HYDROLOGIC AND SEDIMENTOLOGIC DATA COLLECTED DURING FOUR CRUISES AT HIGH WATER ON THE MISSISSIPPI RIVER AND SOME OF ITS TRIBUTARIES, MARCH 1989-JUNE 1990

by John A. Moody and Robert H. Meade

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TABLES (Cont.)

CONVERSION FACTORS

Multiply	*By*	*To obtain*
	Length	
micrometer (μm)	0.00003937	inch
millimeter (mm)	0.03937	inch
centimeter (cm)	0.3937	inch
meter (m)	3.281	foot
kilometer (km)	0.6214	mile
	Area	
square meter (m^2)	10.76	square foot
square kilometer (km^2)	0.3861	square mile
	Volume	
milliliter (mL)	0.03382	ounces, fluid
liter (L)	0.2642	gallon
cubic meter (m^3)	35.31	cubic foot
	Velocity	
centimeter per second (cm/s)	0.03281	foot per second
meter per second (m/s)	3.281	foot per second
kilometer per hour (km/h)	0.6214	mile per hour
	Discharge	
cubic meter per second (m^3/s)	35.31	cubic foot per second
cubic meter per year (m^3/yr)	35.31	cubic foot per year
liter per minute (L/min)	0.2642	gallon per minute
metric ton per year (metric ton/yr)	1.102	ton per year
	Mass	
milligram (mg)	0.00003527	ounce, avoirdupois
gram (g)	0.002205	pound, avoirdupois
metric ton	2,205	pound, avoirdupois
	Temperature	
degree Celsius (°C)	°F=1.8×°C+32	degree Fahrenheit

HYDROLOGIC AND SEDIMENTOLOGIC DATA COLLECTED DURING FOUR CRUISES AT HIGH WATER ON THE MISSISSIPPI RIVER AND SOME OF ITS TRIBUTARIES, MARCH 1989-JUNE 1990

By John A. Moody and Robert H. Meade

ABSTRACT

Bed-sediment, water, and suspended-sediment samples were collected from 33 sites on the Mississippi River and some of its tributaries. Four cruises were made at high water during a 16-month period from March 9, 1989, to June 27, 1990. The maximum measured water discharge was about 34,100 cubic meters per second on March 10, 1990, in the Mississippi River at Vicksburg, Mississippi, and the maximum measured suspended-sediment discharge was 1,330,000 metric tons per day in the Mississippi River at Thebes, Illinois, on June 13, 1990. Depth-integration and pumping methods were used at equally spaced locations across the river to collect two composite samples of river water containing suspended sediment. The depth-integrated composite samples were approximately 100 liters and the pumped composite samples were approximately 500 liters. Both sampling methods used Teflon or Teflon-coated parts to prevent chemical contamination.

This report contains the following data associated with the samples: cross-sectional area of the river, water depths, depth-averaged velocities, water discharge, surface temperature and specific conductance, concentrations of the suspended sand and silt/clay and colloid fractions, and particle sizes of bed material and suspended sediment. These data provide the framework for interpreting subsequent chemical analyses of the water and suspended-sediment samples collected during the four cruises and for calculating bed-load transport in the Mississippi River and some of its tributaries.

INTRODUCTION

The Mississippi River drains about 40 percent of the conterminous United States and commonly is divided into two parts--the Lower Mississippi River and the Upper Mississippi River. Distances on the Lower Mississippi River begin at zero where the mouth of the river divides into three separate channels at Head of Passes in Louisiana and increase upstream to the mouth of the Ohio River at Cairo, Ill. Distances on the Upper Mississippi River begin at zero at the mouth of the Ohio River (Lower Mississippi River mile 953.8) and increase upstream to the source of the Mississippi River in Minnesota.

At Vicksburg, Miss., the river has a mean annual water discharge of about 500×10^9 m^3/yr and a mean annual sediment discharge of about 200×10^6 metric tons/yr. At 191 kilometers downstream from Vicksburg, approximately

25 percent of the water discharge and sediment discharge is diverted from the Mississippi River by the Old River Control Structures into the Atchafalaya River and then into the Gulf of Mexico. The remaining water (375×10^9 m^3/yr) and sediment (150×10^6 metric tons/yr) are discharged by the Mississippi River directly into the Gulf of Mexico (Moody and Meade, 1992).

The U.S. Geological Survey (USGS) began a study of the sediment-transported pollutants in the Mississippi River and some of its tributaries in 1987 and made three research cruises at low water in July-August 1987, in November-December 1987, and during the record low water in May-June 1988 (Moody and Meade, 1992). These cruises started about 50 km upstream from the confluences of the Upper Mississippi-Missouri-Illinois Rivers near St. Louis, Mo., and ended about 40 km downstream from New Orleans, La. On the basis of distinctive differences in water chemistries, the Mississippi River basin was divided into eight subbasins (fig. 1). The corresponding drainage areas and the mean annual discharges of water and sediment for the eight subbasins are listed in table 1.

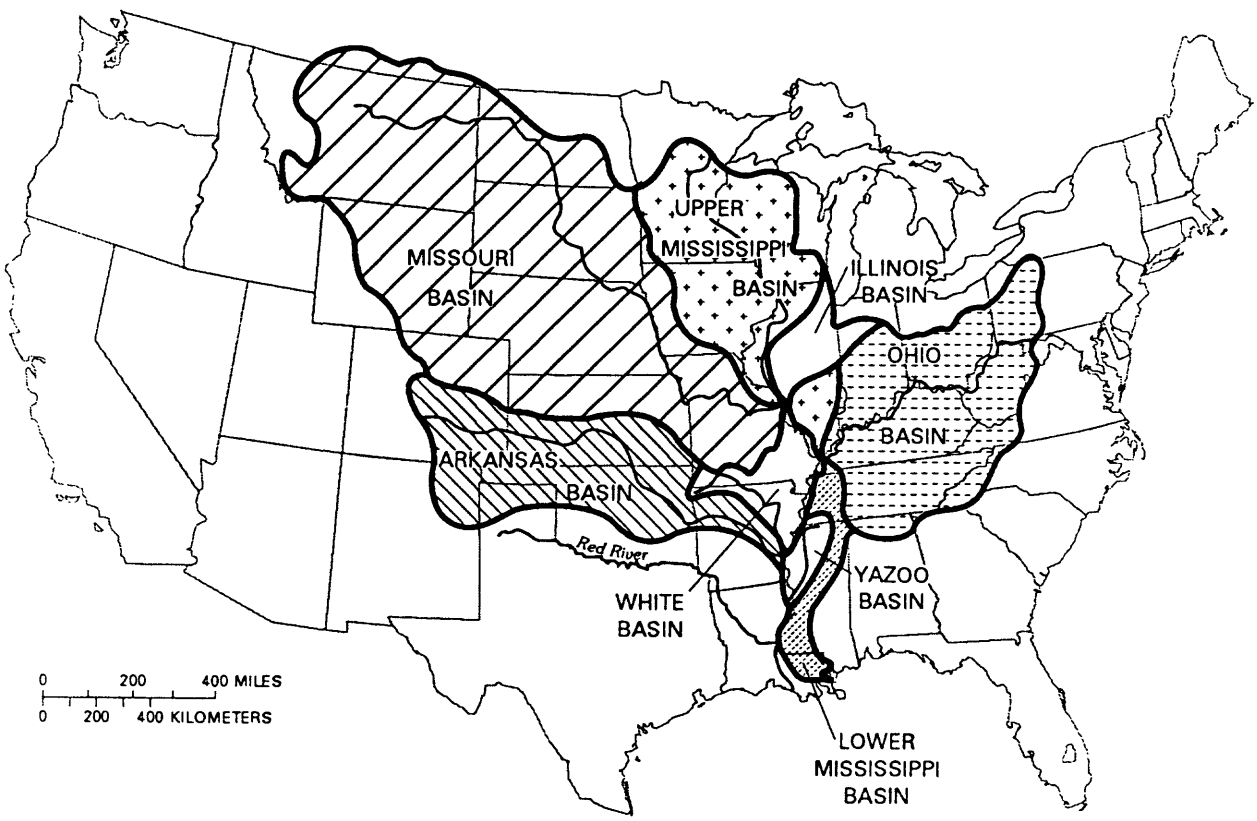


Figure 1.--Mississippi River drainage basin and eight subbasins. The Red River basin was not included because it is no longer a tributary to the Mississippi River. (Modified from Bragg, 1977.)

Table 1.--Drainage areas and mean annual discharges of water and sediment for eight subbasins in the Mississippi River basin

[The basin areas and sediment discharges are taken from Keown and others, 1981, except where noted. Values of the water discharges were taken from the U.S. Geological Survey water-resources data reports for the appropriate States, except where noted; km^2, square kilometer; m^3/yr, cubic meter per year; /yr, per year]

Basin	Length of record (years)	Drainage area		Mean annual discharge			
				Water		Sediment	
		(km^2)	(percent)	(10^9 m^3/yr)	(percent)	(10^6 metric tons/yr)	(percent)
Upper Mississippi River less Illinois River and Missouri River	58	407,660	14	[1]73	15	16.0	8
Illinois River	48	80,810	3	[2]20	4	6.7	3
Missouri River	88	[3]1,357,670	45	72	15	78.5	40
Ohio River	58	528,310	18	243	50	[4]72.6	37
White River	2	[5]66,190	2	19	4	3.4	2
Arkansas River	60	416,600	14	37	8	10.3	5
Lower Mississippi River less the Yazoo River[6]	17-50	80,530	3	11	2	6.7	3
Yazoo River	20	35,840	1	[7]12	2	3.8	2
TOTAL		2,973,610		487		198.0	

[1]Discharge for Mississippi River at Alton, Illinois, minus discharge for the Illinois River.
[2]Discharge for the Illinois River at Meredosia, Illinois.
[3]Drainage area taken from the Missouri Water-Resources Data for water year 1986.
[4]Sediment discharge was estimated by Keown and others (1981) by differences.
[5]Drainage area is for the gaging station at Clarendon, Arkansas. Discharge was supplied by U.S. Army Corps of Engineers, Memphis, Tennessee (oral commun., 1988).
[6]Seven tributaries: St. Francis, Obion, Hatchie, Wolf, Big Black, Homochitto, and Buffalo Rivers.
[7]Combined discharges (1967-87) for the Yazoo River at Greenwood, Mississippi, and the Big Sunflower River at Sunflower, Mississippi (Henry Noble, U.S. Army Corps of Engineers, Vicksburg, Mississippi, oral commun., 1988).

Objectives of the Study

The broad objectives of this multidisciplinary research study are to investigate the movement, mixing, and storage processes of sediment-associated and dissolved pollutants in the Mississippi River system. Some specific objectives are to:

1. Understand the compartmentalization of organic and inorganic agrochemicals among the water, sediment, and biotic phases;
2. Investigate the mixing, partitioning, and redistribution processes of the various pollutants downstream from major river confluences;
3. Understand the movement, storage, and remobilization of suspended sediment and associated pollutants at seasonal or longer time periods;
4. Predict the location and travel time of water masses and the associated sediment and pollutants; and
5. Examine the geochemistry of the suspended silt, clay, colloidal material, and dissolved phases of river water.

Purpose and Scope

The purposes of this report are (1) to provide a description of the sampling sites on the Mississippi River and some of its tributaries, (2) to describe the sampling procedures used to collect and process bed-sediment samples and a representative water and suspended-sediment sample for physical and chemical analysis, and (3) to publish the hydrologic and sedimentologic data collected during four cruises. The hydrologic data are cross-sectional area of the river, water depths, depth-averaged velocities, and water discharge. The sedimentologic data are concentrations of suspended sand (greater than 63 μm), concentrations of silt/clay and colloidal material (finer than 63 μm), and particle-size distributions of the bed material and suspended sediment. Surface temperature and specific conductance are listed in this report, but inorganic and organic chemical data are published elsewhere. The hydrologic data that are published in this report provide some of the necessary framework for interpreting the chemical data.

The 17-m research vessel ACADIANA, owned and operated by the Louisiana Universities Marine Consortium, was used for collecting the samples because it has a shallow draft (about 1.2 m), which permitted samples to be collected close to the river banks. The researchers, during each cruise, used a Lagrangian scheme that collected an initial sample from the Mississippi River near St. Louis, Mo., followed the water, and collected samples at additional sampling sites downriver. A 2-dimensional sampling scheme (different locations across the river) was used at each sampling site to collect individual water samples and to measure water surface properties. The individual water samples were combined to make a single composite sample for each sampling site so that the data consists of a primary data set that is 1-dimensional and a secondary data set that is 2-dimensional. This Lagrangian sampling scheme was limited by the logistical constraints of using a single vessel to sample the tributaries and the Mississippi River and by the time required to process samples (Moody, 1993). This report includes data from four cruises that collected samples from sites on the Mississippi River starting about 100 km upstream from St. Louis, Mo., and ending about 40 km downstream from New Orleans, La. (fig. 2). Samples also were collected from sites within 230 km of the mouths of the following tributaries: Illinois, Missouri, Ohio, Wabash, Cumberland, Tennessee, White, Arkansas, and Yazoo Rivers. The sampling-site locations for each cruise are listed in table 2 and shown in figures 2 and 3 .

The March-April 1989 cruise (March 9 through April 1, 1989) and the June 1989 cruise (June 4 through June 28, 1989) were planned to sample the Mississippi River when the water level and corresponding water discharge were high. The February-March 1990 cruise (February 23 through March 14, 1990) was designed to follow the high water created by the spring runoff of the Ohio River (starting at the confluence of the Wabash and Ohio Rivers) down the Ohio and Lower Mississippi Rivers. The May-June 1990 cruise had two purposes. The purpose of the first leg (May 30 through June 6, 1990) was to conduct a 2-dimensional study of the mixing processes downstream from the confluence of the Mississippi and Ohio Rivers during a period of high water (see fig. 3), and the purpose of the second leg (June 7 through June 27, 1990) was a joint project with NASQAN (National Stream Quality Accounting Network) to compare collection, processing, and analytical techniques for trace-element analysis of water collected from the Mississippi River and some of its tributaries.

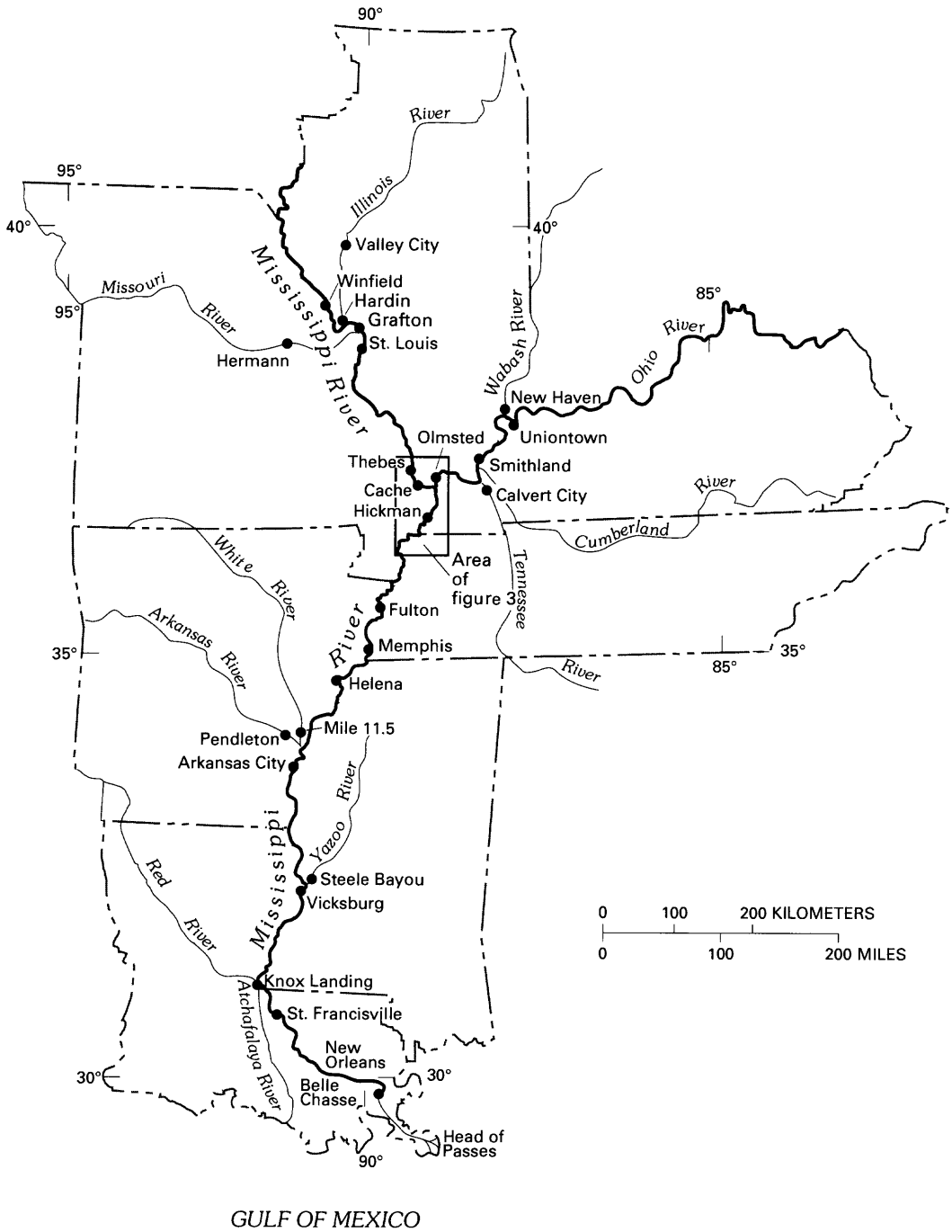


Figure 2.--Location of sampling sites on the Mississippi River and some of its tributaries. Sampling sites are shown as solid circles. Sampling sites within the rectangular area that includes the Mississippi-Ohio confluence are shown in figure 3.

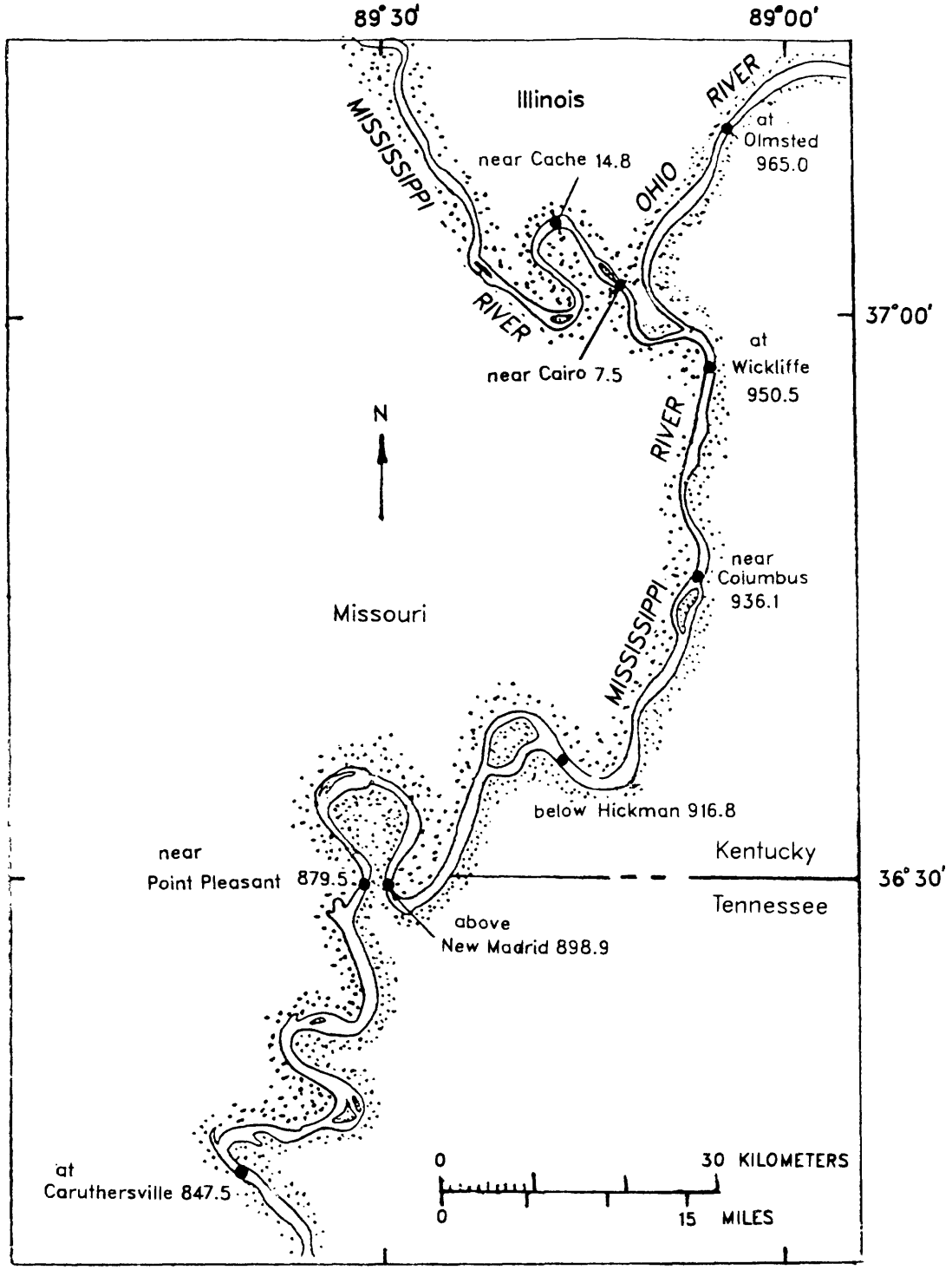


Figure 3.--Location of sampling sites near the confluence of the Mississippi and Ohio Rivers, May-June 1990 cruise. The number after the site name is the river mile [modified from 1989 Flood Control and Navigation Maps of the Mississippi River, U.S. Army Corps of Engineers River Commission (1989a?)].

Table 2.--Sampling sites for March-April 1989 cruise, June 1989 cruise, February-March 1990 cruise, and May-June 1990 cruise

[River miles taken from navigation charts, U.S. Army Corps of Engineers, 1983?, 1986?, 1987a, 1987b, 1989a?, 1989b?; the X designates that the site was sampled]

Site name	River mile[1]	Cruise			
		March-April 1989	June 1989	February-March 1990	May-June 1990
Upper Mississippi River basin					
Mississippi River near Winfield, Mo.	UM 239.2	X	X		
Illinois River at Valley City, Ill.	IL 61.0				X
Illinois River at Hardin, Ill.	IL 21.8	X	X		
Mississippi River below Grafton, Ill.	UM 214.6				X
Missouri River at Hermann, Mo.	MO 97.9	X	X		
Mississippi River at St. Louis, Mo.	UM 179.3	X	X		
Mississippi River at Thebes, Ill.	UM 43.9	X	X		X
Mississippi River near Cache, Ill.	UM 14.8			X	
Mississippi River near Cairo, Ill.	UM 7.5				X
Ohio River basin					
Ohio River at Uniontown, Ky.	OH 842.4			X	
Wabash River near New Haven, Ill.	WA 13.8			X	
Cumberland River near Smithland, Ky.	CU 6.8			X	
Tennessee River near Calvert City, Ky.	TE 11.1			X	
Ohio River at Olmsted, Ill.	OH 965.0	X	X	X	X
Near Mississippi-Ohio River confluence					
Mississippi River at Wickliffe, Ky.	LM 950.5				X
Mississippi River near Columbus, Ky.	LM 936.1				X
Mississippi River below Hickman, Ky.	LM 916.8	X	X	X	
Mississippi River above New Madrid, Mo.	LM 898.9				X
Mississippi River near Point Pleasant, Mo.	LM 879.5				X
Mississippi River at Caruthersville, Mo.	LM 847.5				X
Lower Mississippi River basin					
Mississippi River at Fulton, Tenn.	LM 777.3		X		
Mississippi River below Fulton, Tenn.	LM 773.5	X		X	
Mississippi River below Memphis, Tenn.	LM 731.2				X
Mississippi River at Helena, Ark.	LM 663.9	X	X	X	
White River at Mile 11.5, Ark.	WH 11.5	X	X		
Arkansas River at Pendleton, Ark.	AR 22.4	X	X		
Mississippi River above Arkansas City, Ark.	LM 566.0	X	X	X	
Mississippi River below Arkansas City, Ark.	LM 551.7				X
Yazoo River below Steele Bayou, Miss.	YZ 9.0	X	X		X
Mississippi River below Vicksburg, Miss.	LM 433.4	X	X	X	X
Old River Outflow Channel near Knox Landing, La.	OR 5.5	X	X		
Mississippi River near St. Francisville, La.	LM 266.4	X	X	X	X
Mississippi River below Belle Chasse, La.	LM 73.1	X	X	X	X

[1]UM, Upper Mississippi River miles measured upriver from confluence with Ohio River.
IL, Illinois River miles measured upriver from confluence with Mississippi River (UM mile 218.0).
MO, Missouri River miles measured upriver from confluence with Mississippi River (UM mile 195.3).
OH, Ohio River miles measured downriver from Pittsburgh, Pa. Ohio-Mississippi confluence is at Ohio River mile 981.5 and Lower Mississippi River mile 953.8.
LM, Lower Mississippi River miles measured upriver from Head of Passes, La.
WH, White River miles measured upriver from confluence with Mississippi River (LM mile 598.8).
AR, Arkansas River miles measured upriver from confluence with Mississippi River (LM mile 581.5).
YZ, Yazoo River miles measured upriver from confluence with Mississippi River (LM mile 437.2).
WA, Wabash River miles measured upriver from confluence with Ohio River (OH mile 848.0).
CU, Cumberland River miles measured upriver from confluence with Ohio River (OH mile 923.2).
TE, Tennessee River miles measured upriver from confluence with Ohio River (OH mile 935.5).
OR, Old River Outflow Channel miles measured downriver from the Old River Control Structure (LM mile 314.5)

While all the cruises sampled high-water conditions, the proportions of water contributed by the Mississippi River and its tributaries were different for each cruise (figs. 4, 5, and 6). The first two cruises predominantly sampled Ohio River water, much of which was contributed by the Tennessee River (figs. 4 and 6). The third and fourth cruises sampled water with increasing proportions of Upper Mississippi and Missouri River water, and in samples collected downstream from the Arkansas River (fig. 5b and 5c), during the fourth cruise, there was a major contribution of Arkansas River water.

Acknowledgments

The U.S. Army Corps of Engineers representatives from the following districts and divisions provided extremely helpful and friendly assistance during and after the cruises: David Legg, Cincinnati District; Samuel Lehr, Whit Barton, and Janet Garner, Memphis District; Billy Garrett, John Miller, and Cecil Soileau, New Orleans District; Ray Kopsky, St. Louis District; Henry Noble, Vicksburg District; and James Farrell of the Lower Mississippi Valley Division.

Many people along the river provided facilities for docking, loading, and repairing the ship and equipment, and they often went out of their way to be helpful: Renee Ory and the people at Ory Brothers Marine Service of America in Hartford, Ill.; Rusty Sutton in Grafton, Ill.; Daniel Gipe and the people at Hermann Sand and Gravel Company in Hermann, Mo.; Captain William Carroll and the people at Gateway River Cruises in St. Louis, Mo.; Kent Hoffmeister and the workers at Missouri Dry Dock and Repair Company in Cape Girardeau, Mo.; the crew at Lock and Dam 53 near Olmsted, Ill.; the Coast Guard Station in Hickman, Ky.; John Janoush and the people at Janoush Marine, Inc., in Rosedale, Miss.; the crew at Norrell Lock #1 near Arkansas Post, Ark,; Mary and John Hoseman and the people working on the SPIRIT OF VICKSBURG in Vicksburg, Miss.; and the people running the New Roads Ferry at St. Francisville, La., and the Belle Chasse Ferry at Belle Chasse, La.

The crew of the research vessel ACADIANA, Lee Black, Steve Rabalais, Wayne Simoneaux, Craig LeBoeuf, Chuck Guidry, and Wilton Delaune, were especially accommodating and showed an unusual interest and concern to maintain proper scientific operations.

Measuring river discharge or collecting suspended-sediment samples from large rivers is not a two-man operation, and the following individuals' collaboration was necessary to get the job done: Ellen Axtmann, Terry Brinton, Pat Brown, Daphne Frilot, John Garbarino, Lois Koehnken, Tom Kraemer, Jerry Leenheer, Tom Leiker, Debby Martin, Dick Martin, Ted Noyes, Dale Peart, Willie Pereira, Jim Ranville, Terry Rees, Colleen Rostad, Jim Seeley, Alan Shiller, Herb Stevens, Bob Stallard, Dick Tagg, and Howard Taylor. Particle-size analyses of suspended and bed sediments were made by Mike Werito, Carol Anderson, and her colleagues.

Jerry Leenheer, Colleen Rostad, Bill Emmett, Marjorie Pokladnik, Mary Kidd, and John Flager made so many helpful changes to the text, that whose words these are we do not know.

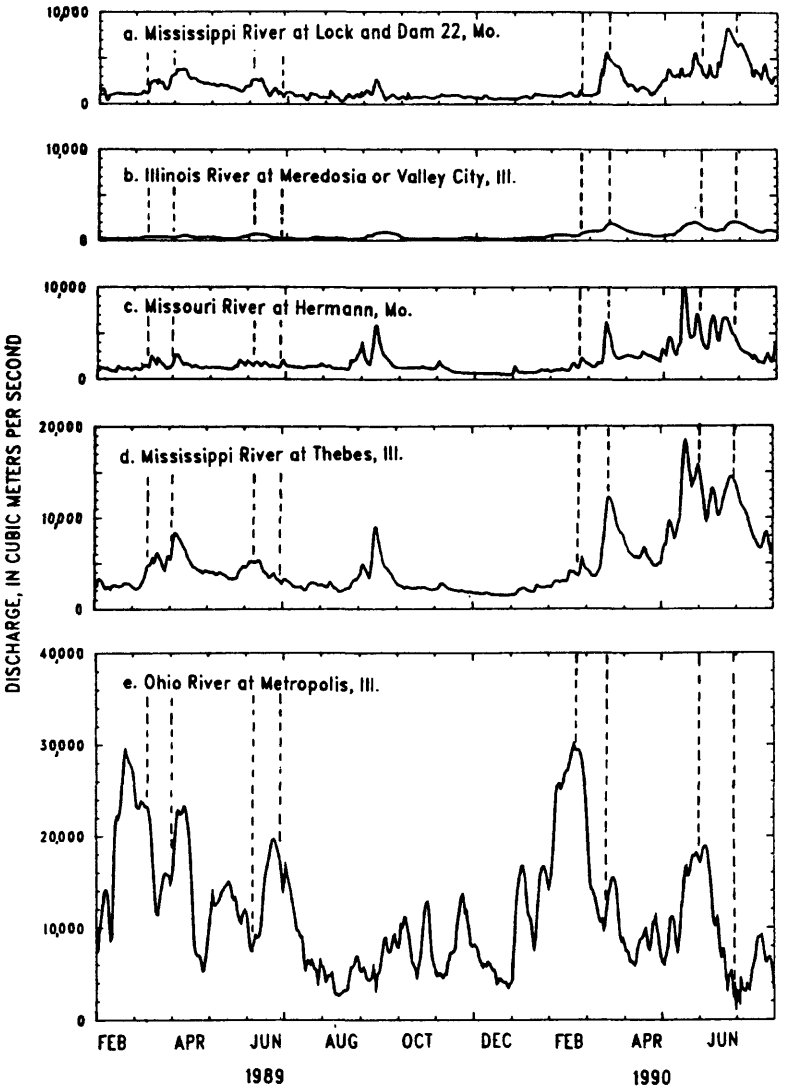


Figure 4.--Water discharge at two locations on the Upper Mississippi River and for three tributaries from February 1989 through July 1990. The period of time for each cruise is shown by two vertical dashed lines.

a. Lock and Dam 22 is on the Upper Mississippi River about 98 kilometers upstream from the sampling site near Winfield, Mo.
b. The discharge gaging station on the Illinois River was at Meredosia, Ill., from February 1989 through September 1989 and at Valley City, Ill., from October 1989 through July 1990. Meredosia is about 72 kilometers and Valley City is 63 kilometers upstream from the sampling site at Hardin, Ill.
c. Sampling site on the Missouri River.
d. Sampling site is on the Upper Mississippi River about 71 kilometers upstream from the confluence of the Upper Mississippi and Ohio Rivers.
e. The Ohio River at Metropolis, Ill., is about 29 kilometers upstream from the sampling site at Olmsted, Ill.

Discharge data are from the U.S. Geological Survey, except for the Mississippi River at Lock and Dam 22 (U.S. Army Corps of Engineers, Rock Island District, written commun., 1990).

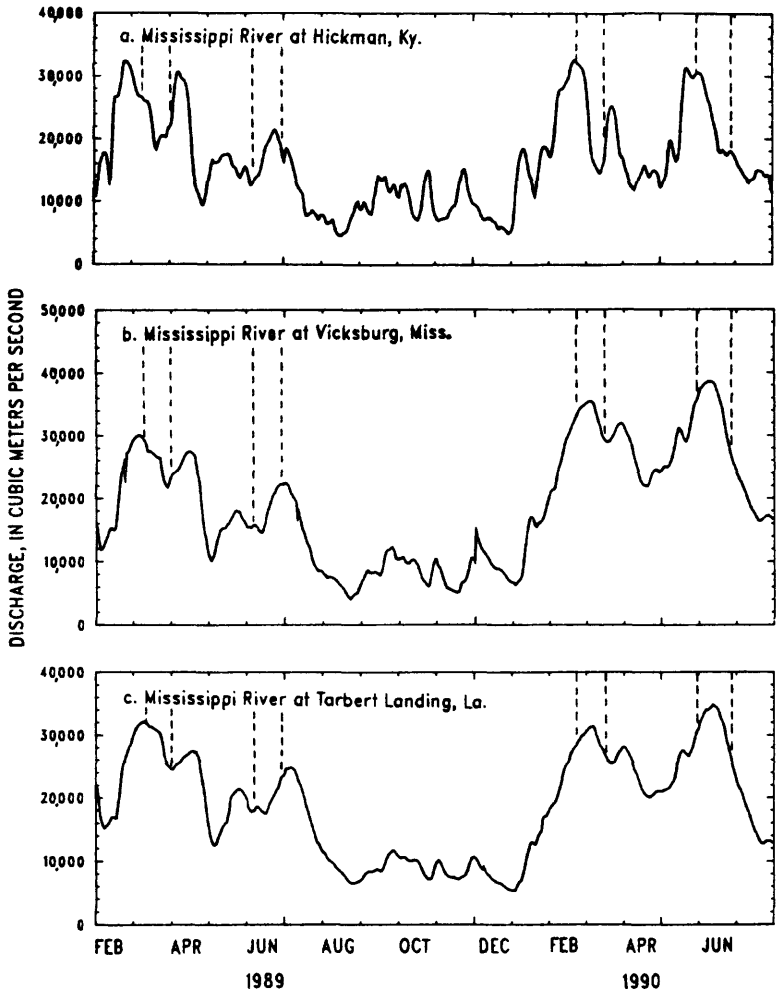


Figure 5.--Water discharge at three locations on the Lower Mississippi River from February 1989 through July 1990. The period of time for each cruise is shown by two vertical dashed lines.

a. Hickman, Ky., is about 58 kilometers downstream from the confluence of the Upper Mississippi and Ohio Rivers.

b. The discharge at Vicksburg, Miss., is near the maximum for the entire Mississippi River because, at 191 kilometers downstream from Vicksburg, approximately 25 percent of the water in the river is diverted through the Old River Outflow Channel into the Atchafalaya River.

c. Tarbert Landing, La., is about 13 kilometers downstream from the Old River Outflow Channel near Knox Landing, La., and 63 kilometers upstream from the sampling section near St. Francisville, La.

Discharge data are from the U.S. Army Corps of Engineers, Memphis District (Hickman) (1990?, 1991?); Vicksburg District (Vicksburg) (1990?, 1991?); and New Orleans District (Tarbert Landing) (1990?, 1991?).

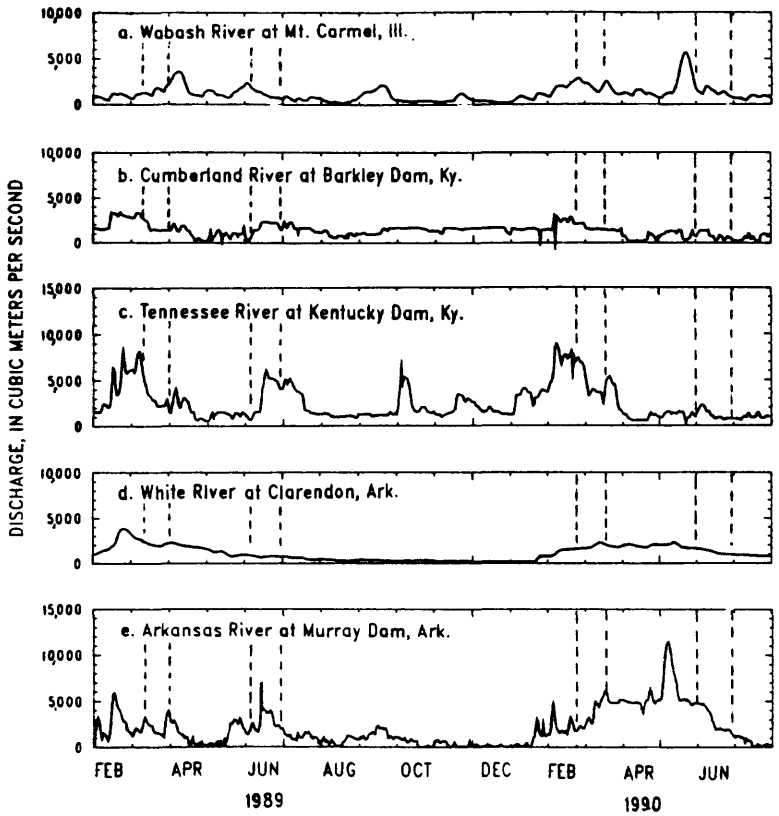


Figure 6.--Water discharge at locations on three secondary tributaries of the Mississippi River (Wabash, Cumberland, and Tennessee Rivers) and two tributaries of the Lower Mississippi River from February 1989 through July 1990. The period of time for each cruise is shown by two vertical dashed lines.

a. Mt. Carmel is about 130 kilometers upstream from the sampling site on the Wabash River.
b. Barkley Dam is about 39 kilometers upstream from the sampling site on the Cumberland River.
c. Kentucky Dam is about 18 kilometers upstream from the sampling site on the Tennessee River.
d. Clarendon is about 142 kilometers upstream from the sampling site on the White River at Mile 11.5, Ark.
e. Murray Dam is about 191 kilometers upstream from the sampling site on the Arkansas River at Pendleton, Ark. Bayou Meto is the primary tributary (mean discharge is less than 1 percent of Arkansas River) between Murray Dam and the sampling site on the Arkansas River.

Discharge data are from U.S. Geological Survey (Wabash, Cumberland, and Arkansas Rivers) and the U.S. Army Corps of Engineers, Memphis District (White River) (1990?, 1991?), and Cincinnati District (Tennessee River).

SAMPLING PROCEDURES AND RESULTS

The onsite sampling procedures were carried out from the ACADIANA and consisted of collecting representative samples of bed sediment, water, and suspended sediment, and of measuring physical and simple chemical properties of the water. Bed sediments were sampled at three to five locations across the channel to provide information for velocity, suspended-sediment, and bed-load calculations. Suspended sediments were collected at a number of locations or verticals spaced across the river channel by two different methods: (1) pumping from fixed depths, and (2) depth integration. For each of the two suspended-sediment sampling methods, the individual samples from each vertical across the river were combined to form two representative samples, which were processed differently--a pumped composite sample and a depth-integrated composite sample. While the depth-integrated sample was being collected, the physical (the water depth, the depth-integrated or depth-averaged velocity, and the surface temperature) and simple chemical (surface pH and surface specific conductance) properties of the water were measured at each location across the river.

This report is organized in the order in which the data are needed to investigate the movement, mixing, and storage processes of sediment-associated and dissolved pollutants. The detailed bed-sediment procedures and results are presented first because bed sediments affect velocities, suspended-sediment transport and bed-load transport. The water-discharge procedures and results are presented second because this information is needed to compute the flux of suspended sediment and dissolved constituents.

Suspended-sediment collecting methods, processing procedures, and results follow the "Water-Discharge" section. This section also briefly describes the procedures used for concentrating the suspended sediment finer than 63 μm. These procedures were carried out aboard the ACADIANA to reduce the sample volumes to a manageable size that could be shipped to the laboratory for chemical analyses. This report does not include a description of how each of the numerous chemical subsamples from the pumped and depth-integrated composites were prepared, treated, and processed in the laboratory.

The fourth section describes the procedures for determining the suspended-sediment concentration and particle sizes of both the suspended sand and the suspended silt and clay fractions. There also is a discussion of the reproducibility or precision and the accuracy of the depth-integration method as a function of the number of sampled verticals.

The last section discusses some surface-water properties measured at each sampling site and presents some additional data collected at sites where bed sediments and representative water and suspended-sediment samples were not collected.

Bed Sediments

A BM-54 sampler (Guy and Norman, 1970, p. 15) was used to collect bed-sediment samples for particle-size analyses. At the beginning of the measurements at each sampling site, while equipment was being set up for the water-discharge measurement and suspended-sediment sampling, the ship drifted downstream, and as it crossed the line of section a bed-sediment sample was collected. A fathometer (Lowrance, Model X16) was used to obtain a continuous record of depth; at the time each bed sample was taken a mark was made on this continuous trace of the river bottom. Samples generally were collected at 0.1, 0.3, 0.5, 0.7, and 0.9 of the distance between the left and right banks. Particle-size analyses were done at the U.S. Geological Survey Sediment Laboratory in Lakewood, Colorado, for the March-April 1989 cruise and at the USGS Sediment Laboratory in Iowa City, Iowa, for the June 1989, February-March 1990, and May-June 1990 cruises. The particle sizes (expressed in millimeters) are listed in tables 3-6 along with the median diameter determined by straight-line interpolation between appropriate particle sizes.

Table 3.--Particle size, determined by sieving, of bed material collected from the Mississippi River and some of its tributaries for March-April 1989 cruise

[Analyses by M.J. Werito, U.S. Geological Survey, Colorado Sediment Laboratory; m, meter; mm, millimeter]

Date 1989	Location in cross section (fraction of distance between left and right banks)	Depth of water (m)	Percent finer than indicated size (mm)													Median diameter[1] (mm)
			0.063	0.090	0.125	0.180	0.250	0.355	0.50	0.71	1.00	1.41	2.00	4.00	8.00	16.00	
3-10						Mississippi River near Winfield, Missouri[2]											
	0.1	7.5	0.5	0.8	1.5	2.6	4.6	20.0	52.6	82.1	95.3	98.7	99.7	100.0			0.48
	0.3	7.4	0.2	0.3	0.4	1.0	4.7	26.3	55.0	75.2	82.9	86.0	87.5	90.8	96.0	96.7	0.47
	0.5	5.6	0.7	0.9	1.0	2.0	6.0	22.1	47.6	70.3	83.9	90.9	95.7	99.5	100.0		0.52
	0.7	4.3	1.0	1.1	1.2	2.0	5.5	23.5	51.7	79.2	93.0	98.2	99.6	100.0			0.49
	0.9	3.8	0.8	1.1	1.3	1.9	5.4	30.1	68.5	88.7	96.0	98.0	98.9	99.5	100.0		0.43
3-12						Missouri River at Hermann, Missouri											
	0.2	5.9	0.1	0.1	0.3	3.6	43.2	95.7	99.4	99.7	99.8	99.9	100.0				0.26
	0.3	4.6	0.0	0.1	0.5	6.7	43.8	75.9	93.5	98.5	99.6	99.8	99.9	99.9	100.0		0.27
	0.5	4.2	0.0	0.0	0.2	2.8	17.6	38.7	60.7	74.4	82.4	87.3	90.9	96.3	98.6	100.0	0.43
	0.7	3.5	0.0	0.0	0.0	1.7	12.9	27.9	49.1	71.9	87.7	93.4	95.7	96.9	98.2	100.0	0.51
	0.9	4.2	0.0	0.0	0.0	0.8	7.2	16.2	31.9	53.2	72.9	85.0	91.8	99.0	100.0		0.68
3-13						Mississippi River at St. Louis, Missouri[2]											
	0.1	10.1	0.0	0.0	0.1	1.2	10.6	39.5	93.8	98.0	99.8	99.2	99.4	99.8	100.0		0.39
	0.3	8.6	0.0	0.0	0.2	2.5	42.2	82.0	95.3	97.1	97.5	97.7	97.9	98.7	99.6	100.0	0.27
	0.5	6.5	0.0	0.1	0.4	3.4	27.1	40.6	51.5	63.1	71.2	75.3	78.9	84.1	87.9	93.8	0.48
	0.7	4.9	0.0	0.0	0.2	1.8	19.1	47.7	63.1	78.3	86.5	89.9	91.5	94.1	97.6	100.0	0.38
	0.9	4.9	0.0	0.0	0.1	1.8	5.6	15.2	35.2	68.2	86.9	93.1	96.6	99.1	100.0		0.59
3-15						Mississippi River at Thebes, Illinois											
	0.3	9.4	0.0	0.0	0.1	0.6	1.7	5.6	22.9	42.7	58.5	71.6	81.7	95.4	99.3	100.0	0.84
	0.5	9.2	0.0	0.1	0.7	6.6	35.3	79.5	95.6	99.0	99.6	99.7	99.8	100.0			0.28
	0.7	7.5	0.1	0.1	0.4	3.3	12.8	40.5	74.5	93.3	98.5	99.5	99.8	99.9	100.0		0.40
	0.9	5.5	0.0	0.1	0.5	3.6	25.7	79.8	97.9	99.9	99.9	99.9	99.9	100.0			0.30
3-16						Ohio River at Olmsted, Illinois[2]											
	0.1	11.8	0.0	0.0	0.1	0.8	7.9	49.2	92.8	95.5	95.7	95.7	95.8	96.0	97.9	100.0	0.36
	0.3	13.9	0.0	0.0	0.0	0.3	2.9	16.9	65.2	87.0	91.6	93.2	94.3	95.8	98.9	100.0	0.45
	0.5	15.6	0.0	0.0	0.0	0.0	0.7	4.2	18.1	42.7	60.6	71.4	78.0	88.8	96.8	98.0	0.83
	0.7	18.5	0.0	0.0	0.0	0.1	0.7	5.8	31.4	60.6	73.7	81.1	87.1	94.8	99.4	100.0	0.63
	0.9	18.1	0.0	0.0	0.0	0.1	0.5	3.0	17.4	42.3	58.3	69.2	77.1	89.7	97.7	100.0	0.85
3-17						Mississippi River below Hickman, Kentucky[2]											
	0.3	13.0	0.0	0.0	0.0	0.2	1.0	2.2	6.0	20.0	37.4	49.4	60.3	78.6	90.7	96.9	1.42
	0.5	11.0	0.0	0.0	0.0	0.4	2.7	10.5	41.3	77.4	93.3	98.3	99.5	99.9	100.0		0.55
	0.7	16.2	0.0	0.0	0.0	1.1	6.4	10.8	17.4	31.3	48.2	61.2	72.3	89.0	98.1	100.0	1.06
	0.9	16.2	0.0	0.0	0.0	1.2	8.4	26.2	68.5	95.1	99.4	99.8	99.9	100.0			0.44
3-19						Mississippi River below Fulton, Tennessee											
	0.1	11.1	0.0	0.1	0.7	10.9	72.1	89.4	92.7	95.7	97.8	98.9	99.5	99.9	100.0		0.22
	0.3	11.7	0.0	0.0	0.2	1.8	9.4	44.7	87.4	97.5	99.4	99.8	99.9	100.0			0.37
	0.5	12.0	0.0	0.0	0.8	1.3	5.7	23.6	59.7	83.0	92.0	95.9	97.9	99.1	99.7	100.0	0.46
	0.7	12.5	0.0	0.0	0.0	0.4	3.4	22.9	50.8	82.7	96.2	99.1	99.6	99.9	100.0		0.50
	0.9	16.7	0.0	0.0	0.0	0.4	2.2	11.9	27.8	48.6	69.0	78.9	84.9	91.0	95.4	100.0	0.73
3-21						Mississippi River at Helena, Arkansas											
	0.3	17.8	0.0	0.0	0.0	0.1	0.4	2.0	13.2	59.9	91.8	97.0	98.0	98.5	99.0	100.0	0.67
3-22						White River at Mile 11.5, Arkansas											
	0.2	13.8	0.1	0.2	0.4	2.2	12.9	71.2	94.2	98.3	98.9	99.0	99.1	99.3	100.0		0.32
	0.5	12.6	0.2	0.2	0.3	1.7	11.1	33.8	72.4	92.1	96.1	97.5	98.4	99.5	100.0		0.42
	0.9	10.5	0.2	0.3	0.6	1.4	2.9	18.6	62.7	93.7	98.3	99.1	99.4	99.8	100.0		0.46
3-23						Arkansas River at Pendleton, Arkansas											
	0.3	5.1	0.0	0.1	0.5	3.6	23.7	60.7	84.3	96.3	99.1	99.7	99.8	99.9	100.0		0.32
	0.5	6.7	0.0	0.1	0.8	5.6	45.9	95.2	99.1	99.6	99.6	99.7	99.7	99.7	99.9	100.0	0.26
	0.7	8.8	0.0	0.0	0.0	1.3	19.1	90.1	97.9	99.6	99.9	100.0					0.30
3-24						Mississippi River above Arkansas City, Arkansas											
	0.1	10.4		Mud		with	some	sand									
	0.3	16.2	0.0	0.5	4.4	23.9	94.6	99.9	99.9	100.0							0.21
	0.5	20.8	0.0	0.0	0.0	1.2	20.9	62.5	87.1	91.4	91.8	92.1	92.3	93.0	94.2	100.0	0.32
	0.8	18.3	0.0	0.0	0.0	0.5	2.3	22.5	80.3	98.9	99.6	99.7	99.7	99.7	99.7	100.0	0.42
	0.9	18.0	0.0	0.1	0.3	2.0	8.4	21.8	53.0	79.9	87.1	91.2	93.7	97.1	98.5	100.0	0.49

Table 3.--Particle size, determined by sieving, of bed material collected from the Mississippi River and some of its tributaries for March-April 1989 cruise--Continued

Date 1989	Location in cross section (fraction of distance between left and right banks)	Depth of water (m)	Percent finer than indicated size (mm)													Median diameter[1] (mm)
			0.063	0.090	0.125	0.180	0.250	0.355	0.50	0.71	1.00	1.41	2.00	4.00	8.00	16.00	
3-26							Yazoo River below Steele Bayou, Mississippi										
	0.5	15.7	0.0	0.1	0.1	0.2	0.9	17.7	66.1	97.0	99.7	99.9	100.0				0.45
3-27							Mississippi River below Vicksburg, Mississippi										
	0.1	21.4	0.0	0.0	0.1	1.2	8.2	46.7	88.1	93.1	94.4	95.5	96.3	97.6	99.3	100.0	0.37
	0.3	19.7	0.0	0.0	0.0	0.3	1.8	23.6	58.0	80.8	95.9	98.8	99.3	99.6	100.0		0.47
	0.5	17.0	0.0	0.0	0.1	1.6	19.9	69.8	96.7	99.9	100.0						0.32
	0.7	11.5	0.0	0.0	0.1	1.8	21.9	95.5	100.0								0.29
	0.9	9.6	0.5	1.4	5.8	33.0	86.9	98.7	99.9	100.0							0.20
3-29							Old River Outflow Channel near Knox Landing, Louisiana										
	0.1	13.5	0.2	0.3	0.7	4.1	42.3	65.1	89.4	97.8	98.9	99.2	99.3	99.5	100.0		0.29
	0.3	13.0	0.1	0.2	0.5	2.3	24.1	79.1	94.8	99.2	99.6	99.7	99.7	99.8	100.0		0.30
	0.5	12.0	0.1	0.2	0.6	4.1	25.2	73.1	91.3	98.8	99.6	99.6	99.6	99.6	99.7	100.0	0.30
	0.7	10.2	0.2	0.3	0.7	5.2	25.0	71.1	92.1	99.2	99.8	99.9	99.9	99.9	100.0		0.31
	0.9	10.5	0.1	0.3	0.8	5.8	23.7	63.7	91.1	99.0	99.5	99.5	99.6	99.6	99.8	100.0	0.32
3-30							Mississippi River near St. Francisville, Louisiana										
	<0.1	10.1	11.4	20.2	55.7	92.1	97.4	99.6	99.9	100.0							0.12
	0.1	15.5	0.3	2.4	16.1	73.6	99.6	99.9	100.0								0.16
	0.4	14.2	0.0	1.0	5.5	30.9	98.4	99.8	100.0								0.20
	0.5	17.3	0.1	0.1	0.7	9.6	78.1	99.2	100.0								0.22
	0.7	18.5	0.0	0.1	0.2	1.4	7.5	45.6	98.3	100.0							0.37
	0.9	19.5	0.0	0.0	0.1	0.5	2.0	12.8	78.1	99.8	100.0						0.44
4-01							Mississippi River below Belle Chasse, Louisiana										
	0.1	24.6	0.1	1.1	11.8	70.9	98.4	100.0									0.16
	0.4	25.6	0.0	0.7	4.9	23.6	80.0	98.9	100.0								0.21
	0.6	25.8	0.0	0.2	1.0	5.1	27.7	82.7	99.4	100.0							0.29
	0.7	24.7	0.0	0.2	0.9	4.7	18.7	94.2	99.8	99.9	100.0						0.29
	0.9	23.4	0.3	0.7	3.5	28.2	88.6	99.2	99.7	99.8	100.0						0.21

[1]Median diameter determined by straight-line interpolation.
[2]Percent finer than 32.0 mm is 100.0.

Table 4.--Particle size, determined by sieving, of bed material collected from the Mississippi River and some of its tributaries for June 1989 cruise

[Analyses by U.S. Geological Survey Sediment Laboratory in Iowa City, Iowa; m, meter; mm, millimeter; --, no measurement]

Date 1989	Location in cross section (fraction of distance between left and right banks)	Depth of water (m)	Percent finer than indicated size (mm)													Median diameter[1] (mm)
			0.063	0.090	0.125	0.180	0.250	0.355	0.50	0.71	1.00	1.41	2.00	4.00	8.00	16.00	
6-05			Mississippi River near Winfield, Missouri														
	0.1	8.5	0.1	0.2	0.2	0.3	1.0	11.9	36.3	71.0	85.6	96.3	96.3	99.1	99.8	100.0	0.58
	0.3	8.8	0.0	0.1	0.5	2.7	7.2	29.6	55.6	74.7	84.7	93.6	93.6	97.3	99.7	100.0	0.47
	0.5	6.7	0.0	0.1	0.2	1.2	6.1	30.6	64.0	87.1	95.9	98.3	99.7	100.0			0.44
	0.7	5.2	0.0	0.0	0.3	1.5	6.6	27.3	42.6	67.3	77.4	82.6	88.2	95.0	99.9	100.0	0.56
	0.9	3.9	0.4	0.6	0.8	1.0	2.1	18.2	53.4	82.8	94.9	98.3	99.9	100.0			0.49
6-07			Missouri River at Hermann, Missouri														
	0.1	7.0	0.0	0.0	0.0	0.2	1.6	9.9	31.1	58.8	78.4	91.6	91.6	94.9	96.4	100.0	0.64
	0.3	5.9	0.0	0.1	0.5	7.5	49.4	97.5	99.3	99.7	99.8	99.9	99.9	100.0			0.25
	0.6	4.7	0.0	0.0	0.3	3.3	26.7	80.4	96.6	99.4	99.7	99.9	99.9	100.0			0.30
	0.8	4.2	0.0	0.0	0.0	0.7	8.4	34.6	67.0	88.6	96.8	99.0	99.0	99.2	100.0		0.42
	0.9	4.5	0.0	0.0	0.1	0.3	3.1	20.9	55.5	88.2	96.6	99.6	99.6	100.0			0.48
6-08			Mississippi River at St. Louis, Missouri														
	0.2	10.9	0.0	0.0	0.1	0.9	9.9	64.0	96.1	98.8	99.1	99.3	99.3	99.4	99.8	100.0	0.33
	0.4	8.6	0.0	0.1	0.1	1.7	15.7	59.4	92.9	98.9	99.2	99.2	99.2	99.2	100.0		0.33
	0.6	7.1	0.0	0.1	0.5	3.2	20.9	70.8	92.9	97.1	98.3	99.2	99.2	99.7	100.0		0.31
	0.8	6.1	0.0	0.1	0.3	2.2	13.0	44.7	63.5	81.4	88.6	93.8	93.8	96.4	97.7	100.0	0.40
	0.9	6.6	0.0	0.0	0.2	2.3	10.0	30.3	46.3	63.7	75.9	90.5	90.5	98.0	99.8	100.0	0.54
6-10			Mississippi River at Thebes, Illinois														
	0.2	9.7	0.0	0.0	0.2	1.3	3.7	7.9	11.3	15.4	20.0	24.6	35.6	60.1	84.6	100.0	3.18
	0.4	8.3	0.0	0.0	0.2	2.7	15.7	54.3	65.5	79.0	88.2	91.7	95.8	99.1	100.0		0.34
	0.6	7.8	0.0	0.0	0.2	5.0	23.5	63.6	75.1	88.4	94.8	97.2	98.8	99.5	99.5	100.0	0.32
	0.8	5.0	0.0	0.0	0.1	1.3	12.1	66.5	94.9	99.4	99.8	99.8	99.8	99.9	100.0		0.32
6-11			Ohio River at Olmsted, Illinois[2]														
	0.1	6.5	0.2	0.4	0.8	2.1	13.0	60.8	87.1	89.9	90.0	90.1	90.2	90.7	95.3	100.0	0.33
	0.3	7.9	0.0	0.1	0.2	0.6	2.8	13.2	42.5	62.6	70.1	73.9	80.8	92.8	98.8	100.0	0.58
	0.5	12.1	0.1	0.3	0.6	1.8	5.5	15.7	35.6	50.3	57.7	61.7	67.9	77.9	89.0	98.3	0.71
	0.7	11.0	0.0	0.0	0.0	0.1	0.3	2.5	14.3	44.1	66.4	78.7	90.5	97.8	99.8	100.0	0.79
	0.9	12.6	0.1	0.2	0.4	2.0	14.2	25.1	32.0	48.0	61.6	70.1	81.4	93.3	98.2	100.0	0.75
6-12			Mississippi River below Hickman, Kentucky														
	0.3		Gravel.														
	0.5	8.1	0.0	0.0	0.1	1.2	11.8	51.2	71.2	84.4	91.7	93.8	95.6	96.6	97.4	100.0	0.35
	0.7	11.3	0.0	0.0	0.0	0.8	10.3	36.7	67.7	88.2	95.8	97.4	99.0	99.8	100.0		0.42
	0.9	12.5	0.0	0.0	0.1	0.7	8.5	38.3	71.5	89.9	96.4	98.0	98.9	99.6	99.6	100.0	0.41
6-14			Mississippi River at Fulton, Tennessee														
	0.1		Possible rock ledge.														
	0.3	14.0	0.0	0.0	0.0	0.1	0.3	1.5	13.7	45.4	67.6	78.1	87.8	94.3	97.8	100.0	0.77
	0.5	15.2	0.0	0.0	0.0	0.5	3.7	14.5	37.6	84.4	98.6	99.9	100.0				0.56
	0.7	12.8	0.0	0.1	0.5	5.7	23.9	56.3	92.6	99.8	100.0						0.33
	0.9	7.0	0.3	0.9	3.5	11.0	47.8	66.8	70.3	78.2	84.1	87.3	91.0	94.1	96.1	100.0	0.26
6-17			Mississippi River at Helena, Arkansas[3]														
	0.1		Pebbles in jaw of BM54 allowed sample to wash out.														
	0.3	13.2	0.0	0.0	0.0	0.2	1.2	15.9	42.1	77.8	93.5	--	98.8	99.3	100.0		0.55
	0.5	15.0	0.1	0.1	0.3	3.2	27.5	80.8	98.1	99.0	99.7	--	99.9	100.0			0.29
	0.7	17.6	0.1	0.2	1.1	6.7	18.6	55.6	79.9	97.3	99.3	--	99.9	100.0			0.34
	0.9	9.0	0.0	0.0	0.3	0.7	1.1	3.1	20.7	62.5	84.8	--	96.4	98.3	99.4	100.0	0.65
6-18			White River at Mile 11.5, Arkansas[3]														
	0.2	10.0	0.2	0.4	0.5	0.9	4.5	29.6	93.9	98.9	99.4	--	99.7	100.0			0.40
	0.4	9.3	0.3	0.4	0.5	2.3	16.2	53.6	85.4	94.3	97.1	--	99.0	100.0			0.34
	0.8	8.7	0.3	0.4	0.5	1.2	6.3	43.0	72.2	93.5	96.9	--	99.2	100.0			0.39
6-19			Arkansas River at Pendleton, Arkansas[3]														
	0.1	4.8	0.1	0.4	0.4	1.6	15.9	51.1	78.7	94.7	98.5	--	99.7	100.0			0.35
	0.4	6.5	0.1	0.2	0.8	5.9	59.3	98.5	99.8	100.0							0.24
	0.5	7.0	0.0	0.1	0.7	5.4	46.3	95.1	99.7	100.0							0.26
	0.7	8.0	0.1	0.1	0.3	2.9	26.5	83.6	86.5	99.9	100.0						0.29
	0.9	15.6	0.0	0.0	0.3	2.1	23.6	90.1	99.1	100.0							0.29

Table 4.--Particle size, determined by sieving, of bed material collected from the Mississippi River and some of its tributaries for June 1989 cruise--Continued

Date 1989	Location in cross section (fraction of distance between left and right banks)	Depth of water (m)	Percent finer than indicated size in millimeters (mm)													Median diameter[1] (mm)
			0.063	0.090	0.125	0.180	0.250	0.355	0.50	0.71	1.00	1.41	2.00	4.00	8.00	16.00	
6-20			Mississippi River above Arkansas City, Arkansas[2,3]													
	0.1	7.9	48.4	56.5	72.2	92.8	98.4	99.4	99.7	100.0							0.07
	0.3	17.1	0.1	0.2	0.9	8.6	57.5	96.3	99.7	99.9	100.0						0.24
	0.5	20.0	0.0	0.0	0.0	0.8	9.1	71.5	96.7	100.0							0.32
	0.7	18.2	0.0	0.0	0.1	0.2	0.6	9.4	74.2	98.8	100.0						0.45
	0.9	16.5	0.6	1.3	4.9	19.2	37.1	46.2	51.1	53.2	53.8	--	55.1	57.5	63.2	77.3	0.47
6-22			Yazoo River below Steele Bayou, Mississippi[3]													
	0.5	13.8	0.1	0.1	0.2	0.3	0.8	6.1	37.3	82.5	94.7	--	98.5	99.3	100.0		0.56
6-23			Mississippi River below Vicksburg, Mississippi[2,3]													
	0.1	20.3	0.0	0.1	0.1	0.3	1.1	7.2	20.3	32.8	35.9	--	42.6	53.9	73.0	87.8	3.31
	0.3	17.3	0.0	0.0	0.0	0.3	2.1	20.5	77.1	95.4	98.9	--	99.7	100.0			0.43
	0.5	14.4	0.0	0.1	0.2	2.6	20.5	85.8	99.6	99.9	99.9	--	99.9	100.0			0.30
	0.7	10.1	0.0	0.1	0.4	2.6	14.6	88.5	99.9	100.0							0.30
	0.9	8.5	0.0	0.0	0.5	3.8	25.7	98.5	100.0								0.29
6-25			Old River Outflow Channel near Knox Landing, Louisiana[3]													
	0.1	12.0	58.5	82.7	97.9	99.5	99.8	99.8	100.0								unknown
	0.3	11.8	2.0	5.9	12.5	16.4	36.6	85.2	95.7	99.2	99.7	--	99.9	100.0			0.28
	0.5	10.5	0.8	3.0	11.1	22.2	45.5	81.8	90.8	96.1	97.8	--	99.1	99.8	100.0		0.26
	0.7	8.5	0.2	1.0	3.3	11.0	43.7	94.1	97.6	98.5	98.5	--	98.6	98.8	100.0		0.26
	0.9	9.2	0.2	1.3	3.3	6.6	28.0	78.3	94.4	98.9	99.1	--	99.2	99.6	100.0		0.30
6-26			Mississippi River near St. Francisville, Louisiana													
	0.1	9.7	76.8	90.2	96.5	98.4	99.0	99.4	100.0								unknown
	0.3	13.6	0.2	0.9	8.0	47.8	98.3	99.5	99.6	99.7	99.7	99.8	99.8	100.0			0.18
	0.5	13.4	0.1	0.2	0.5	4.9	44.3	96.1	99.7	100.0							0.26
	0.6	16.5	0.0	0.1	0.3	1.9	13.3	73.0	97.9	100.0							0.31
	0.9	17.5	0.0	0.0	0.0	0.2	0.9	7.0	35.0	75.9	96.8	98.0	98.9	99.6	100.0		0.58
6-28			Mississippi River below Belle Chasse, Louisiana													
	0.3	24.1	0.2	2.4	16.0	67.5	93.0	99.8	100.0								0.16
	0.5	27.0	0.1	0.3	2.3	12.5	38.2	86.9	98.9	100.0							0.28
	0.7	28.6	0.1	0.3	2.8	13.0	46.1	94.1	99.1	100.0							0.26
	0.9	28.6	3.6	7.8	19.5	59.8	94.1	99.1	99.7	99.8	99.9	99.9	100.0				0.16

[1]Median diameter determined by straight-line interpolation.
[2]Percent finer than 32 mm is 100.0.
[3]The 1.41-mm sieve was not used.

Table 5.--Particle size, determined by sieving, of bed material collected from the Mississippi River and some of its tributaries for February-March 1990 cruise

[Analyses by U.S. Geological Survey Sediment Laboratory in Iowa City, Iowa; m, meter; mm, millimeter]

Date 1990	Location in cross section (fraction of distance between left and right banks)	Depth of water (m)	Percent finer than indicated size (mm)													Median diameter[1] (mm)
			0.063	0.090	0.125	0.180	0.250	0.355	0.50	0.71	1.00	1.41	2.00	4.00	8.00	16.00	
3-01						Ohio River at Uniontown, Kentucky											
	0.3	9.8	0.1	0.2	0.3	0.5	4.8	37.4	65.3	78.1	84.8	87.8	91.5	96.5	99.0	100.0	0.42
	0.5	12.0	0.1	0.1	0.1	0.3	1.1	5.1	18.6	49.4	68.2	77.3	86.7	95.2	99.0	100.0	0.71
	0.8	12.5	0.1	0.2	0.3	0.5	1.1	3.3	4.3	5.5	6.5	7.0	8.3	10.6	17.9	43.6	unknown
2-28						Wabash River near New Haven, Illinois											
	0.2	7.9	0.0	0.1	0.3	1.2	4.2	21.0	47.7	73.8	84.7	89.1	93.2	97.2	99.0	100.0	0.52
	0.5	7.2	0.1	0.2	0.3	0.6	3.1	9.4	21.2	35.6	49.9	59.4	71.7	85.2	95.3	100.0	1.00
	0.8	4.9	0.2	0.3	0.6	1.2	6.7	17.5	26.7	36.4	42.4	46.9	56.0	75.3	93.4	100.0	1.61
2-23						Cumberland River near Smithland, Kentucky											
						Gravel prevented collection of a representative sample.											
2-24						Tennessee River near Calvert City, Kentucky											
						No sample.											
3-03						Ohio River at Olmsted, Illinois											
	0.2	10.6	0.0	0.0	0.1	0.3	4.2	41.8	73.6	80.0	80.8	81.1	81.4	83.5	92.5	100.0	0.39
	0.5	15.7	0.0	0.0	0.0	0.1	1.2	12.0	30.5	51.8	63.4	70.3	80.0	91.2	97.1	100.0	0.69
	0.8	15.0	0.0	0.0	0.0	0.0	0.2	1.9	14.5	37.1	52.2	59.4	70.9	88.0	98.2	100.0	0.96
3-04						Mississippi River below Hickman, Kentucky[2]											
	0.2	12.1	0.0	0.0	0.1	0.2	0.8	1.3	3.1	12.8	21.5	27.1	36.1	54.1	77.6	98.1	3.54
	0.5	11.0	0.0	0.0	0.0	0.2	1.9	5.2	13.7	23.0	30.3	38.5	56.7	82.7	96.5	100.0	1.78
	0.9	17.1	0.0	0.1	0.1	1.5	19.2	43.1	76.7	93.7	98.7	99.4	99.7	99.9	100.0		0.38
3-05						Mississippi River below Fulton, Tennessee											
	0.2	12.7	0.0	0.0	0.1	1.0	8.5	49.6	85.4	96.1	98.7	99.1	99.2	99.4	100.0		0.36
	0.5	13.0	0.0	0.0	0.0	0.1	1.6	7.1	17.3	64.3	91.1	95.5	97.3	97.9	98.6	100.0	0.65
	0.8	15.0	0.1	0.2	0.3	0.8	4.1	13.9	26.1	65.9	82.1	85.7	89.0	93.8	98.1	100.0	0.63
3-07						Mississippi River at Helena, Arkansas											
	0.2	14.5	0.0	0.0	0.0	0.1	0.2	0.9	6.7	33.7	65.6	79.4	88.6	93.9	97.4	100.0	0.86
	0.5	21.7	0.0	0.0	0.2	2.1	17.9	73.9	95.9	99.4	99.8	99.9	100.0				0.31
	0.7	23.6	0.0	0.2	1.9	16.7	74.3	96.1	96.2	99.6	99.8	99.8	99.9	99.9	100.0		0.22
03-08						Mississippi River above Arkansas City, Arkansas											
						No bed material was collected.											
3-10						Mississippi River below Vicksburg, Mississippi											
	0.2	22.5	0.0	0.1	0.6	5.8	60.7	96.9	98.3	98.7	99.0	99.1	99.1	99.3	99.3	100.0	0.24
	0.4	20.3					Insufficient material.										
	0.8	9.8	0.0	0.1	0.3	4.5	38.2	97.9	100.0								0.27
3-12						Mississippi River near St. Francisville, Louisiana											
	0.2	16.2	0.4	3.0	20.8	77.8	98.9	99.6	99.9	100.0							0.15
	0.3	16.4					Insufficient material.										
	0.5	18.6	0.0	0.1	1.7	18.0	69.8	95.9	99.6	100.0							0.22
	0.7	19.5	0.0	0.0	0.0	0.6	5.8	36.6	92.8	99.9	100.0						0.39
	0.8	21.1	0.0	0.0	0.1	1.1	4.0	23.3	76.8	99.8	100.0						0.43
3-14						Mississippi River below Belle Chasse, Louisiana											
	0.2	25.1	0.0	0.2	3.0	25.8	69.0	94.8	99.3	100.0							0.22
	0.5	27.5	0.0	0.2	0.8	3.2	11.4	61.6	92.8	99.7	100.0						0.33
	0.8	24.0	0.0	0.0	0.1	0.5	3.1	12.6	60.7	95.3	99.7	100.0					0.47

[1]Median diameter determined by straight-line interpolation.
[2]Percent finer than 32 mm is 100.0.

Table 6.--Particle size, determined by sieving, of bed material collected from the Mississippi River and some if its tributaries for the second leg of the May-June 1990 cruise

[Analyses by U.S. Geological Survey Sediment Laboratory in Iowa City, Iowa; m meter, mm, millimeter]

Date 1990	Location in cross section (fraction of distance between left and right banks)	Depth of water (m)	Percent finer than indicated size (mm)														Median diameter (mm)
			0.063	0.090	0.125	0.180	0.250	0.355	0.50	0.71	1.00	1.41	2.00	4.00	8.00	16.00	
6-07							Illinois River at Valley City, Illinois										
	0.5	8.9	0.1	0.1	0.2	0.6	3.1	26.1	54.7	77.7	90.3	95.0	97.8	99.4	99.9	100.0	0.48
6-11							Mississippi River below Grafton, Illinois										
	0.1	8.6	0.0	0.0	0.1	0.2	1.6	10.4	35.6	61.1	78.3	85.6	91.9	97.1	99.3	100.0	0.62
	0.4	6.3	0.0	0.1	0.3	2.3	10.7	41.4	79.3	93.8	97.3	98.3	99.1	99.7	100.0		0.39
	0.7	7.4	0.1	0.1	0.8	0.9	6.3	34.2	70.0	89.2	96.3	98.3	99.5	99.9	100.0		0.42
6-13							Mississippi River at Thebes, Illinois[2]										
	0.3	14.0	0.0	0.0	0.1	0.3	1.3	2.9	15.1	41.9	59.2	67.6	75.7	85.0	90.4	97.8	0.85
	0.7	12.1	0.0	0.1	2.7	3.7	20.1	61.5	71.2	83.2	92.6	96.5	99.2	99.8	100.0		0.33
6-14							Ohio River at Olmsted, Illinois										
	0.1	9.6	0.2	0.4	1.0	2.2	11.2	70.4	96.5	99.1	99.5	99.6	99.7	100.0			0.32
	0.5	13.7	0.0	0.1	0.1	0.1	0.3	6.3	31.8	57.7	74.8	84.1	93.6	99.0	99.9	100.0	0.65
	0.9	14.7	0.4	0.5	0.6	0.7	1.0	1.5	5.3	20.7	41.4	55.4	71.9	91.5	99.5	100.0	1.25
6-18							Mississippi River below Memphis, Tennessee										
	0.2	10.8	0.0	0.0	0.0	0.1	0.2	2.6	19.1	54.1	77.6	87.9	95.8	98.9	99.2	100.0	0.69
	0.5	20.5	0.0	0.0	0.1	0.8	4.7	17.4	59.1	93.8	99.1	99.8	99.9	100.0			0.47
	0.8	18.0	0.0	0.0	2.4	2.8	14.7	81.6	99.3	99.8	99.8	99.9	100.0				0.31
6-20							Mississippi River below Arkansas City, Arkansas[2]										
	0.2	9.0	0.1	0.2	1.1	12.1	67.6	97.8	99.7	99.9	99.9	100.0					0.23
	0.5	17.0	0.0	0.1	0.1	1.5	17.7	65.2	96.9	99.8	99.9	100.0					0.32
	0.8	23.0	0.0	0.0	0.1	0.2	0.5	3.2	14.4	20.1	25.8	30.6	36.9	47.8	68.6	86.2	4.42
6-22							Yazoo River below Steele Bayou, Mississippi[3]										
	0.1	14.6	0.0		9.0		70.5		99.0		100.0						0.21
	0.5	15.3	0.1	0.1	0.2	0.2	0.8	26.2	84.2	99.4	100.0						0.41
	0.8	7.7	0.0		57.0		97.9		100.0								0.12
6-23							Mississippi River below Vicksburg, Mississippi[2]										
	0.2	20.5	0.0	0.0	0.0	0.1	0.5	2.3	10.6	28.2	41.5	48.8	57.1	69.8	80.3	90.4	1.50
	0.5	18.2	0.1	0.1	1.9	2.2	21.8	88.4	99.4	100.0							0.29
	0.8	9.1	0.0	0.1	0.3	3.0	27.2	96.1	100.0								0.28
6-25							Mississippi River near St. Francisville, Louisiana										
	0.2	15.0	0.1	0.7	46.4	59.4	99.2	100.0									0.14
	0.5	17.8	0.0	0.1	0.8	7.0	47.4	98.5	99.7	99.8	99.9	99.9	100.0				0.26
	0.8	20.4	0.0	0.0	0.3	0.4	1.1	10.9	76.6	98.8	99.6	99.6	99.7	99.7	100.0		0.44
6-27							Mississippi River below Belle Chasse, Louisiana										
	0.2	31.2	0.3	1.0	8.5	63.1	88.1	97.4	99.0	99.5	99.7	99.8	99.8	100.0			0.17
	0.5	21.8	0.0	0.0	4.1	4.1	15.6	60.2	95.6	99.9	99.9	100.0					0.33
	0.8	15.0	0.0	0.2	1.0	5.4	15.1	73.1	99.1	99.9	99.9	99.9	99.9	100.0			0.31

[1]Median diameter determined by straight-line interpolation.

[2]Percent finer than 32 mm is 100.0.

[3]Samples at depths of 14.6 and 7.7 m were too small for sieving. Particle size was measured with the visual-accumulation tube and only whole phi sizes were determined.

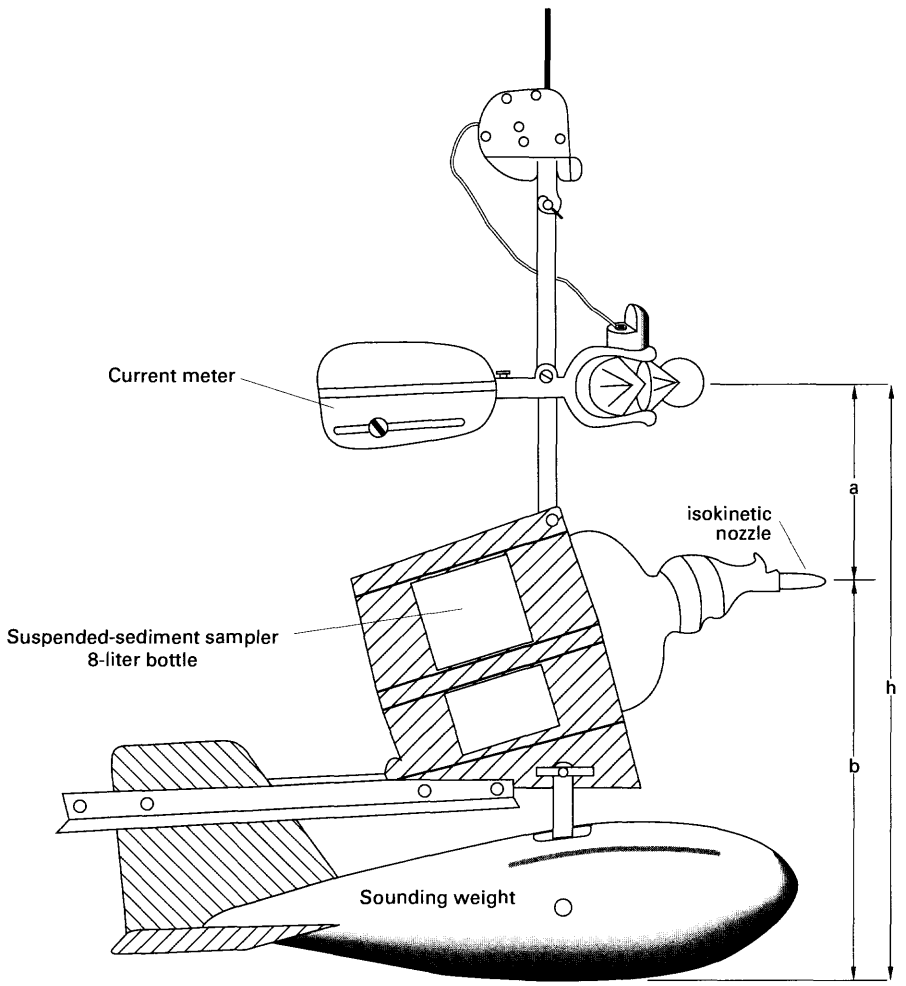
Water Discharge

The depth-averaged velocity was measured by depth integration from the river bottom to the river surface at several locations (referred to as verticals) across the river. The current meter (a Price AA with a solid, polymer bucket wheel; fig. 7) and suspended-sediment sampler were first lowered to the bottom at a constant transit rate. The depth-averaged velocity was determined only during the upcast because the current meter was not in the turbulent wake of the suspended-sediment sampler bottle. Ideally, for discharge measurements, the transit rate should be as slow as possible so that the integration time is as long as possible. However, at very slow transit rates the suspended-sediment sampler would overfill. The transit rate was therefore determined by the requirements for collecting a total composite sample of 100 to 130 L of water and suspended sediment (see Nordin and others, 1983) and keeping the transit rate less than 20 percent of the mean velocity (based on unpublished data for the Amazon River) in order to obtain a reliable measurement of velocity and hence discharge.

Because the ship usually was not anchored during the vertical sampling procedure, the measured velocities were corrected for ship drift according to procedures described by Moody and Troutman (1992). Two microwave transmitter/receiver stations on shore and a master station (Del Norte Technology Trisponder system) aboard the ship were used to measure the change in upriver-downriver and cross-river position. The mean depth was obtained from the fathometer, which produced a continuous strip-chart record of depth during the upcast. In the Mississippi River, the depth-averaged velocity was measured at 13 to 36 equally spaced vertical locations across the river. In most tributaries, which were narrower than the Mississippi River, the depth-averaged velocity was measured at 5 to 14 vertical locations across the river. At some sampling sites, especially those where cross sections were asymmetrical and the discharge per unit width was large, additional verticals were occupied in order to measure additional velocities. At these additional verticals, even though no suspended-sediment sample was collected, a sample bottle was put in the holder so that the current-meter calibration was not altered. The calibration equation had a standard error less than 1 cm/s.

This method of measuring discharge has associated bias and standard errors, as discussed by Moody and Troutman (1992). Most of the error in the discharge measurement results from errors in measuring the depth-averaged velocity. The major bias is the incomplete depth-integration error (2-5 percent) incurred because the measurement of velocity is started slightly above the bottom (see h in fig. 7). This error can be estimated by assuming a theoretical velocity profile dependent upon the roughness length scale, z_o, the water depth, D, and the height, h, of the unmeasured zone. The major source of standard error comes from the natural variability (which is assumed to be random) of river velocities. The standard error of the natural variability is about 5-12 percent of the mean velocity. Typical standard errors in discharge are between 1 and 2 percent. Because the total discharge is essentially a statistically weighted mean of the random velocities, the total discharge error is reduced by the averaging process. The bias and standard errors have been estimated for each discharge measurement according to the methods discussed by Moody and Troutman (1992) (see tables 7-10). The estimated bias error generally is positive (overestimated) because the

velocities in the unmeasured zone near the bottom (where velocities are lowest) have not been included in determining the mean velocity. However, at some sections where only a few verticals were measured, this positive bias error may be smaller than the negative bias error that results from neglecting the flow between the banks and halfway out to the first or last vertical; thus the total bias error is negative (for example see White River, tables 7 and 8, and Mississippi River near Cache, Ill., in table 9). The standard errors in discharge were 5 percent or less and generally were 1 or 2 percent.



DISTANCE, IN CENTIMETERS

WEIGHT, IN POUNDS	a	b	h
150	22	42	64
200	22	45	67
300	22	48	70

Figure 7.--Suspended-sediment sampler with current meter. No water velocity is measured in a zone of height, h, above the bottom.

Table 7.--Summary of discharge measurements made of the Mississippi River and some of its tributaries using the depth-integration method for March-April 1989 cruise

[All velocity measurements were made with a Price AA solid, polymer bucket-wheel current meter with calibration equation: velocity (m/s) = 0.765 × revolutions per second + 0.006; NC indicates that discharge was measured by a different method and errors were not calculated; m, meter; m^2, square meter; m/s, meter per second; m^3/s, cubic meter per second; %, percent]

Date 1989	Site name	Width (m)	Area (m^2)	Mean depth (m)	Mean velocity (m/s)	Discharge		
						Magnitude (m^3/s)	Errors	
							Bias (%)	Standard (%)
3-10	Mississippi R. near Winfield, Mo.	552	2,930	5.3	0.29	850	9	2
3-09	Illinois R. at Hardin, Ill.[1]	269	1,090	4.1	0.38	410	NC	NC
3-12	Missouri R. at Hermann, Mo.	270	1,220	4.5	1.21	1,480	7	2
3-13	Mississippi R. at St. Louis, Mo.	490	3,380	6.9	1.16	3,940	6	1
3-15	Mississippi R. at Thebes, Ill.	602	4,390	7.3	1.11	4,890	6	1
3-16	Ohio R. at Olmsted, Ill.	1,070	14,690	13.7	1.39	20,400	4	1
3-17	Mississippi R. below Hickman, Ky.	1,165	14,960	12.8	1.65	24,700	4	1
3-19	Mississippi R. below Fulton, Tenn.	1,337	16,210	12.1	1.53	24,800	4	1
3-21	Mississippi R. at Helena, Ark.	913	15,090	16.5	1.72	25,900	4	1
3-22	White R. at Mile 11.5, Ark. estimate of in-channel flow, no estimate of overbank flow	200	2,060	10.3	0.73	1,500	-3	4
3-23	Arkansas R. at Pendleton, Ark.	380	2,690	7.1	0.71	1,900	6	2
3-24	Mississippi R. above Arkansas City, Ark.	1,035	16,420	15.9	1.63	26,800	3	1
3-26	Yazoo R. below Steele Bayou, Miss.	182	1,890	10.4	0.79	1,500	4	2
3-27	Mississippi R. below Vicksburg, Miss.	1,210	17,510	14.5	1.52	26,600	3	1
3-29	Old River Outflow Channel near Knox Landing, La.	556	6,180	11.1	1.00	6,160	5	1
3-30	Mississippi R. near St. Francisville, La.	1,011	15,710	15.5	1.47	23,100	3	1
4-01	Mississippi R. below Belle Chasse, La.	800	17,190	21.5	1.31	22,500	2	1

[1]Water and suspended sediment were collected from 1 vertical in midriver while the water discharge was measured at 27 verticals.

Table 8.--Summary of discharge measurements made of the Mississippi River and some of its tributaries using the depth-integration method for June 1989 cruise

[All velocity measurements were made with a Price AA solid, polymer bucket-wheel current meter with calibration equation: velocity (m/s) = 0.765 × revolutions per second + 0.006; m, meter; m^2, square meter; m/s, meter per second; m^3/s, cubic meter per second; %, percent]

Date 1989	Site name	Width (m)	Area (m^2)	Mean depth (m)	Mean velocity (m/s)	Discharge		
						Magnitude (m^3/s)	Errors	
							Bias (%)	Standard (%)
6-05	Mississippi R. near Winfield, Mo.	562	3,460	6.2	0.67	2,320	6	1
6-04	Illinois R. at Hardin, Ill.	273	1,110	4.1	0.70	780	2	4
6-07	Missouri R. at Hermann, Mo.	270	1,400	5.2	1.26	1,760	7	2
6-08	Mississippi R. at St. Louis, Mo.	508	3,890	7.7	1.22	4,760	5	1
6-09	Mississippi R. at St. Louis, Mo. based on 13 verticals	508	3,920	7.7	1.31	5,120	4	2
6-10	Mississippi R. at Thebes, Ill.	609	4,020	6.6	1.30	5,230	5	1
6-11	Ohio R. at Olmsted, Ill.	1,008	9,390	9.3	0.94	8,760	4	1
6-12	Mississippi R. below Hickman, Ky.	1,135	10,640	9.4	1.33	14,100	4	1
6-13	Mississippi R. below Hickman, Ky. based on 17 verticals	1,135	10,540	9.3	1.32	13,900	4	2
6-14	Mississippi R. at Fulton, Tenn.[1]	1,102	10,900	9.9	1.40	15,300	4	1
6-17	Mississippi R. at Helena, Ark.	897	11,750	13.1	1.44	16,900	4	1
6-18	White R. at Mile 11.5, Ark.[2]	195	1,460	7.5	0.53	770	-3	4
6-19	Arkansas R. at Pendleton, Ark.	391	2,810	7.2	1.28	3,600	5	1
6-20	Mississippi R. above Arkansas City, Ark.	990	14,960	15.1	1.56	23,300	3	1
6-22	Yazoo R. below Steele Bayou, Miss.	165	1,520	9.2	0.70	1,070	3	3
6-23	Mississippi R. below Vicksburg, Miss.	1,222	16,180	13.2	1.53	24,800	3	1
6-25	Old River Outflow Channel near Knox Landing, La.	562	5,410	9.6	0.90	4,890	5	1
6-26	Mississippi R. near St. Francisville, La.	1,020	14,540	14.3	1.31	19,000	3	1
6-28	Mississippi R. below Belle Chasse, La.	813	17,750	21.8	1.13	20,100	3	1

[1]Estimates of width, area, and discharge in an overflow channel are included in the width, area, and magnitude of discharge listed here.

[2]Based on 7 verticals plus 23 depths from depth profile and assuming unit discharge is proportional to depth to 5/3 power.

Table 9.--Summary of discharge measurements made of the Mississippi River and some of its tributaries using the depth-integration method for February-March 1990 cruise

[All velocity measurements were made with a Price AA solid, polymer bucket-wheel current meter with calibration equation: velocity (m/s) = 0.744 × revolutions per second + 0.011; m, meter; m^2, square meter; m/s, meter per second; m^3/s, cubic meter per second; %, percent]

Date 1990	Site name	Width (m)	Area (m^2)	Mean depth (m)	Mean velocity (m/s)	Discharge		
						Magnitude (m^3/s)	Errors	
							Bias (%)	Standard (%)
2-25	Mississippi R. near Cache, Ill.	696	7,270	10.4	0.58	4,240	-5	5
3-01	Ohio R. at Uniontown, Ky.	761	7,490	9.8	0.88	6,620	4	1
2-28	Wabash R. near New Haven, Ill.[1]	355	2,170	6.1	1.08	2,340	5	1
2-23	Cumberland R. near Smithland, Ky.[1]	175	2,680	15.3	0.81	2,170	4	1
2-24	Tennessee R. near Calvert City, Ky.[1]	340	5,550	16.3	1.18	6,570	4	1
3-03	Ohio R. at Olmsted, Ill.	1,080	13,460	12.5	1.20	16,100	3	1
3-04	Mississippi R. below Hickman, Ky.	1,153	13,880	12.0	1.51	21,000	4	1
3-05	Mississippi River below Fulton, Tenn.	1,260	15,320	12.2	1.49	22,800	4	1
3-07	Mississippi River at Helena, Ark.	855	14,770	17.3	1.58	23,300	4	1
3-08	Mississippi R. above Arkansas City, Ark.	1,080	18,360	17.0	1.81	33,200	3	1
3-10	Mississippi R. below Vicksburg, Miss.	1,308	19,820	15.2	1.72	34,100	3	1
3-12	Mississippi R. near St. Francisville, La.[1]	1,013	16,970	16.8	1.55	26,300	2	1
3-14	Mississippi R. below Belle Chasse, La.	881	18,670	21.2	1.43	26,700	2	1

[1]Discharge was measured from left edge of flow to right edge of flow. No overbank measurement was made.

Table 10.--Summary of discharge measurements made of the Mississippi River and some of its tributaries using the depth-integration method for May-June 1990 cruise

[All velocity measurements were made with a Price AA solid, polymer bucket-wheel current meter with calibration equations: velocity (m/s) = 0.744 × revolutions per second + 0.011 from 6-07 through 6-18, and velocity (m/s) = 0.755 × revolutions per second + 0.011 from 6-20 through 6-27; m, meter; m^2, square meter; m/s, meter per second; m^3/s, cubic meter per second; %, percent]

Date 1990	Site name	Width (m)	Area (m^2)	Mean depth (m)	Mean velocity (m/s)	Discharge		
						Magnitude (m^3/s)	Errors	
							Bias (%)	Standard (%)
6-07	Illinois R. at Valley City, Ill.	221	1,370	6.2	0.90	1,230	5	2
6-11	Mississippi R. below Grafton, Ill.	941	6,060	6.4	0.83	5,040	5	1
6-13	Mississippi R. at Thebes, Ill.	623	7,120	11.4	1.77	12,600	4	1
5-31	Mississippi R. near Cairo, Ill.	696	8,490	12.2	1.60	13,600	-2	4
5-31	Ohio R. at Olmsted, Ill.	1,098	15,410	14.0	1.01	15,600	5	2
6-14	Ohio R. at Olmsted, Ill.	1,046	12,310	11.8	0.78	9,550	6	1
5-30	Mississippi R. at Wickliffe, Ky.	827	13,940	16.9	2.17	30,300	2	2
6-01	Mississippi R. at Wickliffe, Ky.	827	13,870	16.8	2.14	29,700	2	2
6-04	Mississippi R. at Wickliffe, Ky.	827	14,120	17.1	2.04	28,800	2	2
6-01	Mississippi R. near Columbus, Ky.	912	14,240	15.6	2.06	29,400	2	2
6-02	Mississippi R. above New Madrid, Mo.	1,060	17,690	16.7	1.69	29,900	2	2
6-02	Mississippi R. near Pt. Pleasant, Mo.	1,350	17,910	13.3	1.62	29,000	2	2
6-03	Mississippi R. at Caruthersville, Mo.	849	13,010	15.3	2.23	29,000	1	3
6-18	Mississippi R. below Memphis, Tenn.	1,002	14,130	14.1	1.47	20,800	4	1
6-20	Mississippi R. below Arkansas City, Ark.	1,055	15,840	15.0	1.61	25,500	3	1
6-22	Yazoo R. below Steele Bayou, Miss.	200	1,950	9.8	0.64	1,250	4	2
6-23	Mississippi R. below Vicksburg, Miss.	1,255	18,750	14.9	1.46	27,300	3	1
6-25	Mississippi R. near St. Francisville, La.	1,025	16,340	15.9	1.42	23,200	3	1
6-27	Mississippi R. below Belle Chasse, La.	845	16,900	20.0	1.38	23,300	3	1

Water and Suspended Sediment

Two methods were used for collecting composite water and suspended-sediment samples. One method was the pumping method from fixed depths, which yielded large volumes (300-700 L) of water and a representative sample of particles finer than 63 μm. The other method was the depth-integration method, which yielded about 100-130 L of water and representative samples of both sand (greater than 63 μm) and silt/clay fractions (finer than 63 μm) of suspended sediment. Different procedures were used to dewater the pumped and depth-integrated composite samples after collection.

Pumped Composite Sample

The pumped composite sample was collected by using a 12-mm-diameter, perfluorinated-alkoxy (PFA) Teflon tube inside a 12.7-mm-diameter, double-braided stainless-steel hose, which was attached to a 300-pound sounding weight to keep the nozzle directed into the current. A hydraulic winch was used to lower the nozzle and sounding weight at each vertical to a depth of 5 m below the surface or one-half the water depth (whichever was less). Water was pumped from the fixed depth by a double-diaphragm pump (Wilden MI/UP/TF/TF/TF), driven by compressed air and constructed entirely of PFA Teflon, through a 63-μm sieve and into a calibrated funnel (45-L upside-down carboy with no bottom).

The sand that collected in the 63-μm sieve was called the pumped, composite sand sample, and the water and remaining suspended sediment was called the pumped, composite silt/clay and colloid sample. The volume of river water that was pumped at each vertical was proportional to the estimated fractional water discharge at each vertical. The following steps were used to determine the volume of water to be pumped at each vertical:

1. Determine the depth of each vertical (where water will be pumped) from the continuous strip-chart record of the bottom provided by the fathometer.
2. Measure a few depth-averaged velocities at three to five locations with different depths.
3. Calculate the proportionality constant relating depth-averaged velocity to the depth to the 2/3 power (Manning's formula, Chow, 1959; Sium, 1975; and Sayre and Caro-Cordero, 1977).
4. Interpolate the value of the proportionality constant at verticals (where water will be pumped) between the three to five locations where depth-averaged velocities were measured.
5. Compute the discharge, centered about each vertical, and its fraction of the total discharge.
6. Calculate the volume to be pumped at each vertical as the fraction of the total discharge at each vertical times the total volume to be pumped.

The total volume of river water collected by the pumping method is listed in tables 11 and 12 for the March-April 1989 cruise, in tables 13 and 14 for the June 1989 cruise, in tables 15 and 16 for the February-March 1990 cruise, and in tables 17 and 18 for the second leg of the May-June 1990 cruise.

The water and suspended-sediment mixture in the funnel was processed by allowing it to drain at 2 L/min into a continuous-flow centrifuge (Sharples, model AS-12; see Leenheer and others, 1989, and Rees and others, 1991, for more details) spinning at about 16,000 r.p.m. The sediment that was retained on the centrifuge liner was called the pumped, composite silt/clay sample. The water and remaining sediment was processed further by passing it through an ultrafiltration unit with pore sizes of 0.005 μm. The sediment retained on the membranes of the ultrafilter was called the pumped, composite colloid sample. The mass of silt/clay and colloid material that was recovered is listed in table 12 for the March-April 1989 cruise, in table 14 for the June 1989 cruise, in table 16 for the February-March 1990 cruise, and in table 18 for the second leg of the May-June 1990 cruise.

Depth-Integrated Composite Sample

The equal-width-increment (equal-transit-rate), depth-integration method (Nordin and others, 1983; Richey and others, 1986; Meade and Stevens, 1990) was used to collect a depth-integrated composite sample of water and suspended sediment from 1 to 36 vertical locations across the river. A collapsible-bag sampler (Stevens and others, 1980) fitted with an isokinetic nozzle (Guy and Norman, 1970, p. 8-10) collected suspended sediment in sand, silt, and clay sizes (see tables 11, 13, 15, and 17 for nozzle sizes). The sampler was held in a frame so that the nozzle was horizontal, faced into the current, and was about 45 cm above the bottom of a sounding weight (fig. 7). A Price AA current meter with a solid, polymer bucket wheel was mounted 22 cm above the nozzle of the sampler. The current meter was used to measure the depth-averaged velocity and to determine the nozzle efficiency (volume of water collected divided by the mean velocity, the cross-sectional area of the nozzle, and the integration time). The vertical transit rate was controlled by a hydraulic winch, which produced a constant rate for the downcast and for the upcast. The multiple gears on the hydraulic system allowed transit rates as slow as 2 cm/s and as fast as 22 cm/s. The same transit rate was reproduced within 1 cm/s for each vertical across the river and was verified with a hand-held tachometer at the beginning of each downcast and at the beginning of each upcast.

Two 8-L plastic bottles, identified as A and B, with collapsible, perfluorinated-alkoxy (PFA) Teflon bags and fluorinated-ethylene-propylene (FEP) Teflon nozzles were used in the isokinetic sampler to collect individual samples at alternate verticals, which were combined into two separate, depth-integrated, composite samples. Generally, bottle A was used to collect samples at the odd-numbered verticals and bottle B at the even-numbered verticals. The A and B samples were poured into separate glass, graduated cylinders through separate, nickel-mesh, 63-μm sieves to remove the sand. This sand was saved and called the depth-integrated, composite sand sample. The water volume (see section "Tabulated Cruise Data") collected at each individual vertical was measured and then composited in two separate Teflon-coated, stainless-steel, churn splitters labeled A and B (see tables 11, 13, 15, and 17 for total volume of water collected). The only significant difference between these procedures and those described by Leenheer and others (1989) and Moody and Meade (1992) for the low-water cruises is the substitution of the stronger, but less flexible, PFA Teflon bags for the

previously used FEP Teflon bags. Leenheer and others (1989) described the Teflon bags, nickel sieves, and churn splitters in more detail and discussed the evaluation of materials considered for the fabrication of each item so they would meet the diverse requirements for suspended-sediment, trace-organic, and trace-element analysis.

The remaining water and suspended sediment was processed further by keeping the suspended sediment in suspension by churning, and different-sized subsamples were taken from the A and B churn splitters for determining suspended-sediment concentration (150-250 mL) and particle-size distribution (8-22 L) and for analysis of major ions, trace elements, organic compounds, and nutrients. The remaining water and suspended sediment in the A and B churn splitters were combined and processed through the continuous-flow centrifuge and ultrafilter (discussed above) to obtain a depth-integrated composite silt/clay sample and a depth-integrated composite colloid sample. The mass of silt/clay and colloid material recovered is listed in tables 12, 14, 16, and 18, and a generalized flow diagram for processing the depth-integrated composite sample is in figure 8.

This procedure was modified for the mixing study near the confluence of the Upper Mississippi and Ohio Rivers during the first leg of the May-June 1990 cruise. Instead of compositing the samples at each vertical, the individual sample (approximately 5 L) from each vertical was put into a small churn splitter and subsamples were taken for determining suspended-sediment concentration and particle sizes and for analysis of major ions, trace elements, and selected organic compounds. No samples were processed through the centrifuge or ultrafilter.

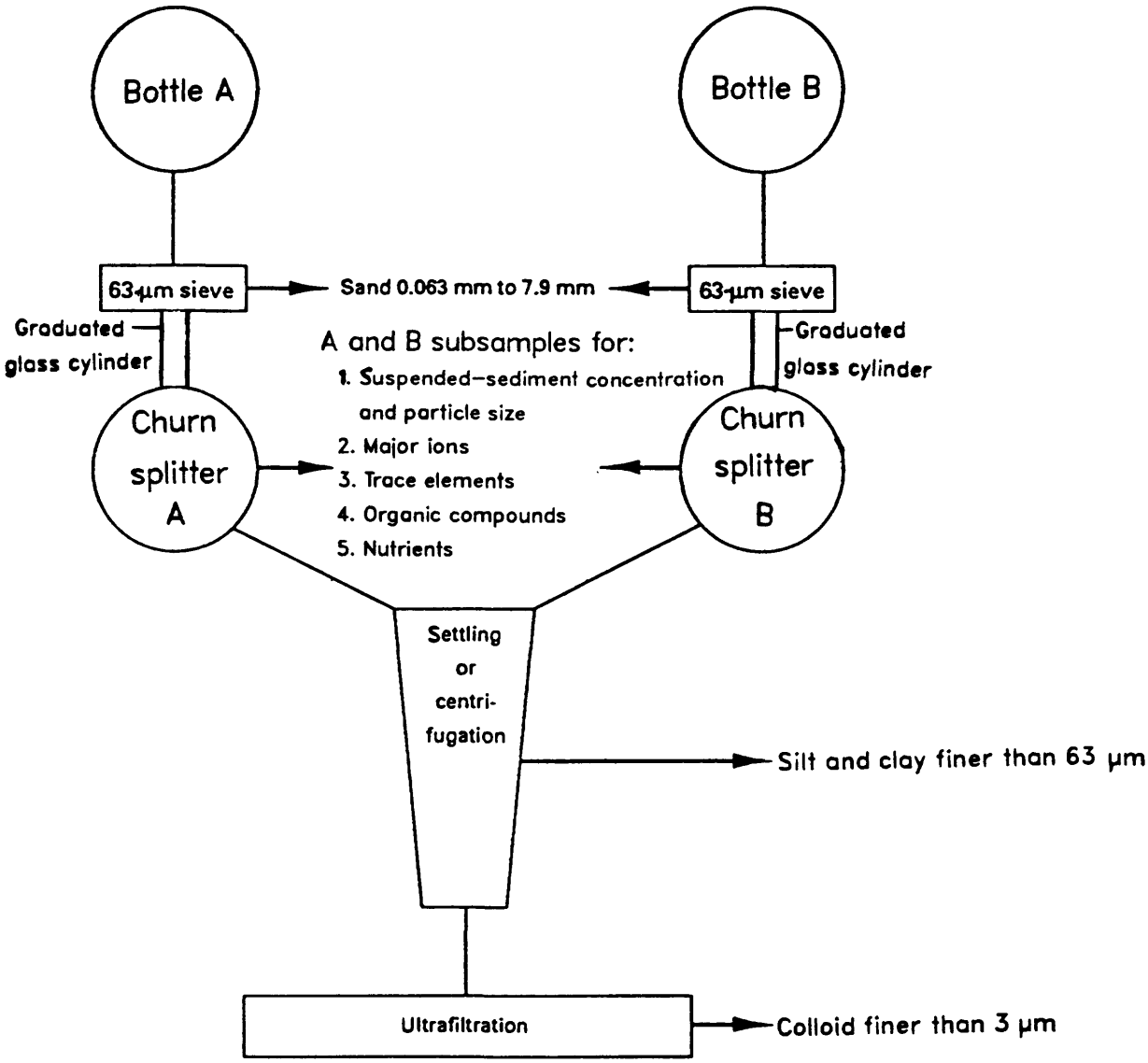


Figure 8.--Flow diagram for processing the suspended-sediment sample collected by depth-integration method. Abbreviations are µm, micrometer and mm, millimeters.

(PAGE 30 FOLLOWS)

Table 11.--Volumes of river water collected and processed and associated sampling parameters for March-April 1989 cruise

[V_p is the total volume collected by pumping; V_c is the total volume collected by depth integration; V_d is the total volume of depth-integrated sample that was dewatered by processing through the centrifuge and ultrafilter; L, liter; cm/s, centimeter per second]

Date 1989	Site name	Sample volumes			Sampling parameters		
		V_p (L)	V_c (L)	V_d (L)	Number of verticals	Nozzle size (inches)	Transit rate (cm/s)
3-10	Mississippi R. near Winfield, Mo.	590	119.4	113.7	[1]20	none[2]	6
3-09	Illinois R. at Hardin, Ill.	597	117.9	93.7	1	none[2]	3-6
3-12	Missouri R. at Hermann, Mo.	507	127.1	95.4	30	5/16	11
3-13	Mississippi R. at St. Louis, Mo.	500	114.5	95.7	30	1/4	10
3-15	Mississippi R. at Thebes, Ill.	490	133.0	101.2	27	1/4	8
3-16	Ohio R. at Olmsted, Ill.	720	112.9	91.2	30	3/16	16
3-17	Mississippi R. below Hickman, Ky.	505	117.0	98.3	30	3/16	17
3-19	Mississippi R. below Fulton, Tenn.	606	101.3	80.6	30	3/16	17
3-21	Mississippi R. at Helena, Ark.	499	126.1	107.3	30	3/16	22
3-22	White R. at Mile 11.5, Ark.	500	108.6	89.6	5	1/4	6
3-23	Arkansas R. at Pendleton, Ark.	600	110.7	98.8	[3]10	1/4,5/16	4-12
3-24	Mississippi R. above Arkansas City, Ark.	500	116.7	98.1	30	3/16	22
3-26	Yazoo R. below Steele Bayou, Miss.	500	116.1	109.4	[1]5	1/4,3/16,5/16	7-16
3-27	Mississippi R. below Vicksburg, Miss.	641	113.9	97.2	36	1/8	11
3-29	Old River Outflow Channel near Knox Landing, La.	503	116.0	97.3	30	1/4	15
3-30	Mississippi R. near St. Francisville, La.	505	120.5	101.9	32	3/16	20
4-01	Mississippi R. below Belle Chasse, La.	499	98.3	84.7	24	1/8	10

[1]Anchored at each vertical.
[2]The sampling bottle had a cap without the isokinetic nozzle; the diameter of the threaded hole in the cap was ½ inch.
[3]Anchored at one-half of the verticals--see Data Listings.

Table 12.--Water volumes processed and masses of silt/clay and colloid fractions recovered from samples of Mississippi River and some of its tributaries for March-April 1989 cruise

[L, liter; g, gram; μm, micrometer; <, less than; integ. or pump indicates that samples were collected by depth-integration or pumping method; -- indicates that colloid was not collected and total is unknown]

Date 1989	Site name	Collection method	Sample volume processed (L)	Mass recovered			Total[3] suspended sediment <63 μm (g)	Percent recovery (%)
				Silt/clay[1] (g)	Colloid[2] (g)	Total (g)		
3-10	Mississippi R. near	integ.	113.7	1.38	0.35	1.73	2.62	66
	Winfield, Mo.	pump	590	8.5	--	--	13.6	--
3-09	Illinois R. at	integ.	93.7	6.76	0.45	7.21	9.28	78
	Hardin, Ill.	pump	597	59.9	--	--	59.1	--
3-12	Missouri R. at	integ.	95.4	5.28	0.53	5.81	7.06	82
	Hermann, Mo.	pump	507	28.7	--	--	37.5	--
3-13	Mississippi R. at	integ.	95.7	2.34	0.41	2.75	6.51	42
	St. Louis, Mo.	pump	500	28.0	1.83	29.8	34.0	88
3-15	Mississippi R. at	integ.	101.2	6.69	0.84	7.53	10.6	71
	Thebes, Ill.	pump	490	33.4	--	--	51.5	--
3-16	Ohio R. at	integ.	91.2	7.79	1.04	8.83	13.9	64
	Olmsted, Ill.	pump	720	92.4	4.18	96.6	109.4	88
3-17	Mississippi R. below	integ.	98.3	7.86	1.12	8.98	13.1	69
	Hickman, Ky.	pump	505	52.5	--	--	67.2	--
3-19	Mississippi R. below	integ.	80.6	5.62	0.90	6.52	11.1	59
	Fulton, Tenn.	pump	606	62.5	6.28	68.8	83.6	82
3-21	Mississippi R. at	integ.	107.3	9.63	1.39	11.02	14.3	77
	Helena, Ark.	pump	499	54.7	--	--	66.4	--
3-22	White R. at	integ.	89.6	1.69	1.79	3.48	3.94	88
	Mile 11.5, Ark.	pump	500	10.4	--	--	22.0	--
3-23	Arkansas R. at	integ.	98.8	2.34	Lost		4.05	--
	Pendleton, Ark.	pump	600	15.9	--	--	25.0	--
3-24	Mississippi R. above	integ.	98.1	7.46	Lost		12.2	--
	Arkansas City, Ark.	pump	500	43.2	--	--	62.0	--
3-26	Yazoo R. below	integ.	109.4	9.33	4.75	14.08	16.4	86
	Steele Bayou, Miss.	pump	500	46.4	--	--	75.0	--
3-27	Mississippi R. below	integ.	97.2	8.74	1.36	10.10	11.9	85
	Vicksburg, Miss.	pump	641	55.1	7.41	62.5	78.2	80
3-29	Old River Outflow	integ.	97.3	10.37	1.58	11.95	15.8	76
	Channel near Knox Landing, La.	pump	503	61.4	--	--	81.5	--
3-30	Mississippi R. near	integ.	101.9	7.67	1.37	9.04	11.8	77
	St. Francisville, La.	pump	505	42.8	--	--	58.6	--
4-01	Mississippi R. below	integ.	84.7	6.82	1.02	7.84	12.4	63
	Belle Chasse, La.	pump	499	52.0	--	--	72.9	--

[1]Mass recovered from a centrifuge bowl (approximate radius is 5.2 cm and length is 71 cm) operating at about 16,000 revolutions per minute with a flow rate of about 2 L/min.

[2]Mass that had passed through the centrifuge and was recovered from ultrafilter membranes (0.005-μm pore size). This includes mineral and organic colloid.

[3]Suspended-sediment concentration (average of A and B composite in table 19 for <63-μm material) times the sample volume processed.

Table 13.--Volumes of river water collected and processed and associated sampling parameters for June 1989 cruise

[V_p is the total volume collected by pumping; V_c is the total volume collected by depth integration; V_d is the total volume of depth-integrated sample that was dewatered by processing through the centrifuge and ultrafilter; L, liter; cm/s, centimeter per second]

Date 1989	Site name	Sample volumes			Sampling parameters		
		V_p (L)	V_c (L)	V_d (L)	Number of verticals	Nozzle size (inches)	Transit rate (cm/s)
6-05	Mississippi R. near Winfield, Mo.	584	125.4	99.7	[1]20	1/4	6
6-04	Illinois R. at Hardin, Ill.	502	94.6	83.4	1	5/16	variable
6-07	Missouri R. at Hermann, Mo.	519	138.6	125.4	30	5/16	14
6-08	Mississippi R. at St. Louis, Mo.	598	118.6	98.0	30	1/4	14
6-10	Mississippi R. at Thebes, Ill.	500	120.2	100.6	28	1/4	12
6-11	Ohio R. at Olmsted, Ill.	604	131.9	110.2	30	1/4	10
6-12	Mississippi R. below Hickman, Ky.	506	126.0	107.4	30	3/16	10
6-14	Mississippi R. at Fulton, Tenn.	500	116.2	97.7	28	3/16	15
6-17	Mississippi R. at Helena, Ark.	510	111.3	92.7	30	3/16	18
6-18	White R. at Mile 11.5, Ark.	580	123.9	105.1	[2]3	5/16	4-9
6-19	Arkansas R. at Pendleton, Ark.	499	77.6	74.3	30	3/16	13
6-20	Mississippi R. above Arkansas City, Ark.	502	103.3	87.8	28	1/8	12
6-22	Yazoo R. below Steele Bayou, Miss.	611	122.3	111.9	[2]6	1/4	2-14
6-23	Mississippi R. below Vicksburg, Miss.	629	126.6	106.0	36	1/8	10
6-25	Old River Outflow Channel near Knox Landing, La.	501	106.3	89.7	30	1/4	13
6-26	Mississippi R. near St. Francisville, La.	505	124.6	104.5	30	3/16	16
6-28	Mississippi R. below Belle Chasse. La.	508	59.3	52.9	14	1/8	10

[1]Anchored at each vertical.
[2]Equal-discharge increments collected while anchored at each vertical.

Table 14.--Water volumes processed and masses of silt/clay and colloid fractions recovered from samples of the Mississippi River and its principal tributaries for June 1989 cruise

[L, liter; g, gram; μm, micrometer; <, less than; integ. or pump indicates that samples were collected by depth integration or pumping method; -- indicates that colloid was not collected and total is unknown]

Date 1989	Site name	Collection method	Sample volume processed (L)	Mass recovered			Total[3] suspended sediment <63 μm (g)	Percent recovery (%)
				Silt/clay[1] (g)	Colloid[2] (g)	Total (g)		
6-05	Mississippi R. near	integ.	99.7	4.62	0.59	5.21	6.98	75
	Winfield, Mo.	pump	584	32.9	--	--	40.9	--
6-04	Illinois R. at	integ.	83.4	49.87	0.66	50.53	59.0	86
	Hardin, Ill.	pump	502	303.2	--	--	355.0	--
6-07	Missouri R. at	integ.	125.4	54.46	2.20	56.66	59.2	96
	Hermann, Mo.	pump	519	219.2	--	--	245.0	--
6-08	Mississippi R. at	integ.	98.0	7.89	0.76	8.65	12.0	72
	St. Louis, Mo.	pump	598	63.9	3.36	67.3	73.0	92
6-10	Mississippi R. at	integ.	100.6	9.02	0.74	9.76	11.8	83
	Thebes, Ill.	pump	500	47.0	--	--	58.5	--
6-11	Ohio R. at	integ.	110.2	8.97	0.64	9.61	12.7	76
	Olmsted, Ill.	pump	604	56.1	3.23	59.3	69.5	85
6-12	Mississippi R. below	integ.	107.4	9.87	0.73	10.60	14.0	76
	Hickman, Ky.	pump	506	56.3	--	--	65.8	--
6-14	Mississippi R. below	integ.	97.7	14.33	1.04	15.37	17.8	86
	Fulton, Tenn.	pump	500	75.5	--	--	91.0	--
6-17	Mississippi R. at	integ.	92.7	14.58	1.12	15.70	19.8	79
	Helena, Ark.	pump	510	90.6	--	--	109.1	--
6-18	White R. at	integ.	105.1	5.85	1.42	7.27	9.67	75
	Mile 11.5, Ark.	pump	580	42.7	--	--	53.4	--
6-19	Arkansas R. at	integ.	74.3	2.90	0.69	3.59	5.05	71
	Pendleton, Ark.	pump	499	23.2	--	--	33.9	--
6-20	Mississippi R. above	integ.	87.8	10.51	1.00	11.51	14.9	77
	Arkansas City, Ark.	pump	502	67.8	--	--	85.3	--
6-22	Yazoo R. below	integ.	111.9	21.10	5.67	26.77	30.4	88
	Steele Bayou, Miss.	pump	611	137.5	--	--	166.0	--
6-23	Mississippi R. below	integ.	106.0	10.04	1.45	11.49	16.2	71
	Vicksburg, Miss.	pump	629	68.6	5.25	73.9	96.2	77
6-24	Old River Outflow	integ.	89.7	8.03	1.22	9.25	14.4	64
	Channel near Knox Landing, La.	pump	501	54.1	--	--	80.2	--
6-26	Mississippi R. near	integ.	104.5	10.73	1.19	11.92	16.1	74
	St. Francisville, La.	pump	505	63.7	--	--	77.8	--
6-28	Mississippi R. below	integ.	52.9	6.37	0.51	6.88	8.99	77
	Belle Chasse, La.	pump	508	66.9	--	--	86.4	--

[1]Mass recovered from a centrifuge bowl (approximate radius is 5.2 cm and length is 71 cm) operating at about 16,000 revolutions per minute with a flow rate of about 2 L/min.

[2]Mass which had passed through the centrifuge and was recovered from ultrafilter membranes (0.005-μm pore size). This includes mineral and organic colloid.

[3]Suspended-sediment concentration (average of A and B composite in table 20 for <63-μm material) times the sample volume processed.

Table 15.--Volumes of river water collected and processed and associated sampling parameters for February-March 1990 cruise

[V_p is the total volume collected by pumping; V_c is the total volume collected by depth integration; V_d is the total volume of depth-integrated sample that was dewatered by processing through the centrifuge and ultrafilter; L, liter; cm/s, centimeter per second]

Date 1990	Site name	Sample volumes			Sampling parameters		
		V_p (L)	V_c (L)	V_d (L)	Number of verticals	Nozzle size (inches)	Transit rate (cm/s)
2-25	Mississippi R. near Cache, Ill.	598	21.5	0	5	1/4	5
3-01	Ohio R. at Uniontown, Ky.	503	114.3	95.9	29	1/4	9
2-28	Wabash R. near New Haven, Ill.	497	119.0	104.6	14	1/4	7
2-23	Cumberland R. near Smithland, Ky.	499	74.3	67.5	10	3/16	9
2-24	Tennessee R. near Calvert City, Ky.	500	117.9	110.0	14	3/16	15
3-03	Ohio R. at Olmsted, Ill.	510	119.8	104.2	15	3/16	12
3-04	Mississippi R. below Hickman, Ky.	520	132.1	116.0	15	3/16	14
3-05	Mississippi R. below Fulton, Tenn.	501	122.3	106.2	15	3/16	16
3-07	Mississippi R. at Helena, Ark.	512	126.8	110.7	15	3/16	22
3-08	Mississippi R. above Arkansas City, Ark.	509	120.5	104.4	16	1/8	17
3-10	Mississippi R. below Vicksburg, Miss.	524	123.1	106.9	18	1/8	15
3-12	Mississippi R. near St. Francisville, La.	499	138.9	122.5	15	1/8	10
3-14	Mississippi R. below Belle Chasse, La.	505	113.5	98.9	13	1/8	13

Table 16.--Water volumes processed and masses of silt/clay and colloid fractions recovered from samples of the Mississippi River and some of its tributaries for February-March 1990 cruise

[L, liter; g, gram; µm, micrometer; <, less than; integ. or pump indicates that samples were collected by depth-integration or pumping method; -- indicates that colloid was not collected and total is unknown]

Date 1990	Site name	Collection method	Sample volume processed (L)	Mass recovered			Total[3] suspended sediment <63 µm (g)	Percent recovery (%)
				Silt/clay[1] (g)	Colloid[2] (g)	Total (g)		
2-25	Mississippi R. near	integ.	0	not processed for suspended sediment				
	Cache, Ill.	pump	598	51.0	--	--	64.6	--
3-01	Ohio R. at	integ.	95.9	14.70	1.40	16.10	19.6	82
	Uniontown, Ky.	pump	503	81.2	--	--	102.6	--
2-28	Wabash R. near	integ.	104.6	11.38	2.7	14.1	15.5	91
	New Haven, Ill.	pump	497	62.1	--	--	73.6	--
2-23	Cumberland R. near	integ.	67.5	0.88	0.33	1.17	2.16	54
	Smithland, Ky.	pump	499	12.9	--	--	16.0	--
2-24	Tennessee R. near	integ.	110.0	3.61	1.2	4.8	5.28	91
	Calvert City, Ky.	pump	500	18.5	--	--	24.0	--
3-03	Ohio R. at	integ.	104.2	10.00	1.50	11.50	15.0	77
	Olmsted, Ill.	pump	510	53.8	--	--	73.4	--
3-04	Mississippi R. below	integ.	116.0	12.09	1.8	13.9	18.3	76
	Hickman, Ky.	pump	520	59.8	--	--	82.2	--
3-05	Mississippi R. below	integ.	106.2	9.68	[4]1.52	11.20	15.0	75
	Fulton, Tenn.	pump	501	61.9	--	--	70.6	--
3-07	Mississippi R. at	integ.	110.7	10.67	1.3	12.0	16.2	74
	Helena, Ark.	pump	512	58.1	--	--	74.8	--
3-08	Mississippi R. above	integ.	104.4	9.03	[4]1.51	10.54	13.2	80
	Arkansas City, Ark.	pump	509	56.2	--	--	64.1	--
3-10	Mississippi R. below	integ.	106.9	9.60	1.67	11.27	13.5	83
	Vicksburg, Miss.	pump	524	55.6	--	--	66.0	--
3-12	Mississippi R. near	integ.	122.5	8.18	[4]1.40	9.58	12.0	79
	St. Francisville, La.	pump	499	36.5	--	--	48.9	--
3-14	Mississippi R. below	integ.	98.9	10.15	[4]1.33	11.48	13.8	83
	Belle Chasse, La.	pump	505	--	--	--	70.7	--

[1]Mass recovered from a centrifuge bowl (approximate radius is 5.2 cm and length is 71 cm) operating at about 16,000 revolutions per minute with a flow rate of about 2 L/min.

[2]Mass which had passed through the centrifuge and was recovered from ultrafilter membranes (0.005-µm pore size). This includes mineral and organic colloids.

[3]Suspended-sediment concentration (average of A and B composite in table 21 for <63-µm material) times the sample volume processed.

[4]The mass includes only mineral colloids.

Table 17.--Volumes of river water collected and processed and associated sampling parameters for second leg of the May-June 1990 cruise

[V_p is the total volume collected by pumping; V_c is the total volume collected by depth integration; V_d is the total volume of depth-integrated sample that was dewatered by processing through the centrifuge and ultrafilter; L, liter; cm/s, centimeter per second]

Date 1990	Site name	Sample volumes			Sampling parameters		
		V_p (L)	V_c (L)	V_d (L)	Number of verticals	Nozzle size (inches)	Transit rate (cm/s)
6-07	Illinois R. at Valley City, Ill.	500	78.3	61.1	[1]5	1/4,5/16	4-19
6-11	Mississippi R. below Grafton, Ill.[2]	516	64.9	54.5	20	1/4	8
6-10	Missouri R. at St. Charles, Mo.	0	8.5	0	1	3/16	12,15
6-13	Mississippi R. at Thebes, Ill.	307	71.5	62.4	20	3/16	20
6-14	Ohio R. at Olmsted, Ill.	393	87.2	70.3	20	1/4	11
6-18	Mississippi R. below Memphis, Tenn.	349	58.7	42.0	20	1/8	13
6-20	Mississippi R. below Arkansas City, Ark.	299	59.3	48.5	20	1/8	16
6-22	Yazoo R. below Steele Bayou, Miss.	0	47.6	30.8	[1]5	1/4-5/16	7-12
6-23	Mississippi R. below Vicksburg, Miss.	349	57.3	40.5	20	1/8	15
6-25	Mississippi R. near St. Francisville, La.	351	61.1	50.3	20	1/8	15
6-27	Mississippi R. below Belle Chasse, La.	350	51.5	40.6	20	1/8	20

[1]Equal-discharge increments collected while anchored at each vertical.
[2]Single 7.2-L sample was collected at vertical 17 to represent the Mississippi River upstream from the Illinois River.

Table 18.--Water volumes processed and masses of silt/clay and colloid fractions recovered from samples of the Mississippi River and some of its tributaries for second leg of the May-June 1990 cruise

[L, liter; g, gram; μm, micrometer; <, less than; integ. or pump indicates that samples were collected by depth-integration or pumping method; -- indicates that colloid was not collected and total is unknown]

Date 1990	Site name	Collection method	Sample volume processed (L)	Mass recovered			Total[3] suspended sediment <63 μm (g)	Percent recovery (%)
				Silt/clay[1] (g)	Colloid[2] (g)	Total (g)		
6-07	Illinois R. at	integ.	61.1	4.81	0.26	5.07	5.99	85
	Valley City, Ill	pump	500	44.6	--	--	49.0	--
6-11	Mississippi R. below	integ.	54.5	21.2	1.20	22.4	25.3	89
	Grafton, Ill.	pump	516	219.7	--	--	239	--
6-13	Mississippi R. at	integ.	62.4	58.93	3.05	61.98	69.6	89
	Thebes, Ill.	pump	307	309.7	--	--	342	--
6-14	Ohio R. at	integ.	70.3	9.43	0.84	10.27	12.4	83
	Olmsted, Ill.	pump	393	64.7	--	--	69.6	--
6-18	Mississippi R. below	integ.	42.0	16.20	0.91	17.11	18.1	95
	Memphis, Tenn.	pump	349	--	--	--	151	--
6-20	Mississippi R. below	integ.	48.5	13.08	0.92	14.00	16.2	86
	Arkansas City, Ark.	pump	299	--	--	--	99.9	--
6-22	Yazoo R. below	integ.	30.8	1.80	0.91	2.71	3.57	75
	Steele Bayou, Miss.	pump	0	--	--	--	--	--
6-23	Mississippi R. below	integ.	40.5	8.10	0.63	8.73	11.1	79
	Vicksburg, Miss.	pump	349	89.0	--	--	95.3	--
6-25	Mississippi R. near	integ.	50.3	6.88	0.60	7.48	9.26	81
	St. Francisville, La.	pump	351	56.7	--	--	64.6	--
6-27	Mississippi R. below	integ.	40.6	2.77	0.50	3.27	7.43	44
	Belle Chasse, La.	pump	350	54.7	--	--	64.1	--

[1]Mass recovered from a centrifuge bowl (approximate radius is 5.2 cm and length is 71 cm) operating at about 16,000 revolutions per minute with a flow rate of about 2 L/min.

[2]Mass which had passed through the centrifuge and was recovered from ultrafilter membranes (0.005-μm pore size). No organic colloids are included in these masses.

[3]Suspended-sediment concentration (average of A and B composite in table 22 for <63-μm material) times the sample volume processed.

Suspended-Sediment Analysis

The suspended sediment collected by using the depth-integration method was split into a sand fraction consisting of particle diameters greater than 63 μm and a fine fraction consisting of silt and clay-type particles with diameters finer than 63 μm. The concentrations of the sand and the silt/clay fractions were measured separately and then added together to determine the total concentration.

The particle-size analysis of the sand and the silt/clay fraction used different methods. However, the results were combined to give particle-size distribution for the entire depth-integrated composite suspended-sediment sample collected at each sampling site.

Concentration

There were two replicate suspended-sand samples (composites A and B) for each sampling site. If there was not enough sand in either the A or B composite samples, the two samples were combined to form a single suspended-sand sample. The sands were transferred to glass jars and transported to a USGS laboratory in Denver, Colo., where they were dried at 80°C, weighed to within 0.1 mg, and stored in polypropylene bottles for particle-size analysis. The mass ranged from 1 mg to about 5,000 mg. The collected volume of water was about 50 L (measured to 0.1 L) so that the sand concentrations in tables 19-22 have analytical errors ranging from about 2 percent for concentrations of 0.1 mg/L to less than 0.1 percent for concentrations of 100 mg/L. The mean percent difference between the two replicate sand concentrations was 9 percent of the mean sand concentration for the March-April 1989 cruise, 10 percent for the June 1989 cruise, 6 percent for the February-March 1990 cruise, and 18 percent for the June 1990 cruise.

Two or three subsamples (about 150-250 mL) were taken from composite A and composite B for determining the suspended-sediment concentration of material finer than 63 μm. Each of the four to six subsamples was filtered through paired, preweighed Millipore HA filters (0.45-μm pore size) and dried on board the research vessel. Later, in a laboratory ashore, the filter with sediment was dried to 110°C and reweighed to within 0.1 mg, and the preweight of the filter was subtracted to obtain the mass of silt and clay, which typically was 20 to 40 mg. The volume of each subsample was measured to within ±1 mL, so that the concentrations in tables 19-22 have an analytical error of ±1 percent, or typically 1 mg/L.

The mean range in silt and clay concentration for all sampling sites (calculated from two to four filters per sampling site) was 3±2 percent of the mean silt and clay concentration for the March-April 1989 cruise, 2±2 percent for the June 1989 cruise, 2±1 percent for the February-March 1990 cruise, and 2±1 percent for the June 1990 cruise. The mean percent difference between the silt and clay concentrations of the two replicates (composite A and B) was about 1±1 percent of the mean silt and clay concentration for all four cruises.

The suspended-sediment concentrations were multiplied by the water discharges (listed in tables 7-10), and by a unit-conversion constant (0.0864) to obtain the sediment discharges in metric tons per day listed in the last columns of tables 19-22.

Table 19.--Suspended-sediment concentrations in depth-integrated, composite samples collected from the Mississippi River and some of its tributaries and the corresponding sediment discharges for March-April 1989 cruise

[Total sediment concentration of composites A and B were averaged in order to calculate a single value for sediment discharge m^3/s, cubic meter per second; mg/L, milligram per liter; µm, micrometer; <, less than; >, greater than; data for 5-vertical composite were not used to calculate the total concentration or the sediment discharge; C, collected concurrently with larger composite; nd indicates not determined. Analyses by R.H. Meade]

Date 1989	Site name	Composite	Number of verticals	Water discharge (m^3/s)	Sediment concentration (mg/L)			Sediment discharge (metric tons/day)		
					Silt and clay <63 µm	Sand >63 µm	Total	Silt and clay <63 µm	Sand >63 µm	Total
3-10	Mississippi R. near Winfield, Mo.	A + B	20	850	23	0	23	1,700	0	1,700
		C	5		24	0				
3-09	Illinois R. at Hardin, Ill.[1]	A	1	410	97	0.3	97	3,500	10	3,510
		B	1		101		101			
3-12	Missouri R. at Hermann, Mo.	A	15	1,480	74	100	174	9,400	12,000	21,400
		B	15		73	87	160			
		C	5		nd	93				
3-13	Mississippi R. at St. Louis, Mo.	A	15	3,940	69	78	147	23,000	25,000	48,000
		B	15		68	69	137			
		C	5		69	77				
3-15	Mississippi R. at Thebes, Ill.[1]	A	14	4,890	105	50	155	44,400	21,000	65,000
		B	13		105					
		C	5		107	49				
3-16	Ohio R. at Olmsted, Ill.	A	15	20,400	152	16	168	269,000	28,000	297,000
		B	15		153	16	169			
		C	5		150	18				
3-17	Mississippi R. below Hickman, Ky.	A	15	24,700	133	75	208	284,000	161,000	445,000
		B	15		133	76	209			
		C	5		136	86				
3-19	Mississippi R. below Fulton, Tenn.	A	15	24,800	137	80	217	295,000	182,000	477,000
		B	15		138	90	228			
		C	5		136	94				
3-21	Mississippi R. at Helena, Ark.	A	15	25,900	133	68	201	298,000	140,000	438,000
		B	15		133	57	190			
		C	5		134	68				
3-22	White R. at Mile 11.5, Ark.	[2]A	5	1,500	43	0.4	43	5,600	50	5,600
		[2]B	5		44	0.4	44			
		C	5		43	0.4				
3-23	Arkansas R. at Pendleton, Ark.	[2]A	10	1,900	41	1.5	43	6,730	260	6,800
		[2]B	10		41	1.7	43			
		C	5		42	1.6				
3-24	Mississippi R. above Arkansas City, Ark.	A	15	26,800	126	69	195	288,000	168,000	456,000
		B	15		123	76	199			
		C	5		124	89				
3-26	Yazoo R. below Steele Bayou, Miss.[1]	[2]A	5	1,500	150	0.7	151	19,400	90	19,500
		[2]B	5		149		150			
		C	5		153	0.6				
3-27	Mississippi R. below Vicksburg, Miss.	A	18	26,600	122	88	210	280,000	185,000	465,000
		B	18		122	73	195			
		C	5		123	76				
3-29	Old River Outflow Channel near Knox Landing, La.	A	15	6,160	163	18	181	86,000	9,800	95,800
		B	15		160	19	179			
		C	5		151	18				
3-30	Mississippi R. near St. Francisville, La.	A	16	23,100	117	77	194	233,000	151,000	384,000
		B	16		116	74	190			
		C	5		118	64				
4-01	Mississippi R. below Belle Chasse, La.	A	12	22,500	147	72	219	284,000	140,000	424,000
		B	12		145	72	217			
		C	4		147	84				

[1]Sand in composites A and B were combined to give one value listed opposite composite A.
[2]A and B composites were collected at the same verticals.

Table 20.--Suspended-sediment concentrations in depth-integrated, composite samples collected from the Mississippi River and some of its tributaries and the corresponding sediment discharges for June 1989 cruise

[Total sediment concentration of composites A and B were averaged in order to calculate a single value of sediment discharge; <, less than; >, greater than; m^3/s, cubic meter per second; µm, micrometer; data for 5-vertical composite were not used to calculate the total concentration or the sediment discharge; C, collected concurrently with larger composite; NC, not collected concurrently with larger composite; nd indicates not determined. Analyses by R.H. Meade]

Date 1989	Site name	Composite	Number of verticals	Water discharge (m^3/s)	Sediment concentration (mg/L)			Sediment discharge (metric tons/day)		
					Silt and clay <63 µm	Sand >63 µm	Total	Silt and clay <63 µm	Sand >63 µm	Total
6-05	Mississippi R. near Winfield, Mo.[1]	[3]A	20	2,320	71	0.1	71	14,000	20	14,000
		[3]B	20		68		68			
		C	5		67	nd				
6-04	Illinois R. at Hardin, Ill.		1	780	708	0.5	709	48,000	30	48,000
6-07	Missouri R. at Hermann, Mo.	A	15	1,760	471	64	535	71,700	11,000	83,000
		B	15		472	76	548			
		C	5		467	56				
6-08	Mississippi R. at St. Louis, Mo.	A	15	4,760	122	34	156	50,200	15,000	65,000
		B	15		122	37	159			
		C	5		120	37				
6-10	Mississippi R. at Thebes, Ill.	A	14	5,230	117	50	167	52,900	22,000	75,000
		B	14		117	49	166			
		C	5		117	53				
6-11	Ohio R. at Olmsted, Ill.	A	15	8,760	115	1.4	116	87,000	1,100	88,100
		B	15		115	1.5	116			
		C	5		112	1.5				
6-12	Mississippi R. below Hickman, Ky.	A	15	14,100	129	13	142	158,000	17,000	175,000
		B	15		130	15	145			
		NC	5		124	13				
6-14	Mississippi R. at Fulton, Tenn.	A	14	15,300	182	26	208	240,000	35,000	275,000
		B	14		181	27	208			
		NC	5		186	26				
6-17	Mississippi R. at Helena, Ark.	A	15	16,900	216	45	261	313,000	65,000	378,000
		B	15		213	44	257			
		NC	5		212	40				
6-18	White R. at Mile 11.5, Ark.[1]	[3]A	3	770	91	0.1	91	6,100	7	6,100
		[3]B	3		92		92			
6-19	Arkansas R. at Pendleton, Ark.[2]	A	15	3,600	68	81	149	21,000	26,000	47,000
		B	15			89	157			
		C	5		69	81				
		NC	5		65	93				
6-20	Mississippi R. above Arkansas City, Ark.	A	14	23,300	170	72	242	341,000	135,000	476,000
		B	14		169	62	231			
		NC	5		172	67				
6-22	Yazoo R. below Steele Bayou, Miss.	[3]A	6	1,070	271	1.2	272	25,100	110	25,200
		[3]B	6		272	1.1	273			
		C	6		270	1.1				
6-23	Mississippi R. below Vicksburg, Miss.	A	18	24,800	154	58	212	328,000	122,000	450,000
		B	18		152	56	208			
		NC	6		153	52				
6-25	Old R. Outflow Channel near Knox Landing, La.	A	15	4,890	162	62	224	67,600	25,000	92,600
		B	15		158	57	215			
		NC	5		160	57				
6-26	Mississippi R. near St. Francisville, La.	A	15	19,000	155	54	209	253,000	83,000	336,000
		B	15		153	47	200			
		NC	5		152	43				
6-28	Mississippi R. below Belle Chasse, La.	A	7	20,100	169	36	205	296,000	69,000	365,000
		B	7		172	44	216			
		NC	5		168	27				

[1]Sand in composites A and B were combined to give one value listed opposite composite A.
[2]Silt and clay in composites A and B were combined to give one value listed opposite composite A.
[3]A and B composites were collected at the same verticals.

Table 21.--Suspended-sediment concentrations in depth-integrated, composite samples collected from the Mississippi River and some of its tributaries and the corresponding sediment discharges for February-March 1990 cruise

[Total sediment concentration of composites A and B were averaged in order to calculate a single value of sediment discharge; <, less than; >, greater than; m^3/s, cubic meter per second; mg/L, milligram per liter; µm, micrometer; data for 5-vertical composite were not used to calculate the total concentration or the sediment discharge; C, collected concurrently with large composite; NC, not collected concurrently with larger composite; nd indicates not determined. Analyses by R.H. Meade]

Date 1990	Site name	Composite	Number of verticals	Water discharge (m^3/s)	Sediment concentration (mg/L)			Sediment discharge (metric tons/day)		
					Silt and clay <63 µm	Sand >63 µm	Total	Silt and clay <63 µm	Sand >63 µm	Total
2-25	Mississippi R. near Cache, Ill.	One	5	4,240	108	1.2	109	39,600	440	40,000
3-01	Ohio R. at Uniontown, Ky.[1]	A	15	6,620	205	4.8	210	117,000	2,800	120,000
		B	14		204	4.9	209			
		NC	5		208	4.2				
2-28	Wabash R. near New Haven, Ill.[1]	[3]A	14	[1]2,340	148	25	173	30,000	5,100	35,100
		[3]B	14		147	25	172			
		NC	5		nd	30				
2-23	Cumberland R. near Smithland, Ky.[1,2]	[3]A	10	[1]2,170	32	0.05	32	6,000	9	6,000
		[3]B	10		32		32			
		NC	5		32	0.0				
2-24	Tennessee R. near Calvert City, Ky.[1,2]	[3]A	14	[1]6,570	49	0.03	49	28,000	20	28,000
		[3]B	14		48		48			
		NC	5		37	0.0				
3-03	Ohio R. at Olmsted, Ill.	[3]A	15	16,100	143	5.3	148	200,000	7,600	208,000
		[3]B	15		145	5.6	151			
		NC	5		141	4.4				
3-04	Mississippi R. below Hickman, Ky.	[3]A	15	21,000	158	48	206	287,000	87,000	374,000
		[3]B	15		158	48	206			
3-05	Mississippi R. below Fulton, Tenn.	[3]A	15	22,800	141	90	231	278,000	182,000	460,000
		[3]B	15		141	95	236			
		NC	5		138	83				
3-07	Mississippi R. at Helena, Ark.	[3]A	15	23,300	147	70	217	295,000	130,000	425,000
		[3]B	15		146	59	205			
		NC	5		142	65				
3-08	Mississippi R. above Arkansas City, Ark.	[3]A	16	33,200	126	94	220	361,000	255,000	616,000
		[3]B	16		126	84	210			
3-10	Mississippi R. below Vicksburg, Miss.	[3]A	18	34,100	126	117	243	370,000	331,000	701,000
		[3]B	18		125	108	233			
		NC	6		124	111				
3-12	Mississippi R. near St. Francisville, La.[1]	[3]A	15	26,300	99	85	184	224,000	190,000	414,000
		[3]B	15		98	82	180			
		NC	5		97	62				
3-14	Mississippi R. below Belle Chasse, La.	[3]A	13	26,700	140	83	223	322,000	187,000	509,000
		[3]B	13		139	79	218			
		NC	4		135	77				

[1]Water discharge was measured from left edge of flow to right edge of flow. No overbank measurement was made.
[2]Sand in composites A and B was combined to give one value listed opposite composite A.
[3]A and B composites were collected at the same verticals.

Table 22.--Suspended-sediment concentrations in depth-integrated, composite samples collected from the Mississippi River and some of its tributaries and the corresponding sediment discharges for second leg of the May-June 1990 cruise

[Total sediment concentration of composites A and B were averaged on order to calculate a single value of sediment discharge; <, less than; >, greater than; m^3/s, cubic meter per second; mg/L, milligram per liter; μm, micrometer. Analyses by R.H. Meade]

Date 1990	Site name	Composite	Number of verticals	Water discharge (m^3/s)	Sediment concentration (mg/L)			Sediment discharge (metric tons/day)		
					Silt and clay <63 μm	Sand >63 μm	Total	Silt and clay <63 μm	Sand >63 μm	Total
6-07	Illinois R. at Valley City, Ill.	[1]A	5	1,230	97	4.6	102	10,400	440	10,800
		[1]B	5		99	3.8	103			
6-11	Mississippi R. below Grafton, Ill.	A	10	5,040	459	2.5	462	202,000	1,000	203,000
		B	10		469	2.2	471			
6-10	Missouri R. at St. Charles, Mo.	None	1	not measured	1,940	392	2,332	no water-discharge data		
6-13	Mississippi R. at Thebes, Ill.	A	10	12,600	1,110	101	1,211	1,210,000	121,000	1,330,000
		B	10		1,120	122	1,242			
6-14	Ohio R. at Olmsted, Ill.	A	10	9,550	180	0.2	180	146,000	200	146,000
		B	10		174	0.3	174			
6-18	Mississippi R. below Memphis, Tenn.	A	10	20,800	432	38	470	776,000	58,000	834,000
		B	10		432	27	459			
6-20	Mississippi R. below Arkansas City, Ark.	A	10	25,500	336	67	403	736,000	123,000	859,000
		B	10		332	45	377			
6-22	Yazoo R. st Mile 9.0, Miss.	[1]A	5	1,250	116	0.2	116	12,600	20	12,600
		[1]B	5		117	0.2	117			
6-23	Mississippi R. below Vicksburg, Miss.	A	10	27,300	273	31	304	644,000	70,000	714,000
		B	10		273	28	301			
6-25	Mississippi R. near St. Frsncisville, La.	A	10	23,200	184	47	231	368,000	95,000	463,000
		B	10		183	48	231			
6-27	Mississippi R. below Belle Chasse, La.	A	10	23,300	183	50	233	368,000	98,000	466,000
		B	10		183	47	230			

[1]A and B composites were collected at the same verticals.

Our usual sampling procedure, wherein we collected duplicate composite samples (A and B) at each sampling site, allowed us to estimate the precision or reproducibility of the suspended-sediment concentrations in relation to the number of verticals sampled. The percent difference in the concentration of the composite A and B samples (relative to the average concentration of composites A and B) in tables 19-22 were grouped by the number of verticals. For the verticals having five or more comparisons, the average percent difference is listed in table 23. Concentrations of suspended silt and clay in depth-integrated composite samples are reproducible within about 1 percent, while concentrations of sand are reproducible within about 16 percent for 10-vertical composites, within 10 percent for 15-vertical composites, and 7 percent for 18-vertical composites.

Table 23.--Average difference in suspended-sediment concentration in duplicate depth-integrated samples (composite A and B) expressed as percent of the average concentration

[<, less than; >, greater than; µm, micrometer; values in parentheses include similar data from Moody and Meade, 1992]

Number of verticals	Number of comparisons		Average percent difference	
	Silt and clay <63 µm	Sand[1] >63 µm	Silt and clay <63 µm	Sand >63 µm
10	10 (15)	9 (13)	1 (1)	20 (16)
14	5 (8)	4 (6)	1 (1)	5 (6)
15	20 (41)	21 (40)	1 (1)	9 (10)
16	2 (5)	2 (5)	1 (1)	8 (9)
[2]18	3 (5)	3 (5)	1 (1)	10 (7)

[1]Does not include samples with no sand, samples for which composite A and B were combined to obtain enough sand for analysis, or samples noted as having mostly organic material.

[2]All comparisons are for Mississippi River below Vicksburg, Mississippi.

The accuracy in measuring suspended-sediment concentration using the depth-integration method as a function of the number of verticals was estimated from data collected at only those sites listed in tables 19-20 where a 5-vertical composite was collected concurrently with two 15-vertical composites (denoted by A and B in the composite column of tables 19-20). The A and B composites were collected at different verticals; thus, by averaging the composite A and B concentration values, a 30-vertical, suspended-sediment concentration was determined. This 30-vertical concentration was assumed to represent the actual concentration for calculating the percent difference of the 5- and 15-vertical composite concentrations. The concentrations of silt and clay in these comparisons of concurrent samples ranged from 68 to 472 mg/L and the sand ranged from 1 to 94 mg/L. For samples collected concurrently, the concentration of sand from the 15-vertical composites differed by about 5 percent and the concentration from the 5-vertical composites differed by about 9 percent from the concentrations of the 30-vertical composites. However, the concentration of suspended sediment finer than 63 µm from 15-vertical composites differed by 1 percent or less and concentrations from the 5-vertical composites differed by 2 percent or less from the concentrations of the 30-vertical composites.

Particle Size

Particle-size distributions of the suspended sediment (from 1 to 1,000 μm) for the four cruises are listed in tables 24-27. The particle-size distributions of the suspended sand (greater than 63 μm) were analyzed by the visual-accumulation tube method, and the particle-size distribution of the suspended silt and clay (finer than 63 μm) were analyzed by the Sedigraph method. Both methods are based on settling properties of the particles. Both methods involve preliminary chemical treatment that disaggregates the particles as they exist in the river. Therefore, the size analyses reported here are more representative of the assemblages of individual particles available to interact with the dissolved matter in the river and less representative of the hydraulic properties of the grains as they are transported by the river. Stallard and Martin (1989) noted that settling velocities of suspended sediments that were chemically dispersed for analysis, such as those reported here, were markedly slower than settling velocities of suspended sediments that were allowed to settle in native river water immediately after sampling.

The sand samples that were saved in separate polypropylene bottles were sent to the USGS Sediment Laboratory in Iowa City, Iowa, for size analysis by the visual-accumulation-tube method (Guy, 1969). Replicate samples were run and if the results did not agree within 5 percent for all size classes, the analysis was repeated (Matthes and others, 1992). A complication arose during the particle-size analysis when the sand samples were treated with hydrogen peroxide, the standard technique for removing organic matter (Guy, 1969, p. 52). This treatment apparently disaggregated silt particles from sand-size aggregates. In most of the suspended-sand samples, the hydrogen peroxide treatment released silt grains from sand-size aggregates. Although the quantities of released silt grains were almost always (in all samples but one) 2 percent or less of the total concentration of suspended sediment, they were subtracted, where appropriate, from the sand concentrations and added to the concentration of the coarsest silt fraction (32 to 63 μm) in the data reported in tables 19-22 and tables 24-27.

The reproducibility of the sampling and size-analysis procedures was previously addressed by Moody and Meade (1992, table 18) for the sand fractions of the A and B composites of 12 suspended-sediment samples collected during 1987-88. When results were expressed as percentages of the sand fraction, differences between percents finer than certain sizes were as great as 7 percent. When results were expressed as percentages of the total sample, these differences were never more than 2 percent.

Only the samples collected by the depth-integration method were used in the particle-size analysis of suspended sediment finer than 63 μm. The essential problem in preparing a silt and clay fraction sample for particle-size analysis is one of converting the dilute suspensions collected in the field into the concentrated suspensions required for Sedigraph analysis. In our procedure, the suspended-sediment sample remained wet from the time it was collected to the time it was analyzed. The two subsamples of about 4-11 L of water and sediment (finer than 63 μm) that were taken from the A and B churn splitters on the research vessel were combined in a polyethylene carboy to which 10-15 mL of chloroform was added to retard organic growth.

The carboys from all sampling sites were transported to the USGS laboratory in Denver, where the suspended sediment was allowed to settle undisturbed for at least 15 days. At the maximum vertical settling distance of 36 cm in the carboys, this time was sufficient for all particles coarser than about 0.5 μm to settle (assuming Stokesian settling of quartz spherical particles). After 15 days or longer, the supernatant water was siphoned from the carboys, and the settled sediment was transferred to 1-L glass jars (maximum settling distance, 15 cm) where it was allowed to settle for another 10 days or more. The supernatant was siphoned off once more, and the settled sediment was transferred to 250-mL polyethylene bottles.

All analyses of the size distribution of particles finer than 63 μm were made in the USGS sediment laboratory in Iowa City, Iowa, by the Sedigraph method as described by Lara and Matthes (1986). At least 1 in 10 Sedigraph samples were reanalyzed, and if the results did not agree within 5 percent for all size classes, the analysis was repeated (Matthes and others, 1992). After the particle-size distribution is determined, the sample is dried and weighed. The dry weight is compared with the weight of sediment that is calculated from the concentration of suspended sediment finer than 63 μm determined by the filtering-and-weighing procedure (silt and clay column in tables 19-22) and the known volume (8-22 L) of river water from which the analyzed sample is allowed to settle. The differences between the calculated dry weights and the measured dry weights are assumed to represent the material finer than 0.5 μm that remained in suspension and was siphoned from the carboys along with the supernatant water. These differences have been added to the mass of material finer than 1 μm for purposes of calculating the percentages listed in tables 24-27. The amount of siphoned material finer than 0.5 μm averaged 15 percent for the March-April 1989 cruise, 7 percent for the June 1989 cruise, 10 percent for the February-March 1990 cruise, and 6 percent for the May-June 1990 cruise. The largest amounts of siphoned material finer than 0.5 μm (21-57 percent) were measured in samples collected from the White, Arkansas, and Yazoo Rivers for the March-April 1989 cruise; from the Yazoo River for the June 1989 cruise and the second leg of the May-June 1990 cruise; and from the Cumberland and Tennessee Rivers for the February-March 1990 cruise. The amount of siphoned material finer than 0.5 μm ranged between 1 and 12 percent for the remaining sampling sites.

To evaluate the differences incurred by using different collecting methods and processing procedures, two additional suspended-sediment subsamples were obtained at selected sampling sites for the March-April 1989 and the June 1989 cruises: (1) samples collected by the pumping method and processed by continuous-flow centrifugation, and (2) samples collected by depth integration and processed by churning and continuous-flow centrifugation. For these selected river sampling sites and cruises, a size distribution of the suspended sediment was obtained for each of these samples. The concentration of sediment for individual size classes is listed in table 28, in addition to the concentration of sediment for individual size classes from the depth-integrated, churned and settled sample, which is also listed in tables 24 and 25 as cumulative percent by weight.

Table 24.--Particle-size distribution of suspended-sediment samples collected from the Mississippi River and some of its tributaries for March-April 1989 cruise

[Finer than 63 μm determined by Sedigraph; coarser than 63 μm determined by visual-accumulation tube; <, less than; mg/L, milligram per liter; μm, micrometer. Analyses by C.J. Anderson and J.A. Moody]

Date 1989	Site name	Total suspended-sediment concentration[1] (mg/L)	Percent finer than indicated size (μm)											Median diameter[2] (μm)
			1	2	4	8	16	32	63	125	250	500	1,000	
3-10	Mississippi R. near Winfield, Mo.	23	No size analysis.											
3-09	Illinois R. at Hardin, Ill.	99	55	70	87	95	99	100						<1
3-12	Missouri R. at Hermann, Mo.	167	22	26	29	33	38	42	44	48	95	100		130
3-13	Mississippi R. at St. Louis, Mo.	142	27	32	35	37	40	47	49	55	95	100		64
3-15	Mississippi R. at Thebes, Ill.	155	39	48	58	64	67	69	71	87	100			2
3-16	Ohio R. at Olmsted, Ill.	168	47	59	71	85	87	90	91	94	98	100		1
3-17	Mississippi R. below Hickman, Ky.	208	34	41	49	55	59	63	64	68	93	99	100	5
3-19	Mississippi R. below Fulton, Tenn.	222	31	38	47	53	58	61	62	66	88	99	100	6
3-21	Mississippi R. at Helena, Ark.	195	33	40	48	54	59	64	66	72	92	98	100	5
3-22	White R. at Mile 11.5, Ark.	44	94	97	98	98	98	99	100					<1
3-23	Arkansas R. at Pendleton, Ark.	43	78	85	90	93	94	95	96	97	99	100		<1
3-24	Mississippi R. above Arkansas City, Ark.	197	35	41	46	51	57	62	63	67	92	100		7
3-26	Yazoo R. below Steele Bayou, Miss.	150	86	93	95	96	98	100						<1
3-27	Mississippi R. below Vicksburg, Miss.	202	34	41	46	50	53	60	61	65	88		100	8
3-29	Old River Outflow Channel near Knox Landing, La.	180	49	57	64	70	78	87	92	98	100			1
3-30	Mississippi R. near St. Francisville, La.	192	33	38	43	48	54	59	61	75	97	100		11
4-01	Mississippi R. below Belle Chasse, La.	218	36	42	48	53	59	65	68	91	100			6

[1]Total suspended-sediment concentration is the average of the composite A and B values in table 19.
[2]Median diameter was computed by linear interpolation.

Table 25.--Particle-size distribution of suspended-sediment samples collected from the Mississippi River and some of its tributaries for June 1989 cruise

[Finer than 63 μm determined by Sedigraph; coarser than 63 μm determined by visual-accumulation tube; <, less than; mg/L, milligram per liter; μm, micrometer. Analyses by C.J. Anderson and J.A. Moody]

Date 1989	Site name	Total suspended-sediment concentration[1] (mg/L)	Percent finer than indicated size (μm)											Median diameter[2] (μm)
			1	2	4	8	16	32	63	125	250	500	1,000	
6-05	Mississippi R. near Winfield, Mo.	70	61	71	81	88	95	98	100					<1
6-04	Illinois R. at Hardin, Ill.	709	42	53	64	77	91	99	100					2
6-07	Missouri R. at Hermann, Mo.	542	44	55	68	78	83	86	88	89	99	100		2
6-08	Mississippi R. at St. Louis, Mo.	158	34	42	52	61	69	76	77	79	95	100		4
6-10	Mississippi R. at Thebes, Ill.	166	29	37	45	52	59	68	70	74	94	100		7
6-11	Ohio R. at Olmsted, Ill.	116	53	63	73	82	91	97	99	100				<1
6-12	Mississippi R. below Hickman, Ky.	144	43	53	64	74	82	87	89	91	98	100		2
6-14	Mississippi R. at Fulton, Tenn.	208	45	54	63	71	79	86	88	90	98	100		2
6-17	Mississippi R. at Helena, Ark.	259	33	45	57	67	75	80	83	85	96	100		3
6-18	White R. at Mile 11.5, Ark.	92	53	64	75	85	93	98	100					<1
6-19	Arkansas R. at Pendleton, Ark.	153	29	32	35	37	39	43	45	54	93	100		97
6-20	Mississippi R. above Arkansas City, Ark.	236	29	38	48	55	62	69	72	78	89	100		5
6-22	Yazoo R. below Steele Bayou, Miss.	272	78	88	92	94	96	99	100					<1
6-23	Mississippi R. below Vicksburg, Miss.	210	39	46	53	60	66	71	73	79	92	99	100	3
6-25	Old River Outflow Channel near Knox Landing, La.	220	39	46	52	57	63	70	75	100				3
6-26	Mississippi R. near St. Francisville, La.	204	41	47	54	59	67	74	77	86	98	100		3
6-28	Mississippi R. below Belle Chasse, La.	210	42	50	57	63	70	78	82	94	99	100		2

[1]Total suspended-sediment concentration is the average of the composite A and B values in table 20.
[2]Median diameter was computed by linear interpolation.

Table 26.--Particle-size distribution of suspended-sediment samples collected from the Mississippi River and some of its tributaries for February-March 1990 cruise

[Finer than 63 μm determined by Sedigraph; coarser than 63 μm determined by visual-accumulation tube; <, less than; mg/L, milligram per liter; μm, micrometer. Analyses by C.J. Anderson and J.A. Moody]

Date 1989	Site name	Total suspended-sediment concentration[1] (mg/L)	Percent finer than indicated size (μm)											Median diameter[2] (μm)
			1	2	4	8	16	32	63	125	250	500	1,000	
2-25	Mississippi R. near Cache, Ill.	109	70	80	90	94	96	98	100					<1
3-01	Ohio R. at Uniontown, Ky.	210	44	55	67	80	90	96	99	100				2
2-28	Wabash R. near New Haven, Ill.	172	56	66	76	79	82	83	86	93	98	100		<1
2-23	Cumberland R. near Smithland, Ky.	32	68	78	86	91	95	98	100					<1
2-24	Tennessee R. near Calvert City, Ky.	49	71	80	89	94	96	98	100					<1
3-03	Ohio R. at Olmsted, Ill.	150	55	63	73	80	88	95	98	99	100			<1
3-04	Mississippi R. below Hickman, Ky.	206	42	50	59	65	71	75	78	80	95	100		2
3-05	Mississippi R. below Fulton, Tenn.	234	30	37	44	49	55	59	61	64	89	98	100	9
3-07	Mississippi R. at Helena, Ark.	211	41	47	53	59	64	68	70	75	92	98	100	3
3-08	Mississippi R. above Arkansas City, Ark.	215	30	35	41	46	51	56	58	63	90	98	100	14
3-10	Mississippi R. below Vicksburg, Miss.	238	30	35	41	45	49	52	54	59	93	100		21
3-12	Mississippi R. near St. Francisville, La.	182	38	43	48	51	53	54	55	69	96	100		7
3-14	Mississippi R. below Belle Chasse, La.	220	35	40	46	50	55	61	67	90	99	100		8

[1]Total suspended-sediment concentration is the average of the composite A and B values in table 21.
[2]Median diameter was computed by linear interpolation.

Table 27.--Particle-size distribution of suspended-sediment samples collected from the Mississippi River and some of its tributaries for second leg of the May-June 1990 cruise

[Finer than 63 μm determined by Sedigraph; coarser than 63 μm determined by visual-accumulation tube; <, less than; mg/L, milligram per liter; μm, micrometer. Analyses by C.J. Anderson and J.A. Moody]

Date 1990	Site name	Total suspended-sediment concentration[1] (mg/L)	Percent finer than indicated size (μm)											Median diameter[2] (μm)
			1	2	4	8	16	32	63	125	250	500	1,000	
6-07	Illinois R. at Valley City, Ill.	102	38	52	66	76	85	93	96	98	100			2
6-11	Mississippi R. below Grafton, Ill.	466	50	59	70	80	90	97	99	99	100			1
	vertical 17	498	43	55	70	82	91	97	100					2
6-10	Missouri R. at St. Charles, Mo.	2,332	31	39	50	59	71	81	86	90	98	100		4
6-13	Mississippi R. at Thebes, Ill.	1,226	39	48	58	67	78	88	92	93	98	100		2
6-14	Ohio R. at Olmsted, Ill.	177	50	60	72	84	93	98	100					1
6-18	Mississippi R. below Memphis, Tenn.	464	42	52	63	73	83	91	94	95	98	100		2
6-20	Mississippi R. below Arkansas City, Ark.	390	46	54	64	72	79	85	88	90	95	100		1
6-22	Yazoo R. below Steele Bayou, Miss.	116	85	93	95	96	97	98	100					<1
6-23	Mississippi R. below Vicksburg, Miss.	302	47	55	64	73	81	87	90	92	97	100		1
6-25	Mississippi R. near St. Francisville, La.	231	45	52	59	65	71	76	81	87	98	100		2
6-27	Mississippi R. below Belle Chasse, La.	232	Sample spilled before analysis.											

[1]Total suspended-sediment concentration is the average of the composite A and B values in table 22.
[2]Median diameter was computed by linear interpolation.

Table 28.--Suspended-sediment concentration, by particle-size class, obtained by different collecting methods and concentrated by different processing procedures

[Abbreviations for collecting and processing methods are: CS, depth integrated, churned, and settled; CC, depth integrated, churned, and centrifuged; PC, pumped and centrifuged; <1 siphoned off, estimate of suspended material that did not settle in at least 15 days and was siphoned off, does not epply to CC or PC samples; mg/L, milligram per liter]

Date	Site name	Collecting and proceseing methods	Total suspended-sediment concentration (mg/L)	Concentration of suspended sediment (mg/L) greater than the indicated size class (in micrometers) but less than the next larger size class													
				<1 siphoned off	<1	1	2	4	8	16	32	63	88	125	175	250	350	500
6-05-89	Mississippi R. near Winfield, Mo.[1]	CS	70	11	31	7	7	5	5	2	1	0	0	0	0	0	0	0
		CC	45		25	6	5	3	3	2	1	0	0	0	0	0	0	0
		PC	57		30	6	7	5	5	2	1	1	0	0	0	0	0	0
3-09-89	Illinois R. at Hardin, Ill.	CS	99	5	49	15	16	8	4	1	1	0	0	0	0	0	0	0
		CC	71		27	17	13	8	4	1	1	0	0	0	0	0	0	0
		PC	99		37	17	18	13	8	4	2	0	0	0	0	0	0	0
6-09-89	Illinois R. at Hardin, Ill.	CS	709	37	261	77	79	92	97	56	10	0	0	0	0	0	0	0
		CC	581		233	90	89	74	58	27	10	0	0	0	0	0	0	0
		PC	605		254	81	81	79	69	30	10	1	0	0	0	0	0	0
3-12-89	Missouri R. at Hermann, Mo.	CS	167	9	29	6	5	6	9	7	3	1	6	39	40	7	0	0
		CC	150		29	5	5	5	6	5	2	1	6	39	40	7	0	0
		PC	140		31	5	6	5	5	3	3	1	5	32	37	6	1	0
6-07-89	Missouri R. at Hermann, Mo.	CS	542	20	234	62	59	46	27	16	9	1	6	28	25	7	2	0
		CC	497		210	60	60	51	30	13	4	1	6	28	25	7	2	0
		PC	521		226	74	65	51	32	9	5	2	5	24	23	4	1	0
3-13-89	Mississippi R. at St. Louis, Mo.	CS	142	15	25	6	4	3	5	10	2	1	7	21	35	7	1	0
		PC	114		23	9	7	5	4	7	1	1	5	14	33	5	0	0
6-08-89	Mississippi R. at St. Louis, Mo.	CS	158	9	45	12	17	14	14	11	1	1	3	12	12	6	1	0
		PC	135		52	15	14	12	10	2	2	1	3	11	10	2	0	0
3-15-89	Mississippi R. at Thebes, Ill.	CS	155	16	44	14	15	9	4	3	2	5	20	16	6	1	0	0
		CC	115		25	10	10	5	6	7	4	5	20	16	6	1	0	0
		PC	90		24	11	9	7	6	9	4	2	6	7	5	0	0	0
6-10-89	Mississippi R. at Thebes, Ill.	CS	166	9	39	13	14	12	12	15	4	1	4	18	14	8	2	1
		CC	138		28	15	16	10	11	9	1	1	4	18	14	8	2	1
		PC	131		49	14	12	9	7	2	2	1	4	10	18	3	0	0
3-16-89	Ohio R. at Olmsted, Ill.	CS	168	14	65	19	19	25	3	6	2	3	3	3	3	2	1	0
		CC	97		43	12	11	7	5	2	2	3	3	3	3	2	1	0
		PC	140		53	22	21	19	8	5	3	2	3	2	2	0	0	0
6-11-89	Ohio R. at Olmsted, Ill.	CS	116	11	51	12	12	10	10	6	4	0	0	0	0	0	0	0
		CC	82		32	12	12	10	8	6	2	0	0	0	0	0	0	0
		PC	95		40	15	14	11	7	5	1	1	1	0	0	0	0	0
3-17-89	Mississippi R. below Hickman, Ky.	CS	208	10	61	15	17	12	7	9	4	2	5	25	27	9	4	1
		CC	149		38	11	10	8	4	3	2	2	5	25	27	9	4	1
		PC	149		56	14	14	9	5	3	1	2	4	15	20	5	1	0
6-12-89	Mississippi R. below Hickman, Ky.	CS	144	8	56	15	16	15	12	7	3	1	1	4	4	2	0	0
		CC	105		51	11	13	9	5	2	2	1	4	5	2	0	0	0
		PC	121		56	12	14	14	7	7	2	1	1	3	3	1	0	0
3-19-89	Mississippi R. below Fulton, Tenn.	CS	222	18	50	16	19	14	11	7	3	3	7	21	27	17	6	3
		CC	153		39	12	10	5	1	1	1	3	7	21	27	17	6	3
6-14-89	Mississippi R. at Fulton, Tenn.	CS	208	9	87	19	17	17	17	14	4	1	3	10	6	2	2	0
		CC	169		62	23	20	16	13	9	2	1	3	10	6	2	2	0
		PC	171		77	17	14	14	17	11	4	1	3	7	5	1	0	0
3-21-89	Mississippi R. at Helena, Ark.	CS	195	16	51	14	16	12	11	9	5	2	9	20	17	7	3	3
		CC	150		47	13	12	7	5	3	2	2	9	20	17	7	3	3
		PC	138		50	16	14	9	9	5	7	4	11	9	3	1	0	0

Table 28.--Suspended-sediment concentration, by particle-size class, obtained by different collecting methods and concentrated by different processing procedures--Continued

Date	Site name	Collecting and processing methods	Total suspended-sediment concentration (mg/L)	Concentration of suspended sediment (mg/L) greater than the indicated size class (in micrometers) but less than the next larger size class													
				<1 siphoned off	<1	1	2	4	8	16	32	63	88	125	175	250	350	500
6-18-89	White R. at Mile 11.5, Ark.	CS	92	5	44	10	10	9	8	5	1		Too little sand for analysis.					
		PC	74		43	8	8	5	5	2	3	0	0	0	0	0	0	0
3-23-89	Arkansas R. at Pendleton, Ark.	CS	43	14	19	3	2	1	1	1	1	0	0	0	1	0	0	0
		PC	29		19	3	2	1	1	1	1	0	0	0	1	0	0	0
6-19-89	Arkansas R. at Pendleton, Ark.	CS	153	14	33	5	4	3	3	6	3	5	8	25	34	10	0	0
		PC	117		29	6	3	5	2	2	3	8	7	21	27	4	0	0
3-24-89	Mississippi R. above Arkansas City, Ark.	CS	197	12	57	11	10	10	13	10	5	2	5	18	29	13	2	0
		CC	144		35	11	12	7	5	2	3	2	5	18	29	13	2	0
		PC	115		44	9	10	8	6	6	3	2	5	8	10	4	0	0
6-20-89	Mississippi R. above Arkansas City, Ark.	CS	236	12	56	22	24	16	17	17	8	6	7	13	14	13	11	0
		CC	183		53	17	17	12	8	7	5	6	7	13	14	13	11	0
		PC	172		55	22	22	16	10	7	7	6	7	9	7	3	1	0
3-26-89	Yazoo R. below Steele Bayou, Miss.	CS	150	67	62	11	3	1	2	3	1	0	0	0	0	0	0	0
		CC	86		66	12	3	0	2	2	1	0	0	0	0	0	0	0
		PC	93		70	11	4	2	3	2	1	0	0	0	0	0	0	0
6-22-89	Yazoo R. below Steele Bayou, Miss.	CS	272	57	154	27	10	4	6	10	3	1	0	0	0	0	0	0
		CC	175		120	27	12	3	5	4	3	1	0	0	0	0	0	0
		PC	227		169	23	10	6	7	7	4	1	0	0	0	0	0	0
3-27-89	Mississippi R. below Vicksburg, Miss.	CS	202	16	52	15	11	8	5	14	3	2	6	15	31	16	6	2
		CC	169		49	9	9	8	7	6	3	2	6	15	31	16	6	2
		PC	119		47	10	10	9	7	2	1	2	5	9	11	5	1	0
6-23-89	Mississippi R. below Vicksburg, Miss.	CS	210	10	72	14	14	16	13	12	5	5	5	8	15	11	7	3
		CC	150		54	11	9	7	6	6	3	5	5	8	15	11	7	3
		PC	140		61	13	12	9	9	5	3	4	7	9	6	2	0	0
3-29-89	Old R. Outflow Channel near Knox Landing, La.	CS	180	17	71	14	13	11	14	16	10	7	4	2	1	0	0	0
		CC	125		48	19	19	12	5	3	5	7	4	2	1	0	0	0
		PC	141		62	14	13	13	10	7	9	7	4	1	1	0	0	0
6-25-89	Old R. Outflow Channel near Knox Landing, La.	CS	220	10	76	15	14	12	13	16	10	32	21	1	0	0	0	0
		CC	148		37	13	14	11	8	5	6	32	21	1	0	0	0	0
		PC	157		50	17	17	9	7	7	15	24	9	1	1	0	0	0
3-30-89	Mississippi R. near St. Francisville, La.	CS	192	16	49	10	10	10	11	9	4	7	20	25	16	5	0	0
		CC	149		33	11	12	8	6	3	3	7	20	25	16	5	0	0
		PC	121		33	15	16	9	7	3	5	5	9	13	5	1	0	0
6-26-89	Mississippi R. near St. Francisville, La.	CS	204	13	70	13	13	10	17	14	7	6	12	16	9	4	0	0
		CC	150		52	14	11	8	8	7	3	6	12	16	9	4	0	0
		PC	unknown		72	13	14	11	12	7	3	Sample not available for analysis						
4-01-89	Mississippi R. below Belle Chasse, La.	CS	218	20	59	13	12	11	14	14	7	17	31	14	6	0	0	0
		CC	153		44	12	12	6	4	3	4	17	31	14	6	0	0	0
		PC	134		58	12	11	9	7	6	4	9	14	3	1	0	0	0
6-28-89	Mississippi R. below Belle Chasse, La.	CS	210	15	74	17	14	13	16	17	8	7	19	8	2	0	0	0
		CC	159		57	17	17	9	9	7	7	7	19	8	2	0	0	0
		PC	148		61	17	15	13	13	11	6	5	4	3	0	0	0	0
6-17-89	Mississippi R. at Helena, Ark.	CS	259	8	79	31	32	25	20	13	7	1	3	12	16	9	3	0
		CC	199		85	26	26	9	5	2	2	1	3	12	16	9	3	0
		PC	202		67	33	31	19	17	9	2	2	4	7	8	3	0	0
3-22-89	White R. at Mile 11.5, Ark.	CS	44	26	17	1	0	0	0	0	0		Too little sand for analysis.					
		PC	20		17	2	1	0	0	0	0	0	0	0	0	0	0	0

[1]Only composite B was used.

Surface-Water Properties

At each sampling site, a bucket was used to collect a surface-water sample at each vertical, and the temperature, pH, and specific conductance were measured (see "Tabulated Cruise Data" section). Temperatures and pH were measured with a Beckman meter (model ϕ12), and the specific conductance was measured with an Amberscience conductivity meter (model 604). The meters were calibrated with pH and specific conductance standards.

During the May-June 1990 cruise, a series of closely spaced sites was sampled in two reaches of the Lower Mississippi River downstream from the confluence of the Upper Mississippi and Ohio Rivers in order to study the mixing processes downstream from the confluence (see fig. 3). The first reach was straight and started with a sampling site at Wickliffe, Ky. (river mile 950.5), and ended with a sampling site near Columbus, Ky. (river mile 936.1). The second reach was curved and extended around the tight bend of the river at New Madrid, Mo. It started with a sampling site upstream from New Madrid (river mile 898.9) and ended with a sampling site near Point Pleasant, Mo. (river mile 879.5). The last sampling site at Caruthersville, Mo. (river mile 847.5), was selected far enough downstream from the confluence that the mixing of the Upper Mississippi and Ohio Rivers should be virtually complete. At each sampling site, the specific conductance of the surface water was measured and the specific conductance, temperature, pH, and suspended-sediment concentration of a depth-integrated sample (about 5 L) were measured at 9 to 15 verticals across the river (see May-June 1990 cruise sampling sites: Mississippi River at Wickliffe, near Columbus, above New Madrid, near Point Pleasant, and at Caruthersville in the "Tabulated Cruise Data" section).

By comparing the surface and depth-integrated specific conductances, the error in using the surface value of specific conductance as an approximation of the depth-integrated value of specific conductance for all sampling sites for all cruises could be estimated. In general, the specific conductance of the surface-water sample averaged 2-3 µS/cm greater than the specific conductance of the depth-integrated samples (see fig. 9). The depth-integrated water sample was aerated as it was poured through a 63-µm mesh sieve. A single test indicated that the specific conductance of a depth-integrated sample decreased from 364 µS/cm (before being poured through the sieve) to 360 µS/cm (after being poured through the sieve).

The specific conductance of the surface water was measured at different locations across the Lower Mississippi River at additional sampling sites in the straight reach between Wickliffe, Ky., and Columbus, Ky., and in the curved reach around the bend at New Madrid during June 1-4, 1990 (see fig. 3). The additional sites were sampled in the downriver direction on June 1 and June 2, 1990 (table 29), in the upriver direction on June 3 and June 4, 1990 (table 29), and for a second time in the downriver direction on June 14 and June 16, 1990 (table 30). Similar measurements were made at five sampling sites on the Upper Mississippi River on June 12, 1990 (see table 31).

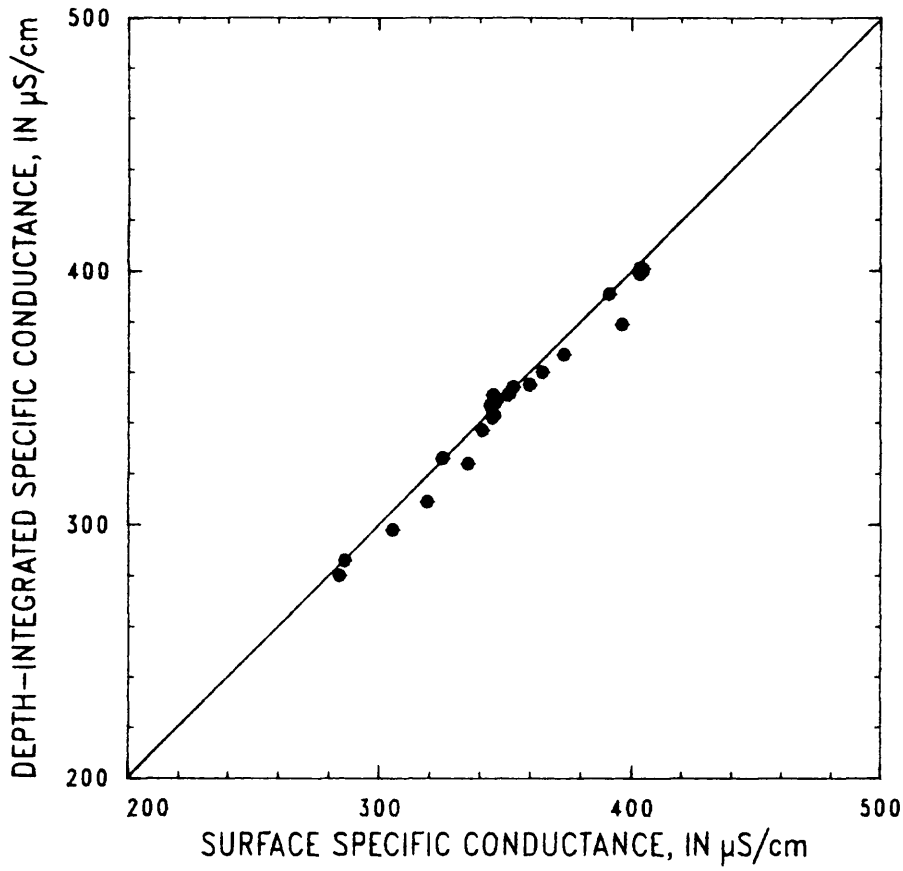


Figure 9.--Specific conductance of surface and depth-integrated water samples. Samples of surface water were collected about halfway through the depth-integration sampling process. The diagonal line indicates perfect agreement and is not a regression line. The abbreviation µS/cm is microsiemens per centimeter at 25° Celsius.

Table 29.--Specific conductance of surface water at locations across the Lower Mississippi River for the first leg of the May-June 1990 cruise, between river miles 879.5 and 946.4

[m, meter; specific conductance is in microsiemens per centimeter at 25 degrees Celsius; NS, no sample was collected; + overbank indicates that water was over the banks and could not be sampled from the research vessel]

Date 1990	Site name	Percent of channel width from left edge of flow								
		10	20	30	40	50	60	70	80	90
6-01	Mississippi R. at river mile 946.4 - 1,500 m wide + overbank									
	Water depth (m)	11.5	NS	7.0	7.0	8.3	10.0	13.0	NS	24.0
	Specific conductance	310	NS	323	329	331	334	340	NS	361
	Mississippi R. at river mile 942.9 - 1,020 m wide + overbank									
	Water depth (m)	20.0	NS	22.0	20.0	16.0	15	13.0	NS	16.0
	Specific conductance	312	NS	339	351	362	363	364	NS	365
6-02	Mississippi R. at river mile 898.9 - 1,070 m wide									
	Water depth (m)	30.8	26.2	24.0	19.0	14.8	12.5	14.5	13.0	11.0
	Specific conductance	327	336	338	345	345	346	348	349	352
	Mississippi R. at river mile 894.2 - 1,540 m wide + overbank									
	Water depth (m)	15.0	15.0	16.0	14.0	13.0	13.0	11.6	10.3	10.0
	Specific conductance	331	335	339	344	348	350	352	353	354
	Mississippi R. at river mile 889.5 - 890 m wide									
	Water depth (m)	8.3	14.0	17.0	19.5	23.5	23.5	23.0	22.0	19.7
	Specific conductance	330	332	333	335	336	341	345	349	350
	Mississippi R. at river mile 885.7 - 1,700 m wide									
	Water depth (m)	9.0	9.5	6.5	7.5	8.0	9.5	15.8	18.2	22.0
	Specific conductance	332	332	334	336	341	341	343	346	349
	Mississippi R. at river mile 882.2 - 1,594 m wide									
	Water depth (m)	18.6	17.3	15.0	12.5	9.0	10.2	8.5	8.0	8.5
	Specific conductance	333	341	344	345	346	348	349	349	349
	Mississippi R. at river mile 879.5 - 1,350 m wide									
	Water depth (m)	23.5	17.0	13.0	12.0	12.3	13.1	14.3	15.2	13.7
	Specific conductance	334	340	342	344	344	346	348	349	349
6-03	Mississippi R. at river mile 879.5 - 1,300 m wide									
	Water depth (m)	22.5	15.5	12.0	11.1	13.1	13.5	14.5	15.6	13.9
	Specific conductance	344	345	349	350	351	353	355	357	357
	Mississippi R. at river mile 882.2 - 1,580 m wide									
	Water depth (m)	18.5	17.5	13.3	12.4	10.5	9.3	8.0	7.8	7.5
	Specific conductance	340	348	351	353	355	355	356	357	357
	Mississippi R. at river mile 885.7 - 1,740 m wide									
	Water depth (m)	9.2	9.7	6.3	7.0	8.5	9.6	16.3	17.8	19.8
	Specific conductance	337	338	341	341	345	349	351	354	358
	Mississippi R. at river mile 889.5 - 870 m wide									
	Water depth (m)	8.3	12.6	17.8	20.2	24.1	23.0	24.0	24.0	20.2
	Specific conductance	337	339	341	344	348	348	359	360	361
	Mississippi R. at river mile 894.2 - 1,560 m wide + overbank									
	Water depth (m)	14.0	15.0	15.2	14.5	12.5	12.8	11.5	10.0	9.8
	Specific conductance	339	344	345	352	358	361	362	363	363
	Mississippi R. at river mile 898.8 - 980 m wide									
	Water depth (m)	30.5	24.4	23.2	18.2	14.0	13.5	13.5	12.1	9.8
	Specific conductance	329	333	347	353	357	361	363	363	364
6-04	Mississippi R. at river mile 936.1 - 830 m wide									
	Water depth (m)	27.0	26.5	26.2	22.0	17.0	10.2	8.5	8.6	9.0
	Specific conductance	309	308	341	373	382	387	388	389	389
	Mississippi R. at river mile 942.9 - 1,020 m wide									
	Water depth (m)	20.7	20.0	20.0	17.1	17.5	14.3	12.4	12.3	15.5
	Specific conductance	301	316	338	363	379	387	392	396	397
	Mississippi R. at river mile 946.4 - 1,480 m wide									
	Water depth (m)	11.5	9.2	7.0	6.6	7.5	10.3	13.0	20.5	24.6
	Specific conductance	297	302	309	313	316	321	336	359	384

Table 30.--Specific conductance of surface water at locations across the Lower Mississippi River for the second leg of the May-June 1990 cruise, between river miles 950.5 and 736.7

[Specific conductance in microsiemens per centimeter at 25 degrees Celsius; NS, no sample collected]

Date 1990	Site name	Percent of channel width from left edge of flow								
		10	20	30	40	50	60	70	80	90
6-14	Mississippi R. at river mile 950.5 - 740 m wide									
	Water depth (m)	10.0	27.0	26.0	24.0	22.5	18.0	12.0	8.5	8.5
	Specific conductance	280	287	310	347	370	378	379	379	378
	Mississippi R. at river mile 946.4 - 1,500 m wide									
	Water depth (m)	9.2	6.8	5.0	4.5	5.2	7.0	10.2	17.2	22.0
	Specific conductance	286	296	297	298	298	302	313	339	353
	Mississippi R. at river mile 942.9 - 1,000 m wide									
	Water depth (m)	19.3	20.0	17.5	16.0	15.3	12.8	11.0	10.8	13.3
	Specific conductance	283	290	320	339	360	364	372	374	374
	Mississippi R. at river mile 936.1 - ~800 m wide									
	Water depth (m)	24.0	25.0	25.0	21.2	16.5	13.0	7.0	6.4	6.7
	Specific conductance	280	310	324	355	361	365	367	367	368
6-15	Mississippi R. at river mile 898.9 - 980 m wide									
	Water depth (m)	27.5	23.0	20.0	14.0	11.9	10.7	12.4	11.0	9.2
	Specific conductance	310	317	326	341	347	352	355	357	358
	Mississippi R. at river mile 894.2 - 1,450 m wide									
	Water depth (m)	12.2	11.9	13.2	12.4	11.5	9.6	9.2	10.5	12.1
	Specific conductance	318	322	328	334	338	344	350	353	357
	Mississippi R. at river mile 889.5 - 850 m wide									
	Water depth (m)	6.0	11.8	15.5	17.1	19.6	21.0	21.5	21.0	18.0
	Specific conductance	314	314	317	321	325	332	345	348	348
	Mississippi R. at river mile 885.7 - 1,690 m wide									
	Water depth (m)	6.9	8.1	4.1	5.2	6.8	7.6	13.7	15.6	18.5
	Specific conductance	313	315	317	319	325	330	335	340	344
	Mississippi R. at river mile 882.2 - 1,580 m wide									
	Water depth (m)	~16.3	~15.3	12.2	9.6	7.7	6.5	6.2	5.0	5.7
	Specific conductance	315	331	335	339	337	339	341	341	342
6-15	Mississippi R. at river mile 879.5 - 1,300 m wide									
	Water depth (m)	20.4	12.7	10.3	9.9	12.0	11.1	12.3	12.8	13.1
	Specific conductance	313	329	332	335	337	339	341	341	342
6-16	Mississippi R. at river mile 847.5 - 780 m wide									
	Water depth (m)	7.5	NS	NS	NS	15.2	NS	NS	NS	23.1
	Specific conductance	315	NS	NS	NS	318	NS	NS	NS	324
	Mississippi R. at river mile 801.0 - 760 m wide									
	Water depth (m)	25.8	NS	NS	NS	17.7	NS	NS	NS	11.0
	Specific conductance	315	NS	NS	NS	320	NS	NS	NS	321
	Mississippi R. at river mile 778.5 - 570 m wide									
	Water depth (m)	23.3	NS	NS	NS	24.9	NS	NS	NS	6.5
	Specific conductance	311	NS	NS	NS	318	NS	NS	NS	319
	Mississippi R. at river mile 736.7 - 1,110 m wide									
	Water depth (m)	19.8	NS	NS	NS	12.5	NS	NS	NS	15.8
	Specific conductance	317	NS	NS	NS	321	NS	NS	NS	325

Table 31.--Specific conductance of surface water at locations across the Upper Mississippi River for the second leg of the May-June 1990 cruise, between river miles 179.0 and 53.5

[m, meter; specific conductance in microsiemens per centimeter at 25 degrees Celsius]

Date 1990	Site name	Percent of channel width from left edge of flow								
		10	20	30	40	50	60	70	80	90
6-12	Mississippi R. at river mile 179.0 - 500 m wide									
	Water depth (m)	16.0	14.5	15.0	13.3	12.5	12.2	11.2	11.2	8.1
	Specific conductance	458	432	414	391	353	333	331	325	325
	Mississippi R. at river mile 165.0 - 590 m wide									
	Water depth (m)	13.8	13.2	14.2	13.2	12.5	11.7	11.7	12.0	11.1
	Specific conductance	433	422	401	377	364	344	335	331	328
	Mississippi R. at river mile 125.4 - 700 m wide									
	Water depth (m)	11.7	12.8	13.0	12.7	11.8	11.2	11.0	10.0	9.5
	Specific conductance	377	378	375	368	361	351	345	341	338
	Mississippi R. at river mile 79.8 - 540 m wide									
	Water depth (m)	7.5	7.6	9.3	13.0	17.5	20.8	18.7	14.7	8.9
	Specific conductance	365	364	363	362	360	359	358	358	358
	Mississippi R. at river mile 53.5 - 520 m wide									
	Water depth (m)	9.1	13.0	16.8	20.2	19.7	18.2	17.0	13.7	12.6
	Specific conductance	379	371	368	368	366	365	366	367	368

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TABULATED CRUISE DATA

The data in this section are organized by individual cruises. In the listings of measurements made at each vertical, the A and B after the vertical number identifies the sample bottle, the X preceding the vertical number indicates that an extra velocity measurement was made but no sample was collected, and an R indicates that the vertical was repeated because the velocity measurement was incorrect, the suspended-sediment collection bag leaked, or debris on the nozzle prevented the collection of a suitable sample. Verticals usually were occupied in numerical order. Exceptions due to weather conditions or towboat traffic are noted in the REMARKS section of each sampling site listing. Inch-pound units are used in these listings for (1) part of the name of a sampling site; (2) gage heights, which will serve as a reference for future cruises; (3) the name of a sampling weight; and (4) the designation of the nozzle size used to sample suspended sediment.

SOLID CUP refers to the standard Price AA current meter with solid, polymer bucket wheels. This current meter was used for the vertical integration measurements of discharge in this report because it does not respond to vertical velocities; however, later studies indicated that this current meter does not have a good cosine response to varying angles of attack, and its use by the U.S. Geological Survey has been discontinued.

The following abbreviations are used in the tabulated cruise data and are listed below.

SOLID CUP = Price AA solid, polymer bucket-wheel current meter
SUSP = type of suspension
Dist. = distance
Std. dev. = standard deviation of the location of the vertical
V_i = volume of river water collected by the depth-integration method
V_p = volume of river water collected by pumping
pH = surface pH of the river water
EST = estimated
LEW = left edge of water
LEF = left edge of flow
REF = right edge of flow
REW = right edge of water
RPS = revolutions per second
-- = no sample was collected or no measurement was made
ft = feet
lb = pound
cm = centimeter
cm/s = centimeter per second
m/s = meter per second
°C = degree Celsius
L = liter
µS/cm = microsiemens per centimeter at 25 degrees Celsius
<63 µm = finer than 63 micrometers
>63 µm = greater than 63 micrometers

DATA LISTINGS
FOR
MARCH-APRIL 1989 CRUISE

SITE: Mississippi River near Winfield, Missouri 03-10-89
PARTY: Moody, Stevens, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight. Current meter 32 cm above nozzle.
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Anchored at 20 verticals in the following order: 5,4,3,2,1,6-20
Many dead or dying fish floating by the section.
Transit rate 6 cm/s and no nozzle. Delta x based on 20-second printout.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01	23	5.5	0.12	15	0.86	29	2.7	9.1	439
02	46	7.6	0.29	45	7.31	47	3.1	9.0	431
02R	54	7.4	0.40	53	--	--	--	--	--
03	82	7.6	0.39	62	11.04	48	2.3	9.0	408
04	106	7.7	0.42	60	11.81	46	1.7	8.9	435
05	119	7.9	0.42	32	12.82	49	2.3	8.6	442
X01	124	7.8	0.38	66	--	--	--	--	--
06	163	7.2	0.37	75	12.00	46	3.8	9.0	448
07	181	7.4	0.28	63	7.29	45	2.7	9.0	456
08	224	6.5	0.32	58	8.42	43	2.8	9.0	438
09	237	6.2	0.31	42	8.55	34	3.1	9.0	435
10	268	5.9	0.29	41	5.77	34	3.1	9.1	432
11A	285	5.4	0.29	17	5.76	27	3.1	9.0	443
11B	290	5.4	0.28	32	--	--	--	--	--
12	328	5.0	0.24	31	6.48	23	2.6	8.9	--
13	342	4.8	0.27	27	3.98	22	3.2	8.9	440
14	369	4.4	0.26	26	3.89	18	2.8	9.0	435
15	389	4.9	0.24	20	2.20	18	2.8	8.9	448
16A	403	3.9	0.26	12	4.99	14	3.3	9.0	428
16B	412	2.7	0.25	16	--	--	--	--	--
17	451	4.3	0.16	17	1.40	18	2.9	9.0	433
18C	460	4.0	0.18	5	--	--	--	--	--
18	466	4.1	0.15	13	2.26	13	3.0	8.9	433
19	503	3.3	0.11	10	1.26	16	3.4	8.8	423
20	521	2.9	0.08	6	1.32	--	3.4	9.0	430
REW	552	0.0	0.00	0	--	--	--	--	--
MEAN		5.3	0.29						
TOTAL	552			844	119.41	590			

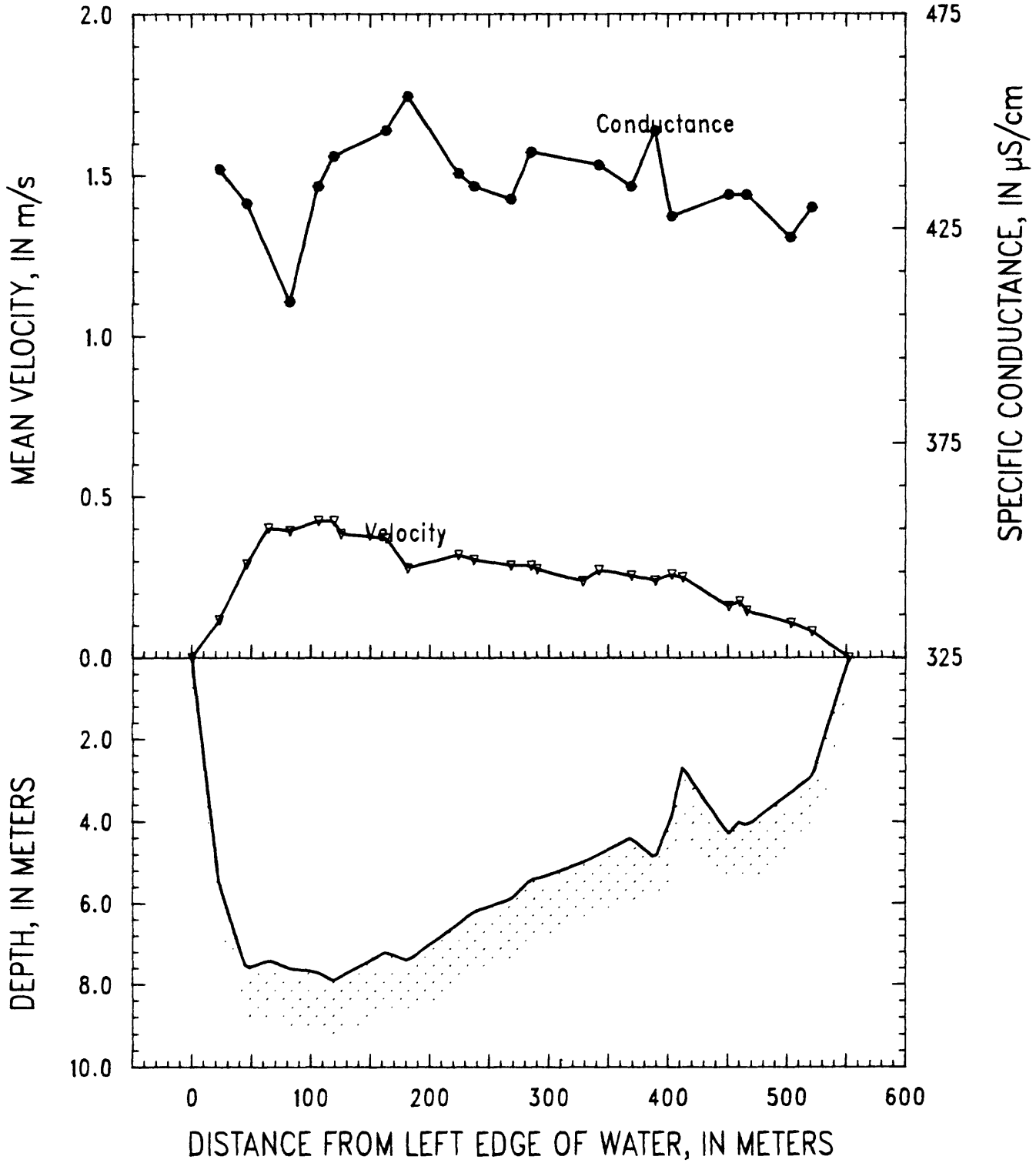

Figure 10. Mississippi River near Winfield, Missouri, on March 10,1989.

SITE: Illinois River at Hardin, Illinois 03-09-89
PARTY: Moody METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: 15-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 06-29-88 (for 15-lb weight only)
CURRENT METER EQUATION: V(m/s) = RPS * 0.751 + 0.016

REMARKS: Anchored at about 120 m from LEW, and collected a 117.89-L depth-integrated composite and a 597-L pumped composite. No nozzle. Transit rate was 6 cm/s down and 3 cm/s up. Discharge was measured using a handline from small boat. Tagline stretched from R/V ACADIANA to LEW and then to REW. Water temperature was 1.6-2.2°C.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01	10	0.4	0.10	0	--	--	--	--	--
02	20	1.5	0.22	3	--	--	--	--	--
03	30	2.2	0.29	6	--	--	--	--	--
04	40	2.7	0.33	9	--	--	--	--	--
05	50	3.3	0.36	12	--	--	--	--	--
06	60	3.4	0.38	13	--	--	--	--	--
07	70	3.9	0.38	15	--	--	--	--	--
08	80	4.0	0.39	16	--	--	--	--	--
09	90	4.0	0.37	15	--	--	--	--	--
10	100	3.7	0.36	13	--	--	--	--	--
11	110	4.0	0.37	13	--	--	--	--	--
12	117	4.0	0.39	10	--	--	--	--	--
13	123	4.0	0.40	9	--	--	--	--	--
14	129	4.0	0.36	11	--	--	--	--	--
15	139	4.8	0.33	16	--	--	--	--	--
16	149	5.6	0.43	24	--	--	--	--	--
17	159	5.8	0.35	21	--	--	--	--	--
18	169	6.0	0.36	22	--	--	--	--	--
19	179	6.0	0.39	23	--	--	--	--	--
20	189	5.9	0.41	24	--	--	--	--	--
21	199	5.9	0.45	27	--	--	--	--	--
22	209	5.9	0.43	25	--	--	--	--	--
23	219	5.6	0.44	25	--	--	--	--	--
24	229	5.5	0.40	22	--	--	--	--	--
25	239	5.0	0.35	18	--	--	--	--	--
26	249	4.0	0.34	14	--	--	--	--	--
27	259	2.8	0.29	8	--	--	--	--	--
REW	269	0.0	0.00	0	--	--	--	--	--
MEAN		4.1	0.38						
TOTAL	269			414					

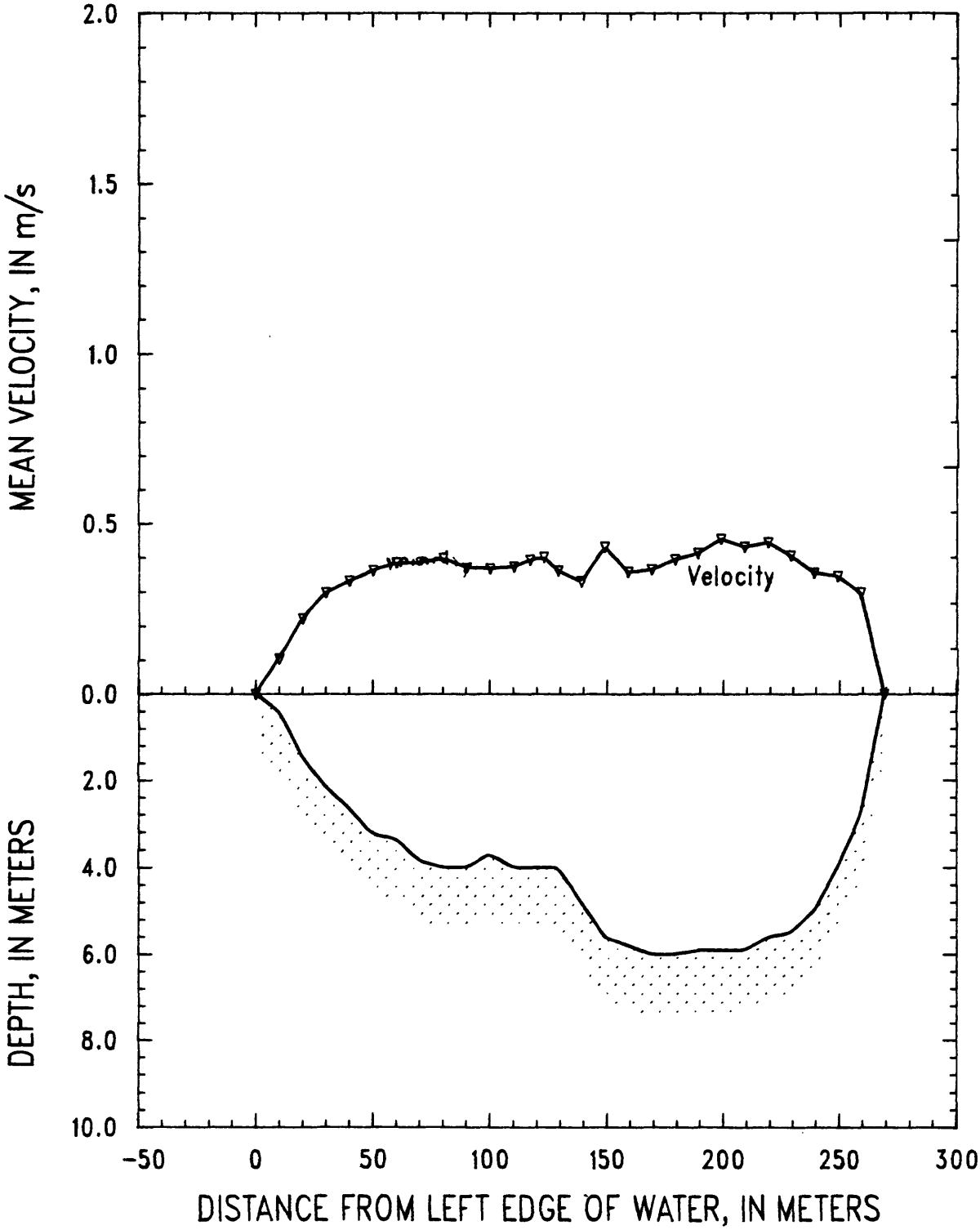

Figure 11. Illinois River at Hardin, Illinois, on March 9, 1989.

SITE: Missouri River at Hermann, Missouri 03/12/89
PARTY: Moody, Stevens, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight. Current meter 32 cm above nozzle.
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate 11 cm/s. Nozzle was 5/16 inch. Slope gage was estimated at 5.5 ft. Coast Guard reported stage was 7.5 ft. Verticals occupied in order for depth-integrated sampling.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	9	6.3	1.03	62	4.43	15	6.4	7.8	625
02B	19	6.3	1.18	67	5.92	23	6.8	8.0	641
03A	27	6.2	1.13	67	6.23	28	6.8	8.0	636
04B	38	5.7	1.22	56	6.20	27	6.7	8.0	624
05A	43	6.3	1.29	73	5.52	26	6.7	8.1	627
06B	56	5.8	1.37	80	6.76	27	6.6	8.1	599
07A	63	6.2	1.50	60	5.89	24	6.8	8.1	581
08B	69	6.3	1.54	44	5.65	19	7.3	8.0	559
X03	72	4.7	1.43	27	--	--	--	--	--
09A	77	5.2	1.43	82	5.09	19	7.0	8.0	583
10B	94	4.5	1.44	71	4.74	22	7.0	8.1	565
11R	99	4.3	1.37	29	4.31	16	7.1	8.1	549
12B	104	4.3	1.51	58	4.97	14	7.1	8.1	458
13A	117	4.8	1.25	57	4.95	16	7.1	8.1	446
14B	123	5.2	1.30	37	4.65	18	7.1	8.0	448
15A	128	4.6	1.27	29	4.10	15	7.5	7.9	431
X06	133	4.6	1.32	33	--	--	--	--	--
16B	139	4.4	1.14	28	3.93	14	7.4	8.0	434
17A	144	4.3	1.16	50	3.94	16	7.4	8.0	390
18B	159	4.4	1.18	49	3.90	15	7.4	8.0	375
19A	163	4.2	1.22	36	3.46	13	7.5	8.0	350
20B	173	3.6	1.04	41	3.41	13	7.5	8.0	354
21A	185	3.3	1.16	36	3.22	13	7.6	8.0	328
22B	192	3.4	0.96	29	2.86	12	7.6	7.9	326
23A	203	3.4	1.10	32	2.76	11	7.5	8.0	330
24B	209	3.4	1.29	42	3.33	14	7.9	8.0	326
25A	222	3.1	1.11	34	3.16	10	7.9	8.0	324
26B	229	3.2	1.08	19	2.94	11	7.6	8.0	319
27A	233	3.0	1.02	20	2.01	9	7.8	8.0	324
28B	242	3.3	1.01	27	2.06	11	7.9	8.1	319
29A	249	5.5	0.85	40	2.93	20	7.7	8.1	315
30B	259	6.3	0.95	63	3.80	16	7.9	8.1	315
REW	270	0.0	0.00	0	--	--	--	--	--
MEAN		4.5	1.21						
TOTAL	270			1,478	127.12	507			

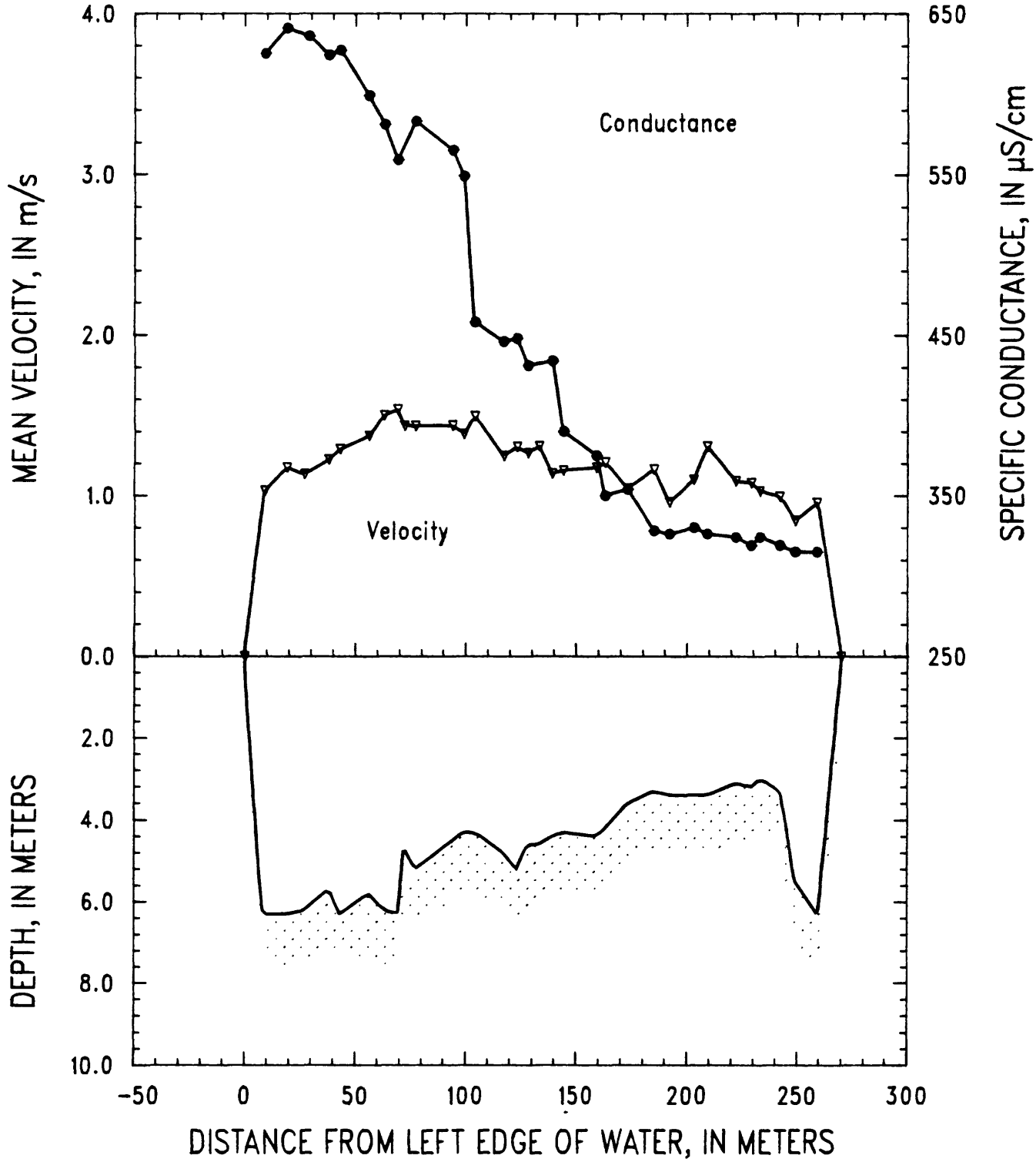

Figure 12. Missouri River at Hermann, Missouri, on March 12, 1989.

SITE: Mississippi River at St. Louis, Missouri 03-13-89
PARTY: Moody, Stevens, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight. Current meter 32 cm above nozzle.
CURRENT METER NO.: P8308282 DATE RATED: 7-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 10 cm/s and nozzle was 1/4 inch. Simultaneous discharge measurement made by George Gray, USGS, Missouri District, from the Poplar Street Bridge. Verticals occupied in order for depth-integrated sampling and surface-water measurements.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	25	10.3	0.79	150	4.04	16	5.4	8.7	590
02B	37	10.2	1.09	145	4.84	25	5.3	8.8	581
03A	51	10.0	1.46	204	5.70	28	5.6	8.9	586
04B	65	10.2	1.43	212	6.60	31	5.9	8.8	587
05A	80	10.6	1.35	222	6.34	32	5.3	8.8	585
06B	96	10.3	1.27	157	6.02	31	5.3	8.8	583
X07	104	10.2	1.36	138	--	--	--	--	--
07A	116	9.7	1.23	125	4.99	30	6.0	8.8	586
08B	125	9.3	1.28	178	5.46	26	6.3	8.9	579
09A	146	8.9	1.27	170	5.09	25	5.5	8.8	574
10B	155	8.8	1.23	173	4.98	22	5.6	8.8	568
11A	178	7.8	1.21	175	4.67	20	5.7	8.8	561
12B	192	7.2	1.15	124	4.02	17	5.8	8.7	562
13A	208	7.1	1.10	117	3.77	17	6.0	8.7	551
14B	222	6.6	1.09	100	3.74	15	6.5	8.7	550
15A	236	6.2	1.24	123	3.91	16	6.2	8.8	549
16B	254	6.5	1.18	161	3.71	14	6.2	8.7	538
17A	278	6.2	1.22	132	3.55	13	6.3	8.6	532
18B	289	5.8	1.16	81	3.15	12	6.6	8.6	533
19A	302	5.7	1.17	84	3.38	12	6.5	8.6	532
20B	314	5.3	1.17	90	2.77	11	7.0	8.5	527
21A	331	5.2	1.04	103	2.06	9	6.6	8.6	526
22B	352	5.3	1.08	92	2.54	9	6.7	8.6	523
23A	363	5.2	1.08	92	2.31	9	7.0	8.5	518
24B	385	5.3	1.14	99	2.89	10	6.9	8.5	515
25A	396	5.7	1.11	82	2.89	8	6.5	8.5	513
26B	411	5.5	1.06	99	2.44	10	6.9	8.5	518
27A	430	5.3	0.99	95	2.44	11	7.5	8.4	--
28B	447	5.1	0.96	71	2.45	9	7.5	8.4	520
29A	459	5.2	1.06	72	2.03	7	7.3	8.4	530
30B	473	5.9	0.77	71	1.72	5	7.6	8.4	527
REW	490	0.0	0.00	-	--	--	--	--	--
MEAN		6.9	1.17						
TOTAL	490			3,937	114.50	500			

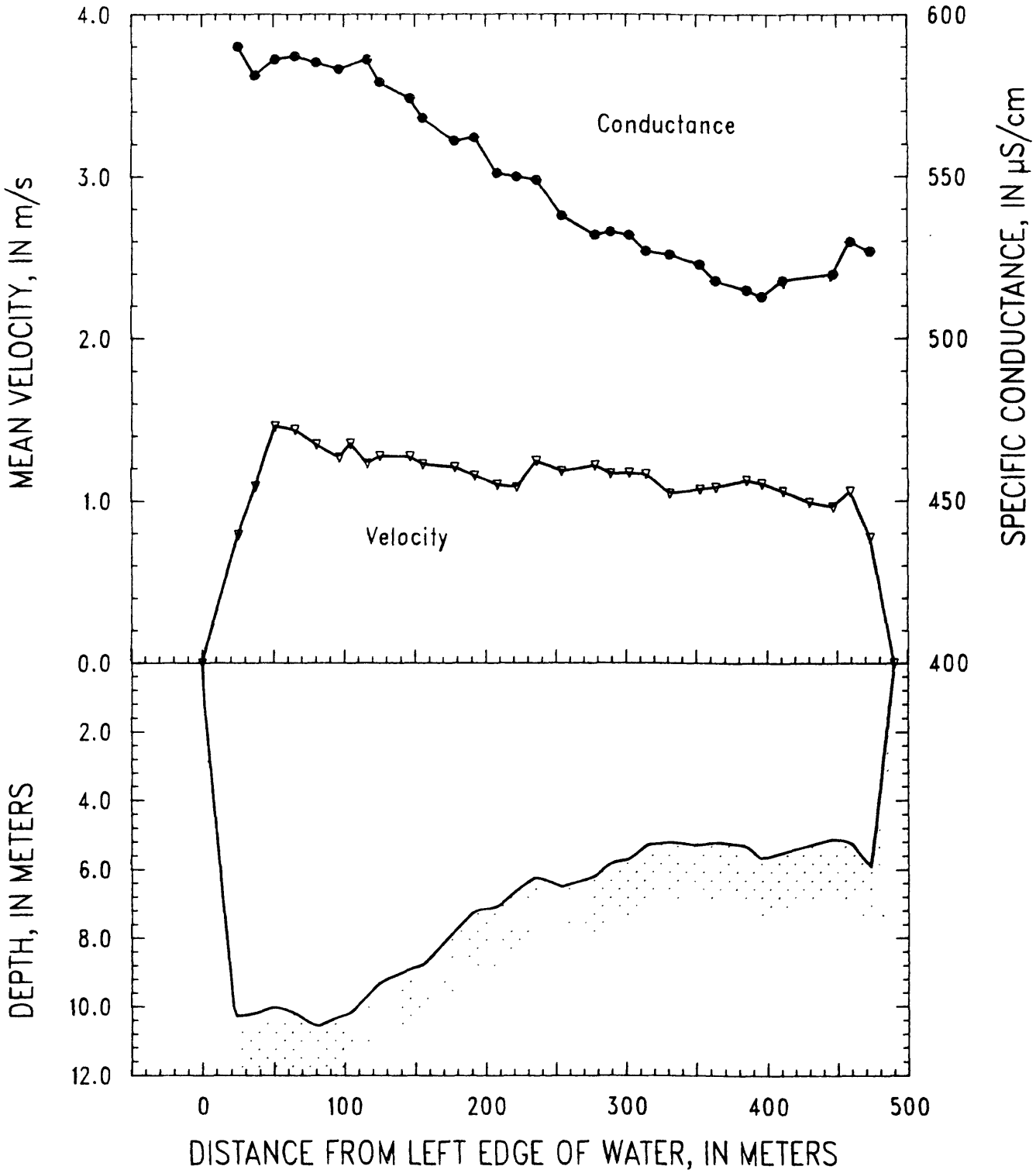

Figure 13. Mississippi River at St. Louis, Missouri, on March 13, 1989.

SITE: Mississippi River at Thebes, Illinois 03-15-89
PARTY: Moody, Stevens, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight. Current meter 32 cm above nozzle.
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 8 cm/s and nozzle was 1/4 inch. Verticals were occupied in order 01-27; flow at verticals 28-30 was estimated to be proportional to depth to the 2/3 power. Simultaneous discharge measurement was made by George Gray, USGS, Missouri District, from Thebes railroad bridge. Backwater from the Ohio River.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	32	4.5	0.38	42	0.58	3	7.5	8.2	477
02B	49	7.1	0.51	58	1.57	6	7.6	8.3	505
03A	64	6.8	0.63	56	1.99	11	7.2	8.4	508
X01	75	9.8	0.84	82	--	--	--	--	--
04B	84	8.8	0.98	86	4.42	25	7.1	8.4	510
05A	95	9.0	1.09	142	5.43	21	7.0	8.5	514
06B	113	9.2	1.25	213	6.43	23	7.0	8.4	510
07A	132	9.1	1.29	252	6.70	23	7.2	8.4	508
08B	156	9.4	1.35	229	6.78	23	7.2	8.4	505
X02	168	9.4	1.41	152	--	--	--	--	--
09A	179	9.4	1.38	136	6.74	23	7.1	8.5	511
10B	189	9.5	1.39	258	6.81	23	7.7	8.5	511
11A	218	9.4	1.39	321	6.97	23	7.6	8.6	517
12B	238	9.5	1.33	152	6.83	23	7.9	8.4	511
13A	242	9.5	1.30	179	6.58	23	7.6	8.5	519
14B	267	9.3	1.28	274	6.80	23	7.5	8.5	518
15A	288	9.3	1.23	222	5.92	23	7.5	8.5	522
16B	306	9.6	1.27	201	6.51	23	7.7	8.6	512
17A	321	9.6	1.31	264	5.88	25	7.4	8.7	525
18B	348	9.8	1.20	258	6.37	25	7.8	8.6	519
19A	365	8.9	1.11	222	5.49	19	7.8	8.5	532
20B	393	7.5	1.05	174	4.23	19	7.2	8.5	519
21A	409	8.0	1.05	160	4.98	17	7.5	8.5	519
22B	431	7.1	1.02	152	4.02	11	7.4	8.6	523
23A	451	6.7	1.02	103	3.68	13	7.7	8.6	511
24B	461	6.7	0.98	108	3.60	13	7.8	8.5	511
25A	484	6.4	0.95	106	2.64	11	7.6	8.5	519
26B	496	6.0	1.00	60	2.65	11	7.5	8.6	511
26R	504	6.0	0.83	48	--	--	--	--	--
27A	515	5.3	0.93	59	2.41	7	7.9	8.5	515
X05	528	3.5	0.80	40	--	--	--	--	--
28	544	2.6	0.58	26	--	--	--	--	--
29	563	3.0	0.51	30	--	--	--	--	--
30	583	3.0	0.32	19	--	--	--	--	--
REW	602	0.0	0.00	0	--	--	--	--	--
MEAN		7.3	1.11						
TOTAL	602			4,884	133.01	490			

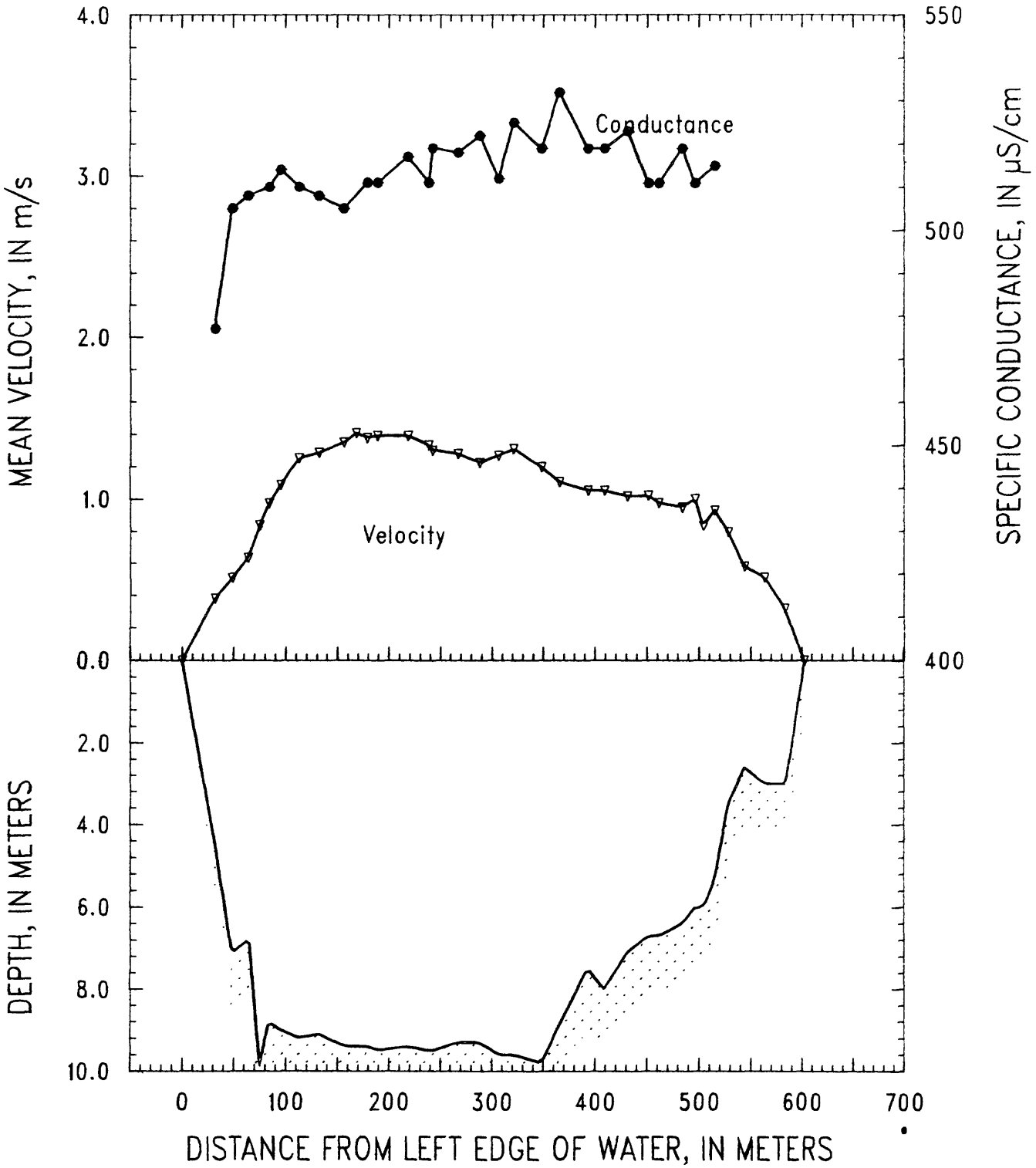

Figure 14. Mississippi River at Thebes, Illinois, on March 15, 1989.

SITE: Ohio River at Olmsted, Illinois 03-16-89
PARTY: Moody, Stevens, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: 44.9 ft at Lock and Dam 53
SUSP: Bag sampler and 300-lb weight. Current meter 32 cm above nozzle.
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 16 cm/s and 3/16-inch nozzle. Verticals were occupied from 31 to 1. Vertical 31 was the right edge of flow.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	39	9.0	0.72	233	1.01	5	10.5	7.5	163
02B	72	10.0	1.06	328	1.71	10	10.6	7.4	164
03A	101	10.8	1.29	417	2.61	13	10.6	7.4	164
04B	132	11.3	1.24	456	2.35	17	10.5	7.5	169
05A	166	11.5	1.33	589	2.72	16	10.5	7.4	173
06B	209	12.0	1.25	632	2.90	17	10.7	7.5	176
07A	250	12.4	1.33	468	3.22	18	10.3	7.3	182
08B	266	12.8	1.22	360	2.85	19	10.3	7.4	189
X04	296	13.1	1.30	340	--	--	--	--	--
09A	306	13.3	1.26	377	3.36	20	10.3	7.4	194
10B	341	14.1	1.45	603	3.67	23	10.1	7.5	199
11A	365	14.1	1.41	469	3.95	21	9.9	7.4	200
12R	388	14.8	1.37	293	--	--	--	--	--
12B	394	14.9	1.40	438	3.82	21	9.8	7.5	206
13A	430	14.7	1.36	569	3.59	22	9.9	7.5	210
14B	451	14.5	1.43	643	3.61	24	9.5	7.4	223
15R	492	14.6	1.60	573	--	--	--	--	--
15A	500	14.9	1.61	156	4.47	26	9.2	7.4	229
16R	505	14.9	1.59	414	--	--	--	--	--
16B	535	15.8	1.57	621	4.21	27	9.3	7.5	234
17A	555	15.8	1.68	808	5.18	26	8.8	7.3	241
18B	596	15.3	1.44	747	4.48	31	8.8	7.4	237
19A	623	16.2	1.57	687	4.46	27	8.6	7.4	250
20B	650	16.3	1.65	848	4.35	25	8.6	7.4	254
21A	686	16.4	1.45	762	4.41	28	10.4	7.3	249
22B	714	16.6	1.67	804	4.85	30	8.4	7.5	237
23A	744	17.9	1.40	837	4.85	30	8.4	7.4	242
24B	781	18.7	1.34	879	4.39	33	8.3	7.5	254
25A	814	18.3	1.22	760	4.41	34	8.5	7.4	254
26B	849	18.3	1.49	925	4.48	34	9.0	7.5	266
27A	882	18.3	1.58	837	5.21	34	8.4	7.3	265
28B	907	17.8	1.52	878	4.39	33	8.4	7.4	248
29A	947	18.4	1.38	901	4.47	35	8.3	7.5	235
30B	978	13.6	1.25	597	2.91	17	8.4	7.3	255
31	1,017	5.6	0.65	168	--	4	8.3	7.3	263
REW	1,070	0.0	0.00	0	--	--	--	--	--
MEAN		13.7	1.39						
TOTAL	1,070			20,417	112.89	720			

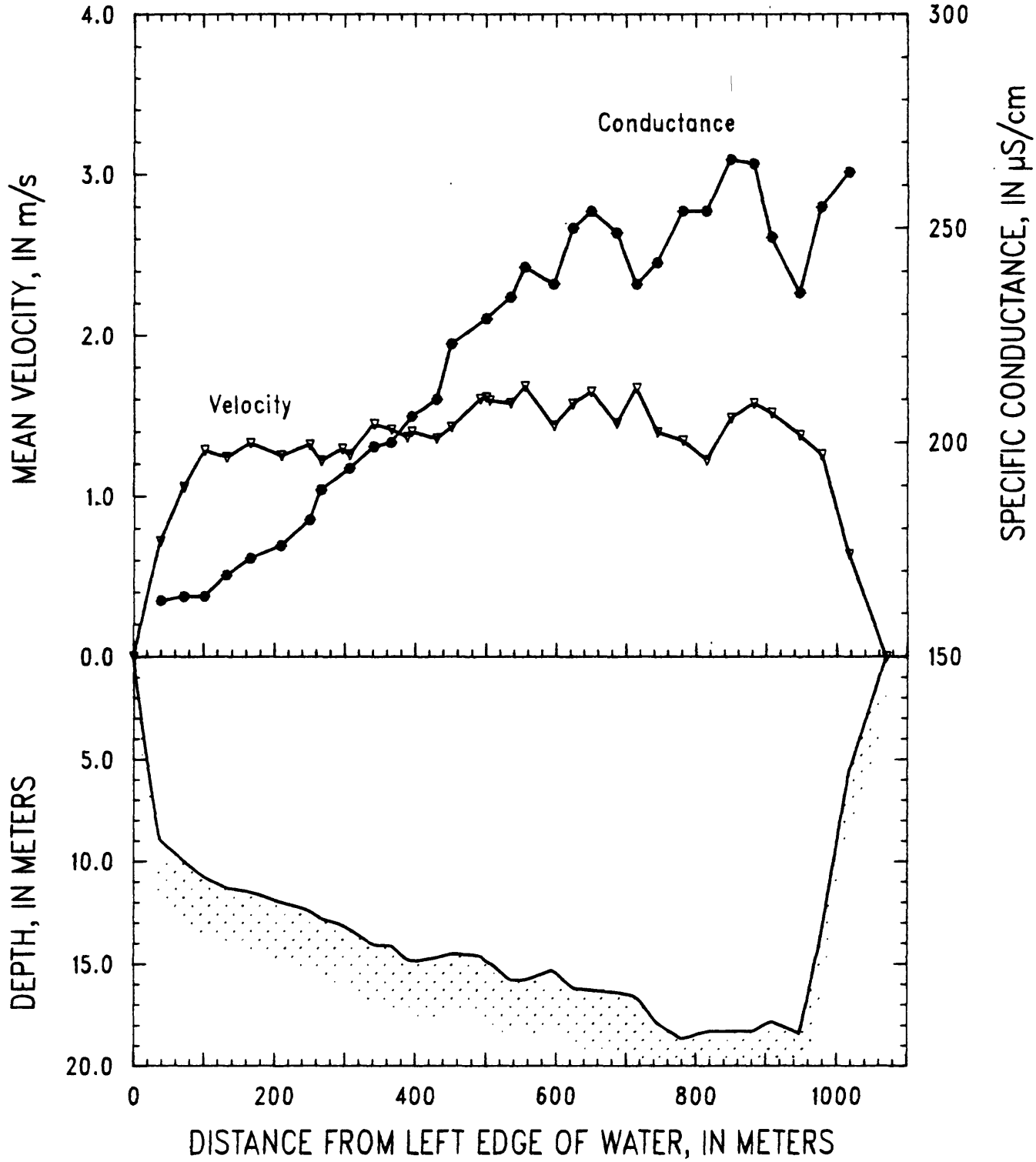

Figure 15. Ohio River at Olmsted, Illinois, on March 16, 1989.

SITE: Mississippi River below Hickman, Kentucky 03-17-89
PARTY: Moody, Stevens, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: 35.33 ft at Hickman Harbor gage
SUSP: Bag sampler and 300-lb weight. Current meter 32 cm above nozzle.
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 17 cm/s and 3/16-inch nozzle. Verticals were occupied in in order 1-30. Windy. B-52 buzzed ship.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	48	12.6	0.99	562	2.15	7	9.9	7.3	217
02B	90	13.4	1.71	791	3.83	15	10.7	7.3	207
03A	117	13.1	1.70	814	3.91	18	9.7	7.3	212
04B	163	13.5	1.81	975	4.37	20	10.1	7.3	221
05A	197	13.5	1.87	769	4.18	22	9.9	7.2	222
06B	224	13.3	1.69	371	3.72	23	9.9	7.2	225
X07	230	13.2	1.80	487	--	--	--	--	--
07A	265	13.8	1.58	763	4.66	23	10.0	7.5	223
08B	300	13.2	1.39	689	4.45	20	10.1	7.3	223
09A	340	13.6	1.75	573	3.73	18	9.8	7.4	234
X02	348	13.5	1.88	560	--	--	--	--	--
10B	384	12.4	1.81	786	3.61	16	9.8	7.4	245
11A	418	12.0	1.60	671	3.55	17	10.0	7.4	233
12B	454	11.6	1.84	928	3.80	14	10.2	7.5	237
13A	505	11.6	1.69	725	3.47	15	9.6	7.5	254
14B	528	11.2	1.85	705	3.52	16	9.5	7.6	265
15A	573	11.4	1.74	604	3.47	15	9.5	7.6	278
X03	589	10.6	1.90	413	--	--	--	--	--
16B	614	11.7	1.66	487	4.09	16	9.7	7.6	286
17A	639	11.9	1.76	744	4.03	16	10.1	7.6	291
18B	685	12.7	2.00	1,067	4.39	16	9.7	7.5	293
19A	723	13.4	2.04	970	5.36	17	9.3	7.7	300
20B	756	13.8	2.05	594	4.78	20	9.5	7.7	305
20R	765	13.8	1.98	382	--	--	--	--	--
X04	784	13.8	2.02	558	--	--	--	--	--
21A	805	14.9	1.95	407	4.89	19	10.0	7.8	329
21R	812	13.9	1.89	368	--	--	--	--	--
22B	833	13.5	1.99	698	4.85	18	10.0	7.8	346
23A	864	13.0	1.88	980	4.19	18	8.8	7.9	364
24B	913	14.5	1.64	832	4.27	16	8.9	7.9	356
X06	934	14.9	1.49	311	--	--	--	--	--
25A	941	15.4	1.55	429	3.92	17	9.4	7.9	374
26B	970	16.3	1.31	599	3.73	19	9.2	7.9	381
X05	997	16.1	1.43	413	--	--	--	--	--
27A	1,006	16.2	1.25	365	3.68	19	9.1	7.9	379

SITE: Mississippi River below Hickman, Kentucky--continued 03-17-89

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
28B	1,033	16.3	1.40	1,076	3.57	17	9.1	8.0	386
29A	1,100	14.4	1.10	728	2.72	13	9.5	8.1	386
30B	1,125	14.0	1.07	488	2.08	5	9.4	8.0	396
REW	1,165	0.0	0.00	0	--	--	--	--	--
MEAN		12.8	1.65						
TOTAL	1,165			24,682	116.97	505			

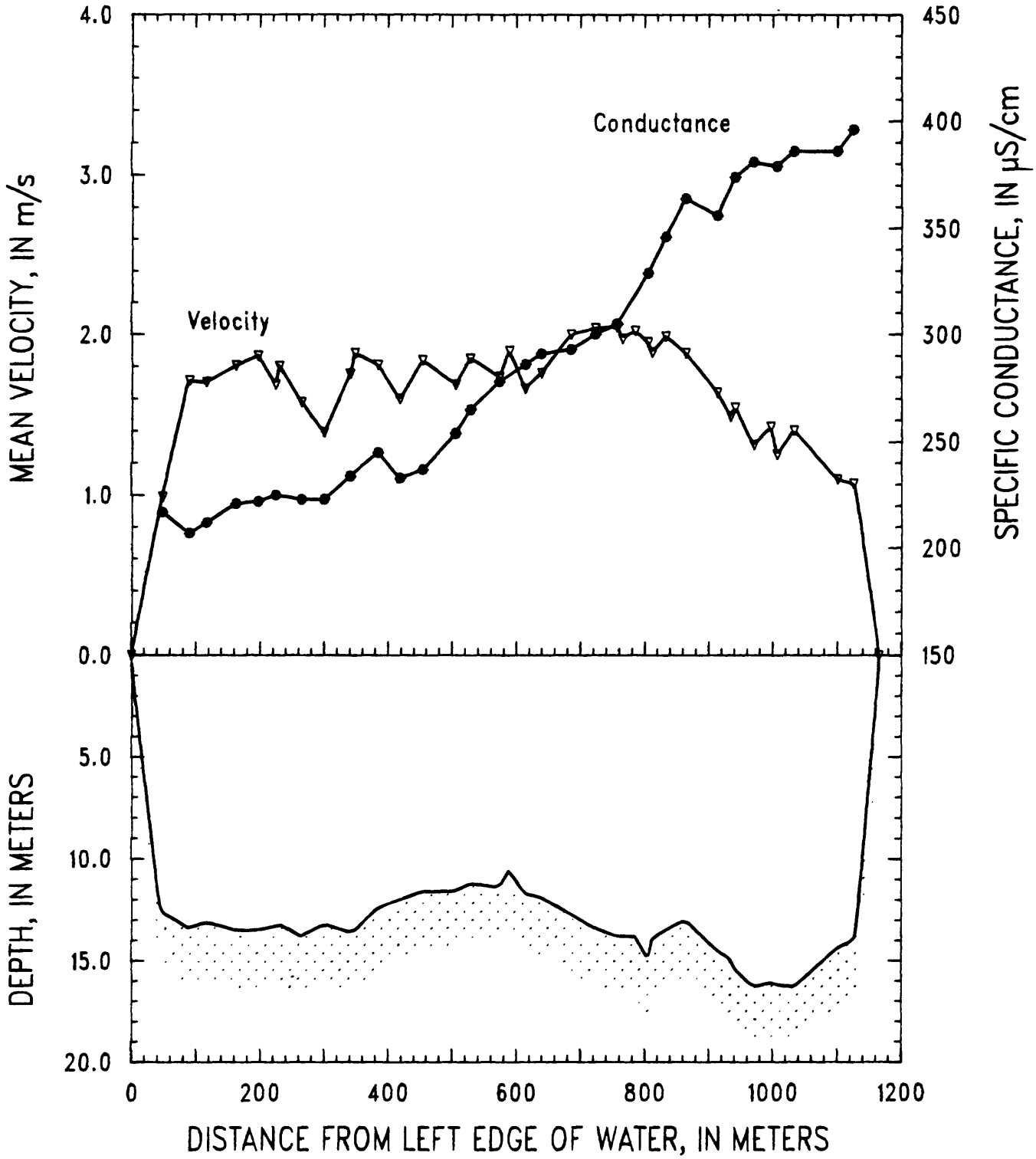

Figure 16. Mississippi River below Hickman, Kentucky, on March 17, 1989

SITE: Mississippi River below Fulton, Tennessee 03-19-89
PARTY: Moody, Stevens, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: Stage fell about 0.3 m during sampling.
SUSP: Bag sampler and 300-lb weight. Current meter 32 cm above nozzle.
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 17 cm/s and the nozzle was 3/16 inch. Verticals were occupied in reverse order (30-1) for the integrated sample. Site was below Sunrise Towhead but above Hatchie River.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	45	7.1	0.57	173	0.62	13	9.5	7.8	287
02B	86	10.7	0.90	371	1.62	11	9.3	7.7	283
03A	122	11.3	0.95	495	1.58	12	9.1	7.8	287
04B	178	11.1	1.13	565	1.65	13	9.3	7.8	284
05A	212	11.5	1.13	506	2.31	14	9.5	7.8	288
06B	256	12.0	1.21	639	2.50	14	9.4	7.8	288
07A	300	11.9	1.33	696	2.63	16	9.4	7.8	288
08R	344	11.8	1.31	579	2.56	16	9.4	7.9	289
09A	375	11.9	1.30	293	2.66	16	9.4	7.7	290
X09	382	12.1	1.31	357	--	--	--	--	--
10B	420	11.7	1.48	693	3.04	18	9.3	7.7	289
11A	462	11.8	1.45	781	2.69	18	9.4	7.7	283
12B	511	11.7	1.36	797	2.80	18	9.5	7.7	288
13A	562	11.7	1.51	644	3.05	18	9.7	7.7	290
14B	584	11.6	1.53	513	3.08	16	9.5	7.7	290
15A	620	11.0	1.44	397	2.90	16	9.5	7.7	290
X08	634	10.5	1.61	177	--	--	--	--	--
X07	641	11.3	1.55	262	--	--	--	--	--
16B	664	11.2	1.62	661	2.97	18	9.5	7.7	286
17A	714	11.2	1.71	861	3.87	21	9.4	7.7	290
18B	754	11.7	1.78	616	3.71	23	9.4	7.8	289
18R	773	11.5	1.82	428	--	--	--	--	--
19A	795	11.5	1.92	474	4.27	25	9.3	7.7	286
X02	816	11.4	1.91	576	--	--	--	--	--
20B	848	11.7	1.94	841	4.46	23	9.4	7.7	288
X06	890	12.1	1.98	648	--	--	--	--	--
21A	902	12.0	2.07	558	4.36	23	9.5	7.7	291
22B	935	12.4	1.93	861	4.79	24	9.2	7.6	291
23A	974	13.5	1.88	1,240	4.64	26	9.3	7.6	287
24B	1,033	15.0	1.88	1,577	4.98	26	9.5	7.7	295
25R	1,086	15.7	1.73	1,249	--	--	--	--	--
X01	1,125	17.0	1.88	784	5.48	29	9.3	7.7	285
26B	1,135	16.8	1.85	450	5.68	31	9.3	7.7	292

SITE: Mississippi River below Fulton, Tennessee--continued 03-19-89

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
27A	1,154	17.2	1.69	947	4.91	34	9.3	7.7	295
28B	1,200	18.0	1.57	1,318	5.18	35	9.3	7.7	295
29A	1,247	18.2	1.51	1,345	4.51	33	9.1	7.7	295
30B	1,298	9.7	1.00	439	1.84	6	9.3	7.7	301
REW	1,337	0.0	0.00	0	--	--	--	--	--
MEAN		12.1	1.53						
TOTAL	1,337			24,811	101.34	606			

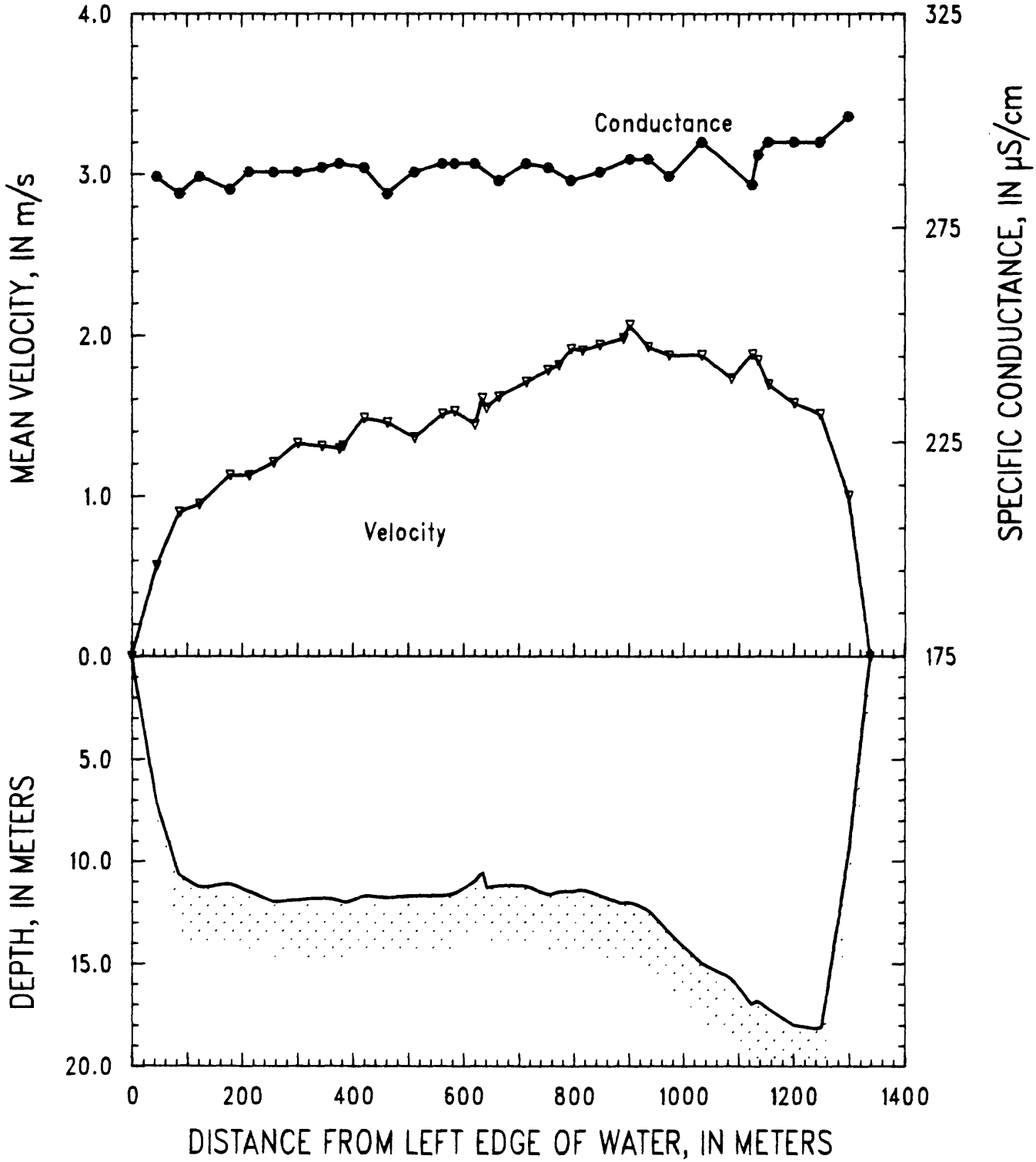

Figure 17. Mississippi River below Fulton, Tennessee, on March 19, 1989

SITE: Mississippi River at Helena, Arkansas 03-21-89
PARTY: Moody, Stevens, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: 33.35 ft ENDING GAGE HEIGHT: 32.78 ft
SUSP: Bag sampler and 300-lb weight. Current meter 32 cm above nozzle.
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 22 cm/s and nozzle was 3/16 inch. Verticals occupied from 30-1. Greatest velocities are not located in deepest water. Sand transport may be visible on depth recorder, especially at vertical 13.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	--	--	--	--	--	--
01A	34	7.2	0.66	129	0.78	3	9.2	7.5	295
02B	54	11.7	1.12	314	1.73	9	9.1	7.5	296
03A	82	12.9	1.76	409	3.48	9	9.2	7.5	292
X04	90	12.6	1.92	423	--	--	--	--	--
04B	117	13.3	2.03	580	3.72	11	9.1	7.5	296
05A	133	13.8	1.94	749	4.95	12	9.2	7.5	296
06B	173	15.0	2.28	1,178	4.83	13	9.2	7.5	292
07A	202	15.6	2.13	1,232	4.98	15	9.1	7.6	295
08B	247	16.8	2.03	921	5.38	15	9.1	7.5	296
09A	256	16.9	2.11	624	4.43	16	9.0	7.5	297
10B	282	17.8	2.09	1,099	5.31	18	9.0	7.5	296
11A	315	18.1	2.04	1,347	5.92	18	9.2	7.5	290
12B	355	18.8	2.24	1,202	5.60	19	9.1	7.5	291
13A	372	18.8	2.27	769	6.86	19	9.0	7.5	291
13R	391	18.7	2.30	924	--	--	--	--	--
14B	415	18.8	2.14	805	6.08	20	9.1	7.5	295
14R	431	19.5	2.15	714	--	--	--	--	--
15A	449	20.0	2.16	843	5.33	22	9.1	7.5	285
16B	470	19.6	1.93	831	5.39	20	9.2	7.5	289
17A	493	19.2	1.64	900	5.38	19	9.2	7.5	291
18B	527	20.2	1.58	1,289	4.11	21	9.0	7.5	291
19A	574	20.3	1.38	801	3.64	21	9.3	7.5	279
20R	584	20.2	1.45	411	--	--	--	--	--
20B	602	20.3	1.43	391	4.29	22	9.2	7.5	291
21A	611	20.7	1.42	791	4.27	24	9.3	7.4	284
22B	656	23.6	1.37	969	4.50	27	9.3	7.5	277
23A	671	24.1	1.47	477	4.87	31	9.2	7.4	265
24B	683	25.1	1.39	735	4.33	30	9.5	7.4	274
25A	713	24.6	1.36	1,224	4.42	26	9.4	7.5	260
26B	756	20.0	1.44	1,167	3.63	12	9.6	7.3	262
27R	794	12.2	1.40	589	2.72	9	9.5	7.4	240
28B	825	11.5	1.50	484	2.30	8	9.4	7.4	253
29A	850	10.6	1.33	361	1.98	6	9.5	7.4	243
30B	876	10.1	0.68	215	0.88	4	9.5	7.5	251
REW	913	0.0	0.00	0	--	--	--	--	--
MEAN		16.5	1.72						
TOTAL	913			25,897	126.09	499			

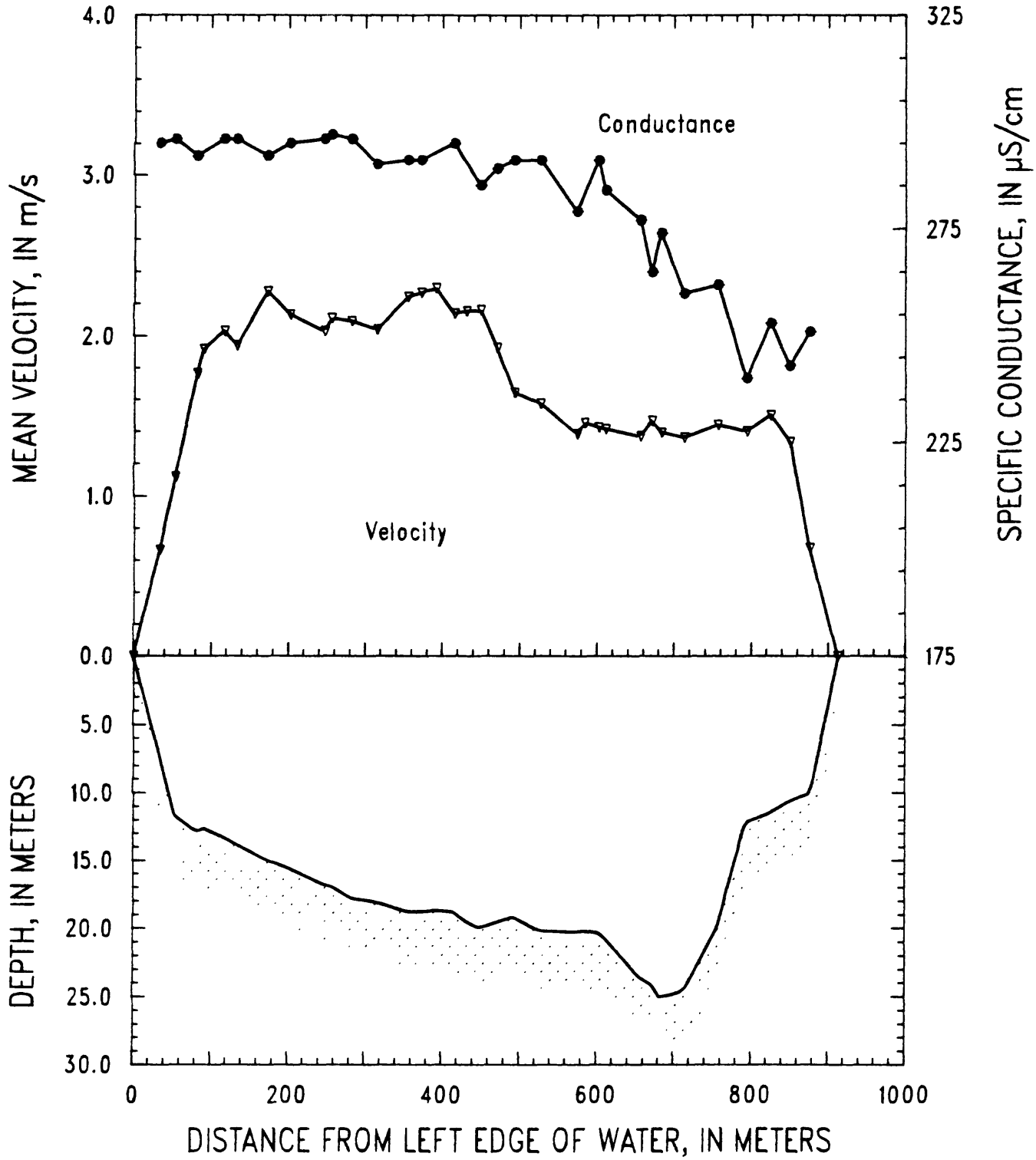

Figure 18. Mississippi River at Helena, Arkansas, on March 21, 1989.

SITE: White River at Mile 11.5, Arkansas 03-22-89
PARTY: Moody, Stevens, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 150-lb weight. Current meter 32 cm above nozzle.
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 6 cm/s and nozzle was 1/4 inch. Water is over the bank and 2-3 m deep.

Vertical	Dist. from LEF (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEF	0	3.0	0.00	0	--	--	--	--	--
01	37	13.3	0.69	346	24.88	117	11.6	7.1	150
02	75	13.4	0.85	374	26.15	111	11.6	7.2	152
03	103	12.5	0.83	320	24.87	104	11.5	7.1	151
04	137	11.7	0.76	302	21.22	91	11.5	7.1	150
05	171	10.5	0.50	165	11.47	77	11.5	7.0	152
REF	200	2.0	0.00	0	--	--	--	--	--
MEAN		10.3	0.73						
TOTAL	200			1,507	108.59	500			

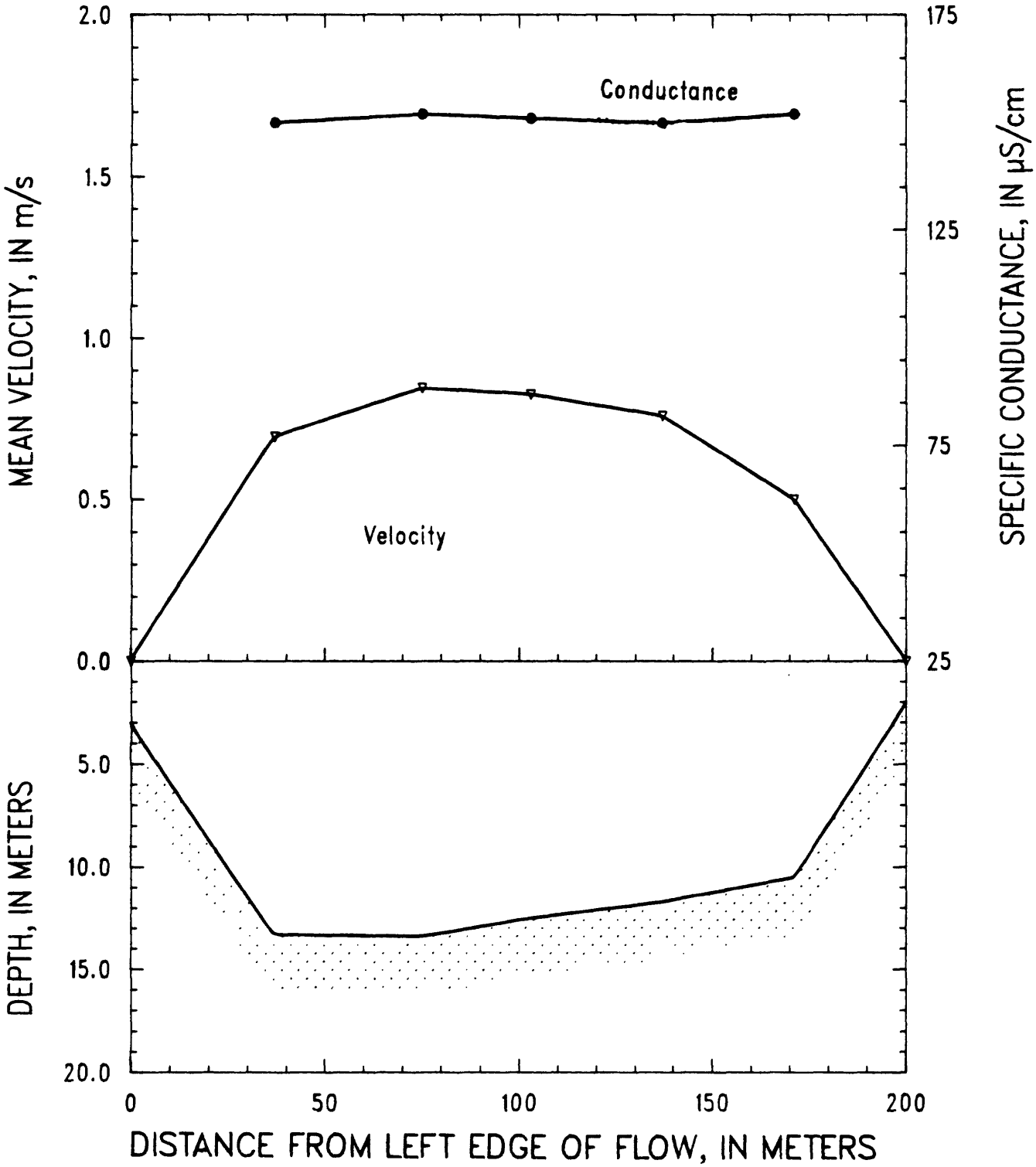

Figure 19. White River at Mile 11.5, Arkansas, on March 22, 1989.

SITE: Arkansas River at Pendleton, Arkansas 03-23-89
PARTY: Moody, Stevens, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 150-lb weight. Current meter 32 cm above nozzle.
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Ten equal discharge verticals. Used various transit rates (4-12 cm/s) and various nozzles (1/4, 5/16). Verticals occupied in reverse order 10-1. Anchored at verticals.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01	58	3.7	0.62	120	12.55	60	11.8	7.9	275
X04	104	5.7	0.61	149	--	--	--	--	--
02	144	5.8	0.66	184	10.28	60	11.9	7.9	298
03	200	6.1	0.60	196	10.33	60	11.6	7.8	326
04	250	8.2	0.82	261	12.43	60	11.5	8.0	341
05	278	9.5	0.71	108	11.93	60	11.6	8.0	354
X02	282	10.7	0.58	89	--	--	--	--	--
06	307	14.5	0.78	225	10.73	60	11.7	8.0	348
07	322	15.2	0.82	156	10.13	60	11.6	7.9	350
08	332	15.0	0.85	141	11.27	60	11.5	7.9	353
09	344	15.7	0.74	99	10.69	60	11.1	7.2	354
X05	349	13.5	0.74	70	--	--	--	--	--
10	358	9.5	0.69	102	10.38	60	11.1	7.3	351
REW	380	0.0	0.00	0	--	--	--	--	--
MEAN		7.1	0.71						
TOTAL	380			1,900	110.72	600			

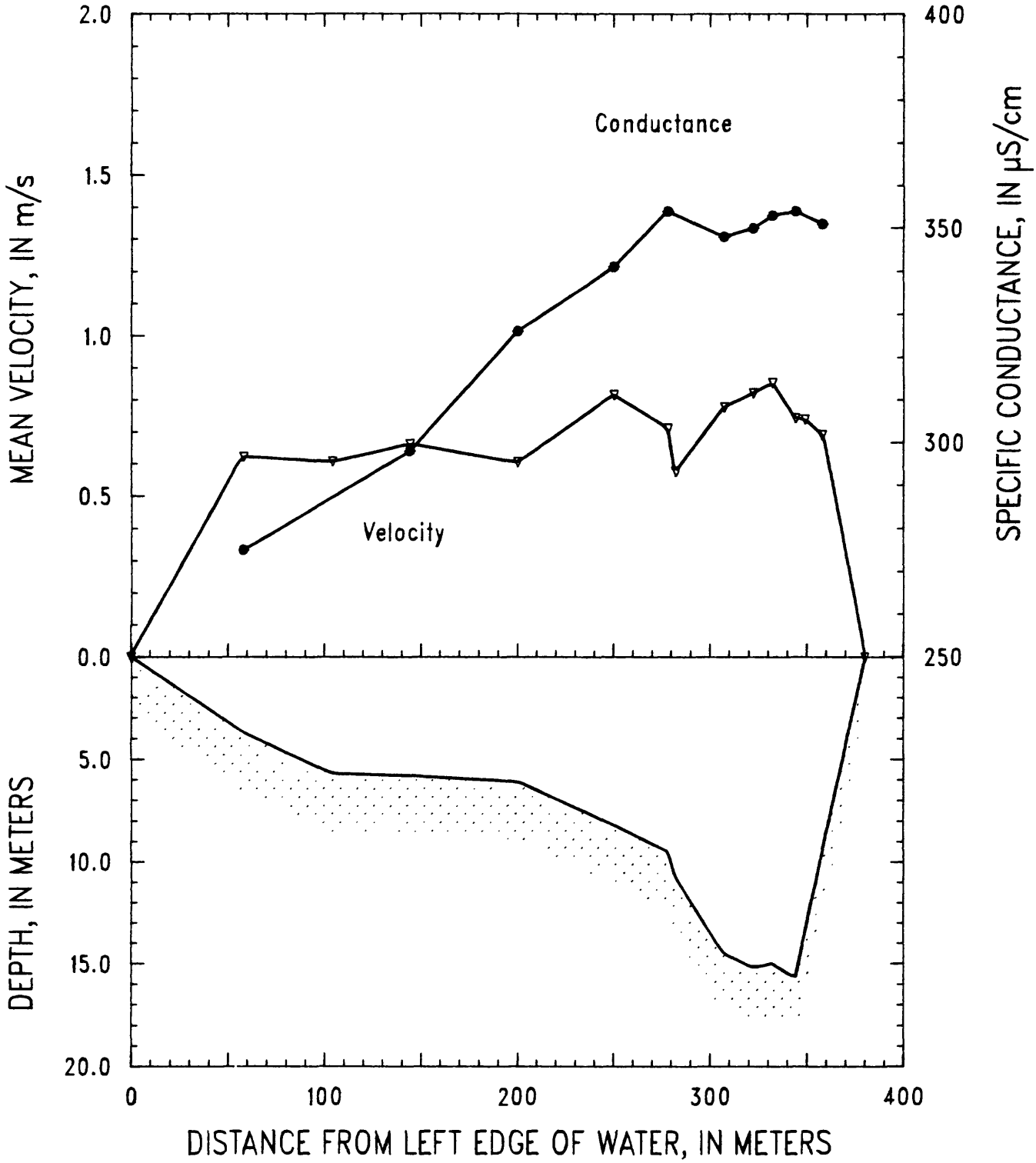

Figure 20. Arkansas River at Pendleton, Arkansas, on March 23, 1989.

SITE: Mississippi River above Arkansas City, Arkansas 03-24-89
PARTY: Moody, Stevens, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: 29.23 ft is mean gage height from 0600 to 1200.
SUSP: Bag sampler and 300-lb weight. Current meter 32 cm above nozzle.
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 22 cm/s and nozzle was 3/16 inch. Velocity was estimated to be 1 cm/s in the trees at station 39. Velocity reported at vertical 17 was the average of verticals 16 and 18. Narrow band of velocity in center 300 meters. Low velocities on side may explain high mud deposits that exist there.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
EST	39	5.0	0.01	2	--	--	--	--	--
01A	118	6.4	0.07	22	0.19	3	10.6	7.7	308
02B	140	8.6	0.20	56	0.25	6	11.3	8.0	300
03A	184	11.2	0.33	132	0.43	7	10.8	7.9	303
04B	211	13.9	0.49	158	0.70	10	10.9	7.9	311
05A	230	15.7	0.82	161	1.45	14	10.9	7.9	306
X01	236	16.1	0.92	200	--	--	--	--	--
06B	257	17.2	0.82	505	1.40	16	10.5	7.9	306
07A	308	17.5	1.06	714	2.08	16	10.5	7.9	304
08B	334	16.3	1.34	436	3.16	16	10.9	8.0	306
09A	348	16.5	1.32	522	3.49	15	11.0	8.0	305
X02	382	16.7	1.52	522	--	--	--	--	--
10B	389	16.6	1.53	431	3.81	16	11.3	8.0	305
11A	416	18.5	1.53	905	4.45	17	10.8	8.0	303
12B	453	18.2	2.00	1,255	5.43	17	10.5	8.0	305
13A	485	19.4	2.03	1,360	6.43	19	10.4	8.0	309
14B	522	21.4	2.41	1,416	7.03	19	10.3	8.0	304
15A	540	22.6	2.53	1,228	6.74	20	10.4	8.0	305
16B	565	22.7	2.51	1,764	5.05	25	10.7	7.9	291
17A	602	23.0	2.52	2,119	7.11	28	10.4	7.9	300
18B	638	23.9	2.34	1,372	6.98	28	10.3	8.0	301
19A	651	22.9	2.47	1,360	6.95	28	10.5	7.9	300
20B	686	21.2	2.44	1,214	6.92	22	10.6	7.9	302
X04	698	20.8	2.26	939	--	--	--	--	--
21A	726	20.3	2.35	906	6.91	21	10.4	8.0	305
22B	736	19.7	2.42	1,358	6.47	19	10.5	7.9	301
23A	783	18.6	2.04	1,766	5.70	18	10.6	7.9	308
24B	829	17.9	1.95	1,134	5.12	18	10.5	7.9	309
X05	848	18.0	1.84	415	--	--	--	--	--

SITE: Mississippi River above Arkansas City, Arkansas--continued 03-24-89

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
25A	854	17.9	1.60	444	4.45	17	10.5	7.9	302
26B	879	18.0	1.43	890	3.45	17	10.6	7.9	302
27A	923	17.9	0.94	481	2.04	17	10.5	8.0	307
28B	936	17.7	0.93	453	1.69	15	10.5	7.9	308
29A	978	13.2	0.47	204	0.63	11	10.5	8.0	301
30B	1,001	8.8	0.01	2	0.18	5	10.6	8.0	305
REW	1,035	0.0	0.00	0	--	--	--	--	--
MEAN		15.9	1.63						
TOTAL	1,035			26,846	116.69	500			

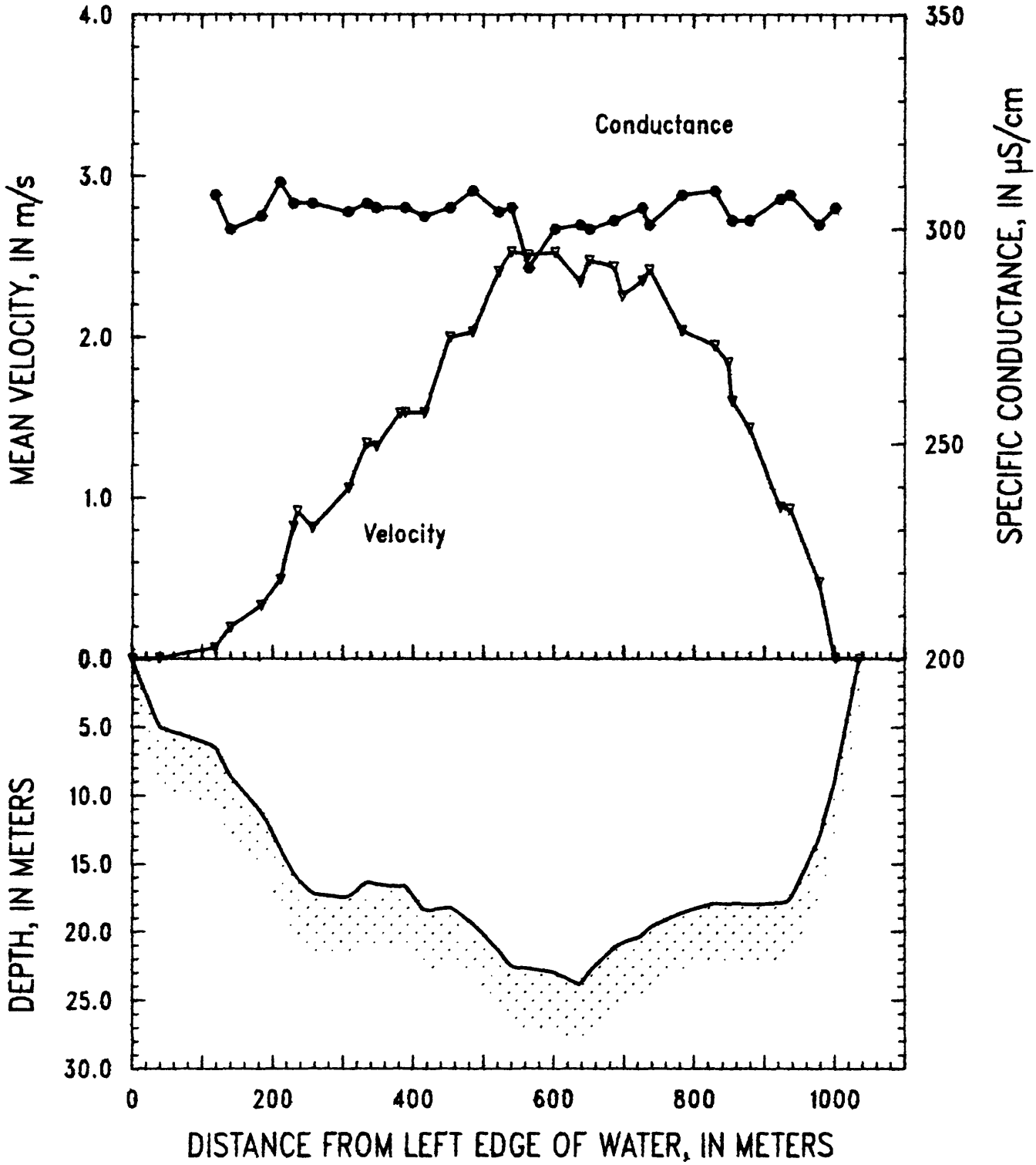

Figure 21. Mississippi River above Arkansas City, Arkansas, on March 24, 1989.

(PAGE 90 FOLLOWS)

SITE: Yazoo River below Steele Bayou, Mississippi 03-26-89
PARTY: Moody, Stevens, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 150-lb weight. Current meter 22 cm above nozzle.
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Sampled five equal-discharge-increment verticals with various transit rates (7-16 cm/s) and nozzles (1/4, 3/16, and 5/16 inch). Stage is dropping at Vicksburg, creating higher discharge than measured here previously. About 50 m of trees on the left bank so that LEW is about -50 m; assumed no flow.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEF	0	5.0	0.00	0	--	--	--	--	--
1A1	23	9.1	0.34	50	--	--	--	--	--
01	33	11.8	0.75	80	23.80	100	15.3	7.7	75
X05	41	13.0	0.70	127	--	--	--	--	--
02	61	15.8	0.95	263	22.51	100	15.5	7.4	83
03	76	15.7	0.97	175	22.50	100	14.1	7.5	75
X03	84	15.7	0.86	163	--	--	--	--	--
04	100	15.5	1.00	257	22.50	100	14.9	7.5	80
X11	117	13.5	0.97	131	--	--	--	--	--
05	120	12.7	0.93	35	24.83	100	14.5	7.6	84
05B	123	11.9	0.83	34	--	--	--	--	--
X10	127	10.8	0.81	92	--	--	--	--	--
X01	144	8.0	0.43	95	--	--	--	--	--
REW	182	0.0	0.00	0	--	--	--	--	--
MEAN		10.4	0.79						
TOTAL	182			1,502	116.14	500			

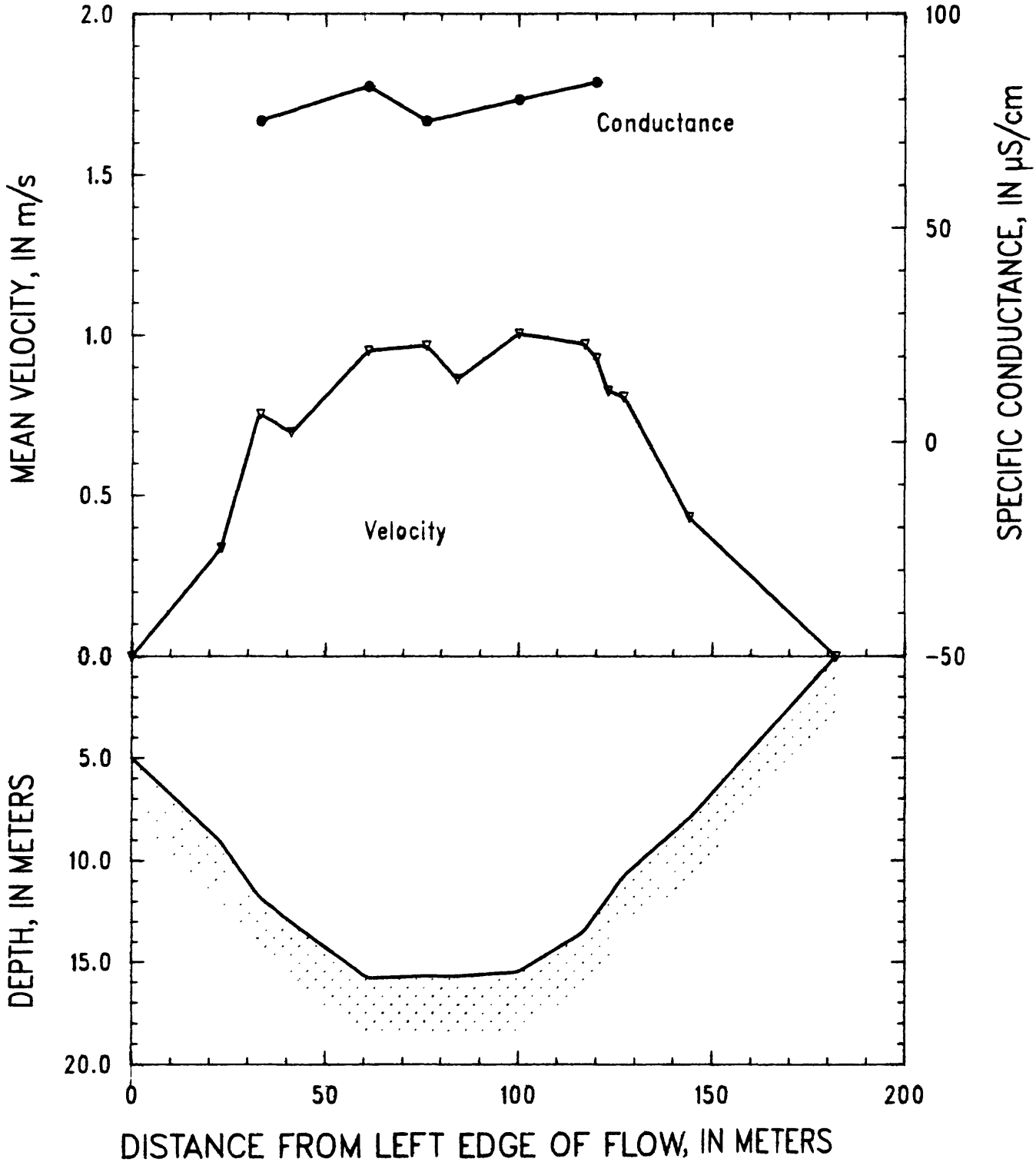

Figure 22. Yazoo River below Steele Bayou, Mississippi, on March 26, 1989.

STATION: Mississippi River below Vicksburg, Mississippi 03-27-89
PARTY: Moody, Stevens, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: 32.5 ft ENDING GAGE HEIGHT:
SUSP: Bag sampler and 300-lb weight. Current meter 22 cm above nozzle.
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 11 cm/s and the nozzle was 1/8 inch. Verticals occupied in order 1-36. Highest velocities are not in the deep water but over moving sand bed.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	45	11.2	0.49	182	0.43	6	12.3	7.8	262
02B	66	14.2	0.73	326	0.94	11	13.1	7.8	260
03A	125	20.5	1.02	733	3.06	20	12.5	7.8	262
04B	136	21.5	1.37	926	4.19	25	12.6	7.7	268
05A	171	21.2	1.52	724	3.75	25	12.3	7.7	272
X03	181	21.3	1.58	471	--	--	--	--	--
06B	199	21.1	1.42	777	4.39	26	12.2	7.7	279
07A	234	20.6	1.56	1,096	4.89	25	12.8	7.6	279
08B	267	20.3	1.73	1,230	5.31	25	12.0	7.7	285
09A	303	20.1	1.62	913	5.30	24	11.9	7.8	289
10B	323	20.1	1.76	1,149	4.59	26	12.5	7.7	295
11A	368	19.2	1.72	992	5.00	31	12.0	7.7	289
X04	383	19.4	1.80	523	--	--	--	--	--
12B	398	19.5	1.79	577	5.01	27	12.5	7.7	305
13A	416	19.5	2.03	1,109	5.51	39	12.0	7.7	312
14B	454	17.7	1.96	1,234	6.01	23	11.8	7.7	309
15A	487	18.0	1.98	979	5.17	21	12.2	7.7	317
X08	509	17.7	2.06	673	--	--	--	--	--
16B	524	17.5	2.14	749	5.66	25	11.9	7.8	317
17A	549	17.6	2.06	833	4.60	27	11.7	7.7	316
18R	570	16.5	2.24	685	3.68	27	12.5	7.7	316
X09	586	16.5	2.07	870	--	--	--	--	--
19A	621	15.5	2.06	1,136	5.12	23	12.1	7.7	316
20B	657	15.5	1.95	950	4.99	22	12.3	7.7	316
21A	684	14.0	1.75	822	3.80	23	12.3	7.7	317
22B	724	13.1	1.65	766	3.20	18	12.0	7.7	317
23A	755	12.8	1.43	694	2.92	15	11.8	7.7	314
24B	800	11.7	1.35	474	2.27	13	11.9	7.7	319
25A	815	11.5	1.39	231	1.64	12	11.7	7.7	320
X10	829	11.4	1.29	316	--	--	--	--	--
26B	858	10.7	1.40	426	1.89	10	11.9	7.7	315
27A	886	10.5	1.26	402	1.89	10	12.0	7.7	318
28B	919	10.2	1.14	390	1.33	9	11.8	7.7	317
29A	953	9.9	1.07	340	0.99	7	12.0	7.7	316
30B	983	9.7	1.01	294	1.20	7	11.7	7.7	316
31A	1,013	9.8	0.98	246	1.14	8	11.7	7.7	318
X01	1,034	9.9	0.99	190	--	--	--	--	--
X11	1,052	9.8	0.90	120	--	--	--	--	--

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
32B	1,061	9.5	0.89	156	1.13	7	11.7	7.7	316
33A	1,089	9.5	0.85	233	0.66	7	11.8	7.7	316
34B	1,119	10.1	0.85	259	0.86	6	11.8	7.7	315
35A	1,149	10.1	0.78	210	0.82	6	11.9	7.7	315
36B	1,172	9.4	0.51	145	0.57	5	11.8	7.7	315
REW	1,210	0.0	0.00	0	--	--	--	--	--
MEAN		14.5	1.52						
TOTAL	1,210			26,551	113.91	641			

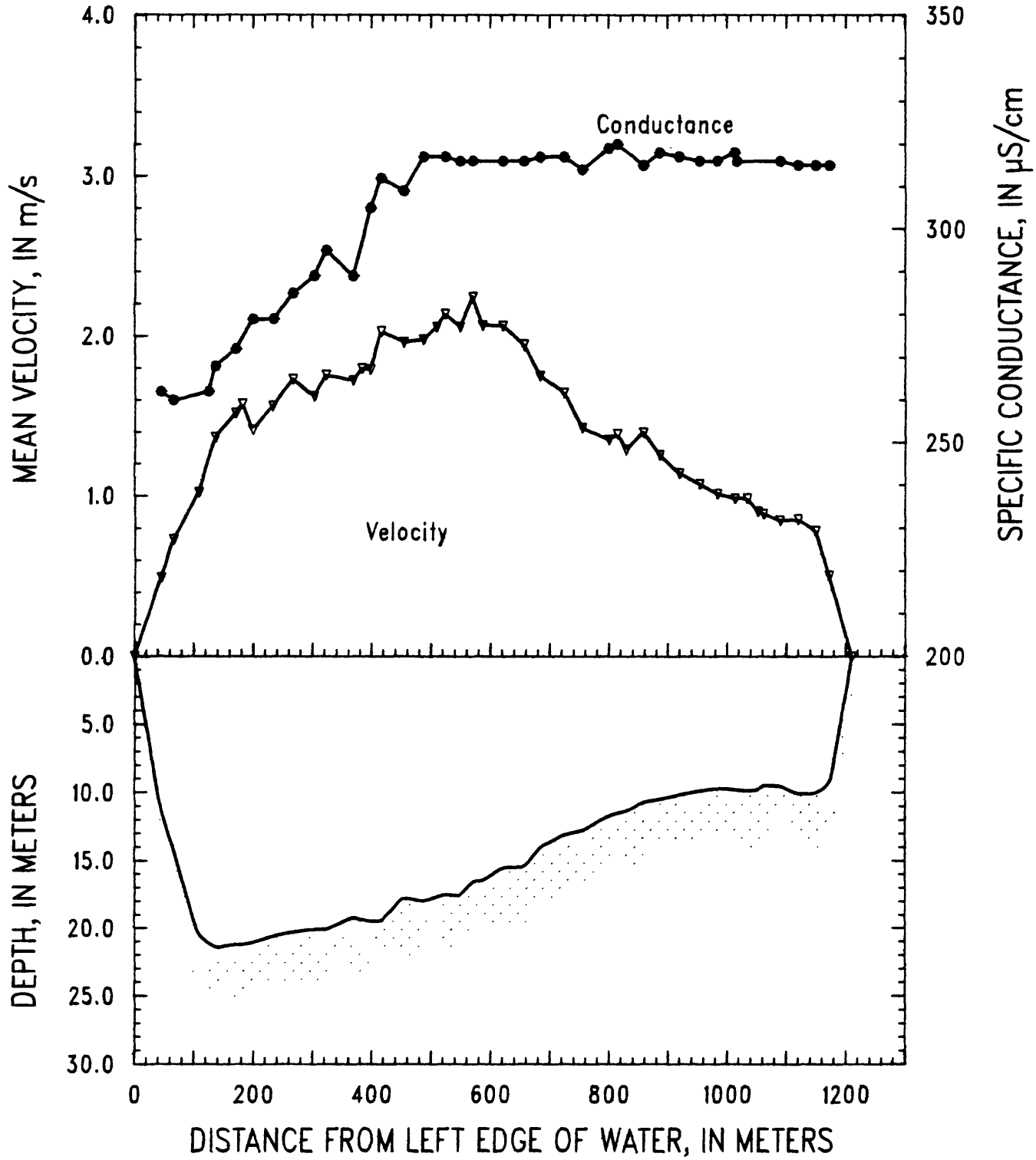

Figure 23. Mississippi River below Vicksburg, Mississippi, on March 27, 1989.

(PAGE 96 FOLLOWS)

SITE: Old River Outflow Channel near Knox Landing, Louisiana 03-29-89
PARTY: Moody, Stevens, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight. Current meter 20 cm above nozzle.
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 15 cm/s and nozzle was 1/4 inch. Verticals were occupied in order 1-30. Heavy rain in the morning--about 5 cm.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01R	20	6.9	0.60	46	--	--	--	--	--
01A	22	8.7	0.60	49	1.59	5	13.2	7.8	291
02B	39	13.2	0.87	184	3.71	19	13.2	7.7	286
03A	54	13.1	0.94	123	4.19	19	13.0	7.7	293
03R	59	13.2	1.00	99	--	--	--	--	--
04R	69	13.1	1.06	145	--	--	--	--	--
04B	80	13.2	1.06	189	4.58	19	12.7	7.7	293
05A	96	13.2	1.02	223	4.74	19	12.7	7.7	295
06B	113	13.3	1.07	221	4.68	20	12.6	7.7	293
07A	127	13.2	1.01	206	4.68	19	12.6	7.7	296
08B	144	13.3	1.05	265	4.68	19	12.7	7.7	295
09A	165	13.0	1.05	274	4.81	18	12.7	7.7	295
10B	184	13.0	0.99	233	4.39	18	12.8	7.8	298
11A	201	12.9	1.01	234	4.16	18	13.1	7.7	297
12B	220	12.7	1.12	284	4.84	20	12.9	7.7	296
13A	241	12.5	1.01	208	4.30	19	12.9	7.7	297
14B	253	12.4	1.06	197	4.64	19	12.8	7.8	297
15A	271	12.0	1.03	217	4.32	19	12.5	7.7	297
16B	288	11.8	1.06	275	3.84	18	13.0	7.7	297
17A	315	11.1	1.02	225	4.16	17	12.6	7.8	298
18B	328	10.9	1.06	168	3.91	17	13.2	7.8	301
19A	344	10.7	1.03	143	3.95	16	12.8	7.8	305
20B	354	10.4	1.12	145	3.41	16	13.1	7.8	305
21A	369	10.4	1.04	231	3.36	16	12.9	7.8	305
22B	397	10.2	1.02	230	3.27	16	13.0	7.8	303
23A	413	10.2	0.97	133	2.84	16	13.0	7.8	302
24B	424	10.0	1.03	98	3.95	16	13.1	7.8	306
X01	432	10.2	1.10	90	--	--	--	--	--
25A	440	10.2	1.01	165	3.57	16	13.0	7.8	302
26B	464	10.4	0.98	178	3.28	16	13.1	7.8	304
27A	475	10.5	0.95	160	3.22	15	13.4	7.8	307
28B	496	10.6	0.94	189	3.28	16	13.1	7.8	304
29A	513	10.8	0.88	186	3.19	17	13.5	7.8	304
30B	535	9.4	0.71	143	2.47	5	13.7	7.8	306
REW	556	0.0	0.00	0	--	--	--	--	--
MEAN		11.1	1.00						
TOTAL	556			6,156	116.01	503			

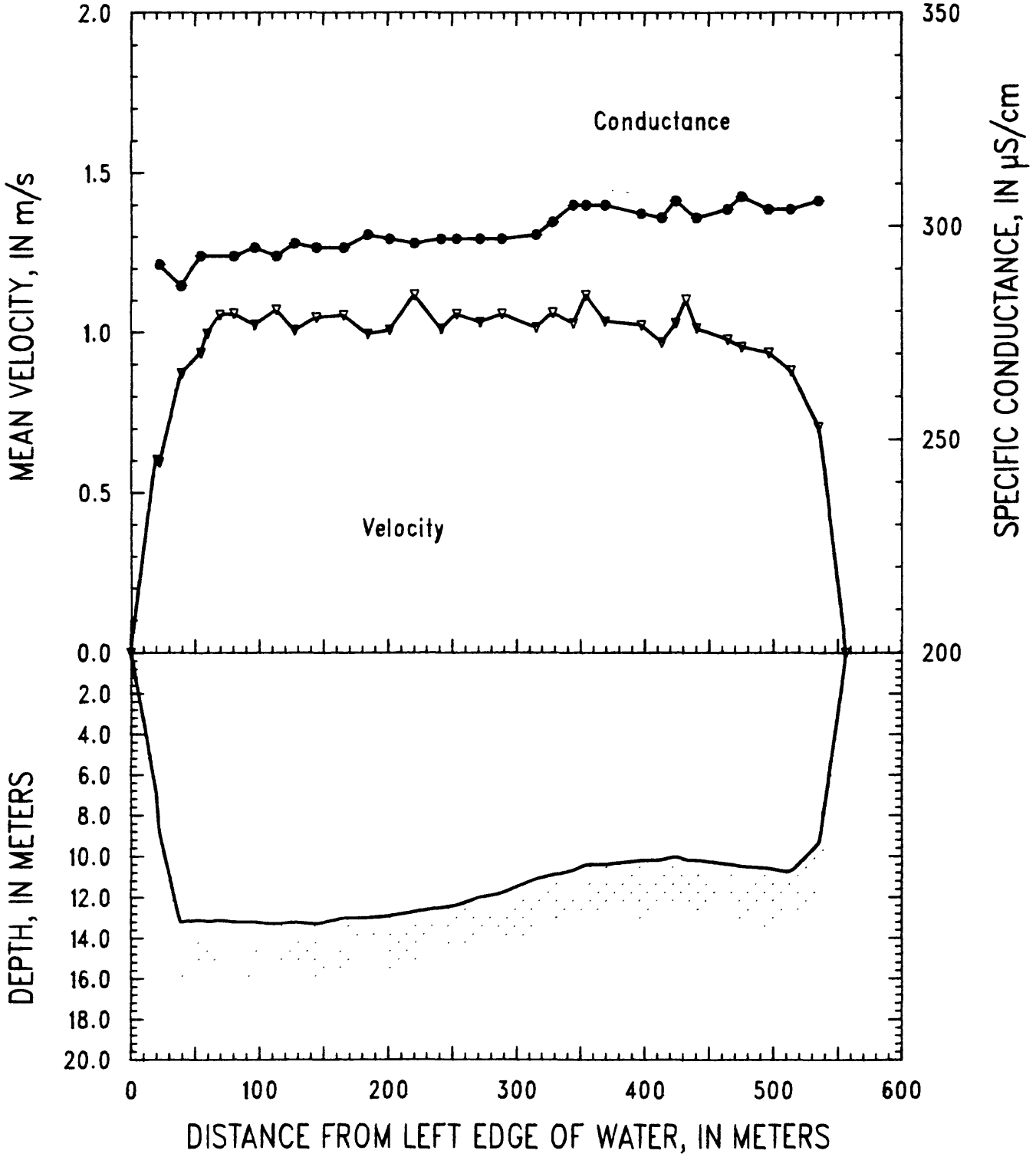

Figure 24. Old River Outflow Channel near Knox Landing, Louisiana, on March 29, 1989.

SITE: Mississippi River near St. Francisville, Louisiana 03-30-89
PARTY: Moody, Stevens, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight at verticals 32-18 and 200-lb weight at verticals 17-1.
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 20 cm/s and nozzle was 3/16 inch. Vertical 1A was at a transit rate of 10 cm/s to represent 1A and 3A.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEF	0	0.0	0.00	0	--	--	--	--	--
01A	33	8.5	0.34	99	0.62	5	14.9	7.6	297
02B	69	10.2	0.21	56	0.48	3	15.7	7.6	287
X01	85	10.4	0.45	146	--	--	--	--	--
04B	131	11.1	0.85	288	1.04	3	13.7	7.6	300
05A	146	11.8	1.02	217	1.90	4	13.5	7.6	301
X10	167	13.9	1.06	310	--	--	--	--	--
06B	188	15.5	1.12	372	2.79	13	13.7	7.6	301
07A	210	16.1	1.20	475	2.19	13	13.3	7.6	301
X02	237	16.0	1.20	345	--	--	--	--	--
08B	246	15.7	1.42	470	3.56	14	13.5	7.6	304
09A	279	14.8	1.65	758	3.95	12	13.7	7.6	302
10B	308	15.8	1.69	734	4.19	17	13.5	7.6	303
11A	334	16.1	1.72	749	3.74	19	13.9	7.6	302
12R	362	16.8	1.86	359	--	--	--	--	--
X09	357	18.2	1.42	103	--	--	--	--	--
12B	370	17.6	1.67	499	4.95	21	13.5	7.6	302
X03	391	16.9	1.71	461	--	--	--	--	--
13A	402	18.3	1.77	438	5.31	22	13.5	7.6	302
14B	418	17.6	1.56	824	4.09	21	13.7	7.6	300
15A	462	16.5	1.75	1,008	4.94	19	14.0	7.6	302
16B	488	16.4	1.77	696	3.97	18	13.5	7.6	301
17A	510	16.3	1.84	962	4.93	20	13.7	7.6	304
18B	552	16.6	1.79	995	4.72	19	14.2	7.6	302
19A	577	17.8	1.64	874	4.75	18	14.9	7.6	302
20B	612	16.5	1.63	871	4.68	17	15.3	7.6	300
21A	642	17.8	1.53	791	4.42	21	15.0	7.6	304
22B	670	18.6	1.56	987	4.46	23	14.1	7.6	300
23A	710	18.7	1.61	857	4.86	23	14.6	7.7	311
24B	727	19.1	1.63	623	4.91	25	14.0	7.7	301
X07	750	19.3	1.52	646	--	--	--	--	--
25A	771	19.7	1.56	769	6.08	19	13.8	7.7	301
26B	800	19.7	1.57	928	4.83	19	13.6	7.7	299
27A	831	19.5	1.61	628	5.14	19	13.8	7.7	300
X05	840	19.4	1.48	330	--	--	--	--	--
28B	854	19.5	1.64	830	4.98	19	13.5	7.7	301

SITE: Mississippi River near St. Francisville, Louisiana--continued 03-30-89

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
29A	892	19.7	1.46	946	4.75	20	13.8	7.7	299
30B	920	19.1	1.48	832	4.85	19	14.0	7.7	298
31A	951	15.6	1.48	727	3.96	16	13.5	7.7	304
32B	983	6.3	0.62	117	0.49	4	14.7	7.7	311
REW	1,011	0.0	0.00	0	--	--	--	--	--
MEAN		15.5	1.47						
TOTAL	1,011			23,120	120.53	505			

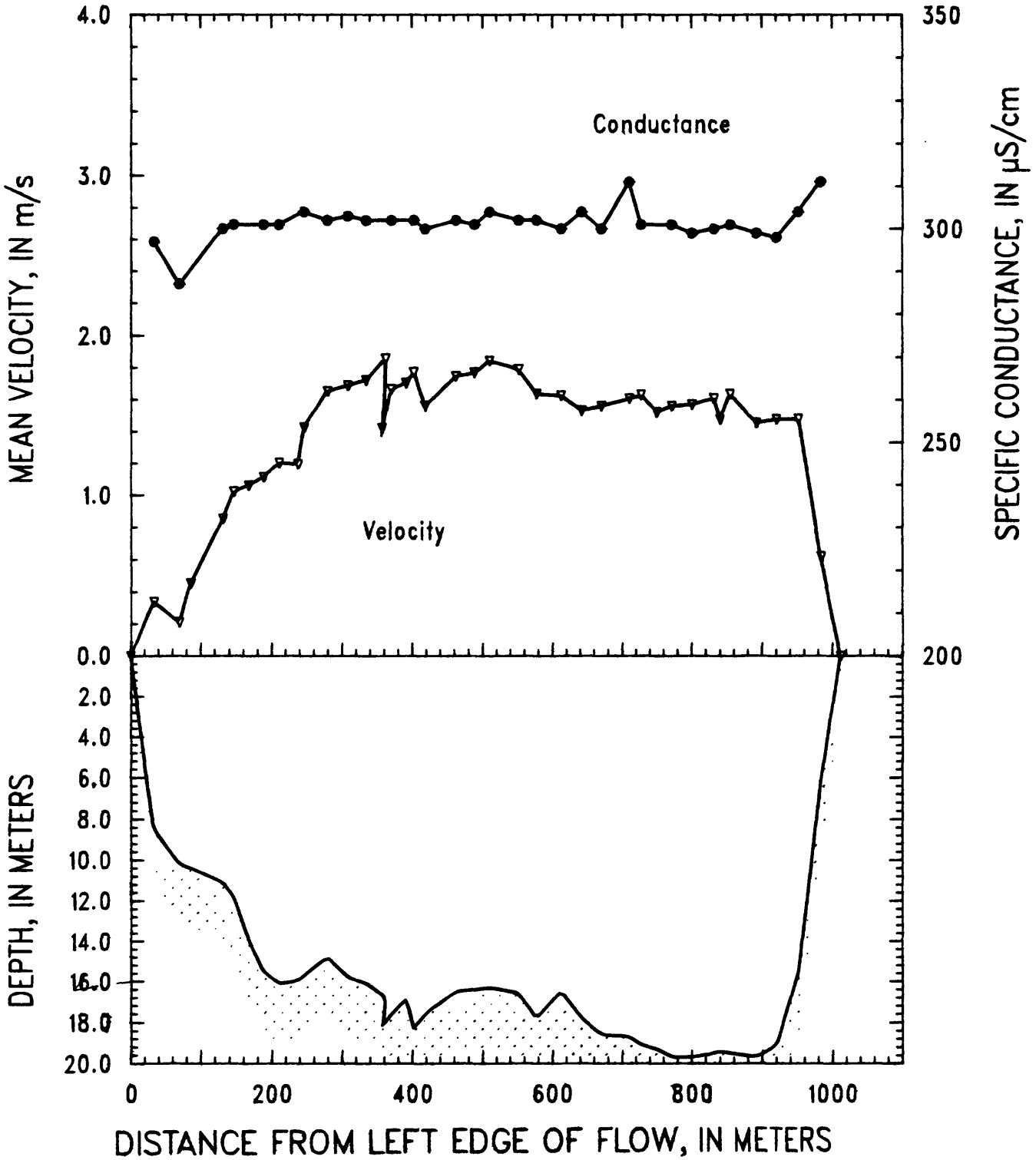

Figure 25. Mississippi River near St. Francisville, Louisiana, on March 30, 1989.

(PAGE 102 FOLLOWS)

SITE: Mississippi River below Belle Chasse, Louisiana 04-01-89
PARTY: Moody, Stevens, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight. Current meter 20 cm above nozzle.
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 10 cm/s and the nozzle was 1/8 inch.
Verticals were occupied in the following order: 1-10, 24-20, and 11-19.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	35	8.4	0.79	256	0.72	4	13.7	7.8	305
02B	77	16.4	1.14	633	2.39	11	13.5	7.8	304
03A	103	18.8	1.05	634	3.34	15	13.4	7.7	304
04B	141	23.5	1.44	1,170	3.87	20	13.4	7.7	304
05A	172	24.4	1.50	1,173	4.76	23	13.4	7.7	304
06B	205	24.7	1.68	1,533	4.25	23	13.5	7.7	304
07A	246	25.0	1.53	1,144	4.28	25	13.5	7.7	304
08B	265	25.8	1.54	951	6.25	25	13.6	7.7	305
09A	294	25.5	1.56	1,295	5.27	25	13.6	7.7	305
10B	330	25.4	1.55	1,497	5.80	25	13.7	7.7	305
11A	370	25.5	1.49	1,176	5.95	25	13.8	7.7	307
12B	392	26.0	1.48	1,154	6.23	26	13.8	7.7	307
13A	430	27.0	1.47	1,334	6.54	28	13.7	7.6	307
14B	459	26.5	1.42	1,090	5.26	27	13.7	7.7	307
15A	488	25.7	1.39	1,123	4.80	26	13.7	7.7	307
16B	522	25.0	1.25	1,027	4.99	24	13.5	7.7	307
17A	554	24.6	1.14	704	4.10	23	13.8	7.7	309
18B	572	24.5	1.13	651	4.10	23	13.9	7.7	309
19A	601	24.1	1.09	896	3.95	22	13.9	7.7	310
20B	640	23.6	1.05	582	3.06	21	13.6	7.7	307
X04	648	23.4	0.97	499	--	--	--	--	--
21A	684	23.2	1.00	583	2.58	21	13.7	7.7	307
22B	698	23.3	0.98	626	3.02	22	13.6	7.7	307
23A	739	17.6	0.93	607	2.28	11	13.7	7.7	307
24B	772	6.7	0.68	139	0.50	4	14.6	7.7	308
REW	800	0.1	0.00	0	--	--	--	--	--
MEAN		21.5	1.31						
TOTAL	800			22,477	98.29	499			

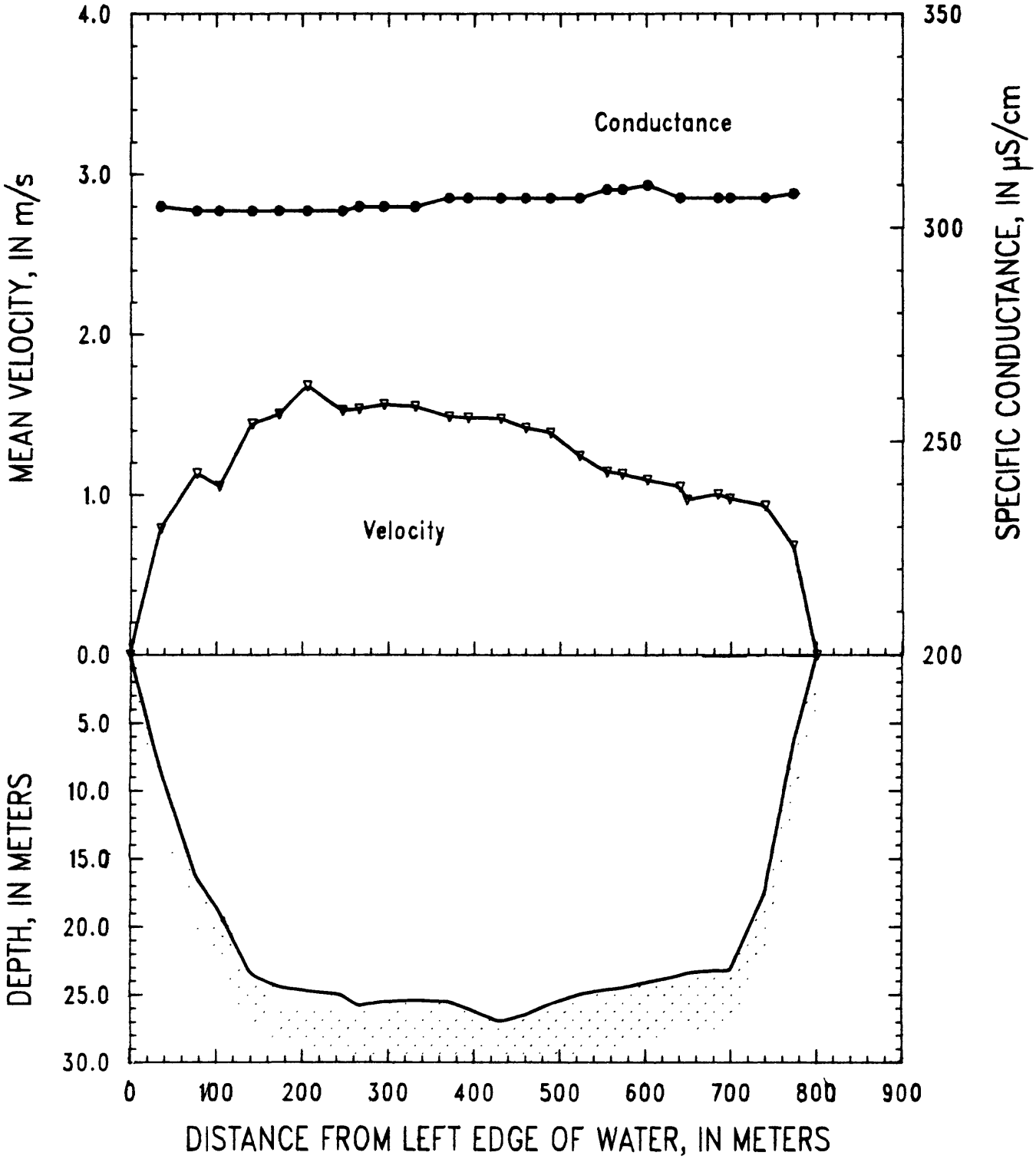

Figure 26. Mississippi River below Belle Chasse, Louisiana, on April 1, 1989.

(PAGE 105 FOLLOWS)

DATA LISTINGS
FOR
JUNE 1989 CRUISE

SITE: Mississippi River near Winfield, Missouri 6-05-89
PARTY: Moody, Stevens, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 150-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 6 cm/s and nozzle 1/4 inch. Anchored at each vertical from 1 to 20. A and B sample collected at each vertical.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01	27	5.4	0.27	38	1.33	19	23.2	7.0	366
02	51	8.1	0.69	136	8.55	47	23.2	7.0	365
03	76	8.3	0.85	124	11.41	46	23.4	6.9	364
X03	86	8.4	0.80	115	--	--	--	--	--
04	110	8.8	0.75	168	10.38	49	23.4	7.0	381
05	137	8.6	0.78	181	12.31	47	23.2	6.9	366
06	164	8.3	0.74	163	9.68	44	23.8	7.0	367
07	190	7.9	0.73	135	8.22	42	23.7	7.0	365
08	211	7.7	0.67	72	7.53	38	23.6	7.2	365
X02	218	7.8	0.65	89	--	--	--	--	--
09	246	7.2	0.67	138	7.12	34	23.6	7.1	364
10	275	6.9	0.70	120	5.35	33	23.7	6.8	364
11	296	6.4	0.70	119	7.00	29	23.7	7.2	364
12	328	6.1	0.67	114	5.99	26	24.1	7.2	363
13	352	5.8	0.66	107	5.98	24	23.9	7.1	363
14	364	5.3	0.67	89	5.23	20	23.9	7.1	363
15	402	5.3	0.66	87	4.83	19	24.0	7.1	364
16	434	4.7	0.62	77	4.20	17	24.0	7.2	365
17	455	5.2	0.59	43	3.40	18	23.9	7.2	366
X01	462	4.9	0.51	27	--	--	--	--	--
18	477	4.4	0.58	57	3.31	14	24.0	7.3	364
19	507	4.8	0.55	67	2.10	18	24.1	7.2	365
20	528	4.1	0.46	52	1.48	--	23.9	7.3	364
REW	562	0.0	0.00	0	--	--	--	--	--
MEAN		6.2	0.67						
TOTAL	562			2,318	125.40	584			

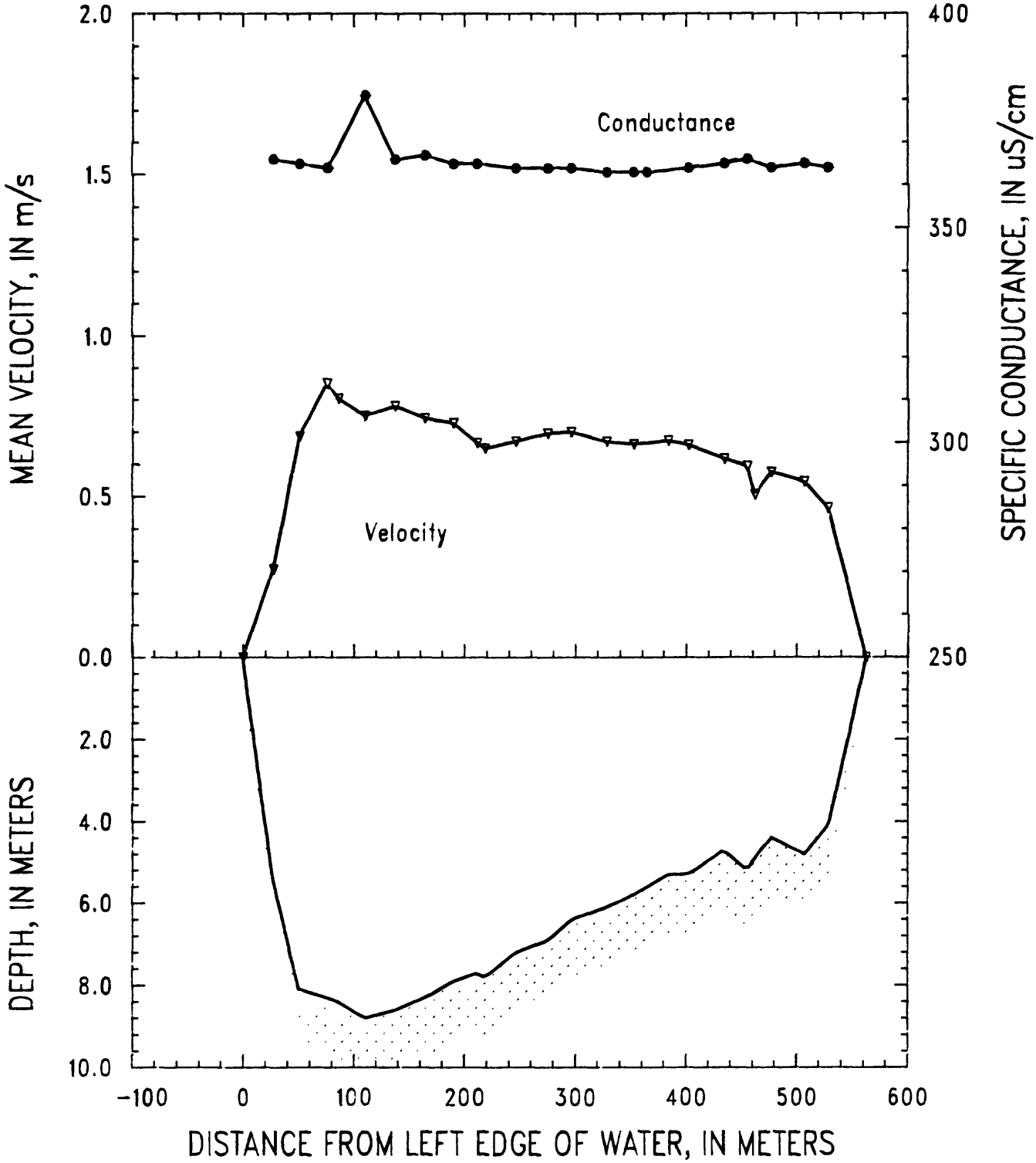

Figure 27. Mississippi River near Winfield, Missouri, on June 5, 1989.

SITE: Illinois River at Hardin, Illinois 06-04-89
PARTY: Moody, Stevens, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 150-lb weight
METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was variable and nozzle was 5/16 inch. Suspended-sediment sample collected from vertical 1 at 158 m from the LEW.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
06	53	3.3	0.59	109	--	--	--	--	--
05	112	4.2	0.63	139	--	--	--	--	--
01	158	5.6	0.70	172	94.56	502	24.1	7.51	729
04	199	6.2	0.79	170	--	--	--	--	--
03	227	5.9	0.77	108	--	--	--	--	--
02	247	4.7	0.72	78	--	--	--	--	--
REW	273	0.0	0.00	0	--	--	--	--	--
MEAN		4.1	0.70						
TOTAL	273			776	94.56	502			

(PAGE 110 FOLLOWS)

SITE: Missouri River at Hermann, Missouri 06-07-89
PARTY: Moody, Stevens, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: 7.85 ft ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 14 cm/s and nozzle 5/16 inch. Rising stage-- 7.87 ft at 0845 Central Daylight Time and 9.05 ft at approximately 1100 Central Daylight Time.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	12	6.9	1.11	61	5.92	19	23.5	6.3	720
02B	16	6.8	1.22	67	5.82	21	23.3	7.0	764
03A	28	6.8	1.27	104	6.11	20	23.2	7.5	697
04B	40	6.5	1.48	96	6.98	25	23.3	7.8	699
05A	48	6.2	1.44	67	5.99	23	23.3	7.8	683
06B	55	6.1	1.33	57	5.72	22	23.2	7.9	692
07A	62	5.7	1.32	45	5.77	21	23.4	7.9	678
08B	67	5.7	1.27	72	5.75	19	23.4	7.9	671
09A	82	6.0	1.44	69	4.92	20	23.3	8.1	652
10B	83	5.6	1.38	42	5.50	22	23.2	8.1	651
11A	93	5.7	1.34	84	4.75	22	23.9	8.1	643
12B	105	4.8	1.27	58	4.78	22	23.5	8.1	631
13A	112	5.0	1.46	73	5.17	16	23.3	8.1	617
14B	125	5.3	1.36	54	5.03	16	23.4	8.1	615
15A	127	5.2	1.28	23	4.92	16	22.9	8.1	599
X04	132	5.4	1.35	40	--	--	--	--	--
16B	138	5.2	1.26	49	4.88	17	23.8	8.1	597
17A	147	5.2	1.28	70	4.50	15	23.1	8.1	588
18B	159	4.9	1.25	43	4.33	17	23.8	8.1	581
19A	161	5.1	1.12	48	3.32	16	22.9	7.8	579
20B	176	4.8	1.25	57	4.16	13	22.8	7.5	570
21A	180	4.7	1.30	55	3.99	14	22.7	7.3	565
22B	194	4.3	1.11	48	3.79	13	22.6	7.5	557
23A	200	4.3	1.06	32	3.42	14	22.9	7.6	557
24B	208	4.3	1.34	60	3.86	17	22.8	7.6	555
25A	221	4.2	1.07	34	3.23	15	22.6	7.6	546
26B	223	4.2	1.03	28	2.96	13	22.9	7.6	545
27A	234	4.4	1.09	48	3.19	13	22.9	7.5	548
28B	243	4.8	1.03	40	3.08	12	23.0	7.5	548
29A	250	6.2	0.99	52	3.80	11	22.9	7.6	547
30B	260	6.8	1.16	79	4.55	15	22.9	7.6	548
REW	270	0.0	0.00	0	--	--	--	--	--
MEAN		5.2	1.26						
TOTAL	270			1,755	138.56	519			

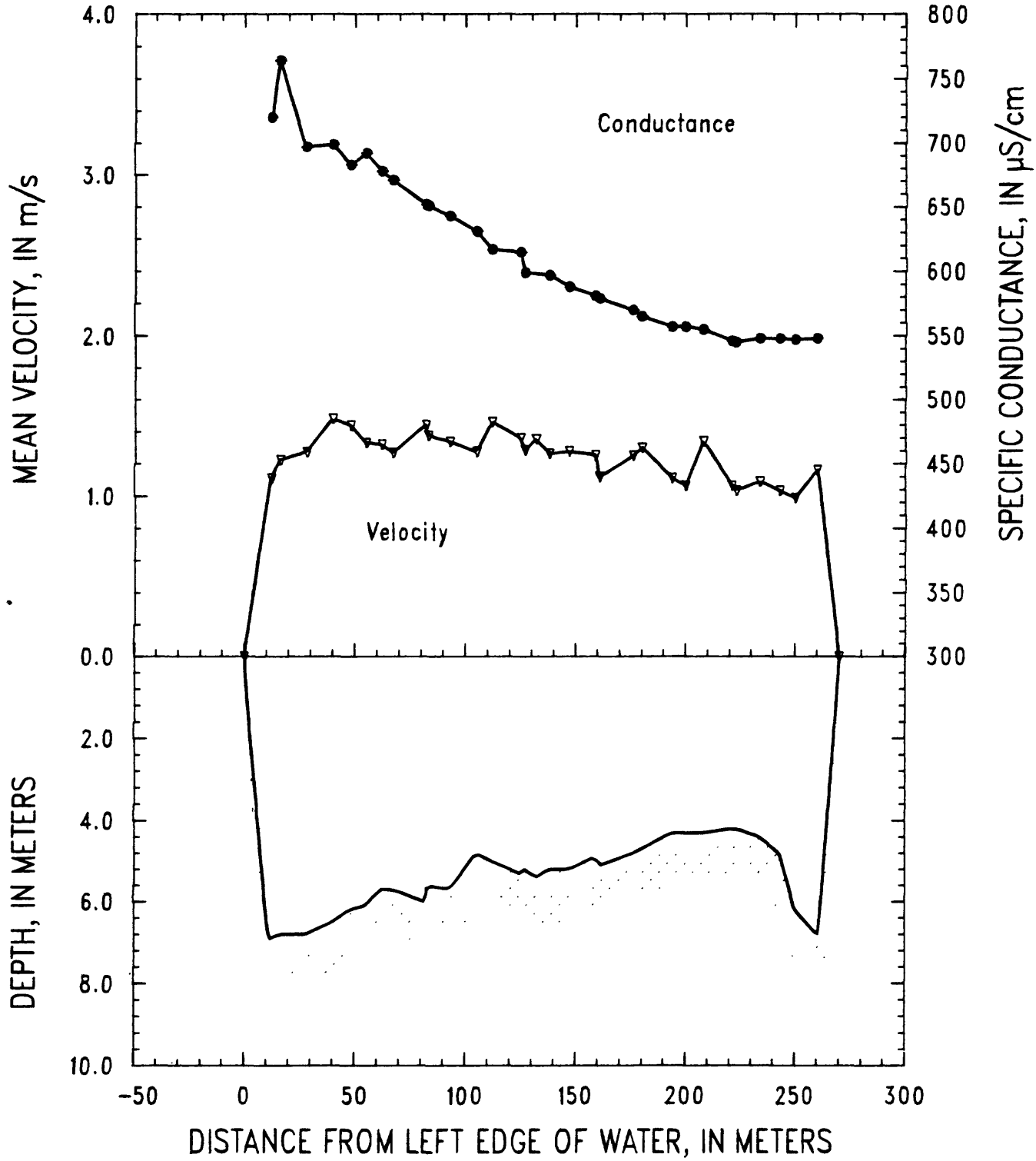

Figure 28. Missouri River at Hermann, Missouri, on June 7, 1989.

SITE: Mississippi River at St. Louis, Missouri 06-08-89
PARTY: Moody, Stevens, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 150-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 14 cm/s and nozzle was 1/4 inch. Simultaneous discharge measurement made by George Gray, USGS Missouri District, from the Poplar Street Bridge. Verticals occupied in order for depth-integrated sampling and surface-water measurements.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
X01	15	1.7	0.25	6	--	--	--	--	--
X02	30	9.1	0.36	57	--	--	--	--	--
01A	50	11.0	1.22	276	4.96	18	24.6	6.3	467
02B	71	10.8	1.43	279	6.52	25	24.6	6.5	466
03A	86	10.8	1.50	210	5.59	38	24.7	6.7	462
04B	97	10.8	1.47	222	6.30	32	24.6	6.7	465
05A	114	10.7	1.42	258	5.85	30	24.7	6.8	466
06B	131	10.6	1.33	218	5.67	27	24.7	6.8	465
07A	145	10.1	1.36	185	5.32	26	24.8	6.9	466
08B	158	9.6	1.22	182	4.93	25	24.7	7.0	472
09A	176	9.0	1.39	168	4.87	23	24.7	7.0	480
10B	185	8.8	1.34	189	4.85	21	24.7	7.0	480
11A	208	8.3	1.44	197	4.85	20	24.8	7.0	501
12B	218	8.1	1.12	136	3.93	26	24.8	7.0	511
13A	238	7.7	1.40	178	4.28	18	24.6	7.0	507
14B	251	7.5	1.24	121	3.60	17	24.6	7.1	534
15A	264	7.3	1.40	123	3.98	20	24.8	7.1	530
16B	275	7.3	1.32	158	3.84	18	24.7	7.1	557
17A	292	7.1	1.21	150	3.70	18	24.8	7.2	561
18B	310	6.9	1.16	124	3.14	18	24.7	7.2	577
19A	328	6.7	1.22	126	3.37	18	24.6	7.2	598
20B	341	6.7	1.17	114	2.82	18	24.8	7.2	606
21A	357	6.6	1.13	130	2.83	15	24.7	7.3	613
22B	376	6.3	1.33	155	2.62	15	24.7	7.3	629
23A	394	6.3	1.19	101	3.06	15	24.8	7.4	634
24B	403	6.2	1.06	79	2.33	15	24.7	7.4	640
25A	418	6.2	1.20	104	2.69	14	24.7	7.4	652
26B	431	6.7	1.09	109	2.50	14	24.6	7.4	655
27A	448	6.8	1.11	117	3.05	15	24.9	7.4	659
28B	462	6.7	1.18	118	2.90	15	24.6	7.4	667
29A	478	6.8	1.02	101	2.96	17	24.6	7.5	669
30B	491	6.4	0.66	64	1.29	7	24.6	7.5	672
REW	508	0.0	0.00	0	--	--	--	--	--
MEAN		7.7	1.22						
TOTAL	508			4,755	118.60	598			

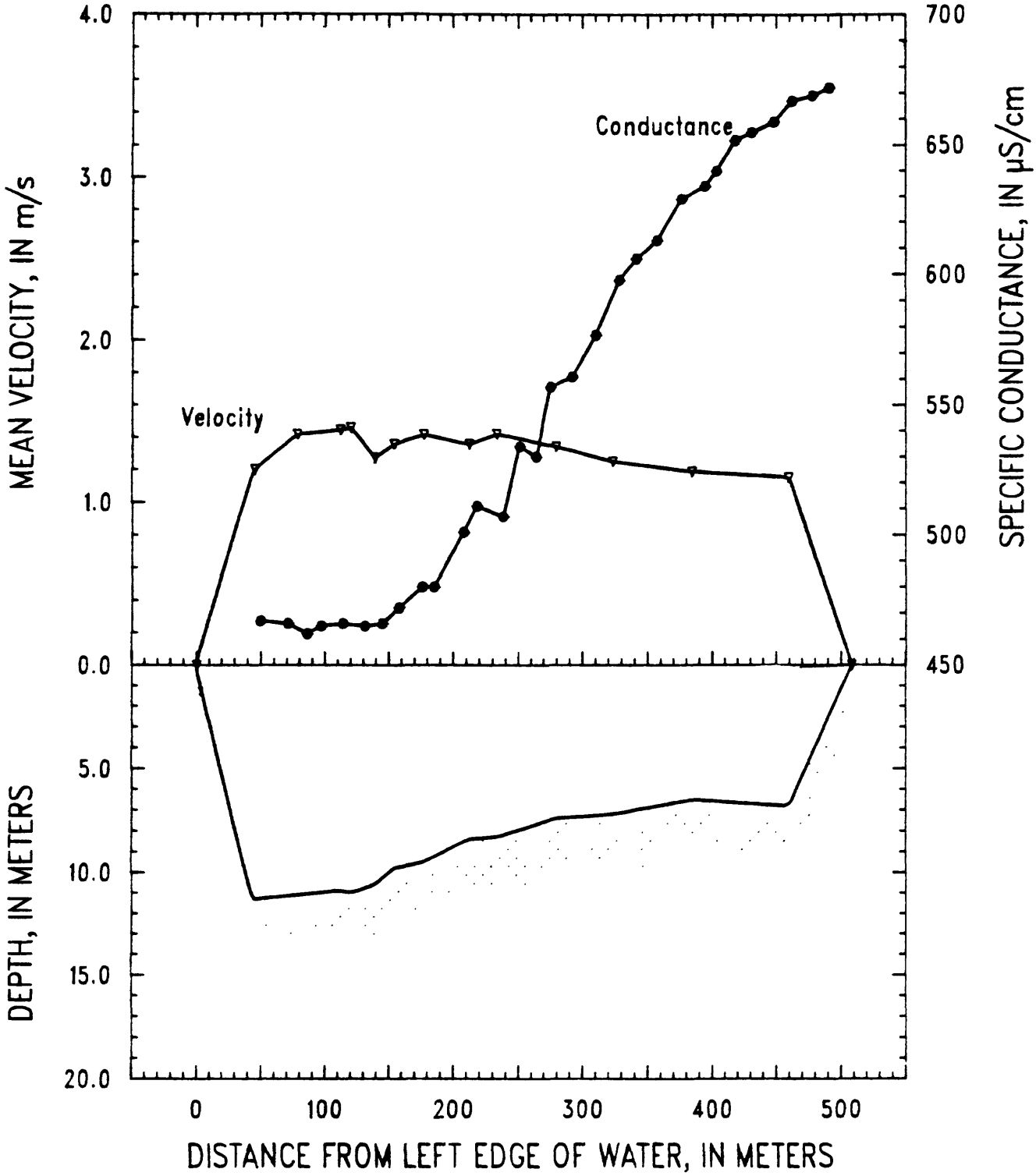

Figure 29. Mississippi River at St. Louis, Missouri, on June 8, 1989.

SITE: Mississippi River at St. Louis, Missouri 06-09-89
PARTY: Moody, Stevens, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 150-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Nozzle was 1/4 inch. Values to the right of the S represent the surface-water sample and values to the right of the D represent the depth-integrated sample.
Verticals 1-10 are spaced at equal-discharge increments.
Used variable transit rates to collect full bottles at each vertical.
Larger suspended-sediment concentrations from Missouri River rise of June 06-07 may have arrived on section since 06-08-89.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)		V_i (L)	Suspended sediment (mg/L) <63 µm	Suspended sediment (mg/L) >63 µm	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0		--	--	--	--	--	--
01	45	11.3	1.20	529	S	--	--	--	24.0	6.6	445
					D	5.63	101	8	23.7	7.3	456
02	78	11.1	1.42	527	S	--	--	--	23.6	6.7	465
					D	5.95	104	23	23.2	7.7	451
03	112	10.9	1.45	331	S	--	--	--	23.9	7.6	456
					D	5.74	111	33	23.5	7.9	451
13	120	11.0	1.46	217	S	--	--	--	23.6	8.1	455
					D	5.92	117	25	23.4	8.1	452
04	139	10.6	1.27	229	S	--	--	--	23.5	7.7	458
					D	4.85	123	40	23.1	8.0	456
12	154	9.8	1.36	253	S	--	--	--	23.7	8.1	470
					D	5.16	128	51	23.3	8.0	458
05	177	9.5	1.42	391	S	--	--	--	23.6	7.9	499
					D	5.37	136	41	23.6	8.0	466
11	212	8.4	1.36	319	S	--	--	--	24.0	8.1	493
					D	5.91	170	67	23.7	8.1	485
06	233	8.3	1.42	395	S	--	--	--	22.9	8.0	504
					D	4.87	190	77	23.4	8.1	503
07	279	7.4	1.34	447	S	--	--	--	23.3	8.0	525
					D	4.40	221	73	23.6	8.1	525
08	323	7.2	1.25	473	S	--	--	--	23.2	8.0	556
					D	5.41	258	50	23.5	8.1	553
09	384	6.5	1.19	524	S	--	--	--	23.1	8.1	578
					D	6.37	344	33	23.5	8.1	583
10	459	6.8	1.15	484	S	--	--	--	23.1	8.1	604
					D	5.02	309	20	23.1	8.1	605
REW	508	0.0	0.00	0		--	--	--	--	--	--
MEAN		7.7	1.31								
TOTAL	508			5,119							

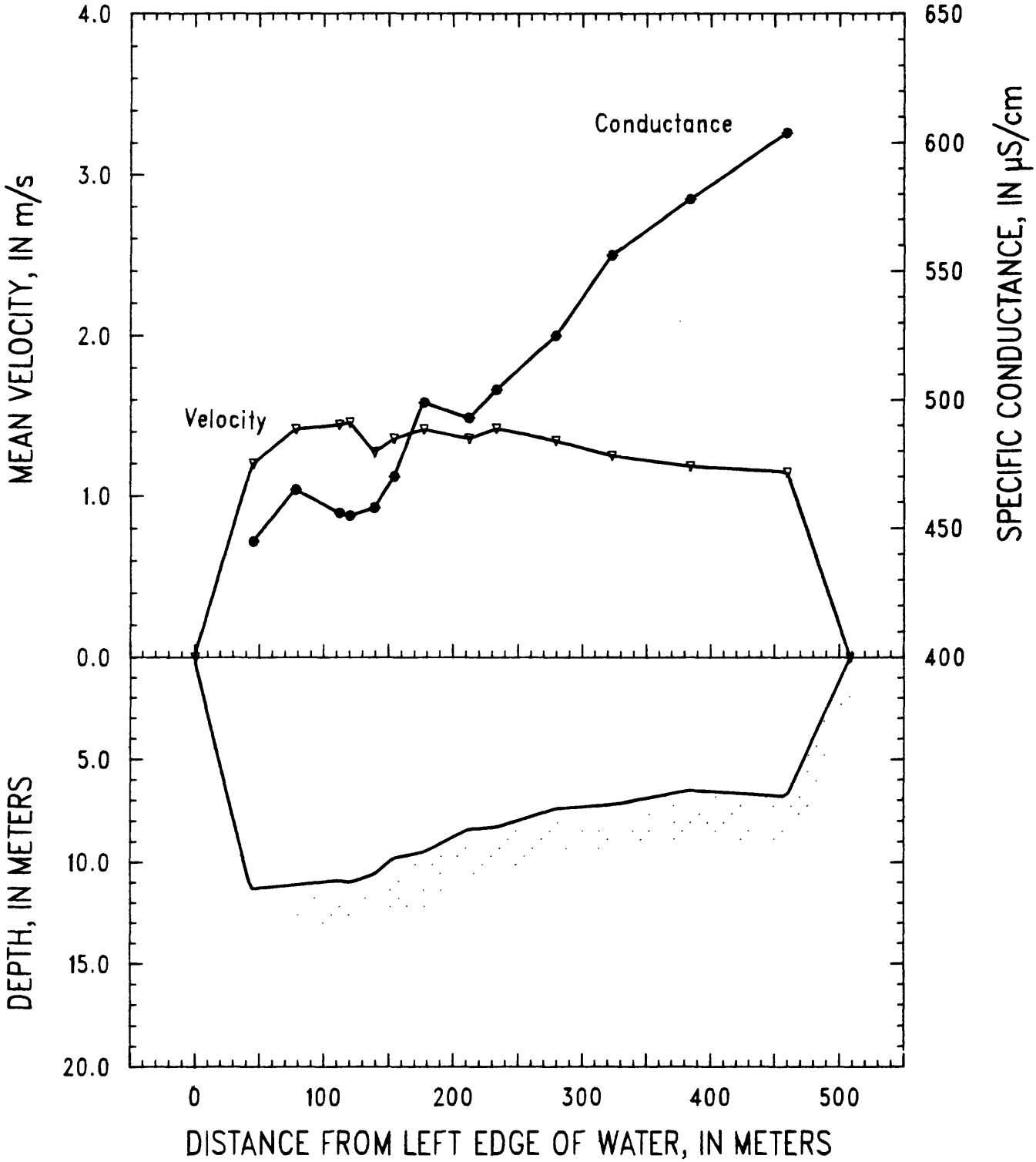

Figure 30. Mississippi River at St. Louis, Missouri, on June 9, 1989.

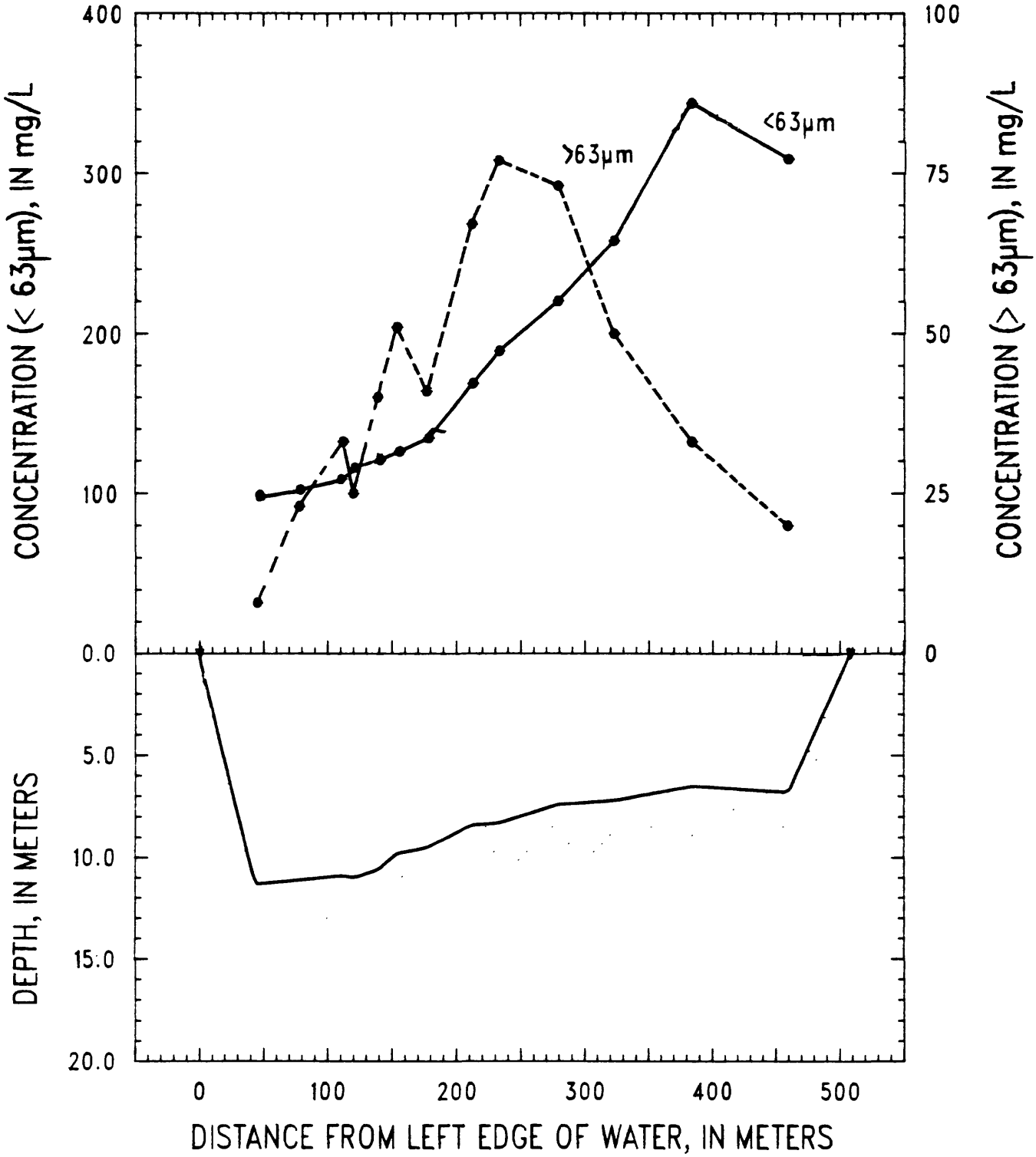

Figure 31. Mississippi River at St. Louis, Missouri, on June 9, 1989. Depth-integrated suspended-sediment concentration.

(PAGE 118 FOLLOWS)

SITE: Mississippi River at Thebes, Illinois 06-10-89
PARTY: Moody, Stevens, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 150-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 12 cm/s and nozzle was 1/4 inch. Verticals 28, 29, and 30 collected at 28. Used distances and depths from cross-section profile for verticals 28, 29, and 30.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	--	--	--	--	--	--
01A	35	5.3	0.57	62	0.85	3	24.2	6.90	493
02B	41	5.2	0.74	54	1.61	6	24.1	6.97	507
03A	63	7.1	0.83	121	2.37	11	24.3	7.02	484
04B	82	8.2	1.12	175	4.12	17	24.4	7.04	508
05A	101	8.4	1.37	196	5.06	19	24.6	7.01	506
06B	116	8.6	1.55	281	6.02	23	24.7	7.04	512
07A	143	8.9	1.47	256	6.20	26	24.7	7.08	521
08B	155	8.9	1.53	251	6.00	28	25.0	7.11	513
09A	180	8.4	1.60	316	6.24	27	25.9	7.12	511
10B	202	8.4	1.59	254	6.19	26	25.3	7.20	512
11A	218	8.4	1.56	269	6.16	25	25.1	7.20	514
12B	243	8.3	1.56	272	6.09	25	24.9	7.20	521
13A	260	8.1	1.46	207	5.49	23	25.0	7.20	516
14B	278	7.7	1.59	245	5.46	21	25.1	7.35	518
X03	295	7.3	1.48	87	--	--	--	--	--
15A	300	8.3	1.66	117	4.78	21	25.2	7.31	520
16B	316	7.7	1.44	200	4.94	20	24.9	7.26	524
17A	331	7.2	1.52	247	5.45	21	25.3	7.17	518
18B	361	7.7	1.39	198	4.70	20	25.2	7.28	528
19A	368	7.5	1.34	156	4.77	18	25.4	7.32	519
20B	392	7.8	1.27	218	4.15	19	25.2	7.33	521
21A	412	7.7	1.13	170	4.30	17	25.4	7.34	529
22B	431	7.8	1.17	182	3.83	19	25.6	7.33	521
23A	452	7.0	1.05	155	3.13	17	25.1	7.38	527
24B	473	6.3	1.15	159	2.98	15	25.0	7.38	527
25A	496	5.2	1.03	96	2.56	10	25.1	7.39	528
26B	509	5.0	1.11	78	2.02	8	24.9	7.40	527
27A	524	4.1	0.78	33	2.93	6	24.8	7.46	528
X05	530	3.9	0.91	46	--	--	--	--	--
28B	550	2.6	0.77	40	1.77	9	25.0	7.42	527
29A	570	3.0	0.77	45	--	--	--	--	--
30B	589	3.0	0.77	45	--	--	--	--	--
REW	609	0.0	0.00	0	--	--	--	--	--
MEAN		6.6	1.30						
TOTAL	609			5,231	120.17	500			

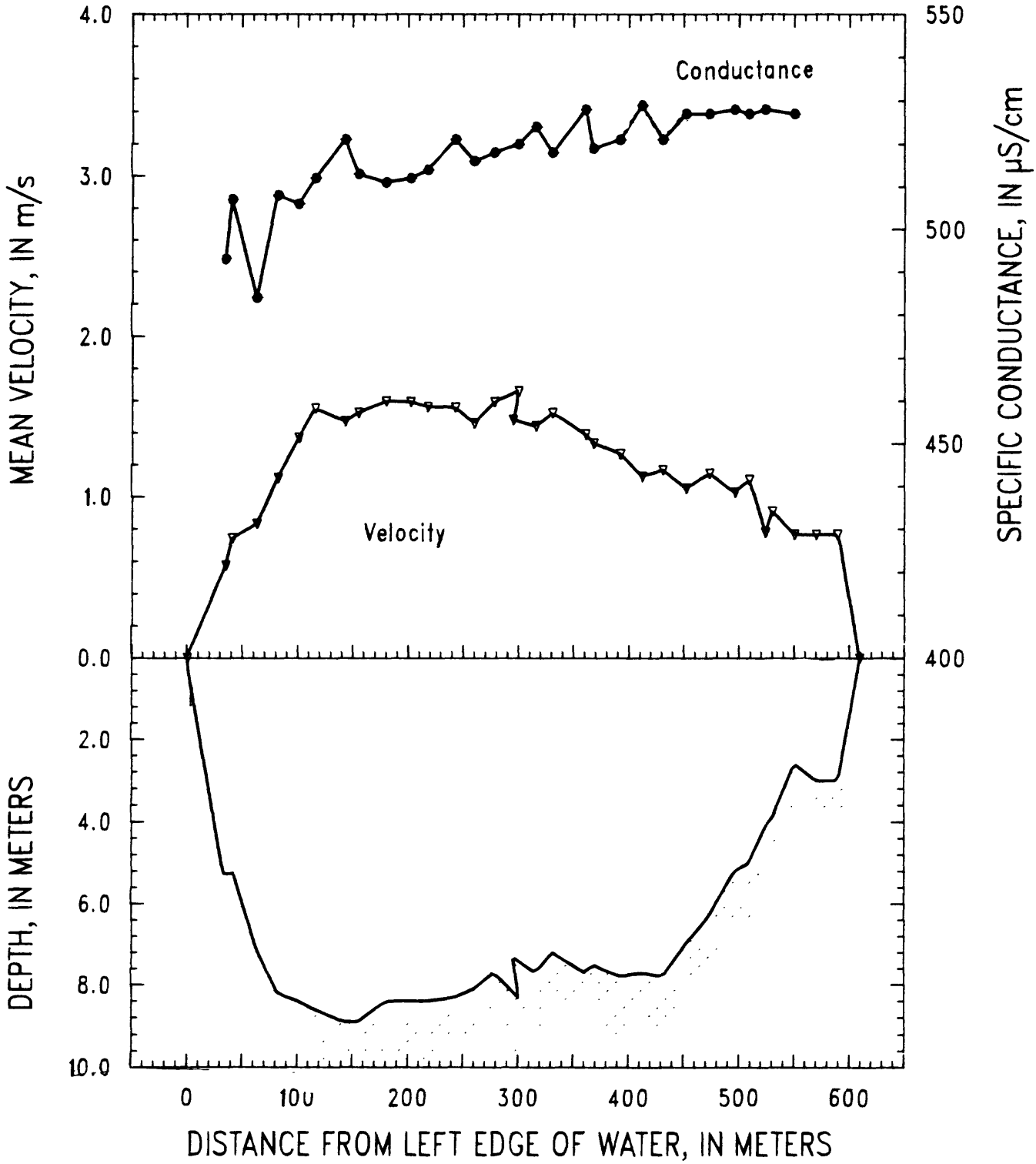

Figure 32. Mississippi River at Thebes, Illinois, on June 10, 1989.

SITE: Ohio River at Olmsted, Illinois 06-11-89
PARTY: Moody, Stevens, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 10 cm/s and nozzle was 1/4 inch. X verticals measured first, then verticals 30 to 1.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	37	4.9	0.47	78	0.85	4	24.2	7.0	202
02B	68	5.4	0.54	96	1.02	7	24.2	7.6	205
03A	96	6.7	0.64	73	1.88	9	24.2	7.6	208
X09	103	6.8	0.66	63	--	--	--	--	--
04B	137	6.8	0.73	157	2.32	10	24.1	7.6	215
05A	159	7.1	0.76	159	2.81	11	24.2	7.6	224
06B	196	7.4	0.83	203	2.83	12	24.1	7.6	231
07A	225	7.8	0.82	214	2.50	12	24.2	7.6	238
08B	263	7.8	0.83	257	3.17	13	24.2	7.6	257
09A	304	7.8	0.80	215	3.34	13	24.1	7.6	252
10B	332	8.2	0.90	210	3.84	14	24.0	7.6	267
11A	361	8.7	0.95	222	4.12	17	24.0	7.6	270
X03	386	9.2	0.96	160	--	--	--	--	--
12B	397	9.3	1.00	224	4.64	20	24.2	7.6	276
13A	434	11.6	0.89	321	4.32	27	23.8	7.6	294
14B	459	11.8	0.94	305	5.56	28	24.1	7.6	302
15A	489	12.3	0.96	406	5.62	29	23.8	7.6	310
16B	528	12.7	0.91	364	5.48	33	23.9	7.6	308
17A	552	11.7	1.05	395	5.86	33	24.0	7.6	317
18B	592	11.3	1.06	366	6.17	31	23.9	7.6	331
19A	613	11.4	1.08	320	5.81	27	23.5	7.6	334
20B	644	11.2	1.10	233	6.43	27	23.3	7.6	348
X02	651	10.9	1.14	218	--	--	--	--	--
X06	679	11.1	1.01	185	--	--	--	--	--
21A	684	11.2	1.04	181	5.16	27	23.1	7.6	367
22B	710	10.7	1.15	357	6.32	25	23.0	7.6	369
23A	742	10.6	1.06	372	6.21	23	23.1	7.6	381
24B	776	10.7	1.08	392	5.74	23	23.2	7.6	378
25A	810	11.6	1.11	387	6.40	24	23.7	7.5	389
26B	836	11.4	1.10	363	6.39	23	24.0	7.5	397
X05	868	11.7	1.07	256	--	--	--	--	--
27A	877	12.0	1.03	279	5.45	24	24.1	7.5	402
28B	913	12.7	0.91	324	5.91	27	24.0	7.4	399
29A	933	13.3	0.75	303	4.66	26	24.1	7.2	399
30B	974	5.6	0.49	103	1.08	5	24.2	6.9	397
REW	1,008	0.0	0.00	0	--	--	--	--	--
MEAN		9.3	0.94						
TOTAL	1,008			8,761	131.89	604			

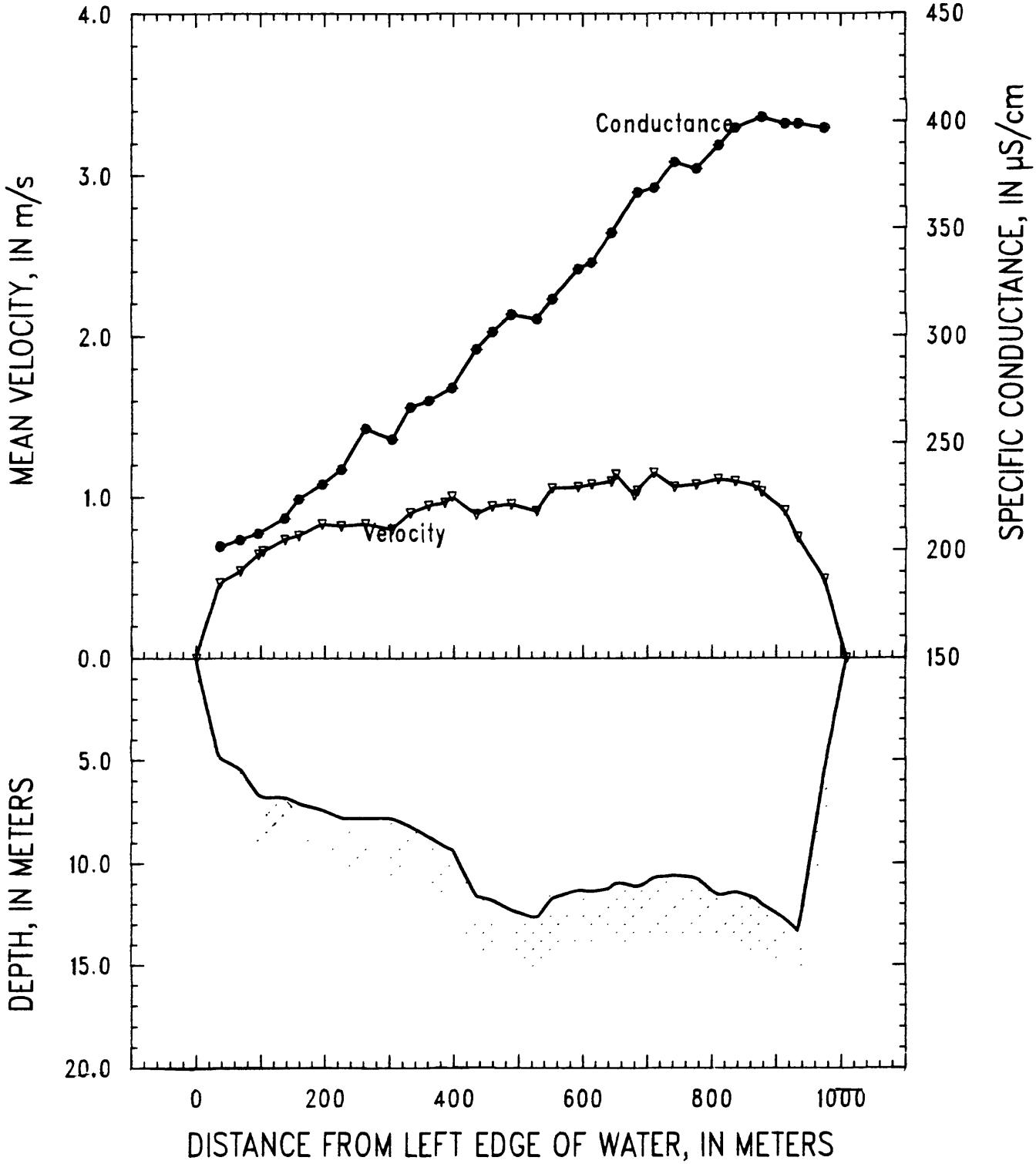

Figure 33. Ohio River at Olmsted, Illinois, on June 11, 1989.

SITE: Mississippi River below Hickman, Kentucky 06-12-89
PARTY: Moody, Stevens, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: 22.84 ft ENDING GAGE HEIGHT: 23.10 ft
SUSP: Bag sampler and 200-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 10 cm/s and nozzle was 3/16 inch. The 5-vertical composite sample was collected with the test velocities.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	42	9.5	1.18	488	3.27	10	24.5	7.7	324
02B	87	9.3	1.44	535	4.51	16	24.9	7.7	327
03A	122	9.5	1.63	394	5.49	18	25.0	7.7	332
X04	138	9.7	1.56	264	--	--	--	--	--
04B	157	9.8	1.52	350	4.95	19	24.6	7.7	332
05A	185	9.9	1.56	524	5.64	20	24.7	7.8	335
06B	225	9.5	1.42	465	4.69	19	24.3	7.8	335
07A	254	9.1	1.50	486	4.76	17	24.2	7.8	340
08B	296	9.0	1.27	468	3.76	18	24.3	7.8	337
09A	336	8.4	1.48	287	4.00	16	24.2	7.8	343
X02	342	8.7	1.48	219	--	--	--	--	--
10B	370	8.3	1.27	358	3.74	16	24.0	7.8	346
11A	410	8.8	1.36	455	3.47	18	24.1	7.8	349
12B	446	8.3	1.35	374	3.59	12	24.4	7.8	353
13A	477	7.7	1.29	431	2.75	15	24.5	7.8	358
14B	533	7.7	1.51	494	3.69	12	24.2	7.8	358
15A	562	7.7	1.16	170	2.99	14	24.2	7.7	381
X03	571	7.8	1.44	62	--	--	--	--	--
16B	573	7.5	1.41	316	3.15	17	25.2	7.7	385
17A	631	7.9	1.28	465	2.97	18	24.8	7.7	391
18B	665	9.3	1.27	361	4.10	17	24.5	7.7	395
19A	692	9.5	1.33	499	4.28	17	25.2	7.7	404
20B	744	10.1	1.37	610	4.85	17	25.2	7.7	420
21A	780	11.2	1.47	478	4.94	16	24.7	7.7	424
22B	802	11.2	1.29	224	5.24	19	24.0	7.7	428
X08	811	11.3	1.36	361	--	--	--	--	--
23A	849	11.7	1.20	553	5.19	24	27.6	7.7	439
24B	890	12.1	1.23	491	4.43	19	27.6	7.7	445
25A	915	12.2	1.38	496	4.81	19	27.6	7.7	448
26B	949	12.6	1.26	579	5.69	20	27.7	7.7	463
27A	988	12.7	1.24	605	4.70	19	27.7	7.7	467
X06	1,026	12.3	1.24	312	--	--	--	--	--
28B	1,029	12.7	1.11	190	5.02	18	27.6	7.7	463
29A	1,053	11.9	1.04	377	3.79	19	27.6	7.7	467
30B	1,090	8.8	0.97	350	2.04	7	27.8	7.6	473
REW	1,135	0.0	0.00	0	--	--	--	--	--
MEAN		9.4	1.33						
TOTAL	1,135			14,091	126.00	506			

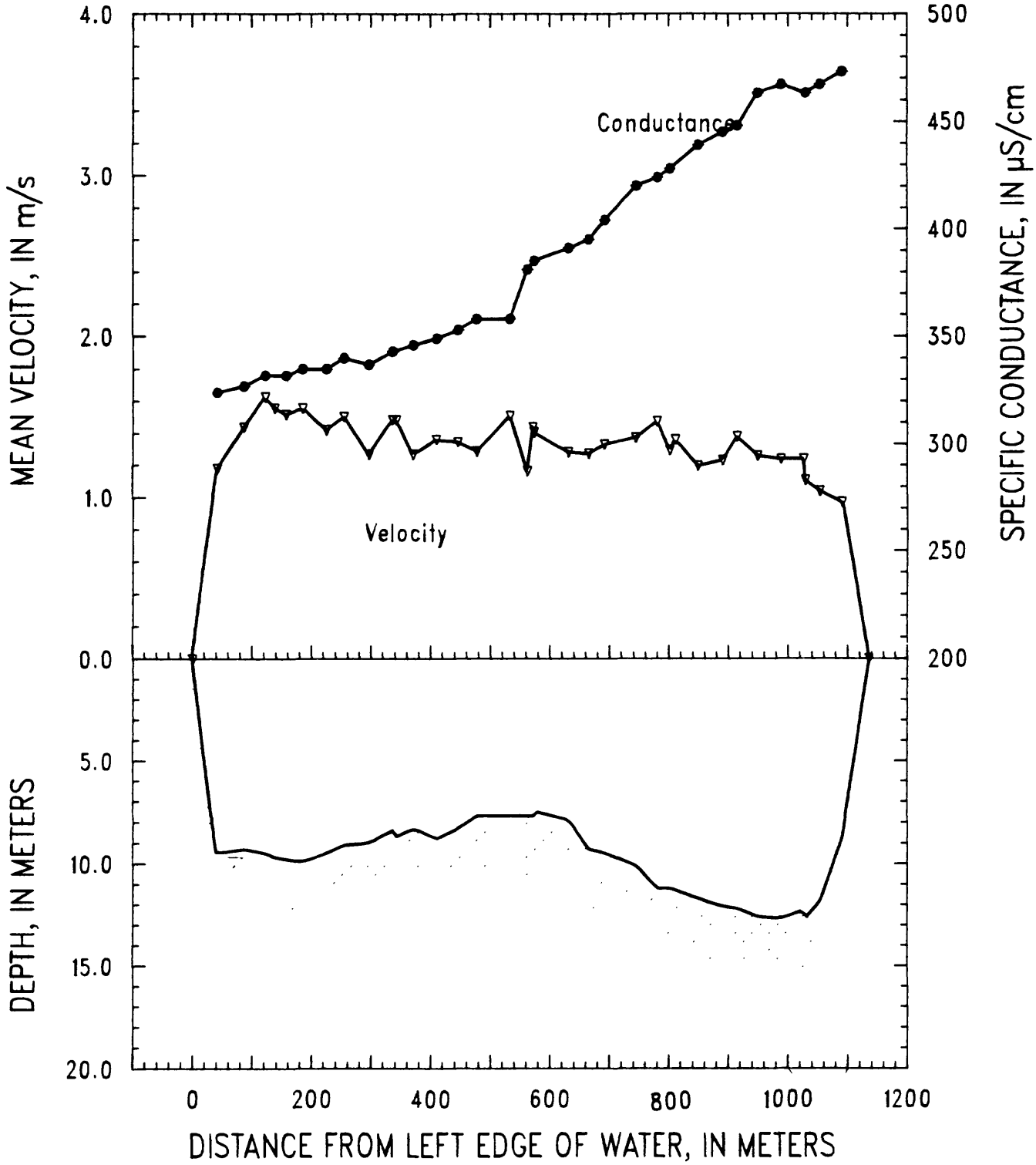

Figure 34. Mississippi River below Hickman, Kentucky, on June 12, 1989.

SITE: Mississippi River below Hickman, Kentucky 06-13-89
PARTY: Moody, Stevens, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Nozzle was 3/16 inch. Varied transit rates to get full bottles at each vertical. Values to the right of the S represent the surface-water sample and values to the right of the D represent the depth-integrated water sample. There was a temporal change in suspended-sediment concentration of about 1 mg/L per minute.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)		V_i (L)	Suspended sediment (mg/L) <63 µm	Suspended sediment (mg/L) >63 µm	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0		--	--	--	--	--	--
01	64	9.2	1.18	939	S	--	--	--	23.0	7.0	331
					D	3.52	159	1	23.1	7.2	332
02	173	10.2	1.53	1,750	S	--	--	--	22.9	7.1	319
					D	4.99	140	2	22.9	7.2	335
03	288	9.3	1.42	1,116	S	--	--	--	23.2	7.2	331
					D	6.37	140	6	23.2	7.3	339
13	342	8.8	1.48	720	S	--	--	--	23.1	7.6	341
					D	4.79	239	11	23.2	7.6	352
04	399	9.0	1.45	430	S	--	--	--	23.2	7.2	352
					D	4.62	154	8	22.9	7.3	357
X01	408	9.1	1.36	272	S	--	--	--	--	--	--
12	443	8.1	1.41	629	S	--	--	--	23.2	7.7	347
					D	5.75	242	17	23.0	7.5	346
05	518	7.9	1.41	700	S	--	--	--	23.3	7.3	363
					D	5.97	176	19	23.2	7.4	376
11	569	7.8	1.31	568	S	--	--	--	23.5	7.7	358
					D	4.30	231	45	23.1	7.6	366
06	629	8.7	1.28	667	S	--	--	--	23.3	7.4	377
					D	5.08	196	32	23.0	7.5	395
14	689	9.6	1.40	755	S	--	--	--	23.3	7.6	399
					D	5.16	239	32	23.2	7.6	411
07	741	10.4	1.37	806	S	--	--	--	23.4	7.4	413
					D	6.27	217	35	23.3	7.5	426
15	802	11.4	1.34	925	S	--	--	--	23.6	7.6	423
					D	5.82	241	37	23.4	7.5	437
08	862	12.2	1.32	903	S	--	--	--	23.3	7.5	439
					D	5.44	236	19	23.2	7.7	459
16	914	12.3	1.24	792	S	--	--	--	23.5	7.6	443
					D	5.45	261	15	23.3	7.5	462
09	966	12.3	1.15	1,179	S	--	--	--	23.3	7.5	462
					D	4.37	229	10	23.2	7.6	477
10	1,081	9.1	0.99	759	S	--	--	--	23.4	7.5	474
					D	5.03	208	1	23.2	7.5	479
REW	1,135	0.0	0.00	0		--	--	--	--	--	--
MEAN		9.3	1.32								
TOTAL	1,135			13,910							

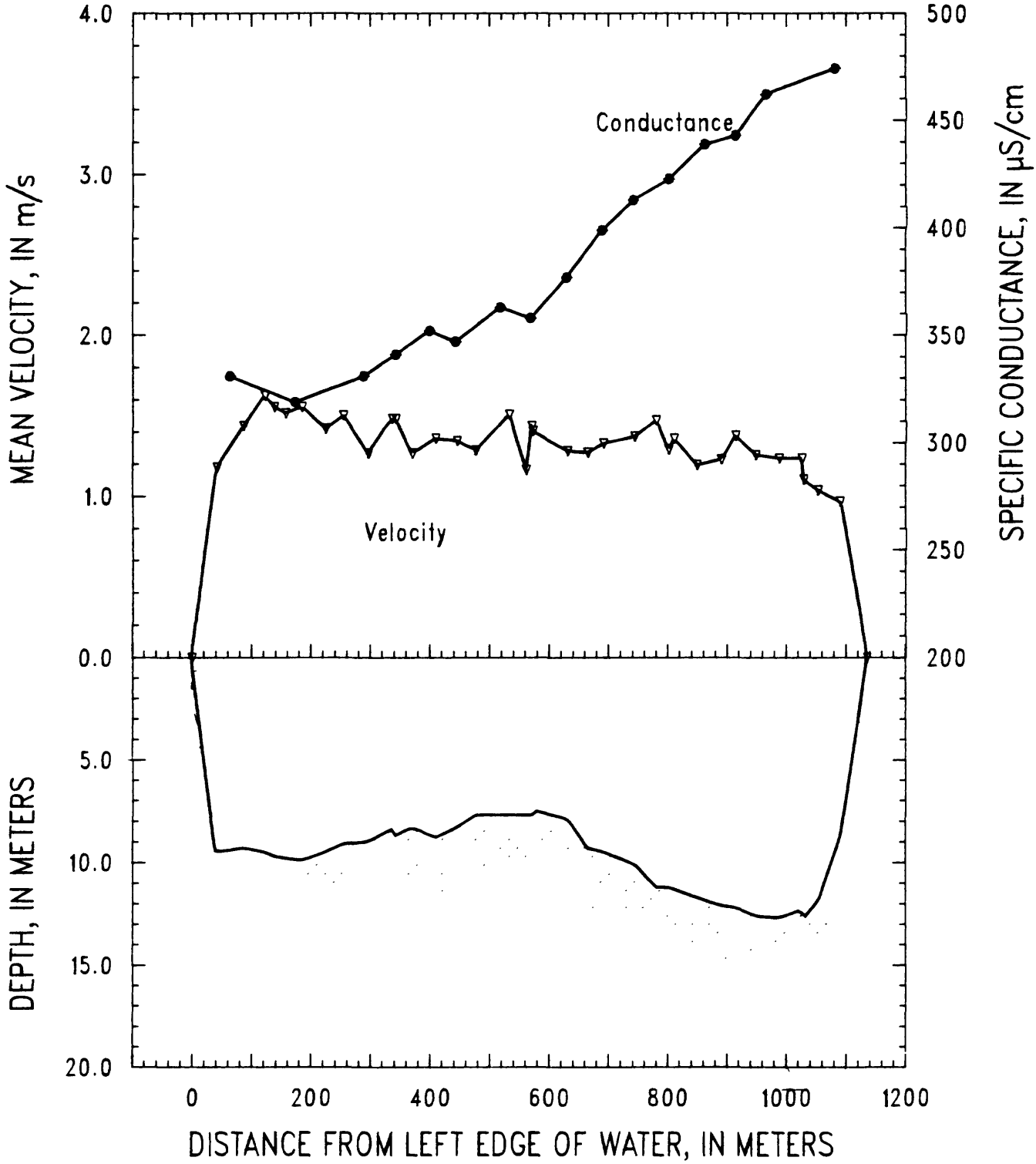

Figure 35. Mississippi River below Hickman, Kentucky, on June 13, 1989.

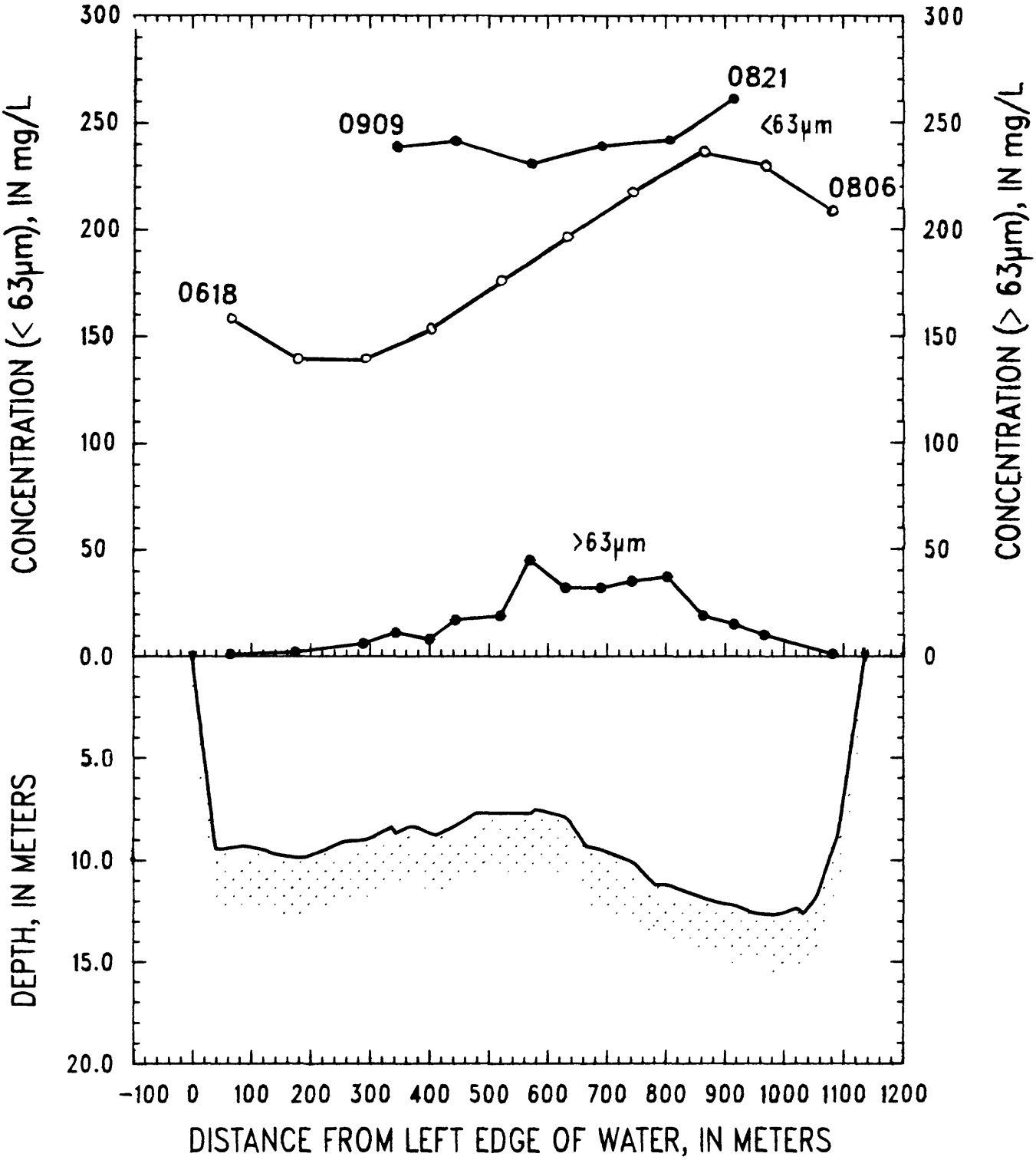

Figure 36. Mississippi River below Hickman, Kentucky, on June 13, 1989. Depth-integrated suspended-sediment concentration. Starting and ending sampling times are shown.

(PAGE 128 FOLLOWS)

SITE: Mississippi River at Fulton, Tennessee 06-14-89
PARTY: Moody, Stevens, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 15 cm/s and nozzle was 3/16 inch. Five-vertical composite sample collected with test velocities. New solid cup in current meter.
Started depth-integrated sampling at vertical 3A.
Estimates for overflow channel must be added to width, area, and discharge totals below: Velocity = 0.8 m/s; Width = 200 m; Area = 500 m^2; Discharge = 400 m^2/s.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	--	--	--	--	--	--
01	--	--	--	--	--	3	--	--	--
02	--	--	--	--	--	4			
03A	87	8.5	0.72	410	1.49	7	24.0	6.7	384
04B	134	9.6	1.22	403	2.77	8	23.9	6.8	388
05A	156	11.2	1.47	362	3.76	9	24.0	6.9	374
06B	178	11.7	1.62	418	4.47	12	23.9	7.0	382
07A	200	12.2	1.77	724	4.81	16	23.6	7.0	380
08B	245	13.7	1.73	758	6.01	22	23.5	7.5	384
09A	264	14.3	1.62	302	5.43	27	23.6	7.3	370
X02	271	13.4	1.77	379	--	--	--	--	--
10B	296	14.6	1.70	582	5.15	25	23.7	7.3	387
11A	318	14.3	1.85	716	6.28	24	24.0	7.3	385
X05	350	14.2	1.73	478	--	--	--	--	--
12B	357	14.8	1.72	395	5.71	24	23.8	7.2	389
13A	381	15.5	1.61	461	6.48	26	23.6	7.1	386
14B	394	16.3	1.67	720	6.33	29	23.5	7.1	388
15A	434	16.8	1.60	766	6.26	25	23.5	7.1	387
X03	451	16.1	1.48	406	--	--	--	--	--
16B	468	16.4	1.51	570	5.45	26	23.4	7.1	387
17A	497	15.1	1.52	679	5.63	23	22.9	7.4	393
18B	527	14.3	1.46	659	4.69	24	23.2	7.3	380
19A	560	13.6	1.57	728	5.34	22	23.3	7.2	386
20B	595	13.2	1.48	672	3.61	20	23.5	7.2	390
21A	629	12.7	1.46	473	4.04	19	23.3	7.2	387
22B	646	12.9	1.48	401	3.71	20	23.5	7.2	388
X06	671	12.9	1.39	268	--	--	--	--	--
23A	676	13.0	1.33	172	3.77	20	23.0	7.1	387
24B	691	13.4	1.18	450	3.75	22	23.3	7.2	384
25A	733	13.5	1.21	563	3.58	17	23.3	7.3	390
26B	760	12.3	1.24	443	2.65	11	23.4	7.3	397
27A	791	10.1	0.94	242	2.11	8	23.2	7.3	395
28B	811	7.9	0.79	93	1.40	4	23.0	7.3	391
X05	821	6.9	0.67	76	--	--	--	--	--
29A	844	5.4	0.79	81	0.88	2	23.2	7.3	388
30B	859	4.3	0.66	83	0.65	1	23.3	7.3	397
REW	902	0.0	0.00	0	--	--	--	--	--
MEAN		11.5	1.43						
TOTAL	902			14,933	116.21	500			

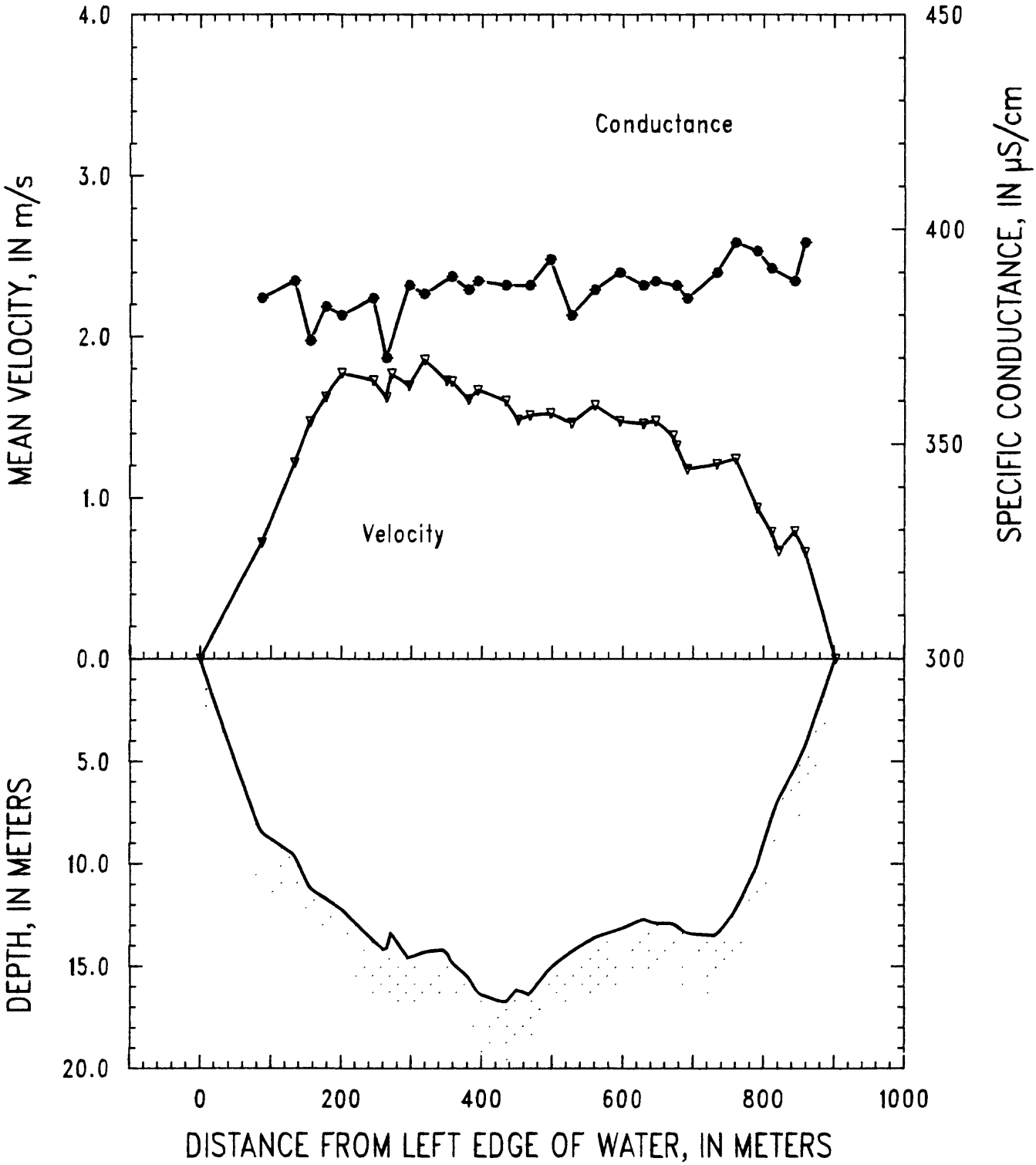

Figure 37. Mississippi River at Fulton, Tennessee, on June 14, 1989.

SITE: Mississippi River at Helena, Arkansas 06-17-89
PARTY: Moody, Stevens, Rees, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: 23.45 ft ENDING GAGE HEIGHT: 23.85 ft
SUSP: Bag sampler and 200-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 18 cm/s and nozzle was 3/16 in. Verticals occupied in the order 1 to 30.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
30B	28	7.5	0.61	132	0.79	6	23.8	7.7	365
29A	58	9.7	1.11	279	2.00	12	23.8	7.7	364
X05	80	10.2	1.39	212	--	--	--	--	--
28B	88	10.6	1.54	303	3.08	13	23.8	7.7	364
27A	117	10.8	1.77	642	3.78	15	23.8	7.8	365
26B	155	11.3	1.86	611	4.02	16	23.8	7.8	365
25A	175	11.9	1.75	572	4.63	17	23.9	7.8	365
24B	210	12.0	1.92	773	5.04	19	23.9	7.8	364
23A	242	12.2	2.03	681	5.06	19	23.7	7.8	364
22B	265	12.8	2.01	463	5.15	20	23.7	7.7	365
X04	278	12.8	1.88	337	--	--	--	--	--
21A	293	13.6	1.91	635	5.21	21	23.8	7.7	365
20B	327	13.7	2.12	959	5.31	24	--	--	--
19A	359	14.2	1.93	863	5.57	22	23.7	7.7	365
18B	390	13.7	1.80	739	4.60	24	23.8	7.8	364
17A	419	14.1	1.87	685	5.62	22	23.7	7.8	365
16B	442	14.3	1.73	446	4.47	25	23.8	7.7	365
X03	455	14.9	1.85	401	--	--	--	--	--
15A	471	15.9	1.63	636	4.59	27	23.6	7.8	365
14B	504	16.9	1.57	861	4.79	25	23.9	7.7	365
13A	536	17.0	1.30	619	4.45	22	23.8	7.8	366
12B	560	17.0	1.31	545	4.07	20	23.9	7.8	365
11A	585	17.1	1.22	563	3.63	15	23.8	7.8	364
10B	614	18.6	1.19	477	3.50	18	24.1	7.9	363
X02	628	19.3	1.08	251	--	--	--	--	--
09A	638	19.8	0.97	403	3.57	20	23.7	7.9	362
08B	670	22.0	1.02	698	3.50	23	23.7	7.8	362
07A	700	21.0	0.95	487	3.35	21	23.8	7.9	360
06B	719	18.7	1.06	307	3.35	13	23.7	7.8	358
05A	731	16.8	0.98	420	2.99	9	23.7	7.9	358
04B	770	9.8	0.99	257	1.65	8	23.7	7.8	357
X01	784	9.1	0.99	139	--	--	--	--	--
03A	801	7.9	1.02	173	1.57	6	23.7	7.8	357
02B	827	6.8	0.91	201	1.19	5	23.5	7.8	357
01A	866	6.8	0.75	178	0.73	3	23.7	7.8	357
REW	897	0.0	0.00	0	--	--	--	--	--
MEAN		13.1	1.44						
TOTAL	897			16,948	111.32	510			

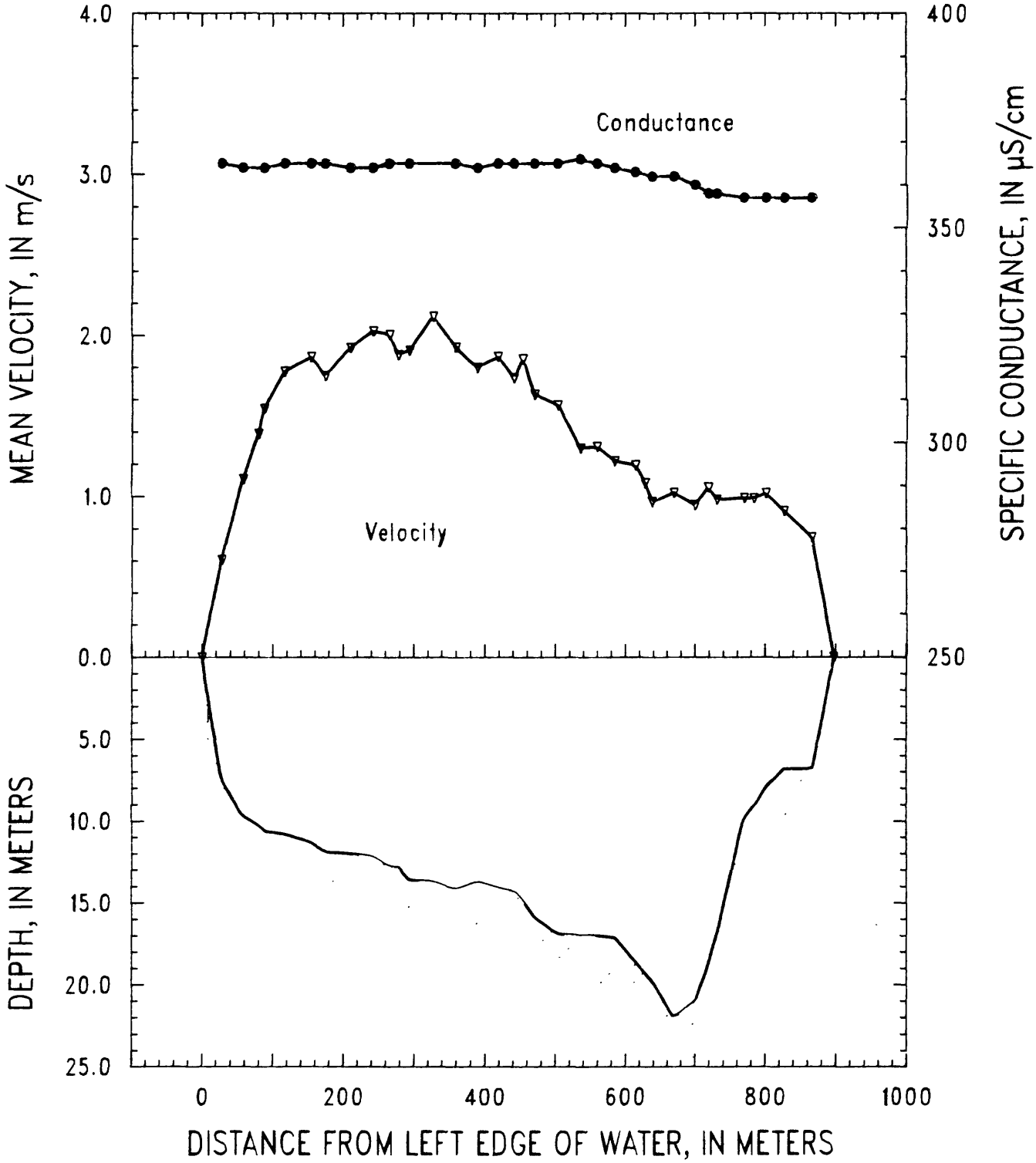

Figure 38. Mississippi River at Helena, Arkansas, on June 17, 1989.

SITE: White River at Mile 11.5, Arkansas 06-18-89
PARTY: Moody, Stevens, Rees, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Anchored at three verticals and nozzle was 5/16 in. Varied transit rate at three centroids of equal discharge.
Discharge based on the listed seven verticals (1, 2, 3, X01, X02, X03, and X04) plus 23 depths from depth profile and unit discharge proportional to depth 5/3 powers was 860 m^3/s.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
03A	39	9.8	0.52	116	21.43	194	23.7	7.8	239
03B	39	9.8	0.52	--	19.93	--	--	--	--
X01	46	9.8	0.51	33	--	--	--	--	--
X02	52	9.5	0.52	122	--	--	--	--	--
X03	95	9.1	0.59	128	--	--	--	--	--
02A	100	9.1	0.57	167	19.64	193	23.4	7.9	238
02B	100	9.1	0.57	--	21.65	--	--	--	--
01A	159	8.4	0.51	141	20.61	193	23.1	7.8	235
01B	159	8.4	0.51	--	20.65	--	--	--	--
X04	166	8.3	0.43	64	--	--	--	--	--
REW	195	0.0	0.00	0	--	--	--	--	--
MEAN		7.5	0.53						
TOTAL	195			771	123.91	580			

(PAGE 134 FOLLOWS)

SITE: Arkansas River at Pendleton, Arkansas 06-19-89
PARTY: Moody, Stevens, Rees, and Black .ETER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 13 cm/s and nozzle was 3/16 inch. Verticals occupied from 1 to 30.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
30B	22	4.1	0.97	50	0.93	4	25.1	7.7	602
29A	25	4.3	0.99	34	1.09	7	25.2	7.7	602
28B	38	4.9	1.07	63	1.30	10	25.2	7.7	604
27A	49	4.7	1.05	62	1.21	9	25.2	7.7	603
26B	63	5.0	1.09	90	1.32	10	25.1	7.7	605
25A	82	5.3	1.22	88	1.74	10	25.1	7.7	609
24B	90	5.5	1.14	63	1.81	11	24.0	7.7	611
23A	102	5.3	1.11	74	1.73	12	25.0	7.7	619
22B	115	5.8	1.24	76	1.75	13	25.2	7.8	614
X05	123	6.4	1.34	81	--	--	--	--	--
21A	134	6.4	1.28	90	2.26	14	25.0	7.7	621
20B	145	6.4	1.15	96	2.16	14	24.9	7.7	630
19A	160	6.9	1.14	90	2.11	15	25.0	7.7	631
18B	168	7.0	1.20	101	2.24	15	25.2	7.7	626
17A	184	6.6	1.34	120	2.45	15	24.9	7.7	633
16B	195	6.6	1.30	95	2.09	13	25.2	7.7	653
15A	206	6.7	1.29	87	1.94	15	24.8	7.7	646
14B	215	6.3	1.55	141	2.43	13	24.7	7.7	656
13A	235	7.3	1.58	184	3.06	15	24.7	7.7	658
12B	247	7.7	1.50	156	2.82	16	24.9	7.8	656
11A	262	7.8	1.35	111	2.77	16	24.8	7.7	663
10B	268	8.0	1.38	77	3.08	17	25.5	7.7	661
09B	276	8.3	1.35	73	--	--	--	--	--
09A	281	8.7	1.30	102	2.84	19	24.7	7.7	663
08B	294	10.5	1.21	184	3.37	22	24.7	7.7	660
07A	310	13.2	1.27	227	4.70	29	25.1	7.7	662
06B	323	15.3	1.31	210	5.17	36	24.6	7.7	660
05A	331	15.4	1.32	234	5.31	39	24.7	7.7	656
03A	344	14.7	1.33	147	5.39	29	24.6	7.8	647
04B	346	14.3	1.40	171	4.81	44	24.7	7.7	650
02B	361	8.7	1.26	153	2.32	9	24.6	7.9	646
01A	374	4.0	1.12	67	1.40	8	24.8	8.0	647
REW	391	0.0	0.00	0	--	--	--	--	--
MEAN		7.2	1.28						
TOTAL	391			3,597	77.60	499			

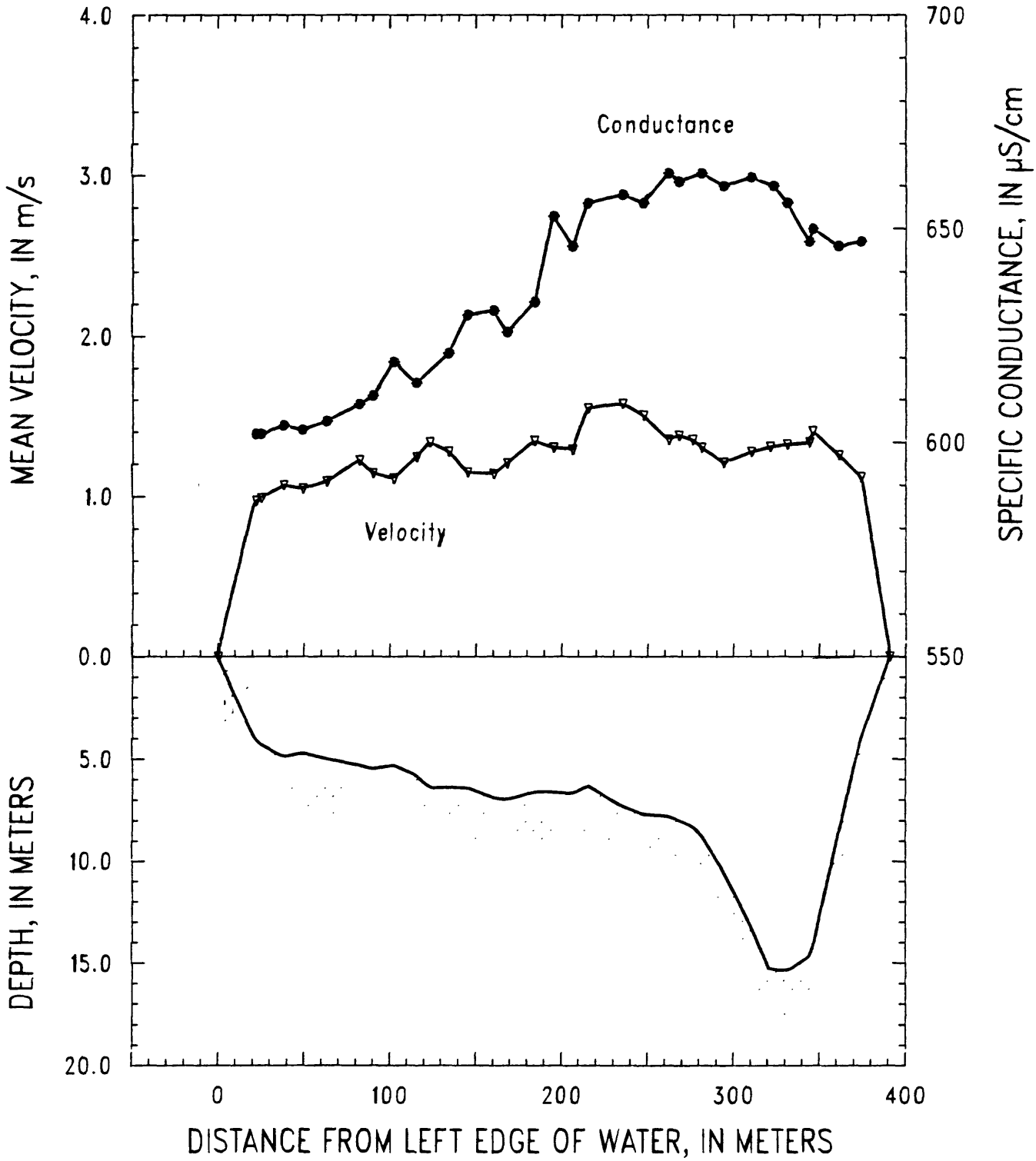

Figure 39. Arkansas River at Pendleton, Arkansas, on June 19, 1989.

SITE: Mississippi River above Arkansas City, Arkansas 06-20-89
PARTY: Moody, Stevens, Rees, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 12 cm/s and nozzle was 1/8 inch. Verticals occupied from 1-29.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
29A	62	5.5	0.31	83	0.24	2	24.9	7.7	328
X04	98	8.1	0.48	82	--	--	--	--	--
28B	104	8.6	0.59	84	0.51	3	24.8	7.7	327
27A	131	10.7	0.67	189	0.84	5	24.9	7.6	328
26B	157	13.6	0.88	363	1.53	9	24.7	7.7	328
25A	192	14.8	0.86	422	1.48	12	24.6	7.7	331
24B	223	15.8	1.03	553	2.22	14	24.7	7.7	329
23A	260	16.7	1.22	611	2.65	16	24.6	7.7	332
22B	283	17.2	1.35	686	2.78	20	24.5	7.7	335
21A	319	17.6	1.50	737	3.66	18	24.5	7.7	333
20B	339	18.8	1.61	785	4.64	22	24.6	7.7	351
19A	371	19.5	1.66	746	4.63	25	24.5	7.7	352
X19	385	20.0	1.92	942	--	--	--	--	--
18B	420	21.0	2.06	1,058	6.47	32	24.6	7.8	343
17A	434	20.3	2.14	435	5.89	34	24.7	7.7	354
X17	440	19.8	2.20	435	--	--	--	--	--
16B	454	19.6	2.33	1,166	6.64	32	24.7	7.7	365
X05	491	20.3	2.21	1,012	--	--	--	--	--
15A	499	21.0	2.19	919	6.54	31	24.6	7.7	363
14B	531	19.8	1.90	1,014	5.83	28	24.5	7.7	384
13A	553	19.4	1.98	1,443	5.46	27	24.6	7.7	386
12B	606	18.2	2.06	1,553	5.44	25	24.7	7.7	389
11A	636	18.1	1.97	1,014	5.13	26	24.8	7.7	402
10B	663	17.8	1.99	922	4.86	25	24.8	7.7	404
X02	688	17.7	1.93	582	--	--	--	--	--
09A	697	17.8	2.03	813	5.35	22	24.8	7.7	403
08B	733	17.4	1.77	1,077	4.89	20	24.7	7.7	408
07A	767	17.0	1.71	859	4.37	15	24.7	7.7	410
06B	792	16.9	1.49	730	3.38	12	24.8	7.8	416
05A	825	17.0	1.43	787	3.68	9	24.7	7.8	418
04B	857	17.4	1.22	793	2.68	8	24.8	7.9	424
03A	900	14.6	0.60	269	0.86	5	24.6	7.9	421
02B	918	11.4	0.49	174	0.61	4	25.2	7.9	421
01A	962	3.7	0.02	2	no sample	1	25.1	7.9	420
REW	990	0.0	0.00	0	--	--	--	--	--
MEAN		15.1	1.56						
TOTAL	990			23,340	103.26	502			

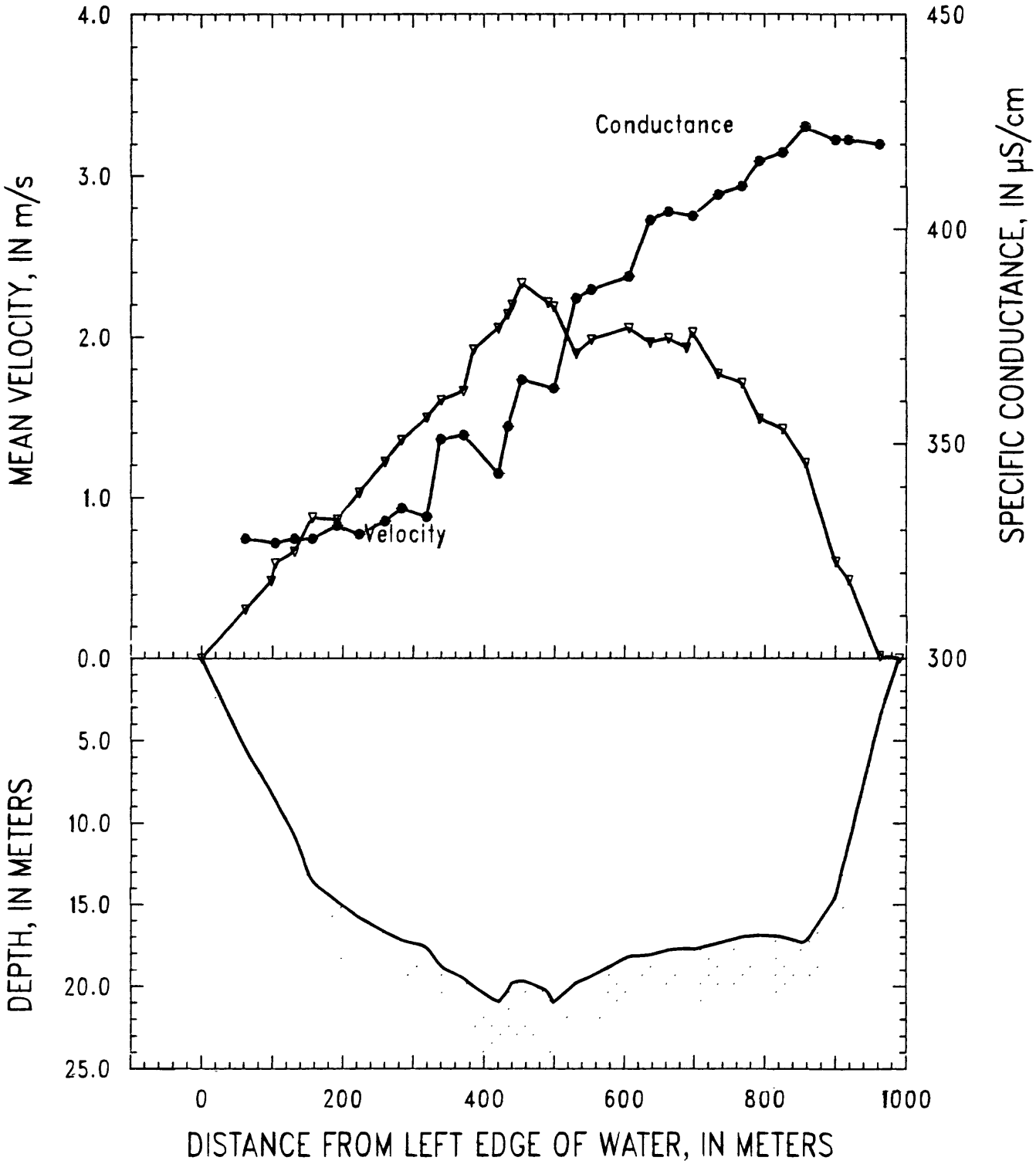

Figure 40. Mississippi River above Arkansas City, Arkansas, on June 20, 1989.

STATION: Yazoo River below Steele Bayou, Mississippi 06-22-89
PARTY: Moody, Stevens, Rees, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 150-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Used 1/4-inch nozzle and various transit rates to get a full bottle at six equal-discharge centroids.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
X03	18	7.4	0.37	33	--	--	--	--	--
01	24	8.5	0.55	63	19.88	100	25.4	6.8	62
02	45	13.8	0.78	211	21.60	100	25.5	6.5	63
03	63	13.7	0.86	212	20.82	100	26.0	6.4	66
04	81	13.8	0.88	171	20.05	111	26.1	6.4	65
05	91	13.8	0.85	313	19.34	100	26.1	6.4	66
06	134	6.2	0.30	42	20.66	100	26.2	6.5	66
X04	136	5.6	0.31	5	--	--	--	--	--
X05	140	5.6	0.26	21	--	--	--	--	--
REW	165	0.0	0.00	0	--	--	--	--	--
MEAN		9.2	0.70						
TOTAL	165			1,071	122.35	611			

(PAGE 140 FOLLOWS)

SITE: Mississippi River below Vicksburg, Mississippi 06-23-89
PARTY: Moody, Stevens, Rees, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 10 cm/s and nozzle was 1/8 inch.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	7	0.0	0.00	0	--	--	--	--	--
01A	38	9.2	0.60	193	0.58	4	25.6	6.8	298
02B	70	12.8	0.94	470	1.71	7	25.3	6.9	303
03A	116	19.7	1.34	688	4.43	11	25.3	7.1	303
X01	122	19.7	1.48	437	--	--	--	--	--
04B	146	20.4	1.60	883	5.51	26	25.4	7.0	318
05A	176	20.1	1.70	1,006	6.44	26	25.5	6.9	320
06B	205	19.6	1.62	1,114	5.67	28	25.7	7.3	329
07A	246	19.1	1.69	1,081	5.91	26	25.6	8.0	336
08B	272	19.0	1.76	938	6.10	28	25.2	8.1	342
09A	302	18.7	1.72	612	6.00	30	25.3	7.9	345
X02	310	18.6	1.85	585	--	--	--	--	--
10B	336	18.0	1.87	978	5.87	30	25.3	7.8	353
11A	368	17.8	1.81	1,014	4.89	27	25.4	7.8	352
12B	399	17.3	1.83	1,110	5.30	27	25.2	7.8	354
13A	438	16.9	1.79	1,166	4.93	27	25.3	7.7	364
14B	476	17.3	1.84	1,192	4.90	29	25.4	7.8	360
15A	513	15.6	1.90	905	4.97	27	25.3	7.9	360
16B	537	15.9	1.75	404	5.03	28	25.7	7.8	360
X07	542	15.6	1.85	173	--	--	--	--	--
17A	549	15.6	1.96	1,117	5.56	22	25.3	7.8	361
18B	615	15.2	1.86	1,243	4.19	26	25.3	7.8	360
19A	637	14.2	1.69	587	4.16	20	25.3	7.7	359
20B	664	13.7	1.56	576	3.49	19	25.3	7.8	360
21A	691	13.5	1.70	630	3.60	17	25.3	7.8	360
22B	719	13.5	1.55	636	3.38	17	25.3	7.7	362
23A	752	12.2	1.43	576	2.41	15	25.3	7.7	360
24B	785	11.7	1.35	555	2.56	13	25.4	7.7	361
25A	822	10.2	1.05	381	2.23	12	25.4	7.7	361
26B	856	9.7	1.51	512	2.12	12	25.3	7.7	360
27A	892	9.4	1.26	343	2.09	10	25.6	7.7	361
X05	914	9.1	1.12	158	--	--	--	--	--
28B	923	8.8	1.21	256	1.58	10	25.4	7.7	360
29A	962	8.4	1.13	346	1.50	9	25.5	7.7	360
30B	996	8.3	1.03	265	1.42	8	25.4	7.7	360
31A	1,024	8.4	0.91	241	1.15	8	25.4	7.7	362
32B	1,059	8.6	1.15	336	1.51	8	25.7	7.8	360
33A	1,092	9.0	1.00	252	1.35	8	25.4	7.8	362
34B	1,115	8.8	1.09	258	1.48	6	25.5	7.9	361
35A	1,146	8.9	1.07	320	1.40	5	25.6	7.8	361
36B	1,182	8.0	0.93	284	1.14	3	25.6	7.8	362
REW	1,222	0.0	0.00	0	--	--	--	--	--
MEAN		13.2	1.53						
TOTAL	1,222			24,821	126.56	629			

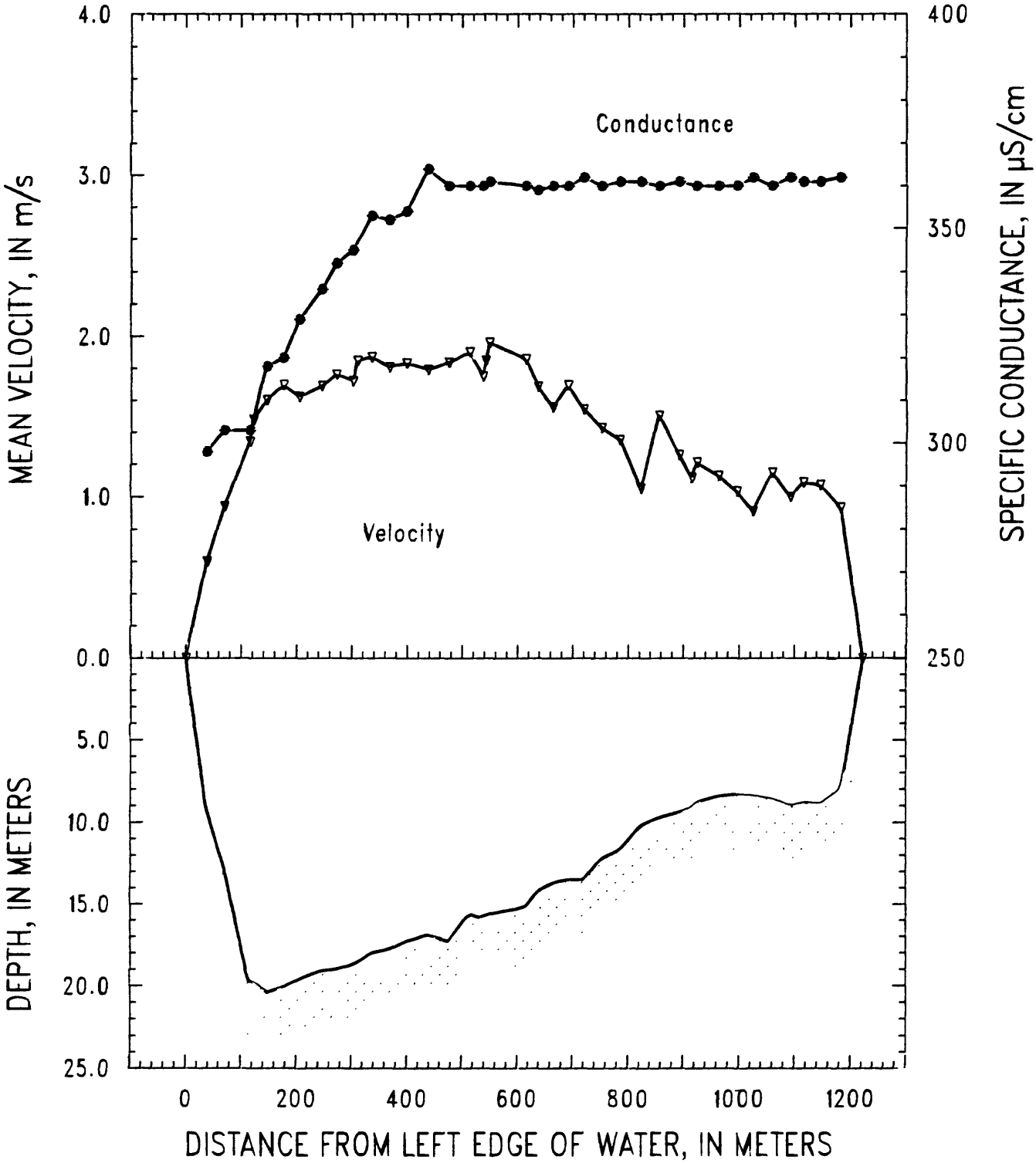

Figure 41. Mississippi River below Vicksburg, Mississippi, on June 23, 1989.

SITE: Old River Outflow Channel near Knox Landing, Louisiana 06-25-89
PARTY: Moody, Stevens, Rees, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 150-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 13 cm/s and nozzle was 1/4 inch.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	26	6.9	0.62	92	1.68	4	25.8	7.6	349
02B	43	11.4	0.87	143	3.78	13	25.8	7.6	349
X05	55	12.0	0.93	94	--	--	--	--	--
03A	60	12.1	0.94	130	4.05	21	25.9	7.7	348
04B	78	12.2	0.93	232	4.60	23	25.8	7.7	348
05A	101	12.3	0.92	176	3.65	23	25.8	7.7	348
06A	109	12.3	0.94	190	4.92	23	25.8	7.7	348
07A	134	12.2	0.99	247	4.39	21	25.8	7.7	348
08B	150	11.9	0.98	187	4.76	21	25.9	7.7	348
09A	166	11.8	0.94	166	3.89	21	25.9	7.7	348
10B	180	11.8	0.93	175	4.79	21	25.9	7.7	348
11A	198	11.6	0.91	191	3.83	19	25.8	7.7	348
12B	216	11.4	0.94	205	4.53	21	25.8	7.7	347
13A	236	11.1	0.92	133	3.68	19	25.7	7.7	348
14B	242	10.8	0.91	162	3.92	18	25.9	7.7	348
15A	269	10.2	0.91	162	3.83	16	25.9	7.7	348
X03	277	10.1	0.99	70	--	--	--	--	--
16B	283	9.8	0.94	133	3.74	16	25.9	7.7	349
17A	306	8.8	0.88	136	3.12	14	25.9	7.7	348
18B	318	9.1	0.98	156	3.67	15	25.9	7.7	347
19A	341	8.7	0.88	157	3.10	14	25.8	7.7	348
20B	359	8.6	0.95	147	3.14	15	25.9	7.7	347
21A	377	8.8	0.90	110	3.04	14	26.1	7.7	347
X02	387	8.6	0.90	93	--	--	--	--	--
22B	401	8.7	0.88	99	2.78	15	25.8	7.7	348
23A	413	8.8	0.90	138	3.01	16	26.0	7.7	347
24B	436	8.7	0.92	164	3.40	16	26.1	7.7	349
25A	454	8.9	0.93	132	2.98	16	26.1	7.7	348
26B	468	9.1	0.95	142	3.67	16	26.1	7.7	350
27A	487	9.1	0.89	147	2.58	15	26.2	7.7	348
28B	504	9.0	0.93	155	3.46	15	25.9	7.7	348
29A	524	8.9	0.82	135	2.55	13	25.9	7.7	349
30B	541	8.2	0.56	87	1.73	6	26.0	7.7	350
REW	562	0.0	0.00	0	--	--	--	--	--
MEAN		9.6	0.90						
TOTAL	562			4,886	106.27	501			

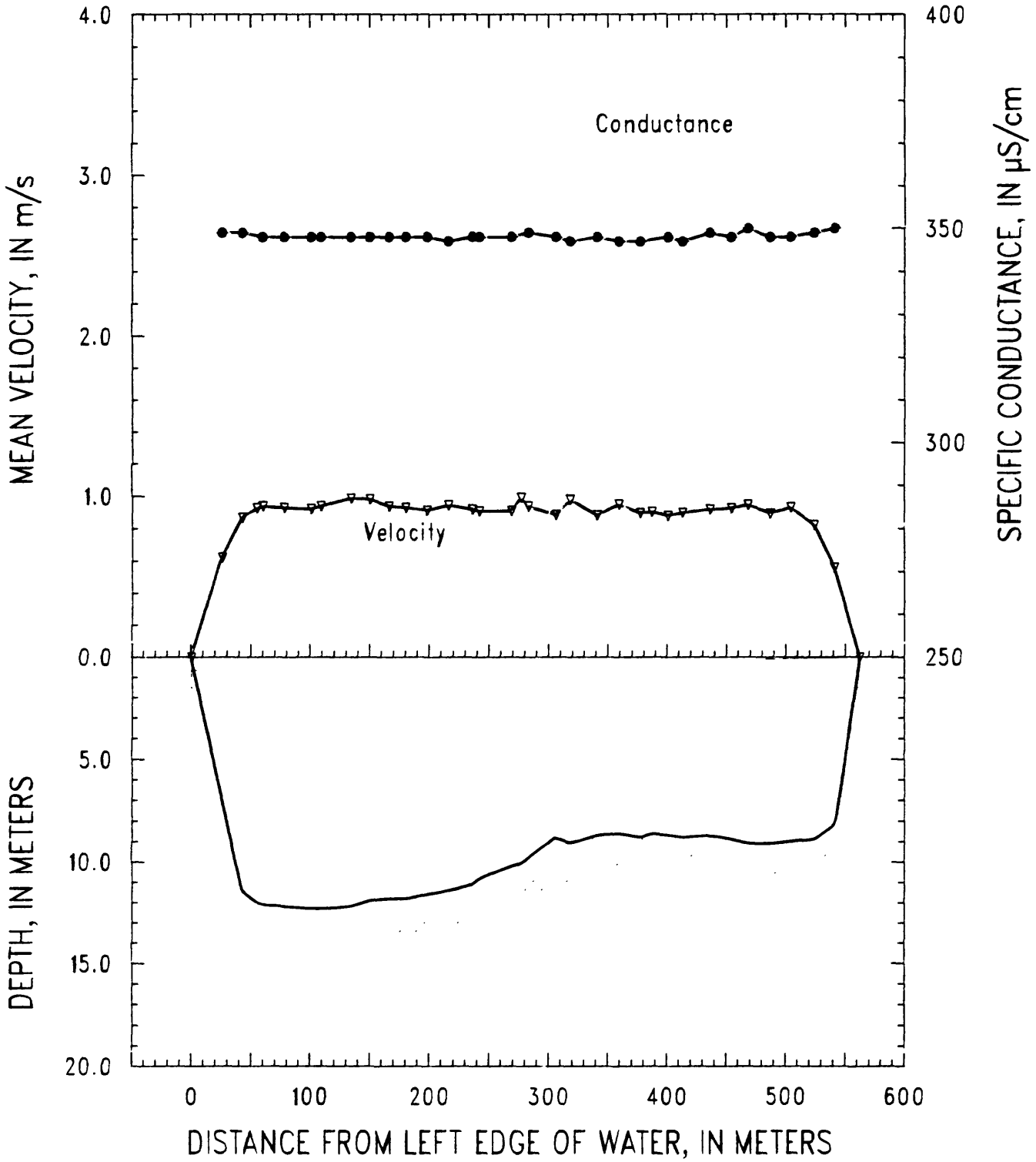

Figure 42. Old River Outflow Channel near Knox Landing, Louisiana, on June 25, 1989.

SITE: Mississippi River near St. Francisville, Louisiana 06-26-89
PARTY: Moody, Stevens, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 16 cm/s and nozzle was 3/16 inch. LEW was in the trees. Estimated depth at LEF (left edge of flow).

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEF	0	0.0	0.00	0	--	--	--	--	--
30B	31	8.1	0.57	149	0.84	2	26.0	7.7	337
29A	64	9.9	0.86	281	1.75	6	26.0	7.7	337
28B	97	10.8	0.92	369	1.73	10	25.8	7.7	337
27A	138	12.3	1.08	453	2.67	11	25.9	7.7	337
26B	165	13.2	0.97	412	2.38	14	26.0	7.7	337
25A	202	13.7	1.22	500	3.43	14	25.8	7.7	337
24B	225	13.3	1.16	534	3.26	14	25.8	7.7	337
23A	271	14.6	1.33	711	4.01	16	25.8	7.6	337
X05	298	14.6	1.35	306	--	--	--	--	--
22B	302	12.3	1.52	205	4.28	17	25.8	7.6	337
21A	320	14.1	1.33	592	3.43	15	25.7	7.6	341
20B	365	14.2	1.49	700	4.71	15	25.9	7.8	338
19A	386	14.6	1.25	537	4.27	14	25.7	7.8	337
18B	424	14.1	1.45	642	3.56	19	26.0	7.7	338
17A	449	14.0	1.48	661	4.36	16	26.1	7.6	338
16B	488	13.2	1.34	522	4.22	17	26.2	7.6	338
X04	508	13.7	1.38	322	--	--	--	--	--
15A	522	13.7	1.34	412	4.21	17	26.1	7.6	339
14B	553	14.2	1.48	524	4.39	17	26.0	7.6	339
13A	572	14.6	1.35	413	4.53	18	25.9	7.6	340
X13	595	15.0	1.32	475	--	--	--	--	--
12B	620	15.7	1.24	534	4.34	19	26.0	7.6	340
11A	650	16.2	1.36	792	5.12	19	25.9	7.6	340
10B	692	17.7	1.36	709	5.28	22	26.0	7.6	340
X03	709	18.4	1.39	306	--	--	--	--	--
09A	716	18.5	1.30	336	6.33	24	26.0	7.6	340
08B	737	18.6	1.43	839	5.70	22	25.9	7.6	340
07A	779	18.1	1.40	902	5.57	26	25.9	7.6	340
X02	808	18.5	1.48	548	--	--	--	--	--
06B	819	20.1	1.43	676	6.37	27	25.8	7.6	340
05A	855	19.2	1.45	889	6.03	26	25.9	7.6	339
04B	883	18.0	1.42	766	5.39	23	25.9	7.6	340
03A	915	17.3	1.45	626	5.46	21	25.9	7.6	340
X01	933	17.7	1.42	426	--	--	--	--	--
02B	949	17.4	1.45	669	5.39	18	25.9	7.7	340
01A	986	9.3	0.93	306	1.60	6	26.1	7.8	341
REW	1,020	0.0	0.00	0	--	--	--	--	--
MEAN		14.3	1.31						
Total	1,020			19,044	128.61	505			

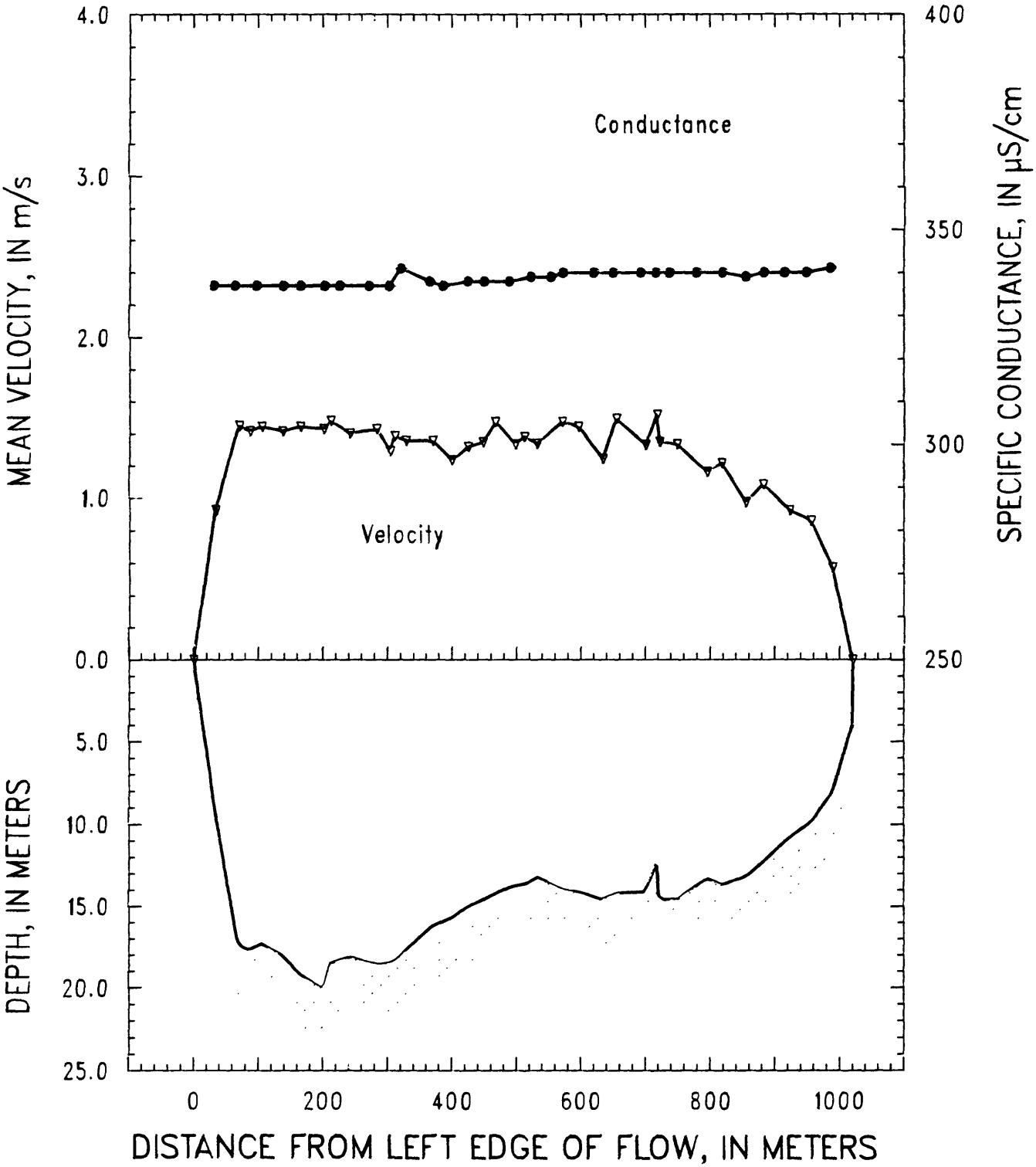

Figure 43. Mississippi River near St. Francisville, Louisiana, on June 26, 1989.

SITE: Mississippi River below Belle Chasse, Louisiana 06-28-89
PARTY: Moody, Stevens, and Black METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight
CURRENT METER NO.: P8308282 DATE RATED: 07-08-88
CURRENT METER EQUATION: V(m/s) = RPS * 0.765 + 0.006

REMARKS: Transit rate was 10 cm/s and nozzle was 1/8 inch.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	63	11.3	0.83	388	1.39	10	26.2	7.9	362
X01	83	14.9	0.89	384	--	--	--	--	--
02B	121	18.5	1.12	770	3.31	27	26.2	7.9	364
03A	157	19.2	1.21	1,042	4.17	33	26.2	7.9	362
04B	211	20.9	1.24	1,157	4.23	37	26.2	7.9	364
X02	246	22.1	1.24	812	--	--	--	--	--
05A	270	23.0	1.37	1,075	4.90	43	26.3	7.9	361
06B	314	24.6	1.35	1,857	5.11	47	26.2	7.9	363
07A	382	25.7	1.43	1,873	5.99	48	26.2	7.9	362
X03	416	26.3	1.34	1,237	--	--	--	--	--
08B	452	26.7	1.33	1,435	5.63	40	26.1	7.9	363
09A	497	28.3	1.20	1,691	5.84	48	26.1	7.8	363
X04	552	28.5	1.15	1,095	--	--	--	--	--
10B	564	29.8	1.12	681	6.02	49	26.1	7.8	363
11A	593	29.7	0.98	1,467	4.42	45	26.0	7.8	364
12B	665	29.7	0.83	1,270	3.66	39	26.1	7.8	365
13A	696	28.9	0.85	786	3.24	35	26.2	7.9	366
X05	729	24.5	0.79	501	--	--	--	--	--
14B	748	16.0	0.80	535	1.55	7	26.8	7.8	368
REW	813	0.0	0.00	0	--	--	--	--	--
MEAN		21.8	1.13						
TOTAL	813			20,056	59.26	508			

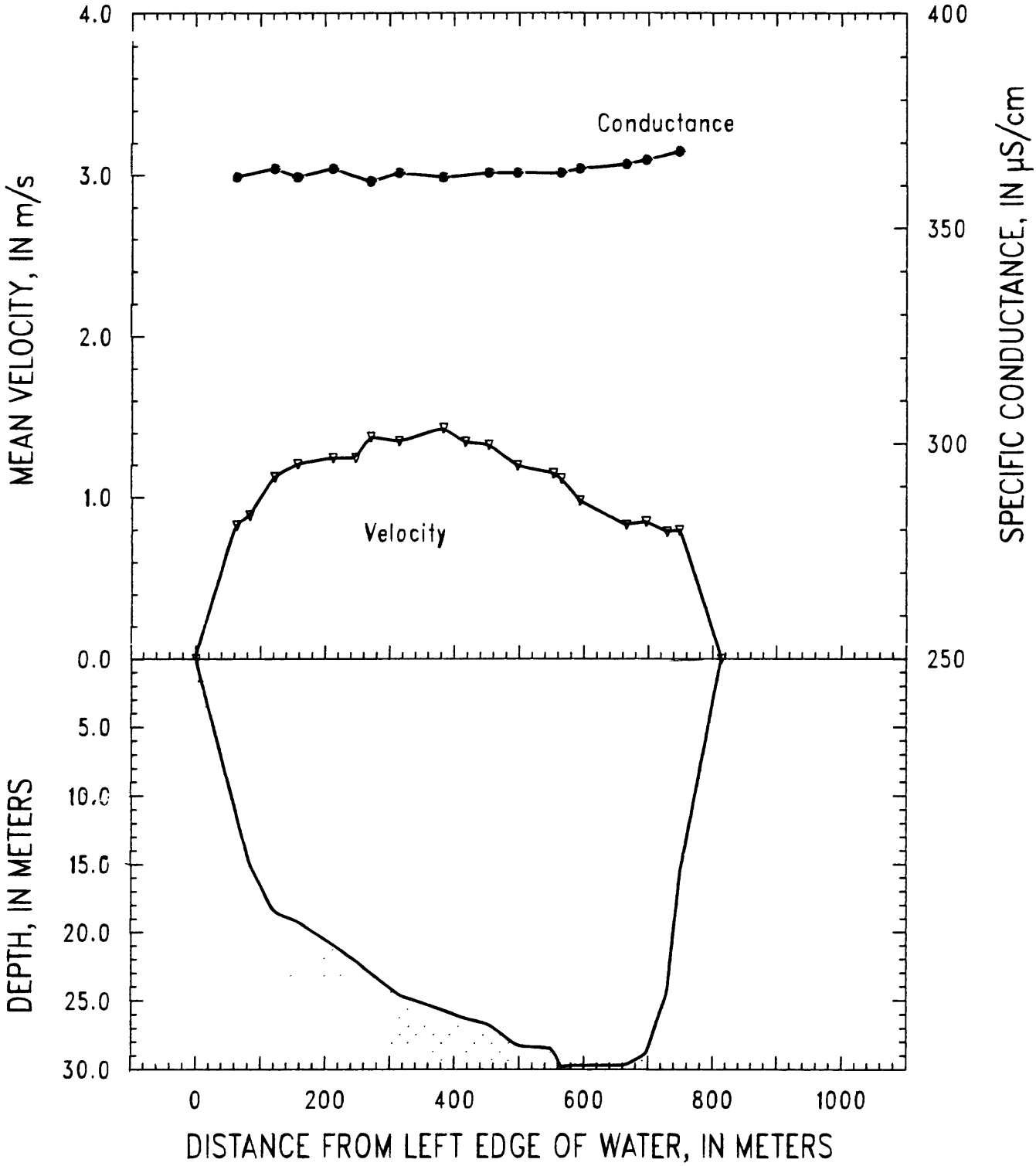

Figure 44. Mississippi River below Belle Chasse, Louisiana, on June 28, 1989.

(PAGE 149 FOLLOWS)

DATA LISTINGS
FOR
FEBRUARY-MARCH 1990 CRUISE

SITE: Mississippi River near Cache, Illinois 02-25-90
PARTY: Moody, Meade, Tagg, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 150-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Transit rate was 5.0 cm/s, and 1/4-inch nozzle was used, no screen. Section is in last bend upstream from the confluence of the Upper Mississippi and Ohio Rivers. Water seems to be standing in fields beyond small levees on both sides of river.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	13.0	0.00	0	--	--	--	--	--
X01	117	15.1	0.62	1,060	6.23	156	5.3	8.1	--
X04	227	14.2	0.62	1,022	5.11	142	4.7	8.2	--
X05	350	11.5	0.60	823	4.73	106	4.7	8.2	504
X06	467	10.0	0.59	716	3.59	86	5.0	8.0	504
X07	594	11.4	0.47	617	1.80	108	5.2	8.1	502
REW	696	8.0	0.00	0	--	--	--	--	--
MEAN		10.4	0.58						
TOTAL	696			4,238	21.46	598			

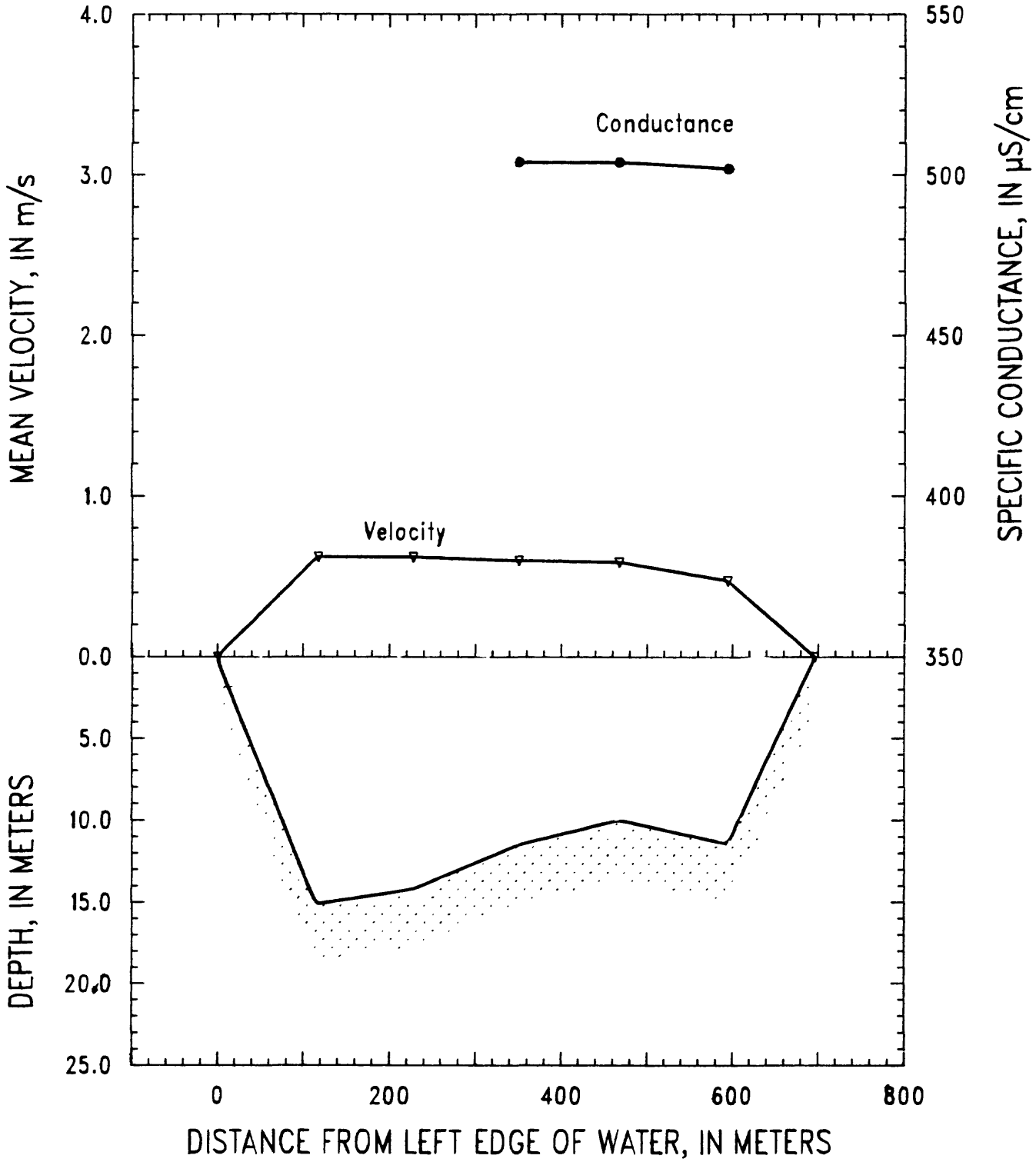

Figure 45. Mississippi River near Cache, Illinois, on February 25, 1990

SITE: Ohio River at Uniontown, Kentucky 03-01-90
PARTY: Moody, Tagg, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Transit rate was 9 cm/s, and 1/4-inch nozzle was used. Leaves very troublesome in middle of section. Verticals occupied from 30 to 2. National Weather Service forecasted discharge for Uniontown was 6,660 m^3/s.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
02A	59	4.2	0.40	67	0.81	3	--	7.3	273
03B	79	4.9	0.41	36	0.69	3	--	7.4	275
04A	95	5.7	0.42	43	0.80	5	--	7.4	275
05B	115	6.8	0.45	82	1.19	8	--	7.5	277
06A	148	8.6	0.61	171	1.41	13	5.1	7.4	278
07B	180	8.9	0.77	164	3.43	13	5.2	7.5	278
08A	196	9.0	0.71	128	2.76	14	5.3	7.4	279
09B	220	9.3	0.83	143	3.60	16	5.4	7.4	279
X04	233	9.7	0.80	94	--	--	--	--	--
10A	244	9.7	0.90	175	3.64	17	5.5	7.4	279
11B	273	9.8	0.87	255	3.70	17	5.7	7.4	280
12A	304	10.5	0.95	255	2.69	17	5.8	7.2	282
13B	324	10.8	0.99	145	3.72	19	6.0	7.3	280
X12	331	10.9	0.92	121	--	--	--	--	--
14A	348	11.2	0.95	208	3.51	19	6.1	7.3	282
15B	370	11.7	1.06	223	5.16	21	6.1	7.3	284
X03	384	11.8	0.96	148	--	--	--	--	--
16A	396	11.9	0.97	231	3.34	22	6.1	7.3	284
17B	424	12.2	0.99	291	5.51	22	6.1	7.2	286
18A	444	12.5	1.05	281	5.28	22	6.1	7.2	287
19B	467	12.8	1.02	352	5.29	24	6.1	7.2	287
20A	498	12.7	0.96	263	5.48	23	6.3	7.3	289
21B	510	12.8	1.01	285	5.93	23	6.1	7.2	288
22A	542	12.5	0.98	354	4.74	23	6.1	7.2	290
23B	568	12.3	0.93	268	5.27	22	6.2	7.2	290
24A	589	12.0	0.96	258	5.19	22	6.2	7.3	291
25B	613	12.0	0.98	278	5.86	22	6.1	7.0	296
26A	636	12.4	0.94	290	5.18	23	5.9	7.2	294
27B	663	12.6	0.94	289	6.20	22	5.9	7.2	295
28A	685	12.4	0.89	259	5.00	21	6.0	7.2	298
29B	710	12.3	0.86	243	5.24	17	6.3	7.2	296
30A	731	10.9	0.80	221	3.69	10	6.1	7.3	295
REW	761	0.0	0.00	0	--	--	--	--	--
MEAN		9.8	0.88						
TOTAL	761			6,621	114.31	503			

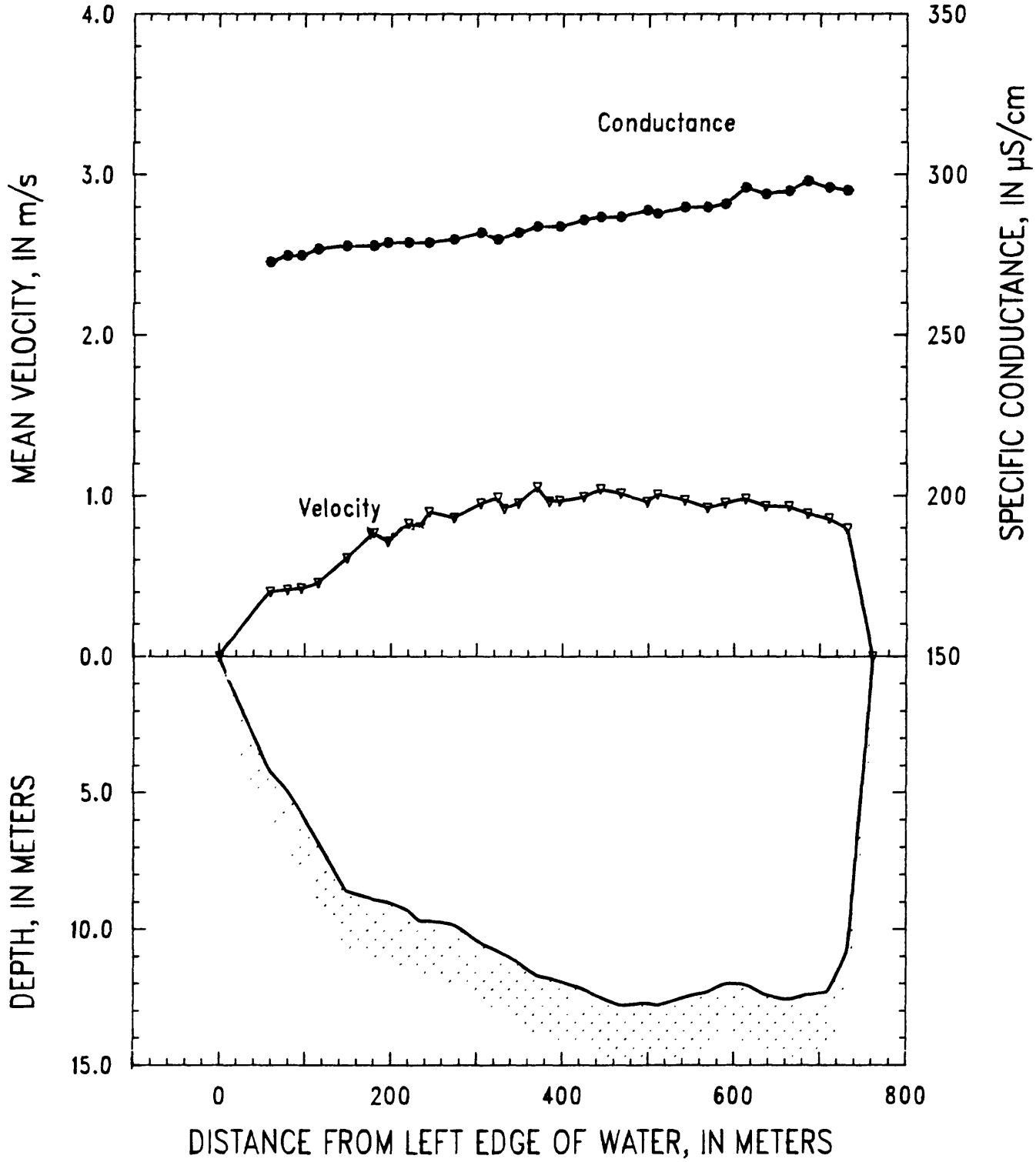

Figure 46. Ohio River at Uniontown, Kentucky, on March 1, 1990.

SITE: Wabash River near New Haven, Illinois 02-28-90
PARTY: Moody, Tagg, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 150-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Transit rate was 7 cm/s, 1/4-inch nozzle was used. REW and LEW were probably >200 m from REF and LEF. There was flow across the flood plain (perhaps 0.5 m deep) which was not measured. National Weather Service forecast model for the Wabash River at New Harmony was 2,660 m^3/s.

Vertical	Dist. from LEF (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEF	0	0.5	0.00	0	--	--	--	--	--
01A,B	33	7.8	1.16	262	8.38	27	2.9	7.8	405
02A,B	58	7.7	1.08	133	9.45	44	3.1	7.9	403
X01	65	7.8	1.08	51	--	--	--	--	--
X02	70	7.8	1.05	49	--	--	--	--	--
03A,B	77	7.8	1.07	125	9.43	41	3.9	7.5	404
04B	100	7.9	1.03	118	5.57	--	--	--	--
04A	106	8.0	1.02	106	5.57	43	3.3	7.8	402
05A	126	8.3	1.01	105	4.99	42	3.5	7.7	403
05B	131	8.2	1.07	127	6.04	--	--	--	--
06B	155	7.9	1.10	122	6.00	--	--	--	--
06A	159	7.7	1.06	77	4.63	42	3.4	7.7	403
07A	174	7.2	1.09	74	4.82	45	3.5	7.7	402
07B	178	7.2	1.08	93	5.06	--	--	--	--
08A,B	198	6.5	1.07	150	8.88	43	3.0	7.7	404
09A,B	221	5.6	1.15	119	7.77	33	3.1	7.8	401
X05	235	5.5	1.14	72	--	--	--	--	--
10A,B	244	5.3	1.16	98	7.47	33	3.2	7.7	401
11A,B	267	5.0	1.05	120	6.67	31	3.1	7.9	402
12A,B	290	4.8	1.09	95	6.37	30	3.4	7.8	403
13A	303	4.7	1.13	72	3.37	26	3.5	7.7	398
13B	317	4.6	1.16	96	3.70	--	--	--	--
14A,B	339	4.6	0.87	76	4.82	17	3.6	7.7	399
REF	355	0.5	0.00	0	--	--	--	--	--
MEAN		6.1	1.08						
TOTAL	355			2,340	118.99	497			

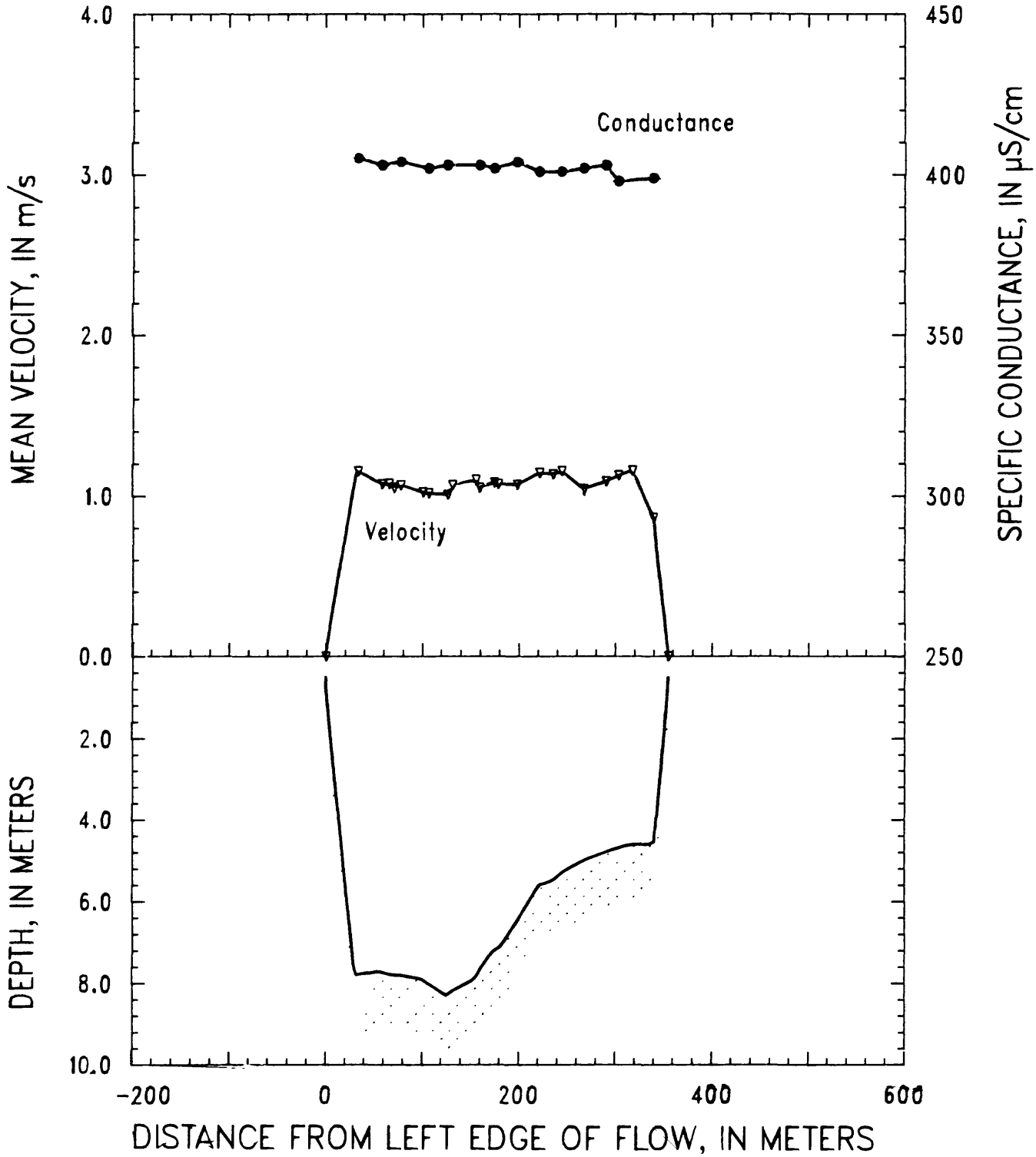

Figure 47. Wabash River near New Haven, Illinois, on February 28, 1990.

SITE: Cumberland River near Smithland, Kentucky 02-23-90
PARTY: Moody, Tagg, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Transit rate was 9 cm/s, and 3/16-inch nozzle was used. LEW=-40 m, REW=216 m, and unmeasured overbank=(40+41)=81 m. Barkley Dam's discharge was reported as 2,270 m^3/s.

Vertical	Dist. from LEF (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEF	0	9.0	0.00	0	--	--	--	--	--
01B	4	9.7	0.49	19	1.12	--	--	--	--
01A	8	10.8	0.56	46	1.37	27	10.3	7.6	216
2A,B	19	13.7	0.55	49	3.65	50	10.4	7.7	221
X04	21	14.0	0.52	51	--	--	--	--	--
03B	33	15.3	0.65	124	3.49	--	--	--	--
03A	46	15.3	0.74	107	3.47	50	10.7	7.7	216
04A	52	15.3	0.82	63	4.36	48	10.3	7.5	215
04B	56	15.4	0.82	126	3.56	--	10.3	7.5	215
05B	72	15.7	0.90	234	4.70	--	--	--	--
05A	78	15.8	--	--	4.04	55	10.2	7.6	214
06A	89	16.4	0.98	184	5.46	60	10.3	7.7	216
06B	95	16.7	0.97	113	5.17	--	--	--	--
X02	103	17.2	0.96	124	--	--	--	--	--
07A	110	17.5	0.93	89	5.17	66	10.4	7.5	216
07B	114	17.8	0.94	142	5.87	--	--	--	--
08B	127	17.5	0.95	133	5.62	--	--	--	--
08A	130	17.2	0.97	134	5.68	59	10.4	7.5	214
X03	143	16.6	0.92	161	--	--	--	--	--
09A	151	16.3	0.87	71	3.73	49	10.2	7.6	214
09B	153	15.9	0.73	116	3.97	--	--	--	--
X08	171	13.7	0.51	73	--	--	--	--	--
10A,B	174	13.0	0.50	13	3.82	35	10.4	7.5	213
REF	175	10.0	0.00	0	--	--	--	--	--
MEAN		15.3	0.81						
TOTAL	175			2,172	74.25	499			

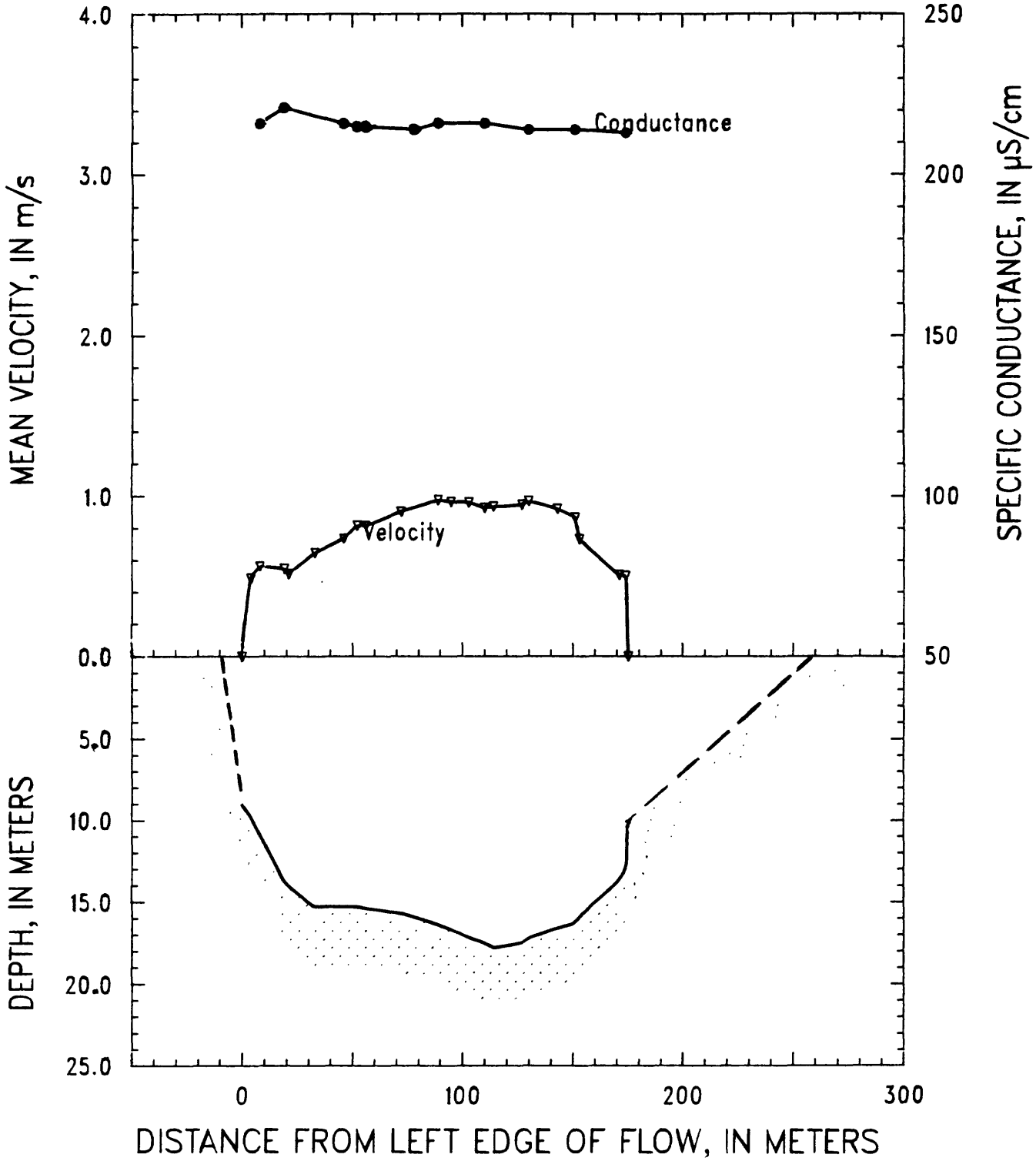

Figure 48. Cumberland River near Smithland, Kentucky, on February 23, 1990.

SITE: Tennessee River near Calvert City, Kentucky 02-24-90
PARTY: Moody, Tagg, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Transit rate was 15 cm/s, and 3/16-inch nozzle was used. Cold, cold and windy day, gusts 30-40 mph from northwest. E-reel damaged. REW=382 m; LEW was at least -312 m; overbank discharge was not measured. Discharge at Kentucky Dam was reported as 6,990 m^3/s.

Vertical	Dist. from LEF (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEF	0	10.0	0.00	0	--	--	--	--	--
01B	8	10.7	0.76	65	2.16	--	--	--	--
01A	14	13.2	0.93	153	2.65	17	10.4	7.4	137
02A,B	33	15.4	1.19	448	8.05	35	10.6	7.2	136
03A,B	33	16.6	1.29	449	8.93	42	10.4	7.3	137
04A	75	17.1	1.34	286	5.37	44	10.5	7.2	135
04B	90	17.8	1.40	460	5.03	--	--	--	--
05A,B	112	19.4	1.29	512	11.63	48	10.6	7.4	136
06A	131	20.6	1.26	352	5.48	50	10.6	7.4	138
06B	139	20.5	1.33	341	5.67	--	--	--	--
07B	156	21.4	1.25	320	5.57	--	--	--	--
07A	163	21.6	1.22	381	6.61	53	10.6	7.3	137
08A,B	185	21.8	1.30	565	12.08	54	10.8	7.3	137
09A,B	203	21.3	1.28	423	11.97	51	10.8	7.4	138
10A	216	20.5	1.28	368	5.64	40	10.7	7.3	138
10B	231	19.2	1.22	375	5.06	--	--	--	--
11A	240	18.5	1.15	223	3.87	18	10.6	7.3	140
11B	252	18.2	1.11	223	4.31	--	--	--	--
12B	270	13.8	0.93	154	2.47	--	--	--	--
12A	276	13.8	0.86	207	2.43	34	10.7	7.3	138
13A,B	305	9.9	0.76	189	2.50	9	10.7	7.3	138
14A,B	326	6.5	0.69	78	1.45	5	10.7	7.3	138
REF	340	5.0	0.00	0	--	--	--	--	--
MEAN		16.3	1.18						
TOTAL	340			6,572	117.94	500			

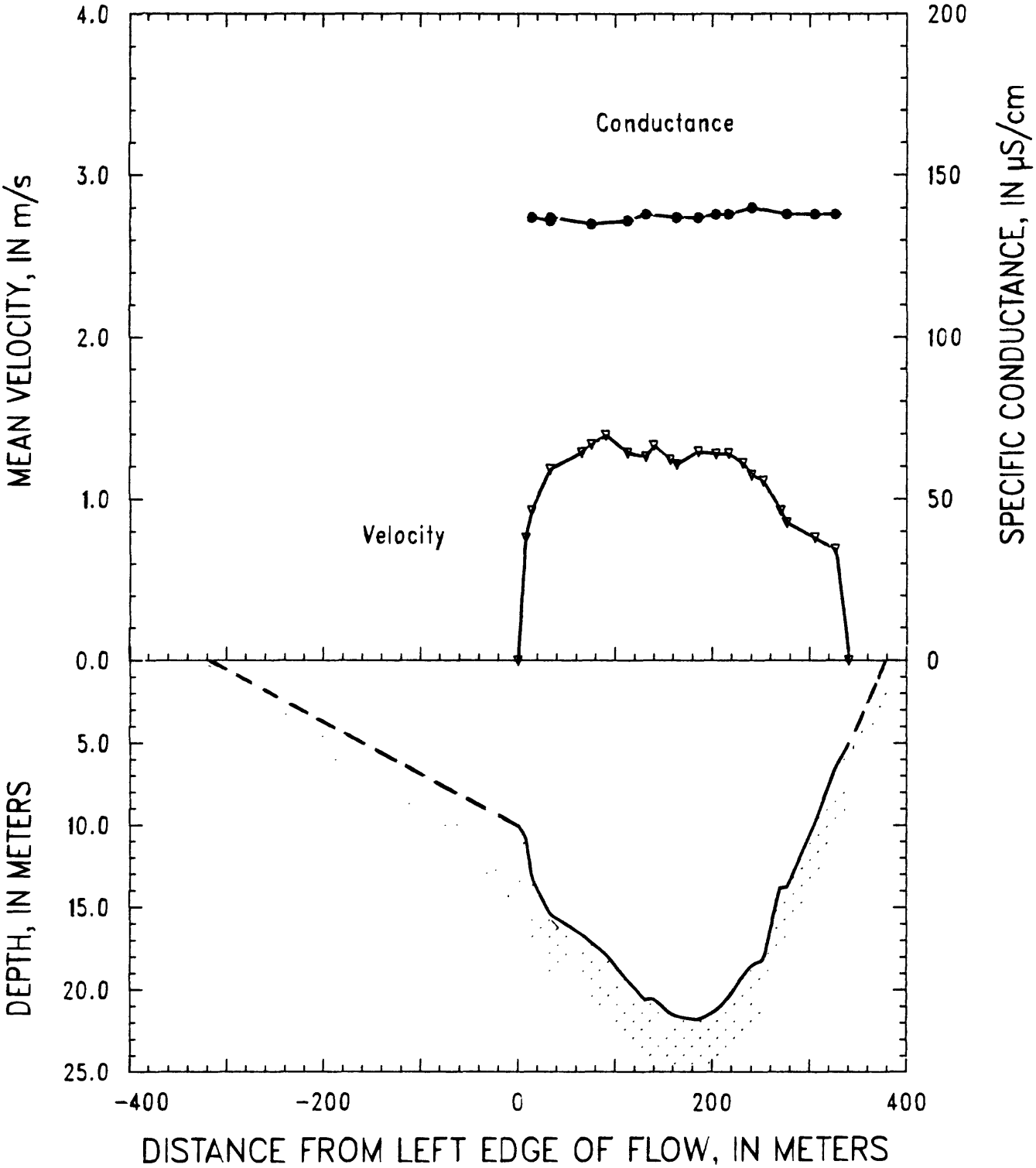

Figure 49. Tennessee River near Calvert City, Kentucky, on February 24, 1990.

SITE: Ohio River at Olmsted, Illinois 03-03-90
PARTY: Moody, Tagg, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: 41.4 ft ENDING GAGE HEIGHT: 40.2 ft
SUSP: Bag sampler and 200-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Transit rate was 12 cm/s, and 3/16-inch nozzle was used. Verticals occupied from 15 to 1. National Weather Service forecast for Joppa was 15,750 m^3/s. Five drift cards marking Uniontown water passed by between 1235-1431.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01B	71	8.6	0.75	246	1.11	--	--	--	--
01A	76	8.7	0.83	133	1.49	20	10.9	7.6	149
X05	108	9.8	0.93	279	--	--	--	--	--
02A,B	137	9.9	1.03	495	4.35	20	9.3	7.6	153
X07	205	10.2	1.06	400	--	--	--	--	--
03A,B	211	10.4	1.02	366	5.67	22	9.7	7.6	164
04A,B	274	11.5	1.10	830	5.37	27	9.7	7.6	173
05A	342	12.9	1.12	530	3.67	37	10.2	7.6	190
05B	347	12.7	1.09	421	2.79	--	--	--	--
06A	403	13.5	1.05	475	3.87	35	7.5	7.7	203
06B	414	13.7	1.21	623	3.40	--	--	--	--
07B	478	15.2	1.15	657	4.83	--	--	--	--
07A	489	15.5	1.27	570	5.25	43	9.0	7.7	235
08A,B	536	15.5	1.27	1,123	9.51	40	7.4	7.7	248
09B	603	15.0	1.22	724	4.95	--	--	--	--
09A	615	14.9	1.20	660	5.31	40	7.6	7.7	270
10A,B	677	14.2	1.31	1,180	9.51	37	7.0	7.7	291
11A,B	742	15.3	1.35	805	10.49	47	8.0	7.6	319
X02	755	15.6	1.35	642	--	--	--	--	--
12B	803	14.4	1.35	552	5.20	--	--	--	--
12A	812	14.4	1.38	417	5.29	39	7.4	7.6	328
X09	845	15.1	1.32	597	--	--	--	--	--
13A,B	872	14.6	1.35	954	10.18	41	6.7	7.6	329
14B	942	16.0	1.46	934	5.88	--	--	--	--
14A	952	16.4	1.25	298	5.31	45	6.0	7.7	333
X01	971	17.0	1.34	663	--	--	--	--	--
15A,B	1,010	11.8	0.92	267	6.42	17	6.4	7.7	330
X06	1,020	9.2	0.79	255	--	--	--	--	--
REW	1,080	0.0	0.00	0	--	--	--	--	--
MEAN		12.5	1.20						
TOTAL	1,080			16,096	119.80	510			

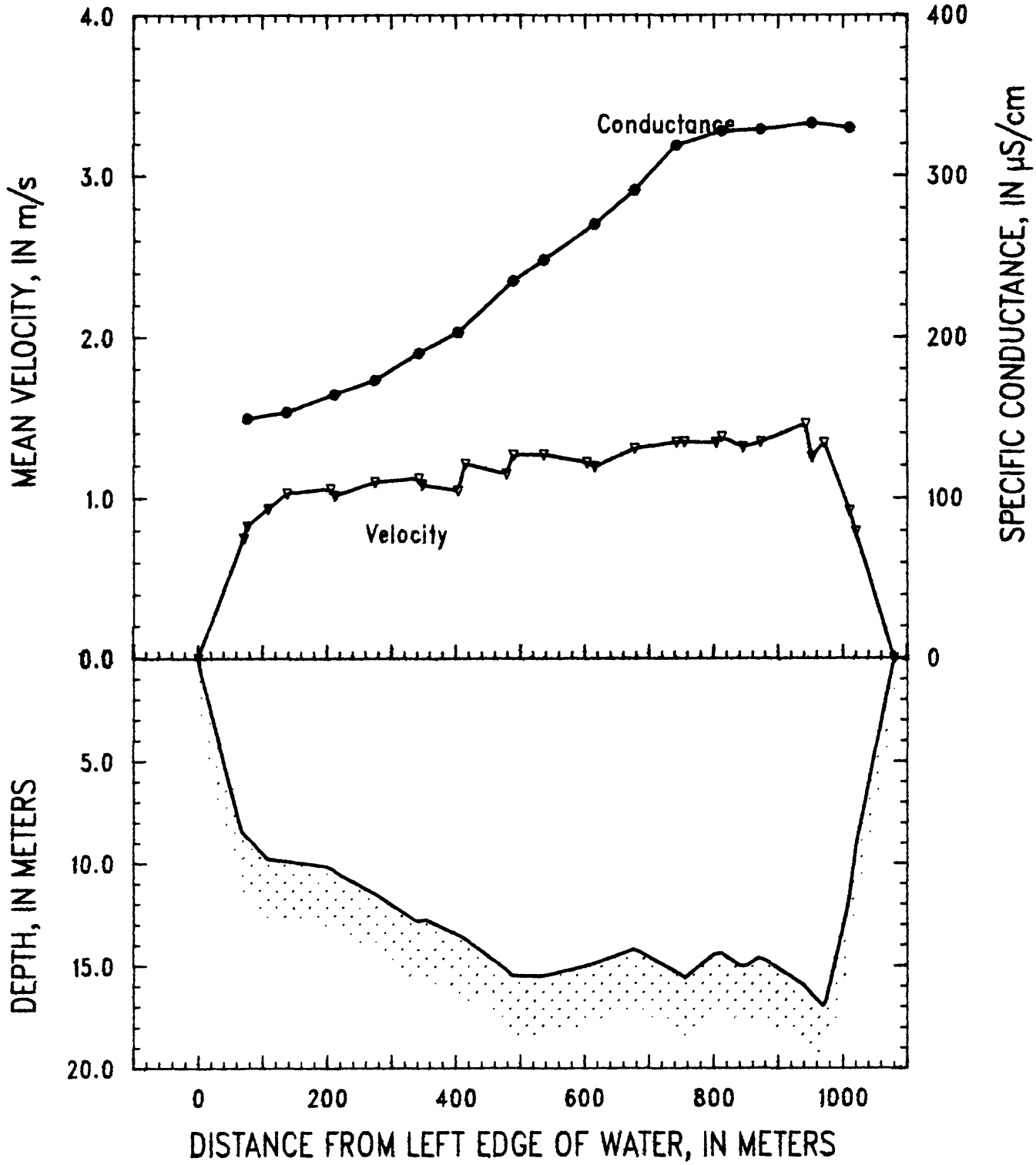

Figure 50. Ohio River at Olmsted, Illinois, on March 3, 1990.

SITE: Mississippi River below Hickman, Kentucky 03-04-90
PARTY: Moody, Tagg, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: 32.22 ft On wire-line gage at Hickman.
SUSP: Bag sampler and 200-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Transit rate was 14 cm/s, and 3/16-inch nozzle was used. Reported stage for 03-03-90 (marine radio station WJG) was 30.8 ft.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A,B	78	12.2	1.46	1,352	8.65	28	7.4	7.6	217
02A	152	12.6	1.63	833	4.49	31	7.3	7.8	222
02B	159	12.1	1.75	488	5.09	--	--	--	--
X05	298	11.6	1.49	527	--	--	--	--	--
03A	220	11.9	1.62	414	4.13	31	7.4	7.8	228
03B	241	11.4	1.52	459	3.68	--	--	--	--
04A	273	10.9	1.62	433	3.79	50	7.3	7.8	232
04B	290	11.2	1.40	626	3.77	--	--	--	--
X04	353	11.5	1.69	680	--	--	--	--	--
05A,B	360	11.3	1.63	738	8.55	31	7.1	7.8	240
06A	433	11.0	1.54	670	4.31	31	6.7	7.9	251
06B	439	11.1	1.56	562	4.23	--	--	--	--
07A	498	10.9	1.53	542	4.25	30	6.3	7.9	274
07B	504	10.9	1.49	682	3.49	--	--	--	--
08A,B	582	11.1	1.53	1,338	7.88	28	5.9	7.9	302
09A,B	662	12.3	1.63	1,508	8.50	33	5.8	7.9	326
10A,B	732	13.4	1.71	1,386	10.50	43	5.6	8.0	347
X02	783	15.3	1.73	928	--	--	--	--	--
11A,B	802	14.9	1.63	1,031	11.42	39	5.6	8.0	368
12A	868	14.6	1.61	845	5.19	42	5.6	8.0	390
12B	814	14.8	1.53	829	5.10	--	--	--	--
13A,B	941	16.1	1.39	1,376	9.68	40	5.2	8.0	404
X01	997	16.8	1.33	749	--	--	--	--	--
14B	1,008	16.8	1.24	261	4.45	--	--	--	--
14A	1,022	16.3	1.19	552	4.30	39	5.5	8.0	415
15A	1,065	14.8	1.23	521	3.25	24	5.5	8.0	419
15B	1,079	13.2	1.13	657	3.36	--	--	--	--
REW	1,153	0.0	0.00	0	--	--	--	--	--
MEAN		12.0	1.51						
TOTAL	1,153			20,987	132.06	520			

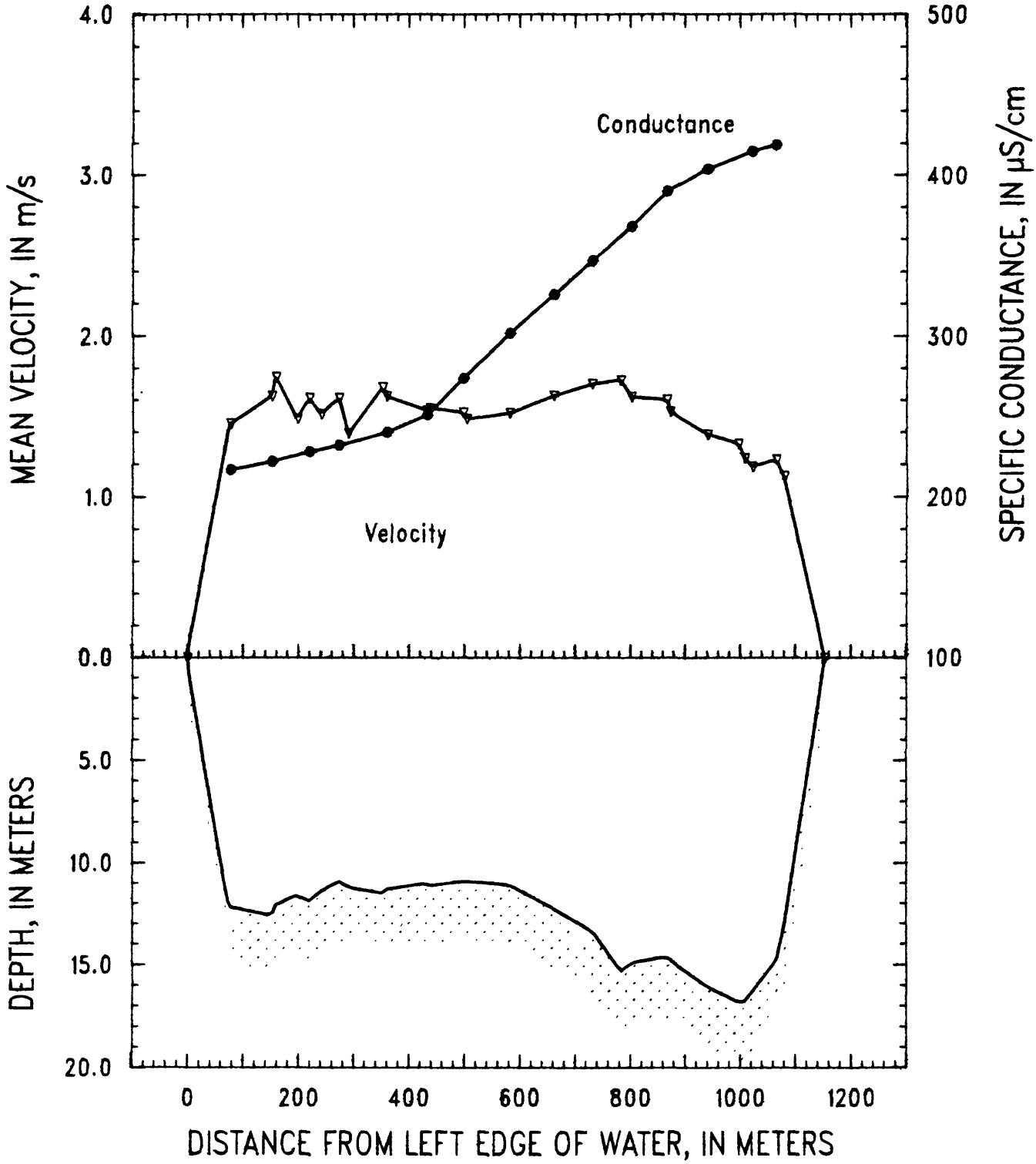

Figure 51. Mississippi River below Hickman, Kentucky, on March 4, 1990.

SITE: Mississippi River below Fulton, Tennessee 03-05-90
PARTY: Moody, Garbarino, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 200-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Transit rate was 15.5 cm/s, and 3/16-inch nozzle was used.
Verticals occupied from 15 to 1.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01B	81	11.5	0.89	474	2.07	--	--	--	--
01A	93	12.5	0.96	228	2.16	19	7.5	7.7	280
X06	119	12.5	1.05	413	--	--	--	--	--
02B	156	12.5	1.06	310	2.91	--	--	--	--
02A	166	12.5	1.11	533	2.67	25	7.8	7.7	280
X08	233	12.7	1.19	560	--	--	--	--	--
03A,B	240	12.6	1.19	584	6.33	26	7.7	7.8	283
04A	311	12.0	1.33	622	3.30	25	7.9	7.8	285
04B	318	12.0	1.37	511	3.24	--	--	--	--
X05	373	12.0	1.21	514	--	--	--	--	--
05B	389	11.7	1.22	208	2.91	--	--	--	--
05A	402	11.8	1.33	618	2.94	26	7.9	7.8	290
06A,B	468	11.4	1.46	1,174	7.40	28	7.9	7.8	290
07A,B	543	12.1	1.54	1,469	7.94	33	7.7	7.9	290
08A,B	626	12.5	1.64	789	9.34	40	7.5	7.8	291
X04	620	12.3	1.78	820	--	--	--	--	--
09A	701	12.7	1.77	980	4.56	38	7.2	7.8	291
09B	707	12.7	1.72	883	4.72	--	--	--	--
10B	782	12.2	1.93	954	5.37	--	--	--	--
10A	788	12.5	1.97	777	5.28	39	7.5	7.8	292
11B	845	12.3	1.92	781	5.16	--	--	--	--
11A	854	12.4	1.82	394	5.28	39	7.3	7.8	293
X03	880	12.5	1.74	969	--	--	--	--	--
12A	943	13.1	1.82	837	5.29	41	7.6	7.8	295
12B	950	13.1	1.80	861	4.85	--	--	--	--
13B	1,016	14.3	1.50	836	4.63	--	--	--	--
13A	1,028	14.3	1.64	482	4.56	47	8.5	7.8	296
X02	1,057	15.3	1.72	1,025	--	--	--	--	--
14A,B	1,106	16.8	1.67	1,066	11.99	48	9.1	7.9	295
X01	1,133	18.0	1.47	963	--	--	--	--	--
15A	1,179	16.7	1.35	552	4.00	27	7.7	8.0	298
15B	1,182	14.5	1.06	622	3.41	--	--	--	--
REW	1,260	0.0	0.00	0	--	--	--	--	--
MEAN		12.2	1.49						
TOTAL	1,260			22,809	122.31	501			

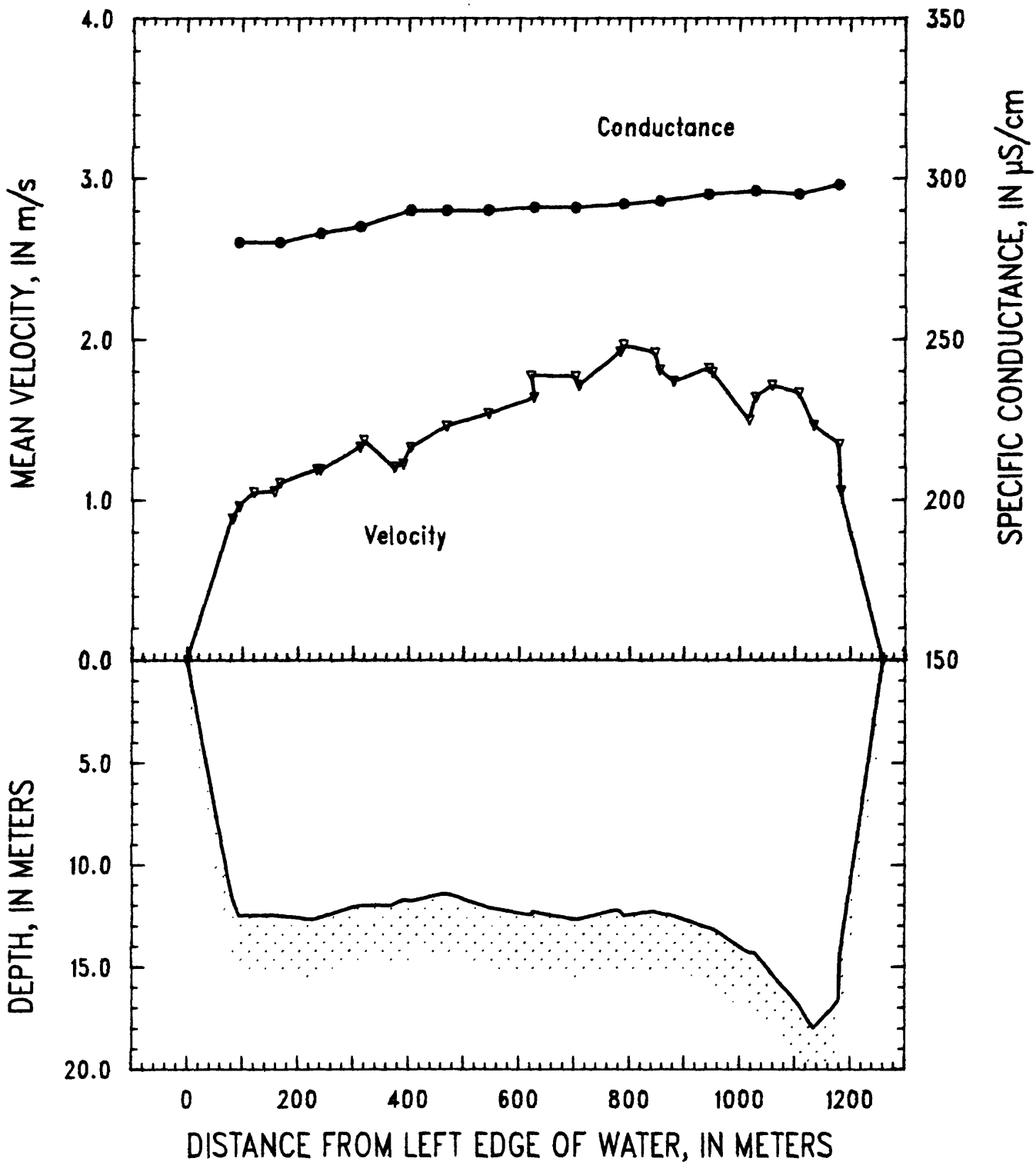

Figure 52. Mississippi River below Fulton, Tennessee, on March 5, 1990.

SITE: Mississippi River at Helena, Arkansas 03-07-90
PARTY: Moody, Garbarino, and Rabalais METER: SOLID CUP
STARTING GAGE HEIGHT: 32.75 ft ENDING GAGE HEIGHT: 31.55 ft
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Transit rate was 22 cm/s, and 3/16-inch nozzle was used.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	43	10.9	0.82	223	1.42	23	7.7	7.8	292
01B	50	12.1	1.18	236	1.95	--	--	--	--
02B	76	13.2	1.48	283	3.01	--	--	--	--
X06	79	13.2	1.60	328	--	--	--	--	--
02A	107	13.6	1.56	701	2.79	26	7.7	7.9	295
03B	145	14.5	1.88	969	4.85	--	--	--	--
03A	178	14.8	1.93	1,001	5.01	32	7.7	7.9	295
04A,B	215	16.3	1.99	890	10.00	35	7.5	7.9	301
X05	233	17.2	1.92	645	--	--	--	--	--
05A	254	17.1	2.12	599	5.55	40	7.4	7.9	296
05B	268	18.1	2.11	1,432	5.20	--	--	--	--
06B	329	18.3	2.06	1,509	5.25	--	--	--	--
06A	346	19.1	2.22	891	6.31	41	7.4	7.9	295
07A	371	18.9	1.98	712	5.17	37	7.1	7.9	294
07B	384	20.1	1.91	364	4.05	--	--	--	--
X07	390	20.8	1.89	295	--	--	--	--	--
X08	399	19.9	1.94	308	--	--	--	--	--
08B	406	21.6	1.94	419	5.15	--	--	--	--
08A	419	21.6	1.79	752	5.82	46	7.1	7.9	294
X09	445	23.5	1.88	949	--	--	--	--	--
09B	462	22.1	1.78	630	5.51	--	--	--	--
09A	477	21.7	1.62	1,126	5.22	43	7.0	7.9	294
10B	526	21.8	1.37	928	4.65	--	--	--	--
10A	539	21.8	1.29	547	4.52	38	7.2	7.9	295
11A,B	565	21.6	1.30	952	7.83	35	7.1	7.9	293
X03	607	23.8	1.24	857	--	--	--	--	--
12A	623	24.8	1.14	426	4.05	41	7.3	7.9	291
12B	637	25.0	1.18	488	4.67	--	--	--	--
X02	656	25.7	1.23	647	--	--	--	--	--
13A	678	23.6	1.34	569	4.48	33	7.2	7.9	277

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
13B	692	22.5	1.28	691	4.80	--	--	--	--
14A	726	20.5	1.24	750	3.56	31	7.3	7.9	273
14B	751	14.1	1.23	294	2.75	--	--	--	--
X01	760	13.3	1.20	390	--	--	--	--	--
15A	800	10.4	0.94	240	1.53	11	7.4	7.9	269
15B	809	9.6	1.14	302	1.68	--	--	--	--
REW	855	0.0	0.00	0	--	--	--	--	--
MEAN		17.3	1.58						
TOTAL	855			23,343	126.78	512			

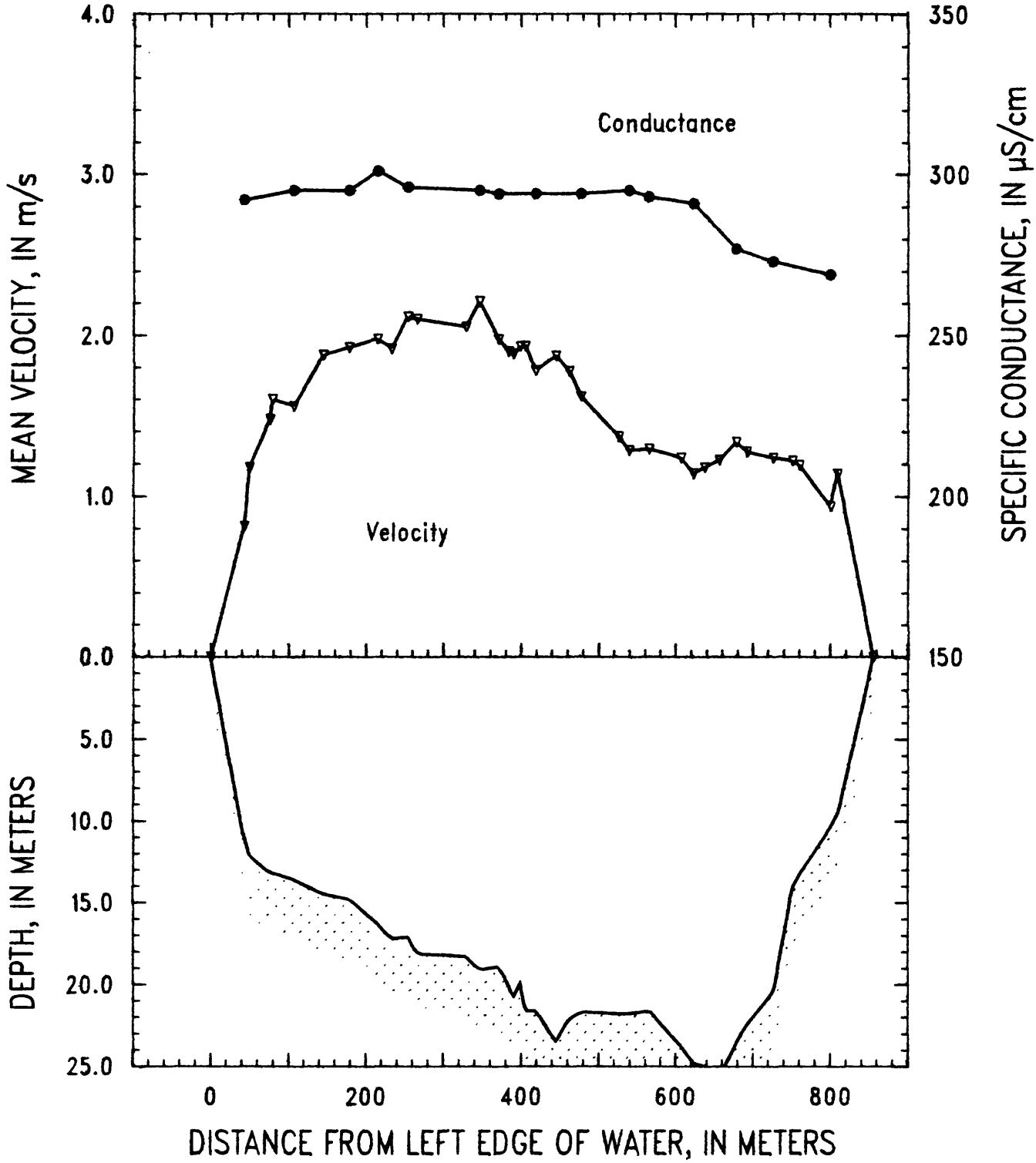

Figure 53. Mississippi River at Helena, Arkansas, on March 7, 1990.

(PAGE 170 FOLLOWS)

SITE: Mississippi River above Arkansas City, Arkansas 03-08-90
PARTY: Moody, Garbarino, and Rabalais METER: SOLID CUP
STARTING GAGE HEIGHT: 34.8 ft ENDING GAGE HEIGHT: 34.5 ft
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Transit rate was 17 cm/s, and 1/8-inch nozzle was used. Water was in the trees so that LEF was estimated to be at 90 m and the REF to be at 1,050 m.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
02A	150	8.8	0.21	144	0.35	2	8.5	7.9	275
02B	153	9.8	0.30	56	0.19	--	--	--	--
03A	188	16.0	0.44	198	0.54	13	8.0	7.9	280
03B	209	16.8	0.52	175	1.26	--	--	--	--
X01	228	17.2	0.90	371	--	--	--	--	--
04A	257	17.4	0.84	301	1.16	15	8.0	7.9	278
04B	269	17.9	0.76	198	1.14	--	--	--	--
05	286	17.5	0.85	520	3.41	18	8.2	7.9	280
06B	339	19.3	1.45	1,263	2.49	--	--	--	--
06A	376	19.8	1.53	1,329	3.67	18	8.1	7.9	281
07A	427	22.1	2.00	1,417	5.16	32	8.0	7.9	281
07B	440	22.1	1.84	1,079	4.54	--	--	--	--
08	480	24.1	2.12	1,484	9.31	45	7.9	7.9	280
09A	498	25.0	2.49	840	6.51	53	8.0	7.9	278
09B	507	25.2	2.11	1,434	4.75	--	--	--	--
X03	552	25.5	2.66	2,514	--	--	--	--	--
10B	581	25.9	2.78	1,406	6.06	--	--	--	--
10A	591	25.6	2.73	1,574	6.53	54	8.1	7.9	281
11B	626	25.0	2.85	2,601	6.79	--	--	--	--
11A	664	22.1	2.86	2,088	6.80	51	8.4	7.9	289
12A	692	22.1	2.41	1,120	6.11	56	8.6	7.8	287
12B	706	21.6	2.65	572	6.62	--	--	--	--
X04	712	20.5	2.76	509	--	--	--	--	--
13B	724	20.4	2.63	965	5.89	--	--	--	--
13A	748	20.1	2.54	1,251	5.68	37	8.4	7.8	290
14A	773	19.9	2.48	912	5.74	30	8.2	7.8	291
14B	785	19.9	2.28	2,383	4.72	--	--	--	--
15A	878	18.7	1.74	1,794	3.65	27	8.1	7.9	292
15B	895	19.0	1.65	565	3.09	--	--	--	--
16	914	19.4	1.49	955	3.26	26	8.2	7.8	291
17B	961	18.6	0.88	419	1.26	--	--	--	--
17A	965	17.5	0.73	763	1.02	32	--	--	--
REW	1,080	0.0	0.00	0	--	--	--	--	--
MEAN		17.0	1.81						
TOTAL	1,080			33,200	120.50	509			

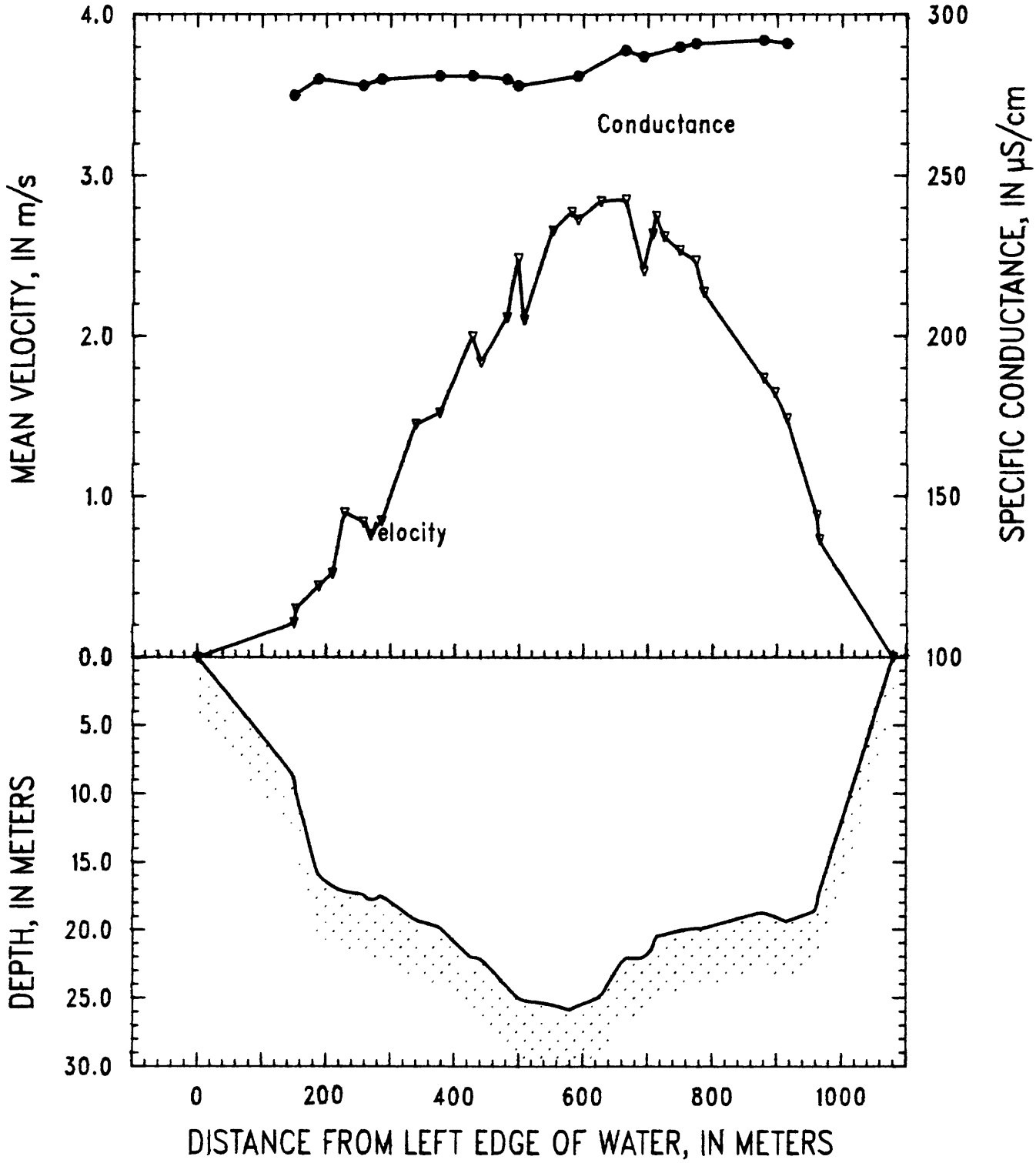

Figure 54. Mississippi River above Arkansas City, Arkansas, on March 8, 1990.

SITE: Mississippi River below Vicksburg, Mississippi 03-10-90
PARTY: Moody, Garbarino, and Rabalais METER: SOLID CUP
STARTING GAGE HEIGHT: 38.95 ft ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: LEF is approximately 25 m and REF is about 1,252 m. REW is unknown but chosen so that the neglected flow near the bank is beyond 1,252 m. Yazoo River water opposite the Port of Vicksburg was 13.5°C, with pH=7.48 and specific conductance of 122 µS/cm.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	53	11.8	0.21	75	0.43	12	11.1	7.5	240
01B	60	13.1	0.55	315	0.56	--	--	--	--
02A,B	141	22.8	1.33	1,755	6.72	33	11.3	7.5	244
X06	176	22.6	1.45	953	--	--	--	--	--
03A,B	199	22.0	1.63	1,469	7.99	33	11.2	7.5	241
04B	258	21.7	1.78	1,311	5.08	--	--	--	--
04A	267	21.9	1.77	1,317	5.24	36	11.2	7.5	253
05B	326	22.1	1.81	1,457	5.24	--	--	--	--
05A	340	22.1	2.00	1,126	4.63	40	10.9	7.5	263
X05	377	22.0	1.79	1,303	--	--	--	--	--
06B	406	21.7	2.08	881	6.07	--	--	--	--
06A	416	21.4	2.14	1,213	5.70	48	10.8	7.6	262
07A,B	459	22.1	2.21	1,492	12.02	42	10.7	7.5	276
X07	477	22.1	2.08	1,772	--	--	--	--	--
08A,B	536	20.1	2.25	2,349	10.97	42	11.3	7.6	286
09A	581	17.7	2.52	1,206	5.23	36	10.7	7.7	287
09B	590	17.1	2.56	1,491	5.24	--	--	--	--
10B	649	17.5	2.41	1,600	4.04	--	--	--	--
10A	666	16.5	2.41	1,015	4.47	34	11.2	7.6	292
X03	700	16.2	2.27	973	--	--	--	--	--
11A,B	719	16.5	2.18	1,724	7.98	34	10.7	7.7	294
12A	796	14.1	2.02	1,224	3.64	30	10.4	7.7	292
12B	805	14.1	2.05	780	3.81	--	--	--	--
13B	850	14.1	1.87	750	3.09	--	--	--	--
13A	862	13.4	1.71	344	2.47	28	11.0	7.7	292
X02	880	11.6	1.67	532	--	--	--	--	--
14A	917	12.0	1.54	405	1.85	23	10.8	7.7	293
14B	924	11.8	1.55	569	2.04	--	--	--	--
15A	979	9.9	1.08	358	1.28	18	10.8	7.7	293
15B	991	10.1	1.21	390	1.31	--	--	--	--
16A,B	1,043	9.8	0.98	420	2.15	16	10.7	7.7	293
X01	1,078	9.6	0.91	313	--	--	--	--	--
17A,B	1,115	9.7	0.94	463	2.03	9	10.5	7.7	292
18A,B	1,179	10.9	0.74	776	1.78	10	10.3	7.7	285
REW	1,308	0.0	0.00	0	--	--	--	--	--
MEAN		15.2	1.72						
TOTAL	1,308			34,121	123.06	524			

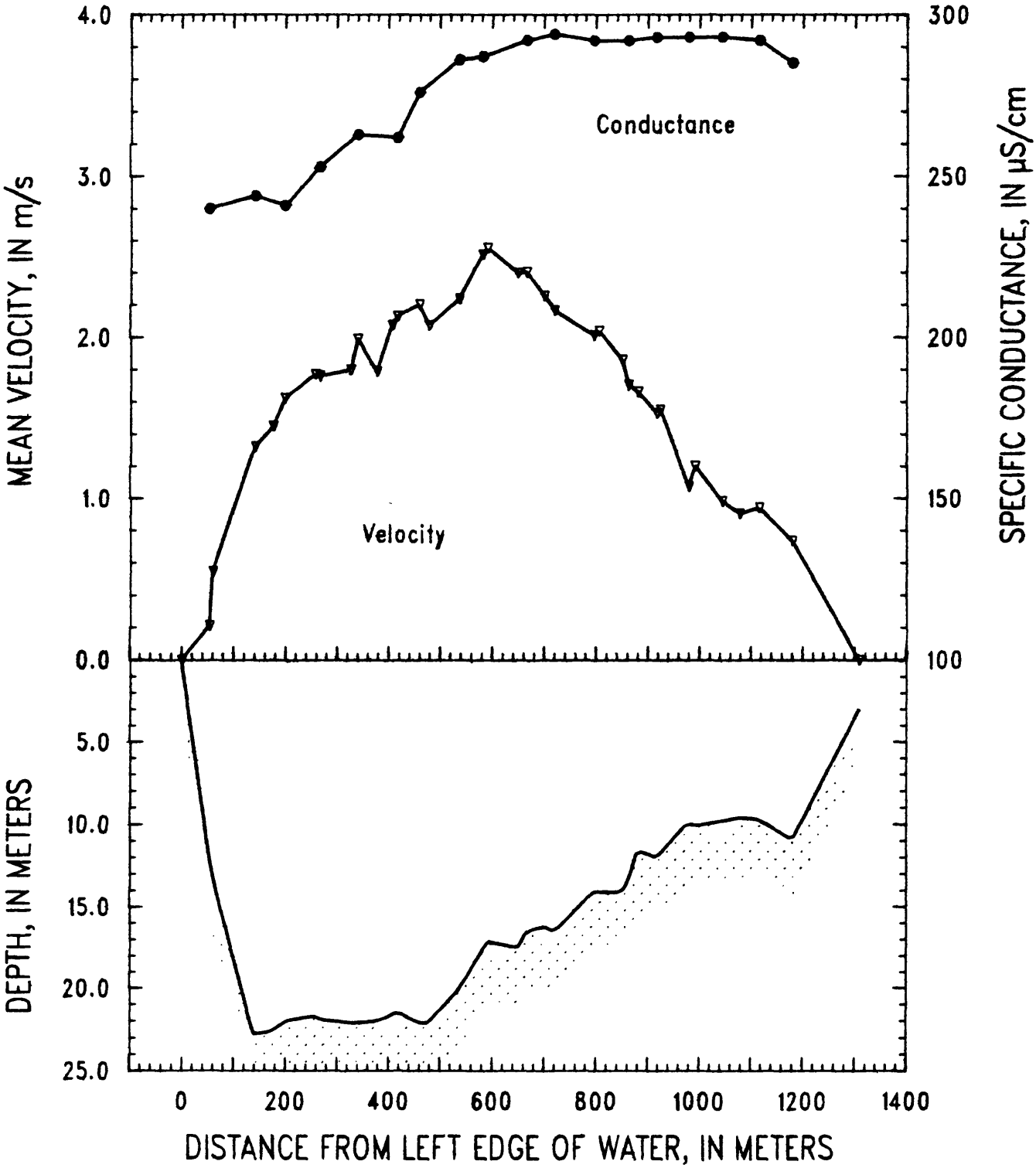

Figure 55. Mississippi River below Vicksburg, Mississippi, on March 10, 1990.

SITE: Mississippi River near St. Francisville, Louisiana 03-12-90
PARTY: Moody, Garbarino, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Transit rate was 10 cm/s, and 1/8-inch nozzle was used.
LEF is at 0 m, depth of 3.0 m is an estimate, and LEW is unknown.
Flow coming into river from left side was not measured.

Vertical	Dist. from LEF (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEF	0	3.0	0.00	0	--	--	--	--	--
01B	48	10.4	0.33	97	0.25	--	--	--	--
01A	57	11.3	0.10	31	0.26	7	13.0	7.6	279
02B	103	13.5	0.55	224	0.85	--	--	--	--
02A	117	13.6	0.49	296	0.62	12	12.0	7.7	280
03	191	16.0	1.06	1,186	4.63	18	13.2	7.6	279
04B	257	15.7	1.09	734	3.26	--	--	--	--
04A	277	15.9	1.06	557	2.84	24	11.9	7.7	279
05	323	16.3	1.76	1,631	9.26	30	11.8	7.7	280
06	391	16.9	2.06	2,137	12.14	36	12.2	7.6	280
07A	446	19.2	2.08	1,276	6.80	56	12.4	7.6	280
07B	455	19.2	2.09	1,286	6.36	--	--	--	--
08	510	18.8	2.26	1,339	11.67	52	12.7	7.7	280
X03	518	18.2	2.15	1,195	--	--	--	--	--
09	571	17.9	1.95	1,933	12.44	38	12.6	7.7	279
10B	629	18.1	1.87	1,187	6.50	--	--	--	--
10A	641	19.7	2.00	1,302	6.35	41	13.4	7.6	279
11B	695	19.8	1.62	1,028	5.66	--	--	--	--
11A	705	19.8	1.61	1,038	5.65	36	12.6	7.6	277
12A	760	20.8	1.64	1,059	5.48	40	12.2	7.6	279
12B	767	20.8	1.66	983	6.89	--	--	--	--
13B	817	21.1	1.58	1,117	6.39	--	--	--	--
13A	834	21.1	1.56	1,120	5.77	39	12.2	7.6	278
14A	885	21.3	1.44	874	4.75	39	12.3	7.6	279
14B	891	21.1	1.57	598	5.67	--	--	--	--
X01	921	20.2	1.49	813	--	--	--	--	--
15A	945	19.5	1.44	462	4.55	31	12.9	7.6	272
15B	954	18.4	1.32	824	4.36	--	--	--	--
REW	1,013	0.0	0.00	0	--	--	--	--	--
MEAN		16.8	1.55						
TOTAL	1,013			26,327	138.90	499			

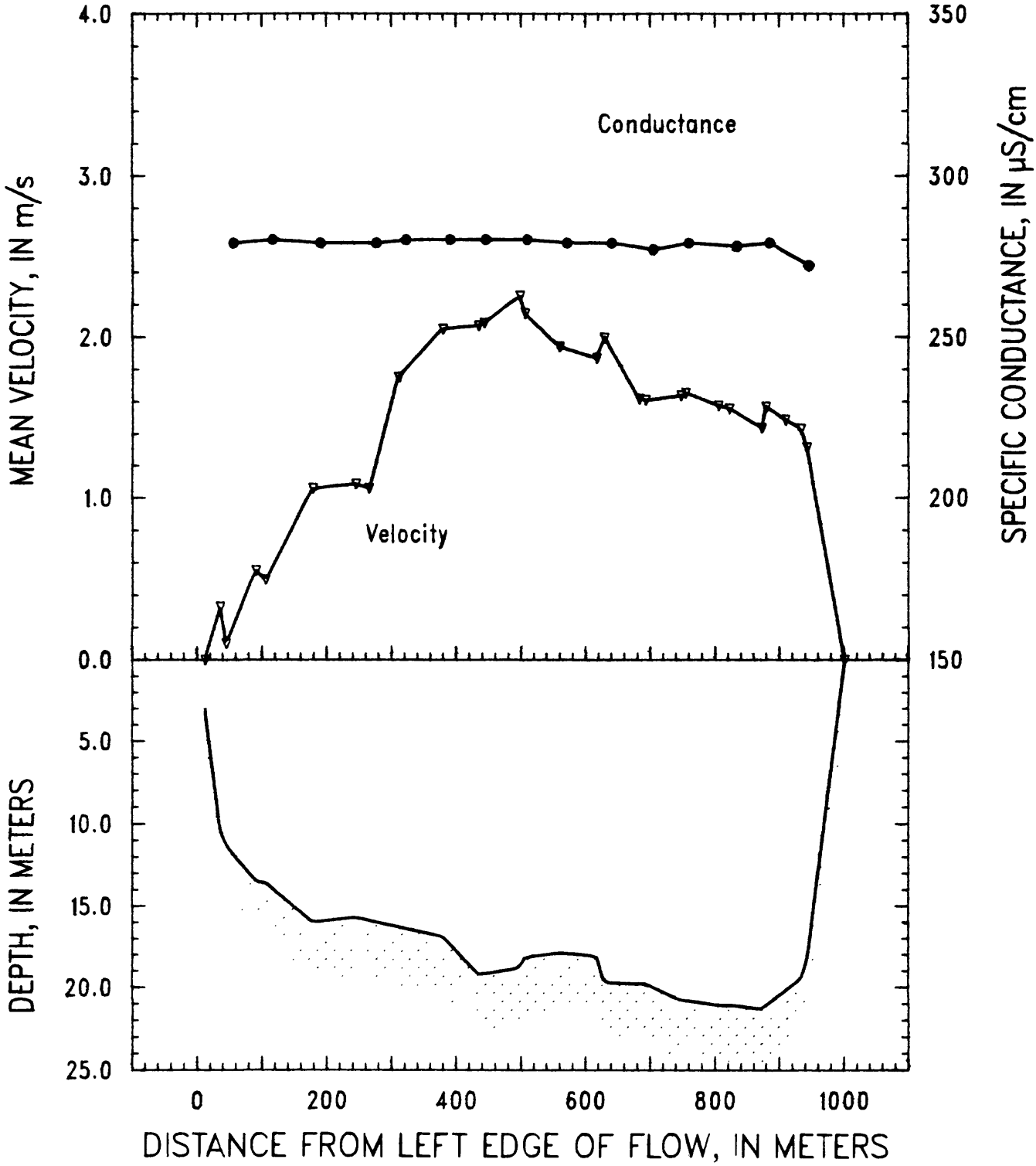

Figure 56. Mississippi River near St. Francisville, Louisiana, on March 12, 1990.

SITE: Mississippi River below Belle Chasse, Louisiana 03-14-90
PARTY: Moody, Garbarino, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: 13.8 ft ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Transit rate was 13 cm/s, and 1/8-inch nozzle was used. LEF is at 27 m, and REF is at 824 m. Verticals occupied in the following order: 1-4, 6-9, 13, 12, 5, 11, then 10.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	37.5	0.00	0	--	--	--	--	--
01A	75	12.5	0.87	465	1.13	18	14.0	7.8	288
01B	86	14.9	0.97	433	1.74	--	--	--	--
02A	135	21.8	1.38	845	3.21	35	14.4	7.7	286
02B	142	21.9	1.33	583	3.98	--	--	--	--
X02	175	23.9	1.56	935	--	--	--	--	--
03A	192	24.1	1.66	559	4.01	46	13.2	7.7	284
03B	203	25.5	1.73	1,452	5.25	--	--	--	--
04B	258	25.6	1.83	1,450	5.37	--	--	--	--
04A	265	25.3	1.78	1,327	5.77	46	13.3	7.7	288
05A	317	27.8	1.71	1,404	5.90	51	13.7	7.7	289
05B	324	27.5	1.74	574	6.09	--	--	--	--
X04	341	27.6	1.80	1,265	--	--	--	--	--
06A,B	375	27.6	1.65	1,961	11.49	51	12.7	7.8	290
07A,B	427	28.1	1.62	2,525	12.51	55	12.8	7.7	290
08A,B	486	27.1	1.59	1,468	10.43	49	12.9	7.7	293
X05	495	27.0	1.64	1,129	--	--	--	--	--
09A,B	537	26.4	1.50	1,925	10.47	45	12.5	7.8	290
10A,B	592	25.7	1.35	1,800	8.77	35	12.4	7.7	289
11A,B	641	24.4	1.14	1,421	6.78	31	12.7	7.8	290
12A	694	23.4	1.10	852	3.32	29	13.0	7.7	286
12B	707	23.3	1.01	657	2.96	--	--	--	--
13A	750	23.5	0.94	718	2.51	14	13.4	7.7	289
13B	772	16.2	0.93	986	1.78	--	--	--	--
REW	881	0.0	0.00	0	--	--	--	--	--
MEAN		21.2	1.43						
TOTAL	881			26,732	113.47	505			

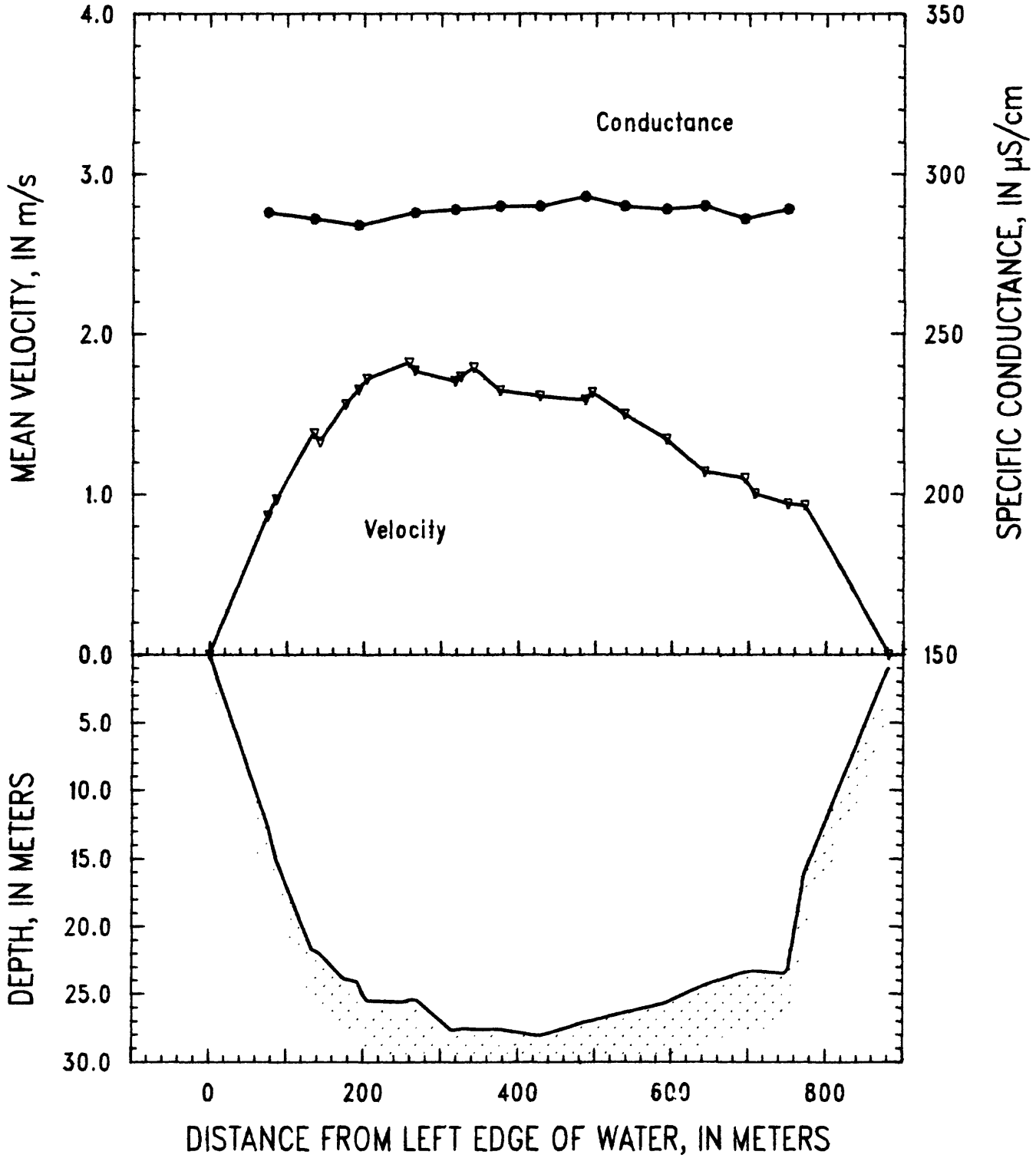

Figure 57. Mississippi River below Belle Chasse, Louisiana, on March 14, 1990.

(PAGE 179 FOLLOWS)

DATA LISTINGS
FOR
MAY-JUNE 1990 CRUISE

SITE: Mississippi River near Cairo, Illinois 05-31-90
PARTY: Moody, Delaune, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Flow in 100-m section west of small levee road (on right side) was not measured nor was the possible flow in a section of about 100 m beyond a line of trees on the left edge. Vertical 3.5 was done last, between verticals 3 and 4. Individual verticals were collected using various nozzles and transit rates.

Vertical	Mean dist. from LEW (m)	Standard deviation (m)	Mean depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Suspended sediment (mg/L) <63 µm	Suspended sediment (mg/L) >63µm	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0	00.0	0.00	0	--	--	--	--	--
1B	161	10	13.5	0.49	933	582	20	19.1	7.6	367
2A	280	1	14.3	1.38	2,540	655	46	19.1	7.7	365
3B	418	1	15.6	2.03	2,916	694	64	18.9	7.9	364
3.5	464	1	16.3	2.10	1,555	704	91	19.2	7.7	365
4A	509	2	16.4	2.43	2,991	680	90	19.2	7.7	361
5B	614	1	14.5	1.95	2,649	613	69	19.2	7.7	362
REW	696	0	0.0	0.00	0	--	--	--	--	--
MEAN			12.2	1.60						
TOTAL	696				13,584					

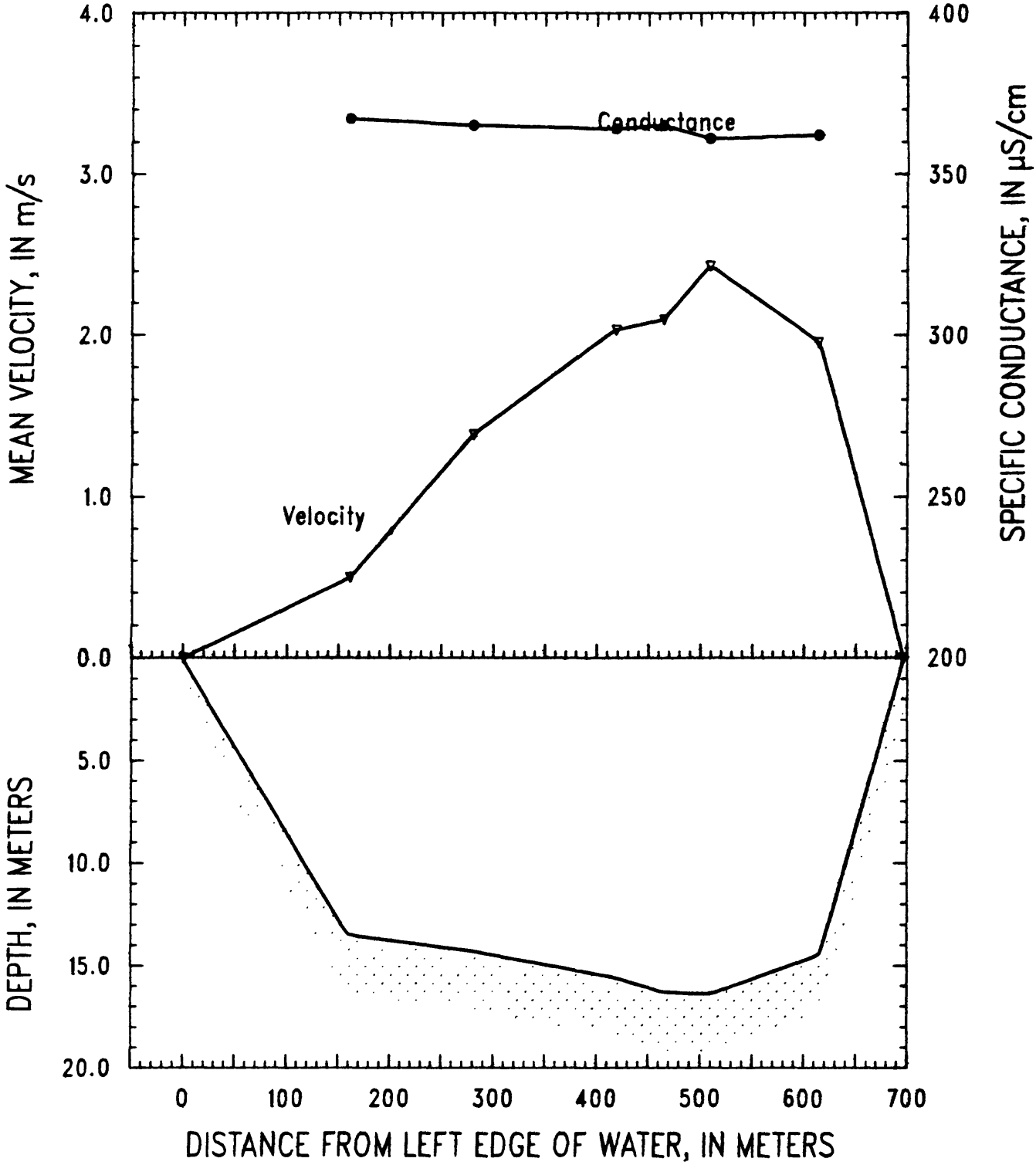

Figure 58. Mississippi River near Cairo, Illinois, on May 31, 1990.

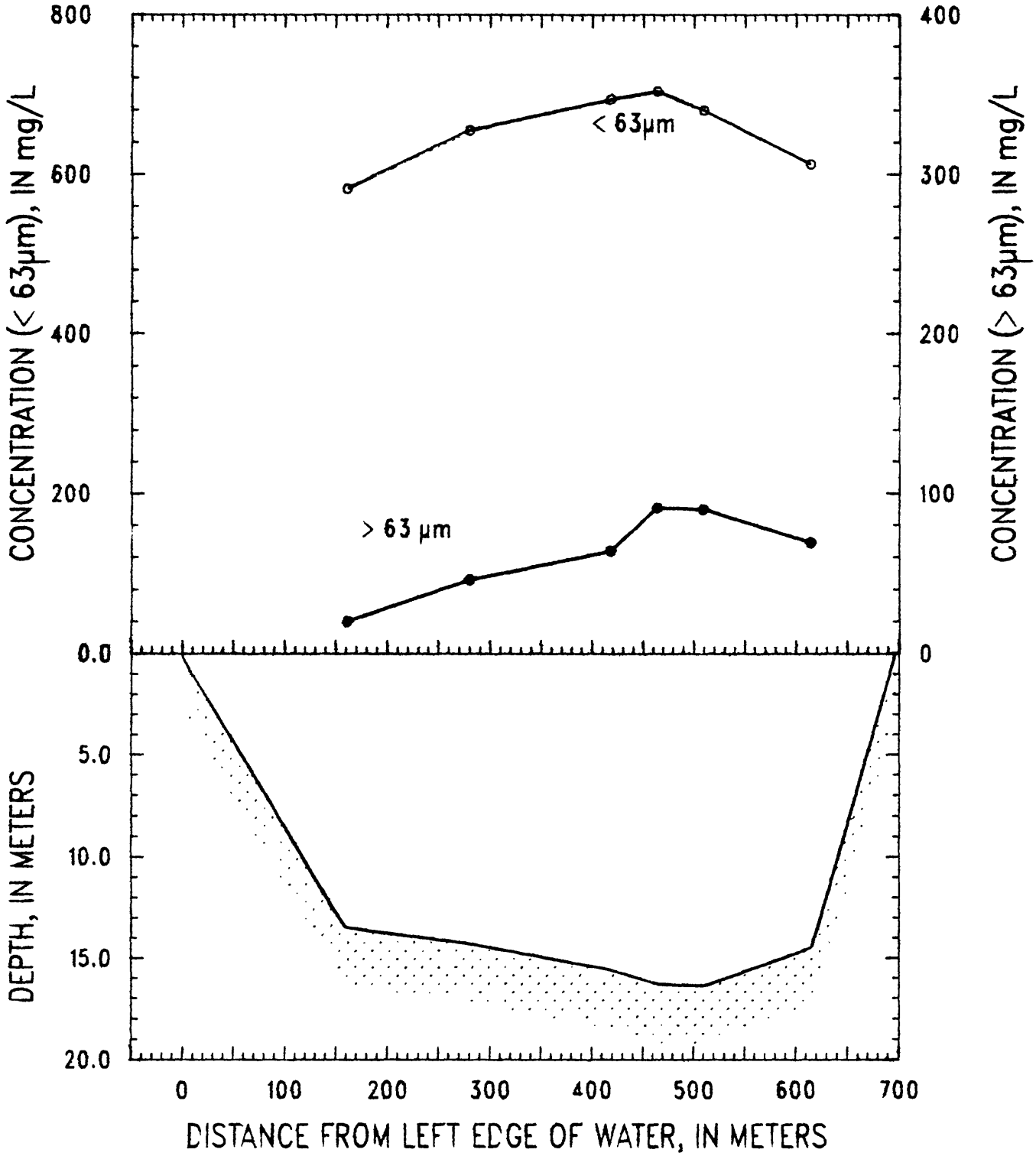

Figure 59. Mississippi River near Cairo, Illinois, on May 31, 1990--suspended-sediment concentration.

SITE: Ohio River at Olmsted, Illinois 05-31-90
PARTY: Moody, Delaune, Simoneaux, and LeBoeuf METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Individual verticals were collected using the 1/4-inch nozzle and various transit rates. Section is 16.5 miles upriver from the confluence of the Ohio and Mississippi Rivers.

Vertical	Mean dist. from LEW (m)	Standard deviation (m)	Mean depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Suspended sediment (mg/L)		Temperature (°C)	pH	Specific conductance (µS/cm)
						<63 µm	>63µm			
LEW	0	--	0.0	--	0	--	--	--	--	--
01A	74	3	11.0	0.65	501	87	4	19.8	7.6	249
02B	141	4	12.5	0.86	671	107	6	19.7	7.7	263
03A	199	4	12.9	0.91	628	106	5	19.8	7.7	256
04B	248	7	13.9	0.94	965	110	3	19.7	7.6	274
05A	347	8	15.3	1.02	1,314	120	3	19.6	7.7	293
06B	416	5	16.0	0.98	1,127	125	4	19.6	7.7	307
07A	491	7	17.1	1.05	1,230	128	4	19.5	7.7	319
08B	553	4	15.9	1.11	1,067	126	2	19.3	7.7	327
09A	612	5	17.7	1.04	1,215	136	3	19.1	7.7	335
10B	685	2	16.4	1.14	1,364	140	3	19.3	7.8	340
11A	758	2	16.6	1.19	1,344	132	2	19.2	7.6	341
12B	821	2	16.7	1.32	1,332	127	3	19.3	7.7	329
13B	879	2	16.8	1.21	1,222	125	1	19.4	7.7	337
14A	941	2	17.8	0.93	1,048	124	3	19.4	7.7	330
15B	1,005	2	11.8	0.62	577	99	2	19.7	7.6	324
REW	1,090		0.0	0.00	0	--	--	--	--	--
MEAN			14.0	1.01						
TOTAL	1,098				15,605					

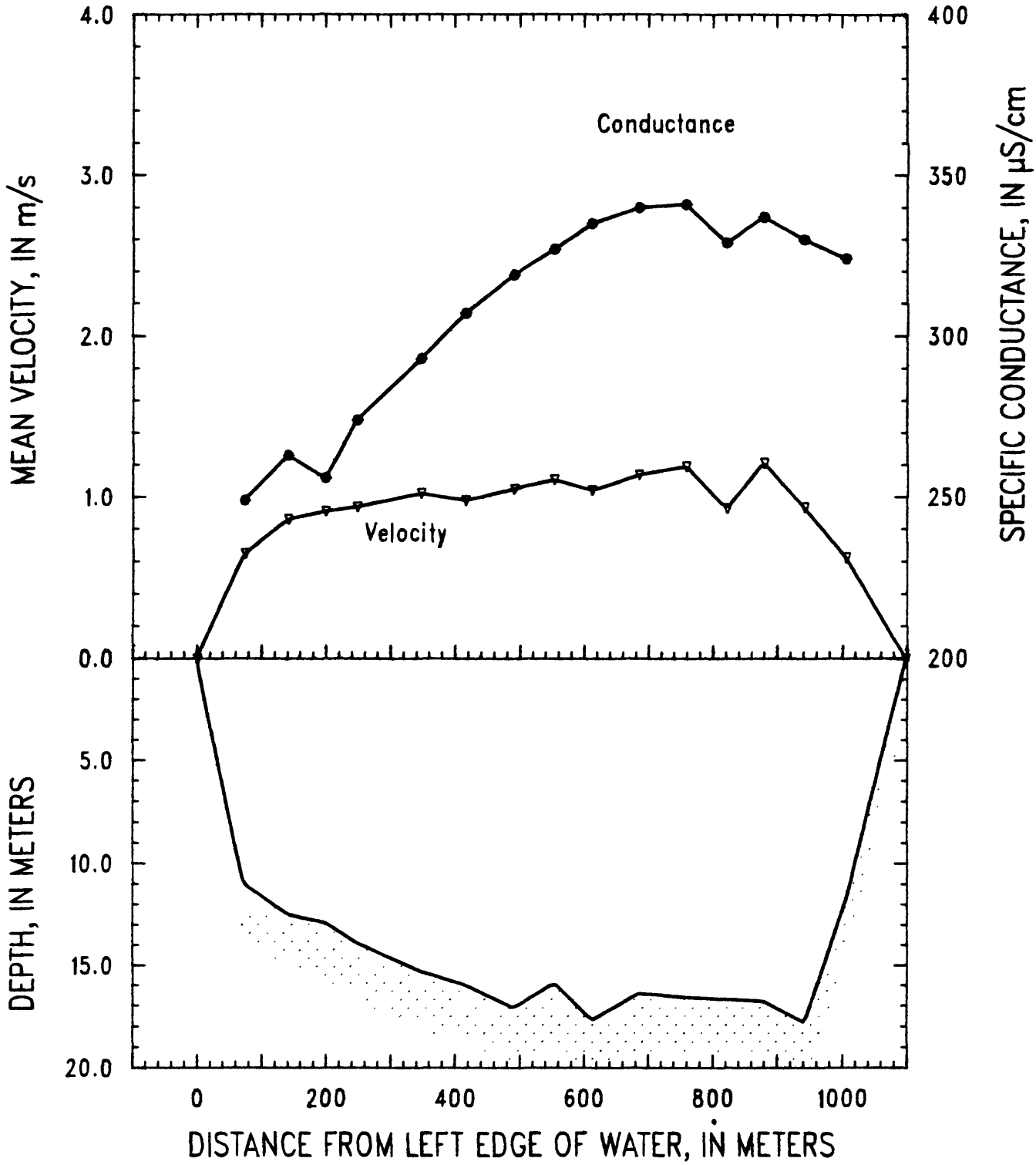

Figure 60. Ohio River at Olmsted, Illinois, on May 31, 1990.

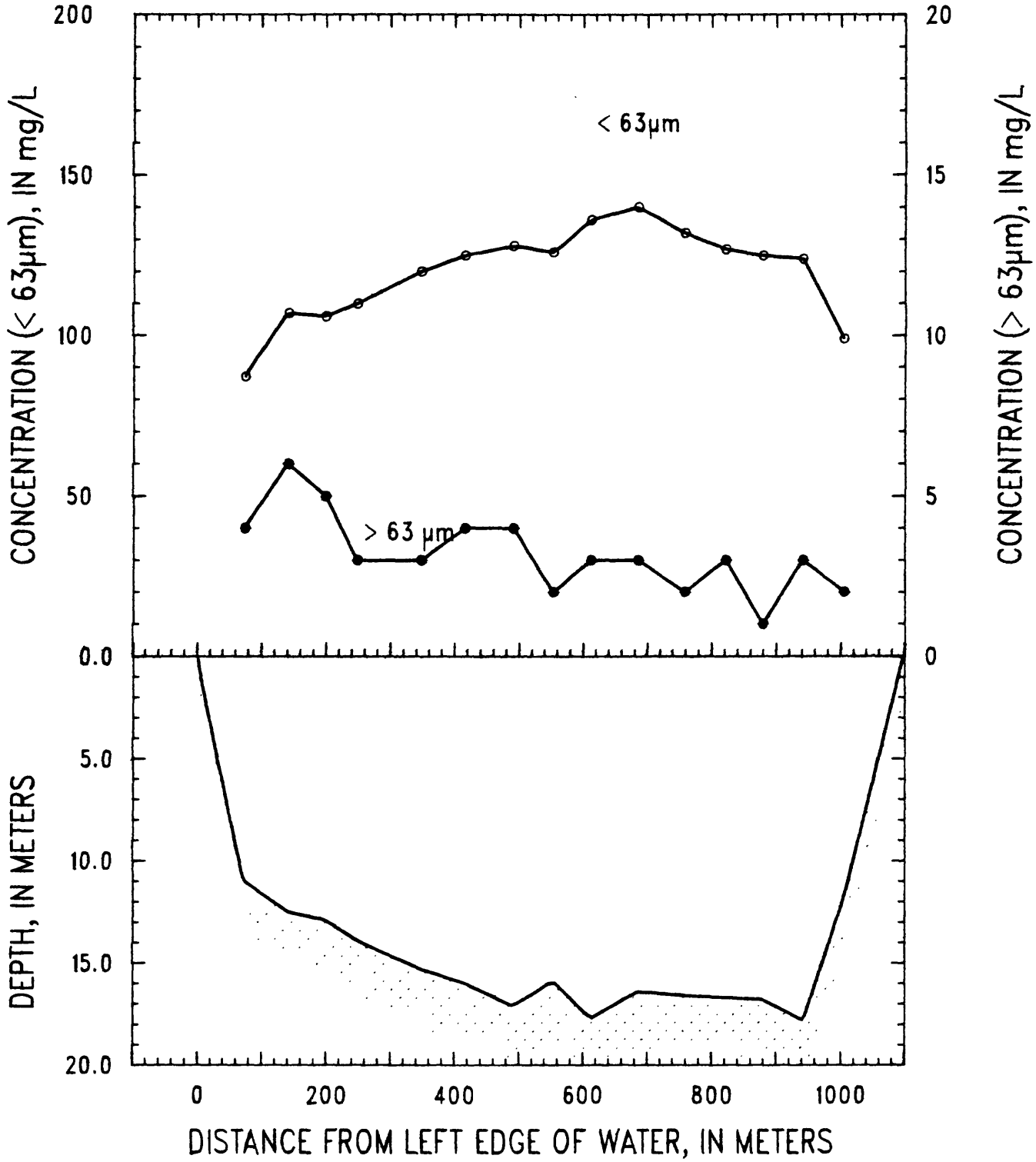

Figure 61. Ohio River at Olmsted, Illinois, on May 31, 1990--suspended-sediment concentration.

SITE: Mississippi River at Wickliffe, Kentucky 05-30-90
PARTY: Moody, Delaune, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: 47 ft ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Individual verticals were collected using 1/8- and 3/16-inch nozzles and various transit rates. First measurement in a short time series of 3.

Vertical	Mean dist. from LEW (m)	Standard deviation (m)	Mean depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Suspended sediment (mg/L)		Temperature (°C)	pH	Specific conductance (µS/cm)
						<63 µm	>63µm			
LEW	0	--	0.0	0.00	0	--	--	--	--	--
01B	58	5	10.8	2.20	1,343	99	6	20.0	7.8	281
02A	113	8	18.2	2.60	2,812	105	5	20.0	7.8	288
03B	177	17	29.0	2.60	3,801	124	17	18.7	7.7	304
04A	214	5	30.0	2.40	3,236	138	12	18.7	7.6	298
05B	267	8	26.9	2.41	3,148	270	35	18.8	7.7	330
06A	311	9	26.2	2.39	2,688	344	48	19.5	7.7	345
07B	353	8	26.2	2.22	2,876	470	54	19.2	7.8	334
08A	410	10	22.4	2.06	2,428	535	99	18.5	7.8	372
09A	458	3	19.5	2.06	1,828	632	136	18.3	7.7	373
10B	501	4	16.8	2.01	1,668	619	153	18.2	7.8	379
11A	557	5	13.4	1.68	1,135	621	146	17.9	7.7	378
12B	602	2	11.5	1.62	855	614	91	18.8	7.7	383
13A	649	2	10.4	1.66	873	609	45	19.3	7.7	384
14B	703	2	10.2	1.41	706	598	45	19.6	7.8	385
15A	747	1	9.4	1.50	875	590	32	19.1	7.8	382
REW	827	--	0.0	0.00	0	--	--	--	--	--
MEAN			16.9	2.17						
TOTAL	827				30,272					

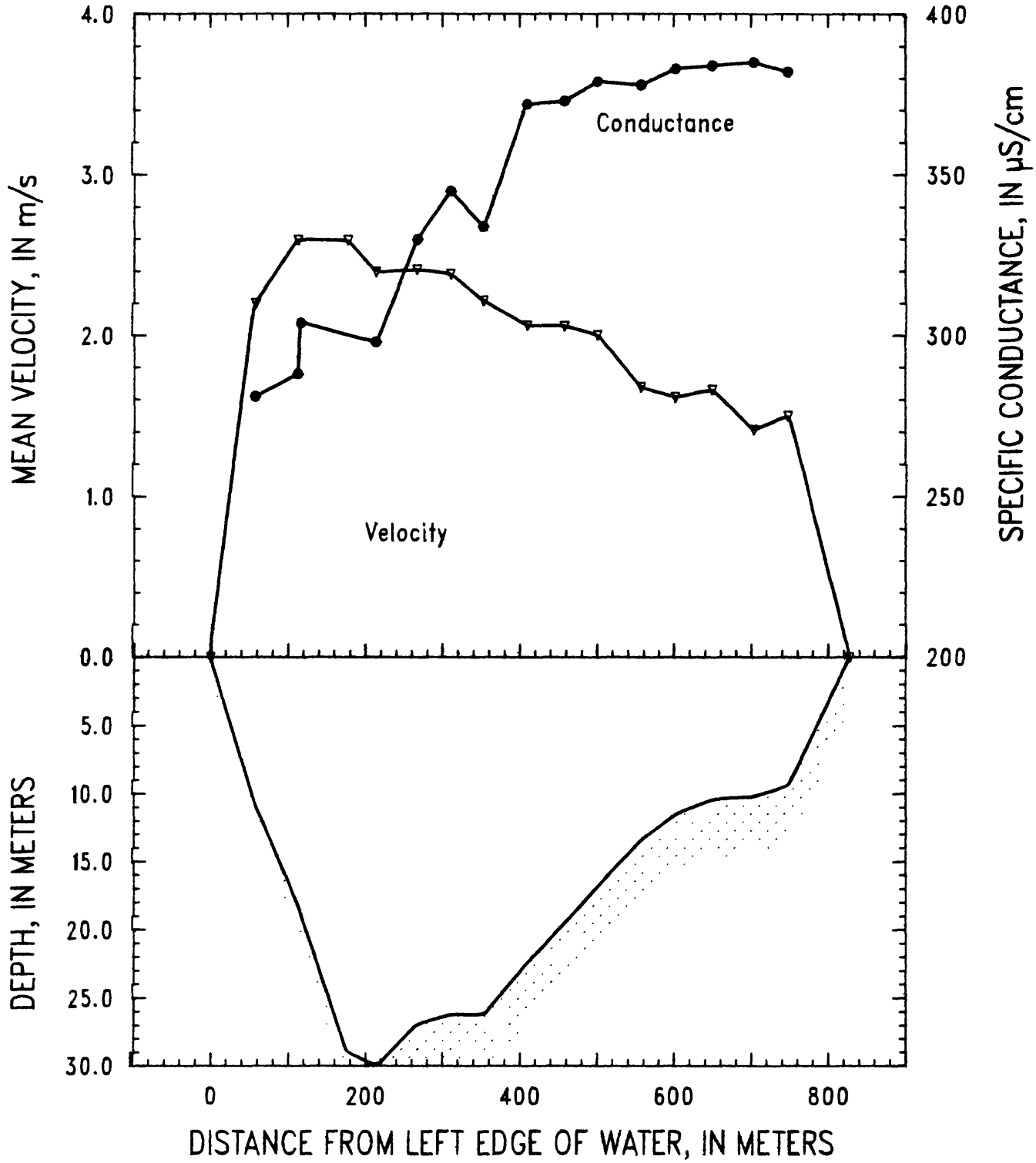

Figure 62. Mississippi River at Wickliffe, Kentucky, on May 30, 1990.

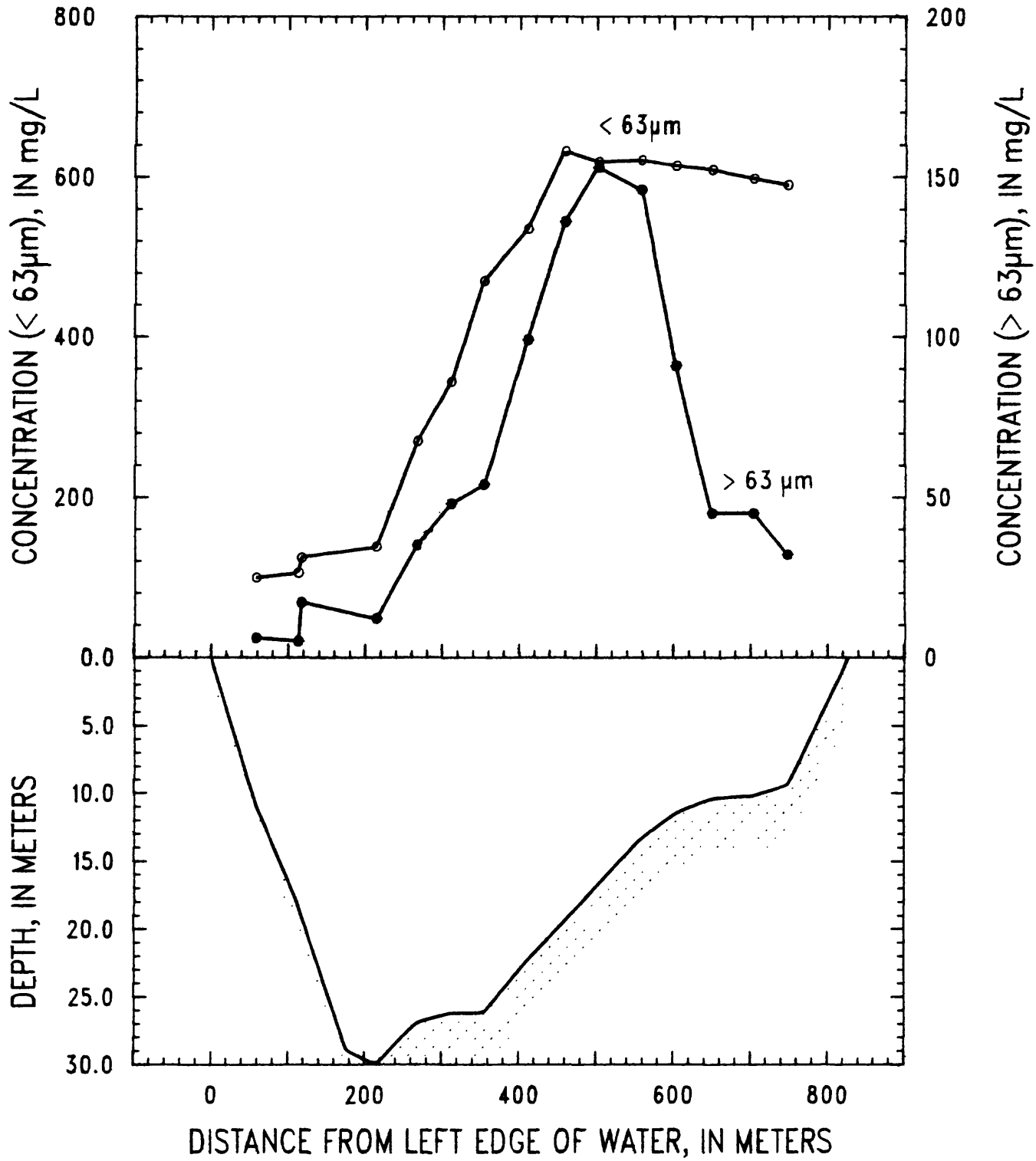

Figure 63. Mississippi River at Wickliffe, Kentucky, on May 30, 1990--suspended-sediment concentration.

SITE: Mississippi River at Wickliffe, Kentucky 06-01-90
PARTY: Moody, Delaune, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Individual verticals were collected using 1/8- and 3/16-inch nozzles and various transit rates. Second sampling in the short time series of 3. Numerous patches of wood and trash. An oily film collected on the hydrowire. Values of temperature, pH, and specific conductance are measurements of the depth-integrated sample and measurements of the surface sample are in parentheses.

Vertical	Mean dist. from LEW (m)	Standard deviation (m)	Mean depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Suspended sediment (mg/L) <63 µm	Suspended sediment (mg/L) >63µm	Temperature (°C)	pH	Specific conductance (µS/cm)	
LEW	0	--	0.0	0.00	0	--	--	--	--	--	
01A	65	4	11.3	2.15	1,251	112	3	19.5	7.3	296	
02B	103	2	15.0	2.34	1,650	114	3	19.2	7.4	301	
03A	159	7	29.1	2.53	3,527	130	3	19.3	7.5	307	
04B	199	4	30.3	2.38	3,785	157	7	19.0	7.5	322	
05A	264	7	26.8	2.34	3,361	307	30	18.7	7.5	341	
06B	306	3	27.1	2.30	2,646	396	36	18.7	7.5	349	
07B	349	4	24.4	2.27	2,937	419	63	18.3	7.6	352	
08A	412	9	21.3	2.28	2,675	497	73	19.1	7.5	355	(360)
09B	459	8	19.9	2.01	1,777	615	97	19.0	7.5	360	
10A	501	4	16.8	1.97	1,537	610	149	18.7	7.6	361	
11B	552	3	14.1	1.77	1,273	590	123	18.9	7.4	357	
12A	603	2	11.7	1.60	872	583	103	18.5	7.5	355	
13B	645	3	10.3	1.53	741	565	39	18.5	7.5	361	
14A	697	2	9.6	1.54	776	551	39	18.7	7.6	360	
15A	750	2	9.6	1.44	898	555	45	18.8	7.5	360	
REW	827	--	0.0	0.00	0	--	--	--	--	--	
MEAN			16.8	2.14							
TOTAL	827				29,706						

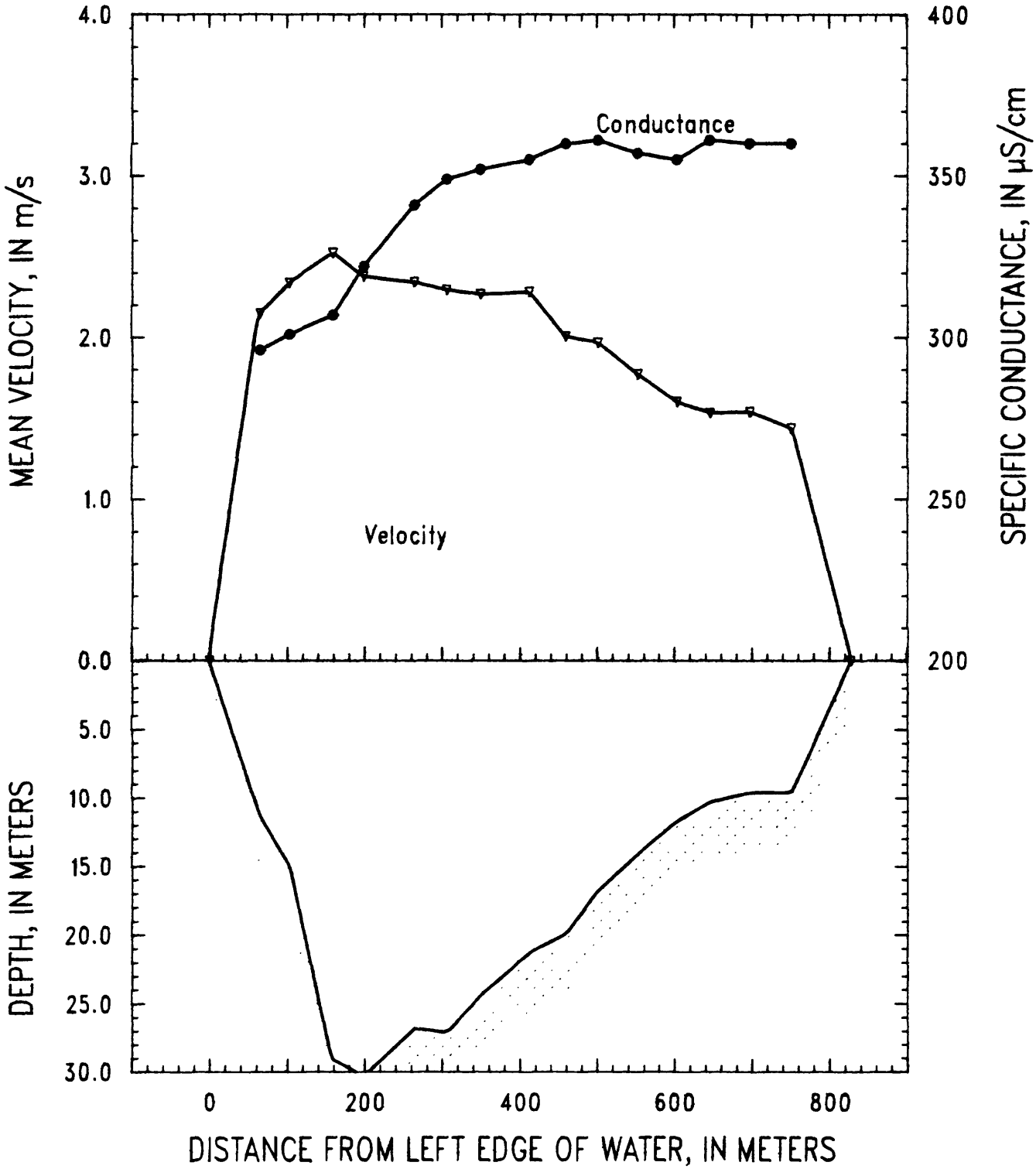

Figure 64. Mississippi River at Wickliffe, Kentucky, on June 1, 1990.

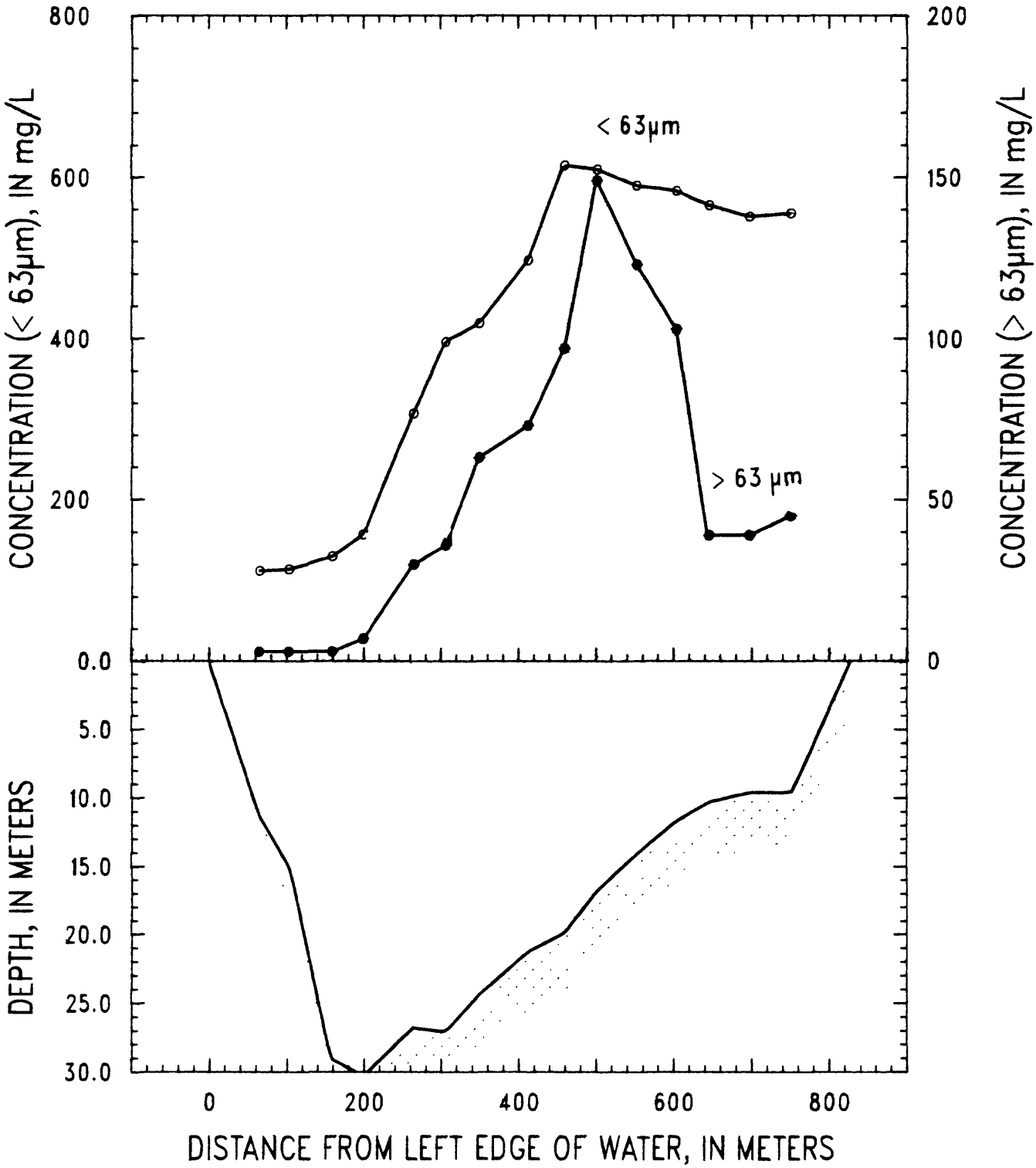

Figure 65. Mississippi River at Wickliffe, Kentucky, on June 1, 1990--suspended-sediment concentration.

SITE: Mississippi River at Wickliffe, Kentucky 06-04-90
PARTY: Moody, Delaune, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: 46.8 ft
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Individual verticals were collected using 1/8- and 3/16-inch nozzles and various transit rates. Third sampling in a short time series of 3. No trash today, and no oily film collected on the hydrowire. Values of temperature, pH, and specific conductance are measurements of the depth-integrated samples and measurements of the surface sample are in parentheses.

Vertical	Mean dist. from LEW (m)	Standard deviation (m)	Mean depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Suspended sediment (mg/L) <63 µm	Suspended sediment (mg/L) >63µm	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	--	0.0	0.00	0	--	--	--	--	--
01A	63	3	10.5	2.05	1,111	131	5	21.1	7.7	280 (284)
02B	103	3	13.5	2.35	1,537	141	6	20.8	7.9	286 (286)
03A	160	6	29.1	2.50	3,706	150	7	20.9	7.8	298 (305)
04B	205	5	29.4	2.37	3,379	160	11	20.8	7.9	309 (319)
05B	257	3	28.6	2.20	3,119	168	17	20.7	7.9	324 (335)
06A	304	8	27.8	2.12	2,801	232	17	20.7	7.8	351 (345)
07B	352	3	25.3	1.99	2,514	294	35	20.6	7.9	367 (373)
08A	404	7	24.0	2.08	2,366	367	65	20.4	7.9	379 (396)
09B	447	5	22.0	2.00	2,095	430	57	20.4	8.0	391 (391)
10A	499	6	17.9	1.94	1,960	478	88	20.4	7.9	399 (403)
11A	560	5	13.7	1.69	1,145	490	122	20.4	8.0	399 (403)
12B	598	3	11.9	1.53	883	470	88	20.3	7.9	399 (403)
13A	657	2	10.0	1.43	679	466	42	20.0	7.9	401 (403)
14B	693	1	10.0	1.36	603	475	61	19.8	7.9	401 (404)
15A	746	5	9.6	1.46	938	460	24	19.8	8.0	400 (403)
REW	827	--	0.0	0.00	0	--	--	--	--	--
MEAN			17.1	2.04						
TOTAL	827				28,836					

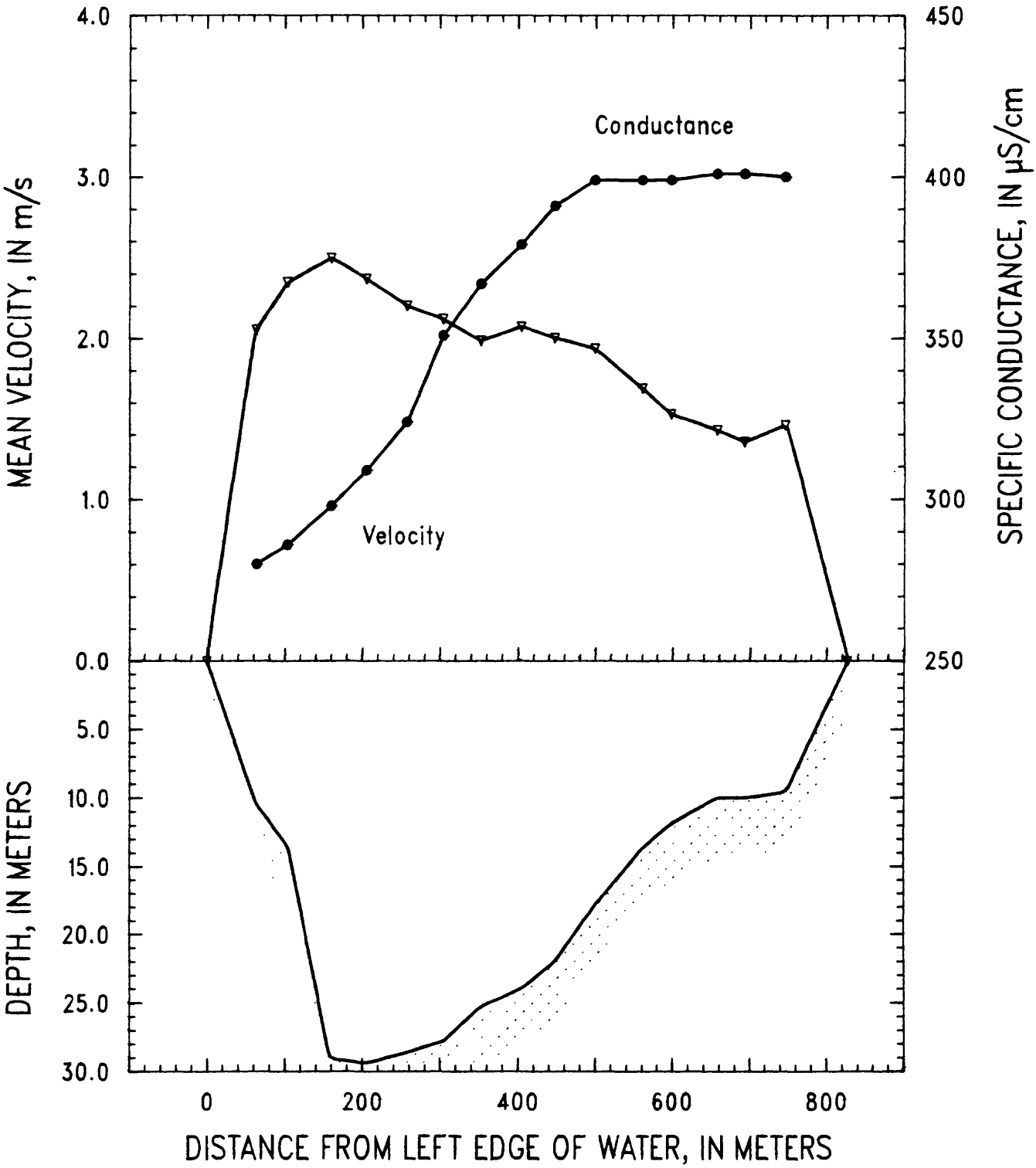

Figure 66. Mississippi River at Wickliffe, Kentucky, on June 4, 1990.

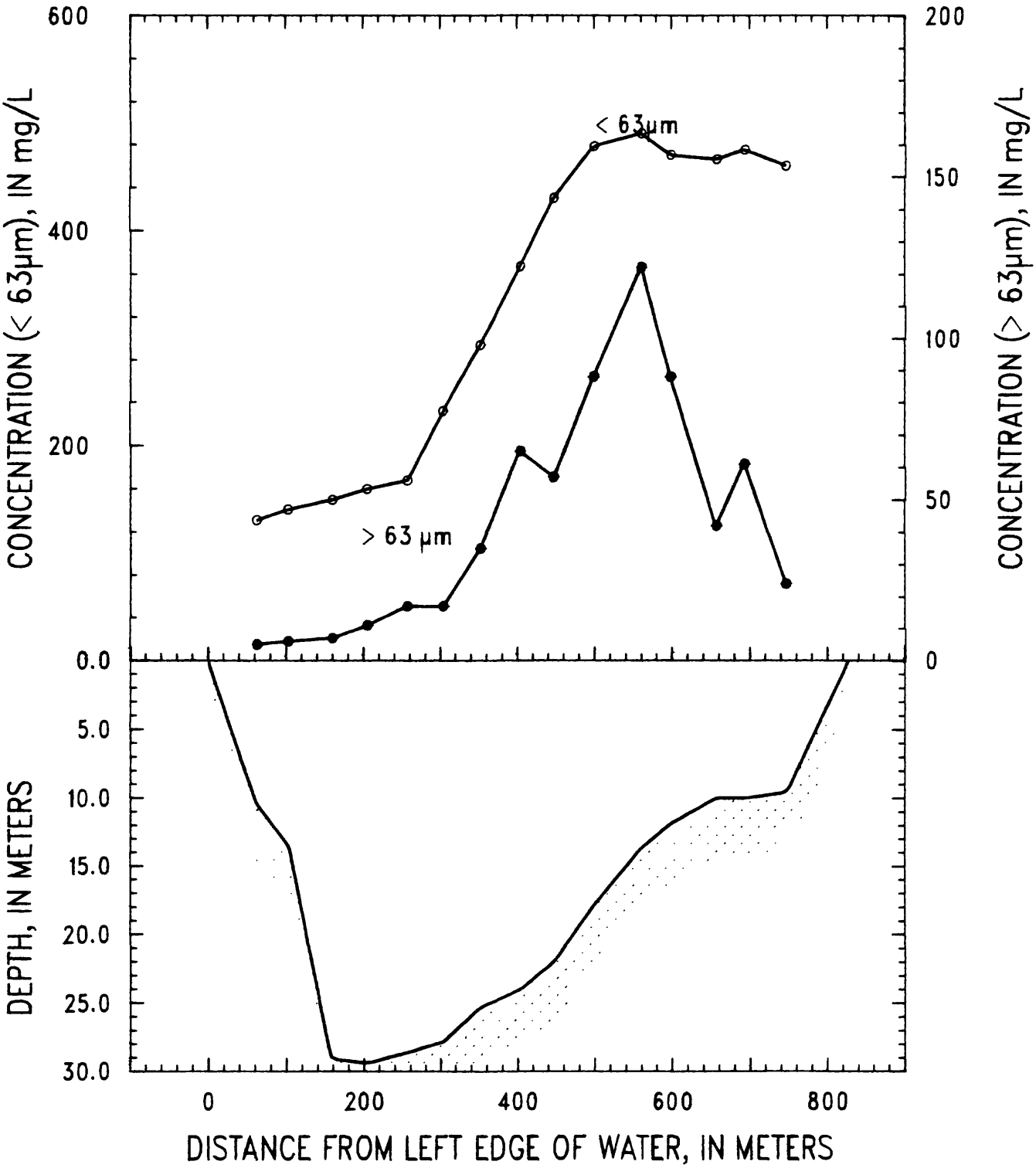

Figure 67. Mississippi River at Wickliffe, Kentucky, on June 4, 1990--suspended-sediment concentration.

SITE: Mississippi River near Columbus, Kentucky 06-01-90
PARTY: Moody, Delaune, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: 44.4 ft ENDING GAGE HEIGHT: 44.4 ft
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Individual verticals were collected using the 1/8- and 3/16-inch nozzles and variable transit rates. Values of temperature, pH, and specific conductance are measurements of the depth-integrated sample and measurements of the surface sample are in parenthese.

Vertical	Mean dist. from LEW (m)	Standard deviation (m)	Mean depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Suspended sediment (mg/L) <63 µm	Suspended sediment (mg/L) >63µm	Temperature (°C)	pH	Specific conductance (µS/cm)	
LEW	0	0	0.0	0.00	0	--	--	--	--	--	
01A	69	6	17.8	2.05	2,150	108	10	20.0	7.7	304	
02B	118	4	26.5	2.24	3,000	150	62	20.3	7.7	305	
03A	170	2	27.8	2.23	3,440	173	74	20.1	7.7	316	
04A	229	4	26.9	2.35	3,578	261	84	20.7	7.6	332	
05B	283	4	27.0	2.57	3,717	361	126	20.2	7.6	344	
06A	336	5	24.3	2.38	3,725	442	80	20.1	7.7	352	
07B	412	8	20.2	1.94	2,445	472	62	20.0	7.7	356	
08A	461	2	16.6	1.98	1,558	477	36	20.0	7.7	360	(360)
09B	507	3	13.1	1.74	1,368	508	4	20.0	7.7	360	
10A	581	4	9.1	1.65	923	509	19	19.9	7.7	356	
11B	630	3	8.1	1.55	620	508	29	19.9	7.8	362	
12A	680	1	8.4	1.45	580	495	8	20.1	7.8	359	
13B	725	4	8.7	1.42	642	497	16	19.8	7.7	363	
14A	784	4	8.9	1.51	845	485	14	20.1	7.7	358	
15B	851	2	8.8	1.37	773	478	9	20.0	7.7	361	
REW	912	--	0.0	0.00	0	--	--	--	--	--	
MEAN			15.6	2.06							
TOTAL	912				29,364						

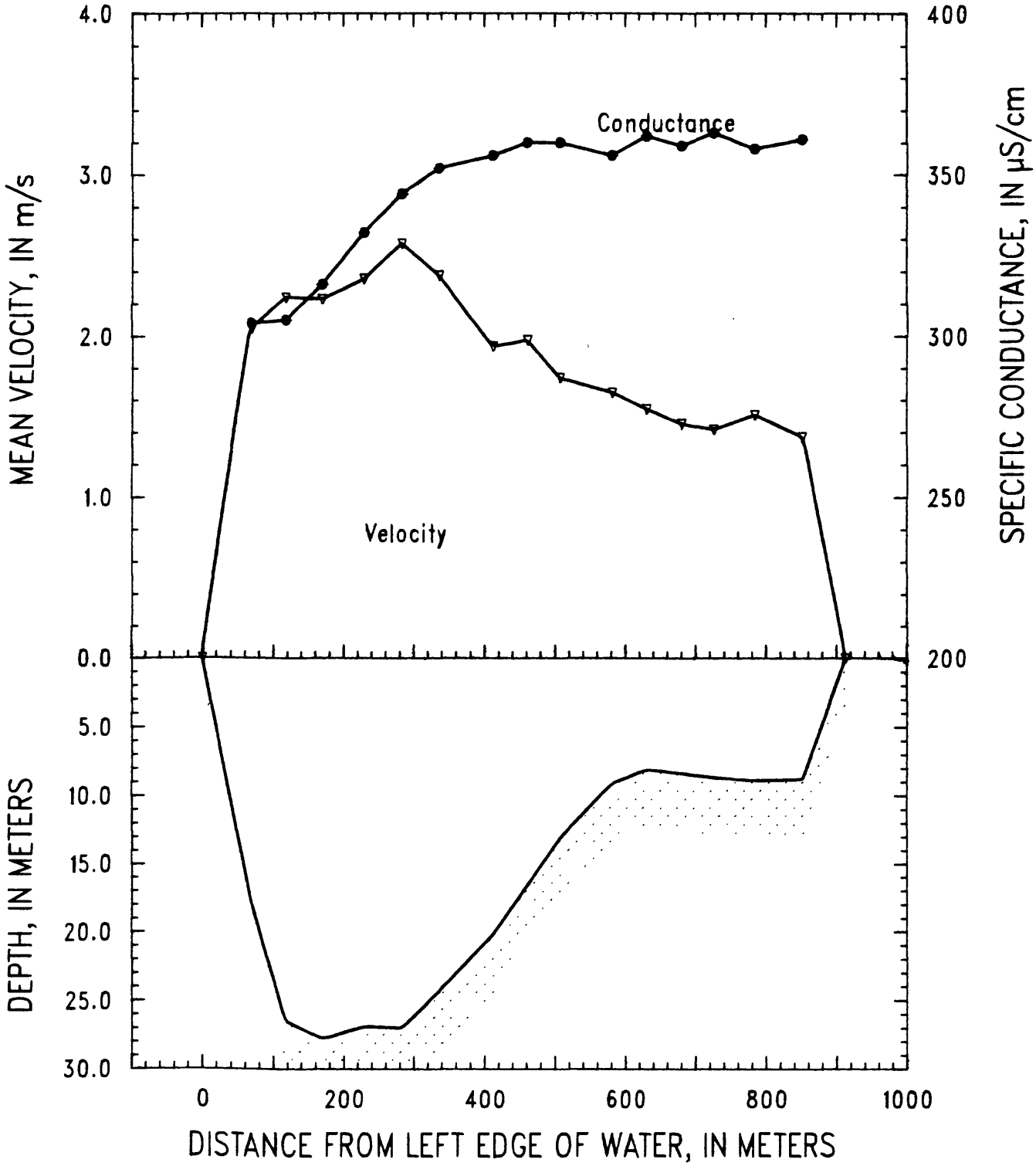

Figure 68. Mississippi River near Columbus, Kentucky, on June 1, 1990.

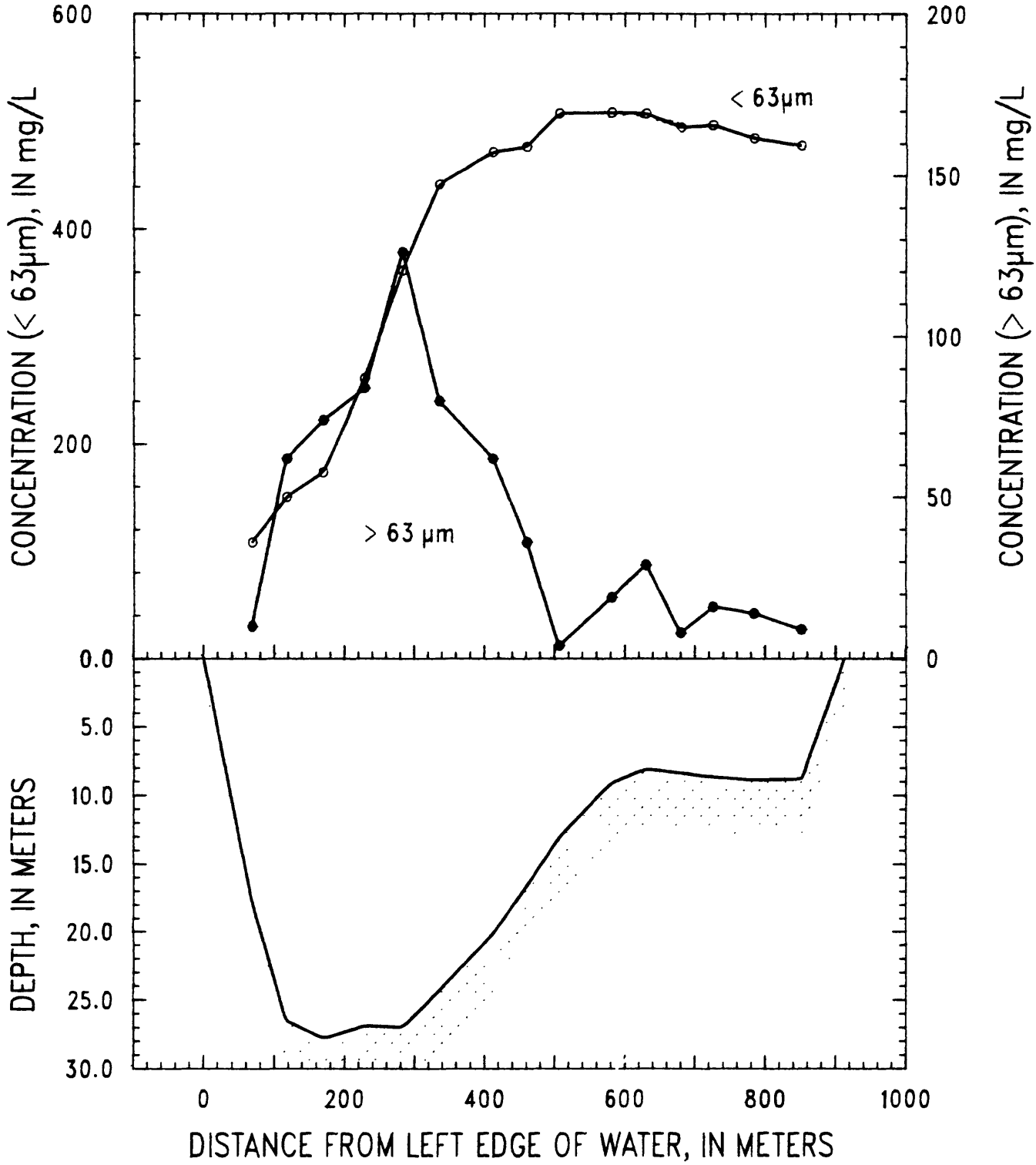

Figure 69. Mississippi River near Columbus, Kentucky, on June 1, 1990--suspended-sediment concentration.

SITE: Mississippi River above New Madrid, Missouri 06-02-90
PARTY: Moody, Delaune, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Ten-vertical section using 1/8- and 3/16-inch nozzles and variable transit rates. Strong (20-30 knots) southwest wind. Values of temperature, pH, and specific conductance are measurements of the depth-integrated sample and measurements of the surface sample are in parentheses.

Vertical	Mean dist. from LEW (m)	Standard deviation (m)	Mean depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Suspended sediment (mg/L) <63 µm	Suspended sediment (mg/L) >63µm	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	--	0.0	0.00	0	--	--	--	--	--
01A	120	10	30.4	1.25	4,315	207	35	21.0	7.6	326 (325)
02B	228	12	25.1	1.38	3,569	251	22	20.7	7.8	332
03A	326	5	24.2	1.74	3,015	271	29	20.6	7.7	336
04B	371	10	21.6	1.77	1,915	281	62	20.7	7.9	337 (341)
05A	426	18	19.0	1.80	2,821	290	84	20.7	7.9	342
06B	536	7	14.5	1.91	2,964	320	64	20.5	7.8	347 (344)
07A	640	7	14.9	1.98	3,132	325	74	20.6	7.7	348 (346)
08B	748	6	16.5	2.00	3,467	330	58	20.5	7.7	351 (351)
09A	850	3	11.7	2.01	2,479	343	70	20.6	7.8	351 (351)
10B	959	1	11.1	1.91	2,221	355	74	20.8	7.7	354 (353)
REW	1,060	--	0.0	0.00	0	--	--	--	--	--
MEAN			16.7	1.69						
TOTAL	1,060				29,898					

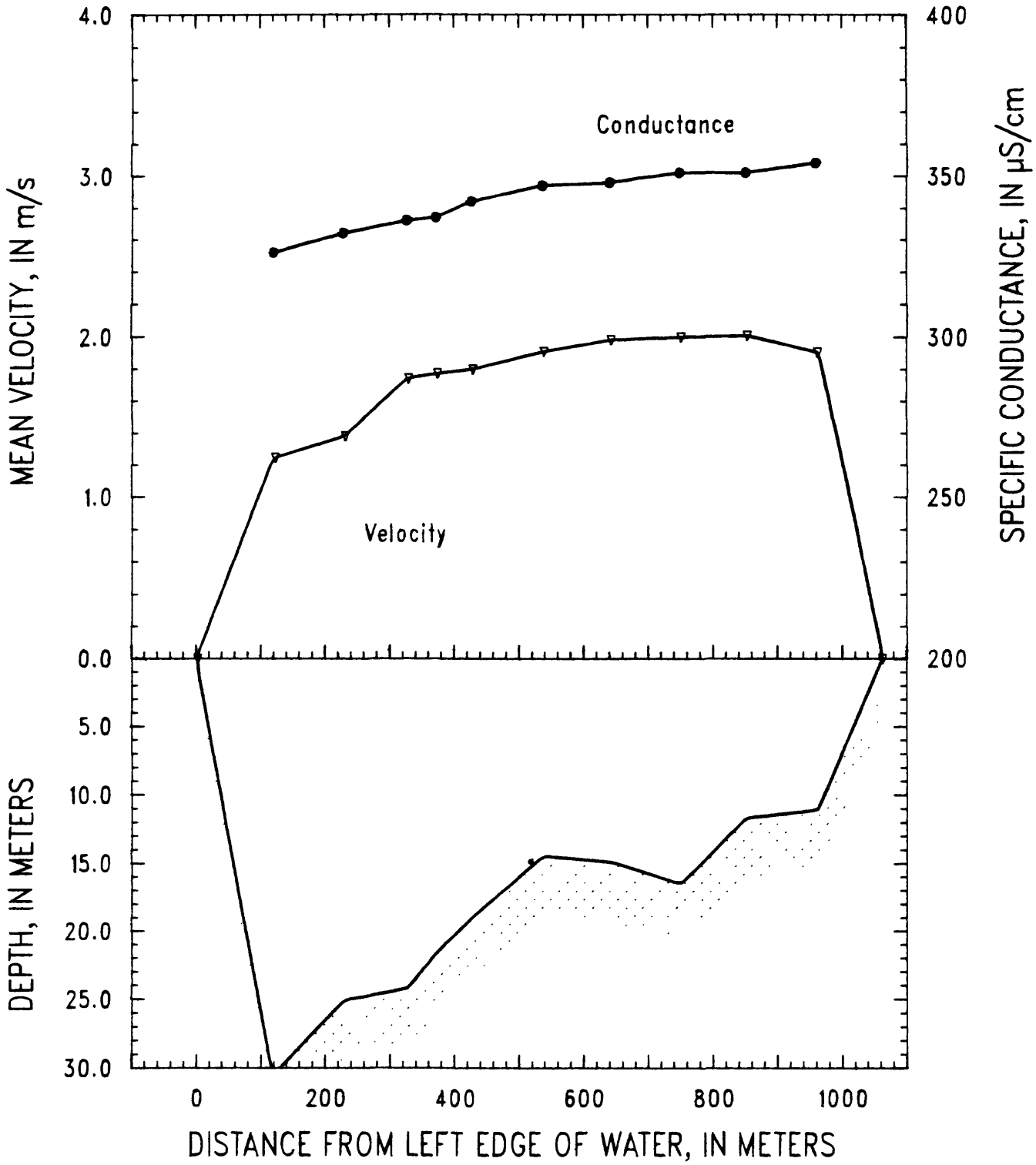

Figure 70. Mississippi River above New Madrid, Missouri, on June 2, 1990.

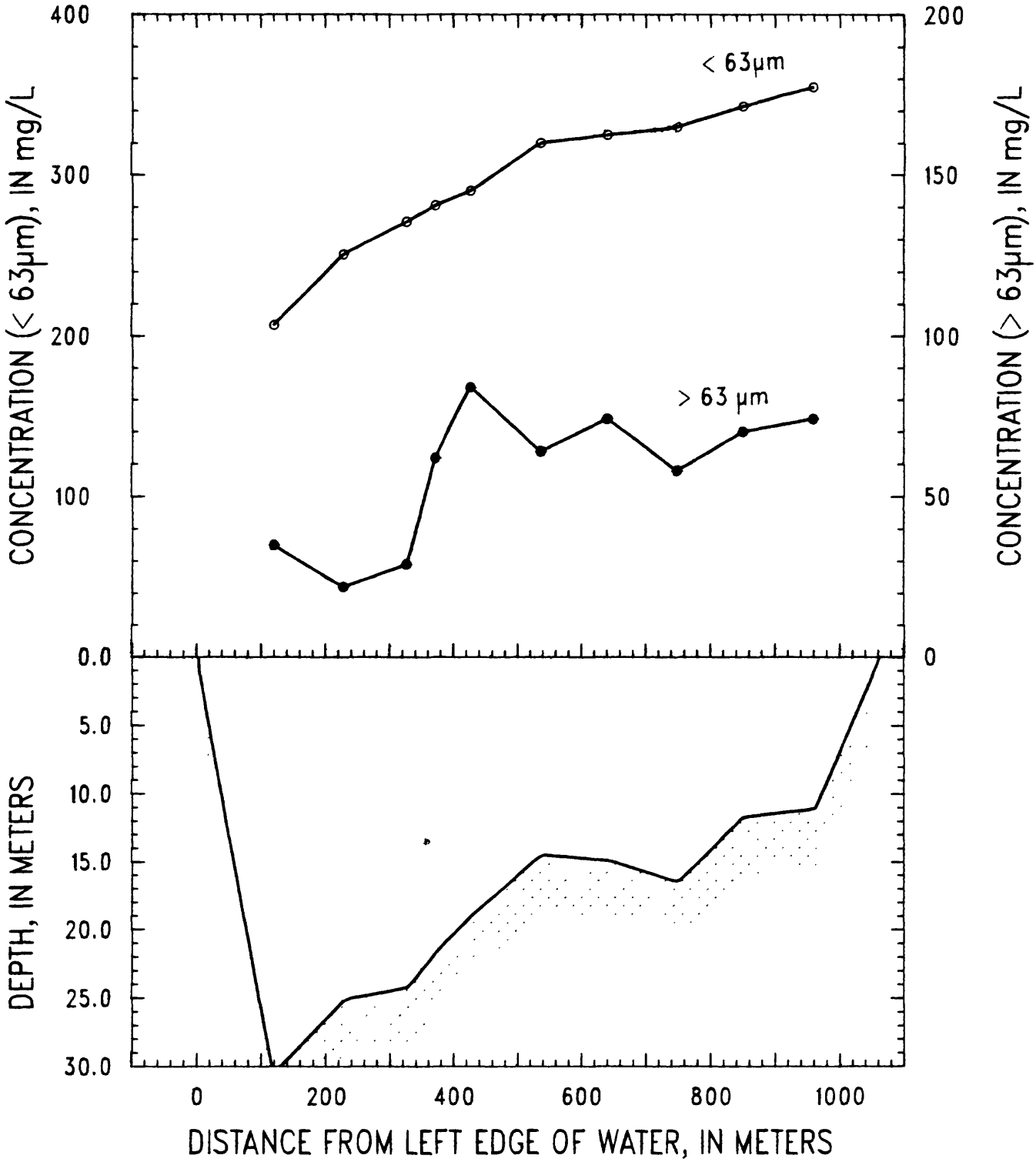

Figure 71. Mississippi River above New Madrid, Missouri, on June 2, 1990--suspended-sediment concentration.

SITE: Mississippi River near Point Pleasant, Missouri 06-02-90
PARTY: Moody, Delaune, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Ten verticals using 1/8- and 3/16-inch nozzles and variable transit rate. Strong southwest wind dropped off to 5-10 knots. Values of temperature, pH, and specific conductance are measurements of the depth-integrated sample and measurements of the surface sample are in parentheses.

Vertical	Mean dist. from LEW (m)	Standard deviation (m)	Mean depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Suspended sediment (mg/L) <63 µm	Suspended sediment (mg/L) >63µm	Temperature (°C)	pH	Specific conductance (µS/cm)	
LEW	0	--	0.0	0.00	0	--	--	--	--	--	
01B	149	4	22.8	1.93	4,356	239	48	20.9	7.8	332	
02A	198	4	19.7	1.92	2,496	257	131	20.7	7.8	334	
03A	281	4	15.4	1.79	2,926	278	--	20.9	7.7	336	
04B	410	5	13.0	1.79	3,207	296	133	20.7	7.7	341	
05A	556	10	12.5	1.58	2,750	303	42	21.0	7.9	342	
06B	689	6	12.4	1.57	2,574	302	31	20.7	7.8	344	(345)
07A	821	9	13.7	1.43	2,527	309	25	20.7	7.7	346	
08B	947	7	14.4	1.35	2,524	309	20	20.5	7.8	347	
09A	1,081	4	15.1	1.41	2,815	318	15	20.6	7.7	349	
10B	1,211	3	14.2	1.48	2,823	317	16	20.6	7.7	347	
REW	1,350	--	0.0	0.00	0	--	--	--	--	--	
MEAN			13.3	1.62							
TOTAL	1,1350				28,998						

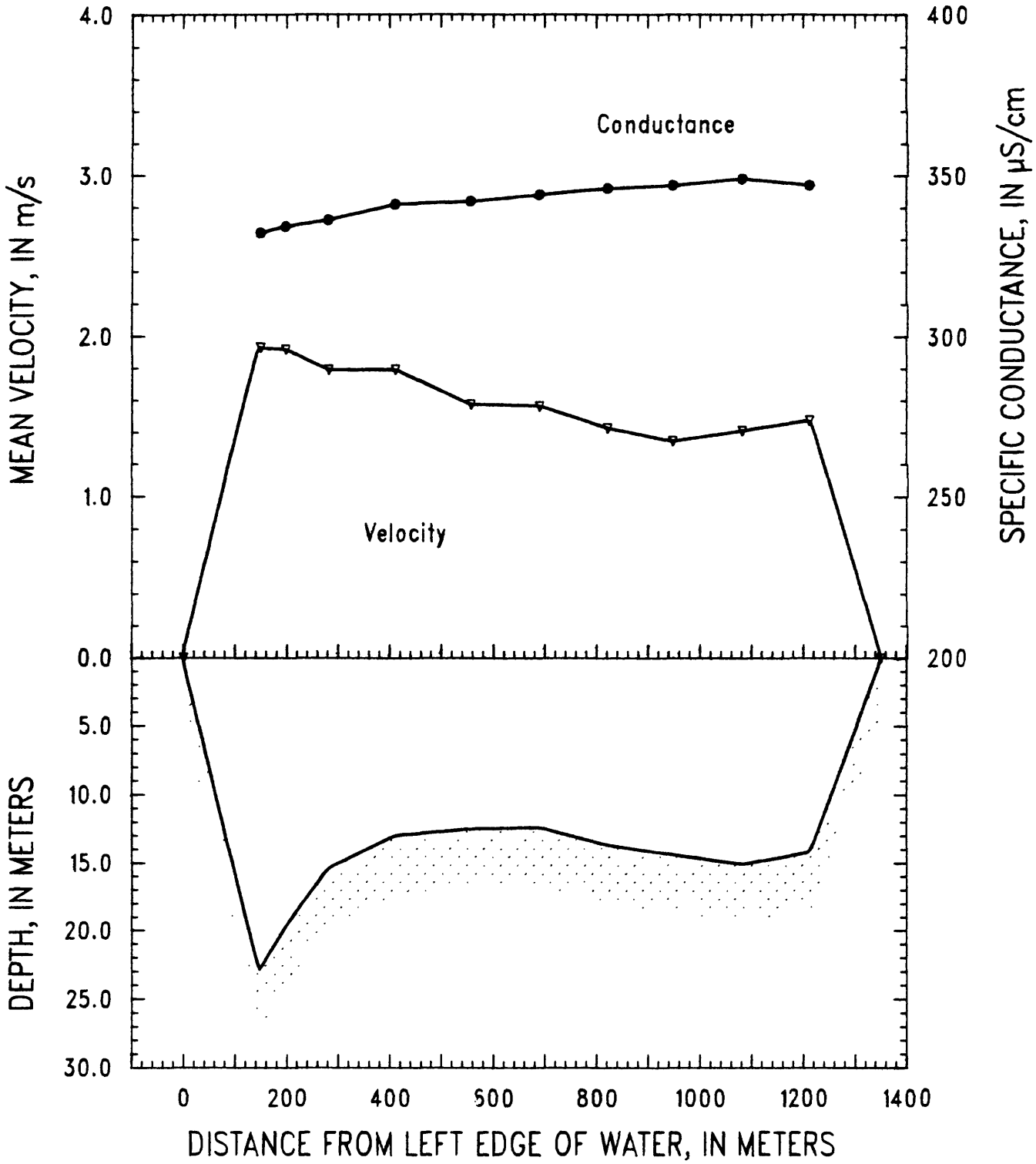

Figure 72. Mississippi River near Point Pleasant, Missouri, on June 2, 1990.

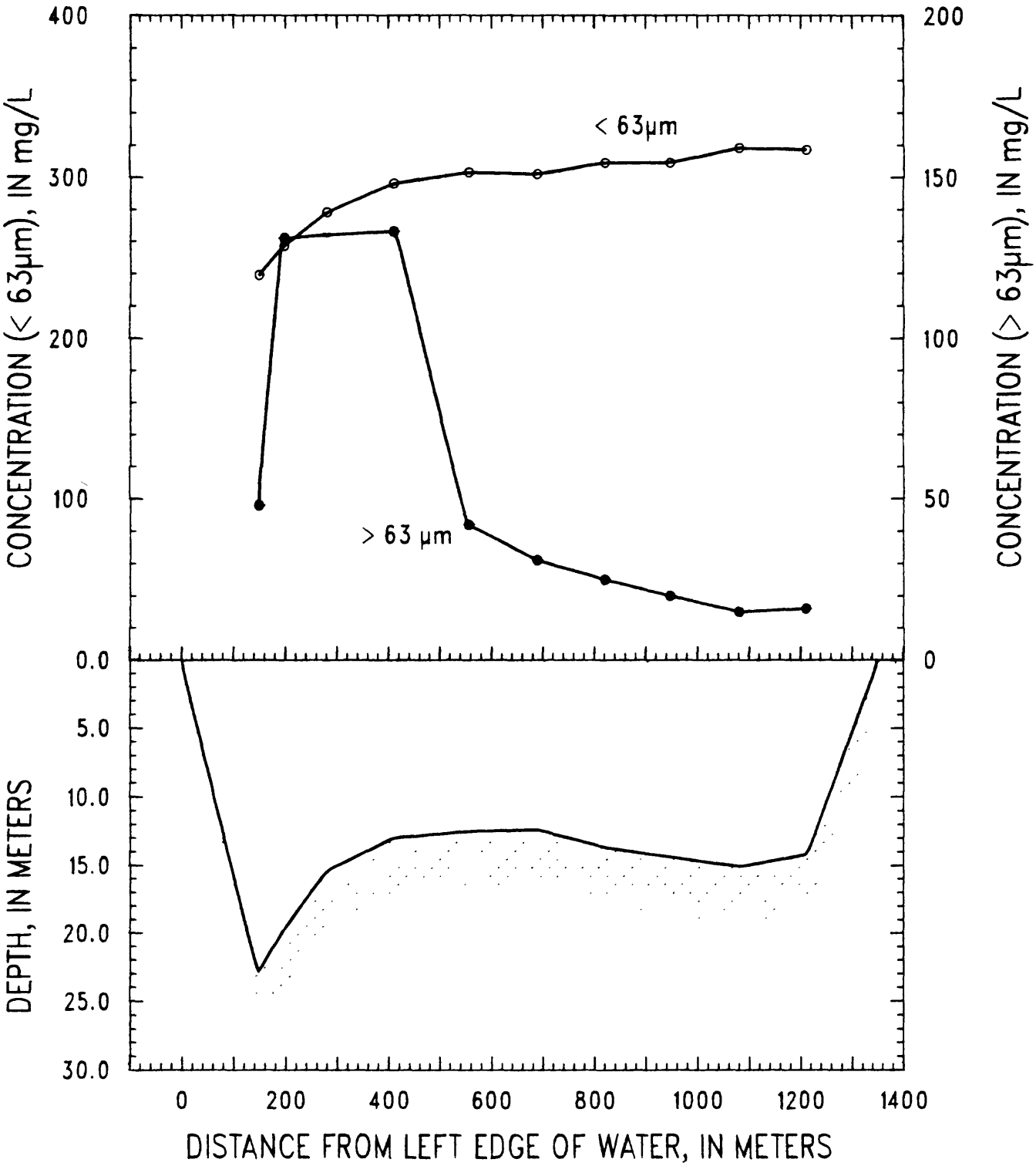

Figure 73. Mississippi River near Point Pleasant, Missouri, on June 2, 1990--suspended-sediment concentration.

SITE: Mississippi River at Caruthersville, Missouri 06-03-90
PARTY: Moody, Delaune, LeBoeuf, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Nine verticals collected using the 1/8- and 3/16-inch nozzles and a variable transit rate. Values of temperature, pH, and specific conductance are measurements of the depth-integrated sample and measurements of the surface sample are in parentheses.

Vertical	Mean dist. from LEW (m)	Standard deviation (m)	Mean depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Suspended sediment (mg/L) <63 µm	Suspended sediment (mg/L) >63µm	Temperature (°C)	pH	Specific conductance (µS/cm)	
LEW	0	--	1.0	0.00	0	--	--	--	--	--	
01B	95	4	8.9	1.51	1,202	238	65	20.0	7.8	336	
02A	179	2	9.4	1.76	1,343	242	56	20.0	7.7	337	
03B	257	1	11.4	1.86	1,751	243	108	19.8	7.8	338	
04A	344	3	14.2	2.04	2,537	246	100	19.8	7.8	339	
05B	432	3	18.4	2.22	3,554	255	128	19.8	7.8	340	
06B	518	2	22.2	2.46	4,280	263	88	20.1	7.8	343	
07A	589	5	24.3	2.53	4,219	268	39	20.1	7.8	342	
08B	655	9	24.7	2.63	4,847	271	27	20.3	7.7	342	(345)
09A	738	19	25.0	2.18	5,294	242	9	20.7	7.8	343	(345)
REW	849	--	0.0	0.00	0	--	--	--	--	--	
MEAN			15.3	2.23							
TOTAL	849				29,027						

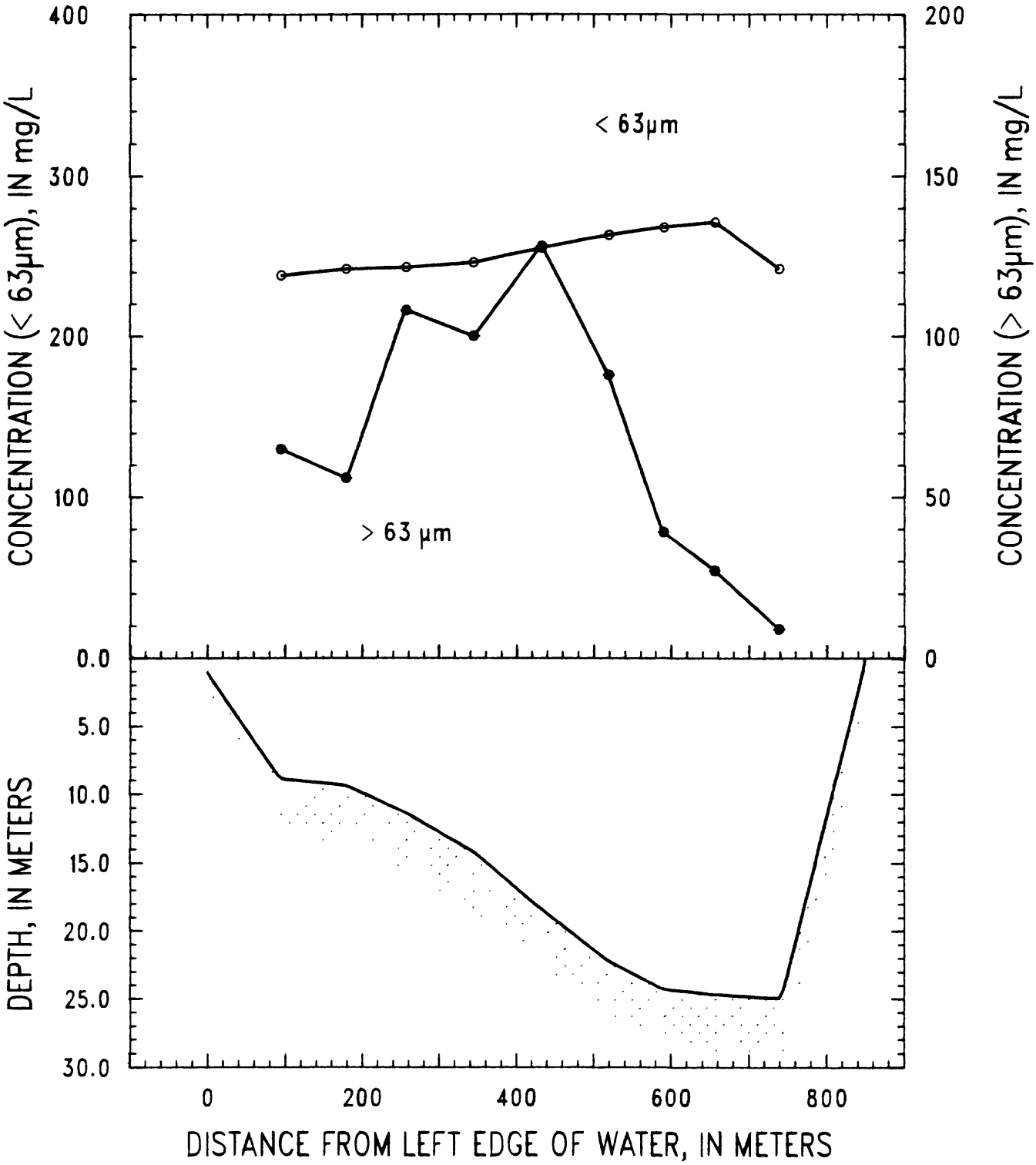

Figure 75. Mississippi River at Caruthersville, Missouri, on June 3, 1990--suspended-sediment concentration.

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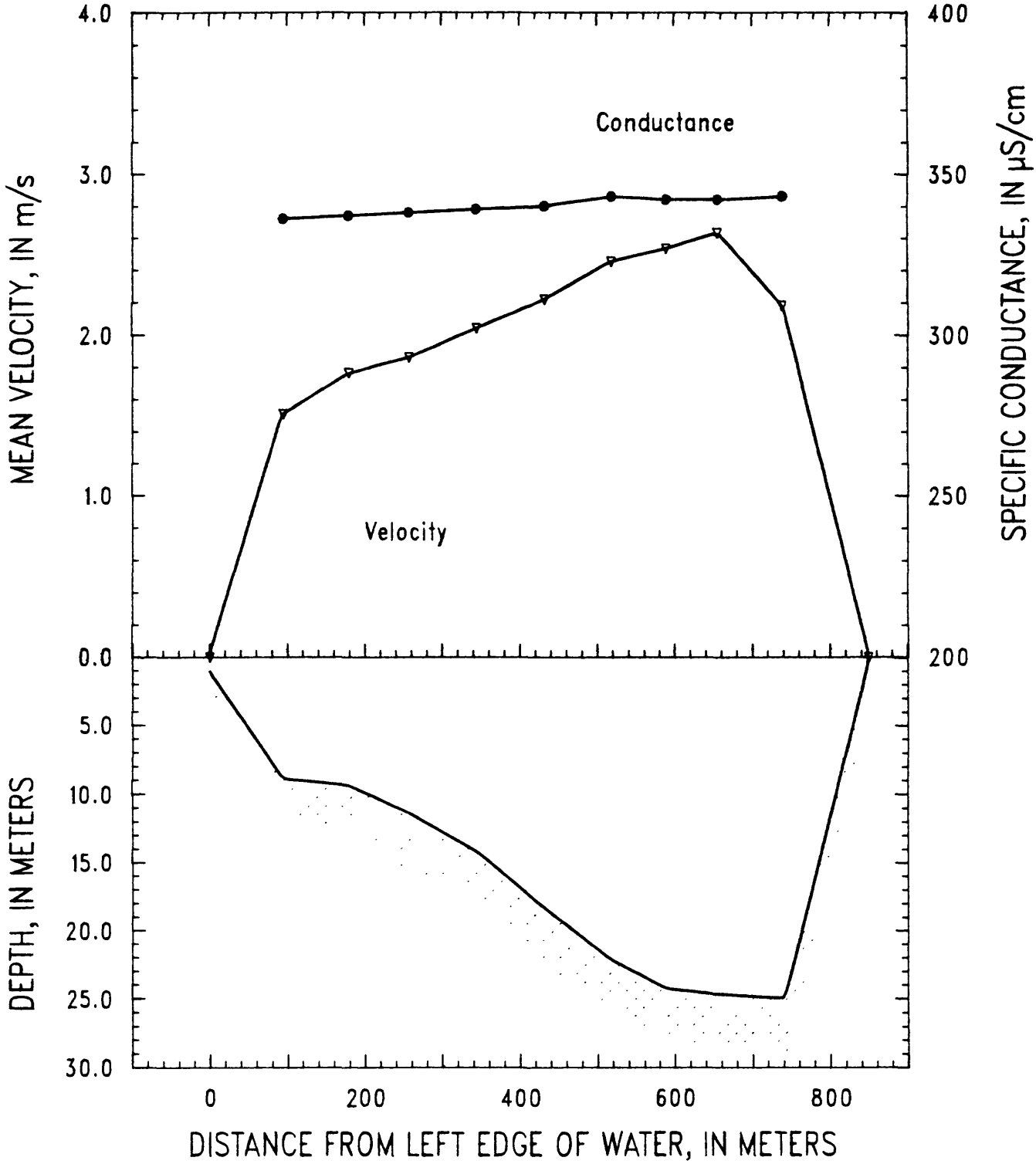

Figure 74. Mississippi River at Caruthersville, Missouri, on June 3, 1990.

SITE: Illinois River at Valley City, Illinois 06-07-90
PARTY: Moody, Delaune, LeBoeuf, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: 13.03 ft ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 150-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: USGS Illinois District collected simultaneous NASQAN sample. Dense fog in the morning and heavy thunderstorm in the afternoon. Five test velocities (free boat); anchored at five verticals to collect water. Various transit rates (4-19 cm/s) and various nozzle sizes (1/4 inch and 5/16 inch) were used.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
X05	40	5.0	0.84	122	--	--	--	--	--
1AB	58	7.1	0.93	123	16.22	100	9.4	7.9	691
X04	77	7.4	0.80	103	--	--	--	--	--
2AB	93	8.0	0.99	127	15.87	100	9.6	8.2	735
X03	109	8.7	1.09	105	--	--	--	--	--
3AB	115	8.8	1.04	196	15.33	100	9.5	8.2	737
4AB	152	8.8	1.00	246	15.42	100	9.7	8.2	736
05B	171	7.2	0.73	58	7.42	--	--	--	--
05A	174	7.0	0.79	53	8.04	100	9.7	8.2	735
X01	190	5.4	0.76	63	--	--	--	--	--
X06	205	4.8	0.41	31	--	--	--	--	--
REW	221	1.0							
MEAN		6.2	0.90						
TOTAL	221			1,227	78.30	500			

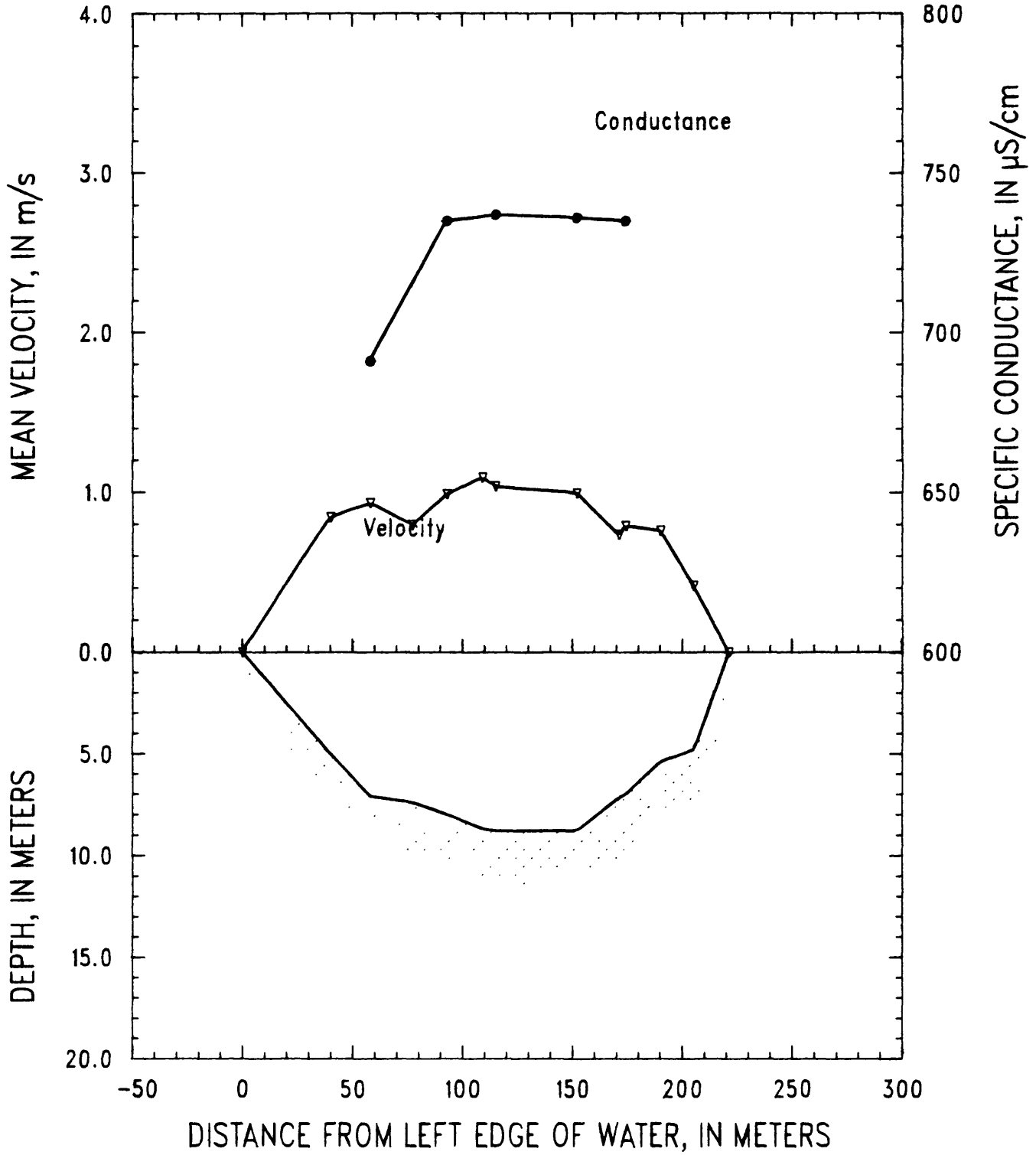

Figure 76. Illinois River at Valley City, Illinois, on June 7, 1990.

SITE: Mississippi River below Grafton, Illinois 06-11-90
PARTY: Moody, Garbarino, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: 16.8 ft ENDING GAGE HEIGHT: 16.1 ft
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Beautiful day and wonderful scenery. Transit rate was 8 cm/s and the nozzle was 1/4 inch. Open river. USGS Missouri District collected a simultaneous NASQAN sample.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	53	8.1	1.05	376	4.71	30	22.0	8.0	737
X01	88	9.2	1.02	206	--	--	--	--	--
02B	97	9.2	1.02	240	5.51	42	22.0	7.9	617
03A	139	8.7	0.96	383	5.01	45	21.9	7.8	566
04B	189	7.7	0.96	323	4.62	39	22.0	7.8	497
X02	226	7.3	1.02	171	--	--	--	--	--
05A	235	7.3	0.95	180	4.36	37	22.0	7.7	466
06B	278	7.4	0.92	304	3.77	33	21.9	7.8	416
07A	324	6.5	0.81	227	3.04	29	21.8	7.8	402
X10	364	5.4	0.86	109	--	--	--	--	--
08B	371	6.1	0.86	111	2.57	29	21.8	7.7	401
X11	406	6.4	0.85	101	--	--	--	--	--
09A	408	5.1	0.90	126	2.46	25	21.9	7.7	396
10B	461	5.3	0.78	179	2.43	24	22.0	7.8	391
11A	494	5.0	0.90	175	2.28	22	22.0	7.7	389
12B	539	5.7	0.72	127	2.46	18	22.1	7.7	388
X04	556	5.8	0.78	138	--	--	--	--	--
13A	600	5.0	0.77	155	2.62	15	22.1	7.7	385
14B	636	6.9	0.81	190	3.56	19	22.1	7.7	384
15A	668	7.8	0.81	187	4.03	23	22.2	7.7	382
X05	695	9.2	0.52	131	--	--	--	--	--
16B	723	8.2	0.49	155	2.08	31	22.2	7.7	376
17A	772	7.8	0.80	272	2.94	21	22.2	7.6	359
18B	810	7.0	0.73	123	3.26	19	22.4	7.7	355
X06	820	7.1	0.69	101	--	--	--	--	--
19A	851	5.4	0.71	144	2.18	11	22.4	7.7	355
20B	895	4.2	0.57	107	1.03	4	22.6	7.7	353
REW	941	0.0	0.00	0	--	--	--	--	--
MEAN		6.4	0.83		64.92	516			
TOTAL	941			5,041					

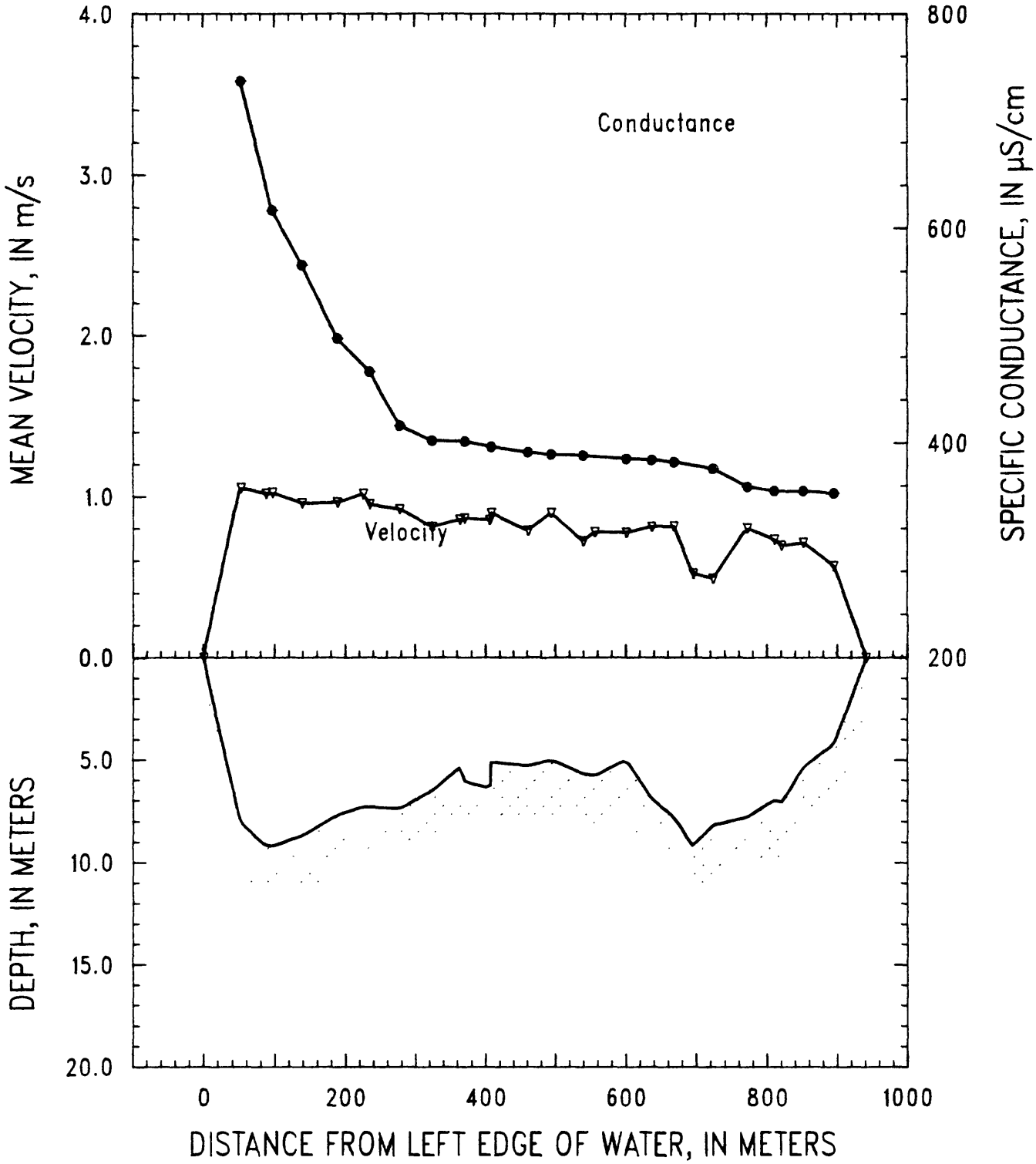

Figure 77. Mississippi River below Grafton, Illinois, on June 11, 1990.

SITE: Mississippi River at Thebes, Illinois 06-13-90
PARTY: Moody, Garbarino, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: 32.98 ft
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Transit rate was 20 cm/s and the nozzle was 3/16 inch. Measured to the right edge of flow; the edge of water was far into the willows, but there was no significant flow. Depth was estimated at REF. USGS Missouri District collected a simultaneous NASQAN sample from Thebes railroad bridge.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	30	5.5	0.16	27	0.31	7	22.0	7.5	363
02B	61	11.9	1.21	419	2.35	12	21.7	7.5	358
03A	88	12.1	1.62	559	3.20	15	21.8	7.5	361
04B	118	13.2	1.85	611	4.42	16	21.1	7.5	360
05A	138	14.1	1.99	814	4.49	21	22.2	7.5	360
06B	176	13.7	2.11	911	4.68	19	22.1	7.4	359
07A	201	14.0	2.12	905	4.48	20	22.1	7.5	359
08B	237	13.8	2.19	966	5.52	21	21.3	7.8	359
09A	265	13.9	2.21	954	5.52	20	21.8	7.9	357
10B	299	14.3	2.18	702	5.10	24	22.1	7.9	356
X03	310	13.5	2.36	335	--	--	--	--	--
X08	320	14.0	2.03	242	--	--	--	--	--
11A	327	13.5	2.05	541	5.17	22	20.9	8.0	357
12B	359	13.8	2.30	938	4.97	23	20.5	7.8	356
13A	386	12.6	2.25	794	4.81	21	21.1	7.7	355
14B	415	12.3	1.99	637	4.23	17	21.7	7.7	356
15A	438	12.1	1.77	622	3.15	12	20.9	7.7	356
16B	473	12.3	1.41	562	3.16	12	21.9	7.7	356
17A	503	10.7	1.21	369	2.18	9	21.3	7.7	356
18B	530	10.2	0.98	270	1.66	7	22.1	7.6	357
19A	557	9.7	0.96	302	1.61	6	21.4	7.6	357
20B	595	6.8	0.57	129	0.46	3	22.7	7.6	356
REF	623	2.0	0.00	0	--	--	--	--	--
MEAN		11.4	1.77						
TOTAL	623			12,609	71.47	307			

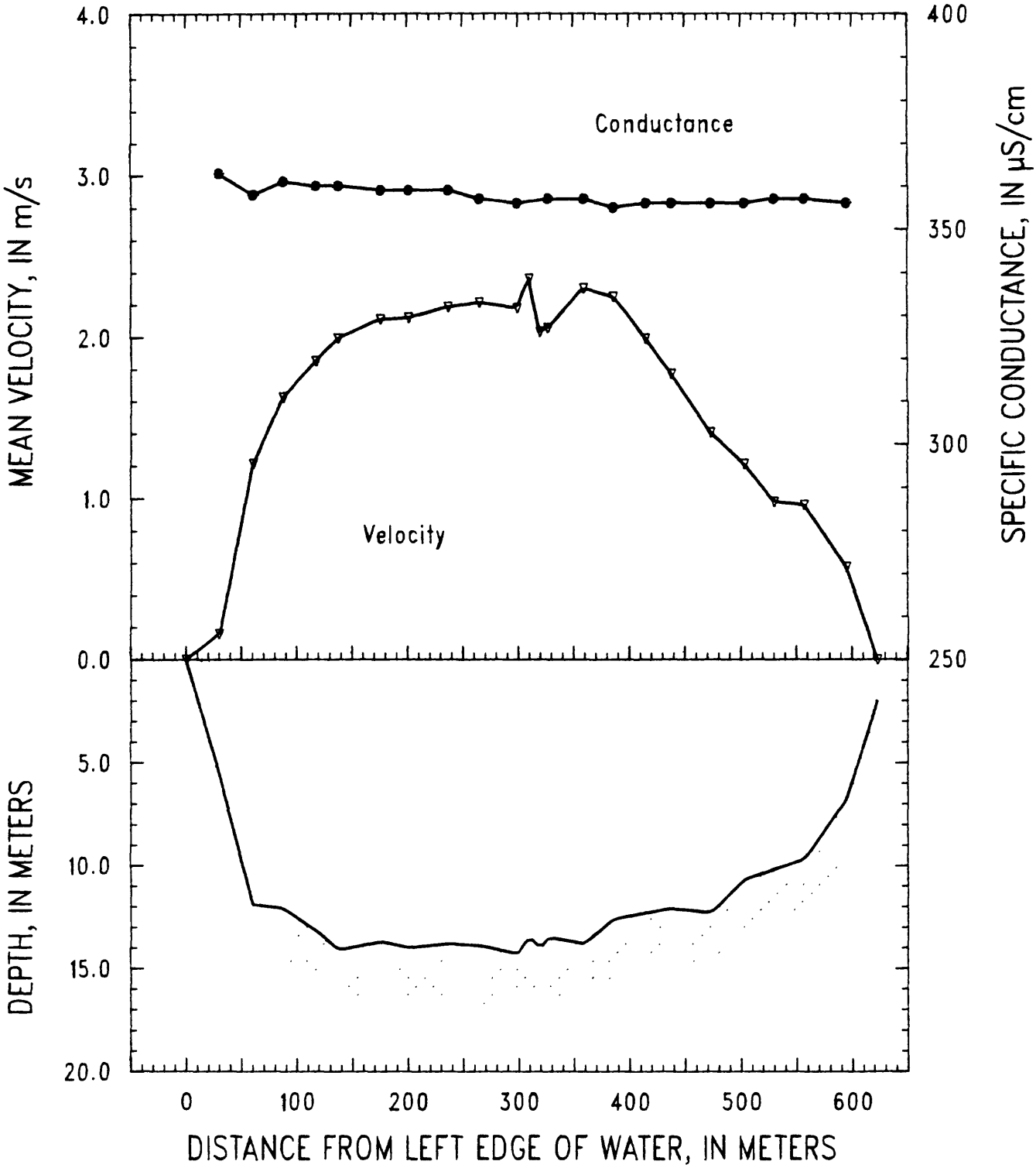

Figure 78. Mississippi River at Thebes, Illinois, on June 13, 1990.

SITE: Ohio River at Olmsted, Illinois 06-14-90
PARTY: Moody, Garbarino, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: 38.0 ft ENDING GAGE HEIGHT: 37.8 ft
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS: Transit rate was 11 cm/s; nozzle was 1/4 inch; order of verticals: 15, 20-1. USGS Kentucky District collected a NASQAN sample about 2 miles upriver.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	53	7.4	0.53	202	1.64	8	22.0	7.6	267
02B	103	9.1	0.69	305	2.97	13	22.2	7.7	270
X05	150	9.7	0.66	199	--	--	--	--	--
03A	165	9.6	0.71	181	2.89	14	21.7	7.7	271
04B	203	10.0	0.81	391	3.32	16	21.6	7.7	271
05A	262	10.9	0.74	369	2.62	16	21.8	7.7	270
06B	295	11.8	0.74	391	3.70	19	22.2	7.7	270
X04	352	13.3	0.71	302	--	--	--	--	--
07A	359	13.2	0.71	262	4.39	20	22.3	7.7	271
08B	408	13.9	0.75	488	4.20	23	22.2	7.7	270
09A	453	13.7	0.84	529	4.84	24	22.0	7.7	270
10B	500	13.4	0.82	541	5.23	23	22.3	7.7	269
X03	551	13.4	0.80	312	--	--	--	--	--
11A	558	13.5	0.81	258	5.60	23	22.4	7.7	266
12B	598	13.7	0.86	505	5.58	24	22.2	7.7	267
13A	644	13.9	0.83	581	5.30	24	23.2	7.6	273
14B	699	13.8	0.90	625	5.75	27	21.7	7.7	276
15A	745	14.0	0.89	306	5.73	27	23.2	7.7	282
X02	748	14.1	0.88	340	--	--	--	--	--
16B	800	14.1	0.88	633	5.82	27	22.5	7.7	285
17A	850	14.6	0.83	591	5.54	25	22.2	7.6	286
18B	897	14.7	0.78	542	5.48	21	21.9	7.6	290
19A	944	15.3	0.62	447	4.79	22	22.9	7.6	292
20B	991	8.2	0.60	251	1.79	5	23.0	7.6	291
REW	1,046	0.0	0.00	0	--	--	--	--	--
MEAN		11.8	0.78						
TOTAL	1,046			9,551	87.18	393			

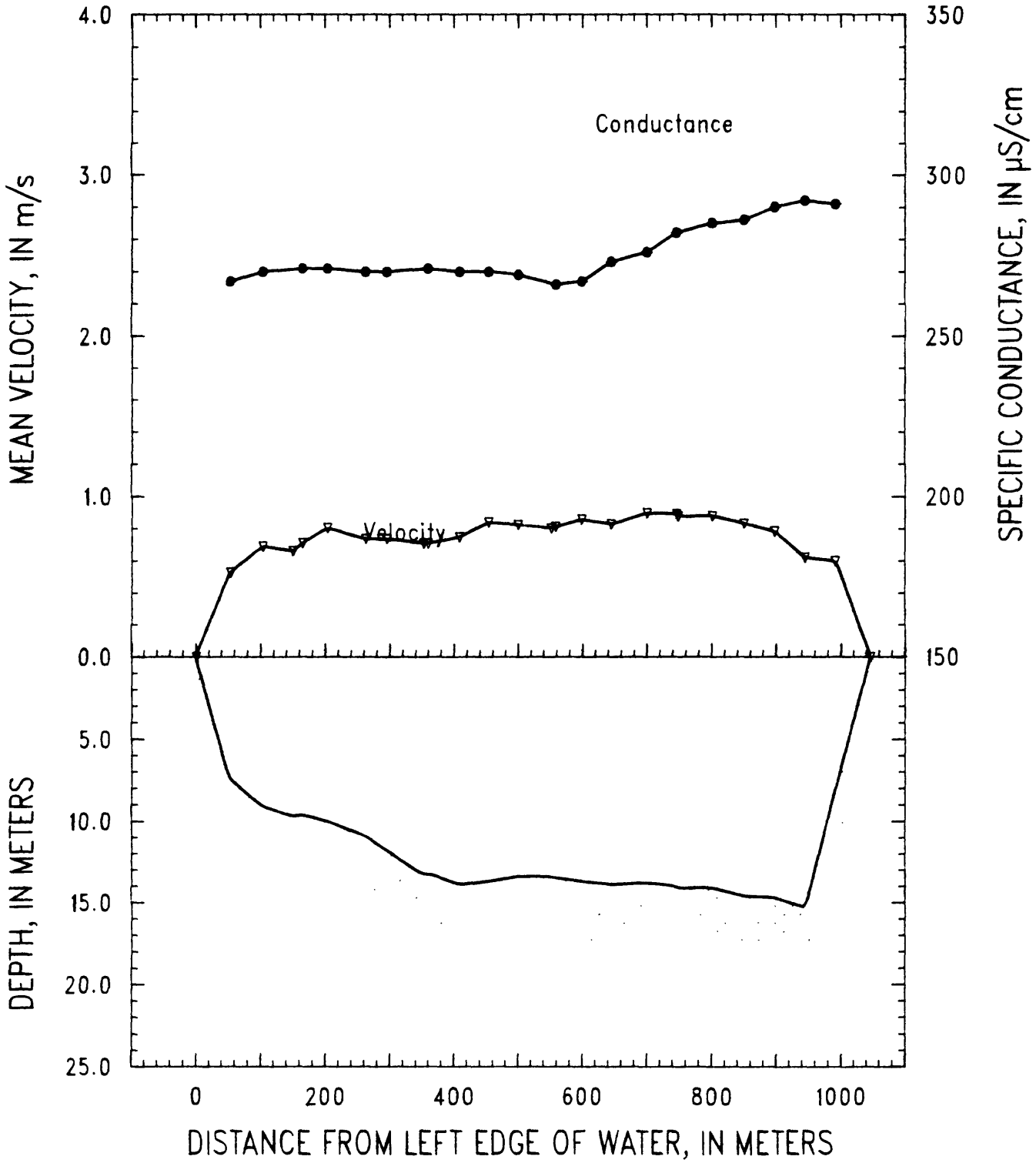

Figure 79. Ohio River at Olmsted, Illinois, on June 14, 1990.

SITE: Mississippi River below Memphis, Tennessee 06-18-90
PARTY: Moody, Garbarino, and LeBoeuf METER: SOLID CUP
STARTING GAGE HEIGHT: 22.3 ft ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: W-297222 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.744 + 0.011

REMARKS:
Discharge was measured between the left edge of water and the right edge of flow. Transit rate was 13 cm/s and nozzle was 1/8 inch. Arkansas District collected a simultaneous NASQAN sample at mile 734.6.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	60	10.1	1.00	545	1.32	9	25.6	7.5	341
02B	108	10.3	1.29	624	1.49	12	25.6	7.5	342
03A	154	10.1	1.63	675	2.30	14	25.6	7.5	338
04B	190	10.3	1.77	800	2.61	15	25.6	7.5	337
05A	242	11.7	1.91	1,006	3.42	19	25.6	7.5	338
06B	280	12.4	1.88	1,373	3.29	20	25.6	7.5	340
07A	360	15.3	1.95	1,449	4.47	23	25.6	7.5	340
08B	377	16.0	1.99	845	4.46	24	26.2	7.5	341
X04	413	17.4	1.93	1,077	--	--	--	--	--
09A	441	18.2	1.93	772	4.29	27	25.7	7.5	344
10B	457	19.1	1.83	1,402	5.11	29	26.0	7.5	344
11A	521	20.7	1.84	1,333	5.06	29	25.9	7.4	345
X07	527	21.4	1.88	905	--	--	--	--	--
X08	566	21.0	1.77	1,041	--	--	--	--	--
12B	583	21.2	1.69	608	5.29	30	25.9	7.4	347
X03	600	20.8	1.76	749	--	--	--	--	--
13A	624	20.3	1.57	1,180	3.84	25	25.6	7.4	346
14B	674	18.7	1.40	1,110	3.90	21	25.6	7.4	344
X02	709	18.8	1.35	712	--	--	--	--	--
15A	730	18.8	1.12	536	2.46	17	26.3	7.4	346
16B	760	18.4	1.09	683	2.11	14	25.7	7.4	348
X01	798	16.7	0.88	367	--	--	--	--	--
17A	810	16.0	0.81	370	1.47	10	25.7	7.4	348
18B	855	13.0	0.70	454	1.22	6	25.8	7.4	348
19A	910	9.3	0.31	153	0.27	3	25.5	7.5	350
20B	962	6.7	0.08	24	0.36	2	26.6	7.5	349
REF	1,002	2.0	--	--	--	--	--	--	--
MEAN		14.1	1.47						
TOTAL	1,002			20,793	58.74	349			

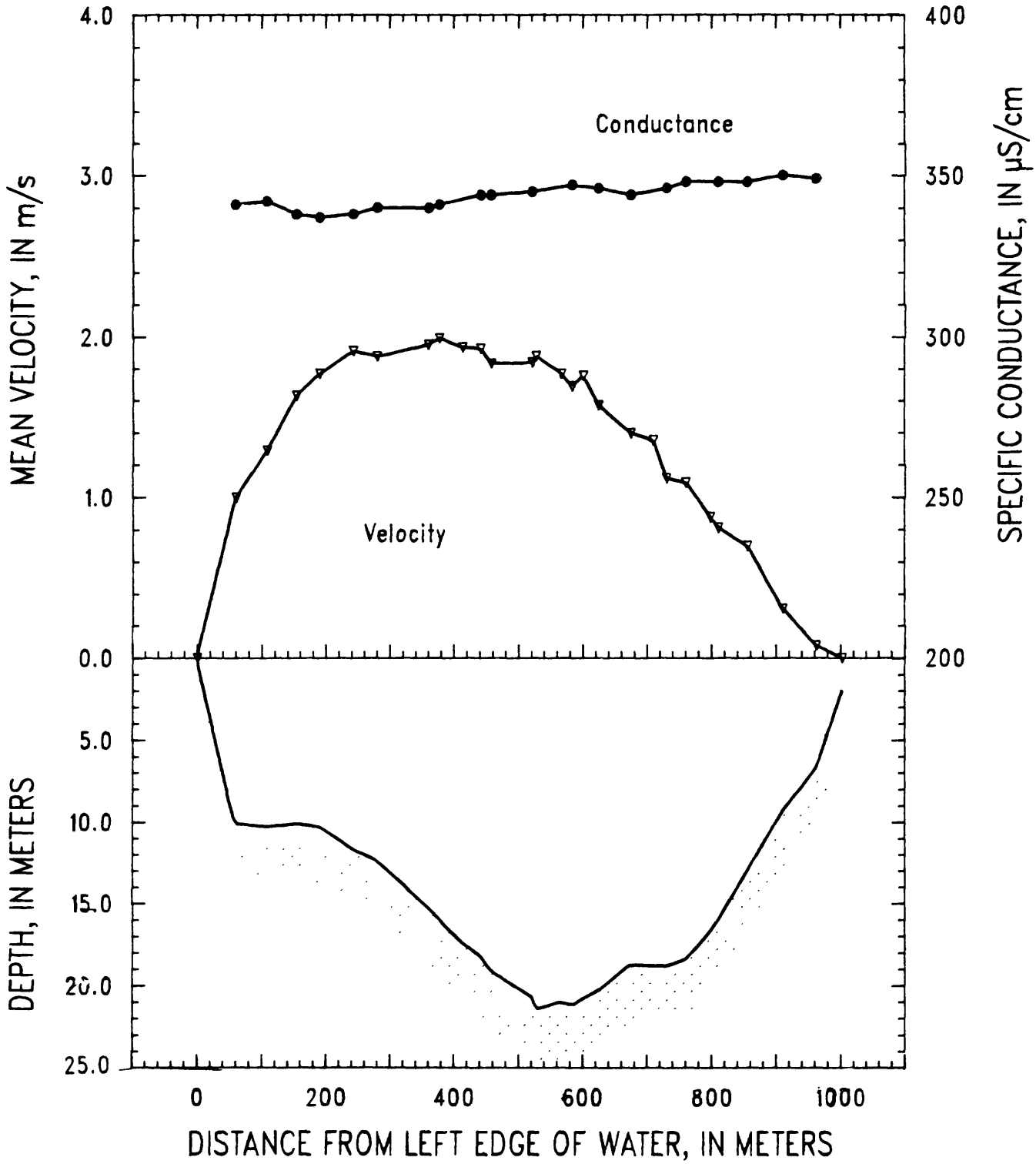

Figure 80. Mississippi River below Memphis, Tennesse, on June 18, 1990.

SITE: Mississippi River below Arkansas City, Arkansas 06-20-90
PARTY: Moody, Garbarino, and LeBoeuf METER: SOLID CUP
STARTING GAGE HEIGHT: 29.8 ft ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: 90JM1 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.755 + 0.011

REMARKS: USGS Arkansas District collected a simultaneous NASQAN sample 0.1 mile below the section. Transit rate was about 16 cm/s and the nozzle was 1/8 inch.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01B	56	4.5	0.45	97	0.25	2	26.1	7.6	326
02A	95	7.4	0.63	199	0.52	4	26.2	7.7	325
03B	141	8.7	0.82	275	0.99	5	26.0	7.6	325
X05	172	8.9	0.95	194	--	--	--	--	--
04A	187	8.7	0.88	287	1.02	5	25.9	7.6	326
05B	247	9.4	0.99	511	1.15	6	26.0	7.6	326
06A	297	10.5	1.10	491	1.42	8	26.0	7.6	326
07B	332	11.3	1.19	704	1.66	10	26.3	7.6	325
08A	402	12.6	1.35	691	1.91	12	26.0	7.6	325
X04	413	12.6	1.57	257	--	--	--	--	--
09B	428	12.9	1.54	297	2.42	15	26.0	7.7	325
X07	443	13.4	1.53	411	--	--	--	--	--
10A	468	14.3	1.76	1,286	3.09	19	26.1	7.6	323
11B	545	19.7	1.89	1,581	4.53	18	26.1	7.7	322
X06	553	19.2	2.06	809	--	--	--	--	--
12A	586	18.0	2.35	1,457	5.04	23	26.2	7.7	321
X03	622	22.5	1.86	1,127	--	--	--	--	--
13B	640	22.3	1.74	1,375	4.49	23	26.2	7.6	320
14A	693	21.5	2.02	2,196	5.28	24	26.1	7.6	321
15B	741	21.9	2.03	1,268	5.27	27	26.0	7.6	320
X02	750	22.0	2.01	1,572	--	--	--	--	--
16A	812	23.0	1.88	2,145	5.47	27	25.5	7.6	318
17B	849	23.3	1.95	2,154	5.00	25	25.5	7.6	319
18A	907	25.0	1.51	1,245	4.80	26	26.1	7.6	317
X01	915	25.0	1.88	894	--	--	--	--	--
19B	945	23.7	1.33	1,276	3.60	18	26.2	7.7	313
20A	996	14.2	0.84	659	1.38	2	26.1	7.7	317
REW	1,055	0.0	0.00	0	--	--	--	--	--
MEAN		15.0	1.61						
TOTAL	1,055			25,458	59.29	299			

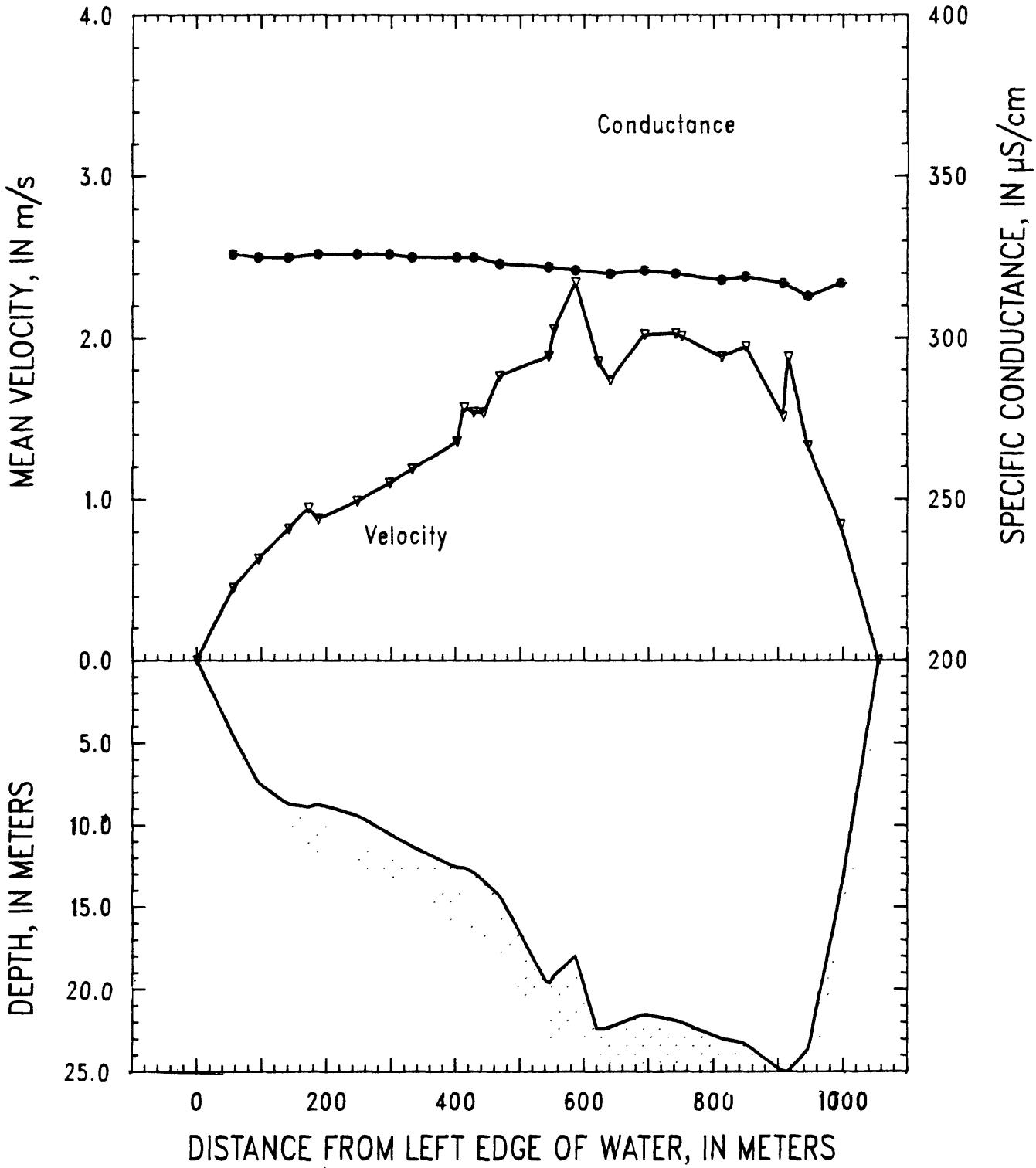

Figure 81. Mississippi River below Arkansas City, Arkansas, on June 20, 1990.

SITE: Yazoo River below Steele Bayou, Mississippi 06-22-90
PARTY: Moody, Garbarino, and LeBoeuf METER: SOLID CUP
STARTING GAGE HEIGHT: 37.7 ft at Vicksburg bridge
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: 90JM1 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.755 + 0.011

REMARKS: Transit rate (7-12 cm/s) and nozzle sizes (1/4-5/16 inch) were variable. Equal-discharge sampling at anchor stations: 31, 58, 79, 100, and 129. Collected 2A- and 2B-composite samples at each vertical. The second B sample at vertical 1 (1B2) was not at 34 m from LEW. Underestimated effect of bank and submerged brush on left bank. Order of verticals: 4, 3, 2, 1, 5. USGS Mississippi District collected simultaneous NASQAN sample at three verticals. Steele Bayou was flowing and entered on the right bank about mile 0.5 downstream from the station.

Vertical	Dist. from LEF (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEF	0	2.0	--	--	--	--	--	--	--
1A,B	34	10.3	0.37	78	10.08	0	27.7	6.9	118
1B2	41	11.2	0.57	45	--	--	--	--	--
X01	48	14.6	0.74	119	--	--	--	--	--
2A,B	63	14.9	0.78	133	9.49	0	27.7	6.8	118
3A,B	71	15.1	0.78	142	8.78	0	28.0	6.9	118
X03	87	15.7	0.77	127	--	--	--	--	--
4A,B	92	15.5	0.79	256	8.10	0	28.1	6.8	114
05B	129	13.4	0.64	177	5.91	--	--	--	--
05A	133	12.8	0.57	72	5.23	0	27.8	6.9	115
X02	149	7.6	0.38	98	--	--	--	--	--
REW	200	0.0	0.00	0	--	--	--	--	--
MEAN		9.8	0.64		47.59	0			
TOTAL	200			1,247					

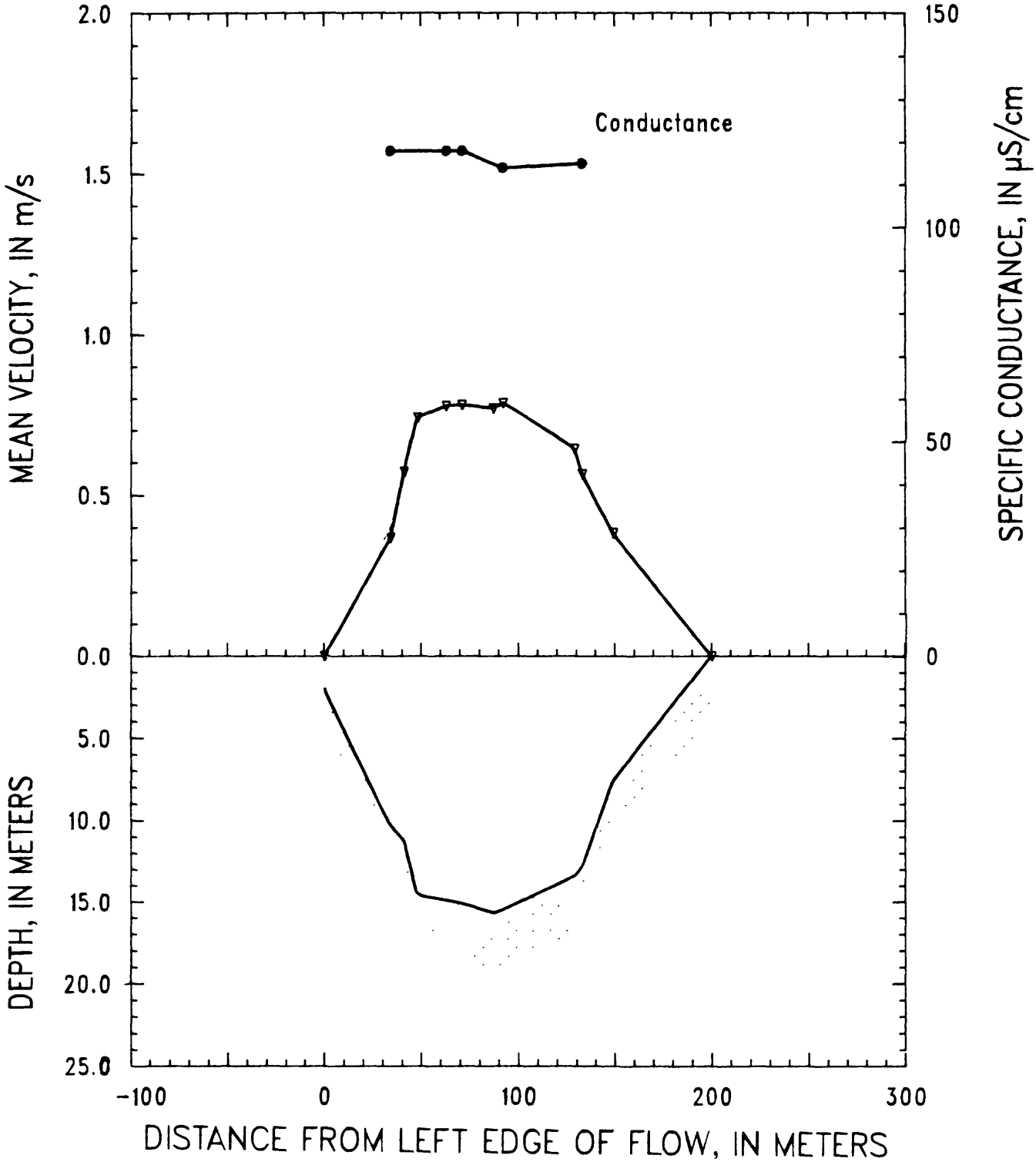

Figure 82. Yazoo River below Steele Bayou, Mississippi, on June 22, 1990.

SITE: Mississippi River below Vicksburg, Mississippi 06-23-90
PARTY: Moody, Garbarino, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: 36.7 ft ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: 90JM1 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.755 + 0.011

REMARKS: Transit rate was 15 cm/s and a 1/8-inch nozzle was used. USGS Mississippi District collected a NASQAN sample just downriver from the bridge from ACADIANA after we sampled this site. Beautiful day (low humidity) with light breeze.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	66	13.6	0.75	691	1.23	7	26.8	7.5	288
02B	135	22.1	1.55	1,659	4.06	26	26.7	7.5	289
X01	163	21.6	1.61	815	--	--	--	--	--
03A	182	21.3	1.73	1,637	4.39	27	26.6	7.6	295
04B	252	20.7	1.64	1,866	4.59	26	26.2	7.6	303
X02	292	20.6	1.75	1,012	--	--	--	--	--
05A	308	20.6	1.74	608	4.58	28	26.5	7.6	308
X06	326	20.3	1.74	988	--	--	--	--	--
06B	364	20.1	1.82	1,828	4.46	27	26.5	7.7	318
07A	426	19.5	1.69	1,844	4.10	25	26.7	7.6	315
X07	476	18.9	1.61	912	--	--	--	--	--
08B	486	19.3	1.76	543	4.48	24	26.7	7.7	323
X03	508	19.6	1.68	888	--	--	--	--	--
09A	540	18.9	1.60	1,485	4.19	24	26.3	7.7	322
10B	606	18.7	1.49	1,685	3.92	24	26.6	7.7	321
11A	661	18.5	1.62	1,721	3.66	22	26.8	7.7	326
12B	721	17.3	1.47	1,523	3.05	20	26.8	7.7	326
13A	781	15.4	1.29	763	2.10	15	26.9	7.7	323
X04	798	14.7	1.12	486	--	--	--	--	--
14B	840	12.9	1.21	809	1.65	12	26.9	7.7	325
15A	902	11.1	1.15	709	1.21	9	27.0	7.7	322
16B	951	10.1	1.16	635	1.34	8	26.8	7.7	323
17A	1,010	8.9	1.09	447	1.17	7	26.8	7.7	320
X05	1,043	8.6	1.02	269	--	--	--	--	--
18B	1,071	8.5	1.09	414	1.10	6	26.9	7.7	324
19A	1,132	8.9	1.00	536	1.08	6	26.9	7.7	322
20B	1,191	9.2	0.92	520	0.95	6	27.1	7.7	322
REW	1,255	0.0	0.00	0	--	--	--	--	--
MEAN		14.9	1.46						
TOTAL	1,255			27,293	57.31	349			

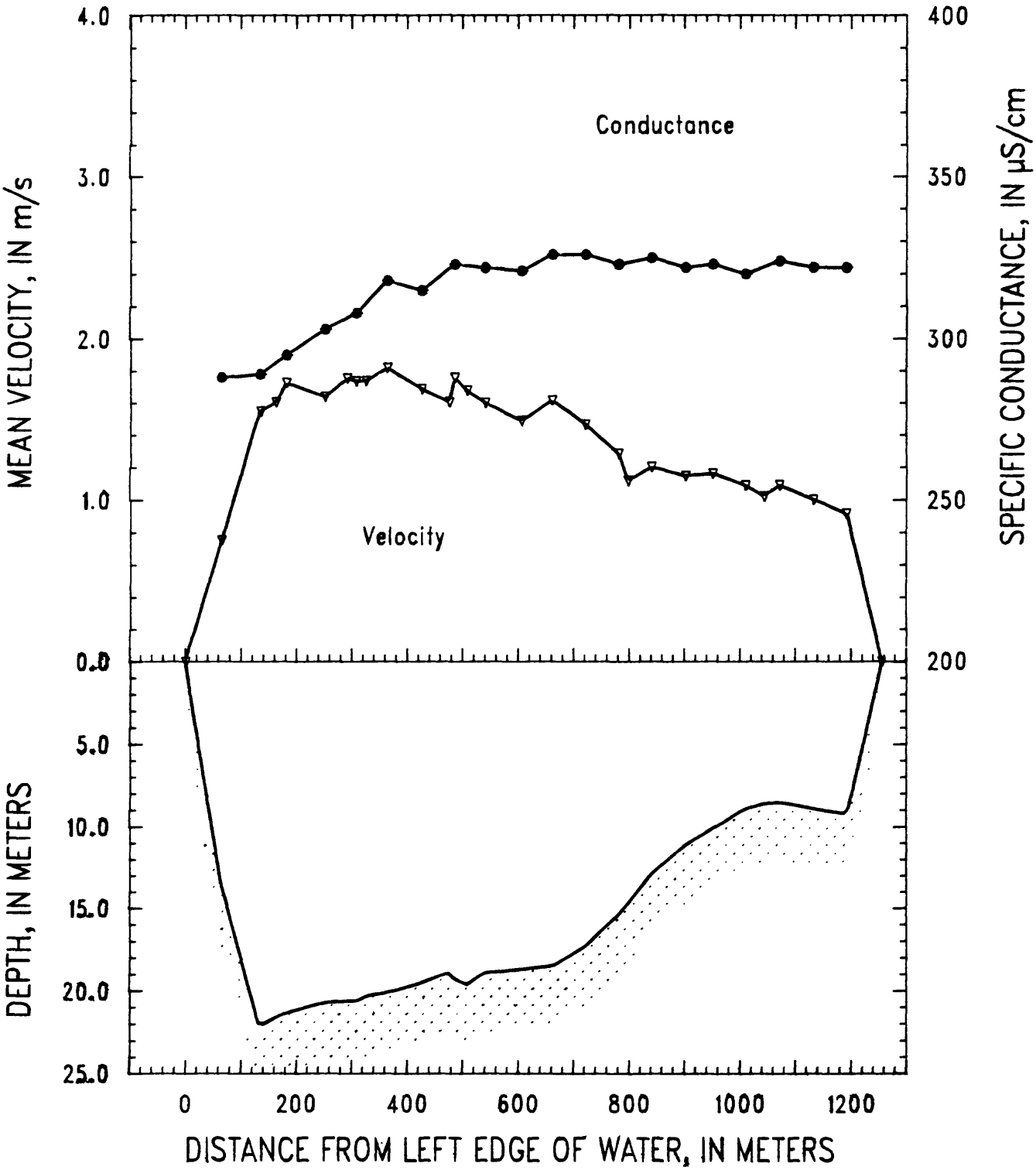

Figure 83. Mississippi River below Vicksburg, Mississippi, on June 23, 1990.

SITE: Mississippi River near St. Francisville, Louisiana 06-25-90
PARTY: Moody, Garbarino, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: -- ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: 90JM1 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.755 + 0.011

REMARKS: Transit rate was 15 cm/s and nozzle was 1/8 inch. USGS Louisiana District collected a simultaneous NASQAN sample. Order of verticals was 20-1.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEF	0	2.0	0.00	0	--	--	--	--	--
01B	60	11.0	0.09	54	0.34	3	27.1	7.4	312
02A	105	12.1	0.45	135	0.51	4	27.1	7.6	313
X05	110	12.2	0.45	131	--	--	--	--	--
03B	153	13.6	0.66	417	0.97	5	27.2	7.6	313
04A	203	14.8	1.02	743	1.66	6	27.1	7.6	309
05B	251	14.9	1.22	993	2.28	10	27.5	7.6	311
06A	312	15.5	1.53	865	2.81	15	26.4	7.6	311
X04	324	15.9	1.57	550	--	--	--	--	--
07B	356	17.0	1.58	900	3.57	20	27.4	7.6	311
08A	391	14.0	1.85	1,221	3.32	21	27.2	7.6	312
09B	450	17.0	1.83	1,559	4.84	24	27.2	7.6	315
10A	491	17.8	1.70	861	3.79	23	27.2	7.7	311
X03	507	17.7	1.69	792	--	--	--	--	--
11B	544	17.9	1.69	1,122	4.20	23	27.0	7.6	310
12A	581	18.2	1.58	1,499	3.44	25	27.0	7.6	308
13B	648	19.6	1.52	1,561	4.01	22	26.8	7.6	311
14A	686	19.4	1.56	789	3.77	22	26.5	7.6	311
X02	700	20.2	1.50	680	--	--	--	--	--
15B	731	20.9	1.62	1,611	4.09	24	26.6	7.6	311
16A	795	20.8	1.51	1,555	3.63	24	26.8	7.6	312
17B	830	20.6	1.67	1,566	4.39	26	26.6	7.6	311
18A	886	20.4	1.56	1,161	3.85	24	26.4	7.6	314
X01	903	19.6	1.59	717	--	--	--	--	--
19B	932	19.6	1.58	1,131	4.13	22	26.8	7.6	313
20A	976	12.1	1.04	586	1.48	8	27.1	7.6	312
REW	1,025	0.0	0.00	0	--	--	--	--	--
MEAN		15.9	1.42						
TOTAL	1,025			23,199	61.08	351			

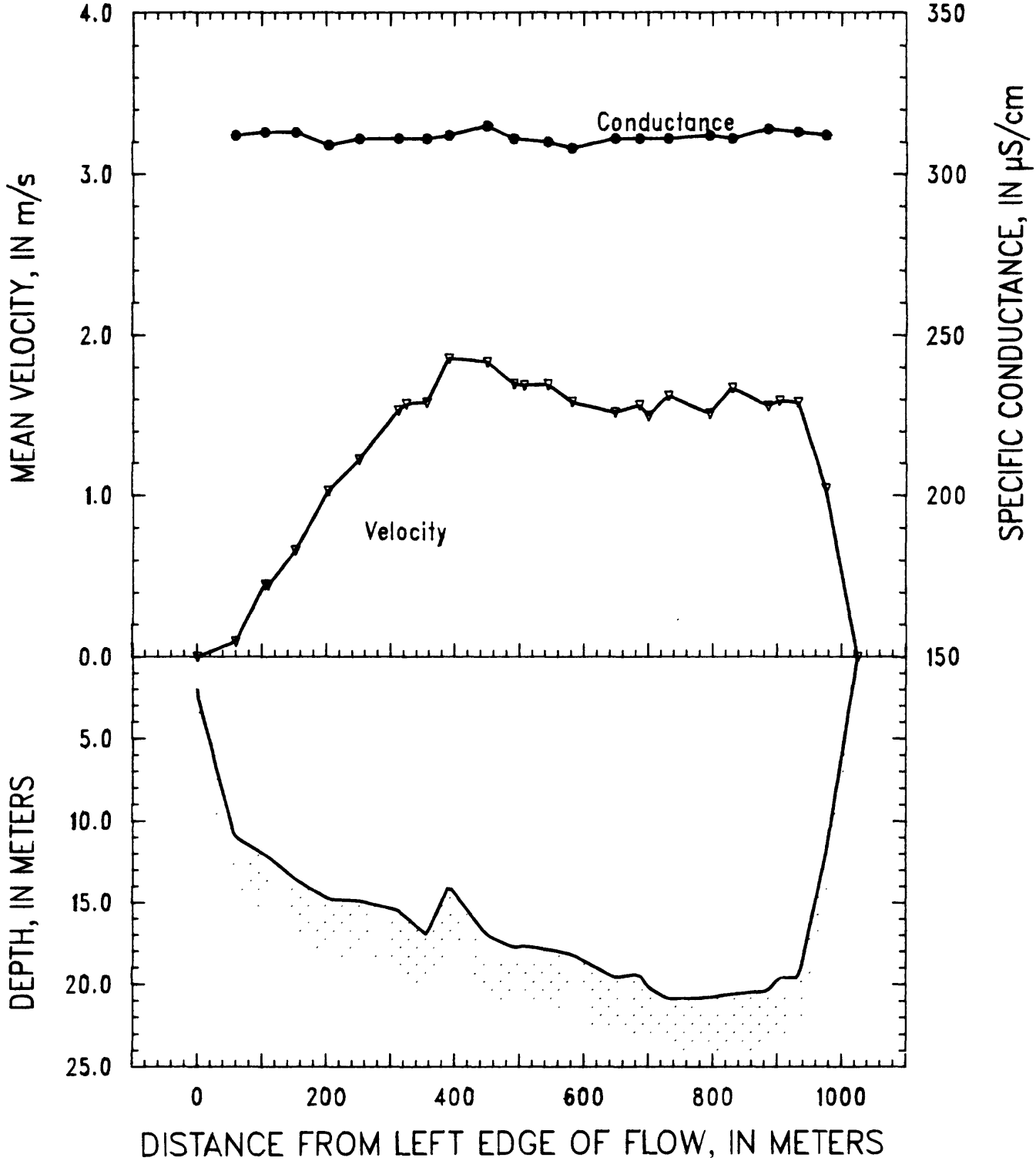

Figure 84. Mississippi River near St. Francisville, Louisiana, on June 25, 1990.

SITE: Mississippi River below Belle Chasse, Louisiana 06-27-90
PARTY: Moody, Garbarino, and Simoneaux METER: SOLID CUP
STARTING GAGE HEIGHT: 13.3 ft ENDING GAGE HEIGHT: --
SUSP: Bag sampler and 300-lb weight
CURRENT METER NO.: 90JM1 DATE RATED: 04-90
CURRENT METER EQUATION: V(m/s) = RPS * 0.755 + 0.011

REMARKS: Transit rate was 20 cm/s and a 1/8-inch nozzle was used. Section was moved about 0.4 mile upriver from usual location at river mile 73.1 because a ship anchored on section. USGS Louisiana District collected a simultaneous NASQAN sample about 1 mile upriver.

Vertical	Dist. from LEW (m)	Depth (m)	Mean velocity (m/s)	Discharge (m^3/s)	Volume V_i (L)	Volume V_p (L)	Temperature (°C)	pH	Specific conductance (µS/cm)
LEW	0	0.0	0.00	0	--	--	--	--	--
01A	47	10.0	0.78	361	0.69	2	27.3	7.6	325
02B	92	20.5	1.33	967	2.99	16	27.3	7.6	324
X05	118	34.0	1.34	842	--	--	--	--	--
03A	129	35.0	1.32	371	3.83	37	27.4	7.6	325
X06	134	32.4	1.48	866	--	--	--	--	--
04B	165	31.2	1.62	1,770	4.66	33	27.5	7.6	323
05A	204	30.6	1.65	2,070	3.62	32	27.7	7.6	323
06B	247	29.8	1.65	1,670	4.71	29	27.4	7.6	322
X04	272	28.7	1.67	935	--	--	--	--	--
07A	286	28.4	1.64	1,394	3.96	26	27.3	7.6	323
08B	332	25.9	1.64	1,342	3.98	25	27.5	7.6	322
09A	349	25.4	1.59	769	3.94	21	27.4	7.6	324
X07	370	24.8	1.55	867	--	--	--	--	--
X03	394	23.1	1.56	703	--	--	--	--	--
10B	409	22.7	1.46	764	3.04	19	27.7	7.6	324
11A	440	21.3	1.50	1,180	2.84	16	27.5	7.6	323
12B	483	19.6	1.40	1,238	2.22	14	27.5	7.6	323
13A	530	18.3	1.24	590	1.92	14	26.7	7.6	323
X02	535	17.8	1.24	188	--	--	--	--	--
14B	547	17.6	1.25	717	2.07	12	27.8	7.6	324
15A	600	15.6	1.16	789	1.41	10	27.7	7.6	325
16B	634	15.3	1.00	568	1.20	10	27.5	7.6	323
17A	674	14.7	1.08	452	1.18	9	27.5	7.6	322
X01	691	14.8	1.08	320	--	--	--	--	--
18B	714	14.7	1.05	517	1.21	10	27.6	7.6	324
19A	758	15.3	0.88	567	1.05	10	27.5	7.6	326
20B	798	15.0	0.74	484	0.96	5	27.3	7.6	324
REF	845	1.0	0.00	0	--	--	--	--	--
MEAN		20.0	1.38						
TOTAL	845			23,301	51.48	350			

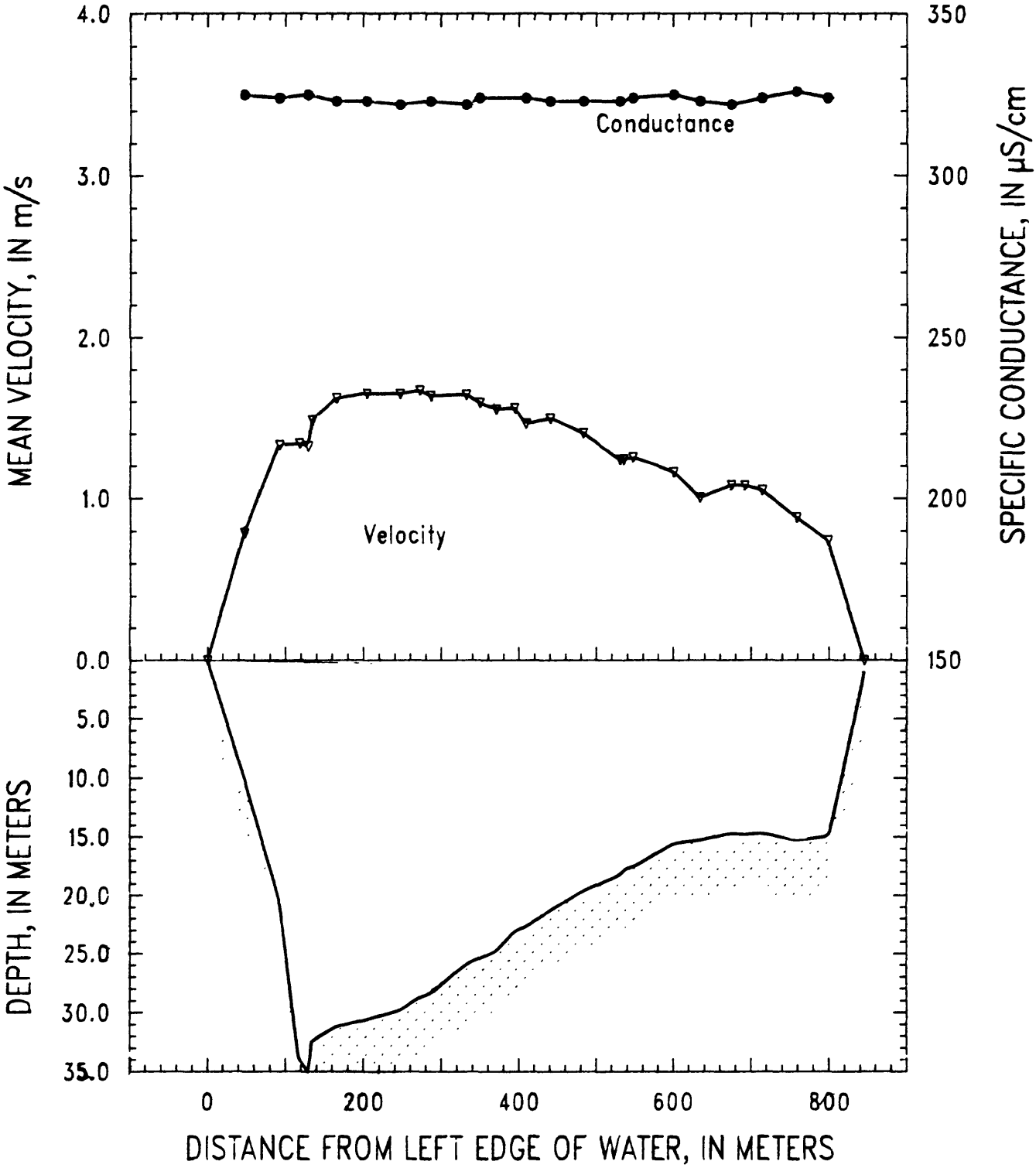

Figure 85. Mississippi River below Belle Chasse, Louisiana, on June 27, 1990.