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ARKANSAS GEOLOGICAL COMMISSION

WATER-RESOURCES INVESTIGATIONS REPORT 95-4000
Westerfield, P.W., 1995, Potentiometric-surface of the Sparta and Memphis aquifers in eastern Arkansas, April through July 1993

INTRODUCTION

Aquifers in the Sparta Sand and the Memphis Sand are a major source of water for much of eastern and south-central Arkansas. Major withdrawals occur from the aquifers for industrial and public supply, with lesser but locally significant withdrawals for agricultural uses. During 1990, about 222.50 Mgal/d (million gallons per day) of water was withdrawn from the Sparta and Memphis aquifers; together the two are the second most productive source of ground water in Arkansas (Holland, 1993).

The U.S. Geological Survey (USGS) in cooperation with the Arkansas Geological Commission has monitored water levels in the Sparta and Memphis aquifers since 1928. During April through July 1993, personnel of the USGS and the Arkansas Soil and Water Conservation Commission made 169 water-level measurements in wells completed in these aquifers (table 1). Data from these measurements were used to prepare a potentiometric-surface map (fig. 2).

The study area coincides with most of the Coastal Plain physiographic province in Arkansas. The area is bounded on the north by the Missouri State line, on the south by the Louisiana State line, and on the east by the Mississippi State line. The western boundary is defined as the western extent of the outcrop and subcrop of the Sparta Sand and the Memphis Sand (fig. 1).

DESCRIPTION OF AQUIFERS

The Sparta Sand and Memphis Sand of Eocene age are part of the Claiborne Group. In the central and southern parts of the study area, the Sparta Sand is underlain by the Cane River Formation, which serves as the lower confining unit, in the northern part of the study area, a lithologic facies change occurs (Hosman and others, 1968). In this area, the Claiborne Group is not subdivided into the Sparta Sand, Cane River Formation, and Carrizo Sand, but the equivalent section is a single formation called the Memphis Sand. The Memphis Sand is underlain by a thick layer of clay that is part of the Wilcox Group. Both the Sparta Sand and Memphis Sand are overlain by the Cook Mountain Formation, which serves as an upper confining unit. The Sparta Sand makes up the Sparta aquifer and the Memphis Sand makes up the Memphis aquifer. Water levels in the Sparta aquifer generally correlate with those in the Memphis aquifer, so the water-bearing formations are treated as one hydrologic unit.

Water in the Sparta and Memphis aquifers generally is confined except in the outcrop and subcrop areas (fig. 2). Recharge to the aquifers chiefly occurs from precipitation on the outcrop areas and from downward percolation of water from the overlying alluvium in the subcrop area. Minor amounts of recharge also occur from leakage of water through the upper and lower confining beds where the heads in the adjacent aquifers are greater than the head in the Sparta or Memphis aquifer. Discharge from the Sparta and Memphis aquifers occurs by withdrawal from wells and by discharge to beds above or below. A more detailed description of the Sparta and Memphis aquifers is given in Hosman and others (1968).

POTENTIOMETRIC-SURFACE MAP

The potentiometric-surface map shows the altitude to which water would rise in tightly cased wells screened in the aquifers (fig. 2). The map is based on 169 water-level measurements made during April through July 1993. Water-level data collected prior to 1993 at selected wells completed in the Sparta and Memphis aquifers also were used where control was lacking. The potentiometric-surface map reflects the general ground-water flow pattern in the Sparta and Memphis aquifers, with lateral movement generally being perpendicular to the contours in the direction of hydraulic gradient. The regional direction of ground-water flow is to the east and south away from the outcrop and subcrop region except where affected by intense ground-water withdrawals. Three cones of depression centered in Columbia, Jefferson, and Union Counties are a result of large withdrawals of water for industrial and public supplies. The cone of depression centered in Jefferson County is elongated to the northeast because of withdrawals for irrigation in Arkansas and Prairie Counties.

GROUND-WATER WITHDRAWALS

Withdrawals from the Sparta and Memphis aquifers nearly doubled between 1965 and 1990 (table 2). Withdrawals from 1965 to 1990 for the 10 counties that pumped the largest amount of water from the Sparta and Memphis aquifers in 1990 and total State use for the same years are summarized in table 2. In most of these counties, the water is used principally for industrial and public supply; however in Arkansas, Lonoke, and Prairie Counties most of the water is used for irrigation.

LONG-TERM HYDROGRAPHS

Hydrographs for wells completed in the Sparta and Memphis aquifers in Arkansas, Columbia, Jefferson, Lafayette, Phillips, Poinsett, and Union Counties illustrate water-level changes since 1969 (fig. 3). Water levels in these selected wells, on average, have declined more than 2 ft/yr in Arkansas and Union Counties; 1 to 2 ft/yr in Columbia, Jefferson, and Poinsett Counties; and about 0.6 ft/yr in Phillips County. The well in Lafayette County is located in an area of recharge, and the hydrograph does not show a large long-term change in water level, but the hydrograph does show small fluctuations that reflect local, short-term changes in storage.

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Table 1. Water-level measurements in wells completed in the Sparta and Memphis aquifers

[USGS, U.S. Geological Survey; ASWCC, Arkansas Soil and Water Conservation Commission

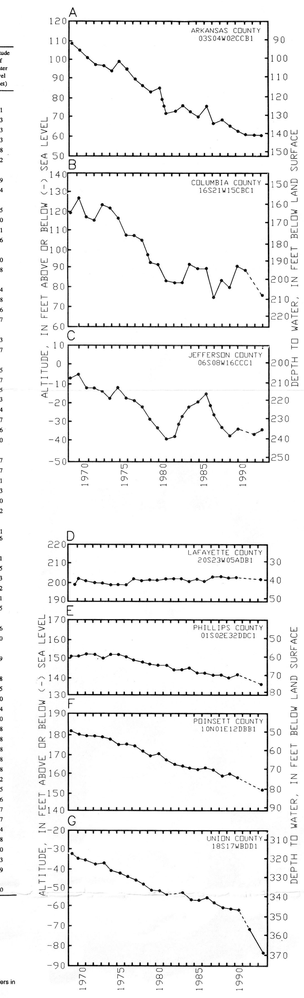
Well number	Collection agency	Measurement date	Depth to water below land surface (feet)	Altitude of water level (feet)
ARKANSAS COUNTY				
025S04W06CDB1	USGS	4-06-93	145.17	67
025S04W23DAA1	USGS	4-06-93	126.50	82
025S04W33BBB1	USGS	4-06-93	139.58	65
035S04W02CCB1	USGS	4-06-93	140.89	61
035S04W26CDA1	USGS	4-06-93	136.06	67
035S04W33BAA1	USGS	4-06-93	133.64	67
035S05W02AAB1	USGS	4-06-94	149.08	61
035S05W33BDC1	USGS	4-06-93	157.95	52
035S05W35CBB1	USGS	4-06-93	150.95	55
035S05W18CAB1	USGS	4-06-93	142.57	53
035S06W21ACC1	USGS	4-06-93	138.63	56
035S06W31BDD1	USGS	4-06-93	135.46	56
045S01W28BBA1	USGS	4-06-93	93.10	97
045S04W11BDD1	USGS	4-06-93	138.66	59
045S04W19CBB1	USGS	4-05-93	135.85	59
045S04W22DAA1	USGS	4-06-93	130.58	64
045S05W26DCC1	USGS	4-05-93	140.89	55
055S03W04DB1	USGS	4-06-93	119.38	68
055S04W26ACA1	USGS	4-05-93	120.68	67
055S05W34DAA1	USGS	4-05-93	118.26	62
075S02W28ABA1	USGS	4-05-93	92.15	89
075S03W06ABC1	USGS	4-05-93	112.90	72
085S02W01CBA1	USGS	4-05-93	77.85	87
085S03W22J99	USGS	4-05-93	101.60	73
085S03W23307	USGS	4-05-93	97.96	78
ASHLEY COUNTY				
155O7W32CDD1	USGS	6-08-93	151.59	38
165O8W33DDC1	ASWCC	7-06-93	87.13	78
195O5W23ADC1	ASWCC	7-06-93	65.41	40
BRADLEY COUNTY				
135O9W06ACA1	USGS	6-09-93	159.53	48
135I1W17BCD1	USGS	6-09-93	186.12	64
165I2W21CAA1	USGS	6-09-93	67.49	33
CALHOUN COUNTY				
115I4W12CAC2	USGS	6-09-93	140.08	170
135I3W32CDA1	USGS	6-09-93	173.28	35
135I5W36CBD1	ASWCC	7-07-93	54.47	100
145I3W12CCB1	USGS	6-09-93	165.87	39
145I3W29DAC1	ASWCC	6-24-93	14.87	123
145I4W33BBD1	ASWCC	7-07-93	97.69	7
145I5W16BAA1	ASWCC	7-07-93	76.43	70
CLEVELAND COUNTY				
085I2W13CAA1	ASWCC	6-23-93	164.59	86
095O6W04BBD1	ASWCC	6-23-93	216.33	65
095O9W27CBD1	ASWCC	6-23-93	165.64	124
095I1W01DDA2	USGS	6-10-93	203.00	63
105O9W22CDC1	USGS	6-15-93	151.97	68
105I2W12BDD1	USGS	6-10-93	110.28	110
COLUMBIA COUNTY				
165I2W18ACD1	USGS	5-17-93	267.09	70
165I2W14CBB1	USGS	5-17-93	218.02	63
165I2W15CBC1	USGS	4-17-93	207.53	77
165I2W35CCD1	USGS	5-19-93	307.40	-32
175I1W30ABB1	USGS	5-19-93	218.28	30
175I2W17CDA1	USGS	5-19-93	326.35	-1
175I2W01BBC1	USGS	5-20-93	327.32	-22
175I2W11DCC2	USGS	5-17-93	324.79	-22
185I2W18ABD1	USGS	5-20-93	306.71	-31
185I3W15BDC1	ASWCC	6-16-93	50.73	240
195I3W11CDA2	USGS	5-19-93	48.59	199
CRAIGHEAD COUNTY				
13N04E05DCC1	USGS	5-20-93	137.98	202
14N04E22CBD1	USGS	5-20-93	42.31	214
CRITTENDEN COUNTY				
05N08E31CCA2	USGS	6-30-93	21.25	190
06N07E01DAD2	USGS	6-30-93	18.10	191
CROSS COUNTY				
07N05E16CCC1	USGS	6-30-93	86.13	167
07N05E09ADD1	USGS	5-21-93	29.68	179
09N01E16CAC1	USGS	5-19-93	74.50	160
09N03E22AAD1	USGS	6-30-93	115.69	162
09N04E30DCA1	USGS	5-21-93	250.22	179
DALLAS COUNTY				
09S13W35CCD1	USGS	6-28-93	65.36	135
10S15W24AAB1	ASWCC	6-15-93	13.98	228
DESHA COUNTY				
09S02W26AAC1	USGS	6-22-93	61.75	91
09S04W08DDA1	USGS	6-23-93	93.82	69
09S06W28DDD1	USGS	6-17-93	101.15	64
10S02W26CCC2	USGS	6-16-93	63.50	85
11S01W31BBB1	USGS	6-17-93	89.26	52
11S02W03CCA1	USGS	6-17-93	60.13	79
12S01W32DCA1	USGS	6-17-93	58.37	78
12S03W34DAD1	USGS	6-16-93	73.77	73
DREW COUNTY				
11S04W25DAA1	USGS	6-17-93	75.26	73
12S06W30BCB1	ASWCC	6-24-93	208.64	48
12S06W32DAD1	USGS	6-16-93	160.48	52
13S05W36ACB1	USGS	6-15-93	88.42	81
GRANT COUNTY				
03S13W12AAA1	USGS	4-08-93	127.01	234
03S14W35DCA1	USGS	4-02-93	69.36	251
04S12W17DCC2	ASWCC	6-23-93	53.03	207
04S14W14ADC1	USGS	4-02-93	81.25	229
05S13W03CDA4	USGS	4-12-93	108.58	172
05S13W03DBC1	USGS	4-12-93	84.80	175
05S14W06DCC1	USGS	4-08-93	88.94	204
05S15W05ABD1	USGS	4-02-93	16.33	216
06S11W05ACA1	USGS	5-08-93	194.83	85
06S15W15DDB1	ASWCC	6-15-93	11.64	213
06S15W26ACA1	USGS	4-02-93	67.24	213
JEFFERSON COUNTY				
03S11W22ABC1	USGS	5-05-93	165.92	144
04S07W8CCC1	USGS	6-16-93	166.63	33
04S08W35BBD1	ASWCC	6-09-93	196.84	3
05S07W33AAB1	ASWCC	6-09-93	170.62	24
05S08W30ADB1	USGS	4-13-93	273.44	-52
05S08W30CBA1	USGS	7-02-93	268.09	-61
05S09W19BAD1	USGS	5-05-93	223.30	-4
05S09W35AAB1	USGS	7-02-93	261.80	-57
05S10W16DBD1	USGS	4-13-93	268.42	32
06S06W20CAA1	USGS	6-19-93	148.05	45
06S08W10CAC1	USGS	4-13-93	238.69	-36
06S08W16CCC1	USGS	4-13-93	236.80	-34
06S09W17CCA1	USGS	4-13-93	254.44	-20
06S10W21DBA1	USGS	7-02-93	212.25	18
LAFAYETTE COUNTY				
16S24W19DBC1	USGS	5-26-93	53.91	211
17S23W21BCB1	ASWCC	6-16-93	42.27	253
18S23W29ACC1	USGS	5-26-93	11.90	243
19S23W13CAB1	USGS	5-19-93	12.02	243
19S25W18DCB1	ASWCC	6-16-93	8.80	198
20S23W05ADB1	USGS	5-19-93	39.73	202
LEE COUNTY				
03N01E28CDB1	USGS	5-20-93	48.26	159
03N05E19ADA1	USGS	5-20-93	26.09	174
LINCOLN COUNTY				
08S05W35ACC1	USGS	7-01-93	90.32	75
08S06W35DBB1	USGS	7-01-93	199.76	40
09S07W07DAD1	USGS	7-01-93	258.65	41
10S05W05ADB1	USGS	7-01-93	105.32	66
LONOKE COUNTY				
01N07W03BCC1	USGS	4-09-93	113.38	110
02N09W35BBC1	USGS	4-19-93	76.25	158
MONROE COUNTY				
01N03W34BAB1	ASWCC	7-15-93	56.40	114
03N02W12CBC1	USGS	6-29-93	28.32	158
04N02W26DDD4	USGS	5-19-93	26.12	166
04N02W30BAC1	USGS	5-19-93	13.42	167
NEVADA COUNTY				
13S20W36DCC1	USGS	5-25-93	107.14	243
14S21W32DCD1	USGS	5-25-93	113.03	257
OUACHITA COUNTY				
12S16W12ADB1	USGS	6-28-93	24.12	135
12S18W19CDC1	USGS	6-28-93	38.40	197
13S16W28BDB1	ASWCC	6-15-93	24.59	85
13S18W31BDD1	USGS	6-28-93	69.47	173
14S19W29ABB1	USGS	5-24-93	85.91	194
15S19W33CBA1	ASWCC	7-07-93	141.80	-37
15S16W23DAC1	USGS	5-24-93	124.22	46
15S19W10DCC1	USGS	5-24-93	69.94	140
PHILLIPS COUNTY				
01S02E32DDC1	USGS	5-20-93	74.32	137
02S01E36CDD1	ASWCC	7-14-93	54.80	127
02S04E02DBA1	USGS	5-20-93	118.53	131
02S05E16BCB1	USGS	5-20-93	37.05	153
02S05E29CCC1	USGS	5-20-93	18.80	160
04S02E25CCC1	USGS	5-20-93	34.04	132
POINSETT COUNTY				
10N01E15DBB1	USGS	5-19-93	81.02	151
11N01E25ACC1	USGS	5-19-93	117.12	156
PRAIRIE COUNTY				
01N06W02ABB1	USGS	4-09-93	102.19	121
01S05W06BCB1	USGS	4-07-93	135.15	85
01S06W11DBD1	USGS	4-07-93	143.23	83
02N06W20BCB1	USGS	4-09-93	123.84	112
02N06W21DAD1	USGS	4-07-93	111.00	121
02N06W22BDD1	USGS	4-07-93	107.94	125
ST. FRANCIS COUNTY				
04N06E16CCB1	ASWCC	7-15-93	41.80	156
05N01E19DBD1	ASWCC	7-29-93	49.60	160
SALINE COUNTY				
03S14W05CCC1	USGS	4-02-93	6.35	309
UNION COUNTY				
16S14W15CAB1	USGS	4-29-93	142.21	-48
16S15W20DAA1	USGS	4-29-93	275.00	-55
16S16W02ABC1	USGS	4-29-93	165.66	-50
17S12W32BBC1	USGS	4-26-93	225.92	4
17S13W31BAC1	USGS	4-20-93	296.02	-80
17S15W31BBB1	USGS	4-29-93	381.37	-198
17S15W31DCA1	USGS	4-28-93	460.45	-188
17S16W24DBB1	USGS	4-29-93	403.09	-198
17S17W30DCD1	USGS	4-29-93	307.85	-28
18S12W33BBB1	USGS	4-26-93	119.75	-8
18S15W33ADA1	USGS	4-28-93	375.48	-122
18S15W35DAC1	USGS	4-28-93	295.61	-95
18S16W12ACB1	USGS	4-28-93	458.56	-156
18S16W28BBB1	USGS	4-28-93	331.88	-107
18S17W18BD1	USGS	4-27-93	306.93	-37
18S17W22BDD1	USGS	4-27-93	368.61	-84
19S10W19CBC1	USGS	4-26-93	73.60	8
19S11W25AAA1	USGS	4-26-93	134.80	0
19S16W35DDC1	USGS	4-27-93	227.88	-53
19S17W06DAC1	ASWCC	7-07-93	249.21	-29
WOODRUFF COUNTY				
05N01W17DBB1	ASWCC	7-29-93	40.15	170

Table 2. Withdrawals from the Sparta and Memphis aquifers in selected counties in Arkansas

[Million gallons per day]

County	1965[1]	1970[2]	1975[3]	1980[4]	1985[5]	1990[6]
Arkansas	17.39	20.26	24.25	36.97	36.50	67.99
Columbia	3.03	5.84	6.02	7.22	7.10	4.50
Desha	.83	.76	1.35	1.73	6.45	6.23
Jefferson	44.56	59.30	53.82	71.13	42.38	78.50
Lee	.09	.57	.98	2.84	1.72	3.32
Lonoke	.24	.03	.06	.09	3.43	3.08
Phillips	4.57	9.19	7.56	5.84	6.00	9.27
Prairie	6.75	7.72	15.80	20.92	20.70	22.58
Saline	.57	.20	.18	.28	3.43	3.43
Union	19.07	18.85	17.40	16.07	13.85	10.83
State total	111.73	141.53	144.48	185.46	157.00	222.50

[1] Halberg and Stephens (1966).
[2] Halberg (1972).
[3] Halberg (1977).
[4] Holland and Ludwig (1981).
[5] Holland (1987).
[6] Holland (1993).



POTENTIOMETRIC SURFACE OF THE SPARTA AND MEMPHIS AQUIFERS IN EASTERN ARKANSAS, APRIL THROUGH JULY 1993

Paul W. Westerfield

1995