Prepared in cooperation with the
CITY OF MEMPHIS,
MEMPHIS LIGHT, GAS AND WATER DIVISION

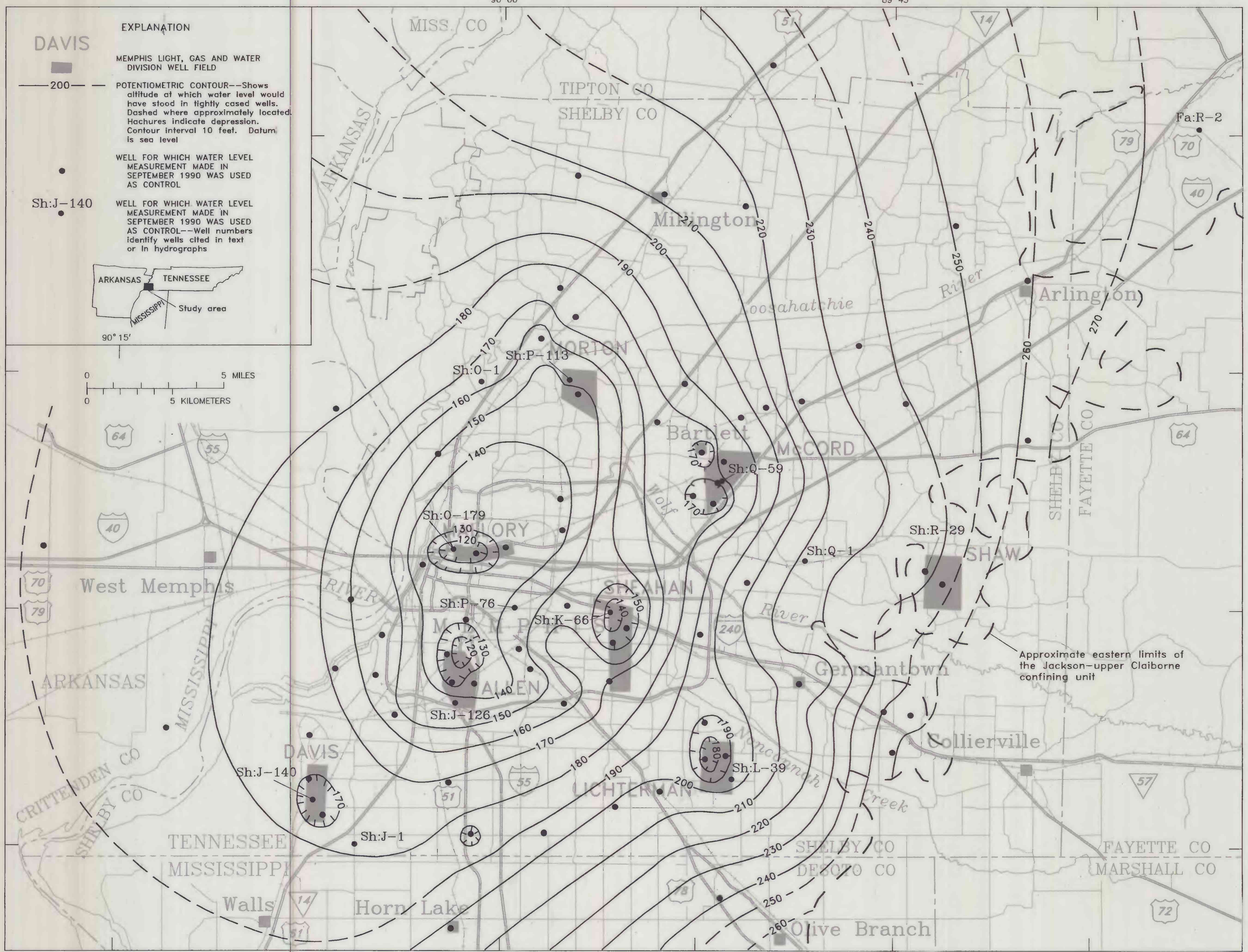

Figure 1.--Map showing altitude of the potentiometric surface of the Memphis aquifer in the Memphis area, Tennessee, September 1990.

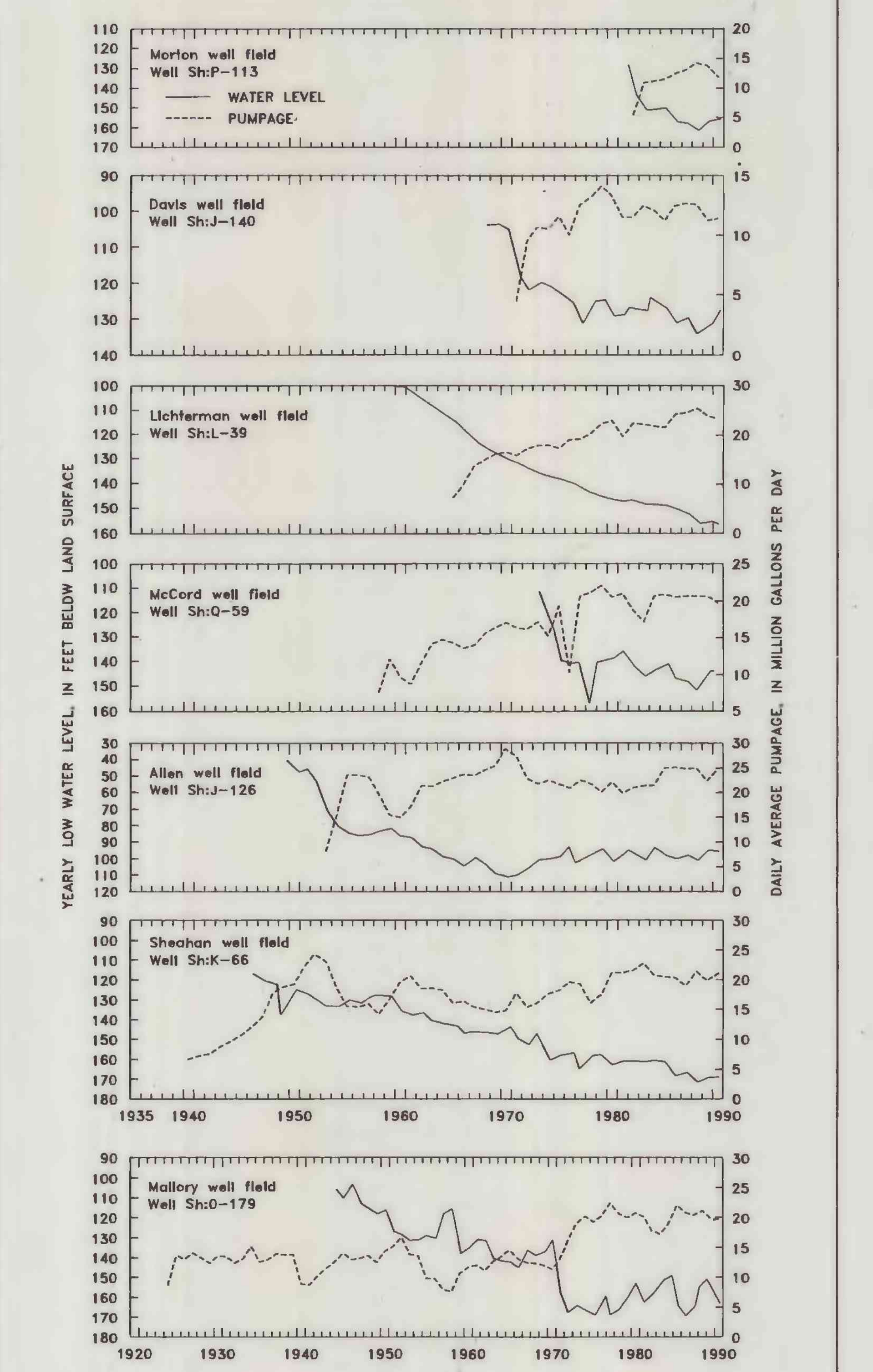

Figure 2.--Yearly low water levels and daily average pumpage of selected wells at municipal well fields in the Memphis area.

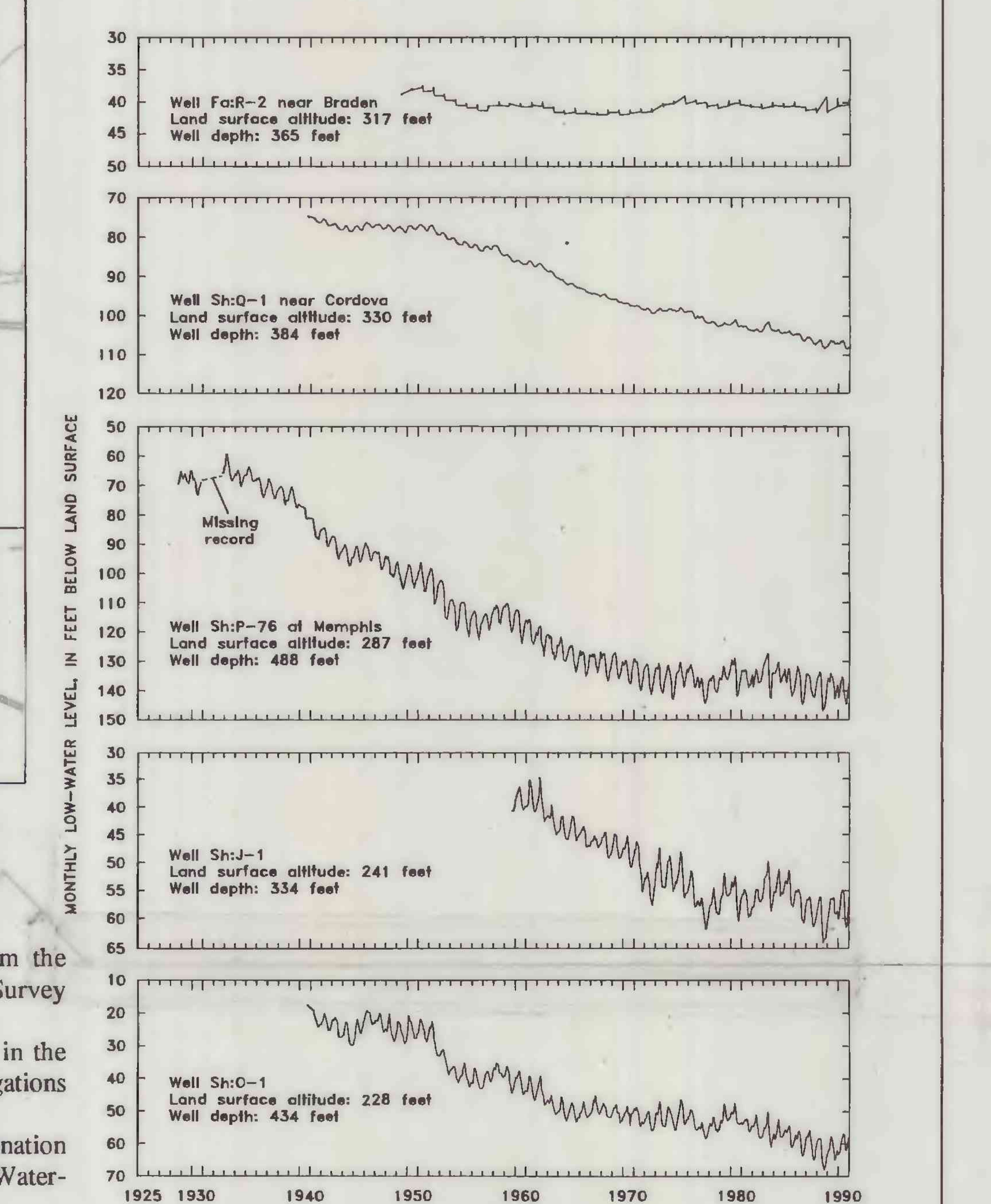

Figure 3.--Historic water-level changes in selected Memphis aquifer wells located away from well fields.

INTRODUCTION

The City of Memphis, Tennessee, obtains most of its municipal, industrial, and commercial water supply from the Memphis aquifer. Since pumping began in 1886, a relatively steady increase in the rate of water withdrawals from the Memphis aquifer has lowered its potentiometric surface, as indicated by declining water levels in observation wells in the Memphis area. This report shows the altitude of the potentiometric surface of the Memphis aquifer based on water-level measurements made during September 1990, and describes historic water-level changes in the aquifer in the Memphis area. The Memphis area comprises about 1,500 square miles in Shelby County and parts of Tipton and Fayette Counties, all in Tennessee; parts of DeSoto and Marshall Counties in Mississippi; and part of Crittenden County in Arkansas (fig. 1).

AQUIFER DESCRIPTION

In the Memphis area, unconsolidated Cretaceous and Tertiary sediments dip gently westward as part of the Mississippi embayment, a broad syncline that plunges southward with its axis roughly coincident with the Mississippi River. The Tertiary Memphis Sand is a thick layer of fine to coarse sand with lenses of clay and silt and minor amounts of lignite at various stratigraphic horizons. In the Memphis area, the Memphis Sand ranges in thickness from about 500 to 900 feet and is thickest in southwestern Shelby County.

The Memphis Sand constitutes the Memphis aquifer. Confining clay beds above and below the aquifer create artesian conditions, although recent studies have identified areas where the overlying Jackson-upper Claiborne confining unit is thin or absent in the Memphis area (Graham and Parks, 1986; Parks, 1990). Recharge to the Memphis aquifer primarily occurs east of the eastern extent of the Jackson-upper Claiborne confining unit (fig. 1), but some recharge occurs where the confining unit is thin or absent.

POTENTIOMETRIC-SURFACE MAP

The potentiometric-surface map for the Memphis aquifer was prepared from water-level measurements made in 81 wells in the Memphis area. These measurements were made in September when water levels are usually lowest; therefore, this map represents low water-level conditions for 1990. Prior to withdrawals from the Memphis aquifer, the potentiometric surface was a smooth surface with a gentle dip to the west (Criner and Parks, 1976). However, since 1886, withdrawals from the aquifer have created a large cone of depression in the potentiometric surface in the Memphis area and several smaller cones of depression centered under municipal well fields (fig. 1). The Shaw well field in the eastern part of the Memphis area (fig. 1) began production just 3 months before measurements for the potentiometric-surface map were completed. At that time, withdrawals had not substantially changed the shape of the potentiometric surface of the Memphis aquifer, although the water level in observation well Sh:R-29 was 6 feet lower than in 1988 (Parks, 1990).

WATER-LEVEL CHANGES AND PUMPAGE AT WELL FIELDS

Municipal, industrial, and commercial withdrawals of water from the Memphis aquifer totaled approximately 196 million gallons per day during 1990. About 60 percent of that total was withdrawn by the Memphis Light, Gas and Water Division well fields (fig. 1). Annual low water levels in observation wells and daily average pumpage for the year for well fields with long-term record are shown in figure 2. In each well field, most declines in water level correspond to increases in pumpage. A direct correlation between pumpage and water-level change exists for most of the well fields. Lack of correlation at some well fields may be due, in part, to the distance between the observation well and the production wells in a well field and the distribution of pumpage within the well field in a given year. For example, the pumpage at the McCord well field has remained nearly constant from 1985 to 1990, but the water level in Sh:Q-59 has fluctuated about 10 feet (fig. 2). Water levels in well Sh:Q-59 may be affected by varying amounts of pumpage from a nearby production well and also by withdrawals at the Bartlett municipal well field approximately 1 mile to the north.

WATER-LEVEL CHANGES AWAY FROM WELL FIELDS

Hydrographs for selected wells away from municipal and industrial well fields illustrate the effects of long-term pumpage on water levels in the Memphis aquifer. Water-level declines in the Memphis area have not been uniform. Water levels in wells closer to the center of pumping show much larger declines than those in outlying wells, which are only minimally affected by withdrawals in Memphis. For example, the hydrograph for well Fa:R-2 (fig. 3), located outside the large cone of depression in the potentiometric surface, shows a slight decline in water levels. During the 41-year period of record (1949-90) for well Fa:R-2, the water level has declined 2.1 feet, which is an average rate of less than 0.1 foot per year (fig. 3). Well Sh:Q-1 is located between well Fa:R-2 and the center of the large cone of depression (fig. 1). In contrast to the hydrograph for well Fa:R-2, the hydrograph for well Sh:Q-1 shows a fairly steady decline in water levels. Since 1940, the water level in well Sh:Q-1 has declined about 34 feet, an average rate of about 0.7 foot per year. Near the center of the cone of depression, the hydrograph for well Sh:P-76 (fig. 3) indicates an even larger decline in water levels. During the 62-year period of record (1928-90), the water level has declined about 72 feet, or an average rate of about 1.2 feet per year. However, water levels for well Sh:P-76 have not declined substantially since about 1975, indicating that water levels near the center of the depression have stabilized (Parks and Carmichael, 1990). Hydrographs for wells Sh:J-1 and Sh:O-1 (fig. 3) located north and south, respectively, of the center of the cone of depression show average rates of decline in water levels of about 0.7 and 0.9 foot per year. These data and the data for well Sh:Q-1 indicate that the depression in the potentiometric surface is continuing to expand. The seasonal fluctuation in water levels in these wells (fig. 3) can be attributed primarily to seasonal differences in water demand and pumpage, rather than to variations in the response of the aquifer to recharge.

REFERENCES CITED

Criner, J.H., and Parks, W.S., 1976, Historic water-level changes and pumpage from the principal aquifers of the Memphis area, Tennessee: 1886-1975: U.S. Geological Survey Water-Resources Investigations Report 76-67, 45 p.
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.
Parks, W.S., 1990, Hydrogeology and preliminary assessment of the potential for contamination of the Memphis aquifer in the Memphis area, Tennessee: U.S. Geological Survey Water-Resources Investigations Report 90-4092, 39 p.
Parks, W.S., and Carmichael, J.K., 1990, 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, 8 p.

CONVERSION FACTORS, VERTICAL DATUM, AND WELL NUMBERING SYSTEMS

Multiply	*By*	*To obtain*
foot	0.3048	meter
mile	1.609	kilometer
square mile	2.590	square kilometer
million gallons per day	0.04381	cubic meter per second

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 the United States and Canada, formerly called Sea Level Datum of 1929.

Tennessee District well-numbering system: In this report, wells are identified according to the numbering system used by the U.S. Geological Survey, Water Resources Division. The well number consists of three parts: an abbreviation of the name of the county in which the well is located; a letter designating the $7^{1}/_{2}$-minute topographic quadrangle on which the well is plotted; quadrangles are lettered from left to right across the county beginning in the southwest corner of the county; and a number generally indicating the numerical order in which the well was inventoried. For example, Sh:R-29 indicates that the well is located in Shelby County on the "R" quadrangle and is identified as well 29 in the numerical sequence.

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ALTITUDE OF THE POTENTIOMETRIC SURFACE, SEPTEMBER 1990, AND HISTORIC WATER-LEVEL CHANGES IN THE MEMPHIS AQUIFER IN THE MEMPHIS AREA, TENNESSEE

By
James A. Kingsbury

1992

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