Water Resources of Randolph and Lawrence Counties, Arkansas

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1879-B

Prepared in cooperation with the Arkansas Geological Commission

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By A. G. LAMONDS, MARION S. HINES, *and* RAYMOND O. PLEBUCH

CONTRIBUTIONS TO THE HYDROLOGY OF THE UNITED STATES

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UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1969

UNITED STATES DEPARTMENT OF THE INTERIOR

WALTER J. HICKEL, *Secretary*

GEOLOGICAL SURVEY

William T. Pecora, *Director*

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WATER RESOURCES OF RANDOLPH AND LAWRENCE COUNTIES, ARKANSAS

By A. G. LAMONDS, MARION S. HINES, and RAYMOND O. PLEBUCH

ABSTRACT

Water is used at an average rate of almost 27 million gallons per day in Randolph and Lawrence Counties, and quantities sufficient for any foreseeable use are available. Supplies for the large uses—municipal, industrial, and irrigation—can best be obtained from wells in the Coastal Plain part of the counties and from streams in the Interior Highlands part.

The counties have abundant supplies of hard but otherwise good-quality surface water, particularly in the Interior Highlands and along the western boundary of the Coastal Plain. Minimum recorded flows of four streams (Black, Current, Eleven Point, and Spring Rivers) exceeded 200 cubic feet per second, or 129 million gallons per day. Five other streams have flows in excess of 13 cubic feet per second 95 percent of the time. Water supplies can be obtained without storage from the larger streams in the area. Many of the smaller streams in the Interior Highlands also have large water-supply potential because of the excellent impoundment possibilities.

Most of the water used in the two counties is obtained from ground-water reservoirs in the Coastal Plain. Wells that tap alluvial deposits of Quaternary age commonly yield 1,000 gallons per minute. However, the water often is unsuitable for many uses unless treated to remove hardness, iron, and manganese. Water possibly may be obtained in the southeastern part of the area from the Wilcox Group of Tertiary age and the Nacatoch Sand of Cretaceous age, but these formations have not been explored in the report area.

Wells in the Interior Highlands generally are less than 200 feet deep and yield 10 gallons per minute, or less. It may be possible to obtain greater amounts of ground water from two unexplored formations, the Roubidoux and the Gunter Sandstone Member of the Van Buren Formation, in the Interior Highlands. Ground water in the Interior Highlands is very hard and is more susceptible to local bacterial contamination than is ground water in the Coastal Plain. However, with proper sanitary safeguards against contamination and with treatment for reduction of hardness, ground water in the Interior Highlands is suitable for most uses.

INTRODUCTION

PURPOSE

This report was prepared by the U.S. Geological Survey in cooperation with the Arkansas Geological Commission, as a part of a statewide program of water-resources investigations in Arkansas. The purpose of the report is to provide a basic assessment of the location, quantity, and quality of water in Randolph and Lawrence Counties and to serve as a preliminary guide in the development and management of the water resources in the area.

ACKNOWLEDGMENTS

The authors acknowledge, with thanks, the help received from the many landowners, well drillers, and city officials who supplied information during this project. Many individuals and establishments permitted use of their wells for water-level measurements and for collection of water samples. The writers are particularly indebted to the members of the Arkansas Geological Commission, who gave freely of their time and knowledge, and to the Arkansas State Department of Health, which furnished technical assistance and performed the bacteriological analyses for this study.

THE AREA

Randolph and Lawrence Counties comprise an area of 1,229 square miles in northeastern Arkansas (fig. 1). This area is divided by the Fall Line (physiographic boundary between the Interior Highlands and the Coastal Plain) into two parts almost equal in size but distinctly different in physiographic characteristics. Figure 1 shows that the Fall Line extends approximately from the northeast corner of Randolph County to the southwest corner of Lawrence County.

The Coastal Plain is characterized by nearly flat topography. Land-surface elevations range from about 250 feet above sea level in southern Lawrence County, to about 280 feet above sea level in northeastern Randolph County. Because of the flat terrain the streams in the Coastal Plain are sluggish, and runoff is slow.

The Interior Highlands is characterized by hilly dissected uplands. Land-surface elevations range from about 400 feet to almost 1,000 feet above sea level. Streams in the Interior Highlands have steep gradients, particularly in their upper reaches, and runoff is fast.

The geologic formations exposed in Randolph and Lawrence Counties range in age from early Paleozoic to Quaternary. Northwest of the Fall Line, the area is underlain by the older rocks of Paleozoic age (fig. 2). These rocks consist chiefly of limestone and dolomite, which

FIGURE 1.—Location and physiographic divisions of report area.

dip southeastward beneath the unconsolidated deposits in the Coastal Plain.

The Coastal Plain is underlain, in descending order, by strata of Quaternary, Tertiary, and Cretaceous age, which rest on a basement of Paleozoic rocks. Alluvial deposits of Quaternary age blanket most of the Coastal Plain area of Randolph and Lawrence Counties. Sand and gravel of Tertiary and Cretaceous age, which dip to the southeast, are exposed in small areas along the Fall Line in southwestern Lawrence County. In some places the Tertiary and Cretaceous deposits are overlain by deposits of windblown silt (loess) of Quaternary age.

SURFACE-WATER RESOURCES

Randolph and Lawrence Counties lie wholly within the White River basin and have numerous streams with excellent water-supply potential. The Interior Highlands and about half of the Coastal Plain areas of the counties are drained by the Black River and its tributaries; prin-

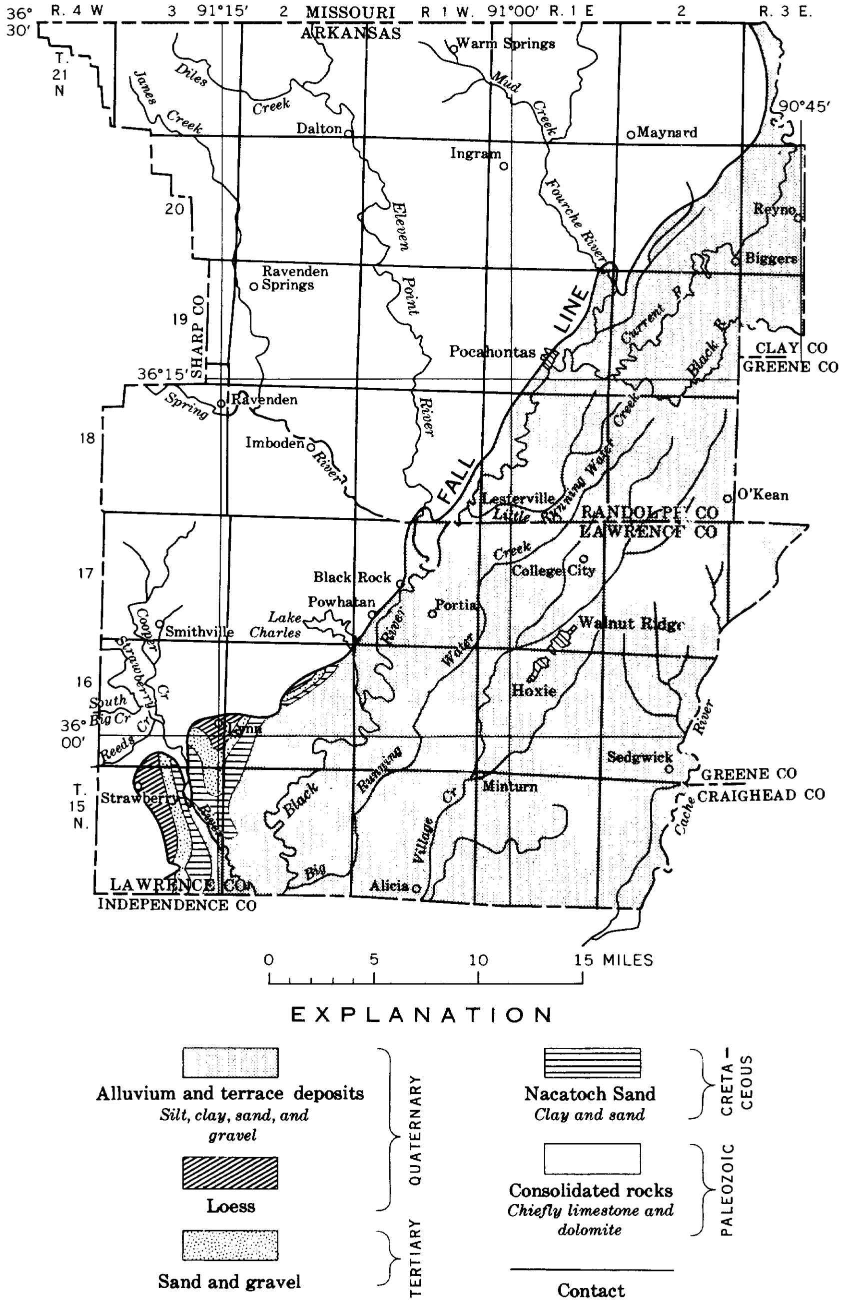

FIGURE 2.—Generalized geology of Randolph and Lawrence Counties, Ark. (Modified from Arkansas Geological Survey, 1929.)

cipally the Current, Strawberry, and Spring Rivers, and the Eleven Point River, which is tributary to the Spring River. The rest of the area is drained by the Cache River and Village Creek, which are direct tributaries to the White River.

Streams in the two counties yield about 16 inches of runoff, about 1,450 cfs (cubic feet per second), from an average annual precipitation of about 48 inches. About 8,500 cfs also enters the area from Missouri and adjacent counties in Arkansas. This means that, on the average, about 10,000 cubic feet of surface water leaves the area every second. This amounts to 6.46 bdg (billion gallons per day), or three times the average daily water use for the State of Arkansas (Halberg and Stephens, 1966).

AVAILABILITY

A map showing the major streams in Randolph and Lawrence Counties and the data-collection sites on these streams is shown in figure 3. Flow in these streams is derived from direct surface runoff of precipitation and from ground-water discharge (base flow). Most of the base flow in the Interior Highlands is derived from ground-water effluence in springs, most of which are outside the area of this report. In the Coastal Plain the base flow is derived from seeps rather than springs. Most of the streams flow during dry periods; but the base flows of streams in the Interior Highlands are generally greater than those of streams in the Coastal Plain.

Development of water supplies from streams in the Coastal Plain beyond the base flow is limited by the lack of suitable reservoir sites. In contrast, numerous reservoir sites are available in the Interior Highlands, and development beyond natural low flow is feasible. With adequate storage reservoirs the amount of water that could be made available for use approaches the average discharge of a stream. The average discharge at sites (station number in parentheses) on the major streams that supply or drain the area are: (7–0680) Current River at Doniphan, Mo., 2,710 cfs; (7–0640) Black River near Corning (Clay County), 1,730 cfs; (7–0690) Black River at Pocahontas, 5,550 cfs; (7–0725) Black River at Black Rock, 8,070 cfs; (7–0720) Eleven Point River near Ravenden Springs, 1,080 cfs; (7–0695) Spring River at Imboden, 1,320 cfs; and (7–0740) Strawberry River near Poughkeepsie (Sharp County), 510 cfs. These averages were computed from periods of record ranging from 28 to 48 years.

LOW-FLOW FREQUENCY

In the analysis of the water-supply potential of a stream, a dependable yield during periods of drought is one of the most important considerations. Analysis of the low-flow yield of streams can be made by

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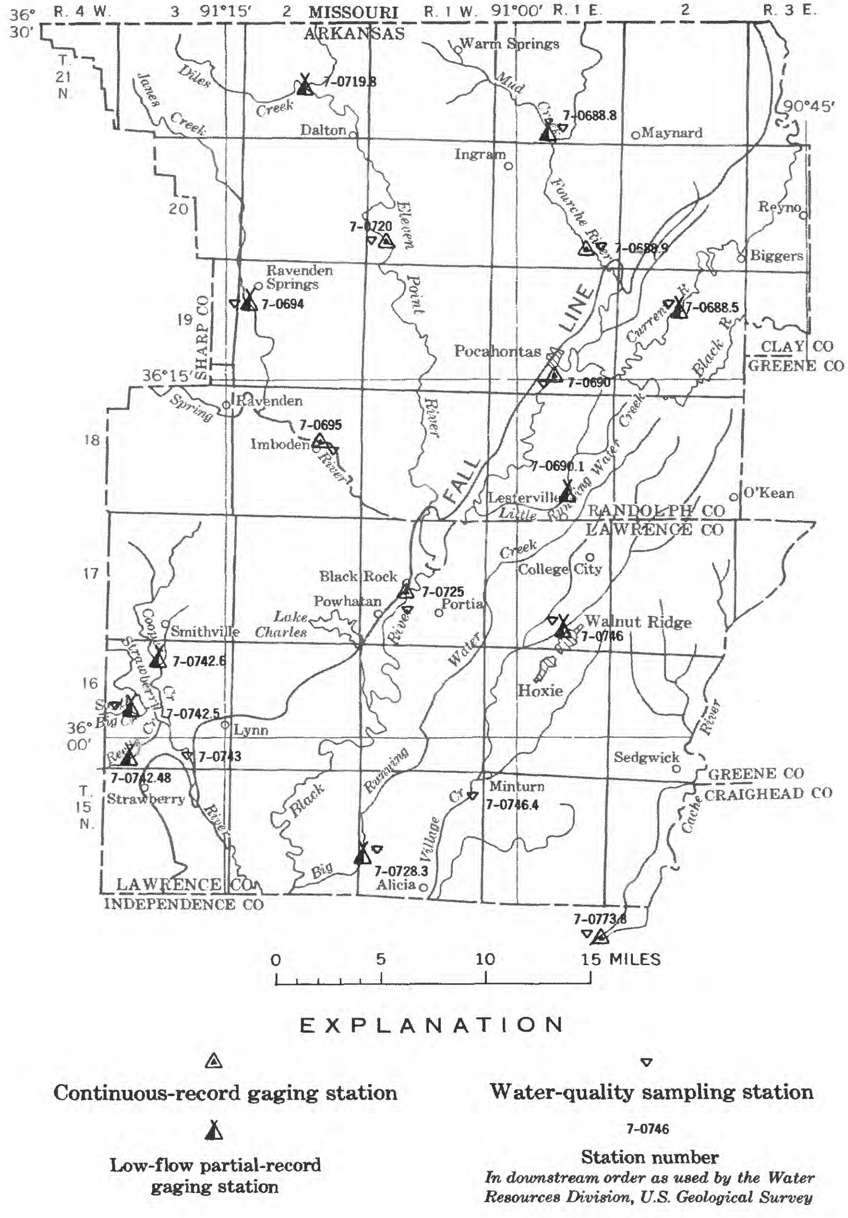

FIGURE 3.—Stream-gaging stations and surface-water sampling stations.

use of low-flow frequency curves. These curves are based on the lowest annual flow for various selected periods of consecutive days and indicate the frequency with which these events may recur. Low-flow frequency curves for the seven long-term continuous-record gaging stations are shown in figures 4, 5, and 6. These curves can be used to

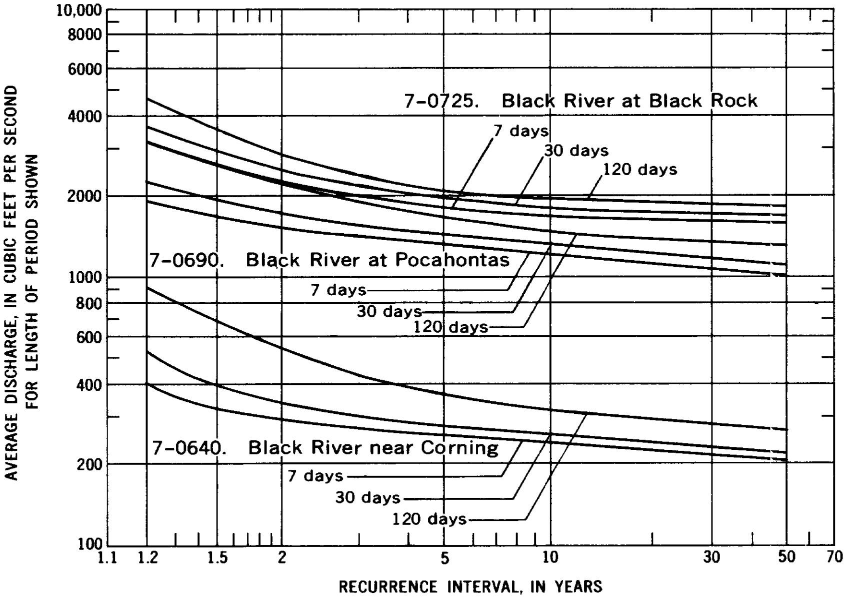

FIGURE 4.—Magnitude and frequency of annual low flows for Black River near Corning (Clay County), Black River at Pocahontas, and Black River at Black Rock.

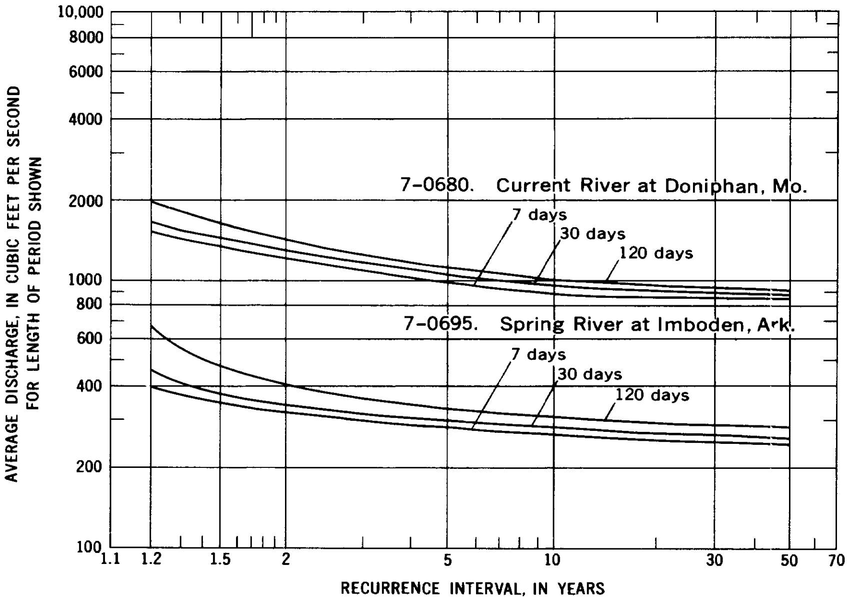

FIGURE 5.—Magnitude and frequency of annual low flows for Current River at Doniphan and Spring River at Imboden.

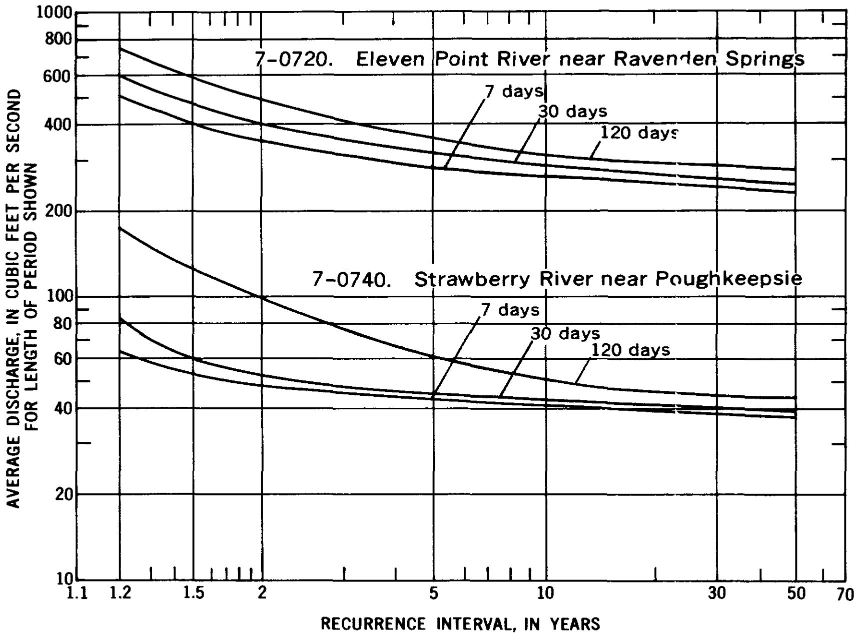

FIGURE 6.—Magnitude and frequency of annual low flows for Eleven Point River near Ravenden Springs and Strawberry River near Poughkeepsie (Sharp County).

predict the average time interval between low flows of a particular magnitude and duration, provided the hydrologic and climatic conditions do not change. These curves show recurrence intervals for average low flows of periods of 7, 30, and 120 consecutive days. Recurrence intervals for periods other than those for which curves are drawn can be estimated by interpolating between existing curves. More complete information is given in a report by Hines (1965).

Interpretation of the low-flow frequency curves is illustrated in figure 4 by the data for Black River at Pocahontas (7–0690). The curves for this station indicate that an average flow of 1,320 cfs or less for a period of 7 consecutive days will be experienced on the average of once each 5 years. This discharge is referred to as the 7-day 5-year low flow. An average discharge of 1,320 cfs, or less, for a 30-day period will occur on an average of once each 11 years. The recurrence intervals are long-term averages, not regular occurrences. The 7-day 2-year low flow can be expected 10 times in 20 years; but it can occur in consecutive years during an extended drought.

Interpretation of the curves in figures 4, 5, and 6 emphasizes the excellent water-supply potential of the streams. For example, the 7-day 50-year low flows indicate that these streams have large sustained flows, even during a drought having a recurrence interval of 50 years. The 7-day 50-year low flows range from 37 cfs to 1,600 cfs, and all but one exceed 200 cfs.

Low-flow frequency data are presented in table 1. Frequency data for the low-flow and short-term gaging stations were based on a few base-flow measurements and should be considered only as estimates of the probable magnitude and frequency of low flows at the indicated locations.

TABLE 1.—*Low-flow characteristics of streams that traverse Randolph and Lawrence Counties, Ark.*

[Class of station: C, continuous-record; P, partial-record or short-term continuous-record]

Station No.	Gaging station	Class of station	Drainage area (sq mi)	Annual low flow (cfs) for indicated period of consecutive days and indicated recurrence interval, in years				Flow (cfs) equaled or exceeded for indicated percentage of time	
				7-day		30-day			
				2-year	10-year	2-year	10-year	90	95
7-0640	Black River near Corning, Ark.[1]	C	1,749	295	240	336	258	333	298
7-0680	Current River at Doniphan, Mo.[2]	C	2,038	1,200	880	1,300	940	1,120	1,020
7-0688.5	Current River near Pochanotas, Ark.	P	2,608	1,270	920	1,380	980	970	950
7-0688.8	Mud Creek near Ingram, Ark.	P	[3] 35	.6	.4	.8	.5	1.0	.8
7-0688.9	Fourche River above Pocahontas, Ark.	P	228	19	13	21	16	25	21
7-0690	Black River at Pochantas, Ark.	C	4,843	1,520	1,210	1,710	1,330	1,660	1,460
7-0690.1	Little Running Water Creek near Lesterville, Ark.	P	[3] 12	.9	.7	.9	.8	1.0	.9
7-0694	Janes Creek at Ravenden Springs, Ark.	P	78.5	.07	0	.1	0	.4	.1
7-0695	Spring River at Imboden, Ark.	C	1,162	320	265	340	280	345	311
7-0719.8	Diles Creek near Dalton, Ark.	P	[3] 24	.6	.2	1.0	.3	.6	.4
7-0720	Eleven Point River near Ravenden Springs, Ark.	C	1,123	352	268	410	286	361	316
7-0725	Black River at Black Rock, Ark.	C	7,323	2,280	1,680	2,500	1,800	2,440	2,200
7-0728.3	Big Running Water Creek near Alicia, Ark.	P	[3] 60	.07	0	.2	.02	.2	.07
7-0740	Strawberry River near Poughkeepsie, Ark.[4]	C	476	48	41	52	43	58	51
7-0742.48	South Big Creek near Strawberry, Ark.	P	69.4	17	13	19	15	20	18
7-0742.5	Reeds Creek near Strawberry, Ark.	P	34.9	13	12	14	12	14	13
7-0742.6	Cooper Creek near Smithville, Ark.	P	[3] 30	1.1	.5	1.3	.9	1.6	1.3
7-0746	Village Creek at Walnut Ridge, Ark.	P	34.3	0	0	0	0	.02	0
7-0773.8	Cache River at Egypt, Ark.[5]	P	698	21	6.1	27	9.6	25	18

[1] 24 miles upstream from the Clay-Randolph County line.
[2] 13.3 miles upstream from the Arkansas-Missouri State line.
[3] Estimated.
[4] 11.2 miles upstream from the Lawrence County line.
[5] 2.4 miles downstream from the Lawrence-Craighead County line.

To compare the low-flow characteristics of one stream with those of another, streamflow records at the gaging stations were adjusted to the period 1929–57 (Speer and others, 1966). The average precipitation for this period was nearly the same as the average precipitation since 1891. Streamflow data for continuous-record gaging stations with short periods of record were adjusted to this base period by regression analysis. At the low-flow partial-record stations, all available streamflow records were correlated with concurrent records of gaging stations for which frequency data for this base period have been determined.

Most of the larger streams in Randolph and Lawrence Counties receive high base flows from large springs outside the project area. Of the smaller streams in the area, South Big Creek and Reeds Creek, which are spring fed, have the largest ratios of discharge to drainage area. Owing primarily to the inflow of Reeds Creek and South Big Creek, the 7-day 2-year low flow of Strawberry River near Strawberry is estimated to be almost twice that at Poughkeepsie. Because of the high base flow, the lower part of the Strawberry River is important as a potential water supply.

FLOW DURATION

Flow duration, as well as low-flow frequency, is a valuable tool in analyzing the water-supply characteristics of a stream. Flow-duration curves, giving the percentage of time that certain discharges are equaled or exceeded at the seven long-term continuous-record gaging stations, are shown in figure 7.

The slope of a flow-duration curve is a measure of the variability of streamflow. A flat slope at the lower end of the duration curve indicates high base flow and good water-supply potential without storage. Conversely, a steep slope at the lower end of the curve indicates low base flow. A flat slope at the upper end of the duration curve indicates relatively low peak flows that are probably due to flat streambed slopes and large flood-plain storage. A steep slope at the upper end of the curve indicates relatively high peak flows, resulting from steep streambed slopes and narrow flood plains. Figure 7 shows that the flow-duration curve of Strawberry River near Poughkeepsie, which has the highest peak discharge and the lowest base flow per square mile of drainage area of the seven stations, has the steepest slope throughout its range of discharge.

Discharges which are equaled or exceeded for 90 and 95 percent of the time for all streamflow stations in the area, including the short-term stations, are shown in table 1. The duration figures for stations other than the seven long-term continuous-record gaging stations are estimates. The duration and frequency figures in table 1 are useful in comparing the water-supply characteristics of the streams.

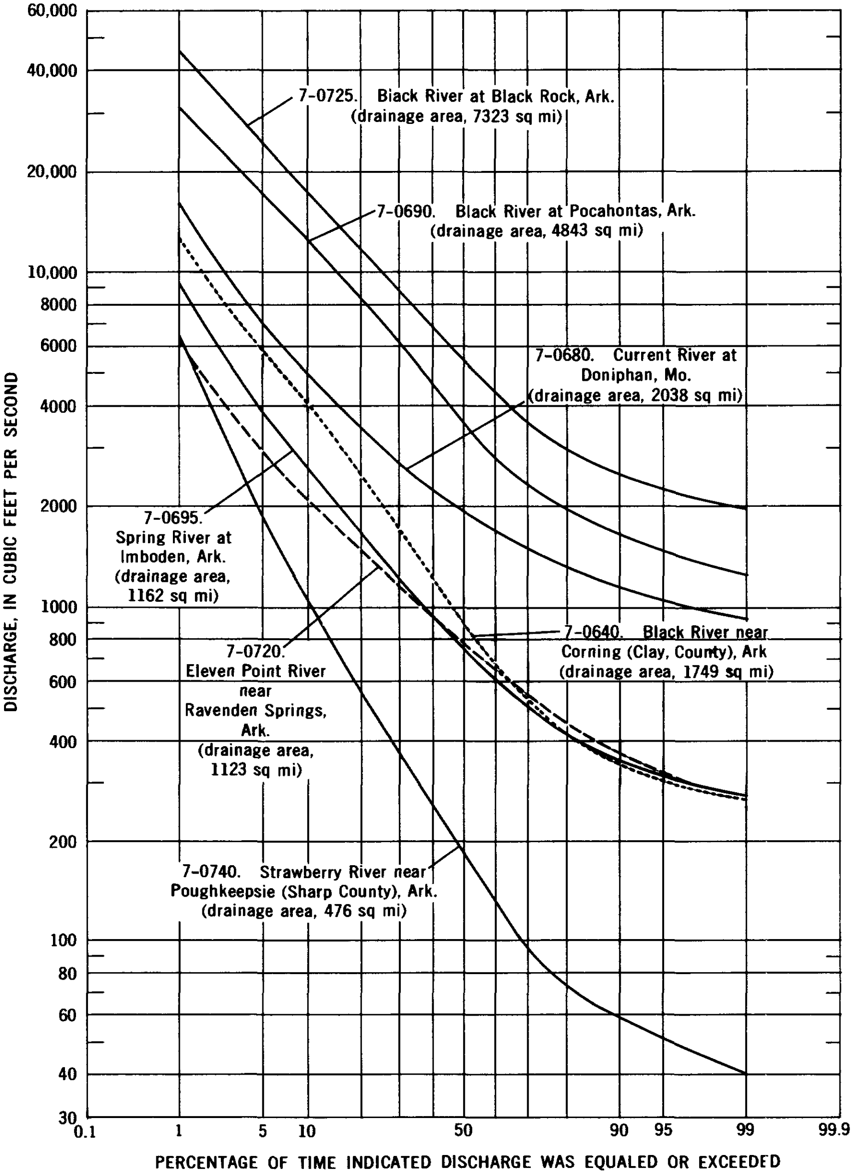

FIGURE 7.—Flow-duration curves for continuous-record gaging stations.

Duration and frequency figures can be used also to determine the adequacy of streamflow for a given demand. For instance, if a water supply of 50 cfs is needed and an insufficient supply can be tolerated for not more than 5 percent of the time, inspection of the 95-percent-duration figures in table 1 indicates that the flow of the Black, Current, Spring, Eleven Point, and Strawberry Rivers at the points where they were measured will meet that demand.

The flow-duration and low-flow-frequency values, however, are applicable only at the sites for which they were computed. Comparable figures may be estimated for other sites on the basis of drainage-area ratios; but care must be used in transferring data to ungaged sites because of variations in geology and hydrology within the stream basin. Good practice demands that supplemental base-flow measurements be made when gaging-station data are not available at or near the site.

FLOODS

Floods, which are more spectacular than low flows, present both a problem of damage and an opportunity to store water that ordinarily would be unavailable or wasted. Floods are more of a problem in the Coastal Plain than in the Interior Highlands. Owing to the lack of suitable sites for flood-control reservoirs in the Coastal Plain, the construction of levees and the improvement of drainage channels are the most effective means of controlling floods. Because of the wide flat flood plains, large areas in the Coastal Plain are inundated by floods, and the water recedes slowly. However, because of the low floodflow velocities, destruction from the force of the water is slight, and flood losses are generally due to water damage and silt deposition.

In the Interior Highlands, stream gradients are much higher than those in the Coastal Plain, and floodflow velocities are often high enough to cause destruction from the force of the water. However, the effects of floods in the highlands are limited to relatively narrow stream valleys. The narrow valleys also enhance the feasibility of constructing flood-control and storage reservoirs.

The magnitude and frequency of floods at continuous-record gaging stations in and near the two-county area are given in table 2.

Reasonable estimates of magnitude and frequency of peak flows at ungaged sites can be computed from regional curves developed by Patterson (1964). Peak-flow characteristics of streams in the Interior Highlands differ widely from those of streams in the Coastal Plain. Peak flows of streams in the Interior Highlands of Randolph and Lawrence Counties are flashy, with rapid rises and recessions, due to the steep land slopes and the low permeability of the surface materials.

TABLE 2.—*Magnitude and frequency of floods (annual-flood series) at continuous-record gaging stations on streams that traverse Randolph and Lawrence Counties, Ark.*

[Flood-frequency relations computed from station data unless otherwise noted]

Station No.	Gaging station	Drainage area (sq mi)	Elevation (ft) of bankful stage above mean sea level	Recurrence interval, in years: 2		5		10		25		50	
				Elevation above mean sea level (ft)	Discharge (cfs)	Elevation above mean sea level (ft)	Discharge (cfs)	Elevation above mean sea level (ft)	Discharge (cfs)	Elevation above mean sea level (ft)	Discharge (cfs)	Elevation above mean sea level (ft)	Discharge (cfs)
7-0680	Current River at Doniphan, Mo.[1]	2,038	334	334.5	26,000	339.5	50,000	341.5	65,000	343.5	85,000	345.0	100,000
7-0688.9	Fourche River above Pocahontas, Ark.[2]	228	274	279.5	8,600	281.5	18,000	282.5	24,000	283.5	32,000	284.0	38,000
7-0690	Black River at Pocahontas, Ark	4,843	260	263.0	22,000	265.0	39,000	266.0	52,000	267.5	69,000	268.5	83,000
7-0695	Spring River at Imboden, Ark	1,162	270	274.5	22,000	278.5	44,000	280.5	60,000	282.5	78,000	283.5	92,000
7-0720	Eleven Point River near Ravenden Springs, Ark.	1,123	306	305.5	10,000	310.0	23,000	311.5	31,000	313.0	39,000	314.0	45,000
7-0725	Black River at Black Rock, Ark	7,323	250	253.0	40,000	255.5	67,000	257.0	88,000	259.0	117,000	260.5	140,000
7-0740	Strawberry River near Poughkeepsie, Ark.[3]	476	318	317.0	16,000	321.0	27,000	323.0	35,000	325.5	44,000	327.0	51,000
7-0773.8	Cache River at Egypt, Ark.[4]	689	241	243.0	6,300	([5])	9,600	([5])	12,000	([5])	15,000	([5])	17,000

[1] 13.3 miles upstream from Arkansas-Missouri State line.
[2] Flood-frequency data computed from regional curves in Water-Supply Paper 1681, Patterson (1964).
[3] 11.2 miles upstream from Lawrence County line.
[4] 2.4 miles downstream from Lawrence-Craighead County line. Flood-frequency data computed from regional curves in Water-Supply Paper 1681, Patterson (1964).
[5] Stage-discharge relationship not defined in this range.

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In contrast, the flat topography of the Coastal Plain of the two counties and the higher permeability of the surface materials cause slow runoff, and streams in the Coastal Plain are somewhat sluggish. Examples of the characteristic floods in the Interior Highlands and Coastal Plain can be seen by examining table 2. The 50-year flood on Current River at Doniphan, Mo., in the Interior Highlands, has a greater discharge (100,000 cfs) than that of the 50-year flood (83,000 cfs) at the downstream station, Black River at Pocahontas, Ark., in the Coastal Plain. This occurs because the peak flows downstream from Doniphan are temporarily stored in the flood plain and are returned to the Current River as it recedes. As a result the peak discharges at Pocahontas are smaller, but of longer duration, than the flashy peak discharges at Doniphan, Mo.

QUALITY

CHEMICAL AND PHYSICAL QUALITY

During the investigation 45 water samples were collected from streams in the vicinity of Randolph and Lawrence Counties. The chemical analyses of these samples and several analyses made prior to this investigation are shown in table 3. Samples were collected monthly at Black River near Corning, Black River at Pocahontas, and Cache River at Egypt. The averages of the analyses of samples collected at these stations represent approximations of time-weighted averages of the chemical constituents. Table 3 contains only the most recent chemical analyses of surface water in the area. An inventory of additional information on the quality of surface water in the area is given in table 4.

The dissolved-solids content of surface water in the area generally is less than 300 mg/l (milligrams per liter), well below the limit of 500 mg/l recommended by the U.S. Public Health Service (1962) for drinking water on interstate carriers. Dissolved-solids content of streams in the Coastal Plain is generally less than that of streams in the Interior Highlands. However, concentrations of iron and manganese in streams in the Coastal Plain often exceed the recommended limits of 0.30 and 0.05 mg/l respectively. Although streams in the Interior Highlands occasionally contain concentrations of iron that exceed the recommended limit, they seldom contain significant concentrations of manganese. Concentrations of iron and manganese that are much greater than the recommended limits not only cause staining problems but often add to the color. Color, as well as iron and manganese content, of streams in the Coastal Plain is greater than that of streams in the Interior Highlands. Almost one-third of the water samples collected from the Black and the Cache Rivers had color in excess of 15 units, which is the recommended limit.

Although there is no suggested limit for the hardness of drinking water, hard water is inconvenient and troublesome. The hardness of water destroys the cleansing action of soaps and detergents, forms scale on boilers which reduces heat-transfer efficiency, and forms scale on water-system piping, thereby reducing the capacity of the system. Hardness, as $CaCO_3$, of water from streams in Randolph and Lawrence Counties ranges from about 10 to about 300 mg/l. A comparison of the classification of hardness in the following table with chemical analyses in table 3 shows that streams in the Coastal Plain generally contain water that is moderately hard to hard; whereas, streams draining the limestone and dolomite that underlie the Interior Highlands generally contain very hard water.

Hardness (mg/l)	Rating	Usability
0–60	Soft	Suitable for many uses without further softening.
61–120	Moderately hard.	Usable except in some industrial applications. Softening profitable for laundries.
121–180	Hard	Softening required by laundries and some other industries.
181+	Very hard	Softening desirable for most purposes.

The hardness of surface waters in the area is due almost entirely to the concentrations of calcium, magnesium, and bicarbonate ions. The high ratios of calcium and magnesium ions to sodium ions in these waters indicate that the quality of surface water is excellent for the irrigation of most crops.

The dissolved-solids content and hardness of surface water generally are highest during periods of low flow, when the more mineralized ground water makes up a large part of the streamflow. The dissolved-solids content and hardness as $CaCO_3$ of water from streams during periods of low flow are illustrated in figure 8. This figure shows that the Current River and that part of the Black River above the mouth of the Spring River, as well as other lowland streams, contain softer and less mineralized water than streams in the Interior Highlands and lower reaches of the Black River.

TABLE 3.—*Selected chemical analyses of water from streams that traverse Randolph and Lawrence Counties, Ark.*

[Chemical constituents in milligrams per liter except as indicated]

Date of collection	Mean discharge (cfs)	Water temperature (° C)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Organic and ammonia nitrogen as N	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)
7-0640 Black River near Corning [1]													
Oct. 6, 1965	2,800	16	9.0	0.23	0.02	17	11	1.9	1.2	0.54	106	0	5.0
Nov. 9, 1965	496	16	8.8	.12	.00	26	16	3.0	1.0	.28	161	0	4.2
Dec. 16, 1965	810		8.0	.35	.01	22	11	2.4	1.4	1.3	120	0	5.8
Jan. 19, 1966	3,390		7.5	.10	.01	19	9.3	1.4	.6	.67	100	0	5.8
Feb. 17, 1966	3,190		6.5	.29	.00	7.8	5.3	1.0	1.8	.46	42	0	6.6
Mar. 31, 1966	945		8.2	.38	.03	28	12	1.6	.9	.76	139	0	5.4
June 8, 1966	3,140		7.7	.12	.07	17	10	1.2	1.2	.00	103	0	4.6
July 13, 1966	476		10.0	.15	1.2	31	13	3.4	1.4	.08	160	0	4.2
Aug. 18, 1966	684		12.0	.10	.04	28	12	1.2	1.5		143	1	3.6
Sept. 22, 1966	440		9.2	.08	.04	34	15	2.6	1.2	.34	176	0	2.8
Oct. 27, 1966	486		8.6	.04	.02	30	19	2.4	.8	.64	180	4	3.6
Average	1,532		8.7	0.18	0.13	24	12	2.0	1.2	0.50	130	0	4.7
7-0688.5 Current River near Pocahontas													
July 26, 1966	1,840	24				35	18				190	4	
7-0688.8 Mud Creek near Ingram													
Nov. 17, 1964	1.20		9.0		0.00	67	32	1.5	0.7		342	11	8.4
7-0688.9 Fourche River above Pocahontas													
Sept. 10, 1963	18		8.9	0.01	0.00	55	26	3.4	1.6		302	0	4.6
Oct. 28, 1965	50	13	9.0	.24	.00	55	32	3.1	1.0		321	4	5.8
Apr. 25, 1966	2,100	17	8.1	.10	.00	30	12	.9	1.3		148	0	5.2
July 27, 1966	36												

Date of collection	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Phosphorus as PO_4	Dissolved solids (residue at 180° C)	Hardness as $CaCO_3$		Specific conductance (micromhos at 25° C)	pH	Color	Turbidity	Oxygen	
							Calcium-magnesium	Noncarbonate					Dissolved	Percent saturation
7-0640 Black River near Corning [1]														
Oct. 6, 1965	1.2	0.1	0.3	0.01	0.10	93	88	0	178	7.6	7	20		
Nov. 9, 1965	2.3	.0	.6	.07	.10	172	131	0	261	8.0	5	30		
Dec. 16, 1965	2.2	.0	.3	.00	.10	115	100	2	205	7.2	15	35		
Jan. 19, 1966	1.2	.0	1.0	.03	.08	96	86	4	174	7.4	10	26		
Feb. 17, 1966	2.2	.0	.4	.04	.04	64	42	7	87	6.9	30	100		
Mar. 31, 1966	2.5	.3	.0	.08	.08	128	120	6	233	7.5	5	10		
June 8, 1966	1.1	.1	.0	.00		93	84	0	172	7.3	7			
July 13, 1966	3.3	.1	.5	.00		150	131	0	268	7.6	3			
Aug. 18, 1966	2.1	.1	.0				120	1	236	8.3				
Sept. 22, 1966	2.1	.1	.0	.02		149	147	2	280	7.5	10			
Oct. 27, 1966	2.0	.0	.0			156	153	0	276	8.4	5			
Average	2.0	0.1	0.3	0.03	0.08	122	109	2	215	7.6	10	37		
7-0688.5 Current River near Pocahontas														
July 26, 1966						[2] 165	162	0	272	8.3			7.7	92
7-0688.8 Mud Creek near Ingram														
Nov. 17, 1964	1.8	0.0	0.1			279	299	0	520	8.5	5			
7-0688.9 Fourche River above Pocahontas														
Sept. 10, 1963	5.0	0.0	0.1			253	244	0	457	7.0	5			
Oct. 28, 1965	2.7	.1	.0			273	269	0	483	8.4	5	2	8.9	84
Apr. 25, 1966	1.0	.2	.5		0.04	145	125	4	239	7.7	20		8.5	
July 27, 1966						[2] 222			400					

See footnotes at end of table.

TABLE 3.—*Selected chemical analyses of water from streams that traverse Randolph and Lawrence Counties, Ark.*—Continued

Date of collection	Mean discharge (cfs)	Water temperature (°C)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Organic and ammonia nitrogen as N	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)
7-0690 Black River at Pocahontas													
Oct. 7, 1965	4,200	16	8.8	0.24	0.03	22	14	1.9	1.0	0.13	139	0	4.0
Nov. 8, 1965	1,820	17	8.5	.13	.01	31	19	3.2	.8	.18	196	0	3.8
Dec. 15, 1965	2,890		8.5	.21	.00	31	16	2.8	1.0	.30	174	0	5.0
Jan. 18, 1966	10,700		7.3	.27	.00	15	7.7	1.6	1.4	.19	81	0	5.0
Feb. 18, 1966	18,000		6.7	.22	.00	15	10	1.0	1.6	1.0	92	0	5.4
Mar. 31, 1966	3,450		6.9	.17	.03	30	15	2.3	.9	.81	168	0	4.6
June 8, 1966	6,160		7.9	.20	.06	24	11	1.6	1.2	.17	124	0	3.8
July 13, 1966	2,160		11	.07	.05	39	14	3.1	1.3	.00	191	0	4.2
July 27, 1966	2,340												
Aug. 19, 1966	3,920		7.3	[3] .01	.00	25	11	1.7	1.5		132	0	2.0
Sept. 23, 1966	1,850		9.5	.05	.01	39	17	2.5	1.1	.37	202	0	3.2
Oct. 28, 1966	2,010		8.4	.11	.01	32	24	2.4	.9	3.0	204	4	4.0
Average	4,960		8.2	0.15	0.02	27	14	2.2	1.2	0.62	155	0	4.1
7-0694 Janes Creek at Ravenden Springs													
Aug. 13, 1963	7.19		10			28	26	1.3	1.0		196	8	3.6
Oct. 28, 1965	7.75	16	8.9	0.06	0.00	58	35	1.9	.8		344	4	5.4
Apr. 25, 1966	430	17	8.3	.29	.00	34	16	.8	1.3		182	0	4.6
July 27, 1966	8.15												
7-0695 Spring River at Imboden													
Sept. 10, 1963	369		8.7	0.01	0.00	47	28	1.8	1.2		288	0	3.0
July 27, 1966	545	26				48	28				272	6	
7-0720 Eleven Point River near Ravenden Springs													
Sept. 9, 1963	424		8.3	0.00	0.00	53	17	1.1	0.9		248	0	2.4
July 27, 1966	653	26				43	23				224	8	
7-0728.3 Big Running Water Creek near Alicia													
July 26, 1966	[4] 45	26				17	6.2				76	0	

Date of collection	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Phosphorus as PO_4	Dissolved solids (residue at 180° C)	Hardness as $CaCO_3$: Calcium magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25° C)	pH	Color	Turbidity	Oxygen: Dissolved	Oxygen: Percent saturation
7-0690 Black River at Pocahontas														
Oct. 7, 1965	1.6	0.0	0.3	0.04	0.08	130	113	0	216	7.5	12	25		
Nov. 8, 1965	2.8	.0	.8	.06	.17	170	156	0	306	8.0	5	35		
Dec. 15, 1965	2.4	.1	.5	.01	.05	146	144	1	277	7.6	4	36		
Jan. 18, 1966	1.3	.1	.3	.08	.09	88	69	2	147	7.5	40	25		
Feb. 18, 1966	1.1	.0	.3	.03	.10	95	78	3	155	7.2	20	60		
Mar. 31, 1966	1.8	.2	.0	.06	.07	145	137	0	267	7.7	7	4		
June 8, 1966	1.5	.1	6.1	.01		113	105	4	218	7.2	5			
July 13, 1966	2.7	.1	.5	.02	.07	155	155	0	302	8.1	3			
July 27, 1966						[2] 137			255					
Aug. 19, 1966	1.6	.0	.0	.01		109	108	0	217	7.2	16			
Sept. 23, 1966	2.1	.1	.0	.01		160	168	2	318	7.7	12			
Oct. 28, 1966	1.8	.0	.0			176	179	5	321	8.4	5			
Average	1.9	0.1	0.8	0.03	0.09	135	128	2	250	7.6	12	31		
7-0694 Janes Creek at Ravenden Springs														
Aug. 13, 1963	1.4	0.2	0.2			176	177	3	320	8.5	4			
Oct. 28, 1965	1.6	.1	.0			255	289	0	504	8.4	5	0	10.4	105
Apr. 25, 1966	.9	.1	.8		0.04	150	151	2	283	7.8	8		9.1	
July 27, 1966						[2] 210			415					
7-0695 Spring River at Imboden														
Sept. 10, 1963	4.0	0.0	0.1			236	232	0	428	6.8	5			
July 27, 1966						[2] 204	235	2	370	8.4			6.3	77
7-0720 Eleven Point River near Ravenden Springs														
Sept. 9, 1963	3.0	0.0	0.6			208	202	0	379	7.0	5			
July 27, 1966						[2] 176	202	4	320	8.3			7.2	88
7-0728.3 Big Running Water Creek near Alicia														
July 26, 1966						[2] 224	68	6	355	7.4			4.8	58

See footnotes at end of table.

TABLE 3.—*Selected chemical analyses of water from streams that traverse Randolph and Lawrence Counties, Ark.*—Continued

Date of collection	Mean discharge (cfs)	Water temperature (°C)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Organic and ammonia nitrogen as N	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)
7-0742.48 South Big Creek near Strawberry													
Nov. 17, 1964	21.4		7.5		0.00	25	23	1.5	0.9		180	4	7.2
7-0743 Strawberry River near Strawberry													
Oct. 28, 1965	165	15	7.4	0.14	0.00	51	25	1.8	0.8		270	6	5.4
Apr. 26, 1966	4,970	17	7.5	.16	.00	26	12	.9	1.4		133	0	4.6
July 27, 1966	280												
7-0746 Village Creek at Walnut Ridge													
Aug. 13, 1963	4.67		28			36	15	9.4	3.6		195	2	9.0
7-0746.4 Village Creek near Minturn													
July 26, 1966	[4] 40	27				21	7.6				100	0	
7-0773.8 Cache River at Epypt [5]													
Oct. 5, 1965	684	16	7.6	2.4	0.01	9.5	5.0	3.3	6.0		67	0	0.2
Nov. 10, 1965	35.6	16	24	.23	.00	41	12	18	3.0		222	0	4.0
Dec. 14, 1965	827		9.7	.82	.00	7	2.7	5.6	5.2		32	0	9.6
Jan. 18, 1966	3,940		3.8	.33	.00	1.3	2.4	1.9	3.0		14	0	4.2
Feb. 16, 1966	2,670		4.4	.69	.00	2.9	2.3	2.2	3.4	0.84	15	0	7.4
Mar. 30, 1966	172		21	.43	1.0	24	7.3	3.1	2.2	.51	132	0	7.4
Apr. 26, 1966	4,500	18	4.7		.00	3.8	1.1	3.0	2.1		31	0	5.0
June 7, 1966	1,170		2.3	1.5	.5	9.5	1.6	3.0	2.6	3.4	29	0	3.4
July 12, 1966	88.3		21	.21	.68	40	8.6	17	3.2	.43	196	0	5.4
July 25, 1966	1,400												
Aug. 18, 1966	756		11	1.4	.13	9	2.7	5.4	4.2		49	0	4.8
Sept. 20, 1966	131		22	.18	.22	36	9.1	16	3.4	.35	184	0	2.6
Oct. 25, 1966	54		18	.91	.04	26	9.5	13	4.2	1.2	151	0	4.2
Average	1,360		11	0.83	0.22	18	5.4	7.9	3.5	1.1	96	0	4.9

Date of collection	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Phosphorus as PO_4	Dissolved solids (residue at 180°C)	Hardness as $CaCO_3$: Calcium-magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25° C)	pH	Color	Turbidity	Oxygen: Dissolved	Oxygen: Percent saturation
7-0742.48 South Big Creek near Strawberry														
Nov. 17, 1964	1.7	0.0	0.1			153	157	3	290	8.4	2			
7-0743 Strawberry River near Strawberry														
Oct. 28, 1965	2.2	0.2	0.1			214	227	0	412	8.4	5	0	10.4	103
Apr. 26, 1966	1.0	.2	.6		0.04	136	115	6	207	7.5	16		8.3	
July 27, 1966						[2] 140			215					
7-0746 Village Creek at Walnut Ridge														
Aug. 13, 1963	0.6	0.3	0.6			201	152	0	318	8.3	18			
7-0746.4 Village Creek near Minturn														
July 26, 1966						[2] 230	85	3	365	7.4			5.2	64
7-0773.8 Cache River at Epypt [5]														
Oct. 5, 1965	2.5	0.1	0.8			90	44	0	118	6.9	26	35		
Nov. 10, 1965	6.0	.2	.3			220	152	0	358	7.7	10	10		
Dec. 14, 1965	5.0	.2	.6			114	28	20	98	6.7	140	140		
Jan. 18, 1966	1.2	.2	.5			76	13	2	41	6.7	160	88		
Feb. 16, 1966	1.7	.2	.5	0.05	0.06	50	16	4	52	6.4	50	560		
Mar. 30, 1966	3.4	.2	.1	.09	.19	162	115	0	273	7.4	10	4		
Apr. 26, 1966	1.4	.3	.8			37	14	0	44	6.4		5		
June 7, 1966	1.4	.2	10	.02		50	30	6	86	6.5	16			
July 12, 1966	5.8	.2	.0	.04	.08	187	136	0	328	7.4	9			
July 25, 1966						[2] 68			105					
Aug. 18, 1966	1.3	.1	1.9			[6] 66	34	0	99	7.8				
Sept. 20, 1966	8.1	.2	.1	.08		181	128	0	315	7.4	15			
Oct. 25, 1966	5.7	.2	.1			163	104	0	257	8.0	8			
Average	3.6	0.2	1.3	0.06	0.11	113	68	3	167	7.1	44	120		

[1] 24 miles upstream from Randolph-Clay County line.
[2] Calculated from specific conductance.
[3] In solution when analyzed.
[4] Estimated.
[5] 2.4 miles downstream from Lawrence-Craighead County line.
[6] Calculated value.

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Table 4.—*Inventory of information on the quality of surface water in the vicinity of Randolph and Lawrence Counties, Ark.*

[Top number in boxheads indicates water year; number in parentheses indicates series number of U.S. Geol. Survey Water Supply Paper]

C: Chemical analyses.
T: Records of water temperature.
X: Sampled intermittently—miscellaneous analyses.
M: Sampled monthly.
D: Sampled daily.

A: One or more chemical analyses available in reports published annually by the U.S. Geological Survey in cooperation with the Arkansas Geological Commission.
N: Water Resources Data for Arkansas, Part 2, Water Quality Records, 1964.

Station No.	Station name	1946 (1050)	1947 (1102)	1948 (1133)	1949 (1163)	1950 (1188)	1951 (1199)	1952 (1252)	1953 (1292)	1954 (1352)	1955 (1402)
7-0640	Black River near Corning	C, X	C, X	C, X	C, X	C, X	C, X	C, X	C, X	C, X	C, M
7-0688.5	Current River near Pocahontas	-----	-----	-----	-----	-----	-----	-----	-----	-----	C, M
7-0690	Black River at Pocahontas	C, X	C, X	C, X	C, X	C, X	C, X	C, X	C, X	C, X	A
7-0695	Spring River at Imboden	C, X	C, X	C, X	C, X	C, X	C, X	C, X	C, X	C, M	C, M
7-0720	Eleven Point River near Ravenden Springs.	C, X	C, X	C, X	C, X	C, X	C, X	C, X	C, X	C, M	C, M
7-0725	Black River at Black Rock	C, D T, D	C, X	C, X	C, X	C, X	C, X	C, X	C, D T, D	-----	-----
7-0740	Strawberry River near Poughkeepsie	C, X	C, X	C, X	C, X	C, X	C, X	C, X	C, X	C, M	C, M

Station No.	Station name	1956 (1452)	1957 (1522)	1958 (1573)	1959 (1644)	1960 (1744)	1961 (1884)	1962 (1944)	1963 (1950)	1964 (N)
7-0640	Black River near Corning	C, M	C, D T, D	C, D T, D	C, D T, D	C, M	A	-----	A	A
7-0688.5	Current River near Pocahontas	C, M	C, M	C, M	-----	-----	-----	-----	-----	-----
7-0690	Black River at Pocahontas	A	-----	-----	-----	-----	-----	-----	A	A
7-0695	Spring River at Imboden	C, D T, D	C, D T, D	C, D T, D	C, D T, D	C, D T, D	C, D T, D	-----	A	-----
7-0720	Eleven Point River near Ravenden Springs	C, M	C, D T, D	C, I T, D	C, D	A	-----	-----	A	-----
7-0725	Black River at Black Rock	-----	-----	-----	-----	-----	-----	-----	-----	-----
7-0740	Strawberry River near Poughkeepsie	C, M	C, D T, D	C, D T, D	A	A	-----	-----	-----	-----

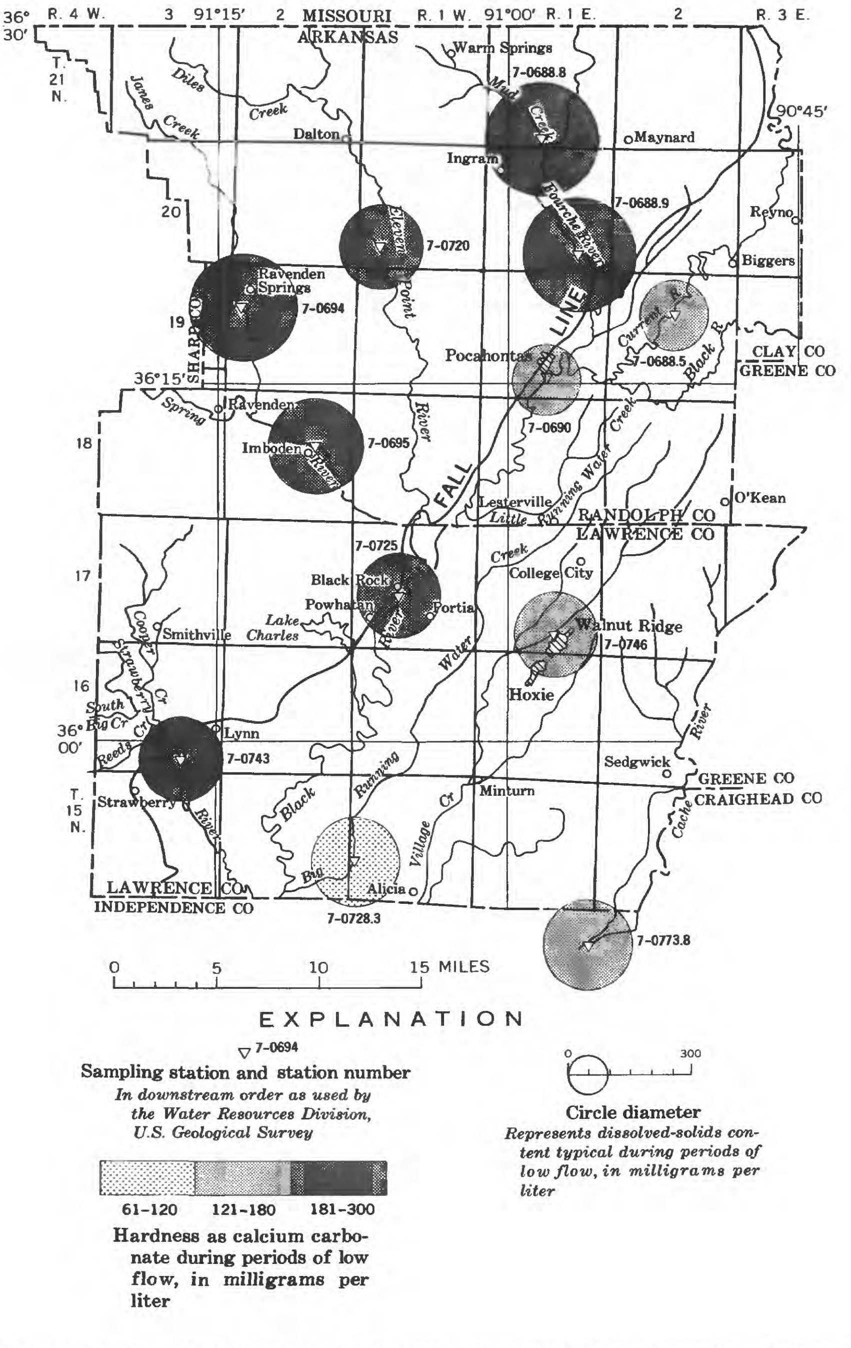


FIGURE 8.—Dissolved-solids content and hardness as $CaCO_3$ at sampling stations during periods of low flow.

Duration curves for dissolved-solids content and temperature of Spring River at Imboden and Black River near Corning are shown in figure 9. These curves are based on information collected daily from October 1, 1956, to September 30, 1959. Examination of the limited information available on the chemical quality of surface water in the area indicates that the temperature and dissolved-solids duration curves for streams that drain the Coastal Plain would be similar to those of Black River near Corning. Chemical analyses of water from streams in the Interior Highlands indicate that the temperature and dissolved-solids duration curves for highland streams would be similar to those of Spring River at Imboden.

The temperature-duration curves in figure 9 indicate that the temperature of surface water in the area ranges from near freezing to about 30°C. Intepretation of these curves also indicates that during warm weather water in the spring-fed steams of the Interior Highlands is probably several degrees cooler than that in the slower moving lowland streams.

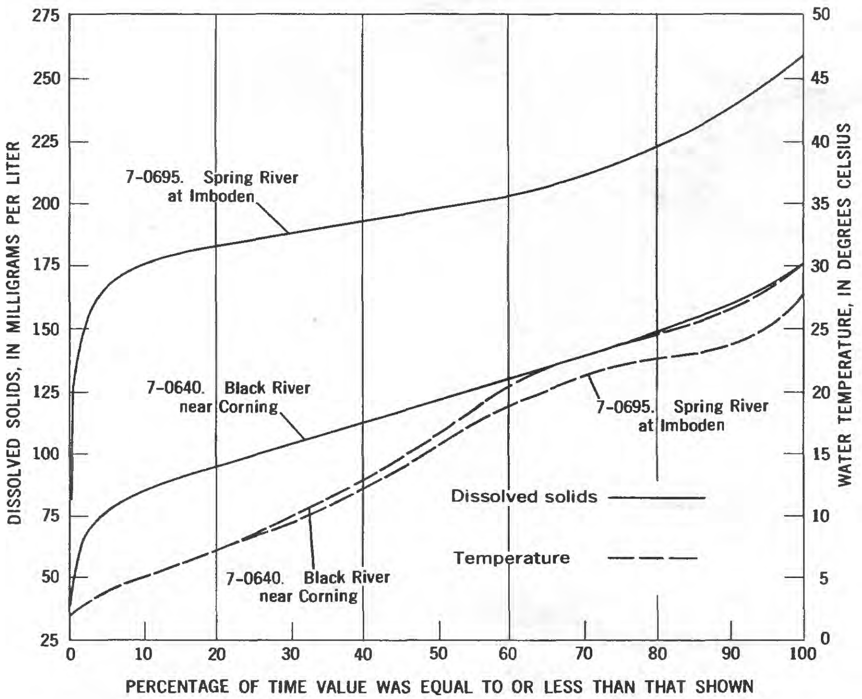


FIGURE 9.—Dissolved-solids and temperature-duration curves for Spring River at Imboden and Black River near Corning (Clay County).

The turbidity of samples collected from the streams in the study area indicates that the silt load of many streams in the Coastal Plain may be a problem in developing the streams for water supply. However, insufficient data preclude an accurate evaluation of the sediment load of streams in the area.

BACTERIAL QUALITY

Bacterial analyses were made on samples collected at most of the surface-water sampling sites. These analyses, made by the Bureau of Environmental Engineering of the Arkansas State Department of Health, show the bacterial quality of water in the streams only at the instant the samples were collected. Several of the streams sampled were found to contain coliform bacteria in excess of the suggested limit for water used for public swimming. Coliform concentrations much in excess of this limit often indicate sewage pollution or pollution from animal wastes; but based on the one sampling, very few of the streams in the two counties would be classified as polluted streams.

GROUND-WATER RESOURCES

Ground-water reservoirs furnish nearly 80 percent of the total amount of water used in Randolph and Lawrence Counties. Eighty-four percent of the inhabitants of the two counties depend upon ground water for their domestic water supply. Ground-water supplies sufficient for household and nonirrigation farm use can be obtained from wells nearly everywhere in the two counties. Larger supplies of ground water generally can be obtained only from wells in the Coastal Plain.

Wells mentioned in this report are referred to by location numbers, which are based upon the Federal land-survey system as used in Arkansas. The system of locating and numbering wells is illustrated in figure 10.

COASTAL PLAIN PROVINCE

AVAILABILITY

The Coastal Plain of Randolph and Lawrence Counties is underlain by alluvial deposits of Quaternary age, except for a small area in southwestern Lawrence County. This small area is immediately underlain by windblown silt of Quaternary age (loess), sand and gravel of Tertiary age, and deposits of Cretaceous age (Nacatoch Sand). The loess in Lawrence County is the only unit that does not yield water to wells.

DEPOSITS OF QUATERNARY AGE

The principal aquifer in the area of this report is the alluvial deposits of Quaternary age. In most places these deposits grade downward, from silt and clay at the surface to a basal sand and gravel.

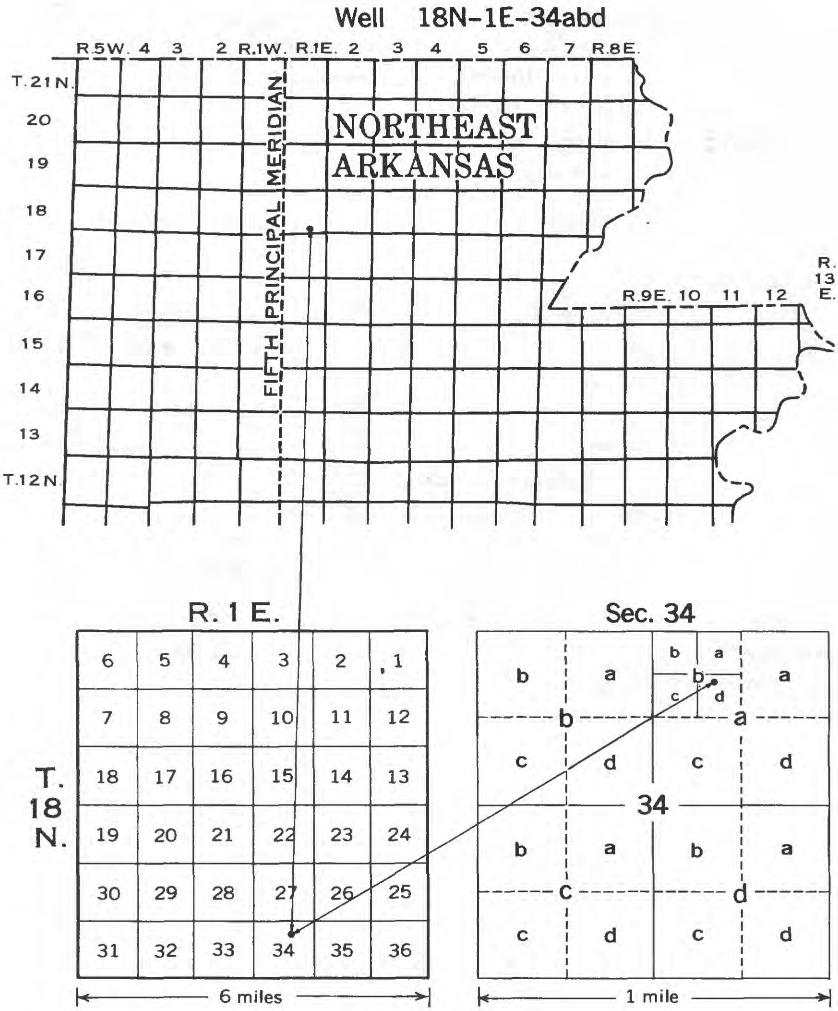
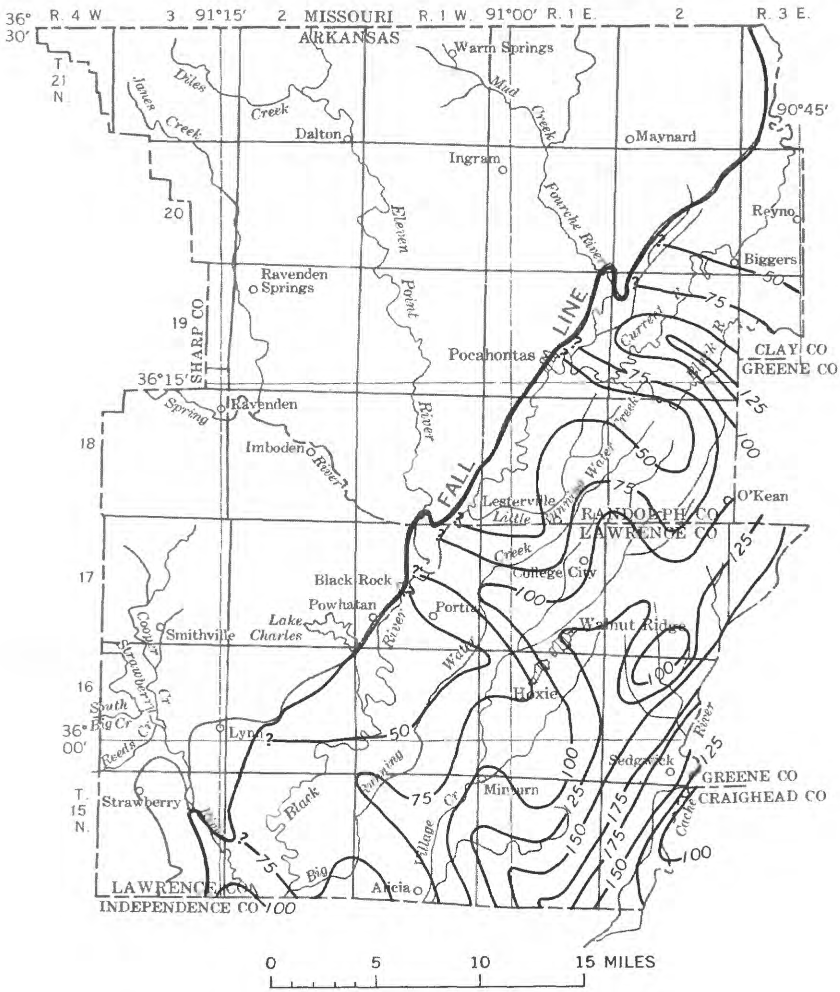


FIGURE 10.—Well-numbering system.

Wells that have the largest yields are screened in the coarse gravel at the base of these deposits. The Quaternary deposits in Randolph and Lawrence Counties generally increase in thickness to the southeast and reach a maximum thickness of about 180 feet; but well logs indicate that in most places the base of this aquifer is at depths of 80–130 feet below land surface. To utilize the full water-supply potential of the Quaternary deposits, wells should penetrate the thickness of the aquifer. The thickness of the Quaternary deposits is shown in figure 11.



EXPLANATION

Western boundary of Quaternary deposits
In most places, coincides with Fall Line

——50——?
Line of equal thickness of Quaternary deposits
Queried where doubtful. Interval 25 feet

FIGURE 11.—Thickness of deposits of Quaternary age. (From Krinitzsky and Wire, 1964.)

Irrigation wells in the Quaternary deposits generally range from 10 to 14 inches in diameter and yield about 1,000 gpm (gallons per minute), or more than 4.4 acre-feet per day. Well yields of as much as 1,300 gpm were measured during this investigation, and some irrigation wells were reported to yield more than 2,000 gpm.

The yield per foot of drawdown in the water level is a measure of the ability of the ground-water reservoir to yield water and of the efficiency of the well. The yields per foot of drawdown, or specific capacities, of five wells in the deposits of Quaternary age are given in table 5. The specific capacities of these wells range from 18 to 90 gpm per foot of drawdown. These specific capacities indicate that the Quaternary aquifer is moderately to highly permeable.

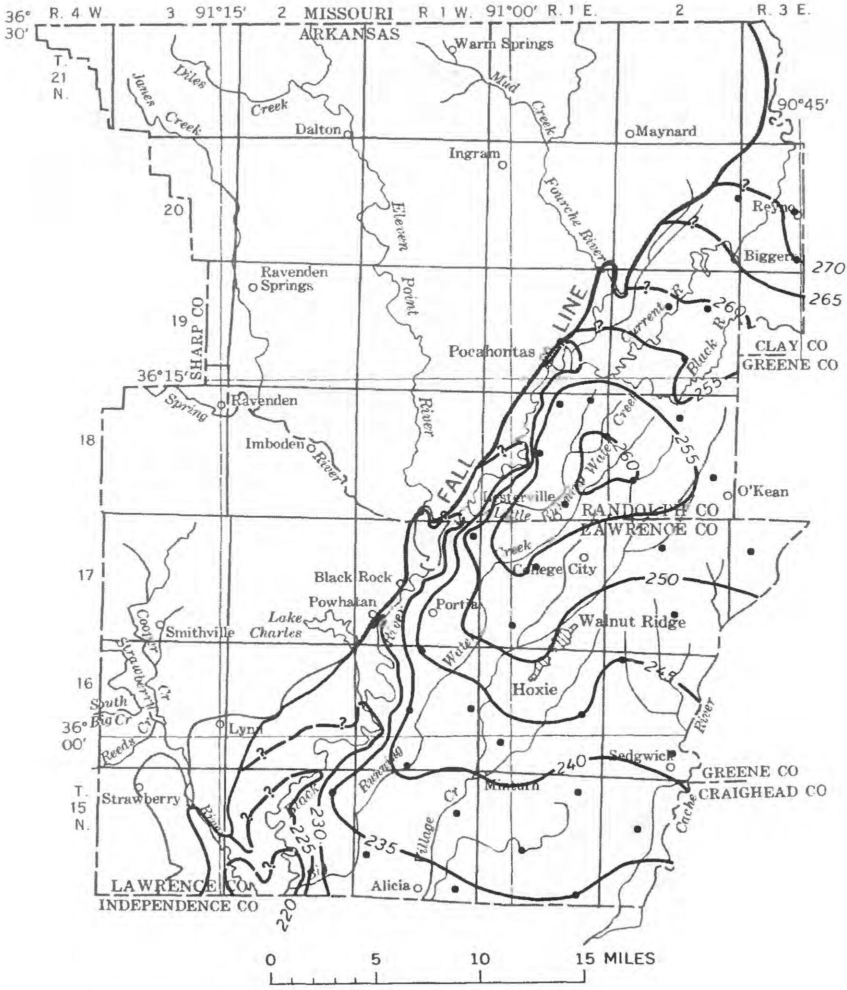
TABLE 5.—*Specific capacity of selected wells in deposits of Quaternary age in Randolph and Lawrence Counties, Ark.*

Well location	County	Static measurements		Pumping measurements			Specific capacity (gpm per ft of drawdown)
		Water level (feet below land surface)	Date	Water level (feet below land surface)	Date	Well yield (gpm)	
16N-1E-11dbd	Lawrence	[1] 13	4- -66	35.00	7-14-66	900	41
16N-1E-26aad	do	20.90	11- 8-66	28.40	11- 8-66	675	90
16N-2E-6aac	do	[1] 20	4- -66	31.84	7-27-66	875	74
17N-2E-4abb	do	[1] 18	4- -66	32.60	7-26-66	1,050	72
20N-2E-13daa	Randolph	8.06	4-11-66	34.98	7-26-66	480	18

[1] Static water levels, spring 1966, taken from water-level contour map.

Water levels in the Quaternary deposits generally are less than 20 feet below land surface and fluctuate only a few feet. The configuration of the water table in the spring and the fall of 1966 is shown in figures 12 and 13. Average surface-water elevations for 30 days prior to the water-level measurements were used to help define the water table near Black, Current, and Cache Rivers. Inasmuch as the movement of ground water is perpendicular to the contour lines, figures 12 and 13 indicate that the large streams in the Coastal Plain, particularly the Black River, receive ground water from the Quaternary aquifer in most of the two-county area. In general, ground-water movement is both toward and with the major streams. Rate of movement depends upon aquifer characteristics and the gradient. In the area of this report, the rate of movement ranges from more than 100 feet per year near pumping wells and large streams to about 10 feet per year elsewhere.

Figure 14 shows the water-level declines from spring to fall 1966. In areas adjacent to the Black and Current Rivers where the decline was in response to the stage of the stream, the seasonal water-level decline exceeded 3 feet. Seasonal declines were generally less than 1 foot in the southeastern part of the area, where irrigation is greatest. Such declines are not unusual for the normally dry growing season. The fact that water levels generally recover during the wet winter and spring months is illustrated in figure 15, which shows long-term hydrographs



EXPLANATION

Western boundary of Quaternary deposits
In most places, coincides with Fall Line

•
Well used for control

——230—— —?—

Water-table contour
Shows elevation of the water table. Dashed where approximately located; queried where doubtful. Contour interval 5 feet. Datum is mean sea level

FIGURE 12.—Configuration of the water table in deposits of Quaternary age, spring 1966.

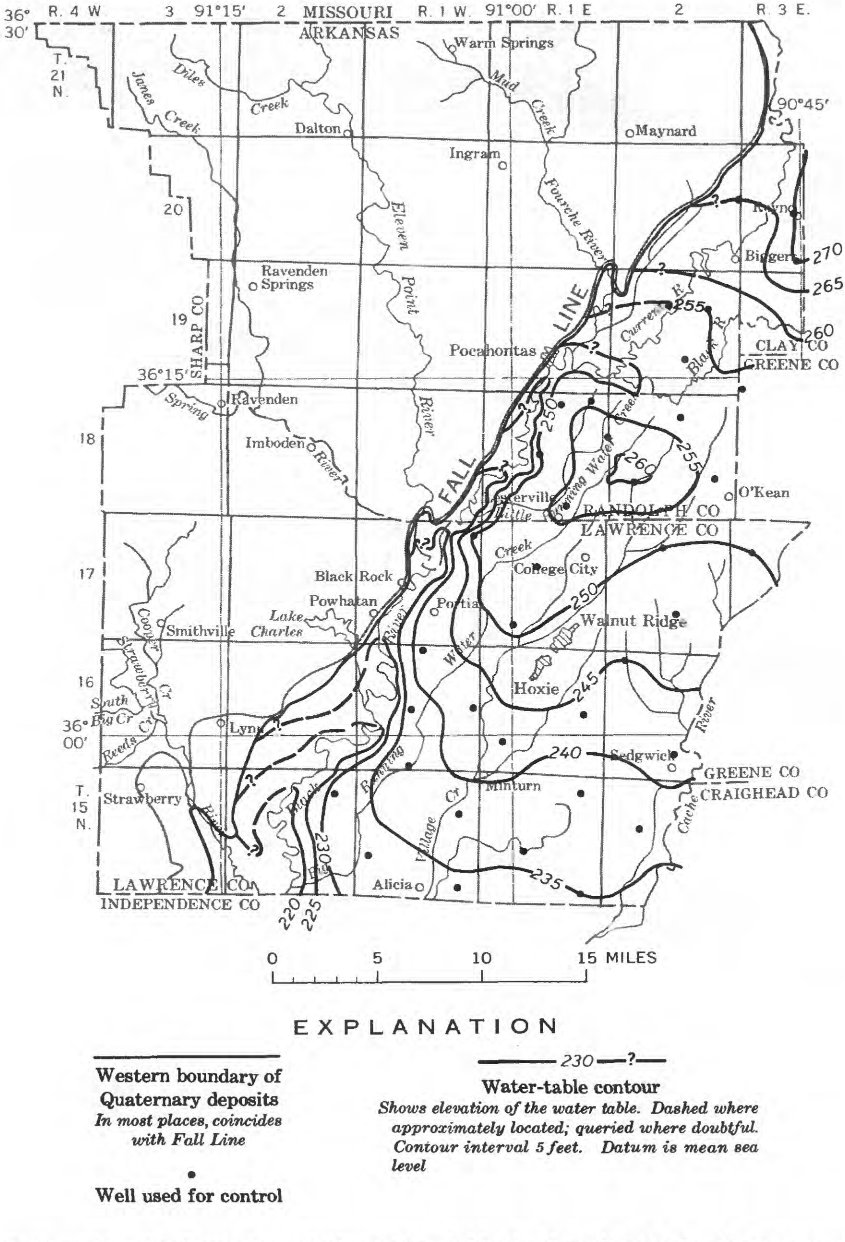


FIGURE 13.—Configuration of the water table in deposits of Quaternary age, fall 1966.

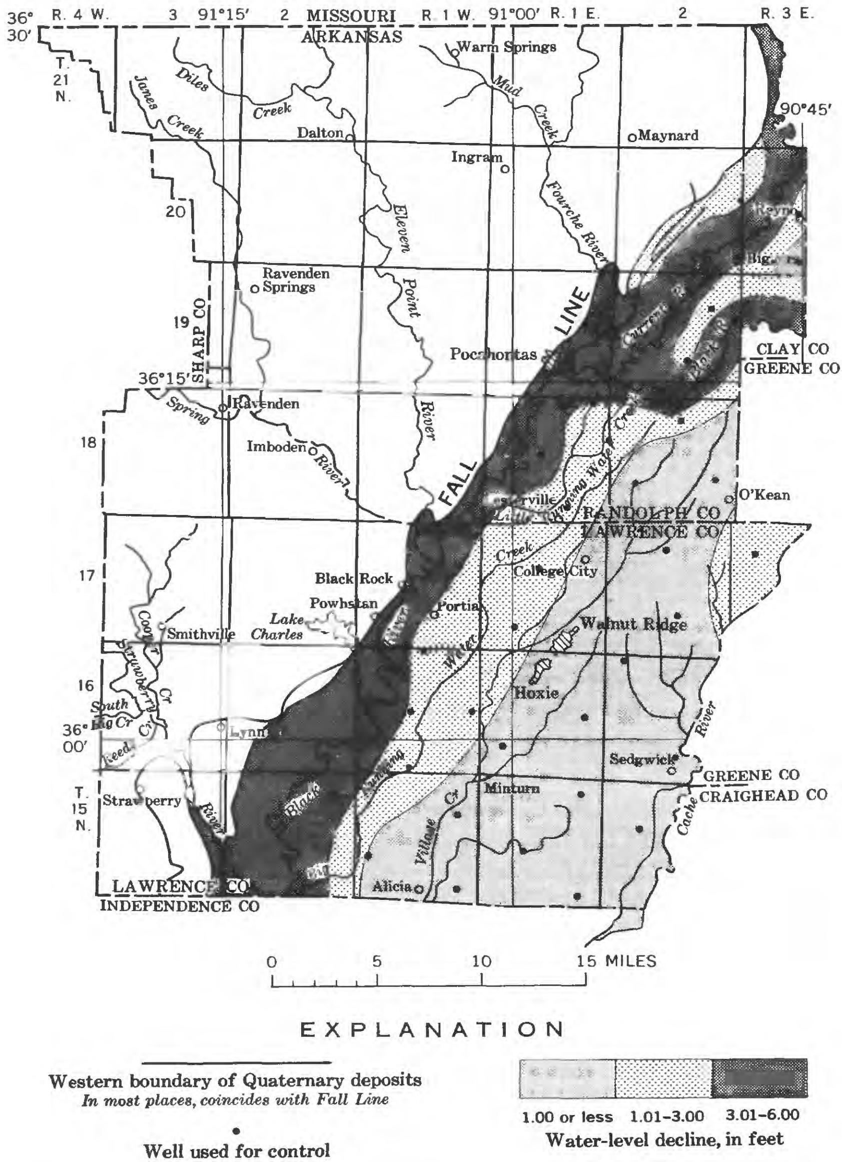


Figure 14.—Water-level declines in deposits of Quaternary age, spring to fall 1966.

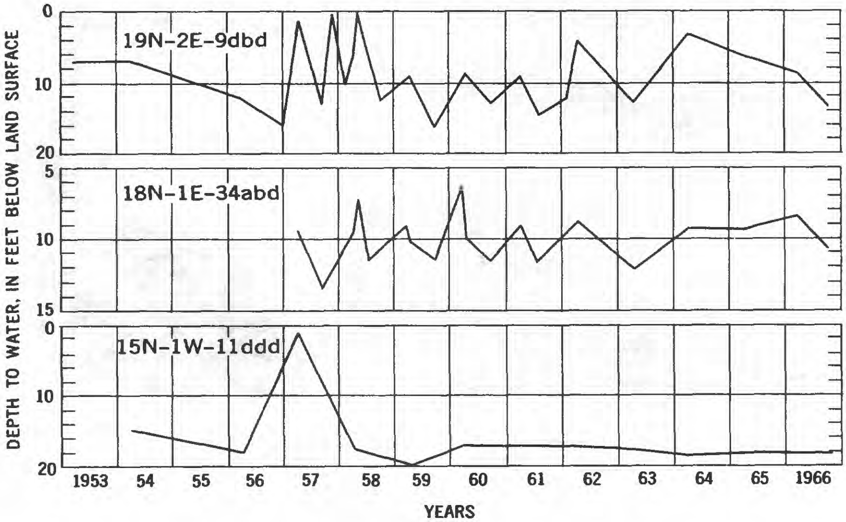


FIGURE 15.—Hydrographs of wells 19N–2E–9dbd, 18N–1E–34abd, and 15N–1W–11ddd.

of three wells in deposits of Quaternary age. Although water levels in these wells have fluctuated as much as 20 feet during the period of record, the hydrographs indicate that there are no continuing declines due to pumpage. The largest fluctuations in these hydrographs are generally due to abnormal amounts of rainfall or to the influence of nearby streams. Although irrigation wells withdraw annually about 6.8 billion gallons (20,868 acre-ft) of water from the ground-water reservoir, the small seasonal water-level declines and the lack of significant declines during the last 10 years indicate that there are no serious ground-water-supply problems in the Quaternary deposits of these two counties.

The Quaternary deposits are capable of supplying water to many more wells than are presently in use, but well spacing should be considered carefully before additional high-yield wells are installed. The greater the distance between wells, the smaller the influence one well has on another. The results of studies in Jackson and Independence Counties (Albin and others, 1967), which border the project area, indicate that high-yield wells in the Quaternary deposits should be spaced more than a thousand feet apart. This spacing would avoid excessive mutual interference between wells and would result in high pumping levels and lower pumping costs.

DEPOSITS OF TERTIARY AGE

Sands and Gravels.—Sands and gravels of Tertiary age crop out in several small areas near the Fall Line in southwestern Lawrence County (fig. 2). These deposits are relatively thin and of limited areal extent and are utilized for small domestic supplies.

Wilcox Group.—The Wilcox Group, which consists of silt, clay, and sand, and minor amounts of lignite, does not crop out in the report area. The unit, however, is present in the subsurface directly beneath the Quaternary alluvium in extreme southeastern Lawrence County, where the Wilcox is less than 200 feet thick. At the present time (1967), the Wilcox Group is not utilized as a source of water in the report area. However, a study by Hosman, Long, Lambert, and others (1968) suggests that the Wilcox Group may be a potential source of water in southeastern Lawrence County (fig. 16). This study indicates that wells drilled into the Wilcox would be artesian and that water levels probably would rise to within about 60 feet of the land surface. Well yields cannot be predicted for the Wilcox in this area, but the unit probably contains some sand and should be investigated as a possible source of water.

DEPOSITS OF CRETACEOUS AGE

The Nacatoch Sand, of Late Cretaceous age, crops out in a narrow band along the Fall Line in southwestern Lawrence County. The formation dips to the southeast at about 40 feet per mile. Sand increases

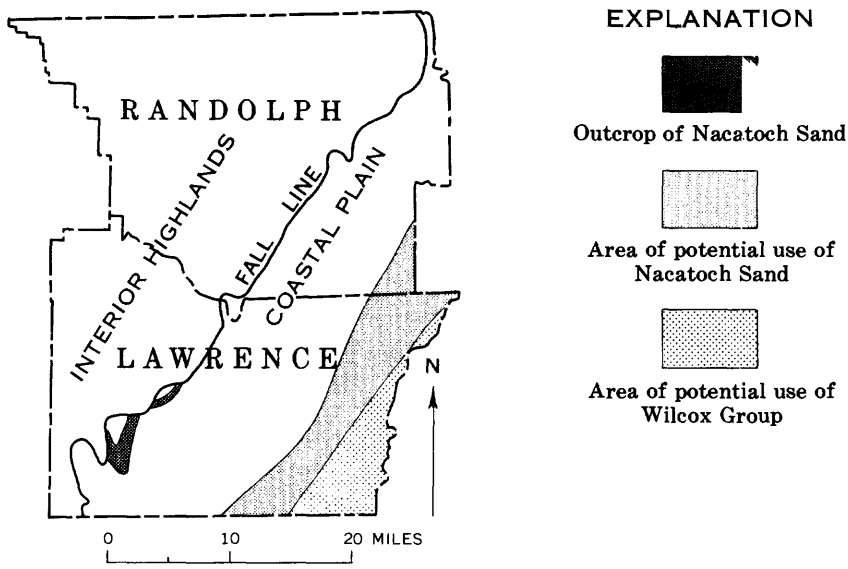


FIGURE 16.—Areas of potential development of ground water from the Wilcox Group and the Nacatoch Sand.

in percentage downdip and makes up 40–60 percent of the formation in extreme southeastern Randolph and eastern Lawrence Counties.

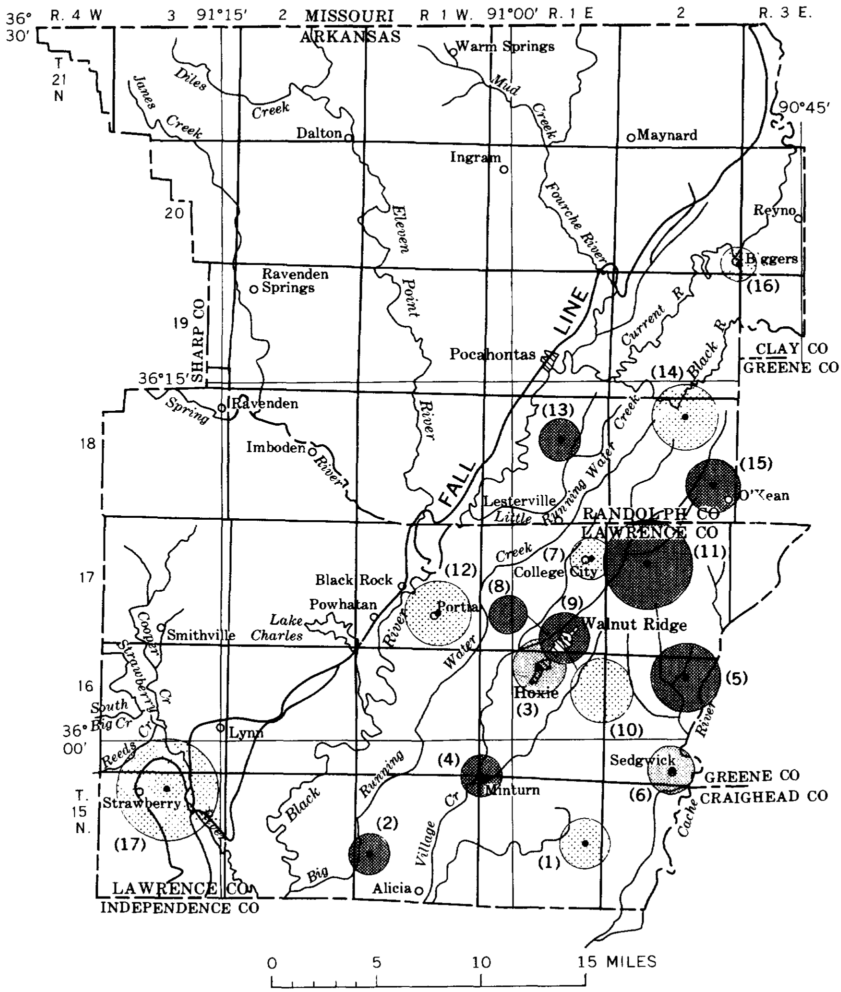
The Nacatoch Sand is not utilized as a source of water in the project area except for some wells for domestic purposes in the outcrop. However, it yields substantial amounts of water to wells in northeastern Clay County, Ark., and in the bootheel of Missouri. A study by Boswell, Moore, MacCary, and others (1965) indicates that the formation may be a potential source of water in southeastern Randolph and eastern Lawrence Counties (fig. 16). The top of the Nacatoch Sand is abount 400 feet below sea level in the southeast corner of Lawrence County and is near sea level at the west boundary of the area of potential use. Wells drilled into the Nacatoch probably would be artesian, but water levels and well yields cannot be predicted at present.

QUALITY

CHEMICAL AND PHYSICAL QUALITY

The Quaternary deposits yield a hard to very hard calcium magnesium bicarbonate water that is moderately mineralized. The dissolved-solids content of 16 water samples from these deposits (table 6) ranged from 153 to 434 mg/l, and averaged 257 mg/l. The hardness as $CaCO_3$ ranged from 50 to 349 mg/l, and averaged 174 mg/l. Iron and manganese concentrations, which averaged 2.0 and 1.0 mg/l, respectively, often exceeded the 0.30-mg/l limit for iron and the 0.05-mg/l limit for manganese recommended by the U.S. Public Health Service (1962) for drinking water. Eight of the 16 samples had combined iron and manganese concentrations between 4.1 and 5.1 mg/l. High concentrations of iron and manganese cause stains on clothing and plumbing fixtures. Manganese is less common than iron in ground water, but it is more stable and more difficult to remove. Aeration of water containing high concentrations of iron and manganese will generally precipitate most of the iron and some of the manganese. There is no apparent pattern in the occurrence of these high concentrations of iron and manganese nor is there an apparent relation to the dissolved-solids content (fig. 17). The data in table 6 show that three samples (from wells 12, 14, and 16) were found to contain abnormally high concentrations of nitrate and chloride ions. The relatively high concentrations of these ions did not exceed the limits recommended for drinking water; but they indicate the possible contamination of the ground water by sewage, drainage from barnyards, or by commercial fertilizers.

Although the quality of water from the deposits of Quaternary age is such that treatment is necessary to make the water suitable for public-supply purposes, the water is used without treatment through-



EXPLANATION

Western boundary of Quaternary deposits
In most places, coincides with Fall Line

•
Location of well from which sample was collected and analyzed

0-1.0 | 1.1-4.0 | 4.1-5.5
Combined iron and manganese, in milligrams per liter

(12)
Number in parentheses refers to complete chemical analysis in table 6

0 500
Circle diameter
Represents dissolved-solids content typical during periods of low flow, in milligrams per liter

Figure 17.—Dissolved-solids and combined iron and manganese content of water from selected wells in the Coastal Plain.

TABLE 6.—*Chemical analyses of water from wells in Quaternary and Tertiary deposits of the Coastal Plain, Randolph and Lawrence Counties, Ark.*

[Results in milligrams per liter except as indicated. Dashed leaders indicate sample not analyzed for this constituent]

Well No. (fig. 17)	Location	Date of collection	Depth of well (feet)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue at 180°C)	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25°C)	pH	Color
Quaternary deposits																					
1	15N-1E-13ccc	6-15-66	58	35	0.84	0.01	51	12	22	2.5	272	0.6	4.6	0.1	0.4	255	177	0	400	7.4	3
2	15N-1W-19dcc	6-16-66	50	41	3.4	1.7	38	12	7.7	1.6	178	11	5.9	.0	.4	200	145	0	300	7.3	5
3	16N-1E-4dad [1]	2- -65	-------	-------	2.3	1.3	52	15	8	1.7	201	15	8.0	.2	-------	276	194	0	-------	7.5	-------
4	-31ccc	6-16-66	35	44	3.0	1.9	35	10	9.6	1.2	172	12	1.7	.0	.0	190	129	0	250	7.3	5
5	16N-2E-10bac	7-20-65	81	34	4.8	.01	81	19	15	1.8	376	1.6	2.2	.0	.1	329	280	0	527	7.3	5
6	-34bdb	6-15-66	60	34	3.4	.34	51	13	12	1.7	260	.0	1.0	.0	.0	229	181	0	380	7.6	15
7	17N-1E-12cbd	10-26-62	120	19	.11	.01	39	9.8	7.0	2.0	151	19	9.8	.0	.0	202	138	14	274	6.9	5
8	-33aaa	6-15-66	38	40	3.0	1.4	40	7.1	3.7	2.6	156	13	1.1	.0	.0	184	129	1	270	7.5	5
9	-34aca [1]	7- -64	130	-------	2.4	2.6	49	11	11	1.5	165	14	2.0	.2	-------	245	165	3	-------	7.4	-------
10	-34abd [1]	5- -64	130	-------	.3	.7	63	15	16	2.6	200	40	12	.3	-------	309	200	18	-------	7.7	-------
11	17N-2E-9cbc	6-15-66	28	40	2.9	2.0	102	23	21	2.5	450	27	8.2	.0	.0	434	349	0	625	7.2	10
12	17N-1W-27adc	6-15-66	23	21	.04	.02	37	12	26	21	122	44	30	.0	45	316	142	42	400	6.7	8
13	18N-1E-15abb	6-15-66	-------	33	1.4	2.7	33	12	13	3.8	150	26	9.6	.0	1.2	208	132	9	260	7.5	7
14	18N-2E-3cdd	6-14-66	21	41	.54	.14	47	10	27	2.3	140	43	28	.0	26	316	158	44	380	6.8	3
15	-26aaa	7-20-65	105	41	3.2	1.2	60	15	6.9	1.4	269	1.8	2.5	.2	.0	261	211	0	415	7.2	5
16	20N-2E-36daa	6-14-66	36	43	.00	.01	12	4.8	14	1.4	30	18	14	.0	18	153	50	25	170	6.2	5
Average			65	36	2.0	1.0	49	12	14	3.2	206	18	8.8	0.1	7.0	257	174	10	358	7.2	6
Tertiary deposits																					
17	15N-3W-3cca	9-15-66	33	22	0.02	0.01	99	45	19	1.1	404	77	43	0.3	1.8	499	432	101	700	7.5	0

[1] Chemical analyses obtained from Bureau of Environmental Engineering, Arkansas State Department of Health.

out much of the area for domestic supplies, irrigation, fish farming, and some industrial purposes.

Table 6 also contains one chemical analysis of a water sample collected from a well in the outcrop of the Tertiary sands and gravels. Ground water from these sediments is higher in dissolved-solids content and hardness than is the water from the deposits of Quaternary age. The water is a calcium magnesium bicarbonate type and has a relatively high noncarbonate hardness and sulfate concentration.

The quality of water from the Wilcox Group in the area of potential use in southeastern Lawrence County is unknown. However, east of the project area the Wilcox yields a sodium bicarbonate water with a dissolved-solids content ranging from 100 to 150 mg/l. The iron content is variable, but it generally is much lower than the iron content of the water from the deposits of Quaternary age.

No chemical analyses of water from the Nacatoch Sand of Cretaceous age were available for the area of this report. However, studies of the Cretaceous aquifers in the Mississippi embayment indicate that the dissolved-solids content is fairly low in the outcrop in Missouri, and that the water is commonly of the calcium bicarbonate type. In the outcrop of Nacatoch Sand in Lawrence County, the water is probably soft and of the same type as that in Missouri. Downdip from the outcrop, the sodium chloride and dissolved-solids content probably increases, as is generally true in Missouri. Studies by Cushing (1966) indicate that in southeastern Randolph and eastern Lawrence Counties, where the Nacatoch Sand is a potential source of water, the water may have a high sodium chloride content and may have dissolved-solids concentrations of more than 1,000 mg/l. Such highly mineralized water would be unsuitable for most uses.

Ground-water temperatures in the Coastal Plain are relatively constant. They fluctuate only a few degrees and normally range from 16°C to 18°C in the shallower aquifers. Ground-water temperatures in the deeper aquifers are slightly higher.

BACTERIAL QUALITY

Samples of water from 11 of the private wells represented in table 6 were analyzed for coliform bacteria by the Bureau of Environmental Engineering of the Arkansas State Department of Health. Samples from two of the 11 wells contained coliform bacteria and did not meet public-water-supply standards. The relatively small percentage of samples containing coliform bacteria indicates that the contamination generally is due to local conditions, such as the location and construction of the wells. Wells which are more than 50 feet from septic tanks or other sewage-disposal systems and which are protected against surface contamination are normally free from pollution by coliform bacteria. The sand and gravel in the deposits of the Coastal Plain serve as a filter, and bacterial pollution generally is confined to areas near the sewage-disposal facilities.

INTERIOR HIGHLANDS

AVAILABILITY

Ground water is not so plentiful in the consolidated rocks of the Interior Highlands part of Randolph and Lawrence Counties as it is in the Coastal Plain part. However, small quantities of water are available from wells nearly everywhere in the limestone and dolomite of Paleozoic age that underlie the Interior Highlands. Because the limestone and dolomite are dense and consolidated, ground water is available only from the secondary openings, such as joints, fractures, and solution cavities. The successful completion of a well in the Interior Highlands depends almost entirely upon the number and size of the secondary openings that are penetrated. The occurrence of the secondary openings is difficult to predict; but these joints, fractures, and solution channels generally are more numerous near the surface. Where water is not obtained within depths of about 250 feet, a new location generally will present a better chance of finding water than will deepening of the hole. Most wells in the highlands are less than 200 feet deep, but some are as much as 700 feet deep.

Drilled wells in the highlands seldom exceed 6 inches in diameter, and most yield 10 gpm or less. Although some wells less than 200 feet deep in the highlands, in and near the area of this report, yield enough water for small municipal supplies, the only municipality in the two counties that depends upon ground water for its public supply is Black Rock, which obtains water from an abandoned mine shaft.

Water levels in the Interior Highlands differ considerably from one well to another, and there is no apparent areal relationship of water levels. In the spring of 1966, water-level measurements made in 20 wells ranged from 5 to 83 feet below land surface and averaged about 30 feet below land surface. Measurements made in the fall of that same year indicated that water levels had declined as much as 30 feet in some wells, and that the average seasonal decline was about 10 feet.

Two deeper formations, the Roubidoux and the Gunter Sandstone Member of the Van Buren Formation of Paleozoic age, are potential sources of ground water in the highlands. The water-supply potential of these formations has not been explored in the area of this report; but wells to the north and west of this area indicate that the top of the upper formation, the Roubidoux, is probably between 200 and 400 feet above sea level in northern Randolph County and becomes progressively deeper to the southeast. The Gunter, if present, is probably 600–800 feet below the Roubidoux. These formations may have water-upply potential throughout the report area, but in the southern part of Randolph County and in Lawrence County; these formations may be at depths that would make their use economically impractical for other than municipal and industrial water supplies.

QUALITY

CHEMICAL AND PHYSICAL QUALITY

The mineral content of ground water in the Interior Highlands is related closely to the mineral content of the geologic formation. Water in the limestone and dolomite of this area is primarily of the calcium and magnesium bicarbonate type and is very hard. Chemical analyses of water from 14 wells in the Interior Highlands are given in table 7. The dissolved-solids content of the ground-water samples (table 7) ranges from 324 mg/l to 532 mg/l. The average dissolved-solids content of the 14 samples is 394 mg/l, which is considerably higher than the average dissolved-solids content of water from the Quaternary deposits, given in table 6. The higher dissolved-solids content is due primarily to the fact that ground water in the highlands is much harder than that in the Quaternary deposits. The hardness as $CaCO_3$ of the water samples in table 7 ranges from 283 mg/l to 495 mg/l and averages 368 mg/l. Four of the 14 ground-water samples listed in this table contained more than 400 mg/l hardness as $CaCO_3$. Figure 18 shows that the hardness of ground water throughout the Interior Highlands varies randomly. Although the dissolved solids, iron, and manganese content of ground water in the highlands occasionally exceeds the limits recommended by the U.S. Public Health Service for drinking water, the hardness is the most troublesome property of the water. Ground water in the highlands is used without treatment for rural, domestic, and some industrial uses; but to be suitable for municipal supplies and many industrial uses the water would require softening.

Ground-water temperatures in the Interior Highlands normally range from 16°C to 18°C and reflect the average annual air temperature. Ground-water temperatures increase slightly with depth.

Wells that tap the Roubidoux and the Gunter to the north and west of the report area yield moderately mineralized calcium and magnesium bicarbonate type water which is hard and often contains high concentration of iron. The water in the report area will probably be of the same general type, but the lack of data precludes an accurate appraisal of its quality.

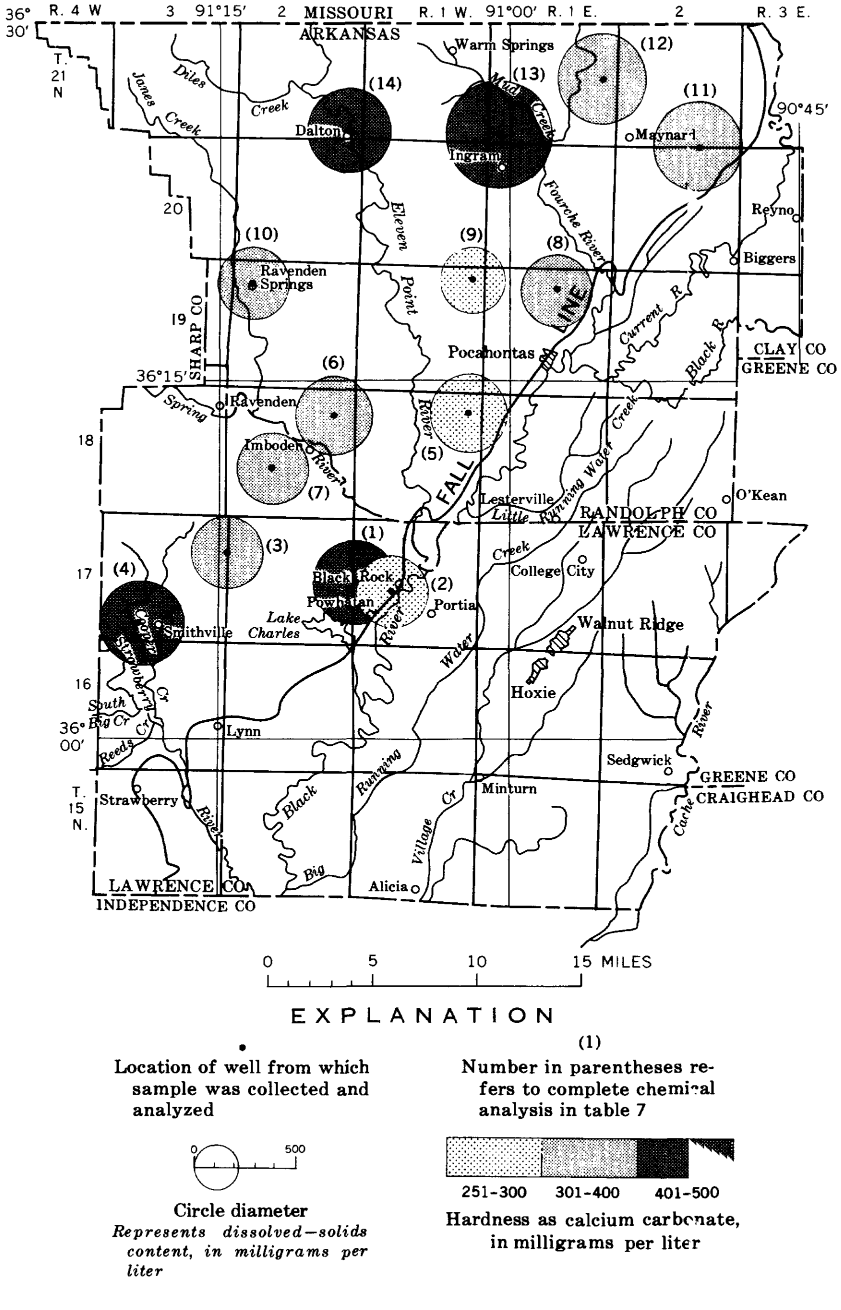


FIGURE 18.—Dissolved-solids content and hardness as $CaCO_3$ of water from selected wells in the Interior Highlands.

TABLE 7.—*Chemical analyses of water from wells in Paleozoic rocks of the Interior Highlands, Randolph and Lawrence Counties, Ark.*

[Results in milligrams per liter except as indicated. Color tested 0]

Well No. (fig. 18)	Location	Date of collection	Depth of well (feet)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue at 180° C)	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25° C)	pH
1	17N-1W-19bbb	9-15-66	250	17	0.05	0.00	101	40	6.7	1.3	476	12	20	0.2	1.1	433	417	26	700	7.1
2	-20dac[1]	4- -65	300	----	.3	.0	70	30	3	2.5	287	32	4.0	.0	----	343	287	11	----	7.3
3	17N-3W-12dda	9-15-66	75	12	.19	.00	75	39	2.4	1.0	412	4.4	3.4	.2	1.0	345	348	10	530	7.2
4	-32ada	9-15-66	80	9.1	.17	.01	99	39	1.3	7.4	498	12	1.4	.1	3.5	416	408	0	625	6.9
5	18N-1W-1ccd	9-14-66	165	14	.41	.01	64	30	13	3.4	332	1.0	16	.1	21	365	283	11	500	7.4
6	18N-2W-11aab	9-14-66	135	12	.05	.00	79	40	4.7	.9	446	3.0	2.9	.2	4.6	374	362	0	575	6.9
7	-21ccb	9-14-66	220	12	.07	.00	71	39	3.6	2.8	408	14	1.4	.3	.0	349	338	3	600	7.3
8	19N-1E-10baa	9-13-66	107	15	.01	.00	81	42	3.4	1.1	454	2.2	1.4	.2	1.7	375	375	2	590	7.2
9	19N-1W-1cad	9-13-66	65	20	.08	.00	65	32	7.0	1.0	334	6.6	19	.1	5.7	324	294	20	470	7.4
10	19N-2W-7aaa	9-14-66	150	11	.11	.00	81	36	3.1	1.7	404	2.2	4.4	.3	9.1	366	350	19	500	7.4
11	20N-2E-3aaa	9-13-66	150	16	.21	.71	85	42	32	2.1	449	56	18	.1	.0	447	385	16	695	7.7
12	21N-1E-13ccc	9-13-66	90	13	.02	.01	90	42	7.8	3.0	468	21	8.0	.2	15	434	397	14	625	7.1
13	-31dcb	9-13-66	----	11	.07	.00	101	59	6.7	1.2	560	13	26	.2	17	532	495	36	780	7.0
14	21N-2W-36cdb	9-14-66	179	11	.02	.00	87	48	3.4	1.6	468	14	5.6	.1	14	415	415	31	600	7.2
Average			151	13	0.12	0.05	82	40	7.0	2.2	428	14	9.4	0.2	7.2	394	368	14	599	7.2

[1] Chemical analyses obtained from Bureau of Environmental Engineering, Arkansas State Department of Health.

BACTERIAL QUALITY

Water samples collected from 13 private wells in the Interior Highlands part of the area of the report were analyzed for coliform bacteria by the Bureau of Environmental Engineering of the Arkansas State Department of Health. Of the 13 water samples analyzed, six were found to contain coliform bacteria and did not meet public-water-supply standards. Bacterial pollution of ground water generally is local in extent and may be due to contamination from nearby barnyards and sewage-disposal systems. Contaminated water often is carried from the surface into the ground-water supply by the fractures and solution channels which at depth constitute the local ground-water reservoir. When wells are constructed, safeguards against bacterial contamination—such as the proper location and the proper construction of wells—should be carefully considered.

USE OF WATER

Water was used in Randolph and Lawrence Counties at an average rate of 26.85 mgd (million gallons per day) in 1965. Of this total, 21 percent was obtained from streams and surface-water reservoirs, and 79 percent was obtained from wells. Data on the sources of supply and the major uses of water for 1965 are shown in table 8. The greatest water use is of ground water for the irrigation of crops. The second largest use of water is of surface water for irrigation. The irrigation of crops, mostly rice, averaged about 23.2 mgd, and 86 percent of all water used in the counties was for this purpose.

Surface water was used in 1965 at an average rate of 5.6 mgd in these two counties. About 80 percent of this water (4.5 mgd) was used for the irrigation of rice and other crops in the Coastal Plain of the two counties. The other principal uses of surface water were for the water-

TABLE 8.—*Use of water in Randolph and Lawrence Counties, Ark., 1965*

[By principal use and source, in million gallons per day. From Halberg and Stephens (1966)]

Water use	Randolph County		Lawrence County		Total	Percentage of total for all uses
	Ground water	Surface water	Ground water	Surface water		
Public supply	0	0.45	0.71	0.02	1.18	4.4
Self-supplied industry	.02	0	0	0	.02	0
Rural use:						
Domestic	.32	0	.41	0	.73	2.7
Livestock	.05	.29	.05	.28	.67	2.5
Irrigation:						
Rice	2.65	1.12	10.91	2.73	17.41	64.9
Other crops	.32	.05	4.78	.64	5.79	21.6
Fish and minnow farms	0	0	1.03	.02	1.05	3.9
Total	3.36	1.91	17.89	3.69	26.85	100.0

ing of livestock (about 0.6 mgd) and for public supply at Pocahontas and Imboden (about 0.5 mgd combined). The 5.6 million gallons of surface water used each day is equal to about 8.7 cfs of streamflow. This amount of water is less than the 7-day 2-year low flows of nine streams in the two counties, four of which have 7-day 2-year low flows greater than 200 cfs. However, only three of the nine streams are in the Coastal Plain, where crop irrigation uses large amounts of water.

Ground water was used in Randolph and Lawrence Counties in 1965 at an average rate of 21.25 mgd. Approximately 20.8 mgd, or 98 percent of the ground water used in 1965, was withdrawn from the Quaternary deposits of the Coastal Plain. About 88 percent of the ground water used in the Coastal Plain was withdrawn for crop irrigation during the growing season. The second largest use of ground water in the Coastal Plain was for fish and minnow farming, which used about 1 mgd in 1965.

Ground-water use in the Interior Highlands in 1965 amounted to about 0.37 mgd. This was about 2 percent of the ground water used in the two counties. The largest use of ground water in the Interior Highlands in 1965 was for rural-domestic and stock purposes. The largest single development of ground water was at Black Rock, which used about 0.04 mgd in 1965.

CONCLUSIONS

Water is used at an average rate of almost 27 mgd in Randolph and Lawrence Counties. Ground-water reservoirs supply 79 percent of the water used in the area. Supplies for the large uses—municipal, industrial, and irrigation—can best be obtained from wells in the Coastal Plain part of the counties and from streams in the Interior Highlands part.

Four streams, the Black, Current, Eleven Point, and Spring Rivers, have 7-day 50-year low flows greater than 200 cfs (129.2 mgd) and, without storage, can supply large amounts of water. Five additional streams in the project area have flows greater than 13 cfs (8.40 mgd) 95 percent of the time. Surface-water use is limited in the Coastal Plain part of the counties by the lack of suitable reservoir sites, but streams in the Interior Highlands offer excellent impoundment possibilities. A comparison between the surface water used and the surface water available for use indicates that streams, particularly Black River and its western tributaries, are sources of large supplies of water that are practically untapped. Water from streams throughout the area of this report is of excellent quality for irrigation; and with treatment for the reduction of hardness, the water generally is suitable for public supply and most industrial uses.

Ground-water reservoirs in the Coastal Plain furnish almost 98 percent of the ground water used in Randolph and Lawrence Counties and can supply much more water than is presently used. Virtually all ground water used in the Coastal Plain is supplied by wells in the Quarternary deposits. The irrigation and public-supply wells in this formation generally are 80 to 130 feet deep and commonly yield 1,000 gpm. Water levels in the Quarternary deposits generally are less than 20 feet below land surface and fluctuate only a few feet. Small seasonal water-level declines are common, but there are no long-term declines as a result of the annual seasonal withdrawal of about 6.8 billion gallons of water for irrigation. Ground water in the Coastal Plain part of the area is used without treatment for irrigation and for many domestic supplies, but generally it will require treatment for the removal of iron and manganese and for the reduction of hardness to make it suitable for municipal and many industrial uses. Two formations, the Wilcox Group and the Nacatoch Sand, both of which lie below the Quarternary deposits in the southeastern part of the area, are potential sources of water; but the Wilcox Group and Nacatoch Sand have not been explored in the area of this report. The quality of the water in these formations is unknown, but water in the Nacatoch may have a high dissolved-solids content.

In the Interior Highlands of Randolph and Lawrence Counties, ground water occurs in the fractures and solution channels in the consolidated limestone and domolite rocks of Paleozoic age. These rocks can supply more water than is presently used; but well yields, which are dependent upon the number and size of openings penetrated, are generally small. Although some wells and springs in the area yield moderate supplies, most wells yield 10 gpm or less. The water-bearing fractures and solution channels generally are more numerous near the surface, and most wells are less than 200 feet deep. Two unexplored formations, the Roubidoux and the Gunter Sandstone Member of the Van Buren Formation, which subcrop beneath the limestone and domolite, may be potential sources of water. However, in much of the area, the Roubidoux and the Gunter may be at depths that would make their use economically impractical except for municipal and industrial water supplies. Ground water in the Interior Highlands may be more susceptible to local bacterial pollution, due to the nature of the aquifer, than is ground water in the Coastal Plain. Ground water in the Interior Highlands is used without treatment throughout much of the area, but the water is very hard and has a high dissolved-solids content. However, ground water in the Interior Highlands has lower concentrations of iron and manganese than does ground water in the Coastal Plain. With proper sanitary safeguards against bacterial pollution and with treatment for reduction of hardness, ground water in the Interior Highlands of Randolph and Lawrence Counties is suitable for most uses.

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