STATE OF ARKANSAS

Arkansas Geological and Conservation Commission

Norman F. Williams, Geologist-Director

WATER RESOURCES CIRCULAR NO. 3

GROUND-WATER RESOURCES OF CHICOT COUNTY, ARKANSAS

By

Frank E. Onellion and James H. Criner, Jr.

U. S. GEOLOGICAL SURVEY

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GROUND WATER RESOURCES OF CHICOT COUNTY, ARKANSAS

By Frank E. Onellion and James H. Criner, Jr.

ABSTRACT

This report describes the geology and the water resources of Chicot County in southeastern Arkansas. The total area of the county, which lies on the flood plain of the Mississippi River, is 647 square miles, and its population in 1950 was 22,306. The drainage consists of numerous bayous, all flowing in a southerly direction, the more notable ones being Macon Bayou, Boeuf River, Crooked Bayou, and Big Bayou. The climate is temperate, and the average rainfall is about 50 inches. Farming is the principal occupation in this county; cotton is the most important crop, although the growing of rice is increasing rapidly, and some small grains and hay also are grown. Irrigation practices are increasing with the increased growing of rice.

The rocks exposed at the surface consist of terrace deposits and alluvium of Pleistocene and Recent ages.

About 12.5 million gallons per day (mgd) of ground water is used in Chicot County. The principal use is for irrigation, smaller amounts being used for municipal and domestic supplies. Potable water is obtained from the Cockfield formation and the deposits of Quaternary age.

In northern Chicot County the Cockfield formation, about 500 feet below the ground surface, yields about 500,000 gallons per day (gpd) of water which is used for municipal and domestic supplies. The water is of sodium bicarbonate type. In the south-central and southern parts of the county the water from this formation tends to be more mineralized and harder, and in the southernmost part it is probably too mineralized for most uses.

The deposits of Quaternary age, occurring generally at depths less than 150 feet below the ground surface, are the most important source of ground water. Water is used from these deposits at an estimated rate of 12 mgd, principally for irrigation. The water is moderately mineralized, is hard, and contains considerable iron. In parts of T. 18 S., R. 3 W., the water contains considerable sodium chloride (common salt) and is unsuitable for most uses.

All domestic, public, and irrigation supplies are obtained from wells. The irrigation and public-supply wells are drilled, and most of the domestic wells are driven.

Records of 60 wells, logs of 17 wells, and chemical analyses of water from 48 wells are given in this report.

INTRODUCTION

PURPOSE AND CHARACTER OF THE REPORT

The purpose of this report is to present information about the occurrence, quality, and use of ground water in Chicot County, Ark. Ground water is one of the most important natural resources of the county, and it is being used at a rapidly increasing rate. Mr. Norman F. Williams, Director of the Arkansas Geological and Conservation Commission, recognized the need for further information about this resource and suggested that a study should be made under the cooperative program.

This study, therefore, is part of the program of ground-water investigations begun in 1946 by the United States Geological Survey in cooperation with the University of Arkansas, Bureau of Research. In 1950 the cooperation was transferred to the Arkansas Resources and Development Commission, Division of Geology. The University's Agricultural Experiment Station still cooperates in a program of water-level measurements in the Grand Prairie region of Arkansas.

The areas covered by these cooperative ground-water investigations, for which reports have recently been published or are in preparation, are shown on figure 1. Earlier reports dealing with ground water in southern and northeastern Arkansas, published by the U. S. Geological Survey, were prepared by Veatch (1906)[1] and by Stephenson and Crider (1916).

METHODS OF INVESTIGATION AND ACKNOWLEDGMENTS

The investigation upon which this report is based was begun in the summer of 1952, although H. B. Counts and Howard Klein had made an inventory of municipal wells in 1950. An inventory of existing irrigation and deep domestic wells in the area was made by the junior author during 2 months of field work in 1952 and 3 weeks in 1953. The geology of the area was studied by the senior author, chiefly from subsurface data, including all available well logs; he also spent 3 weeks in the field in 1952.

Samples of water were collected from 48 wells in the county, and chemical analyses of them were made by the U. S. Geological Survey at Fayetteville.

Highway maps of Chicot County compiled by the State Highway Commission were used as base maps in preparing figure 4.

The help of many people who gave information about wells in Chicot County is gratefully acknowledged. Mr. James Lingo, Mr. Doyne Lloyd, and Mr. M. L. Rhodes assisted in making the pumping tests. The Layne-Arkansas Co., the Lilly Bros., and the H. S. Ragland Co. gave well logs and information about water wells in the county.

DESCRIPTION OF THE AREA

Location and Extent

Chicot County is located in the southeast corner of Arkansas. It is bounded on the east by the Mississippi River, on the south by the State of Louisiana, on the west by Ashley and Drew Counties, and on the north by Desha County.

The total area of the county is 647 square miles, about 37 miles from north to south and about 17 miles from east to west.

Topography and Drainage

Chicot County lies in the Gulf Coastal Plain physiographic province and is an area of slight topographic relief; in fact, the land surface over most of the county is almost flat. It slopes generally to the southeast at about 1 foot per mile, the altitude ranging from 135-140 feet above mean sea level in the northern part of the county to 100-105 feet in the southern part. Along the Mississippi River the altitude ranges from 105 feet above mean sea level in the northern part of the county to 85 feet in the southern part.

The land surface is characterized by flood-plain and old meander-belt topography. In general it is a flat to slightly undulating plain with occasional remnants of natural levees, numer-

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[1] See "Selected references," p. 26.

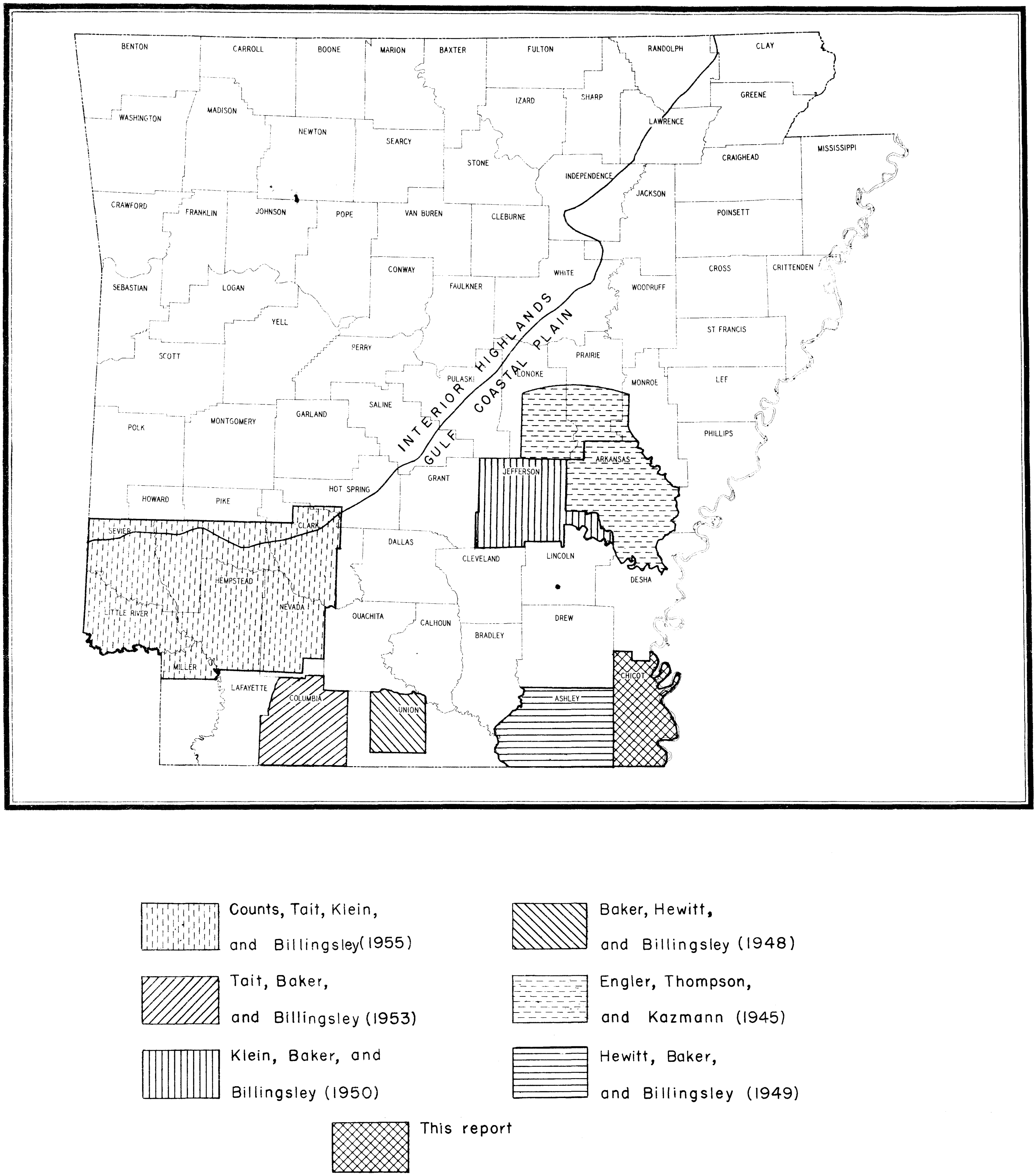


Figure 1. Areas in Arkansas Covered by Recent Ground-Water Reports.

ous oxbow lakes, and swampy areas which generally mark the sites of older oxbow lakes. Rising 10 to 20 feet above the surrounding plain in the vicinity of Eudora is the Macon Ridge, which extends in a southwesterly direction to the vicinity of Bakers, La. It is ½ to 2½ miles wide and consists of the eroded remnants of older terrace materials which once covered most of southeastern Arkansas. On the basis of a correlation with terrace deposits in Louisiana, Fisk (1944, p. 30) considers the deposits to be of Pleistocene age.

The drainage system of the county consists of the Mississippi River, which flows along its eastern side, and numerous bayous, all flowing in a southerly direction. From east to west the main streams are Macon Bayou, occupying an old meander belt of the Arkansas River, Boeuf River, Crooked Bayou, and Big Bayou. Among the more prominent oxbow lakes in the area are Lake Chicot and Grand Lake.

Climate

The climate of southeastern Arkansas is mild and favorable for agriculture and many other pursuits. The winters are usually short and mild, although there are a few cold, snappy days. The summers are long and temperatures of 100° or more are not uncommon. The rainfall in this area is usually abundant, sometimes excessive, but there are also years of light summer rainfall when crops suffer from inadequate moisture. The weather in spring and autumn is pleasant.

No continuous record of the weather has been kept in Chicot County. However, the nearest United States Weather Bureau station is at Portland, only about 7 miles west. Figure 2 gives information about the growing season, temperature, and precipitation at Portland.

The average length of the growing season is about 223 days, although killing frost has occurred as early as October 10 and as late as April 16. The average mean temperature recorded at Portland is 64.4°, and the average annual precipitation is 49.72 inches. The average monthly precipitation ranges from 5.56 inches in December to 2.54 inches in September. The maximum precipitation generally occurs from December through May and the minimum from June through October. The maximum, minimum, and mean precipitation for this area are given in figure 2.

Culture

The population of Chicot County in 1950 was 22,306, the average density being 34.4 inhabitants per square mile. In 1940 the population was 27,452. The largest cities and their population in 1950 were: Dermott, 3,601, Eudora, 3,072, and Lake Village, 2,484.

The residents of Chicot County are almost entirely dependent on agriculture for a livelihood, 69.5 percent of the population being engaged in that occupation. The total area of the county is approximately 414,080 acres. In 1945 there were 3,169 farms with a total acreage of 245,667 (an average of 77.5 acres per farm). Of this farm acreage, 56 percent was in crops, 34.3 percent in timber, and 9.7 percent in pasture. The county lies in the delta region of Arkansas, and its highly productive soil is especially suited for growing cotton. In 1947 this one crop is estimated to have produced 80 percent of the income obtained from farming. Other principal crops are oats, alfalfa and lespedeza hay, sweet potatoes, and small grains. The growing of rice has increased rapidly since 1947, and on some farms it is reported to be replacing cotton as the principal cash crop. The raising of livestock is increasing, but in 1947 it made up only 4.1 percent of all farm products marketed.

Timber is an important source of income; the county ranks 22d in the State in total stand of commercial timber. In 1947 there were 12 active mills producing 7,527,000 board-feet per year.

The county is served by U. S. Highway 65, which passes diagonally through it from northwest to southeast, by U. S. Highway 82, which crosses it in an east-west direction near its center and extends into the State of Mississippi across the Mississippi River, and by U. S. Highway 165, which crosses the northwest corner of the county. Auxiliary county roads are graveled and kept in good condition.

A line of the Missouri Pacific Railroad passes through the center of the county in a general north-south direction.

Soil and water are by far the most important mineral resources of the county. Sand and gravel have been produced on a small scale and are important in road construction and building. Several unsuccessful oil tests have been drilled in the county.

There are no large factories in the county. Several cotton gins and a few active sawmills constitute the present industrial establishments.

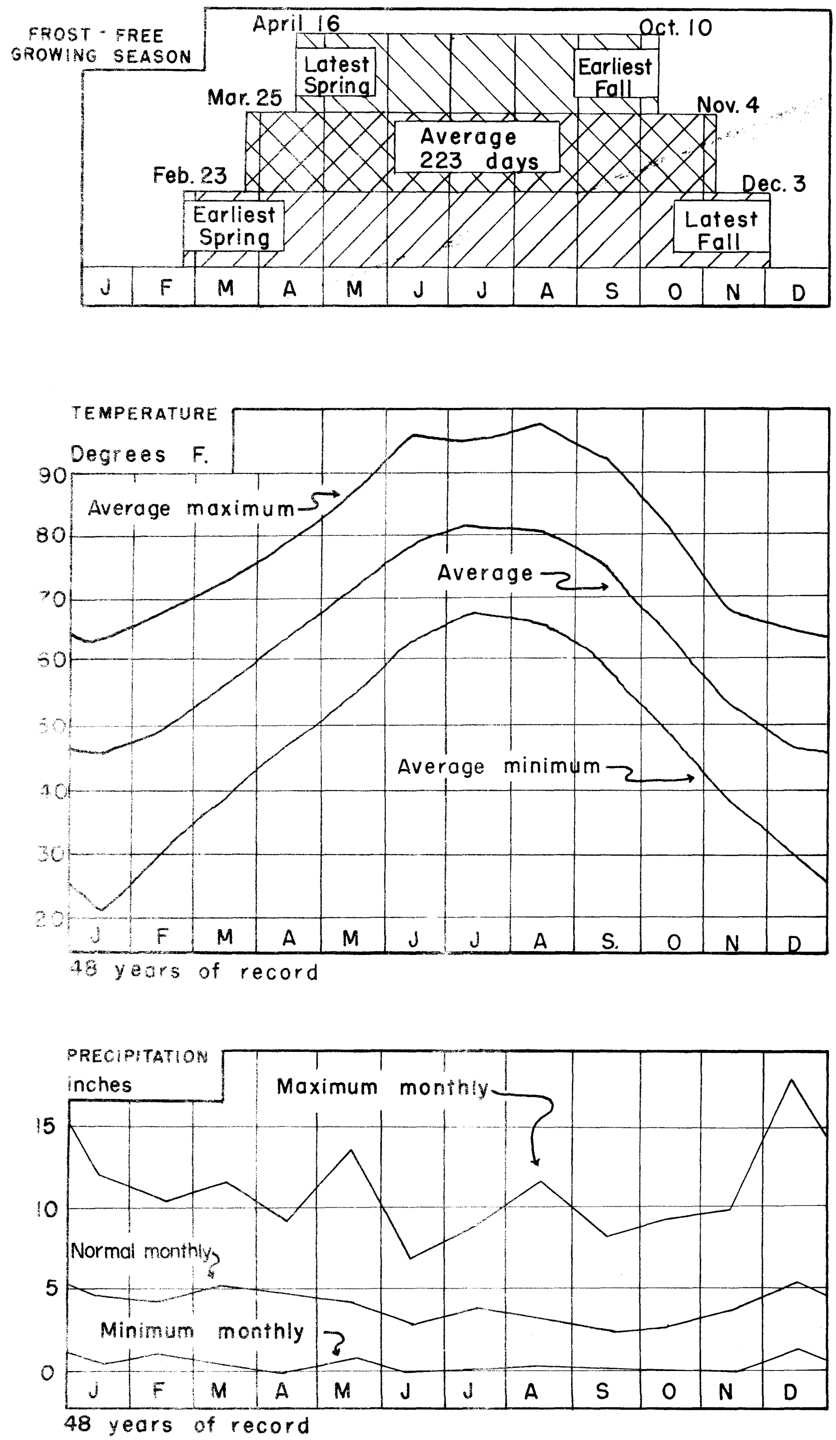


Figure 2. Selected Climatological Data for Portland, Near Chicot County, Ark.

GEOLOGY AND WATER-BEARING PROPERTIES OF ROCK FORMATIONS

Chicot County is in the Gulf Coastal Plain of Arkansas. The surface of the plain is mantled by alluvial and terrace deposits of Recent and Pleistocene age, generally ranging between 75 and 150 feet in thickness. The mantle rests unconformably on gently tilted Tertiary rocks consisting of alternating marine and nonmarine deposits, between 2,000 and 3,000 feet thick. The Tertiary is underlain unconformably by Mesozoic rocks which may be 5,000 to 6,000 feet thick. The Mesozoic rocks are in turn underlain unconformably by a basement complex of relatively hard and intensively deformed rocks of Palezoic age. The older and least important rocks, from the hydrologic point of view, will be described first, and the younger and more important hydrologic units will be described in greater detail.

PALEOZOIC ROCKS

Rocks of Paleozoic age crop out in northwestern Arkansas and form the hilly and mountainous Paleozoic uplands. According to Spooner (1935), these rocks extend southward and eastward beneath the Gulf Coastal Plain, becoming progressively deeper toward the Mississippi River. No wells are known to have been drilled to the basement complex in Chicot County; however, from well records in adjacent areas, Fisk (1944, fig. 61) concludes that Paleozoic rocks occur at depth of 7,500 to 9,500 feet below the land surface.

From what is known of their character in the area of outcrop and from the few oil-test holes that have been drilled into them, it seems unlikely that any Paleozoic rocks underlying Chicot County are permeable enough to constitute important aquifers. Furthermore, any water encountered in such rocks is likely to be very saline.

MESOZOIC ROCKS

Mesozoic rocks of Lower and Upper Cretaceous age crop out in southwestern Arkansas. From evidence obtained from deep oil tests in southern Arkansas and adjoining States, Imlay (1949, p. 2) concludes that the rocks of Cretaceous age thicken southward and are underlain by older Mesozoic rocks of Jurassic age. Information gathered from records of oil-test wells in Chicot County indicates that Cretaceous and Jurassic deposits are present in this area.

The Mesozoic rocks of Arkansas consist of sand, marl, chalk, limestone, anhydrite, red beds, salt, volcanic material, and igneous rock. Spooner (1935, p. 28 and 63) and Imlay (1949, p. 3) believed that the Mesozoic sediments were deposited under nearshore and offshore marine conditions. Spooner (p. 72) postulated that during Cretaceous time the volcanic materials were ejected from vents in southwestern Arkansas and that they were deposited by water. Also, he believed that some of the igneous rocks were intruded during this time. Both volcanic material and intrusive rocks have been encountered by wells in the basal beds of the Upper Cretaceous formations. In Chicot County the Mesozoic beds are about 5,000 to 6,000 feet thick.

Owing to the fine-grained nature of the Mesozoic rocks penetrated by oil-test wells in Chicot County, it is doubtful if much water could be obtained from them. Moreover, that which they might contain is probably too highly mineralized for most uses.

CENOZOIC ROCKS

Cenozoic rocks cropping out in eastern Arkansas consist of Paleocene, Eocene, and Pliocene deposits of Tertiary age and Pleistocene and Recent Deposits of Quaternary age. Information from well records of oil tests indicates that the formations of Paleocene and Eocene age are present in Chicot County, unconformably underlying Pleistocene and Recent deposits, which are the only rocks that crop out in this county.

The Tertiary rocks consist of marine sand, sandy clay, clay, and marl, in part glauconitic and containing thin beds and lenses of limestone and chalk, and nonmarine sand, sandy clay, and clay, in part lignitic and carbonaceous. The deposits of Pleistocene and Recent age consist of fluvial clay, sand, and gravel. Information obtained from oil-test wells in Chicot County indicates that the Cenozoic rocks are about 2,800 to 3,300 feet thick in this area.

Because the Cenozoic rocks are the source of ground water in Chicot County, they will be described in greater detail in this report.

Structure of the Cenozoic Rocks

Chicot County is located on the flank of a large structural dome known as the Monroe Uplift; north of the county is a structural basin known as the Desha Basin. During Late

Cretaceous time and during the Tertiary period, the area of the Monroe Uplift was elevated relative to the Desha Basin. As a result the Tertiary formations dip to the northeast, and some of them tend to thicken in that direction.

A normal fault in Ashley County, described by Hewitt (Hewitt and others, 1949, p. 10), may extend into southwest Chicot County, but no information was found that would substantiate or disprove such an extension.

Tertiary System

The Tertiary system in southeastern Arkansas is represented by marine deposits of Paleocene age and by marine and nonmarine deposits of Eocene age. The nature of the deposits indicates that the sea made several inroads over the area during that time.

Data from drillers' logs and electric logs of oil tests reveal a considerable difference in the strata laterally, with a complex interfingering of different kinds of material. Also, in a vertical direction, zones consisting of one type of material tend to grade into zones consisting largely of another type, without well-defined contacts between them.

In Arkansas the Tertiary strata were divided originally into four formational units—Midway, Wilcox, Claiborne, and Jackson. In more recent times, however, the Claiborne formation has been considered a group, as it is designated in adjoining States, and is divisible into the Cane River, Sparta, Cook Mountain, and Cockfield formations (Spooner, 1935, p. 120). These formations are recognized in a general way from data obtained from electric logs and drillers' logs, but there is considerable uncertainty about some of the correlations and particularly about the position of the formational contacts. Data from records of oil tests reveal that these formations are present in Chicot County. (See figure 3, p. 28.)

The data concerning the characteristics of the Cenozoic formations were gathered from publications by Veatch (1906) and Spooner (1935) and from drillers' logs and electric logs of oil tests in Chicot County; the thicknesses of the formations were calculated from records of oil tests in this county.

Paleocene Series

Midway Formation

The Midway formation unconformably overlies the deposits of Mesozoic age. The formation is of offshore marine origin (Veatch, 1906, p. 31) and is lithologically similar to the underlying Cretaceous formations. The basal part consists of calcareous clay, marl, and limestone; the upper part consists of dark-gray noncalcareous clay infrequently interbedded with stringers of fine sand. It ranges in thickness from about 425 feet in the southwestern part of the county to about 700 feet in the northeastern part. The formation dips to the northeast at a rate of about 27 feet per mile.

The Midway formation is not a source of fresh water in Chicot County. Owing to the fine-grained nature of the deposits, it is not likely to contain water in any appreciable amounts and that which it does contain is probably too saline for most uses.

Eocene Series

Wilcox Formation

The Midway formation is overlain conformably by the Wilcox formation and grades into it without a well-defined contact. As a result of uplift, the sea withdrew from this area during Wilcox time and sediments were deposited in low-lying swamps or marshes that were occasionally submerged by the sea (Veatch, 1906, p. 31). This formation consists predominantly of white to gray sand complexly interbedded with chocolate-brown sandy clay and shale, in part lignitic and carbonaceous. It contains some thin beds of chalk and limestone. It tends to thicken and thin laterally, attaining a maximum thickness of about 1,080 feet in the northeastern part of the county and a minimum thickness of about 875 feet in the southeastern part of the county. It dips to the northeast at a rate of about 8 feet per mile.

According to Veatch (p. 83) the Wilcox formation, which he called Sabine, is an important aquifer in northern Louisiana and southern Arkansas, but electric logs of oil tests in Chicot County indicate that water from the formation is probably so highly mineralized as to be unsuitable for most uses. However, it should be remembered that only an estimation of the water's quality can be obtained from electric logs, and it will be necessary to collect samples of water from the formation in order to determine its actual quality.

Claiborne Group

The deposits of Claiborne age in southeastern Arkansas are probably largely of continental or near-shore marine origin. In ascending order, they consist of the marine Cane River formation, the continental Sparta sand, the marine Cook Mountain formation, and the continental Cockfield formation. This group is 1,250 to 1,500 feet thick and becomes thicker to the northeast in the direction of dip. The beds dip at a rate of about 8 feet per mile. Correlation of the formations of the Claiborne group in southeastern Arkansas is uncertain and tentative.

Cane River formation.—The Cane River formation, the lowermost of the Claiborne group, conformably overlies the Wilcox formation, but their contact is gradational and is not well defined. The deposits of this formation are of near-shore marine origin. Veatch (p. 32) believed that the sea that withdrew prior to Wilcox time readvanced over this area during Cane River time. This formation consists predominantly of brown lignitic and glauconitic clay, sandy clay, and sand with some thin beds of chalk and limestone (Spooner, 1935, p. 122-123). It ranges in thickness from 350 to 515 feet, the thickness increasing to the northeast.

The fine-grained nature of the deposits of this formation is not favorable to the conditions required of a good aquifer. Therefore, the Cane River is not a source of water in Chicot County.

Sparta sand.—The Sparta sand overlies and is gradational with the Cane River formation. It occurs at depths ranging from about 760 feet in the southwestern part of the county to about 1,150 feet in the northeastern part. The absence of marine fossils and the presence of lignitic material suggests that the Sparta is of continental origin. This formation consists of massive beds of white to gray, fine-to medium-grained sand with beds and lenses of sandy or silty clay and some thin beds of lignite. The occurrence, thickness, and continuity of the sand beds is quite variable, but in general the sands appear to be interconnected. The maximum thickness of the formation is about 480 feet, the thickest part occurring in the western part of the county.

The Sparta sand is an important source of ground water in south-central Arkansas but not in Chicot County. A well drilled to a depth of 1,064 feet at Eudora (well 38, table 11) reportedly produced brackish water from this formation; the well later was finished at 150 feet. The data obtained from electric logs of oil-well tests in this county also indicate that the water in the Sparta is saline. However, electric logs give an indication of the probable salinity only, and the actual quality of the water can be determined only by chemical analysis of samples of the water. Possibly fresh water can be obtained from the Sparta sand in the northern part of the county.

Cook Mountain formation.—The Cook Mountain formation overlies the Sparta sand with no well-defined contact between them. Spooner (p. 123) reports Cook Mountain beds of marine origin in Bradley County, and it is believed that beds of that age in Chicot County are also of marine origin. The formation consists of beds of clay and sandy clay with some impure limestone and some thin lenses of sand. The thickness ranges from 100 to 160 feet, being greatest in the northeastern part of the county.

Because the deposits are fine-grained, the Cook Mountain formation is not a source of water in this county.

Cockfield formation.—The Cockfield formation overlies and is gradational with the Cook Mountain formation. It is the uppermost and youngest formation of the Claiborne group in Chicot County. It occurs at depths of 500 feet below the land surface in the northern part of the county, 195 feet in the east-central part, and 195 to 325 feet in the southern part.

On the basis of its lignitic nature and the absence of marine fossils, Veatch (p. 37) considered the Cockfield to be of nonmarine origin.

The thickness ranges from 300 to 625 feet, being greatest in the northeastern part of the county. The Cockfield formation consists largely of gray to white, fine- to medium-grained sand, in part lignitic, with some beds of gray to brown sandy to silty clay and occasional thin beds of lignite. Locally the sand beds may reach a continuous thickness of as much as 300 feet, but in most places the sand is interbedded with layers of clay.

In Chicot County, water has been taken from the Cockfield formation for more than 50 years; however, the rate of use has always been relatively small. The present rate of pumping is estimated to be about 500,000 gallons per day. Eight wells tap the Cockfield, seven of which are in the northern half of the county. Six of the wells are for public supply, of which three are at Lake Village, two at Dermott, and one at Eudora. Two wells are used for domestic purposes. The wells range in depth from 311 feet at Lake Village to 500 feet at Dermott. The maximum reported yield is 410 gallons per minute. Information about these wells is given in tables 9 and 11, and their locations are shown on figure 4.

Jackson Formation

The Jackson formation is the youngest formation of Tertiary age in Chicot County. It overlies the Cockfield formation with no marked break in sedimentation. On the basis of foraminifera and other marine fossils and fossil plant remains, Wilbert (1953, p. 23) believes the strata of Jackson age to contain both marine and nonmarine beds in southeastern Arkansas. Data obtained from records of oil tests in Chicot County indicate that these strata are present in this county. This formation consists of blue to gray clay, sandy clay, and thin beds of gray sand. The lower beds are somewhat glauconitic and the upper beds are, in part, carbonaceous. Its maximum thickness in Chicot County is about 200 feet.

Owing to its fine-grained nature, the Jackson formation is not a source of ground water in Chicot County. It is relatively impermeable and thus tends to prevent the movement of water downward from the overlying formations or upward from the Cockfield formation. As a result of its low permeability, the Jackson formation serves as the confining bed for artesian water in the Cockfield formation.

Quaternary System

The deposits of Quaternary age lie unconformably on the Jackson formation and are the surface material in Chicot County. The deposits consist mostly of alluvium deposited by the Mississippi and Arkansas Rivers and are considered to be of Recent age, although there are some terrace deposits of Pleistocene age, as verified by their presence on Macon Ridge (Fisk, p. 30).

In Chicot County, the Quaternary deposits attain a maximum thickness of about 150 feet. They consist of blue, red, or yellow clay and silt, and red, blue, brown, yellow, and gray sand and gravel. In general the lower part of the deposits consists of coarse-grained material and the upper part of fine-grained material. The basal portion generally is made up of coarse-grained sand and gravel, which contains lenses of fine- to medium-grained sand and some clay balls. Its thickness ranges from 10 to 30 feet. Overlying the basal sands and gravels are beds of fine- to medium-grained sand that range up to 70 feet in thickness. For the most part, the Quaternary aquifer grades from coarse sand at the bottom to fine sand at the top, and it usually contains lenses of clay and gravel. The upper part of the deposits consists largely of clay and silt, which ranges in thickness from 10 to 50 feet. The clay is frequently sandy or silty and is interbedded with thin lenses of fine- to medium-grained sand. The nature of the deposits of Quaternary age is shown on figure 5, p. 30.

The deposits of Quaternary age are the most important source of ground water in Chicot County. Water from them is used at an average rate of about 12 million gallons per day. Table 11 gives information about 52 wells tapping these deposits, and table 9 gives chemical analyses of water from 40 of the wells. The location of these wells is shown on figure 4, p. 29.

These deposits are the principal source of water for domestic supplies in the county, although the amount withdrawn for this use is relatively small.

Of the two wells at Eudora, used for public supply, the shallower is believed to yield water from these deposits. Both wells were drilled to a considerable depth, then backfilled and screened at shallower depths. Some of the water from the deeper well probably comes from the upper beds of the Cockfield formation. The chemical quality of the water from the shallower well suggests that it draws largely from the Quaternary deposits.

The largest use of water from the deposits of Quaternary age is for the irrigation of rice. The estimated use during 1952 averaged nearly 12 million gallons per day, even though rice has been grown in this county only since 1946. The acreage of rice harvested and the number of irrigation wells drilled are listed, by years, in table 1.

TABLE 1
Rice Acreage and Irrigation Wells Drilled in Chicot County, by Years, 1946-54

Year	Acres of rice harvested	Number of irrigation wells drilled[1]
1946	70	0
1947	850	0
1948	3,300	2
1949	5,800	6
1950	6,800	10
1951	10,000	9
1952	9,700	7
1953	12,500	12
1954	15,400	14

[1] Plus two irrigation wells for which drilling dates are not known.

The maximum reported depth of any well tapping deposits of Quaternary age only in

Chicot County is 150 feet. Because the larger wells are commonly drilled to the base of the Quaternary, 150 feet is considered to be the approximate maximum thickness of these deposits. The wells of largest capacity are in the southeastern part of the county, where one well has a reported yield of 5,000 gallons per minute (gpm) and two others have reported yields of 6,000 gpm. All the irrigation wells have yields reported to be in excess of 1,000 gpm.

GROUND WATER

OCCURRENCE OF GROUND WATER

The following discussion on the source and occurrence of ground water is based on the detailed treatment of the subject by Meinzer (1923, p. 2-102), to which the reader is referred.

The crust of the earth is formed by rocks that generally contain numerous voids and interstices. It is in these open spaces that the water below ground surface accumulates and from which water is furnished to springs and wells. The porosity, the percentage of the volume of the rock mass consisting of such interstices, governs the amount of water that can be stored in any rock. Although the porosity of the strata of an area is an important factor when considering the problems of ground water, the permeability determines the ability of the strata to yield water to springs or wells. The size, shape, and arrangement of the openings determine the permeability of a rock. For example, a bed of fine silt or clay may have a high porosity or water-holding capacity, but, because of the small size of the openings and the adherence of water to the grains of material, the permeability or water-yielding capacity may be very low. Conversely, well-sorted gravel containing large openings that are freely interconnected will transmit water freely. Therefore, water moves most freely through rock that has relatively large and well-connected openings.

Permeability of Water-Bearing Materials

The rate of movement of ground water is determined by the size, shape, quantity, and degree of interconnection of the interstices and by the hydraulic gradient. The capacity of a water-bearing material for transmitting water under hydraulic head is known as its permeability. The field coefficient of permeability is defined by Wenzel (1942, p. 7) as the number of gallons of water a day that percolates under prevailing conditions through each mile of water-bearing bed under investigation (measured at right angles to the flow) for each foot of thickness of the bed and for each foot per mile of gradient. The coefficient of transmissibility is a similar measure for the entire thickness of the water-bearing formation and may be expressed as the number of gallons a day transmitted through each strip of the aquifer 1 mile wide and extending the height of the aquifer, under a hydraulic gradient of 1 foot to the mile. It is the field coefficient of permeability multiplied by the thickness of the aquifer.

The hydraulic properties of the water-bearing materials in Chicot County were determined at two places by pumping tests on wells 27 and 59. Measurements of the drawdown and recovery were made with a steel tape.

The Theis (1935) nonequalibrium method was used to determine the coefficient of transmissibility and the coefficient of storage. The coefficient of storage may be defined as the amount of water, in cubic feet, that will be released from storage in each vertical column of the aquifer having a basal area of 1 square foot when the water level is lowered 1 foot. The Theis nonequilibrium formula may be written as follows:

$$s=\frac{114.6q}{T}\int_{\frac{1.87r^2S}{Tt}}^{\infty}\frac{e^{-u}}{u}du \qquad (1)$$

Where:

s = drawdown of water level, in feet.

Q = discharge of pumped well, in gallons per minute

r = distance of observation well from pumped well, in feet

T = coefficient of transmissibility, in gallons per day per foot

S = coefficient of storage

t = time well has been pumped, in days

The exponential integral of formula (1) is replaced by the term W(u) which is read "Well function of u," and the equation is rewritten as follows:

$$s=\frac{114.6\ Q}{T}W(u) \qquad (2)$$

The value of the integral is given by the following series:

$$W(u) = -0.577216 - \log_e u + u - \frac{u^2}{2.2!} + \frac{u^3}{3.3!} - \frac{u^4}{4.4!} \quad (3)$$

$$\text{where } u = \frac{1.87r^2S}{Tt} \quad (4)$$

Values of W(u) for values of u between 9.9 and 1.0 x 10^{-15} are given by Wenzel (1942). The "well function of u" is plotted against u on log-log paper to form a type curve for determining the transmissibility and the storage coefficients of the formation tested. The observed drawdowns are plotted against $\frac{r^2}{t}$ on log-log paper. The graph of the observed data is matched with the type curve by superposition, keeping the axes of the two graphs parallel, and the values of $\frac{r^2}{t}$, s, W(u), and u are selected for any convenient point on the graph. The value of transmissibility is obtained from equation 2, and the value of the storage coefficient is then obtained from equation 4.

The recovery formula of Theis (1935) which was used in computing transmissibility may be expressed as follows:

$$T = \frac{264\ Q}{s} \log_{10} \frac{t}{t'}$$

in which

T = coefficient of transmissibility in gallons per day per foot

Q = pumping rate, in gallons per minute

t = time since pumping began, in minutes

t' = time since pumping stopped, in minutes

s = residual drawdown at the pumped well, in feet at time t'.

The residual drawdown (s) is computed by subtracting the static water level before pumping began from appropriate water levels taken from the recovery curve. The proper ratio $\frac{\log_{10} \frac{t}{t'}}{s}$ is determined graphically by plotting values of $\log_{10} \frac{t}{t'}$ against corresponding values of s. This method is simplified by plotting $\frac{t}{t'}$ on the logarithmic coordinate of semi-logarithmic paper.

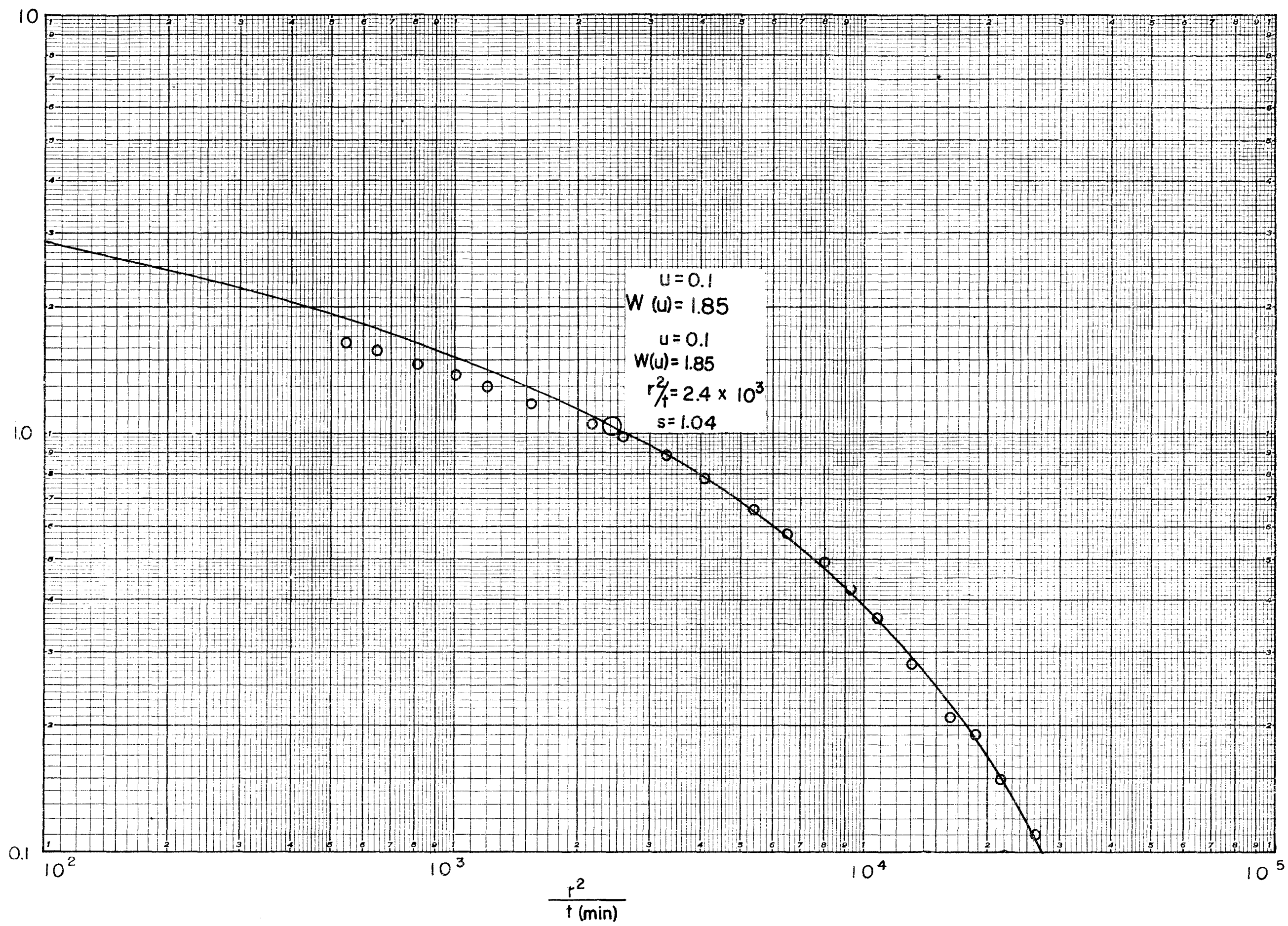
Lake Village Pumping Test

A pumping test was made on well 28 (table 11) in the town of Lake Village in the NW¼SE¼ sec. 2, T. 16 S., R. 2 W. The well was pumped on January 22, 1953, from 12 noon to 2:20 p.m., at an average rate of 250 gallons a minute. The water-level measurements made in a nearby well during the pumping period are given in table 2. The drawdown curve is shown in figure 6. In applying the Theis nonequilibrium formula to the data given in table 2, the value of T (coefficient of transmissibility) was found to be about 51,000 gpd/ft. The value of S (coefficient of storage) was found to be about 0.0008; which means that for each foot the water level falls, 0.0008 cubic foot of water will be released from storage in each column the height of the aquifer having a base 1 foot square. An average coefficient of permeability of 850 gpd/ft² was obtained by dividing the coefficient of transmissibility (51,000) by the thickness of the saturated water-bearing material (60 feet).

TABLE 2

Data on Aquifer Test in Deposits of Claiborne Age, Well 28 Being Pumped at 250 gpm and Water-Level Measurements Made in Well 27

t Time in minutes since pumping started	$\frac{r^2}{t\ (\text{min.})}$ r=255 feet= distance from pumped well	s Drawdown in feet
0		
1	6.5 x 10^4	0.03
2	3.25 x 10^4	0.08
2.5	2.6 x 10^4	0.11
3	2.16 x 10^4	0.15
3.5	1.86 x 10^4	0.19
4	1.62 x 10^4	0.21
5	1.3 x 10^4	0.28
6	1.08 x 10^4	0.36
7	9.3 x 10^3	0.42
8	8.13 x 10^3	0.49
10	6.5 x 10^3	0.58
12	5.4 x 10^3	0.66
16	4.06 x 10^3	0.79
20	3.25 x 10^3	0.89
25	2.6 x 10^3	0.99
30	2.16 x 10^3	1.07
42	1.55 x 10^3	1.18
54	1.2 x 10^3	1.30
65	1 x 10^3	1.38
80	8.13 x 10^2	1.48
100	6.5 x 10^2	1.58
120	5.4 x 10^2	1.64



Q = 250 gpm

m = 60 feet

$$T = \frac{114.6\ Q\ W(u)}{s} = \frac{114.6 \times 250 \times 1.85}{1.04} = 51{,}000 \text{ gpd/ft.}$$

$$S = \frac{ut}{1.87\ r^2/t \text{ (days)}} = \frac{0.1 \times 51{,}000}{1.87 \times 2.4 \times 10^3 \times 1440} = .0008$$

$$P = \frac{51{,}000}{60} = 850 \text{ gpd/ft}^2$$

Figure 6. Drawdown Curve for Aquifer Test in Deposits of Claiborne Age, Well 28 Being Pumped at 250 gpm and Water-Level Measurements Made in Well 27.

James Lingo Pumping Test

A pumping test was made October 30 and 31, 1952, on well 59 (See table 11) on the farm of James Lingo, in the SE¼SE¼SE¼ sec. 29, T. 19 S., R. 1 W. The well was pumped at an average of about 1,450 gallons a minute from 3:00 p.m., October 30 to 10:35 a.m., October 31. The static water level before pumping started was 30.82 feet below the land surface. After pumping had stopped, water-level measurements were made in the pumped well and in a nearby observation well. Pumping water levels were erratic, owing to fluctuations in discharge, and therefore only recovery measurements were used to compute the coefficient of transmissibility and storage.

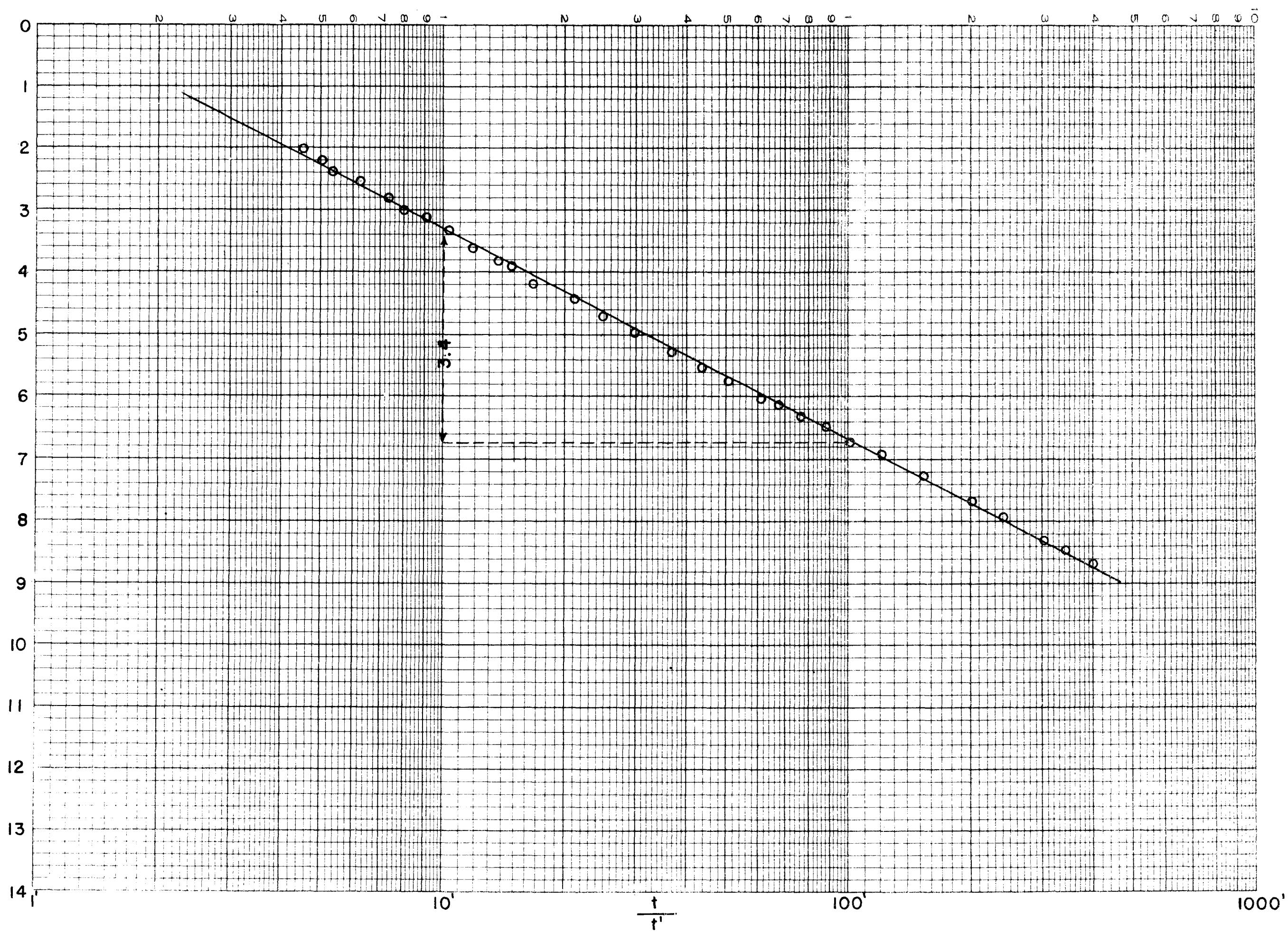
In applying the Theis recovery formula to the data given in table 3, the value of T (coefficient of transmissibility) was found to be 112,000 (fig. 7).

No log was available for this well and the thickness of the saturated water-bearing material was not known; therefore, the coefficient of permeability could not be determined.

TABLE 3

Data on Aquifer Test in Deposits of Quaternary Age, with Water-Level Measurements Made in Well 59 After It Was Pumped at 1,450 gpm

Time since pumping started (minutes) t	Time since pumping stopped (minutes) t^1	$\frac{t}{t^1}$	Depth to water level (feet)	Residual drawdown (feet) s	Remarks
			30.82		Static water level
0					Pump started
1200	0				Pump stopped
1203	3	401.0	39.49	8.67	
1203½	3½	341.0	39.29	8.47	
1204	4	301.0	39.17	8.35	
1205	5	241.0	38.74	7.92	
1206	6	201.0	38.50	7.68	
1208	8	151.0	38.10	7.28	
1210	10	121.0	37.80	6.98	
1212	12	101.0	37.54	6.72	
1214	14	86.71	37.32	6.50	
1216	16	76.0	37.15	6.33	
1218	18	67.11	36.99	6.17	
1220	20	61.0	36.84	6.02	
1224	24	51.0	36.59	5.77	
1228	28	43.86	36.39	5.57	
1234	34	36.3	36.07	5.25	
1242	42	29.57	35.79	4.97	
1251	51	24.53	35.51	4.69	
1260	60	21.0	35.29	4.47	
1272	72	17.67	35.02	4.20	
1287	87	14.79	34.75	3.93	
1295	95	13.63	34.64	3.82	
1310	110	11.9	34.43	3.61	
1330	130	10.23	34.19	3.37	
1350	150	9.0	33.99	3.17	
1370	170	8.06	33.82	3.00	
1390	190	7.32	33.66	2.84	
1430	230	6.22	33.40	2.58	
1460	260	5.23	33.24	2.42	
1500	300	5.0	33.05	2.23	
1540	340	4.53	32.89	2.07	



Q = 1,450 g.p.m.

$$T = \frac{264\,Q}{s}\log_{10}\frac{t}{t'} = \frac{264 \times 1{,}450}{3.4} = 112{,}000$$

Figure 7. Recovery Curve for Aquifer Test in Deposits of Quaternary Age, with Water-Level Measurements Made in Well 59 After Being Pumped at 1,450 gpm.

TABLE 4

Data on Aquifer Test in Deposits of Quaternary Age, with Water-Level Measurements Made in Observation Well 432.5 Feet East of Well 59

Time since pumping stopped (minutes) t	r=432.5 feet= distance from pumped well $\frac{r^2}{t\ (\text{min.})}$	Depth to water level (feet)	Recovery (feet) s	Remarks
0		29.85		Static water level
2.0	9.4×10^4		0.60	
2.5	7.2×10^4		.77	
3.0	6.27×10^4		.98	
3.5	5.37×10^4		1.11	
4.0	4.7×10^4		1.32	
5.0	3.76×10^4		1.54	
6.0	3.13×10^4		1.77	
7.0	2.68×10^4		1.96	
8.0	2.35×10^4		2.15	
10.0	1.88×10^4		2.45	
12.0	1.57×10^4		2.67	
14.0	1.34×10^4		2.89	
16.0	1.17×10^4		3.05	
18.0	1.04×10^4		3.21	
20.0	9.04×10^3		3.35	
24.0	7.83×10^3		3.61	
28.0	6.72×10^3		3.81	
34.0	5.53×10^3		4.07	
42.0	4.48×10^3		4.37	
51.0	3.69×10^3		4.62	
60.0	3.13×10^3		4.85	
72.0	2.61×10^3		5.10	
87.0	2.16×10^3		5.38	
95.0	1.98×10^3		5.49	
110.0	1.71×10^3		5.66	
130.0	1.45×10^3		5.93	
150.0	1.25×10^3		6.13	
180.0	1.04×10^3		6.40	
210.0	8.95×10^2		6.58	
240.0	7.84×10^2		6.75	
300.0	6.27×10^2		7.04	
350.0	5.37×10^2		7.23	

A 1¼-inch well 432.5 feet east of the pumped well was used as an observation well. Its static water level before pumping began was 20.75 feet below the land surface. The drawdown was about 9.10 feet. The water level measurements made during the recovery period are given in table 4. The recovery curve is shown in figure 8. In applying the Theis nonequilibrium formula to the data given in table 4, the value of T (coefficient of transmissibility) was found to be about 112,000 gallons. The value of S (coefficient of storage) was found to be about 0.0003.

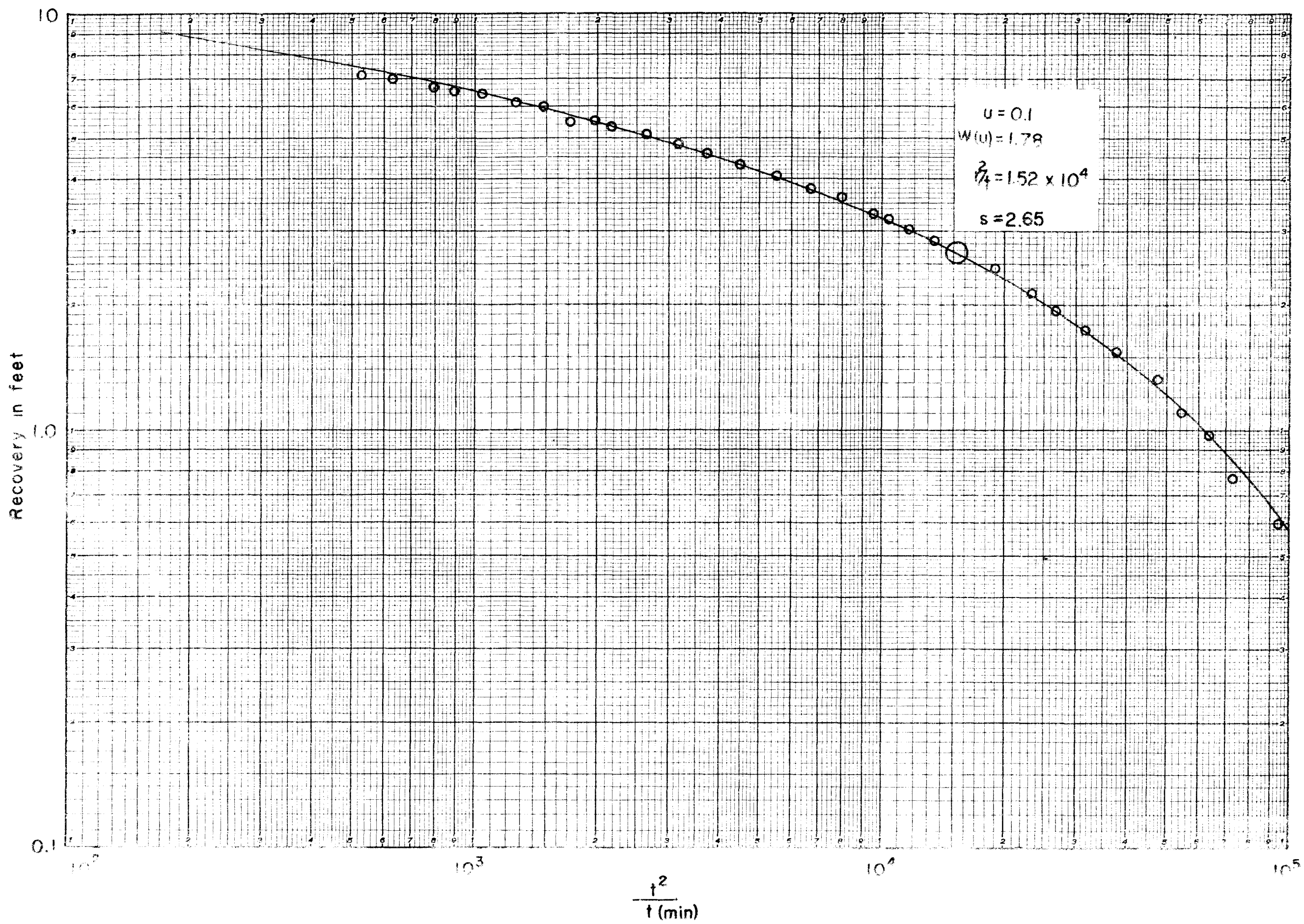
The values for the coefficient of transmissibility and the coefficient of storage in the Claiborne aquifer at Lake Village are of the same order of magnitude as values obtained for Claiborne aquifers elsewhere in Arkansas. Although too much reliance cannot be placed on a single test, it seems probable that these sand beds, which range up to 300 feet in thickness, are capable of supplying many additional wells in Chicot County.

The coefficients obtained for the Quaternary aquifer are about average as compared to values obtained for that aquifer in the Grand Prairie and northeastern Arkansas. This fact indicates that, so far as these characteristics are concerned, the yields of wells and the total amount of water available to wells will also be comparable in the several localities.

Fluctuations of Water Level

The water level in Chicot County is not a stationary surface but rises and falls in a way somewhat comparable to the fluctuations of the water level of a lake or reservoir. In general, the water level rises when the amount of recharge exceeds the amount of discharge, and, conversely, it falls when the amount of discharge exceeds the amount of recharge. Thus, the fluctuation of water level indicates to what extent the ground-water reservoir is being replenished or depleted.

The factors that control the rise of water level are the amount of rainfall that pene-



$$Q = 1450$$

$$T = \frac{114.6\ Q\ W(u)}{s} \quad \frac{114.6 \times 1450 \times 1.78}{1.04} = 112{,}000 \text{ gpd/ft}$$

$$S = \frac{ut}{1.87\ r^2/t\ \text{(days)}} \quad \frac{0.1 \times 112{,}000}{1.87 \times 1.52 \times 10^4 \times 1440} = .0003$$

Figure 8. Recovery Curve for Aquifer Test in Deposits of Quaternary Age, Well 59 Being Pumped at 1,450 gpm, and Water-Level Measurements Made in an Observation Well 432.5 Feet East of Well 59.

trates the soil and reaches the water-bearing strata, the amount of water added by influent streams, and the amount of water that enters the county from adjoining areas. The factors that control the decline of the water level are the amount of water pumped from wells, the amount of water lost by plant absorption (transpiration), water lost directly from the ground-water reservoir by evaporation, water lost by seepage into streams, and water lost by slow movement to adjacent areas.

There is very little information about water levels in the Cockfield formation in Chicot County. The water in the formation is under artesian pressure; that is, in wells tapping the formation it rises above the top of the formation. In 1950 the water levels in the two wells at Lake Village, 487 and 390 feet deep, were 25.99 and 19.57 feet, respectively, below the ground surface.

Table 5 gives the depths to static water level in selected wells tapping deposits of Quaternary age in Chicot County, measured by the U. S. Geological Survey. The water levels are less than 25 feet below the ground surface, except in well 21, which had a water level of 35.19 feet below in April 1954. The water levels have not been measured over a sufficient period of time to permit an analysis of the effects of natural recharge and discharge and of pumping from the deposits.

Most of the measured wells showed a decline in water level from 1953 to 1954 and from 1954 to 1955. This decline may have been due to a deficiency of rainfall in the area during the preceding few years, and thus to inadequate recharge. However, excessive pumping of the measured wells during the growing season and incomplete recovery may account for some of the decline.

In general, the silt and clay in the upper part of the deposits of Quaternary age tend to prevent the downward percolation of surface water into the more permeable lower parts of the deposits. However, it appears that at some places the upper part of the deposits is sufficiently permeable to allow an appreciable amount of recharge. At present the location and extent of the areas in which recharge occurs are not known. Ultimately there may be some recharge from the Mississippi River into the deposits of Quaternary age. This recharge can occur only when the water level in the deposits along the river is lower than the level of the river. Recharge from the river can be of importance only in a band a few miles wide along-side the river, because sufficiently steep hydraulic gradients cannot be established to move appreciable amounts of water farther inland, where the base of the gravels is generally less than 50 feet below river level.

TABLE 5
Water Levels in Chicot County, 1952, 1953, 1954, and 1955
(Depths to Water Below Land Surface in Feet)

Year and month	Well Nos.												
	5	10	13	19	21	22	25	26	32	34	56	57	59
1952													
January	—	—	—	—	—	—	—	—	—	15.22	10.79	7.46	8.02
April	—	—	—	—	—	—	—	—	—	—	8.32	3.81	4.36
May	—	—	—	—	—	—	16.11	—	—	—	—	—	—
1953													
January	—	—	—	—	—	—	—	9.33	—	—	14.02	9.74	19.81
April	12.18	11.77	23.50	18.36	21.48	17.46	17.94	18.19	17.51	16.21	12.97	11.61	12.79
1954													
April	13.68	14.50	22.59	18.82	35.19	18.56	23.17	10.67	24.29	18.43	18.61	4.11	19.42
1955													
February	14.52	15.22	26.62	22.64	23.43	20.32	22.25	21.07	—	—	—	—	—
March	—	—	—	—	—	—	—	—	19.13	19.52	17.60	7.06	18.58

RECOVERY OF GROUND WATER

Principles of Recovery

When water is withdrawn from a well, the water table in the vicinity of the well declines and assumes a form comparable to that of an inverted cone. This is called the cone of depression. An increase in the rate of pumping, in any given well, produces a greater drawdown; as pumping time increases, the effect of the discharge is felt at greater and greater distances and the water levels in wells several hundred feet, or even a mile or so, from the pumped well are lowered somewhat.

The specific capacity of a well is its rate of yield per unit of drawdown and is generally stated in gallons a minute per foot of drawdown. For example, well 17 with a measured yield of 1,100 gallons a minute and a drawdown of 5.26 feet has a specific capacity of 209.1 gallons a minute per foot of drawdown. When a well is pumped the water level drops rapidly at first and then more slowly until conditions of approximate equilibrium between discharge and recharge is reached. In testing the specific capacity of a well, it is important to pump the well until the water level remains approximately stationary. When the pump is stopped, the water level in the well rises rapidly at first, then progressively slower until it reaches approximately its original position.

The character and thickness of the water-bearing materials have a definite bearing on the yield of a well and, hence, on the specific capacity of a well. Drawdown increases the height that the water must be lifted in pumping a well, thus increasing the cost of pumping. Other things being equal, the drawdown in a well varies inversely with the permeability of the water-bearing material.

Well Construction

Driven wells generally are put down where the water-bearing material is only a few feet below the surface of the ground. Such wells are used extensively for domestic supplies in Chicot County. They are generally 1¼ or 1½ inches in diameter and are equipped at the bottom with a screened drivepoint. Most of them are equipped with hand-operated pitcher pumps, but some have small jet or suction pumps.

All irrigation and public-supply wells and some domestic wells in Chicot County are drilled wells. They are drilled by rotary or cable-tool rigs and are lined with galvanized-iron casing. The diameter of the wells ranges from 4 to 14 inches for domestic and public-supply wells and from 8 to 30 inches for irrigation wells. All wells in this area obtain water from relatively unconsolidated deposits and are therefore cased to the bottom to prevent caving of the walls. In some wells the casing is perforated or slotted below the water level, but in most wells a screen or strainer is used to provide a greater intake surface.

Most of the wells in Chicot County that have been drilled in the last several years for municipal or irrigation supplies are gravel packed. In one method of constructing such wells, a large-diameter hole is first drilled and temporarily lined with unperforated casing. A well screen or perforated casing is then centered in the hole opposite the water-bearing material and enough blank casing added to reach the surface. The space between the two casings is filled with carefully screened gravel, and all but 20 to 30 feet of the outer casing is pulled from the hole. In another method the hole is drilled to the top of the aquifer, usually with a rotary machine, the casing is set, and then an underreamer is used to drill a large-diameter hole below the casing. After the screen has been placed in the bottom of the well, gravel is placed around the screen as the well is developed.

A packing of well-sorted, medium to coarse gravel is generally considered to give the best results, but where the water-bearing material is extremely fine, coarse sand or fine gravel may be preferred. The use of the gravel packing permits the use of coarser screens, even though the aquifer may consist of uniform, fine-grained material.

Types of Pumps

All irrigation and public-supply wells in Chicot County are equipped with turbine pumps powered by butane engines, electric motors, or diesel engines. Most domestic wells are equipped with pitcher pumps, but some have suction or jet pumps powered by electric motors.

UTILIZATION OF GROUND WATER

Data were obtained on 60 wells in Chicot County during the course of this investigation. Of these wells, 36 were used for irrigation, 17 for domestic purposes, and 7 for public supplies. Table 11 lists all public-supply and irrigation wells in operation at the time of this investigation. Most of the deeper domestic wells and some of the shallow ones also are listed.

Domestic Supplies

Domestic supplies of water in this area are obtained primarily from driven wells. Because water-bearing materials in the Quaternary deposits are present nearly everywhere and because the water table is rarely more than 20 feet below the surface, shallow driven wells can be obtained practically everywhere in the county. The shallow water in the Quaternary deposits is suitable for most domestic uses.

Public Supplies

Three municipalities in Chicot County have public water supplies obtained from wells: they are Dermott, Lake Village, and Eudora.

The city of Dermott, in northwestern Chicot County, obtains its water supply from two wells (8 and 9, table 11) drilled into the sand of Claiborne age. Water is pumped from these wells to a standpipe at the northwest side of town, whose reported capacity is 100,000 gallons. Each of the two wells is pumped with a turbine pump powered by an electric motor. The reported maximum daily capacity of the system is 100,000 gallons but the daily consumption is not known. The water is of good quality and is not treated.

The city of Lake Village, in the central part of the county, obtains its water supply from three wells (27, 28, and 29, table 11) drilled into upper Claiborne sands. Water is pumped from these wells into a steel standpipe at the north side of town, which has a capacity of 75,000 gallons. Each of the three wells is pumped by an electrically powered turbine pump. The maximum daily use of water in Lake Village is reported to be about 130,000 gallons. The water is somewhat mineralized, containing chloride in excess of 250 parts per million, but is not treated.

Eudora, in the southeastern part of the county, obtains its water supply from two wells (38 and 39, table 11) drawing chiefly from deposits of Quaternary age. Water is pumped from these wells to an elevated steel storage tank and a ground reservoir, each with a reported capacity of 50,000 gallons. Each well is pumped with a turbine pump powered by electricity. The reported maximum daily use is 100,000 gallons per day. The water is very hard, but it is not treated.

Irrigation Supplies

Ground water for irrigation has been used in increasing amounts in Chicot County. Prior to 1946 little or no water was used for this purpose, but as a result of the introduction of rice in this area in 1946, the demands for ground water have increased yearly. It is estimated that an average of about 12 million gallons of water per day was used for irrigation in 1952. This water is supplied largely from wells. The rice acreage and the number of wells drilled in this area are listed in table 1, p. 9.

The deposits of Quaternary age are the only source of the ground water that is used for irrigation in Chicot County. These deposits seem capable of furnishing an ample supply of water everywhere in the county except for a small area in the central part of T. 18 S., R. 3 W. In this area the water is too mineralized for practically all crops. All irrigation wells have yields reported to be in excess of 1,000 gallons per minute, three wells in the southeastern part of the county yielding 5,000 to 6,000 gallons per minute. The maximum reported depth of any well tapping these deposits is 150 feet.

No water for irrigation is obtained from deposits of Claiborne age, and it is doubtful if these deposits would furnish sufficient quantities of water for the irrigation of rice. Furthermore, the water in the southern part of the county is too mineralized for most uses.

The depths and diameters of the irrigation wells in this county are given in tables 6 and 7, respectively.

TABLE 6
Irrigation Wells in Chicot County Classified According to Depth

Depth in feet	Number of wells
70-80	8
80-90	3
90-100	8
100-110	15
110-120	None
120-130	2
130-140	None
140-150	1

TABLE 7
Irrigation Wells in Chicot County Classified According to Diameter

Diameter, inches		Number of wells
Outer casing	Inner casing	
10	----	1
12	----	1
12	8	3
12	10	2
14	----	2
14	8	2
14	10	1
18	8	2
18	9	3
18	10	13
18	12	1
20	10	1
24	10	2
30	10	1

QUALITY OF THE GROUND WATER

All ground water contains more or less dissolved mineral matter. When the quantities of certain dissolved mineral constituents become large, the water is rendered unsuitable for some uses. The following discussion of the significance of various constituents in water is taken largely from previous Arkansas ground-water reports.

Water Standards

Water used for drinking and domestic purposes should have certain general chemical characteristics. These chemical characteristics are independent of any sanitary specifications established for protection of public health. In 1946 the U. S. Public Health Service established certain limits as to chemical substances in drinking water used on interstate carriers:

- Lead should not exceed 0.1 part per million
- Fluoride should not exceed 1.5 parts per million
- Iron and manganese together should not exceed 0.3 part per million
- Magnesium should not exceed 125 parts per million
- Chloride should not exceed 250 parts per million
- Sulfate should not exceed 250 parts per million.

In irrigation water the proportion of sodium is particularly important. Water in which sodium makes up more than 60 percent of the cations (on an equivalent-per-million basis) may be injurious when applied to certain types of soil. An irrigation water having a high proportion of sodium will eventually cause the soil to become relatively impermeable, because of the dispersion of the colloids. Even on sandy soils with good drainage, water having a percent sodium of 85 or higher will produce a relatively impermeable soil after prolonged use. On a heavy soil already high in replaceable sodium, the water of poorest quality that could be used would be one low in total salts but having a high proportion of sodium. (Majistad and Christiansen, 1944.) Water containing 3,000 ppm, or more, of solids is sometimes successfully used for irrigation when large volumes are applied to well-drained soils. Standards for irrigation water are presented in table 8.

TABLE 8
Generalized Quality of Water Standards for Irrigation Water[1]

Water class	Conductance (K x 10^6 at 25° C)	Salt content Total (ppm)	Salt content Per acre (foot-tons)	Sodium (percent)	Boron (ppm)
Excellent to good	1,000	700	1	0-60	0.5
Good to injurious	1,000-3,000	700-2,000	1-3	60-75	0.5-2.0
Injurious to unsatisfactory	+3,000	+2,000	+3	75	2.0

[1] Condensed from Majistad and Christiansen (1944, p. 9).

With the exception of that which is hard or which contains excessive amounts of iron or manganese, water containing less than 500 ppm of dissolved solids generally is satisfactory for most domestic uses. Water with more than 1,000 ppm of dissolved solids is likely to include certain constituents that make it unsuitable for domestic uses.

Analyses of Chicot County Ground-Water Supplies

Samples were taken from 48 wells to determine the chemical character of the ground-water supplies in Chicot County. Twenty-four of the wells are used for irrigation, seventeen for domestic purposes, and seven for public supply. The samples were collected from representative wells distributed as uniformly as possible geographically for each of the principal water-bearing formations. The analyses of the samples are presented in table 9, p. 31.

The analyses deal with the dissolved mineral constituents, which determine the fitness of the water for industrial, agricultural, and domestic uses without reference to the sanitary quality. In most cases a single sample from a well is regarded as representative of the chemical quality, because the concentration of dissolved minerals in water from an individual well seldom shows much variation. Exceptions to this generalization include very shallow wells where the concentration changes with variations in rainfall, wells tapping aquifers subject to salt-water encroachment, and wells recharged by streams that fluctuate in mineral concentration.

Samples of ground water from Chicot County were analyzed according to methods regularly used by the Geological Survey. These methods are essentially the same as, or are modifications of, methods described in authoritative publications for the mineral analysis of water samples (American Public Health Association, 1946).

Chemical Constituents

Silica (SiO_2)

All waters in their natural condition contain silica, which is dissolved from practically all rocks. Some natural waters may contain as little as 3 ppm of silica, whereas others contain more than 50 parts, but the common range is 10 to 30 ppm. The use of water for most domestic purposes and for irrigation is not affected by the presence of silica. In boilers, however, soluble silica has a tendency to form a scale having the composition of the analcite series of minerals.

As shown in table 9, water from the Cockfield formation has a silica content ranging from 12 to 27 ppm, whereas that from the Quaternary deposits has silica ranging from 23 to 38 ppm.

Iron (Fe)

Iron is one of the most common elements found in the earth's crust. It occurs normally as an oxide in sands and gravels, which constitute the chief sources of ground-water supplies. Water passing through the soil generally contains sufficient organic matter and carbon dioxide to dissolve some of the iron and hold it in solution. Objectionable quantities of iron also may be dissolved from pipes and boilers.

The quantity of iron in ground water differs greatly from one locality to another, even though the water is derived from the same water-bearing formation. On exposure to air, normal water that contains more than about 0.5 ppm of dissolved iron soon becomes turbid as the iron is oxidized and precipitated. Some acid water is able to carry much larger quantities of iron in solution even when exposed to the air. Large amounts of iron may interfere with the efficient operation of silicate water softeners, and may prove more troublesome than either excessive hardness or dissolved solids. Iron in water used for domestic purposes is objectionable because it often causes reddish-brown stains on white porcelain or enameled ware and fixtures, and on clothes and other fabrics. Iron in water is most readily removed by aeration and filtration.

Ground water sampled in Chicot County contained 0.1 to 20 ppm of iron. The waters from the Cockfield formation have iron concentrations ranging from 0.1 to 0.5 ppm and those from the Quaternary deposits have 0.1 to 20 ppm of iron. A comparison of the concentration of iron in the two water-bearing formations is shown in table 10.

The high values for iron content in waters from wells in the Quaternary deposits presumably represent the true iron content. Most of the wells had been flowing continuously for several weeks before the samples were collected and no suspended material was present in any of the samples. On the few analyses where color was determined, no correlation between color intensity and iron content could be shown. Also, no correlation was found between pH and iron content. For the complete analyses, a separate sample was collected for iron analysis only, and these show the high content as often as do the partial analyses.

Calcium (Ca) and Magnesium (Mg)

Calcium is found in all natural water, usually in greater quantities in water that is in contact with limestone, dolomite, and gypsum. Magnesium is dissolved from many rocks, particularly dolomitic rocks. The concentration of calcium and magnesium in water determines the hardness of the water. These two ions react with soap, forming a scum which is objectionable, and they are largely responsible for the formation of boiler scale. In the samples for which analyses are given in this report, the calcium ranged from 0.4 to 432 ppm, and the magnesium ranged from 0.4 to 174 ppm.

TABLE 10

Comparison of the Chemical Character of Water from the Cockfield Formation and from Quarternary Deposits in Chicot County

Chemical constituents	Range, in parts per million	Number of samples: Cockfield formation	Number of samples: Quaternary deposits
Dissolved solids	Less than 500	2	18
	501 to 1,000	5	10
	More than 1,000	0	13
Hardness	0 to 60	6	0
	61 to 120	0	0
	121 to 200	0	8
	201 to 300	1	8
	301 to 400	0	4
	401 to 500	0	3
	501 to 1,000	0	11
	More than 1,000	0	7
Iron	Less than 0.1	1	1
	0.1 to 1.0	5	0
	1.1 to 5.0	0	5
	5.1 to 10.0	0	22
	10.1 to 15.0	0	3
	15.1 to 20.0	0	9
	20.1 to 25.0	0	1
Chloride	Less than 250	4	31
	251 to 500	3	5
	More than 500	0	5

Sodium (Na) and Potassium (K)

All natural water contains compounds of sodium and potassium in solution. Water that contains less than 5 ppm of the two together is likely to carry almost as much potassium as sodium. As the total quantity of these constituents increases, the proportion of sodium generally becomes greater.

Moderate quantities of sodium and potassium have little effect on the suitability of the water for most uses. However, when sodium and potassium salts make up most of the mineral content, the water may not be satisfactory for irrigation. The effects of sodium in water used for irrigation are discussed under "Water Standards." In the analyses of water in Chicot County (table 9), the sodium ranged from 13 to 494 ppm, and the potassium ranged from 0.6 to 8.6 ppm. Samples from the Cockfield formation contained 95 to 317 ppm of sodium, the greatest concentration occurring in the water at Lake Village. The sodium content in water from the Quaternary deposits is usually less than 120 ppm.

Carbonate (CO_3) and Bicarbonate (HCO_3)

Carbonate and bicarbonate occur in water as a result of the solvent action of carbon dioxide in rain or surface water reacting with the minerals present in the earth, such as calcite and dolomite, and forming calcium and magnesium bicarbonates. Carbonate is rarely present in appreciable quantities in natural water. The bicarbonates in water that comes from relatively insoluble rocks may amount to 50 ppm or less; many samples of water from limestones contain 200 to 400 ppm. Bicarbonate in moderate concentration has no effect for most uses; however, large quantities of sodium bicarbonate will cause foaming and priming in boilers. The bicarbonate content in the ground water sampled ranged from 130 to 662 ppm; in samples from the Cockfield it ranged from 237 to 425 ppm, and in those from the Quaternary deposits, from 130 to 662 ppm.

Sulfate (SO_4)

Sulfate is dissolved in large quantities from gypsum, shale, and deposits of sodium sulfate. When present in sufficient quantities, sulfate will combine with calcium to form a hard calcium sulfate boiler scale. The sulfate content of the ground water sampled ranged from 0.6 to 342 ppm.

Chloride (Cl)

Chloride occurs in varying amounts in all natural water because the chlorides of calcium, magnesium, sodium, and potassium are extremely soluble. Chloride in excess of 500 ppm affects the palatability of drinking water. Large quantities of chloride may affect the industrial use of water by increasing the corrosiveness of water that contains large quantities of calcium and magnesium.

The concentration of chloride in samples from the Cockfield formation ranged from 14 to 313 ppm and in samples from the Quaternary from 4.5 to 1,490 ppm, but in most samples it was less than 300 ppm.

Nitrate (NO_3)

Nitrate is usually present in natural water in relatively small quantities. Its presence in excessive amounts may indicate contamination by sewage and other organic matter, as it represents the final stage of oxidation in the nitrogen cycle. Maxcy (1950, p. 271) concludes that water having a nitrate content in excess of 44 ppm (as NO_3) should be regarded as unsafe for use in infant feeding. Several studies have indicated that an excessive nitrate content in water used in feeding may be the cause of methemoglobinemia in infants. Research is being carried on by several agencies throughout the country to establish the maximum permissible amount. The nitrate content of water sampled for the present study ranged up to 3.5, and most samples contained less than 2 ppm.

Dissolved Solids

The values listed in table 9 for the dissolved solids represent approximately the dissolved mineral constituents in the water, plus small amounts of organic matter and any water of crystallization. Twenty of the samples analyzed contained less than 500 ppm of dissolved solids; this water is satisfactory for most domestic uses and some industrial uses, after proper treatment. Many samples were very hard and contained excessive amounts of iron. The range in dissolved solids in water sampled in Chicot County was from 191 to 3,720 ppm. Dissolved solids found in 17 samples, and indicated by specific conductance in other samples, from the two formations are listed in table 10.

Chemical Characteristics of the Water

The degree of acidity or alkalinity of water, as indicated on the pH scale, is related to the corrosive properties of water and must be known for proper treatment by coagulation. A pH of 7.0 indicates that the water is neutral. Values progressively lower than 7.0 denote increasing acidity, and values progressively greater than 7.0 denote alkalinity. The pH of most natural water is in the range of 6 to 8, although more acid conditions result where the water contains high concentrations of free carbon dioxide or mineral acid, such as that from mine drainage. As the pH becomes progressively less than 7.0, and especially less than 5.0, the water becomes more corrosive. The pH of the water sampled in Chicot County ranged from 7.0 to 8.9.

Hardness is generally considered one of the most important factors in choosing a water supply for either domestic or industrial use. It is recognized by the increased quantity of soap required to produce lather, by the formation of an insoluble curd that is objectionable in all washing processes, or by the deposits of insoluble salts when a water is heated or evaporated. In addition to its soap-consuming capacity, hard water is objectionable because it leaves a scale in boilers, which results in decreased heat transfer, loss in flow, and possibility of boiler failure.

Hardness is caused mainly by calcium and magnesium. Iron and aluminum likewise cause hardness but are normally present in much smaller quantities. The hardness equivalent to the carbonate and bicarbonate in a water is called carbonate hardness; the hardness due to sulfates, chlorides, nitrates, and other soluble salts of calcium and magnesium is called noncarbonate hardness.

Water that has less than 60 parts per million of hardness is usually rated as soft and suitable for most purposes without further softening. Water with hardness ranging between 60 and 120 ppm may be considered moderately hard, but its use for many purposes is not seriously affected. Where hardness is in the upper part of the range, laundries and some other industries may profitably soften the supply. Water with hardness ranging from 120 to 200 ppm is considered hard. Water with hardness beyond 200 ppm needs some softening before it can be used satisfactorily for most purposes, though much harder water is sometimes used without treatment, especially for domestic purposes. The hardness of water from the two water-bearing formations sampled for this study is compared in table 10. The hardness of water from the Quaternary deposits generally ranged from 125 to 787 ppm, although that from a few wells in T. 18 S., R. 3 W., ranged from 1,140 to 1,790 ppm. Water from the Cockfield generally had a hardness of 3 to 54 ppm; however, two samples had a hardness of 284 and 320.

The chemical characteristics of the ground water in Chicot County have been considered primarily in relation to the water-bearing formations from which they are derived. The results of 48 analyses have been grouped to represent the two principal aquifers in the county; namely, the Cockfield formation and Quaternary deposits.

Water in Cockfield formation

Analyses were made of samples collected from 7 wells in the northern part of the county. No water is used from the Cockfield formation in southern Chicot County because of its high salinity and general unsuitability for most purposes. The water from the several wells differs considerably in chemical composition and shows a marked increase in the amount of sodium chloride to the south. The dissolved solids range from 250 to 854 ppm and the water is generally soft. The Cockfield formation yields a sodium bicarbonate type of water, which is very low in sulfate. The iron content of the water ranges from 0.1 to 2.5 ppm. The percent sodium is generally high, ranging from 92 to 98 in 6 of the 7 samples.

Water in Quaternary Deposits

Information about the quality of water in the deposits of Quaternary age is based on samples from 41 wells. These wells are 150 feet or less in depth. The water differs considerably from place to place and tends to be more mineralized in the southern part of the county. Most of the water taken from the Quaternary deposits is used for irrigation; it is generally undesirable for domestic and municipal uses, mainly because of its extreme hardness and high-iron content.

The dissolved solids as determined and indicated by specific conductance range from 191 to 3,720 ppm, 13 samples containing 1,000 ppm or more. The hardness ranges from 131 to 1,790 ppm, that of most samples being in excess of 200 ppm. The Quaternary deposits generally yield a calcium bicarbonate type of water. The iron content of the water ranges from 0.1 to 21 ppm, only one sample containing less than 0.3 ppm. The percent sodium ranges from 7 to 37.

The calcium content of 10 samples of water ranges from 32 to 432 ppm, and only two are below 50 ppm. The magnesium content ranges from 11 to 174 ppm. The water is similar in quality to water taken from shallow depths and used for irrigation at other places in Arkansas. The Soil Testing Laboratory of the College of Agriculture of the University of Arkansas has found that, at places where water from these deposits has been used for irrigation for many years, the calcium and magnesium may accumulate in the soil and raise the pH of the soil so that it is unsuitable for growing rice. This is a complex condition that depends not only on the calcium and magnesium content of the water but also on the type of soil, on the percentage of the crop years that rice is raised on the soil, on the fertilizer used, and on the types of other crops grown. The rate of increase of pH tends to be more rapid in silty soil than in heavy clay soil. Although this information has not been published, studies being conducted by the College of Agriculture at the University of Arkansas indicate that water high in calcium and magnesium may not be suitable for irrigation of rice (Prof. Kyle Engler, oral communication), and it appears that water from the deposits of Quaternary age in Chicot County may, upon continued use, cause undesirable soil conditions. Periodic soil analysis should be made in order to evaluate the effect of this water use.

In the southwestern part of the county in T. 18 S., R. 3 W., water from most of the wells contain large amounts of dissolved solids, particularly sodium chloride, and is unsuitable for most uses. The source of the mineralized water is not known, but it is possible that the water moves upward from the underlying formation. Periodic chemical analysis of water from wells in this area is needed to show if there are any changes and trends in the water quality.

LOGS OF WELLS

Listed in the following pages are the logs of 17 wells. They are presented as they were recorded by the respective drillers, except that formational boundaries have been added where possible by the authors. The locations of the wells are shown on figure 4 and listed in table 11 with the same number. The altitude is given in feet above mean sea level.

WELL 4

Owner: George Jones
Location: NW¼NW¼NW¼ sec. 33, T. 13 S., R. 3 W.
Altitude: 120 feet
Source: H. S. Ragland

	Thickness (feet)	Depth (feet)
Clay	26	26
Medium sand	25	51
Clay balls and good sand	28	79

WELL 6

Owner: Charles Currie
Location: SE¼SW¼NW¼ sec. 3, T. 14 S., R. 3 W.
Altitude: 132 feet
Source: Layne-Arkansas Co.

	Thickness (feet)	Depth (feet)
Clay	26	26
Fine sand	34	60
Medium sand and gravel	15	75
Gumbo	26	101

WELL 7

Owner: Floyd Pierce
Location: NE¼SW¼SW¼ sec. 4, T. 14 S., R. 3 W.
Altitude: 135 feet
Source: H. S. Ragland

	Thickness (feet)	Depth (feet)
Top soil and sand	15	15
Fine sand	20	35
Clay and sand	14	49
Good sand	30	79

WELL 11

Owner: Jack Gibson
Location: SW¼SW¼NW¼ sec. 17, T. 14 S., R. 3 W.
Altitude: 135 feet

	Thickness (feet)	Depth (feet)
Clay	17	17
Red sand	14	31
Medium sand	29	60
Coarse sand and gravel	40	100
Gumbo	at 100 feet	

WELL 15

Owner: C. H. McCrosky
Location: NW¼NE¼NW¼ sec. 19, T. 15 S., R. 2 W.
Altitude: 120 feet
Source: H. S. Ragland

	Thickness (feet)	Depth (feet)
Blue clay	31	31
Fine sand	10	41
Coarse sand	41	82

WELL 17

Owner: Doyne Lloyd
Location: SE¼NE¼NE¼ sec. 29, T. 15 S., R. 2 W.
Altitude: 120 feet
Source: Lily Bros.

	Thickness (feet)	Depth (feet)
Surface clay	10	10
Yellow and blue clay	15	25
Yellow sand and clay	25	50
Blue sand	10	60
Blue sand and gravel	8	68
Blue coarse sand and gravel	17	85
Light yellow sand	10	95
Yellow sand and gravel	20	115
Dark gray sand with some gravel	5	120
Gumbo		120±

WELL 19

Owner: J. L. Hayes
Location: NW¼NW¼SW¼ sec. 3, T. 15 S., R. 3 W.
Altitude: 120 feet

	Thickness (feet)	Depth (feet)
Surface clay	10	10
Red and yellow clay	20	30
Fine sand	20	50
Sand and some gravel	10	60
Coarse gray sand and gravel	6	66
Coarse sand and gravel packed	6	72
Light blue coarse sand and gravel	33	105
Coarse at bottom—clay in water		

WELL 21

Owner: George Knoll
Location: NW¼NW¼SW¼ sec. 17, T. 15 S., R. 3 W.
Altitude: 120 feet

	Thickness (feet)	Depth (feet)
Clay	30	30
Fine sand	14	44
Medium sand	16	60
Medium sand and gravel	17	77
Gravel	31	108

WELL 26

Owner: McCarty Farms
Location: SE¼NE¼NE¼ sec. 29, T. 15 S., R. 3 W.
Altitude: 115 feet
Source: Alf Jones

	Thickness (feet)	Depth (feet)
Topsoil	40	40
Medium sand	45	85
Clay	18	103
Coarse sand and gravel interspersed with lignite	7	110

WELL 29

Owner: Town of Lake Village
Location: NE¼SW¼SW¼ sec. 2, T. 16 S., R. 2 W.
Altitude: 125 feet
Source: Layne-Arkansas Co.

	Thickness (feet)	Depth (feet)
Quaternary		
Clay	14	14
Sand	56	70
Sand and gravel	23	93
Eocene (Jackson formation)		
Chocolate clay	9	102
Shale	8	110
Gumbo	43	153
Shale boulders	13	166
Rock	2	168
Shale	8	176
Sandy shale	33	209
Rock	1	210
Shale	4	214
Eocene (Cockfield formation)		
Fine sand	14	228
Shale	5	231
Fine sand	18	249
Rock	2	251
Shale	41	292
Sand (water)	69	361

WELL 30

Owner: N. W. Bunker
Location: SE¼NE¼SE¼ sec. 26, T. 16 S., R. 2 W.
Altitude: 121 feet
Source: J. E. Mellor, Jr.

	Thickness (feet)	Depth (feet)
Quaternary		
No log	30	30
Sand and gravel	48	78
Eocene (Jackson formation)		
Gumbo	67	145
Shale and gumbo	50	195
Eocene (Claiborne group)		
Coarse sand	305	500
Gumbo and shale	79	579
Sand	55	634
Sandy shale	78	712
Sand	39	751

WELL 31

Owner: Dean Stuart
Location: NW¼NW¼SE¼ sec. 28, T. 16 S., R. 2 W.
Altitude: 120 feet
Source: Lily Bros.

	Thickness (feet)	Depth (feet)
Surface clay	10	10
Yellow packed sand	15	25
Fine blue sand	35	60
Blue sand	5	65
Coarse blue sand and some gravel	4.5	69.5
Coarse blue sand and gravel	25.5	95
Gravel and small rock	11.5	106.5

WELL 32

Owner: Earl Harris
Location: SE¼NE¼SW¼ sec. 15, T. 16 S., R. 3 W.
Altitude: 115 feet

	Thickness (feet)	Depth (feet)
Topsoil	20	20
Sand	76	96
Blue clay on bottom		

WELL 33

Owner: Bynum Cooperage
Location: SE¼SE¼NE¼ sec. 21, T. 17 S., R. 1 W.
Altitude: 115 feet
Source: Layne-Arkansas Co.

	Thickness (feet)	Depth (feet)
Gumbo	12	12
Fine sandy clay	12	24
Fine sand	14	38
Medium sand	15	53
Coarse sand and small gravel	29	82
Gravel	38	120
Gumbo		120+

WELL 37

Owner: Earl Verser, Jr.
Location: NE¼NE¼NW¼ sec. 17, T. 18 S., R. 1 W.
Altitude: 110 feet
Source: H. S. Ragland

	Thickness (feet)	Depth (feet)
Clay	6	6
Coarse sand	13	19
Coarse sand and gravel	4	23
Blue clay	21.5	44.5
Good sand and gravel	59.25	103.75

WELL 39

Owner: City of Eudora
Location: SE¼SE¼SW¼ sec. 24, T. 18 S., R. 2 W.
Altitude: 140 feet
Source: Layne-Arkansas Co.

	Thickness (feet)	Depth (feet)
Quaternary		
Topsoil	4	4
Clay	31	35
Fine sand	42	77
Coarse sand and gravel	47	124
Eocene (Jackson formation)		
Clay	44	168
Sand clay	14	182
Clay	24	206
Sand shale	21	227
Clay	8	235
Fine sand	102	337
Clay	59	396
Eocene (Claiborne group)		
Good sand (salty)	52	448
Gumbo	26	474
Rock	1	475
Gumbo	32	507
Rock	1	508
Sand shale	6	514
Rock	1	515
Gumbo	45	560
Rock	1	561
Shale	59	620
Rock	2	622
Sandy shale	23	645
Fine sand	9	654
Gumbo	16	670
Sandy shale	15	685
Gumbo	10	695
Coarse sand	24	719
Gumbo	11	730
Sandy shale	26	756
Gumbo	12	768
Sandy shale	10	778
Rock	2	780
Sandy shale	52	832
Gumbo	48	880
Rock	2	882
Gumbo	28	910
Sandy shale	53	963
Gumbo	12	975
Shale	24	999
Rock	1	1,000
Gumbo	15	1,015
Sandy shale	16	1,031
Rock	3	1,034
Gumbo	5	1,039
Sandy shale	16	1,055
Sand	9	1,064

WELL 57

Owner: Art DesLauris
Location: NE¼NE¼NE¼ sec. 21, T. 19 S., R. 1 W.
Altitude: 110 feet

	Thickness (feet)	Depth (feet)
Clay	14	14
Fine blue sand	46	60
Fine gray sand	17	77
Coarse sand	22	99
Gravel	22	121
Coarse sand and gravel	11	132
Log	3	135
Sand and gravel—still in sand	12	147

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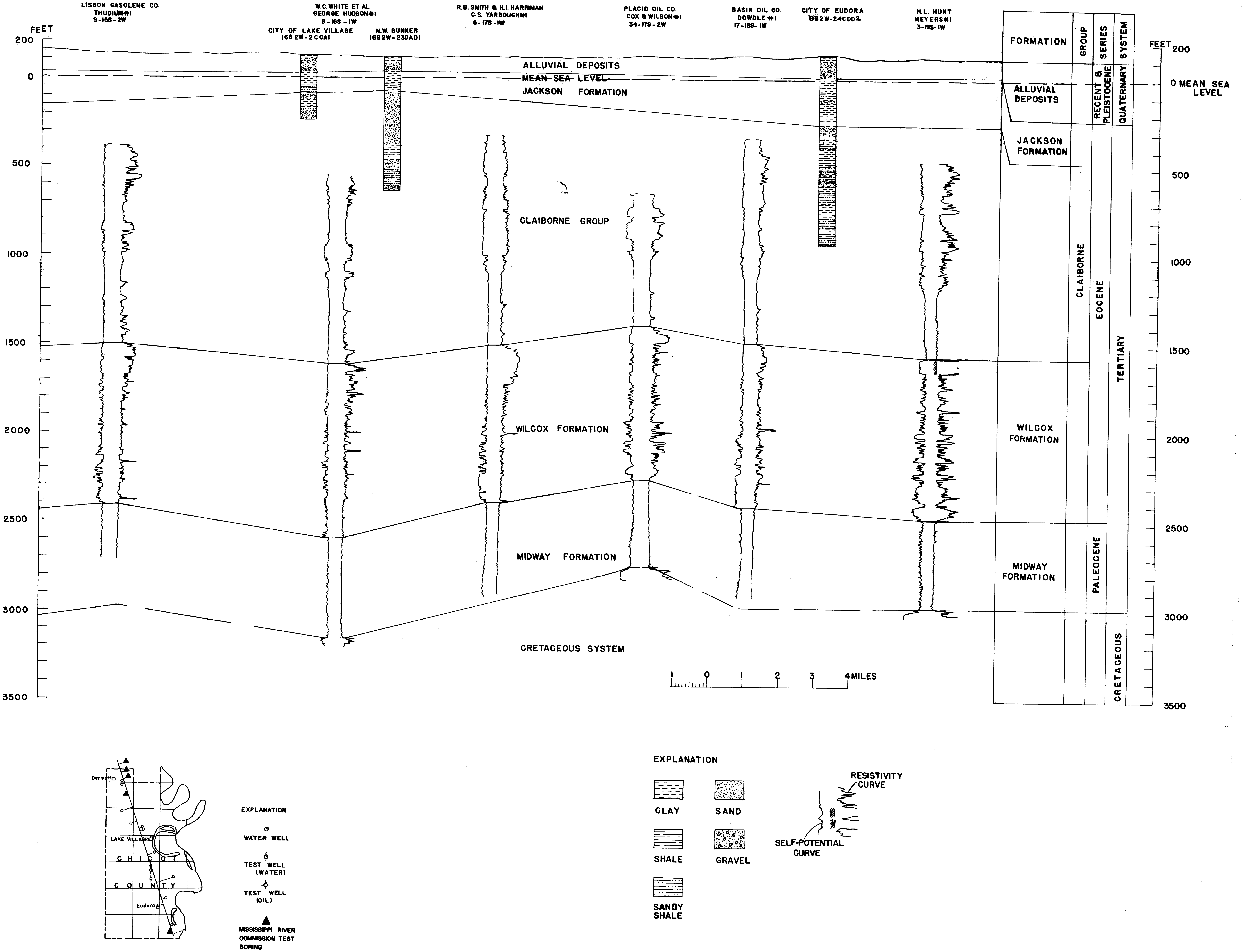

FIGURE 3. GENERALIZED GEOLOGIC SECTION SOUTHEASTWARD ACROSS CHICOT COUNTY SHOWING THE DEPOSITS OF TERTIARY AGE.

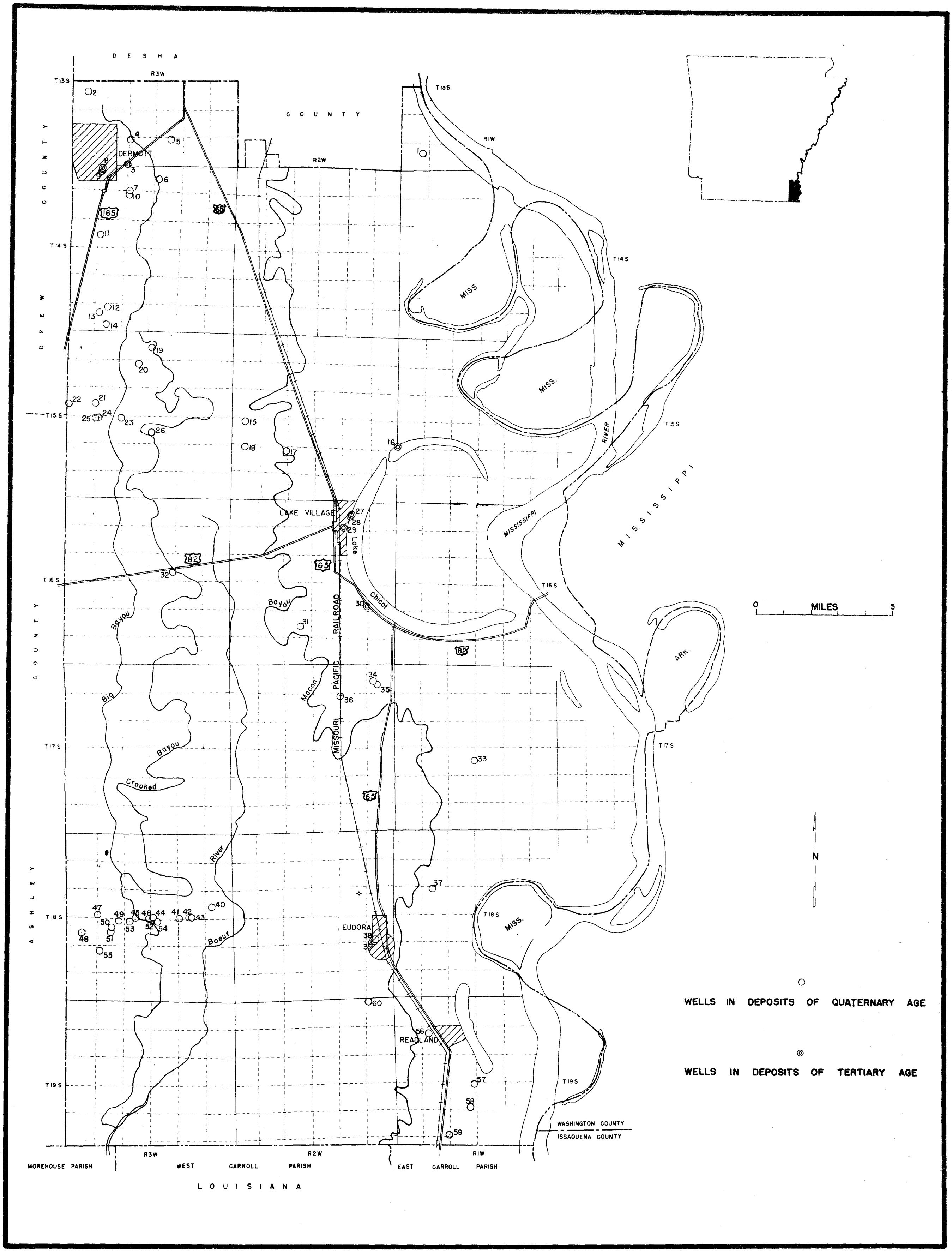

Figure 4. Map of Chicot County, Ark., Showing Locations of Wells.

FIGURE 5. GENERALIZED GEOLOGIC SECTION SOUTHEASTWARD ACROSS CHICOT COUNTY SHOWING DEPOSITS OF QUATERNARY AGE

Table 9. Analyses of Water from Wells in Chicot County, Arkansas (In Parts Per Million Except pH and as Indicated)

Well no. on map	Location no.	Owner	Depth of well	Aquifer	Date of collection	Temp. (°F)	Silica (SiO_2)	Aluminum (Al)	Total Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$ Total	Hardness as $CaCO_3$ Non-carbonate	Percent sodium	Specific conductance (micromhos at 25°C)
1	13S1W-31acc1	Harold Ives	102	Quaternary	5-22-52	66	32	0.8	11	113	47	24	1.6	0	600	10	7.8	0.1	0.3	526	475	0	10	873
3	13S3W-32dd1	George Jones	79	Quaternary	7-15-52	65	....	....	4.7	....	....	....	....	0	152	7	8.2	....	.4	....	136	11	....	274
5	-34baa1	Harold Bynum	100±	Quaternary	7-15-52	65	....	....	7.2	....	....	....	....	0	365	9	211	....	3.2	....	519	220	....	1,200
6	14S3W-3bcd1	Charles Currie	75	Quaternary	7-15-52	65	38	.5	5.2	85	16	24	2.6	0	340	11	24	.1	.2	365	328	50	16	588
7	-4cca1	Floyd Pierce	79	Quaternary	7-15-52	65	....	....	4.8	....	....	....	....	0	141	8	5.5	....	.3	....	131	15	....	251
8	-5bbb1	City of Dermott	510	Cockfield	2-15-46	72	12	1.4	.10	1.4	.6	95	1.5	0	237	.6	14	....	.2	250	6	0	96	407
9	-5bbb2	City of Dermott	510	Cockfield	1- 7-53	70	13	.1	.30	.4	.4	97	2.0	0	239	.9	16	.3	1.5	251	3	0	98	396
10	-9bbb1	Grady Bros.	73	Quaternary	7-15-52	65	37	.1	6.1	32	11	13	1.5	0	159	13	7.2	.1	.4	191	125	0	18	294
11	-17bcc1	Jack Gibson	91	Quaternary	7-15-52	65	....	....	15	....	....	....	....	4	292	7	36	....	.4	....	271	25	—	557
12	-32bad1	W. B. Bynum Cooperage	100	Quaternary	7-15-52	65	....	....	20	....	....	....	....	0	267	3	33	....	1.7	....	261	42	....	499
13	-32bcd1	W. B. Bynum Cooperage	100	Quaternary	7-15-52	65	....	....	16	....	....	....	....	0	165	6	16	....	.4	....	154	19	....	311
14	-32cda1	W. B. Bynum Cooperage	90	Quaternary	7-15-52	65	....	....	19	....	....	....	....	0	240	2	18	....	.4	....	221	24	....	410
15	15S2W-19bab1	C. H. McCrosky	82	Quaternary	7-28-52	65	....	....	7.4	....	....	....	....	14	330	99	84	....	.2	....	504	210	....	1,040
16	-24dda1	Evelyn Thudium	388	Cockfield	7-16-52	72	....	....	.33	....	....	....	....	0	401	2	243	....	1.2	....	39	0	....	1,350
17	-29aad1	Doyne Loyd	120	Quaternary	7-15-52	66	....	....	8.6	....	....	....	....	0	483	158	75	....	.2	....	542	146	....	1,150
18	-30baa1	C. H. McCrosky	92	Quaternary	7-28-52	65	34	.5	6.1	116	39	88	1.7	0	440	163	70	.1	1.2	758	450	90	30	1,120
19	15S3W-3cbb1	J. L. Hayes	100	Quaternary	7-14-52	65	....	....	6.6	....	....	....	....	0	480	102	203	....	1.3	....	670	276	....	1,450
20	-9abb1	Owen Henderson	78	Quaternary	7-14-52	64	....	....	14	....	....	....	....	0	373	93	253	....	1.3	....	604	298	....	1,450
21	-17cbb1	George Knoll	96	Quaternary	9- 4-52	65	....	....	10	....	....	....	....	4	130	6	124	....	.0	....	202	89	....	612
22	18-cbb1	Joe Knoll	105	Quaternary	9- 4-52	65	....	....	18	....	....	....	....	4	136	11	23	....	.0	....	122	4	....	291
23	-20aaa1	McCarthy Farms	110	Quaternary	7-14-52	65	....	....	9.4	....	....	....	....	0	419	104	379	....	3.5	....	787	443	....	1,910
25	-20bbb1	Spencer Farm	110	Quaternary	7-14-52	65	....	....	8.8	....	....	....	....	0	262	7	38	....	.2	....	240	25	....	496
26	-22cbc1	McCarthy Farms	110	Quaternary	7-14-52	65	31	.1	6.4	94	41	108	3.9	0	342	80	187	.1	2.0	854	403	123	37	1,220
27	16S2W-2bdc1	City of Lake Village	487	Cockfield	1-25-50	68	12	2.7	.35	17	2.8	310	4.4	8	370	4.1	280	.3	1.9	799	54	0	92	1,410
28	-2bdc2	City of Lake Village	390	Cockfield	....	68	12	.1	.22	9.5	4.3	317	.6	0	370	1.4	313	.4	.8	854	41	0	94	1,500
29	-2cca1	City of Lake Village	355	Cockfield	1- 8-53	68	15	.2	2.5	13	4.9	302	2.6	0	372	2.3	277	.3	.3	800	52	0	92	1,400
30	-23dad1	N. W. Bunker	311	Cockfield	2-28-52	64	27	1.7	1.4	77	31	58	2.3	0	388	54	44	.0	.0	469	320	2	28	794
33	17S1W-21add1	Bynum Cooperage	120	Quaternary	7-16-52	65	....	....	8.2	....	....	....	....	0	330	2	8.8	.3	....	....	296	25	—	510
38	18S2W-24cdd1	City of Eudora	320	Cockfield?	5- 1-46	68	24	....	....	71	26	43	3.4	0	425	0.6	22	0	0	401	284	0	25	679
39	-24cdd2	City of Eudora	150	Quaternary	1- 8-53	67	29	.1	9.5	64	23	20	2.0	0	223	63	34	.2	0	369	254	72	14	551
40	18S3W-13cbd1	G. Merriwether, Jr.	110	Quaternary	2-15-52	....	23	2.2	8.3	144	48	121	3.6	0	429	264	137	.1	2.2	1,000	557	206	32	1.430
41	-14ccc1	H. A. Cyrier	30	Quaternary	9- 9-53	65	....	....	8.2	....	....	....	....	0	458	213	286	....	.6	....	705	329	....	1,900
42	-14cdd1	R. A. Lingo	27	Quaternary	9- 9-53	65	....	....	4.7	....	....	....	....	0	480	240	276	....	.4	....	715	321	....	1,990
43	-14dcc1	Gilmer Merriwether	32	Quaternary	9- 9-53	67	....	....	7.5	....	....	....	....	9	185	18	8.0	....	.5	....	170	4	....	360
44	-15ccc1	J. E. Burgess	32	Quaternary	9- 9-53	65	....	....	7.2	....	....	....	....	0	489	250	1,180	....	2.4	....	1,580	1,180	....	4,630
45	-16cdd1	G. C. Collins	30	Quaternary	9- 9-53	65	....	....	17	....	....	....	....	0	570	342	1,230	....	2.8	....	1,620	1,150	....	4,940
46	-16ddd1	J. E. Burgess	33	Quaternary	9- 9-53	65	....	....	16	....	....	....	....	0	446	2	222	....	.8	....	538	172	....	1,380
47	-17ccc1	Henry Gillam	28	Quaternary	9- 9-53	65	....	....	18	....	....	....	....	0	335	23	62	....	.6	....	315	39	....	744
48	-19dbb1	J. H. Coleman	30	Quaternary	9- 9-53	65	....	....	5.5	....	....	....	....	0	394	77	342	....	.6	....	682	359	....	1,790
49	-20aab1	R. D. Sikes	31	Quaternary	9- 9-53	65	....	....	8.1	....	....	....	....	0	498	144	752	....	.6	....	1,140	732	....	3,160
50	18S3W-20bda1	C. M. Durham	20	Quaternary	9- 9-53	65	....	....	5.4	....	....	....	....	43	397	123	63	....	1.6	....	258	0	....	1,150
51	-20bbd1	C. M. Durham	90±	Quaternary	9- 9-53	69	....	....	2.3	....	....	....	....	18	282	3	230	....	1.9	....	185	0	....	1,220
52	-21aab1	R. A. Lingo	76.5	Quaternary	2- -52	....	24	5.3	18	432	174	494	8.6	0	481	282	1,490	0.0	1.5	3,720	1,790	1,400	37	5,110
53	-21bba1	B. F. Perkins	30	Quaternary	9- 9-53	65	....	....	16	....	....	....	....	0	519	215	1,210	....	2.9	....	1,560	1,130	....	4,710
54	-22bba1	Harry Hill	33	Quaternary	9- 9-53	65	....	....	7.9	....	....	....	....	0	521	270	1,060	....	.8	....	1,420	993	....	4,310
55	-29bbd1	Orange Harris	30	Quaternary	9- 9-53	65	....	....	21	....	....	....	....	0	662	320	512	....	.4	....	1,080	537	....	2,940
57	19S1W-21aaa1	Art DesLauris	90	Quaternary	1-15-52	65	29	1.6	.10	101	30	14	2.6	0	470	3.6	5.8	.1	.1	402	376	0	8	663
60	19S2W-1bbb1	Steve Ball	87	Quaternary	1-15-52	65	36	1.6	5.6	42	20	13	1.0	3	235	3.1	4.5	.4	1.2	239	189	0	13	361

Table 11. Records of Wells in Chicot County, Arkansas

Well number in parentheses indicates that analysis of water is given in Table 9. Depth to water given to tenths and hundredths if measured, and to nearest foot if reported. Yields are reported.

Well no.	Location no.	Owner	Driller	Date completed	Type of well	Depth of well (feet)	Diameter of well (inches)	Aquifer	Depth to water below surface (feet)	Date of measurement	Method of lift	Yield (gpm)	Use of Water	Remarks
(1)	13S1W-31acc1	Harold Ives	H. S. Ragland	1951	Drilled	102	18-12	Quaternary	12.0	1952	Turbine	1,500	Irrigation	
2	13S3W-19ac1	McCauley Farms			Drilled	100±	18-10	Quaternary	21.97	7-16-52	Turbine		Irrigation	
(3)	-32dd1	George Jones	H. S. Ragland	1949	Drilled	79	18-9	Quaternary			Turbine	1,500	Irrigation	
4	-33bbb1	George Jones	H. S. Ragland	1950	Drilled	79	18-9	Quaternary			Turbine	1,800	Irrigation	See log
(5)	-34baa1	Harold Bynum	H. S. Ragland	1949	Drilled	100±		Quaternary			Turbine	1,700	Irrigation	
(6)	14S3W-3bcd1	Charles Currie	Layne-Arkansas Co.	1951	Drilled	75	18-8	Quaternary	18.0	1951	Turbine	1,200	Irrigation	See log
(7)	-4cca1	Floyd Pierce	H. S. Ragland	1949	Drilled	79	18-10	Quaternary	16.0	1949	Turbine	1,200	Irrigation	See log
(8)	-5bbb1	City of Dermott	John Fleming	1923	Drilled	510	8	Cockfield			Turbine	350	Public supply	
(9)	-5bbb2	City of Dermott	John Fleming	1927	Drilled	510	8	Cockfield			Turbine	350	Public supply	
(10)	-9bbb1	Grady Bros.		1951	Drilled	73	12-8	Quaternary				1,800	Irrigation	
(11)	-17bcc1	Jack Gibson		1950	Drilled	91	12-8	Quaternary				1,200	Irrigation	See log
(12)	-32bad1	W. B. Bynum Cooperage		1948	Drilled	100	18-10	Quaternary				1,000	Irrigation	
(13)	-32bcd1	W. B. Bynum Cooperage		1950	Drilled	100		Quaternary				1,200	Irrigation	
(14)	-32cda1	W. B. Bynum Cooperage		1949	Drilled	90	18-9	Quaternary				1,200	Irrigation	
(15)	15S2W-19bab1	C. H. McCrosky	H. S. Ragland	1950	Drilled	82		Quaternary			Turbine	2,230	Irrigation	See log
(16)	-24dda1	Evelyn Thudium	Southern Well Drilling Co.	1947	Drilled	388	6-4	Cockfield					Domestic	
(17)	-29add1	Doyne Lloyd	Lilly Bros.	1942	Drilled	120	18-10	Quaternary	14.0	5- ?-52	Turbine	1,800	Irrigation	See log
(18)	-30baa1	C. H. McCrosky	H. S. Ragland	1951	Drilled	92	18-10	Quaternary			Turbine	1,100	Irrigation	
(19)	15S3W-3cbb1	J. L. Hayes		1952	Drilled	100	12	Quaternary			Turbine	2,000	Irrigation	See log
(20)	-9abb1	Owen Henderson	Howard Shutts	1952	Drilled	78		Quaternary			Turbine	1,200	Irrigation	
(21)	-17cbb1	George Knoll		1948	Drilled	96	18-10	Quaternary			Turbine	1,900	Irrigation	See log
(22)	-18cbb1	Joe Knoll		1950	Drilled	105	18-10	Quaternary					Irrigation	
(23)	-20aaa1	McCarthy Farms	Alf Jones	1952	Drilled	110	14	Quaternary	18.0	5-21-52	Turbine	1,500	Irrigation	
24	-20bba1	McCarthy Farms	Alf Jones	1952	Drilled	110	10	Quaternary	18.0	5-21-52	Turbine	1,200	Irrigation	
(25)	-20bbb1	Spencer Farm	Alf Jones		Drilled	110	18-8	Quaternary			Turbine	1,100	Irrigation	
(26)	-22cbc1	McCarthy Farms	Alf Jones	1952	Drilled	110	14	Quaternary			Turbine	1,500	Irrigation	See log
(27)	16S2W-2bdc1	City of Lake Village	Leo Galvin	1910	Drilled	487	14-8	Cockfield	25.99	1-23-50	Turbine	100	Public Supply	
(28)	-2bdc2	City of Lake Village	Mellor Well Drilling Co.	1941	Drilled	390	14-8	Cockfield	19.57	1-23-50	Turbine	250	Public Supply	
(29)	-2cca1	City of Lake Village	Southern Well Drilling Co.	1951	Drilled	355	14-10	Cockfield	22.0	1951	Turbine	410	Public Supply	See log
(30)	-23dad1	N. W. Bunker	Mellor Well Drilling Co.	1941	Drilled	311		Cockfield					Domestic	See log
31	-28dbb1	Dean Stuart	Lilly Bros.	1949	Drilled	110	20-10	Quaternary			Turbine		Irrigation	See log
32	16S3W-15dac1	Earl Harris		1952	Drilled	96	18-10	Quaternary			Turbine	2,500	Irrigation	See log
(33)	17S1W-21add1	Bynum Cooperage	Layne-Arkansas Co.	1951	Drilled	120	18-10	Quaternary	12.0	1951	Turbine	2,500	Irrigation	See log
34	17S2W-1cb1	John Wumpel		1950	Drilled	87	12-10	Quaternary			Turbine	1,600	Irrigation	
35	-1cb2	John Wumpel		1952	Drilled	87	12-8	Quaternary			Turbine		Irrigation	
36	-10aaa1	Dickson Bros.	Layne-Arkansas Co.	1951	Drilled	90	18-10	Quaternary			Turbine	2,000	Irrigation	Well destroyed in 1952
37	18S1W-17baa1	Earl Verser, Jr.	H. S. Ragland	1951	Drilled	103	18-10	Quaternary	9.42	1-15-52	Turbine	3,000	Irrigation	See log
(38)	18S2W-24cdd1	City of Eudora		1916	Drilled	320	8	Cockfield ?			Turbine		Public supply	
(39)	-24cdd2	City of Eudora	Layne-Arkansas Co.	1947	Drilled	150		Quaternary			Turbine	450	Public supply	Drilled to 1,064 ft.—See log
(40)	18S3W-13cbd1	Gilmer Merriwether, Jr.	H. S. Ragland	1950	Drilled	110	18-10	Quaternary			Turbine	2,000	Irrigation	
(41)	-14ccc1	H. A. Cyrier			Driven	30	1¼	Quaternary			Suction		Domestic	
(42)	-14cdd1	R. A. Lingo			Driven	27	1¼	Quaternary			Jet		Domestic	
(43)	-14dcc1	Gilmer Merriwether			Driven	32	1¼	Quaternary			Pitcher		Domestic	
(44)	18S3W-15ccc1	J. E. Burgess			Driven	32		Quaternary	18.0		Suction		Domestic	
(45)	-16cdd1	G. C. Collins			Driven	30	1¼	Quaternary			Pitcher		Domestic	
(46)	-16ddd1	J. E. Burgess			Driven	33	1¼	Quaternary	18.0		Pitcher		Domestic	
(47)	-17ccc1	Henry Gillam		1953	Driven	28	1¼	Quaternary			Pitcher		Domestic	
(48)	-19dbb1	John H. Coleman			Driven	30	1¼	Quaternary			Jet		Domestic	
(49)	-20aab1	R. D. Sikes			Driven	31	1¼	Quaternary			Pitcher		Domestic	
(50)	-20bda1	C. M. Durham			Driven	20	1¼	Quaternary			Pitcher		Domestic	
(51)	-20bdd1	C. M. Durham		1918	Drilled	90±	4	Quaternary			Jet		Domestic	
(52)	-21aab1	R. A. Lingo	Baker & Lingo	1951	Drilled	76.5	18-10	Quaternary	17.53	1-16-52	Turbine	2,000	Irrigation	Water killed rice (well destroyed)
(53)	-21bba1	B. F. Perkins			Driven	30	1¼	Quaternary			Pitcher		Domestic	
(54)	-22bba1	Harry Hill			Driven	33	1¼	Quaternary			Pitcher		Domestic	
(55)	-29bbd1	Orange Harris		1952	Driven	30	1¼	Quaternary			Pitcher		Domestic	
56	19S1W-8bd1	E. F. Smith	H. S. Ragland	1950	Drilled	100±	12-10	Quaternary			Turbine	5,000	Irrigation	
(57)	-21aaa1	Art DesLauris	Layne-Arkansas Co.	1949	Drilled	90	30-10	Quaternary			Turbine	2,750	Irrigation	See log
58	-21ddc1	Fred Lingo	H. S. Ragland	1950	Drilled	90	24-10	Quaternary			Turbine	6,000	Irrigation	
59	-29dd1	James Lingo	Layne-Arkansas Co.	1950	Drilled	90	24-10	Quaternary			Turbine	6,000	Irrigation	
(60)	19S2W-1bbb1	Steve Ball		1946	Driven	87	1¼	Quaternary			Pitcher		Domestic	