DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
ARKANSAS GEOLOGICAL COMMISSION
and the
ARKANSAS SOIL AND WATER CONSERVATION COMMISSION

WATER-RESOURCES INVESTIGATIONS
REPORT 88-4042

INTRODUCTION

The Sparta-Memphis aquifer (location map) is a major source of water supply for much of eastern and southern Arkansas. Major withdrawals from the aquifer are for industrial and public supplies; generally smaller, but locally significant, amounts are also withdrawn for agricultural uses. Water-level data from wells completed in the Sparta-Memphis aquifer indicate steadily declining water levels in some areas where relatively large withdrawals occur. In addition, a simulation of future water levels in the Sparta-Memphis aquifer using projected withdrawals to the year 1990 indicated continued water-level declines in the aquifer (Reed, 1972). In parts of southern Arkansas, simulated water levels actually declined to below the top of the aquifer; continued declines could result in local water-table conditions and a reduction in the saturated thickness and aquifer transmissivity. Declining water levels also increase the potential for contamination from any near surface sources and from saline water in water-bearing units underlying the Sparta-Memphis aquifer.

Because of the potential quantity and quality problems, the continual monitoring of water levels in the Sparta-Memphis aquifer is essential for proper water management and the continuation of the use of the aquifer as a major source of water for much of eastern and southern Arkansas. The U.S. Geological Survey in cooperation with the Arkansas Geological Commission has been monitoring water levels in the aquifer in the Sparta and Memphis Sands annually throughout the aquifer's extent within the State of Arkansas.

This report, prepared in cooperation with the Arkansas Geological Commission and the Arkansas Soil and Water Conservation Commission presents an analysis of water-level data through hydrologic maps of the potentiometric surface and water-level changes in the Sparta-Memphis aquifer. The potentiometric surface map is based on water levels measured in spring 1986. The water-level change map is based on the difference between water levels collected in spring 1981 and spring 1986. This report includes most of the Sparta-Memphis aquifer within the State of Arkansas. Little or no data are available in the northeastern part of the State where there are limited withdrawals from the aquifer.

AQUIFER DESCRIPTION

The Sparta-Memphis aquifer is composed of Eocene Sparta and Memphis Sands. The Sparta Sand, located in the central and southern parts of the study area, is underlain by the Cane River Formation and overlain by the Cook Mountain Formation, both confining units of Eocene age. In the northern part of the study area, the Cane River Formation changes facies from clay to sand, forming a single sand unit from the bottom of the Eocene Cerrion Sand, which underlies the Cane River Formation, to the top of the Sparta Sand. This unit locally is as much as 900 feet thick and is referred to as the Memphis Sand. Hosman and others (1968) show the facies change occurring near latitude 35° N. Since water levels in wells in the Sparta Sand generally correlate with water levels in wells in the Memphis Sand, the water-bearing formations are treated as one hydrologic unit.

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

WATER USE

Water use from the Sparta-Memphis aquifer varies widely throughout its extent. Largest withdrawals occur from the Sparta Sand in Arkansas, Columbia, Jefferson, Prairie and Union Counties. Withdrawal data for these counties between 1965 and 1985 are summarized in table 1. Withdrawals in Columbia, Jefferson and Union Counties are predominantly for industrial and public supplies. Withdrawals in Arkansas and Prairie Counties are used for irrigation and are seasonal. Relatively minor amounts are withdrawn from the aquifer elsewhere in Arkansas.

POTENTIOMETRIC-SURFACE MAP

The potentiometric-surface map indicates the altitude to which water would rise in tightly cased wells completed in the Sparta-Memphis aquifer. The map is based on 215 water-level measurements made from March 17 to May 27, 1986 (Edds and Remsing, 1986), prior to the beginning of pumping for the irrigation season. The general direction of ground-water flow is perpendicular to the contours.

Ground water flows down-gradient to the east and south except where affected by withdrawals. Three cones of depression centered in Columbia, Union, and Jefferson Counties are a result of large withdrawals in these areas (table 1). The effect of the withdrawals for irrigation in Arkansas and Prairie Counties is a northeastward elongated cone of depression, centered in Jefferson County. The actual magnitude of decline in the aquifer in Arkansas and Prairie Counties at other times of the year may be greater than that indicated because more than 90 percent of this withdrawal occurs during the summer months for irrigation. The time lapse between the end of the irrigation season and the spring water-level measurements is sufficient to allow for recovery of the potentiometric surface in these two counties.

WATER-LEVEL CHANGE MAP

Changes in water levels for a 5-year period are illustrated by the water-level change map. These changes are based on the net difference in water levels from 185 wells measured during spring 1981 and spring 1986. As shown, water levels have both increased and decreased slightly over large parts of the study area. The largest rises in water levels occurred within parts of Columbia, Jefferson and Phillips Counties. The largest decline was in parts of Union County. These differences indicate changes in withdrawals from the aquifer.

Long-term trends in water levels are illustrated by the hydrographs of five wells completed in the Sparta-Memphis aquifer in Jefferson, Arkansas and Columbia Counties. Water-level changes over time generally are in response to changes in withdrawal rates (table 1). The hydrograph of the well in Arkansas County generally reflects changes in withdrawals for agriculture, whereas the hydrographs of wells in Jefferson, Columbia and Union Counties generally reflect changes in withdrawals for industry and public supply.

For additional information write to:

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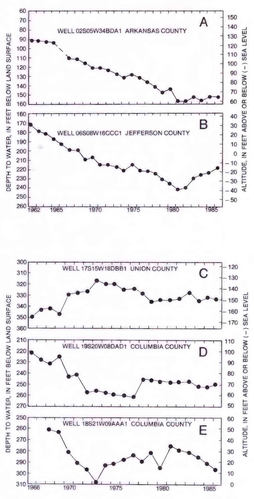


SELECTED REFERENCES

Edds, Joe and Remsing, L.M., 1986, Ground-water levels in Arkansas, spring 1986: U.S. Geological Survey Open-File Report 86-406W, 62 p.

Edds, Joe and Fitzpatrick, D.J., 1984, Maps showing altitude of the potentiometric surface and changes in water levels of the Sparta Sand and Memphis Sand aquifers in eastern Arkansas, spring 1983: U.S. Geological Survey Water-Resources Investigations Report 84-4265, scale 1:500,000, 1 sheet.

——1985, Maps showing altitude of the potentiometric surface and changes in water levels of the Sparta Sand and Memphis Sand aquifers in eastern Arkansas, spring 1984: U.S. Geological Survey Water-Resources Investigations Report 85-4223, 1 sheet.

——1986, Maps showing altitude of the potentiometric surface and changes in water levels in the aquifer in the Sparta and Memphis Sands in eastern Arkansas, spring 1985: U.S. Geological Survey Water-Resources Investigations Report 86-4094, 1 sheet.

Halberg, H.N., 1972, Use of water in Arkansas, 1970: Arkansas Geological Commission Water Resources Summary Number 7, 17 p.

——1977, Use of water in Arkansas, 1975: Arkansas Geological Commission Water Resources Summary Number 9, 28 p.

Halberg, H.N., and Stephens, J.W., 1966, Use of water in Arkansas, 1965: Arkansas Geological Commission Water Resources Summary Number 5, 12 p.

Holland, T.W., 1987, Use of water in Arkansas, 1985: Arkansas Geological Commission Water Resources Summary Number 16, 27 p.

Holland, T.W., and Ludwig, A.H., 1981, Use of water in Arkansas, 1980: Arkansas Geological Commission Water Resources Summary Number 14, 30 p.

Hosman, R.L., 1982, Outcropping Tertiary units in southern Arkansas: U.S. Geological Survey Miscellaneous Investigations Series, Map I-1405, 1 sheet.

Hosman, R.L., Long, A.T., Lambert, T.W., and others, 1968, Tertiary aquifers in the Mississippi embayment: U.S. Geological Survey Professional Paper 448-D, 29 p.

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

Reed, J.E., 1972, Analog simulation of water-level declines in the Sparta Sand, Mississippi embayment: U.S. Geological Survey Hydrologic Investigations Atlas HA-434, 1 sheet.

CONVERSION FACTORS

For use of readers who prefer to use metric (International System) units, rather than the inch-pound units used in this report, the following conversion factors may be used:

Multiply inch-pound unit	By	To obtain metric unit
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)

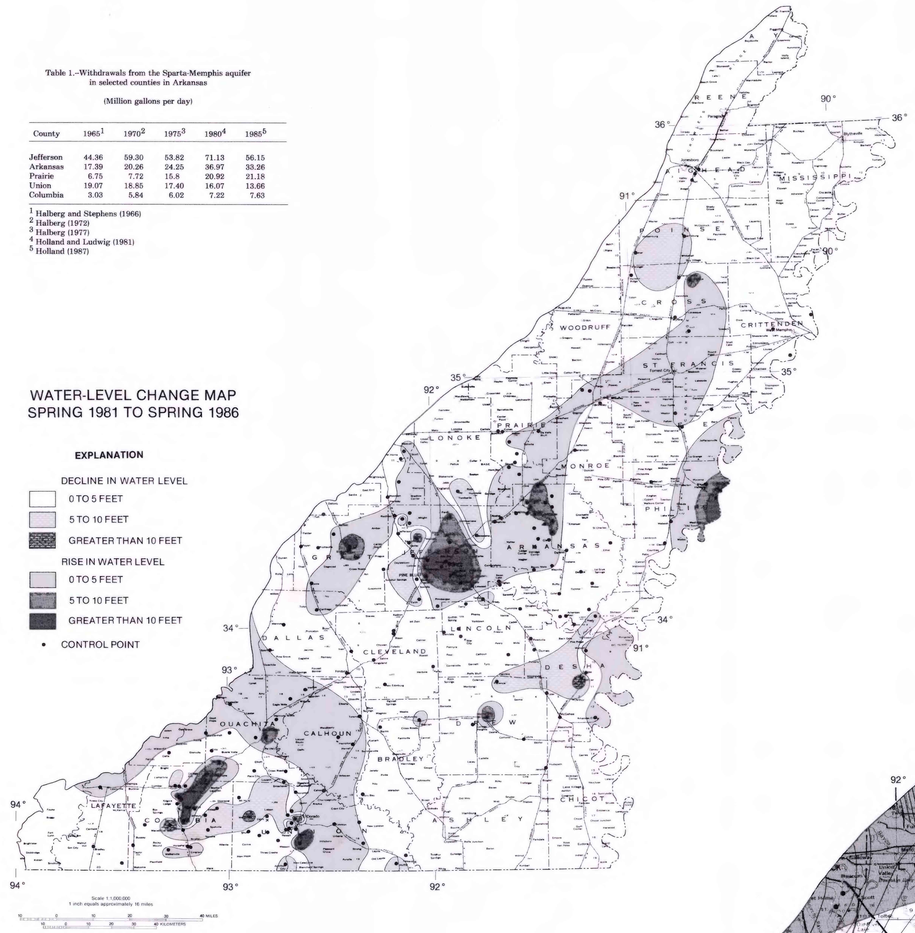
Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)–a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Sea Level Datum of 1929."

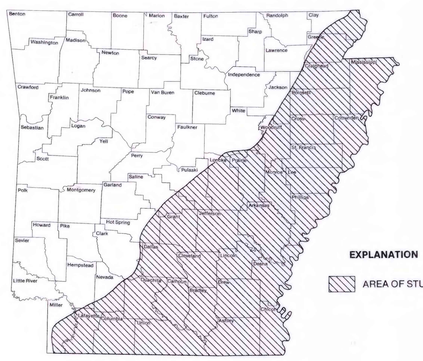
Table 1.–Withdrawals from the Sparta-Memphis aquifer in selected counties in Arkansas

(Million gallons per day)

County	1965[1]	1970[2]	1975[3]	1980[4]	1985[5]
Jefferson	44.36	59.30	53.82	71.13	56.15
Arkansas	17.39	20.26	24.25	36.97	33.26
Prairie	6.75	7.72	15.8	20.92	21.18
Union	19.07	18.85	17.40	16.07	13.66
Columbia	3.03	5.84	6.02	7.22	7.63

1 Halberg and Stephens (1966)
2 Halberg (1972)
3 Halberg (1977)
4 Holland and Ludwig (1981)
5 Holland (1987)





LOCATION MAP

ALTITUDE OF THE POTENTIOMETRIC SURFACE AND CHANGES IN WATER LEVELS IN THE SPARTA-MEMPHIS AQUIFER IN EASTERN AND SOUTHERN ARKANSAS, SPRING 1986

By Joe Edds and Daniel J. Fitzpatrick

1989