TEXAS WATER DEVELOPMENT BOARD

REPORT 57

OCCURRENCE AND QUALITY OF GROUND WATER IN COLEMAN COUNTY, TEXAS

By

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FOREWORD

On September 1, 1965 the Texas Water Commission (formerly, before February 1962, the State Board of Water Engineers) experienced a far-reaching realignment of functions and personnel, directed toward the increased emphasis needed for planning and developing Texas' water resources and for administering water rights.

Realigned and concentrated in the Texas Water Development Board were the investigative, planning, development, research, financing, and supporting functions, including the reports review and publication functions. The name Texas Water Commission was changed to Texas Water Rights Commission, and responsibility for functions relating to water-rights administration was vested therein.

For the reader's convenience, references in this report have been altered, where necessary, to reflect the current (post September 1, 1965) assignment of responsibility for the function mentioned. In other words credit for a function performed by the Texas Water Commission before the September 1, 1965 realignment generally will be given in this report either to the Water Development Board or to the Water Rights Commission, depending on which agency now has responsibility for that function.

Ground-water studies that are currently being conducted by the staff of the Texas Water Development Board in a block of counties in north-central Texas were undertaken by the Texas Water Commission beginning January 1962 to meet a growing need for more detailed and accurate ground-water information in this area.

In recognizing the significance of ground water in this area, the Water Development Board is aware of the vital need for obtaining information on the depth of occurrence of usable quality water as the basis for providing adequate and equitable protection for these water supplies.

As initially planned, the investigations will be conducted in the following counties: Archer, Brown, Callahan, Clay, Coleman, Eastland, Jack, Jones, Montague, Palo Pinto, Shackelford, Stephens, Taylor, Throckmorton, and Young Counties. In these counties, several towns with municipal water supplies are served by ground water or have water wells as a standby supply. In addition to meeting municipal needs for water, ground water is often the sole source supplying domestic, farm, and ranch needs.

The area under study is underlain by Pennsylvanian and Permian rocks which either crop out at the surface or underlie Cretaceous and alluvial sediments at shallow depths. Ground water occurs erratically in shallow discontinuous zones of low permeability in Pennsylvanian and Permian rocks, in sands and fractured limestones in the relatively thin Cretaceous sediments, and in Pleistocene to Recent alluvial sediments that are found at the surface in parts of most of the counties included in this study. Initially the objective of these investigations was to provide additional data for use in making recommendations to the Railroad Commission and oil industry as to the depth to which usable quality water should be protected. It was recognized early in the course of the investigations, however, that the scope of the program should be enlarged to provide information for the use of landowners and others interested in water-resource development to facilitate development of the ground-water supplies available.

The present program of study has been under consideration for several years, although personnel had not been available to initiate such a long-range study. However, the scope, objectives, and methods of study to be employed had been part of the planning of the Texas Water Commission, and when funds became available to begin these investigations they were included in the ground-water program of the Commission.

In January 1962, funds allocated to the then Texas Water Commission by the Texas Water Pollution Control Board, for the purpose of investigation and prevention of ground-water pollution made possible the beginning of the present program. These funds were allocated to the Water Commission by the Pollution Control Board under the provision of the Act creating the Pollution Control Board which directs the Texas Water Commission to, "...investigate and ascertain those situations in which the underground waters of the State are being polluted or are threatened with pollution, and it shall report all findings to the Board together with its recommendations in regard thereto."1/

It was determined that these studies could be most feasibly conducted on a county-by-county basis, and the initial investigations were begun in Stephens, Young, and Brown Counties. Reports from the results of the investigations in Stephens and Young Counties were published as Texas Water Commission Bulletins 6412 and 6415, respectively, whereas, on September 1, 1965 the ground-water programs became the responsibility of the Texas Water Development Board. Reports on each of the 13 remaining counties will be prepared and published by the Texas Water Development Board as the field studies are completed.

Texas Water Development Board

John J. Vandertulip

John J. Vandertulip
Chief Engineer

1/ 57th Texas Legislature, 1961, Article 7621d, Vernon's Civil Statutes.

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OCCURRENCE AND QUALITY OF GROUND WATER IN COLEMAN COUNTY, TEXAS

ABSTRACT

Coleman County is near the geographic center of the State, and is within the outcrop area of the upper Pennsylvanian and lower Permian rocks of north-central Texas. Several erosional remnants of Cretaceous rocks are present in the county. These rocks are a part of the Trinity and Fredericksburg Groups, and are outliers to the Callahan Divide, which separates the Brazos River valley from the Colorado River valley. Pleistocene to Recent alluvial sediments occur along the streams in Coleman County.

Ground water of usable quality occurs in limited amounts in Coleman County in sediments of Ordovician, Pennsylvanian, Permian, and Cretaceous ages, and in alluvial deposits in the stream valleys. The Trinity Group of Cretaceous age supplies approximately 45 percent of usable quality ground water in the county. About 40 percent of usable quality ground water is supplied from shallow, discontinuous zones of low permeability within the Wichita and Clear Fork Groups of Permian age. The remaining 15 percent is produced from sediments of the Canyon and Cisco Groups of Pennsylvanian age, surficial alluvium, and the Ellenburger Group of Ordovician age.

The principal chemical constituents affecting quality of ground water in Coleman County are calcium, sodium, bicarbonate, chloride, and sulfate. The range in chemical quality of ground water is variable. An attempt was made to determine the native quality of ground water in the several aquifers by noting trends in the variations of chemical constituents. Water from several wells contains a high concentration of chloride, which does not coincide with the probable native quality of ground water, and these wells are treated in this report as apparently contaminated or possibly contaminated wells.

The methods of disposal of oil-field brine account for the impairment of soils and native-quality water in some areas in Coleman County. Reported brine production in the county for 1961 was 9,713,711 barrels. Of this amount, 96 percent was reported returned to the subsurface through injection and disposal wells, 3 percent was reported disposed into surface pits, and 1 percent was reported disposed of by other methods.

OCCURRENCE AND QUALITY OF GROUND WATER IN COLEMAN COUNTY, TEXAS

INTRODUCTION

Purpose and Scope

The economy and future growth of the north-central Texas area is directly dependent upon the availability of water of usable quality. Because of the scarcity of surface-water supplies of good quality, additional information regarding the occurrence and availability of ground water was essential to an evaluation of the area's potential water-resources development. The purpose of the study in Coleman County was twofold: to obtain information regarding the occurrence and chemical quality of ground water for use by landowners and others interested in water-resources development in the county, and to provide sufficient information for the Texas Water Development Board and other agencies responsible for protection of water quality so that water-quality protection programs can be both adequate for protection of the water available and equitable when applied to industries operating in the county.

The objectives of the Coleman County study were to compile supplementary basic data in order to more accurately delineate underground formations containing usable water; to determine the depth of this water, and its quality as indicated by chemical analyses; to tabulate available data on brines produced with oil and gas, and to determine the location and method of disposal of the brine; to review surface-casing recommendations of this agency in the light of field observations in order to determine where revisions are needed; and to prepare a report for the use of landowners, the Texas Water Development Board, other State and Federal agencies, and the general public.

This study was made under the general direction of John J. Vandertulip, Chief Engineer, Richard C. Peckham, director, Ground Water Division, and Bernard B. Baker, assistant director in charge of Availability Programs.

Method of Investigation

An inventory of 488 wells and springs was conducted during 1964 to determine the depths of wells, the aquifers in which the wells are completed, and the methods of well construction.

Elevations were established on most wells and springs with the aid of topographic maps, grade elevations furnished by the Texas Highway Department, elevations established by the U.S. Soil Conservation Service, and by altimeter. These elevations aid in comparing the measurements of depth to water made in numerous wells.

Chemical analyses of 384 water samples collected from wells in Coleman County were studied to determine the quality characteristics of ground water.

Available electric logs were used as an aid in the interpretation of subsurface geologic conditions related to the occurrence of ground water.

Oil-field brine disposal practices were observed and available brine analyses were tabulated.

Previous Investigations

Several reports contain general information on the geology of north-central Texas; however, no detailed investigation of Coleman County ground water has been made prior to this study. Samuell and Davis (1937) recorded the inventory of 368 wells and included drillers' logs of 19 oil tests and partial chemical analyses of 129 water samples from wells in Coleman County. Holloway (1962) reported on ground-water contamination in a small area of west-central Coleman County.

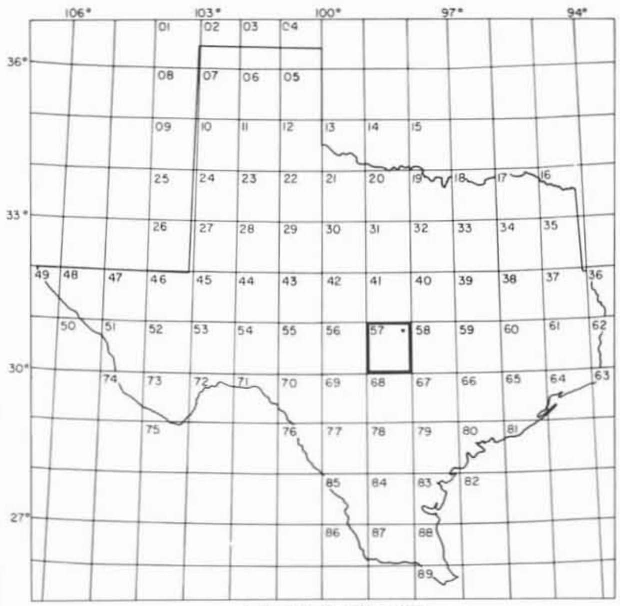
A recent reconnaissance investigation of ground-water resources of the entire Colorado River basin was made by Mount and others (1967), but coverage within Coleman County was generalized as would be expected in a study of this type. Other reports relating to the geology of the area are listed at the end of this report in the selected references.

Well-Numbering System

The numbers assigned to wells and springs in this report conform to the statewide well-numbering system used by the Texas Water Development Board. Each well and spring is assigned a number to facilitate record keeping and locating the well within the State. This system is based on division of the State into quadrangles formed by degrees of latitude and longitude, and repeated divisions of these quadrangles into smaller ones as illustrated in Figure 1.

The largest quadrangle, a 1-degree quadrangle, is divided into sixty-four $7\frac{1}{2}$-minute quadrangles, each of which is further divided into nine $2\frac{1}{2}$-minute quadrangles. Each 1-degree quadrangle in the State has been assigned a number for identification. The $7\frac{1}{2}$-minute quadrangles are numbered consecutively from left to right beginning in the upper left hand corner of the 1-degree quadrangle, and the $2\frac{1}{2}$-minute quadrangles within the $7\frac{1}{2}$-minute quadrangle are similarly numbered. The first two digits of a well number identify the 1-degree quadrangle, the third and fourth digits identify the $7\frac{1}{2}$-minute quadrangle, the fifth digit identifies the $2\frac{1}{2}$-minute quadrangle, and the last two digits designate the order in which the well was inventoried within the $2\frac{1}{2}$-minute quadrangle. In addition to the 7-digit well number, a 2-letter prefix is used to identify the county. The prefix for Coleman County is DS.

Some of the wells and springs for which data are given in this report (Tables 2 and 3) are the same wells for which data are given in an earlier



I-degree Quadrangles

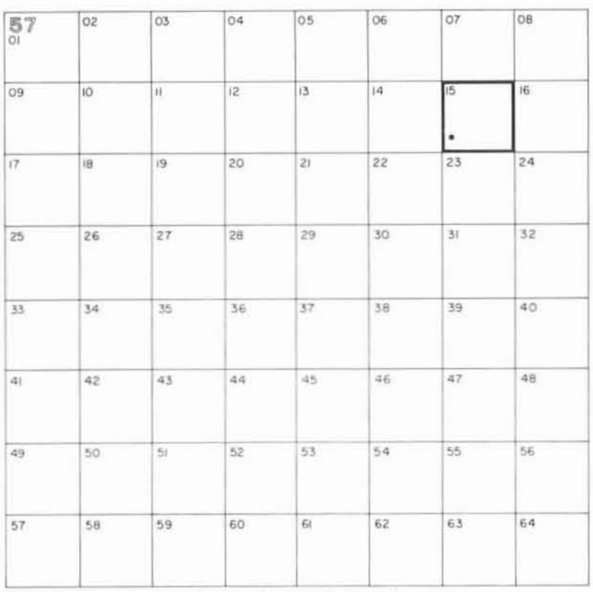
Location of Well 57-15-701

57 I-degree quadrangle

15 7 1/2-minute quadrangle

7 2 1/2-minute quadrangle

01 Well number within 2 1/2-minute quadrangle


7 1/2-minute Quadrangles

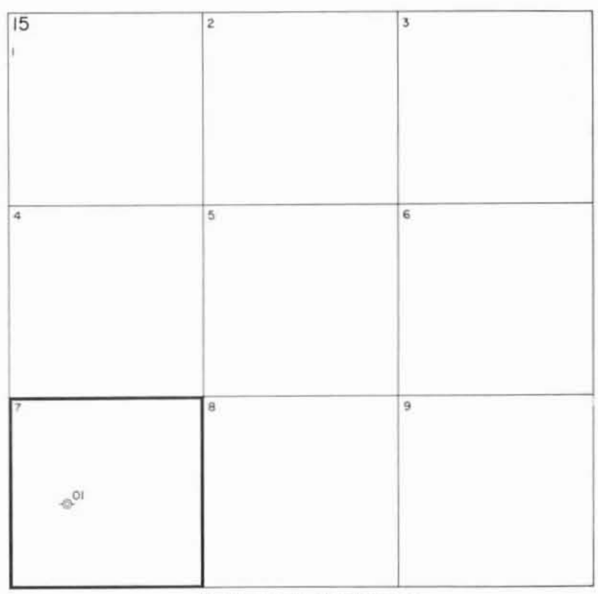

2 1/2-minute Quadrangles

Figure 1

Well - Numbering System

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Works Progress Administration report by Samuell and Davis (1937). The numbers assigned to these wells in the earlier report are listed in the Remarks column in Table 2. Some of the well records included in the earlier report are omitted in this report because the wells were abandoned, not visited, or could not be located during the present investigation.

Acknowledgements

Appreciation is expressed to the many ranchers, farmers, and well drillers who generously contributed information and cooperated in the collection of field data. Appreciation also is expressed to the U.S. Soil Conservation Service, the Railroad Commission of Texas, the Texas State Department of Health, the Texas Highway Department, the U.S. Geological Survey, and other County, State, and Federal agencies who furnished information. Special appreciation is expressed to Mr. R. L. Barnett, Land Surveyor, who generously contributed time and data on surface elevations in the county.

GEOGRAPHIC SETTING

Location

Coleman County comprises an area of 1,282 square miles, and lies generally between 99°13' and 99°43' west longitude and between 31°25' and 32°05' north latitude in the plateau region of north-central Texas (Figure 2). Coleman, the county seat, is about 160 miles southwest of Fort Worth near the intersection of U.S. Highways 84 and 283.

Climate

The Coleman County climate is subhumid. The average annual rainfall depth is 26 inches, based on U.S. Weather Bureau records for the 30-year period 1931-60. The greatest officially recorded annual rainfall depth in the county, based on U.S. Weather Bureau records for 1931-60, was 45.28 inches at Coleman in 1935, and the least amount was 11.57 inches at Novice in 1943.

The mean temperature for the month of January is 46°F, while the mean temperature for July is 84°F. The average annual-mean temperature is about 66°F, based on records for the 30-year period 1931-60. The first frost in autumn usually occurs about November 15, while the last frost in spring usually occurs about March 26, leaving an annual average of about 230 frost-free days.

The average annual gross lake surface evaporation depth is about 81 inches, based on records for the 18-year period 1940-57.

The average monthly distribution of the precipitation and the average monthly distribution of the gross and net lake surface evaporation are shown on Figure 3.

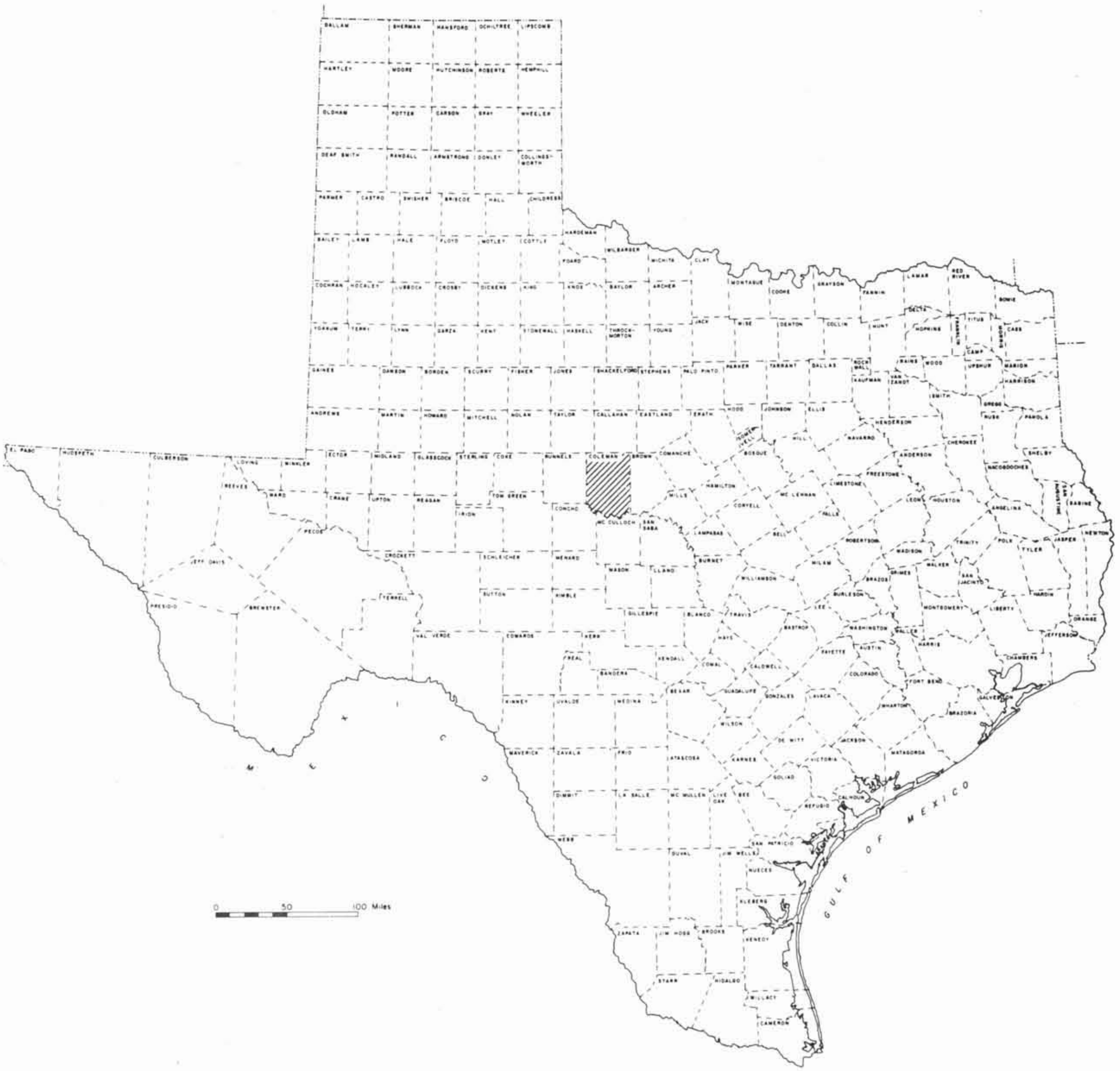

Figure 2

Map of Texas Showing Location of Coleman County

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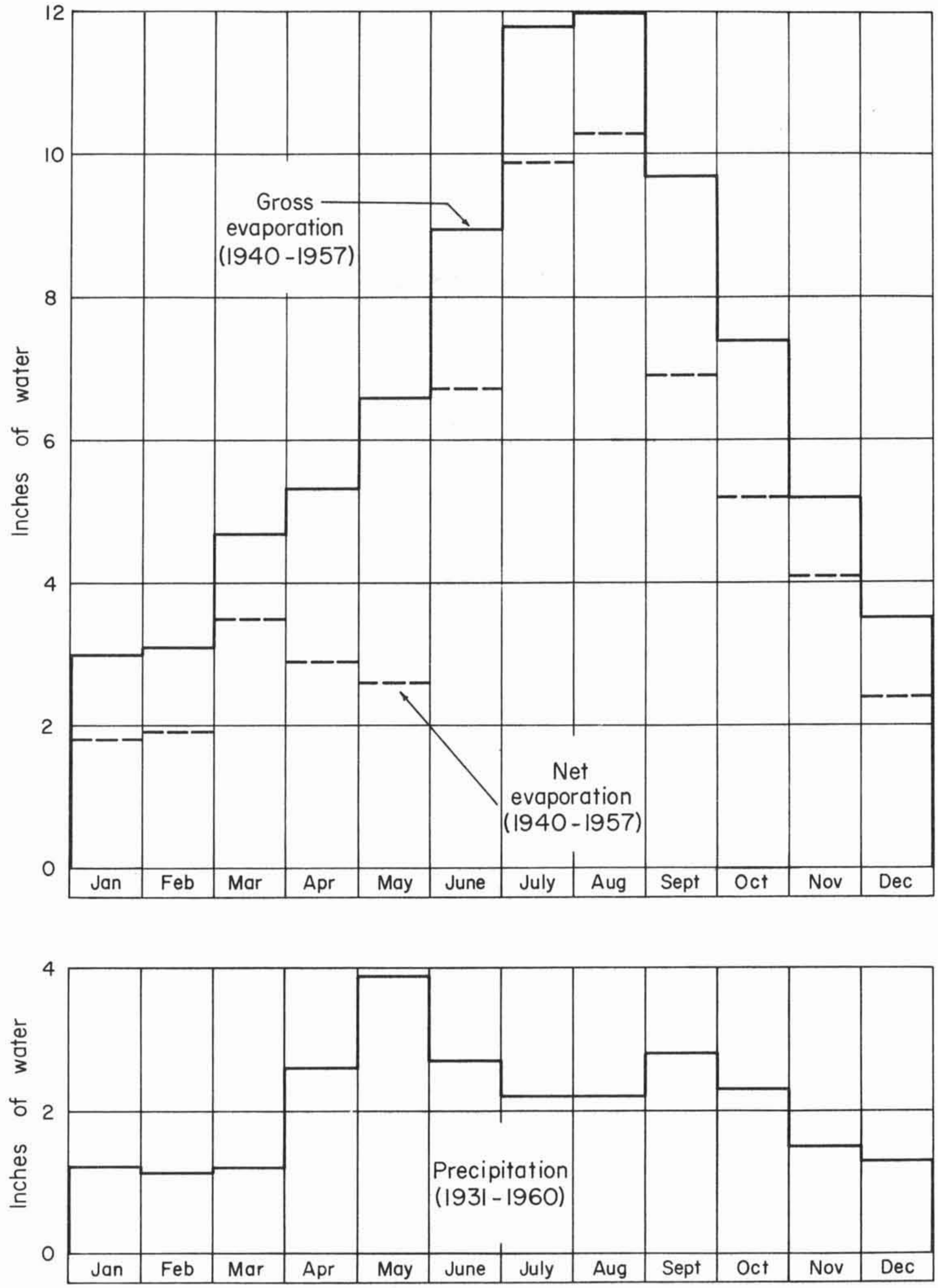


Figure 3

Average Monthly Precipitation and Lake-Surface Evaporation, Coleman County

(From records of U. S. Weather Bureau, and Lowry, 1960)

Texas Water Development Board

Topography and Drainage

The land surface in Coleman County is generally rolling terrain with some prominent hills, and ranges in elevation from approximately 1,300 to 2,250 feet above mean sea level. Prominent elevations include Chambers Peak, Jim Ned Peak, Robinson Peak, Santa Anna Mountain, Bead Mountain, Parks Mountain, and Round Mountain.

Coleman County lies entirely within the Colorado River drainage system.

A drainage divide trends east-west across Coleman County. This divide enters the county east of Santa Anna, passes through the town of Coleman, and enters Runnels County about 3 miles north of Talpa. The northern part of the county is drained by Jim Ned and Hords Creeks, and Pecan Bayou, tributaries of the Colorado River. These streams flow eastward into Brown County. The central and south portions of the county are drained by Home, Grape, Elm, Panther, Bull, and Mukewater Creeks and their tributaries which flow into the Colorado River.

Lake Scarborough, with a capacity of 2,153 acre-feet, is 4 miles north of Coleman on Indian Creek, a tributary of Jim Ned Creek. This reservoir provided the primary municipal water supply for the town of Coleman from 1923 to 1948, at which time Coleman's water supply was augmented by an annual 2,240 acre-feet of water from Hords Creek Reservoir.

Hords Creek Reservoir, constructed in 1948 with a capacity of 8,640 acre-feet, is 9 miles west of the town of Coleman on Hords Creek, a tributary of Jim Ned Creek. The reservoir is owned by the U.S. Government and operated by the U.S. Army Corps of Engineers, Fort Worth District. The city of Coleman purchased the conservation storage in this reservoir by contributing $100,000.00 toward the first cost of the project.

Coleman Reservoir on Jim Ned Creek 14 miles north of Coleman, with a storage capacity of 40,000 acre-feet, was built during 1965-66 by the city of Coleman for an additional water supply for municipal and industrial purposes.

History, Population, and Economy

Coleman County was created from a part of Travis County, the first organization being perfected in 1858 by the Texas Supreme Court. During the Civil War the original county organization was abandoned. The present organization of the county was perfected in 1875, and Coleman was made the county seat in 1876. According to the 1960 Federal census, the population of Coleman County was 12,458 and that of Coleman, the largest town in the county, was 6,371.

The highway system in Coleman County includes U.S. Highways 67, 84, and 283, State Highway 206, and many paved farm-to-market roads. Coleman is served by the Gulf, Colorado, and Sante Fe Railroad. The nearest scheduled airline service is at Abilene, which is 60 miles northwest of Coleman.

Cattle, sheep, and goat raising produce three-fourths of the farm-ranch income. The principal crops are wheat, oats, barley, grain sorghum, and cotton. According to the 1959 census of agriculture, about 100,463 acres is under cultivation (Coleman County Extension Service, 1964), which represents 8 percent of total land area in the county.

Production of oil and natural gas provides an important source of income in Coleman County. Oil was first discovered in 1910. The greatest number of field discoveries for one year was 29, during 1952. Total oil production for the county was 2,721,554 barrels in 1962, and total natural gas produced was approximately 11 billion cubic feet, according to the 1962 annual report of the Oil and Gas Division of the Railroad Commission of Texas.

OCCURRENCE AND QUALITY OF GROUND WATER

Ground water of usable quality occurs in limited amounts in Coleman County in rocks of Ordovician, Pennsylvanian, Permian, and Cretaceous ages, and in alluvial deposits of Quaternary age.

In Coleman County, all formations (excluding the surficial alluvial deposits) dip west-northwest except the Cretaceous rocks which dip gently southeast. The Pennsylvanian and Permian rocks crop out in a northeast-southwest trend, with the older beds cropping out in the eastern part of the county and progressively younger beds cropping out to the west.

Ground-water development is principally in the Trinity Group of Cretaceous age, which is generally confined to the northwest part of the county, and in the Wichita Group of Permian age which is exposed at the land surface over about three-fourths of the county (Figure 4). Water-well development is concentrated in the northwest part of the county as shown on Figure 7.

A major portion of the well development in Coleman County is for domestic and livestock purposes. In 1964, there were 444 domestic and livestock wells, 2 irrigation wells, 5 industrial wells, and 2 public-supply wells in use in the county.

In following sections of this report, conditions of ground-water occurrence in the following geologic units are discussed: the Ellenburger Group of the Ordovician System, the Canyon and Cisco Groups of the Pennsylvanian System, the Wichita and Clear Fork Groups of the Permian System, the Trinity Group of the Cretaceous System, and alluvial sediments of the Quaternary System. Brief descriptions of the lithologic characteristics of these and associated rock units are listed in Table 1. The stratigraphic relationships of these rock units are illustrated by Figure 8, and their areas of exposure at the land surface are shown on Figure 4. The depositional history of these rocks is discussed in more detail in the Appendix.

The wide range in depth and manner of occurrence of ground water in Coleman County is reflected in the varied chemical character of the water. The quality of water particular to each of the geologic units is discussed in detail in the following sections. The Appendix contains a discussion of water-quality criteria, which will be helpful in interpreting the data on chemical analyses of water discussed in the following text and tabulated in Table 3.

A total of 384 water samples were collected for chemical analysis from water wells in Coleman County. The principal chemical constituents as identified by these analyses are silica, calcium, magnesium, sodium, bicarbonate, sulfate, chloride, fluoride, and nitrate (Table 3). The silica content of ground water is low and relatively constant throughout the county, ranging from 1 to 34 ppm (parts per million). Magnesium, like silica, is generally in small

Table 1.--Geologic units and their lithologic descriptions, Coleman County

System	Group	Formation	Member	Approximate thickness (feet)	Lithologic character
Quaternary				20	Surficial flood-plain and terrace alluvium of Pleistocene to Recent age along the streams; consists of gravel, sand, silt, and clay.
Unconformity					
Cretaceous	Fredericksburg	Edwards Limestone Comanche Peak Limestone Walnut Clay		30 ? 10	Limestone and clay.
	Trinity	Antlers		150	Sandstone, gravel, shale, and some silt.
Unconformity					
Permian	Clear Fork	Lueders Limestone		?	Massive to thin-bedded limestone and shale.
		Clyde	Talpa Limestone Grape Creek Limestone	180 325	
	Wichita	Belle Plains	Bead Mountain Limestone Valera Shale Jagger Bend Limestone Voss Shale Elm Creek Limestone Jim Ned Shale	45 50 85 50 45 ?	Limestone, shale, and thin sandstone lenses.
		Admiral	Overall Limestone Wildcat Creek Shale Hords Creek Limestone Lost Creek Shale	20 70 30 30	Limestone, shale, and sandstone.
		Putnam	Coleman Junction Limestone Santa Anna Branch Shale	20 120	Limestone and shale.
		Moran	Sedwick Limestone Santa Anna Shale Gouldbusk Limestone Ibex Limestone Watts Creek Shale	25 85 8 ? 30	Limestone and shale.
		Pueblo	Camp Colorado Limestone Salt Creek Bend Shale Stockwether Limestone Camp Creek Shale	20 45 20 80	Limestone, shale, sand lenses, and channel sand.
—?—?—?					
Pennsylvanian	Cisco	Harpersville	Saddle Creek Limestone Waldrip Shale Chaffin Limestone	10 50 10	Limestone, shale, and channel sand.
		Thrifty	Breckenridge Limestone Speck Mountain Limestone Ivan Limestone	5 10 ?	Limestone and shale.
		Graham	Wayland Shale Gunsight Limestone Bunger Limestone Bluff Creek Shale	100 15 70 90	Thin to massive limestone, shale, and sand. Some limestones grade laterally into sand.
	Canyon	Home Creek Limestone Colony Creek Shale Ranger Limestone Placid Shale Winchell Limestone Cedarton Shale Brownwood Shale--Palo Pinto Limestone		25 60 15 85 120 60 300	Massive limestone, shale, and sand lenses, and channel sand. Palo Pinto Limestone thins to extinction eastward.
	Strawn		Capps Limestone Caddo Limestone	700+	Limestone, sandstone, and thick shale.
	Bend		Smithwick Shale Marble Falls Limestone	?	Shale and limestone.
Ordovician	Ellenburger			700+	Limestone, dolomitic limestone, and chert.

amounts, with most samples containing less than 75 ppm. Only twelve samples (3 percent) contain more than 125 ppm, which is the maximum recommended by the U.S. Health Service (1962) for drinking water suitable for the traveling public. Sodium content of all samples ranges from 3 to 1,380 ppm. The water from the alluvium and Cretaceous rocks is lower in sodium content than water from rocks of Permian, Pennsylvanian, and Ordovician age.

The sulfate content of all water samples analyzed ranges from less than 3 to 2,980 ppm. Sixty-six samples (58 percent) contain more than 250 ppm sulfate, which is the maximum recommended by the U.S. Public Health Service.

A wide range in chloride content of the ground-water samples was noted. The chloride range in 384 samples is from 5 to 8,300 ppm. However, in some wells water having a high chloride content is apparently contaminated. These wells are shown in Figure 9, and are discussed in following parts of this report. The chloride concentration in 75 percent of the samples is less than 250 ppm, which is the maximum amount recommended by the U.S. Public Health Service (1962).

The flouride content of all the samples analyzed ranges from 0.1 to 8.4 ppm. Eighty-four percent (323) of the samples contain less than 1.5 ppm, which is the maximum quantity of fluoride recommended by the U.S. Public Health Service (1962).

The range in dissolved-solids content of the 384 water samples analyzed is shown below:

Range in dissolved solids (ppm)	Number of analyses	Percent of total analyses	Cumulative percent
500 or less	89	23.18	23.18
501 to 1,000	154	40.10	63.28
1,001 to 1,500	67	17.45	80.73
1,501 to 2,000	32	8.33	89.06
2,001 to 3,000	24	6.25	95.31
over 3,000	18	4.69	100.00

Ordovician System

Ellenburger Group

The Ellenburger Group underlies the entire county and is the oldest geologic group from which water of usable quality is produced. This Group is divided into the Tanyard and Gorman Formations. These rock units crop out in the Bald Ridge area, 20 miles south of the Colorado River in McCulloch County, and dip beneath the surface in Coleman County. Depths to the Ellenburger Group range from 1,260 feet in the southeast part of the county to 4,400 feet in the northwest part.

Rocks of this group, averaging approximately 750 feet in thickness, are composed of fine- to coarse-grained dolomite which frequently contains vugs, fractures, and solution cavities, and sublithographic to fine-textured limestone. Sparse to abundant amounts of chert occur throughout the section as nodules, lenses, plates, and beds (Cloud and Barnes, 1946).

Several wells, ranging in depth from 1,500 to 4,600 feet, produce water from Ellenburger rocks in Coleman County. Water from several wells in the northern part of the county is utilized for secondary recovery of oil, and wells 42-31-401 and 42-39-201 near the southeast corner of the county supply water for livestock use.

Water samples from wells 42-39-201 and 42-31-401 contain 570 and 2,720 ppm of chloride, respectively. The content of dissolved solids in the two samples is respectively 1,360 and 4,860 ppm. No water samples were collected from the water-supply wells that produce highly saline water from the Ellenburger Group. However, a reported chemical analysis of water from the Ellenburger in the Burt-Ogden-Mabee oil field, located in area 14 (Figure 9), is listed in Table 5.

It is apparent that the Ellenburger rocks contain fresh to slightly saline water (3,000 ppm dissolved solids or less) only in the southeast part of Coleman County.

Pennsylvanian System

Canyon Group

The oldest rocks exposed at the surface in Coleman County are rocks of the Canyon Group of upper Pennsylvanian age. These crop out in the southeast corner of the county along the Colorado River and along Home Creek near its confluence with the Colorado River (Figure 4).

The Canyon Group is generally composed of thick limestone interbedded with shale, sandstone, and thin limestone beds. Thickness of this group in Coleman County is about 600 feet (Eargle, 1960). The sequence of rocks assigned to the Canyon Group in Coleman County includes the limestones, shales, and sandstones from the top of the Capps Limestone to the top of the Home Creek Limestone (Table 1).

The primary water-bearing units of this group are the sandstones and channel sands which occur in the Colony Creek Shale and the Placid Shale. Well 42-39-202, in the southeast corner of Coleman County, is apparently completed in a sandstone bed in the Placid Shale. This well was drilled to a depth of 51 feet and encountered water-bearing sand at a depth of 25 feet. Water from this well is used for domestic and livestock supply.

The quality of ground water from sediments of the Canyon Group ranges within relatively wide limits in areas south and east of Coleman County. This is due in part to variations in the lithology of the formations in which the water occurs, the depth at which the water-bearing formation is encountered, and the proximity of the recharge area. The water sample from well 42-39-202 contains 410 ppm dissolved solids, with bicarbonate and calcium being the principal constituents (Table 3).

Cisco Group

Rocks of the Cisco Group, the youngest rocks of Pennsylvanian age in Coleman County, overlie the Canyon Group and crop out along a northeast-southwest band which is about 9 miles wide in the vicinity of Rockwood (Figure 4).

In Coleman County, this group is approximately 400 feet in thickness. The rocks assigned to the group include the shales, thin limestones, sandstones, channel sands, siltstones, and thin beds of coal that occur from the top of the Home Creek Limestone to the top of the Saddle Creek Limestone (Table 1). While it is recognized that the boundary between the Pennsylvanian and Permian Systems is obscure in north-central Texas, and has been placed at several horizons, the Saddle Creek Limestone is a persistant and mappable unit over most of the area and is considered to mark the top of the Cisco Group for purposes of this report.

The Cisco Group, like the underlying Canyon Group, contains channel-fill deposits consisting of lenticular sandstone and conglomerate; however, these are more numerous and of greater thickness than those in the Canyon Group. Most of the ground water occurs in these lenticular sand units. Some water occurs also in the fractured limestone beds at or near their outcrop area.

In Coleman County, 56 wells and 2 springs produce water from rocks of the Cisco Group. The greatest development of wells is near Rockwood, in grids 42-37 and 42-38, and near Santa Anna, in grids 42-14, 42-15, 42-22, and 42-23 (Figure 7). Water from the Cisco Group is used for domestic and livestock purposes. Four communities and several public schools formerly used water from the Cisco Group; however, such well supplies have been abandoned in favor of surface-water supplies or as the result of the closing and consolidation of some schools.

Water samples were collected for chemical analysis from 29 wells and 2 springs that produce water from rocks of the Cisco Group (Table 3). The quality of water produced from this group is not uniform throughout the area of development. This quality variation is probably due in part to man-made alteration of the native chemical quality, but the historical records necessary for comparison to indicate where or how much alteration has occurred are not available.

Sodium and chloride are predominant ions in ground water from the Cisco rocks. The range in chloride concentration is from 5 to 1,890 ppm. Sixty-one percent (19) of the water samples analyzed contain more than 250 ppm chloride, which is the maximum recommended by the U.S. Public Health Service (1962). Sixty-eight percent (21) of the samples analyzed contained more than 200 ppm sodium.

The silica and magnesium concentrations are low. Silica content ranges from 3 to 23 ppm, and magnesium from 2 to 117 ppm. The range in calcium is from 5 to 458 ppm, with five samples (19 percent) exceeding 200 ppm.

The range in dissolved solids is from 222 ppm, in the water sample from a spring, 42-22-702, to 4,110 ppm in the sample from well 42-22-602, which is 275 feet in depth (Table 3). Twenty samples (65 percent) contain more than 1,000 ppm dissolved solids.

Water wells completed in rocks of the Cisco Group range in depth from 15 to 380 feet and yield from 3 to 20 gallons per minute.

Well construction generally is with 5- to 7-inch steel or galvanized iron casing set above the water-producing zone or set at total depth and slotted opposite the water-producing zone. Casing is generally cemented near the land surface, and a cement base is provided for a pump or windmill. A few wells are hand-dug and lined with brick or concrete.

Permian System

Wichita Group

Rocks assigned to the Wichita Group of lower Permian age include the thick shales, thin to massive limestones, thin sandstones, and channel sands that occur from the top of the Saddle Creek Limestone to the top of the Bead Mountain Limestone (Table 1).

Sediments of this group are exposed at the land surface over approximately three-fourths of Coleman County, and overlie rocks of the Cisco Group of upper Pennsylvanian age (Figure 4).

In Coleman County the thickness of the Wichita Group averages about 1,200 feet. These rocks were deposited in an extensive shallow sea, and thus were deposited under widely varying conditions. Channel-fill sandstone deposits in the Wichita Group appear to be more numerous in the northeast part of the county.

Water-bearing strata of the Wichita Group consist of channel sands, fractured limestones, and also thin sands that occur in massive shale beds.

Inventory of 135 wells and 5 springs producing water from the Wichita Group was made during this investigation. This represents approximately 30 percent of the water-well development in the county. Wells producing usable quality water from the Wichita Group are generally scattered over the outcrop area. However, well development is greatest in the Burkett-Echo area in the northeast, the Valera area in the west, and the Voss-Leaday area in the southwest parts of the county (Figure 7). Many wells that formerly produced usable-quality water from rocks of the Wichita Group were abandoned because of the increased use of surface-water supplies and as a result of urbanization.

One-hundred and fifteen water samples were collected for chemical analysis from wells and springs that produce water from rocks of the Wichita Group. The quality of the water in the Wichita Group, like that in the underlying Cisco Group, is not uniform throughout the area of development. The sulfate content ranges from 9 to 2,980 ppm. Thirty-eight samples (33 percent) contain more than 250 ppm sulfate. Water from several wells in the Valera area, grid 42-12, contains a high content of sulfate, up to 1,620 ppm. This may be due in part to the presence of anhydrite and gypsum in the rocks. Conversely, analyses of water from wells in the Voss-Leaday area, grids 42-19 and 42-20 (Figure 7), reveal a very low concentration of sulfate, as low as 14 ppm. This is due in part to the paucity of evaporites in the water-bearing rocks, and a larger and more permeable recharge area.

Chloride concentration ranges from 7 to 2,470 ppm. Ninety samples (78 percent) contain less than 250 ppm chloride, which is the maximum recommended by the U.S. Public Health Service (1962).

The dissolved-solids content ranges from 138 to 5,200 ppm. The great majority of the samples, however, contain between 500 and 2,000 ppm (Table 3).

Depths of wells range from 11 to 200 feet. Several springs discharge small amounts of water in the outcrop of the Wichita Group. Drilled wells are lined with galvanized or steel casing, generally bonded to the bore hole at the land surface with concrete. Hand-dug wells are lined with field stone or concrete.

Water wells completed in rocks of the Wichita Group produce from 3 to 30 gallons per minute. Windmills and jet and submersible pumps are used to lift the water.

Clear Fork Group

Rocks assigned to the Clear Fork Group of Permian age are the limestones and shales which occur from the top of the Bead Mountain Limestone to the youngest rocks of the Lueders Limestone that occur in Coleman County. This group is restricted to the western part of Coleman County. Rocks of this group conformably overlie rocks of the Wichita Group, and are in part overlain by a large outlier of Cretaceous rocks. (See Figure 4.) Thickness of the Clear Fork Group ranges from a few feet to about 600 feet in Coleman County.

Ground water occurs erratically in the somewhat porous and fractured limestones. Springs and shallow wells in the area of Talpa and Glen Cove, grids 42-11 and 42-19, provide a small but adequate supply for livestock and domestic uses. It appears that the limestones of the Clear Fork Group are recharged by water from the overlying alluvium and Cretaceous rocks.

Fifty-eight wells and springs produce water from the Clear Fork Group for livestock and domestic purposes. Forty-eight water samples were collected for chemical analysis from these wells and springs.

The quality of water in the Clear Fork Group, like that in the underlying Wichita Group, is not uniform throughout the area of development. Water from springs and shallow wells generally contains less sulfate and chloride and more bicarbonate than the water from deeper wells. The range in dissolved solids is 295 to 5,200 ppm; however, 54 percent (26) of the samples contain less than 1,000 ppm dissolved solids.

Water wells completed in the Clear Fork Group in Coleman County produce from 3 to 10 gallons per minute. Windmills and jet pumps are used to lift the water. The depth of the wells ranges from 9 to 180 feet.

Construction of drilled wells is generally with 5- to 7-inch galvanized iron or steel casing, either set at total depth and perforated opposite the water-producing zone or set above the water-producing zone. The casing is cemented near the land surface, and a concrete curb is placed around the casing as a base for a pump or windmill. Dug wells are shallow in depth and are lined with field stone to prevent caving.

Cretaceous System

Trinity Group

Rocks of both the Trinity and Fredericksburg Groups of Cretaceous age are present in Coleman County. However, the Fredericksburg Group is not known to yield water to wells in this area. Rocks of the Trinity Group occur as erosional remnants or outliers of the Callahan Divide. The largest of these remnants overlies rocks of the Clear Fork Group of Permian age in the vicinity of Novice, Glen Cove, Silver Valley, and Valera. Another remnant is near Santa Anna in the east-central part of the county, and overlies rocks of the Wichita Group (Figure 4).

The thickness of the Trinity Group in northwestern Coleman County ranges from a few feet to approximately 150 feet. This estimated maximum thickness is based on surface elevations and study of available electrical logs of oil and gas tests drilled on the Cretaceous outcrop. Water-bearing zones of the group consist of sandstone, clay, gravel, and sandy to shaley limestone. Grain size of sand and gravel varies from a fine-grained pack sand to a rather coarse gravel. Facies changes within the group apparently cause local variations in water availability.

The Trinity Group is the most highly developed water-bearing unit in Coleman County. Two-hundred and thirteen wells and springs supply about 40 percent of the water used for domestic and livestock purposes.

Water from the Trinity Group is the most desirable ground water found in Coleman County. The range in dissolved-solids content of 157 water samples from wells completed in this group is shown below:

Range in dissolved solids (ppm)	Number of analyses	Percent of total analyses	Cumulative percent
500 or less	45	28.66	28.66
501 to 1,000	75	47.77	76.43
1,001 to 1,500	19	12.10	88.53
1,501 to 2,000	5	3.18	91.71
2,001 to 3,000	7	4.46	96.17
over 3,000	6	3.83	100.00

The concentrations of chemical constituents of the water range within wide limits, as follows:

Calcium........22 to 1,780 ppm	Bicarbonate....77 to 850 ppm
Magnesium...... 7 to 810 ppm	Sulfate........ 3 to 2,980 ppm
Sodium......... 3 to 3,310 ppm	Chloride....... 6 to 8,300 ppm

Alteration of native-quality water has occurred in some areas of the Trinity Group, but historical data necessary for comparison to indicate where or how much alteration has occurred are not available. Chemical analyses of water from two wells, 42-12-404 and 42-12-509, show high concentrations of dissolved solids, 13,600 and 11,300 ppm, respectively. Chloride content of these two analyses is 8,300 and 6,500 ppm (Figure 6). The owners report that water from the two wells became unsuitable for domestic and livestock use in 1960.

The depth of wells completed in rocks of the Trinity Group ranges from 10 to 260 feet. The base of usable-quality water could not be defined because of the lack of adequate drillers' logs or of electrical logs of the shallow, surface-hole section of oil and gas tests, and because of probable movement of water from the Trinity Group into the unmappable underlying Permian strata.

Windmills power 122 of the water wells. These produce about 3 gallons per minute, and overhead storage tanks are generally used to meet maximum requirements of water for domestic purposes. Seventy-nine wells use small jet or cylinder pumps, each producing about 10 gallons per minute, and one industrial well uses a turbine pump to produce an average of 6,300 gallons per day.

Water well construction generally includes 5- to 7-inch steel or galvanized iron casing bonded to the bore hole by cement near the land surface. Concrete curb is used as a base for a pump or windmill. Hand-dug wells are lined with field stone or concrete.

Quaternary System

Alluvium

Surficial deposits of terrace gravel, sand, silt, and clay occur along streams and valleys in Coleman County. Only the alluvium along the Colorado River is shown on the geologic map (Figure 4). According to Stafford (1960, p. 68), the alluvial deposits are probably Quaternary in age, and are derived from rocks of Pennsylvanian, Permian, and Cretaceous age. The deposits are generally thin; however, stringers of sand and gravel in stream channels are known to be as much as 20 feet in thickness. Due to stream sorting and little compaction, these sediments are easily recharged by streamflow during flood stage and by rainfall.

Thirty-five wells and springs which produce water from alluvial deposits were inventoried during this investigation. All of the wells supply water for domestic or livestock use except well 42-13-201, which furnishes water for public supply and irrigation of a city park.

The quality of water produced from these alluvial deposits varies within wide limits. The dissolved-solids content ranges from 114 to 4,600 ppm, with 16 samples (53 percent) containing less than 1,000 ppm.

The depth of the wells completed in the alluvial deposits ranges from 6 to 40 feet. Several of the drilled wells penetrate strata beneath the alluvium sediments, affording a storage reservoir in the bottom of the well.

Yields of wells completed in the alluvium are generally larger than yields of wells completed in the Trinity Group and other rocks in Coleman County. Well 42-13-201, in the alluvium of Hords Creek at Coleman, is equipped with a turbine pump and has an estimated yield of 25 gallons per minute. According to Lang (1944, p. 4), other wells in this area were tested at a rate of 180 to 250 gallons per minute. Most of these wells are either abandoned or unused at present.

The hand-dug wells are lined with field stone, brick, or concrete rings. Steel, galvanized iron, or plastic casing is used in drilled wells, and is bonded to the bore hole near the surface with concrete.

QUALITY-OF-WATER PROTECTION PROGRAMS

Surface Casing

The function of the Surface Casing Program of the Ground Water Division of the Texas Water Development Board is to recommend to members of the oil and gas industry and the Texas Railroad Commission the depth to which ground water should be protected in drilling tests for oil and gas. The authority for participation by the Texas Water Development Board in the surface casing program is derived from rules promulgated by the Railroad Commission under authority given that agency by the statutes dealing with regulation of drilling and production activities of the oil industry.

Statewide Rule 13 (Formerly Rule 12a) of the Railroad Commission requires that operators obtain a letter from the Texas Water Development Board recommending the depth to which fresh water strata should be protected when drilling a new lease or area if the lease or area is not covered by field rules or lease recommendations. Rule 8 (Formerly Rule 20) of the Railroad Commission requires that all fresh water strata be protected in drilling or production activities.

In carrying out its duties under Rule 13, the then Texas Water Commission created the Surface Casing Program in the Ground Water Division. The staff of the Surface Casing Program is responsible for maintaining technical data files upon which to base fresh water protection recommendations in all areas of the State, and for preparing these recommendations on application by operators contemplating drilling test wells. The depth to which ground water of usable quality should be protected which is recommended in a given area is based on all pertinent information available to the Surface Casing Program staff at the time the recommendation is given. Recommended depths in any one area may therefore be revised from time to time as additional subsurface information becomes available. Known depths of water wells being used or depths of wells known to contain water of usable quality, such as domestic, municipal, industrial, livestock, or irrigation wells, are of primary value. Electric or gamma-ray neutron logs run on oil and gas tests are used in many areas of the State to determine the depth to which the base of usable quality ground water occurs. Surface elevation is considered when a recommendation is given in an area that has moderate to high surface relief, as is common in the north-central Texas counties. This consideration is imperative when the slope of the land surface does not conform to the dip of the underlying rocks because of the danger that poor quality water will cause contamination of surface and ground water by moving along the dip of the beds to points of discharge in stream channels. All of this information is interpreted in the light of the best knowledge of the geology and ground water hydrology available on the area involved.

Because of the erratic occurrence of ground water in Coleman County, which was described in the preceding sections of this report, known depths of water wells are given special weight in preparing surface-casing recommendations in the county.

In Coleman County, a county-wide depth recommendation is not feasible because the depth of protection which would be required in those areas of the county where deep water wells are found would be an excessive requirement in many other parts of the county. The preceding section of this report describes the occurrence of ground water of usable quality from formations at depths ranging from the surface to 1,500 feet. Thus, the results of this study confirm that surface-casing recommendations in this county should be made on a well-to-well or lease-to-lease basis in order to provide adequately for water protection without imposing unnecessary burdens of excessive protection in those areas where deep protection is not needed.

During the 7-year period from 1960 to 1966, the Surface Casing staff prepared 807 recommendations for protection of usable quality ground water for oil and gas tests in Coleman County. Sixty-seven recommendations were prepared during 1966. The depths of these recommendations range from 100 to 200 feet.

Subsurface Disposal

The 57th Legislature enacted Senate Bill 72 (Article 7621b, Vernon's Revised Civil Statutes) which defined a permit system for subsurface disposal of municipal and industrial wastes in Texas. This act in effect designated the Texas Water Development Board as the permit-issuing agency for all injection wells to dispose of "...industrial and municipal waste, other than salt water or other waste arising out of or incidental to the drilling for or the producing of oil or gas...," and the Texas Railroad Commission as the permit-issuing agency for all injection wells "...for the purpose of disposing of salt water or other waste arising out of or incidental to the drilling for or the producing of oil or gas...." However, Section 2-c of this statute also directed that any person applying to the Railroad Commission for a permit to inject salt water resulting from the drilling for or production of oil or gas shall obtain a letter from the Board stating that the "...drilling of such injection well and the injection of such salt water or other such waste into such subsurface stratum will not endanger the fresh water strata in that area and that the formation or strata to be used for such salt water or other such waste disposal are not fresh water sands."

Opinions by the Attorney General of Texas pertinent to the implementation of Article 7621b are: (1) that "injection well," when correctly interpreted, includes only those wells which are drilled or used for the purpose of disposal and does not include an injection well where the purpose of the well is to increase production from an oil- or gas-bearing stratum, and (2) that a determination by the Texas Water Development Board is not binding on the Railroad Commission but merely advisory.

The staff of the Subsurface Disposal Program of the Texas Water Development Board reviews applications to dispose of salt water into subsurface zones and advises the operators and the Railroad Commission of the acceptability of such applications. Waterflood, pilot recovery, and other secondary recovery operations where salt water is injected into subsurface zones which are productive of oil or gas are granted permits by the Railroad Commission without consultation with the Texas Water Development Board. Also, the inspection of construction and completion of all injection systems is a regulatory function of the Railroad Commission.

Since the effective date of Senate Bill 72, August 28, 1961, the staff of the Subsurface Disposal Program has reviewed 26 applications to the Railroad Commission for salt water disposal wells in Coleman County. Each of these applications was reviewed on an individual basis with consideration given to geologic and hydrologic data of the area, the method of completion of the proposed injection well, the volume of salt water to be disposed, and injection pressure to be used.

In addition to the salt water disposal wells, since January 1960, the Railroad Commission has granted permits to 41 projects involving the use of injection wells in pilot recovery, waterflood, and other secondary recovery operations in Coleman County. The number of injection wells utilized in these projects ranges from one well in pilot recovery programs to as many as six or more injection wells in the waterflood projects. Generally, these projects are granted permits which contain provisions for expansion of the water-injection facilities by the use of additional injection wells as the operations progress.

OIL-FIELD BRINE PRODUCTION AND DISPOSAL

Quantity and Distribution of Produced Brine

The 1961 inventory of salt-water production throughout the State, compiled by the Railroad Commission of Texas and the then Texas Water Commission from data reported by oil companies and operators, shows that a total of 9,713,711 barrels of oil-field brine was produced in Coleman County in 1961. This total is all within the Colorado River basin.

A total of 9,375,722 barrels or 96.5 percent was disposed of into injection wells, 324,498 barrels or 3.3 percent was placed into open surface pits, and 13,491 barrels or 0.2 percent was disposed of by other methods such as dumping into surface drainageways or hauling and spraying on roads and lease surfaces.

The brine production and method of disposal, by oil and gas producing areas, is recorded in Table 4. These areas were drawn on Figure 9 by outlining the areas of greatest concentration of producing oil and gas wells. No attempt was made to define individual oil and gas fields on Figure 9, but the areas of concentrated oil and gas well development are outlined to show the relative concentration of production.

Chemical Quality of Produced Brine

The chemical quality of brine produced along with oil and gas in Coleman County is presented in Table 5, which is a tabulation of chemical analyses. As can be seen, the ions normally present in most samples from water wells (Table 3) are present in the brines, but sodium, chloride, magnesium, and calcium are present in greater abundance.

Sodium concentration in the brine samples ranges from 11,040 to 52,700 ppm. Thirty-nine percent of the 23 samples contain a sodium concentration of more than 40,000 ppm. The concentration of chloride ranges from 21,000 to 127,500 ppm, with 79 percent of the samples having a chloride content of more than 50,000 ppm. The concentration of magnesium ranges from 393 to 9,202 ppm, and of calcium, 1,120 to 20,100 ppm.

ALTERATION OF NATIVE CHEMICAL QUALITY OF WATER

Recharge of the limited aquifers in Coleman County is by precipitation in the aquifer outcrops and by seepage from streams and lakes that cross these outcrops. Although a study of contamination of surface water was not contemplated in the scope of this project, it is important to note that ground and surface water are interrelated. If the chemical quality of surface water is significantly altered, the ground water may be affected through downward percolation of the chemically altered water; also, water quality of the stream may be affected by altered ground water which contributes to the base flow of the stream.

The chemical quality of ground water may be altered by natural or artificial means, or a combination of the two. Percolating ground water is altered naturally by solution of minerals such as chloride, sodium, sulfate, calcium, and magnesium which occur in the sediments. Downward percolation or seepage of oil-field produced brines placed in shallow surface pits may alter ground water by commingling. Alteration of usable-quality ground water may be effected by saline water moving up the bore hole of improperly plugged or improperly cased wells into the shallow fresh-water zones. Improperly constructed wells which are used for disposal of industrial and municipal wastes and for secondary recovery projects may alter ground water by allowing vertical and lateral movement of injection fluids into fresh-water zones.

The quality of ground water may be altered by organic sources if the water well is not properly constructed or located. Some shallow wells in Coleman County appear to be contaminated due to poor well construction and location within the drainage areas of septic tanks, barnyards, and other sources of organic waste. One evidence of this is the high nitrate content of the water.

Six wells that are apparently brine contaminated, and several vegetative-kill areas, where no vegetation is present and that apparently resulted from discharge of brine onto the surface or overflow of disposal pits, are shown on Figure 9. Figure 6 compares diagrams of these apparently contaminated wells with native-quality ground water and typical oil-field brines. Chemical analyses of water from some wells in Coleman County indicate that previous methods of brine disposal have altered the native-water quality, but efforts have been made by many petroleum operators to eliminate contamination of the soil, surface water, and ground water.

The vegetative-kill areas observed in this study range in size from less than 1 acre to several acres. In Figure 5, photographs A, B, and C show an area of previous surface contamination on the outcrop of sand of the Trinity Group. As a result of a landowner's complaint of water-well contamination, the operator of this producing property has abandoned a brine injection well and five marginal oil wells, and drilled a water well for the complainant. Apparently all contamination has not been eliminated as of 1964, as shown by photograph B.

An area of several acres where no vegetation is present, apparently a result of brine discharge onto the surface or overflow of disposal pits, is shown by photograph D in Figure 5. Landowners affected by surface brine disposal in this area repeatedly protested this action by the operator. The oil wells adjacent to this contaminated area have now been abandoned.

Much evidence of previous surface brine disposal is present in the Burkett area of northeast Coleman County. One such area of several acres is shown by photographs E and F in Figure 5. The absence of vegetation, dead trees, and eroded surface indicate that considerable amounts of brine have been placed in surface pits or dumped on the surface. Photographs G and H show the apparent and immediate effect on the surface and drainageways of fluids from oil-well remedial workover and abandonment.

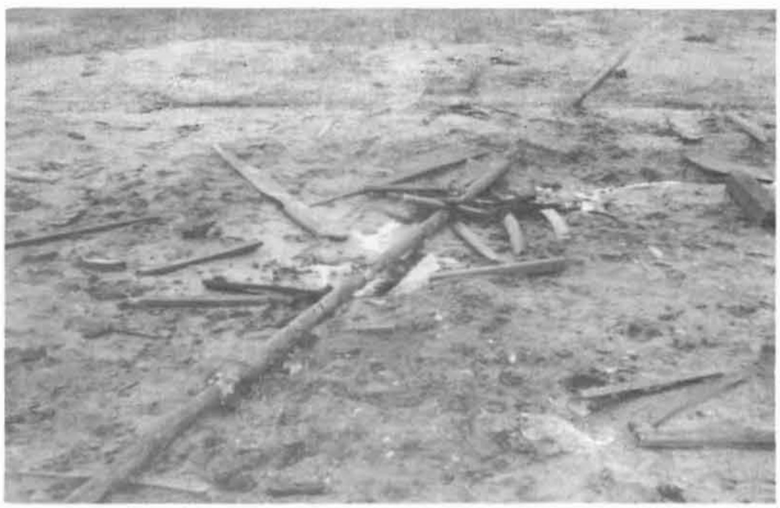
A tributary of Pecan Bayou in the Burkett area is shown in photographs J and K. Some evidence of surface kill is shown by these two photographs. Although recent rains had fallen in the area, the chloride content of a water sample collected from the creek in May 1965 was 6,500 ppm.

A large vegetative-kill area, where contamination of the soil by brines has destroyed a pecan orchard, is shown by photograph L. This soil condition became apparent about 1959, and water from well 42-12-509 at this site, which contains 6,500 ppm chloride, has not been used since 1960.

Figure 6 compares water-quality diagrams for several apparently contaminated water wells with native-quality ground water and typical oil-field brines. Chemical analyses of samples representing a native-quality water, brine, and the apparently contaminated water were converted from parts per million to equivalents per million for purposes of construction of these diagrams. The available brine analysis nearest the apparently contaminated well was used, and was plotted on a scale of 1 inch equals 800 epm--80 times smaller than the scale used to illustrate the native quality of water--in order to plot the pattern diagram for the brine on standard-size paper.

The source of contamination in wells 42-11-334, 42-12-404, and 42-12-509 appears to be previous disposal of oil-field brines into shallow surface pits and onto the nearby land surface which shows salt-impregnated vegetative-kill areas. In other cases of apparent water-quality alteration the source is not

A. Abandoned tank battery and salt-water disposal area, in section 10, T & NO RR Co. Survey, 1/2 mile north of Glen Cove. View is northeast.



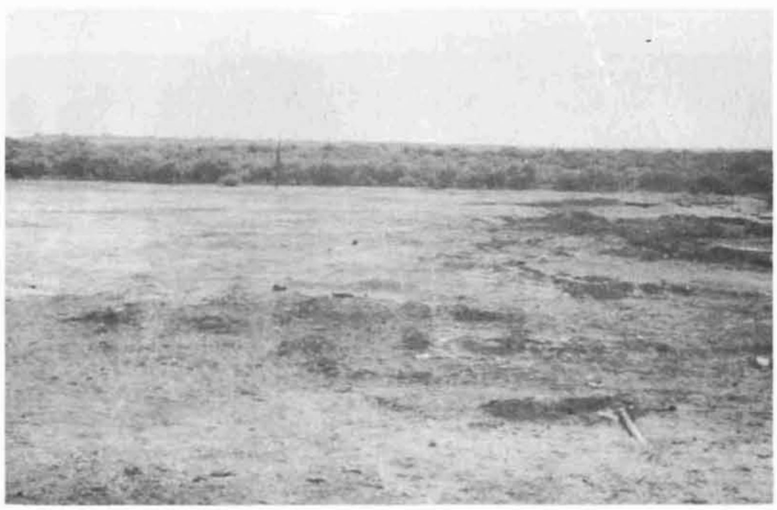
B. Salt Water leaking from "patched" disposal line, in section 10, T & NO RR Co. Survey, 1/2 mile north of Glen Cove. Surface is sand of the Trinity Group. View is northwest.

Figure 5

Views of Vegetative — Kill Areas, 1964

Texas Water Development Board

C. Previous method of salt water disposal into North Prong Hords Creek, in section 10, T&NO RR Co. Survey, 1/2 mile north of Glen Cove. Surface is sand of the Trinity Group. Note vent on large pipe indicated by arrow. View is east.



D. Abandoned tank battery and brine disposal area, in William Webber Survey 722, 6 miles northeast of Coleman. Drainage is south into tributary of Hords Creek. View is south.

Figure 5 --Continued

Views of Vegetative – Kill Areas, 1964

Texas Water Development Board

E. Waterflood system in the Burkett field, in John Sanders Survey 162, 1 1/2 miles north of Burkett. Note leveled surface pit in right background. Apparent overflow or discharge from previous pit has eroded surface soil (rock masses in foreground). Drainage is into tributary of Pecan Bayou. View is southeast.

F. Abandoned catchment or overflow area for surface pits and surface brine disposal, in same area as photograph E. View is southwest.

Figure 5 -- Continued

Views of Vegetative—Kill Areas, 1964

Texas Water Development Board

G. Waterflood well in Burkett field, John Sanders Survey 162, 1/2 mile north-northeast of Burkett. Surface contaminant appears to be oil and salt water from remedial workover. Drainage is into tributary of Pecan Bayou. View is west-northwest.

H. Abandoned oil well in Burkett field, Asa Wickson Survey 168, 1 1/2 miles north-northwest of Burkett. View is southwest.

Figure 5 -- Continued

Views of Vegetative—Kill Areas, 1964

Texas Water Development Board

J. Tributary of Pecan Bayou, in Burkett field area, Asa Wickson Survey 168, 1 mile north-northwest of Burkett. Water in creek contained 6,500 ppm chloride when analyzed in May 1965. View is north.

K. Same area as photograph J. Note lack of vegetation along creek bank in right centerground. View is east.

Figure 5--Continued

Views of Vegetative—Kill Areas, 1964

Texas Water Development Board

L. Surface-kill area in pecan grove, in Burnet C. S. L. Survey 703, 3 miles north of Valera. Chemical analyses of water from well 42-12-509 in right background showed 11,300 ppm dissolved solids and 6,500 ppm chloride. Water sample collected April 1964. View is southeast.

Figure 5--Continued

Views of Vegetative—Kill Areas, 1964

Texas Water Development Board

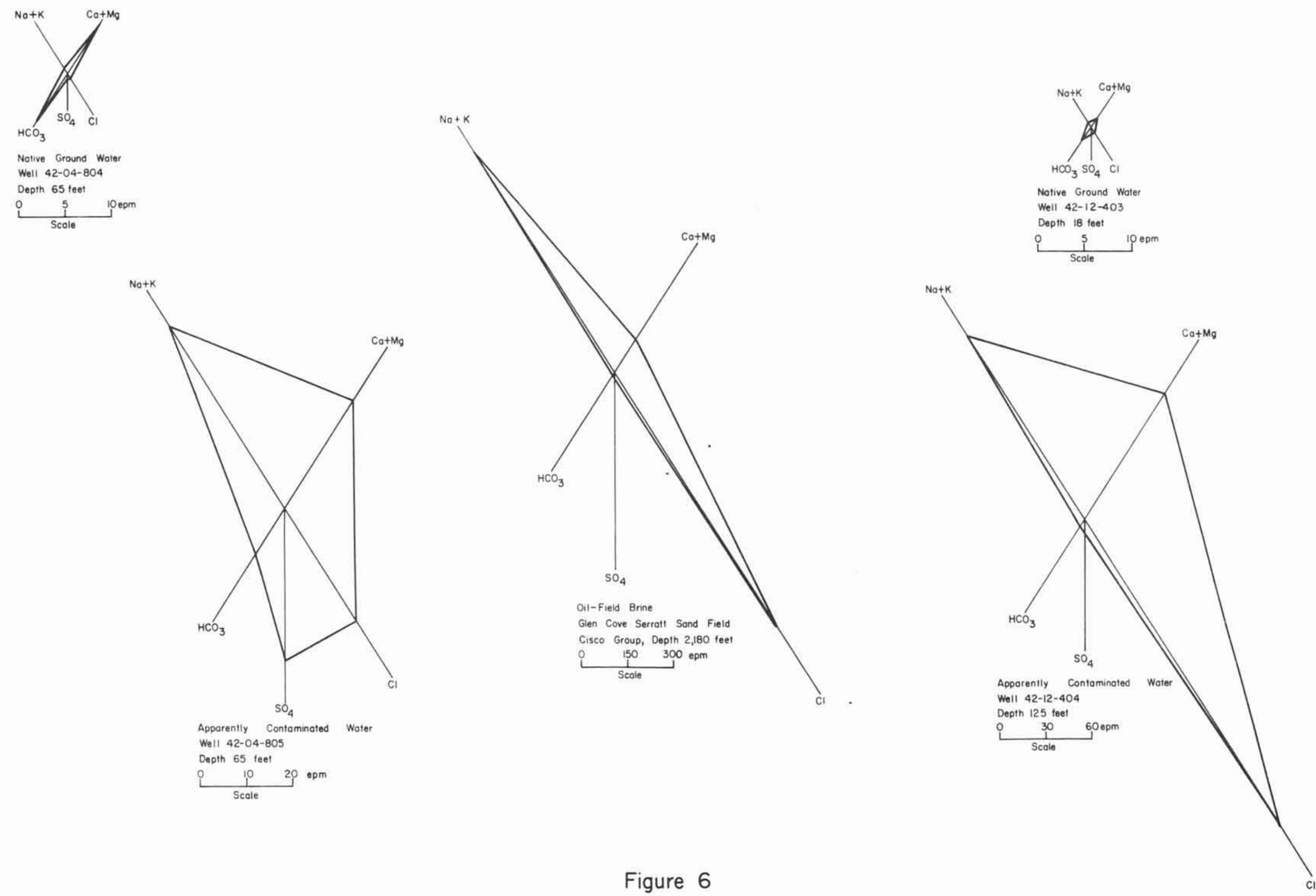


Figure 6

Diagrams of Chemical Analyses of Ground Water and a Typical Oil-Field Brine

Texas Water Development Board

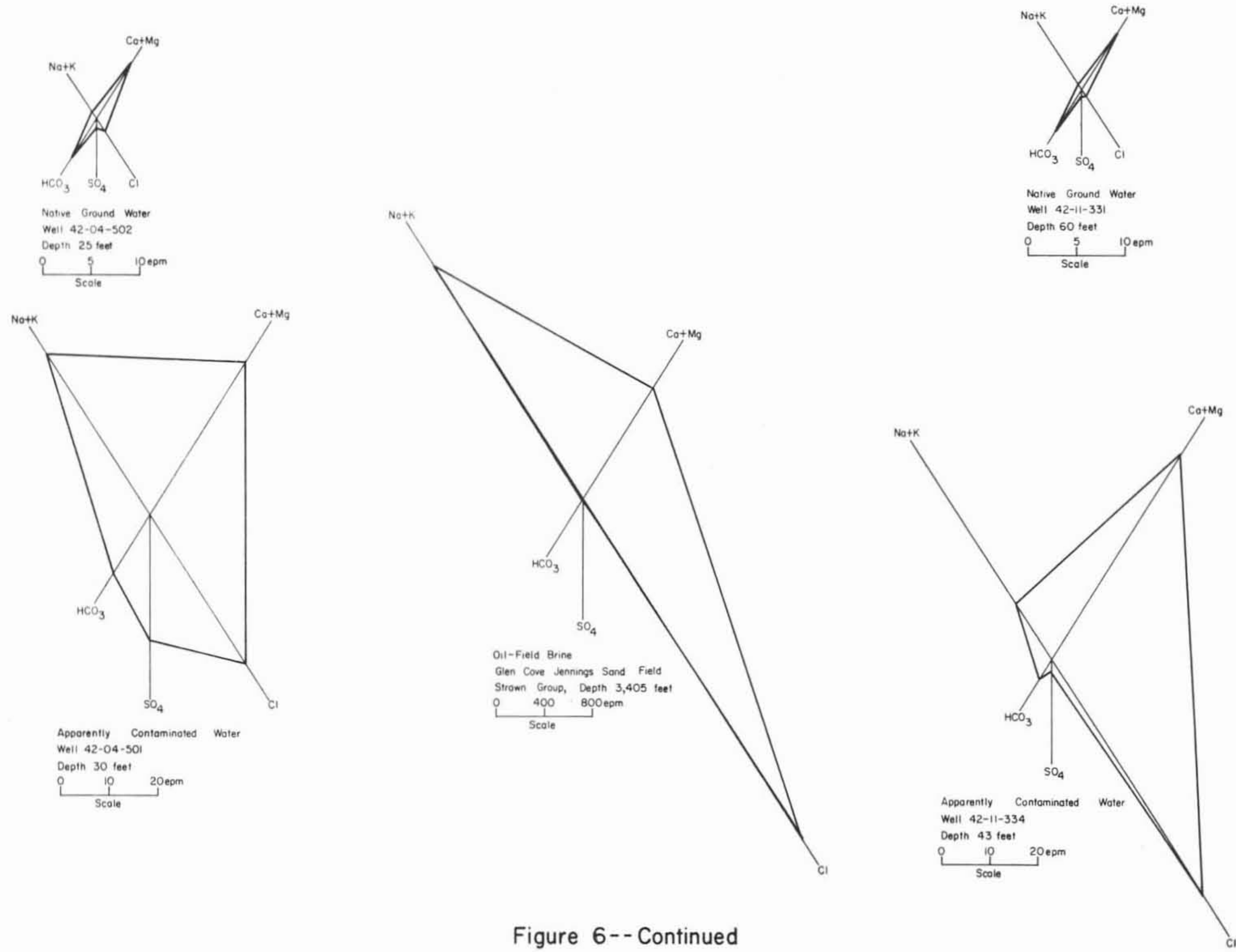


Figure 6--Continued

Diagrams of Chemical Analyses of Ground Water and a Typical Oil-Field Brine

Texas Water Development Board

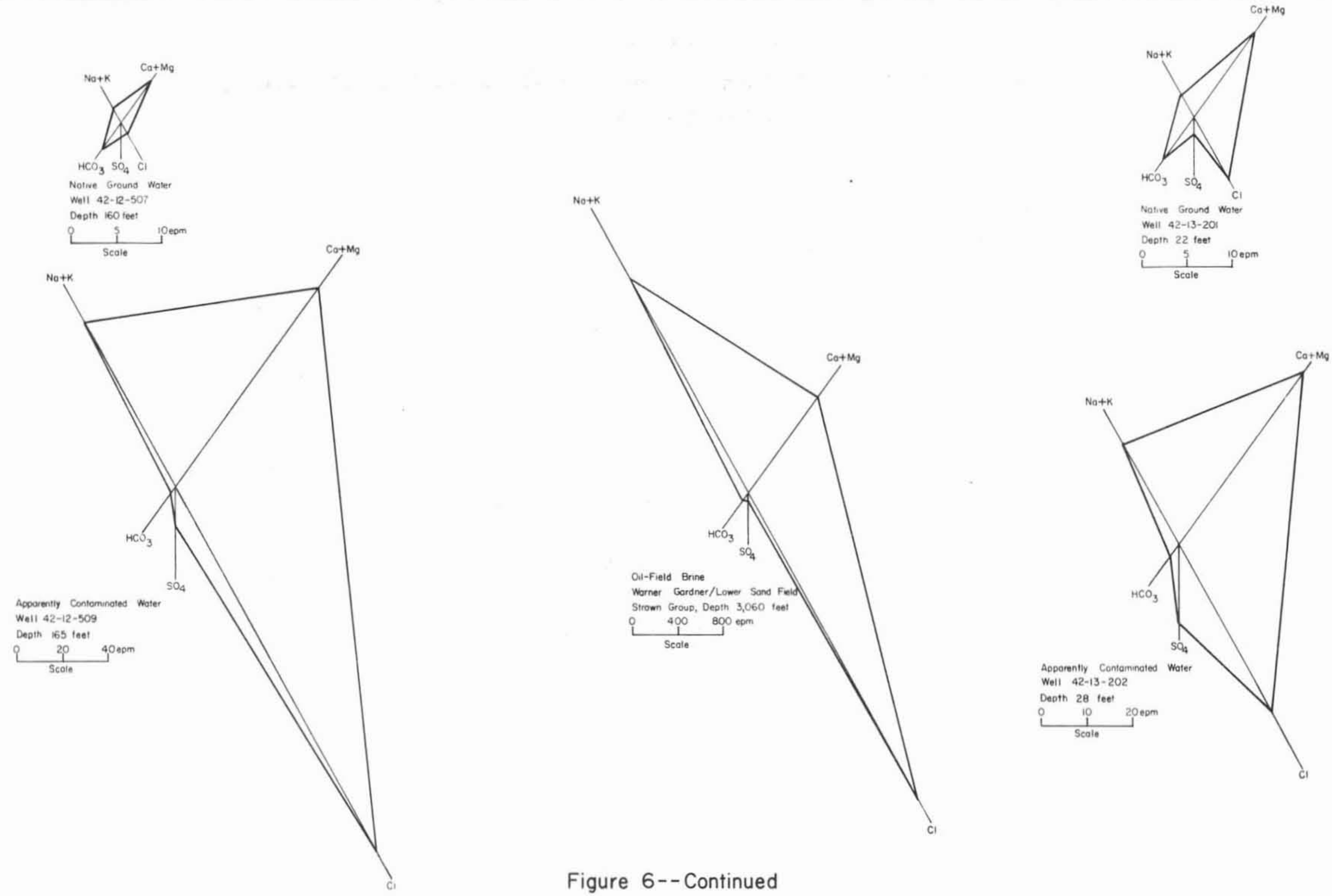


Figure 6--Continued

Diagrams of Chemical Analyses of Ground Water and a Typical Oil-Field Brine

Texas Water Development Board

apparent, but salt water injection and pressure maintenance wells, and unplugged or improperly plugged and abandoned oil and gas tests may be contributing to ground-water mineralization.

SELECTED REFERENCES

BJ Service, Inc., 1960, The chemical analyses of brines from some fields in north and west Texas: Am. Inst. Mining, Metall., and Petroleum Engineers.

Bayha, D. C., 1964, Occurrence and quality of ground water in Stephens County, Texas: Texas Water Comm. Bull. 6412, 96 p.

Cheney, M. G., 1929, Stratigraphic and structural studies in north-central Texas: Univ. Texas Bull. 2913, 27 p.

Cloud, P. E., Jr., and Barnes, V. E., 1946, The Ellenburger Group of central Texas: Univ. Texas Pub. 4621, 473 p.

Coleman County Extension Service, 1964, Your county program, 46 p.

Dean, H. T., Arnold, F. A., and Elvove, Elias, 1942, Domestic water and dental caries: Public Health repts., v. 57, p. 1155-1179.

Eargle, D. H., 1960, The stratigraphy of Pennsylvanian and lower Permian rocks in Brown and Coleman Counties, Texas: U.S. Geol. Survey Prof. Paper 315-D, 77 p.

Galagan, D. J., and Lamson, G. F., Jr., 1953, Climate and endemic dental fluorosis: U.S. Public Health repts., v. 68, no. 5, p. 497-508.

Hem, J. D., 1959, Study and interpretation of the chemical characteristics of natural water: U.S. Geol. Survey Water-Supply Paper 1473, 269 p.

Holloway, H. D., 1962, City of Valera, Coleman County, Texas, investigation of ground-water contamination: Texas Water Comm. rept. LD-0362-MR, 9 p.

Holmquest, J. H., Jr., 1955, Structural development of west central Texas: Abilene Geol. Soc. guidebook, p. 19-32.

Hudnall, J. S., and Pirtle, G. W., 1937, Geologic map of Coleman County, Texas: Univ. Texas, Bur. Econ. Geology, geol. map.

Kelley, W. P., 1951, Alkali soils: New York, Reinhold Pub. Corp., 176 p.

Lang, J. W., 1944, Ground water at Coleman, Texas: U.S. Geol. Survey open-file rept., 9 p.

Laxson, Rowland, and others, 1960, Resistivities and chemical analyses of formation waters from the west central Texas area: West Central Texas Section, Soc. Petroleum Engineers of Am. Inst. Mining, Metall., and Petroleum Engineers.

Lee, Wallace, 1938, Stratigraphy of the Cisco Group of the Brazos River basin, in Stratigraphic and paleontologic studies of the Pennsylvanian and Permian rocks in north-central Texas: Univ. Texas Pub. 3801, p. 11-90.

Lowry, R. L., Jr., 1960, Monthly reservoir evaporation rates for Texas, 1940 through 1957: Texas Board Water Engineers Bull. 6006, 95 p.

Maxcy, K. F., 1950, Report on the relation of nitrate concentrations in well waters to the occurrence of methemoglobinemia: Natl. Research Council Bull. Sanitary Engineering and Environment, App. D, p. 265-271.

Moore, R. C., 1949, Rocks of Permian(?) age in the Colorado River Valley: U.S. Geol. Survey Oil and Gas Inv. Prelim. Map 80 (in two sheets).

Morris, D. E., 1964, Occurrence and quality of ground water in Young County, Texas: Texas Water Comm. Bull. 6415, 106 p.

Mount, J. R., Rayner, F. A., Shamburger, V. M., Jr., Peckham, R. C., and Osborne, F. L., Jr., 1967, Reconnaissance investigation of the ground-water resources of the Colorado River basin, Texas: Texas Water Devel. Board manuscript rept.

Plummer, F. B., 1943, The Carboniferous rocks of the Llano region of central Texas: Univ. Texas Pub. 4329.

Plummer, F. B., and Moore, R. C., 1921, Stratigraphy of the Pennsylvanian formations of north-central Texas: Univ. Texas Bull. 2132, 228 p.

Samuell, J. H., and Davis, D. A., 1938, Records of wells and springs, drillers' logs, records of streams and lakes, analyses of water from wells, springs, streams, and lakes, and map showing locations in Coleman County, Texas: Texas Board Water Engineers duplicated rept., 65 p.

Scofield, C. S., 1936, The salinity of irrigation water: Smithsonion Inst. ann. rept., 1934-35, p. 275-287.

Sellards, E. H., Adkins, W. S., and Plummer, F. B., 1932, The geology of Texas, v. 1, Stratigraphy: Univ. Texas Bull. 3232.

Stafford, P. T., 1960, Geology of the Cross Plains quadrangle, Brown, Callahan, Coleman, and Eastland Counties, Texas: U.S. Geol. Survey Bull. 1096-B, 72 p.

Terriere, R. T., 1960, Geology of the Grosvernor quadrangle, Brown and Coleman Counties, Texas: U.S. Geol. Survey Bull. 1094-A.

Texas Water Commission and Texas Water Pollution Control Board, 1963, A statistical analysis of data on oil-field brine production and disposal in Texas for the year 1961 from an inventory conducted by the Texas Railroad Commission: Compilation of 17 vols.

Thompson, D. R., 1967, Occurrence and quality of ground water in Brown County, Texas: Texas Water Devel. Board Rept. 46, 143 p.

U.S. Public Health Service, 1962, Public Health Service drinking water standards: Public Health Service Pub. 956, 61 p.

U.S. Salinity Laboratory Staff, 1954, Diagnosis and improvement of saline and alkali soils: U.S. Dept. Agriculture, Agr. Handb. 60, 160 p.

Wilcox, L. V., 1955, Classification and use of irrigation waters: U.S. Dept. Agriculture Circ. 969, 19 p.

Winslow, A. G., and Kister, L. R., Jr., 1956, The saline water resources of Texas: U.S. Geol. Survey Water-Supply Paper 1365, 105 p.

Table 2.--Records of wells and springs, Coleman County

Water-bearing unit : Qa, Quaternary alluvium; Kt, Trinity Group; Pcf, Clear Fork Group; Pw, Wichita Group; Pcs, Cisco Group; Pcn, Canyon Group; Oe, Ellenburger Group.
Water levels : Reported water levels given in feet; measured water levels given in feet and tenths.
Method of lift and type of power: B, bucket or bailer; C, cylinder; Cf, centrifugal; E, electric; G, natural gas, butane, or gasoline; H, hand; J, jet; N, none; S, submersible; T, turbine; W, windmill.
Use of water : D, domestic; Ind, industrial; Irr, irrigation; P, public supply; S, livestock; N, none.

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
*30-59-801	L. A. Sampson	--	--	30	--	--	Pcf	1,961	20	Mar. 4, 1964	C,E	D,S	Dug well.
*802	Walter Matthews	--	--	Spring	--	--	Pcf	1,969	(+)	--	Flows	D,S	
*803	Frank Armour	--	--	60	--	--	Pcf	2,043	55	Mar. 4, 1964	C,W	D	Dug well.
*60-801	R. A. Cox	--	--	65	--	--	Pcf	1,954	55.1	Mar. 3, 1964	C,W	D	Do.
802	do	--	--	15	--	--	Pcf	1,923	7	do	B	D	Do.
803	Harker & McDaniels	--	--	Spring	--	--	Pcf	1,879	(+)	--	Flows	D,S	Well 11 in 1937 Coleman County report.
*902	W. E. Stephens	--	--	Spring	--	--	Pcf	1,908	(+)	--	do	S	Flows into stock tank.
903	do	--	--	Spring	--	--	Pcf	1,891	(+)	--	do	S	
*61-901	C. E. Stephens	--	--	30	4	--	Pw	1,645	--	--	C,W	S	
*62-601	R. T. Watson	--	--	20	--	--	Pw	1,612	15	June 11, 1964	C,E	D,S	Dug well.
*602	do	--	--	20	--	--	Qa	1,598	10	do	C,E	D,S	Do.
*603	do	--	--	72	10	72	Pw	1,615	20	do	C,W	D,S	Sand reported at 42 and 58 ft.
*604	P. T. Connally	--	--	46	3	46	Pw	1,582	14.6	do	N	N	
*801	Eldon Knox	--	--	200	6	200	Pw	1,676	80	June 10, 1964	J,E	D	Water reported encountered at 118 and 125 ft.
901	Clyde Thate	--	--	24	6	24	Pw	1,555	22	do	C,W	S	
*902	do	--	--	Spring	--	--	Qa	1,590	(+)	--	Flows	S	
*903	do	--	--	Spring	--	--	Qa	1,562	(+)	--	do	S	
*904	do	--	--	Spring	--	--	Qa	1,585	(+)	--	do	S	
*63-401	Bill Hunter	--	--	50	7	50	Pw	1,675	3	June 10, 1964	J,E	D,S	
*402	Deel Edington	--	--	30	--	--	Pw	1,642	15	June 19, 1964	C,E	D,S	Water from stock tank reportedly recharges well.
403	do	--	--	110	5	--	Pw	1,658	70	do	C,E	S	
*501	E. C. Koenig	--	--	90	6	90	Pw	1,615	55	June 10, 1964	C,E	D,S	
*502	do	--	--	90	6	90	Pw	1,655	--	--	C,W	S	

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
30-63-503	Deel Edington	--	--	110	8	110	Pw	1,675	70	June 19, 1964	C,W	S	Water has sulfurous odor.
*42-03-201	Earl Davis	--	--	56	--	--	Kt	2,076	51	Mar. 6, 1964	C,W	S	Dug well.
202	Mrs. Della McCain	--	--	30	--	--	Pcf	1,991	20	Mar. 10, 1964	H	D	Do.
*301	Ray Andrews	--	--	60	7	--	Pcf	1,975	45	Mar. 12, 1964	J,E	D	
302	Bayne Miller	--	--	80	5	80	Kt	2,073	60	Mar. 19, 1964	C,W	S	
*401	Rube Whitley	--	--	110	5	110	Pcf	2,033	60	Apr. 10, 1964	C,W	D,S	
*402	R. P. McWilliams	--	--	160	6	160	Pcf	2,086	80	Apr. 22, 1964	J,E	D,S	
*502	Earl Davis	--	--	80	8	--	Kt	2,096	77	Mar. 6, 1964	C,W	S	
503	Mrs. L. I. Bains	--	--	72	5	--	Kt	2,087	65	Mar. 10, 1964	C,W	D,S	
*504	A. H. Armor	--	--	40	--	--	Kt	2,068	37	Mar. 11, 1964	J,E	D,S	Dug well.
*505	L. B. Parham	--	--	54	4	54	Kt	2,094	30	do	C,W	D	
*506	O. L. DePrang	--	--	56	6	56	Kt	2,178	54	do	C,W	D,S	
*601	Earnest Reeves	--	--	89	6	89	Kt	2,036	86	Mar. 10, 1964	C,E	S	
602	J. N. DePrang	--	--	150	4	150	Kt	2,113	100	Mar. 11, 1964	J,E	S	
*603	A. H. Armor	--	--	75	7	75	Kt	2,114	55	do	C,W	D,S	
*604	L. B. Parham	--	--	150	7	150	Kt	2,126	100	do	C,W	S	
605	O. L. DePrang	--	--	140	6	--	Kt	2,186	70	Apr. 3, 1964	C,W	S	
606	do	--	--	140	5	--	Kt	2,202	70	do	C,W	S	
607	R. B. Casey	--	--	Spring	--	--	Kt	1,983	(+)	--	Flows	Irr	
*608	do	--	--	18	--	--	Kt	1,983	8	Mar. 11, 1964	J,E	D,S	Sand reported from 14 to 18 ft. Dug well.
*609	A. C. Atchley	--	--	100	5	100	Kt	2,025	50	do	C,E	D	
*610	Jim Paxton	--	--	22	--	--	Kt	2,030	20	do	C,W	D,W	
*611	do	--	--	260	5	260	Kt	2,102	--	--	C,W	S	
*612	Bayne Miller	--	--	99	6	99	Kt	2,111	84	Mar. 19, 1964	C,W	S	
*613	do	--	--	80	5	80	Kt	2,130	20	do	C,W	S	
*614	J. C. Williamson	--	--	25	--	--	Kt	2,087	15	do	C,W	S	Dug well.

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
42-03-615	Bayne Miller	--	--	88	5	88	Kt	2,058	68	Mar. 19, 1964	C,W	S	
* 701	Clyde Brevard	--	--	115	5	115	Kt	2,115	20	Apr. 10, 1964	C,W	S	Water reported at 85 and 115 ft.
* 702	do	--	--	85	5	85	Kt	2,101	20	do	C,W	D,S	Water reported at 40 ft.
703	Owen Bragg	--	--	22	--	--	Kt	2,060	16.3	do	C,W	S	Dug well.
* 801	McCord Estate	--	--	120	5	--	Kt	2,106	105	Mar. 17, 1964	C,W	D,S	
* 802	do	--	--	135	5	--	Kt	2,128	--	--	C,W	S	
* 803	do	--	--	Spring	--	--	Kt	2,108	(+)	--	Flows	S	
* 804	do	--	--	135	5	--	Kt	2,097	--	--	C,W	S	
* 805	E. W. Hennig	--	--	81	9	81	Kt	2,063	36.8	Apr. 3, 1964	C,E	S	
* 806	Vernon Bragg	--	--	135	5	135	Kt	2,140	85	Apr. 10, 1964	C,W	D,S	
* 807	do	--	1963	100	5	100	Kt	2,126	75	do	C,W	D,S	
* 808	do	--	1937	125	5	125	Kt	2,155	100	do	C,W	D,S	
* 809	Owen Bragg	--	--	85	5	85	Kt	2,100	75	do	C,W	D,S	
* 810	Clyde Brevard	--	--	65	5	65	Kt	2,102	20	do	C,W	D,S	
* 811	McCord Estate	--	--	110	5	--	Kt	2,075	90	May 26, 1964	C,W	S	
* 812	do	--	--	135	5	--	Kt	--	--	--	C,W	S	
* 813	do	--	--	135	5	--	Kt	2,098	--	--	C,W	S	
901	Mrs. R. L. Todd, Jr.	--	--	120	5	120	Kt	2,081	65	Apr. 16, 1964	C,W	D,S	
* 902	McCord Estate	--	--	135	5	--	Kt	2,122	--	--	C,W	S	
* 903	E. W. Hennig	--	--	52	--	--	Kt	2,062	26.9	Apr. 3, 1964	C,W	S	Dug well.
904	Mrs. R. L. Todd, Jr.	--	--	30	5	30	Kt	2,027	5	Apr. 2, 1964	C,W	S	
* 905	Matt Williams	--	--	50	6	50	Kt	2,062	33	do	J,E	D,S	
* 906	O. C. Morton	--	--	50	5	50	Kt	2,104	47	do	C,W	D,S	
907	E. W. Hennig	--	--	140	6	140	Kt	2,142	90	Apr. 3, 1964	C,W	S	
* 908	do	--	--	Spring	--	--	Kt	2,071	(+)	--	Flows	S	

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date com-plet-ed	Depth of well (ft)	Casing: Diam-eter (in.)	Casing: Depth (ft)	Water-bear-ing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
42-03-909	E. W. Hennig	--	--	80	6	80	Kt	2,069	--	--	C,W	S	
* 910	do	--	--	50	5	--	Kt	2,070	22	--	C,W	D,S	Original depth 100 ft.
911	do	--	--	100	10	100	Kt	2,070	22	--	J,E	D,S	Water reported at 25 and 50 ft.
* 912	do	--	--	12.4	--	--	Kt	2,051	4.8	--	B	S	Dug well.
913	A. C. May	--	--	113	5	113	Kt	2,057	40	Apr. 2, 1964	C,W	S	
* 914	do	--	--	100	5	100	Kt	2,052	40	do	C,W	D,S	
* 915	Ben Steffen	--	--	80	5	--	Kt	2,053	50	Apr. 7, 1964	C,W	D,S	Weak well.
* 916	do	--	--	Spring	--	--	Kt	2,019	(+)	--	Flows	S	Water has salty taste.
917	W. F. Galloway	--	--	80	5	80	Kt	2,074	60	Apr. 8, 1964	C,W	D,S	Water sand reported at 12 ft.
* 918	do	--	--	80	6	80	Kt	2,068	60	do	C,E	D,S	Water sand reported at 20 ft.
* 919	T. P. Story	--	--	Spring	--	--	Kt	2,054	(+)	--	C,E	S	
* 920	do	--	--	60	5	60	Kt	2,062	20	Apr. 3, 1964	C,W	S	
921	do	--	--	Spring	--	--	Kt	2,015	(+)	--	C,W	S	
* 04-101	Doyle Shamblin	--	--	50	5	--	Kt	2,006	36	Apr. 12, 1964	C,W	S	
102	Sam Sprinkles	--	--	23	--	--	Kt	1,993	22.7	do	C,W	D	Dug well.
* 103	Mrs. W. L. White	--	--	18	--	--	Pcf	1,938	9.5	do	C,W	D	Well 13 in 1937 Coleman County report.
* 201	Jim Bates	--	--	60	5	--	Kt	1,995	45	Mar. 3, 1964	C,W	D,S	
* 202	J. C. Bates	--	--	70	5	--	Kt	1,992	--	--	C,W	D,S	
* 203	Paul Templeton	--	--	200	--	--	Kt	1,961	50	Mar. 19, 1964	S,E	S	Well 17 in 1937 Coleman County report.
204	Joe Burroughs	--	1936	100	5	100	Kt	2,010	70	Mar. 26, 1964	C,W	D,S	
* 301	W. E. Stephens	--	--	180	6	180	Pcf	1,973	150	Mar. 3, 1964	C,W	D,S	Well 37 in 1937 Coleman County report.
* 302	Fred Croom	--	--	Spring	--	--	Pcf	1,984	(+)	--	Flows	S	Well 36 in 1937 Coleman County report.
303	do	--	--	Spring	--	--	Pcf	1,943	(+)	--	do	S	
304	C. D. Crossman	--	--	Spring	--	--	Pcf	1,935	(+)	--	do	S	
305	do	--	--	Spring	--	--	Pcf	1,937	(+)	--	do	S	
* 401	Loy Jackson	--	--	18	--	--	Kt	2,004	14.9	Mar. 13, 1964	C,W	S	Dug well.

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing		Water-bearing unit	Altitude of land surface (ft)	Water level		Method of lift	Use of water	Remarks
					Diameter (in.)	Depth (ft)			Below land-surface datum (ft)	Date of measurement			
*42-04-402	Loy Jackson	--	--	120	7	120	Kt	2,062	55	Mar. 13, 1964	C,W	S	Reported strong well.
403	L. Z. Beck	--	--	60	5	--	Kt	2,036	16	do	C,E	D,S	Water reported at 25, 40, and 50 ft.
* 404	Martha Morris	--	--	47	5	--	Kt	2,024	24	Mar. 16, 1964	C,W	D,S	
* 405	C. B. Mosley	--	--	65	--	--	Kt	1,968	17.4	Mar. 26, 1964	C,W	D,S	Dug well.
* 406	Mrs. J. H. Sansom	--	--	26	--	--	Kt	2,034	22	Apr. 8, 1964	B	S	Do.
407	do	--	--	160	8	--	Kt	2,076	--	--	C,W	S	
* 501	Arch Huddle	--	--	30	--	--	Kt	1,983	26.9	Mar. 13, 1964	C,W	S	Dug well.
* 502	Mrs. Bland Smith	--	--	25	--	--	Kt	2,015	21	do	C,W	D,S	Do.
* 503	Zelma Ray	--	--	41	--	--	Kt	2,009	37	Mar. 16, 1964	C,W	D,S	Well 20 in 1937 Coleman County report.
* 504	C. L. Saunders	--	--	32	--	--	Kt	2,033	31.6	do	C,W	S	
* 505	Mrs. Lucy Billings	-- Mueller	--	150	5	--	Kt	2,097	120	Mar. 19, 1964	J,E	S	
* 506	do	--	--	100	5	100	Kt	2,023	40	do	C,W	D,S	
507	Tom Popnoe	--	--	26	--	--	Kt	2,028	20	do	C,W	S	Dug well.
508	Paul Templeton	--	--	25	--	--	Kt	2,018	22	do	C,W	S	Do.
* 509	A. B. Kidd	--	--	30	--	--	Kt	2,018	25	Mar. 26, 1964	C,E	D,S	
* 601	Nora Tomlinson	--	--	140	5	140	Kt	1,985	120	Mar. 3, 1964	C,W	D	
602	Foy Tomlinson	--	--	28	--	--	Kt	2,009	6.5	Mar. 19, 1964	C,W	S	Dug well.
603	W. J. Smith	--	--	38	--	--	Kt	1,992	27.5	do	J,E	S	Do.
* 604	Wanda Corder	-- Grimes	--	90	5	80	Kt	2,014	45	Mar. 24, 1964	C,W	D	
* 605	Silver Valley Community	--	--	90	5	90	Kt	2,014	45	do	C,W	P	
* 606	C. A. Preas	-- Preas	--	110	5	110	Kt	1,998	60	Mar. 19, 1964	J,E	D	
607	Mollie Beall	--	--	25	--	--	Kt	2,024	22	Apr. 14, 1964	C,W	S	Well 21 in 1937 Coleman County report.
* 608	A. H. Thurmond	--	--	24	--	--	Kt	1,958	16	May 5, 1964	J,E	D,S	Dug well.
701	Foy Tomlinson	--	--	50	5	--	Kt	2,104	40	Mar. 16, 1964	C,W	S	
702	W. W. West	--	--	65	5	--	Kt	2,029	35	do	C,W	S	
* 703	do	M. Strickland	1963	120	5	120	Kt	2,022	65	do	C,W	S	

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
*42-04-704	J. J. Schneider	--	--	125	5	125	Kt	2,118	--	--	C,W	S	
* 705	McCord Estate	--	--	150	5	150	Kt	2,110	100	Apr. 9, 1964	C,W	S	
* 706	do	--	--	70	5	70	Kt	2,071	50	do	C,W	S	
* 707	do	--	--	110	5	110	Kt	2,117	90	do	C,W	S	
* 708	Jo Dean Whittington	--	--	44	--	--	Kt	2,005	12	Apr. 27, 1964	C,W	S	Dug well.
709	John Frazer	--	--	--	--	--	Kt	2,056	--	--	C,W	--	
* 801	W. W. West	--	--	33	--	--	Kt	1,993	21.8	Mar. 13, 1964	J,E	D,S	Dug well.
* 802	Arch Hamilton	--	--	12.5	--	--	Kt	1,952	3	Mar. 16, 1964	J,E	D	Do.
* 803	W. W. West	--	--	37	--	--	Kt	2,016	31	do	J,E	D,S	Do.
* 804	do	Bob Johnson	1961	65	5	65	Kt	2,021	35	do	C,W	D,S	Water reported at 45 ft. Weak well.
* 805	H. C. Williams	-- Rogers	1964	65	5	--	Kt	2,014	15	Mar. 25, 1964	J,E	D,S	
* 806	McCord Estate	--	--	50	5	50	Kt	2,032	35	Apr. 9, 1964	C,W	S	
* 901	Joe Holder	-- Strickland	1940	85	5	85	Pw	1,940	35	Mar. 20, 1964	C,E	D	
902	W. C. Ray	--	--	200+	6	--	Pw	1,917	--	--	C,W	S	
* 903	L. W. Witt	--	--	20	--	--	Pw	1,910	10	May 20, 1964	C,E	D,S	Dug well.
* 05-101	L. Flippen	--	--	Spring	--	--	Pw	1,790	(+)	--	Flows	S	
* 102	do	--	--	Spring	--	--	Pw	1,770	(+)	--	do	S	
* 701	T. J. Allen	--	--	52	6	52	Pw	1,748	48	Mar. 6, 1964	J,E	D,S	
* 702	do	--	--	Spring	--	--	Pw	1,780	(+)	--	Flows	S	
* 802	Don Wilkins	--	--	Spring	--	--	Qa	1,665	(+)	--	do	S	
* 901	Ray Jameson	--	--	17	--	--	Pw	1,640	5	May 6, 1964	C,W	D	Dug well.
* 902	V. K. Jameson	--	--	Spring	--	--	Pw	1,620	(+)	--	Flows	D,S	
* 903	Jim Gill	--	--	18	--	--	Pw	1,648	8.8	May 26, 1964	N	N	Dug well.
* 904	C. H. Abbey	--	--	16	--	--	Pw	1,621	8	June 3, 1964	B	D	Do.
* 06-201	W. H. Henderson	--	--	120	5	120	Pw	1,725	80	June 10, 1964	C,W	S	Water sand reported at 100 ft.
* 202	do	--	--	120	5	120	Pw	1,690	80	do	C,W	D	

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
42-06-301	S. T. Burkett	--	--	14	--	--	Pw	1,628	12	June 9, 1964	C,E	D	Dug well.
302	J. C. Slack	--	--	22	--	--	Pw	1,662	15.4	June 19, 1964	C,W	D	Do.
502	H. C. Burkett	--	--	12	--	--	Pw	1,604	8	June 10, 1964	C,E	D	Do.
601	A. I. Edwards	--	--	Spring	--	--	Pw	1,618	(+)	--	Flows	D	
602	J. G. Tabor	--	--	18	--	--	Pw	1,633	--	--	C,W	D	
603	R. B. Hollingworth	--	--	27	5	--	Pw	1,622	20	June 8, 1964	C,W	D,S	
604	T. Hipsher	--	--	35	5	35	Pw	1,621	--	--	C,W	S	
605	do	--	--	35	5	35	Pw	1,640	--	--	C,W	D,S	
606	Sam Hunter	--	--	16	--	--	Pw	1,680	8.8	June 8, 1964	C,W	D	
607	Mrs. C. M. Dibrell, Sr.	--	--	25	--	25	Pw	1,543	6	June 11, 1964	C,W	D,S	
608	E. E. Eddington	--	--	20	--	--	Pw	1,638	15	do	C,W	D,S	Dug well.
901	Frank Gillespie	--	1927	60	5	60	Pw	1,535	30	June 4, 1964	C,W	D,S	Well 65 in 1937 Coleman County report.
07-201	Mrs. B. R. Wooten	--	--	85	5	85	Pw	1,542	--	--	C,W	D	
401	Mrs. H. Adams	--	--	110	5	110	Pw	1,590	80	June 4, 1964	C,E	D	
402	T. L. Stephens	--	--	142	3	142	Pcs	1,628	112	do	C,W	D,S	
403	R. E. Harris	--	--	128	5	--	Pw	1,607	75	do	C,W	D,S	
701	O. W. Mayfield	--	--	130	5	130	Pcs	1,650	110	do	C,W	D	Well 64 in 1937 Coleman County report.
810	Lee D. Cox	--	--	115	5	115	Pcs	1,672	100	do	C,W	D,S	
11-201	McCord Estate	--	--	Spring	--	--	Kt	2,043	(+)	--	Flows	S	
202	do	--	--	14	5	--	Kt	2,020	10	Mar. 17, 1964	C,E	D,S	
203	Alfred Herring	--	--	60	5	--	Kt	2,080	--	--	C,E	S	
204	do	--	--	30	--	--	Pcf	1,963	15	Apr. 8, 1964	J,E	D,S	Well 158 in 1937 Coleman County report. Dug well.
205	Bunn Jeffreys	--	--	65	5	--	Kt	2,081	--	--	C,E	D,S	
206	Kenneth McWilliams	--	--	46	6	46	Kt	2,095	43	Apr. 13, 1964	C,W	S	
207	Edgar Herring	-- Mueller	--	50	6	50	Kt	2,063	40	Apr. 14, 1964	C,W	S	

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
*42-11-208	Elliott Kemp	--	--	65	5	--	Kt	2,091	40	Apr. 17, 1964	C,W	S	
* 209	A. J. Morrison	--	--	60	5	60	Kt	2,062	27	Apr. 21, 1964	C,W	S	
* 301	McCord Estate	--	--	130	5	--	Kt	2,087	--	--	C,W	S	
302	L. Whittington	--	--	16	--	--	Kt	1,987	8	Mar. 31, 1964	C,W	N	Dug well.
* 303	do	--	--	60	6	51	Kt	1,988	24.5	do	J,E	D,S	
* 304	Mrs. J. Futtrell	--	--	29	--	--	Kt	1,987	19.8	Apr. 2, 1964	J,E	D,S	Dug well.
305	C. T. Whittington	--	--	26	--	--	Kt	1,975	16.6	do	C,W	S	
* 306	E. G. Simpkins	C. Duncan	--	40	6	40	Kt	1,993	22.6	do	J,E	D,S	Water reported at 24 ft.
* 307	E. W. Hennig	--	--	80	6	--	Kt	2,045	--	--	C,W	D,S	
* 308	Charles Mitchell	--	--	65	5	--	Kt	2,007	35	Apr. 3, 1964	J,E	D,S	
* 309	Steve Hale	--	--	50	5	50	Kt	2,001	30	do	C,W	D	Oil and gas odor, and salty taste.
* 310	J. C. Williams	-- Strickland	--	58	5	58	Kt	2,004	28	do	C,W	D	
* 311	Mrs. Stinson	--	--	78	5	--	Kt	2,008	45	Apr. 7, 1964	C,W	D,S	
* 312	Mrs. Cora Watkins	-- Ayers	--	65	5	--	Kt	2,013	40	Apr. 3, 1964	C,W	D,S	
313	Glen Cove Gasoline Plant	-- Walker	1953	85	7	85	Kt	2,023	70	do	J,E	D	
* 314	do	do	1953	85	7	85	Kt	2,022	70	do	S,E	Ind	Average use, 150 bbl per day.
315	do	do	1953	85	7	85	Kt	2,021	70	do	S,E	Ind	
* 316	Steve Hale	--	--	50	6	--	Kt	1,997	--	--	J,E	D	
* 317	G. Ayers	--	--	65	5	--	Kt	1,997	--	--	C,W	D	
* 318	Walter Carter	--	--	50	5	--	Kt	1,997	--	--	C,E	D	
* 319	Mrs. C. C. Duncan	--	--	50	5	--	Kt	1,992	--	--	C,W	D	
* 320	F. W. Dunaway	--	1918	62	6	--	Kt	2,041	50.4	Apr. 7, 1964	C,W	D,S	Caved from total depth of 75 ft.
* 321	J. S. Braswell	-- Mueller	1962	108	5	108	Kt	2,041	57	do	J,E	D	Reported weak well; 10-ft drawdown in 19 min.
* 322	Homer Davis	--	--	40	--	--	Kt	2,004	34	do	J,E	D,S	Dug well.
323	do	--	--	40	5	40	Kt	2,004	23	do	C,W	S	
324	do	--	--	Spring	--	--	Kt	2,059	(+)	--	Flows	S	

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
*42-11-325	I. C. Whittington	--	--	30	--	--	Kt	2,002	13.1	Apr. 7, 1964	C,W	D,S	Dug well.
326	E. C. Jones	-- Ayers	--	60	5	--	Kt	2,000	--	--	C,W	D,S	
*327	J. B. Helm	--	--	100	5	100	Kt	2,070	90	Apr. 7, 1964	C,G	D,S	Reported weak well.
328	do	--	--	40	--	--	Kt	2,042	37	do	C,W	D	Dug well.
*329	do	--	--	25	--	--	Kt	2,042	15	do	C,G	S	Has supplied water for drilling rig.
*330	C. C. Duncan	--	1916	42	5	42	Kt	2,082	17	Apr. 20, 1964	C,W	D,S	Water sand reported at 45 to 48 ft.
*331	do	--	--	60	5	60	Kt	2,078	33	do	C,W	D	
*332	do	--	1916	22	--	--	Kt	2,078	18	do	C,E	D	Dug well.
*333	Toppy Beaver	--	--	125	6	125	Kt	2,055	60	Apr. 17, 1964	C,E	D,S	Water sand reported at 60 ft.
*334	C. H. Wilson	--	--	43	--	--	Kt	2,011	11.8	Apr. 22, 1964	C,W	D,S	
335	J. C. King, Sr.	--	--	15	--	--	Kt	2,029	11	Apr. 20, 1964	C,W	D	
*401	Edgar Herring	--	--	Spring	--	--	Pcf	1,934	(+)	--	Flows	S	
*501	M. L. Stone	--	--	84	5	--	Kt	2,063	45	Apr. 8, 1964	C,W	S	Water sand reported at 78 ft.
*502	E. E. Evans	--	--	100	--	--	Kt	1,966	50	Apr. 10, 1964	C,W	D	
*503	M. L. Stone	--	--	50	--	--	Kt	1,962	45	Apr. 8, 1964	C,W	S	Dug well.
*504	Hubert Stokes	--	--	38	7	38	Kt	1,974	22	Apr. 10, 1964	C,W	S	
505	do	--	--	65	7	65	Kt	1,973	20	do	C,W	D,S	
*506	do	--	--	96	6	96	Kt	1,977	50	do	C,W	S	
*507	Mrs. Maggie Beaver	--	--	37	--	--	Kt	1,984	31	Apr. 13, 1964	C,W	D,S	Dug well.
*508	Horace Stokes	--	--	20	--	--	Pcf	1,911	15.8	do	C,W	D	Well 165 in 1937 Coleman County report.
*509	C. E. Jacobs	--	--	80	6	80	Kt	2,072	65	Apr. 15, 1964	J,E	D,S	
510	J. T. Thompson	--	--	36	--	--	Pcf	1,950	30	May 8, 1964	C,W	D	Dug well.
511	Benton Cassidy	-- Mueller	1961	130	6	130	Kt	1,961	45	July 6, 1964	C,W	S	
512	do	--	1917	15	--	--	Pcf	1,917	13.3	do	N	D,S	Dug well.
601	G. L. Joyce	--	--	30	--	--	Pcf	1,945	25	Apr. 13, 1964	J,E	N	Do.
*602	do	-- Mueller	--	99	5	99	Kt	1,977	76	do	C,E	D,S	

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
42-11-603	G. L. Joyce	--	--	15	--	--	Kt	2,045	11.5	Apr. 13, 1964	C,E	D	Dug well.
* 604	C. E. Jacobs	--	--	115	7	115	Kt	2,132	85	Apr. 15, 1964	C,E	S	Previously used as industrial well.
* 605	G. L. Joyce	--	--	125	5	125	Kt	2,115	94	Apr. 13, 1964	C,W	S	
* 606	C. E. Brown Estate	--	--	100	6	83	Kt	1,961	20	Apr. 14, 1964	C,W	S	
* 607	McCord Estate	--	--	57	--	--	Pcf	1,944	39.3	do	C,W	S	
608	A. A. Brown	--	--	51	--	--	Pcf	1,934	48	Apr. 17, 1964	C,W	S	
* 609	do	--	--	63	5	63	Kt	1,935	48	do	C,W	S	
* 610	W. Mulanax	--	--	39	5	39	Kt	1,968	18	Apr. 15, 1964	J,E	D,S	
* 611	Toppy Beaver	--	--	26	--	--	Kt	1,968	20	Apr. 17, 1964	J,E	D,S	Dug well.
* 612	O. C. Bertrand	--	--	101	5	101	Kt	2,118	100	Apr. 15, 1964	C,W	D,S	
613	do	--	--	120	5	120	Kt	2,123	188	do	C,W	D	
614	do	--	--	135	5	135	Kt	2,138	86	do	C,W	D	Water reported encountered at 105, 120, and 130 ft.
* 615	do	--	--	80	5	80	Kt	2,093	77	do	C,W	S	Well 166 in 1937 Coleman County report.
* 616	do	--	--	135	8	135	Kt	2,116	126	do	C,W	D,S	
617	do	--	--	135	8	135	Kt	2,118	126	do	C,W	D	
* 618	do	--	--	30	--	--	Kt	2,018	28	do	C,W	S	Dug well.
* 619	Toppy Beaver	--	--	77	7	77	Kt	2,104	55.4	Apr. 20, 1964	C,E	S	
620	George Vincent	--	--	89	--	--	Kt	2,060	86	Apr. 15, 1964	C,W	D	
621	do	--	--	31	--	--	Kt	2,068	30	do	C,W	S	
622	do	--	--	27	--	--	Kt	2,066	25	do	B	S	
* 623	Toppy Beaver	--	--	32	--	--	Kt	2,023	30	Apr. 17, 1964	C,E	D,S	Dug well.
* 624	C. H. Wilson	--	--	104	5	104	Kt	2,058	45.8	Apr. 21, 1964	C,W	D,S	
* 625	R. C. Hinds	--	--	24	--	--	Kt	2,014	20	Apr. 29, 1964	C,W	S	Dug well.
* 801	Gorden Brookshire	--	--	14	--	--	Pcf	1,937	8	Apr. 1, 1964	J,E	D,S	Reported adequate supply. Dug well.
* 802	Roy Pearce	--	--	15	--	--	Pcf	1,934	6	Apr. 9, 1964	C,W	D,S	Recharged by creek. Dug well.
* 803	do	--	--	18	--	--	Pcf	1,945	6	do	C,W	S	Do.

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
*42-11-804	J. C. Reis	--	--	15	--	--	Pcf	1,957	12.2	Apr. 13, 1964	C,W	D,S	Well 163 in 1937 Coleman County report.
* 805	L. E. Hinter Estate	--	--	60	--	--	Pcf	1,912	30	do	C,H	S	
* 901	Bryan Clayton	--	--	110	5	--	Pcf	1,950	30	do	C,W	S	
* 902	Glynn Mitchell	--	--	90	5	90	Pcf	1,961	--	Apr. 15, 1964	C,W	S	
* 903	H. A. Mercer	--	--	23	5	--	Pcf	1,950	17	May 13, 1964	C,W	S	
* 12-101	H. C. Snodgrass	--	--	92.7	6	--	Kt	1,962	32.2	Mar. 31, 1964	C,W	D,S	Well 120 in 1937 Coleman County report.
* 102	D. R. Shuford	--	--	100	5	95	Kt	2,022	90	do	C,W	D	Well 121 in 1937 Coleman County report.
103	Ed Hamon, Jr.	--	1887	50	--	--	Kt	2,024	46	do	C,H	N	Well 122 in 1937 Coleman County report.
* 104	Dick Hamon	--	--	50	--	--	Kt	2,055	46	do	C,W	S	Dug well.
105	I. C. Whittington	M. Close	--	60	5	60	Kt	2,060	48	Apr. 14, 1964	C,W	S	
* 106	J. J. Schneider	--	--	160	5	160	Kt	2,057	110	Apr. 2, 1964	C,W	D,S	
* 107	I. C. Whittington	--	--	75	5	75	Kt	2,006	67	Mar. 31, 1964	C,W	D,S	
* 108	do	--	--	45	--	--	Kt	1,989	37	do	N	N	
109	Fred G. Vincent	--	--	90	5	90	Kt	1,997	--	Apr. 20, 1964	C,W	D	Water reported at 65 ft. Well 124 in 1937 Coleman County report.
* 201	M. D. Whittington	-- McShan	1918	130	7	130	Kt	1,914	80	Mar. 30, 1964	C,W	D,S	
* 202	Mrs. J. M. Savage	--	1884	33	--	--	Pcf	1,935	13.7	Mar. 31, 1964	B	S	Dug well.
* 203	Bill Beaver	--	--	Spring	--	--	Kt	1,929	(+)	--	Flows	S	
204	D. A. Coursey	--	--	163	8	163	Pw	1,970	133	Apr. 23, 1964	C,W	S	
* 301	J. M. Roberts	--	--	20	--	--	Kt	1,820	3	Mar. 20, 1964	J,E	S	Dug well.
* 302	-- Rhodes	--	--	16	--	--	Pw	1,775	10	do	B	D,S	Do.
* 303	I. O. Hill	--	--	22	--	--	Pw	1,913	15	Mar. 25, 1964	J,E	D,S	
* 304	R. I. Bowen, Jr.	--	--	29	--	--	Pw	1,896	24.9	Mar. 30, 1964	B	D,S	Dug well.
* 305	D. A. Coursey	--	--	35	5	--	Pw	1,944	32	do	C,W	D,S	
* 306	A. J. Walton	--	--	21	--	--	Pw	1,912	17	Mar. 31, 1964	C,W	D	Dug well.
402	Pearl Titsworth	--	--	100	5	--	Pw	1,935	20	Apr. 24, 1964	C,W	D	
* 403	E. M. Martin	--	--	18	--	--	Kt	1,948	10.1	Apr. 30, 1964	C,H	D,S	Dug well.

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing		Water-bearing unit	Altitude of land surface (ft)	Water level		Method of lift	Use of water	Remarks
					Diameter (in.)	Depth (ft)			Below land-surface datum (ft)	Date of measurement			
*42-12-404	E. M. Martin	--	--	125	--	--	Kt	1,953	16	Apr. 30, 1964	N	N	Not used since 1960.
*405	Chub Dubois	--	--	30	--	--	Kt	1,995	24	Apr. 29, 1964	C,W	S	Dug well.
*406	F. Pauley	--	--	Spring	--	--	Kt	1,991	(+)	--	Flows	S	
*407	Wesley James	--	--	180	5	--	Kt	1,983	90	Apr. 29, 1964	C,E	D,S	
408	A. J. Morrison	--	--	--	--	--	--	--	--	--	C,W	S	
*501	M. West	--	--	190	5	190	Kt	1,978	170	Apr. 24, 1964	C,E	D,S	
*502	do	--	--	50	--	--	Kt	1,977	33	do	N	D,S	
503	Dick McMahan	--	1933	160	5	--	Kt	1,966	85	do	C,W	D,S	Water reported encountered at 76, 115, and 150 ft.
*504	do	--	1896	150	5	--	Kt	1,966	75	do	C,W	D,S	
505	Grady Laws	--	--	106	6	105	Kt	2,004	42.1	Apr. 28, 1964	C,W	S	
*506	do	--	--	141	5	141	Kt	1,967	59.6	do	C,W	N	
*507	F. C. Barsch	--	--	160	5	--	Kt	1,996	157	Apr. 27, 1964	N	D,S	
*508	J. P. Leseur	--	--	Spring	--	--	Kt	1,933	(+)	--	C,E	D	Pump used to lift water to house.
*509	M. M. Mulanax	-- Drake	1925	165	5	--	Kt	1,919	--	--	C,W	N	Not used since water became salty in 1960.
*510	do	-- Mueller	1959	140	6	140	Kt	1,970	120	Apr. 29, 1964	S,E	D,S	Water reported at 133 ft.
*511	J. T. Thompson	--	--	150	5	150	Kt	1,963	140	May 8, 1964	C,W	D	
*701	Mrs. D. Martin	--	1938	180	5	180	Pcf	2,002	40	Apr. 8, 1964	S,E	D,S	
*702	Ralph Edens	B. Close	1951	157	5	157	Pcf	1,968	23	do	C,W	S	Reported strong well.
*703	George Gould	--	--	17	--	--	Kt	1,992	13.1	Apr. 14, 1964	C,W	S	Dug well.
*704	Mrs. Earl Arthur	--	--	35	--	--	Kt	1,981	32	do	C,W	D	Do.
*705	John Bomar	--	--	100	5	100	Kt	2,003	53	do	C,W	D	
*706	Zoella McKissick	--	--	60	5	--	Pcf	1,967	40	Apr. 27, 1964	C,W	D,S	
*707	A. W. Gulley	--	--	10	--	--	Kt	1,974	5	Apr. 28, 1964	C,W	D,S	Dug well.
*801	Santa Fe Railroad	--	--	22	5	22	Qa	1,812	15	Apr. 9, 1964	C,W	D	
*802	W. T. Gassiot	--	--	26	--	--	Pw	1,821	20	do	J,E	D,S	
*803	Mrs. Nettie Hoover	--	--	41	5	40	Pw	1,822	35	do	C,W	D,S	

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
*42-12-804	Charles Basham	--	--	33	--	--	Pw	1,810	29	Apr. 13, 1964	N	N	Dug well.
* 805	Mrs. Hazel Henderson	--	--	29	5	29	Pw	1,810	19	do	J,E	D	Water used only for bath, kitchen, and garden.
* 806	W. P. Turner	--	--	42	--	--	Pw	1,810	20	do	J,E	D	Dug well.
807	Grady Laws	--	--	131	5	131	Pw	1,932	38.8	Apr. 24, 1964	C,W	D	
* 808	E. E. Maples	--	--	147	5	147	Pcf	1,970	85	Apr. 28, 1964	J,E	D,S	
* 809	Bryan Clayton	--	--	106	5	106	Kt	1,966	--	--	C,W	D,S	
* 810	J. T. Thompson	--	--	150	5	150	Kt	1,946	34.6	May 8, 1964	C,W	D	
* 811	V. C. Patterson	--	--	60	6	--	Pw	--	46	Aug. 1, 1962	J,E	D	
* 812	Robert Moser	Robt. Moser	1964	56	5	56	Pw	--	46	May 12, 1964	J,E	D	
813	V. C. Patterson	--	--	41	5	--	Pw	--	32.5	Aug. 1, 1962	N	N	
* 814	C. Duncan	C. Duncan	1961	46	3	46	Pw	--	33.5	do	C,E	D	Water reported at 33 ft.
815	Mrs. E. L. Moser	--	--	36	--	--	Pw	--	32	do	N	N	Last used in 1950. Dug well.
816	do	--	1950	55	5	55	Pw	--	--	--	N	N	Casing collapsed.
* 817	do	C. Duncan	1960	53	5	53	Pw	--	33.8	July 31, 1962	J,E	D	Water reported encountered at 26 and 36 ft.
* 818	Methodist Church	--	--	18	--	--	Pw	--	16.9	Aug. 2, 1962	N	N	Dug well.
819	do	--	--	34	5	34	Pw	--	27.8	Aug. 1, 1962	N	N	
* 820	do	--	--	50	4	50	Pw	--	--	--	J,E	D	
* 821	F. J. Baker	--	--	40	--	--	Pw	--	39.4	Aug. 2, 1962	J,E	D	Dug well.
* 822	Mrs. Lydie Miller	--	--	55	5	55	Pw	--	36.4	do	J,E	D	
823	C. R. McNeill	--	--	50	5	50	Pw	--	--	--	C,W	D	
* 824	H. H. Mitchell	--	1905	45	5	45	Pw	--	32.5	Aug. 2, 1962	C,W	D	
825	do	--	--	36	--	--	Pw	--	34.8	do	N	N	Dug well.
* 826	Louise Cagle	--	1955	55	--	--	Pw	--	29.3	do	C,E	D	
* 827	Cora Mitchell	--	--	29	--	--	Pw	--	28.2	do	N	D	Dug well.
* 828	A. L. Mardgen	--	1950	27	--	--	Pw	--	24.5	do	J,E	D	Do.
* 829	L. D. Gassiott	--	1944	26	--	--	Pw	--	14.5	Aug. 3, 1962	J,E	D,S	Do.

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
*42-12-830	Mrs. H. T. Marcus	C. Duncan	1958	30	7	30	Pw	--	23.6	Aug. 3, 1962	J,E	D	Water reported at 28 ft.
831	W. T. Nixon	--	1950	42	6 4	27 42	Pw	--	22.3	do	J,E	D	
* 832	A. T. Roberts	--	1950	55	6	55	Pw	--	36.4	do	J,E	Ind	
833	Valera School	--	--	42	5	--	Pw	--	40.5	do	C,W	N	Well 304 in 1937 Coleman County report.
834	H. Mulanax	Close & Strickland	1950	53	5	53	Pw	--	35	Aug. 15, 1962	J,E	D	
* 13-201	City of Coleman	--	--	22	--	--	Qa	1,690	14	May 4, 1964	Cf,E	P	Well 83 in 1937 Coleman County report.
* 202	R. E. McWhirter	--	--	28	--	--	Qa	1,727	16.5	Mar. 3, 1964	B	D,S	Dug well.
* 203	Lewis Simpson	--	--	60	5	56	Pw	1,720	35	Mar. 20, 1964	C,W	D	
* 301	W. O. Ward	--	--	14	--	--	Pw	1,663	7.1	May 28, 1964	J,E	D,S	Dug well.
* 302	J. C. Barr	-- Wilkins	1962	38	8	--	Pw	1,682	28	do	C,E	D	
* 303	Coleman Butane Co.	L. Ray	1964	41	6	41	Pw	1,715	26	May 25, 1964	J,E	D,S	
* 304	Coleman County Precinct No. 1	--	--	60	6	60	Pw	1,714	15	May 28, 1964	S,E	Ind	
* 305	B. C. Bartley	--	--	52	6	52	Pw	1,675	14.5	May 29, 1964	J,E	D	
* 402	Cecil Horne	--	--	20	--	--	Qa	1,795	18	Apr. 29, 1964	C,W	D	Dug well.
502	J. W. Mead	--	--	14	--	--	Qa	1,713	7	do	C,W	D	Do.
* 601	O. L. Griffith	--	--	24	8	24	Qa	1,650	14	May 20, 1964	J,E	D,S	
* 602	H. G. Dunn	C. D. Currie	--	25	8	25	Qa	1,650	18	do	J,E	D,S	
* 603	L. F. Craig	--	--	38	10	38	Qa	1,712	1	May 28, 1964	C,E	D,S	
* 604	H. Watson	--	--	22	--	--	Qa	1,735	20.2	June 2, 1964	C,E	D	Dug well.
* 605	Clyde Byrd	B. Martin	--	45	5	45	Qa	1,727	12	May 19, 1964	N	D	Water reported in lime at 31 ft.
* 701	Theo Griffis	--	--	25	--	--	Qa	1,650	19	Apr. 14, 1964	C,E	D	
* 801	Carl Stoup	--	--	11	--	--	Pw	1,650	4	Apr. 30, 1964	C,G	S	Dug well.
* 802	Richie Perkins	--	--	22	--	--	Pw	1,687	20.9	do	B	D,S	Water has salty taste.
* 803	do	--	--	14	--	--	Qa	1,675	9.9	do	C,W	S	Dug well.
804	J. W. Hunter	--	--	16	--	--	Pw	1,677	10	do	C,W	D,S	Do.

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
*42-13-805	P. Guerrero	--	--	31	--	--	Pw	1,675	6.3	May 6, 1964	N	N	Well 197 in 1937 Coleman County report. Dug well.
* 901	J. B. Watson	--	--	20	--	--	Pw	1,640	17	May 12, 1964	--	D,S	Dug well.
* 14-201	I. R. Wagnon	--	--	Spring	--	--	Qa	1,530	(+)	--	Cf,G	S	Pump used to lift water to stock tanks.
* 402	S. T. Lindsey	--	--	16	--	--	Pw	1,680	7	June 2, 1964	C,W	D	Dug well.
601	J. Fox Casey	B. Parrish	1906	140	5	--	Pcs	1,645	107	Nov. 10, 1960	N	N	Well 232 in 1937 Coleman County report.
* 602	do	-- Smith	1937	150	5	--	Pcs	1,645	110	May 12, 1964	C,W	D	Well 233 in 1937 Coleman County report.
* 701	Brannon & Murray	--	--	100	8	100	Pw	1,735	93	do	C,E	D	
* 702	do	--	--	86	5	--	Pw	1,723	86	do	C,E	D	
* 703	L. D. Franklin	--	--	17	--	--	Pw	1,713	6.2	June 2, 1964	C,G	D,S	Dug well.
* 801	L. E. Story	--	--	28	--	--	Pw	1,751	20	do	J,E	D	Do.
* 901	T. E. Todd	--	--	242	5	242	Pcs	1,595	130	do	C,W	D,S	
902	J. E. Stephens	--	--	240	5	240	Pcs	1,603	130	do	C,W	S	
* 903	U. S. Brannon	--	--	380	5	380	Pcs	1,575	65	do	J,E	D,S	Well 288 in 1937 Coleman County report.
15-101	B. H. Nolen	--	--	40	12	40	Qa	1,510	--	--	C,W	S	
102	do	--	--	40	12	40	Qa	1,500	--	--	C,G	S	
503	J. H. Singletary	--	--	165	5	--	Pcs	1,495	--	--	C,W	S	
* 701	A. E. McCarrell	--	--	160	5	160	Pcs	1,545	40	June 30, 1964	C,W	D,S	
702	W. R. Hickman, Jr.	--	--	83	5	83	Pcs	--	20	June 2, 1964	C,W	S	
* 815	C. N. Powell	--	1927	190	6	190	Pcs	1,550	40	June 30, 1964	J,E	D,S	
816	W. R. Hickman	--	--	83	5	83	Pcs	--	20	do	C,W	S	
* 19-101	E. E. Evans	--	1914	15	6	15	Qa	1,858	12	May 13, 1964	C,W	D,S	Reported weak well; goes dry during drouth.
* 102	do	--	1914	6	--	--	Qa	1,856	3.5	do	N	S	Reported strong well.
* 202	Curtis Beck	--	--	15	--	--	Pcf	1,859	9.2	Apr. 7, 1964	C,W	S	Well 312 in 1937 Coleman County report.
* 203	do	--	--	Spring	--	--	Pcf	1,842	(+)	--	Flows	S	
* 204	do	--	--	Spring	--	--	Pcf	1,819	(+)	--	do	S	
* 205	do	--	--	Spring	--	--	Pcf	1,769	(+)	--	do	S	

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
*42-19-206	Ralph M. Edens	--	1964	140	--	--	Pcf	--	120	Apr. 17, 1964	N	N	Water reported encountered at 70 ft.
* 301	George Beck	--	--	10	--	--	Pcf	1,848	6	Apr. 8, 1964	C,W	D,S	Well 313 in 1937 Coleman County report.
* 302	D. W. Franke	--	--	28	6	28	Pcf	1,899	15	Apr. 9, 1964	C,W	D,S	
* 303	R. H. Stainback	--	--	23	--	--	Pcf	1,888	10	do	C,W	D	
* 304	D. W. Franke	--	--	15	--	--	Qa	1,905	8.6	do	C,W	S	
* 305	R. E. Bailey	--	1916	18	--	--	Pcf	1,913	16	do	C,W	S	Well 310 in 1937 Coleman County report.
* 602	Robert Horne	--	--	10	--	--	Pcf	1,847	4.5	Apr. 7, 1964	C,W	S	Near creek.
* 603	do	--	--	50	6	50	Pcf	1,847	14	do	C,W	S	Drilled as seismic shothole.
* 604	do	--	--	90	6	90	Pcf	1,826	14	do	C,W	S	Do.
* 801	Day Ranch Estate	--	1930	80	6	80	Pcf	1,625	55	Mar. 25, 1964	C,W	D,S	Well 316 in 1937 Coleman County report.
* 802	Clyde Duncan	-- Stokes	--	94	6	94	Pcf	1,615	49.5	Mar. 31, 1964	C,W	S	
803	Day Ranch Estate	--	--	102	6	102	Pw	1,678	91	Mar. 25, 1964	C,W	N	
* 901	Mrs. E. M. Knox	--	--	93	6	93	Pw	1,732	75.2	Apr. 3, 1964	C,W	S	
* 902	J. E. Bryson	--	--	93	6	93	Pw	1,707	--	--	C,W	S	
* 903	do	--	--	73	6	73	Pw	1,717	49.4	Apr. 1, 1964	C,W	S	
* 904	Mrs. O. E. Beck	--	--	90	6	90	Pw	1,706	76.3	Mar. 31, 1964	C,W	S	
* 905	do	--	--	--	--	--	--	1,745	--	--	C,W	S	Found bridge at 21 ft.
* 906	J. E. Bryson	--	--	91	6	91	Pw	1,718	70	Mar. 31, 1964	C,W	S	
* 907	Day Ranch Estate	--	--	124	6	--	Pw	1,697	100.5	do	C,W	S	
908	do	--	--	100	6	100	Pw	1,738	87	Apr. 1, 1964	C,W	N	
* 20-201	H. C. Parrott	--	--	43	6	43	Pw	1,835	39.5	Apr. 2, 1964	C,W	D,S	
* 202	C. Morris	--	--	60	6	60	Pw	1,821	48.7	do	C,W	D,S	
* 203	J. Le May	--	--	85	6	80	Pw	1,858	79	do	C,W	D,S	Well 293 in 1937 Coleman County report.
204	T. J. Allen	--	--	120	6	120	Pw	1,865	40	Mar. 6, 1964	C,W	S	Water reported encountered at 80 and 100 ft.
301	Robert Horne	--	--	16	--	--	Qa	--	15.2	July 8, 1964	C,W	D,S	
* 501	C. W. Hemphill	--	--	25	--	--	Qa	1,777	12	Apr. 2, 1964	C,W	S	

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
*42-20-701	Roberta Farris	--	--	103	--	--	Pw	1,673	100	Mar. 30, 1964	C,W	D,S	Reported weak well.
* 702	I. S. Pate	F. Allen	1963	117	7	117	Pw	1,687	90	do	S,E	Irr	Reported strong well.
* 703	do	--	1907	100	6	100	Pw	1,693	65	do	C,W	D,S	Well 329 in 1937 Coleman County report.
* 704	J. W. Guthrie	--	--	82	6	82	Pw	1,742	75	Apr. 1, 1964	C,W	S	Reported strong well; water from cavity.
* 705	E. M. Knox	-- Mueller	1963	200	6	200	Pw	1,765	--	--	C,W	S	
* 801	Ina Turner	--	--	18	--	--	Qa	1,654	3.5	Apr. 1, 1964	C,E	D,S	
* 802	A. E. Turner	--	--	35	6	35	Pw	1,678	29	Apr. 2, 1964	C,W	D	
* 21-201	P. T. Skaggs	--	--	19	--	--	Pw	1,680	12	May 6, 1964	J,E	D,S	Well 194 in 1937 Coleman County report.
301	T. E. McDonald	--	--	27	--	--	Qa	--	7	do	J,E	D,S	Near creek. Dug well.
302	A. J. Dodgen	--	--	45	--	--	Pw	--	9	do	--	N	Reported strong well. Dug well.
* 303	R. C. Smith	--	--	20	--	--	Pw	1,560	15	Apr. 22, 1964	B	--	Dug well.
* 401	F. Ehrler	--	--	36	--	--	Pw	1,688	29	Apr. 2, 1964	H	D	Do.
* 402	P. S. Simmons	--	--	15	--	--	Pw	1,650	8	Apr. 3, 1964	J,E	D,S	Do.
* 403	W. F. Kinsey	--	1959	80	6	80	Pw	1,655	30	Apr. 2, 1964	J,E	D	Reported adequate supply.
* 404	J. E. Snider	--	1934	23	--	--	Pw	1,650	--	Apr. 3, 1964	J,E	Ind	Well 281 in 1937 Coleman County report. Dug well.
* 405	T. T. Sikes	--	1946	28	--	--	Pw	1,650	10	Apr. 14, 1964	C,E	N	Reported weak well; fails during drouth.
* 406	W. A. Moore	--	1935	20	--	--	Pw	1,655	10	do	J,E	D	Dug well.
* 601	Page Mays	--	--	18	--	--	Qa	1,550	16.5	Apr. 15, 1964	C,W	D,S	Do.
* 602	do	--	--	Spring	--	--	Qa	1,545	(+)	--	Flows	S	Reported weak supply.
* 603	A. L. Griffin	--	--	12	--	--	Pw	1,555	8	Apr. 15, 1964	C,W	S	Well 278 in 1937 Coleman County report. Dug well.
* 701	J. H. Candler	--	1850	20	--	--	Qa	1,603	2.5	Apr. 14, 1964	N	N	Near Creek. Owner reports well recharged by nearby pond.
* 22-401	M. T. Knight	--	--	17	--	--	Pw	1,620	9	Apr. 22, 1964	B	N	Dug well. Surface drainage into well.
501	Jetta Kirkpatrick	--	1959	90	6	90	Pcs	1,561	60	Apr. 23, 1964	C,W	S	
* 602	R. P. Knowles	J. Joiner	1963	275	6	275	Pcs	1,562	119	Apr. 29, 1964	J,E	D	
* 603	J. T. Frazier	--	--	80	6	--	Pcs	1,535	--	--	C,W	D	

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
*42-22-701	John Hensley	--	--	20	--	--	Qa	1,500	3	Apr. 22, 1964	C,E	D,S	
*702	C. R. Allen	--	--	Spring	--	--	Pcs	1,485	(+)	--	Flows	D,S	
*23-101	W. M. Drury	--	--	46	6	46	Pcs	1,555	25	Apr. 30, 1964	C,W	D,S	
*102	T. Goodsell	--	--	--	6	--	Pcs	1,575	--	--	J,E	D	
*103	M. Duggins	--	--	160	6	160	Pcs	1,578	--	--	C,W	S	
*104	S. H. Duggins	--	--	195	6	190	Pcs	1,589	140	Apr. 30, 1964	C,E	D,S	Reported adequate supply.
*105	S. M. Russell	--	--	220	6	220	Pcs	1,600	--	--	C,W	S	
*106	W. H. Pittard	--	--	104	6	104	Pcs	1,595	94	Apr. 30, 1964	C,W	D,S	
*107	H. O. Norris	--	1907	250	6	250	Pcs	1,572	40	do	C,W	S	
*510	A. J. Marshall	J. Latimer	1963	72	6	72	Pcs	1,542	20.1	May 15, 1964	J,E	D,S	Water sands reported at 37 and 72 ft.
701	W. P. McClatchy	--	--	18	--	--	Pcs	1,452	16.2	Sept. 26, 1962	N	N	
*27-201	Jas. T. Padgitt	--	--	87	6	87	Pcf	1,555	76.8	Apr. 1, 1964	C,W	D,S	
*202	do	--	--	90	6	90	Pcf	1,563	61.1	Mar. 25, 1964	C,W	D,S	
*203	do	--	--	60	6	60	Pcf	1,559	45	Mar. 26, 1964	J,E	D,S	
*204	do	--	--	76	6	76	Pcf	1,545	55.5	Mar. 25, 1964	C,W	D,S	
*301	Day Ranch	--	--	80	6	80	Pw	1,733	59	Mar. 30, 1964	C,W	S	
*302	do	--	--	175	6	175	Pw	1,739	139.5	do	C,W	D,S	
*303	do	--	--	167	6	160	Pw	1,693	86.5	do	C,W	S	
304	U. Duncan	--	--	95	6	95	Pw	1,643	64.5	do	C,W	N	
*305	Day Ranch	--	--	84	6	84	Pw	1,662	80	May 5, 1964	C,W	S	
*502	Jas. T. Padgitt	--	--	61	6	61	Pcf	1,520	53	Mar. 25, 1964	C,W	D,S	Well 321 in 1937 Coleman County report.
*601	Day Ranch Estate	--	--	97	6	97	Pw	1,618	93.5	Mar. 31, 1964	C,W	D,S	
*28-101	Frank Rodden	--	--	90	6	90	Pw	1,664	68.7	Mar. 30, 1964	C,W	D,S	
*102	Mrs. P. R. Ransbarger	--	--	62	6	62	Pw	1,665	45.5	May 8, 1964	C,W	D,S	
*103	W. F. Gotcher	--	--	70	4	70	Pw	1,665	--	--	C,W	S	Reported weak well.
*104	do	--	--	50	6	50	Pw	1,654	--	--	C,W	D,S	Reported strong well.

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
*42-28-201	Voss School	--	--	42	--	--	Pw	1,555	30.3	Mar. 31, 1964	C,E	D	Well 332 in 1937 Coleman County report.
* 202	D. Loggins	--	1934	37	--	--	Pw	1,672	29	Apr. 2, 1964	J,E	D,S	Dug well.
* 29-101	Mozelle School	--	--	30	--	--	Pw	1,595	20	Apr. 14, 1964	J,E	N	Used only during drouth.
* 102	do	--	--	30	--	--	Pw	1,595	19	do	C,W	N	Dug well. Well 285 in 1937 Coleman County report.
* 201	G. Williams	--	--	19	--	--	Pw	1,575	6	Apr. 15, 1964	J,E	D,S	
* 202	R. V. Rogers	--	--	20	--	--	Pw	--	12	do	B	S	
* 501	B. Fowler	--	--	60	6	60	Pw	1,515	50	Apr. 16, 1964	C,W	D,S	Dug well.
* 502	H. Stephens	--	--	30	--	--	Qa	1,560	10	do	J,E	D,S	Nearby tank reportedly recharges well.
* 30-101	R. Stewardson	--	1890	50	--	--	Pcs	1,520	48.2	Apr. 29, 1964	C,W	N	Used only during drouth. Well 349 in 1937 Coleman County report.
* 501	Ben Yarbrough	-- McShan	--	--	6	--	Pcs	1,380	--	--	C,W	S	Drilled as oil test; plugged back and completed as water well.
* 602	Lige Lancaster	--	--	20	--	--	Qa	1,485	10	Apr. 23, 1964	C,E	S	Seepage into cistern.
* 702	T. Connally Estate	--	--	Spring	--	--	Pcs	1,445	(+)	--	Flows	S	Water reported to have salty taste during drouth.
* 31-215	E. M. Whitley	--	--	5	8	--	Pcs	1,483	--	--	C,E	D,S	
* 401	Bill Vaughn	Producers Inc.	1915	1,925	12	--	Oe	1,400	--	--	Flows	N	Drilled as oil test.
* 806	M. L. Gutherie	--	1929	21	--	--	Pcs	1,466	15	Apr. 24, 1964	C,W	S	Water reported from sandy shale at 15 ft.
* 807	do	--	1932	15	--	--	Pcs	1,466	12	do	C,W	S	Do.
* 37-101	E. Rezzelle	--	--	16	6	--	Qa	1,440	5	Apr. 16, 1964	C,W	D,S	
* 102	Mrs. W. G. Norwood	-- Mueller	1961	80	6	80	Pcs	1,470	59.5	Apr. 30, 1964	C,W	S	Water sand reported at 60 and 80 ft. Well 341 in 1937 Coleman County report.
* 301	Carl Buttry	--	--	135	6	135	Pcs	1,460	130	Apr. 15, 1964	C,W	D,S	Well 355 in 1937 Coleman County report. Reported weak well.
* 302	do	--	--	130	5	130	Pcs	1,445	120	do	C,W	D,S	Well 356 in 1937 Coleman County report. Reported strong well.
303	Mrs. A. L. Crutcher	-- Preas	1964	90	5	90	Pcs	1,400	27	Apr. 16, 1964	N	N	
304	Mrs. R. F. Blackwell	--	--	160	6	160	Pcs	1,440	--	--	C,W	D,S	Well 359 in 1937 Coleman County report.

See footnote at end of table.

Table 2.--Records of wells and springs, Coleman County--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Casing: Diameter (in.)	Casing: Depth (ft)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
*42-37-305	Mrs. R. F. Blackwell	--	--	20	--	--	Qa	1,440	10	Apr. 16, 1964	C,G	D	Well 360 in 1937 Coleman County report. Dug well.
* 38-101	B. B. Bryan	--	1956	110	6	110	Pcs	1,460	60	Apr. 29, 1964	C,W	D,S	
301	E. W. Gill, Jr.	-- Davis et al.	1952	1,658	--	--	--	1,419	--	--	N	N	Oil test. Reported flow of water from Ellenburger Group suitable for livestock consumption. Plugged and abandoned.
* 501	W. F. Barnes	--	--	38	--	--	Pcs	1,415	27.5	Apr. 29, 1964	C,W	S	Well 365 in 1937 Coleman County report. Dug well.
* 39-201	Bill Miller	C. P. Porter	1954	1,500	12	1,500	Oe	1,320	(+)	--	Flows	S	Abandoned oil test completed as water well.
* 202	do	G. Stewart	--	51	5	51	Pcn	1,340	15.1	Apr. 29, 1964	C,W	D,S	

* Chemical analysis of water shown in Table 3.

Table 3.--Chemical analyses of water from wells and springs, Coleman County

(Analyses are in parts per million except specific conductance and pH)

Analyses performed by Texas State Department of Health.

Well	Owner	Depth of well (ft)	Date of collection	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C.)	pH
							Ellenburger Group									
42-31-401	Bill Vaughn	1,925	Apr. 23, 1964	15	40	13	1,840	448	<3	2,720	8.4	<0.4	4,860	153	8,130	7.8
39-201	Bill Miller	1,500	May 6, 1964	14	25	9	478	428	21	570	3.9	<.4	1,360	102	2,450	7.6
							Canyon Group									
42-39-202	Bill Miller	51	May 6, 1964	12	123	4	24	351	19	43	0.4	12	410	324	720	7.6
							Cisco Group									
42-07-402	T. L. Stephens	142	June 4, 1964	18	74	14	198	351	227	107	0.8	3.5	820	244	1,300	7.7
701	O. W. Mayfield	130	do	19	300	24	82	448	530	93	.7	<.4	1,500	850	1,740	7.2
810	Lee D. Cox	115	do	23	226	20	93	423	347	111	.6	<.4	1,030	650	1,530	7.2
14-602	J. Fox Casey	150	June 2, 1964	18	33	9	143	344	37	81	.6	<.4	491	118	845	7.8
901	T. E. Todd	242	do	7	42	22	660	401	590	483	1.5	<.4	2,000	196	3,160	7.7
903	U. S. Brannon	380	do	9	22	8	1,400	660	365	1,650	3.5	<.4	3,780	88	6,180	7.7
15-701	A. E. McCarrell	160	do	9	14	5	489	530	81	440	2.8	<.4	1,300	54	2,290	7.9
815	C. N. Powell	190	do	9	5	3	327	500	68	170	1.9	<.4	830	24	1,440	7.8
22-602	R. P. Knowles	275	Apr. 29, 1964	10	22	8	1,580	680	263	1,890	1.9	<.4	4,110	90	6,840	7.9
603	J. T. Frazier	80	do	7	14	9	1,430	500	334	1,720	2.5	<.4	3,790	73	6,350	8.6
702	Chas. R. Allen	Spring	Apr. 28, 1964	9	72	2	6	222	9	5	.3	10	222	190	392	7.6
23-101	W. M. Drury	46	Apr. 30, 1964	14	255	58	278	384	344	500	.9	90	1,730	870	2,810	7.2
102	Ted Goodsell	--	do	10	31	19	276	361	98	253	1.5	<.4	870	156	1,550	7.8
103	J. M. Duggins	160	do	7	33	14	620	305	378	580	1.6	<.4	1,780	141	3,100	7.9
104	S. H. Duggins	195	do	8	10	4	463	422	192	354	1.6	<.4	1,240	41	2,150	7.9
105	S. M. Russell	220	do	7	6	3	462	421	119	386	1.8	<.4	1,200	27	2,130	8.5

Table 3.--Chemical analyses of water from wells and springs, Coleman County--Continued

Well	Owner	Depth of well (ft)	Date of collection	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C.)	pH
42-23-106	W. H. Pittard	104	Apr. 30, 1964	9	7	3	580	414	201	530	1.6	<0.4	1,540	32	2,690	8.3
107	H. O. Norris	250	do	8	10	4	740	475	340	660	2.2	<.4	2,000	42	3,410	8.1
510	A. J. Marshall	72	do	10	23	9	450	427	122	413	2.1	<.4	1,240	95	2,190	8.0
30-101	R. Stewardson	50	Apr. 29, 1964	14	93	16	63	257	64	116	1.1	9	500	299	890	7.7
501	Ben Yarbrough	--	Apr. 30, 1964	13	227	117	406	285	184	1,070	.9	<.4	2,160	1,050	3,820	7.5
702	T. Connally Estate	Spring	May 14, 1964	10	55	6	3	182	8	9	.4	<.4	180	162	332	7.6
31-215	E. M. Whitley	5	May 6, 1964	3	161	14	381	89	252	590	2.2	111	1,560	460	2,650	7.5
806	M. L. Gutherie	21	do	14	116	14	57	307	162	40	1.0	5	560	349	890	7.6
807	do	21	Sept. 29, 1962	20	458	106	420	444	1,230	530	.5	<.4	3,002	1,580	3,670	7.3
37-102	Mrs. W. G. Norwood	80	Apr. 27, 1964	3	7	5	860	760	109	840	4.5	<.4	2,200	38	3,850	8.3
301	Carl Buttry	135	Apr. 15, 1964	15	231	38	243	355	318	288	2.2	260	1,570	740	2,400	7.3
302	do	130	do	13	67	23	258	325	206	233	.9	<.4	960	261	1,630	7.6
304	Mrs. R. F. Blackwell	160	Apr. 16, 1964	15	172	25	79	400	255	78	.7	<.4	820	530	1,270	7.6
38-101	B. B. Bryan	110	Apr. 28, 1964	10	113	24	346	289	329	368	2.1	24	1,360	381	2,260	7.9
501	W. F. Barnes	38	Apr. 29, 1964	19	141	15	71	206	55	127	.4	222	750	414	1,200	7.9
							Wichita Group									
30-61-901	C. E. Stephens	30	June 11, 1964	3	418	344	920	74	1,490	2,020	0.8	<0.4	5,200	2,460	7,510	6.4
62-601	R. T. Watson	20	do	14	105	82	63	449	138	99	.8	120	840	600	1,370	7.3
603	do	72	do	11	132	84	298	320	510	391	1.0	<.4	1,580	680	2,460	7.5
604	P. T. Connally	46	do	5	96	79	340	249	710	259	1.0	<.4	1,610	560	2,400	8.1
801	Eldon Knox	200	June 10, 1964	13	46	21	323	429	241	207	.9	6	1,070	201	1,760	7.6
63-401	Bill Hunter	50	do	15	105	49	104	323	290	92	.9	<.4	820	465	1,250	7.5
402	Deel Edington	30	June 19, 1964	10	74	13	10	284	13	11	.4	<.4	271	239	501	7.7
501	E. C. Koenig	90	June 10, 1964	18	115	19	47	353	115	47	.8	<.4	540	368	876	7.4

Table 3.--Chemical analyses of water from wells and springs, Coleman County--Continued

Well	Owner	Depth of well (ft)	Date of collection	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C.)	pH
30-63-503	Deel Edington	110	June 19, 1964	<1	52	10	1,780	23	540	2,470	1.5	<0.4	4,870	170	7,850	8.4
42-04-901	Joe Holder	85	Mar. 24, 1964	20	143	21	66	492	39	60	1.6	68	910	442	1,085	7.2
903	L. N. Witt	20	Mar. 25, 1964	8	63	16	6	259	13	9	1.6	<.4	376	224	451	7.8
05-101	L. Flippen	Spring	Mar. 24, 1964	4	78	34	52	227	91	72	1.1	80	640	334	892	7.7
102	do	Spring	do	3	203	72	302	277	485	470	1.2	45	1,860	810	2,740	7.8
701	T. J. Allen	52	Mar. 6, 1964	12	84	23	48	227	101	81	.7	.4	580	304	809	7.4
702	do	Spring	do	8	128	49	92	327	194	158	.7	35	990	520	1,380	7.6
901	Ray Jameson	17	May 6, 1964	15	93	26	263	368	414	122	1.1	20	1,320	339	1,720	7.6
902	V. K. Jameson	Spring	May 26, 1964	3	58	5	22	60	138	18	.7	<.4	305	163	447	7.5
903	Jim Gill	18	do	13	95	26	39	294	112	43	.7	23	497	345	810	7.6
904	C. H. Abbey	16	May 28, 1964	9	46	5	63	162	61	23	1.9	36	325	135	547	7.5
06-201	W. H. Henderson	120	June 10, 1964	17	80	11	47	296	68	28	.6	<.4	398	244	660	7.7
202	do	120	do	21	94	18	153	367	204	89	.7	<.4	760	309	1,186	7.9
502	H. C. Burkett	12	do	13	211	44	152	243	101	443	.6	121	1,210	710	2,140	7.4
601	A. I. Edwards	Spring	June 3, 1964	12	86	18	33	292	77	20	.6	20	411	288	674	7.5
602	J. G. Tabor	18	June 8, 1964	13	104	23	156	283	223	126	1.0	84	870	356	1,370	7.7
603	R. B. Hollingsworth	27	do	15	133	81	109	367	241	217	.8	55	1,030	660	1,710	7.3
604	T. Hipsher	35	do	12	236	94	195	392	484	423	1.1	<.4	1,640	970	2,520	7.6
606	Sam Hunter	16	do	13	99	56	129	328	213	123	2.3	120	920	477	1,440	7.9
607	Mrs. C. M. Dibrell, Sr.	25	June 11, 1964	13	238	69	131	270	198	530	.7	<.4	1,310	880	2,330	7.5
608	E. E. Edington	20	do	15	77	44	58	458	63	34	1.9	17	540	375	901	7.8
901	Frank Gillespie	60	June 4, 1964	21	98	19	138	210	277	119	.7	<.4	780	321	1,190	7.9
07-201	Mrs. B. R. Wooten	85	June 8, 1964	17	198	93	195	367	359	453	.9	<.4	1,500	880	2,440	7.8
401	Mrs. H. Adams	110	June 4, 1964	8	32	11	240	359	227	82	.9	<.4	780	126	1,250	7.6

Table 3.--Chemical analyses of water from wells and springs, Coleman County--Continued

Well	Owner	Depth of well (ft)	Date of collection	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C.)	pH
42-07-403	R. E. Harris	128	June 8, 1964	16	54	20	297	414	142	274	1.0	<0.4	1,010	216	1,740	7.5
12-302	-- Rhodes	16	Mar. 25, 1964	13	213	50	232	314	322	412	1.1	80	1,640	740	2,380	7.6
303	I. O. Hill	22	do	16	108	25	115	379	69	142	1.2	45	900	374	1,210	7.4
304	R. I. Bowen, Jr.	29	Mar. 30, 1964	7	64	47	15	316	22	22	1.2	80	570	354	727	8.1
305	D. A. Coursey	35	do	12	90	13	26	284	31	45	1.0	9	510	280	657	7.4
306	A. J. Walton	21	Mar. 31, 1964	15	109	10	51	346	43	52	1.2	17	640	314	797	7.5
802	W. T. Gassiot	26	Apr. 9, 1964	8	161	17	18	292	208	31	.5	12	600	474	927	7.2
803	Mrs. Nettie Hoover	41	do	9	118	9	15	326	48	27	.4	7	393	331	687	7.3
804	Chas. Basham	33	Apr. 13, 1964	18	433	74	182	384	930	341	1.2	3	2,170	1,390	2,930	7.2
805	Mrs. Hazel Henderson	29	do	15	230	39	55	392	462	53	1.0	3.5	1,050	730	1,460	7.3
806	W. P. Turner	42	do	15	393	34	70	351	860	53	1.1	<.4	1,600	1,120	1,990	7.2
811	V. C. Patterson	38	Aug. 1, 1962	18	368	61	81	342	920	65	.9	13	1,868	1,170	2,050	7.6
812	Robert Moser	56	May 13, 1964	15	640	58	59	371	1,620	31	2.0	<.4	2,610	1,830	2,720	7.2
814	Clyde Duncan	46	Aug. 1, 1962	17	318	58	70	349	796	62	.8	9	1,680	1,035	1,850	7.5
817	Mrs. E. L. Moser	44	do	17	264	51	48	405	545	54	.7	2.8	1,387	870	1,550	7.5
818	Methodist Church	18	Aug. 2, 1962	22	218	54	92	400	142	330	.4	49	1,307	766	2,060	7.8
820	do	50	Aug. 1, 1962	17	108	40	50	417	84	50	.5	32	798	435	980	7.6
821	F. J. Baker	40	Aug. 2, 1962	19	66	36	98	403	96	40	.8	31	789	314	950	7.8
822	Mrs. Lydie Miller	55	do	17	107	37	47	400	84	59	.6	11	762	427	952	7.8
824	H. H. Mitchell	45	do	16	581	92	46	381	1,512	45	.7	<.4	2,673	1,830	2,590	7.2
826	Louise Cagle	36	do	17	200	46	50	400	363	55	.4	38	1,169	690	1,350	7.5
827	Cora Mitchell	29	do	17	98	38	43	388	105	45	.6	13	747	402	880	7.5
828	A. L. Maedgen	27	do	18	244	72	62	376	596	60	.5	32	1,460	905	1,650	7.5
829	L. D. Gassiot	26	do	21	504	81	99	290	1,438	93	.9	<.4	2,505	1,594	2,550	7.2

Table 3.--Chemical analyses of water from wells and springs, Coleman County--Continued

Well	Owner	Depth of well (ft)	Date of collection	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C.)	pH
42-12-830	Mrs. H. T. Marcus	30	Aug. 2, 1962	17	287	69	50	398	668	57	0.5	28	1,574	1,000	175	7.3
832	A. J. Roberts	55	Aug. 3, 1962	17	271	51	76	354	668	51	.9	14	1,502	885	1,650	7.5
13-203	Lewis Simpson	60	Mar. 24, 1964	13	174	44	294	425	384	344	.7	19.5	1,700	610	2,330	7.4
301	W. O. Ward	13	May 29, 1964	14	136	31	98	262	114	212	.9	53	790	466	1,370	7.4
302	J. C. Barr	38	do	15	93	15	75	407	74	33	.7	7	510	297	854	7.3
303	Coleman Butane Co.	41	May 25, 1964	15	297	46	147	389	760	127	1.0	12	1,790	930	2,110	7.3
304	Coleman County Precinct No. 1	60	June 3, 1964	14	233	51	432	321	750	490	1.1	<.4	2,130	790	3,140	7.6
305	B. C. Bartley	52	May 29, 1964	14	347	53	276	299	447	670	.6	49	2,000	1,080	3,200	7.1
801	Carl Stoup	11	Apr. 30, 1964	10	120	91	530	367	940	359	3.0	4	2,420	670	3,240	7.7
802	Richie Perkins	22	do	8	61	33	68	139	34	192	.6	17	550	287	951	7.5
805	P. Guerrero	31	May 6, 1964	13	389	54	309	307	1,120	317	3.2	15	2,530	1,200	3,140	7.4
901	J. B. Watson	20	May 12, 1964	12	169	34	79	246	441	64	.8	3.5	1,050	560	1,310	7.5
14-402	S. T. Lindsey	16	May 19, 1964	12	124	122	379	316	303	680	2.9	108	2,050	810	3,190	7.6
701	Brannon & Murray	100	May 12, 1964	10	17	11	224	490	57	81	2.0	1.5	890	86	1,096	8.1
702	do	86	do	13	81	41	76	404	19	131	.7	6.5	770	373	1,050	7.6
703	L. D. Franklin	17	do	10	166	58	49	153	71	80	.5	600	1,190	650	1,610	7.5
801	L. E. Story	28	June 2, 1964	14	110	66	190	405	199	234	1.6	136	1,150	550	1,810	--
19-901	Mrs. E. M. Knox	93	Apr. 3, 1964	14	95	17	7	339	17	9	.2	19	520	308	598	7.4
902	J. E. Bryson	93	Mar. 31, 1964	2	75	9	29	195	26	75	.3	<.4	410	224	608	7.3
903	do	73	Apr. 1, 1964	16	123	5	14	368	14	17	.4	23	580	330	678	7.3
904	Mrs. O. E. Beck	90	Mar. 31, 1964	15	114	7	22	329	20	47	.3	7	560	315	696	7.7
905	do	--	do	13	102	9	9	304	29	19	.3	6	491	292	590	7.4
906	J. E. Bryson	91	do	16	123	10	21	305	30	66	.3	15	590	349	767	7.3
907	Day Ranch Estate	124	do	16	140	13	23	337	97	42	.3	15	680	405	847	7.3

Table 3.--Chemical analyses of water from wells and springs, Coleman County--Continued

Well	Owner	Depth of well (ft)	Date of collection	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C.)	pH
42-20-201	H. C. Parrott	43	Apr. 2, 1964	16	115	45	79	355	118	89	0.9	115	930	475	1,190	7.9
202	C. Morris	60	do	13	213	85	361	312	487	610	1.9	12	2,100	880	3,100	7.9
203	J. LeMay	85	do	13	95	27	27	345	47	37	.2	20	610	348	754	7.4
701	Roberta Farris	103	Mar. 30, 1964	15	133	21	36	356	73	73	.3	25	730	420	952	7.2
702	I. S. Pate	117	do	15	190	24	99	343	243	164	.6	25	1,100	570	1,490	7.2
703	do	100	do	15	172	20	60	342	182	93	.6	30	920	510	1,170	7.2
704	J. W. Gutherie	82	Apr. 1, 1964	15	123	7	26	349	17	25	.4	56	620	338	748	7.3
705	Mrs. E. M. Knox	200	Mar. 31, 1964	13	81	16	15	283	28	24	.3	7	467	268	571	8.0
802	A. E. Turner	35	Apr. 2, 1964	14	88	35	40	388	48	33	.6	48	700	364	835	7.8
21-201	P. T. Skaggs	19	May 5, 1964	15	178	133	140	426	461	269	3.0	135	1,540	990	2,300	7.5
303	R. C. Smith	20	Apr. 22, 1964	13	157	18	48	326	275	19	.5	1.5	690	469	1,070	7.5
401	Fred Ehrler	36	Apr. 2, 1964	19	217	13	111	237	188	73	.7	429	1,290	600	1,640	7.5
402	P. S. Simmons	15	Apr. 3, 1964	11	203	55	221	272	325	380	1.1	128	1,460	730	2,300	7.4
403	W. F. Kinsey	80	do	16	93	49	190	476	113	133	.7	176	1,010	437	1,590	7.5
404	J. E. Snider	30	do	14	92	46	169	410	132	139	.7	144	940	421	1,500	7.9
405	T. T. Sikes	28	Apr. 14, 1964	15	173	38	124	381	123	192	.8	195	1,050	590	1,680	7.4
406	W. A. Moore	20	do	15	136	55	190	479	143	190	.7	22	990	570	1,860	7.9
603	A. L. Griffin	12	Apr. 15, 1964	15	85	24	90	322	69	55	1.5	133	630	310	985	7.5
22-401	M. T. Knight	17	Apr. 22, 1964	3	41	4	14	104	39	12	.2	4	168	118	307	7.5
27-301	Day Ranch Estate	190	Apr. 3, 1964	15	93	16	10	333	15	17	.3	10	510	299	599	7.5
302	do	175	Mar. 30, 1964	15	96	13	10	327	15	17	.3	9	500	295	595	7.3
303	do	167	do	26	610	88	256	254	1,500	470	2.0	<.4	3,210	1,900	3,820	7.2
305	do	84	June 5, 1964	15	103	17	39	320	53	66	.4	8	458	330	796	8.0
601	do	97	Mar. 31, 1964	18	112	17	38	290	60	81	.4	17	630	350	848	8.0

Table 3.--Chemical analyses of water from wells and springs, Coleman County--Continued

Well	Owner	Depth of well (ft)	Date of collection	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C.)	pH
42-28-101	Frank Rodden	90	Mar. 30, 1964	15	121	15	37	337	34	78	0.2	22	660	364	868	7.7
102	Mrs. P. R. Ransbarger	62	May 5, 1964	15	99	10	17	331	15	15	.3	25	359	289	614	7.4
103	W. F. Gotcher	70	Mar. 30, 1964	15	138	40	207	270	105	414	.4	56	1,250	510	1,970	7.9
104	do	50	do	17	81	14	40	222	33	81	.3	22	510	261	721	7.8
201	Voss School	42	Mar. 31, 1964	13	166	23	88	345	101	205	.7	17	960	510	1,370	7.6
202	D. Loggins	37	Apr. 2, 1964	18	119	21	21	357	24	22	.4	110	690	386	825	7.6
29-101	Mozelle School	30	Apr. 14, 1964	2	42	4	3	137	9	7	.4	4	138	122	273	7.7
102	do	30	do	19	145	27	86	278	82	213	.9	46	760	472	1,340	7.8
201	G. Williams	19	Apr. 15, 1964	11	155	97	600	315	830	620	3.7	168	2,640	770	3,840	7.8
202	R. V. Rogers	20	do	13	98	23	31	292	95	28	.8	39	472	338	770	7.8
501	B. Fowler	60	do	13	85	13	74	349	34	72	.8	7	471	265	828	7.7
							Clear Fork Group									
30-59-801	L. A. Sampson	30	Mar. 4, 1964	15	95	41	178	409	147	202	2.0	31	1,120	335	1,560	7.6
802	Walter Matthews	Spring	do	1	74	30	38	333	<3	82	1.3	<.4	560	273	757	8.0
803	Frank Armour	60	do	13	173	38	16	401	61	110	.3	111	920	329	1,200	7.7
60-801	R. A. Cox	65	Mar. 3, 1964	15	118	79	104	425	376	75	1.2	<.4	1,190	620	1,520	7.6
803	Harker & McDaniels	Spring	Mar. 12, 1964	12	160	25	108	359	189	163	.8	22	1,040	500	1,440	7.2
902	W. E. Stephens	do	Mar. 3, 1964	5	77	4	44	150	27	110	.4	<.4	417	210	674	7.7
42-03-301	Ray Andrews	60	Mar. 12, 1964	23	277	121	370	520	610	630	1.9	44	2,600	1,190	3,580	7.2
401	Rube Whitley	110	Apr. 10, 1964	10	95	40	47	311	8	121	.5	<.4	710	401	982	7.7
402	R. P. McWilliams	160	Apr. 22, 1964	10	58	29	10	298	24	11	.5	<.4	441	264	512	7.8
04-103	Mrs. W. L. White	18	Mar. 12, 1964	7	67	12	42	226	78	27	.9	<.4	470	219	600	8.5
301	W. E. Stephens	180	Mar. 3, 1964	10	89	49	227	360	357	149	2.4	20	1,260	421	1,700	7.6
302	Fred Croom	Spring	do	6	268	22	459	199	113	1,050	.6	8	2,130	760	3,700	7.5

Table 3.--Chemical analyses of water from wells and springs, Coleman County--Continued

Well	Owner	Depth of well (ft)	Date of collection	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C.)	pH
42-11-204	Alfred Herring	30	Apr. 8, 1964	15	88	22	37	334	42	47	0.8	17	600	312	753	7.5
401	Edgar Herring	Spring	Apr. 14, 1964	3	47	23	98	127	69	180	.6	<.4	483	212	920	7.3
508	Horace Stokes	20	Apr. 11, 1964	17	159	56	250	377	262	324	2.5	168	1,420	630	2,260	7.4
801	Gordon Brookshire	14	Apr. 7, 1964	10	175	30	159	323	114	362	1.2	10	1,020	560	1,820	7.6
802	Roy Pearce	15	Apr. 9, 1964	11	147	25	150	283	115	285	1.0	27	900	468	1,590	7.7
803	do	18	do	12	153	23	110	282	95	237	.8	40	810	477	1,440	7.4
804	J. C. Reis	15	Apr. 13, 1964	24	235	28	177	289	165	442	.9	71	1,430	700	2,200	7.6
805	L. E. Hinter Estate	60	do	13	189	42	213	277	268	376	.8	110	1,350	640	2,190	7.6
901	Bryan Clayton	110	do	13	196	36	163	395	139	378	.5	<.4	1,320	640	1,980	7.3
902	Glynn Mitchell	90	Apr. 15, 1964	5	85	54	175	344	336	136	3.3	<.4	1,140	435	1,550	7.6
903	H. A. Mercer	23	May 13, 1964	13	146	15	83	365	72	125	.5	62	700	425	1,176	7.2
12-101	H. C. Snodgrass	93	Apr. 2, 1964	16	166	11	111	337	69	217	.9	36	960	458	1,400	7.3
202	Mrs. J. M. Savage	32	Mar. 31, 1964	19	278	246	520	560	335	1,420	2.4	47	3,430	1,710	5,330	7.8
701	Mrs. D. Martin	180	Apr. 8, 1964	8	76	82	245	372	481	182	3.3	<.4	1,260	520	1,970	7.6
702	Ralph M. Edens	157	do	11	92	100	374	345	790	253	3.0	<.4	1,790	640	2,610	8.3
706	Zoella McKissick	60	Apr. 27, 1964	11	143	124	248	414	188	580	1.9	39	1,750	870	2,740	7.5
808	E. E. Maples	147	Apr. 28, 1964	9	81	36	53	368	84	590	1.2	<.4	1,220	352	892	7.5
19-202	Curtis Beck	15	Apr. 7, 1964	12	70	8	23	221	24	14	.6	34	295	207	492	7.5
203	do	Spring	do	8	109	8	43	255	68	68	.9	20	450	304	773	7.5
204	do	Spring	do	7	103	8	28	270	42	49	.5	17	388	289	684	7.6
205	do	Spring	do	3	58	7	51	154	55	65	.7	4	320	175	582	7.9
206	Ralph M. Edens	140	Apr. 17, 1964	6	195	202	1,380	301	1,510	1,800	1.1	<.4	5,200	1,320	7,680	7.5
301	Geo. Beck	10	Apr. 8, 1964	9	94	12	72	254	48	117	.8	12	490	284	882	7.7
302	D. W. Franke	28	Apr. 9, 1964	12	128	96	276	438	600	217	2.4	<.4	1,550	710	2,270	7.4

Table 3.--Chemical analyses of water from wells and springs, Coleman County--Continued

Well	Owner	Depth of well (ft)	Date of collection	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C.)	pH
42-19-303	R. H. Stainback	23	Apr. 9, 1964	14	94	16	110	345	92	103	1.1	3	600	299	1,031	7.5
305	Walter Ray	18	do	15	186	24	88	309	125	233	1.0	58	880	560	1,500	7.7
602	Robert Horne	10	Apr. 8, 1964	7	76	3	8	190	24	15	.3	24	250	203	431	7.7
603	do	50	Apr. 7, 1964	12	88	5	11	253	19	13	.4	20	293	241	490	8.4
604	do	90	Apr. 8, 1964	8	91	11	14	326	14	13	.4	<.4	311	273	563	7.4
801	Day Ranch Estate	80	Mar. 25, 1964	18	110	29	17	339	124	17	.5	<.4	660	395	764	7.3
802	Clyde Duncan	94	Mar. 31, 1964	15	128	12	11	378	53	10	.3	11	620	371	715	7.3
27-201	Jas. T. Padgitt	87	Apr. 1, 1964	15	119	16	20	270	116	38	.3	12	610	362	761	7.9
202	do	90	Mar. 25, 1964	13	101	32	18	273	126	34	3.6	16	620	383	771	7.4
203	do	60	Mar. 26, 1964	15	143	9	39	305	92	75	2.3	12	690	393	918	7.3
204	do	76	Mar. 25, 1964	18	390	20	26	293	750	50	3.9	10	1,560	1,060	1,800	7.7
502	do	61	do	16	252	85	63	215	700	153	2.5	<.4	1,490	980	1,830	7.9
Trinity Group																
42-03-201	Earl Davis	56	Mar. 6, 1964	13	107	26	13	325	105	22	0.5	<0.4	610	374	737	7.9
502	do	81	do	15	110	12	22	365	36	26	.3	2.0	590	322	695	7.8
504	A. H. Armour	40	Mar. 11, 1964	12	299	88	342	364	395	750	2.0	18.0	2,220	980	3,360	8.0
505	L. B. Parham	54	do	11	104	21	8	382	24	13	.3	<.4	560	345	655	7.3
506	O. L. DePrang	56	do	13	86	17	6	328	11	10	.2	8.5	480	286	559	7.9
601	Earnest Reeves	89	Mar. 10, 1964	10	68	40	37	344	102	23	1.0	<.4	630	337	776	7.5
603	A. H. Armor	75	Mar. 11, 1964	7	89	16	10	311	14	31	.3	<.4	478	290	608	7.4
604	L. B. Parham	150	Mar. 12, 1964	13	71	25	8	320	12	14	.4	<.4	463	280	556	7.8
608	R. B. Casey	18	Mar. 11, 1964	19	83	27	9	383	11	9	.8	<.4	540	320	622	7.9
609	A. C. Atchley	95	do	10	65	18	31	338	7	14	.9	<.4	480	236	564	7.9
610	Jim Paxton	22	do	15	111	72	53	497	90	69	.7	129	1,040	570	1,290	7.5

Table 3.--Chemical analyses of water from wells and springs, Coleman County--Continued

Well	Owner	Depth of well (ft)	Date of collection	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C.)	pH
42-03-611	Jim Paxton	260	Mar. 11, 1964	12	66	33	13	353	23	11	0.6	4	520	300	610	7.8
612	Bayne Miller	99	Mar. 19, 1964	11	59	37	9	348	23	13	.8	<.4	500	302	590	8.1
613	do	99	do	10	74	31	19	365	36	13	.9	<.4	550	312	650	8.0
614	J. C. Williamson	25	do	14	129	41	38	403	47	62	.8	123	860	488	1,078	7.5
701	Clyde Brevard	115	Apr. 10, 1964	12	54	33	8	326	16	6	.7	<.4	456	271	533	7.6
702	do	85	do	11	53	34	8	326	17	7	.8	<.4	457	271	526	7.8
801	McCord Estate	120	Mar. 17, 1964	12	83	21	6	342	8	10	.2	4	486	291	556	7.7
802	do	135	do	10	61	32	9	322	21	11	.6	5.5	472	285	565	7.6
803	do	Spring	do	10	81	22	3	338	9	7	.3	6.5	477	294	549	7.6
804	do	135	do	12	57	23	9	281	10	12	.4	5.0	409	239	478	7.8
805	E. W. Hennig	81	Apr. 3, 1964	15	99	39	15	460	16	24	1.4	9	680	408	791	7.8
806	Vernon Bragg	135	Apr. 10, 1964	9	56	31	9	315	16	9	.5	3	289	266	526	7.8
807	do	100	do	7	125	34	8	350	13	121	.2	<.4	660	451	924	7.8
808	do	125	do	10	57	34	8	332	19	7	.6	2	470	281	545	8.1
809	Owen Bragg	85	do	11	64	35	8	353	29	10	.5	<.4	332	306	593	8.0
810	Clyde Brevard	65	do	4	32	30	5	242	6	8	.1	<.4	327	201	395	7.5
811	McCord Estate	110	May 26, 1964	11	65	26	8	320	12	9	.4	<.4	288	270	527	7.7
812	do	135	Mar. 17, 1964	13	61	23	6	290	5	7	.3	4	409	245	469	7.7
813	do	135	do	12	52	25	9	281	8	7	.5	4	399	230	463	7.9
902	do	135	do	8	96	26	8	410	8	13	.4	<.4	570	348	658	7.6
903	E. W. Hennig	52	Apr. 3, 1964	13	97	16	12	316	21	22	.4	28	530	309	635	7.9
905	Matt Williams	50	Apr. 2, 1964	13	119	16	17	342	19	33	.2	70	630	365	782	7.5
906	O. C. Morton	50	do	13	104	24	35	344	19	32	.3	78	650	355	784	7.4
908	E. W. Hennig	Spring	Apr. 3, 1964	18	129	23	15	438	18	33	.2	26	700	420	833	7.3

Table 3.--Chemical analyses of water from wells and springs, Coleman County--Continued

Well	Owner	Depth of well (ft)	Date of collection	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C.)	pH
42-03-910	E. W. Hennig	50	Apr. 3, 1964	16	143	15	21	361	30	55	0.3	72	710	418	894	7.2
912	do	12	do	15	116	52	51	428	69	98	.9	47	880	500	1,142	7.6
914	A. C. May	100	Apr. 2, 1964	12	72	63	29	338	20	120	.7	5	710	439	964	7.6
915	Ben Steffen	80	Apr. 7, 1964	11	38	57	26	386	37	26	1.0	<.4	386	329	691	8.3
916	do	Spring	do	13	126	63	157	445	228	233	.9	7	1,270	570	1,750	7.8
918	W. F. Galloway	80	Apr. 8, 1964	12	80	19	10	305	15	15	.4	17	473	277	567	7.5
919	T. P. Story	Spring	Apr. 9, 1964	9	190	50	67	272	53	398	.3	<.4	890	680	1,710	7.8
920	do	60	do	13	77	21	7	304	22	12	.3	8	464	277	548	7.5
04-101	Doyle Shamblin	50	Mar. 12, 1964	34	264	70	111	510	129	447	2.7	<.4	1,570	950	2,340	7.4
201	Jim Bates	60	Mar. 17, 1964	13	64	35	17	353	31	15	.9	<.4	530	303	635	7.4
202	J. C. Bates	70	Mar. 18, 1964	15	212	59	48	399	83	173	.4	275	1,260	770	1,720	7.1
203	Paul Templeton	200	Mar. 24, 1964	9	169	102	1,270	220	2,980	213	4.2	<.4	4,970	840	5,960	7.8
401	Loy Jackson	18	Mar. 13, 1964	15	95	27	14	410	13	18	.4	<.4	590	348	690	7.8
402	do	120	do	13	99	32	16	416	34	26	.5	<.4	640	379	755	7.3
404	M. Morris	47	Mar. 16, 1964	15	111	16	11	357	14	22	.4	26	570	342	705	7.5
405	C. B. Moseley	65	Mar. 26, 1964	13	136	69	81	454	118	208	.7	<.4	1,080	620	1,500	7.2
406	Mrs. J. H. Sansom	26	Apr. 8, 1964	16	174	98	313	580	362	476	2.5	6	2,030	840	2,780	7.8
501	Arch Huddle	29	Mar. 13, 1964	16	172	352	910	850	1,230	1,300	4.7	9	4,840	1,880	6,350	7.7
502	Mrs. Bland Smith	25	do	13	114	16	33	305	38	46	.5	62	630	350	810	7.5
503	Zelma Ray	41	Mar. 16, 1964	16	93	31	56	415	43	60	.8	12	730	363	900	7.5
504	C. L. Saunders	33	Mar. 19, 1964	13	99	12	5	350	8	10	.2	2	500	298	575	7.6
505	Mrs. Lucy Billings	150	do	12	109	17	6	400	7	10	.3	<.4	560	340	636	7.4
506	do	100	do	12	121	21	8	349	13	29	.3	71	620	387	766	7.5
509	A. B. Kidd	30	Mar. 26, 1964	14	114	27	25	392	35	50	.3	23	680	395	840	7.6

Table 3.--Chemical analyses of water from wells and springs, Coleman County--Continued

Well	Owner	Depth of well (ft)	Date of collection	Silica (SiO_2)	Cal-cium (Ca)	Magne-sium (Mg)	Sodium and Potassium (Na + K)	Bicar-bonate (HCO_3)	Sul-fate (SO_4)	Chlo-ride (Cl)	Fluo-ride (F)	Ni-trate (NO_3)	Dis-solved solids	Total hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C.)	pH
42-04-601	Nora Tomlinson	140	Mar. 24, 1964	8	196	121	169	384	167	630	0.5	<0.4	1,680	980	2,690	7.5
604	Wanda Corder	90	do	16	436	91	365	459	321	1,120	1.2	19	2,830	1,470	4,420	7.0
605	Silver Valley Community	90	do	13	93	32	29	431	18	34	.4	<.4	650	364	775	7.4
606	C. A. Preas	110	Mar. 19, 1964	13	115	72	69	530	56	241	.5	<.4	1,130	670	1,570	7.2
608	A. H. Thurmond	24	May 5, 1964	18	153	74	700	640	570	730	9.0	90	2,980	690	4,100	7.5
703	W. W. West	120	Mar. 16, 1964	13	86	30	20	362	33	35	.7	<.4	580	336	715	7.4
704	J. J. Schneider	125	Apr. 2, 1964	13	92	42	14	426	53	21	.4	<.4	660	403	775	7.2
705	McCord Estate	150	Apr. 9, 1964	11	70	35	12	367	21	15	.4	<.4	530	319	627	7.8
706	do	70	do	13	106	28	20	409	38	27	.4	12	650	381	791	7.6
707	do	110	do	15	89	44	11	468	13	21	.4	2	660	404	764	7.4
708	Jo Dean Whittington	44	Apr. 27, 1964	14	307	106	170	336	269	435	.8	528	2,170	1,200	3,020	7.5
801	W. W. West	33	Mar. 16, 1964	13	165	70	121	405	110	357	.8	11	1,250	700	1,910	7.2
802	Arch Hamilton	13	do	10	52	7	6	189	11	8	.6	<.4	284	156	335	7.4
803	W. W. West	37	do	13	103	18	12	354	26	20	.3	17	560	332	675	7.4
804	do	65	do	13	99	19	10	366	17	18	.3	5	550	324	650	7.5
805	H. C. Williams	65	Mar. 25, 1964	19	330	140	1,080	710	1,590	1,010	2.5	<.4	4,880	1,400	6,070	7.3
806	McCord Estate	50	Mar. 16, 1964	12	107	28	16	417	22	34	.4	7	640	383	767	8.0
11-201	do	Spring	Mar. 17, 1964	10	70	18	4	279	10	6	.3	11	408	249	476	7.8
202	do	14	do	15	100	30	8	433	12	12	.5	<.4	610	373	695	7.5
207	Edgar Herring	50	Apr. 14, 1964	8	78	19	3	316	11	6	.2	<.4	280	275	517	7.5
208	Elliott Kemp	65	Apr. 17, 1964	12	93	23	6	382	10	10	.2	<.4	540	327	608	7.7
209	A. J. Morrison	37	Apr. 21, 1964	11	98	19	9	362	14	16	.4	26	560	323	643	7.5
301	McCord Estate	130	Mar. 17, 1964	13	107	20	9	418	8	18	.2	<.4	590	353	681	7.5
303	L. Whittington	52	Mar. 31, 1964	15	146	41	140	510	97	211	.5	11	1,170	530	1,580	7.2

Table 3.--Chemical analyses of water from wells and springs, Coleman County--Continued

Well	Owner	Depth of well (ft)	Date of collection	Silica (SiO_2)	Cal-cium (Ca)	Magne-sium (Mg)	Sodium and Potassium (Na + K)	Bicar-bonate (HCO_3)	Sul-fate (SO_4)	Chlo-ride (Cl)	Fluo-ride (F)	Ni-trate (NO_3)	Dis-solved solids	Total hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C.)	pH
42-11-304	Mrs. J. Futtrell	30	Apr. 2, 1964	18	101	52	99	475	67	141	0.7	8	960	466	1,260	7.5
306	E. G. Simpkins	40	do	15	108	47	164	416	168	192	1.0	17	1,130	464	1,560	7.3
307	E. W. Hennig	80	Apr. 3, 1964	15	82	33	41	336	55	45	1.1	47	660	342	816	7.7
308	Chas. Mitchell	65	do	15	198	63	309	510	306	419	.8	78	1,900	760	2,640	7.1
309	Steve Hale	50	do	16	250	79	367	357	370	700	.6	53	2,190	950	3,320	7.6
310	J. C. Williams	58	do	16	242	67	160	471	189	450	.6	17	1,610	880	2,360	7.3
311	Mrs. Stinson	78	Apr. 7, 1964	13	191	56	122	497	112	305	.6	9	1,050	710	1,850	7.2
312	Mrs. Cora Watkins	65	Apr. 3, 1964	15	177	51	86	450	127	221	.5	<.4	1,130	650	1,630	7.4
314	Glen Cove Gasoline Plant	85	do	15	185	53	104	458	130	272	.6	9	1,230	680	1,740	7.0
316	Steve Hale	50	Apr. 7, 1964	14	223	74	210	438	237	500	.8	11	1,490	860	2,520	7.1
317	G. Ayers	65	do	13	224	72	221	510	220	463	.8	<.4	1,470	850	2,420	7.4
318	Walter Carter	50	do	9	80	39	54	467	20	47	.6	1.5	480	360	861	7.5
319	Mrs. C. C. Duncan	50	do	8	165	68	148	511	111	339	.6	<.4	1,090	690	1,950	7.4
320	F. W. Dunaway	62	do	10	66	53	59	483	28	58	.7	3	520	381	925	7.5
321	J. S. Braswell	108	do	11	133	92	111	510	91	313	.7	7	1,010	710	1,830	7.5
322	Homer Davis	40	do	13	97	41	72	423	34	113	.7	23	600	411	1,067	7.5
325	I. C. Whittington	30	do	9	125	14	67	387	99	63	1.0	4	570	369	936	8.2
327	J. B. Helm	100	Apr. 8, 1964	12	99	16	6	354	13	13	.2	10	343	314	650	7.8
329	do	25	Apr. 7, 1964	12	98	25	10	390	20	14	.4	3	462	347	657	7.5
330	C. C. Duncan	42	Apr. 20, 1964	10	109	21	9	399	23	14	.4	10	600	360	689	7.3
331	do	60	do	12	102	22	6	397	15	8	.2	<.4	560	345	651	7.4
332	do	22	do	12	101	26	14	387	21	29	.4	12	600	358	718	7.6
333	Toppy Beaver	125	Apr. 17, 1964	11	97	24	5	403	10	6	.2	2	560	339	627	7.8
334	C. H. Wilson	43	Apr. 22, 1964	15	486	314	310	260	107	2,050	.9	<.4	3,540	2,510	6,160	7.3

Table 3.--Chemical analyses of water from wells and springs, Coleman County--Continued

Well	Owner	Depth of well (ft)	Date of collection	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C.)	pH
42-11-501	M. L. Stone	84	Apr. 8, 1964	12	60	29	9	326	8	9	0.3	3.5	457	267	519	8.0
502	E. E. Evans	100	Apr. 10, 1964	12	73	23	4	332	8	6	.3	7.0	296	279	526	8.0
503	M. L. Stone	50	do	10	68	20	4	265	18	7	.2	21	413	250	488	7.8
504	Hubert Stokes	38	do	8	100	27	10	275	20	35	.2	112	447	362	748	7.6
506	do	96	do	11	72	28	5	354	9	7	.3	<.4	306	297	557	7.7
507	Mrs. Maggie Beaver	37	Apr. 13, 1964	11	91	8	8	262	12	24	.2	27	310	263	551	7.5
509	C. E. Jacobs	80	Apr. 15, 1964	13	146	20	58	450	9	134	.2	3	600	449	1,105	7.4
602	G. L. Joyce	99	Apr. 13, 1964	12	96	12	5	348	6	6	.1	4	489	288	550	7.6
604	C. E. Jacobs	115	Apr. 15, 1964	10	76	43	9	372	67	8	.6	<.4	590	366	687	7.6
605	G. L. Joyce	125	Apr. 13, 1964	12	91	20	5	364	9	8	.2	<.4	510	310	577	7.4
606	C. E. Brown Estate	100	Apr. 14, 1964	8	106	11	5	307	11	29	.1	15.0	492	311	606	7.4
609	A. A. Brown	63	Apr. 17, 1964	6	76	12	4	290	<3	8	.2	12	408	239	462	7.6
610	W. Mulunax	39	Apr. 15, 1964	10	91	8	3	293	11	8	.2	9	433	259	499	7.5
611	Toppy Beaver	26	Apr. 17, 1964	9	99	11	6	315	15	13	.2	13	481	293	568	7.4
612	O. C. Bertrand	101	Apr. 15, 1964	10	63	37	12	350	37	9	.6	<.4	520	308	609	7.6
615	do	80	do	9	75	33	6	336	46	7	.5	<.4	510	322	605	7.8
616	do	135	do	12	78	31	10	365	33	11	.4	<.4	540	324	630	7.7
618	do	30	do	10	102	25	11	411	23	15	.3	<.4	600	359	688	7.6
619	Toppy Beaver	77	Apr. 20, 1964	10	85	23	10	357	14	15	.2	1.5	520	307	601	7.6
623	do	32	Apr. 17, 1964	13	111	48	52	451	74	98	.8	3.5	850	476	1,088	7.4
624	C. H. Wilson	88	Apr. 20, 1964	8	97	24	8	378	<3	24	.4	<.4	540	343	653	7.4
625	R. C. Hinds	24	Apr. 29, 1964	12	146	103	97	383	190	270	1.1	127	1,330	790	1,910	7.8
12-102	D. R. Shuford	100	Mar. 31, 1964	16	84	12	9	312	7	12	.2	<.4	452	259	515	8.0
104	Dick Hamon	50	Mar. 3, 1964	13	140	16	21	349	24	61	.2	78	700	418	894	7.8

Table 3.--Chemical analyses of water from wells and springs, Coleman County--Continued

Well	Owner	Depth of well (ft)	Date of collection	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C.)	pH
42-12-106	J. J. Schneider	160	Apr. 2, 1964	10	159	18	15	356	32	76	0.2	87	750	472	980	7.3
107	I. C. Whittington	75	Mar. 31, 1964	15	113	37	45	483	31	69	.7	12	810	433	980	7.4
108	do	45	do	13	160	67	300	426	225	500	.9	3	1,700	680	2,530	7.8
201	M. D. Whittington	130	do	9	85	51	153	404	242	123	2.5	<.4	1,070	423	1,450	7.4
203	Bill Beaver	Spring	Apr. 10, 1964	6	56	18	94	168	76	145	1.1	7	570	212	897	7.0
301	J. M. Roberts	20	Mar. 25, 1964	12	383	73	280	238	425	860	2.2	13.5	2,290	1,260	3,540	7.3
403	E. M. Martin	18	Apr. 30, 1964	6	22	3	7	77	<3	15	.2	<.4	130	68	186	7.3
404	do	11	do	11	640	810	3,310	235	269	8,300	2.6	<.4	13,600	4,950	>12,000	7.5
405	Chub Dubois	30	do	12	46	40	37	322	36	47	.3	<.4	540	280	688	8.3
406	F. Pauley	Spring	Apr. 27, 1964	17	46	47	19	344	10	27	1.0	<.4	520	309	617	8.5
407	Wesley James	180	Apr. 29, 1964	8	64	68	128	377	283	91	2.9	<.4	1,020	422	1,350	7.8
501	M. West	190	Apr. 24, 1964	5	90	40	35	349	109	54	1.2	<.4	680	389	882	7.6
502	do	50	do	11	103	23	16	298	21	87	.3	4	560	352	773	7.8
504	Dick McMahan	150	do	8	131	67	87	395	92	274	1.4	11	1,070	610	1,590	7.9
506	Grady Laws	141	Apr. 28, 1964	6	45	59	49	339	135	36	2.7	<.4	670	355	871	7.6
507	F. C. Barsch	160	Apr. 27, 1964	8	51	39	33	255	89	47	1.4	<.4	520	287	707	8.1
508	J. P. LeSueur	Spring	Apr. 29, 1964	8	77	11	30	255	38	29	.8	4	453	238	569	7.5
509	M. M. Mulunax	165	do	4	1,780	304	1,890	115	740	6,500	.8	<.4	11,300	5,700	>12,000	6.6
510	do	140	do	13	116	42	78	409	76	152	.9	10	900	461	1,210	7.4
511	J. T. Thompson	150	May 8, 1964	2	54	38	49	220	125	70	1.7	<.4	560	291	793	7.9
703	George Gould	16	Apr. 14, 1964	11	92	11	9	314	17	13	.2	12	479	274	547	7.5
704	Mrs. Earl Arthur	35	do	13	79	16	17	307	12	21	.5	9	475	263	566	7.9
705	John Bomar	100	do	10	60	27	14	375	13	13	.4	<.4	452	260	534	7.6
707	A. W. Gulley	10	Apr. 28, 1964	17	99	24	21	405	23	21	.6	3	610	344	709	7.4

Table 3.--Chemical analyses of water from wells and springs, Coleman County--Continued

Well	Owner	Depth of well (ft)	Date of collection	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C.)	pH
42-12-809	B. Clayton	106	Apr. 29, 1964	10	102	45	69	376	86	146	1.4	1.5	840	441	1,145	7.6
810	J. T. Thompson	150	May 8, 1964	7	78	9	77	339	45	57	.2	<.4	610	233	772	7.5
							Quaternary Alluvium									
30-62-602	R. T. Watson	20	June 11, 1964	16	74	23	8	346	10	4	0.8	<0.4	306	280	546	7.4
902	Clyde Thate	Spring	June 10, 1964	2	58	18	86	131	45	174	.9	<.4	448	218	872	7.8
903	do	do	do	5	69	25	29	315	49	22	1.1	<.4	355	276	638	7.5
904	do	do	do	4	28	5	7	109	12	4	.8	<.4	114	90	222	7.6
42-05-802	T. L. Miller	do	May 26, 1964	10	88	32	38	382	36	57	.6	<.4	640	353	814	7.5
12-801	Santa Fe Railroad	22	Apr. 9, 1964	9	236	35	164	204	305	431	.5	<.4	1,280	730	2,130	7.8
13-201	City of Coleman	22	May 4, 1964	14	191	31	63	351	77	271	.4	<.4	1,000	610	1,500	7.2
202	R. E. McWhirter	28	Mar. 3, 1964	22	580	219	570	174	840	1,490	2.0	700	4,600	2,350	6,570	7.7
402	Cecil Horne	20	Apr. 30, 1964	11	81	31	40	346	78	35	.8	6	630	331	774	7.9
601	O. L. Griffith	24	May 20, 1964	15	177	58	197	450	362	269	.5	<.4	1,530	680	2,050	7.3
602	H. G. Dunn	25	do	17	126	87	213	442	438	154	1.2	120	1,600	670	2,040	7.4
603	L. F. Craig	38	May 28, 1964	11	76	48	24	422	88	7	1.6	<.4	463	388	778	7.5
604	H. Watson	22	June 2, 1964	13	254	179	454	270	227	900	2.7	810	2,970	1,370	4,490	7.5
605	Clyde Byrd	45	June 11, 1964	13	600	190	252	620	2,070	155	2.5	<.4	3,590	2,290	3,960	6.8
701	Theo Griffis	25	Apr. 14, 1964	11	204	39	191	228	181	500	.4	21	1,260	670	2,240	7.5
803	Richie Perkins	22	Apr. 30, 1964	9	26	8	12	123	11	5	.7	10	205	101	258	7.6
14-101	I. R. Wagnon	Spring	May 28, 1964	6	147	47	184	162	110	500	.4	<.4	1,070	560	2,040	7.8
19-101	E. E. Evans	15	May 13, 1964	11	115	12	46	239	85	113	.7	8	510	338	888	7.5
102	do	6	do	10	81	9	46	238	41	76	.8	4	385	239	689	7.5
304	D. W. Franke	15	Apr. 9, 1964	11	121	22	62	332	63	110	.8	28	580	393	1,026	7.4
20-501	C. W. Hemphill	25	Apr. 2, 1964	13	107	9	10	326	18	15	.4	22	520	304	615	7.6

Table 3.--Chemical analyses of water from wells and springs, Coleman County--Continued

Well	Owner	Depth of well (ft)	Date of collection	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C.)	pH
42-20-801	Ina Turner	18	Apr. 1, 1964	13	217	51	175	272	259	397	0.7	66	1,450	750	2,180	8.3
21-601	Page Mays	18	Apr. 15, 1964	15	230	51	74	378	218	154	.5	264	1,190	790	1,740	7.7
602	do	Spring	do	14	118	31	67	476	56	57	.7	38	620	424	1,009	7.8
701	J. H. Candler	20	Apr. 14, 1964	16	327	89	290	322	396	740	.8	75	2,090	1,180	3,410	7.4
22-701	John Hensley	20	Apr. 22, 1964	14	179	18	182	284	89	333	.4	143	1,100	520	1,880	7.4
29-502	H. Stephens	30	Apr. 16, 1964	9	50	9	34	246	21	12	.8	4	261	160	455	7.8
30-602	Lige Lancaster	20	Apr. 23, 1964	24	415	94	256	201	379	540	.6	880	2,690	1,420	3,730	7.5
37-101	Eli Rezzlle	16	Apr. 16, 1964	14	57	9	27	249	19	10	.7	3.5	263	180	456	8.0
305	Mrs. R. F. Blackwell	16	do	25	80	16	82	277	123	64	2.0	2	530	264	861	7.8

Table 4.--Reported brine production and disposal in 1961, Coleman County

Area shown on Figure 9	Field name[a]		Disposal in pits (bbl)	Disposal in injection wells (bbl)	Total brine production (bbl)
1	Goldsboro/Gardner		0	3,270,885	
	Goldsboro/Gray		0	1,460	
	County Regular		18,600	0	
		Total	18,600	3,272,345	[b]3,294,595
2	Coker		600	0	
	Silver Valley		864	0	
		Total	1,464	0	1,464
3	Lavelle/Gray		0	4,815	
		Total	0	4,815	4,815
4	Mary Opal/Morris		91	0	
		Total	91	0	91
5	Five Try/Cross Cut		9,125	0	
		Total	9,125	0	9,125
6	Anzac/Morris		7,000	0	
	County Regular		1,100	0	
		Total	8,100	0	8,100
7	County Regular		0	3,285	
		Total	0	3,285	3,285
8	County Regular		320	2,986,456	
		Total	320	2,986,456	2,986,776
9	Novice		54	0	
	Novice, West/Gardner		4,380	0	
	Novice, West/Gray		246	0	
	Novice, S.W./Jennings		36,500	0	
	Novice, S.W./Gardner		730	0	
	Novice, S.W./Palo Pinto		365	0	
	Truax/Gray		2,918	0	
	Whitley/Jennings		9,135	1,981	
	Whitley/Gray		1,460	0	
	Williams/Gray		12,806	0	
	County Regular		8,081	0	
		Total	76,675	1,981	78,656

See footnotes at end of table.

Table 4.--Reported brine production and disposal in 1961, Coleman County--Continued

Area shown on Figure 9	Field name[a]		Disposal in pits (bbl)	Disposal in injection wells (bbl)	Total brine production (bbl)
10	Billings-Dunn/Gray		730	0	
	Croom/Morris		0	27,375	
	Jones-Hill/Morris		200	0	
	Jones-Hill/Jennings		550	0	
	Templeton/U. Gardner		700	1,095	
	Templeton/Gray		0	5,110	
	Templeton, North/Gray		180	0	
	County Regular		1,955	0	
		Total	4,315	33,580	37,895
11	County Regular		1,095	0	
		Total	1,095	0	1,095
12	County Regular		0	112,425	
		Total	0	112,425	112,425
13	Ralston-Bragg/Gray		1,150	0	
	Ralston-Bragg, N.W./Gardner		1,133	0	
	County Regular		116	0	
		Total	2,399	0	2,399
14	Burt-Ogden-Mabee		1,486	7,784	
	Dugold		1,250	0	
	McWilliams-Davis/Fry		2,071	0	
	Talpa, North/Serratt		1,095	0	
	County Regular		849	0	
		Total	6,751	7,784	14,535
15	Glen Cove/Jennings		770	624,564	
	United Western/Gardner		0	1,440	
	County Regular		123	122,500	
		Total	893	748,504	[c]749,413
16	Bowen/Morris		960	0	
	County Regular		6,365	0	
		Total	7,325	0	[d]10,325
17	Ballard/Morris		1,825	0	
		Total	1,825	0	1,825
18	County Regular		1,095	611,847	
		Total	1,095	611,847	612,942

See footnotes at end of table.

Table 4.--Reported brine production and disposal in 1961, Coleman County--Continued

Area shown on Figure 9	Field name[a]		Disposal in pits (bbl)	Disposal in injection wells (bbl)	Total brine production (bbl)
19	Twitty/Morris		5,768	0	
		Total	5,768	0	5,768
20	County Regular		0	46,720	
		Total	0	46,720	46,720
21	Camp Colorado/Marble Falls		90	0	
	County Regular		11,000	0	
		Total	11,090	0	11,090
22	Hagler/Capps		4,015	0	
		Total	4,015	0	4,015
23	County Regular		1,600	0	
		Total	1,600	0	1,600
24	Naylor/Jennings		36	0	
	County Regular		265	0	
		Total	301	0	301
25	County Regular		962	0	
		Total	962	0	962
26	Berryman		91	0	
		Total	91	0	91
27	Valera, North/Gardner		182	0	
	Warner/Lower Gardner		0	99,665	
	Warner/Morris		0	1,600	
	County Regular		875	90	
		Total	1,057	101,355	[e]105,412
28	County Regular		2,000	0	
		Total	2,000	0	2,000
29	County Regular		700	286,525	
		Total	700	286,525	287,225

See footnotes at end of table.

Table 4.--Reported brine production and disposal in 1961, Coleman County--Continued

Area shown on Figure 9	Field name[a]		Disposal in pits (bbl)	Disposal in injection wells (bbl)	Total brine production (bbl)
30	Andres/Gardner		730	0	
	Dominy-Lydick/Gardner		0	1,825	
	Maxwell/Morris		0	730	
	Wigner/Morris		1,095	12,100	
	County Regular		4,352	18,365	
		Total	6,177	33,020	39,197
31	County Regular		11,660	178,550	
		Total	11,660	178,550	190,210
32	Valera		200	0	
		Total	200	0	200
33	Snave/Overall		730	0	
		Total	730	0	730
34	Valera/Lower Fry		1,095	0	
		Total	1,095	0	1,095
35	Overall		15,000	0	
		Total	15,000	0	15,000
36	Fisk		1,596	0	
	County Regular		1,929	0	
		Total	3,525	0	3,525
37	Burba Breneke		0	146,000	
	Davis-Bell/Fry		0	63,740	
	County Regular		698	177,025	
		Total	698	386,765	387,463
38	Santa Anna/Breneke		1,265	0	
	County Regular		730	0	
		Total	1,995	0	1,995
39	Gladys Bell, South/Fry		0	10,950	
	Henry Campbell		721	0	
	Dunham and Young		600	0	
	Santa Anna Gas		499	0	
	County Regular		25,411	11,570	
		Total	27,231	22,520	[f]51,576

See footnotes at end of table.

Table 4.--Reported brine production and disposal in 1961, Coleman County--Continued

Area shown on Figure 9	Field name[a]		Disposal in pits (bbl)	Disposal in injection wells (bbl)	Total brine production (bbl)
40	Moore		21,900	0	
	Santa Anna Gas		233	0	
	County Regular		8,715	52,925	
		Total	30,848	52,925	83,773
41	Santa Anna Gas		35	0	
	County Regular		3,685	434,320	
		Total	3,720	434,320	438,040
42	County Regular		365	0	
		Total	365	0	365
43	Vance/Ranger		240	0	
		Total	240	0	240
44	County Regular		3,996	0	
		Total	3,996	0	3,996
45	County Regular		3,250	0	
		Total	3,250	0	3,250
46	County Regular		61	0	
		Total	61	0	61
47	County Regular		9,540	0	
		Total	9,540	0	[g]11,540
48	County Regular		35,415	50,000	
		Total	35,415	50,000	85,415
49	County Regular		1,095	0	
		Total	1,095	0	1,095
	Total, Coleman County		324,499	9,375,722	9,713,711

a/ As assigned by the Railroad Commission of Texas.
b/ Includes 3,650 barrels disposed of by methods other than pits and injection wells in County Regular field in Area 1.
c/ Includes 16 barrels disposed of by methods other than pits and injection wells in Glen Cove field in Area 15.
d/ Includes 3,000 barrels disposed of by methods other than pits and injection wells in County Regular field in Area 16.
e/ Includes 3,000 barrels disposed of by methods other than pits and injection wells in Warner/Lower Gardner field in Area 27.
f/ Includes 1,825 barrels disposed of by methods other than pits and injection wells in County Regular field in Area 39.
g/ Includes 2,000 barrels disposed of by methods other than pits and injection wells in County Regular field in Area 47.

Table 5.--Chemical analyses of oil-field brines, Coleman County

(Analyses are in parts per million except pH.)

After Rowland Laxson, et al., 1960, Resistivities and chemical analyses of formation waters from the West Central Texas area: West Central Texas Section of the Society of Petroleum Engineers of A.I.M.E.; and BJ Service Inc., 1960, The chemical analyses of brines from some fields in North and West Texas: Am. Inst. Mining, Metall., and Petroleum Engineers.

Producing zone	Field	Average depth of well (ft)	Area shown on Figure 9	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved solids	pH
				Permian System							
Amerada Sand	County Regular	420	8	1,120	672	11,040	105	0	21,000	33,830	7.5
				Pennsylvanian System							
McMillan Sand	Glen Cove	--	15	2,900	1,075	20,800	170	725	39,600	77,500	6.8
Serratt Sand	do	2,180	15	1,820	455	19,780	140	600	34,500	62,200	7.4
Cross Cut Sand	Echo	--	18	4,000	980	23,000	50	0	45,200	82,000	--
Overall Sand	Fisk	--	36	4,420	1,580	29,000	105	0	57,000	102,800	6.6
Morris Sand	Croom-Morris	--	10	8,330	1,860	42,900	50	0	86,450	147,700	7.6
Do.	Silver Valley	--	10	9,160	2,540	42,000	49	0	88,400	164,500	6.2
Breneke Sand	35E. Santa Anna	2,065	38	8,130	2,060	30,500	125	0	67,400	121,500	6.2
Do.	County Regular	--	37	4,580	1,470	27,700	120	0	55,000	102,800	6.8
Fry Sand	Coleman Junction	2,050	30	9,640	2,488	34,780	50	2	77,100	--	5.9
Do.	County Regular	--	31	10,750	2,280	37,800	100	0	84,000	148,500	6.7
L. Fry Sand	Valera	2,605	34	15,400	2,500	44,000	46	Trace	103,000	165,000	6.3
Jennings Sand	Glen Cove	3,405	15	17,600	2,770	52,200	30	0	119,500	217,300	6.0
Do.	Jennings	3,400	24	17,100	2,940	52,700	200	180	120,000	212,500	7.1
Gardner Sand	Dunman	3,677	1	16,170	1,585	45,000	161	264	102,700	--	--
Do.	County Regular	--	30	16,900	2,750	52,700	95	180	119,000	215,700	5.6
Do.	Williams	3,850	9	1,181	9,202	28,752	105	91	73,126	--	6.8
L. Gardner Sand	Warner	3,060	27	17,000	2,560	48,500	71	495	112,200	220,000	5.4
Gray Sand	Atchley	3,725	15	11,140	2,502	34,100	41	113	79,250	--	4.3
Do.	S. Goldsboro	4,000	1	15,600	2,580	48,000	20	140	109,000	198,300	6.4
Do.	Whitley	3,840	9	20,100	2,270	--	90	140	127,500	225,300	6.0
Marble Falls	Santa Anna	2,350	39	11,600	902	28,850	284	316	67,600	109,552	--
				Ordovician System							
Ellenburger	Burt-Ogden-Mabee	4,225	14	1,200	393	20,400	229	1,015	33,900	--	7.6
				Cambrian System							
Cambrian	Glen Cove	4,902	15	2,700	655	31,900	217	500	55,500	91,500	6.7

APPENDIX

SUPPLEMENTARY DISCUSSIONS OF
QUALITY OF WATER, GEOLOGY,
AND HYDROLOGY

SUPPLEMENTARY DISCUSSIONS OF QUALITY OF WATER, GEOLOGY, AND HYDROLOGY

Geology of North-Central Texas

Regional Structure

The counties included by the Texas Water Commission in the study of ground-water resources in north-central Texas are in the Grand Prairie and Osage Plains geographic provinces of Texas. The Grand Prairie region is defined as a belt of counties west of the Balcones fault zone and north of the Llano uplift, and has been described as a modified northeastward continuation of the Edwards Plateau. At the surface in the Grand Prairie region are Cretaceous rocks of the Comanche Series dipping gently to the east and southeast. Some faulting is exhibited in the Cretaceous formations near the Balcones zone, but in general no major structural features are reflected by these beds other than the regional eastward dip. To the west of the Grand Prairie region is the Osage Plains province extending from the Edwards Plateau and Llano uplift northward to the Red River. Surface formations in the Osage Plains of north-central Texas are of Pennsylvanian and Permian age except where these rocks are overlain locally by remnants of Cretaceous sediments or Recent alluvial deposits. Pennsylvanian and Permian beds of the region form a westward dipping homocline with an average dip of 50 feet per mile. Formations significant to the occurrence of ground water under study in the Osage Plains have not been affected by major structural deformation. The principal, large, buried structural features, illustrated in Figure A1, include the Bend flexure, the Red River uplift, eastern Midland shelf, and the Concho arch and developing Concho foreland.

Depositional History

The geologic environment in which the rock units underlying north-central Texas were laid down and the stratigraphic relationship of these units one to another determine the character of the water-bearing formations, which are the sources of ground water. Structural movement and crustal settling and shifting, which followed the deposition of the rocks in the area, influenced the mode of occurrence of ground water. An understanding of these complex historical events is important to a comprehension of how ground water occurs and how it can best be developed.

The sequence of geologic events significant to the occurrence of ground water in north-central Texas began in Ordovician time.

The massive epicontinental seas in which the Ellenburger sediments were deposited ranged in depth from about 600 feet to shallow banks and mud flats with a subsidence of the sea floor necessary for accumulation of sediments. This is evidenced by the calcitic and dolomitic facies which range from sub-lithographic to pelleted and ripple-marked limestones, and fine- to coarse-grained, commonly vugular dolomite that contains probable wind-borne sands. As a result of probable non-deposition and post-Ellenburger erosion, the Ellenburger sediments vary in thickness from a few feet to about 800 feet in north-central Texas.

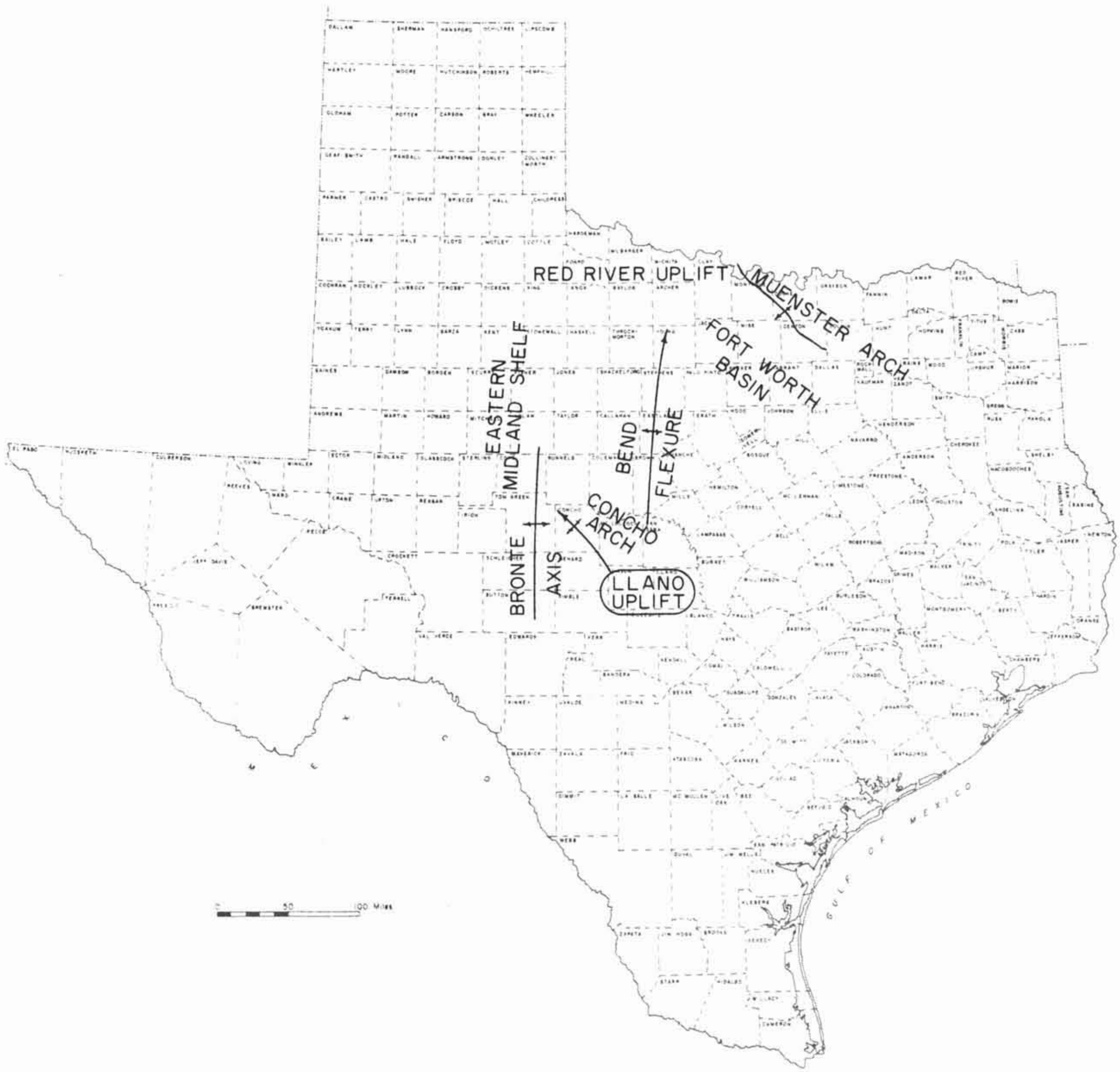


Figure A1

Major Structural Features in North-Central Texas

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The Pennsylvanian and Permian seas that deposited sediments in the north-central Texas area were shallow, probably less than 100 feet deep. This is evidenced by the large amounts of sandstone, the repetition and extent of coal deposits, and the presence of frequent local unconformities. Present also are conglomerates, mud cracks, ripple marks, cross-bedding, and fossils that are found in a shallow-water environment. Thus, ground water occurs in this area in formations of sediments deposited very nearly horizonally in shallow seas that were alternately advancing and retreating. Such a depositional environment resulted in a complex system of lateral and vertical changes in the character of the materials deposited. Few widespread continuous mantles of sediments such as those that characterize the Gulf Coast region of Texas are found. However, in contrast to the local, discontinuous, highly variable, shallow-water, clastic deposits characteristic of these periods, certain limestone units are relatively widespread. These limestones were deposited in extensive shallow seas advancing from the north and east, and are traceable as continuous units throughout much of the area under study. Thus, these limestone beds, while only locally significant as water-bearing units, are extremely important as horizon markers in identifying the age and character of the intervening sediments.

Ordovician Deposition

The lower Ordovician rocks of north-central Texas include the Ellenburger Group. In the Colorado River basin northwest of the Llano uplift, the Ellenburger Group is composed of the Tanyard and Gorman Formations. The Ellenburger Group is characterized by thick beds of limestone and dolomite with varying amounts of chert and scattered sand grains. It appears that the source of the bulk of these sediments was originally chemical precipitates. This is evidenced by the scarcity of terrigenous material, and limestones which are almost wholly calcitic.

From the number of springs along the outcrop, and the limited subsurface information concerning the occurrence of usable water in the Ellenburger Group, it is apparent that the water would most likely occur in joints, fractures, and solution openings in the dolomitic facies of the Tanyard and Gorman Formations.

Pennsylvanian Deposition

The upper Pennsylvanian rocks of north-central Texas include the Strawn, Canyon, and Cisco Groups, each of which has been subdivided into several formations and members. In the Colorado River basin the Strawn Group is composed principally of alternating beds of sandstone and shale, probably representing near-shore deposits with the source area for the sediments being a land mass to the east and northeast, which is now concealed under younger strata. Beds of the Strawn Group overlap to the west so that the total thickness of the group is probably not greater than 1,200 feet at any one point. Cretaceous rocks overlying these older beds in the area of the Bend flexure prevent tracing individual units of the Strawn on the surface from the Colorado River basin into the Brazos River basin. In general, the Strawn of the Colorado River basin contains coarser sediments than in the Brazos River basin, although beneath the Cretaceous sediments to the north in Wise County the Strawn again assumes a near-shore facies marked by coal beds and lenses of sand and sandy shale.

The Canyon Group in north-central Texas is characterized by thick limestone beds alternating with shale, and contains relatively little sandstone. The source of the sediments in the Canyon was again from the east, and was lower than during Strawn deposition as shown by the decrease of terrigenous clastic material, which marked much of the Strawn deposition. Sandstone lenses occurring in the Canyon Group, of extreme importance to the occurrence of ground water in local areas, probably were deposited in channels formed during periods of nonmarine occurrence. In Jack and Wise Counties the character of Canyon sediments--conglomerates, irregular sands, and several coal beds--indicates an approach to the shoreline. Also in the southern region of the Colorado River basin some conglomerates are found in the basal Canyon. The surface expression of the Canyon Group in the Brazos River basin is separated by Cretaceous rocks from Canyon beds in the Colorado River basin, and no definitive stratigraphic correlation of individual formations has been made from one basin into the other.

There was no widespread erosion of Canyon deposits except perhaps in the western Llano area. Tectonic activity to the north included the gradual uplift of the Red River arch, possible folding in the Wichita system, and other disturbances in the mid-continent area. Canyon sedimentation was also affected by the continued development of the eastern Midland shelf and the subdued, but still prominent, Concho arch and the Bronte axis.

Sedimentation continued into Cisco time, as evidenced by the lack of a marked unconformity between the Canyon and Cisco strata. Local disconformities and channeling are apparent in both the outcrop areas of these beds and in the subsurface, indicating that the shelf environment of late Canyon time became more and more deltaic locally during Cisco time. The Cisco Group in the north-central Texas region is comprised chiefly of shale, sandstone, conglomerate, and limestone, with local coal beds. Eastward the sand and conglomerate deposits increase in thickness while to the west the conglomerate and the coal disappear. In the northern part of the area the limestone disappears from the Cisco Group as deposition occurred in a nonmarine or partially marine facies.

Deposition in the late Pennsylvanian was affected by uplift in the Llano area as the initial westward tilting of the Concho foreland began toward the Midland basin. This westward tilting was to continue throughout Permian time. The Bend flexure, previously called the Bend arch, which extends from the Llano area to the Red River uplift, came into existence during late Pennsylvanian and early Permian times as a result of the differential subsidence of the Midland basin and the eastern Midland shelf, and the consequent westward tilting of the Concho foreland.

Permian Deposition

No major unconformity marks the contact between Pennsylvanian and Permian rocks, indicating relatively continuous deposition from the Cisco of the upper Pennsylvanian into the Wichita of the lower Permian. Local disconformities and channeling are apparent both in the surface and the subsurface, however, with the shoreline of the Permian sea having oscillated back and forth while it continued its slow migration toward the west as the tilting of the Concho foreland into the Midland basin progressed. The extensive Permian sea was shallow over north-central Texas, resulting in deposition of sediments under widely varying conditions.

Rocks of the Wichita Group have been mapped at the surface from the Red River to the Llano uplift. In the Colorado River basin the Wichita Group, representing the oldest Permian deposition, is characterized by a marine shale and limestone facies, while northward the marine beds decrease in importance and red beds are more prominent. Near the Red River, deposition of the Wichita Group was in a marginal marine environment marked chiefly by a red-bed facies of shale and sandstone. Deposition was apparently continuous in the Wichita, and no pronounced unconformities have been found in the Group.

Cretaceous Deposition

The close of Wichita deposition marked the end of Paleozoic time in north-central Texas, and great changes in the position of the land masses in Texas were to characterize the beginning of the Mesozoic in the State. The early Mesozoic was a period of continental elevation, and no Triassic deposition is known to have occurred in the area included in this study. This period of non-deposition continued through the Jurassic, and the first marine deposition that occurred in north-central Texas after the close of the Permian was in early Cretaceous time. As a result of the massive change in land-surface elevation in the first half of the Mesozoic, however, drainage in the Texas area had been reversed by the time Cretaceous deposition began. Instead of northwesterly drainage into inland Paleozoic seas, drainage from the earliest Cretaceous period onward was toward the southeast in the direction of what is now the Gulf of Mexico. Thus the regional dip of Cretaceous rocks overlying the Pennsylvanian and Permian sediments of north-central Texas is toward the southeast.

West of an irregular, northeast-trending line through Brown, Eastland, Jack, Wise, and Montague Counties, the only Cretaceous rocks remaining after extensive periods of erosion are remnants and outliers that, although not extensive, are locally significant as sources of ground water and as recharge areas for underlying older rocks. East of this irregular line Cretaceous beds are found at the surface in a continuous band eastward to the outcrop of Eocene sediments.

All of the known Cretaceous deposition in the area of study belongs to the Comanche Series. The Comanche has been divided into the Trinity, Fredericksburg, and Washita Groups, and both the Trinity and the Fredericksburg are found in this area. Generally, all of the Comanche sediments belong to a near-shore or shallow-water environment.

Quality of Ground Water

All ground water contains dissolved mineral constituents. The type and concentration depend upon the source, movement, and the environment of the ground water. Water derived from precipitation is relatively free of mineral matter, but because water has considerable solvent power, it dissolves minerals from the soil and rocks through which it passes. Therefore, the differences in chemical character of ground water reflect in a general way the nature of the geologic formations and the soils that have been in contact with the water. The concentration of dissolved solids generally increases with depth, especially where the movement of the water is restricted. Rocks deposited under marine conditions will contain brackish or highly mineralized water unless flushing by fresh water has been accomplished. This flushing action will occur in the outcrop area and to a limited distance downdip, depending upon the permeability of the rocks.

The chemical quality of ground water that has not been artificially altered is relatively constant, as is the temperature of ground water, which makes it highly desirable for many uses.

In addition to the natural mineralization of water that occurs in its environment, the quality of ground water can also be affected by man. Municipal and domestic sewage systems (including septic tanks), industrial waste, and oil-field brine that is improperly disposed of can enter into ground-water bodies and render them unfit for most uses.

Included among the factors determining the suitability of ground water as a supply are the limitations imposed by the contemplated use of the water. Criteria have been developed to cover most categories of water quality, including bacterial content, physical characteristics, and chemical constituents. Water-quality problems associated with the first two categories can usually be alleviated economically, but the removal of undesirable chemical constituents can be difficult and expensive. For many purposes the dissolved-solids content constitutes a major limitation on the use of water. One general classification of water based on dissolved-solids content (Winslow and Kister, 1956, p. 6) is as follows:

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

The United States Public Health Service has established standards of drinking water to be used on common carriers engaged in interstate commerce. The standards are designed primarily to protect the traveling public, and are often used to evaluate public water supplies. According to these standards, chemical constituents should not be present in the water supply in excess of the listed concentration shown in the following table, except where other more suitable supplies are not available. Some of the standards adopted by the U.S. Public Health Service (1962, p. 2152-2155) are as follows:

Substance	Concentration (ppm)
Chloride (Cl)	250
Fluoride (F)	(*)
Iron (Fe)	0.3
Manganese (Mn)	0.05
Nitrate (NO_3)	45
Sulfate (SO_4)	250
Total dissolved solids	500

*When fluoride is present naturally in drinking water, the concentration should not average more than the appropriate upper limit shown in the following table:

Annual average of maximum daily air temperatures (°F)	Recommended control limits of fluoride concentrations (ppm)		
	Lower	Optimum	Upper
50.0 - 53.7	0.9	1.2	1.7
53.8 - 58.3	.8	1.1	1.5
58.4 - 63.8	.8	1.0	1.3
63.9 - 70.6	.7	.9	1.2
70.7 - 79.2	.7	.8	1.0
79.3 - 90.5	.6	.7	.8

Water having concentration of chemical constituents in excess of the recommended limits may be objectionable for many reasons. Water containing an excess of 45 ppm of nitrate has been related (Maxcy, 1950, p. 271) to the incidence of infant cyanosis (methemoglobinemia or "blue baby" disease). The high concentrations of nitrate may be an indication of pollution from organic matter, commonly sewage. Iron and manganese in excessive concentrations cause reddish-brown or dark gray precipitates, which stain clothing and plumbing fixtures. Sulfate in water in excess of 250 ppm may produce a laxative effect, and water containing chloride exceeding 250 ppm may have a salty taste. Fluoride in concentrations of about 1 ppm may reduce the incidence of tooth decay, but excessive concentration may cause teeth to become mottled (Dean, Arnold, and Elvove, 1942, p. 1155-1159).

Hardness in water is caused principally by calcium and magnesium. Excessive hardness causes increased consumption of soap, and induces the formation of scale in hot water heaters and water pipes. The following table shows the commonly accepted standards and classifications of water hardness:

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

Water that is suitable for industrial use may not be acceptable for human consumption, and different standards may apply. Ground water used for industry may be classified into four principal categories: cooling water, boiler water, process water, and water used for secondary recovery of oil by water injection.

Although cooling water is usually selected on the basis of its temperature and source of supply, its chemical quality is also significant. Any characteristic that may adversely affect the heat-exchange surfaces is undesirable. Substances such as magnesium, calcium, iron, and silica may cause the formation of scale. Another objectionable feature that may be found in cooling water is corrosiveness caused by calcium and magnesium chloride, sodium chloride in the presence of magnesium, acids, and the gases oxygen and carbon dioxide.

The production of steam requires high quality-of-water standards. Under the extreme temperature and pressure conditions the problems of corrosion and incrustation are intensified. Under these conditions the presence of silica becomes undesirable as it forms a hard scale or incrustation.

Water coming in contact with, or incorporated into, manufactured products is termed "process water" and is subject to a wide range of quality requirements. These requirements involve physical, biological, and chemical factors. Water used in the manufacture of textiles must be low in dissolved-solids content and free of iron and manganese, which could cause staining. The beverage industry normally requires water free of iron, manganese, and organic substances.

Water used for injection in the secondary recovery of oil is generally that water taken from the oil reservoir. However, this water--usually brine--must generally be supplemented in order to meet the requirements of volume. Careful control must be exercised over the injected water with regard to suspended solids, dissolved gases, microbiological growths, and mineral constituents. Suspended solids in the water, of course, can cause plugging of the reservoir. Hydrogen sulfide, carbon dioxide, and oxygen all have corrosive effects on the well equipment, and oxygen reacting with the metallic ions, primarily iron (Fe^{+++}), will cause plugging of the reservoir. Organisms, iron bacteria, algae, and fungi have an effect of plugging the reservoir or pumping equipment, and the sulfate reducers have a corrosive effect.

Insofar as the mineral constituents are concerned, iron and manganese are undesirable as they cause plugging in injection wells. Sulfates are of interest from a standpoint of deposition. Water that is high in sulfate should not be mixed with water containing appreciable amounts of barium, for this would result in formation of barium sulfate with a very low solubility. The pH value is also significant when corrosion control and the solubilities of calcium carbonate and iron are considered. The higher the pH, the more difficult it is to maintain iron in solution and to keep calcium scale from forming.

Both the concentration and the composition of the dissolved constituents should be considered in appraising quality of water for irrigation. The chemical characteristics that appear to be most important in evaluating the quality of water for irrigation are: (1) relative proportion of sodium to the other cations, (2) total concentration of soluble salt, (3) amount of residual sodium carbonate, and (4) concentration of boron.

The U.S. Salinity Laboratory staff (1954, p. 69-82) proposed a system of classification commonly used for checking the quality of water for irrigation. The classification is based on the salinity hazard as measured by the electrical conductivity of the water and the sodium hazard as measured by the sodium-adsorption ratio (SAR). Figure A2 illustrates this classification system.

The importance of the dissolved constituents of water to be used for irrigation depends upon the degree to which the constituents accumulate in the soil. Kelley (1951, p. 95-99) cited areas having an average annual precipitation of about 18 inches in which the salts did not accumulate in the irrigated soil. It has been suggested (Wilcox, 1955, p. 15) that the system of classification of irrigation water proposed by the salinity laboratory staff is not directly applicable to the supplemental waters used in areas of relatively high rainfall.

Boron in excess will also make water unsuitable for irrigation. Scofield (1936, p. 286) has indicated that a boron concentration of as much as 1 ppm is permissible for irrigating sensitive crops, and as much as 3 ppm is permissible for tolerant crops. His suggested permissible limits of boron for irrigation waters are shown in the following table:

Classes of water		Sensitive crops (ppm)	Semitolerant crops (ppm)	Tolerant crops (ppm)
Rating	Grade			
1	Excellent	<0.33	<0.67	<1.00
2	Good	.33 to .67	.67 to 1.33	1.00 to 2.00
3	Permissible	.67 to 1.00	1.33 to 2.00	2.00 to 3.00
4	Doubtful	1.00 to 1.25	2.00 to 2.50	3.00 to 3.75
5	Unsuitable	>1.25	>2.50	>3.75

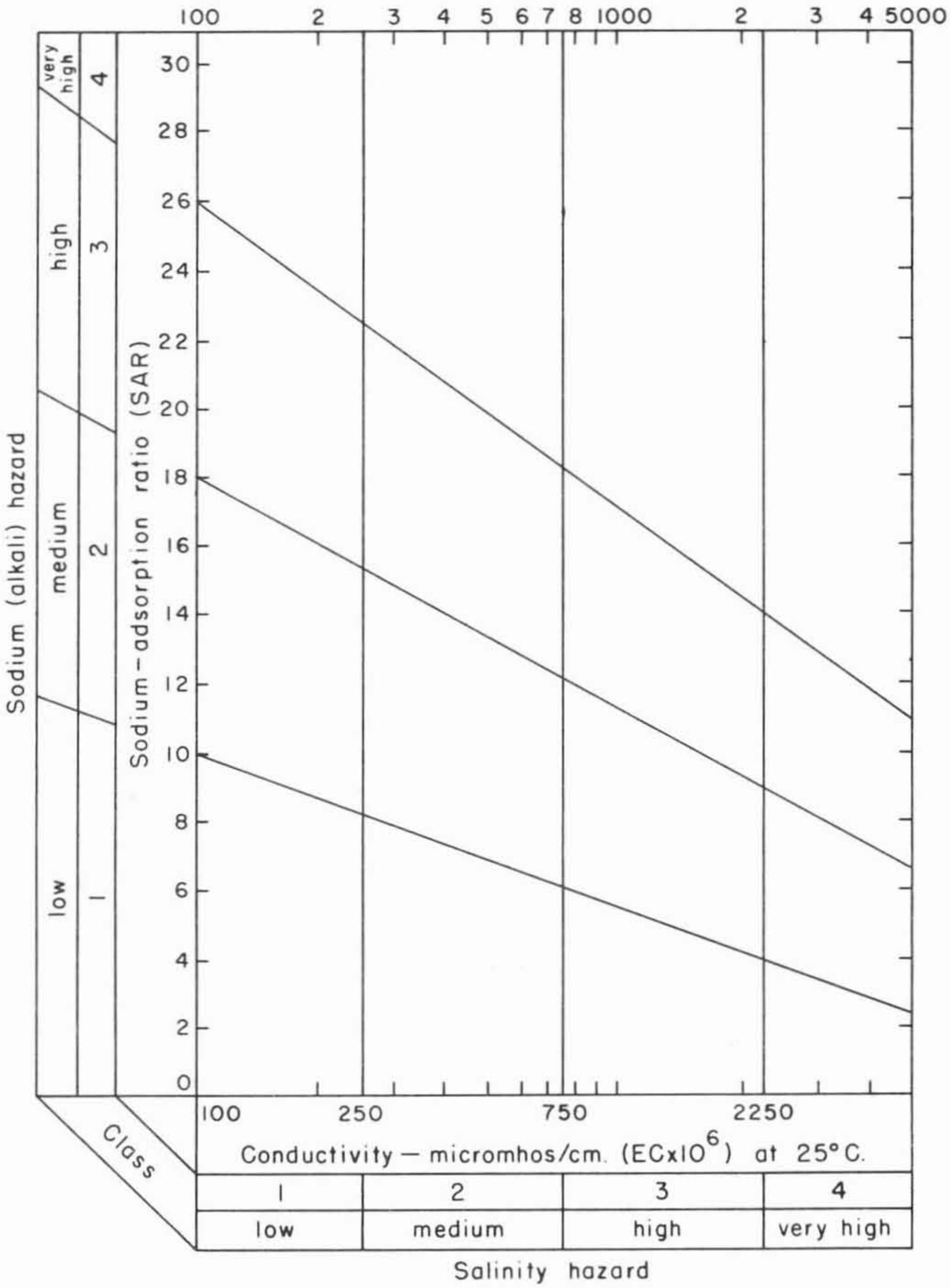

Figure A2

Diagram for the Classification of Irrigation Waters

(After United States Salinity Laboratory Staff, 1954, p. 80)

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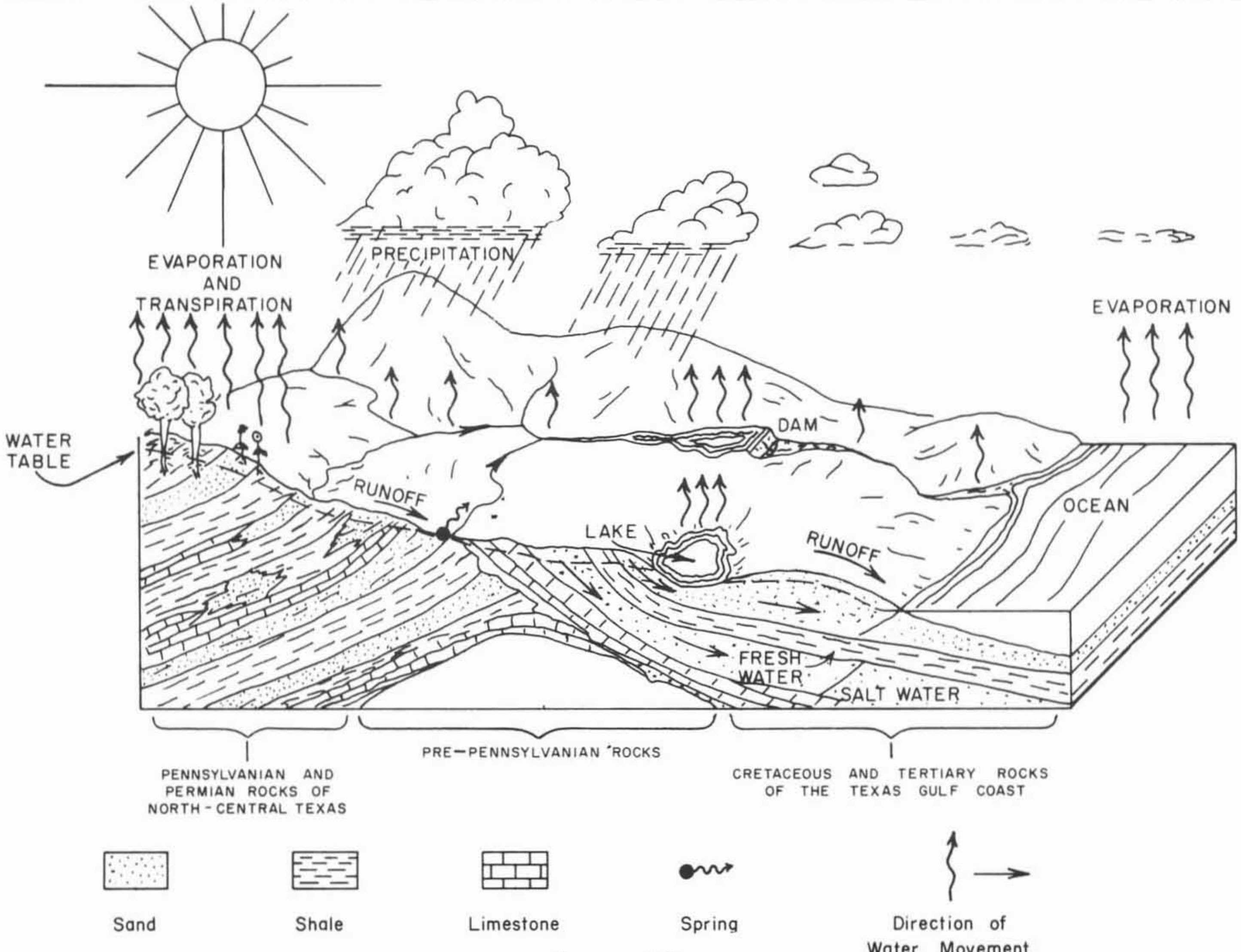

Figure A3

Hydrologic Cycle

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Ground-Water Hydrology

In north-central Texas the occurrence of ground water is erratic, and there are no large, continuous, prolific ground-water aquifers such as those found in the High Plains region of Texas and in the Gulf Coast. However, ground-water occurrences in north-central Texas conform to the same fundamental principles as those in other areas of the State.

Hydrologic Cycle

The water available for use by man--whether as rain, streamflow, water from wells, or spring discharge--is captured in transit, and after its use and reuse is returned to the hydrologic cycle from which it came. This cycle is illustrated in Figure A3. Graphically, Figure A3 shows the continuing movement of water from the oceans through evaporation to precipitation and its return either directly or ultimately to the ocean.

Ground-Water Occurrence and Movement

The geologic history of sedimentary deposition and erosion are primary factors controlling the occurrence and movement of ground water in the north-central Texas area. The rocks found in the shallow subsurface range from sporadic, uncemented, clastic beds to the more widespread, continuous, cemented or compacted shales, sandstones, and limestones. In uncemented rocks such as sand, gravel, and clay, water occurs in the spaces between individual particles, whereas in well cemented or compacted sedimentary rocks it occurs chiefly in cracks and fissures produced by earth movement or contraction, and in openings formed by solution where the rocks are soluble. If these openings are isolated, the movement of ground water is hindered. However, most openings are interconnected so as to permit ground water to move through them. The essential factor is that ground water of usable quality is continually moving from the point at which it entered the ground-water body, called the recharge area, to points of discharge, generally at lower elevations, either in stream drainage or through wells.

Recharge is the process by which water is added to an underground water-bearing formation, whether by precipitation on the outcrop of the formation or by seepage from surface streams or lakes on the outcrop. Factors that limit the amount of recharge received by a formation are the amount and frequency of precipitation, the area and extent of the outcrop, the topography, the type and amount of vegetation, the condition of the soil in the outcrop area, and the capacity of the formation to accept recharge. Discharge is the process by which water is removed from the formation, either through surface drainage or through wells.

The direction and rate of movement of water through a porous medium, such as an underground geologic formation, is influenced by a variety of factors, which include the nature of the formation itself and the external pressures applied on it as well as the fundamental physical laws of gravity and momentum. These factors include surface tension, friction, atmospheric pressure where the formation encounters the earth's surface, paths of differential permeability, effects of heavy local withdrawals or injection of water, and climatic changes affecting recharge. In north-central Texas, ground-water movement is not constant in either direction or rate. The environment through which it moves is a heterogeneous complex of sedimentary deposits varying in porosity, permeability, and angle of repose. Thus it is not easy, and frequently not even possible in the light of present knowledge, to determine precisely the route water will take from the point of recharge to the points at which it is once again discharged at the ground surface. In the area of this study, however, this route generally is circuitous and probably of relatively short geographic extent. As a consequence, a landowner whether private or public has a particular need for understanding the hydrologic factors affecting the occurrence of ground water. Only by a carefully discriminating study of the geological environment of his immediate locality can he determine the availability of ground water for beneficial use, or the means required to protect available ground water from pollution.