GROUND-WATER LEVELS IN THE MISSISSIPPI RIVER VALLEY ALLUVIAL AQUIFER NEAR POOL 5 ON THE LOWER ARKANSAS RIVER DURING AND AFTER A 1-FOOT INCREASE IN POOL STAGE, AUGUST THROUGH DECEMBER 1987

By Maria Plafcan

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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)

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."

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ABSTRACT

The U.S. Geological Survey, in cooperations with the U.S. Army Corps of Engineers, conducted a 5-month study to collect ground-water measurements in the Mississippi River Valley alluvial aquifer near pool 5 on the lower Arkansas River during and after a 1-foot increase in river-pool stage.

An existing monitoring well network adjacent to pool 5 consisted of 2 recorders and 18 observation wells located at different distances from the river to form 2 cross sections. Ground-water-level data were collected during five measurement periods. Three measurement periods occurred while the river stage for pool 5 was maintained 1 foot above normal, and two measurement periods occurred after the river-pool stage was lowered to its normal level. All five measurement periods are illustrated for both cross sections and show the hydraulic gradient sloping eastward away from the river during the study period. Hydrographs of concurrent water levels in the aquifer and the river showed a general rise in ground-water level at both wells throughout the study period.

INTRODUCTION

The lower Arkansas River flows across eastern Arkansas and extends from Little Rock to the Mississippi River. Agriculture is the principal land use in eastern Arkansas and requires large quantities of freshwater for irrigating rice and other crops. Farmers use the Mississippi River Valley alluvial aquifer as their main source of freshwater, but farmers, who are riparian landowners, divert surface water when and wherever possible for irrigating crops.

In 1986, the U.S. Army Corps of Engineers raised the pool stages at lock and dam 2 and 5 by 1-foot during the summer months in an effort to provide more surface water to the landowners along the tributaries adjacent to navigation pools 2 and 5 on the lower Arkansas River. The results of this study were published in a U.S. Geological Survey report by Freiwald and Grosz (1988). During their study, a flood event on the Arkansas River cut short the observation period when pool levels rose instead of dropping the intended 1 foot. Therefore, instead of describing the observed effect of the increased river-pool stage, the authors described "the effects of fluctuating river-pool stages on water levels in the adjacent alluvial aquifer along the Arkansas River encountered during the field study". They also applied a theoretical equation, the Fourier integral, to estimate the effect of a 1-foot rise in river-pool stage on ground-water levels after equilibrium conditions were established between the river and the aquifer. In 1987, the Corps of Engineers again raised the pool stage of the Arkansas River at lock and dam 5 by 1 foot.

Purpose and Scope

The purpose of this study was to collect additional water-level measurements in the adjacent alluvial aquifer along pool 5 of the Arkansas River during and after an increase in river-pool stage. The purpose of this report is to present the collected water-level data in tables and to illustrate these data in graphs.

Monthly and continuous water levels were measured from mid-August through mid-December 1987 in an existing monitoring network of wells developed in the alluvial aquifer. The monitoring well network consisted of 2 recorders and 18 observation wells which formed 2 cross sections. Each cross section intersects pool 5 upstream from lock and dam 5 on the Arkansas River. While the river-pool stage was maintained 1-foot above normal, wells in the monitoring network were measured monthly (August 17 and 18, September 14 and 15, and October 19 and 20). After the river-pool stage had been dropped to its normal level on October 31, measurements were made on November 16 and on December 15 and 16.

Study Area and Aquifer Description

The study was conducted on the lower Arkansas River southeast of Little Rock, Arkansas. The Arkansas River flows generally southeast from Little Rock to its confluence with the Mississippi River (fig. 1). The study area is located along navigation pool 5, which extends for 23 river miles from lock and dam 5 near Wright, Arkansas, upstream to lock and dam 6 near Scott, Arkansas.

There is little relief in the area, and secondary streams are sluggish. Land surface altitudes range from 215 to 235 feet above sea level. Oxbow lakes and point bars are common physiographic features.

The Mississippi River Valley alluvial aquifer is composed of alluvial and terrace deposits of Quaternary age. These deposits are present at the surface throughout eastern Arkansas (fig. 1), but only the alluvial deposits are present in the study area. A common characteristic within the alluvial deposits is the upward gradation in grain size from coarse sand and gravel at the base to fine sand and silt. Typical thickness of the alluvial deposits in the study area is about 67 ft. The upper part of the alluvium is characterized by fine sand, silt, and clay and may act as a confining layer to the aquifer in the coarser sediments below. Thickness of the silt and clay layer in the study area ranges from about 3 to 35 ft. Semiartesian conditions exist in the study area due to water-level fluctuations in the aquifer caused by large ground-water withdrawals during the irrigation season that may lower the water-level altitude below the base of the confining layer. Static water levels for the alluvial aquifer measured in the study area ranged from 3 to 31 ft below land surface. The potentiometric surface slopes east, away from the river toward a large cone of depression centered in Arkansas County east of the study area.

For more information about the alluvial aquifer, the reader is referred to the following references: Bedinger and Jeffery (1964), Boswell and others (1968), Bryant and others (1985), and Plafcan and Edds (1986).

DESCRIPTION OF WELL NETWORK AND DATA COLLECTION

The existing well network adjacent to pool 5 that was used in the previous study (Freiwald and Grosz, 1988) was used for the present study. The network consists of both U.S. Geological Survey monitor wells and private irrigation wells. All wells are screened in the alluvial aquifer and range in depth from 39 to 95 ft.

Eighteen wells are located at various distances from the river forming two cross sections, A-A' and B-B' (fig. 2). Cross-section A-A', crossing the Arkansas River at river mile 95.7, consists of 12 wells. Cross-section B-B', located at river mile 87.7, consists of six wells and lies east of the river due to the absence of the alluvial aquifer west of the river in this area.

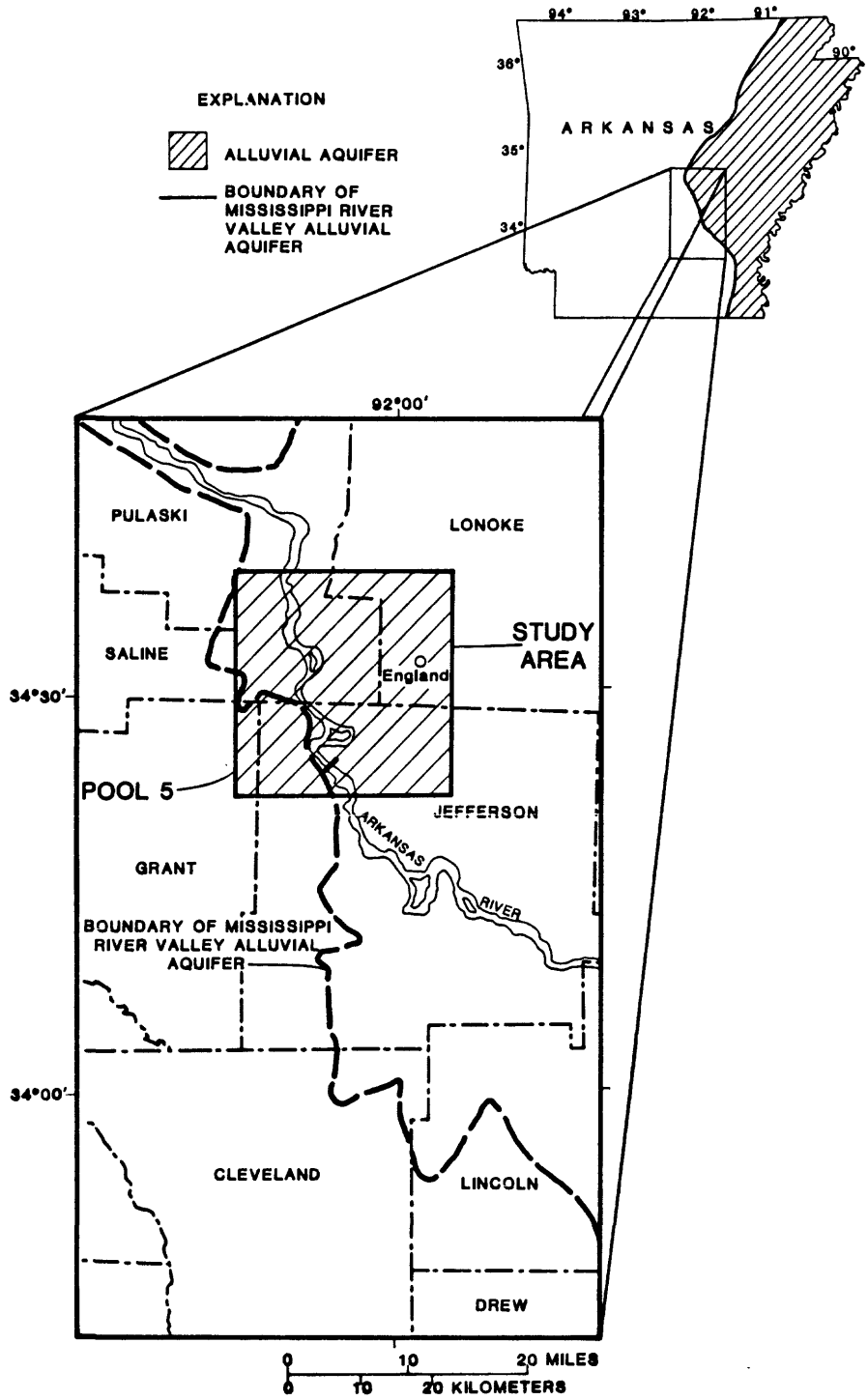

Figure 1.--Location of study area.

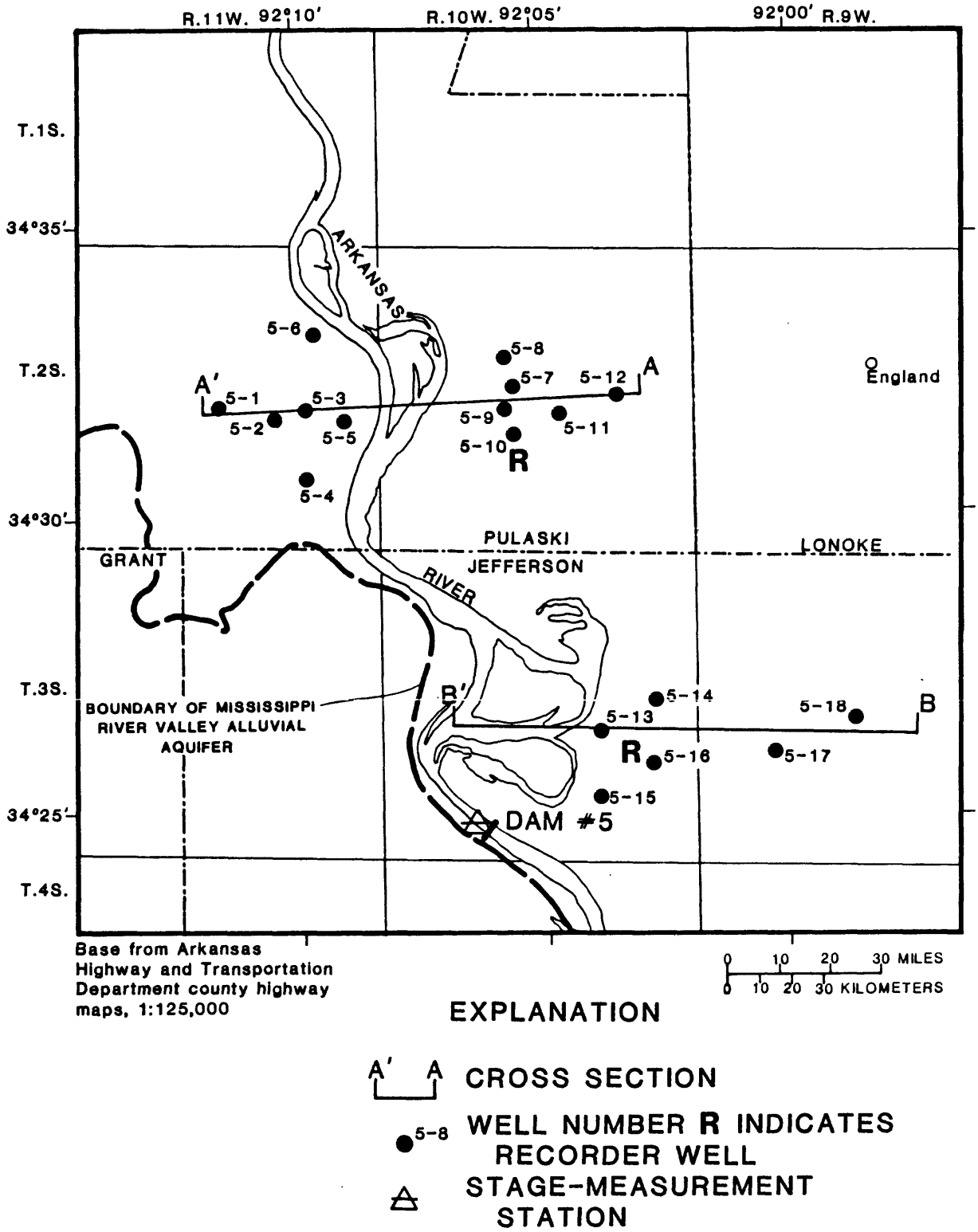

Figure 2.--Location of cross sections, wells, and stage-measurement station for pool 5 (Freiwald and Grosz, 1988).

DATA COLLECTION

Five sets of water-level measurements were made in most wells in the network during the study. During the first three sets (August 17 and 18, September 14 and 15, and October 19 and 20) river stage for pool 5 was maintained at a level 1 foot above normal. On October 31, the river-pool stage was lowered to its normal level and two more sets of measurements were collected on November 16 and December 15 and 16. Table 1 presents the water-level-altitude data for the wells which formed the network.

Wells 5-10 and 5-16, one in each cross section, were equipped with a digital recorder to monitor hourly fluctuations in ground-water levels (fig. 2).

River-pool-stage data were obtained from the Corps of Engineers gage located at dam 5. River-pool stages for the measured periods at each cross section are shown in the table below.

Arkansas River stages at pool 5

[Altitude in feet above sea level]

Date	Altitude of river pool stage
August 17, 1987	213.88
September 14, 1987	213.40
October 19, 1987	213.54
November 16, 1987	212.83
December 15, 1987	212.67

The well referencing system was the same as used by Freiwald and Grosz (1988). It was described by them as follows: "To establish an axis for referencing the wells along the cross sections A-A' and B-B' the centerline of the navigation channel was labeled zero (figs. 3 and 4). The effective position of each well is defined as the shortest distance from each well to the river's edge plus the distance from the river's edge to the zero point as measured along the cross-section line." For example, on cross-section A-A' in figure 3, the left bank is 0.10 mile from the channel centerline. The shortest distance from well 5-7 to the nearest river bank is 1.09 mile. Thus, the effective position (distance) of well 5-7 from the navigation channel centerline is 1.19 mile.

Table 1.--Location and altitude of water levels in wells along cross-section A-A' and B-B' for August through December 1987

[Altitude in feet above sea level; some land surface altitudes are estimated from topographic maps]

Well number	U.S. Geological Survey well number	Location from channel centerline, in miles	Altitude of land surface	Aug 17	Aug 18	Sept 14	Sept 15	Oct 19	Oct 20	Nov 16	Dec 15	Dec 16
					Cross-Section A-A'							
5-1	2S11W21AAC1	3.54	231.37	212.87	---	212.38	---	211.95	---	212.17	211.85	---
5-2	2S11W23BCB1	2.64	236.76	213.78	---	208.27	---	204.01	---	203.17	205.74	---
5-3	2S11W23BAA1	2.40	230.0	211.04	---	210.51	---	209.97	---	209.78	210.04	---
5-4	2S11W26DBB1	1.73	233.40	214.95	---	214.68	---	214.38	---	215.10	214.14	---
5-5	2S11W24BDB1	1.57	227.0	212.82	---	213.67	---	213.89	---	214.13	---	---
5-6	2S11W11DCA1	1.23	220.0	214.22	---	214.10	---	215.18	---	216.27	---	---
5-7	2S10W16CCA1	1.19	230.76	---	202.92	---	203.28	---	205.35	205.50	207.37	---
5-8	2S10W16BAA1	1.31	234.0	---	214.92	---	203.07	---	205.86	206.83	207.10	---
5-9	2S10W21BBA1	1.38	230.0	---	---	---	203.76	---	205.39	206.63	207.17	---
5-10	2S10W21CAC1	1.59	227.0	---	204.83	---	205.93	---	207.68	208.81	209.05	---
5-11	2S10W22BAD1	2.52	226.0	---	190.69	---	194.03	---	198.35	199.74	198.85	---
5-12	2S10W14CDD1	3.40	225.0	---	195.18	---	194.94	---	194.60	192.07	200.31	---
					Cross-Section B-B'							
5-13	3S10W23BCC1	2.90	223.65	---	207.16	---	207.97	---	211.33	212.21	---	209.12
5-14	3S10W13CCA1	3.74	217.76	---	197.39	---	200.26	---	201.33	202.12	---	202.08
5-15	3S10W26CBC1	3.93	218.94	---	198.95	---	197.33	---	201.35	202.33	---	203.22
5-16	3S10W25BBB1	4.02	216.37	---	194.65	---	198.15	---	198.63	200.44	---	199.54
5-17	3S09W20CCD1	6.15	217.94	---	193.58	---	193.29	---	193.26	193.45	---	193.30
5-18	3S09W21ADB1	7.51	223.38	---	192.03	---	191.78	---	191.63	191.54	---	191.39

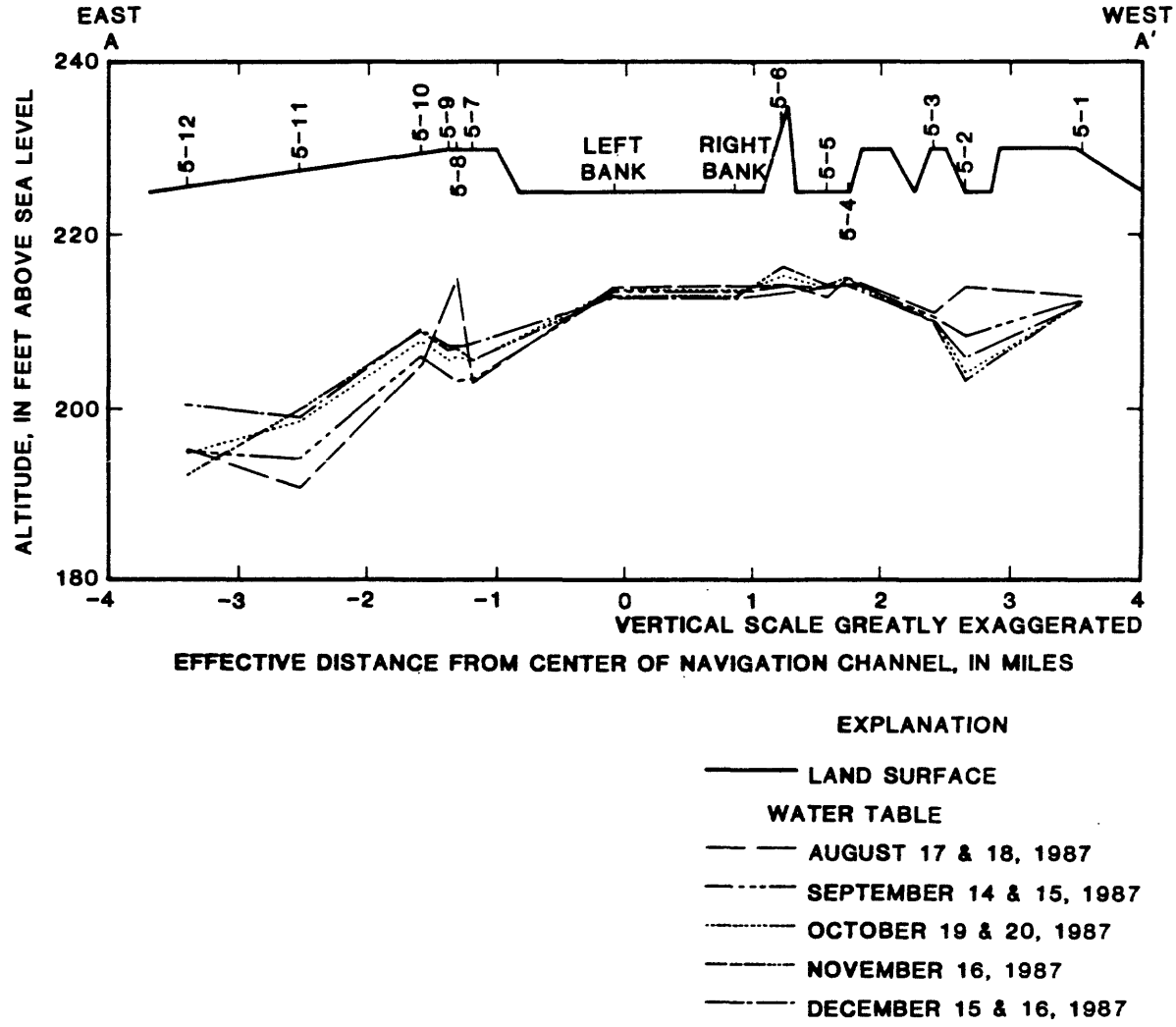

Figure 3.--Water table and river-pool stage along cross section A-A' (river mile 95.7) at pool 5.

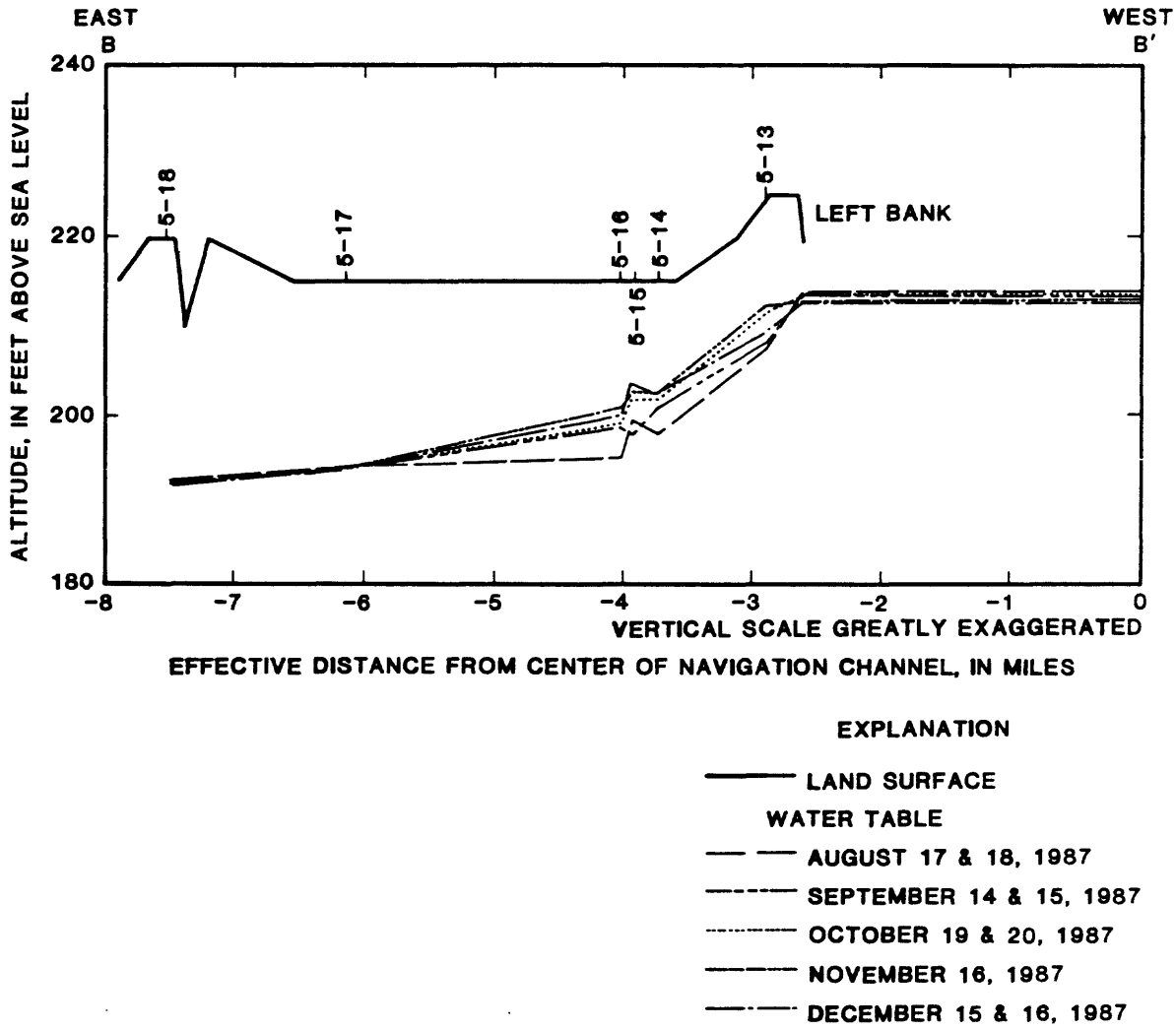

Figure 4.--Water table and river-pool stage along cross section B-B' (river mile 87.7) at pool 5.

OBSERVED GROUND-WATER LEVELS DURING AND AFTER AN INCREASE IN POOL STAGE

Water-level and river-pool-stage data for cross-sections A-A' and B-B' are illustrated in figures 3 and 4 and are viewed in the downstream direction. The land-surface profiles shown in both figures are estimated from topographic maps. They represent general topography along the cross sections and are only to be used as a reference and not actual depth to water.

The hydraulic gradients, as illustrated by the cross sections (figs. 3 and 4), sloped away from the river for all five measurement periods. Ground-water levels on the east side of the river (figs. 3 and 4) showed a steady rise throughout the first four measurement periods and remained steady or slightly decreased during the fifth measurement period. Ground-water levels declined on the west side of the river throughout the first four measurements in wells 5-1 through 5-3 and showed slight increases in wells 5-4 through 5-6 near the river. Ground-water levels during the last measurement were slightly higher than the previous set. Data were not available for wells nearest the river during the final measurements.

Continuous water-level data were collected from wells 5-10 and 5-16 from August through mid-December. These data were plotted and compared with river stages from pool 5 for the same period. The hydrographs are illustrated in figures 5 and 6. Ground-water levels generally rose throughout the study period at both wells.

SUMMARY

The U.S. Geological Survey, in cooperation with the U.S. Army Corps of Engineers, conducted a 5-month study to collect ground-water measurements in the Mississippi River Valley alluvial aquifer near pool 5 on the lower Arkansas River during and after a 1-foot increase in river-pool stage.

An existing monitoring well network adjacent to pool 5 consisted of 2 recorders and 18 observation wells located at different distances from the river to form 2 cross sections. Ground-water-level data were collected during five measurement periods. Three measurement periods occurred while the river stage for pool 5 was maintained 1 foot above normal, and two measurement periods occurred after the river-pool stage was lowered to its normal level. All five measurement periods are illustrated for both cross sections and show the hydraulic gradient sloping eastward away from the river during the study period. Hydrographs of concurrent water levels in the aquifer and the river showed a general rise in ground-water level at both wells throughout the study period.

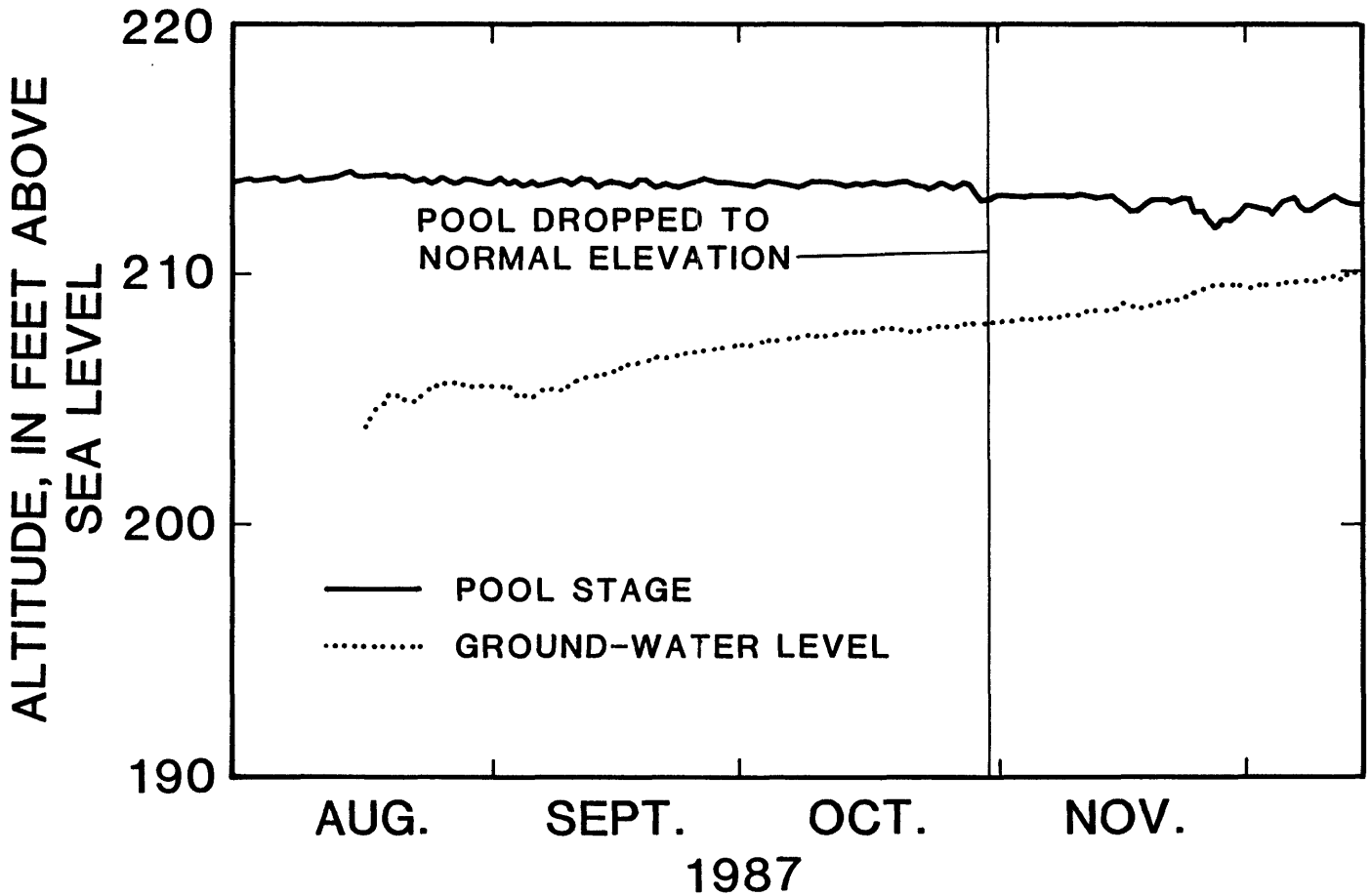

Figure 5.--Fluctuations of pool 5 stage along cross section A-A', and water levels in well no. 5-10.

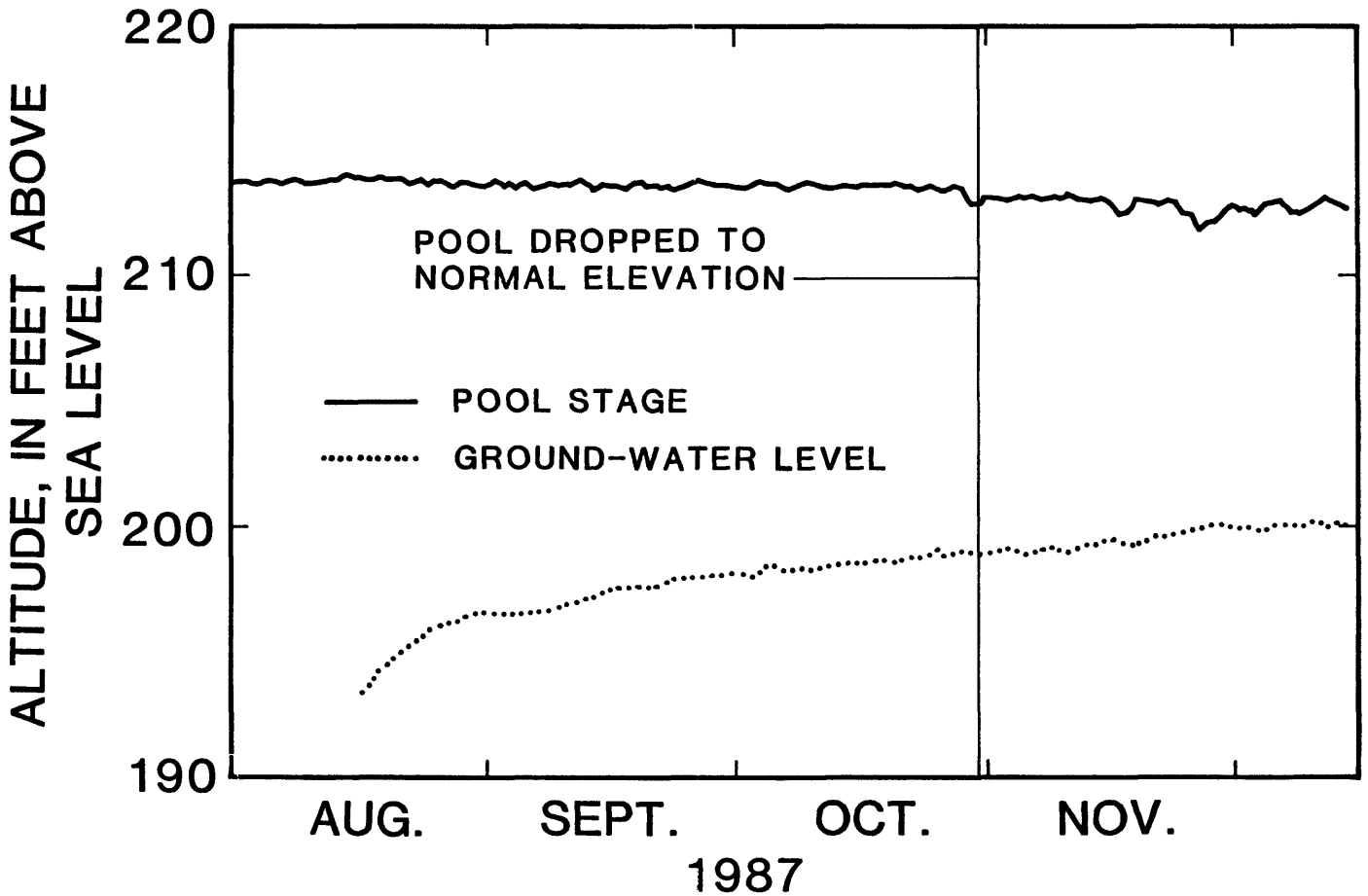

Figure 6.--Fluctuations of pool 5 stage along cross section B-B', and water levels in well no. 5-16.

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