GEOHYDROLOGY AND SUSCEPTIBILITY OF MAJOR AQUIFERS TO SURFACE CONTAMINATION IN ALABAMA; AREA 3

by V. E. Stricklin

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CONTENTS

ILLUSTRATIONS

TABLES

CONVERSION FACTORS

For use of readers who prefer to use metric (International System) units, conversion factors for inch-pound units used in this report are listed below:

Multiply inch-pound unit	By	To obtain metric unit
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
acre-foot (acre-ft)	1,233	cubic meter (m^3)
cubic foot per second per square mile [(ft^3/s)/mi^2]	0.01093	cubic meter per second per square kilometer [(m^3/s)/km^2]
gallon per minute (gal/min)	0.06308	liter per second (L/s)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Sea Level Datum of 1929."

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ABSTRACT

The U.S. Geological Survey, in cooperation with the Alabama Department of Environmental Management, is conducting a series of geohydrologic studies to delineate the major aquifers in Alabama and their susceptibility to contamination. This report delineates and describes the geohydrology and the susceptibility to contamination of the major aquifers in Area 3--Cullman, Fayette, Lamar, Marion, Walker, and Winston Counties.

The major aquifers in the study area are the Tuscaloosa, Pottsville, and Bangor aquifers. The Pottsville aquifer is the most extensively used in the study area. The aquifer consists of sandstones and conglomerates having fractures and bedding planes and weathered zones where decomposition has reduced rocks to sand and gravelly sand. The Tuscaloosa aquifer is used primarily in the western and southwestern part of the study area and is composed of sands and gravels in the Tuscaloosa Group. The Bangor aquifer, the least used aquifer in the study area, consists of limestone having bedding planes, solution cavities, and fractures.

All three aquifers are recharged throughout their outcrop areas and are susceptible to contamination from the surface within these areas. The Tuscaloosa aquifer is the most susceptible aquifer to contamination within the study area. Absence of confining layers, shallow depth to the water surface, and relatively uniform porosity and permeability of aquifer materials permit contaminants in water to move downward to the aquifer. The Pottsville and Bangor aquifers are less susceptible to surface contamination than the Tuscaloosa aquifer. Both aquifers generally have lower permeability and receive less recharge than the Tuscaloosa aquifer; this makes surface contamination less likely.

INTRODUCTION

The Alabama Department of Environmental Management (ADEM) is developing a comprehensive program in Alabama to protect ground water defined by the U.S. Environmental Protection Agency (EPA) as "Class I and II" from surface contamination (U.S. Environmental Protection Agency, 1984). The U.S. Geological Survey, in cooperation with ADEM, is conducting a series of geohydrologic studies in Alabama to delineate recharge areas of the major aquifers and areas susceptible to contamination. This report covers a six-county area in northwestern Alabama that includes Cullman, Fayette, Lamar, Marion, Walker, and Winston Counties (fig. 1).

Location and Extent of the Area

The study area is located in northwestern Alabama and comprises an area of about 4,133 square miles. The area includes the cities of Cullman, Jasper, Fayette, Hamilton, Vernon, and Haleyville (plate 1) and numerous other small communities and towns. Total population of the area in 1982 was 217,680 (Alabama Department of Economic and Community Affairs, 1984). The area is 80 percent rural and 20 percent urban or suburban. Public water systems in the western part of the area are mainly dependent on ground water; those in the eastern part rely mainly on surface water. Most self-supplied homes use ground water.

Purpose and Scope

The purposes of this report are to delineate the major aquifers within the study area and their recharge areas, and to describe the geohydrology of the major aquifers and the susceptibility of these aquifers to contamination from the surface. All wells used for public supplies were inventoried and water-level measurements obtained where possible. These data and water-level data from previously published reports were used to prepare generalized potentiometric maps of the major aquifers in the study area (plate 1).

Previous Studies

Several reports describing the geology and ground-water resources for individual counties in the study area have been published. These reports include the results of well inventories and water-level measurements. They are a valuable source of basic data and are listed, by county, below:

Cullman - Faust, R.J., and Jefferson, P.O. (1980)
Fayette - Knight, A.L. (1972)
Marion - Causey, L.V., Wahl, K.D., Jefferson, P.O., and Harris, W.F. (1972)
Walker - O'Rear, D.M., Wahl, K.D., and Jefferson, P.O. (1972)
Winston - Wahl, K.D., Harris, W.F., and Jefferson, P.O. (1971)

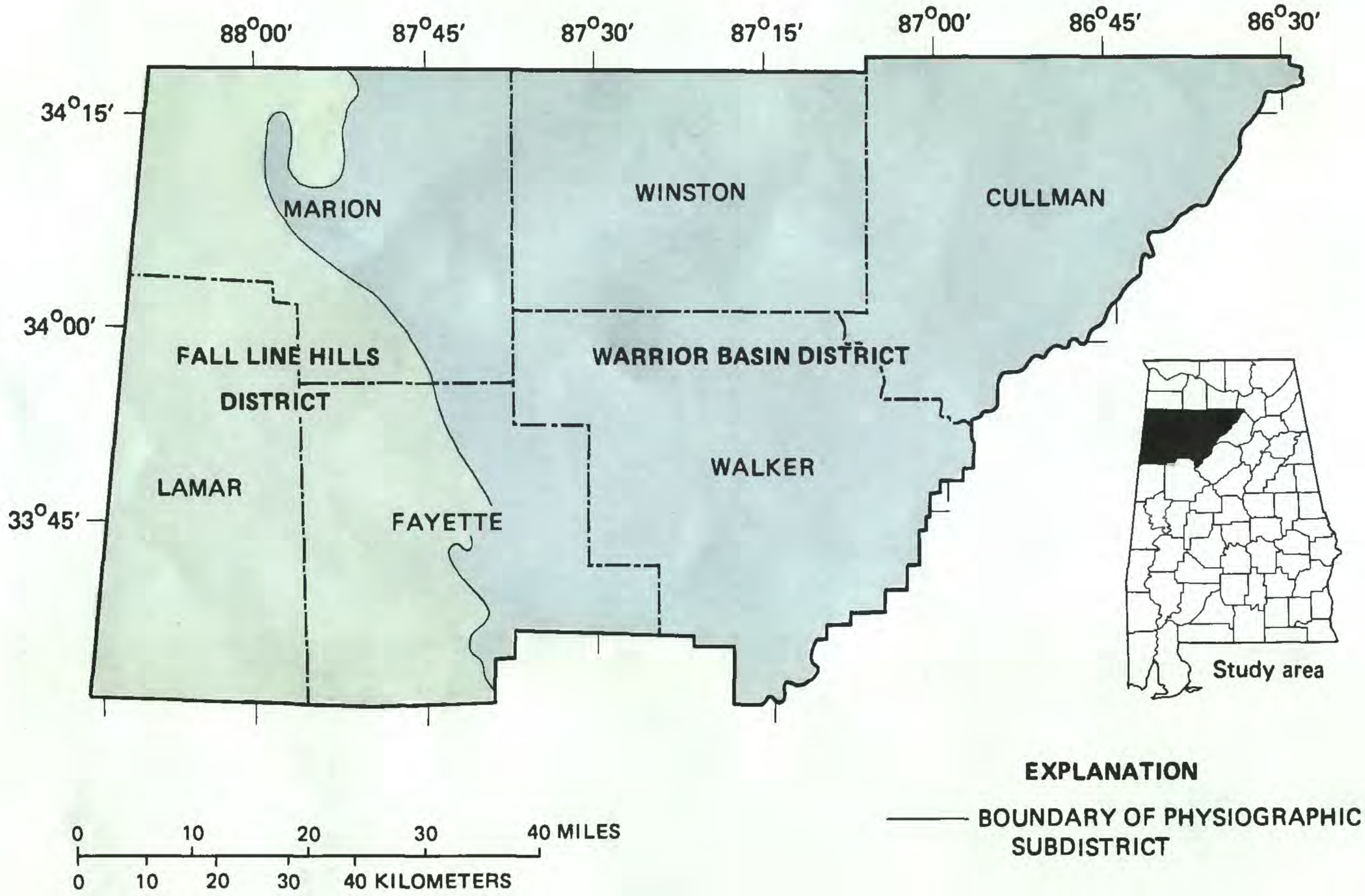

Figure 1.--Physiographic regions of the study area.

Additional data used in this report were obtained from "Ground water resources of the Cretaceous area of Alabama" (Carlston, 1944) and "Surface water resources and hydrology of west-central Alabama" (Peirce, 1959).

Physical Features

Parts of the Appalachian Plateaus and Coastal Plain physiographic provinces are included in the study area (Sapp and Emplaincourt, 1975). Each province is subdivided into sections and each section into districts. Only two districts are present in the study area: the Warrior Basin district of the Cumberland Plateau section of the Appalachian Plateaus province, and the Fall Line Hills district of the East Gulf Coastal Plain section of the Coastal Plain province (fig. 1). The altitude of the land surface generally ranges from about 250 feet in the southwest part of the study area to 1,100 feet above sea level in the northeast part of the study area.

The Warrior Basin district, which comprises about two-thirds of the area, consists of a dissected peneplain of moderate relief that is underlain predominantly by sandstone and shale. The Fall Line Hills district consists of dissected uplands with some flat, broad ridges underlain by unconsolidated gravel, sand and clay.

Most of the study area is drained by tributaries of the Tombigbee and Black Warrior Rivers. A small part of the study area is drained by tributaries of the Tennessee River. Lewis Smith Lake, a reservoir on the Sipsey Fork of the Black Warrior River, is a source of hydroelectric power, and is a major source of industrial water for the city of Birmingham.

GEOLOGY

The study area is underlain by geologic formations of Paleozoic and Mesozoic ages (fig. 2 and table 1). Paleozoic rocks that crop out in the region are of Mississippian and Pennsylvanian Systems. The only Mesozoic rocks are those of the Cretaceous System. The following descriptions of geology were derived from Causey and others (1972), Faust and Jefferson (1980), Knight (1972), O'Rear and others (1972), and Wahl and others (1971).

Mississippian System

Formations of the Mississippian System that crop out in the study area include the Bangor Limestone and Parkwood Formation. The Bangor Limestone has small outcrops in the northern part of the study area and is a source of water for public supply in the towns of Grayson and Addison in Winston County. The Bangor Limestone is a major aquifer north of the study area. The Parkwood Formation consists of shales and mudstones and crops out along the northern margin of the study area. Because it is not considered as a major aquifer, the Parkwood Formation will not be further described in this report.

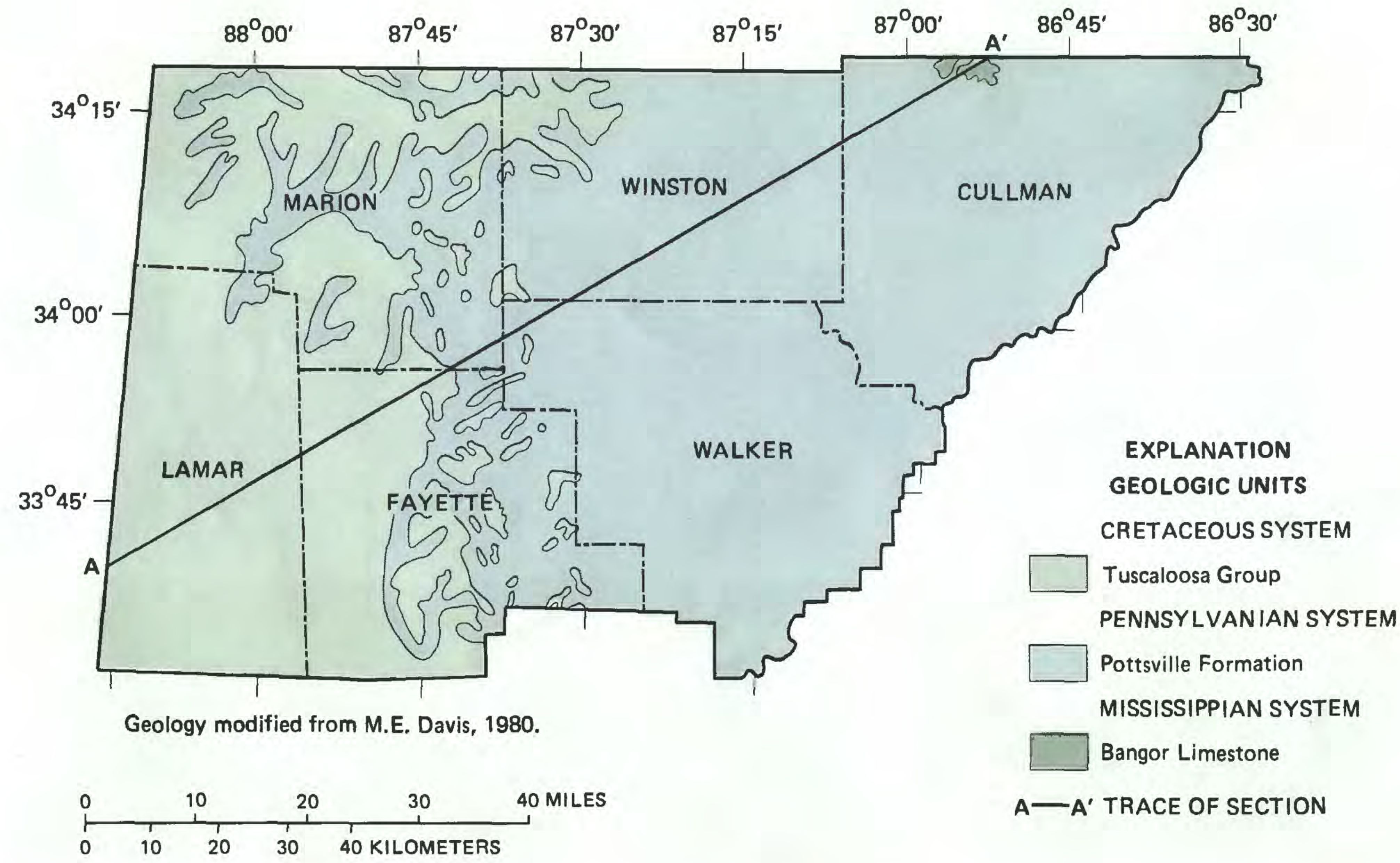

Figure 2.--Generalized geology of the study area.

Bangor Limestone

The Bangor Limestone crops out in the study area only in the northern part of Cullman and Marion Counties. It is overlain by the Pottsville Formation in Cullman County and by the Parkwood and Pottsville Formations in Winston and Marion Counties. The Bangor Limestone consists mainly of thin- to thick-bedded bioclastic and oolitic limestone interbedded with some clay and cherty limestones that dip to the southwest. The formation ranges in thickness, based on oil-test well sample descriptions and exposures in adjacent counties, from 375 to 600 feet.

Pennsylvanian System

The Pennsylvanian System is represented in the study area by the Pottsville Formation. This formation crops out over about two-thirds of the study area (fig. 2).

Pottsville Formation

The Pottsville Formation crops out mainly in the eastern two-thirds of the study area. It consists of consolidated and tightly cemented interbeds of quartzose sandstone, shale, siltstone, conglomerate, clay, limestone, and several bituminous coal beds that dip toward the southwest. The thickness of the formation ranges from 375 feet in the northern part of the area to 4,000 feet in the southern part.

Cretaceous System

Unconsolidated rocks of Cretaceous age that crop out in the area include the Coker, Gordo, and Eutaw Formations. The Eutaw Formation caps only a few hills within the study area, and is not considered a major aquifer in the study area. The Coker and Gordo Formations are in the Tuscaloosa Group in this report.

Tuscaloosa Group

The Tuscaloosa Group crops out mainly in the western part of the study area (fig. 2). It consists of unconsolidated sand, gravel, and clay that dip gently toward the southwest. The Tuscaloosa Group unconformably overlies rocks of Pennsylvanian age, and ranges in thickness from 50 to 400 feet (fig. 3). Massive beds of highly-permeable gravel and gravelly sand commonly occur near the base of the Tuscaloosa Group and are normally underlain by a thick basal clay.

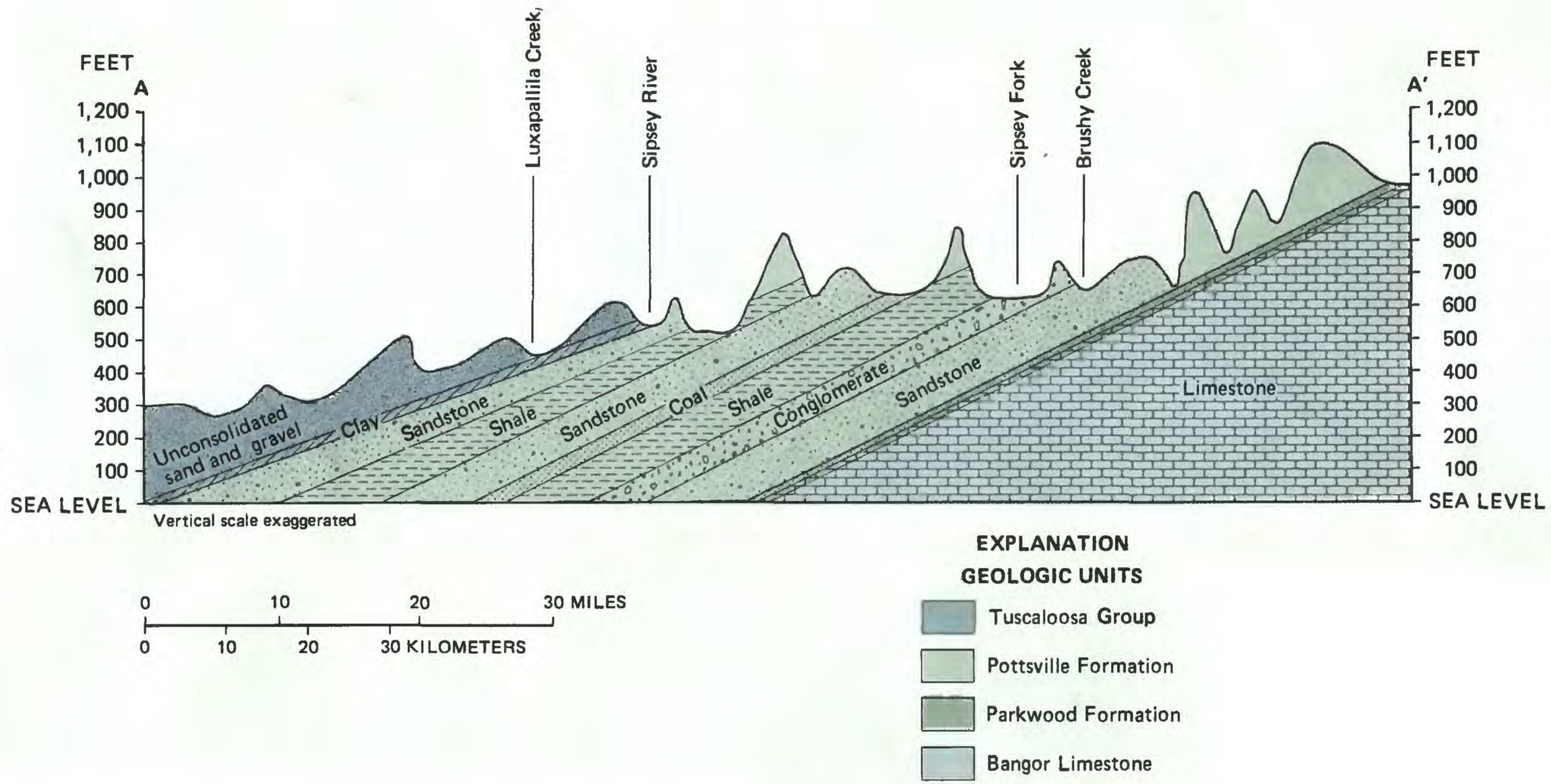

Figure 3.--Generalized subsurface cross section across the study area.

HYDROLOGY OF THE MAJOR AQUIFERS

There are three major aquifers in the study area; the Bangor aquifer, Pottsville aquifer, and Tuscaloosa aquifer (fig. 3 and table 1). The Tuscaloosa aquifer consists of unconsolidated sands and gravels of the Tuscaloosa Group. The Tuscaloosa aquifer is a major aquifer in the western part of the study area. Ground water in the Tuscaloosa aquifer occurs in relatively uniform permeable sand and gravel deposits usually under water-table conditions. The depth to the water table generally is less than 75 feet. Additional data on the depth to the water table are given in table 2.

The quantity of water available from the aquifer is dependent on the saturated thickness, areal extent, and permeability of the sands and gravels penetrated by the well.

The Pottsville aquifer is the most extensively used aquifer in the study area. Water in the Pottsville aquifer occurs under confined conditions due to sharp contrast in permeability within the aquifer. Ground water usually occurs at depths of less than 200 feet in secondary features such as openings along fractures and bedding planes and in weathered sandstone and conglomerate beds. Only small amounts of ground water suitable for domestic use are available in the weathered deposits. The quantity of water available to wells throughout the remainder of the aquifer depends on the size and extent of the water-bearing openings.

The Bangor aquifer crops out along and north of the northern margin of the study area. Ground water in the aquifer usually occurs at depths less than 100 feet and is partially confined. Water in the Bangor aquifer occurs in secondary features such as joints, fractures, and bedding planes. These secondary features may become substantially enlarged into solution cavities due to the soluble nature of limestone. The solution cavities could be a significant source of ground water, but the aquifer is not extensively used in the study area.

Recharge areas for the major aquifers, which coincide with their outcrop areas, are shown on plate 1. Also shown on plate 1 are generalized potentiometric surfaces of the Pottsville and Tuscaloosa aquifers and locations of public water-supply wells. Construction of wells, water levels, and other pertinent well data are given in table 2.

Recharge and Movement of Ground Water

The source of recharge to the major aquifers in the study area is rainfall which averages about 52 inches per year. A large part of the rainfall runs off during and directly after rainstorms, and most of the remainder is returned to the atmosphere by evaporation and transpiration by plants. A small part infiltrates to the water table to recharge the aquifers. The recharging process is active throughout the outcrop area of the major aquifers.

Water-level measurements made during the periods of 1950-66 and 1946-68 from approximately 220 wells were used to construct generalized potentiometric-surface maps for the Tuscaloosa and Pottsville aquifers, respectively (plate 1). Potentiometric surfaces shown on plate 1 generally represent averages for the aquifers. The water level altitude in any particular well may vary from the average to some extent depending on the depth of the well and the local geology. The potentiometric surface for the Pottsville aquifer probably represents the general configuration of many local perched water tables that occur throughout the aquifer due to the interbedded and variable nature of the aquifer. The maps show that ground-water movement within the aquifers generally is from hills and highland interstream areas to streams and other areas of natural discharge. Ground-water movement between aquifers generally is restricted due to the presence of confining beds, such as the clay at the base of the Tuscaloosa aquifer and in the Parkwood Formation between the Pottsville and Bangor aquifers.

Natural Discharge and Ground-Water Withdrawals

Most of the recharge to the major aquifers in the study area discharges through springs and seeps. This discharge provides the base (dry weather) flow of streams, especially in the Tuscaloosa aquifer where streams are entrenched into the aquifer's basal gravelly zone.

The largest ground-water pumping centers in the study area are at the city of Hamilton in Marion County, which uses the Pottsville aquifer, and the city of Vernon in Lamar County, which uses the Tuscaloosa aquifer. Each of these cities withdraws about 1 Mgal/d (million gallons per day). No effects of these withdrawals are apparent on the potentiometric-surface maps for the Tuscaloosa and Pottsville aquifers. In fact, current water-level measurements made at Hamilton (table 2) indicate that these withdrawals have not affected the potentiometric surface. Other cities and towns in the study area that depend on ground water for public supply include Beaverton, Millport, and Sulligent in Lamar County; Brilliant and Winfield in Marion County; Carbon Hill and Nauvoo in Walker County; Addison, Arley, and Lynn in Winston County; and Hanceville in Cullman County. The estimated total withdrawal of ground water for public water supplies in the study area is about 3.5 Mgal/d. The cities of Cullman and Jasper use surface water for public water supplies as do several other smaller towns in the study area. The city of Cullman supplies water to most of Cullman County, and the city of Jasper supplies water to most of Walker County.

SUSCEPTIBILITY OF GROUND-WATER CONTAMINATION

All recharge areas for the major aquifers within the study area are susceptible to contamination from the surface (plate 1). However, most of the recharge areas are in rural terrains that are used for timberlands, farms, or pastures. Because the Tuscaloosa aquifer consists of highly permeable, unconsolidated sands and gravels and occurs unconfined at relatively shallow depths, water can easily infiltrate into the aquifer. Owing to these factors, the Tuscaloosa aquifer is somewhat more susceptible to contamination than the other aquifers in the study area.

The Pottsville and Bangor aquifers also are susceptible to contamination from the surface. However, because these aquifers are indurated and tightly cemented, they generally have less permeability than the Tuscaloosa aquifer. Water enters these aquifers in recharge areas through vertical fractures and horizontal bedding plane openings usually along routes within more permeable layers in the aquifer. These fractures and openings commonly have only local extent. Consequently, contaminants entering these aquifers may not disperse as widely as in the Tuscaloosa aquifer but could create localized areas of contamination.

CONCLUSIONS

Three major aquifers are used for public water supplies in the study area. The Tuscaloosa aquifer, which consists of sands and gravels in the Tuscaloosa Group, is used primarily in the west-southwestern part of the study area to supply several public water systems. The Pottsville aquifer, which is composed of fractures, bedding plane openings, and weathered zones in sandstones and conglomerates in the Pottsville Formation, is the most extensive aquifer in the study area. The Pottsville aquifer is used by the city of Hamilton and by several other towns in the study area. The Bangor aquifer, which is composed of limestone bedding plane openings, fractures, and solution cavities is the least used. Only two public water systems in the northern part of the study area withdraw water from the aquifer. The recharge areas for the major aquifers coincide with their outcrop areas.

All recharge areas for the major aquifers are susceptible to contamination from the surface. The lithologic characteristics and the lack of confining layers in and above the Tuscaloosa aquifer enhance the probability of surface contamination because water can rapidly infiltrate into the aquifer. The Pottsville and Bangor aquifers are also susceptible to contamination from the surface. The lack of directionally uniform permeability of these aquifers lowers the probability of widespread contamination of the aquifers. In areas where the Pottsville aquifer is deeply weathered, infiltration into and movement of water through the aquifer will be similar to that in the Tuscaloosa aquifer.

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Table 1--Generalized geohydrologic units and their water-bearing properties

System	Series	Hydrogeologic unit	Geologic unit	Thickness (feet)	Lithology	Water-bearing properties
Cretaceous	Upper Cretaceous	Tuscaloosa aquifer	Tuscaloosa Group	50-400	Sand, yellowish-orange to gray, fine- to very coarse-grained; clay, varicolored, gravelly, sandy; sandstone.	Major source of ground water in study area. Water generally soft and locally contains iron in excess of 0.3 mg/L.
Pennsylvanian		Pottsville aquifer	Pottsville Formation	375-4,000	Sandstone, siltstone, and shale, interbedded with conglomerate, coal, and underclay; numerous coal beds.	Extensively used in study area. Water in fractures and bedding plane openings. Water ranges from soft to very hard. Locally contains iron in excess of 0.3 mg/L.
Pennsylvanian / Mississippian			Parkwood		Sandstone, thin- to medium-bedded, with interbedded shale and siltstone.	Not used as an aquifer.
Mississippian		Bangor aquifer	Bangor Limestone	375-600	Thin- to thick-bedded limestone. Fine- to coarse-grained bioclastic limestone and oolitic limestone.	Not extensively used in study area.

Table 2.--Records of public water-supply wells in the study area

NOTE: Well numbers correspond to those shown on plate 1.

Geographic coordinate number: Lat (DDMMSS) Long (DDMMSS) sequential number (xx).

Depth of well and water level: Depth of well given in feet; reported water levels are in feet above (-) or below land surface; measured water levels are in feet and tenths.

Well diameter: casing diameter in inches.

Water-bearing unit: Mb, Bangor Limestone; Ppv, Pottsville Formation; Kt, Tuscaloosa Group.

Altitude of land surface: Altitudes given in feet above National Geodetic Vertical Datum of 1929, from topographic map or determined by aneroid barometer.

Method of lift: N, none; S, submergible; T, turbine.

Use of well: N, none; P, public water supply.

Well number	Geographic coordinate number	Well owner	Drilled by	Well depth (feet)	Well diam. (inches)	Water bearing unit	Altitude of land surface	Water level above (-) or below Land Surface Datum	Date of measurement	Method of lift	Use of well	Remarks
1	3416130874900	City of Hackleburg	H. W. Drilling Co.	320	8	Ppv	860	95	Aug. 1955	T	P	Casing: 8 in. from surface to 136 ft.
2	3415000875000	City of Hackleburg	---	Spring	-	Kt	880	---	---	-	P	Reported flow of 55 gal/min 12-10-64.
3	3416450871905	Town of Grayson	H. W. Peerson Drilling Co.	470	6	Mb	850	---	---	S	P	Casing: 6 in. from surface to 34 ft. Reported to produce 50 gal/min.
4	3410260870626	Town of Arley	Knox Drilling Co.	610	6	Ppv	880	482	Oct. 1981	S	P	Casing: 6 in. from surface to 44.5 ft. Reported to produce 60 gal/min.
5	3412010871000	City of Addison	Weldon Drilling Co.	417	8	Ppv	720	191	Apr. 1986	S	P	Casing: 8 in. from surface to 40 ft. Reported drawdown 260 ft when pumping at 100 gal/min.
6	3412310871050	City of Addison	George O. Baird Drilling Co.	401	8	Ppv	780	200	1957	S	P	Casing: 8 in. from surface to 40 ft.
7	3411200871117	City of Addison	George O. Baird Drilling Co.	424	6	Ppv	720	---	---	S	P	Casing: 6 in.; depth unknown. Reported to produce 45 gal/min.
8	3412160871200	City of Addison	Charles Kitchens Drilling Co.	458	8	Mb	700	175	June 1978	S	P	Casing: 8 in. from surface to 38 ft.
9	3410530875635	City of Hamilton	Miller Drilling Co.	755	8	Ppv	680	258	Nov. 1986	S	P	Casing: 8 in. from surface to 296 ft. Reported drawdown of 174 ft while pumping at 100 gal/min.
10	3409380875644	City of Hamilton	Miller Drilling Co.	500	8	Ppv	540	---	---	S	P	Casing: 8 in. from surface to 152 ft.
11	3409010875836	City of Hamilton	H. W. Peerson Drilling Co.	525	10	Ppv	410	---	---	S	P	Casing: 10 in.; depth unknown.

Table 2.--Records of public water-supply wells in the study area--continued

Well number	Geographic coordinate number	Well owner	Drilled by	Well depth (feet)	Well diam. (inches)	Water bearing unit	Altitude of land surface	Water level above (-) or below Land Surface Datum	Date of measurement	Method of lift	Use of well	Remarks
12	340829087592l	City of Hamilton	Faulkner Const. Co.	408	10, 8	Ppv	480	80	1935	-	P	Casing: 10 in. from surface to 74 ft; 8 in. from surface to 193 ft.
13	340839087592l	City of Hamilton	H. W. Peerson Drilling Co.	601	10	Ppv	480	6	1952	T	P	Casing: 10 in. from surface to 60 ft. Reported drawdown of 165 ft while pumping 24 hrs at 180 gal/min.
14	3407550875920	City of Hamilton	H. W. Peerson Drilling Co.	428	10, 8	Ppv	440	40	July 1955	S	P	Casing: 10 in. from surface to 60 ft; 8 in. from surface to 123 ft. Reported drawdown of 150 ft while pumping 24 hrs at 168 gal/min.
15	3407570875930	City of Hamilton	H. W. Peerson Drilling Co.	503	8	Ppv	460	---	---	S	P	Casing: 8 in.; depth unknown.
16	3408140875951	City of Hamilton	H. W. Peerson Drilling Co.	504	8	Ppv	490	78	Nov. 1969	S	P	Casing: 8 in.; depth unknown.
17	3408230880002	City of Hamilton	H. W. Peerson Drilling Co.	448	10	Ppv	500	94.8	Mar. 1964	S	P	Casing: 10 in. from surface to 105 ft. Reported yield 225 gal/min in 1964.
18	3409490880149	City of Hamilton	H. W. Peerson Drilling Co.	407	8	Ppv	560	180	June 1986	S	P	Casing: 8 in.; depth unknown.
19	3408520880053	City of Hamilton	H. W. Peerson Drilling Co.	407	8	Ppv	560	---	---	S	P	Casing: 8 in.; depth unknown.
20	3408480880003	City of Hamilton	---	--	-	Ppv	560	---	---	N	N	Well abandoned.
21	3401410881019	Town of Detroit	Carl O. Baird Drilling Co.	65	6	Kt	360	4	June 1966	J	P	Casing: 6 in. from surface to 65 ft.
22	3401370881028	Town of Detroit	Carl O. Baird Drilling Co.	92	6	Kt	360	10	1963	J	P	Casing: 6 in. from surface to 80 ft; 6 in. screen from 80 to 92 ft.
23	3400420875039	Town of Guin	---	Spring	-	Kt	560	---	---	-	N	Estimated flow 60 gal/min 2-04-64.
24	3401510874513	City of Brilliant	---	--	-	Ppv	540	---	---	T	P	Well not used.
25	3400590874600	City of Brilliant	Graves Drilling Co.	972	6	Ppv	560	34	Dec. 1980	T	P	Casing: 6 in. from surface to 131 ft. Drawdown of 166 ft while pumping at 225 gal/min.

Table 2.--Records of public water-supply wells in the study area--continued

Well number	Geographic coordinate number	Well owner	Drilled by	Well depth (feet)	Well diam. (inches)	Water bearing unit	Altitude of land surface	Water level above (-) or below Land Surface Datum	Date of measurement	Method of lift	Use of well	Remarks
26	3402570873246	Town of Lynn	George O. Baird Drilling Co.	1,100	4	Ppv	700	---	---	S	P	Reported to produce 100 gal/min.
27	3402570873246	Town of Lynn	Knox Drilling Co.	800	8	Ppv	700	---	---	S	P	Reported to produce 100 gal/min.
28	3402520871324	Town of Arley	Graves Drilling Co.	825	6	Ppv	680	369	May 1977	S	P	Reported to produce 54 gal/min.
29	3404140871303	Town of Arley	Graves Drilling Co.	805	6	Ppv	700	375	May 1977	S	P	Reported to produce 40 gal/min.
30	3405120871041	Town of Arley	Graves Drilling Co.	665	6	Ppv	690	373	May 1977	S	P	Reported to produce 30 gal/min.
31	3403380864613	City of Hanceville	---	150	6	Ppv	540	---	---	S	P	Casing: 6 in.; depth unknown.
32	3403380864616	City of Hanceville	H. W. Peerson Drilling Co.	363	8	Ppv	538	---	---	S	P	Casing: 8 in. from surface to 21 ft; none below. Reported drawdown 80 ft while pumping 180 gal/min in 1946.
33	3403370864629	City of Hanceville	Ponder Drilling Co.	188	6	Ppv	540	35	Apr. 1984	S	P	Casing: 6 in. from surface to 38 ft; none below.
34	3400540864440	Town of Garden City	H. W. Peerson Drilling Co.	120	8	Ppv	476	---	---	T	N	Reported drawdown 32.5 ft after 24 hrs pumping 195 gal/min in 1951.
35	3359120872913	Town of Nauvoo	Carl O. Baird Drilling Co.	420	8	Ppv	560	31	July 1961	S	P	Casing: 8 in. from surface to 50 ft. Reported drawdown of 242 ft while pumping at 100 gal/min for 24 hrs.
36	3359060872859	Town of Nauvoo	Charles Kitchens Drilling Co.	1,051	8	Ppv	590	55	Sept. 1979	S	P	Casing: 8 in. from surface to 30 ft. Reported to produce 40 gal/min.
37	3353170873157	City of Carbon Hill	Graves Drilling Co.	1,500	10	Ppv	420	0	July 1983	S	P	Casing: 10 in. from surface to 207 ft. Reported drawdown of 364 ft while pumping at 140 gal/min.
38	3353170873136	City of Carbon Hill	Graves Drilling Co.	1,505	10	Ppv	420	0	June 1983	S	P	Casing: 10 in. from surface to 208 ft. Reported drawdown of 399 ft while pumping at 140 gal/min.
39	3354080873321	Town of Kansas	---	658	6	Ppv	480	---	---	-	P	Casing: 6 in. from surface to 135 ft.

Table 2.--Records of public water-supply wells in the study area--continued

Well number	Geographic coordinate number	Well owner	Drilled by	Well depth (feet)	Well diam. (inches)	Water bearing unit	Altitude of land surface	Water level above (-) or below Land Surface Datum	Date of measurement	Method of lift	Use of well	Remarks
40	3355150873710	Town of Eldridge	Miller Drilling Co.	1,350	8	Ppv	560	66	Oct. 1981	-	P	Casing: 8 in.; depth unknown.
41	3354280874440	City of Glen Allen	Myhand Drilling Co.	610	8	Ppv	522	---	---	-	P	Casing: 8 in.; depth unknown. Reported to produce 52 gal/min.
42	3355330874840	City of Winfield	H. W. Peerson Drilling Co.	660	6	Ppv	454	25	Sept. 1948	T	P	Casing: 6 in. from surface to 21 ft. Reported drawdown of 150 ft while pumping at 42 gal/min for 24 hrs.
43	3357470875452	City of Guin	H. W. Peerson Drilling Co.	450	10, 8	Ppv	455	---	---	N	N	Casing: 10 in. from surface to 27 ft.; 8 in. from surface to 146 ft. Reported drawdown of 170 ft after 2 hrs pumping pumping 30 gal/min in 1951.
44	3356000880107	Town of Beaverton	Acme Drilling Co.	100	6, 4	Kt	360	-7.5	Jan. 1974	-	P	Casing: 6 in. from surface to 73 ft; 4 in. screen from 73 ft to 88 ft. Flowing well. Reported to yield 151 gal/min.
45	3354080880739	City of Sulligent	---	120	8	Kt	330	---	---	S	P	Casing: 8 in.; depth unknown. Reported to yield 150 gal/min.
46	3353070880740	City of Sulligent	---	Spring	-	Kt	315	---	---	-	P	Estimated flow 60 gal/min 5-11-66.
47	3353450880837	City of Sulligent	H. W. Peerson Drilling Co.	120	8	Kt	310	---	---	S	P	Casing: 8 in.; depth unknown. Reported to produce 80 gal/min.
48	3353070880740	City of Sulligent	H. W. Peerson Drilling Co.	120	8	Kt	315	---	---	S	P	Casing: 8 in.; depth unknown.
49	3344030880817	City of Vernon	---	346	24, 12	Kt	300	5	Jan. 1975	-	P	Casing: 24 in. from surface to 275 ft; 12 in. from 215 to 280 ft; 12 in. screen from 280 to 335 ft. Drawdown of 21 ft while pumping 26 hr at 1,893 gal/min.
50	3345290880629	City of Vernon	---	100	18	Kt	298	---	---	T	P	Casing: 18 in. from surface to 100 ft.
51	3345370880625	City of Vernon	H. W. Peerson Drilling Co.	178	12, 8	Kt	297	---	---	T	P	Casing: 12 in. from surface to 102 ft; 8 in. from 102 to 178 ft.
52	3343050872315	Town of Oakman	Carl O. Baird Drilling Co.	147	6	Ppv	380	---	---	N	N	Casing: 6 in. from surface to 43 ft. Reported to produce 66 gal/min.

Table 2.--Records of public water-supply wells in the study area--continued

Well number	Geographic coordinate number	Well owner	Drilled by	Well depth (feet)	Well diam. (inches)	Water bearing unit	Altitude of land surface	Water level above (-) or below Land Surface Datum	Date of measurement	Method of lift	Use of well	Remarks
53	334241087223 8	Town of Oakman	H. W. Peerson Drilling Co.	150	8	Ppv	338	10	1951	N	N	Casing: 8 in. from surface to 40 ft. Reported drawdown of 62 ft while pumping at 66 gal/min.
54	3339390873607	City of Berry	H. W. Peerson Drilling Co.	150	8	Ppv	460	21	Nov. 1948	N	N	Casing: 8 in. from surface to 21 ft.
55	3339530873609	City of Berry	Carl O. Baird Drilling Co.	250	8	Ppv	454	35	Nov. 1966	N	N	Casing: 8 in. from surface to 29 ft. Reported drawdown of 72 ft while pumping at 60 gal/min for 24 hrs.
56	3339210873618	City of Berry	Carl O. Baird Drilling Co.	200	8	Ppv	429	55	May 1966	N	N	Casing: 8 in. from surface to 41 ft. Measured drawdown 55 ft after 12 hrs pumping 125 gal/min.
57	3339260873623	City of Berry	Carl O. Baird Drilling Co.	150	8	Ppv	420	20	Oct. 1962	N	N	Casing: 8 in. from surface to 31 ft. Reported to produce 80 gal/min.
58	3338560875554	Town of Belk	Myhand Drilling Co.	162	6	Ppv	310	11.0	1974	S	P	Casing: 6 in. from surface to 143 ft. Reported drawdown of 86 ft while pumping at 100 gal/min for 24 hrs.
59	3333350880439	Town of Millport	H. W. Peerson Drilling Co.	184	12, 6	Kt	290	---	---	T	P	Casing: 12 in. from surface to 137 ft; 6 in. from 112 to 137 ft; 6 in. screen from 137 to 167 ft.
60	3333330880436	Town of Millport	Acme Drilling Co.	392	12, 8	Kt	310	---	---	T	P	Casing: 12 in. from surface to 350 ft; 8 in. from 310 to 350 ft; 8 in. screen from 350 to 390 ft.
61	3334490875934	Town of Kennedy	---	--	-	Kt	290	---	---	N	N	Well not used.
62	3334490875934	Town of Kennedy	H. W. Peerson Drilling Co.	318	10, 6	Kt	290	52	Feb. 1964	T	P	Casing: 10 in. from surface to 280 ft; 6 in. screen from 276 to 297 ft. Reported drawdown of 34 ft while pumping at 350 gal/min.