Prepared in cooperation with the
Mississippi Board of Water Commissioners
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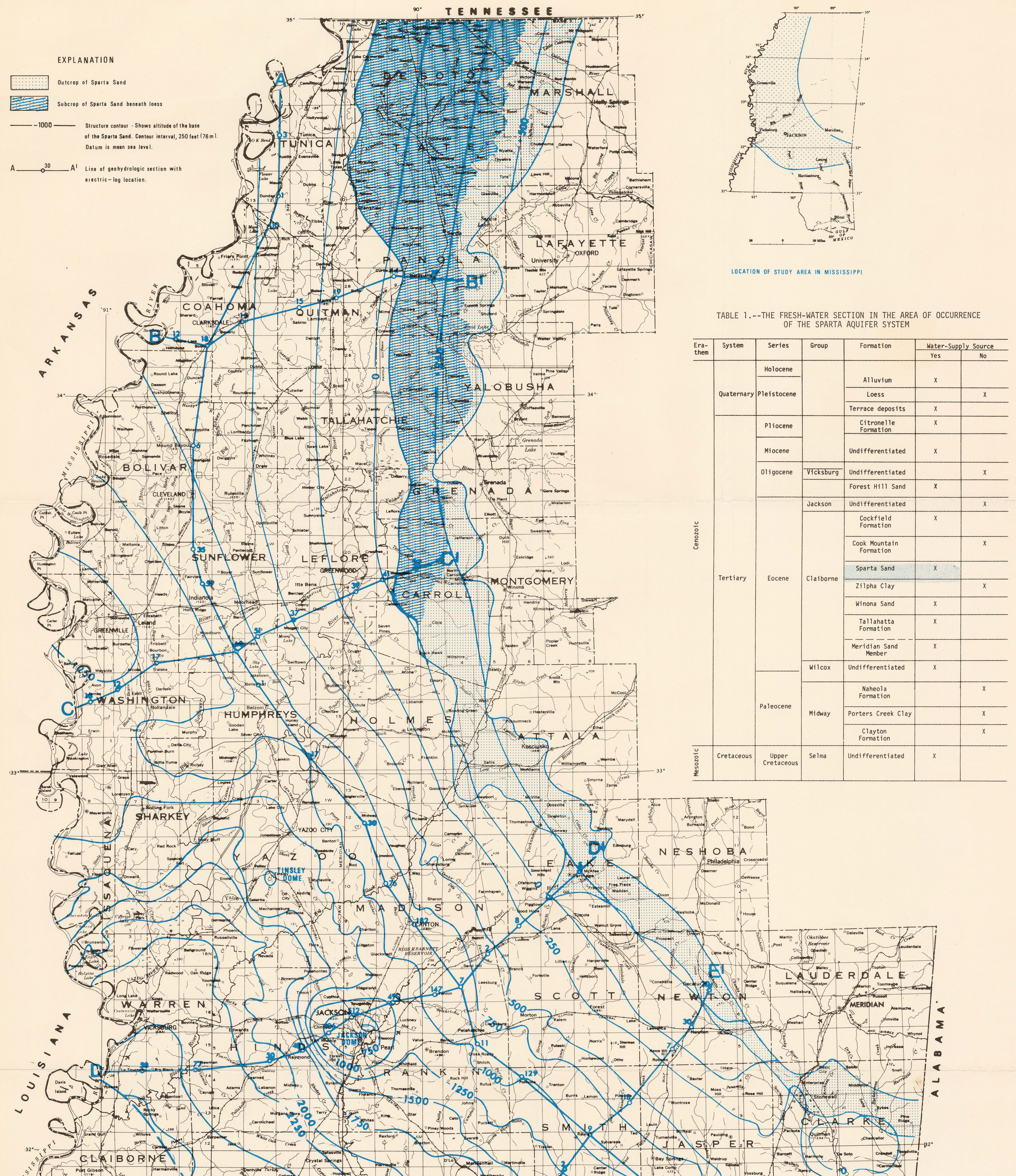

FIGURE 1.--CONFIGURATION OF THE BASE OF THE SPARTA AQUIFER SYSTEM AND LOCATIONS OF GEOHYDROLOGIC SECTIONS.

LOCATION OF STUDY AREA IN MISSISSIPPI

INTRODUCTION

A large amount of information is available on the aquifers of Mississippi. Reports resulting from various areal studies have described the ground-water resources of the areas concerned, but no reports dealing specifically with the entire Mississippi occurrence of individual aquifer systems have previously been prepared. A series of "aquifer atlases" was deemed the most effective way to describe the character, the potential, and the extent of development of the aquifers and thereby provide water managers with data needed for efficient utilization of available resources. This report on the Sparta aquifer system is the third in the series. Information on the aquifers was obtained in the cooperative programs of the U.S. Geological Survey with the Mississippi Board of Water Commissioners and other State and Federal agencies.

The Sparta Sand, a formation of the Claiborne Group of Eocene age (table 1), is a principal source of water supplies in Mississippi. This formation, which usually consists of two or more sand beds separated by clay, is available for water-supply development in more than 40 percent of Mississippi, a larger area than any other aquifer system (fig. 1). The term "aquifer system" is applied to the Sparta when discussing the hydrology because its upper and lower sand beds constitute separate aquifers in many places.

WATER-SUPPLY DEVELOPMENT

In 1975, about 50 Mgal/d (2.2 m^3/s) were pumped from wells in the Sparta, divided about equally between public supply and self-supplied industry. Some of the public-supply pumpage was used by industries located on those systems. The public supplies and other major ground-water uses are described or summarized in table 2, and the distribution of withdrawals, by county, is shown in figure 2.

STRATIGRAPHIC RELATIONS

The Sparta Sand, named for an exposure at Sparta in Bienville Parish, La., is not composed only of sand as the name implies; however, it does contain more sand than any other formation of comparable thickness in Mississippi. Its position in the middle part of the Claiborne Group (table 1) where it is overlain and underlain by almost exclusively clayey formations (Cook Mountain Formation and Zilpha Clay) make it easily identifiable in drill cuttings and on electric logs.

The Sparta Sand is composed principally of rounded quartz grains ranging in size distribution from very fine to coarse, but it is generally well sorted and thus has fairly high permeability. The formation was deposited under continental and marginal deltaic conditions and possesses the irregular bedding common to such depositional environments.

Contours on figure 1 indicate the present-day configuration of the Sparta. Uplifting, alternating with downwarping of the coastal plain as the weight of sediments accumulated, has resulted in a westward to southward dip of the Sparta and other formations in Mississippi. The westward component of dip is toward the trough of the Mississippi embayment whose axis parallels the Mississippi River valley; the southward component is toward the Gulf of Mexico. Several structures having more than local effect are superimposed on the regional structure. In the fresh-water-bearing area of the Sparta in Mississippi, the Jackson and Tinsley domes have a considerable influence on the depth and configuration of the formations. This is apparent on the contour map (fig. 1), and the Jackson dome is shown on geohydrologic section D-D' (fig. 6).

The Sparta thickens westwardly. The thinnest uneroded section, 100 ft (30 m), has been measured in Clarke County and the thickest, 1,000 ft (300 m), is in Warren County. An average thickness for the entire area in which the unit is fresh-water bearing is 600 ft (180 m). There is a great range in thickness among the sand beds of the Sparta, as well as substantial variation in the thickness of individual beds in different places. This is illustrated by the electric-log traces of the geohydrologic sections.

TABLE 1.--THE FRESH-WATER SECTION IN THE AREA OF OCCURRENCE OF THE SPARTA AQUIFER SYSTEM

Erathem	System	Series	Group	Formation	Water-Supply Source: Yes	No
Cenozoic	Quaternary	Holocene, Pleistocene		Alluvium	X	
				Loess		X
				Terrace deposits	X	
	Tertiary	Pliocene		Citronelle Formation	X	
		Miocene		Undifferentiated	X	
		Oligocene	Vicksburg	Undifferentiated		X
				Forest Hill Sand	X	
		Eocene	Jackson	Undifferentiated		X
			Claiborne	Cockfield Formation	X	
				Cook Mountain Formation		X
				Sparta Sand	X	
				Zilpha Clay		X
				Winona Sand	X	
				Tallahatta Formation	X	
				Meridian Sand Member	X	
			Wilcox	Undifferentiated	X	
		Paleocene	Midway	Naheola Formation		X
				Porters Creek Clay		X
				Clayton Formation		X
Mesozoic	Cretaceous	Upper Cretaceous	Selma	Undifferentiated	X	

WATER LEVELS AND RECHARGE

The Sparta is recharged by rainfall on the outcrop or where it is covered by other permeable deposits. Downdip from the outcrop the water is under confined conditions and rises in wells. The drawdown that is available in the deep wells is an important aspect of the aquifer system's value as a source.

Water levels are highest in the outcrop area of the Sparta, and they decline with distance down the dip. The highest water levels are about 450 ft (137 m) above sea level; the lowest are about 100 ft (30 m) and are in the Mississippi River valley, which serves as a drain for the Sparta. Although the latter area, commonly called "The Delta," is not as far down the dip as some of the counties to the south, drainage of the Sparta into the overlying alluvium has dissipated some of the hydrostatic head and caused a more pronounced decline in the potentiometric surface of the aquifer system than has occurred in the highland areas.

Long-term water-level records show the greatest decline at Jackson. Since 1900, water levels in Sparta wells have dropped as much as 210 ft (64 m), or about 3 ft (0.9 m) per year. In other areas of concentrated withdrawal from the Sparta, such as Yazoo and Bolivar Counties, water-level declines have averaged 1 to 2 ft (0.3-0.6 m) per year since 1900. Locations of observation wells are shown on the maps (figs. 8 and 9), and hydrographs (fig. 10) illustrate water-level trends.

WELL AND AQUIFER CHARACTERISTICS

Major wells in the Sparta aquifer system range in depth from 135 to 1,435 ft (41-437 m), the shallower ones being in the eastern part of the area where the Sparta is nearer the surface.

The greatest production from a Sparta well is 3,300 gal/min (208 l/s). This is at Clarksdale, where several high-capacity wells have been developed in the Sparta. About half the wells producing from the Sparta in Mississippi are pumped at rates between 100 and 300 gal/min (6.3-19 l/s). This is not a true indicator, however, of the production the aquifer will support, as wells are designed for a specified rate of discharge that often is far below what could be obtained. Specific capacities (gallons per minute per foot of drawdown) of Sparta wells, measured in pumping tests, range from 1 to 46 (gal/min)/ft, or 0.2 to 9.7 (l/s)/m; about half of those measured are in the 10-20 (gal/min)/ft, or 2.1-4.2 (l/s)/m, range.

The results of 40 pumping tests of Sparta wells are summarized below. These tests are concentrated in the southern half of the Sparta occurrence area, but a few are in the northern half. Sand beds are so thick in the counties near the Tennessee border that no wells approach a full screening of the aquifer; therefore, effective aquifer thickness is unknown and evaluation of hydraulic characteristics is inconclusive.

	Transmissivity		Hydraulic conductivity		Storage coefficient
	$(ft^3/d)/ft$	$(m^3/d)/m$	$(ft^3/d)/ft^2$	$(m^3/d)/m^2$	dimensionless
Maximum	13,000	1,200	130	40	0.0006
Median	6,000	560	60	18	.0003
Minimum	330	31	6	2	.0001

Note: To convert transmissivity and hydraulic conductivity, in cubic feet per day, to the older terms of transmissibility and permeability, in gallons per day, multiply by 7.48.

The values obtained from pumping tests are useful in predicting the capacity of wells and the interference between pumped wells in the same aquifer. The graph of figure 11 shows the specific capacity that could be expected from wells in the Sparta aquifer system. Specific capacity commonly is expressed for a 1-day period of pumping. The graph shows that the specific capacity declines only 11 percent from 1 to 10 days of pumping and another 10 percent in the next 90 days of continuous pumping.

Achieving the specific capacity that is indicated for the various values of transmissivity depends upon construction of efficient wells. In the most efficient wells there is little head loss in moving water from the aquifer into the well and through the pump. The design and development of a well determine its efficiency, and the specific capacity is directly proportionate to the well efficiency.

Another useful application of aquifer hydraulic characteristics is in predicting interference effects between two or more wells pumping from the same aquifer. Well production and spacing that will provide the required quantity at the least cost and with the fewest undesirable effects can thus be included in the design of water systems. The graph of figure 12 can be used in making the drawdown predictions for various times, distances, and pumping rates.

WATER QUALITY

Chemical analyses of water from Sparta wells indicate a good general quality but frequent high concentrations of iron in the eastern half of the area and high fluoride on the southwest margin (table 3). The water is a sodium bicarbonate type and generally has hardness less than 50 mg/l--less than 10 mg/l in the southwestern half of the area.

Figure 13 shows where fresh water (less than 1,000 mg/l of dissolved solids) does not occur below the Sparta Sand. Dissolved-solids concentrations increase with distance from the outcrop area (fig. 14), and consequently with depth.

Color is a common problem in the Sparta water in downdip areas (fig. 15) and is sufficiently high along the southern margin to make the water unusable for most purposes, even where the quality is good otherwise.

Most water from the Sparta is alkaline (pH greater than 7.0), but in the northern quarter of the area, and to some extent in the outcrop area, the water is acidic.

The temperature of water from Sparta wells ranges widely and is a function of aquifer depth. It is about 18°C (65°F) at a depth of 100 ft (30 m) and 38°C (100°F) at 2,000 ft (610 m).

WATER-SUPPLY POTENTIAL

The Sparta aquifer system will continue to be a major source of water supplies in Mississippi. Development can be expected to increase greatly in the northwestern counties where the spillover of industry from Memphis, Tenn., is multiplying the water needs. Elsewhere, industrial public-supply uses are expanding also, but at a slower rate. In places where Sparta water quality is inferior to other aquifers, some increase in Sparta use will occur as the supplies from the other aquifers become strained because of heavy withdrawals. Mixtures of water to get the needed quantities having acceptable chemical quality are feasible in many places.

There are numerous areas where supplies of 2 to 5 Mgal/d (0.1-0.2 m^3/s) can be developed from Sparta wells, and where 200 ft (61 m) or more of sand occurs in the formation it should be possible to construct well fields capable of withdrawing 5 to 10 Mgal/day (0.2-0.4 m^3/s), or even more. In planning water-supply development, care should always be exercised to manage withdrawals in such a way as to minimize pumping interference consistent with the economies of production and distribution of the water.

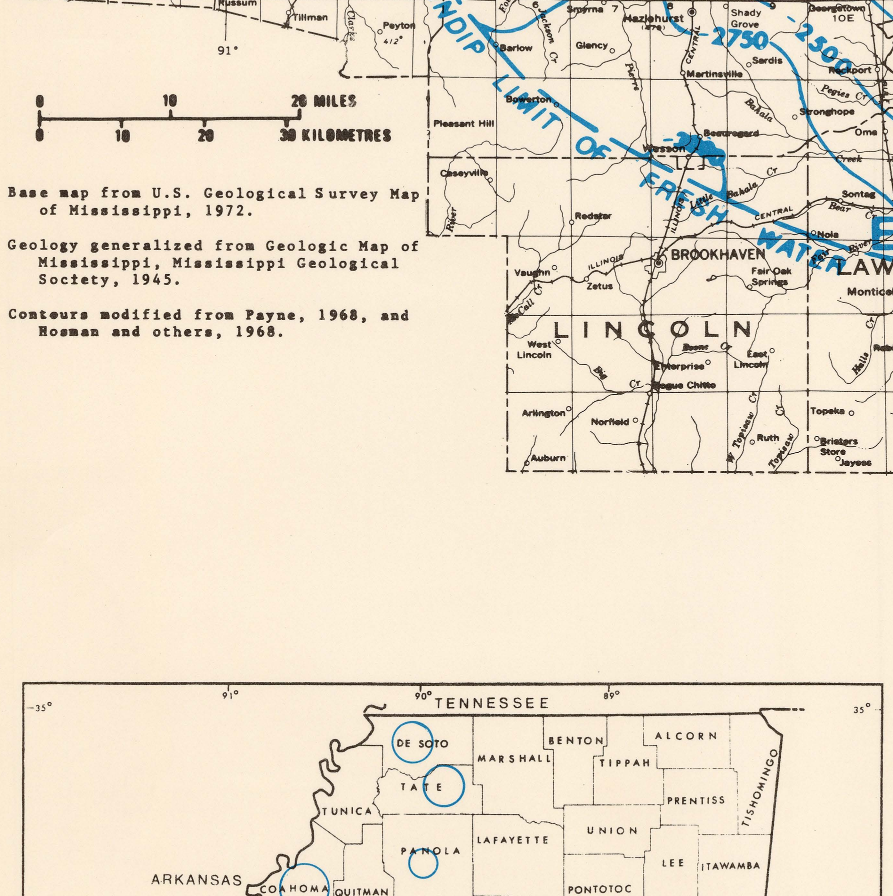

FIGURE 2.--PUBLIC AND INDUSTRIAL WATER USE FROM THE SPARTA, 1975.

TABLE 2.--WATER SUPPLIES FROM THE SPARTA AQUIFER SYSTEM

COUNTY	WATER USER (W A - WATER ASSOCIATION)	DEPTH OF WELLS (FT)	PUMPING RATES OF WELLS (GAL/MIN)	DAILY WITHDRAWAL (THOUS. GAL)	TECHNICAL DATA AVAILABLE: CHEMICAL ANALYSIS	ELECTRIC LOG	PUMPING TEST
BOLIVAR	BENOIT	650	500	31	X		
	CLEVELAND	785-845	700-1900	2,168	X	X	
	DELTA STATE UNIVERSITY	815	450	1,000			
	MERIGOLD	720-790	160-250	60	X	X	
	PACE W A	880	220	42	X		
	RENOVA W A	780	1000	15			
	SHELBY	800	50	[a]150			
	BEULAH	750	250	97	X	X	
	SELF-SUPPLIED INDUSTRY	280-800	150-750	[a]5,627	X	X	
CLARKE	BARNETT W A	330	40	2		X	
	EAST QUITMAN W A	170-320	105-230	28	X	X	X
	HARMONY W A	230-300	110-220	[a]75		X	X
	PACHUTA	370-460	150-200	48	X	X	X
	QUITMAN	205-290	300-600	[a]140	X		
	SELF-SUPPLIED INDUSTRY	600	180	[a]20			
COAHOMA	CLARKSDALE	280-760	900-3300	[a]4,045	X	X	X
	FARRELL W A	380	100	9	X		
	FRIARS POINT	815	400	95	X	X	
	SELF-SUPPLIED INDUSTRY	625-800	400-800	[a]1,200			
DE SOTO	BELMONT ROAD W A	270	175	80	X		
	BRIGHTS W A	270	250	54	X		
	CASTLE CREEK	250	350	25			
	DAYS W A	425	250	49			
	DELTA VILLAGE	370-400	500	265			
	DE SOTO UTILITIES	85-400	60-220	99			
	EUDORA W A	375	150	28	X		
	FAIRHAVEN W A	280	150	29			
	GOODMAN W A	390	150	14	X		
	HERNANDO	320-355	250-750	500	X	X	
	HORN LAKE W A	470	200-500	41		X	
	LEWISBURG W A	250-300	150-200	76	X		
	MAYWOOD SUBDIVISION	220-290	200-300	31			
	MINERAL WELLS W A	255	150	33			
	NESBIT	330	150	46	X		
	OLIVE BRANCH	265-410	270-1250	210	X	X	
	PLEASANT HILL W A	275-300	150	53	X		
	PLUM POINT W A	350-360	250-280	27		X	
	SOUTHAVEN	370-400	680-1300	920	X		
	TRINITY WATER CO.	335-450	200-1000	75		X	
	SELF-SUPPLIED INDUSTRY	250-390	275-1700	1,300	X	X	
HINDS	CLINTON	900-1170	500-540	[a]500	X	X	
	GRANT ROAD W A	800	150	21		X	
	HOMEWOOD MANOR	750	40	31		X	
	JACKSON	700-1125	610-740	[a]1,400		X	X
	ST. THOMAS W A	990	110	16		X	
	TRIANGLE W A	990	600	108		X	
	UNIVERSITY HOSPITAL	760-780	300	660	X		
	WILLOWOOD UTIL. CO.	1410	500	27		X	
	SELF-SUPPLIED INDUSTRY	665-1275	80-900	[a]7,000	X	X	X
HUMPHREYS	BELZONI	780-860	800-1100	1,080	X	X	X
	C&M W A	975	110	2	X	X	
	COBB W A	810	42	1			
	ISOLA	830	250	94	X		
	LOUISE	905	250	[a]45	X	X	
	SELF-SUPPLIED INDUSTRY	955	300	[a]20			
ISSAQUENA	MAYERSVILLE	825	100	11	X	X	
JASPER	BAY SPRINGS	1010-1035	750-1000	[a]550	X	X	X
	BEAVER DAM W A	875	165	[a]20		X	X
	LOUIN	840	350	24		X	
	MONTROSE W A	600	80	24		X	
	PAULDING W A	810	300	32		X	X
	STRINGER W A	1090	200	[a]55		X	
	TALLAHALA W A	435-1010	200-400	294		X	
JONES	SELF-SUPPLIED INDUSTRY	640	175-275	172	X		
LEAKE	FREENY W A	255	310	42	X		X
	LENA	390	100	16	X		
	THOMASTOWN W A	245	150	28	X	X	X
LEFLORE	GREENWOOD	220-250	600-1900	[a]200	X		
	SELF-SUPPLIED INDUSTRY	325	70	[a]2	X		
MADISON	BIG BLACK W A	920	100	74	X	X	
	CAMDEN W A	475	100	21	X		
	CANTON	935-980	450-1000	2,000	X	X	
	EAST MADISON W A	595-635	225-300	113		X	
	FLORA	1240-1365	510-550	59	X	X	
	KEARNEY PARK W A	1315-1400	430-750	440			
	LAKE CAVALIER W A	1215	30	[a]6			
	PEARL RIVER WATER DISTRICT	300-500	25	[a]1		X	
	RIDGELAND	1100	520	[a]100	X	X	
	TOUGALOO COLLEGE	835	300	78		X	
NEWTON	CONEHATTA INDIAN SCHOOL	350	60	[a]5	X		
	NEWTON	310	510	410			X
	SOUTH NEWTON W A	400-500	170-200	63		X	X
PANOLA	INDEPENDENCE W A	240	155	28	X	X	
	SELF-SUPPLIED INDUSTRY	150-240	80-530	[a]800	X	X	
RANKIN	ACL W A	1200-1270	125-250	48		X	
	BRANDON	1280	550-600	384	X	X	
	FANNIN W A	1200	125	32		X	
	FLOWOOD	715-915	100-500	[a]58	X	X	X
	LEESBURG W A	800-840	210-275	50		X	
	METROPOLITAN WATER CO.	870-1140	630-670	1,069		X	
	PEARL RIVER WATER DISTRICT	630	265	[a]30			
	PELAHATCHIE	1000	400-500	192	X	X	
	PUCKETT	1170	100	19	X	X	
	RAN-CO W A	1065	250	[a]15		X	
	RICHLAND W A	765-965	100-350	203	X	X	X
	SOUTHEAST RANKIN W A	1215	200	[a]45		X	
	UNION W A	1240	135	20	X	X	
	WASHINGTON W A	1300	90	10		X	
	SELF-SUPPLIED INDUSTRY	670-860	30-540	[a]500	X		
SCOTT	HOMESTEAD W A	1320	435	54		X	X
	MORTON	830-950	600-700	513	X	X	X
	SELF-SUPPLIED INDUSTRY	600-950	130-400	[a]650		X	
SHARKEY	ANGUILLA	1160-1200	100-300		X		
	CARY	1100	100	31	X		
	ROLLING FORK	1100	500	212	X		
	SELF-SUPPLIED INDUSTRY	1060-1235	100-170	144	X	X	
SMITH	CENTER RIDGE W A	1400	200	50		X	X
	LEMON-LORENA-BURNS W A	1080	250	30		X	X
	MORRIS W A	1520	220	34		X	
	PINEVILLE W A	945	200	18	X		
	RALEIGH	1200	80-200	121	X	X	X
	SYLVARENA W A	1085	220	32	X		
	TRI COUNTY W A	1375-1435	250	110	X	X	X
SUNFLOWER	INVERNESS	735	300	[a]30	X		
	PARCHMAN	555-685	150-200	[a]240	X		
	SUNFLOWER	675	175	[a]40	X		
TATE	ARKABUTLA W A	315	150	30	X	X	
	COLDWATER	160	250	1,450	X	X	
	SAVAGE-COTTONVILLE W A	1695	120	17	X	X	
	SENATOBIA	135	550	[a]60	X		
	SELF-SUPPLIED INDUSTRY	160-300	30-635	20			
WASHINGTON	GLEN-ALLAN W A	1005	215	34		X	X
	RIVERSIDE W A	1165	185	11	X		X
	TRALAKE W A	990	130	2			
YAZOO	HILTON HEIGHTS W A	1330	225	31		X	
	HOLLY BLUFF W A	1100	200	10	X	X	
	SATARTIA	1060	120	10	X		
	YAZOO CITY	900-1025	625-1500	1,455	X	X	
	SELF-SUPPLIED INDUSTRY	570-1065	200-1800	[a]7,638	X		

[a] Withdrawal from the Sparta Sand only; part of supply is obtained from other aquifers.

To convert English units to International System units

Multiply	By	To obtain
feet(ft)	0.3048	metres(m)
miles(mi)	1.609	kilometres(km)
square miles(mi^2)	2.590	square kilometres(km^2)
gallons per minute(gal/min)	.06309	litres per second(l/s)
million gallons per day (Mgal/d)	.044	cubic metres per second(m^3/s)
feet per mile(ft/mi)	.189	metres per kilometre(m/km)
gallons per minute per foot of drawdown[(gal/min)/ft]	.21	litres per second per metre [(l/s)/m]
cubic feet per day per square foot[$(ft^3/d)/ft^2$]	.305	cubic metres per day per square metre[$(m^3/d)/m^2$]
cubic feet per day per foot [$(ft^3/d)/ft$]	.093	cubic metres per day per metre [$(m^3/d)/m$]

THE SPARTA AQUIFER SYSTEM IN MISSISSIPPI

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1975

Jackson, Mississippi

Cartography by Frances M. Hester