955 to about 1.2 mgd (1,400 acre-feet) in 1966. The decrease in the use of ground water for public supply since 1955 resulted from the change from ground water to surface water by the city of Cleburne. Yearly fluctuations in precipitation also cause variations in local annual use. Five newly-formed rural cooperative public-supply systems began operation during 1965 and 1966, and much of the rural domestic ground water used in the county is now supplied by the cooperative systems.

Burleson is currently the largest user of ground water for public supply. During 1966, Burleson used a total of about 0.35 mgd (388 acre-feet), which is about 28 percent of all public supply used in the county that year, or about 10 percent of the total of all ground water used. The water is pumped from three wells in the Paluxy Sand at depths of about 580 feet, and one well in the Travis Peak Formation at a depth of 1,180 feet.

Alvarado is the second largest user of ground water for public supply. In 1966, Alvarado used a total of about 0.18 mgd (198 acre-feet), which is about 14 percent of all public supply used in the county that year, or about 5 percent of the total ground water used. Alvarado obtains its water from three wells: one tapping the Paluxy Sand at a maximum depth of about 860 feet; one tapping the Paluxy, Travis Peak, and Hosston Formations at a depth extending from about 760 feet to 1,630 feet; and one tapping the Hosston at a depth of 1,680 feet.

The city of Cleburne is the third largest user of ground water for public supply in the county. Before it changed to surface water in 1965, Cleburne used a total of about 1.9 mgd (2,168 acre-feet) in 1964, but it used only about 0.13 mgd (147 acre-feet) in 1966. Cleburne obtains its ground water from nine wells tapping both the Travis Peak Formation and the Hosston Formation at total depths of about 1,250 feet.

Bethesda Water Supply Corporation (rural supply district) is the fourth largest user of ground water for public supply. During 1966, Bethesda Corporation used a total of about 0.12 mgd (136 acre-feet), which is about 10 percent of all public supply used in the county that year, or about 4 percent of the total ground water used. The ground water was pumped from two wells that tap both the Travis Peak Formation and the Hosston Formation at total depths of about 1,330 feet in Johnson County and 1,500 feet in the southern-most edge of Tarrant County. Both wells supply water solely to Johnson County and arbitrarily are considered to pump from Johnson County.

Other water systems in Johnson County that used ground water for public supply in 1966 were: Keene and Southwestern Junior College, about 103,000 gpd from the Hosston and Paluxy; Grandview, about 89,000 gpd from the Woodbine and Paluxy; Johnson County Water Supply Corporation No. 2, about 81,000 gpd from the Hosston; Johnson County FWSD No. 1 at Joshua, about 51,000 gpd from the Paluxy; Rio Vista, about 25,000 gpd from the Hosston; Venus, about 22,000 gpd from the Woodbine; Godley, about 19,000 gpd from the Paluxy; Bethany Water Supply Corporation No. 1 near Alvarado, about 19,000 gpd from the Hosston; Parker Water Supply Corporation, about 18,000 gpd from the Hosston; Cresson (Hood County), about 9,000 gpd from the Travis Peak; and Nolands River Water Supply Corporation near Rio Vista, about 6,000 gpd from the Hosston Formation.

Industrial Use and Irrigation

Most of the water pumped for industrial use in Johnson County is provided by local public-supply systems. The three privately operated systems pumped about 190 acre-feet in 1966 (Table 4): the Texas Lime Company near the south edge of Cleburne; the Lone Star Gas Company at the east edge of Joshua; and the Gulf, Colorado, and Santa Fe Railroad in Cleburne. The Texas Lime Company operates two wells tapping the Hosston Formation and one tapping the Paluxy Sand. In 1966, it used about 0.15 mgd (172 acre-feet) of which about 80 percent came from the Hosston. The Lone Star Gas Company pumps two wells tapping the Paluxy and one seldom-used well tapping the Travis Peak. Lone Star Gas used about 0.01 mgd (16 acre-feet) in 1966. The Gulf, Colorado, and Santa Fe Railroad uses two wells tapping the Travis Peak that produced an estimated 0.46 acre-foot of ground water in 1966.

Ground water is not now used for irrigation in Johnson County, but the chemical analyses of water samples (Table 8) indicate that ground water can be used for irrigation from wells less than 250 feet deep in the Woodbine, and from wells 350 to 400 feet deep in the Paluxy. Low coefficients of transmissibility and permeability in the aquifers greatly limit the quantity of water available for irrigation. All water from the sand and gravel in the alluvial deposits is usable for irrigation, but the thin deposits limit the quantity available.

Rural Domestic and Livestock Use

The average annual quantity of ground water used for rural domestic needs in Johnson County since 1955 was determined by three factors: (1) the gradually increasing daily requirement of water per capita because of modernization of rural homes; (2) an increase in the number of rural supply systems; and (3) annual fluctuations in precipitation.

In 1955, the county rural population of about 9,157 used an estimated 0.45 mgd (510 acre-feet) of ground water. By 1966, the rural population of about 10,000 used an estimated 0.98 mgd (1,100 acre-feet) (Table 4); this is about 30 percent of the total ground water used in the county in 1966 for all needs.

The quantity of ground water used in 1966 for livestock was about 1,000 acre-feet (0.89 mgd). This is about 27 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 2,100 acre-feet, or about 57 percent, of all ground water used in the county in 1966. Of the domestic and livestock wells used, about 71 percent tapped the Paluxy Sand and 27 percent tapped the Woodbine Formation. The remaining 2 percent tapped the Travis Peak Formation.

Well Construction

Almost all the wells in Johnson County were completed after 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 20 percent of all water wells in Johnson County. The dug wells are mostly less than 50 feet in depth and range in diameter from 24 inches to 40 inches or more. The yields are small because the wells penetrate only a few feet of saturated material.

The few bored wells in the county are predominantly tile cased, range from 8 to 10 inches in diameter, and are from 40 to 130 feet deep. The yields of these wells are small because the water enters the wells only through the ends of the tile casings.

The drilled, predominantly metal-cased wells, range from 2 to 20 inches in diameter; 4-inch diameters are most common. Most of the larger yields are obtained 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 have 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 380 to 1,680 feet in depth. Figure 11 shows an example of well construction that is characteristic of many public-supply wells in the county. A few of the wells drilled for rural public-supply systems utilize a perforated casing opposite the water-bearing strata rather than a gravel-packed screen as shown in Figure 11. A well having perforated casing is considerably less efficient and more expensive to operate than a screened well. The well construction shown in Figure 11 eliminates or greatly reduces many problems and undesirable effects relating to dependability and yield of the well. Sand may be pumped with the water from a loose, very fine to fine sand aquifer. The sand reduces the effective life of most pumps, especially submergible pumps. A properly gravel-packed well will greatly reduce the sand intake and thus lengthen the life of the pump.

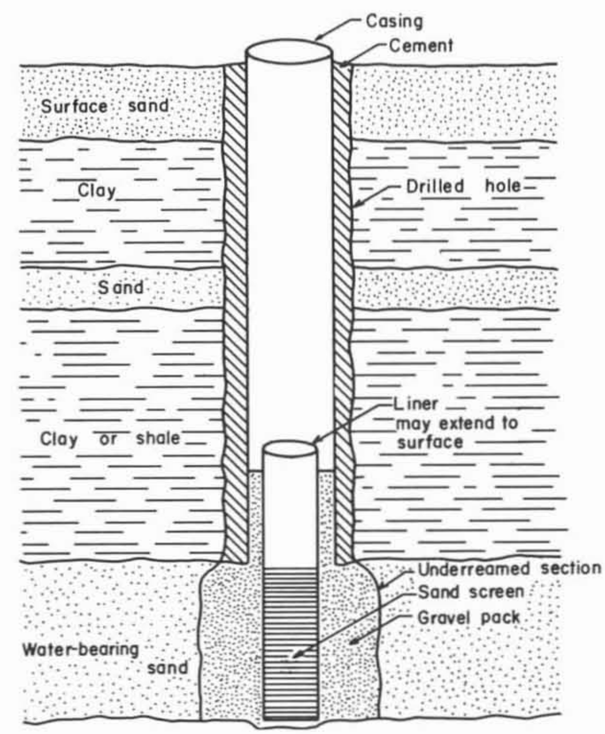

Figure 11.—Construction of a Typical Public-Supply Well

Changes in Water Levels

Water levels in wells continuously respond to natural and artificial influences that act upon 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 usually in or near the aquifer outcrop; the lowering may reflect lack of recharge during drought conditions or overpumping from the aquifer. Where artesian conditions prevail, a lowering of the static 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 Johnson County are not available, but information on long-term net changes of water levels is afforded by several wells (under artesian conditions) in the county. In well PX-32-53-401 tapping the Travis Peak Formation, water levels declined an average of 1 foot per year from 1930 to 1966. In well PX-32-30-803, tapping the Paluxy Sand, a net water level decline of 254 feet occured from 1915 to 1966, averaging about 4.5 feet per year until 1960 and 8.2 feet per year from 1960 to 1966. Water levels in wells tapping the Woodbine Formation fluctuated slightly, depending on pumping and annual recharge. The immediate causes of these declines in water levels are not clearly known because of the inadequate number of water-level measurements for each well. However, the declines undoubtedly were caused by pumping either in Johnson County or, more probably, in Tarrant County.

QUALITY OF GROUND WATER

The chemical constituents in the ground water in Johnson County (Figure 12) are derived principally from the most soluble materials 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 and the length of time in contact. Usually as the water moves deeper, its chemical content is increased. The source and significance of the dissolved-mineral constituents and other properties of ground water are summarized in Table 5, which is modified from Doll and others (1963, p. 37-43). The chemical analyses of water from 119 selected wells in Johnson County are given in Table 8. The depth of the well, dissolved solids, hardness, and source of water for samples from selected wells are shown on Figure 12.

Suitability of Water for Use

The suitability of a water supply depends upon the requirements of the contemplated use of the water. In addition to chemical quality, these requirements may include bacterial content, turbidity, color, odor, temperature, and radioactivity.

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 principal chemical standards adopted by the U.S. Public Health Service (1962, p. 7-8) are as follows:

COMMON CONSTITUENTS IN WATER

SUBSTANCE	CONCENTRATION MG/L †
Chloride (Cl)	250
Fluoride (F)	1.0*
Iron (Fe)	.3
Manganese (Mn)	.05
Nitrate (NO_3)	45
Sulfate (SO_4)	250
Dissolved solids	500

† mg/l (milligrams per liter) is considered equivalent to ppm (parts per million) for waters containing less than 7,000 mg/l dissolved solids.

* The permissible concentration of fluoride is based upon the annual average of maximum daily temperature of 79.0°F (measured at Cleburne for the period 1931-60).

Most ground water available in Johnson County meets the standards established by the Public Health Service, and the wells generally yield water that is suitable for most uses except sustained irrigation (Table 8).

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 mg/l used in this report (Table 5), is from Winslow and Kister (1956, p. 5).

Chemical Quality of Ground Water in the Geologic Units

The concentration of dissolved solids (Table 8) ranged from 302 mg/l in water from well PX-32-44-401 tapping the Paluxy Sand to 1,230 mg/l in well PX-32-47-804 tapping the Woodbine Formation. About 66 percent of the analyzed samples (Table 8) exceeded the 500 mg/l limit and about 8 percent exceeded 1,000 mg/l. At least 60 percent of the samples from the Hosston, Travis Peak, and Woodbine Formations

Table 5.—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 mg/l. High concentrations, as much as 100 mg/l, 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 mg/l stain laundry and utensils reddish-brown. Objectionable for food processing, textile processing, beverages, ice manufacture, brewing, and other processes. U.S. Public Health Service (1962) drinking water standards state that iron should not exceed 0.3 mg/l. 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. U.S. Public Health Service (1962) drinking water standards recommend that the sulfate content should not exceed 250 mg/l.
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. U.S. Public Health Service (1962) drinking water standards recommend that the chloride content should not exceed 250 mg/l.
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 consummed 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. U.S. Public Health Service (1962) drinking water standards suggest a limit of 45 mg/l. 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.

Table 5.—Source and Significance of Dissolved-Mineral Constituents and Properties of Water—Continued

CONSTITUENT OR PROPERTY	SOURCE OR CAUSE	SIGNIFICANCE
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 mg/l is permissible for irrigating sensitive crops; as much as 2.0 mg/l for semitolerant crops; and as much as 3.0 mg/l 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.	U.S. Public Health Service (1962) drinking water standards recommend that waters containing more than 500 mg/l 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 mg/l, is as follows (Winslow and Kister, 1956, p. 5): Waters containing less than 1,000 mg/l of dissolved solids are considered fresh; 1,000 to 3,000 mg/l, slightly saline; 3,000 to 10,000 mg/l, moderately saline; 10,000 to 35,000 mg/l, very saline; and more than 35,000 mg/l, 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 mg/l are considered soft; 61 to 120 mg/l, moderately hard; 121 to 180 mg/l, hard; more than 180 mg/l, 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 milliequivalents per liter (me/l) 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 milliequivalents per liter (me/l) 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, 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.

contained more than 500 mg/l. About 42 percent of the Paluxy samples exceeded 500 mg/l.

Sodium and bicarbonate are the most abundant ions in waters (Table 8) of all aquifers except the alluvium.

Sulfate concentration exceeded 250 mg/l in only 8 percent of all samples. The maximum was 916 mg/l in well PX-32-47-901 in the Woodbine Formation. Most of the waters with sulfate concentrations greater than 250 mg/l were from the Woodbine Formation.

The chloride concentration ranged from 5.8 to 251 mg/l. Chloride content in ground water in Johnson County is not a problem; it rarely exceeds 100 mg/l (Table 8).

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 Cleburne of 79°F from 1931-60, the optimum fluoride content in drinking water in Johnson County is 0.8 mg/l, and should not average more than 1.0 mg/l. Concentrations greater than 1.6 mg/l (twice the optimum) constitute grounds for rejection of a public-water supply by the Public Health Service.

Of the 79 fluoride determinations (Table 8), 29 percent exceeded 1.0 mg/l and 14 percent exceeded 1.6 mg/l. In water samples from the Paluxy Sand and Woodbine Formation, about 23 percent exceeded 1.0 mg/l. In water samples from the Travis Peak about half exceeded 1.0 mg/l and 12.5 percent exceeded 1.6 mg/l. The maximum fluoride concentration measured was 7.2 mg/l in the Grandview public-supply well PX-32-47-802 tapping the Paluxy Sand.

The upper limit for nitrate concentration, according to the Public Health Service, is 45 mg/l. The use of water containing nitrate in excess of 45 mg/l has been related to infant cyanosis or "blue baby" disease (Maxcy, 1950, p. 271). The presence of more than several milligrams per liter of nitrate in 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 84 samples analyzed (Table 8); 57 contained less than 1.0 mg/l. Well PX-32-47-803 (depth 214 feet) tapping the Woodbine contained the maximum of 9.0 mg/l.

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 shown in Table 5.

Of 136 determinations of hardness (Table 8), 33 exceeded 60 mg/l, and 20 exceeded 180 mg/l. Water from the Hosston and Travis Peak Formation was characteristicly soft; that from the Paluxy Sand was generally soft except near the outcrop where hardness increases. Sixty percent of the samples from the Woodbine were hard. One spring supplied by the alluvial deposits yielded fresh, very hard water that is suitable for most uses.

The chemical characteristics of water that are of particular importance to its use for irrigation are SAR (sodium adsorption ratio), RSC (residual sodium carbonate), and boron concentration. Table 8 shows that many values of SAR in Johnson County are above the upper limit of 14 (Wilcox, 1955) and the water is, therefore, usually not desirable for supplemental irrigation. Water produced from the alluvium and shallow parts of the Woodbine and Paluxy Sand 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 me/l (milliequivalents per liter) RSC is undesirable for irrigation and that water containing 1.25 to 2.5 me/l is marginal; water containing less than 1.25 me/l is probably safe. In 94 determinations, RSC exceeded 2.5 me/l in about 79 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 mg/l but for boron-tolerant crops it can be as much as 3.0 mg/l. Boron determinations were made for 13 samples in Johnson County (Table 8). The boron content ranged from 0.14 mg/l in well PX-32-45-308 tapping the Travis Peak Formation to 1.9 mg/l in well PX-32-47-802 tapping the Paluxy Sand.

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 Johnson and Ellis Counties, indicate that the temperature increases about 1.5°F for every 100 feet of increase in depth. The mean annual air temperature (about 66.5°F) approximates the temperature of the ground water near the land surface; therefore, the gradient of 1.5°F of per 100 feet can be applied to this base to determine the approximate temperature at any given depth.

AVAILABILITY OF GROUND WATER

The most favorable areas for development of ground water in Johnson County are where the thicknesses of saturated sand are greatest. Figure 13 shows the approximate thickness of sands containing fresh to slightly saline water in the Hosston and Travis Peak Formations. Figure 14 shows the approximate thickness of the sands containing fresh to slightly saline water in the Paluxy Sand.

Figure 13 shows (by contour lines) that the greatest thickness of saturated sands in the Hosston Formation is 121 feet near the town of Venus, in the northeastern part of the county. Assuming an efficiency of 70 percent, a properly constructed well in the Hosston could be expected to yield as much as 170 gpm with 250 feet of drawdown. Figure 13 also shows (by numbers) that the fresh to slightly saline water-bearing sand in the Travis Peak Formation is considerably more variable in thickness than in the Hosston. The greatest saturated thickness in the Travis Peak is in the central and eastern parts of the county where the thickness exceeds 100 feet in places. Yields of properly constructed wells in the Travis Peak could be expected to be as much as 180 gpm with 250 feet of drawdown, if the well efficiency is 70 percent.

A properly constructed well that taps the sands of both the Travis Peak and the Hosston Formations could be expected to yield as much as 320 gpm with 250 feet of drawdown, if the well efficiency is 70 percent. In this case, the average saturated thickness would be 160 feet and the average coefficient of transmissibility would be 5,000 gpd per foot.

Figure 14 shows the saturated thickness of fresh to slightly saline water-bearing sands in the Paluxy Sand. This figure shows that the greatest thickness of about 90 feet is in the northeastern corner of the county near the Tarrant County line and in Cleburne in the central part of the county. The figure also shows an area in the north-central part of the county in which the thickness is at least 70 feet. Assuming well efficiencies of 70 percent, yields of as much as 130 gpm with 250 feet of drawdown could be expected in properly constructed wells in the Paluxy.

Electric and drillers' logs indicate that the saturated sands of the Woodbine Formation thicken eastward from a thin edge about 2 miles east of Cleburne to a maximum thickness exceeding 100 feet along the Ellis County line. The thickness of the saturated sand averages about 88 feet. Assuming an efficiency of 70 percent, a properly constructed well in the Woodbine near the Ellis County line could be expected to yield as much as 250 gpm with 250 feet of drawdown.

The amount of water that can be pumped perennially in Johnson 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 originally moved through the aquifers. However, this method is useful only if the hydraulic gradient before development can be determined. Because 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 Johnson County have been affected by pumping within the county itself, and, undoubtedly, by pumping in the Fort Worth-Dallas area. The declines of water levels have increased both the hydraulic gradients and the quantities of water moving through the aquifers. Consequently, the original quantities of water transmitted are known to be less than at present.

Estimates of present transmission rates 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 present 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. Because data are not available to determine the undisturbed or original hydraulic gradient, computations can be made only of the quantities of water moving through the county under the present hydraulic gradients.

Data are not available to determine accurately the average hydraulic gradient in the Hosston and Travis Peak Formations in Johnson County; however, sparse control points indicate that the present gradient is about 8 feet per mile. Based on this gradient and an average coefficient of transmissibility of about 5,000 gpd per foot, the present amount of water moving through the county in the Hosston and Travis Peak combined is at least 1.0 mgd, or about 1,121 acre-feet per year. Because the gradient used in this calculation is more than the original hydraulic gradient, the actual recharge figure is probably somewhat less than 1.0 mgd.

The estimate of the quantity of water flowing through the county in the Paluxy Sand at present was based on the present hydraulic gradient of about 20 feet per mile and the average coefficient of transmissibility of about 2,000 gpd per foot. This amount is about 1.0 mgd, or 1,121 acre-feet per year. Water levels in the Paluxy are definitely declining and the present gradient is greater than the original gradient.

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 other aquifers. Based on the present hydraulic gradient of about 20 feet per mile and the coefficient of transmissibility of about 4,000 gpd per foot, the quantity of water now flowing through the Woodbine is about 1.84 mgd, or 2,063 acre-feet per year. About one-third of the water being transmitted through the aquifer is withdrawn by wells in Johnson County (Table

4), and two-thirds is withdrawn in Ellis County. Consequently, an increase in the amount of water pumped in Johnson County would result in a further lowering of the water levels with an accompanying increase in the hydraulic gradient. Even at the present hydraulic gradient of 20 feet per mile, the aquifer doubtlessly is transmitting slightly more water than is being recharged at least in the outcrop area of the aquifer in Johnson County.

Large quantities of water are in storage in all of the major aquifers in Johnson County. Most of this water occurs at great depths and under present economics of pumping, it would be impractical to pump all 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 throughout the eastern part of the county. Assuming a specific yield of 0.15, about 2,100,000 acre-feet of water is theoretically available to wells less than 400 feet deep. 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 may be as much as 15 to 20 gpm.

The quantity of water available for future development from the major aquifers in Johnson County depends to a large extent on the future development in neighboring counties, especially in Tarrant and Dallas Counties and the counties to the west of Johnson County. Because each county is only one part of a larger hydraulic unit, determinations of the availability of water actually 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.

On the basis of the available data, however, it seems apparent that some aquifers in the report area are probably transmitting water in excess of their rate of natural recharge. Consequently, any additional development of these aquifers will result in further lowering of the artesian head, and may cause a dewatering of the Paluxy Sand. Even a moderate increase in withdrawals of water in the relatively undeveloped areas in the county will ultimately have a measurable effect on the artesian head in the heavily pumped areas in the county.

RECOMMENDATIONS

A program should be established in the region for the collection of basic hydrologic data. The program should include periodic measurements of water levels in a network of observation wells for each of the aquifers, not only in the areas of development, but also in the areas of recharge. Records should be kept of the annual withdrawals of water from each aquifer, and a network of wells for the periodic collection of water samples should be established to observe any changes in the chemical quality of the water. Such a program could be established in Johnson County on the basis of the data collected during the present investigation. Detailed studies should be made in Dallas County and the adjoining counties to the west and south of Johnson County 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 acre-foot per year equals 892.13 gallons per day.

Alluvial deposits.—Sediments deposited by streams; includes flood-plain deposits and stream-terrace 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 relationships of 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.—Artesain (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.

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.

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 mg/l (milligrams per liter) of dissolved solids (Winslow and Kister, 1956, p. 5). For dissolved solids, see Table 8.

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.

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

Milligrams per liter (mg/l).—One milligram per liter represents 1 milligram of solute in 1 liter of solution. As commonly measured and used, milligrams per liter is numerically equivalent to parts per million (1 milligram of solute in 1 kilogram of solution).

Million 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).

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 mg/l; slightly saline water, 1,000 to 3,000 mg/l; moderately saline water, 3,000 to 10,000 mg/l; very saline water, 10,000 to 35,000 mg/l; and brine, more than 35,000 mg/l.

Specific capacity.—The rate of yield of a well per unit of drawdown, usually expressed as gallons per minute (gpm) 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 in 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, Springs, and Oil Tests in Johnson and Adjacent Counties

All wells are drilled unless otherwise noted in remarks column.

Water level : Reported water levels given in feet; measured water levels given in feet and tenths.

Method of lift and type of power: A, airlift; C, centrifugal; E, electric; G, gasoline, butane, or Diesel engine; J, jet; N, none; P, piston; S, submergible; T, turbine; W, windmill. Number indicates horsepower.

Use of water : H, domestic; I, irrigation; N, industrial; P, public supply; S, livestock supply; U, unused.

Water-bearing units : Qal, Quaternary alluvium, Kwb, Woodbine Formation; Kp, Paluxy Sand; Kgr, Glen Rose Limestone; Kh, Hosston Formation; Ktp, Travis Peak Formation.

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER 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
						Johnson County						
PX-32-28-501	A. R. Teich	--McCrory	--	465	4	Kp	971	230.6	Sept. 28, 1966	P,E, 0.5	S	
* 701	Julian Ball	--	1929	330	4	Kp	1,055	--		N	U	Formerly used as public supply for Cresson. Destroyed.
* 702	B. F. Bone	Alfred Watts	1964	375	4	Kp	1,032	292.8	Sept. 22, 1966	S,E, 1	H,S	Casing perforated from 355 ft to bottom.
* 703	Julian Ball	C. M. Stoner	1963	910	7	Ktp	1,047	570	1963	S,E, 5	P	Casing perforated from 830 to 855 ft. 1/
901	E. Bishop	Russell & Sons	1952	390	4	Kp	893	125	1952	P,W	H,S	
29-601	Mrs. C. C. Blank-enship	--	1959	500	4	Kp	851	--		P,E, 1	H,S	
701	J. K. Winston	Russell Bros.	1956	465	-	Kp	874	--	--	P,E, 1	H,S	
901	Clyde Luftin	Wallen Bros.	1937	606	4	Kp	916	--	--	N	U	Destroyed.
* 902	Luther Wilson	C. G. Wallen	1965	584	4	Kp	812	439.1	Aug. 11, 1966	S,E, 1.5	H,S	Casing slotted and gravel packed from 510 ft to bottom. Reported discharge 7 gpm. Temp. 76°F.

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson 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
PX-32-29-903	Paul Miller	A. T. Watts	1962	605	4	Kp	911	466.2	Sept. 7, 1966	S,E, 2	H,S	Casing to 589 ft, open hole to bottom.
* 904	Leroy Branson	C. G. Wallen	1965	599	4	Kp	835	464.8	do	S,E, 1.5	H	Casing slotted from 575 ft to bottom. Reported discharge 8 gpm. Temp. 78°F.
* 905	A. R. Johnson	do	1966	640	4	Kp	880	504	Apr. 1966	S,E, 2	H	Casing perforated and gravel packed from 620 ft to bottom. Temp. 74°F.
* 30-501	City of Burleson well 2	J. L. Myers' Sons	1949	1,180	8,6	Ktp	705	305 480	Nov. 1949 Sept. 1959	T,E, 30	P	Casing perforated from 1,040 ft to bottom. Reported discharge 125 gpm. 2/
502	City of Burleson well 4	H. C. Millican	1960	587	10,7	Kp	740	398	May 1960	T,E, 30	P	Casing screened from 472-528, 543-561, 570-586 ft. Reported discharge 115 gpm. Gravel packed.
* 503	City of Burleson well 1	do	1930	580	8	Kp	723	369	Feb. 1958	T,E, 20	P	Reported discharge 80-100 gpm.
701	S. E. McNairn	Wallen Bros.	1950	530	4	Kp	732	430	1959	N	U	Abandoned.
* 702	Joe Pugh	C. G. Wallen	1964	550	4	Kp	804	425 427.5	Aug. 1964 Sept. 1, 1966	S,E, 2	H	Casing slotted from 478-490, 505-510, 515-520, 530 ft to bottom. Gravel packed. Reported discharge 10 gpm.
703	--	--	--	--	5?	--	873	--	--	S,E	P	
704	Stovall & Son	C. G. Wallen	1962	554	4	Kp	752	400 428.6	Dec. 1962 Oct. 7, 1966	S,E, 2	H	Gravel packed and slotted from 530 ft to bottom. Reported discharge 12 gpm.
801	City of Burleson well 3	H. C. Millican	1957	571	10,8	Kp	728	344	June 1957	T,E	P	Casing slotted from 457-490, 513-521, 542-560 ft. Reported discharge 80 gpm.
802	City of Burleson well 5	do	1960	565	--	Kp	685	--	--	T,E	P	

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson 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
*PX-32-30-803	W. R. Lace	Will Hunsucker	1915	585	6,4	Kp	765	200 404.8 454.2	1915 Aug. 10, 1960 Sept. 2, 1966	P,E, .75	H,S	Casing slotted from 565 ft to bottom. Temp. 72°F.
* 804	A. O. Ward	C. G. Wallen	1962	608	4,3	Kp	730	425	Nov. 1962	P,E, 2	H,S	Casing slotted from 555 ft to bottom.
* 805	George H. Webb	Ward & Ward Drilling Co.	1964	657	4	Kp	766	430 462.6	Feb. 1964 Sept. 6, 1966	S,E, 2	H	Casing perforated from 620-650 ft. Temp. 77°F.
806	Clarence Dodd	C. G. Wallen	1963	649	4,3	Kp	755	450	Mar. 1963	S,E, 2	H	Casing slotted from 572-577, and 629 ft to bottom. Gravel packed.
807	E. M. Hickman	A. T. Watts	1964	635	4	Kp	772	500	June 1964	S,E, 2	H	
* 901	Coleman Bros.	C. M. Stoner	1959	658	4	Kp	713	469.8	Sept. 1, 1966	S,E, 1	H,S	Casing perforated from 638 ft to bottom. Temp. 77.5°F.
902	W. E. Melton	C. G. Wallen	1963	661	4	Kp	732	450	July 1963	S,E, 2	H	Casing gravel packed and perforated from 630 ft to bottom.
* 903	L. A. Powers	do	1960	712	4	Kp	768	--	--	S,E, 2	H,S	Casing slotted from 692 ft to bottom. Temp. 77°F.
904	E. E. Doyal	do	1963	575	4	Kp	695	400 430.4	July 1963 Sept. 1, 1966	S,E, 1.5	H	Casing gravel packed and slotted from 555 ft to bottom. Reported discharge 11 gpm.
905	Coleman Bros.	Wallen Bros.	1951	625	7,4	Kp	790	358	Aug. 1960	P,E, 1.5	H,S	Casing perforated from 585 ft to bottom.
906	George H. Reed	C. G. Wallen	1962	572	4	Kp	685	390	May 1962	S,E, 1.5	H,S	Casing gravel packed and slotted from 552 ft to bottom.
31-401	D. L. Lynn	--	--	60	--	Kwb	710	20	Aug. 1960	J,E	H,S	
* 701	M. Marcoux	C. G. Wallen	1964	734	4,3	Kp	723	450	Feb. 1964	S,E, 2	H,S	Casing slotted from 714 ft to bottom. Reported yield 9 gpm. Temp. 78°F.

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson 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
*PX-32-31-702	J. D. McCoy		1964	762	4,3	Kp	732	450 466.4	Mar. 1964 July 29, 1966	S,E, 2	H	Casing slotted from 742 ft to bottom. Reported yield 9 gpm. Temp. 78°F.
703	J. A. Harris	do	1964	759	4,3	Kp	762	490	June 1964	S,E, 2	H,S	Casing slotted from 738 ft to bottom. Reported yield 10 gpm.
704	D. E. Templeton	do	1963	703	4,3	Kp	700	440	May 1963	S,E, 2	H	Casing slotted from 660 ft to bottom.
* 801	Lee Williams	Chester Ball	1957	217	4,3	Kwb	727	57	1957	P,E, .75	H,S	
* 802	P. M. Odem	do	1957	240?	4	Kwb	732	144.5	July 21, 1966	S,E, 1	H	Temp. 72°F.
803	--Hopkins	Bynum Geyer	1966	--	5	Kwb	728	143.3	Oct. 6, 1966	S,E, 1	H	
* 901	C. E. Prater	Ball & Geyer	1953	220	4	Kwb	662	91.9 105.9	Aug. 16, 1960 July 21, 1966	P,E, 0.5	H,S	Temp. 69°F.
32-701	Clarence Phillips	--	--	--	5	Kwb	632	165.5	Oct. 6, 1966	S,E, .75	H	
36-101	E. L. Hoffman	--	--	230?	4	Kp	963	226.2	Oct. 10, 1966	P,W	S	
201	E. B. Goughnour	--	--	420	4	Kp	1,024	--	--	P,W& E,1	H,S	Water reported hard.
* 202	Byron Bast	C. G. Wallen	1963	422	7,4	Kp	1,008	337.6	Sept. 27, 1966	P,E, .75	H,S	Casing slotted from 400 ft to bottom.
301	M. B. Goldsmith	do	1946	500	4	Kp	994	--	--	P,E, 2	H,S	
302	C. M. Wallis	do	1947	510	4	Kp	1,000	--	--	P,E, 1.5	H,S	Pump set at 400 ft.
* 402	J. K. Kimbro	--	--	120±	--	Kp	880	82.7	Sept. 29, 1966	P,W	S	
* 403	F. M. Massey	--	--	300±	4	Kp	841	--	--	P,E, 1	H,S	

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson and Adjacent Counties--Continued

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER 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
*PX-32-36-501	R. L. Smelley (old U.S. Army Eastman well 1)	Wiegand Bros.	1942	1,140	10,8	Ktp, Kh	1,038	365.2 391.8	Sept. 19, 1942 Sept. 26, 1942	P,E	H,S	Casing perforated from 862-1,110 ft. 1/ 2/
* 502	Ben Eastman	C. G. Wallen	1965	408	4	Kp	952	270 272.3	1965 Oct. 10, 1966	S,E, 1.5	H,S	Casing perforated and gravel packed from 376 ft to bottom. Temp. 73°F.
* 601	City of Godley well 1	--	1906±	430	4	Kp	952	319.1	Aug. 8, 1960	N	U	Destroyed.
* 602	City of Godley well 2	--	1931	428	6	Kp	952	--	--	N	U	Do.
603	J. K. Groening	C. G. Wallen	1962	432	4	Kp	898	314	Oct. 1962	P,E, 1	H,S	Casing slotted and gravel packed from 409 ft to bottom. Reported discharge about 4 gpm with a drawdown of 15 ft.
604	--Somerhill	--	1900±	500±	?	Kp	995	381.4	Oct. 6, 1966	P,E	S	
605	--Hadley	C. G. Wallen	1960	468	3	Kp	951	310	1960	P,E, 2	H	Casing slotted and gravel packed from 428 ft to bottom.
* 608	City of Godley city well 2	Morris Pollock	1961	425	7,4	Kp	909	--	--	S,E, 5	P	Pumps continuously.
702	Bill Matlock	Morris Pollock	1959	659	7,5	Ktp	792	--	--	P,E, 2	H	Casing perforated from 617 ft to bottom.
703	Obid Henslee	Watts Drilling Company	1965	383	7,4	Kp	962	286.8	Sept. 29, 1966	S,E, 3	H,S	
* 803	J. F. Meadows	C. G. Wallen	1962	460	4	Kp	995	380	Aug. 1962	P,E, 1	H,S	Casing slotted from 430 ft to bottom. Reported yield 4 gpm. Temp. 72°F.
804	Frank Willingham	Morris Pollock	1962	410	4	Kp	971	309.8	Oct. 6, 1966	S,E	H	
* 901	W. L. Oliver	--	--	500±	3	Kp	903	--	--	P,E, 1	H,S	

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson 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
*PX-32-36-902	Reece Coppenger	C. G. Wallen	--	512	4	Kp	992	341.6	Sept. 28, 1966	P,E, 1.5	H,S	Casing perforated from about 492 ft to bottom.
37-101	O. M. Adams	C. M. Stoner	1949	540	4	Kp	950	--	--	P,W	H,S	
102	Lena Austin	C. G. Wallen	1962	535	4	Kp	972	432	Oct. 1962	P,E, 1.5	H	Casing slotted from 495 to 515 ft. Gravel packed. Reported yield 3 gpm.
103	J. Hackney	Morris Pollock	1963	535	4	Kp	932	400	Oct. 1963	P,E	H	Cased to bottom.
104	Estes Bros.	V. O. Ward	1963	497	4	Kp	941	400 418.8	Mar. 1963 Oct. 4, 1966	S,E, 3	S	Casing to 460 ft, open hole from 460 ft to bottom. Reported yield 25 gpm.
* 105	J. L. Stewart	C. G. Wallen	1961	495	4	Kp	953	408.4	Oct. 10, 1966	S,E, 2	H,S	Temp. 76°F.
* 201	George Philips	do	1962	651	4	Kp	941	460 489.9	Sept. 1962 Sept. 20, 1966	S,E, 1.5	H	Casing slotted and gravel packed from 621 ft to bottom. Reported yield 9.5 gpm with drawdown of 15 ft. Temp. 70°F.
301	L. E. Southard	do	1949	670	4	Kp	925	425	1958	P,E, 15	U	
302	City of Joshua well 1	--Millican	1938	630	4	Kp	925	400 425	Feb. 1943 1958	N	U	Destroyed.
* 303	City of Joshua well 2	J. E. Millican	1930	677	6	Kp	925	407 425 532	1930 1958 Sept. 1964	S,E	P	Cased to bottom.
304	T. W. Mills	C. G. Wallen	1962	622	4	Kp	886	460	Nov. 1962	S,E, 2	H	Casing slotted and gravel packed from 600 ft to bottom. Reported yield 10 gpm with 15 ft drawdown.
* 305	J. T. Ogles	do	1964	621	4	Kp	887	490	Aug. 1964	S,E, 1.5	H	Casing slotted and gravel packed from 565 to 580 ft and 601 ft to bottom. Reported yield 8 gpm with 10 ft drawdown. Temp. 72.5°F.

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson and Adjacent Counties--Continued

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER 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			
PX-32-37-306	Jim D. Taylor	C. G. Wallen	1962	619	4	Kp	867	475	Oct. 1962	S,E, 2	H	Casing slotted and gravel packed from 544 ft to bottom.
307	Leo Baldwin	do	1960±	650±	4	Kp	858	460.1	Sept. 29, 1966	S,E, 1.5	H	
308	Lone Star Gas	--	1925	600±	6	Kp	916	--	--	P,G, 30	N,H	Pumps average 8 hrs. daily. Reported yield 10 gpm.
309	do	--	1925	600?	6	Kp	911	--	--	T,G, 30	H,N	Pumps average 4 to 5 hours daily. Reported discharge 35 gpm.
310	do	--	1925	1,100?	7	Ktp	900	--	--	A,G	N	Used infrequently.
* 311	City of Joshua well 4	Myers' & Sons	1961	688	7	Kp	902	465 500	Nov. 1961 1966	S,E, 20	P	Casing screened from 573-651 ft. Gravel packed. Reported discharge 98 gpm with 65 ft of drawdown after 16 hours.
401	O. L. Dunson	C. G. Wallen	1964	405	4	Kp	870	360	Feb. 1964	P,E, 1	H	Casing slotted and gravel packed from 380 ft to bottom. Reported discharge 4 gpm with 37 ft of drawdown.
402	H. D. Hanna well 1	Warren Petroleum Corporation	1955	3,723	9	--	932	--	--	N	U	Oil test. Destroyed. 2/
501	L. F. Sharp	C. M. Stoner	1925	505	4	Kp	909	319	Aug. 1960	P,W	H	Casing slotted from 485 ft to bottom.
502	R. M. Thetford	C. M. Stoner	1964	624	4	Kp	970	485.8	Oct. 3, 1966	S,E, 2	H,S	Casing perforated from 570 to to 580 ft and 592 to 602 ft.
503	D. H. Needham	Ed. Wallen	1964	--	--	Kp	932	443.9	Oct. 7, 1966	P,W	H	
601	E. W. Carleson	C. G. Warren	1965	631	4	Kp	898	485	July 1965	S,E, 1.5	H	Casing slotted and gravel packed from 590 to 597 ft and 606 ft to bottom. Reported yield 6 gpm with 5 ft of drawdown.
* 602	Harvey Baker	do	1963	623	4	Kp	888	470 469.4	Aug. 1963 Sept. 22, 1966	S,E, 2	H	Casing slotted and gravel packed from 593 ft to bottom. Temp. 75°F.

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson 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
*PX-32-37-603	John Sanders	do	1965	626	4	Kp	871	460 459.2	July 1965 Sept. 21, 1966	S,E, 2	H	Casing slotted and gravel packed from 585 to 595 ft and from 602 ft to bottom. Reported yield 12 gpm. Temp. 76°F.
* 604	M. T. Godby	C. G. Wallen	1965	622	4	Kp	910	460 449.8	Aug. 1965 Sept. 22, 1966	S,E, 2	H,S	Casing slotted and gravel packed from 570 to 580 ft and from 598 ft to bottom. Reported yield 12 gpm. Supplies water for 4,000 chickens. Temp. 76°F.
605	N. W. Williams	do	1965	592	4	Kp	904	450 439.3	July 1965 Sept. 20, 1966	S,E, 1.5	H	Casing slotted and gravel packed from 556 ft to bottom.
606	--	--	1966	600±	4	Kp	899	447.6	Sept. 20, 1966	S,E, 1.5	H	Pump not connected.
* 702	Jim Thomas	C. G. Wallen	1963	478	4	Kp	895	380.8	Oct. 6, 1966	P,E	H,S	Casing slotted and gravel packed from 438 ft to bottom. Temp. 72°F
* 802	James Bullard	do	1965	575	4	Kp	892	430 422.7	Oct. 1965 Sept. 9, 1966	S,E, 1.5	H	Casing slotted and gravel packed from 554 ft to bottom. Reported yield 7 gpm. Temp. 73.5°F.
* 901	City of Cleburne well 12	Layne-Texas Company	1958	1,283	16,8	Ktp, Kh	819	580	Apr. 1958	T,E, 150	P	Gravel packed. Screened from 961 to 1,062 ft, 1,090 to 1,115 ft, 1,130 to 1,245 ft. Reported yield 320 gpm. 1/ 2/
902	R. L. Johnson	--Bayles ?	1963	550	4	Kp	812	388.6	Oct. 14, 1966	S,E, 1.5	H	
38-101	W. C. Cogburn	Russell Bros.	1955	603	5	Kp	782	--	--	P,E, 1.5	H,S	
* 102	Bethesda Water Supply Corp. well 2	Layne-Texas Company	1965	1,437	11,6	Ktp, Kh	815	646.0 568	Sept. 6, 1966 July 1965	S,E, 100	P	Casing screened from 1,076-1,088 ft, 1,122-1,130 ft, 1,160-1,178 ft, 1,188-1,196 ft, 1,212-1,222 ft, 1,230-1,240 ft, 1,254-1,272 ft, 1,278-1,326 ft. Reported yield 275 gpm. Temp. 87°F. 2/ Gravel packed.

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson and Adjacent Counties--Continued

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER 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
*PX-32-38-103	Lewis Rue	C. G. Wallen	1962	647	4	Kp	875	460	June 1962	S,E, 2	H	
104	J. H. Davis	do	1965	667	4	Kp	923	554	Sept. 1965	S,E, 2	H	Casing slotted and gravel packed from 642 ft to bottom.
201	S. W. Harwell	do	1963	693	4,3	Kp	811	500	Oct. 1963	S,E, 1.5	H	Casing slotted from 635 ft to bottom.
* 301	Grant Lewis	do	1964	669	4	Kp	772	472.5	Sept. 6, 1966	S,E, 1.5	H,S	Casing slotted from 640 ft to bottom. Supplies water to 3 families and 30,000 chickens.
302	A. A. Phillips	--	--	77	8	Kwb	820	66	Aug. 1960	N	U	Well now covered by lake.
303	Jim Wilson	C. G. Wallen	1964	687	4,3	Kp	764	440	Apr. 1964	P,E, 2	U	Casing slotted from 663 ft to bottom. Reported discharge 4 gpm.
304	L. W. Cure	do	1963	827	4,3	Kp	874	540	July 1963	S,E, 2	H	Casing slotted from 795 ft to bottom.
306	W. Ballentine	C. M. Stoner	1963	690	4	Kp	800	490?	Aug. 1963	S,E, 2	H	Casing perforated from 675 ft to 680 ft.
* 401	A. N. Yater	Russell Bros.	--	613	4	Kp	862	400	Aug. 1960	P,E, 1	H,S	Casing perforated from 593 ft to bottom
402	do	--	--	20	96,48	Kwb	863	8.6	Aug. 12, 1960	P,E, .25	I	Dug well. Reported goes dry during drought. Used to irrigate garden.
501	C. A. Collins	--	--	33	40	Kwb	852	24.5	Aug. 11, 1960	S,E	U	Dug well. Formerly used to supply domestic and livestock needs.
* 502	Jimmy G. Owens	V. O. Ward	1963	665	4	Kp	806	448.8	Sept. 15, 1966	S,E, 2	H	Cased to bottom with open end. Reported yield 10 gpm. Temp. 76°F
503	Mrs. Chester Jones	C. G. Wallen	1965	732	4	Kp	830	480	Mar. 1965	P,E, 1.5	H,S	Casing slotted and gravel packed from 689 ft to bottom.
504	S. B. Findley well 1	Sunray Dx Oil Company	1963	2,015	16	--	865	--	--	N	U	Oil test.

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson and Adjacent Counties--Continued

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER 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			
PX-32-38-601	Ernest Adams	E. Evans	1957	753	7,4	Kp	840	--	--	P,E, 0.5	H,S	Cased to bottom.
602	do	--	--	25+	48	Kwb	825	17.9	Aug. 11, 1960	P,W	I	Dug well. Used to irrigate trees and garden.
603	M. L. Cartwright	C. G. Wallen	1963	789	4,3	Kp	860	559	Nov. 1963	S,E, 2	H	Casing slotted from 769 ft to bottom. Reported yield 6 gpm.
701	J. C. Seely	C. G. Wallen ?	--	700	4	Kp	790	380.1	Sept. 29, 1966	S,E, 2	H,S	
801	City of Keene well 1, Jr. College	Wallen Bros.	1959	780	7,5	Kp	925		Aug. 1960	P,E, 15	P	Lower part of casing slotted.
802	City of Keene well 2, Jr. College	J. L. Myers	1952	1,508	12	Kh	925	490	1960	S,E, 30	P	Reported discharge 100 gpm.
* 803	J. L. Winn Keene Municipal well 1	C. M. Stoner	1946	800	7,5	Kp	925	--	--	P,E, 15	P	Casing perforated from 735 ft to bottom. Reported discharge 40 gpm.
804	J. L. Winn Keene Municipal well 2	Wallen Bros.	1954	800	7,5	Kp	925	--	--	S,E	P	Casing perforated from 730 to 735 ft. Reported discharge 40 gpm.
* 805	Arthur Ehzroth	C. M. Stoner	1963	716	4	Kp	820	448.6	Sept. 8, 1966	S,E, 3	H	Casing slotted from 680 ft to bottom. Temp. 77°F.
806	Gilbert Mosley	do	1963	767	4	Kp	910	530	Apr. 1963	S,E, 3	H	Casing perforated from 700 to 740 ft.
807	Mrs. Louis Glaves	C. G. Wallen	1964	759	4,3	Kp	809	440 446.1	Sept. 1964 Sept. 13, 1966	S,E, 2	H	Casing slotted from 637 to 723 ft.
808	City of Keene well 3	C. M. Stoner	1966	1,501	7	Kh	925	805	Aug. 1966	S,E, 40	P	Casing slotted from 1,405 ft to bottom. Reported discharge 110 gpm. 1/

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson 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
*PX-32-38-901	Bethany Water Supply Corp. well 1	J. L. Myers	1964	1,630	7	Kh	830	640 639.0	Oct. 1964 Aug. 4. 1966	S,E	P	Casing perforated from 1,522-1,540, 1,544-1,564, 1,570-1,575 ft. Temp. 87°F. 2/
902	Joe L. Eherhart	C. G. Wallen	1963	647	4,3	Kp	740	378 383.5	Dec. 1963 Sept. 13, 1966	S,E, 2	H	Casing slotted from 627 ft to bottom.
* 903	W. W. Spivey	do	1963	725	4,3	Kp	762	425.0	Sept. 27, 1966	S,E, 2	H	Casing slotted from 705 ft to bottom. Temp. 77°F.
* 39-101	Orvil Swindale	Watts Drilling	1966	--	4	Kwb	765	142.0	July 26, 1966	S,E, 1	H,S	Temp. 71.5°F.
* 102	C. B. Deal well 1	C. G. Wallen	1963	215	5,4	Kwb	764	160 141.5	Nov. 1963 Aug. 3, 1966	S,E	H	Casing slotted from 192 ft to bottom. Temp. 70°F.
* 103	C. B. Deal well 2	do	1962	244	5,4	Kwb	754	175	Sept. 1962	S,E, .75	H,S	Casing slotted from 218 ft to bottom. Temp. 73°F.
* 201	Joe Womble	--	1962	270	7	Kwb	733	130.8	Oct. 6, 1966	S,E, 1	H,S	Temp. 71°F.
* 301	Brooks Bradley	C. M. Stoner	1965	252	6	Kwb	641	59.6	Oct. 13, 1966	S,E, 1	H	Casing perforated from 140-146, 195-196, 200-202, 234-240 ft.
* 401	Michiel R. Baker	C. G. Wallen	1964	791	4,3	Kp	775	475	July 1964	S,E, 2	H	Casing slotted from 755 to 765 ft, 773 ft to bottom. Reported discharge 10 gpm. Temp.77.5°F.
402	Jack Travers	V. O. Ward	1963	803	--	Kp	811	430	Nov. 1963	S,E, 2	H	Cased to 788 ft, open hole from 788 ft to bottom.
501	Albert Ezell	P. C. Evans	1956	265	5	Kwb	718	150?	1956	J,E, 0.5	H,S	Cased to bottom.
* 502	B. J. Ray	C. M. Stoner	1965	197	4	Kwb	675	76.8	Oct. 7, 1966	S,E, 1.5	H	
503	--Peikoff well 1	Christie, Mitchell, and Mitchell	1955	8,809	9	--	747	--	--	--	U	Oil test. Maximum temp. 231°F.
505	T. G. Wilkinson	--Geyer	1965	210?	4	Kwb	714	85.1	Oct. 13, 1966	S,E, 0.5	H	

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson and Adjacent Counties--Continued

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER 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
PX-32-39-601	Kermit Basham	--	1957?	158	4	Kwb	678	97.5	Oct. 12, 1966	S,E	S	
602	W. I. Boteler	--	1964?	250?	4	Kwb	720	148.3	Oct. 13, 1966	S,E, 1	H	
603	Kermit Basham	C. G. Wallen	1946	289	4	Kwb	685	--	--	P,E	H	Temp. 75°F.
604	L. E. Owens	Chet Ball	1950	250	4	Kwb	722	148.5	Oct. 13, 1966	S,E, 1	H,S	Cased to bottom; lower part perforated.
* 701	City of Alvarado well 3	Texas Water Wells	1955	861	10	Kp	758	360 465 498.6	Aug. 1960 June 1965 Nov. 1, 1966	S,E, 30	P	Casing screened from 699-709, 723-767, 785-837 ft. Reported discharge 110 gpm. Temp. 78°F. 2/
* 702	City of Alvarado well 2	Layne-Texas Company	1947	1,658	11,9, 7	Kp,Ktp, Kh	752	322 360 430	May 1947 Aug. 1960 June 1963	T,E, 60	P	Casing perforated from 766-790, 798-829, 1,396-1,421, 1,444-1,454 ft, and screened from 1,534-1,634 ft. Reported discharge 190 gpm. Temp. 81°F. 1/ 2/
* 703	City of Alvarado well 1	A. D. Lewis	1931	1,677	10,8	Kh	767	360 500?	Aug. 1960 1965	T,E, 30	P	Casing perforated from 1,534 ft to bottom. Reported discharge 130 gpm. Temp. 89.5°F.
* 704	L. L. Pepper, Jr.	C. M. Stoner	1965	822	4	Kp	783	500 500?	Nov. 1965 Aug. 1966	S,E, 5	H	Casing perforated from 776 to 788 ft, 790 to 810 ft. Temp. 78° F.
* 705	G. H. Jones	C. M. Stoner	1963	251	7	Kwb	742	128.5	Aug. 3, 1966	S,E, 1	H	Casing perforated from 191 to 193 ft, 215 to 218 ft. Temp. 70°F.
* 706	Mrs. --Ross	do	1964	760	4	Kp	750	435 458.1	Jan. 1964 Oct. 27, 1966	S,E, 2	H	Casing perforated from 732 to 742 ft. Reported discharge 10 gpm.
* 801	W. I. Boteler	C. G. Wallen	1964	225	5,4	Kwb	703	90 92.5	Oct. 1964 Aug. 10, 1966	S,E, .75	H	Casing slotted from 180 ft to bottom. Temp. 70°F.
* 802	L. Seery	C. M. Stoner	1963	263	4	Kwb	766	132.7	Aug. 10, 1966	S,E, .75	H	Casing perforated from 240 to 250 ft. Temp. 71°F.

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson 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
PX-32-39-803	Alvarado Oil Company	C. M. Stoner	1963	263	4	Kwb	765	132	May 1963	S,E, .75	N	Casing perforated from 235 to 248 ft.
901	Roy Plunkett	--	1960?	--	4	Kwb	725	163.6	Oct. 12, 1966	S	H	
902	Y. M. Spikes	C. M. Stoner	1965	262	4	Kwb	678	170	Feb. 1965	S,E, 1	H	Casing perforated from 225 to 243 ft.
40-101	E. O. Rayburn	do	1963	273	7	Kwb	639	160	May 1963	S,E, .75	H	Casing perforated from 245 to 252 ft. 1/
401	City of Venus well 2	C. R. Ball	1950	380	5	Kwb	675	140	Aug. 1960	T,E, 5	P	Reported discharge 30 gpm.
* 402	City of Venus well 3	--Guyer	1958	380	6	Kwb	675	140 217.6	Aug. 1960 Nov. 3, 1966	S,E, 7.5	P	Reported discharge 40 gpm.
* 404	J. Thomas Edwards	C. M. Stoner	1963	310	4	Kwb	679	205 210.6	Aug. 1963 Oct. 7, 1966	S,E, 1	H,S	Casing perforated from 274 to 290 ft. Temp. 71°F.
405	Henry Mitchell	do	1963	310	4	Kwb	630	179.4	Oct. 13, 1966	S,E, .75	H	Casing perforated from 279 to 285 ft, 290 to 296 ft.
406	Billy C. Rotan	do	1966	315	4	Kwb	682	234	June 1966	S,E, 1	H	Casing perforated from 279 to 289 ft, 290 to 300 ft.
701	Haskel Dean well 1	Humble Oil & Refining Company	1960	8,967	8	--	664	--	--	N	U	Oil test 2/.
702	J. T. Edwards	C. M. Stoner	1965	355	4	Kwb	653	173.1	Oct. 11, 1966	S,E, 1	H	Casing perforated from 320 to 330 ft, 331 to 342 ft. Reported discharge 8 gpm.
44-101	H. C. Elliott	--Wilbanks	1905	365	5	Kp	939	--	--	P,E, 1	H,S	
102	C. L. Myres	Russell Bros.	1957	355	4	Kp	928	--	--	P,E, 1	H,S	Casing perforated from 345 ft to bottom. Gravel packed.
201	L. L. Gustin	--	1957?	500?	--	Kp	973	--	--	P,E, 2	H,S	

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson and Adjacent Counties--Continued

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER 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			
*PX-32-44-202	E. B. King	--	--	425?	4	Kp	938	--	--	P,W	S	
203	do	Russell Bros.	1940	425	4	Kp	931	--	--	P,W	S	
204	do	do	1954	465	4	Kp	970	--	--	P,W	S	
301	Hugh Jones	Wallen Bros.	1945	427	4	Kp	953	390	1960	P,E, 1	H,S	
* 302	L. C. Jones	Richard Carson	1919	449	7,3	Kp	946	361.7	July 26, 1966	P,E, 1	H,S	
* 303	Hutchison Ranch	--	--	558	5	Kgr?	908	--	--	P,E, W,3	H,S	
304	--	Stoner Drilling Company	1966	500?	--	Kp?	970	379.9	July 26, 1966	S,E, 2	H	
* 401	James Russell	James Russell	1941	212	4	Kp	832	--	--	P,E, 0.75	H,S	
501	E. B. King	Stoner Drilling Company	1939	435	4	Kp	981	--	--	P,W	S	
502	do	Russell Bros.	1958	488	4	Kp	974	--	--	P,E, 1.5	H,S	
503	W. T. Poindexter	--	1900?	380?	4	Kp	951	352	?	P,W	H,S	Lower part of well open.
601	E. M. Smith	C. G. Wallen	1965	405	7,4	Kp	823	261.1	July 20, 1966	S,E, 1.5	H	Casing slotted and gravel packed from 340 to 345 ft, 381 ft to bottom. Reported discharge 13 gpm.
701	U. R. Barker	John Bohannan	1930?	380	4	Kp	958	300	1960	P,W	H,S	
* 702	D. E. Hill	Russell Bros.	1956	747	7,5, 4	Ktp	945	300	July 13, 1966	P,E, 1.5	H,S	
* 704	Opal Callahan	do	1956	260	4	Kp	840	--	--	P,E, 1	H,S	

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson 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
PX-32-44-801	"CCC" State Park	R. E. Wallen	--	226	6,5	Kp	795	--	--	J,E	H,P	Casing screened from 168 ft to bottom.
45-101	C. B. Ewing	--	1938	550±	4	Kp	847	--	--	P,E, 1	H,S	Supplies water for 60 head of dairy cattle.
102	W. S. Brown	Wallen Bros.	1952	490	4	Kp	830	400	Aug. 1960	P,E, 1	H,S	Casing slotted from 470 ft to bottom.
201	Frank Poplowski	C. G. Wallen	1965	493	7,4	Kp	860	390.3	Sept. 13,1966	S,E, 1.5	H	Casing slotted and gravel packed from 470 ft to bottom.
202	John B. Hazlett	do	1962	515	7,4	Kp	830	315	Aug. 1962	S,E, 1.5	H	Casing slotted and gravel packed from 490 ft to bottom. Reported discharge 10 gpm.
301	City of Cleburne well 9	Layne-Texas Company	1952	1,265	16,8	Ktp, Kh	832	555	July 1952	T,E, 125	P	Casing screened from 925-1,079, 1,106-1,200 ft. Gravel packed. Reported discharge 330 gpm.
302	City of Cleburne well 7	do	1944	1,258	16,8	Ktp, Kh	789.2	450	Dec. 1944	T,E, 125	P	Casing screened from 898-1,002, 1,024-1,066, 1,099-1,204 ft. Gravel packed. Reported discharge 340 gpm. 2/
303	City of Cleburne well 8	do	1947	1,294	16,8	Ktp, Kh	813	500	Jan. 1948	T,E, 150	P	Casing screened from 951-1,097, 1,141-1,246 ft. Reported discharge 300 gpm. Gravel packed. 2/
* 304	City of Cleburne well 5	do	1938	1,274	16,8	Ktp, Kh	787	350	Jan. 1938	T,E, 125	P	Casing screened from 941-1,086, 1,130-1,251 ft. Gravel packed. Reported dishcarge 250 gpm. 1/
* 306	City of Cleburne well 4	Q. D. Lewis	1940	936	8,6	Ktp	755	450	Feb. 1943	T,E, 30	P	Reported dishcarge 120 gpm. Temp. 80°F.
* 307	City of Cleburne well 6	Layne-Texas Company	1941	1,206	22,8	Ktp, Kp	758	478 480	June 1941 Mar. 1949	T,E, 125	P	Casing screened from 881-1,049, 1,096-1,180 ft. Temp 79°F. Gravel packed.
* 308	Gulf, Colorado & Santa Fe RR well 8	do	1944	1,206	14,10	Ktp	773	--	--	A	N	Casing screened from 946-975, 1,008-1,040, 1,072-1,105, 1,137-1,170 ft. Temp. 79°F.

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson 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
PX-32-45-309	Gulf, Colorado & Santa Fe RR well 7	Layne-Texas Company	1943	1,215	13,10	Ktp	884	518	Aug. 1943	A	N	Casing screened from 943-1,003, 1,024-1,028, 1,071-1,133, 1,155-1,195 ft.
310	Mrs.H.S. Woodruff	C. G. Wallen	1962	517	7,4	Kp	817	350	Oct. 1962	P,E, 1.5	H	Casing slotted and gravel packed from 497 ft to bottom.
311	J. L. Crist	Stoner Drilling Company	1964	520	4	Kp	815	370	June 1964	S,E	H	Casing perforated from 502-512 ft.
312	Mrs. H.H. King	do	1963	526	4	Kp	816	363.4	Oct. 5, 1966	S,E, 5	H	Casing perforated from 504-513 ft. Reported discharge 20 gpm.
401	G. C. Winnett	C. G. Wallen	1962	425	7,4	Kp	863	315	July 1962	P,E, 1	H	Casing slotted and gravel packed from 399 ft to bottom.
402	A. B. Beckner	Stoner Drilling Company	1963	441	4	Kp	850	335	Aug. 1963	S,E, 1.5	H	Casing perforated from 428-433 ft.
* 501	H. F. Ogden	do	1965	453	4	Kp	797	340	Aug. 1965	S,E, 2	H	Casing perforated from 393-405, 430-442 ft. Reported discharge 10 gpm.
502	Woody Walls	C. G. Wallen	1943	420	4	Kp	720	--	--	P,E, 1	H,S	Reported lake now covers well.
* 503	Lewis Pipes, Jr.	do	1965	498	7,4	Kp	801	360	May 1965	P,E, 1	H	Casing slotted from 475 ft to bottom.
504	C. B. Snider	do	1963	514	7,4	Kp	822	365	June 1963	S,E, 2	H	Casing slotted and gravel packed from 484 ft to bottom.
* 601	City of Cleburne well 11	Layne-Texas Company	1955	1,266	16,8	Kh	746	444 555	Apr. 1955 Apr. 1958	T,E, 125	P	Casing screened from 895-995, 1,015-1,165 ft. Gravel packed. Reported discharge 350 gpm.
602	Texas Lime Company well 1	C. M. Stoner	1951	508	4	Kp	760	100	Sept. 1960	S,E, 2	N	Casing slotted from 448 ft to bottom. Reported discharge 5 to 6 gpm.
603	Texas Lime Company well 2	C. M. Stoner	1957	1,218	7	Ktp, Kh	760	300±	Sept. 1960	S,E, 30	N	Casing perforated from 1138 ft to bottom. Reported discharge 60 gpm.

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson 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
PX-32-45-604	N. H. Hester	C. G. Wallen	1962	475	7,4	Kp	774	345	Oct. 1962	P,E, 1	H	Casing slotted and gravel packed from 454 ft to bottom. Reported discharge 3.5 gpm.
605	L. C. Jones Jr.	do	1965	513	4	Kp	795	375	Aug. 1965	S,E, 2	H	Casing slotted and gravel packed from 485 ft to bottom.
606	Paul Burton	do	1966	--	-	Kp	773	289±	Oct. 1966	--	H	
607	Texas Lime Company	C. M. Stoner	1963	1,220	7	Kh	760	669	Jan. 1963	S,E, 40	N	Casing slotted from 1,120 ft to bottom. Reported discharge 140 gpm.
701	G. O. Brawner	--Bayless	1940?	450±	5	Kp	867	--	--	P,W	H,S	
702	Bill Glass	C. G. Wallen	1965	460	7,4	Kp	833	335	Apr. 1965	S,E, 1.5	H	Casing slotted and gravel packed from 438 ft to bottom.
703	John Fletcher	Stoner Drilling Company	1962	486	4	Kp	882	426	Nov. 1962	S,E, 2	S	Casing slotted from 450 ft to bottom. Reported discharge 6 gpm.
* 704	E. A. Munden	Morris Pollack	1963	454	7,4	Kp	920	350	Nov. 1963	P,E, 1.5	H,S	
* 705	Grady York	do	1966	462	4	Kp	883	370	1966	P,E, 1.5	H,S	
* 801	Woody Walls	C. G. Wallen	1965	610	4,3	Kp	750	270.9	Sept. 13, 1966	S,E, 1	H	Casing slotted and gravel packed from 381 to 445 ft, 529 to 555 ft, and 590 ft to bottom.
* 901	C. R. Hilliard	do	1965	525	7,4	Kp	764	308.2	Aug. 11, 1966	S,E, 1.5	H	Casing slotted and gravel packed from 496 ft to bottom. Reported discharge 8 gpm.
902	Nolan Water Supply Company well 1	C. M. Stoner	1966	1,200?	--	Kh	770	--	--	S,E	P	
46-101	City of Cleburne well 10	Layne-Texas Company	1952	1,296	16	Ktp, Kh	757	557	Oct. 1952	T,E, 125	P	Gravel packed. Casing screened from 939 to 1,093 ft, 1,121 to 1,229 ft. Reported discharge 410 gpm.

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson and Adjacent Counties--Continued

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER 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			
PX-32-46-102	V. L. Bowles	C. G. Wallen	1964	653	7,4	Kp	832	460	Jan. 1964	P,E, 1	H	Casing slotted from 590 ft to bottom.
103	Mrs. Cecil Jones	do	1962	644	7,4	Kp	820	426.3	Sept. 20, 1966	S,E, 1.5	H,S	Casing slotted and gravel packed from 604 ft to bottom.
104	Odis Shum	do	1963	677	7,4	Kp	855	420	Mar. 1963	S,E	H	Casing slotted from 655 ft to bottom. Reported discharge 10 gpm.
* 201	Johnson County Water Supply Corporation well 1	Stoner Drilling Company	1965	1,518	10	Kh	902	730	Sept. 1965	S,E	P	Casing perforated from 1,395 ft to bottom. Reported discharge 225 gpm. 1/ 2/
202	Liberty School District 33	C. G. Wallen	1963	698	7,4	Kp	862	470	Aug. 1963	S,E, 2	P	Casing slotted and gravel packed from 675 ft to bottom. Reported discharge 9 gpm.
* 203	J. L. Dawson	do	1964	782	7,4	Kp	880	490	July 1964	P,E, 1	H	Casing slotted from 730-741 ft, 753-763 ft, 769-780 ft. Reported discharge 4 gpm.
* 204	J. H. Haley, Jr.	do	1964	713	7,4	Kp	853	480	Apr. 4, 1964	P,E, 1.5	H	Cased to bottom. Slotted from 657 ft to bottom.
* 205	James T. Crawford	C. G. Wallen	1964	770	7,4	Kp	855	450	Jan. 1964	S,E, 2	H,S	Casing slotted from 724 to 739 ft, 749 ft to bottom. Reported discharge 9 gpm.
206	Henry Ellis	do	1963	741	7,4, 3	Kp	863	468.1	Sept. 28, 1966	S,E, 1.5	H,S	Casing slotted from 720 ft to bottom.
207	G. C. Taylor	do	1963	778	7,4	Kp	882	475	Feb. 1963	S,E, 1.5	H	Casing slotted from 725 ft to bottom.
208	B. K. Gaines well 1	Shell Oil Company	1965	1,490	7	--	865	--	--	N	U	Oil test.
301	--Rogers	--	--	120	8	Kwb	725	--	--	P,W	U	

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson 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
PX-32-46-302	Charles E. Head	Stoner Drilling Company	1964	798	4	Kp	823	420	Nov. 1964	S,E, 1.5	H	Casing perforated from 707-717 ft, 721-731 ft, 741-745 ft. Reported discharge 5 gpm.
303	T. C. Seale	do	1962	798	4	Kp	795	440	Nov. 1962	S,E, 1.5	H	Casing perforated from 764 to 784 ft. Reported discharge 8 gpm.
* 401	George Wall	do	1964	1,350	7	Kh	810	530	Nov. 1964	S,E, 5	H,S	Casing slotted from 1,284 ft to bottom. Reported discharge 18 gpm.
402	Jack Johnson	C. G. Wallen	1964	640	7,4	Kp	826	400 402.9	July 1964 Sept. 15, 1966	S,E, 2	H,S	Casing slotted and gravel packed from 616 ft to bottom. Reported discharge 10 gpm.
501	J. B. Lackey	do	1964	777	7,4	Kp	853	450	Dec. 1964	S,E, 1.5	H	Casing slotted from 730 to 754 ft. Gravel packed.
502	T. E. Peyton	do	1966	717	7,4	Kp	837	450	Jan. 1966	P,E, 1	H	Casing slotted from 665 to 707 ft. Reported discharge 4 gpm.
503	W. A. Sears	do	1964	712	7,4	Kp	868	440	Mar. 1964	S,E, 2	H	Casing slotted from 657 ft to bottom. Reported discharge 9 gpm.
* 601	Bob Elder	do	1962	719	7,4, 3	Kp	782	390	Dec. 1962	S,E, 1.5	H	Casing slotted from 698 ft to bottom. Reported discharge 10 gpm.
* 602	John Hopper	Stoner Drilling Company	1962	790	4	Kp	811	460	Nov. 1962	S,E, 1.5	H,S	Casing slotted from 749 ft to bottom. Reported discharge 8 gpm.
701	Henry Seago	--	1915	500?	5	Kp	762	200	1960	P,W	H,S	
* 702	G. E. Greeson	Stoner Drilling Company	1964	537	4	Kp	751	300.3	Aug. 18, 1966	S,E, 1.5	H,S	Casing perforated from 500 to 510 ft. Reported discharge 8 gpm.
801	Raymond Halbert	Wallen Bros.	1960	650	6,4	Kp	770	250±	Sept. 1960	P,E, 1	H,S	Casing slotted from 610 ft to bottom.
901	Sam Marlin	do	1959	760	4	Kp	858	--	--	S,E	S	Supplies water to 100 head of livestock.

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson 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
*PX-32-46-902	G. L. Young	Stoner Drilling Company	1964	137	4	Kwb	750	22.6	Aug. 10, 1966	J,E, 1	S	Reported slotted 77 ft.
903	City of Parker Water Supply Corp. well 1	Myers' Sons	1965	1,612	6	Kh	862	700	June 1965	S,E	P	Reported discharge 100 gpm. 2/
904	B. F. Stout	Stoner Drilling Company	1962	798	4	Kp	820	450	Oct. 1962	S,E, 1.5	H,S	Casing perforated from 744 to 777 ft. Reported discharge 8 gpm.
905	Otis Buchanan	C. G. Wallen	1963	200	5	Kwb	827	99	Oct. 1963	S,E, 0.75	H	Casing slotted from 134 ft to bottom. Reported discharge 11 gpm.
906	M. Roy Van Zandt	do	1963	663	7,4	Kp	722	320	June 1963	S,E, 2	H	Casing slotted and gravel packed from 638 ft to bottom. Reported discharge 10 gpm.
* 47-101	Sherman Wright	Ward & Ward Drilling Company	1964	795	4	Kp	755	399.6	Aug. 3, 1966	S,E, 2	H	Reported discharge 10 gpm. Perforated in Paluxy Sand. 1/
* 102	W. R. Fischer	--Reid	1964	220	4	Kwb	778	114.1	Aug. 18, 1966	S,E, 0.75	H	Reported discharge 10 gpm.
103	Johnson County Water Supply Company well 2	C. M. Stoner	1966	1,680	7	Kh	759	543	Oct. 1966	S,E	P	Casing perforated from 1,562-1,582, 1,600-1,608, 1,630-1,646, 1,656-1,660, 1,664-1,672 ft. Reported discharge of 80 gpm with drawdown of 134 ft after 24 hours. 2/
201	B. R. Lewis	do	1964	237	4	Kwb	685	170	Dec. 1964	-,E	H,S	Casing perforated from 218 to 228 ft.
* 202	T. G. Couch	Stoner Drilling Company	1964	216	4	Kwb	671	88.2	Aug. 2, 1966	P,E, 0.5	S	Casing perforated from 189 to 196 ft.
203	L. W. Burks	do	1964	245	4	Kwb	704	170	June 1964	S,E, 0.75	H,S	Casing perforated from 187-193, 204-207, 213-219 ft.
301	J. T. Lomax	--	1948	130	4	Kwb	662	90.2 97.8	Aug. 17, 1960 Aug. 3, 1966	P,W	H,S	

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson 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
*PX-32-47-302	E. W. Frye	--Ball	1950	256	5,3	Kwb	640	--	--	P,W	H,S	Casing slotted from 246 ft to bottom.
* 401	H. W. Ford	C. G. Wallen	1963	772	4	Kp	763	308.4	Aug. 2, 1966	S,E	H	Casing slotted from 730 ft to bottom. Reported discharge 10 gpm.
402	E. E. Cato	do	1962	767	4,3	Kp	732	325	Aug. 1962	P,E, 1	S	Casing slotted from 745 ft to bottom. Reported discharge 4 gpm.
* 403	E. A. Watts	do	1964	152	7,5	Kwb	750	84.8	Aug. 10, 1966	S,E, 0.75	S	Casing slotted from 115 ft to bottom. Reported discharge 10 gpm.
501	W. C. Gayle well 1	W. L. Forbes	1935	762	--	--	695	--	--	--	U	Oil test.
502	Mrs. Stella Atlas	Stoner Drilling Company	1965	275	4	Kwb	730	138.5	Aug. 3, 1966	P,E, W, 0.5	H,S	Casing perforated from 206 to 213 ft, 215 to 228 ft.
503	John Stafford	do	1963	273	4	Kwb	695	--	--	P,E, 0.75	H,S	Casing perforated from 207 to 212 ft, 216 to 217 ft. Reported discharge 3 gpm.
* 504	Edwin Culwell	--	--	187	4	Kwb	711	--	--	J,E, 0.5	H	
505	O. R. Clark	--	--	700±	4	Kp	732	341.6	Sept.20, 1966	N	U	
* 601	G. B. Lintner	Stoner Drilling Company	1965	310	4	Kwb	711	137.2	Aug. 2, 1966	S,E, 0.75	H,S	Casing perforated from 289 to 300 ft. Reported discharge 5 gpm.
602	O. M. Harrell	do	1964	308	4	Kwb	705	170	Dec. 1964	S,E	H,S	Casing perforated from 168 to 172 ft, 183 to 191 ft.
603	B. W. Goodwin well 1	Shell Oil Company	1965	1,570	--	--	686	--	--	--	--	Oil test. 2/

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson 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
PX-32-47-701	W. W. Hutchison	Stoner Drilling Company	1963	168	4	Kwb	730	40 25.7	Oct. 1963 Oct. 14, 1966	C,E	S	Casing slotted from 100 ft to bottom.
702	Homer W. Hutchens	do	1960	151	4	Kwb	665	3.9	Aug. 3, 1966	N	U	
703	John F. Sheets	do	1963	189	5	Kwb	726	--	--	S,E, 0.5	H	Casing perforated from 163 to 182 ft. Reported discharge 4 gpm.
* 801	City of Grandview well 2	G. C. Ingle	1946	210	12	Kwb	691	93	Sept. 1960	T,E, 7.5	P	Reported discharge 80 gpm.
* 802	City of Grandview well 3	C. M. Stoner	1955	868	8,6	Kp	694	257 236	1955 1957	T,E, 20	P	Casing screened from 802 to 846 ft. Reported discharge 125 gpm. Temp. 79°F. 2/
* 803	City of Grandview	Layne-Texas Company	1945	214	12,7	Kwb	695	93 93 108.5	1949 1960 Oct. 26, 1966	T,E, 7.5	P	Stand by well. Casing screened from 188 to 210 ft. Temp. 69°F.
* 804	Duncan Chapman	Stoner Drilling Company	1964	237	4	Kwb	663	83.3	Aug. 3, 1966	S,E, 1	H	Casing perforated from 183-187, 195-199, 218-223 ft. Reported discharge 10 gpm.
* 805	City of Grandview well 1	--Stinson	1931	273	6	Kwb	697	51 105.5	1931 Oct. 25, 1966	S,E, 5	P	
806	City of Grandview well 4	Stoner Drilling Company	1964	224	6	Kwb	698	114.5 107.1	Aug. 30, 1966 Oct. 24, 1966	S,E, 5	P	Casing perforated from 182 to 204 ft. Measured discharge 47 gpm.
807	J. E. Pipes	C. M. Stoner	1966	160?	4	Kwb	655	95.1	Oct. 14, 1966	S,E	H	
* 901	M. C. Laird	English Bros.	1913	210	-	Kwb	620	--	--	P	S	Reported highly mineralized.
48-101	E. R. Griggs	--Ball	1952	225	4	Kwb	619	106.6 113.5	Aug. 17, 1960 Aug. 4, 1966	S,E, 0.75	H,S	
401	--Donnell	--	1901	186?	4	Kwb	592	60	Sept. 1960	P,W	H,S	
402	Horace Mitchell	--	--	140	6	Kwb	647	74.4	Aug. 30, 1966	N	U	
403	O. K. Smith	--	--	135	4	Kwb	579	55.6	do	P,E	H	

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson and Adjacent Counties--Continued

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER 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			
*PX-32-48-702	Floyd Reeves	Wallen Bros.	1955	265	4	Kwb	605	49.4 61.5	Sept. 7, 1960 Aug. 4, 1966	S,E, 1	H,S	Water level reported 1.5 ft above land surface datum when drilled in 1955.
703	Richard Flamson	Stoner Drilling Company	1963	266	4	Kwb	604	61.5	Aug. 4, 1966	S,E, 1	S	Casing perforated from 240 to 245 ft.
52-101	J. Young	--	1966	950	4	Kh	925	386.3	July 27, 1966	S,E, 5	H	
201	Cleburne Independent School District	--	1915	100	4	Kp	681	75.4 72.8	Aug. 23, 1960 July 13, 1966	P,W	H,S	
* 202	Texas Lime Company	Stoner Drilling Company	1965	926	7	Kh	760	250 251.5	Oct. 1965 July 20, 1966	S,E	H,N	Casing slotted from 784 to 893 ft. Reported discharge 222 gpm. 1/
501	Floyd Runnels	--	--	600+	-	Ktp?	670	101.3	Aug. 23, 1960	P,E	H,S	Reported flowed when drilled.
* 502	F. O. Jackson	--	1955?	300	6	Kp	609	76.4	July 14, 1966	P,E, 0.33	H	
* 503	do	--	--	Spring	-	Qal	560	+	--	Flows	S	Estimated flow from several local springs is 80 to 100 gpm. Temp. 82°F.
901	A. G. Baker	M. Pollack	1950	530	7,5	Ktp	568	+	July 14, 1966	J,E, .5 Flows	H,S	Reportedly flowed small stream Dec. 4, 1950.
902	L. B. Callahan	--	1961	532	4	Ktp	630	--	--	N	U	
* 903	W. D. McPherson	Russell Bros.?	1950+	500+	-	Ktp	642	101.7	July 14, 1966	P,E, 1.5	H	
53-101	J. E. Sexton Estate	Russell Bros.	1952	369	4	Kp	740	--	--	P,W	S	Casing perforated from 329 ft to bottom.
201	Tom Hefner	--	1950?	460	4	Kp	840	344?	Aug. 1966	P,E, 0.75	H,S	

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson 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
PX-32-53-301	Lowell Smith	--	--	380?	5	Kp	668	187.4	Aug. 24, 1960	N	U	Well drilled to 420 ft and plugged back to 380 ft prior to Aug. 11, 1966.
* 302	Wallis Simpson well 2	--Bayless	1960	510	7	Kp	743	265 301.0	Sept. 1960 Aug. 17, 1966	S,E, 1.5	P	Open hole from 400 ft to bottom. Reported discharge 10 gpm.
303	Wallis Simpson well 1	A. Y. Wallen	1955	515	7	Kp	740	265	Sept. 1960	S,E, 3	P	Open hole from 400 ft to bottom. Reported discharge 18 gpm. Standby.
401	Albert Sowell	--	--	800?	8	Ktp	581	32.3	Aug. 24, 1960	P,E, 1.5	H,S	Flowed until about 1930.
* 501	Roy Giddens	--Bayless	1961	425	4	Kp	810	307.3	Aug. 23, 1966	S,E, 1	H,S	Casing slotted and gravel packed from 385 ft to bottom.
* 601	Jack Cobb	C. G. Wallen	1965	425	7,4	Kp	640	183.1	Aug. 11, 1966	S,E, 1.25	H,S	Casing slotted and gravel packed from 400 ft to bottom. Reported discharge 10 gpm.
* 54-101	Wallis Simpson Water Company well 3	Stoner Drilling Company	1965	1,215	7	Kh	737	317.4 313.2	Aug. 17, 1966 Oct. 24, 1966	S,E, 25	P	Casing slotted from 1,137 ft to bottom. Measured discharge 168 gpm. Temp. 84.5°F. 1/ 2/
* 201	G. F. Ellis	--	--	18	48	Kwb	810?	11.1	Aug. 16, 1966	J,E, 0.33	S	Dug well. Brick curb casing.
* 202	L. H. Stowe	S. Bayless	1963	560	4	Kp	765?	309.5	do	S,E, 1.5	H	Reported lower part of casing perforated.
* 55-101	W. C. Cottingame	C. G. Wallen	1954	235	4	Kwb	--	--	--	P,E, 0.75	H,S	Do.
						Ellis County						
JK-33-49-101	R. S. LeSage	Lesco, Inc.	1944	2,898	8	--	710	--	--	--	--	Oil test, control well. 2/
						Hill County						
LW-32-47-902	Ella Freeman well 1	Humble Oil and Refining Company	1953	11,808	12,8	--	635	--	--	N	U	Oil test, control well. 2/

See footnotes at end of table.

Table 6.--Records of Wells, Springs, and Oil Tests in Johnson 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
LW-32-61-201	Brazos Lime Company well 1	C. M. Stoner	1964	1,002	7	Kh	675?	143.1	Mar. 11, 1966	S,E, 15	N	Casing slotted from 940 ft to bottom. Control well. 2/
						Hood County						
LY-32-43-102	Van Morrison well 1	B. W. Fritzgerald	1951	4,507	8	--	845	--	--	--	-	Oil test, control well. 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	Control well. Temp. 90°F. 2/

* For chemical analyses of water from wells in Johnson County, see Table 8.
1/ For drillers' logs of wells in Johnson County, see Table 7.
2/ Electric logs in files of Texas Water Development Board of U.S. Geological Survey, Austin, Texas.

Table 7.—Drillers' Logs of Wells in Johnson County

	THICKNESS (FEET)	DEPTH (FEET)
Well PX-32-28-703		
Owner: Julian Ball Driller: C. M. Stoner		
Soil	1	1
Clay, yellow	7	8
Rock, white	252	260
Shale	10	270
Shale, sandy	65	335
Lime and shale	55	390
Lime	70	460
Sand	15	475
Lime and shale	215	690
Sand	10	700
Shale, green	4	704
Sand	10	714
Shale, red	6	720
Sand	77	797
Shale, green and red	20	817
Sand	35	852
Shale, green and red	18	870
Sand	10	880
Shale, green and red	3	883
Sand	27	910
Well PX-32-36-501		
Owner: R. L. Smelley Driller: Wiegand Bros.		
Limerock, hard	5	5
Lime and clay	25	30
Shale, gray	30	60
Shale and lime	40	100
Lime	10	110
Shale, gray and lime streaks	65	175
Shale, gray	15	190
Lime	108	298
Shale	27	325
Lime	7	332
Shale	10	342
Lime with oyster shells	8	350
Lime	30	380
Shale	17	397
Sand	8	405
Lime	35	440
Sand	20	460
Sand and shale streaks	35	495
Sand, shale with lime streaks	22	517
Lime, hard	23	540
Lime streaks and shale breaks	30	570
Lime with shale streaks	35	605
Unknown	10	615
Shale	11	626
Lime, hard	94	720
Lime, hard with shale streaks	31	751
Lime, shaly	2	753
Sand, hard	1	754
Lime, hard	2	756
Lime	14	770
Lime with shale streaks	68	838
Sand	4	842
Sand, and shale	10	852
Sand, soft	5	857
Sand, water	20	877
Sand	40	917
Shale and sand streaks	20	937
Shale, red and lime streaks	20	957
Clay, red	8	965
Sand, gray	6	971
Sand	9	980
Limerock, hard	3	983
Shale, red	34	1,017
Sand with shale streaks	33	1,050
Gravel, fine	35	1,085
Limerock	4	1,089
Rocks, Pennsylvanian	51	1,140

Table 7.—Drillers' Logs of Wells in Johnson County—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PX-32-37-901		
Owner: City of Cleburne Driller: Layne-Texas Co.		
Surface soil	2	2
Clay and gravel	18	20
Shale, gray and lime	48	68
Lime	30	98
Shale and lime	46	144
Lime and shale streaks	40	184
Shale and lime	80	264
Lime	60	324
Lime and shale	121	445
Shale and lime, sandy	39	484
Shale	17	501
Lime and shale	13	514
Lime, sandy and shale	56	570
Lime	2	572
Shale and sand	16	588
Shale	12	600
Lime	23	623
Lime and shale	100	723
Lime	47	770
Shale streaks and lime	68	838
Lime and shale	42	880
Shale, gray	16	896
Lime and shale	28	924
Sand, hard	7	931
Sand and shale breaks	22	953
Shale, sandy	9	962
Lime and shale, sandy	9	971
Sand and shale streaks	60	1,031
Shale, sandy	9	1,040
Shale, sandy and sand streaks	7	1,047
Shale and lime	10	1,057
Sand and shale, red and blue	46	1,103
Sand	8	1,111
Shale, sandy	6	1,117
Shale, sandy and lime	11	1,128
Shale, red and sand	34	1,162
Shale and sandy shale	20	1,182
Sand and shale breaks	63	1,245
Sand, hard and shale	25	1,270
Shale, hard	13	1,283
Well PX-32-38-808		
Owner: City of Keene Driller: C. M. Stoner		
Soil	1	1
Clay, yellow	9	10
Sand	10	20
Shale, sandy	20	40
Shale, blue	50	90
Sand	10	100
Shale	5	105
Sand	10	115
Shale, sandy	35	150
Rock, white	530	680
Sand	20	700
Shale, sandy	35	735
Sand	35	770
Shale and rock	10	780
Sand	7	787
Shale, sandy	8	795
Lime rock	395	1,190
Sand	135	1,325
Red bed	50	1,375
Sand	25	1,400
Red bed	10	1,410
Sand	86	1,496
Shale, red and yellow	5	1,501
Well PX-32-39-702		
Owner: City of Alvarado Driller: Layne-Texas Co.		
Surface soil	5	5
Clay, yellow	19	24
Rock, hard	1	25
Sand	10	35
Shale, sandy	55	90
Shale	45	135

	THICKNESS (FEET)	DEPTH (FEET)
Well PX-32-39-702—Continued		
Sand	12	147
Shale, sandy	42	189
Sand	18	207
Shale, blue	108	315
Lime	52	367
Lime and shale	380	747
Lime and sandy shale	23	770
Shale, sandy	25	795
Shale, sandy shale and sand	31	826
Sand and shale, sandy	23	849
Shale, hard and lime	46	895
Lime, hard	30	925
Shale, hard and lime	32	957
Shale, sandy	12	969
Lime, hard	44	1,013
Lime, sandy	7	1,020
Lime, hard	48	1,068
Lime and shale	12	1,080
Lime, hard	220	1,300
Lime, soft, brown	15	1,315
Sand, fine and lime	35	1,350
Sand and shale layers, blue and lime	63	1,413
Sand, fine and shale, blue layers	16	1,429
Shale, hard, red	16	1,445
Sand	10	1,455
Shale, hard, red and sand layers	46	1,501
Shale, red and blue	43	1,544
Sand and shale layers	28	1,572
Shale	18	1,590
Sand	45	1,635
Shale, red, blue and yellow	23	1,658
Well PX-32-40-101		
Owner: E. O. Rayburn Driller: C. M. Stoner		
Soil	3	3
Clay, yellow	22	25
Shale, brown	28	53
Sand	5	58
Shale, brown	26	84
Shale, broken and sandy	14	98
Shale	24	122
Sand	1	123
Shale	1	124
Sand	5	129
Shale, sandy	15	144
Sand	3	147
Shale	10	157
Sand	16	173
Shale, sandy	6	179
Sand	5	184
Shale, sandy	39	223
Sand	29	252
Rock	2	254
Shale, sandy, green	19	273
Well PX-32-45-304		
Owner: City of Cleburne Driller: Layne-Texas Co.		
Lime	40	40
Shale, brown	10	50
Lime	10	60
Shale, blue	5	65
Lime, white	20	85
Shale, brown	25	110
Lime	5	115
Shale, blue	5	120
Lime, white	71	191
Shale, blue	29	220
Lime, white	70	290
Shale, blue	4	294
Lime, white	56	350
Shale, blue and shell	13	363
Lime, white	7	370
Shale, blue	8	378
Lime	10	388
Shale	6	394

Table 7.—Drillers' Logs of Wells in Johnson County—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well PX-32-45-304—Continued		
Lime	4	398
Shell, hard and rock	17	415
Shale, brown, sandy	25	440
Sand	12	452
Shale	8	460
Shale, hard, sandy and streaks of lime	35	495
Sand	7	502
Lime	1	503
Sand	9	512
Lime, hard	1	513
Sand, hard	8	521
Shale, hard	3	524
Lime	2	526
Shale	6	532
Lime	1	533
Sand, fine, white	5	538
Shale, sandy	11	549
Lime	1	550
Shale	3	553
Lime, hard	8	561
Shale, hard	9	570
Lime	223	793
Lime, sandy and shale streaks	36	829
Shale, and lime streaks	23	852
Shale, hard	8	860
Shale, hard and lime	14	874
Lime	10	884
Shale and lime	11	895
Lime and shale layers	6	901
Lime	10	911
Shale	2	913
Sand, shaly	11	924
Lime	3	927
Sand and shale	6	933
Lime	2	935
Shale, hard	16	951
Sand and shale streaks	14	965
Sand	14	979
Shale, hard	4	983
Sand, broken with shale	13	996
Sand rock	3	999
Rock	6	1,005
Sand	5	1,010
Lime	3	1,013
Shale, red, sandy and sand layers	41	1,054
Sand, hard	11	1,065
Shale	2	1,067
Sand	8	1,075
Shale	4	1,079
Sand	2	1,081
Sand and shale	8	1,089
Shale	35	1,124
Rock	4	1,128
Sand	16	1,144
Shale	2	1,146
Sand	2	1,148
Shale and sand	8	1,156
Sand, broken with shale	21	1,177
Sand rock	4	1,181
Sand, hard with shale layers, red, hard	9	1,190
Shale, hard, red	4	1,194
Sand	20	1,214
Rock	2	1,216
Sand, and gravel, fine	4	1,220
Shale and sand layers	15	1,235
Shale, sandy and sand layers	19	1,254
Shale, red, blue and yellow	20	1,274
Well PX-32-46-201		
Owner: Johnson County Water Supply Corp. Driller: Stoner Drilling Co.		
Soil	1	1
Clay	7	8
Sand and shale	32	40
Shale, blue	35	75

	THICKNESS (FEET)	DEPTH (FEET)
Well PX-32-46-201—Continued		
Sand	25	100
Shale, sandy	30	130
Sand	15	145
Rock, white	505	650
Sand	40	690
Shale, sandy	30	720
Sand	42	762
Lime	433	1,195
Sand, broken, and red bed	45	1,240
Sand	30	1,270
Sand, broken, and red bed	20	1,290
Red bed	25	1,315
Red bed, sandy	20	1,335
Red bed	45	1,380
Red bed, sandy	15	1,395
Sand	115	1,510
Shale, yellow	8	1,518
Well PX-32-47-101		
Owner: Sherman Wright Driller: Ward & Ward Drilling Co.		
Topsoil	3	3
Shale	62	65
Sand	10	75
Shale	51	126
Sand	20	146
Shale	8	154
Sand	20	174
Shale	91	265
Limestone	105	370
Shale	134	504
Limestone	134	638
Shale	12	650
Limestone	55	705
Shale	45	750
Sand	8	758
Shale	32	790
Sand	5	795

	THICKNESS (FEET)	DEPTH (FEET)
Well PX-32-52-202		
Owner: Texas Lime Co. Driller: Stoner Drilling Co.		
Rock, white	145	145
Sand	35	180
Shale, sandy	40	220
Sand	40	260
Lime	338	598
Sand	22	620
Shale, sandy	15	635
Sand	65	700
Red bed	80	780
Sand	95	875
Shale, yellow	51	926
Well PX-32-54-101		
Owner: Wallis Simpson Water Co. Driller: Stoner Drilling Co.		
Rock, white	410	410
Shale, sandy	20	430
Sand	20	450
Shale, sandy	10	460
Sand	45	505
Lime, rock	425	930
Sand	20	950
Shale	20	970
Sand	60	1,030
Red bed	60	1,090
Sand, broken and red bed	15	1,105
Sand	90	1,195
Shale, mixed	20	1,215

Table 8.--Chemical Analyses of Water From Wells and Springs in Johnson County

(Analyses Given Are in Milligrams Per Liter Except Specific Conductance, pH, SAR, RSC, and Percent Sodium.)

WELL	PRODUCING INTERVAL (FT)	DATE OF COLLECTION	WATER-BEARING UNIT	SPECIFIC CONDUCTANCE (MICROMHOS AT 25° C)	pH	MANGANESE (Mn)	SILICA (SiO_2)	IRON (Fe)	CALCIUM (Ca)	MAGNESIUM (Mg)	SODIUM (Na)	POTASSIUM (K)	BICARBONATE HCO_3	CARBONATE CO_3	SULFATE (SO_4)	CHLORIDE (Cl)	FLUORIDE (F)	NITRATE (NO_3)	BORON (B)	DISSOLVED SOLIDS a/	HARDNESS AS $CaCO_3$	PERCENT SODIUM	SODIUM ADSORPTION RATIO (SAR)	RESIDUAL SODIUM CARBONATE (RSC)
PX-32-28-701	?-330	Feb. 11, 1943	Kp	--	7.4	--	18	0.20	68	19	* 34	--	314	0	42	14	0.4	0.5	--	351	248	--	--	--
702	355-375	Sept. 22, 1966	Kp	555	7.5	--	--	--	--	--	--	--	298	0	33	12	--	--	--	(340)	220	--	--	0.48
703	830-855	do	Ktp	978	8.3	--	11	.18	1.2	.3	236	1.0	464	10	59	36	1.2	.8	--	584	4	99	51	7.85
29-902	510-584	Aug. 11, 1966	Kp	1,820	7.0	--	31	--	242	33	106	2.9	374	0	308	251	.2	.0	--	1,160	740	24	1.7	.00
904	575-599	Sept. 7, 1966	Kp	762	8.6	--	--	--	--	--	--	--	396	28	22	6.8	--	--	--	(470)	4	--	--	7.34
905	620-640	do	Kp	851	8.4	--	--	--	--	--	--	--	442	16	48	7.4	--	--	--	--	10	--	--	7.57
b/ 30-501	1040-1070	Apr. 1957	Ktp	1,060	8.5	--	--	.02	2.0	1.0	244	--	--	--	106	27	1.6	1.0	--	640	8	--	--	--
503	580**	Feb. 12, 1943	Kp	--	8.8	--	12	.01	.8	.5	205	8.0	426	27	41	13	.6	3.0	--	520	4	--	--	--
b/ 503	580**	Apr. 1957	Kp	1,040	8.3	--	--	.13	2.0	1.0	244	--	--	--	99	25	1.5	1.0	--	620	8	--	--	--
702	478-550	Sept. 1, 1966	Kp	849	8.3	--	--	--	1.0	.2	--	--	452	8	51	9.8	--	--	--	(520)	4	--	--	7.61
803	565-585	Sept. 2, 1966	Kp	826	8.2	--	--	--	.1	.3	--	--	474	0	38	7.4	--	--	--	(500)	1	--	--	7.75
804	555-608	do	Kp	843	8.4	--	--	--	.7	.2	--	--	444	16	43	9.0	--	--	--	(510)	2	--	--	7.76
805	620-650	Sept. 6, 1966	Kp	839	8.4	--	--	--	--	--	--	--	450	14	40	7.5	--	--	--	(510)	9	--	--	7.67
901	638-658	Sept. 1, 1966	Kp	927	8.2	--	--	--	.8	.3	--	--	488	0	70	11	--	--	--	(570)	3	--	--	7.94
903	692-712	July 28, 1966	Kp	927	8.5	--	--	--	--	--	--	--	478	16	59	11	--	--	--	(570)	4	--	--	8.28
31-701	714-734	July 26, 1966	Kp	908	8.4	--	11	--	.8	.4	222	.9	474	12	56	12	1.2	.0	--	548	4	99	48	8.10
702	742-762	July 29, 1966	Kp	947	8.6	--	--	--	--	--	--	--	448	28	68	13	--	--	--	(580)	4	--	--	8.19
801	217**	Apr. 19, 1961	Kwb	1,000	6.8	--	13	.00	50	16	*144	--	266	0	152	90	.5	.5	--	597	191	62	4.5	--
802	220-240	July 21, 1966	Kwb	973	7.8	--	9.0	.80	18	5.8	192	2.5	332	0	181	24	1.0	.0	--	596	69	85	10	4.06
901	200-220	do	Kwb	746	7.8	--	11	--	24	7.4	134	3.2	308	0	104	20	.6	.0	--	455	90	76	6.1	3.24
36-202	400-422	Sept. 27, 1966	Kp	645	8.1	--	--	--	--	--	--	--	352	0	32	13	--	--	--	(390)	10	--	--	5.57
402	120±**	Sept. 29, 1966	Kp	576	7.0	--	--	--	--	--	--	--	310	0	38	11	--	--	--	(350)	250	--	--	.08
403	300±**	do	Kp	578	7.0	--	--	--	--	--	--	--	318	0	35	8.8	--	--	--	(350)	268	--	--	.00
501	345-410	Aug. 23, 1942	Kp?	--	8.0	--	--	--	--	--	--	--	299	27	47	23	--	.0	--	--	--	--	--	--
501	? -450	Aug. 24, 1942	Kp	--	--	--	--	.01	3.6	1.2	*166	--	317	21	45	23	--	.0	--	416	14	--	--	--
501	440-490	Sept. 13, 1942	Kgr	--	7.9	--	12	2.6	18	8.3	*121	--	342	0	33	18	.4	.0	--	382	79	77	5.9	--

See footnotes at end of table.

Table 8.--Chemical Analyses of Water From Wells and Springs in Johnson County--Continued

WELL	PRODUCING INTERVAL (FT)	DATE OF COLLECTION	WATER-BEARING UNIT	SPECIFIC CONDUCTANCE (MICROMHOS AT 25° C)	pH	MANGANESE (Mn)	SILICA (SiO_2)	IRON (Fe)	CALCIUM (Ca)	MAGNESIUM (Mg)	SODIUM (Na)	POTASSIUM (K)	BICARBONATE HCO_3	CARBONATE CO_3	SULFATE (SO_4)	CHLORIDE (Cl)	FLUORIDE (F)	NITRATE (NO_3)	BORON (B)	DISSOLVED SOLIDS a/	HARDNESS AS $CaCO_3$	PERCENT SODIUM	SODIUM ADSORPTION RATIO (SAR)	RESIDUAL SODIUM CARBONATE (RSC)
PX-32-36-501	580-600	Aug. 27, 1942	Kgr	--	8.2	--	--	0.01	21	11	*103	--	332	0	27	15	--	0.0	--	341	98	--	--	--
501	?-1140	Sept. 23, 1942	Ktp, Kh	--	8.3	--	--	.00	4.0	1.9	*229	--	430	0	106	37	--	.0	--	590	18	--	--	--
501	?-1140	Oct. 17, 1942	Ktp, Kh	--	8.4	--	16	.10	2.5	1.1	*230	--	375	28	91	43	0.6	.0	--	597	10	--	--	--
502	376-408	Oct. 10, 1966	Kp	558	7.1	--	--	.01	--	--	--	--	314	0	26	11	--	--	--	(340)	202	--	--	1.11
601	? -430	Feb. 11, 1943	Kp	--	8.3	--	13	.00	1.7	.7	163	6.4	349	10	39	18	.2	.0	--	424	7	--	--	--
602	? -428	do	Kp	--	8.4	--	11	.01	1.8	.9	164	4.0	330	20	41	16	.4	.0	--	421	8	--	--	--
b/ 602	428**	May 1959	Kp	726	8.2	--	--	--	2.0	1	164	--	--	--	40	16	.1	.4	--	436	8	--	--	--
608	425**	Oct. 4, 1966	Kp	695	8.2	--	11	--	1.5	.6	165	.9	384	0	38	10	.3	.2	--	416	6	98	29	6.17
803	430-460	Sept. 9, 1966	Kp	580	7.6	--	15	--	27	11	84	5.4	322	0	26	10	.2	1.2	--	338	112	60	3.5	3.03
901	500±**	Sept. 28, 1966	Kp	745	8.4	--	--	--	--	--	--	--	396	14	28	12	--	--	--	(450)	4	--	--	6.88
902	512**	do	Kp	638	8.1	--	--	--	--	--	--	--	364	0	22	13	--	--	--	(390)	5	--	--	5.87
37-105	495**	Oct. 7, 1966	Kp	703	8.3	--	--	--	--	--	--	--	380	8	38	12	--	--	--	(430)	5	--	--	6.40
201	621-651	Sept. 20, 1966	Kp	743	8.5	--	--	--	--	--	--	--	380	18	34	14	--	.5	--	(450)	10	--	--	6.63
303	? -677	Feb. 11, 1943	Kp	--	9.0	--	9.2	.05	1.7	.7	175	4.2	346	33	33	12	.4	2.0	--	442	7	97	29	--
b/ 303	630-652	Dec. 1957	Kp	796	8.2	--	--	.02	4.0	1	190	--	--	--	45	38	.4	2.2	--	478	14	--	--	--
305	565-621	Sept. 8, 1966	Kp	753	8.5	--	--	--	--	--	--	--	394	18	32	6.8	--	--	--	(460)	5	--	--	6.96
b/ 311	573-651	Dec. 1, 1961	Kp	727	--	<0.05	--	.20	2.0	<1.0	174	--	366	24	31	10	.4	<.4	--	(440)	6	--	--	--
b/ 311	573-651	July 16, 1965	Kp	768	--	< .05	--	<.02	2.0	1.0	177	--	357	26	30	11	.4	<.4	--	(470)	9	--	--	--
602	593-623	Sept. 22, 1966	Kp	787	8.2	--	--	--	--	--	--	--	448	0	40	13	--	--	--	(480)	4	--	--	7.26
603	585-626	Sept. 21, 1966	Kp	805	7.5	--	--	--	--	--	--	--	410	24	43	9.8	--	--	--	(490)	4	--	--	7.44
604	570-622	Sept. 22, 1966	Kp	769	8.3	--	12	--	.5	.4	188	.6	414	12	39	12	.4	.2	--	468	2	99	58	7.14
702	438-478	Oct. 6, 1966	Kp	730	8.3	--	--	--	--	--	--	--	420	8	28	8.2	--	--	--	(450)	5	--	--	7.05
802	554-575	Sept. 9, 1966	Kp	768	8.5	--	--	--	--	--	--	--	408	20	34	7.8	--	--	--	(470)	4	--	--	7.28
c/ 901	1,283**	Apr. 24, 1958	Ktp, Kh	972	8.7	--	15	.05	2.0	.5	*232	--	403	18	91	39	--	--	--	818	7	--	--	--
b/ 38-102	1076-1326	July 10, 1965	Ktp, Kh	1,100	8.7	--	11	.15	2.0	1.0	*274	--	444	19	146	36	1.7	1.2	--	936	9	--	--	--
102	1076-1326	Aug. 9, 1966	Ktp, Kh	1,120	8.2	.06	13	.11	2.5	.9	259	1.2	452	--	160	27	1.6	.2	0.54	688	10	98	36	7.22

See footnotes at end of table.

Table 8.--Chemical Analyses of Water From Wells and Springs in Johnson County--Continued

	WELL	PRODUCING INTERVAL (FT)	DATE OF COLLECTION	WATER-BEARING UNIT	SPECIFIC CONDUCTANCE (MICROMHOS AT 25° C)	pH	MANGANESE (Mn)	SILICA (SiO_2)	IRON (Fe)	CALCIUM (Ca)	MAGNESIUM (Mg)	SODIUM (Na)	POTASSIUM (K)	BICARBONATE HCO_3	CARBONATE CO_3	SULFATE (SO_4)	CHLORIDE (Cl)	FLUORIDE (F)	NITRATE (NO_3)	BORON (B)	DISSOLVED SOLIDS a/	HARDNESS AS $CaCO_3$	PERCENT SODIUM	SODIUM ADSORPTION RATIO (SAR)	RESIDUAL SODIUM CARBONATE (RSC)
	PX-32-38-301	640-669	Aug. 6, 1966	Kp	843	8.4	--	12	--	0.5	0.3	196	0.7	444	8	41	8.4	0.8	1.8	--	488	2	99	60	7.51
	401	593-613	Apr. 19, 1961	Kp	877	8.6	--	12	0.10	1.8	.5	*215	--	422	21	62	18	.9	1.0	--	539	6	99	38	--
	502	? -665	Sept. 15, 1966	Kp	873	8.5	--	--	--	--	--	--	--	434	20	52	15	--	--	--	(530)	4	--	--	7.70
b/	803	800**	Jan. 1949	Kp	--	8.5	--	--	.12	9.0	1.0	235	--	--	--	60	25	.9	.4	--	583	27	--	--	--
	805	680-716	Sept. 8, 1966	Kp	886	8.5	--	12	--	1.8	.2	210	.9	468	4	56	12	.9	1.5	--	529	6	99	37	7.69
d/	901	1,630**	Oct. 8, 1964	Kh	--	8.8	--	18	.08	1.9	1.8	243	--	412	26	66	63	.4	--	--	833	12	--	--	--
	901	1,630**	Aug. 4, 1966	Kh	1,030	8.1	0.07	14	.04	2.2	.2	237	1.0	450	0	70	64	.7	.0	0.40	610	6	98	42	7.25
	903	705-725	Sept. 27, 1966	Kp	1,020	8.3	--	12	--	.8	.6	247	1.2	504	12	84	18	1.5	.2	--	625	4	99	54	8.57
	39-101	--	July 26, 1966	Kwb	1,350	7.4	--	13	4.1	101	24	155	3.6	336	0	242	120	.4	.0	--	824	350	49	3.6	.00
	102	192-215	Aug. 3, 1966	Kwb	1,080	7.4	--	12	.32	43	12	171	4.1	271	0	256	31	1.0	.2	--	663	157	70	5.9	1.30
	103	218-244	do	Kwb	1,000	7.1	--	--	--	--	--	--	--	293	0	214	27	--	--	--	(610)	119	--	--	2.42
	201	250-270	Oct. 6, 1966	Kwb	892	7.5	--	--	.44	--	--	--	--	350	0	137	22	--	--	--	(540)	52	--	--	4.70
	401	755-791	Aug. 3, 1966	Kp	975	8.2	--	--	--	--	--	--	--	520	0	68	19	--	--	--	(600)	12	--	--	8.28
	502	177-197	Oct. 7, 1966	Kwb	1,870	7.4	--	--	--	--	--	--	--	208	0	656	129	--	--	--	(1,140)	600	--	--	.00
	701	699-837	Oct. 28, 1966	Kp	1,240	8.1	.00	12	.03	2.0	.6	297	.2	584	0	132	28	2.9	.0	1.3	763	8	99	46	9.42
d/	702	766-1454	May 5, 1947	Kp, Ktp, Kh	--	8.4	--	9.0	.10	2.9	1.0	281	--	503	29	102	40	--	--	--	712	11	--	--	--
	702	776-1454	Mar. 7, 1949	Kp, Ktp, Kh	1,170	8.3	--	13	--	1.7	1.2	*285	--	546	0	128	32	--	2.2	--	730	9	99	--	--
b/	702	776-1634	Aug. 1957	Kp, Ktp, Kh	1,350	8.2	--	--	.10	7	1.0	285	--	--	--	140	36	3.2	1.3	--	810	21	--	--	--
	703	1,677*	Feb. 12, 1943	Kh	--	8.4	--	14	.06	2.4	.7	242	4.0	421	18	74	62	.2	.5	--	626	9	--	--	--
	704	766-810	Aug. 3, 1966	Kp	1,200	8.1	--	--	--	--	--	--	--	570	0	127	26	--	--	--	(730)	6	--	--	9.22
	705	191-217	do	Kwb	949	7.6	--	9.6	.10	3.5	1.1	216	2.5	448	0	82	26	1.5	3.8	--	566	13	97	26	7.08

See footnotes at end of table.

Table 8.--Chemical Analyses of Water From Wells and Springs in Johnson County--Continued

WELL	PRODUC-ING INTER-VAL (FT)	DATE OF COLLECTION	WATER-BEARING UNIT	SPECIFIC CONDUC-TANCE (MICROMHOS AT 25° C)	pH	MANGA-NESE (Mn)	SILICA (SiO_2)	IRON (Fe)	CAL-CIUM (Ca)	MAGNE-SIUM (Mg)	SODIUM (Na)	POTAS-SIUM (K)	BICAR-BONATE HCO_3	CAR-BON-ATE CO_3	SUL-FATE (SO_4)	CHLO-RIDE (Cl)	FLUO-RIDE (F)	NI-TRATE (NO_3)	BORON (B)	DIS-SOLVED SOLIDS a/	HARD-NESS AS $CaCO_3$	PER-CENT SODIUM	SODIUM AD-SORP-TION RATIO (SAR)	RESI-DUAL SO-DIUM CAR-BON-ATE (RSC)
PX-32-39-706	732-742	Oct. 27, 1966	Kp	1,310	8.3	--	--	--	--	--	--	--	584	8	146	31	--	--	--	(800)	7	--	--	9.70
801	180-225	Aug. 10, 1966	Kwb	894	7.9	--	--	--	--	--	--	--	388	0	108	19	--	--	--	(550)	56	--	--	5.24
802	240-250	do	Kwb	1,310	8.0	--	--	1.2	--	--	--	--	324	0	298	58	--	--	--	(800)	68	--	--	3.95
40-402	380**	Apr. 19, 1961	Kwb	1,130	8.0	0.03	10	.05	5.0	1.9	259	2.2	388	0	223	21	0.7	0.0	1.1	715	20	96	25	--
404	274-290	Oct. 7, 1966	Kwb	973	7.4	--	--	--	--	--	--	--	316	0	207	15	--	--	--	(590)	88	--	--	3.42
44-202	425**	July 27, 1966	Kp	757	8.7	--	11	--	.9	.4	182	.7	376	22	36	14	.5	.5	--	452	4	99	40	6.82
302	449**	July 26, 1966	Kp	728	8.5	--	11	--	.3	.3	176	.7	386	16	28	11	.4	1.0	--	436	2	99	55	6.83
303	558**	July 26, 1966	Kgr?	805	8.5	--	10	--	.8	.4	192	.7	400	16	42	21	.7	.0	--	479	4	99	42	7.02
401	212**	July 27, 1966	Kp	527	7.2	--	17	1.2	75	15	15	1.9	312	0	17	8.0	.3	.0	--	302	248	11	.4	.14
601	340-405	July 20, 1966	Kp	752	8.3	--	10	--	.6	.4	184	.8	430	6	28	9.8	.5	.2	--	451	3	99	46	7.19
702	747**	July 13, 1966	Ktp	848	7.7	--	10	--	4.6	2.6	180	1.7	414	0	77	21	.8	.2	--	502	22	94	17	6.35
704	260**	do	Kp	593	6.9	--	20	--	79	21	19	2.0	354	0	28	7.5	.3	.0	--	351	284	13	.5	.13
b/ 45-304	1,274**	Jan. 8, 1938	Ktp, Kh	--	8.9	.01	14	.30	3.6	.8	--	--	--	--	97	50	.3	--	--	--	13	--	--	--
306	936**	Feb. 28, 1952	Ktp	983	8.3	.00	14	.01	1.8	1.2	231	1.2	4.6	Traces	109	34	1.1	1.5	.59	602	10	98	--	--
b/ 307	1,206**	Oct. 17, 1941	Ktp, Kh	--	8.5	<.03	10	.06	5.0	2.0	*225	--	384	18	105	39	.8	<.4	--	584	21	--	--	--
307	1,206**	Mar. 7, 1949	Ktp, Kh	979	8.6	--	14	.00	1.8	1.1	222	14	370	24	104	39	1.2	1.5	.42	613	9	98	--	--
308	1,206**	do	Ktp	979	8.6	--	13	.00	2.2	1.3	224	12	356	30	108	40	1.0	1.5	.14	613	11	98	--	--
501	393-442	Aug. 11, 1966	Kp	862	8.6	--	--	--	--	--	--	--	502	22	27	5.8	--	--	--	(530)	4	--	--	8.15
503	475-498	Aug. 23, 1966	Kp	967	8.6	--	--	--	--	--	--	--	486	30	47	18	--	--	--	(590)	5	--	--	8.87
c/ 601	1,266**	Apr. 14, 1955	Kh	--	8.8	--	14	.20	2.0	1.0	*235	--	378	24	106	42	--	--	--	610	9	--	--	--
704	454**	July 21, 1966	Kp	802	8.6	--	11	--	.7	.4	196	.8	434	20	30	9.6	.6	.2	--	482	3	99	49	7.72
705	422-462	Sept. 21, 1966	Kp	1,360	8.4	--	--	--	--	--	--	--	438	16	174	82	--	--	--	(830)	10	--	--	7.51
801	381-610	Sept. 13, 1966	Kp	1,470	8.0	--	--	--	--	--	--	--	768	0	118	19	--	--	--	(900)	13	--	--	12.3
901	496-525	Aug. 11, 1966	Kp	920	8.8	--	11	.04	1.5	.2	217	.9	418	35	49	25	.8	.0	--	545	4	99	47	6.76
46-201	1,395-1,518	Sept. 28, 1966	Kh	1,030	8.0	--	13	.11	2.5	.6	240	1.4	432	0	129	32	1.3	.2	--	632	8	98	37	6.91

See footnotes at end of table.

Table 8.--Chemical Analyses of Water From Wells and Springs in Johnson County--Continued

WELL	PRODUCING INTERVAL (FT)	DATE OF COLLECTION	WATER-BEARING UNIT	SPECIFIC CONDUCTANCE (MICROMHOS AT 25° C)	pH	MANGANESE (Mn)	SILICA (SiO_2)	IRON (Fe)	CALCIUM (Ca)	MAGNESIUM (Mg)	SODIUM (Na)	POTASSIUM (K)	BICARBONATE HCO_3	CARBONATE CO_3	SULFATE (SO_4)	CHLORIDE (Cl)	FLUORIDE (F)	NITRATE (NO_3)	BORON (B)	DISSOLVED SOLIDS a/	HARDNESS AS $CaCO_3$	PERCENT SODIUM	SODIUM ADSORPTION RATIO (SAR)	RESIDUAL SODIUM CARBONATE (RSC)
PX-32-46-203	730-782	Aug. 18, 1966	Kp	959	8.5	--	--	--	--	--	--	--	464	20	66	18	--	--	--	(590)	4	--	--	8.19
204	657-713	do	Kp	992	8.5	--	--	--	--	--	--	--	486	16	74	18	--	--	--	(610)	4	--	--	8.42
205	724-770	Aug. 18, 1966	Kp	1,040	8.4	--	--	--	--	--	--	--	494	8	95	22	--	--	--	(630)	5	--	--	8.27
401	1,284-1,350	do	Kh	1,070	8.3	--	--	--	--	--	--	--	442	8	117	41	--	--	--	(650)	7	--	--	7.37
601	698-719	Aug. 16, 1966	Kp	1,440	8.5	--	--	--	--	--	--	--	624	16	178	27	--	--	--	(880)	9	--	--	10.6
602	749-790	do	Kp	1,260	8.4	--	--	--	--	--	--	--	566	18	135	22	--	--	--	(770)	7	--	--	9.74
702	500-537	Aug. 18, 1966	Kp	1,240	8.4	--	--	--	--	--	--	--	564	18	92	46	--	--	--	(760)	6	--	--	9.72
902	137**	Aug. 10, 1966	Kwb	1,210	6.9	--	--	--	--	--	--	--	320	0	261	85	--	--	--	(740)	580	--	--	.00
47-101	795**	Aug. 3, 1966	Kp	1,260	8.1	--	11	--	0.7	0.5	302	1.8	622	0	109	27	3.8	2.2	--	764	4	99	66	10.0
102	220**	Aug. 18, 1966	Kwb	1,560	7.6	--	11	4.0	125	33	170	6.1	372	0	374	105	.4	.0	--	1,010	448	45	3.5	.00
202	189-196	Aug. 2, 1966	Kwb	828	7.1	--	12	.51	48	15	107	5.0	286	0	147	25	.4	.2	--	501	182	55	3.4	1.06
302	246-256	Aug. 3, 1966	Kwb	689	7.2	--	12	--	10	3.4	139	3.3	316	0	58	20	.9	.2	--	402	39	88	9.7	4.40
401	730-772	Aug. 2, 1966	Kp	1,360	7.9	--	11	.05	2.2	.8	319	1.8	614	0	160	29	3.4	.5	--	830	9	98	46	9.88
403	115-152	Aug. 10, 1966	Kwb	1,490	7.1	--	13	--	178	33	104	5.6	224	0	500	74	.5	2.0	--	1,020	580	28	1.9	.00
504	187**	Aug. 4, 1966	Kwb	652	7.2	--	12	--	26	8.8	99	4.5	275	0	62	25	.7	1.2	--	374	101	67	4.3	2.49
601	289-300	Aug. 2, 1966	Kwb	932	7.6	--	9.6	.29	5.2	2.0	207	2.2	392	0	109	31	1.4	.5	--	561	21	95	20	6.00
b/ 801	210**	Aug. 1952	Kwb	--	7.4	--	--	.36	32	16	140	--	--	--	183	43	.7	.4	--	540	140	--	--	--
b/ 802	802-846	Mar. 1955	Kp	--	8.4	--	--	1.7	3.0	1.0	401	--	--	--	233	50	5.6	.4	--	1,080	12	--	--	--
802	802-846	Aug. 30, 1966	Kp	1,700	8.3	--	11	--	3.0	1.6	408	2.3	684	4	251	39	7.2	.0	1.9	1,060	14	98	47	11.1
803	214**	Mar. 7, 1949	Kwb	1,080	7.2	--	14	.02	63	26	138	7.2	274	0	249	57	.6	9.0	.77	710	264	54	--	--
804	183-223	Aug. 3, 1966	Kwb	1,960	7.4	--	9.8	--	4.4	1.6	451	3.6	556	0	415	71	3.0	.5	--	1,230	18	98	46	8.76
805	273**	Apr. 21, 1943	Kwb	--	7.8	--	13	.04	21	8.6	138	3.4	273	0	115	31	.5	5.6	--	479	88	--	--	--
b/ 805	273**	Aug. 1952	Kwb	--	7.2	0.10	--	2.7	106	44	120	--	--	--	345	75	.4	.4	--	880	446	--	--	--
805	273**	Aug. 30, 1966	Kwb	957	7.4	.04	12	.19	46	17	136	5.0	282	0	192	42	.5	.2	.52	590	185	61	4.4	.92
901	210**	do	Kwb	2,160	7.2	--	--	--	--	--	--	--	264	0	916	78	--	--	--	(1,320)	864	--	--	.00

See footnotes at end of table.

WELL	PRODUC-ING INTER-VAL (FT)	DATE OF COLLECTION	WATER-BEARING UNIT	SPECIFIC CONDUC-TANCE (MICROMHOS AT 25° C)	pH	MANGA-NESE (Mn)	SILICA (SiO_2)	IRON (Fe)	CAL-CIUM (Ca)	MAGNE-SIUM (Mg)	SODIUM (Na)	POTAS-SIUM (K)	BICAR-BONATE HCO_3	CAR-BON-ATE CO_3	SUL-FATE (SO_4)	CHLO-RIDE (Cl)	FLUO-RIDE (F)	NI-TRATE (NO_3)	BORON (B)	DIS-SOLVED SOLIDS a/	HARD-NESS AS $CaCO_3$	PER-CENT SODIUM	SODIUM AD-SORP-TION RATIO (SAR)	RESI-DUAL SO-DIUM CAR-BON-ATE (RSC)
PX-32-48-702	220-265	Apr. 20, 1961	Kwb	1,060	8.3	--	11	0.05	1.5	0.0	*262	--	559	6	70	20	1.1	2.2	--	649	4	99	57	--
52-202	784-893	July 20, 1966	Kh	828	8.3	--	11	--	1.5	.6	195	1.2	400	4	63	24	.4	.0	--	497	6	98	35	6.57
502	300**	July 14, 1966	Kp	803	7.9	--	11	--	3.7	2.6	171	1.4	414	0	68	14	.7	1.0	--	477	20	95	17	6.40
503	Spring	do	Qal	515	7.0	--	15	--	95	6.1	9.9	2.0	310	0	14	7.6	.2	.8	--	303	262	8	.3	.00
903	500+**	do	Ktp	797	7.9	--	11	--	4.4	3.3	167	1.7	386	0	77	16	.7	.2	--	471	24	93	15	5.84
53-302	510**	Apr. 19, 1961	Kp	1,110	8.5	0.01	12	.02	1.5	.4	268	1.5	502	19	79	44	2.2	.0	1.0	676	5	99	52	--
501	380-425	Aug. 23, 1966	Kp	970	8.6	--	--	--	--	--	--	--	484	24	50	21	--	--	--	(590)	6	--	--	8.61
601	400-425	Aug. 11, 1966	Kp	1,270	8.2	--	--	--	--	--	--	--	580	0	116	46	--	--	--	(780)	8	--	--	9.35
b/ 54-101	1,107-1,215	Dec. 7, 1965	Kh	1,000	8.7	--	--	.12	2.0	1.0	224	--	365	12	118	37	.5	.5	--	760	9	--	--	--
101	1,107-1,215	Aug. 17, 1966	Kh	954	8.1	.00	12	.6	2.0	.5	224	10	400	0	107	37	.4	.0	.29	581	7	98	37	6.42
201	18**	Aug. 16, 1966	Kwb	679	6.0	--	21	10	68	17	34	2.7	48	0	164	78	.2	.0	--	409	240	23	1.0	.00
202	560**	do	Kp	1,260	8.4	--	--	--	--	--	--	--	544	16	134	33	--	--	--	(770)	6	--	--	9.33
55-101	235**	do	Kwb	1,220	7.8	--	--	--	--	--	--	--	456	0	194	38	--	--	--	(740)	23	--	--	7.01

a/ Values enclosed in parentheses are approximate dissolved solids based on Johnson County average of factor "K" relationship between measured specific conductance (micromhos at 25° C) and known amount of dissolved solids in the water samples of the county: relationship--------Hem (1959, p. 40) Specific Conductance (micromhos at 25° C) X factor K = Approximate dissolved solids (mg/l), when factor K = 0.61.
b/ Analyses by Texas State Department of Health, Austin, Texas.
c/ Analyses by Curtis Laboratories, Houston, Texas.
d/ Analyses by Pope Testing Laboratories, Dallas, Texas.
* Sodium and potassium calculated as sodium (Na).
** Total depth.