WATER FOR

INDUSTRIAL DEVELOPMENT

IN

Forrest, Greene, Jones, Perry, and Wayne Counties
Mississippi

A COOPERATIVE STUDY SPONSORED JOINTLY BY
WATER RESOURCES DIVISION, U. S. GEOLOGICAL SURVEY
and
Mississippi Research and Development Center
JACKSON, MISSISSIPPI

many municipal and industrial water managers, well owners, water-well contractors, and oil company personnel. The Mississippi Power Company supplied daily temperature readings on the Leaf River at Hattiesburg.

HYDROLOGIC SETTING

Climate

The climate of southeastern Mississippi is humid and semitropical. Average annual rainfall ranges from 56 inches in the northwest corner of the five-county area to 64 inches in southern Forrest and Perry Counties. Average annual runoff from the numerous streams in the area ranges from 18 inches in the north to 26 inches in the south (fig. 1). The remainder of the precipitation seeps into the ground or is dissipated by evapotranspiration. The mean annual temperature in the five-county area is about 66° F; the mean monthly temperature ranges from 82° F in July to 51° F in January at Hattiesburg. On the average, Hattiesburg has 106 days annually with temperatures equal to or greater than 90° F, and only 41 days annually with temperatures equal to or less than 32° F.

Geology and Topography

The study area is within the Pascagoula River basin in the East Gulf Coastal Plain. Exposed rocks are of sedimentary deposition and most are unconsolidated. The exposed sediments range in age from late Eocene to Recent with Miocene and younger sediments forming the majority of the exposed sediments (fig. 3). The geologic units containing fresh-water aquifers range in age from early Eocene to Recent alluvial deposits. Most geologic units are traceable from the surface deep into the subsurface (figs. 2 and 20).

The geologic units have a regional southwestward dip of 20-45 feet per mile (fig. 23 and 24). The dip of the beds is steep (40-45 feet per mile) in Wayne and Jones Counties, but it flattens (20-25 feet per mile) in Greene, Perry, and Forrest Counties owing to the major structural uplift of the Wiggins anticline south of the study area.

Several shallow piercement salt domes in the area locally affect the dip, strike, and thickness of formations. The formations display gentle arching or uplifting across these structures. Caution should be exercised in drilling wells in the vicinity of the shallow domes, especially near the shallow Richton dome (depth of caprock 497 feet, fig. 32) because the base of fresh water is shallow over some of these domes.

One recognizable subsurface fault (figs. 2, 23, and 24) is in southern Forrest County. It is an east-west trending fault associated with the Wiggins anticline, which is south of Forrest County in Stone County. The fault causes an offset in the deep beds but no movement is apparent in the shallower Miocene deposits.

Lithology varies between geologic units, but typically consist of interbedded clay, sand, and gravel. Sand and clay in various proportions constitute most of the sediments; however a few consolidated limestone layers occur in some units, particularly in the Vicksburg Group. The formations thicken downdip to the west and south toward the Mississippi River and the Gulf of Mexico.

The deposits, particularly Miocene and younger, are lenticular (figs. 21 and 22), and lithology changes in short distances. The sands, which are irregular and thicken or thin in short distances, are difficult to trace down the dip. Most of the water-bearing units were deposited in a deltaic environment.

Topography reflects the geology and drainage of the region and results from erosion of the gently dipping unconsolidated sedimentary beds. The landform is characterized by low, dissected, rounded hills and a few large streams in wide, flat valleys. Swamps are common in the lowland areas adjacent to the larger streams. There are many small man-made stock ponds in the area.

Elevation in the area ranges from less than 100 feet above sea level in the southern part along the Leaf River to 430 feet in western Jones County. Local relief is gentle; elevations vary only a small amount in short distances.

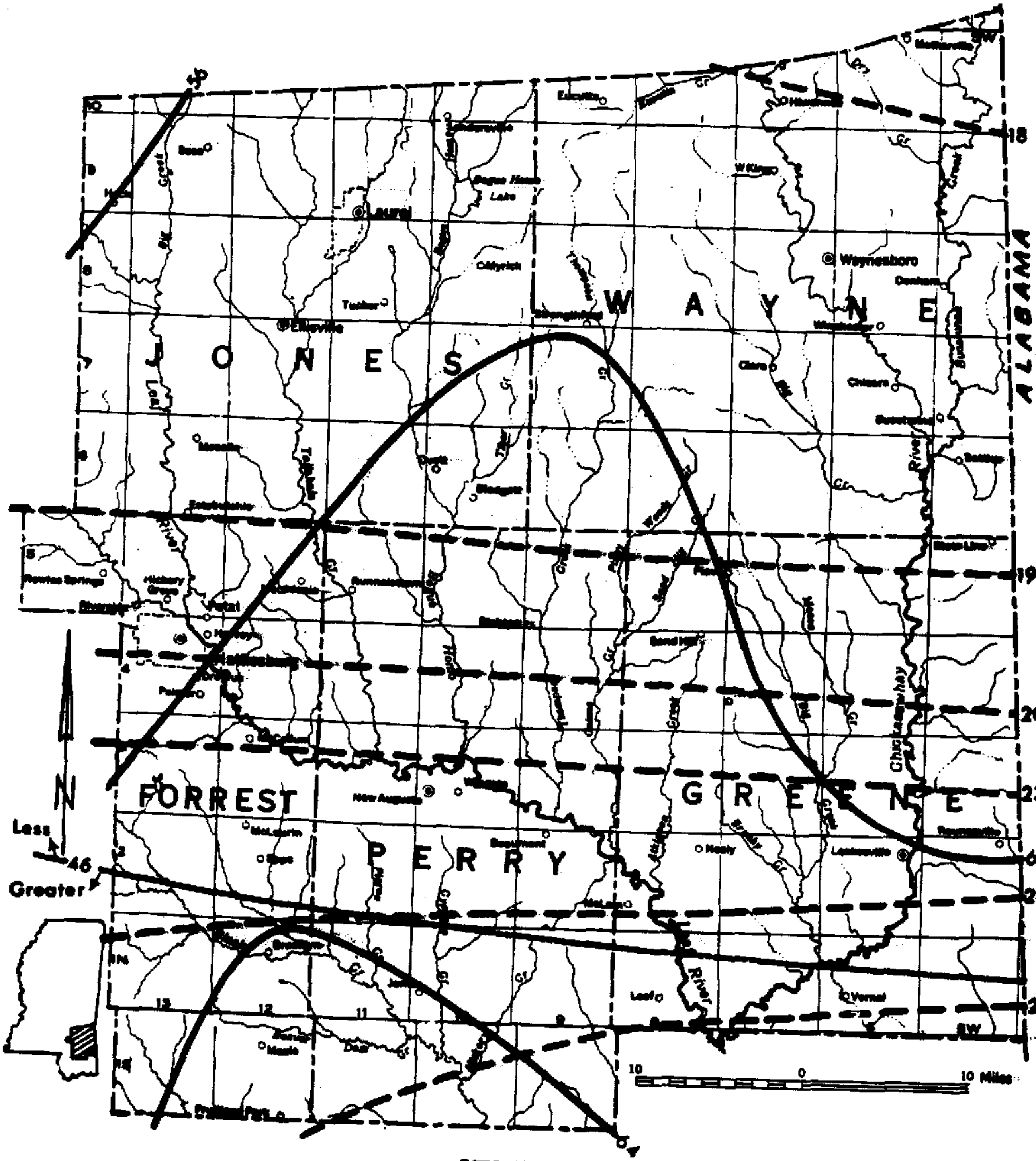
Drainage

The five-county area lies within the central part of the Pascagoula River basin. The major sub-basins in the area are the Leaf River, Chickasawhay River, and Black Creek (fig. 3). The Leaf River enters northwestern Jones County and flows generally southward to the vicinity of Hattiesburg in northern Forrest County, thence southeastward to meet the Chickasawhay River south of the Greene County line to form the main stem of the Pascagoula River. The Chickasawhay River drains the eastern parts of Wayne and Greene Counties. Black Creek flows through southern Forrest and Perry Counties and enters the Pascagoula River south of the study area. The streams are typical of those found in the southern United States, having winding meanders, broad, wooded flood plains, and many oxbow lakes along the larger rivers.

Occurrence of Ground Water

Ground water is any water in the ground that is in the zone of saturation. An aquifer is any water-bearing unit capable of yielding water to wells; in the study area most aquifers are composed of sand and gravel. The unconsolidated sediments have openings, or voids, between grains which are saturated with water below the water table. The shape, size, assortment, and degree of compaction of the grains determines the ease with which water moves through the material.

Water enters the permeable geologic units in their areas of outcrop (fig. 3) and moves generally southwestward in the direction of the dip toward areas of discharge which may be wells, springs, seeps, or adjacent permeable



EXPLANATION

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Average annual precipitation, in inches.
Extracted from U.S. Weather Bureau, 1959, "Climates of the States." Based on period 1931-55.

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Average annual runoff from streams, in inches.
Based on streamflow records for period 1939-1960.

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Average annual lake evaporation, in inches.
Extracted from U.S. Weather Bureau Tech. Paper No. 37. Based on period 1946-55.

Fig. 1. Map showing annual precipitation, evaporation, and run-off

Table 1.—Stratigraphic column and water resources in Forrest, Greene, Jones, Perry, and Wayne Counties, Miss.

System	Series	Group	Formation	Uneroded thickness (ft)	Lithology	Water resources
Quaternary	Recent		Alluvium	0–125	Clay, sand, and gravel in the larger stream valleys, particularly in Forrest, Greene, and Perry Counties.	Important aquifer at certain locations in the larger stream valleys, as at Hattiesburg on the Leaf River. Supplies domestic wells along the streams.
	Pleistocene		Terrace deposits	0–50	Red and gray sand and gravel with clay lens. Deposits cap the hills and form terraces along the streams.	Not an important aquifer, except for shallow dug wells.
Tertiary	Pliocene		Citronelle	0–150	Clay, sand, gravel, and ferruginous layers. These deposits usually are red. Deposits cap the higher hills in the area, particularly in the southern counties.	Not an important aquifer. Supplies shallow domestic wells, particularly in southern part of area.
	Miocene		Pascagoula	50–100	Clay, sandy clay, sand, and gravel, with some thin ferruginous layers. Sand beds occur at various horizons and vary in thickness from thin layers to 200 feet. A thin zone of limestone (Tatum Limestone Member) occurs in the lower half of the unit.	An important source of water in the extreme southern part of Forrest, Greene, and Perry Counties. Sands capable of supplying large quantities of water.
			Hattiesburg	350–600		An important source of water in Forrest, Greene, and Perry Counties. Sands and gravels capable of yielding large amounts of water.
	Miocene(?)		Catahoula Sandstone	450–700		An important source of water in all but northern third of area. Majority of wells throughout the area are completed in the Catahoula. Large yielding wells are possible in most locations from the thick sands.
	Oligocene	Vicksburg	Undifferentiated	70–120	Limestone beds alternating with limy sand and clay beds. Thick sand layers, 30–50 feet, occur locally at Waynesboro and Sandersville.	Generally not an aquifer. A fair aquifer in certain locations such as Waynesboro and Sandersville, where there are beds of sand up to 40 feet thick. The limy interval yields water to domestic wells in central Wayne and northeastern Jones Counties.
			Forest Hill Sand	80–100	Thin sand and clay layers with silt.	Not used as an aquifer, except for shallow domestic wells near outcrop.
	Eocene	Jackson	Yazoo Clay	200–275	Clay and calcareous sand with thin limestone layers. The Cocoa Sand Member, near the bottom, is generally 10 to 15 feet thick and composed of limy sand. In eastern Wayne County, the unit is about 60 feet thick and composed of sand with thin layers of limestone.	Not an aquifer, except in eastern Wayne County, where the Cocoa Sand Member is an important local source of water supply. The Cocoa Sand Member supplies domestic wells and one community water system in the vicinity of Bucatunna.
			Moodys Branch	15–20	Glauconitic, fossiliferous marl and sand. Indurated beds occur near the outcrop.	Not an aquifer.
		Claiborne	Cockfield	700–950	Sand and clay with lignite. Thin to thick beds of sand alternating with clay. Lignite is common but not as prevalent as in the Sparta. Sand beds are 50 feet thick in northeastern Wayne County and 70 feet thick at Laurel.	A potential important source of water in northern Wayne and Jones Counties. Several large industrial wells tap this aquifer at Laurel. Water is colored except near outcrop in northern Wayne County.
			Cook Mountain		Shale, clay, limestone, and sandstone. Top of formation is usually a limestone and bottom is a clay or shale.	Not an aquifer.
			Sparta Sand		Sand, sandy clay and clay, with lignitic layers. Sand thickness ranges from 45 feet in eastern Wayne County to 80 feet in central Jones County. Lithology in southern counties is primarily clay and differentiation from the underlying Zilpha Clay is difficult.	An important source of water in parts of northern Jones and Wayne Counties. Colored water is common in this aquifer.
			Zilpha Clay		Shale and brown clay, with glauconite.	Not an aquifer.
			Winona Sand		Calcareous sandstone and clay with thin beds of sand.	Not an aquifer.
			Tallahatta		Brittle clay and sandstone (buhrstone). Thick sand occurs near bottom of section.	Not an aquifer, except for lower sand (Meridian Sand Member) which is usually not differentiated from the underlying Wilcox. The Meridian Sand Member is unused but is potentially an important source of water in the northern third of Wayne and Jones Counties.
		Wilcox	Undifferentiated	1400–1650	Sand, sandy shale, clay and shale. Beds of lignite occur in the sand and clay. Sand beds compose 10 percent of the unit. Sands are micaceous, medium to coarse-grained. Sand thickness ranges from 150 to 250 feet in northern Wayne County.	Potentially an important source of water in northern third of Wayne County but is untapped in study area. Best aquifers are probably in lower third of the unit.

beds. Water levels are lowered in the aquifers in the vicinity of discharge, and the lower water levels change the direction of ground-water movement. Some of the geologic units are relatively impermeable (aquicludes) and allow little movement of water. Permeability (Glossary) within an aquifer is usually greater horizontally than vertically because of horizontal stratification.

Aquifers are classified as water-table or artesian depending on whether the water level is within the aquifer and unconfined or whether it is confined. Water in a water-table well stands at about the same level as in the aquifer outside the well. Water-table aquifers receive recharge from local precipitation. Discharge from water-table aquifers supplies most of the base flow of the streams, especially during droughts. Water in the terrace and alluvial aquifers in most places occurs under water-table conditions.

In artesian aquifers the water-bearing material is confined by impermeable beds and water is confined under hydrostatic pressure or head; thus, water in wells will rise above the top of the water-bearing material. Water in the majority of aquifers in the study area occurs under artesian conditions, except for small areas in the outcrops.

Changes in quality of water occur as the water moves down the dip from the outcrop to areas of discharge. Dissolved-solids content usually increases down the dip (fig. 20) and the type of the water changes from calcium to sodium bicarbonate. The deeper water is usually softer because the calcium and magnesium content has been decreased by ionic exchange for sodium. The pH of the water increases down the dip, and iron problems are reduced.

The temperature of shallow ground water is about 66° F, which is the mean annual temperature of the air. The temperature of the water increases 1° F for each additional 65 to 100 feet of depth in the five-county area. Ground water temperature, except in shallow water-table wells, does not vary with seasonal changes in air temperature.

able time, as specified by the Board in its authorization, to the stream at a point downstream from the place of withdrawal. This appropriation can be made only if the Board shall find that such action will not result in any substantial detriment to property owners affected thereby or to the public interest.

Average minimum flows calculated for streams in the area are presented in table 11. Data for the period 1941-60 were used for the determinations of the average minimum flows.

The law states that the Board has authority to enter into compacts and agreements concerning the State's share of water flowing in streams, where parts of such water courses are contained within the territorial limits of a neighboring state.

GROUND WATER

Location, Extent, and Lithology of Aquifers

Fresh-water aquifers in the five-county area are mostly beds of sand or zones of sandy beds. The beds dip gently to the southwest and contain fresh water as much as 40 miles from the outcrops and as much as 3,000 feet below land surface. Aquifers of Miocene age are available in practically the entire area, except in the northern third of Jones and Wayne Counties (fig. 19), but no single geologic unit contains fresh water throughout the five counties. Aquifers in Claiborne and Wilcox groups are available in the northern third of the area, but the great depth (1,200-3,000 feet) of the Wilcox has limited its use owing to the higher cost of deep wells. Shallow alluvial deposits in the larger stream valleys are potentially important aquifers in the three southern counties.

Lithology and thickness of aquifers is shown in table 1 and in a northeast-southwest cross-section (fig. 20) parallel to the general dip of the beds. Detailed sections through Laurel and Hattiesburg show the lenticular bedding of the Miocene beds (figs. 21 and 22). Depth and thickness of aquifers can be estimated from the sections for places in the vicinity of the sections, but structure contour maps drawn on mappable geologic horizons are useful for estimating aquifer depths at any place in the area. Because the Moodys Branch Formation is thin (15-20 feet), a contour map showing the configuration of the top of the mappable Moodys Branch Formation (fig. 23) is essentially the top of the Cockfield Formation. Another contour map, showing the configuration of the base of the Catahoula Sandstone (fig. 24), can be used to determine the depth of a well necessary to penetrate the Catahoula.

Thickness of geologic units increase from the outcrop toward the southwest in the direction of the center of deposition. The thickness of the Sparta Sand ranges from 110 feet in northeastern Wayne County to 190 feet in north-central Jones County. Thickness of the Cockfield Formation ranges from 80 feet in northern Wayne County to 150 feet in north-central Jones County. Miocene beds range in thickness from about 100 feet in northern Jones County to about 2,000 feet in southern Forrest County. The alluvium underlying the major flood plains in the area is as much as 125 feet thick, as in the Leaf River flood plain at Hattiesburg.

Most of the aquifers are composed of sand or gravel mixed with varying proportions of silt and clay. Lignite is common in the Claiborne and Wilcox Groups. The alluvium is composed mostly of unstratified coarse sand and gravel. The beds of sand in the Miocene sediments, the principal source of ground water in the area, may be thinner than 2 feet or thicker than 200 feet. Commonly there are several beds of sand in each water-bearing geologic unit.

The marine Vicksburg Groups and Cocoa Sand are more uniform in lithology than most of the other water bearing units. The Cocoa Sand in eastern Wayne County is about 60 feet thick and is composed of thin layers (2-10 feet) of fine- to medium-grained sand alternating with thin layers (4-8 feet) of calcareous sandstone and limestone. The Vicksburg is generally composed of limestone beds alternating with thin beds (2-4 feet) of limy sand and clay. The Vicksburg at particular locations, as at Waynesboro and Sandersville, is composed of relatively thick sand beds (30-50 feet) interspersed with thin layers (1-2 feet) of limestone. The limestone or limy sand section of the Vicksburg (known locally as "Honeycomb rock") yields water to domestic wells across central Wayne and northeastern Jones Counties.

Prediction of aquifer thickness and lithology is difficult because of the lenticular bedding of most units. Lithologic changes occur in short distances and individual sands are difficult to trace, especially along the dip of the beds (figs. 21 and 22); sand beds in the Miocene are characteristically lens shaped or wedge shaped. Construction of a well where water is needed may be a problem because of the lenticular bedding of most sands, and test drilling is recommended to determine the depth, thickness, and character of aquifers underlying a particular site.

The depth of drilled water wells ranges from 20 to 1,316 feet (table 12). A well at Laurel is 1,316 feet deep, but most wells are less than 800 feet deep. At most places more than one aquifer is available.

Aquifer and Well Hydraulics

Transmissibility, Permeability, and Storage

Aquifers vary considerably in their ability to transmit and store water. Transmission and storage of water by an aquifer depends on the porosity (Glossary), size of open spaces between grains of the aquifer material, and interconnection of the open spaces; all of which are related to the depositional history of the aquifer. Coefficients of permeability and transmissibility (Glossary) are measures of the ability of an aquifer to transmit water. The coefficient of

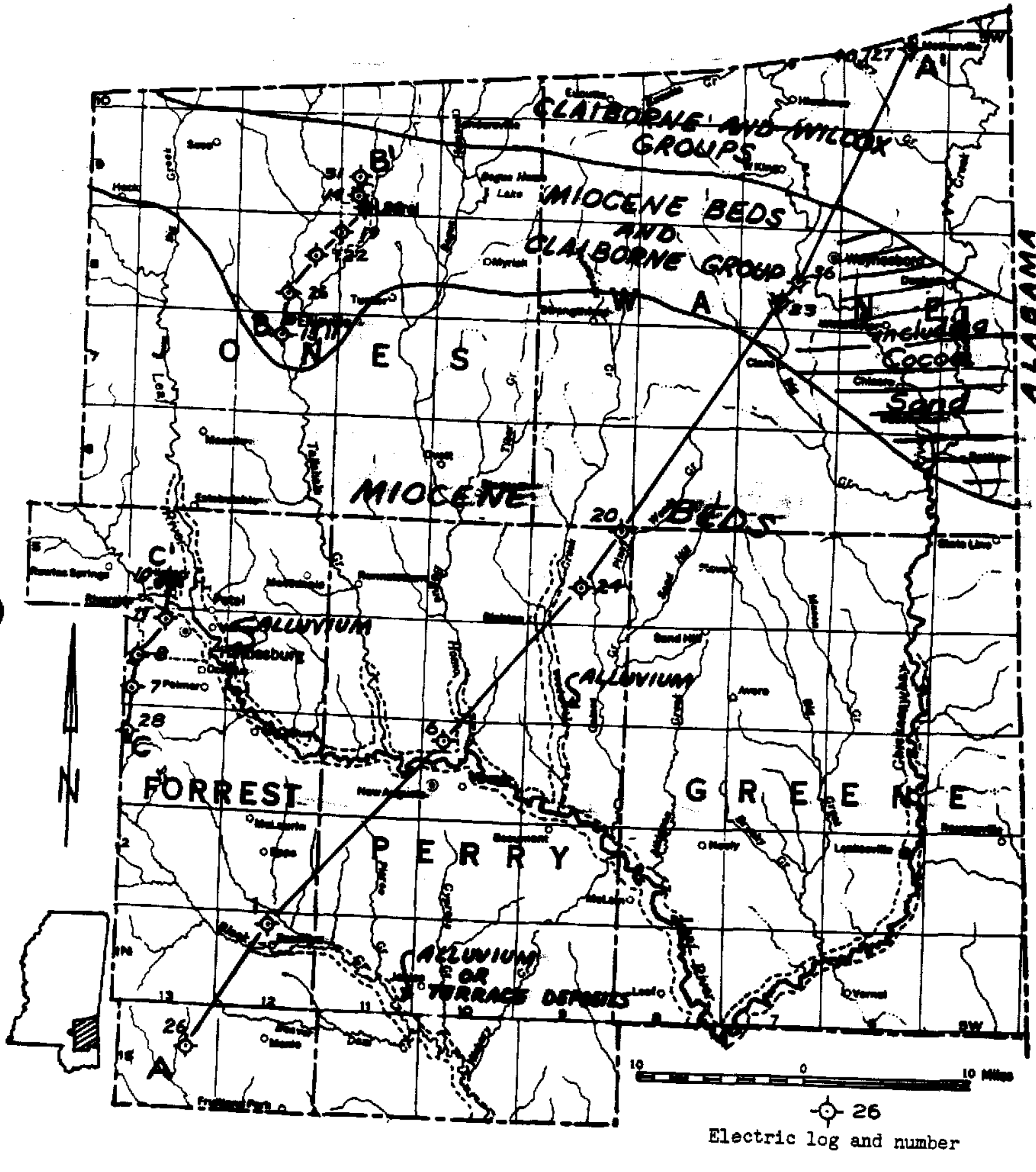
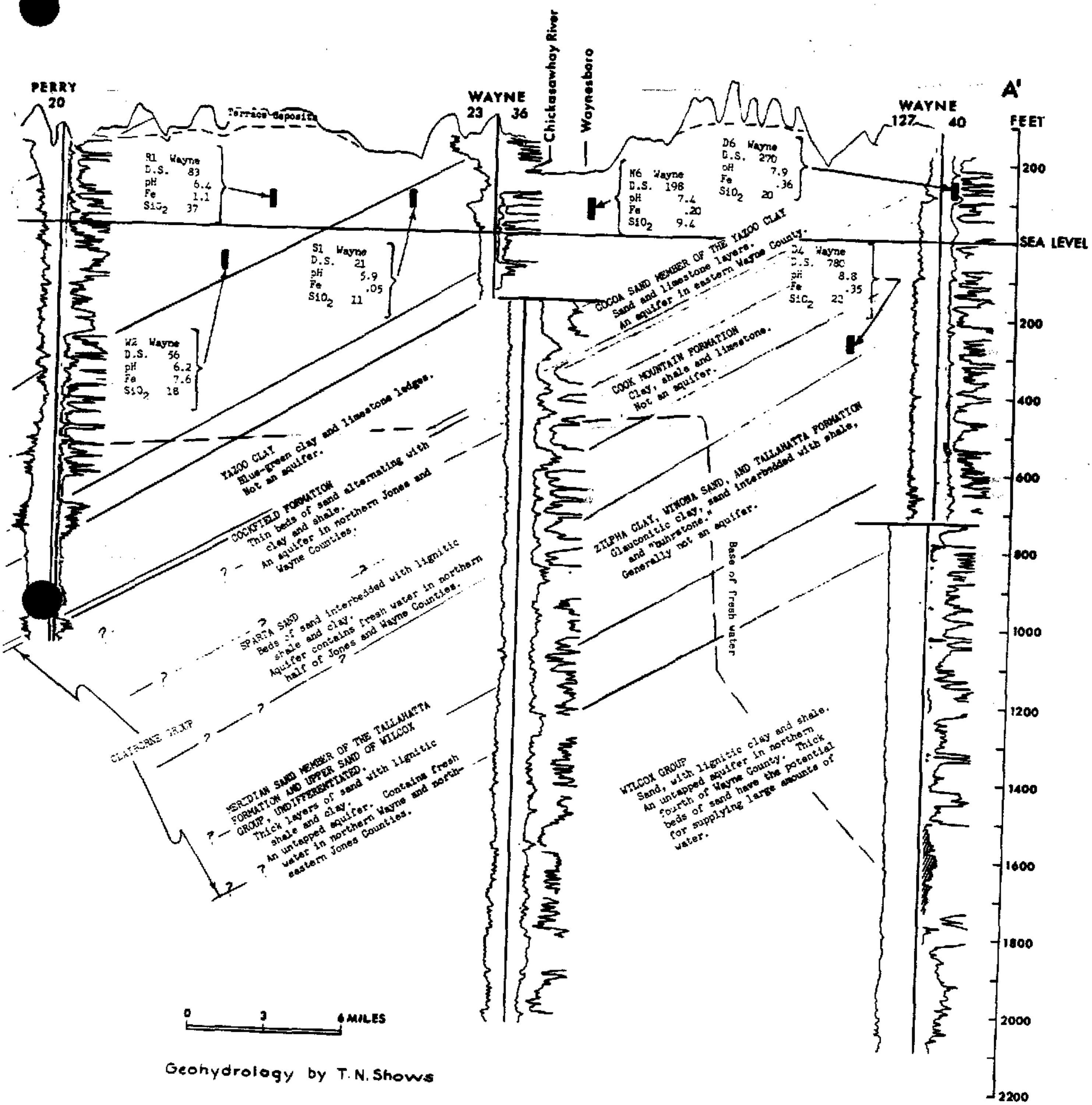


Fig. 19. Map showing distribution of fresh-water aquifers and location of geohydrologic sections



Forrest County to northeastern Wayne County

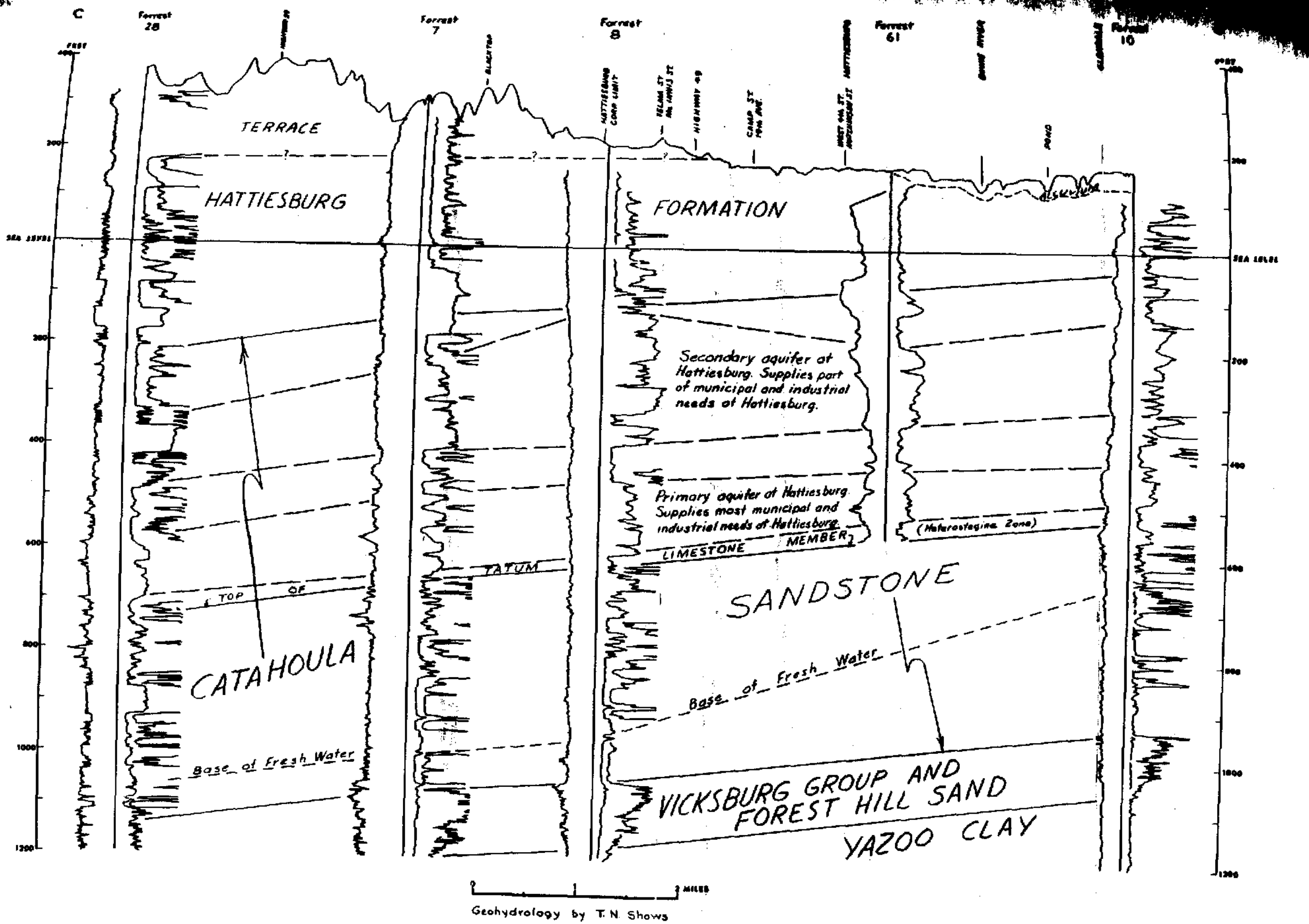


Fig. 22. Geohydrologic section (C-C') through the Hattiesburg area