BULLETIN 6202

GROUND-WATER RESOURCES OF VICTORIA AND CALHOUN COUNTIES, TEXAS

Prepared in cooperation with the Geological Survey
United States Department of the Interior

January 1962

TEXAS BOARD OF WATER ENGINEERS

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By

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United States Geological Survey

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GROUND-WATER RESOURCES OF VICTORIA AND CALHOUN COUNTIES, TEXAS

ABSTRACT

Unconsolidated sand, gravel, and clay of Quaternary age crop out over the greater part of Victoria and Calhoun Counties. Much of the ground water used is withdrawn from wells tapping the Lissie formation, Beaumont clay, and Recent alluvium, all of Quaternary age. Some water is withdrawn from wells tapping the Goliad sand which is exposed in northwestern Victoria County; the underlying Lagarto clay and Oakville sandstone also contain fresh-water aquifers in that area. The Goliad sand, Lagarto clay, and Oakville sandstone are of late Tertiary age. Both the Tertiary and Quaternary formations dip gently toward the coast and strike northeast-southwest. Artesian ground-water conditions exist in the gently dipping, alternating sand and clay beds.

Victoria County has a large reservoir of fresh or slightly saline water that extends from the water table, which is near or above sea level, to at least 940 feet and locally as much as 2,000 feet below sea level. The average daily rate of withdrawal was about 19 million gallons in 1958. More than half the water withdrawn was used for rice irrigation; approximately one-fourth was used for public supply. Most of the water was withdrawn from the Lissie formation and the Goliad sand.

The quality of the usable ground water in Victoria County deteriorates slightly from east to west and deteriorates considerably from the northern to the southern part of the county. Most of the water now being brought to the surface meets the standards for drinking water established by the U. S. Public Health Service for interstate carriers. Water from some wells (mainly shallow wells) in the southern and western parts of the county may contain excessive amounts of iron, chloride, nitrate, or dissolved solids. Water of better quality generally is obtainable at greater depths. Water in the fresh or slightly saline zone is suitable for most industrial purposes although most of it is hard or very hard.

Ground water of varying quality has been used for irrigation for many years in Victoria County without apparent harm to the soil. Although most of this water would be considered marginal or unsuitable in arid to semiarid climates by U. S. Department of Agriculture standards for irrigation waters, the climate of Victoria County is humid.

Calhoun County has a much smaller quantity of fresh or slightly saline ground water than Victoria County. The base of the fresh or slightly saline water is as much as 1,500 feet below sea level in the northwest corner of the county, but is much shallower in the rest of the county. Fresh water is scarce.

Only a thin zone of usable, slightly saline water exists in the center of Calhoun County between Point Comfort and a point south of Seadrift. In the central and southern parts of the county, the fresh or slightly saline water is overlain by a zone of moderately saline to saline water as much as 250 feet thick. Shallow bodies of fresh water may be found in the surface sands in the Recent alluvium along the coast.

The average daily rate of withdrawal in 1958 in Calhoun County was 2.1 million gallons; most of it was used for public or stock supply. The water is withdrawn from wells tapping the Lissie formation, the Beaumont clay, and the Recent alluvium.

Ground water in Calhoun County is generally of poor quality, as much of the usable ground water in the county contains excessive amounts of chloride and dissolved solids. The water of best quality is found (1) in the northeast corner of the county, (2) in the area northwest of Port Lavaca and along the Victoria-Calhoun county line to the Guadalupe River, and (3) in small areas southeast of Seadrift in the Recent alluvium.

Six irrigation wells in a small area east of Green Lake are pumping water from an aquifer about 250 feet below the surface. The water has a very high salinity hazard but is used for supplemental irrigation and its effect upon the soil has not yet been determined.

GROUND-WATER RESOURCES OF VICTORIA AND CALHOUN COUNTIES, TEXAS

INTRODUCTION

Purpose and Scope

The water resources of Victoria and Calhoun Counties were investigated as a part of the statewide cooperative program of the Texas Board of Water Engineers and the U. S. Geological Survey. Factual information on the thickness and areal extent of usable ground water, the hydraulic characteristics of the geologic formations, and the chemical quality of ground water at various depths and locations in the two counties are needed to guide those in search of water for future public supply, industrial development, or irrigation.

The report was prepared by the U. S. Geological Survey in cooperation with the Texas Board of Water Engineers. Field data were gathered from September 1958 to May 1959. The report is based on records of 770 water wells, 100 drillers' logs, 195 electric logs of oil tests, 100 chemical analyses of ground-water samples, and 16 aquifer tests. Data published in reports by White (1940) and Lonsdale and Johnson (1941) were also used in preparing this report. The study was made under the general supervision of A. N. Sayre and P. E. LaMoreaux, successive chiefs of the Ground Water Branch, U. S. Geological Survey, and under the direct supervision of R. W. Sundstrom, district engineer in charge of ground-water investigations in Texas.

Location and Areal Extent

Victoria and Calhoun Counties are in South Texas on the Gulf Coastal Plain (Figure 1). Victoria County is bounded by Jackson County on the east, DeWitt County on the north, Goliad County on the west, and Calhoun and Refugio Counties on the south. Calhoun County, situated on the coast, is bounded by Matagorda County on the east, Jackson and Victoria Counties on the north, and Refugio and Aransas Counties on the west.

Victoria, the county seat of Victoria County, is centrally located within the county and is about midway between Houston and Corpus Christi. Other communities in Victoria County are Bloomington, Placedo, Inez, Telferner, Nursery, Mission Valley, Guadalupe, McFaddin, and DaCosta. The area of the county is 893 square miles.

Port Lavaca, the county seat of Calhoun County, is in the northeast part of the county on the west side of Lavaca Bay, 27 miles southeast of Victoria. Other communities in Calhoun County are Point Comfort, Seadrift, Port O'Connor,

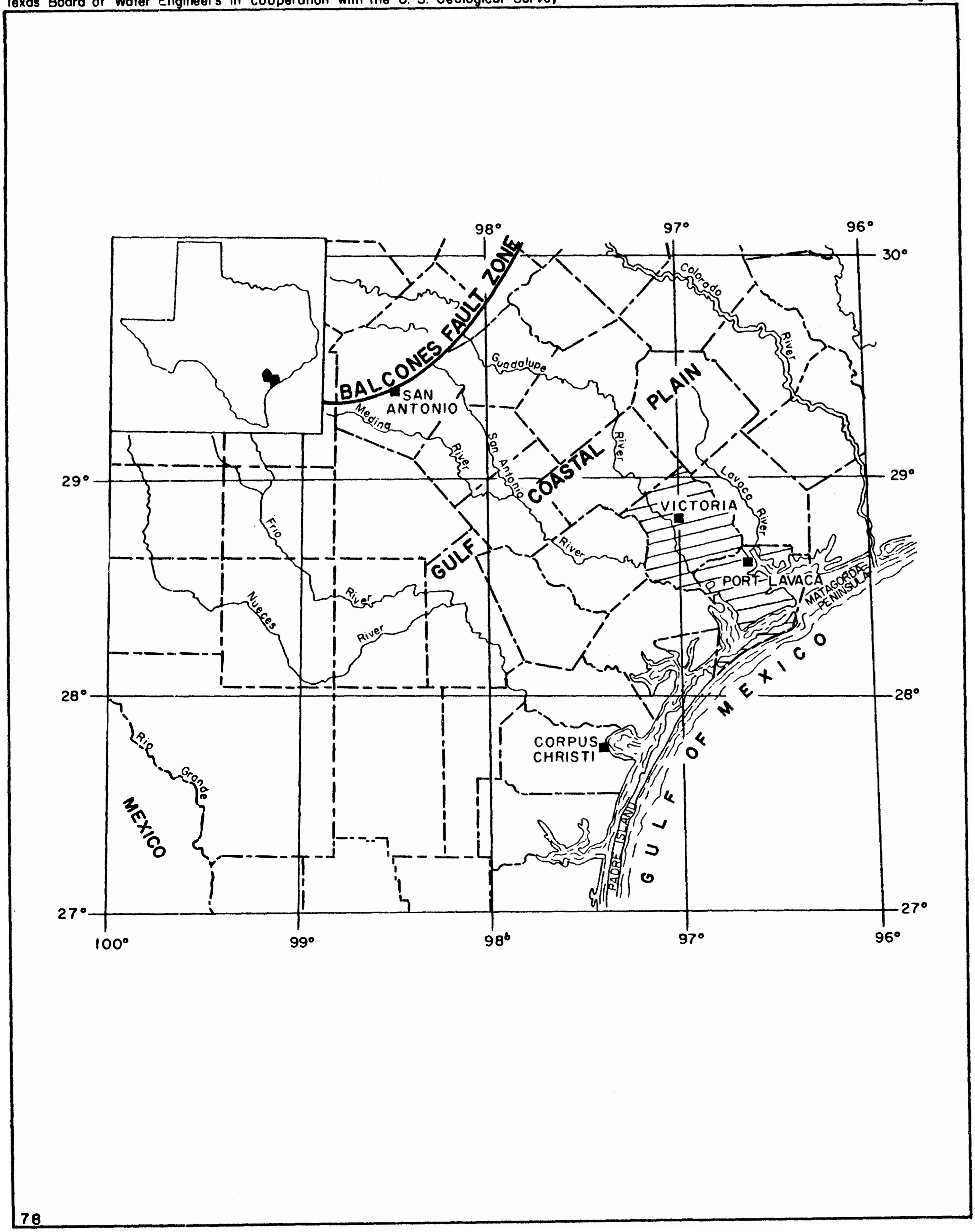

FIGURE 1.– Map of south-central Texas showing location of Victoria and Calhoun Counties

Olivia, Magnolia Beach, Long Mott, and Port Alto. The land area of the county is 537 square miles. The water area, consisting of shallow lakes, bays, and lagoons, is nearly as large.

Cultural Development

Victoria County was the site of colonizing attempts by the French under La Salle in 1685 and by the Spanish in the early seventeen hundreds, Victoria was founded in 1824 when the townsite was laid out by Don Martin De Leon. The county was created in 1836, one of the original counties of Texas. Calhoun County was created in 1846 from Matagorda, Jackson, and Victoria Counties.

Victoria County has a diversified economy supported by farming, ranching, oil production, manufacturing, and general commerce. It has several large cattle ranches and substantial oil (6,805,875 barrels in 1956) and gas production. Rice and cotton are the principal farm crops.

Calhoun County has an economy supported by farming, ranching, manufacturing, and fishing, Much of the land is used for cattle grazing; cultivated land is usually planted in rice, cotton, or grain sorghum. The important mineral resources are oil and gas.

Population growth has been rapid in both counties, due mainly to the development of industries. The population for Victoria County in 1960, according to the U. S. Bureau of the Census, was 46,475; in 1950 it was 31,241. The city of Victoria increased in population from 16,126 in 1950 to 33,047 in 1960. The population for Calhoun County in 1960 was 16,592; in 1950 it was 9,222. Port Lavaca increased in population from 5,599 in 1950 to 8,864 in 1960.

Both Victoria and Calhoun Counties are readily accessible by road. U. S. Highways 59, 77, and 78 all pass through Victoria. Port Lavaca is the southern terminus of U. S. Highway 78. Daily airline service connects Victoria to the major airline terminals of Texas. Good roads, two railroads-the Southern Pacific and the Missouri Pacific-and the Intracoastal Canal System provide ample transportation facilities for moving goods, raw or finished, to and from Victoria and Calhoun Counties. Port Lavaca and Point Comfort have barge channels connecting with the Intracoastal Waterways; a barge canal connecting the Intracoastal Waterways with Victoria was under construction in 1959.

Previous Investigations

An inventory of water wells in Victoria County was made in 1934 by James C. Cumley and again in 1940 (White, 1940). In 1940 a similar inventory of water wells in Calhoun County was made by Carl E. Johnson. An earlier survey by John T. Lonsdale in 1935 was incorporated in a report duplicated in 1941 (Lonsdale and Johnson). In 1945 an inventory was made of the public water-supply wells in the cities of Victoria, Port Lavaca, and Seadrift as part of a cooperative project between the Texas Board of Water Engineers and the U. S. Geological Survey (Broadhurst, Sundstrom, and Rowley, 1950).

Acknowledgments

Appreciation is expressed to the city officials of Victoria, Bloomington, Port Lavaca, and Seadrift; to the well drillers of the area, particularly M. G. Hobbs and R. F. Robbins, Victoria, Texas; B & P Drilling Co., Palacios, Texas; and Burt Well Service, La Ward, Texas; and to farmers, ranchers, and other well owners. Appreciation is also expressed to civilian employees of Foster Air Force Base, superintendents and employees of manufacturing companies operating in Victoria and Calhoun Counties, oil-well service companies, C. B. Burton of the Calhoun County Canal Co., the county agents of Victoria and Calhoun Counties, the Soil Conservation Service, and the Victoria County and Calhoun County Agriculture Stabilization and Conservation offices of the U. S. Department of Agriculture, all of whom contributed valuable information.

Well-Numbering System

For convenience in locating the wells within the county, a grid based on lines of latitude and longitude was constructed forming $7\frac{1}{2}$-minute quadrangles, some of which were modified along the county borders to include small segments in larger quadrangles. The quadrangles in Victoria County are identified by letters of the alphabet starting with A in the northwest corner and ending with T in the southern part of the county. In Calhoun County, the quadrangles are lettered starting with A in the northwestern part of the county and ending with K in the southern part. To avoid confusion, the letters I and O were not used. The location of wells in Victoria and Calhoun Counties are shown on Plate 1.

In the reports by White (1940) and Lonsdale and Johnson (1941), the wells were numbered consecutively within each county. Tables 1 and 2 are indices of well numbers used in the 1940 and 1941 reports, respectively.

Table 1.--Index of previously published well numbers and corresponding numbers in this report, Victoria County

Old No.	New No.	Old No.	New No.	Old No.	New No.	Old No.	New No.	Old No.	New No.
1	C-6	9	G-17	83	K-1	154	M-12	194	T-17
3	C-14	10	H-1	84	K-4	155	M-14	195	T-14
4	C-3	25	D-22	117	J-38	159	M-5	199	T-11
5	C-17	27	C-19	121	H-24	176	M-23	229	N-6
6	C-15	30	D-9	122	H-27	180	S-8	261	N-33
7	G-7	38	A-10	129	H-20	191	T-23	262	P-20
8	G-8	82	K-10	152	G-22	193	T-13		

Table 2.--Index of previously published well numbers and corresponding numbers in this report, Calhoun County

Old No.	New No.	Old No.	New No.	Old No.	New No.	Old No.	New No.	Old No.	New No.
3	A-15	36	B-17	75	D-36	187	E-47	214	G-8
5	A-5	41	B-9	87	A-27	190	E-40	215	G-12
6	A-6	43	B-22	97	B-59	191	E-44	225	F-19
10	A-16	44	B-25	109	B-60	192	H-4	227	G-20
11	A-19	45	B-28	116	B-36	194	H-2	228	G-25
12	A-21	55	D-8	125	B-43	198	E-42	233	G-17
13	A-20	56	D-2	152	C-16	199	H-1	247	E-32
14	A-22	58	D-19	160	C-22	206	F-7	255	E-29
15	A-11	62	D-30	175	E-21	207	F-5	261	E-13
23	A-4	63	D-28	176	E-20	208	G-5		
31	B-13	70	D-24	178	E-23	209	G-4		
32	B-14	71	D-23	179	E-26	211	G-6		
34	B-15	74	D-37	185	E-30	212	G-3		

GEOGRAPHY

Climate

Both Victoria and Calhoun Counties have a humid subtropical climate, characterized by mild winters and hot summers. Breezes from the Gulf of Mexico have a moderating effect on high summer temperatures. The area occasionally is subject to tropical disturbances which move in from the Gulf of Mexico during summer and fall. Destructive winds and torrential rains may occur during these storms. The normal annual rainfall at Victoria is 35.66 inches. Incomplete records of rainfall at Port Lavaca show an average yearly rainfall of 37.10 inches.

Figure 2 shows the annual precipitation recorded at Victoria from 1905 through 1958. From 1950 to 1956, unusually long dry periods were experienced although the annual rainfall never was less than the extremely dry year of 1917. The normal annual rainfall (1921-50), as shown in Figure 2, is well distributed throughout the year; the heaviest rains occur during the growing season.

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

Figure 2

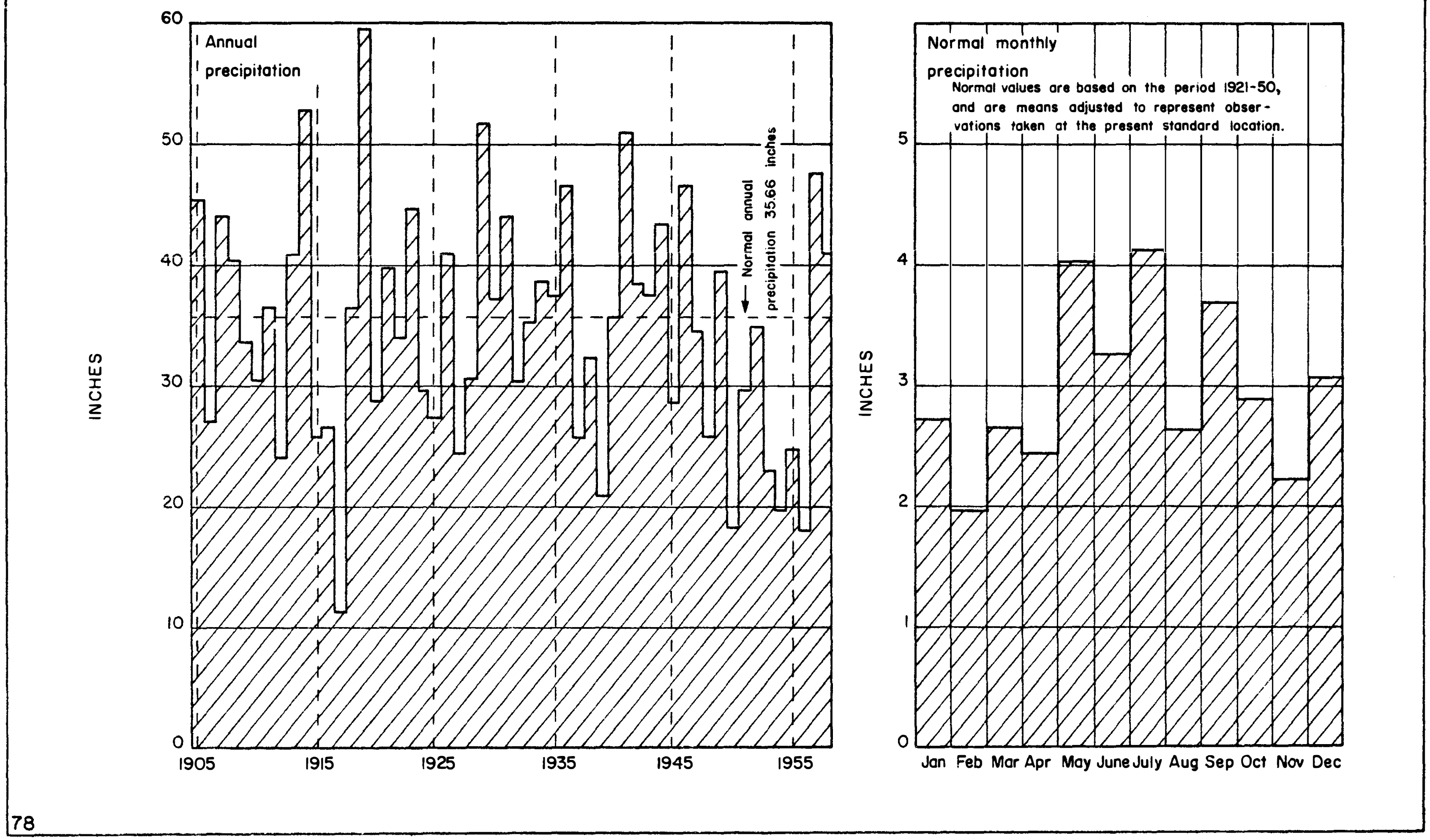

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FIGURE 2.—Annual precipitation, 1905-58, and the normal monthly precipitation at Victoria

(Data from U. S. Weather Bureau)

Topography and Drainage

Most of Victoria County and all the land area of Calhoun County is a grass-covered, slightly rolling plain. A moderately dissected upland, which has a maximum relief of approximately 150 feet, occupies the northwest corner of Victoria County. It is underlain by the Goliad sand of Pliocene age, which supports a dense growth of trees and brush. The change from upland to plain is usually distinguished by the change in vegetation. The plain is the outcrop area of the Lissie formation and the Beaumont clay of Pleistocene age and the Recent alluvium along the coast. Its nearly level surface makes it suitable for irrigation by flooding, but prevents adequate natural drainage. The plain has been dissected in places by stream erosion which provides the only relief. The Guadalupe River has cut a valley floor more than a mile wide at places and 30 to 50 feet below the level of the plain. Smaller valleys have been formed by the San Antonio River and Coleto Creek. A dense growth of trees and brush line the smaller stream courses and cover the valley floors except where they have been cleared.

A small area of the upland in Victoria County adjacent to the northwest county line and just west of the Guadalupe River is more than 200 feet above sea level. The land slopes from this high area toward the Gulf and is at sea level in the southeast corner of the county. In Calhoun County, the highest area, 50 feet above sea level, is in the northwest corner just east of the Guadalupe River. The land gradually falls away to wave-cut bluffs, marshes, or beaches that mark the end of the mainland. The largest part of Calhoun County is a low, broad peninsula bounded on the east by Lavaca and Matagorda Bays and on the southwest by San Antonio Bay, Matagorda Island, an off-shore bar, constitutes the coastline, protecting the shallow bays. One of Texas' largest natural fresh-water lakes, shallow Green Lake, lies on the west side of the Calhoun peninsula.

The western half of Victoria County is in the Guadalupe River drainage system. Most of the eastern half is drained by still intermittent Garcitas Creek and its tributaries, which empties into Lavaca Bay. The natural drainage of Calhoun County and the southern part of Victoria County is by small intermittent streams that empty into salt-water bays or Green Lake. Drainage is facilitated by approximately 500 miles of drainage ditches.

The principal perennial stream is the Guadalupe River. It is joined in Victoria County by two important tributaries, the San Antonio River and Coleto Creek. During the 1950-56 drought, Coleto Creek was dry part of the time and the Guadalupe River diminished in flow until it could not supply the demands made on it by industry and farmers. Guadalupe River empties into San Antonio Bay, Calhoun County. Although it is one of Texas' major rivers, it is not actively engaged in delta building at the present time but has built a delta into San Antonio Bay in Recent time. Similarly, the Lavaca River, which empties into Lavaca Bay, Calhoun County, is not actively building a delta.

In west-central Calhoun County, a network of more than 70 miles of irrigation canals supplies farmers with water from the Guadalupe River. Water is diverted from the Guadalupe River less than one-half mile below the mouth of the San Antonio River; from there it passes through a system of bayous and canals near the mouth of the Guadalupe River to the pumping station at the edge of the Guadalupe Valley about 6 miles north of Seadrift.

A barge canal is being dredged along the east side of the Guadalupe River from San Antonio Bay to a proposed point 6 miles south of the city of Victoria. This canal will be part of the Intracoastal Waterway system.

During the last 40 million years, several thousand feet of clay, silt, sand, and gravel have been deposited by sediment-laden rivers in the Gulf Coastal area. The sediments came to rest on broad deltas or on the floor of the Gulf. The sediments near shore were subject to the currents of the Gulf and storm waves which moved some of the sediments to form off-shore bars and fill lagoons. The modern delta of the Colorado River in Matagorda Bay and the off-shore bars such as Matagorda Island and Matagorda Peninsula are a continuation of the same processes. The coastal region gradually subsided as the sediments were being deposited. When the rate of deposition was less than the rate of subsidence, the sea would invade the land. A subsequent increase in the rate of deposition due to greater streamflow or slight regional uplift would again build the land seaward. Under these conditions, great thicknesses of sediments were deposited. Periodically a slight tilting of the coastal region to seaward occurred, moving the zone of greatest deposition slowly coastward.

The Tertiary formations underlying Victoria and Calhoun Counties were probably deposited in a marine environment. At the start of the Pleistocene, the coastline may have been in northern Victoria County, although it fluctuated back and forth over the county as the rate of deposition changed or as the sea level varied. Since then the land has gradually been built out to its present position, the sediments being deposited in alternately continental, transitional, or marine environments.

The geologic formations found between the surface and 3,000 feet below sea level are listed in Table 3 in the order of their age, the youngest being at the top. The formations are exposed in bands that roughly parallel the coast with the oldest cropping out farthest from the coast and the youngest (Recent alluvium) cropping out nearest the coast. The Lagarto clay, Oakville sandstone, and Catahoula tuff are exposed in DeWitt County to the northwest but do not crop out in Victoria or Calhoun Counties. The Goliad sand of Pliocene age crops out in DeWitt County and forms the dissected upland in the northwestern corner of Victoria County. The Lissie formation, Beaumont clay, and Recent alluvium underlie the grass-covered plain that spreads over the rest of Victoria County and forms the land area of Calhoun County. Northern, northeastern, and most of western Victoria County are underlain by the Lissie formation; the Beaumont clay underlies the southern part of Victoria County and the northern and central parts of Calhoun County. The Recent alluvium is exposed on Matagorda Island, on the mainland southeast of a line from Seadrift to Powderhorn Lake to Olivia to the Jackson County line on Carancahua Bay, and in the valleys of the major streams. The clay beds in the Beaumont clay weather to a black, sticky soil, which, in the area under study, is in marked contrast to the light-colored, weathered surface of the Lissie formation or the light-colored, sandy pimple-marked surface of the Recent alluvium along the coast.

Seven cross sections (Plates 2-8), which were constructed from electric logs, show the base of fresh or slightly saline water in Victoria and Calhoun Counties and indicate the ratio of sand to clay in the different parts of the counties. Five of the cross sections (Plates 2, 3, 4, 5, and 6) are alined along the strike of the formations; two cross sections (Plates 7 and 8) are alined parallel to the dip. The location of the cross sections is shown on Plate 1.

The heterogeneous character of the younger sediments makes correlation of sands and clays difficult and unsure over distances of several miles. The

Table 3.--Geologic formations in Victoria and Calhoun Counties

AGE: System	AGE: Series	Stratigraphic Unit	Approximate maximum thickness (feet)	Character of formation	Water supply
Quaternary	Recent	Alluvium	300	Fluvial and marine deposits of clay, silt, sand, and gravel.	Yields small to moderate supplies of water of variable quality sufficient for municipal, domestic, and stock use.
	Pleistocene	Beaumont clay	600	Clay containing layers of sand.	Yields small to moderate supplies of fresh or slightly saline water in some areas sufficient for municipal, agriculture, and stock purposes.
		Lissie formation	600	Thick beds of sand containing lentils of gravel and layers of clay, silt, and some caliche.	Yields large supplies of fresh water to municipal, industrial, and agricultural wells in Victoria County.
Tertiary	Pliocene	Goliad sand	400	Predominantly sandstone and sand containing some clay, caliche, and gravel.	Yields large supplies of fresh water for municipal, industrial and agricultural use in Victoria County.
	Miocene(?)	Lagarto clay	1,000±	Clay and sandy clay containing interbedded layers of sand and sandstone.	Not known to yield water to wells in Victoria or Calhoun County. However contains fresh to slightly saline water in northern Victoria County.
	Miocene	Oakville sandstone	500±	Crossbedded sand and sandstone containing interbedded sandy, ashy, or bentonitic clay.	Not known to yield water to wells in Victoria or Calhoun County. Contains the base of the fresh or slightly saline water in northwest part of Victoria County.
	Miocene(?)	Catahoula tuff	1,000±	Predominantly volcanic tuff and tuffaceous clay containing sandstone lentils.	Does not contain fresh or slightly saline water in Victoria or Calhoun County.

deposits are often lenticular, the lenses pinch out, coalesce, or grade into each other within a short distance. The formations younger than the Oakville sandstone of Miocene age are not easily differentiated in the subsurface in drillers' or electric logs, owing to the similarity of the sediments and the lack of continuous beds. In Victoria and Calhoun Counties, the strata strike northeastward and dip southeastward toward the Gulf of Mexico. The formations dip less than 20 feet per mile near the outcrop of each formation, but the dip gradually increases so that the older formations dip more than 70 feet per mile near the coast. The Oakville-Catahoula contact (Plates 5, 6, 7, and 8) is approximately 1,500 feet below sea level in the northern part of Victoria County, descending to 3,000 feet below sea level near the center of the county. No other formational contacts are shown as they could not be distinguished on the electric logs or inferred from drillers' logs. Also, no faults are shown on the cross sections, although many faults have been mapped by oil geologists working with electric logs and other data from wells penetrating Miocene and older formations.

DEFINITIONS OF TERMS

Technical terms and terms subject to differences of interpretation are defined, as follows:

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

Artesian water.--Ground water that is under sufficient pressure to rise above the level at which it is encountered by a well is called artesian water; it does not necessarily rise to or above the surface of the ground.

Coefficient of permeability.--The rate of flow of water in gallons a day through a cross section of one square foot under a unit hydraulic gradient.

Coefficient of storage.--The volume of water an aquifer releases from or takes into storage per unit of surface area of the aquifer per unit change in the component of head normal to that surface.

Coefficient of transmissibility.--The number of gallons of water which will move in one day through a vertical strip of the aquifer one foot wide and having the height of the aquifer when the hydraulic gradient is unity. It is the product of the field coefficient of permeability and the saturated thickness of the aquifer.

Quality of water.--Water in this report is classified according to the following tabulation.

Description	Dissolved solids, in parts per million
Fresh	0 - 1,000
Slightly saline	1,000 - 3,000
Moderately saline	3,000 - 10,000
Saline	10,000 - 35,000
Brine	More than 35,000

Resistivity.--The resistivity of a water-saturated rock is a function of both the rock texture and contained fluid and is recorded in ohms per square meter per meter (ohms m^2/m).

Spontaneous potential.--The spontaneous potential is the naturally occurring potential differences between a surface electrode and an electrode that is pulled up in the column of conductive mud past the different formations. Spontaneous potential is recorded in millivolts.

Sodium-adsorption-ratio (SAR).--The sodium-adsorption-ratio is used to express the relative activity of sodium ions in exchange reactions on the soil complex.

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

in which the cohcentrations of ions are expressed in equivalents per million.

Specific conductance (conductivity).--Specific conductance, which is expressed in micromhos per centimeter at 25°C, is a measure of the ability of a solution to conduct an electrical current. It is approximately proportional to the content of dissolved solids.

Water table.--The unconfined surface of the water-saturated zone in an aquifer as measured in wells.

Well depth.--To prevent misinterpretation and to limit explanatory writing, the depths of wells as used in this report have been classified as follows: Shallow, less than 100 feet; moderately deep, 100 to 500 feet; deep, more than 500 feet.

Yield.--The yield of a well is defined in this report by the following terms: small yield, less than 100 gpm (gallons per minute); moderate yield, 100 to 1,000 gpm; large yield, greater than 1,000 gpm.

HYDROLOGY

Movement of Ground Water

The origin of all fresh ground water in Victoria and Calhoun Counties is the precipitation that falls on Victoria, Calhoun, and surrounding counties. Most of the precipitation is evaporated, used in plant growth, or runs off to the Gulf. But a small part percolates through the soil, subsoil, and sediments to become ground water, filling the small spaces between mineral grains. The top of the zone of saturation is called the water table. Beds of clay and silt have very small voids between mineral grains. Water than enters these voids is strongly held by molecular attraction. But in the beds of sand and gravel, the voids are large in comparison to clay voids and water will pass readily from one void to another. Thus, the beds of sand and gravel yield water freely to wells and are the aquifers.

Through the centuries, water from precipitation has been entering the aquifers where they crop out and then percolating downward to the zone of saturation. Some of the water that reaches the water table is discharged by springs at places where streams cut the water table, and some is lost by evapotranspiration from places where the water table is near the surface. The remainder moves downdip, replacing water discharged from wells and water that is lost to overlying horizons.

Figure 3 illustrates the movement of water along the dip of the aquifers. The saline water that filled the aquifers when they were deposited has been flushed from the updip portions of the aquifers by the precipitation entering the outcrop. As the aquifers dip beneath the floor of the Gulf and do not crop out in the Gulf and most of the sand beds pinch out or become clayey downdip, the flushing of the sand beds was made possible by the movement of water upward through the overlying clays (Winslow and others, 1957, pages 387-388). Although the beds of clay and silt have very low permeability and water moves very slowly through them, the movement of water has been occurring over a long time; some of the more permeable of the older aquifers have been flushed many miles downdip from their outcrop. The movement of water between beds is facilitated in many places by the presence of sandy beds that provide vertical connection between aquifers.

The water in the outcrop is subject only to atmospheric pressure and is said to be under water-table conditions. As the water moves downdip and passes beneath a bed having low permeability, it is under the pressure of the water in the outcrop and it will rise above the point that it is encountered in a well. It is then said to occur under artesian conditions. If the land surface at a well is at a lower altitude than the water table in the outcrop of the aquifer tapped by the well, and if the loss of hydrostatic head between the outcrop area and the well is less than this difference in altitude, the well will flow. However, discharge in the area where the well is located lowers the hydrostatic head so that the well will not flow in most instances.

Where large withdrawals have lowered the pressure head in a water-bearing bed or group of water-bearing beds, water moves toward the zone of lower pressure from all directions, laterally and vertically. If the zone of lowered pressure is near the interface between the fresh and saline water, the saline water will move into the zone. However, the rate of ground-water movement in sand is slow, usually only a few hundred feet a year.

Interpretation of Electric Logs

An electric log is a profile of certain electrical characteristics of the sediments and their contained fluids that are penetrated by the well. The right-hand side of the electric log (second curve) indicates the relative resistivity of the fluids contained in the various layers of sediments; each curve is recorded by electrodes of different spacing. The wider the electrode spacing, the deeper the penetration; the wider spacing records the resistivity of a larger volume of sediment by measuring farther from the center of the test hold. The left-hand side (first curve) is a record of the spontaneous potential of the sediments. The base of the fresh or slightly saline water was determined by interpretation of the three resistivity curves generally recorded on electric logs in this area. Generally, fresh water has a high resistivity and slightly saline water has an intermediate resistivity. The zone containing slightly saline water ranges from a few feet to as much as 200 or 300 feet in thickness. The electric logs reproduced on the cross sections show only two of the three

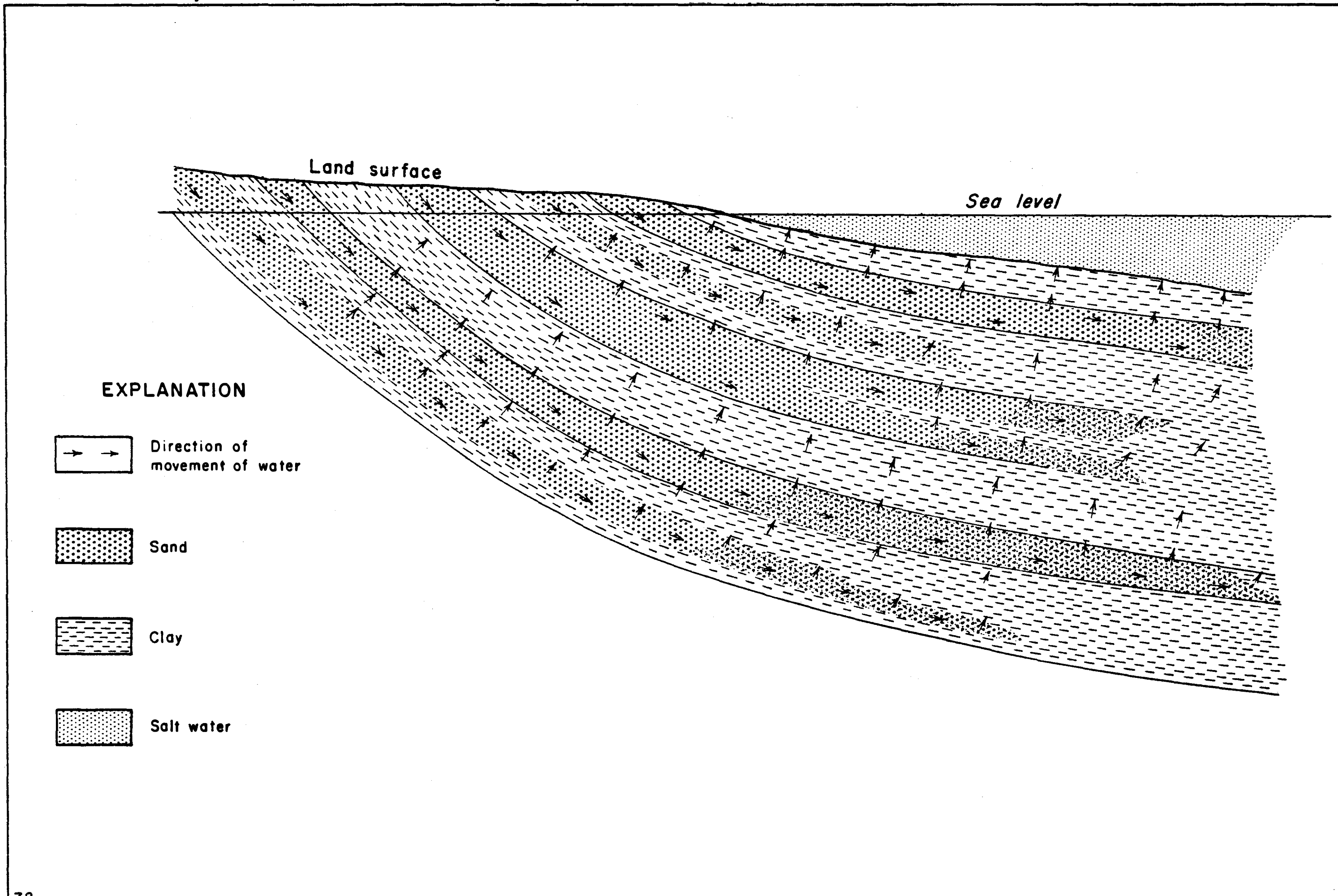

FIGURE 3.- Schematic diagram showing movement of ground water

resistivity curves. The dotted line (third curve) represents the resistivity of the same sediments and fluids plus some of those at a greater distance from the wall of the hole than the solid-line curve. The drilling fluid penetrates the sediments adjacent to the hole, causing a difference in the resistivity compared with that at a greater distance from the center of the hole. On cross section C-C' (Plate 4) examination of the electric logs for Victoria County wells P-21, P-9, and R-9 shows that the third curve (dotted) has a decided change in amplitude where the base of the fresh or slightly saline water has been drawn. The formation water contains more dissolved minerals than the water near the wall of the hole which has filtered from the drilling fluid. The low resistivity of the formation water, as shown by the third curve, indicates that it is moderately saline or saline.

Lack of sufficient chemical information on the mineral content of the slightly to moderately saline water zone in Victoria and Calhoun Counties prevents precise interpretation of the electric logs in some areas. Interpretation was further complicated by the presence of natural gas in some of the sands. On the electric log, natural gas exhibits high resistivity similar to that of fresh water. The presence of gas was noted during fieldwork in most of the moderately deep and deep wells in Victoria County.

The spontaneous-potential curve on the left-hand side of the electric log provides a record of the sand and clay beds penetrated by wells drilled in Victoria and Calhoun Counties. The clay or shale has nearly the same spontaneous potential value throughout the length of the well, but the sand and gravel have either a greater, the same, or lesser potential value than the clay. A displacement of the curve to the right or left usually indicates a sand or gravel bed. On many logs the clay and sand beds are not well defined by the spontaneous-potential curve in the fresh to slightly saline water zone as the drilling fluid is composed of water and clay similar to that penetrated by the hole. On those logs the sand zones were determined from the resistivity curves; the intervals of high resistivity values in the fresh-water zone usually correspond to layers of sand or gravel. A more complete discussion of the interpretation of electric logs in locating fresh water may be found in Jones and Buford (1951).

Occurrence of Ground Water

Water used for many purposes is either fresh or slightly saline as defined earlier (page 12). Although most of the water in Victoria County and northern Calhoun County, as shown on the cross sections as fresh or slightly saline, is fresh, all the fresh or slightly saline water has been grouped as one unit in this report. In all of Victoria County and parts of Calhoun County, both fresh and slightly saline water occur, but in central Calhoun County fresh water is not present. To show that some areas have no fresh water, the term "fresh or slightly saline water zone" is used instead of "fresh to slightly saline water zone," which would be applicable to much of the area under study. Plate 9 is a map of the base of the fresh or slightly saline water zone in Victoria and Calhoun Counties. It was constructed from information obtained from 195 electric logs, some of which are shown on the cross sections (Plates 2, 3, 4, 5, 6, 7, and 8). The approximate base of the fresh or slightly saline ground water also is shown on the cross sections.

A large volume of fresh ground water is stored in the aquifers that underlie Victoria County. The base of the fresh or slightly saline water extends from 940 feet to more than 2,000 feet below sea level. Water near the base of the slightly saline zone is not being tapped except by flowing stock wells 1,300 to

1,460 feet deep in the southeast corner of the county (quadrangles L and R). These are the deepest wells in the county. Only a few heavily pumped wells are more than 1,000 feet in depth.

Calhoun County is not as well endowed with ground water of good quality as Victoria County. In fact, some areas do not have any fresh ground water according to the available electric logs; the best water is slightly saline. Deep fresh water, extending to more than 1,000 feet below sea level, is found only in the northwest part of the county. The base of the fresh or slightly saline water zone is only 200 to 400 feet below sea level through the central part of the county. In some areas the fresh or slightly saline water is overlain by a zone of moderately saline water. Locally, very shallow fresh-water supplies may be created by rain water collecting in beach or surface sands. Such shallow reservoirs are not reliable as they may be easily contaminated or may be inundated by salt water during large storms. During the early 1940's, fresh water from the beach sands of Matagorda Island was used to supply part of the requirements of Matagorda Island Air Force Base.

The base of the fresh or slightly saline water (Plate 9) is quite irregular in Victoria County, containing deep depressions and high areas. The lineation of these structures is usually northeast-southwest in close agreement with the general strike of the sediments. In Calhoun County the base of the fresh or slightly saline water is not as irregular as in Victoria County as shown on Plate 9, possibly because less information is available. The base of the fresh or slightly saline water is shallow from Point Comfort to an area on San Antonio Bay south of Seadrift. The base of the fresh or slightly saline water is 200 feet below sea level southeast of Seadrift, and is less than 400 feet deep in an area about 27 miles long and from 2 to 10 miles wide extending from south of Seadrift to Point Comfort. Northwest of this saline water ridge, the base of the fresh to slightly saline water is deeper; it reaches a depth of more than 1,700 feet below sea level in the northwest corner of the county. Southeast of the ridge, the base reaches a depth of more than 900 feet below sea level in the northeast corner of the county.

The map of the base of the fresh or slightly saline water (Plate 9) is only approximately correct; owing to the rapid pinching out of sands downdip and laterally, the actual base could be 200 feet above or below the contour depth given on the map. An example of this is shown in northwestern Victoria County between wells G-11 and G-12 (Plate 9) where the depth to the base of the fresh or slightly saline water varies 500 feet within a horizontal distance of 1 mile.

Lenses or beds of sand containing saline water may lie between the base of the fresh or slightly saline water and the water table. Cross sections A-A', B-B', F-F', and G-G' (Plates 2, 3, 7, and 8) illustrate instances of sand beds containing saline water occurring above the base of the fresh or slightly saline water. Sand beds close to the surface in Calhoun County (Plates 2, 3, and 7) may contain moderately saline to saline waters above the fresh or slightly saline water. Also, in many parts of Victoria County, sand lenses less than 100 feet below the surface may contain moderately saline to saline waters. In some places the moderately saline or saline waters are the result of contamination by human activities although in most places they appear to be the result of incomplete flushing caused by the isolation of the sand bed by clay beds which hindered fresh water from entering and replacing the saline water.

The seven cross sections graphically depict the vertical position of the fresh to slightly saline water in Victoria and Calhoun Counties. Both the base and top of the fresh or slightly saline water are shown along the coast of

Calhoun County in section A-A' (Plate 2). The shallow sand beds contain either saline or moderately saline water; the fresh or slightly saline zone may contain only slightly saline water.

Cross section B-B' (Plate 3), which crosses the center of Calhoun County, shows that the base of the fresh or slightly saline water zone is nearly 900 feet below sea level near the Refugio county line, less than 400 feet below sea level near the center of Calhoun County, and 800 feet below sea level at the Jackson county line. Moderately saline water overlies the zone of fresh or slightly saline water through much of Calhoun County, but may not be present near the eastern or western boundaries of the county. The thickness of the fresh or slightly saline water zone is about 200 feet in the center of the section even though the depth of the base varies.

Cross section C-C' (Plate 4) shows that the altitude of the base of the fresh or slightly saline water zone near the Victoria-Calhoun county line ranges from 990 to 1,675 feet below sea level. Moderately saline water may be present at depths less than 100 feet between wells T-7 and R-9.

Cross section D-D' (Plate 5) is a section along the strike through the middle of Victoria County where the base of the fresh or slightly saline water zone is from 1,200-1,600 feet below sea level.

Cross section E-E' (Plate 6) shows that the base of the fresh or slightly saline water zone along the Victoria-DeWitt County line is between 1,125 and 1,710 feet below sea level. It is either at or near the base of the Oakville sandstone.

Cross section F-F' (Plate 7), which is alined down the dip of the formations through the western part of Victoria and Calhoun Counties, shows that the base of the fresh or slightly saline water zone dips from 1,340 feet below sea level in Victoria County well C-2 near the DeWitt-Victoria county line to 1,800 feet below sea level in Victoria County well N-26 just north of the Victoria-Calhoun county line. From well N-26 the base of the zone rises gently to Calhoun County wells A-41 and A-48 which contain saline water between the base of the principal fresh or slightly saline water body and the surface. Between Calhoun County wells A-48 and E-46 the base of the fresh or slightly saline water zone rises from 500-600 feet below sea level to 195 feet. Near the coast the base of the fresh or slightly saline water zone is 400-500 feet below sea level and a zone of saline water overlies the fresh or slightly saline water; the top of the fresh or slightly saline water is about 250 feet below sea level.

Cross section G-G' (Plate 8), which is alined down dip through eastern Victoria and Calhoun Counties, shows that the base of the fresh or slightly saline water zone ranges from 980 to 1,990 feet below sea level in Victoria County, but in northern Calhoun County it begins to rise and is less than 400 feet below sea level through central Calhoun County. The altitude of the base is more than 600 feet below sea level on the Gulf coast.

The vertical change of the base of the fresh or slightly saline water zone is not accurately known between Calhoun County wells B-4 and C-10. It is shown on Plate 9 as a gradual change which would result if the fresh or slightly saline water terminated at successively higher altitudes in the sands. However, the deep fresh or slightly saline water could terminate within a short linear distance similar to the change shown on cross section F-F' (Plate 7) between wells A-31 and E-19.

The zone of moderately saline or saline water overlying the fresh or slightly saline water is much more extensive on the eastern edge of the Calhoun peninsula than on the western edge. The top of the fresh or slightly saline water zone has been shown on Plate 8 where possible, otherwise it has been inferred.

Plate 10 is an isopachous map of the sand containing fresh or slightly saline water and is more indicative of the ground water in storage in Victoria and Calhoun Counties than the map showing the altitude of the base of the fresh or slightly saline water (Plate 9). In Victoria County the aggregate thickness of sand ranges from a maximum of more than 900 feet to less than 400 feet. In Calhoun County the total sand thickness ranges from a maximum of about 600 feet in the northwest corner of the county to less than 100 feet in the central area of the county where the base of the fresh or slightly saline water zone is less than 400 feet below the surface. The sand thickness in two-thirds of the county is less than 200 feet. Plate 10 shows that Victoria County has several times the volume of fresh or slightly saline water sand that is present in Calhoun County. Also, in Victoria County the sand contains proportionally more fresh water than in Calhoun County.

The sand thicknesses indicated on the isopachous map were obtained from interpretation of the spontaneous-potential curve or estimated from the resistivity curves of electric logs. Since many of the electric logs were run after the surface casing had been placed in the well, drillers' logs of nearby wells were used to compute the sand thickness in the zone of fresh or slightly saline water that had been cased off. In a few cases, nearby drillers' logs were not available, so that the sand thickness not recorded by the electric log was estimated. Exact thicknesses of sand cannot be interpreted from the map as the intervals are only approximate; sand thicknesses may be quite different in wells that are only a few hundred feet apart.

Fluctuations of Water Levels

The first water-bearing bed is ordinarily encountered at 60 to 70 feet below the surface in the northern part of Victoria County, but is only 30 to 40 feet below the surface in the southern part of the county. In Calhoun County, water is usually encountered within 30 feet of the surface. Near the coast, water is only a few feet below the surface, but it may be water of poor quality.

In most of Victoria County, water levels have declined in recent years due to increased pumping of ground water from new and old wells. In shallow wells part of the decline may be due to below normal rainfall in recent years. Figure 4 is a hydrograph that shows the fluctuation of the water level in Victoria County well N-13, which is in an area where withdrawals are for industrial purposes. The water table in 1959 was nearly 16 feet lower than it was in 1952. The water level dropped several feet in August 1956 after the well was opened to four additional sand beds; the water level shows a somewhat greater range in fluctuation than it did when only two of the sand beds were tapped by the well.

Comparison of water-level measurements made in 1934 (White, 1941) with measurements made in 1958 or 1959 in the same stock wells or replacement wells shows that generally the water table was lower than it was in 1934. The change in most places was less than 12 feet, except in the northeast corner of the county where the water table was 40 or more feet lower. In a few wells the 1958 or 1959 water level was as much as 7 feet higher than it was in 1934. Water-level measurements have been made annually in three irrigation wells since 1956. The greatest change

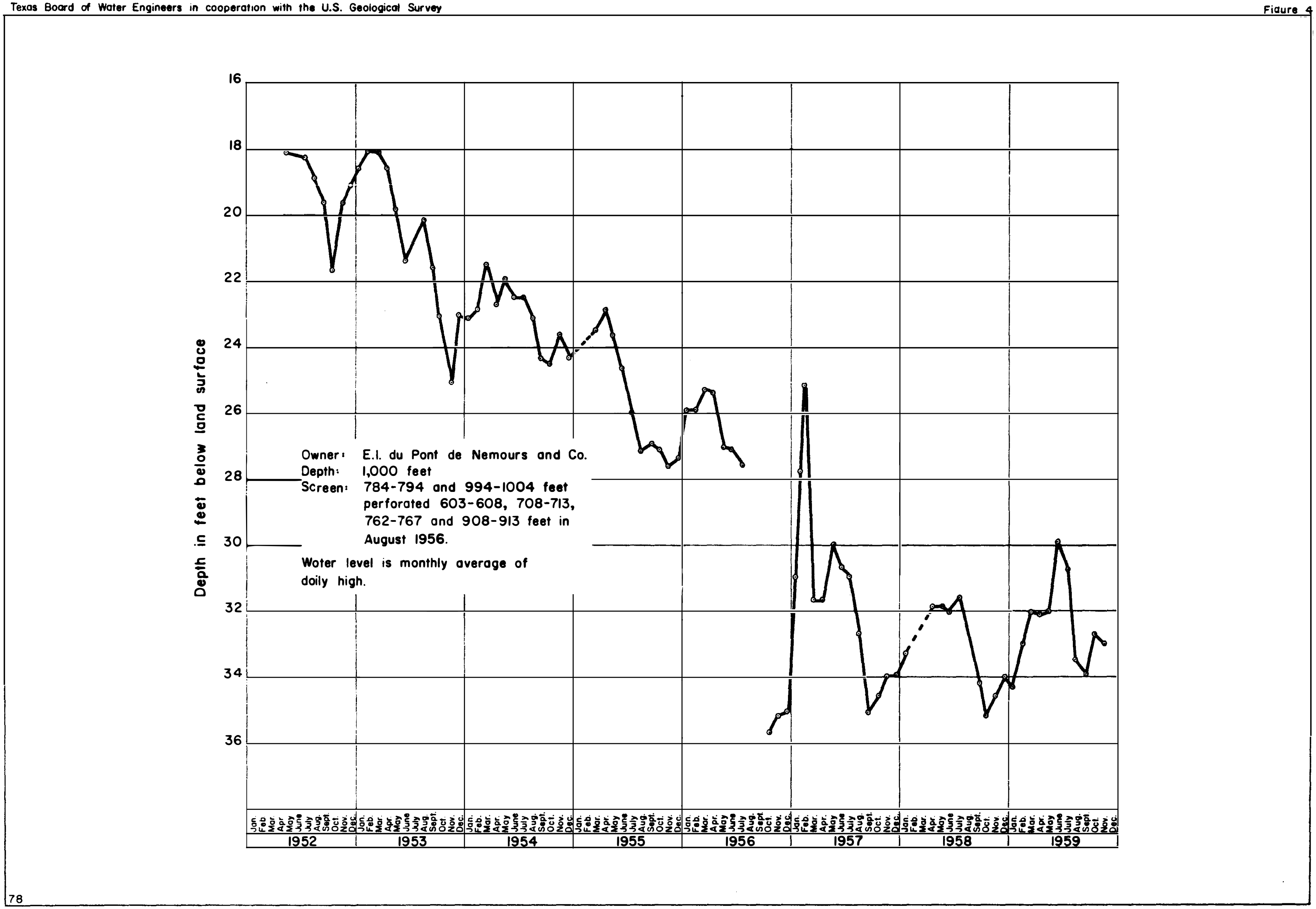

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FIGURE 4.—Hydrograph of Victoria County well N-13, 1952-59

in static water level in those wells from March 1956 to March 1960 was a rise of 5.2 feet in Victoria County well B-19; the other three wells changed less than 1.2 feet. The number of wells measured and the period of record is too short to draw any conclusions.

Some of the moderately deep and deep wells in Victoria County have stopped flowing or their flow has decreased during the past few years. The presence of natural gas in the aquifer has caused some of the wells to flow by lowering the density of the column of water in the casing so that the bottom hole pressure is sufficient to force water to the top of the well. The natural gas drive functions in similar fashion to an air-lift pump. A decrease in the amount of natural gas present has occurred in some wells several years after drilling, causing the flow to decrease or cease. In northern Victoria County sufficient gas is present in a few wells to periodically gush water out of the discharge pipe creating a fire hazard.

Comparison of water-level measurements made in 1934 and 1940 (Lonsdale and Johnson, 1940) with measurements made in 1958 or 1959 in the same wells shows no consistent change in the water table in Calhoun County. The water levels in 1958 or 1959 varied a few feet above or below the altitude of the water in 1934 or 1940. Most of the flowing wells were still flowing. Natural gas is not known to be present in any water well in Calhoun County.

Aquifer Tests

Aquifer tests were made to determine the ability of the sands to store and/or transmit water. The coefficients of transmissibility and storage of the water-bearing beds tapped by a well can be calculated by the Theis non-equilibrium method (Theis, 1935, pages 519-524), by measuring the rate of change in water level in a well caused by a known change in pumping rate in a nearby well tapping the same water-bearing beds. The coefficient of transmissibility can be determined by the Theis recovery method (Theis, 1935, pages 519-524) from recovery measurements in a well that has stopped pumping.

Table 4 contains data obtained from 12 tests analyzed by the Theis recovery method and 4 tests analyzed by the Theis non-equilibrium method as modified by Cooper and Jacob (1946, pages 526-534). The coefficient of transmissibility in 4 wells in Calhoun County (wells A-29, B-27, C-6, and C-26) ranged from 16,000 to 36,000 gallons per day per foot. The field coefficient of permeability ranged from 247 to 570 and averaged 356 gallons per day per square foot.

The coefficient of transmissibility in 8 wells in Victoria County (wells B-20, J-3, J-21, J-22, K-2, K-18, R-15, and S-21) ranged from 21,000 to 87,000 gallons per day per foot. The field coefficient of permeability ranged from 100 to 276 and averaged 192 gallons per day per square foot. Although the coefficient of permeability is only a little more than half of that measured in Calhoun County, the wells generally tap a much greater thickness of sand and, therefore, have a larger coefficient of transmissibility. Also, three of the four wells tested in Calhoun County (A-29, C-26, and C-27) yielded water that contained more than 700 ppm chloride.

Table 4.--Summary of aquifer tests in Victoria and Calhoun Counties

Pumped well		SAND Interval (feet)	SAND Thickness (feet)	Pumping rate (gpm)	Coefficient of trans-missibility	Coefficient of storage	Field permea-bility	Remarks
Victoria County:								
B-20	Richard Burroughs	125 - 610	215	1,570	38,000	--	177	Recovery of pumped well.
J-3	McGinnes & Skopal	257 - 881	384	3,000	87,000	--	226	Do
J-21	Victoria well 14	435 - 1,000	260	1,750	26,000	--	100	Do
J-21	do	--	--	--	59,000	4.8×10^{-4}	--	Recovery after shutting off well 15.
J-22	Victoria well 15	420 - 1,020	330	1,800	41,000	--	124	Recovery of pumped well.
J-22	do	--	--	--	40,000	5.2×10^{-4}	--	Recovery after shutting off well 14.
K-2	J. V. Wilburn	270 - 880	366	2,300	83,000	--	226	Recovery of pumped well.
K-18	Edmond Kainer	160 - 450	170	1,170	47,000	--	276	Do
R-15	G. E. McKamey	158 - 324	91	330	21,000	--	230	Do
S-21	McFaddin Estate	185 - 798	291	1,600	53,000	--	182	Do
Calhoun County:								
A-29	Otto Marek	*185 - 269	**63	450	36,000	--	570	Recovery of pumped well.
B-27	Port Lavaca well 5	162 - 238	60	440	16,000	--	267	Do
C-26	Aluminum Co. of America well 1a/	252 - 359	65	372	16,000	--	247	Do
C-6	Aluminum Co. of America test well 1a/	--	--	--	19,000	3.1×10^{-4}	--	Drawdown due to pumping well C-26
C-27	Aluminum Co. of America well 2a/	260 - 375	74	602	25,000	--	338	Recovery of pumped well.
C-6	Aluminum Co. of America test well 1a/	--	--	--	24,000	1.8×10^{-4}	--	Recovery after shutting off well C-27.

*Screened interval; **Length of screen in screened interval.

a/ Reported by owner from tests performed by N. A. Rose, consulting geologist.

Present Development

Farmers make the greatest demand on ground-water resources in the area, principally for the irrigation of rice and cotton. At the end of 1958, 45 irrigation wells were in use in Victoria County. According to the best estimates obtainable, 9,500 acres were prepared for irrigation in 1958, 7,400 acres were to be supplied with water from wells and 2,100 with water from the Guadalupe River. Of the 7,400 acres prepared for irrigation by ground water, 3,948 acres of rice and approximately 1,200 acres of row crops and pasture, or a total of about 5,150 acres, were irrigated in 1958.

The estimated annual withdrawal of ground water for rice irrigation is shown in the following table.

Estimated withdrawal of ground water for rice irrigation, 1951-58

Year	Acres	Withdrawals (acre-feet)	Year	Acres	Withdrawals (acre-feet)
1951	5,066	14,000	1955	3,748	10,000
1952	5,103	12,000	1956	3,601	11,000
1953	4,712	12,000	1957	4,312	9,000
1954	4,958	14,000	1958	3,948	13,000

(Acreage data from U. S. Department of Agriculture, Stabilization and Conservation Committee, Victoria, Texas)

The amount of ground water used for rice irrigation ranged from about 9,000 acre-feet in 1957 to about 14,000 acre-feet in 1951 and 1954. In 1958, 22 wells were used to irrigate 3,948 acres. The amount of ground water withdrawn was estimated by assuming that a duty of 44 inches of water was required each year to raise a crop of rice in Victoria County. The amount of water supplied from precipitation was subtracted from 44 inches; the remainder was supplied from wells.

About 1,200 acres of cotton, other row crops, and pasture were irrigated from 16 wells in 1958; most were drilled between 1955 and 1958. In 1958 the duty of water for row crop and pasture irrigation was estimated at 4.3 inches from the electric power consumed by the pumps in three wells. Assuming that 4.3 inches of water was applied to all of the 1,200 acres of row crop and pasture, about 430 acre-feet of water was withdrawn in 1958.

Between 1949 and 1958, withdrawals of ground water for public supply ranged from 1,950 acre-feet in 1949 to 5,200 acre-feet in 1956; they were 4,600 acre-feet or about 4.1 million gallons per day in 1958. About 86 percent of the water withdrawn for public supply in Victoria County in 1958 was used in the city of Victoria; other users included Bloomington, Foster Air Force Base, Victoria County Housing Project at the County airport, and two pipeline camps.

Industrial users in Victoria County withdrew about 1,200 acre-feet of ground water from wells in 1958. The largest annual withdrawal was about 1,500 acre-feet in 1952; the annual withdrawal was only about 100 acre-feet before 1951.

Although rural domestic wells and stock wells are generally much smaller than irrigation, industrial, or public supply wells, there are several times as many in Victoria County. In 1958, it is estimated that about 1,700 acre-feet of water was withdrawn from them.

The total withdrawal from wells in Victoria County in 1958 was about 21,000 acre-feet. If an equal amount were withdrawn each day of the year, the daily rate would be about 18.7 million gallons a day; however, most of the water was pumped during the irrigation season. During the summer the average daily pumpage was from 30 to 50 million gallons. Most of the ground water in Victoria County is withdrawn from wells tapping sand beds in the Lissie formation and the Goliad sand.

In Calhoun County, six wells were used for irrigation of about 600 acres in 1958. Irrigation with ground water began in 1953. All six wells were used for row crops or pasture and are on the east side of Green Lake within 3 miles of its eastern shoreline. From electric power records of two wells, it was estimated that 3.5 inches of water was applied twice during the season. If this were true for all of the six farms, about 350 acre-feet of ground water was withdrawn by irrigation wells in Calhoun County in 1958.

About 950 acre-feet of ground water was withdrawn from wells in Calhoun County for public supplies in 1958. About 85 percent was pumped by the city of Port Lavaca; the other 15 percent was pumped by the city of Seadrift and by military installations. Point Comfort obtains its municipal water from a well field in Jackson County.

Withdrawals of ground water for industrial purposes were about 590 acre-feet in 1958 in Calhoun County. Most of the industrial water was used in aluminum refining or by the oil and gas industry. Part of the industrial water was slightly saline.

It is estimated that about 500 acre-feet of water was withdrawn from rural domestic and stock wells in Calhoun County in 1958. A large part of this water was slightly saline.

The total withdrawal of ground water in Calhoun County was about 2,400 acre-feet in 1958; the average daily rate of withdrawal was about 2.1 million gallons, although the rate was greater during the summer than during the winter. Most of the water pumped for public supply and irrigation was from wells tapping sand beds in the Beaumont clay. However, wells tapping the Recent alluvium provide good quality water for the city of Seadrift. The Lissie formation is tapped by industrial wells in the northwest corner of the county.

Potential Development

The principal factors affecting the potential development of ground-water supplies in Victoria and Calhoun Counties are the amount of fresh or slightly saline ground water in storage and the ability of the aquifers to transmit the water to wells. The amount of ground water in storage can be estimated from the isopachous map (Plate 10) and is enormous; for example, Victoria County contains about 100 million acre-feet of water in storage, assuming an average of 600 feet of sand and an average porosity of 30 percent. Assuming a thickness of 200 feet and the same porosity, about 20 million acre-feet of fresh or slightly saline ground water is present in Calhoun County. Most of the water in Victoria County is fresh; most of the water in Calhoun County is slightly saline. The water stored in the sand is in transient storage--that is, it is moving slowly from areas of recharge to areas of discharge. The amount of recharge or the amount of discharge that could be salvaged is not known, but it is believed that they would add appreciably to the amount of water available.

Although an enormous quantity of water is in storage, only a part of it is economically available to wells. The distance that water must be lifted determines a large part of the cost of water. Figure 5 shows the relationship of the decline in water level caused by a pumping well to the transmissibility of the sand tapped by the well. Pumping 1 million gallons per day from a well completed in a sand having a coefficient of storage of 0.0005 and a coefficient of transmissibility of 100,000 gallons per day per foot would cause a decline of about 5 feet at a distance of one mile during the first year, but pumping the same rate from a sand having a coefficient of transmissibility of 10,000 gallons per day per foot would cause about 34 feet of decline in the same period at the same distance.

Figure 6 shows the relation between drawdown and time in a well pumping 1 million gallons per day from a sand that has a coefficient of storage of 0.0005 and a coefficient of transmissibility of 50,000 gallons per day per foot. Most of the drawdown in the well takes place in the first few days, but the water level will continue to decline indefinitely until a source of recharge is intercepted or the sand is no longer confined. When the amount of water moving from the outcrop to the area of discharge equals the discharge rate, the water level will approach equilibrium. If recharge is smaller than the rate of withdrawal, the water level will decline in the outcrop area. However, the rate of decline will be slow as the storage coefficient of an unconfined sand is many times larger than the storage coefficient of a confined sand.

The coefficients of transmissibility usually are highest in the areas of greatest sand thickness (Plate 10). The central part of Victoria County from a point just west of the city of Victoria to the eastern county line has the most potential for development of large water supplies of fresh water. Most of northern, western, and southern Victoria County and northwestern Calhoun County are potentially capable of yielding moderate supplies of fresh water to wells.

Central and southern Calhoun County has the least potential of any area in either of the two counties. In the vicinity of Seadrift, small to moderate supplies of fresh water are obtained from shallow wells, although in most of central and southern Calhoun County only very small supplies of fresh water are available. In many places the only water available is slightly saline.

QUALITY OF WATER

The properties of water that result from the kinds and quantities of dissolved minerals determine the quality of water. Water is described as being either hard, soft, fresh, salty, or otherwise, depending on the nature and quantity of dissolved minerals in the water. Although different persons may disagree on the proper adjective to describe the taste or soap reaction of a particular water, especially if they are accustomed to a different water, certain standards have been established for comparative purposes. The standards are based on the chemical analyses of water. Table 5 contains 62 chemical analyses of ground-water samples collected in Victoria County; Table 6 contains 38 chemical analyses of ground-water samples collected in Calhoun County. Other chemical

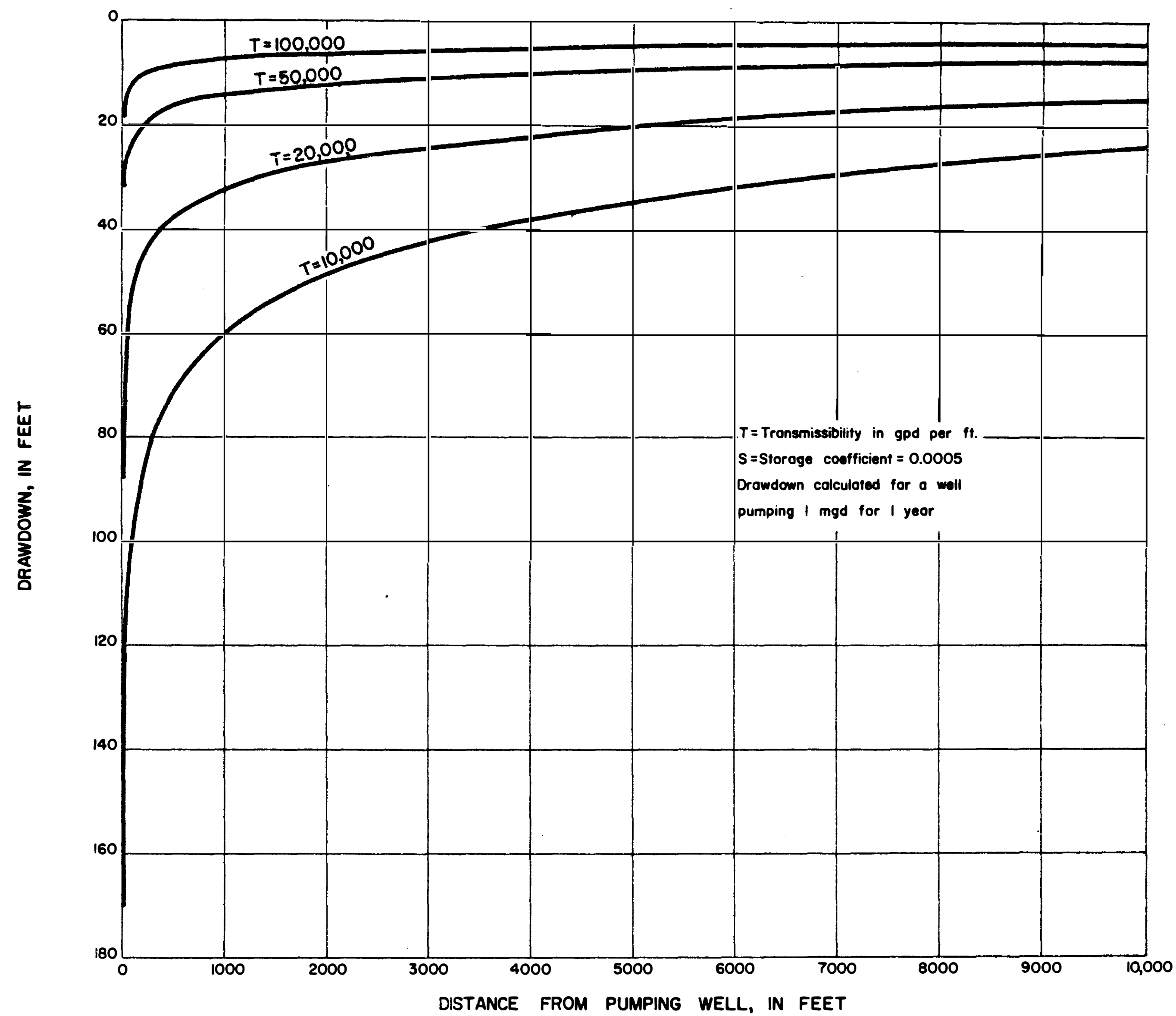

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FIGURE 5.—Relation between drawdown and transmissibility in an infinite aquifer

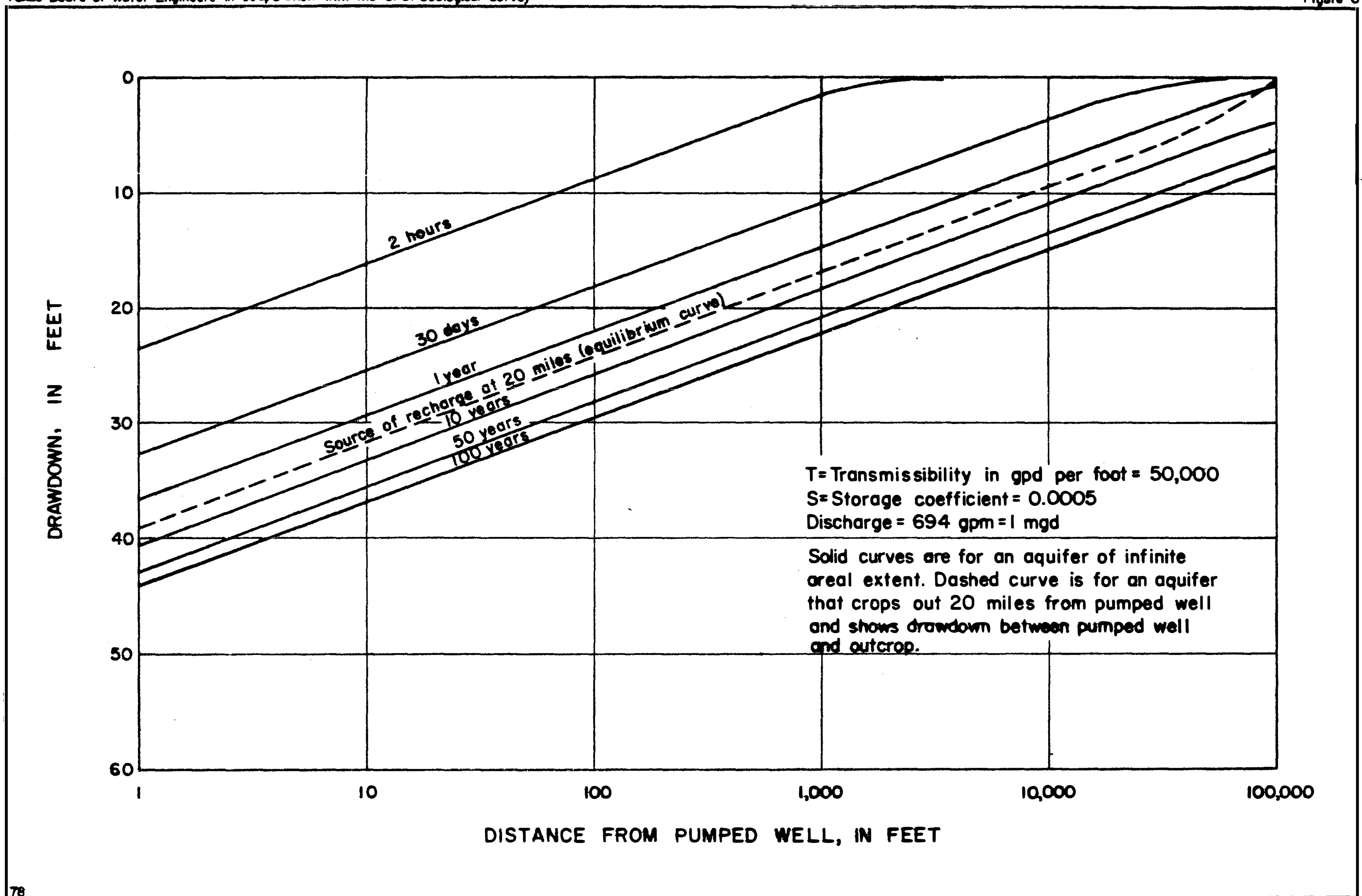

FIGURE 6.—Relation between drawdown and time

analyses of ground water in Victoria and Calhoun Counties were given by White (1940) and Lonsdale and Johnson (1941).

Some Aspects of Quality of Water for Municipal and Industrial Use

Hardness of water is due principally to dissolved calcium and magnesium. Under the following classification of water with respect to hardness, water having a hardness of 60 ppm (parts per million) or less is called soft; 61 to 120 ppm, moderately hard; 121 to 200 ppm, hard; and greater than 200 ppm, very hard. The harder the water, the more soap it consumes in the process of washing and the faster scale will form in pipes, coils, and boilers unless the water is softened prior to use.

The samples of ground water collected in Victoria County range in hardness from 24 ppm to 970 ppm. In the fresh or slightly saline zone, the shallower water contains more calcium and magnesium than the deeper water; hardness usually decreases with depth. Only water from wells L-19 and S-21 and a drill-stem sample from J-24 were classified as soft; moderately hard water was obtained from several wells 600 to 1,100 feet deep. Water from most wells sampled was either hard or very hard, and was dominantly very hard.

The hardness of samples of ground water from Calhoun County ranged from 35 ppm to 1,120 ppm. As in Victoria County, the hardness of the water in the fresh or slightly saline zone generally decreases with increasing depth, but most of the samples analyzed were hard or very hard. However, soft water is present in two areas: A zone approximately 1,000 feet below the surface in the northwest corner of the county (well A-3), and a zone several hundred feet thick underlying much of the area east of Lavaca Bay and north of Matagorda Bay (wells D-31 and D-35).

Water used in many industrial processes must be low in dissolved silica; otherwise, hard adherent silica scale may form in pipes, coils, and boilers. This is especially true when the water is heated under pressure (Moore, 1940, page 263); the higher the temperature and pressure, the lower the concentration of silica that can be tolerated. The concentration of silica (SiO_2) in samples of ground water from Victoria County ranged from 14 to 52 ppm. The concentration generally is smaller in the deeper wells; most of the wells yielding water containing 20 ppm of silica or less where more than 500 feet deep. Samples containing more than 40 ppm silica were nearly all from wells less than 100 feet deep.

Samples of ground water from 32 wells in Calhoun County had silica concentrations ranging from 6.4 to 24 ppm. The samples containing 20 ppm or more came from wells that were less than 350 feet deep. The lowest silica concentrations were found in the samples collected east of Lavaca Bay and north of Matagorda Bay.

The maximum concentrations of some chemical substances as set forth by the U. S. Public Health Service standards (1946) for drinking water used on interstate carriers are as follows:

Iron (Fe) and manganese (Mn) together should not exceed 0.3 ppm.

Magnesium (Mg) should not exceed 125 ppm.

Chloride (Cl) should not exceed 250 ppm.

Sulfate (SO_4) should not exceed 250 ppm.

Fluoride (F) must not exceed 1.5 ppm.

Dissolved solids should not exceed 500 ppm; however, water having 1,000 ppm can be used if better water is not available.

Iron determinations made in a laboratory several days after a sample of water has been collected from a well may not be indicative of the amount of iron in solution in the formation because of oxidation and precipitation of iron from the sample. Total iron includes iron which was in solution when the sample was collected and may or may not have precipitated before the sample was analyzed. A sample drawn from a tap that is rarely used may contain suspended iron. Water having a dissolved iron content greater than 0.3 ppm will cause an objectionable red stain on surfaces that come in contact with it. Although several samples of water from wells in Victoria and Calhoun Counties contain more than 0.3 ppm total iron, it is not known how much dissolved iron was present in the water as it came from the wells. However, iron staining is not known to be a problem in either Victoria or Calhoun Counties. Manganese has been determined in relatively few samples: it is believed to be very low in both Victoria and Calhoun Counties.

Four samples, all from shallow stock or domestic wells in Victoria County, showed an abnormal nitrate content. A high nitrate content may indicate contamination by human or animal wastes or may be from other causes. A nitrate content greater than 44 ppm may cause methemoglobinemia (infant cyanosis or "blue baby" disease) (George and Hastings, 1951, page 451). Water from well G-21 contained 158 ppm nitrate; the others contained less than 44 ppm.

Sulfate content was much smaller than the chloride content in all samples from wells in Victoria and Calhoun Counties with exception of two drill-stem samples from Victoria County well J-24. Magnesium content was less than 25 ppm in most of the samples from Victoria County and less than 75 ppm in most of the wells from Calhoun County.

Fluoride content was less than 1.0 ppm in all but two samples that were analyzed for fluoride from Victoria County; of the samples from wells in Calhoun County that were tested for fluoride, only three wells in D quadrangle contained more than 1.5 ppm.

The chloride content of most of the samples collected in Victoria County was within the limit for drinking water set by the U. S. Public Health Service. The exceptions were mainly samples from shallow wells in the southern and western parts of the county. However, near the Victoria-Calhoun county line, even samples from the moderately deep to deep wells had a chloride content in excess of 250 ppm.

A majority of the samples collected in Victoria County had a dissolved-solids content greater than the desirable limit of 500 ppm. But only seven samples had a dissolved-solids content greater than 1,000 ppm. They were principally samples from shallow wells in the southern and western parts of the county.

Generally speaking, the fresh or slightly saline water zone not only becomes thinner toward the Gulf but also contains water of poorer quality. In many wells in northwestern Calhoun County, fresh or slightly saline water is found beneath water having a higher mineral content; much of this fresh or slightly saline water fails to meet the standards set by the U. S. Public Health Service with respect to chloride and dissolved-solids content.

In places near the coast, analyses of samples from wells (E-34, E-35, E-40, and E-45) which penetrate the sand beds of Recent age show that the best water is within 200 feet of the surface; the water below 200 feet is of poorer quality. Analyses of samples of water taken from test pits dug by the WPA in 1940 (Lonsdale and Johnson, 1941, pages 58-66) show that small areas, probably discontinuous, of shallow ground water of good quality, exist in the Recent alluvium between Seadrift and Port O'Connor.

Much of the water used for public consumption in Calhoun County has a chloride content of about 250 ppm and a dissolved-solids content greater than 500 ppm. The water is apt to have a disagreeable taste to visitors, but many people become accustomed to the taste and use the water without apparent harmful effects. In some of the rural areas, water containing more than 1,000 ppm of dissolved solids is consumed with no apparent ill effects.

Chemical analyses indicate that the greater part of the fresh or slightly saline ground water in Victoria County is suitable for public, industrial, and agricultural uses. In general, the quality of the ground water is slightly better in the eastern part of the county than in the western part and is much better in the northern part than in the southern part of the county. Some areas in Calhoun County have water in sufficient quantity and of suitable quality for public supply, irrigation, and industrial use. In most of the county the high mineral content of the ground water prohibits its use for industrial purposes or the irrigation of crops, although it is used for watering livestock and, in some places, for domestic supply when better water is not available. Owing to the scarcity of fresh water near Point Comfort, water is pumped for public use from the Midway well field, which is 7.5 miles northeast of Point Comfort in Jackson County.

The best ground water in Calhoun County is found in (1) the area north of Matagorda Bay and east of Kellers Bay and Kellers Creek, (2) the area northwest of Port Lavaca and along the Victoria-Calhoun county line between the Guadalupe River and Lavaca Bay, and (3) small areas in the region between Seadrift and Port O'Connor.

Change of Chloride Content Related to Depth

The change in chloride concentration with depth near Victoria County well J-24 in the city of Victoria is shown on Figure 7. The electric log of well J-24 (city of Victoria well 10) shows the resistivity and spontaneous potential at the depths from which water samples were taken. Analyses of samples from nearby wells (J-18, H-9, and H-14) show a more complete picture of the change in chloride concentration with depth. Near well J-24 the chloride content of water from different sand beds ranges from about 60 to about 140 ppm down to 950 feet; water in sand beds below 950 feet contain higher concentrations of chloride (and other dissolved minerals).

Figure 8 shows the change in chloride concentration with depth near Calhoun County well C-6 at Point Comfort. The electric log of well C-6 is reproduced together with the chloride content of water from sand beds encountered at various depths in wells C-6 and C-27. A zone of slightly saline water is between 250

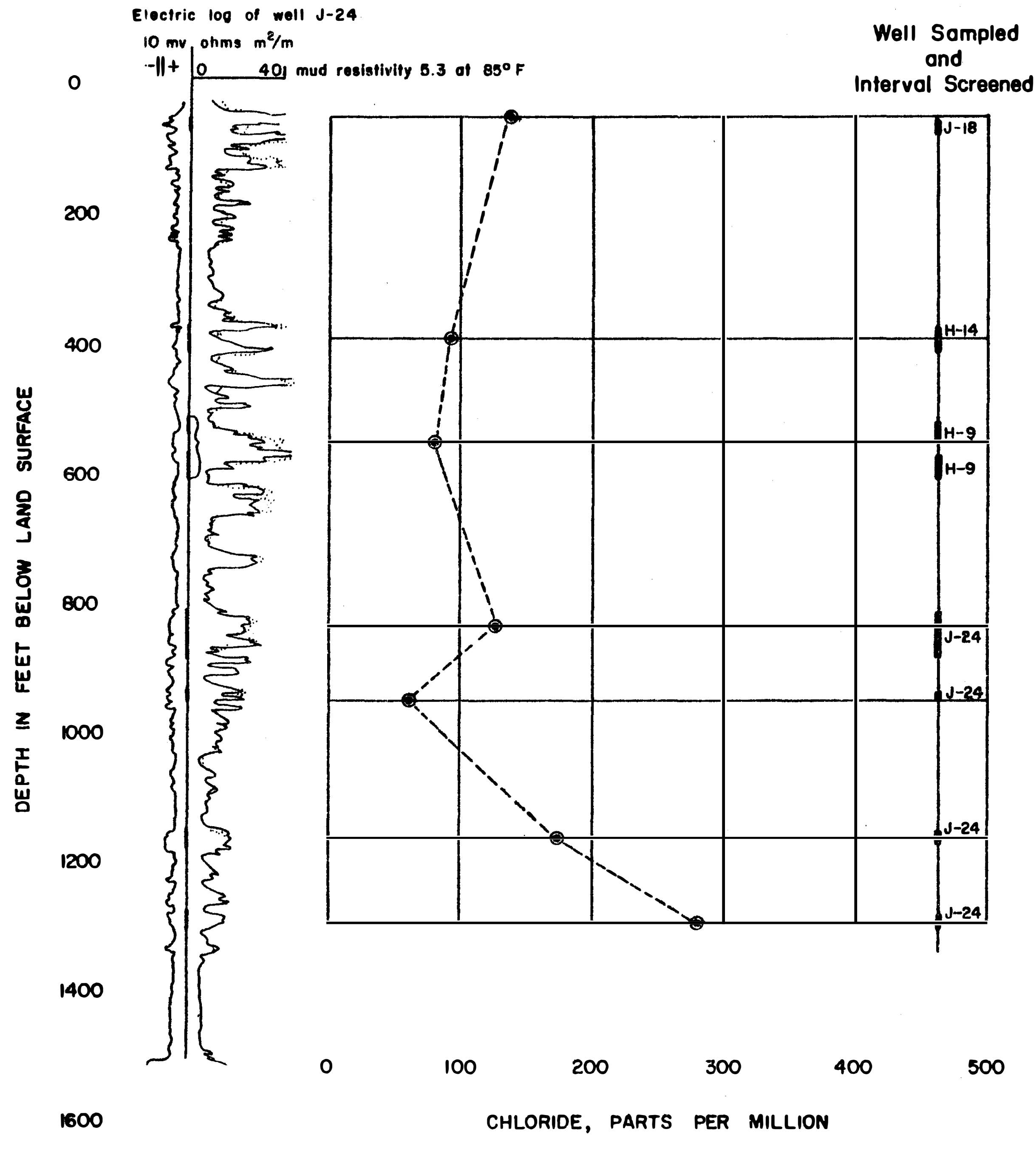

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FIGURE 7.— Chloride content of ground water at various depths near Victoria County well J-24

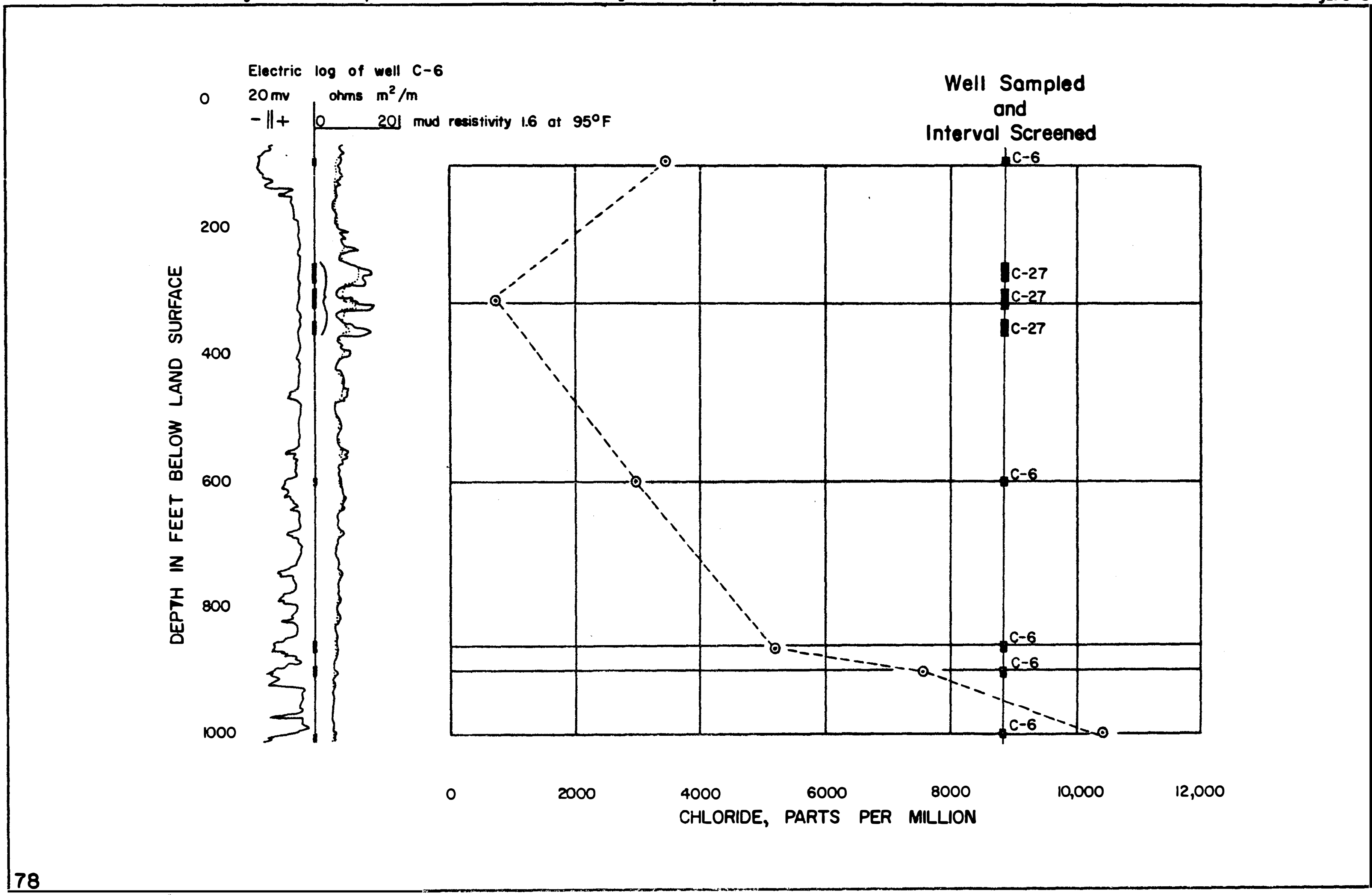

FIGURE 8.— Chloride content of ground water at various depths near Calhoun County well C-6

and 370 feet below the surface; it is overlain by a zone of moderately saline water and underlain by moderately saline to saline water. This situation is common in central and southern Calhoun County with certain modifications.

Quality of Water for Irrigation

According to the U. S. Salinity Laboratory Staff (1954, page 69): "The characteristics of an irrigation water that appear to be most important in determining its quality are: (1) total concentration of soluble salts; (2) relative proportion of sodium to other cations; (3) concentrations of boron or other elements that may be toxic; and (4) under some conditions, the bicarbonate concentration as related to the concentration of calcium plus magnesium." Drainage and management practices also must be considered in recommending the suitability of a water for irrigation. The standards published by the U. S. Salinity Laboratory Staff were established for arid areas and are not always applicable in more humid areas, but are useful as guides.

Under these standards the ground water in Victoria and Calhoun Counties would be considered marginal or unsuited for irrigation, but, because the climate is humid in these counties, the standards cannot be rigidly applied. Most of the ground water used for irrigation in Victoria County would be classified as marginal because of the high salinity hazard. However, the water has been used successfully for irrigating rice for many years without apparent damage. Water from wells near the Victoria-Calhoun county line and in Calhoun County may have a very high salinity hazard and a high to very high SAR. Water from these wells has also been used for irrigation for a few years without apparent damage to crops or soil, but soil damage may be apparent only after many years of continuous irrigation under the existing climatic conditions because for most crops grown in this area, ground water is used only to supplement the rainfall. In summary, ground water in most of Victoria County is satisfactory for irrigation because of the humid climate, but ground water in Calhoun County and parts of southern Victoria County, having high to very high salinity hazard and a high to very high SAR, should be used with caution until the effect of the water upon the soil is determined.

SUMMARY

Victoria County contains an enormous quantity of fresh or slightly saline ground water in storage in the sand beds of the Beaumont clay, Lissie formation, Goliad sand, Lagarto clay, and Oakville sandstone. The order of magnitude of the water in storage is 100 million acre-feet. Although only a part of this is economically available to wells, even 10 percent would supply the 1958 rate of withdrawal (21,000 acre-feet per year) for many years. The amount of recharge or the amount of discharge that could be salvaged is not known, but it is believed that they would add appreciably to the amount of water available. Most of the water in the fresh or slightly saline water zone contains between 500 and 1,000 ppm of dissolved solids. In general, water from wells in the northern and eastern parts of the county is better than water from wells in the southern and western parts of the county.

Calhoun County contains much less fresh or slightly saline water than Victoria County; the ground water in storage is probably in the magnitude of 20 million acre-feet. Most of the water in the fresh or slightly saline zone in

Calhoun County is slightly saline; that is, it contains between 1,000 and 3,000 ppm of dissolved solids. However, fresh water is present in small amounts in most of Calhoun County. The best ground water is present in (1) the area north of Matagorda Bay and east of Kellers Bay and Kellers Creek, (2) the area northwest of Port Lavaca and along the Victoria-Calhoun county line between the Guadalupe River and Lavaca Bay, and (3) small areas in the region between Seadrift and Port O'Connor. The total withdrawal of ground water in Calhoun County was 2,400 acre-feet in 1958. About 40 percent was for municipal use; the remainder was used for industrial, domestic and stock, and irrigation purposes.

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Table 9.--Drillers' logs of wells in Victoria County

Well A-13

Owner: Felecia Gonzales. Driller: Thompson Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface soil and clay--	17	17	Sand------------------	20	213
Sand and gravel with hard streaks---------	59	76	Shale-----------------	32	245
Shale with hard streaks	117	193	Sand------------------	20	265
			Shale-----------------	24	289

Well B-10

Owner: A. J. Brady. Driller: Thompson Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface soil-----------	7	7	Sand, hard, broken----	40	155
Sand-------------------	23	30	Sand------------------	12	167
Shale and caliche------	85	115			

Well D-8

Owner: John Otto. Driller: Thompson Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay-------------------	35	35	Rock and hard streaks-	61	226
Caliche with hard rock streaks--------------	98	133	Shale with hard streaks	34	260
Shale------------------	32	165	Sand with hard streaks	80	340

Well D-12

Owner: Jewel Davies, et al., well 1. Driller: W. H. Cocke and R. H. Goodrich.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay-------------------	30	30	Sand with hard sandstone streaks-------	98	150
Gravel-----------------	11	41	Sand, hard------------	46	196
Sandstone, hard--------	5	46	Shale, sandy----------	6	202
Sand-------------------	6	52			

(Continued on next page)

Well D-12--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand with hard streaks-	73	275	Shale, sandy-----------	14	566
Shale, sandy, with sand streaks--------------	17	292	Shale, sticky----------	11	577
Shale------------------	21	313	Shale, sandy, with sticky and hard streaks--------------	19	596
Sand-------------------	38	351	Sand-------------------	8	604
Shale, sticky----------	20	371	Shale and sand---------	14	618
Sand, hard-------------	14	385	Sand, hard-------------	1	619
Shale with hard streaks	12	397	Shale, sandy-----------	3	622
Sand-------------------	35	432	Sand (gas show)--------	8	630
Lime, hard, sandy------	15	447	Shale------------------	12	642
Shale------------------	13	460	Sand-------------------	51	693
Shale, sandy, with hard sand streaks---------	30	490	Shale, sandy, with hard streaks--------------	21	714
Shale, hard, sticky, and lime-------------	45	535	Sandstone, hard--------	4	718
Shale, hard, and lime--	15	550	Shale, sticky----------	7	725
Sand, hard-------------	2	552			

Well D-20

Owner: Melvin Bowen. Driller: Grady Stalcup.

No record--------------	96	96	Sand, hard, broken-----	6	119
Sand-------------------	6	102	Sand, very hard--------	7	126
Sand, hard-------------	1	103	Sand-------------------	2	128
Sand, hard, and fine gravel---------------	5	108	Sand, coarse-----------	9	137
Sand, hard-------------	5	113	Sand, hard-------------	4	141

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Table 9.--Drillers' logs of wells in Victoria County--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well D-20--Continued					
Sand------------------	4	145	Sand, broken----------	17	182
Sand, hard, broken----	3	148	No record-------------	25	207
Sand, very hard-------	9	157	Sand------------------	35	242
Sand, hard, broken----	6	163	Gravel, fine, and sand	14	256
Shale-----------------	2	165			

Well E-15

Owner: Brown and Corey. Driller: Leonard Mickelson.

Clay------------------	69	69	Rock and sand---------	4	317
Sand------------------	20	89	Shale, sticky---------	22	339
Rock------------------	4	93	Sand------------------	4	343
Sand------------------	11	104	Lime and shale--------	13	356
Clay------------------	6	110	Chalk-----------------	10	366
Sand------------------	14	124	Shale and sand--------	4	370
Lime and shale--------	31	155	Shale, sticky---------	13	383
Sand------------------	10	165	Sandrock, broken------	74	457
Shale and lime--------	14	179	Clay, red-------------	9	466
Sand------------------	10	189	Shale, sand, and rock-	16	482
Sand and lime, broken-	56	245	Clay------------------	7	489
Sand------------------	11	256	Shale and sand--------	9	498
Sandrock--------------	23	279	Clay------------------	17	515
Sand, broken----------	32	311	Sand------------------	80	595
Rock------------------	2	313			

Well E-26

Owner: J. A. McFaddin Estate. Driller: A. H. Masirin.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface soil----------	3	3	Sand and boulders-----	100	497
Clay-----------------	6	9	Shale-----------------	67	564
Sand and gravel-------	53	62	Boulders--------------	4	568
Shale-----------------	18	80	Shale-----------------	43	611
Sand------------------	8	88	Sand and boulders-----	37	648
Shale-----------------	16	104	Shale-----------------	65	713
Sand------------------	9	113	Shale, sandy----------	16	729
Shale-----------------	13	126	Shale-----------------	75	804
Sand and boulders-----	7	133	Sand, hard------------	44	848
Rock, hard------------	9	142	Shale-----------------	6	854
Shale, blue-----------	14	156	Sand, hard------------	51	905
Rock, broken sand, and gravel----------	57	213	Shale-----------------	105	1,010
Rock, hard------------	3	216	Sand and boulders-----	9	1,019
Shale-----------------	34	250	Shale, hard-----------	118	1,137
Sand, hard, gravel, and boulders--------	70	320	Sand and boulders-----	28	1,165
Shale-----------------	18	338	Shale-----------------	13	1,178
Sand and gravel-------	18	356	Sand and boulders-----	30	1,208
Shale-----------------	41	397	Shale-----------------	3	1,211

Well E-35

Owner: J. A. McFaddin Estate. Driller: A. H. Masirin.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	2	2	Clay------------------	13	15

(Continued on next page)

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well E-35--Continued					
Sand and gravel-------	14	29	Shale----------------	16	380
Caliche---------------	5	34	Sand-----------------	45	425
Sand------------------	7	41	Shale----------------	33	458
Caliche---------------	10	51	Sand-----------------	33	491
Sand------------------	12	63	Shale, sticky---------	33	524
Shale-----------------	3	66	Sand and boulders-----	15	539
Sand and gravel-------	6	72	Shale and sand streaks	18	557
Shale-----------------	13	85	Sand and boulders-----	6	563
Sand------------------	11	96	Shale, sandy----------	9	572
Shale-----------------	8	104	Shale----------------	5	577
Sand and boulders-----	3	107	Caliche--------------	79	656
Shale-----------------	13	120	Sand, hard, with shale streaks-------	34	690
Shale, sandy----------	5	125	Shale----------------	17	707
Sand and boulders-----	7	132	Boulders, hard, broken-------------	4	711
Caliche---------------	55	187	Shale, hard, sticky---	49	760
Sand and boulders-----	11	198	Shale, sandy----------	16	776
Shale-----------------	41	239	Sand and boulders-----	11	787
Sand and boulders-----	14	253	Shale, hard----------	82	869
Shale, hard, with lime streaks--------	28	281	Sand, hard, and boulders-----------	33	902
Sand and boulders-----	36	317	Shale, hard----------	13	915
Gumbo-----------------	11	328	Sand and boulders-----	34	949
Shale, sandy----------	16	344	Shale----------------	2	951
Sand------------------	20	364			

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

Well F-1

Owner: Don Meek. Driller: Leonard Mickelson.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay------------------	6	6	Shale and limerock----	38	266
Sand------------------	8	14	Sand and limerock-----	3	269
Clay------------------	14	28	Shale and limerock----	9	278
Sand------------------	28	56	Sand and limerock-----	83	361
Rock and sand---------	25	81	Limerock--------------	3	364
Lime------------------	8	89	Gumbo-----------------	12	376
Rock and clay---------	10	99	Sand and limerock-----	26	402
Sand------------------	15	114	Shale and limerock----	13	415
Limerock--------------	8	122	Sand and clay---------	17	432
Sand, lime, and rock--	48	170	Shale and sand--------	23	455
Shale-----------------	6	176	Sand and limerock-----	29	484
Sand and limerock-----	23	199	Lime and shale--------	10	494
Shale-----------------	5	204	Sand and limerock-----	38	532
Clay, red-------------	19	223	Shale, limy-----------	30	562
Sand and limerock-----	5	228	Sand and limerock-----	38	600

Well F-9

Owner: R. E. Meek. Driller: Leonard Mickelson.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay------------------	45	45	Lime, rock, and sand--	49	189
Sand------------------	19	64	Lime and shale--------	33	222
Lime and gumbo--------	6	70	Lime, shale, and sand-	11	233
Lime, rock, and sand--	65	135	Sand and limerock-----	67	300
Lime------------------	5	140	Lime and shale--------	13	313

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

Well F-9--Continued

Lime, shale, and sand-	7	320	Lime and shale--------	5	483
Lime and gumbo--------	12	332	Sand and limerock-----	16	499
Clay, red-------------	14	346	Lime and shale--------	11	510
Sand------------------	20	366	Sand------------------	24	534
Sand and shale--------	5	371	Lime and shale--------	18	552
Sand and limerock-----	51	422	Sand and limerock-----	33	585
Shale and sand--------	12	434	Shale and sand--------	11	596
Lime and shale--------	31	465	No record-------------	23	619
Sand------------------	13	478			

Well G-10

Owner: Walton Rux. Driller: Thompson Drilling Co.

Clay------------------	6	6	Sand with hard streaks	34	130
Sand------------------	11	17	Rock, hard, and gravel	11	141
Clay------------------	79	96	Gravel----------------	9	150

Well G-18

Owner: Hahn Estate. Driller: Thompson Drilling Co.

Sand with shale streaks	67	67	Shale-----------------	10	197
Shale-----------------	56	123	Sand------------------	16	213
Caliche with shale streaks-------------	64	187			

Well H-4--partial log

Owner: G. and Mary Conti. Driller: Guadalupe Valley Oil Co.

Soil------------------	2	2	Clay------------------	4	6

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	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well H-4--Continued					
Sand	16	22	Gumbo, red	33	497
Gravel	4	26	Shale, blue	6	503
Rock	4	30	Gumbo, red	20	523
Clay	3	33	Gumbo and rock, blue	39	562
Sand and gravel	13	46	Gumbo and shale, brown	84	646
Clay, blue	7	53	Rock, gumbo, and blue shale	26	672
Rock, white	17	70	Gravel, hard	12	684
Sand and gravel	10	80	Gumbo, gray	68	752
Clay	14	94	Gravel, hard	5	757
Rock	2	96	Gumbo and boulders	25	782
Clay	18	114	Shale, blue	3	785
Gumbo, pink	29	143	Gravel, hard	40	825
Rock, white	16	159	Shale and limerock, blue	13	838
Shale, blue	3	162	Sandrock	10	848
Gravel	28	190	Gumbo, gray	17	865
Sandrock	11	201	Sand, loose	12	877
Shale, sandy	21	222	Gumbo, gray	67	944
Chalkrock	23	245	Sand, hard	13	957
Sand, pink, shaly	16	261	Gumbo, gray	63	1,020
Shale, sandy	11	272	Sand, loose	3	1,023
Rock, brown	3	275	Shale, hard	2	1,025
Sand and gravel	45	320	Sand, hard	3	1,028
Gumbo, red	80	400	Shale, hard	2	1,030
Gravel, brown	64	464			

(Continued on next page)

Well H-4--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand, loose-----------	3	1,033	Sand and brown gumbo--	7	1,596
Shale, hard-----------	7	1,040	Lime, white, pasty----	4	1,600
Sand, hard------------	5	1,045	Gumbo-----------------	29	1,629
Shale, hard-----------	51	1,096	Shale, sandy----------	16	1,645
Gumbo, gray-----------	6	1,102	Gumbo-----------------	7	1,652
Gypsum, white---------	12	1,114	Lime, sandy-----------	8	1,660
Gumbo, gray-----------	8	1,122	Gumbo-----------------	83	1,743
Shale, sandy----------	9	1,131	Lime, sandy-----------	10	1,753
Sand and shale, hard--	45	1,176	Gumbo, blue-----------	3	1,756
Gumbo-----------------	222	1,398	Lime, sandy-----------	3	1,759
Lime, blue, sandy-----	28	1,426	Gumbo-----------------	51	1,810
Gumbo, blue-----------	22	1,448	Lime, blue------------	15	1,825
Gumbo, brown----------	32	1,480	Gumbo, blue-----------	111	1,936
Shale, blue-----------	4	1,484	Lime, blue------------	21	1,957
Gumbo, brown----------	25	1,509	Gumbo and shale, blue-	38	1,995
Shale, gumbo and boulders------------	80	1,589	Total Depth-----------		3,855

Well H-13

Owner: City of Victoria, well 9. Driller: Layne-Texas Co.

Clay, sandy-----------	13	13	Shale and caliche-----	19	138
Sand and caliche------	19	32	Shale, gravel, and lime	20	158
Sand and gravel-------	61	93	Shale-----------------	20	178
Sand, shale, and caliche-------------	26	119	Sand------------------	10	188

(Continued on next page)

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well H-13--Continued					
Shale and lime--------	39	227	Sand-----------------	35	409
Sand-----------------	3	230	Shale----------------	5	414
Shale, hard, and lime-	49	279	Sand-----------------	22	436
Sand-----------------	12	291	Shale, sandy---------	12	448
Shale and lime--------	6	297	Shale, hard----------	14	462
Sand, hard-----------	7	304	Shale with lime streaks	10	472
Lime, hard, and shale-	12	316	Sand-----------------	8	480
Shale----------------	7	323	Shale----------------	2	482
Shale, sticky---------	16	339	Sand and gravel, fine-	45	527
Sand-----------------	12	351	Gumbo, pink----------	29	556
Sandrock-------------	2	353	Sand-----------------	44	600
Sandrock and sand-----	8	361	Shale----------------	4	604
Gumbo, pink----------	13	374			

Well H-22

Owner: Central Power and Light Co. Driller: Layne-Texas Co.

Surface soil---------	2	2	Clay and caliche------	44	305
Clay-----------------	13	15	Sand and clay---------	18	323
Sand and gravel-------	65	80	Sand and clay breaks--	14	337
Clay and boulders-----	18	98	Clay, sandy, and caliche------------	21	358
Clay and sand layers--	64	162	Clay-----------------	27	385
Sand-----------------	19	181	Caliche, clay, and sand breaks---------	67	452
Sand and clay streaks-	20	201	Sand, brown----------	24	476
Clay-----------------	60	261			

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	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well H-22--Continued					
Sand, gravel, and clay	35	511	Shale, sticky---------	59	832
Sand and clay breaks--	24	535	Shale, hard-----------	9	841
Clay------------------	12	547	Shale, broken---------	49	890
Sand and hard streaks-	31	578	Sand, hard------------	18	908
Clay------------------	10	588	Shale and sandy shale-	32	940
Sand and shale layers, hard----------------	62	650	Shale, hard, and sand streaks-------------	14	954
Sand------------------	30	680	Sand with shale breaks	30	984
Shale-----------------	7	687	Shale-----------------	27	1,011
Sand------------------	31	718	Shale and sand layers, hard----------------	8	1,019
Shale, red, sticky----	24	742			
Sand with hard layers-	31	773			

Well H-26

Owner: Alvin Helwig. Driller: Thompson Drilling Co.

Surface soil and clay-	50	50	Sand with shale streaks	12	162
Sand and gravel-------	30	80	Shale-----------------	16	178
Caliche and sand------	45	125	Sand------------------	32	210
Clay and gravel-------	25	150			

Well H-29

Owner: Victoria County Housing Project, well 1. Driller: Layne-Texas Co.

Surface soil----------	3	3	Clay------------------	8	23
Clay------------------	6	9	Sand------------------	15	38
Sand------------------	6	15	Clay------------------	15	53

(Continued on next page)

Well H-29--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand	10	63	Lime, hard	10	394
Clay	10	73	Gumbo	11	405
Sand	45	118	Sand	24	429
Clay	6	124	Clay	9	438
Sand	19	143	Gumbo	11	449
Gumbo	65	208	Sand	66	515
Clay, sandy	16	224	Gumbo	9	524
Gumbo	44	268	Sand	18	542
Sand and gravel	90	358	Gumbo	16	558
Lime, hard	6	364	Sand	30	588
Sand and gravel	20	384			

Well J-6

Owner: Duncan Bros. Driller: Katy Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Subsurface soil and clay	47	47	Sandrock	11	231
Clay and sand streaks	13	60	Rock, hard	14	245
Sand, rock, and gravel	30	90	Clay and rock	19	264
Clay and rock	25	115	Rock and sand streaks	14	278
Sand	16	131	Sandrock	10	288
Clay	9	140	Clay	2	290
Sand	5	145	Sand	37	327
Clay	5	150	Clay	6	333
Sand	10	160	Sand	32	365
Clay	60	220	Clay	5	370

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	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well J-6--Continued					
Sandrock-------------	74	444	Sandrock-------------	13	768
Clay and rock---------	50	494	Clay-----------------	16	784
Sand-----------------	9	503	Sand-----------------	5	789
Clay-----------------	16	519	Clay-----------------	3	792
Sand and rock---------	14	533	Sandrock-------------	28	820
Clay-----------------	12	545	Shale----------------	26	846
Sand and sandy shale--	39	584	Sand-----------------	5	851
Clay and sandy shale--	66	650	Shale----------------	18	869
Sand-----------------	53	703	Sand-----------------	6	875
Clay-----------------	52	755	Clay-----------------	10	885

Well J-10

Owner: Owen Kolle. Driller: Mickelson Bros.

Clay-----------------	14	14	Sand-----------------	10	254
Clay and sand---------	31	45	Gumbo and lime--------	49	303
Sand and lime---------	25	70	Sand-----------------	12	315
Sand-----------------	30	100	Lime-----------------	5	320
Clay-----------------	8	108	Sand and lime---------	30	350
Sand and lime---------	44	152	Sand-----------------	15	365
Clay-----------------	6	158	Sand and lime---------	19	384
Sand and lime streaks-	27	185	Lime and gumbo--------	26	410
Lime and gumbo--------	14	199	Sand-----------------	4	414
Sand-----------------	10	209	Lime and gumbo--------	22	436
Lime and gumbo--------	12	221	Sand and lime---------	38	474
Sand-----------------	12	233	Lime-----------------	6	480
Lime and gumbo--------	11	244	Sand and lime---------	52	532

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

Well J-17

Owner: Dowell, Inc. Driller: H & S Drilling Co.

Clay------------------	30	30	Sand and shale--------	22	192
Sand------------------	7	37	Shale-----------------	13	205
Clay------------------	23	60	Sand and shale--------	30	235
Sand with hard streaks	25	85	Sand------------------	12	247
Shale with hard streaks	85	170	Clay------------------	3	250

Well J-21

Owner: City of Victoria. Driller: Layne-Texas Co.

Surface soil----------	6	6	Shale, hard, and lime-	30	314
Clay------------------	9	15	Shale, sandy----------	14	328
Clay, sandy----------	25	40	Shale, hard, and lime-	28	356
Sand, coarse---------	29	69	Sand and gravel-------	12	368
Gravel---------------	27	96	Clay and sandy shale--	15	383
Clay-----------------	12	108	Sand, gravel, and lime	17	400
Sand and fine gravel-	22	130	Sand and gravel-------	14	414
Clay and caliche-----	50	180	Shale, hard, and lime-	20	434
Sand and caliche-----	14	194	Shale, sandy----------	10	444
Shale----------------	11	205	Sand and gravel-------	20	464
Sand-----------------	24	229	Clay and lime---------	16	480
Shale and lime-------	6	235	Shale, sandy----------	16	496
Sand-----------------	18	253	Sand------------------	19	515
Sand, shale, and lime	17	270	Shale, sticky---------	14	529
Sand and hard streaks	14	284	Shale, hard-----------	24	553

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	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well J-21--Continued					
Shale------------------	24	577	Sand------------------	31	811
Sand and hard streaks-	8	585	Shale, sandy----------	7	818
Shale, hard, and lime-	16	601	Clay, hard, sticky----	29	847
Shale, sandy----------	14	615	Shale, hard, sandy----	17	864
Sand and hard streaks-	18	633	Sand, hard------------	21	885
Shale, hard-----------	6	639	Shale-----------------	18	903
Shale, sandy----------	6	645	Shale, sandy----------	5	908
Sand and hard streaks-	28	673	Shale-----------------	21	929
Shale, sandy, and lime	15	688	Shale, sandy----------	4	933
Sand, broken----------	26	714	Sand------------------	28	961
Clay and lime---------	12	726	Shale, hard-----------	15	976
Shale, sandy----------	8	734	Sand, broken----------	25	1,001
Sand with hard layers-	18	752	Shale-----------------	16	1,017
Clay, sandy shale, and lime-----------------	28	780			

Well J-22

Owner: City of Victoria. Driller: Layne-Texas Co.

Surface soil----------	5	5	Caliche and clay------	15	148
Clay------------------	8	13	Sand and caliche------	16	164
Sand------------------	20	33	Sand with shale layers	33	197
Sand and gravel-------	27	60	Shale and sandy shale-	15	212
Gravel----------------	24	84	Sand and sandy shale--	38	250
Caliche and clay------	11	95	Shale-----------------	20	270
Sand, gravel, and clay	38	133	Shale, sandy----------	19	289

(Continued on next page)

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well J-22--Continued					
Shale and sandy shale-	27	316	Sand with shale and lime layers---------	30	720
Sand and lime---------	15	331	Shale-----------------	5	725
Shale and sandy shale-	16	347	Sand with shale and lime layers---------	39	764
Sand, gravel, and lime	25	372	Shale sticky----------	13	777
Sand, shale, and lime-	23	395	Sand with shale and lime streaks--------	40	817
Sand------------------	16	411	Shale, red------------	39	856
Clay------------------	11	422	Shale, hard, sandy----	7	863
Clay, sandy-----------	13	435	Shale, sticky---------	6	869
Sand------------------	29	464	Sand------------------	20	889
Shale, red, sticky----	18	482	Shale-----------------	31	920
Sand------------------	12	494	Sand------------------	32	952
Shale, sticky---------	8	502	Shale-----------------	7	959
Shale, sandy----------	23	525	Sand and sandy shale--	14	973
Sand------------------	37	562	Sand with hard layers-	45	1,018
Shale and sandy shale-	18	580	Shale, sandy----------	2	1,020
Sand------------------	8	588	Shale and lime--------	8	1,028
Shale-----------------	24	612	Shale, sandy, and lime	7	1,035
Sand with hard streaks	39	651			
Shale, sandy, with hard streaks-------	28	679			
Shale, sticky---------	11	690			

Well J-30

Owner: Emil Otto. Driller: Thompson Drilling Co.

Clay------------------	30	30	Sand------------------	8	38

(Continued on next page)

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well J-30--Continued					
Clay------------------	6	44	Sand and caliche, hard	15	210
Sand, hard------------	15	59	Sand with shale streaks	40	250
Sand------------------	11	70	Shale-----------------	10	260
Clay------------------	2	72	Sand------------------	8	268
Sand------------------	8	80	Sand, broken----------	12	280
Sand, hard------------	4	84	Shale-----------------	25	305
Shale-----------------	4	88	Sand------------------	7	312
Sand with hard streaks	30	118	Shale-----------------	13	325
Shale-----------------	20	138	Sand------------------	12	337
Sand with hard streaks	4	142	Shale-----------------	56	393
Sand------------------	11	153	Sand------------------	15	408
Caliche, hard---------	22	155	Shale-----------------	72	480
Sand with hard streaks	20	175	Sand------------------	57	537
Shale and sand--------	20	195			

Well J-35

Owner: George Smyjstrla. Driller: H & S Drilling Co.

Clay and surface soil-	15	15	Shale-----------------	25	340
Sand------------------	15	30	Sand------------------	17	357
Shale-----------------	60	90	Shale-----------------	13	370
Sand------------------	20	110	Sand------------------	38	408
Shale-----------------	20	130	Shale-----------------	10	418
Sand------------------	105	235	Sand------------------	10	428
Shale and sand streaks	45	280	Shale-----------------	72	500
Sand------------------	35	315	Sand and shale streaks	30	530

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

Well J-40

Owner: Mrs. Patricia Welder Robinson. Driller: B. F. Powell.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	3	3	Boulders and clay-----	15	420
Clay------------------	36	39	Gravel and sand-------	28	448
Sand------------------	19	58	Clay, soft------------	4	452
Clay------------------	22	80	Rock and gravel-------	28	480
Gravel and sand-------	170	250	Clay, red-------------	20	500
Clay, soft------------	4	254	Sand, hard, and rock--	70	570
Sand and gravel-------	56	310	Boulders and clay-----	40	610
Clay, white-----------	8	318	Sandrock and gravel---	75	685
Sand and gravel-------	32	350	Clay, white-----------	45	730
Clay, blue and white--	15	365	Sand and rock---------	20	750
Rock and hard sand----	20	385	Clay, red, hard-------	121	871
Clay, blue, hard------	15	400	Sand------------------	38	909
Boulders and sand-----	5	405			

Well K-2

Owner: J. V. Wilburn. Driller: Katy Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface soil----------	15	15	Sand------------------	25	295
Sand------------------	45	60	Shale, sandy----------	20	315
Clay------------------	13	73	Shale and rock--------	25	340
Sand with clay streaks	42	115	Shale-----------------	10	350
Clay------------------	14	129	Sand and rock---------	30	380
Sand and rock---------	101	230	Sand and shale streaks	20	400
Shale, sandy----------	40	270	Sand and rock---------	37	437

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	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well K-2--Continued					
Shale	8	445	Shale	32	690
Sand and rock	38	483	Sand	55	745
Shale	67	550	Shale	8	753
Sand	18	568	Sand	60	813
Shale	27	595	Shale	12	825
Sand and rock	25	620	Sand	25	850
Shale	15	635	Shale	30	880
Sand	23	658			

Well K-5

Owner: Allen Bros. Driller: Mickelson Bros.

Surface soil and shale	22	22	Sand	15	191
Sand	6	28	Shale and lime	19	210
Shale	18	46	Sand and rock	11	221
Sand	12	58	Shale	6	227
Shale	15	73	Sand and rock	9	236
Sand	18	91	Shale, sticky	19	255
Shale	8	99	Shale and sand	16	271
Sand	4	103	Sand and rock	11	282
Shale	10	113	Shale, sticky	6	288
Sand and rock	12	125	Sand and rock	21	309
Shale	6	131	Shale	3	312
Sand and shale	34	165	Sand	4	316
Shale, sticky	11	176	Shale, sticky	18	334

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	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well K-5--Continued					
Shale and sand--------	8	342	Sand and rock---------	6	476
Shale, sticky---------	10	352	Shale-----------------	23	499
Sand and rock---------	11	363	Shale and sand--------	10	509
Shale-----------------	12	375	Shale, sticky---------	36	545
Sand and rock---------	8	383	Rock and sand---------	16	561
Shale, sticky---------	17	400	Shale-----------------	5	566
Sand, rock, and shale-	38	438	Rock and sand---------	88	654
Shale-----------------	32	470			

Well K-11

Owner: D. R. Blackburn. Driller: H & S Drilling Co.

Clay------------------	45	45	Shale and sand streaks	18	203
Sand------------------	5	50	Sand------------------	27	230
Shale-----------------	54	104	Shale and sand streaks	65	295
Sand------------------	11	115	Sand------------------	15	310
Shale and hard sand streaks-------------	18	133	Shale-----------------	35	345
Sand------------------	14	147	Sand------------------	13	358
Shale-----------------	18	165	Shale, sandy----------	139	497
Sand and gravel-------	20	185	Sand------------------	56	553

Well K-18

Owner: Edmund Keiner. Driller: H & S Drilling Co.

No record-------------	30	30	No record-------------	70	110
Sand------------------	10	40	Sand------------------	20	130

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Well K-18--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
No record-------------	13	143	Sand and shale streaks	15	300
Sand------------------	29	172	Sand------------------	38	338
Shale-----------------	10	182	Shale-----------------	27	365
Sand------------------	18	200	Sand------------------	23	388
Shale and sand streaks	53	253	Shale-----------------	12	400
Sand------------------	14	267	Sand and shale streaks	30	430
Shale-----------------	18	285	Sand------------------	20	450

Well K-24

Owner: Mrs. Armel Baker. Driller: H & K Drilling Co.

Dirt------------------	8	8	Clay------------------	85	160
Clay------------------	10	18	Sand------------------	705	865
Sand------------------	8	26	Sand, hard------------	15	880
Clay------------------	24	50	Sand------------------	83	963
Sand------------------	25	75			

Well L-4

Owner: Anton Otto. Driller: H & S Drilling Co.

Clay------------------	35	35	Sand------------------	53	215
Sand------------------	10	45	Shale-----------------	150	365
Clay------------------	13	58	Sand------------------	25	390
Sand------------------	12	70	Shale and sand streaks	45	435
Shale-----------------	92	162	Sand------------------	35	470

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

Well L-8

Owner: Mrs. Emily Campbell. Driller: H & K Drilling Co.

No record-------------	25	25	No record-------------	37	157
Sand and clay----------	95	120	Sand------------------	1,257	1,414

Well M-2--partial log

Owner: Reaves, well 1. Driller: Houston Gulf Gas Co.

Surface sand----------	3	3	Gumbo, red------------	22	378
Clay, white-----------	10	13	Sand and gravel-------	27	405
Sand------------------	12	25	Gumbo, red------------	7	412
Clay, red-------------	5	30	Lime and gravel streaks	8	420
Sand, coarse----------	10	40	Gumbo, red------------	15	435
Sandrock--------------	7	47	Gravel----------------	3	438
Clay, sandy-----------	13	60	Gumbo, red------------	17	455
Sandrock--------------	2	62	Lime and sandy shale--	43	498
Clay, sandy, white----	17	79	Shale, red and blue---	10	508
Sand------------------	14	93	Sand, white, and red, blue, and brown shale	18	526
Rock------------------	1	94	Gumbo, red, red sand and gravel, and blue and yellow clay-----	174	700
Gumbo, red, and lime--	66	160	Gravel----------------	10	710
Lime and gravel streaks	40	200	Gumbo, red------------	30	740
Gravel and coarse sand	45	245	Shale, blue-----------	13	753
Lime------------------	50	295	Gumbo, red and brown--	32	785
Sand and gravel-------	30	325	Gumbo-----------------	43	828
Rock------------------	1	326			
Gravel and coarse sand	30	356			

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	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well M-2--Continued					
Sand and pyrite-------	18	846	Sand------------------	2	1,322
Shale, sand, and pyrite--------------	6	852	Sand and blue gumbo---	8	1,330
Shale, blue-----------	53	905	Sandrock and shale----	4	1,334
Gumbo-----------------	10	915	Gumbo, blue-----------	2	1,336
Shale, blue-----------	81	996	Sandrock--------------	1	1,337
Sand, blue------------	17	1,013	Sand, soft, black-----	1	1,338
Shale, blue-----------	51	1,064	Sand and lime streaks-	11	1,349
Gypsum or soapstone, sand and lime streaks	20	1,084	Gumbo, blue-----------	9	1,358
Sand and rock---------	16	1,100	Clay, green-----------	56	1,414
Clay, brown, flaky----	10	1,110	Gumbo, blue, sandy, and lime streaks----	4	1,418
Gumbo and shale streaks	16	1,126	Sand, yellow and blue clay, and lime streaks	18	1,436
Shale, pink, and lime streaks-------------	24	1,150	Gumbo, green----------	12	1,448
Gumbo-----------------	26	1,176	Sandstone, gray-------	1	1,449
Shale and pyrite------	3	1,179	Gumbo, sandy, green, and lime streaks----	26	1,475
Gumbo containing gypsum, lime, and yellow clay----------	59	1,238	Sand, blue------------	21	1,496
Lime boulders---------	4	1,242	Gumbo, sand, shale, and pyrite----------	64	1,560
Gumbo and lime--------	44	1,286	Shale, sandy, blue----	4	1,564
Sand and lime streaks-	4	1,290	Gumbo, blue-----------	4	1,568
Gumbo, blue, and lime streaks------------	10	1,300	Sand, hard------------	2	1,570
Gumbo, blue, and pyrite--------------	20	1,320	Gumbo, green and blue-	28	1,598
			Shale boulders--------	38	1,636

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Well M-2--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Gumbo, chocolate-brown	16	1,652	Caprock---------------	11	1,831
Sand, blue shale, and pyrite--------------	6	1,658	Sand------------------	4	1,835
Sand, shaly-----------	12	1,670	Shale, blue, sandy----	2	1,837
Gumbo, chocolate-brown	10	1,680	Shale, blue-----------	16	1,853
Sand, shale, and lime streaks-------------	14	1,694	Lime boulders---------	1	1,854
Rock, hard------------	1	1,695	Gumbo, blue, and lime streaks-------------	127	1,981
Gumbo, green----------	33	1,728	Gumbo, blue-----------	13	1,994
Sand------------------	35	1,763	Gumbo, blue and red, and lime streaks----	4	1,998
Gumbo, chocolate, and lime streaks--------	22	1,785	Total depth-----------		3,103
Gumbo, chocolate------	35	1,820			

Well N-10

Owner: E. I. du Pont de Nemours & Co. Driller: Layne-Texas Co.

Clay------------------	25	25	Sand and lime streaks-	30	288
Sand------------------	10	35	Sand, and few shale breaks--------------	102	390
Clay------------------	10	45	Shale, sandy, and sand	60	450
Sand------------------	37	82	Shale-----------------	88	538
Shale-----------------	2	84	Shale, sandy, and shale	115	653
Sand, coarse, and gravel--------------	105	189	Shale-----------------	28	681
Shale, sandy----------	35	224	Shale, sandy, and lime streaks-------------	27	708
Sand and lime streaks-	29	253	Sand------------------	13	721
Shale-----------------	5	258			

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

Well N-10--Continued

Shale-----------------	7	728	Shale-----------------	25	1,000
Sand------------------	101	829	Sand------------------	48	1,048
Shale-----------------	16	845	Shale and sand streaks	25	1,073
Sand------------------	14	859	Shale-----------------	17	1,090
Shale-----------------	8	867	Sand and sandy shale--	15	1,105
Sand and lime streaks-	40	907	Shale-----------------	15	1,120
Shale, tough----------	42	949	Shale, sandy----------	10	1,130
Sand------------------	26	975			

Well N-22

Owner: John Swoboda. Driller: H & S Drilling Co.

Clay------------------	17	17	Clay------------------	70	300
Sand------------------	8	25	Sand and shale--------	30	330
Clay------------------	17	42	Shale-----------------	25	355
Sand------------------	23	65	Sand, thin shale streaks	55	410
Clay------------------	7	72	Sand------------------	60	470
Sand with clay streaks	38	110	Shale, sandy----------	10	480
Shale-----------------	40	150	Sand------------------	23	503
Sand with gravel streaks	65	215	Shale-----------------	17	520
Shale-----------------	15	230	Sand------------------	12	532

Well N-30

Owner: Victoria County Water Control and Improvement Dist. No. 1
Driller: Texas Water Wells Service.

Surface soil----------	5	5	Clay------------------	28	33

(Continued on next page)

Well N-30--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand------------------	6	39	Clay------------------	23	281
Clay------------------	9	48	Sand------------------	48	329
Sand------------------	9	57	Clay------------------	19	348
Clay------------------	31	88	Sand------------------	12	360
Sand and gravel-------	13	101	Clay------------------	10	370
Clay------------------	37	138	Sand------------------	25	395
Sand------------------	20	158	Clay------------------	14	409
Clay------------------	2	160	Sand------------------	9	418
Sand and gravel-------	25	185	Clay------------------	30	448
Clay------------------	18	203	Sand------------------	6	454
Sand------------------	6	209	Clay------------------	8	462
Clay------------------	17	226	Sand------------------	22	484
Sand------------------	14	240	Clay------------------	4	488
Clay------------------	7	247	Sand------------------	11	499
Sand------------------	11	258	Clay------------------	50	549

Well P-4--partial log

Owner: G. Keeran, et al., well 5. Driller: Gulf Production Co.

Surface clay----------	60	60	Shale, sticky---------	80	370
Sand and gravel-------	65	125	Sand------------------	30	400
Clay------------------	23	148	Shale-----------------	40	440
Shale, sticky---------	50	198	Sand and boulders-----	70	510
Sand and gravel-------	82	280	Gumbo-----------------	140	650
Gumbo-----------------	10	290	Sand and gravel-------	30	680

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	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well P-4--Continued					
Shale, sticky----------	215	895	Sand and boulders-----	40	1,490
Sand and boulders-----	55	950	Gumbo-----------------	29	1,519
Shale, sticky----------	65	1,015	Shale and boulders----	26	1,545
Sand and boulders-----	10	1,025	Gumbo, pink-----------	73	1,618
Shale, sticky---------	103	1,128	Sand and boulders-----	52	1,670
Shale and boulders----	72	1,200	Shale and lime--------	252	1,922
Gumbo-----------------	58	1,258	Sand, hard, and boulders	43	1,965
Sand and boulders-----	152	1,410	Total depth-----------		5,570
Gumbo-----------------	40	1,450			

Well P-11

Owner: Sunray Oil Corp. Driller: Townsend Water Well Service.

Clay------------------	30	30	Sand------------------	32	490
Sand------------------	80	110	Clay------------------	30	520
Clay------------------	30	140	Sand------------------	55	575
Sand------------------	50	190	Clay------------------	20	595
Clay------------------	30	220	Sand------------------	43	638
Sand------------------	50	270	Clay, sticky----------	166	804
Clay------------------	40	310	Sand------------------	45	849
Sand------------------	40	350	Clay------------------	91	940
Clay, sticky----------	38	388	Sand------------------	40	980
Sand and clay streaks-	21	409	Clay------------------	10	990
Clay------------------	49	458	Sand------------------	25	1,015

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

Well P-14

Owner: R. H. Matson. Driller: Thompson Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay------------------	30	30	Shale-----------------	35	195
Sand and gravel--------	62	92	Sand------------------	63	258
Shale-----------------	53	145	Shale and sand streaks	102	360
Sand and hard streaks-	15	160	Sand and hard streaks-	114	474

Well P-15

Owner: Bloomington School. Driller: H & K Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay------------------	40	40	Sand------------------	50	240
Sand------------------	10	50	No record-------------	57	297
No record-------------	10	60	Sand------------------	36	333
Sand------------------	20	80	No record-------------	72	405
No record-------------	35	115	Sand------------------	40	445
Sand------------------	33	148	Clay------------------	5	450
No record-------------	42	190			

Well R-1

Owner: John Keeran. Driller: H & K Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay------------------	35	35	Sand, black, coarse---	21	243
Clay with hard streaks	37	72	Shale with hard streaks	27	270
Sand------------------	8	80	Shale-----------------	28	298
Shale-----------------	45	125	Sand, coarse----------	22	320
Sand------------------	40	165	Shale with sand streaks	180	500
Shale, sticky---------	25	190	Sand------------------	25	525
Shale, sandy----------	32	222	Shale-----------------	12	537

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	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well R-1--Continued					
Sand------------------	38	575	Shale with hard streaks	40	1,120
Shale-----------------	12	587	Shale-----------------	70	1,190
Sand------------------	23	610	Sand with hard streaks	20	1,210
Shale-----------------	37	647	Shale-----------------	45	1,255
Sand------------------	21	668	Sand------------------	35	1,290
Shale with hard streaks	133	801	Rock------------------	3	1,293
Sand------------------	38	839	Sand------------------	44	1,337
Shale-----------------	19	858	Shale-----------------	25	1,362
Sand------------------	34	892	Sand------------------	28	1,390
Shale-----------------	68	960	Sand and shale--------	25	1,415
Sand------------------	43	1,003	Sand------------------	25	1,440
Shale with hard streaks	17	1,020	Shale with hard streaks	55	1,495
Sand------------------	60	1,080			

Well R-6

Owner: John Keeran. Driller: H & K Drilling Co.

No record-------------	12	12	Shale-----------------	9	1,415
Sand------------------	1,394	1,406			

Well R-15

Owner: G. E. McKamey. Driller: Townsend Water Well Service.

Clay------------------	18	18	Clay------------------	20	90
Sand------------------	10	28	Sand------------------	25	115
Clay------------------	28	56	Clay------------------	43	158
Sand------------------	14	70	Sand------------------	32	190

(Continued on next page)

Well R-15--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay------------------	45	235	Clay------------------	30	290
Sand------------------	25	260	Sand------------------	34	324

Well S-4

Owner: J. J. Murphy. Driller: Thompson Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface soil and clay-	8	8	Sand------------------	6	108
Sand------------------	4	12	Shale-----------------	14	122
Shale-----------------	18	30	Sand with hard streaks	9	131
Sand------------------	20	50	Shale-----------------	11	142
Shale-----------------	32	82	Sand------------------	14	156
Sand with hard streaks	11	93	Shale-----------------	49	205
Shale-----------------	9	102	Sand------------------	33	238

Well S-12

Owner: Agnes Murphy. Driller: Thompson Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay------------------	18	18	Shale-----------------	12	110
Sand with hard streaks	80	98	Sand with hard streaks	35	145

Well S-21

Owner: J. A. McFaddin Estate. Driller: Layne-Texas Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface soil----------	2	2	Shale, blue-----------	9	76
Clay------------------	40	42	Sand, coarse, gray, and shale streaks---	24	100
Sand------------------	6	48	Clay------------------	44	144
Clay------------------	10	58	Sand, coarse, gray----	31	175
Sand, coarse, gray----	9	67			

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Well S-21--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay------------------	13	188	Clay and sand---------	28	630
Clay and sand streaks-	10	198	Sand and clay streaks-	20	650
Sand, coarse, gray, and clay streaks----	60	258	Clay------------------	19	669
Clay------------------	20	278	Sand, gray, with shale streaks-------------	51	720
Sand, coarse, gray----	11	289	Shale-----------------	8	728
Clay------------------	73	362	Sand, coarse, with shale streaks-------	60	788
Sand with clay streaks	17	379	Shale, sticky---------	40	828
Shale, hard, blue-----	63	442	Shale with sand streaks	10	838
Clay and sand streaks-	16	458	Sand------------------	15	853
Sand, fine, gray------	27	485	Shale, hard-----------	50	903
Shale, sandy----------	26	511	Shale-----------------	25	928
Shale, sandy, hard----	28	539	Sand------------------	13	941
Sand, fine, gray------	9	548	Shale, sandy----------	18	959
Shale-----------------	10	558	Sand------------------	14	973
Sand, fine, gray------	26	584	Shale, sandy----------	30	1,003
Shale, hard-----------	18	602			

Well T-1

Owner: J. A. McFaddin Estate. Driller: Kelley Water Well Service.

Clay------------------	10	10	Sand------------------	20	68
Sand------------------	15	25	Shale-----------------	33	101
Shale-----------------	23	48	Sand------------------	30	131

Well T-4

Owner: J. A. McFaddin Estate. Driller: Unknown.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay------------------	30	30	Shale-----------------	127	558
Sand------------------	20	50	Sand------------------	22	580
Shale, sandy----------	30	80	Shale-----------------	60	640
Sand------------------	15	95	Sand------------------	48	688
Shale with sand streaks	85	180	Shale, sticky---------	112	800
Sand------------------	42	222	Sand------------------	80	880
Shale with sand streaks	181	403	Shale-----------------	8	888
Sand------------------	28	431			

Well T-12

Owner: J. A. McFaddin Estate. Driller: A. H. Masirin.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	2	2	Sand and boulders-----	13	369
Clay------------------	6	8	Shale-----------------	8	377
Sand------------------	128	136	Sand------------------	11	388
Shale-----------------	6	142	Shale-----------------	10	398
Sand------------------	20	162	Sand and boulders-----	25	423
Shale-----------------	8	170	Shale-----------------	49	472
Sand and shale streaks	62	232	Sand------------------	9	481
Shale, sandy----------	27	259	Shale-----------------	94	575
Sand------------------	8	267	Sand------------------	14	589
Shale-----------------	12	279	Shale-----------------	14	603
Sand and boulders-----	36	315	Sand------------------	13	616
Shale-----------------	41	356	Shale-----------------	9	625

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Well T-12--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand	14	639	Sand and boulders	10	673
Shale	3	642	Shale, sticky, hard	57	730
Sand	17	659	Shale, pink	72	802
Shale	4	663	Sand and boulders	61	863

Well T-19--partial log

Owner: A. M. McFaddin Estate. Driller: Houston Oil Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Surface clay	12	12	Sand	80	890
Sand	28	40	Gumbo	26	916
Sand and gravel	90	130	Sand	46	962
Sand	160	290	Gumbo	6	968
Rock	3	293	Sand	30	998
Sand with clay and gravel streaks	87	380	Gumbo	20	1,018
Gumbo, tough	16	396	Sand and hard shale	17	1,035
Rock	4	400	Sand	25	1,060
Sand	20	420	Gumbo, pink	22	1,082
Rock	2	422	Sand	15	1,097
Gumbo, tough	133	555	Gumbo, pink	7	1,104
Sand	12	567	Sand	29	1,133
Gumbo	45	612	Gumbo, pink	9	1,142
Sand	6	618	Lime, hard, sandy, shaly	18	1,160
Gumbo	31	649	Lime, sandy	25	1,185
Sand	53	702	Sand	40	1,225
Gumbo, pink	108	810	Gumbo	35	1,260

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	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well T-19--Continued					
Sand------------------	20	1,280	Gumbo-----------------	108	1,686
Gumbo-----------------	20	1,300	Sand------------------	10	1,696
Sand------------------	20	1,320	Gumbo-----------------	49	1,745
Gumbo-----------------	20	1,340	Lime, sandy-----------	20	1,765
Sand------------------	50	1,390	Sand------------------	32	1,797
Gumbo and shale-------	30	1,420	Gumbo-----------------	38	1,835
Sand boulders---------	40	1,460	Gumbo and shale-------	160	1,995
Gumbo and shale-------	100	1,560	Total depth-----------		4,633
Sand------------------	18	1,578			

Table 10.--Drillers' logs of wells in Calhoun County

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well A-3					
Owner: Humble Oil & Refining Co. Driller: Layne-Texas Co.					
Soil, black------------	4	4	Sand------------------	14	490
Clay and sandy clay---	46	50	Shale, sandy----------	10	500
Sand and gravel-------	25	75	Sand------------------	9	509
Clay, sandy-----------	6	81	Shale and sticky shale	54	563
Shale, sandy, and shale	37	118	Shale, sandy----------	12	575
Sand, hard------------	7	125	Sand and sandy shale--	30	605
Sand and gravel-------	27	152	Shale, hard-----------	23	628
Clay------------------	11	163	Shale, sandy----------	17	645
Sand and gravel-------	32	195	Shale, hard and sticky	58	703
Clay, sandy-----------	11	206	Shale, hard-----------	21	724
Sand------------------	6	212	Shale, hard, sandy----	33	757
Clay, sandy-----------	11	223	Sand and gravel-------	36	793
Sand and clay streaks-	33	256	Shale, hard, sandy----	7	800
Clay------------------	7	263	Shale, hard, sticky---	28	828
Sand------------------	20	283	Shale, hard, sandy----	46	874
Clay and sandy shale--	24	307	Shale, hard, red------	30	904
Sand------------------	15	322	Shale, hard, sandy----	30	934
Shale-----------------	25	347	Shale, hard, red------	25	959
Sand, sandy shale, and hard layers---------	58	405	Shale, sandy----------	4	963
Shale and hard caliche	53	458	Sand------------------	13	976
Sand------------------	8	466	Shale, hard, sandy----	25	1,001
Shale, sandy----------	10	476	Sand and caliche------	19	1,020

(Continued on next page)

Well A-3--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Caliche, hard, sandy--	7	1,027	Shale, sandy----------	5	1,075
Sand and caliche------	23	1,050	Shale-----------------	9	1,084
Sand------------------	20	1,070			

Well A-6

Owner: P. H. Welder. Driller: B. F. Powell.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	2	2	Clay and rock---------	20	540
Clay, red-------------	18	20	Sand, good------------	18	558
Sand------------------	24	44	Sand, brown-----------	32	590
Clay, red-------------	76	120	Sand------------------	22	612
Sand------------------	180	300	Clay------------------	12	624
Clay, white-----------	18	318	Sand------------------	16	640
Clay and rock---------	12	330	Clay------------------	8	648
Sand------------------	10	340	Sand------------------	10	658
Clay------------------	12	352	Clay, dark-brown------	62	720
Sand------------------	38	390	Sandrock--------------	8	728
Clay------------------	20	410	Sand, fine------------	14	742
Rock and sand---------	20	430	Clay, rock, and sand--	53	795
Clay------------------	20	450	Clay, hard, black and white---------------	60	855
Sand------------------	10	460	Clay and rock---------	30	885
Clay, soft------------	30	490	Clay, red-------------	6	891
Rock, hard------------	3	493	Sand (gas)------------	21	912
Sand, dark------------	27	520			

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

Well A-11

Owner: H. C. Robinson. Driller: G. H. Laughter.

Soil------------------	2	2	Clay, mixed-----------	73	385
Clay, red-------------	8	10	Sand------------------	7	392
Sand, fine------------	10	20	Clay, dark------------	42	434
Clay, red-------------	20	40	Sand------------------	10	444
Sand------------------	35	75	Clay, hard, blue------	125	569
Clay, red-------------	40	115	Sand------------------	7	576
Sand, fine------------	5	120	Clay------------------	2	578
Clay, soft, red-------	30	150	Sand, fine------------	5	583
Sand------------------	38	188	Sand, brown-----------	50	633
Clay------------------	5	193	Sand------------------	10	643
Sand------------------	15	208	Clay, blue------------	25	668
Clay, white and blue--	20	228	Sand, fine------------	17	685
Sand------------------	26	254	Clay------------------	12	697
Clay------------------	7	261	Sand, fine------------	5	702
Sand------------------	17	278	Clay, blue and red----	142	844
Sand and clay, fine---	2	280	Sand, fine------------	2	846
Sand, hard------------	20	300	Clay, hard, red-------	39	885
Clay, dark------------	12	312	Sand------------------	43	928

Well A-15

Owner: P. H. Welder. Driller: G. H. Laughter.

Soil, black-----------	2	2	Sand and gravel-------	10	50
Clay, yellow and white	38	40	Clay, white-----------	80	130

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Well A-15--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand------------------	20	150	Clay, blue, and boulders------------	10	370
Clay, yellow, and boulders-------------	10	160	Sand------------------	10	380
Sand------------------	10	170	Clay, blue------------	20	400
Clay, yellow----------	10	180	Clay, red and yellow--	30	430
Sand------------------	35	215	Sand------------------	10	440
Sand and clay streaks-	25	240	Clay, yellow and white	100	540
Sand, coarse----------	20	260	Streaks, blue, hard and soft------------	40	580
Clay, blue------------	15	275	Sand, blue, fine------	10	590
Sand------------------	10	285	Clay, yellow and blue-	110	700
Clay, blue------------	10	295	Clay, red, and boulders	10	710
Sand------------------	20	315	Clay, red and blue----	10	720
Clay, blue and yellow-	25	340	Sand and gravel (gas)-	20	740
Sand------------------	20	360			

Well A-19

Owner: P. H. Welder. Driller: E. T. Elwood.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	5	5	Sand------------------	10	360
Sand------------------	10	15	Clay, brown-----------	56	416
Mud-------------------	5	20	Sand, coarse----------	7	423
Sand and gravel-------	255	275	Clay------------------	20	443
Gravel----------------	15	290	Sand------------------	2	445
Clay, blue------------	10	300	Clay, white-----------	13	458
Gravel, coarse--------	20	320	Sand------------------	6	464
Clay------------------	2	322	Clay, white-----------	16	480
Sand------------------	18	340	Sand------------------	10	490
Clay------------------	10	350			

Well A-21

Owner: H. C. Robinson. Driller: G. H. Laughter.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand, brown----------	10	10	Clay, hard, blue------	20	403
Sand, white----------	10	20	Rock, hard, white-----	2	405
Clay, yellow---------	40	60	Clay and sand streaks, red----------------	47	452
Clay, blue-----------	60	120	Clay and sand streaks, blue---------------	58	510
Sand-----------------	5	125	Sand-----------------	15	525
Wood-----------------	3	128	Clay, hard, red-------	5	530
Clay, blue and white--	52	180	Sand-----------------	26	556
Clay, blue-----------	40	220	Clay, red and blue----	100	656
Rock, hard-----------	1	221	Clay, soft, white, and rock---------------	5	661
Sand-----------------	9	230	Packsand-------------	15	676
Clay, light-blue------	70	300	Clay, soft, white, and hard blue clay------	64	740
Sand-----------------	20	320	Gravel (gas)----------	18	758
Sand and clay streaks-	48	368			
Sand-----------------	15	383			

Well A-22

Owner: H. C. Robinson. Driller: G. H. Laughter.

Dirt, brown----------	10	10	Sand-----------------	15	135
Sand-----------------	20	30	Sand and clay streaks-	20	155
Clay, yellow----------	30	60	Sand and rock---------	15	170
Sand, coarse----------	16	76	Sand-----------------	25	195
Clay, red------------	24	100	Clay, blue-----------	20	215
Clay, white----------	20	120	Sand-----------------	10	225

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Well A-22--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay, blue	10	235	Clay, hard, blue	30	460
Sand	25	260	Clay, soft, blue	40	500
Clay, blue	10	270	Clay, hard, blue	50	550
Clay, white	30	300	Clay, blue and brown	50	600
Sand	10	310	Sand	20	620
Clay, light-blue	30	340	Clay, yellow	44	664
Rock	1	341	Clay, blue and red	46	710
Sand	9	350	Sand	10	720
Clay, light-blue	25	375	Clay, blue and red	50	770
Clay, soft, yellow	10	385	Mud	10	780
Sand	15	400	Clay, blue and red	80	860
Clay, light-blue	30	430	Sand and gravel	21	881

Well A-28

Owner: Otto Marek. Driller: B. & P. Drilling Co.

Soil	3	3	Clay	34	243
Clay	30	33	Sand	16	259
Sand	4	37	Clay	9	268
Clay	27	64	Sand	50	318
Sand	15	79	Clay	26	344
Clay, sandy	47	126	Clay, sandy	12	356
Sand	7	133	Sand	6	362
Clay, sandy	6	139	Clay	21	383
Sand	38	177	Sand	12	395
Clay, sandy	12	189	Clay	10	405
Sand	20	209			

Table 10.--Drillers' logs of wells in Calhoun County--Continued

Well A-39

Owner: J. C. Williams. Driller: H. & S. Well Service.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
No record-------------	67	67	Shale and sand streaks	20	887
Sand------------------	800	867			

Well A-45

Owner: Clyde Bauer. Driller: B. & P. Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	3	3	Sand------------------	4	38
Clay------------------	7	10	Clay------------------	57	95
Clay, sandy-----------	3	13	Sand------------------	9	104
Clay------------------	21	34	Clay------------------	1	105

Well B-8

Owner: Paul Freier. Driller: B. & P. Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	2	2	Clay------------------	60	151
Clay------------------	19	21	Sand------------------	5	156
Sand------------------	21	42	Clay------------------	43	199
Clay------------------	10	52	Sand------------------	17	216
Sand------------------	5	57	Clay------------------	53	269
Clay------------------	2	59	Sand------------------	24	293
Sand------------------	32	91	Clay------------------	1	294

Well B-12

Owner: L. J. Foester. Driller: John O'Neil.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay, white-----------	10	10	Clay, sandy-----------	5	20
Clay, yellow----------	5	15	Sand, fine------------	5	25

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	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well B-12--Continued					
Clay, soft, white-----	10	35	Clay, white-----------	60	162
Clay, white-----------	20	55	Sand, shaly-----------	40	202
Limerock and clay-----	10	65	Sand (water)----------	23	225
Clay, sandy-----------	10	75	Clay------------------	2	227
Clay, yellow----------	27	102			

Well B-23

Owner: L. J. Foester. Driller: B. & P. Drilling Co.

Soil------------------	4	4	Clay------------------	17	173
Clay------------------	14	18	Sand------------------	5	178
Sand------------------	6	24	Clay------------------	22	200
Sand and clay---------	19	43	Sand------------------	9	209
Sand------------------	9	52	Clay------------------	4	213
Clay------------------	101	153	Sand------------------	7	220
Sand and shell--------	3	156	Clay------------------	2	222

Well B-27

Owner: City of Port Lavaca. Driller: Layne-Texas Co.

Soil------------------	5	5	Sand------------------	24	214
Clay------------------	116	121	Clay------------------	6	220
Clay, sandy-----------	5	126	Sand------------------	15	235
Clay------------------	44	170	Clay------------------	18	253
Sand------------------	15	185	Sand------------------	17	270
Clay------------------	5	190	Clay------------------	13	283

Well B-37

Owner: A. B. McDonald. Driller: B. & P. Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	4	4	Sand------------------	10	67
Clay------------------	10	14	Clay, sandy-----------	3	70
Sand------------------	12	26	Sand------------------	2	72
Clay------------------	14	40	Clay, sandy-----------	129	201
Sand------------------	2	42	Sand------------------	24	225
Clay, sandy-----------	15	57	Clay------------------	1	226

Well B-40

Owner: Melvin Blake. Driller: B. & P. Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	3	3	Clay------------------	9	165
Clay------------------	18	21	Sand and clay---------	4	169
Sand------------------	16	37	Clay, sandy-----------	50	219
Clay, sandy-----------	31	68	Sand------------------	6	225
Sand------------------	3	71	Clay, sandy-----------	2	227
Clay------------------	75	146	Sand------------------	22	249
Clay, sandy-----------	10	156			

Well B-44

Owner: Sno-Brite Laundry. Driller: B. & P. Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	3	3	Clay------------------	32	100
Clay------------------	13	16	Sand------------------	2	102
Sand and clay---------	30	46	Clay------------------	33	135
Clay------------------	10	56	Sand------------------	7	142
Sand------------------	12	68	Clay------------------	72	214

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Well B-44--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand	3	217	Sand	27	272
Clay, sandy	28	245	Clay	3	275

Well B-47

Owner: Wilborn & Graham. Driller: B. & P. Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	4	4	Clay	26	118
Clay	20	24	Sand	6	124
Sand	15	39	Clay	67	191
Clay	23	62	Sand	15	206
Sand	30	92	Clay	90	296

Well B-51

Owner: E. S. Ramsey. Driller: B. & P. Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	5	5	Sand	6	216
Clay	37	42	Clay, sandy	4	220
Sand	16	58	Sand	7	227
Clay, sandy	4	62	Clay	2	229
Sand	5	67	Sand	1	230
Sand and clay	31	98	Clay, sandy	4	234
Clay	98	196	Sand	4	238
Sand	2	198	Clay	35	273
Clay, sandy	12	210			

Well B-58

Owner: C. E. Roberts. Driller: B. & P. Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	4	4	Clay	61	65

(Continued on next page)

Well B-58--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand------------------	5	70	Clay------------------	22	235
Clay------------------	22	92	Sand------------------	20	255
Sand and clay---------	7	99	Clay, sandy-----------	4	259
Sand------------------	13	112	Sand------------------	2	261
Clay------------------	95	207	Clay------------------	1	262
Sand------------------	6	213			

Well C-1

Owner: Mrs. John Y. Bell. Driller: Burt Well Service.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	3	3	Sand------------------	11	158
Clay------------------	14	17	Clay------------------	29	187
Sand------------------	4	21	Shell and clay--------	7	194
Clay------------------	16	37	Clay------------------	31	225
Sand------------------	13	50	Sand and gravel-------	13	238
Clay------------------	97	147			

Well C-2

Owner: C. S. Traylor. Driller: Burt Well Service.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	3	3	Lime------------------	2	105
Clay------------------	4	7	Broken formation------	36	141
Sand------------------	2	9	Sand------------------	7	148
Clay------------------	19	28	Clay------------------	17	165
Sand------------------	8	36	Sand------------------	12	177
Clay------------------	19	55	Broken formation------	90	267
Sand------------------	13	68	Sand and gravel-------	13	280
Clay------------------	35	103			

Well C-7

Owner: Maude B. Traylor. Driller: B. & P. Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	4	4	Clay, sandy-----------	22	333
Clay------------------	62	66	Sand------------------	3	336
Sand------------------	35	101	Clay, sandy-----------	2	338
Clay, sandy-----------	5	106	Sand------------------	4	342
Sand------------------	13	119	Clay, sandy-----------	49	391
Clay, sandy-----------	190	309	Sand------------------	21	412
Sand------------------	2	311	Clay------------------	2	414

Well C-13

Owner: John Butler. Driller: B. & P. Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	4	4	Sand, shell, and clay-	14	224
Clay------------------	14	18	Clay------------------	49	273
Clay, sandy-----------	5	23	Sand and shell--------	11	284
Sand------------------	16	39	Clay------------------	62	346
Clay------------------	59	98	Sand and shell--------	10	356
Sand------------------	3	101	Clay------------------	2	358
Clay------------------	65	166	Sand------------------	2	360
Sand------------------	15	181	Clay------------------	10	370
Clay------------------	5	186	Sand------------------	11	381
Sand and clay---------	2	188	Clay------------------	8	389
Clay------------------	22	210			

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

Well C-17

Owner: L. J. Foester, Jr. Driller: John O'Neil.

Sand and clay---------	5	5	Sand, hard (water)----	10	160
Clay, red-------------	15	20	Joint clay------------	45	205
Clay, light-yellow----	20	40	Gumbo, yellow, and clay	40	245
Sand, shaly, salt, and clay------------	10	50	Mudshell--------------	15	260
Sand and salt---------	30	80	Clay, white-----------	35	295
Limerock and clay, light---------------	70	150	Sand (fresh water)----	13	308
			Clay, hard, yellow----	2	310

Well C-18

Owner: M. D. Shillings. Driller: John O'Neil.

Soil------------------	6	6	Clay, yellow----------	54	180
Clay and pebbles------	22	28	Clay, white-----------	51	231
Sand and salt---------	12	40	Sand, shaly-----------	20	251
Clay, red-------------	80	120	Sand------------------	14	265
Shell-----------------	6	126	Clay------------------	2	267

Well C-21

Owner: Tom Deshazor. Driller: B. & P. Drilling Co.

Sand and shell--------	15	15	Sand and shell--------	5	192
Clay, sandy-----------	31	46	Clay, sandy-----------	85	277
Sand------------------	10	56	Sand------------------	16	293
Clay, sandy-----------	36	92	Clay------------------	2	295
Clay------------------	95	187			

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

Well D-4

Owner: Traylor Sells. Driller: Burt Well Service.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	3	3	Clay------------------	16	112
Clay------------------	8	11	Sand------------------	15	127
Sand------------------	10	21	Broken formation------	15	142
Clay and shells-------	41	62	Clay------------------	33	175
Broken formation------	21	83	Sand and gravel-------	23	198
Sand------------------	13	96	Clay------------------	1	199

Well D-8

Owner: Olivia Gin Co. Driller: V. E. Damstrom.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	2	2	Clay, blue------------	31	228
Clay, red, and white rock----------------	16	18	Clay and rock---------	18	246
Sand, fine------------	8	26	Clay, gray and blue, and shells----------	21	267
Clay, red-------------	64	90	Clay------------------	38	305
Clay, blue and red----	10	100	Clay, blue, sticky, and shells----------	20	325
Sand, fine, gray------	5	105	Clay------------------	21	346
Clay, blue and red----	10	115	Clay, blue------------	29	375
Sand, fine, gray------	11	126	Sand------------------	20	395
Clay, blue------------	34	160	Sand, rock, and shell-	6	401
Sand and lime---------	37	197			

Well D-22

Owner: Holmes Drilling Co. Driller: Burt Well Service.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	3	3	Clay------------------	8	11

(Continued on next page)

Well D-22--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand------------------	5	16	Clay------------------	31	172
Clay------------------	35	51	Broken formation------	11	183
Sand------------------	12	63	Clay------------------	37	220
Clay------------------	24	87	Broken formation------	26	246
Sand and gravel-------	39	126	Clay------------------	91	337
Clay------------------	3	129	Sand and gravel-------	20	357
Sand------------------	12	141			

Well D-27

Owner: Maude B. Traylor. Driller: John Finster.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand------------------	3	3	Clay, yellow and blue-	53	170
Clay, red-------------	12	15	Shale, rock, and sand streaks--------------	33	203
Sand, red-------------	15	30	Clay------------------	20	223
Clay, blue------------	28	58	Sand, broken----------	9	232
Sand, gray------------	11	69	Clay------------------	45	277
Clay, blue------------	11	80	Sand------------------	29	306
Sand, fine------------	14	94			
Sand, coarse, white and gray------------	23	117			

Well D-29

Owner: J. A. Wright. Driller: B. & P. Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil------------------	4	4	Clay------------------	2	73
Clay------------------	62	66	Sand------------------	14	87
Sand------------------	5	71	Sand and lime---------	5	92

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	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well D-29--Continued					
Sand------------------	12	104	Sand------------------	5	182
Clay------------------	8	112	Clay------------------	2	184
Sand------------------	4	116	Sand------------------	12	196
Clay------------------	8	124	Clay------------------	12	208
Sand------------------	2	126	Sand------------------	11	219
Clay------------------	51	177	Clay------------------	4	223

Well D-30

Owner: R. T. Damstrom. Driller: V. E. Damstrom.

Clay, red and blue----	60	60	Clay, soft, blue------	15	395
Sand, fine------------	20	80	Clay, blue, red, and green---------------	63	458
Clay, tough, gray, blue and red-------------	284	364	Rock, white, soft, limy	10	468
Sand, white-----------	16	380	Sand, coarse (water)--	12	480

Well D-32

Owner: Maude B. Traylor. Driller: Burt Well Service.

Soil------------------	3	3	Clay------------------	26	191
Clay------------------	26	29	Broken formation------	17	208
Sand------------------	8	37	Clay------------------	18	226
Clay------------------	61	98	Lime------------------	3	229
Sand------------------	23	121	Clay and shells-------	66	295
Clay------------------	37	158	Sand and gravel-------	21	316
Sand------------------	7	165			

Well D-38

Owner: Ernest Schicke. Driller: Burt Well Service.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	2	2	Sand and gravel	8	128
Clay	17	19	Clay	4	132
Sand	2	21	Sand and gravel	25	157
Clay	16	37	Clay	47	204
Sand	32	69	Sand	14	218
Clay	5	74	Clay	49	267
Sand	7	81	Sand	15	282
Clay	17	98	Broken formation	35	317
Sand	5	103	Sand	15	332
Clay	17	120			

Well D-40

Owner: H. C. Smith. Driller: Burt Well Service.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil	3	3	Broken formation	21	248
Clay	35	38	Sand and shells	11	259
Sand	3	41	Clay	2	261
Clay	38	79	Shells	5	266
Sand	5	84	Clay	34	300
Clay	33	117	Sand	23	323
Sand	2	119	Clay	6	329
Broken formation	22	141	Sand	28	357
Clay	79	220	Clay	2	359
Sand	7	227	Sand	10	369

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	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well D-40--Continued					
Clay------------------	5	374	Clay------------------	26	436
Broken formation------	10	384	Broken formation------	14	450
Sand------------------	15	399	Sand and shells-------	26	476
Clay------------------	2	401	Clay------------------	4	480
Sand------------------	9	410			

Well E-4

Owner: Carl Manuel. Driller: B. & P. Drilling Co.

Soil------------------	4	4	Sand------------------	4	143
Clay------------------	7	11	Clay------------------	18	161
Sand------------------	3	14	Sand------------------	17	178
Clay and shell--------	47	61	Clay, sandy-----------	11	189
Sand------------------	20	81	Sand------------------	6	195
Clay, sandy-----------	14	95	Clay, sandy-----------	9	204
Sand------------------	7	102	Sand------------------	7	211
Clay------------------	37	139	Clay------------------	1	212

Well E-10

Owner: Lester Shafer. Driller: B. & P. Drilling Co.

Soil------------------	4	4	Sand------------------	9	200
Clay------------------	103	107	Clay------------------	44	244
Sand and clay streaks-	12	119	Sand------------------	2	246
Clay------------------	2	121	Clay, sandy-----------	6	252
Sand------------------	18	139	Sand------------------	27	279
Clay------------------	52	191	Clay------------------	2	281

Well E-15

Owner: C. H. Stiernberg. Driller: A. T. Marouly.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil and clay---------	12	12	Sand-----------------	20	117
Sand, broken, and clay	46	58	Clay-----------------	33	150
Clay-----------------	21	79	Sand, fine-----------	14	164
Sand, salty----------	10	89	Sand (water)---------	22	186
Clay-----------------	8	97			

Well E-24

Owner: Lockwood, Andrews & Newman. Driller: B. & P. Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Soil-----------------	4	4	Sand-----------------	15	127
Clay, sandy----------	28	32	Clay-----------------	63	190
Clay-----------------	30	62	Sand-----------------	4	194
Clay, sandy----------	6	68	Clay, sandy----------	3	197
Sand-----------------	10	78	Sand-----------------	18	215
Clay, sandy----------	34	112	Clay-----------------	7	222

Well E-27

Owner: L. M. Fisher, Jr. Driller: John O'Neil.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand, clay, and pebbles	10	10	Sand, fine, pasty-----	17	127
Sand, heavy, red-------	15	25	Clay, white-----------	122	249
Clay, red-------------	35	60	Sand-----------------	14	263
Clay, soft, sandy-----	10	70	Clay-----------------	1	264
Clay, yellow----------	40	110			

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

Well E-28

Owner: L. M. Fisher, Jr. Driller: John O'Neil.

Sand and clay----------	15	15	Clay------------------	8	101
Sand, red-------------	10	25	Clay, white, and lime-rock----------------	105	206
Clay, yellow----------	40	65	Sand (water)----------	17	223
Sand, salty-----------	9	74	Clay------------------	1	224
Clay and sand---------	19	93			

Well E-39

Owner: L. M. Fisher, Jr. Driller: John Finster.

Clay, red and yellow--	12	12	Clay, blue------------	4	72
Sandrock--------------	2	14	Sand------------------	3	75
Sand (water)----------	16	30	Clay, blue------------	4	79
Clay------------------	4	34	Sandrock--------------	1	80
Clay, blue------------	18	52	Sand, gray (water)----	5	85
Sand------------------	4	56	Clay, blue------------	1	86
Clay, blue------------	10	66	Sand (water)----------	19	105
Sand------------------	2	68			

Well E-44

Owner: J. J. Welder Estate. Driller: G. H. Laughter.

Soil------------------	2	2	Sand------------------	10	100
Clay------------------	10	12	Clay, red and yellow--	40	140
Sand------------------	38	50	Caliche---------------	1	141
Clay, white-----------	13	63	Clay, soft, yellow----	19	160
Sand------------------	1	64	Sand------------------	10	170
Clay, red and yellow--	26	90	Clay, red and blue----	50	220

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Well E-44--Continued

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand	20	240	Clay, hard, blue	32	320
Clay, blue	38	278	Sand	14	334
Sand	10	288			

Well E-47

Owner: J. J. Welder Estate. Driller: G. H. Laughter.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand	80	80	Sand, blue	15	295
Sand and clay streaks	20	100	Clay, hard, blue	25	320
Clay, white	10	110	Sand, coarse, blue	24	344
Sand	20	130	Clay, hard, blue	108	452
Clay, blue	70	200	Clay, white, red, and yellow	8	460
Material, dark	15	215	Sand, hard, red	5	465
Sand	10	225	Sand, coarse, red	12	477
Clay, dark-blue	55	280			

Well G-5

Owner: San Antonio Loan & Trust Co. Driller: John O'Neil.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay, stiff, red	140	140	Sand (water)	15	230
Sand (salt water)	20	160	Sand and clay	256	486
Sand and shell (water)	10	170	Sand	70	556
Clay, blue	45	215			

Well G-9

Owner: Byers & Schaefer. Driller: B. & P. Drilling Co.

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Sand and shell	61	61	Clay, sandy, and shell	61	122

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

Well G-9--Continued

Sand------------------	2	124	Clay------------------	65	214
Clay------------------	17	141	Sand and clay---------	3	217
Sand and clay---------	5	146	Sand------------------	10	227
Sand------------------	3	149	Clay, sandy-----------	4	231

Well G-15

Owner: Intercoastal Lumber Co. Driller: B. & P. Drilling Co.

Sand and shell--------	78	78	Clay, sandy-----------	8	162
Clay, sandy-----------	51	129	Sand------------------	5	167
Sand------------------	5	134	Clay------------------	35	202
Clay, sandy-----------	8	142	Sand------------------	7	209
Sand------------------	12	154	Clay, sandy-----------	4	213

Well H-2

Owner: J. J. Welder Estate. Driller: G. H. Laughter.

Sand------------------	60	60	Clay, red and yellow--	52	212
Clay, yellow----------	25	85	Sand------------------	18	230
Sand------------------	20	105	Clay, soft, yellow and brown---------------	30	260
Clay, red and yellow--	47	152	Clay, blue and yellow-	50	310
Sand------------------	8	160	Sand and gravel-------	17	327

Well H-4

Owner: J. J. Welder Estate. Driller: G. H. Laughter.

Soil------------------	2	2	Sand------------------	20	30
Clay------------------	8	10	Clay, yellow----------	5	35

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	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Well H-4--Continued					
Sand------------------	10	45	Clay, red and blue----	35	250
Clay, dark-red--------	5	50	Clay, blue------------	45	295
Clay, yellow----------	45	95	Shell and mud---------	5	300
Sand------------------	5	100	Wood------------------	2	302
Clay, yellow----------	95	195	Clay, blue, hard------	6	308
Sand------------------	20	215	Sand, red-------------	17	325

Well J-10

Owner: U. S. Coast Guard. Driller: Henry Cleveland.

No record-------------	190	190	Sand and shell--------	98	433
Sand, fine, and shell-	10	200	No record-------------	17	450
No record-------------	77	277	Sand and rock---------	15	465
Sand and shell--------	16	293	Sand and shell--------	230	695
No record-------------	19	312	Sand, coarse (water)--	32	727
Sand, fine------------	17	329	Clay, sandy-----------	22	749
No record-------------	6	335			