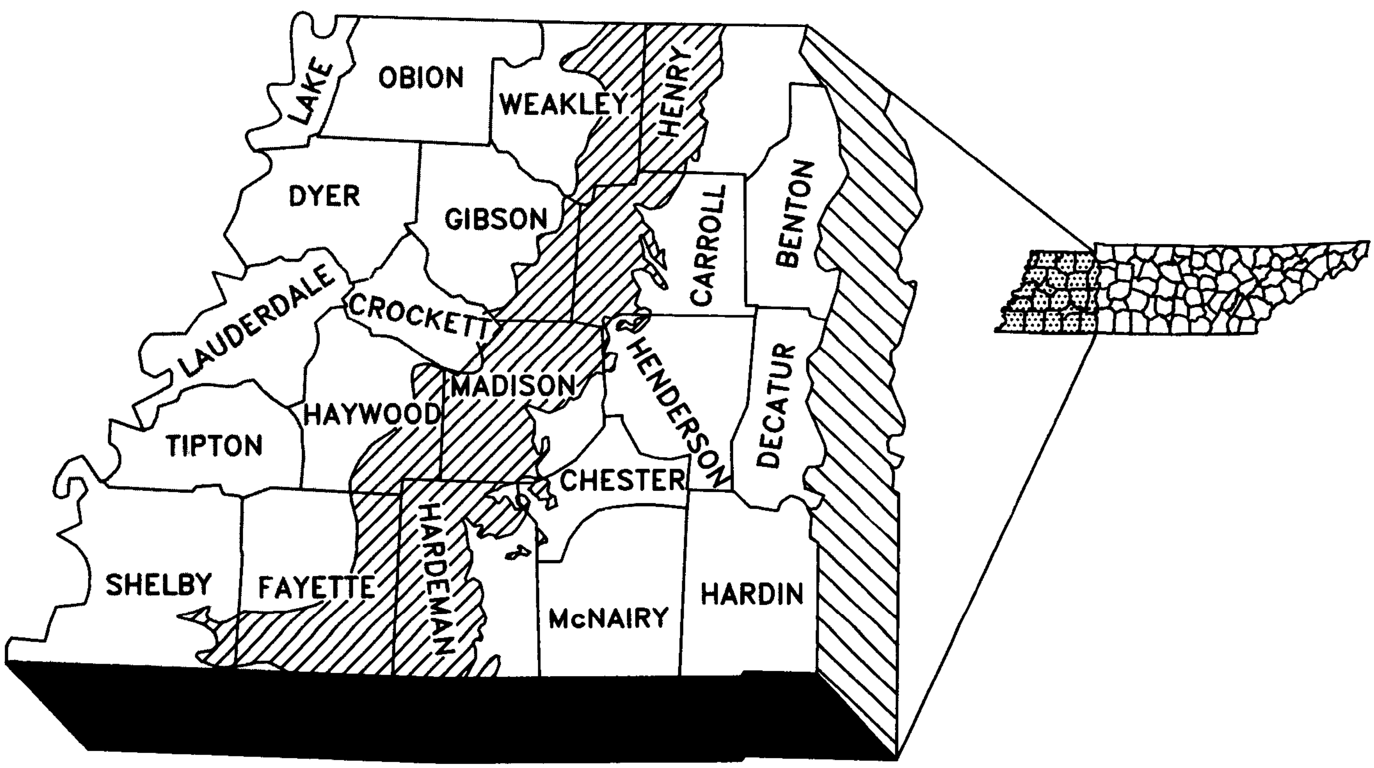
Water-Resources Investigations Report 88-4182

GEOLOGY AND GROUND-WATER RESOURCES OF THE MEMPHIS SAND IN WESTERN TENNESSEE



USGS
science for a changing world

Prepared by the
U.S. GEOLOGICAL SURVEY

GEOLOGY AND GROUND-WATER RESOURCES OF THE MEMPHIS SAND IN WESTERN TENNESSEE

By W.S. Parks and J.K. Carmichael

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 88-4182

Memphis, Tennessee
1990

DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information write:

District Chief
U.S. Geological Survey
A-413 Federal Building
U.S. Courthouse
Nashville, Tennessee 37203

Copies of this report can be purchased from:

U.S. Geological Survey
Books and Open-File Reports Section
Federal Center, Building 810
Box 25425
Denver, Colorado 80225

CONTENTS

PLATES (in pocket)

ILLUSTRATIONS

TABLES

CONVERSION FACTORS

Factors for converting inch-pound units to metric units are shown to four significant digits.

Multiply inch-pound units	By	To obtain metric units
foot (ft)	0.3048	meter (m)
foot per year	30.48	centimeter per year (cm/yr)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
gallon (gal)	0.00379	cubic meter (m^3)
gallon per minute (gal/min)	0.06309	liter per second (L/s)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)
square foot per day (ft^2/d)	0.0929	square meter per day (m^2/d)

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.

Well-Numbering System: Wells are identified according to the numbering system used by the U.S. Geological Survey throughout Tennessee. The well number consists of three parts: (1) an abbreviation of the name of the county in which the well is located; (2) a letter designating the $7^1/_2$-minute topographic quadrangle on which the well is plotted; and (3) a number generally indicating the numerical order in which the well was inventoried. The symbol Dy:H-7, for example, indicates that the well is located in Dyer County on the "H" quadrangle and is identified as well 7 in the numerical sequence. Quadrangles are lettered from left to right, beginning in the southwest corner of the county.

GEOLOGY AND GROUND-WATER RESOURCES OF THE MEMPHIS SAND IN WESTERN TENNESSEE

By W.S. Parks and J.K. Carmichael

ABSTRACT

The Memphis Sand of the Claiborne Group of Tertiary age underlies approximately 7,400 square miles in western Tennessee. The formation primarily consists of a thick body of very fine to very coarse sand that includes subordinate lenses or beds of clay and silt at various horizons. The Memphis Sand ranges from 0 to about 900 feet in thickness, but where the original thickness is preserved, it is about 400 to 900 feet thick. The Memphis Sand yields water to wells in most of the area of occurrence in western Tennessee and, where saturated, makes up the Memphis aquifer.

Recharge to the Memphis aquifer is from precipitation on the outcrop, which is a broad belt across western Tennessee, or by downward infiltration of water from the overlying fluvial deposits of Tertiary(?) and Quaternary age and alluvium of Quaternary age. Long-term data from five observation wells indicate that water levels have declined at average rates ranging from less than 0.1 to 1.3 feet per year during the period 1928-83. The largest declines have been in the Memphis area. Water from the Memphis aquifer generally is a calcium bicarbonate type, but locally is a sodium bicarbonate or mixed type. The water contains low concentrations of most major constituents and generally is suitable for most uses. Dissolved-solids concentrations range from 19 to 333 milligrams per liter. The results from 76 aquifer tests made in the Memphis area and western Tennessee during the period 1949-62 indicate that transmissivities range from 2,700 to 53,500 feet squared per day, and storage coefficients range from 0.0001 to 0.003. The Memphis aquifer provides moderate to large quantities of water for many public and industrial water supplies in western Tennessee and small quantities to numerous domestic and farm wells. Withdrawals for public and industrial supplies in 1983 averaged about 227 million gallons per day, of which 183 million gallons per day were in the Memphis area. The Memphis aquifer has much potential for future use, particularly at places outside the Memphis area.

INTRODUCTION

This report was prepared by the U.S. Geological Survey as part of the Gulf Coast Regional Aquifer-System Analysis (GC RASA) program. The GC RASA study area covers about 230,000 mi^2 onshore in Louisiana and parts of Alabama, Arkansas, Florida, Illinois, Kentucky, Mississippi, Missouri, Tennessee, and Texas. About 60,000 mi^2 offshore on the continental shelf also are included, because the aquifers extend beyond the coast line beneath the Gulf of Mexico. The study is limited to the Coastal Plain sediments of Tertiary and younger age, except for an area in the Mississippi embayment where Upper Cretaceous sediments supply ground water in parts of several States. The objectives of the GC RASA study are to define the geohydrologic framework, to describe the chemistry of the ground water, and to analyze the regional ground-water flow system (Grubb, 1984).

Background Information

Information interpreted or compiled for the aquifers in Tertiary sediments in western Tennessee as a part of the GC RASA study included: (1) geophysical-log correlations of the stratigraphic and geohydrologic units, (2) thicknesses of sand and clay beds in the geohydrologic units, (3) maps of the water-table and potentiometric surfaces in the aquifers, (4) data showing long-term water-level changes, (5) historic pumpage from the aquifers, (6) hydraulic characteristics of the aquifers, (7) water-quality data, and (8) locations of pumping centers. Much of this information was interpreted or compiled from existing geophysical logs, water-level data, pumpage inventories, aquifer-test records, and water-quality analyses. New data collected for GC RASA included: (1) water-quality data from about 40 wells, (2) water-level measurements in about 70 wells, (3) location of currently used public and industrial water-supply wells, and (4) field verification of the locations of wells for which important historic data are available.

Purpose and Scope

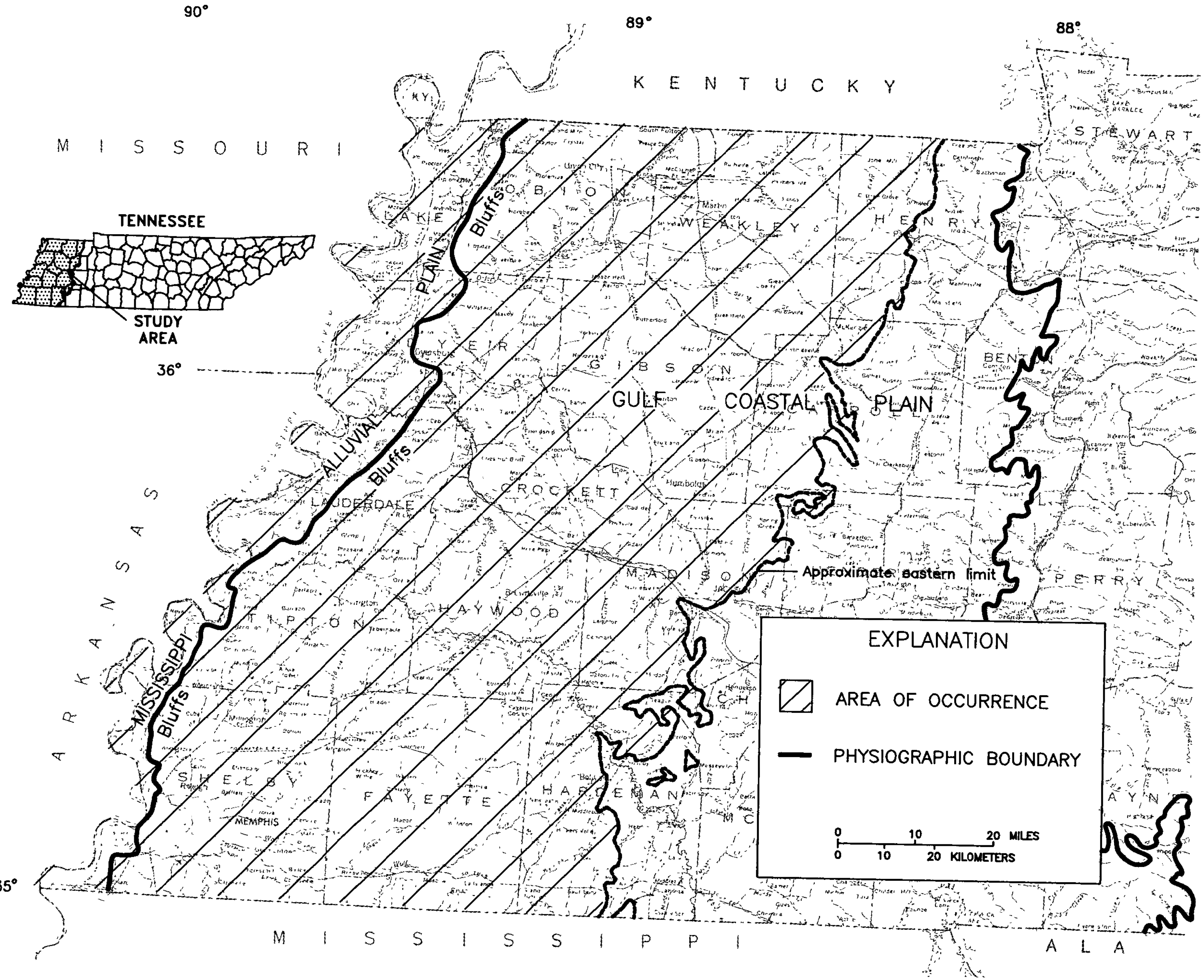
This report summarizes and interprets the information and data collected on the geology and ground-water resources of the Memphis Sand in western Tennessee as part of the larger GC RASA investigation. Similar reports were prepared for the Cockfield Formation and the Fort Pillow Sand (Parks and Carmichael, 1990; and in press, a). Reports also were prepared to show the altitude of the potentiometric surfaces in the Memphis and Fort Pillow aquifers for the fall of 1985 and to describe historic water-level changes in these aquifers (Parks and Carmichael, in press, b, c).

GEOLOGY

The Memphis Sand (Moore and Brown, 1969) of the Claiborne Group of Tertiary age underlies approximately 7,400 mi^2 in the Gulf Coastal Plain of western Tennessee (fig. 1). The formation crops out in a broad belt across western Tennessee, but it is covered at most places by fluvial deposits of Tertiary(?) and Quaternary age and loess and alluvium of Quaternary age. Consequently, exposures are uncommon, except along the eastern part of the outcrop belt. Post-Cretaceous geologic units in western Tennessee and their hydrologic significance are given in table 1.

Stratigraphy

The sequence of strata approximately equivalent to the Memphis Sand was referred to as the "500-foot" sand in many early reports, particularly those for the Memphis area (Klaer, 1940; Kazmann, 1944; Criner and Armstrong, 1958; Criner and others, 1964; Nyman, 1965; Bell and Nyman, 1968). The informal name "500-foot" sand originated at Memphis where wells tapping the Memphis Sand had an "average" depth of about 500 feet. The top of the "500-foot" sand is a hydrologic boundary rather than a stratigraphic boundary. On well logs this top, where distinct, was at a clay-sand contact between the upper confining layer and the aquifer or, where indistinct, arbitrarily in the middle of a gradational sequence of predominantly clay in the upper confining layer and predominantly sand in the aquifer (Criner and others, 1964, p. O16).



Base from U.S. Geological Survey, State base map, 1:500,000, 1973

Figure 1.--Occurrence of the Memphis Sand as related to major physiographic subdivisions in western Tennessee.

Table 1.--*Post-Cretaceous geologic units underlying western Tennessee and their hydrologic significance*

System	Series	Group	Stratigraphic unit	Thickness (in feet)	Lithology and hydrologic significance
Quaternary	Holocene and Pleistocene		Alluvium (alluvial deposits)	0-200	Sand, gravel, silt, and clay. Underlies the Mississippi Alluvial Plain and the alluvial plains of streams in the Gulf Coastal Plain upland areas. Thickest beneath the Mississippi Alluvial Plain where it commonly is between 100 and 150 feet thick and makes up the Mississippi River Valley alluvial aquifer. Generally less than 50 feet thick elsewhere. Provides water to farm and domestic wells and to some industrial and irrigation wells in the Mississippi Alluvial Plain.
	Pleistocene		Loess	0-70	Silt, silty clay, and minor sand. Principal unit at the surface in upland areas of the Gulf Coastal Plain, concealing the older Quaternary and Tertiary units at most places. Thickest on the bluffs that border the Mississippi Alluvial Plain; generally thinner eastwards. Retards downward movement of the water that provides recharge to the water-table aquifers.
Quaternary and Tertiary(?)	Pleistocene and Pliocene(?)		Fluvial deposits (terrace deposits)	0-100	Sand, gravel, minor clay, and ferruginous sandstone. Generally underlie the loess in upland areas, but are locally absent. Thickness varies greatly because of erosional surfaces at top and base. Provides water to farm and domestic wells in rural areas.
Tertiary	Eocene	?	Jackson Formation ?	0-150	Sand, silt, clay, and lignite Because of similarities in lithology, the Jackson and Cockfield cannot be reliably subdivided based on available information. Preserved sequence mostly Cockfield, but locally is overlain by the Jackson. Thicknesses are estimates based on tentative geophysical log correlations. The Jackson and Cockfield provide water to farm and domestic wells in rural areas and the Cockfield provides water for some public and industrial supplies.
		Claiborne	Cockfield Formation ?	0-270	
			Cook Mountain Formation ?	40-200	Clay, silt, and sand. Generally consists of clay and silt, but locally may consist predominately of fine sand. Probably averages about 70 feet in thickness. Unit can be confused with clay lenses in the lower part of the Cockfield or upper part of the Memphis Sand. Serves as upper confining unit for the Memphis Sand.
			Memphis Sand ("500-foot" sand)	400-890	Sand, silt, clay, and minor lignite. Consists of a thick body of sand with clay lenses at various horizons. Sand is fine to very coarse. Upper part commonly contains fine sediments, particularly north of the Hatchie River where it is generally necessary to drill to the middle or lower parts of the aquifer to install large capacity wells. Thickest in Shelby County where it is the principal aquifer supplying water to the City of Memphis. Major aquifer providing water for most public and industrial supplies in the western part of western Tennessee.
	?	Wilcox	Flour Island Formation	0-310	Clay, silt, sand, and lignite. Not an aquifer. Consists predominantly of clay and silt. Where present, serves as lower confining unit for the Memphis Sand and the upper confining unit for the Fort Pillow Sand.
			Fort Pillow Sand ("1,400-foot" sand)	0-350	Sand and minor clay. Sand is fine to very coarse. Thickest in the Dyer-Lake County area. Once used as the second principal aquifer to supply water for the City of Memphis; now used by an industry at Memphis and the City of Millington. Provides water for some municipal and industrial supplies just downdip from its outcrop belt. Major aquifer in rudimentary stage of development.
	Paleocene	?	Old Breastworks Formation [1]	0-310	Clay, silt, sand, and lignite. Not an aquifer. Consists predominantly of clay and silt. Where present, serves as the lower confining unit for the Fort Pillow Sand along with Porters Creek Clay and Clayton Formation.
		Midway	Porters Creek Clay	40-320	Clay and minor sand. Consists of a widespread and generally thick body of clay with local interbeds or lenses of fine sand. Serves as the major confining unit between the Fort Pillow Sand of Tertiary age and the McNairy Sand of Cretaceous age.
			Clayton Formation	40-110	Clay, sand, and limestone. Generally consists of clay with local interbeds or lenses of fine sand and limestone. North of Hardeman County in a narrow belt paralleling and including the outcrop area, the Clayton is predominantly sand and provides water to some farm and domestic wells. Underlain by the Owl Creek Formation and McNairy Sand of Cretaceous age.

[1]Frederiksen and others (1982) tentatively placed the Old Breastworks Formation in the Midway Group, but for the purposes of this report the Old Beastworks Formation of the Wilcox Group as defined by Moore and Brown (1969) is used.

In a report on the geology and the hydrology of the Claiborne Group in western Tennessee, Moore (1965) provided regional-scale maps of the "500-foot" sand. Hosman and others (1968), in a report on the Tertiary aquifers in the Mississippi embayment, assigned the sequence of strata equivalent to the "500-foot" sand to the Memphis aquifer. Moore and Brown (1969) formally named the "Memphis Sand" in their study of the stratigraphy of the Fort Pillow test well in Lauderdale County, Tenn. The Memphis Sand, as defined, includes strata in the upper part that Moore (1965) excluded from the "500-foot" sand north of the Memphis area and included in the "unnamed clay unit" or the "unnamed sand unit."

The eastern boundary of the Memphis Sand was mapped by Parks and Russell (1975) as the contact between the Wilcox Formation and the Claiborne Formation. The Wilcox and Claiborne were mapped as formations because of the uncertainty of the equivalence of the strata cropping out with the units that make up the Wilcox and Claiborne Groups in the subsurface, as subdivided by Moore and Brown (1969). The western boundary of the outcrop belt is not well established because the contact between the Memphis Sand and the overlying Cook Mountain Formation is covered at most places by fluvial deposits, loess, or alluvium.

The Memphis Sand includes strata equivalent to, in ascending order, the Tallahatta Formation, Winona Sand, Zilpha Clay, and Sparta Sand of Mississippi and the Carrizo Sand, Cane River Formation, and Sparta Sand of Arkansas. The Memphis Sand is underlain by the Flour Island Formation of the Wilcox Group, and is overlain by the Cook Mountain Formation of the Claiborne Group (table 1).

Lithology and Thickness

The Memphis Sand consists of a thick body of sand that includes subordinate lenses or beds of clay and silt at various horizons. The clay and silt locally are carbonaceous and lignitic; thin lenses of lignite also occur locally. Thick beds of clay and silt in the upper part of the Memphis Sand in some places can be confused with the overlying Cook Mountain Formation. In Lake County, the upper one-quarter of the Memphis Sand primarily consists of clay and silt. The geophysical logs of deep test holes and wells drilled in Shelby, Lauderdale, and Obion Counties show a clay bed at the approximate stratigraphic horizon of the Zilpha Clay of Mississippi, but well control is too sparse to correlate this clay bed as a continuous unit. In the central part of the Memphis area, a persistent clay bed occurs in the lower part of the Memphis Sand (Criner and others, 1964, p. O11).

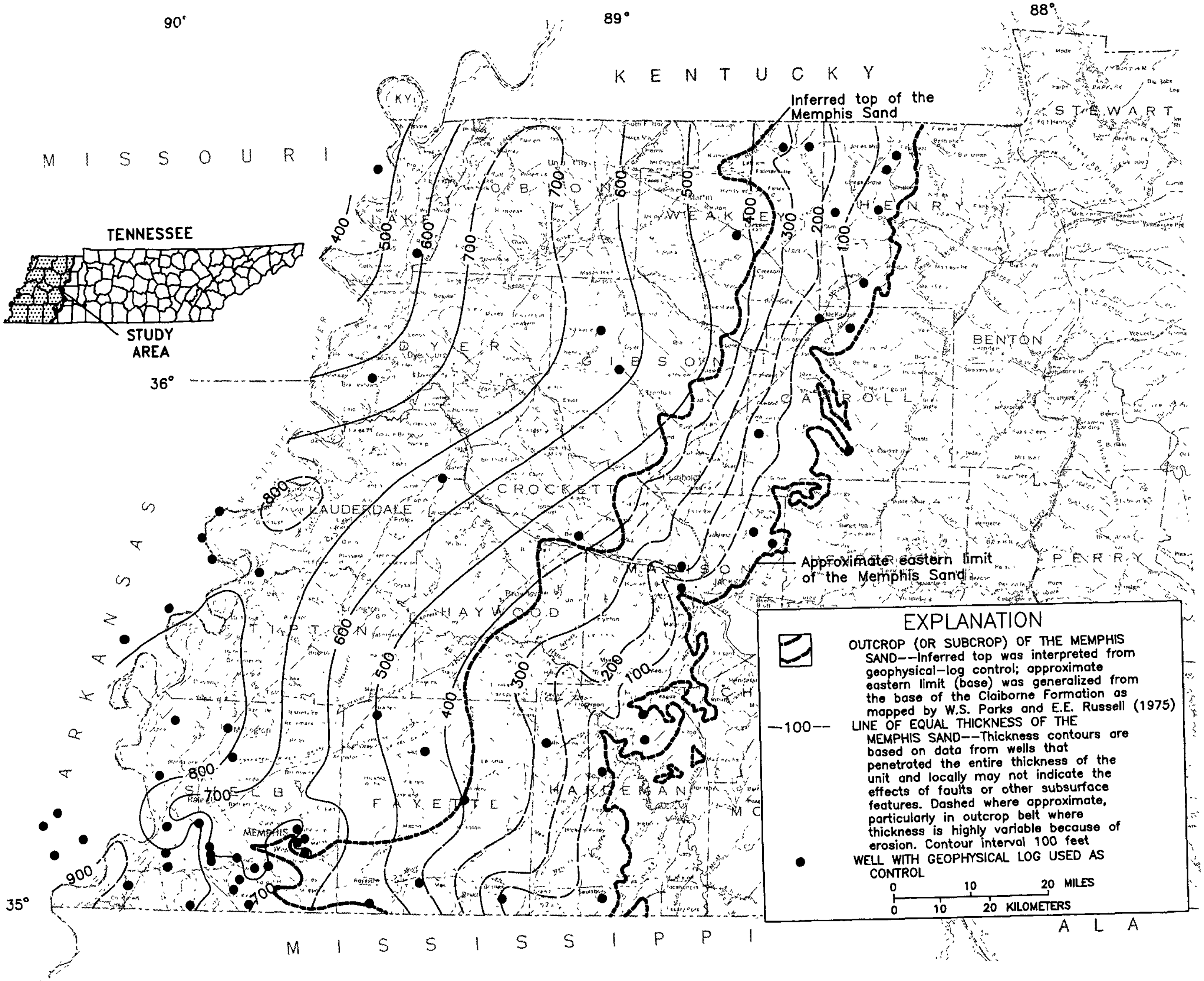
Sand in the Memphis Sand ranges from very fine to very coarse, but it commonly is locally fine, fine to medium, or medium to coarse. In Shelby and Tipton Counties, the coarsest sand commonly is in the upper one-third of the Memphis Sand; to the north, in Lauderdale, Dyer, Lake and Obion Counties, the coarsest sand commonly is in the lower two-thirds.

The generalized thickness of the Memphis Sand is shown in figure 2. The thickness contours are based on data from wells that penetrated the entire thickness of the unit and locally may not indicate the effects of faults or other subsurface features.

The Memphis Sand ranges from 0 to about 900 feet in thickness, and where the original thickness is preserved, it is about 400 to 900 feet thick. The formation is thinnest along the eastern limits of the outcrop belt in Hardeman, Madison, Carroll, and Henry Counties and is thickest in southwestern Shelby County.

Geologic Structure

In western Tennessee, the base of the Memphis Sand dips westward at rates of 20 to



Base from U.S. Geological Survey, State base map, 1:500,000, 1973

Figure 2.--Generalized thickness of the Memphis Sand.

50 ft/mi, and it is faulted at many places (plates 1 and 2). Identification and location of faults that displace the Tertiary formations are difficult because they are covered at most places by Quaternary surficial deposits and subsurface information is sparse. A study of the likelihood of post-Cretaceous faulting in the northern Mississippi embayment, including western Tennessee, has shown that faults that displace the Cretaceous and Tertiary formations probably are relatively common (Stearns and Zurawski, 1976). Correlation and interpretation of geophysical logs made in test holes drilled in Lauderdale County, Tenn., indicate several faults that displace the upper part of the Memphis Sand and the Cook Mountain and Cockfield Formations (Parks and others, 1985).

Faults identified during this investigation that displace the base of the Memphis Sand, are shown in figure 3. Most of these faults are based on an interpretation of the geologic structure using correlations of geophysical logs of wells. Faults in Lake County, however, are based partly on the interpretation of seismic reflection profiles by Zoback (1979) and Hamilton and Zoback (1982). The geophysical log correlations are highly interpretive, but are supported by paleontological evidence from the Fort Pillow test well in Lauderdale County, Tenn. (Moore and Brown, 1969), and the New Madrid test wells in New Madrid County, Mo. (Frederiksen and others, 1982).

HYDROLOGY

The Memphis Sand yields water to wells in most of the area of occurrence in western Tennessee and, where saturated, makes up the Memphis aquifer. In the larger, multistate GC RASA investigation, the Memphis aquifer is included in the lower Claiborne-upper Wilcox aquifer and middle Claiborne aquifer for purposes of studying the regional aspects of the ground-water system (Grubb, 1986).

Recharge and Potentiometric Surface

Recharge to the Memphis aquifer generally occurs along the broad outcrop belt across western Tennessee (fig. 3). Recharge is from precipitation on the outcrop and from downward infiltration of water from the overlying fluvial deposits and alluvium. Along this outcrop-recharge belt, where the Memphis aquifer is under water-table conditions (unconfined), the configuration of the potentiometric surface (fig. 3), whether in the Memphis aquifer or in the overlying fluvial deposits and alluvium, is complex. Except at seeps and springs, the water table is below the land surface, but generally conforms to the topography. In areas of some relief, perched water tables above lenses or beds of clay or silt add to the complexity of the potentiometric surface. In the outcrop-recharge belt, water moves westward down the dip of the Memphis aquifer and also toward the major streams that drain the area. Part of the water that flows toward the major streams passes through the alluvium, discharges along the channels, and sustains base flows.

In the subsurface to the west of the outcrop-recharge belt, where the Memphis aquifer is confined (artesian), the potentiometric surface gently slopes westward (fig. 3), and water moves slowly in that direction. The major cone of depression in the potentiometric surface in the Memphis area is the result of long-term (1886-present) pumping at municipal and industrial well fields.

Where confined and head differences are favorable, a component of recharge locally may enter the Memphis aquifer by downward leakage of water from the water-table aquifers (fluvial deposits and alluvium) or from the Cockfield aquifer. Conditions for downward leakage are particularly favorable where the Cook Mountain Formation, the upper confining unit for the Memphis aquifer, is thin or sandy or where leakage through the Cook Mountain Formation

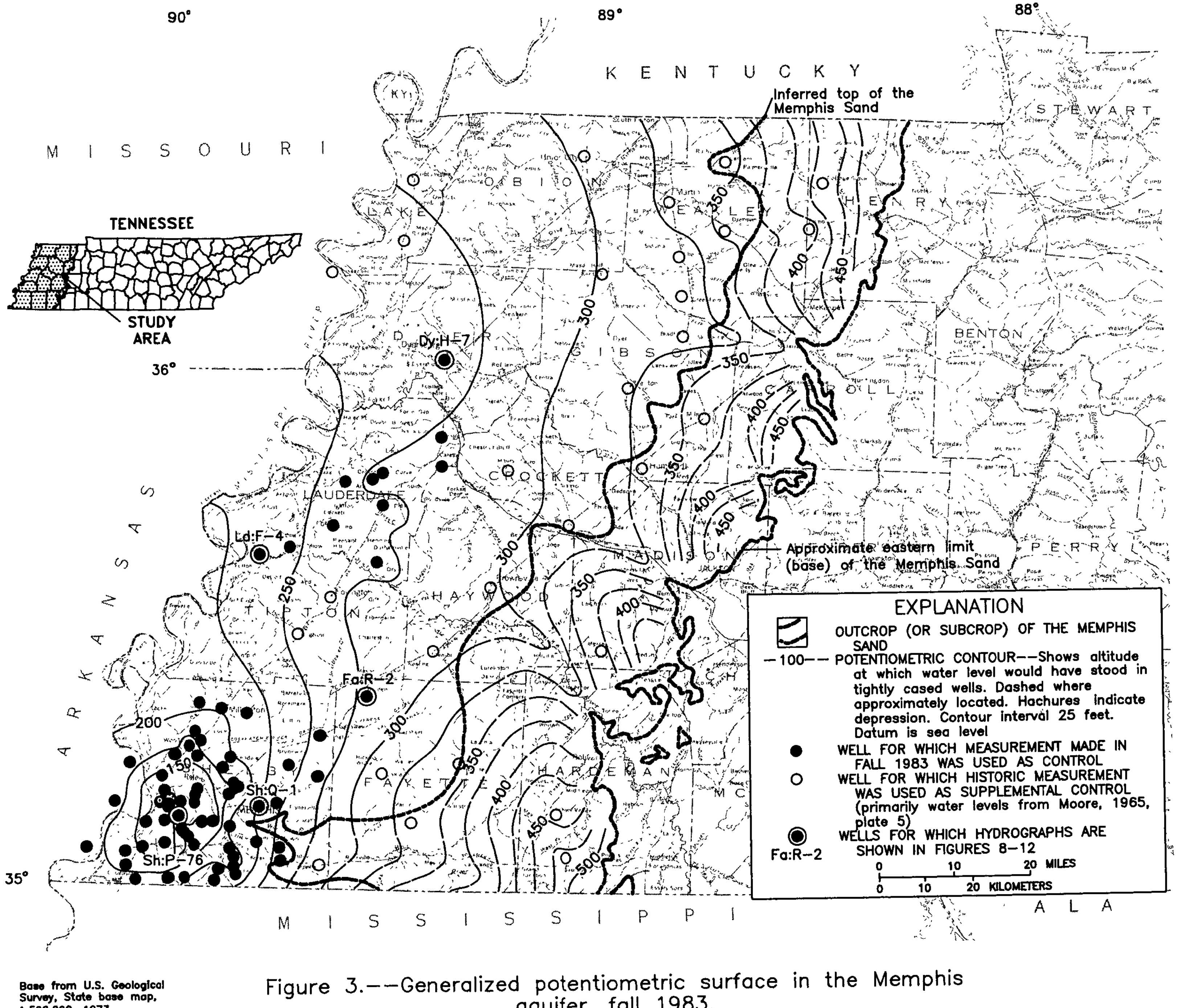


Figure 3.--Generalized potentiometric surface in the Memphis aquifer, fall 1983.

has been induced by intense pumping from the Memphis aquifer, as at Memphis (Graham and Parks, 1986). Conditions for downward leakage also are favorable where the Cook Mountain confining unit has been displaced by faults, leaving the Cockfield and Memphis aquifers in direct hydraulic connection (Parks and others, 1985).

The Flour Island Formation is the lower confining unit for the Memphis aquifer, separating it from the deeper Fort Pillow aquifer. The Flour Island Formation is a relatively thick and widespread confining unit in most of western Tennessee, except in and just downdip from the outcrop-recharge belt where the Flour Island Formation locally is absent and the Memphis Sand directly overlies the Fort Pillow Sand. At these places, the Memphis and the Fort Pillow aquifers have common recharge areas. In the downdip western tier of counties, the Flour Island Formation locally is displaced by faults, leaving the Memphis and Fort Pillow aquifers in direct hydraulic connection, as in Lake County (plate 2). At these places, conditions are favorable for vertical interchange of water between these two aquifers.

Historic Water-Level Changes

Historic water-level changes in the Memphis aquifer are evident from long-term records of water levels in observation wells. Hydrographs for five observation wells are shown in figures 4-8; their locations are shown in figure 3. Well Dy:H-7, in Dyer County, is near municipal and industrial well fields at Dyersburg, and the water level in this well is affected by nearby pumping. Part of the hydrograph (1954-57) for well Dy:H-7, which shows extreme fluctuations of the monthly low water level caused by pumping of nearby wells, was not used in determining the water-level trend at Dyersburg. The water level in well Dy:H-7 has declined about 6.5 feet in 25 years (1958-83), an average rate of about 0.3 ft/yr (fig. 4).

Well Ld:F-4, in Lauderdale County, is in a remote area where water levels are not significantly affected by pumping in the Memphis area or in nearby municipal or industrial well fields. The hydrograph shows a definite correlation with large changes in stage of the Mississippi River, 2.5 miles away. The water-level changes, most evident during long periods of sustained high stage on the Mississippi River and backwater flooding of parts of the Mississippi Alluvial Plain, are attributed to a loading effect (Parks and others, 1985). The monthly low water level in well Ld:F-4 has declined about 1.5 feet in 17 years (1966-83), an average rate of about 0.1 ft/yr (fig. 5).

Key observation wells in the Memphis area show the long-term effects of pumping on water levels in the Memphis aquifer. Well Fa:R-2, in northwestern Fayette County, is the farthest of these wells from the center of the major cone of depression in the potentiometric surface at Memphis (fig. 3). The water level in well Fa:R-2 has declined about 2 feet in 34 years (1949-83), an average rate of less than 0.1 ft/yr (fig. 6). Well Sh:Q-1, in eastern Shelby County, is at an intermediate distance from well Fa:R-2 and the center of the major cone of depression. The water level in well Sh:Q-1 has declined about 29 feet in 43 years (1940-83), an average rate of about 0.7 ft/yr (fig. 7). Well Sh:P-76, at Memphis, is near the center of the major cone of depression. The water level in well Sh:P-76 has declined about 74 feet in 55 years (1928-83), an average rate of about 1.3 ft/yr (fig. 8). The rate of decline in well Sh:P-76 is the best record of the long-term water-level decline caused by total pumping from the Memphis aquifer at Memphis.

Water Quality

Water from the Memphis aquifer generally is a calcium bicarbonate type; but locally in Crockett, Hardeman, Haywood, and Henry Counties, it is a sodium bicarbonate or mixed

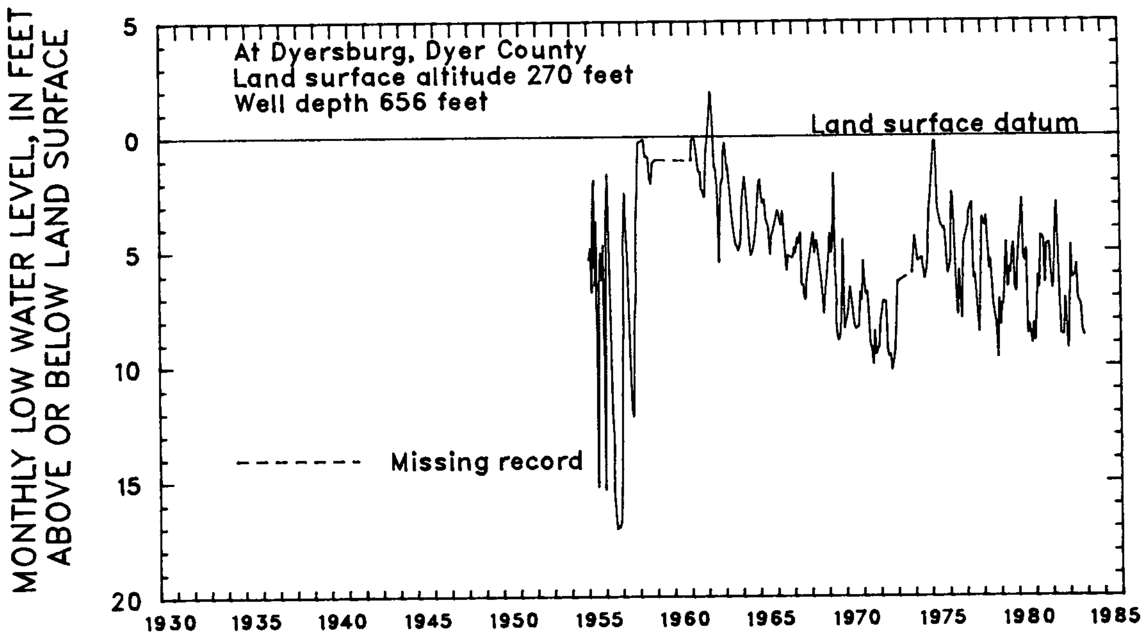


Figure 4.--Water levels in observation well Dy:H-7.

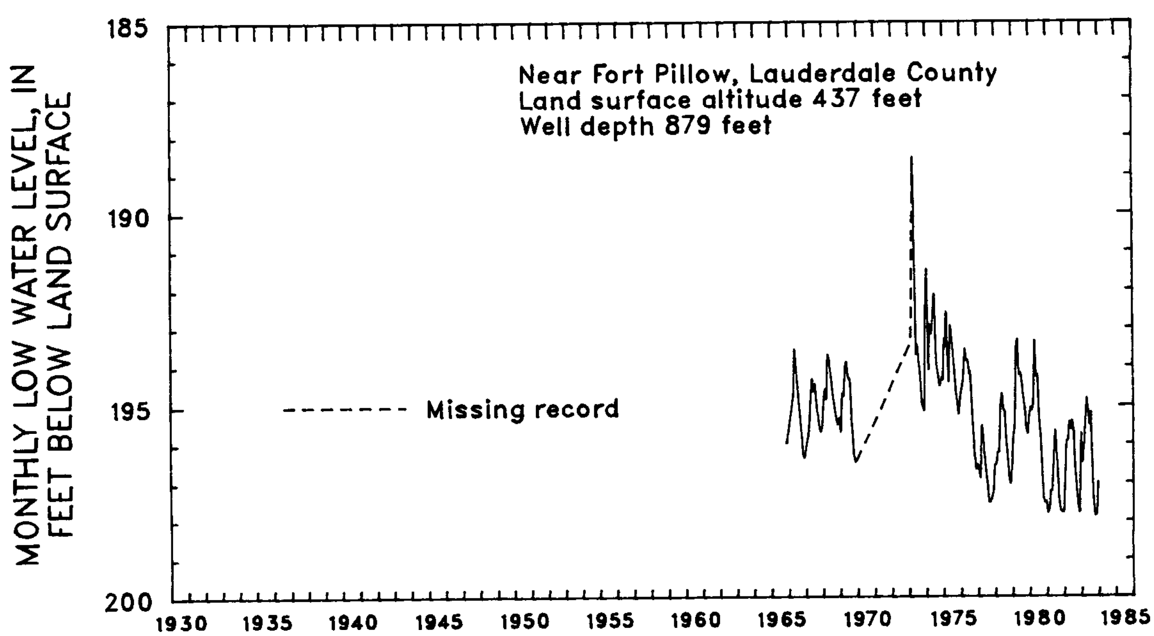


Figure 5.--Water levels in observation well Ld:F-4.

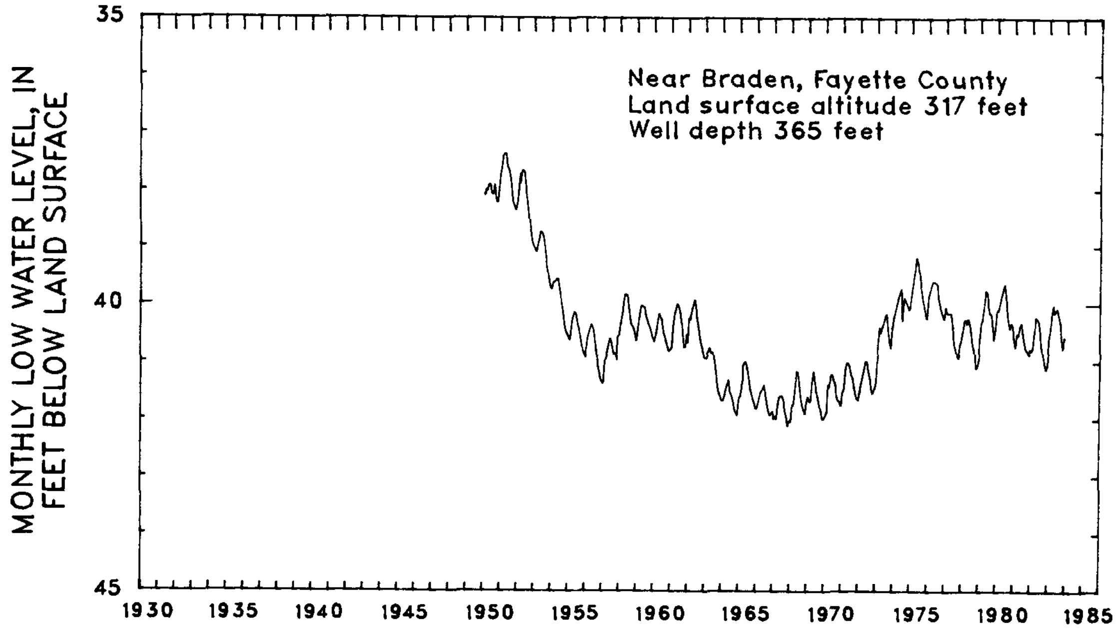


Figure 6.--Water levels in observation well Fa:R-2.

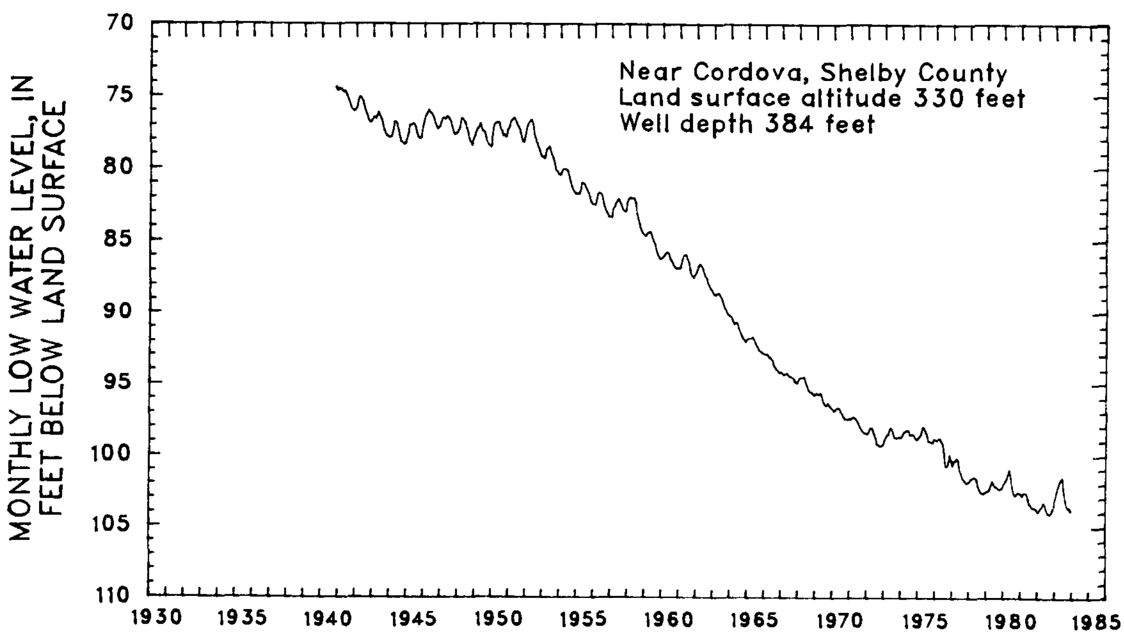


Figure 7.--Water levels in observation well Sh:Q-1.

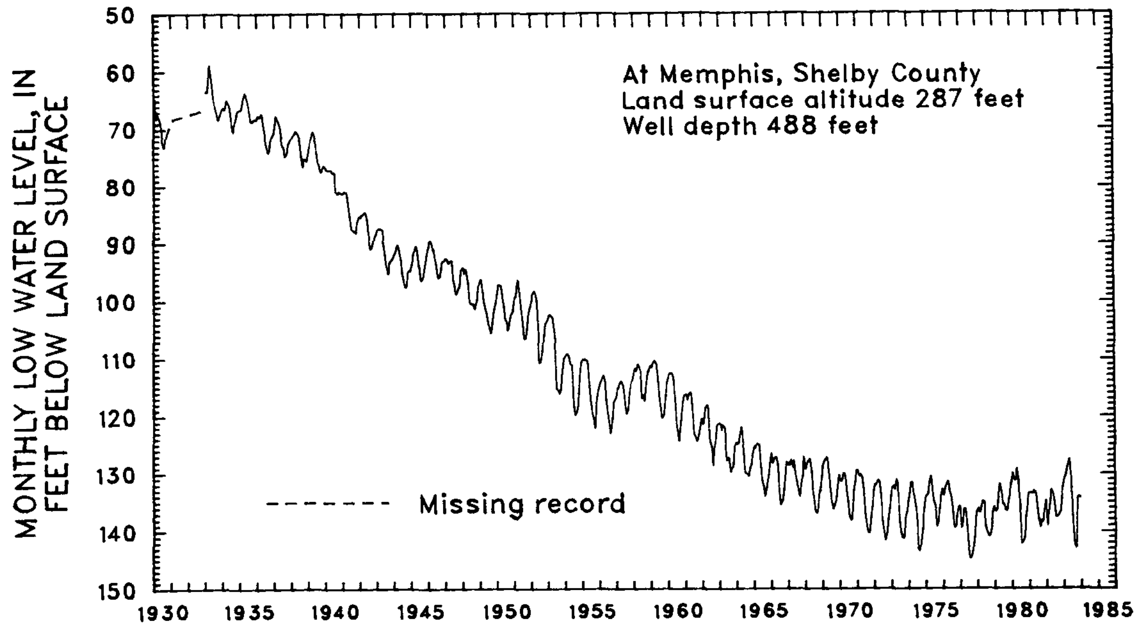


Figure 8.--Water levels in observation well Sh:P-76.

type (table 2). The water contains low concentrations of most major constituents and generally is suitable for most uses. Dissolved-solids concentrations range from 19 to 333 mg/L (milligrams per liter) with a median of 73 mg/L. Hardness ranges from soft (minimum--5 mg/L as $CaCO_3$) to very hard (maximum--306 mg/L), but commonly is soft (median--34 mg/L). Iron concentrations range from 0 to 22,630 μg/L (micrograms per liter) with a median of 300 μg/L. Temperature of the water ranges from 15.0 to 19.5 degrees Celsius (^{o}C) with a median of 17.0 ^{o}C.

Water quality in the Memphis aquifer varies areally in western Tennessee. In general, mineralization of the water increases westward from the outcrop-recharge area--Carroll, Fayette, Hardeman, Henry, and Madison Counties--to the downdip western tier of counties--Dyer, Lake, Lauderdale, Obion, Shelby, and Tipton Counties (table 2). Iron concentrations and hardness commonly increase from the outcrop-recharge area to the western tier of counties. Temperature of the water increases with increasing well depth from the outcrop-recharge area to the western tier of counties. Water-quality variations in the Memphis aquifer are discussed and distributions of iron, hardness, pH, and temperature are illustrated in the report by Moore (1965, p. F32, fig. 10).

Trace constituents in the water from the Memphis aquifer include arsenic, barium, cadmium, chromium, copper, lead, mercury, strontium, and zinc (table 3). Most of these constituents are present in very small concentrations, and all are below the maximum concentrations recommended by the U.S. Environmental Protection Agency (1986a,b) for drinking-water supplies.

Aquifer Characteristics

Many aquifer tests were made using wells in the Memphis aquifer in the Memphis area and other areas of western Tennessee during the period 1949-62. Although many of these tests

Table 2.--*Minimum, median, and maximum values for selected major constituents and properties of water from the Memphis aquifer*

[mg/L, milligrams per liter; μg/L, micrograms per liter; °C, degrees Celsius; μS/cm, microsiemens per centimeter; values given as 0 (zero) or < (less than) indicate that the concentration was below the level of detection for the analytical method used and do not indicate the presence or absence of a constituent; --, median values not determined for less than three wells]

	Specific conductance (μS/cm at 25°C)	pH (units)	Temperature (°C)	Color (platinum cobalt units)	Hardness (mg/L as CaCO3)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)
Carroll County									
Minimum	66	5.5	16.0	<1	11	2.6	1.1	2.9	0.4
Median	--	--	--	--	15	3.9	1.3	3.1	1.1
Maximum	73	5.7	16.5	2	18	4.4	1.6	6.5	1.4
Number of wells	2	2	2	2	3	3	3	3	3
Crockett County									
Minimum	77	5.8	16.0	1	14	3.6	1.3	2.0	0.4
Median	--	--	16.5	--	18	4.2	1.7	5.5	.6
Maximum	90	5.9	16.5	2	68	24	2.0	8.9	2.0
Number of wells	2	2	3	2	3	3	3	3	3
Dyer County									
Minimum	120	6.3	18.5	<1	52	10	6.3	4.4	1.4
Median	---	--	18.5	--	58	12	6.8	5.4	1.6
Maximum	165	6.3	19.0	5	185	43	19	6.5	4.1
Number of wells	2	2	4	2	4	4	4	4	4
Fayette County									
Minimum	21	5.6	15.0	<1	5	1.3	0.5	1.7	0.1
Median	33	6.1	16.5	5	8	1.9	.8	3.1	.4
Maximum	108	7.0	17.0	5	15	3.4	1.7	20	.9
Number of wells	7	8	8	7	9	9	9	9	8
Gibson County									
Minimum	42	5.6	15.5	<1	8	2.1	0.7	1.0	0.5
Median	80	5.9	16.5	3	18	3.7	1.4	5.9	.8
Maximum	160	6.8	17.0	6	52	13	4.7	17	1.3
Number of wells	7	7	9	7	9	9	9	9	9

Table 2.--*Minimum, median, and maximum values for selected major constituents and properties of water from the Memphis aquifer*--Continued

[mg/L, milligrams per liter; μg/L, micrograms per liter; °C, degrees Celsius; μS/cm, microsiemens per centimeter; values given as 0 (zero) or < (less than) indicate that the concentration was below the level of detection for the analytical method used and do not indicate the presence or absence of a constituent; --, median values not determined for less than three wells]

	Specific conductance (μS/cm at 25°C)	pH (units)	Temperature (°C)	Color (platinum cobalt units)	Hardness (mg/L as CaCO3)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)
Hardeman County									
Minimum	28	5.7	16.0	<1	7	1.6	0.5	2.0	0.6
Median	38	5.8	16.5	2	12	3.8	.7	2.7	.6
Maximum	138	6.3	16.5	5	25	6.1	2.3	13	1.0
Number of wells	4	4	4	4	5	5	5	5	4
Haywood County									
Minimum	34	5.8	16.0	1	10	2.8	1.0	4.5	0.3
Median	74	6.0	16.5	2	15	3.7	1.4	7.6	.4
Maximum	102	6.5	19.0	7	30	7.4	2.9	10	1.5
Number of wells	4	4	7	3	7	6	7	6	6
Henry County									
Minimum	54	5.7	15.5	3	9	1.8	1.0	3.7	0.5
Median	--	--	16.5	--	15	3.4	1.6	7.0	1.0
Maximum	54	5.7	16.5	3	19	4.4	2.0	8.0	1.3
Number of wells	1	1	3	1	3	3	3	3	3
Lake County									
Minimum	165	6.0	19.5	<1	40	9.2	3.0	1.0	7.2
Median	201	6.4	---	7	100	24	5.8	5.8	7.5
Maximum	280	7.2	19.5	12	122	44	12	8.0	9.0
Number of wells	3	3	2	3	4	4	4	4	3
Lauderdale County									
Minimum	128	6.2	16.5	2	50	10	6.1	4.5	0.6
Median	195	6.4	18.0	3	84	18	9.5	6.3	2.0
Maximum	380	6.7	19.5	5	167	47	19	11	6.6
Number of wells	13	10	12	4	15	15	15	14	14

Table 2.--*Minimum, median, and maximum values for selected major constituents and properties of water from the Memphis aquifer*--Continued

[mg/L, milligrams per liter; μg/L, micrograms per liter; °C, degrees Celsius; μS/cm, microsiemens per centimeter; values given as 0 (zero) or < (less than) indicate that the concentration was below the level of detection for the analytical method used and do not indicate the presence or absence of a constituent; --, median values not determined for less than three wells]

	Specific conductance (μS/cm at 25°C)	pH (units)	Temperature (°C)	Color (platinum cobalt units)	Hardness (mg/L as CaCO3)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)
Madison County									
Minimum	29	5.4	16.0	<1	6	1.4	0.6	1.0	0.6
Median	--	--	17.0	--	16	4.0	1.0	3.2	--
Maximum	33	5.9	18.0	<1	27	9.0	1.0	5.0	.6
Number of wells	2	2	4	1	6	6	6	5	1
Obion County									
Minimum	46	6.1	16.0	2	13	2.9	1.4	3.2	0.9
Median	117	6.4	17.0	2	58	13	6.1	5.0	1.3
Maximum	149	6.9	18.5	12	73	16	8.1	8.0	1.9
Number of wells	5	5	7	5	7	7	7	7	7
Shelby County									
Minimum	33	5.5	16.0	0	9	2.0	0.8	3.1	0.2
Median	123	6.4	17.5	4	42	10	4.1	8.0	.8
Maximum	412	7.9	19.5	18	306	65	35	22	3.8
Number of wells	95	97	81	81	100	100	101	97	92
Tipton County									
Minimum	58	6.0	16.5	<1	18	4.2	1.7	2.0	0.7
Median	121	6.2	18.0	2	52	12	4.0	6.3	1.4
Maximum	172	6.3	19.0	4	68	20	6.9	8.1	2.9
Number of wells	5	4	5	4	7	7	7	6	4
Weakley County									
Minimum	24	5.7	15.5	0	5	1.0	0.4	2.4	0.3
Median	40	6.2	16.0	2	14	3.0	1.2	2.8	.7
Maximum	52	6.8	16.5	5	18	4.5	2.6	4.8	2.3
Number of wells	10	10	11	9	14	14	14	14	14
All Counties									
Minimum	21	5.4	15.0	0	5	1.0	0.4	1.0	0.1
Median	117	6.3	17.0	3	34	8.5	3.2	6.8	.8
Maximum	412	7.9	19.5	18	306	65	35	22	9.0
Number of wells	162	161	162	135	196	195	197	189	175

Table 2.--*Minimum, median, and maximum values for selected major constituents and properties of water from the Memphis aquifer*--Continued

[mg/L, milligrams per liter; µg/L, micrograms per liter; °C, degrees Celsius; µS/cm, microsiemens per centimeter; values given as 0 (zero) or < (less than) indicate that the concentration was below the level of detection for the analytical method used and do not indicate the presence or absence of a constituent; --, median values not determined for less than three wells]

	Alkalinity (mg/L as $CaCO_3$)	Carbon dioxide, dissolved (mg/L as CO_2)	Sulfate, dissolved (mg/L as SO_4)	Cholride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, residue at 180 °C (mg/L)	Iron (µg/L as Fe)	Manganese (µg/L as Mn)
Carroll County									
Minimum	7.0	50	0.4	2.0	0.0	14	41	<3	0
Median	10	--	2.5	2.7	--	16	51	50	--
Maximum	13	50	5.0	5.3	< .1	16	60	110	<1
Number of wells	3	1	3	3	2	3	3	3	2
Crockett County									
Minimum	19	58	1.2	2.3	<0.1	6.0	44	6	1
Median	27	--	3.5	3.0	--	11	56	1,300	--
Maximum	39	66	27	8.0	< .1	17	104	2,600	58
Number of wells	3	2	3	3	2	3	3	3	2
Dyer County									
Minimum	57	68	4.0	1.5	0.1	3.3	68	2,300	63
Median	68	--	5.7	1.6	--	12	80	5,305	--
Maximum	197	68	8.6	1.6	.3	26	210	9,460	63
Number of wells	4	1	4	4	2	4	4	4	1
Fayette County									
Minimum	7	37	0.3	1.2	0.0	6.2	19	<3	<1
Median	12	46	.8	1.9	.1	14	33	230	<1
Maximum	50	49	3.0	3.5	.4	40	103	22,630	4
Number of wells	9	3	8	9	8	9	9	9	3
Gibson County									
Minimum	7	39	0.4	1.0	0.0	6.0	34	0	0
Median	26	63	2.8	3.0	< .1	15	58	20	1
Maximum	66	68	5.8	13	.1	28	94	1,100	2
Number of wells	9	3	9	9	7	9	9	9	4

Table 2.--*Minimum, median, and maximum values for selected major constituents and properties of water from the Memphis aquifer*--Continued

[mg/L, milligrams per liter; μg/L, micrograms per liter; °C, degrees Celsius; μS/cm, microsiemens per centimeter; values given as 0 (zero) or < (less than) indicate that the concentration was below the level of detection for the analytical method used and do not indicate the presence or absence of a constituent; --, median values not determined for less than three wells]

	Alkalinity (mg/L as $CaCO_3$)	Carbon dioxide, dissolved (mg/L as CO_2)	Sulfate, dissolved (mg/L as SO_4)	Cholride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, residue at 180 °C (mg/L)	Iron (μg/L as Fe)	Manganese (μg/L as Mn)
Hardeman County									
Minimum	8	31	0.3	2.0	0.0	3.0	24	0	0
Median	11	--	1.2	2.8	< .1	14	31	5	<1
Maximum	16	49	11	13	.1	16	88	100	<1
Number of wells	5	2	5	5	4	5	5	5	3
Haywood County									
Minimum	16	49	1.0	1.9	0.0	2.1	24	6	0
Median	20	--	1.8	2.9	< .1	13	52	60	<1
Maximum	46	55	4.8	8.0	< .1	18	71	10,000	<1
Number of wells	7	2	7	7	3	7	6	7	3
Henry County									
Minimum	8	--	2.1	4.8	0.1	13	44	0	--
Median	10	--	3.7	8.0	--	15	44	70	--
Maximum	12	--	4.9	12	.1	17	68	80	--
Number of wells	3	0	3	3	1	3	3	3	0
Lake County									
Minimum	74	117	3.0	1.5	0.0	9.0	84	280	120
Median	115	---	6.4	1.6	< .1	15	135	5,800	---
Maximum	152	143	9.4	2.4	.1	21	144	13,000	190
Number of wells	4	2	4	4	3	4	4	4	2
Lauderdale County									
Minimum	69	46	1.2	1.2	0.0	5	101	2,000	20
Median	98	87	3.3	2.0	.1	12	113	5,800	110
Maximum	203	123	7.4	4.8	.6	19	205	16,000	400
Number of wells	15	6	14	14	11	14	11	15	10
Madison County									
Minimum	8	62	0.2	2.0	<0.1	3.8	26	<3	1
Median	14	--	.4	4.0	--	4.0	30	450	--
Maximum	25	62	.9	15	< .1	14	44	1,100	1
Number of wells	6	1	6	6	1	5	5	6	1

Table 2.--*Minimum, median, and maximum values for selected major constituents and properties of water from the Memphis aquifer*--Continued

[mg/L, milligrams per liter; µg/L, micrograms per liter; °C, degrees Celsius; µS/cm, microsiemens per centimeter; values given as 0 (zero) or < (less than) indicate that the concentration was below the level of detection for the analytical method used and do not indicate the presence or absence of a constituent; --, median values not determined for less than three wells]

	Alkalinity (mg/L as CaCO3)	Carbon dioxide, dissolved (mg/L as CO2)	Sulfate, dissolved (mg/L as SO4)	Cholride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO2)	Solids, residue at 180 °C (mg/L)	Iron (µg/L as Fe)	Manganese (µg/L as Mn)
				Obion County					
Minimum	17	46	1.2	1.5	0.0	8.2	34	20	0
Median	59	--	3.1	2.2	< .1	13	70	70	12
Maximum	80	74	7.5	2.8	.1	14	99	4,600	64
Number of wells	7	2	7	7	5	7	7	7	4
				Shelby County					
Minimum	14	14	0.2	0.6	0.0	4.9	32	0	0
Median	56	66	3.2	3.6	.1	13	78	470	13
Maximum	317	126	25	10	.7	40	333	16,000	220
Number of wells	98	34	98	98	93	90	99	97	71
				Tipton County					
Minimum	22	--	0.3	3.0	<0.1	7.5	42	50	0
Median	49	--	3.4	3.3	.1	11	80	560	10
Maximum	69	--	5.8	6.5	.1	17	131	3,600	59
Number of wells	5	0	7	7	4	6	5	7	3
				Weakley County					
Minimum	7	58	0.4	0.7	0.0	10	24	0	0
Median	16	--	1.6	1.5	< .1	12	34	10	0
Maximum	21	61	5.2	3.6	.4	14	38	170	<1
Number of wells	14	2	14	14	10	14	14	14	5
				All Counties					
Minimum	7	14	0.2	0.6	0.0	2.1	19	0	0
Median	44	62	3.0	3.0	.1	13	73	300	10
Maximum	317	143	27	15	.7	40	333	22,630	400
Number of wells	192	61	192	193	156	183	187	193	114

Table 3.--*Minimum, median, and maximum values for selected trace constituents in water from the Memphis aquifer*

[Concentrations in micrograms per liter; values given as 0 (zero) or < (less than) indicate that the concentration was below the level of detection for the analytical method used and do not indicate the presence or absence of a constituent; --, median values not determined for less than three wells]

	Arsenic, dissolved (as As)	Barium, dissolved (as Ba)	Cadmium, dissolved (as Cd)	Chromium, dissolved (as Cr)	Copper, dissolved (as Cu)	Lead, dissolved (as Pb)	Mercury, dissolved (as Hg)	Strontium, dissolved (as Sr)	Zinc, dissolved (as Zn)
					Carroll County				
Minimum	<1	17	<1	<10	<10	1	<0.1	--	<3
Median	--	--	--	--	--	--	--	--	--
Maximum	<1	17	<1	<10	<10	1	< .1	--	<3
Number of wells	1	1	1	1	1	1	1	0	1
					Crockett County				
Minimum	<1	20	<1	<10	<10	<1	<0.1	16	4
Median	--	--	--	--	--	--	--	--	--
Maximum	<1	25	<1	<10	<10	<1	< .1	29	25
Number of wells	2	2	2	2	2	2	2	2	2
					Dyer County				
Minimum	<1	240	2	<10	<10	1	<0.1	200	12
Median	--	--	--	--	--	--	--	---	--
Maximum	<1	240	2	<10	<10	1	< .1	200	12
Number of wells	1	1	1	1	1	1	1	1	1
					Fayette County				
Minimum	<1	20	<1	<10	<10	1	<0.1	6	4
Median	<1	22	<1	<10	<10	2	< .1	7	5
Maximum	<1	25	<1	20	10	2	< .1	9	11
Number of wells	3	3	3	3	3	3	3	3	3
					Gibson County				
Minimum	<1	37	<1	<10	<10	3	<0.1	--	<3
Median	<1	45	<1	<10	<10	3	< .1	--	4
Maximum	<1	56	<1	<10	<10	4	.2	--	5
Number of wells	3	3	3	3	3	3	3	0	3

Table 3.--*Minimum, median, and maximum values for selected trace constituents in water from the Memphis aquifer*--Continued

[Concentrations in micrograms per liter; values given as 0 (zero) or < (less than) indicate that the concentration was below the level of detection for the analytical method used and do not indicate the presence or absence of a constituent; --, median values not determined for less than three wells]

	Arsenic, dissolved (as As)	Barium, dissolved (as Ba)	Cadmium, dissolved (as Cd)	Chromium, dissolved (as Cr)	Copper, dissolved (as Cu)	Lead, dissolved (as Pb)	Mercury, dissolved (as Hg)	Strontium, dissolved (as Sr)	Zinc, dissolved (as Zn)
Hardeman County									
Minimum	<1	27	<1	<10	<10	1	<0.1	14	3
Median	--	--	--	--	--	--	--	--	--
Maximum	<1	47	<1	<10	10	1	< .1	46	10
Number of wells	2	2	2	2	2	2	2	2	2
Haywood County									
Minimum	<1	21	<1	<10	<10	<1	<0.1	7	4
Median	--	--	--	--	--	--	--	--	--
Maximum	<1	24	<1	<10	<10	<1	< .1	12	7
Number of wells	2	2	2	2	2	2	2	2	2
Lake County									
Minimum	<1	400	<1	<10	<10	3	<0.1	--	8
Median	--	--	--	--	--	--	--	--	--
Maximum	<1	480	2	10	<10	10	< .1	--	13
Number of wells	2	2	2	2	2	2	2	0	2
Lauderdale County									
Minimum	1	--	1	0	0	1	<0.1	--	<10
Median	1	--	1	10	2	4	< .1	--	10
Maximum	2	--	8	10	7	6	.7	--	240
Number of wells	7	0	7	7	7	7	7	0	7
Madison County									
Minimum	1	38	<1	<10	<10	4	<0.1	--	<3
Median	--	--	--	--	--	--	--	--	--
Maximum	1	38	<1	<10	<10	4	< .1	--	<3
Number of wells	1	1	1	1	1	1	1	0	1
Obion County									
Minimum	<1	100	<1	<10	<10	3	<0.1	--	5
Median	--	--	--	--	--	--	--	--	--
Maximum	1	160	1	<10	<10	4	< .1	--	10
Number of wells	2	2	2	2	2	2	2	0	2

Table 3.--*Minimum, median, and maximum values for selected trace constituents in water from the Memphis aquifer*--Continued

[Concentrations in micrograms per liter; values given as 0 (zero) or < (less than) indicate that the concentration was below the level of detection for the analytical method used and do not indicate the presence or absence of a constituent; --, median values not determined for less than three wells]

	Arsenic, dissolved (as As)	Barium, dissolved (as Ba)	Cadmium, dissolved (as Cd)	Chromium, dissolved (as Cr)	Copper, dissolved (as Cu)	Lead, dissolved (as Pb)	Mercury, dissolved (as Hg)	Strontium, dissolved (as Sr)	Zinc, dissolved (as Zn)
Shelby County									
Minimum	0	0	0	0	1	0	<0.1	13	0
Median	2	46	<1	<2	<10	2	< .1	21	10
Maximum	4	644	4	20	54	13	.3	270	170
Number of wells	47	46	36	41	38	27	34	7	36
Tipton County									
Minimum	<1	49	<1	<10	<10	<1	<0.1	41	5
Median	--	--	--	--	--	--	--	--	--
Maximum	<1	200	<1	10	<10	1	< .1	160	10
Number of wells	2	2	2	2	2	2	2	2	2
Weakley County									
Minimum	<1	22	<1	<10	<10	1	<0.1	0	5
Median	--	--	--	--	--	--	--	0	--
Maximum	<1	64	<1	<10	<10	4	< .1	0	6
Number of wells	2	2	2	2	2	2	2	4	2
All Counties									
Minimum	0	0	0	0	0	0	<0.1	0	0
Median	1	44	<1	<10	<10	2	< .1	15	8
Maximum	4	644	8	20	54	13	.7	270	240
Number of wells	77	69	66	71	68	57	64	23	66

were conducted under less than ideal conditions, the results provide a guide to transmissivities and storage coefficients to be expected for this aquifer.

Transmissivities from 60 tests in the Memphis area, ranged from about 6,700 to 53,500 ft^2/d, but most were in the range of 20,000 to 42,800 ft^2/d. Storage coefficients from these tests ranged from 0.0001 to 0.003. Transmissivities from 16 tests made outside the Memphis area ranged from about 2,700 to 29,400 ft^2/d, and storage coefficients ranged from 0.0001 to 0.0006.

The following table summarizes the aquifer characteristics for the Memphis aquifer:

County	Number of tests	Transmissivity (ft^2/d)		Number of tests	Storage coefficient
Crockett	1	5,600		1	0.0005
Dyer	3	18,700	(average)	3	.0004 (average)
Fayette	1	2,700		--	-----
Gibson	3	11,900	(average)	--	-----
Haywood	1	27,100		1	.0001
Lake	1	17,800		1	.0003
Lauderdale	1	22,400		1	.0003
Obion	3	11,700	(average)	2	.0003 (average)
Shelby	60	33,400	(average)	52	.001 (average)
Tipton	1	29,400		--	-----
Weakley	1	7,200		1	.0006

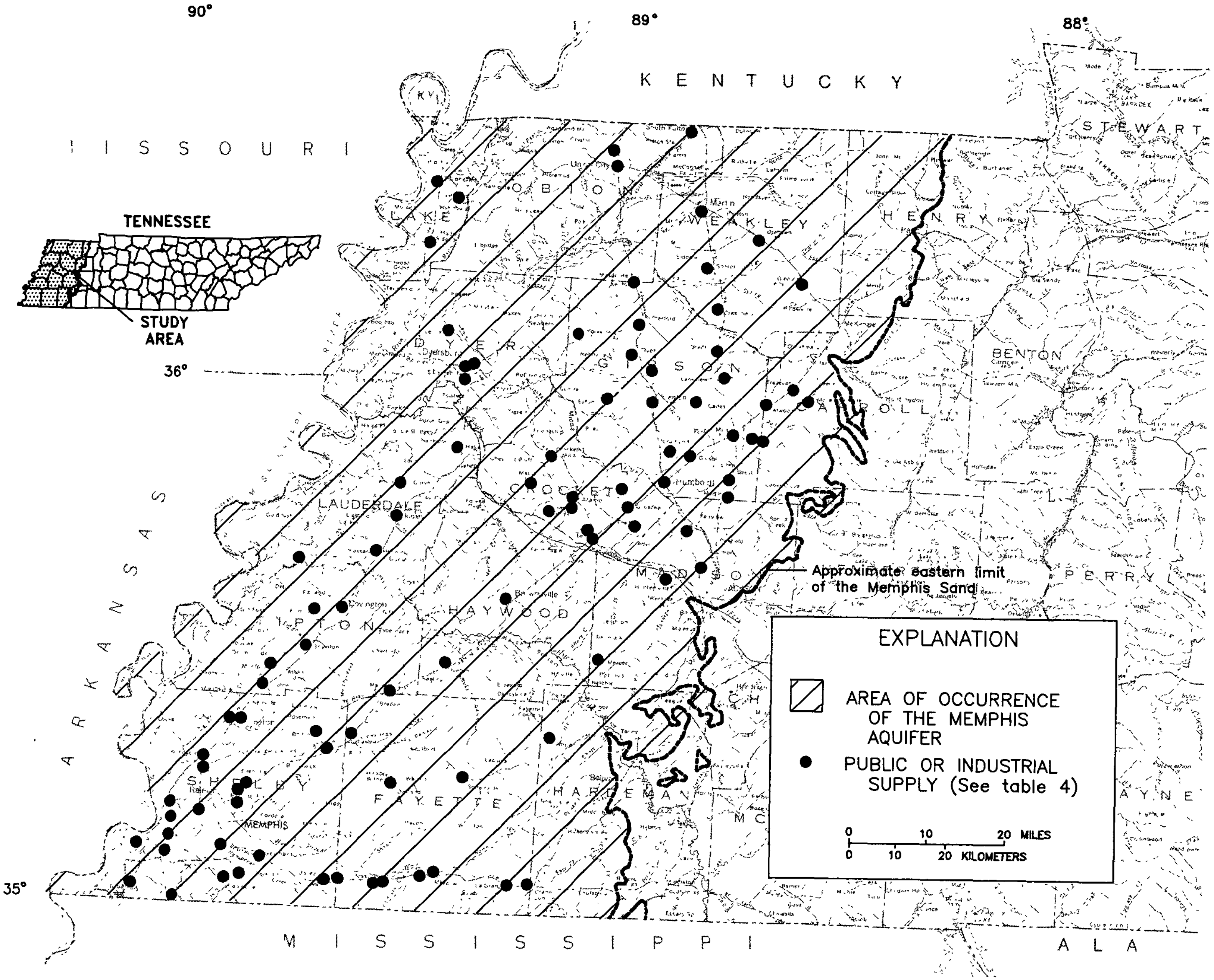
Water Use

The area of present use of the Memphis aquifer coincides with the area of potential use (fig. 9). Average daily withdrawals from this aquifer for public and industrial water supplies in 1983 are given in table 4. Withdrawals for these supplies averaged about 227 Mgal/d, of which 183 Mgal/d was in the Memphis area (Shelby County). Public and industrial supply wells range from 80 to 922 feet deep, and well yields range from 10 to 2,300 gal/min. The aquifer also provides water to numerous domestic and farm wells. The Memphis aquifer has much potential for future use, particularly at places outside the Memphis area.

SUMMARY AND CONCLUSIONS

The Memphis Sand underlies approximately 7,400 mi^2 in western Tennessee. It primarily consists of a thick body of sand that contains subordinate lenses or beds of clay or silt at various horizons. The sand ranges from very fine to very coarse, but commonly it is locally fine, fine to medium, or medium to coarse. The Memphis Sand ranges from 0 to about 900 feet in thickness but, where the original thickness is preserved, it is about 400 to 900 feet thick. The base of the Memphis Sand dips westward at rates of about 20 to 50 ft/mi, but it is faulted at many places. The Memphis Sand yields water to wells in most of the area of occurrence and, where saturated, makes up the Memphis aquifer.

Recharge to the Memphis aquifer is from precipitation on the outcrop, which is a broad belt across western Tennessee, or by downward infiltration of water from the overlying fluvial deposits and alluvium. In the outcrop-recharge belt, the Memphis aquifer is under water-table conditions (unconfined), and the configuration of the potentiometric surface is complex and generally conforms to the topography. In the subsurface to the west of the outcrop-recharge belt where the Memphis aquifer is confined (artesian), the potentiometric surface generally gently slopes westward, and water moves slowly in that direction. A major cone of depression in the potentiometric surface in the Memphis area is the result of long-term (1886-present) pumping at municipal and industrial well fields. Long-term data from five observation wells indicate that water levels have declined at average rates of less than 0.1 to 1.3 ft/yr during the period 1928-83. The largest declines have been in the Memphis area.



Base from U.S. Geological Survey, State base map, 1:500,000, 1973

Figure 9.--Present use of the Memphis aquifer in western Tennessee.

Table 4.--*Public and industrial water supplies from the Memphis aquifer in western Tennessee, 1983*

County	Water user U D - utility districtt W A - water association	Number of wells in use	Reported depth of wells (ft)	Reported pumping rates of wells (gal/min)	Reported average daily withdrawal in 1983 (thousand gallons)	Technical data available: Chemical analysis R-recent H-historic	Technical data available: Geophysical log[1] E-electric G-gamma ray	Technical data available: Aquifer test(s) Year of test
Carroll	Atwood	3	110-204	100-300	131			
	McLemoresville	2	124	540-575	30			
	Trezvant	2	170-175	225-350	109	H-R		
	Self-supplied industry	2	259-260	250-300	79			
Crockett	Alamo	3	129-213	300-400	281	H-R		
	Bells Public U D	2	154-160	380-390	171	H-R		1962
	County-Wide U D[2]							
	Egg Hill (#5)	1	547	200	94			
	Gum Flat (#1)	2	217-260	200-500	204			
	Highway 20 (#5B at Alamo)	2	310-322	250-500	114			
	Salem (#2)	2	226-244	200-300	187			
	Crockett Mills U D	2	113-117	60-90	53			
	Gadsden U D	2	227-343	100	30			
	Maury City	2	397-423	150	97		E-G(413)	
	Self-supplied industry	4	167-260	700-1,100	1,000		G(523)	
Dyer	Dyersburg	4	637-720	1,500-2,300	3,592	H-R	E-G(640)1955	
	Dyersburg Suburban Cons. U D	3	387-398	200	319		E(388)	
	Northwest Dyersburg U D	2	572-612	300	160			
	Self-supplied industry	2	773-922	680-860	800			
Fayette	Gallaway	3	258-372	150-600	150			
	LaGrange	3	230-250	50-200	10			
	Moscow	3	84-300	100-500	80			
	Oakland	3	198-199	200-600	122	R		
	Rossville	2	151-174	284-289	77	R		
	Somerville	4	80-190	268-550	752	H-R		1958
	Self-supplied industry	10	180-275	250-1,000	4,310	H	E(470)	
Gibson	Bradford	3	285-300	390-600	182	H		
	Dyer	3	230-261	460-500	292	H	G(291)	1958
	Gibson	2	160	300	167			
	Gibson Co. Municipal W D							
	Concord	2	252-292	150	98		E(301)	
	Eaton-Central	2	220	150-280	149			
	Fruitland	2	210	150	172			
	Goat City	2	284	150	49			
	Griers Chapel	2	220	150	159			
	Idlewilde	2	368-374	150	53			
	Yorkville	2	329-480	175	93			
	Humboldt	4	192-204	600-1,300	1,490	H-R		
	Medina	2	200	400	62	H		
	Milan	3	229-255	1,100-1,272	1,390	H-R	G(142)	1956
	Rutherford	2	268	400-475	163	H		
	Trenton	3	161-189	550-1,030	704	H-R	E(324)	
	Self-supplied industry	6	141-270	200-1,300	1,069			

Table 4.--*Public and industrial water supplies from the Memphis aquifer in western Tennessee, 1983*--Continued

County	Water user U D - utility districtt W A - water association	Number of wells in use	Reported depth of wells (ft)	Reported pumping rates of wells (gal/min)	Reported average daily withdrawal in 1983 (thousand gallons)	Technical data available: Chemical analysis R-recent H-historic	Geophysical log[1] E-electric G-gamma ray	Aquifer test(s) Year of test
Hardeman	Grand Junction	3	200-260	165-350	200	H-R		
	Whiteville	3	168-226	200-500	91	H-R	G(330)	
Haywood	Brownsville	5	135-334	440-1,100	1,210	H-R	E(357)	
	Stanton	1	242	680	102	H-R		1960
Lake	Reelfoot U D	2	570-574	130	130			
	Ridgely U D	2	730-770	320	150	H-R		
	Tiptonville	3	467-470	350-500	654	H-R		1961
Lauderdale	Halls	1	514	600	[3]15	R		
	Henning	1	570	335	93	R		
	Fort Pillow State Farm	3	656-665	530-850	309	H-R	G(652)	
	Lauderdale County W A	4	491-514	150-500	426	R		
	Ripley	5	700-755	400-1,119	1,298	H-R	E-G(755)	1961
Madison	Jackson U D (north field)[4]	7	274-370	1,090-1,218	[5]7,268	R	E-G(963)	
	Mercer U D	1	187	100	20			
	Self-supplied industry	4	148-195	750-800	750	H		
Obion	Kenton	2	565-600	400-550	175	H-R		1961
	South Fulton	3	525-530	500-1,000	339	H		
	Union City	3	572-616	1,250-2,150	2,210	H-R	E-G(675)	1960
	Self-supplied industry	6	662-718	500-1,000	3,900			
Shelby	Arlington	2	278	700	244	H	G(177)	1959
	Bartlett	5	410-511	500-1,500	1,212	R	E-G(492)	
	Bartlett-Ellendale	1	437	800	908	R	E-G(546)	
	Collierville	4	263-324	500-1,000	1,330	H-R	G(138)	1960
	Germantown	6	302-835	300-1,750	3,753	H-R	E-G(875)	1960
	Memphis Light, Gas and Water							
	Allen Well Field	26	330-559	900-1,425	21,100	H-R	E-G(1,515)	1950
	Davis Well Field	14	418-622	1,027-1,174	12,600	H-R	E-G(1,491)	
	Lichterman Well Field	20	307-615	1,291-1,832	22,100	H-R	E-G(1,231)	1960
	Lng Plant (Arlington)	2	311-338	500-550	500		E-G(436)	
	Mallory Well Field	26	471-797	604-1,480	17,100	H-R	E-G(2,634)	
	McCord Well Field	23	361-868	1,092-1,657	17,200	H-R	E-G(885)	1958
	Morton Well Field	10	404-708	1,300-1,600	10,800	H-R	E-G(904)	
	Palmer Station	4	385-401	1,140-1,200	200	H	G(721)	
	Sheahan Well Field	25	277-883	750-1,764	22,800	H-R	E-G(1,360)	1949
	Millington	4	373-411	363-1,045	1,048	H-R	E-G(1,492)	
	U. S. Naval Air Station	6	339-516	600-715	2,312	H	G(513)	
	Self-supplied industry	110	137-567	10-2,100	48,000	H-R	E-G(1,583)	1959

Table 4.--*Public and industrial water supplies from the Memphis aquifer in western Tennessee, 1983*--Continued

County	Water user U D - utility districtt W A - water association	Number of wells in use	Reported depth of wells (ft)	Reported pumping rates of wells (gal/min)	Reported average daily withdrawal in 1983 (thousand gallons)	Technical data available: Chemical analysis (R-recent, H-historic)	Geophysical log[1] (E-electric, G-gamma ray)	Aquifer test(s) (Year of test)
Tipton	Brighton	2	384-398	150-300	111			
	Covington	4	518-586	900-1,750	1,235	H-R	E-G(725)	1961
	First U D of Tipton County	4	582-592	200-800	350	R	E(608)	
	Mason	2	231-290	240-350	91	H		
	Munford	2	548-592	498-535	275			
	Poplar Grove U D	2	460-470	350	400			
Weakley	Dresden	3	398-410	350-1,050	428	H-R	E-G(575)	1960
	Gleason	2	220-225	525-550	221	H		
	Greenfield	2	300-396	750-1,150	292	H-R	E-G(388)	
	Martin	5	578-598	500-1,100	1,280	H-R		
	Sharon	3	260-435	200-400	231	H	E-G(471)	

[1]More than one geophysical log may be available for each well field; number in parentheses indicates the maximum depth, in feet, logged by either electric or gamma-ray methods.

[2]County-Wide Utility District has well fields in both Crockett and Dyer Counties with wells in both the Cockfield aquifer and the Memphis aquifer; name and number (in parenthesis) indicate well field as designated by the Utility District.

[3]Withdrawal shown is from the Memphis aquifer, part of supply is from the Cockfield aquifer.

[4]Jackson Utility District has north and south well fields. Wells in the south field pump from the Fort Pillow aquifer; the north field is in an area where the Memphis Sand directly overlies the Fort Pillow Sand, and the wells may be in either the lower part of the Memphis aquifer or upper part of the Fort Pillow aquifer. For this report, water pumped at the north field is considered to be from the Memphis aquifer.

[5]Withdrawal shown is from the Memphis aquifer; part of supply is from the Fort Pillow aquifer.

Water from the Memphis aquifer generally is a calcium bicarbonate type, but locally it is a sodium bicarbonate or mixed type. It contains low concentrations of most major constituents and generally is suitable for most uses. Dissolved-solids concentrations range from 19 to 333 mg/L, hardness ranges from soft (5 mg/L as $CaCO_3$) to very hard (306 mg/L), and iron concentrations range from 0 to 22,630 μg/L. Temperature of the water ranges from 15.0 to 19.5 °C. Water quality in the Memphis aquifer varies areally in western Tennessee. In general, mineralization of the water increases westward from the outcrop-recharge area to the downdip western tier of counties along the Mississippi River.

The results of 60 aquifer tests in the Memphis area indicated that transmissivities ranged from about 6,700 to 53,500 ft^2/d, but most ranged from about 20,000 to 42,800 ft^2/d. Storage coefficients from these tests ranged from 0.0001 to 0.003. The results of 16 tests outside the Memphis area indicated that transmissivities ranged from about 2,700 to 29,400 ft^2/d, and storage coefficients ranged from 0.0001 to 0.0006.

The Memphis aquifer provides moderate to large quantities of water for many public and industrial supplies in western Tennessee. Withdrawals for these supplies in 1983 averaged about 227 Mgal/d, of which 183 Mgal/d was in the Memphis area. Public and industrial supply wells range from 80 to 922 feet deep, and well yields range from 10 to 2,300 gal/min. This aquifer also provides small quantities of water to numerous domestic and farm wells. The Memphis aquifer has much potential for future use, particularly at places outside the Memphis area.

REFERENCES

Bell, E.A., and Nyman, D.J., 1968, Flow pattern and related chemical quality of ground water in the "500-foot" sand in the Memphis area, Tennessee: U.S. Geological Survey Water-Supply Paper 1853, 27 p.

Criner, J.H., and Armstrong, C.A., 1958, Ground-water supply of the Memphis area: U.S. Geological Survey Circular 408, 20 p.

Criner, J.H., Sun, P-C.P., and Nyman D.J., 1964, Hydrology of aquifer systems in the Memphis area, Tennessee: U.S. Geological Survey Water-Supply Paper 1779-O, 54 p.

Frederiksen, N.O., Bybell, L.M., Christopher, R.A., Crone, A.J., Edwards, L.E., Gibson, T.G., Hazel, J.E., Repetski, J.E., Russ, D.P., Smith, C.C., and Ward, L.W., 1982, Biostratigraphy and paleoecology of lower Paleozoic, Upper Cretaceous, and lower Tertiary rocks in U.S. Geological Survey New Madrid test wells, southeastern Missouri: Tulane Studies in Geology and Paleontology, v. 17, no. 2, p. 23-45.

Graham, D.D., and Parks, W.S., 1986, Potential for leakage among principal aquifers in the Memphis area, Tennessee: U.S. Geological Survey Water-Resources Investigations Report 85-4295, 46 p.

Grubb, H.F., 1984, Planning report for the Gulf Coast Regional Aquifer-System Analysis in the Gulf of Mexico Coastal Plain, United States: U.S. Geological Survey Water-Resources Investigations Report 84-4219, 30 p.

----- 1986, Gulf Coast Regional Aquifer-System Analysis—a Mississippi perspective: U.S. Geological Survey Water-Resources Investigations Report 86-4162, 22 p.

Hamilton, R.M., and Zoback, M.D., 1982, Tectonic features of the New Madrid seismic zone from seismic-reflection profiles, *in* Investigations of the New Madrid, Missouri, earthquake region: U.S. Geological Survey Professional Paper 1236-F, p. 54-82.

Hosman, R.L., Long, A.T., Lambert, T.W., and others, 1968, Tertiary aquifers in the Mississippi embayment, *with discussions of* Quality of the water by H.G. Jeffery: U.S. Geological Survey Professional Paper 448-D, 29 p.

Kazmann, R.G., 1944, The water supply of the Memphis area, A progress report: U.S. Geological Survey, 66 p.

Klaer, F.H., 1940, Water levels and artesian pressure in wells in the U.S. in 1940, Tennessee-Memphis: U.S. Geological Survey Water-Supply Paper 907, part 2, p. 92-101.

Moore, G.K., 1965, Geology and hydrology of the Claiborne Group in western Tennessee: U.S. Geological Survey Water-Supply Paper 1809-F, 44 p.

Moore, G.K., and Brown, D.L., 1969, Stratigraphy of the Fort Pillow test well, Lauderdale County, Tennessee: Tennessee Division of Geology Report of Investigations 26, 1 sheet.

Nyman, D.J., 1965, Predicted hydrologic effects of pumping from the Lichterman well field in the Memphis area, Tennessee: U.S. Geological Survey Water-Supply Paper 1819-B, 26 p.

Parks, W.S., and Carmichael, J.K., 1990, Geology and ground-water resources of the Fort Pillow Sand in western Tennessee: U.S. Geological Survey Water-Resources Investigations Report 89-4120, p. 20.

----- in press a, Geology and ground-water resources of the Cockfield Formation in western Tennessee: U.S. Geological Survey Water-Resources Investigations Report 88-4181.

----- in press b, Altitude of potentiometric surface, fall 1985, and historic water-level changes in the Memphis aquifer in western Tennessee: U.S. Geological Survey Water-Resources Investigations Report 88-4180.

----- in press c, Altitude of potentiometric surface, fall 1985, and historic water-level changes in the Fort Pillow aquifer in western Tennessee: U.S. Geological Survey Water-Resources Investigations Report 89-4048.

Parks, W.S., Carmichael, J.K., and Graham, D.D., 1985, Preliminary assessment of the ground-water resources of Lauderdale County, Tennessee: U.S. Geological Survey Water-Resources Investigations Report 84-4104, 35 p.

Parks, W.S., and Russell, E.E., 1975, Geologic map showing Upper Cretaceous, Paleocene, and lower and middle Eocene units and distribution of younger fluvial deposits in western Tennessee: U.S. Geological Survey Miscellaneous Investigations Map I-916, scale 1:250,000.

Stearns, R.G., and Zurawski, Ann, 1976, Post-Cretaceous faulting in the head of the Mississippi embayment: Southeastern Geology, v. 17, no. 4, p. 207-229.

U.S. Environmental Protection Agency, 1986a, Maximum contaminant levels (subpart B of part 141, National interim primary drinking-water regulations): U.S. Code of Federal Regulations, Title 40, Parts 100 to 149, revised July 1, 1986, p. 524-528.

----- 1986b, Secondary maximum contaminant levels (section 143.3 of part 143, National secondary drinking-water regulations): U.S. Code of Federal Regulations, Title 40, Parts 100 to 149, revised July 1, 1986, p. 587-590.

Zoback, M.D., 1979, Recurrent faulting in the vicinity of Reelfoot Lake, northwestern Tennessee: Geological Society of America Bulletin, v. 90, p. 1019-1024.

☆ U S GOVERNMENT PRINTING OFFICE 1990—750-122