

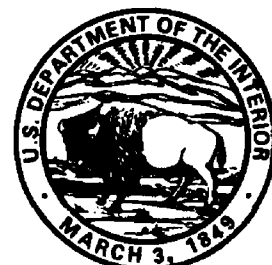
CONCENTRATION AND TRANSPORT DATA FOR SELECTED DISSOLVED INORGANIC CONSTITUENTS AND DISSOLVED ORGANIC CARBON IN WATER COLLECTED FROM THE MISSISSIPPI RIVER AND SOME OF ITS TRIBUTARIES, JULY 1991-MAY 1992

**by J.R. Garbarino, R.C. Antweiler, T.I. Brinton, D.A. Roth
and H.E. Taylor**

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CONVERSION FACTORS

Multiply	By	To obtain
<u>Length</u>		
meter (m)	3.281	foot
millimeter (mm)	3.937×10^{-2}	inch
micrometer (μm)	3.937×10^{-5}	inch
<u>Volume</u>		
milliliter (mL)	3.381×10^{-2}	ounce, fluid
liter (L)	2.642×10^{-1}	gallon
<u>Mass</u>		
microgram (μg)	3.527×10^{-8}	ounce, avoirdupois
milligram (mg)	3.527×10^{-5}	ounce, avoirdupois
gram (g)	3.527×10^{-2}	ounce, avoirdupois
kilogram (kg)	2.205	pound
<u>Temperature</u>		
degree Celsius ($^{\circ}\text{C}$)	1.800 (then add 32)	degree Fahrenheit

ABBREVIATIONS USED IN THIS REPORT

<u>Measurement</u>	<u>Abbreviation</u>
inch	in.
cubic meter per second	m^3/s
milligram per liter	mg/L
microgram per liter	$\mu\text{g}/\text{L}$
kilogram per day	kg/d
<u>Technique</u>	<u>Abbreviation</u>
Automated electrometric titration	AET
Cold vapor-atomic fluorescence spectroscopy	CV-AFS
Flame-atomic absorption spectroscopy	F-AAS
Inductively coupled plasma-mass spectrometry	ICP-MS
Inductively coupled plasma-atomic emission spectroscopy	ICP-AES
Ion chromatography	IC
Oxidation/infrared spectroscopy	OIR
Photometric air-segmented continuous flow analyzer	CFA

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By J.R. Garbarino, R.C. Antweiler, T.I. Brinton, D.A. Roth, and H.E. Taylor

ABSTRACT

The concentration and transport for several dissolved inorganic constituents and dissolved organic-carbon were determined in water samples collected from the Mississippi River and some of its tributaries. Three sampling cruises were made during the summer and fall of 1991 and the spring of 1992 to study the effects of seasonal variation and water discharge on the water chemistry. Depth-integrated, equal-width increment, composite water samples were collected at 12 sites on the Mississippi River between Minneapolis, Minnesota, and New Orleans, Louisiana, and from the Minnesota, Illinois, Missouri, and Ohio Rivers. Surface-grab water samples were collected from the St. Croix, Chippewa, Wisconsin, Rock, Iowa, Des Moines, Kaskaskia, White, Arkansas, and Yazoo Rivers. Composite surface-grab water samples were collected from 25 of the 26 pools of the Upper Mississippi River.

This report describes the protocols that were used for collecting samples, for separating the suspended sediment from unfiltered water, for preserving sample integrity, for estimating sample collection and processing precision, and for evaluating possible sources of contamination. Concentrations for major-elements (calcium, iron, magnesium, potassium, silica, sodium, and strontium), trace-elements (aluminum, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, lithium, manganese, mercury, molybdenum, nickel, thallium, uranium, vanadium, and zinc), major anions (bicarbonate, carbonate, chloride, and sulfate), nutrients (ammonium, nitrate, nitrite, and orthophosphate), and organic carbon for all the Mississippi River and tributary samples are provided. Corresponding transports have been calculated for all Mississippi River sites and the Minnesota, Illinois, Missouri, and Ohio Rivers.

INTRODUCTION

The Mississippi River and its tributaries comprise the largest river system in the United States. Its location causes it to drain both the heavily industrialized urban areas to the east and agricultural rural areas to the west. In addition to being the largest source of chemicals and sediment discharged into the Gulf of Mexico, the river also provides the primary drinking water supply for millions of people along its course. Both naturally occurring and anthropogenic inorganic cations and anions are present in the river system. These constituents can originate from the weathering and erosion of bedrock, the leaching of mine tailings, the irrigation of agricultural areas, or the disposal of municipal wastes. Trace-metal cations are in equilibrium between water-soluble species--ranging from

aqueous to organic complexes that are frequently pH dependent-- and suspended particulate matter or bed sediments, including insoluble precipitates. The nature of this partitioning and interaction plays a significant role in the transport and storage of trace metals in the river system.

Numerous studies of the trace-metal water quality of the Mississippi River have been conducted over the last several decades, but few have examined the entire river in a comprehensive manner. Several studies have emphasized the water quality in specific regions of either the lower reach of the river (Everett, 1971; Hartung, 1974; Presley and Trefry, 1980; Wells, 1980; Shiller and Boyle, 1983; Newchurch and Kahwa 1984; Trefry and others, 1986) or the upper reach of the river (Eisenreich and others, 1980; Water Quality Group of the Great River Environmental Action Team, 1980a and 1980b; Bailey and Rada, 1984; Buhl and McConville, 1984; Wiener and others, 1984). Water-quality data for the Mississippi River at selected locations also has been published (Briggs and Ficke, 1978; DeLeon and others, 1986; Smith and others, 1987; Costner and Thorton, 1989). A comprehensive investigation was described by Taylor and others (1990) and Brinton and others (1995), that compiled seasonal data for the period of 1987 to 1990 for several dissolved inorganic species in samples collected from eleven sites on the Mississippi River and six of its tributaries between St. Louis, Mo., and New Orleans, La.

Purpose and Scope

The distribution, movement, and storage of chemical constituents in the Mississippi River system can have a substantial effect on the ecology, environmental chemistry, and utilization of the river. A multidisciplinary research investigation was undertaken in 1991 by the U.S. Geological Survey to assess the water quality of the entire Mississippi River, from Minneapolis, Minn., to New Orleans, La. (Meade and Stevens, 1990; Moody and Meade, 1992, 1993, 1994a, 1994b; Moody, 1993; Leenheer and others, 1994; Pereira and others, 1995). This report compiles results of the investigation in terms of concentration and transport of selected dissolved inorganic constituents and dissolved organic-carbon in water from the entire Mississippi River and some of its tributaries during the summer and fall of 1991 and the spring of 1992. Corresponding concentration and transport data for inorganic constituents associated with suspended sediment from the Mississippi River during this same period of time has been compiled by Hayes (1993). The experimental design not only provides information on the geographical variations due to tributary inflow and point sources, but also provides some insight on the effects of seasonal and river-stage variations.

Acknowledgments

We extend our deepest appreciation to the research vessel ACADIANA captains, Bob Cutting, Craig LeBoeuf, Wayne Simoneaux, and crew Cheryl Blanchard, George Collier, Wilton Delaune, Mike Detraz, Derral Dupre, Chuck Guidry, Jean Hough, and Jonathan Landry; to all the people from State agencies and universities, especially Dan Helwig, John Sullivan, and Harold Wiegner; and to the Army Corps of Engineers. This study would not have been possible without their help and dedication. Special thanks are expressed to Robert Meade and John Moody for overseeing the logistics of sample collection and for making the water-discharge measurements; to Jonathan Fischer, Heidi Hayes, Charles Patton, and Lisa Torrick for their assistance in field sampling, sample processing, and laboratory analyses; and to Dale Peart for his expertise in managing the data base. Gratitude is also expressed to our other colleagues who assisted in collecting and processing the bulk samples: Larry Barber, LaDonna Bishop, Greg Brown, Wes Campbell, Gail Chmura, Lesly Conaway, Dolly Dieter, Geoff Ellis, Don Goolsby, Bob Hirsch, Jim Krest, Jerry Leenheer, Gail Mallard, Richard Martin, Stephanie Monsterleet, Ted Noyes, Ron Rathbun, Colleen Rostad, Alan Shiller, Mike Simpson, Charles Tabor, Woodrow Wang, and Jeff Writer.

SAMPLE COLLECTION

In all sampling methods, extreme care was used to minimize any possible contamination by using Teflon, high-density polyethylene, or Teflon-coated stainless-steel sample-processing equipment. Talc-free polyethylene, polyvinyl chloride, or Teflon gloves were used during the entire sample-handling and processing procedure. All sampling devices were thoroughly cleaned and rinsed with deionized water (16 megohm or better) prior to use.

Three distinct types of river water samples were collected for dissolved inorganic and organic constituents during this study: (1) discharge-weighted, equal-width increment, and laterally composited samples collected at each cross section of the Mississippi River and selected tributaries, (2) surface-grab samples collected near the mouths of selected tributaries, and (3) surface-grab composite water samples collected from the backwater region of the navigation pools of the Upper Mississippi River (tables 1-3).

Laterally Composited Samples

In general, there were two methods used for collecting laterally composited samples. Whenever water velocities were sufficiently high, greater than 0.5 meter per second (m/s), the preferred method was depth-integrated sampling using the collapsible-

bag sampler (Stevens and others, 1980; and Meade and Stevens, 1990). Whenever the water velocity was less than 0.5 m/s, a composite sample was obtained using a low-velocity method, either by pumping (Moody and Meade, 1993, 1994a) or using a Kemmerer bottle sampler.

Depth-Integrated Sampling

Depth-integrated sampling was conducted from the research vessel ACADIANA at 12 predetermined sites on the Mississippi River between Minneapolis, Minn., and New Orleans, La., as well as near the mouths of the Minnesota, Illinois, Missouri and Ohio Rivers (figs. 1 and 2). Sampling sites on the Mississippi River upstream of Winfield, Mo., were located upstream and downstream from the confluences of major tributaries. Sampling sites on the Mississippi River downstream of Winfield, Mo., were selected as a subset of the sites sampled during earlier cruises (see Brinton and others, 1995). Tributary sites were selected according to their relative discharge into the Mississippi River system and channel navigability.

The depth-integrated sampling strategy and equipment used have been described by others (Meade and Stevens, 1990; Meade and others, 1985; Leenheer and others, 1989). A previously described collapsible-bag sampler (Stevens and others, 1980; Nordin and others, 1983; and Meade, 1985) was used to collect the depth-integrated samples from 5 to 18 equal-width-increment (Guy and Norman, 1970, p. 32-33) verticals comprising the cross section at each sampling site. A Teflon bag was used in the bag sampler to minimize sample contamination and to facilitate quantitative transfer of water and suspended material. The verticals comprising the cross section were equally spaced across the section and identical transit rates were used to collect the sample from each vertical. Therefore, the composite sample collected using this technique represents a sample that is discharge-weighted both laterally and vertically (Meade and Stevens, 1990). Accumulated samples from alternate verticals were combined into two composite samples, denoted by composites A and B (tables 1-3), which were analyzed independently to evaluate sampling precision. Approximately 100 L of composite sample was collected at each site. This large volume of unfiltered water was required to provide sufficient amounts of suspended sediment; less than 5 L of unfiltered water was required for determination of all dissolved constituents.

Depth-integrated samples were passed through a 63- μ m nickel screen to remove sand-size suspended material and miscellaneous debris. Studies using deionized water showed that the nickel screen contributed negligible contamination to trace-metal concentrations. Composite A and composite B samples, made up of water, silt, and finer particulate matter, were representatively split into subsamples by using a Teflon-coated stainless-steel churn splitter. Individual subsamples were split from the churn for trace-

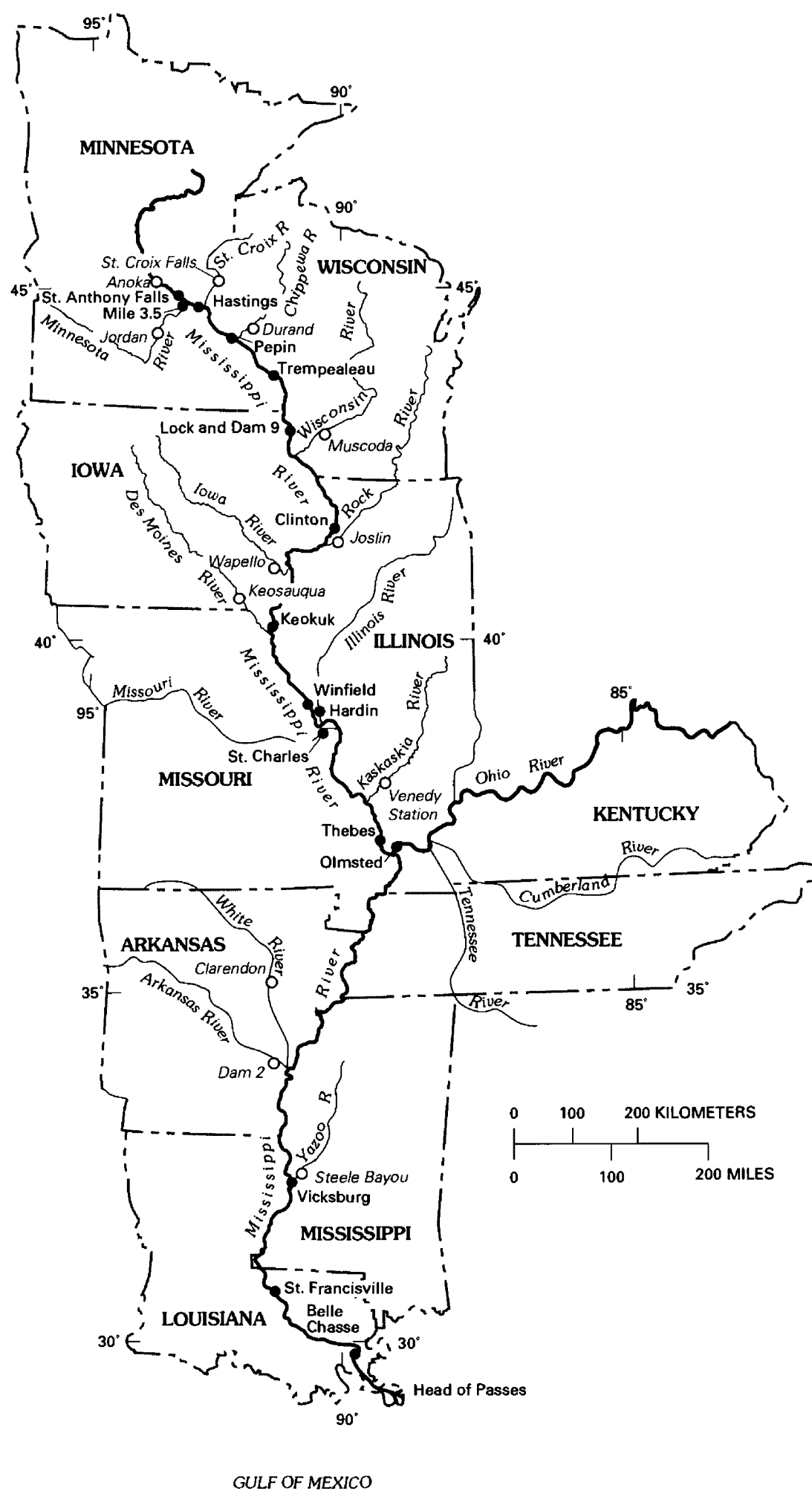


Figure 1.--Sampling sites on the Mississippi River and some of its tributaries.

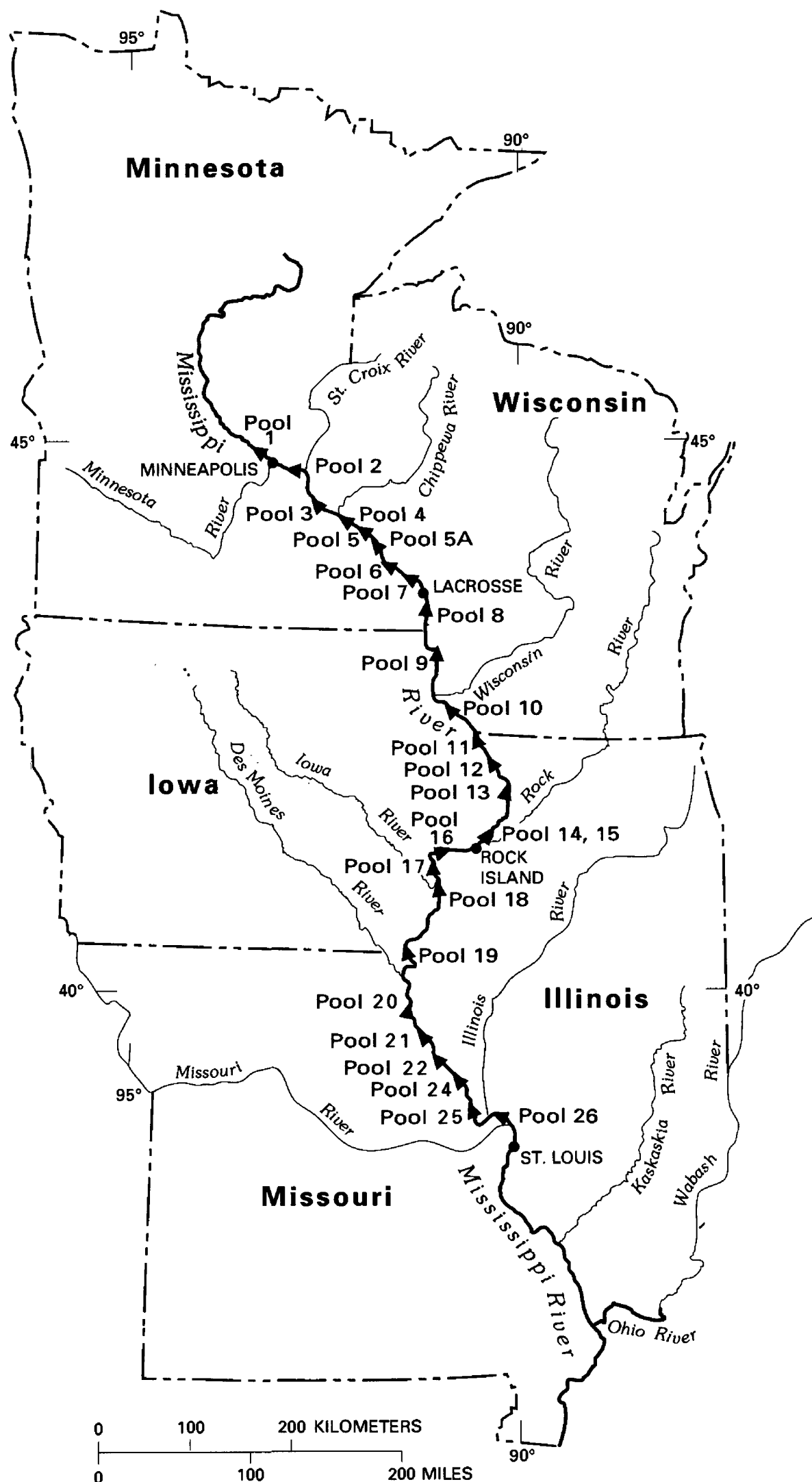


Figure 2.--Location of navigation pools sampled on the Upper Mississippi River (Pool 17 was not sampled because of ship repairs and there is no Pool 23).

Table 1.--Sampling sites on the Mississippi River and some of its tributaries for the July-August 1991 cruise
[see figs. 1 and 2 for location of sampling sites]

Sampling site name	River mile ¹	Samples collected A,B ²
<u>Laterally composited samples</u>		
<u>Upper Mississippi River</u>		
Mississippi River above St. Anthony Falls, Minn.	UM 858.3	D,D
Mississippi River at Hastings, Minn.	UM 812.2	D,D
Mississippi River near Pepin, Wis.	UM 764.5	D,D
Mississippi River at Trempealeau, Wis.	UM 713.8	D,D
Mississippi River below Lock and Dam 9, Wis.	UM 639.7	D,D
Mississippi River at Clinton, Iowa	UM 520.3	D,D
Mississippi River at Keokuk, Iowa	UM 363.1	D,D
Mississippi River near Winfield, Mo.	UM 239.2	D,D
Mississippi River at Thebes, Ill.	UM 44.0	D,D
<u>Lower Mississippi River</u>		
Mississippi River below Vicksburg, Miss.	LM 433.4	D,D
Mississippi River near St. Francisville, La.	LM 266.4	D,D
Mississippi River below Belle Chasse, La.	LM 72.8	P,P
<u>Tributaries</u>		
Minnesota River at Mile 3.5, Minn.	MN 3.5	D,D
Illinois River at Hardin, Ill.	IL 21.8	³ D,P
Missouri River at St. Charles, Mo.	MO 28.4	D,D
Ohio River at Olmsted, Ill.	OH 965.5	P,P
<u>Tributary surface-grab samples</u>		
<u>Other tributaries</u>		
St. Croix River at Mile 0.5, Wis.	SC 0.5	G
Chippewa River at Mile 1.7, Wis.	CH 1.7	G
Wisconsin River at Mile 1.0, Wis.	WI 1.0	G
Rock River at Mile 1.0, Ill.	RK 1.0	G
Iowa River at Mile 1.0, Iowa	IA 1.0	G
Des Moines River at Mile 1.0, Iowa	DM 1.0	G
Kaskaskia River at Mile 1.5, Ill.	KA 1.5	G
White River at Mile 1.2, Ark.	WH 1.2	G
Arkansas River at Mile 0.0, Ark.	AR 0.0	G
Yazoo River at Mile 3.0, Miss.	YZ 3.0	G

Table 1.--Sampling sites on the Mississippi River and some of its tributaries for the July-August 1991 cruise--continued

Sampling site name	River mile ¹	Samples collected A,B ²
<u>Pool composited surface-grab samples</u>		
Mississippi River in Pool 1	UM 848.0-849.2	S
Mississippi River in Pool 2	UM 816.1-821.1	S
Mississippi River in Pool 5	UM 739.8-744.7	S
Mississippi River in Pool 5A	UM 729.8	S
Mississippi River in Pool 7	UM 702.7	S
Mississippi River in Pool 8	UM 682.1-684.7	S
Mississippi River in Pool 10	UM 615.0-617.2	S
Mississippi River in Pool 14	UM 494.8-499.8	S
Mississippi River in Pool 20	UM 344.2-346.6	S
Mississippi River in Pool 22	UM 303.0-306.0	S

¹ River mile codes are UM = Upper Mississippi River miles measured upstream from confluence with Ohio River; LM = Lower Mississippi River miles measured upstream from Head of Passes, La.; OH = Ohio River miles measured downstream from Pittsburgh, Pa. (Ohio-Mississippi confluence is OH 981.5, UM 0.0 and LM 953.8); IL, Illinois River; MO, Missouri River; SC, St. Croix River; CH, Chippewa River; WI, Wisconsin River; RK, Rock River; IA, Iowa River; DM, Des Moines River; KA, Kaskaskia River; WH, White River; AR, Arkansas River; and YZ, Yazoo River; all measured in miles upstream from confluence with Mississippi River.

² For laterally composited sampling, A and B are samples taken from alternate verticals on a single sampling transect using one or two of the following methods:

D is a depth-integrated composite sample;

P is a pumped composite sample taken from one-half river depth (or 5 meters, whichever was less).

For surface-grab sampling, the sample represented one of the following:

G is a tributary surface-grab sample;

S is a pool composite surface-grab sample.

³ Water velocities were so slow here that the nozzle from the bag sampler was removed to collect the sample.

Table 2.--Sampling sites on the Mississippi River and some of its tributaries for the October-November 1991 cruise
[see figs. 1 and 2 for location of sampling sites]

Sampling site name	River mile ¹	Samples collected A,B ²
<u>Laterally composited samples</u>		
<u>Upper Mississippi River</u>		
Mississippi River above St. Anthony Falls, Minn.	UM 857.7	D,P
Mississippi River at Hastings, Minn.	UM 812.2	K,P
Mississippi River near Pepin, Wis.	UM 764.5	K,P
Mississippi River at Trempealeau, Wis.	UM 713.8	K,P
Mississippi River below Lock and Dam 9, Wis.	UM 639.7	K,P
Mississippi River at Clinton, Iowa	UM 520.3	K,P
Mississippi River at Keokuk, Iowa	UM 363.1	K,P
Mississippi River near Winfield, Mo.	UM 239.2	K,P
Mississippi River at Thebes, Ill.	UM 44.0	D,D
<u>Lower Mississippi River</u>		
Mississippi River below Vicksburg, Miss.	LM 433.4	D,D
Mississippi River near St. Francisville, La.	LM 266.4	D,D
Mississippi River below Belle Chasse, La.	LM 73.1	D,P
<u>Tributaries</u>		
Minnesota River at Mile 3.5, Minn.	MN 3.5	D,P
Illinois River at Hardin, Ill.	IL 21.8	K, ³ P
Missouri River at St. Charles, Mo.	MO 28.4	K,P
Ohio River at Olmsted, Ill.	OH 965.0	K,P
<u>Tributary surface-grab samples</u>		
<u>Other tributaries</u>		
St. Croix River at Mile 0.5, Wis.	SC 0.5	G
Chippewa River at Mile 1.7, Wis.	CH 1.7	G
Wisconsin River at Mile 1.0, Wis.	WI 1.0	G
Rock River at Mile 1.0, Ill.	RK 1.0	G
Iowa River at Mile 1.0, Iowa	IA 1.0	G
Des Moines River at Mile 1.0, Iowa	DM 1.0	G
Kaskaskia River at Mile 1.5, Ill.	KA 1.5	G
White River at Mile 1.2, Ark.	WH 1.2	G
Arkansas River at Mile 0.0, Ark.	AR 0.0	G
Yazoo River at Mile 3.0, Miss.	YZ 3.0	G

Table 2.--Sampling sites on the Mississippi River and some of its tributaries for the October-November 1991 cruise--continued

Sampling site name	River mile ¹	Samples collected A,B ²
<u>Pool composited surface-grab samples</u>		
Mississippi River in Pool 2	UM 816.1-821.1	S
Mississippi River in Pool 3	UM 797.3-798.1	S
Mississippi River in Pool 4, Upper Lake Pepin	UM 774.0-778.0	S
Mississippi River in Pool 4, Lower Lake Pepin	UM 768.0-772.0	S
Mississippi River in Pool 8	UM 682.1-684.7	S
Mississippi River in Pool 9	UM 648.0-655.0	S
Mississippi River in Pool 11	UM 585.1-591.9	S
Mississippi River in Pool 13	UM 523.7-526.0	S
Mississippi River in Pool 16	UM 457.0-458.7	S
Mississippi River in Pool 19	UM 366.3-371.6	S
Mississippi River in Pool 24	UM 273.4-275.3	S
Mississippi River in Pool 26	UM 206.1	S

¹ River mile codes are UM = Upper Mississippi River miles measured upstream from confluence with Ohio River; LM = Lower Mississippi River miles measured upstream from Head of Passes, La.; OH = Ohio River miles measured downstream from Pittsburgh, Pa. (Ohio-Mississippi confluence is OH 981.5, UM 0.0 and LM 953.8); IL, Illinois River; MO, Missouri River; SC, St. Croix River; CH, Chippewa River; WI, Wisconsin River; RK, Rock River; IA, Iowa River; DM, Des Moines River; KA, Kaskaskia River; WH, White River; AR, Arkansas River; and YZ, Yazoo River; all measured in miles upstream from confluence with Mississippi River.

² For laterally composited sampling, A and B are samples taken from alternate verticals on a single sampling transect using one or two of the following methods:

D is a depth-integrated composite sample;

K is a depth-integrated composite sample taken from 1 to 8 different depths, depending on the total depth, separated by 1 to 1.5 meters using a Kemmerer bottle sampler;

P is a pumped composite sample taken from one-half river depth (or 5 meters, whichever was less).

For surface-grab sampling, the sample represented one of the following:

G is a tributary surface-grab sample;

S is a pool composite surface-grab sample.

³ Sample taken here was a pumped sample at a single vertical from the center of the channel.

Table 3.--Sampling sites on the Mississippi River and some of its tributaries for the April-May 1992 cruise
[see figs. 1 and 2 for location of sampling sites]

Sampling site name	River mile ¹	Samples collected A,B ²
<u>Laterally composited samples</u>		
<u>Upper Mississippi River</u>		
Mississippi River above St. Anthony Falls, Minn.	UM 857.7	D,D
Mississippi River at Hastings, Minn.	UM 812.2	D,P
Mississippi River near Pepin, Wis.	UM 764.5	P,P
Mississippi River at Trempealeau, Wis.	UM 713.8	D,D
Mississippi River below Lock and Dam 9, Wis.	UM 639.7	D,D
Mississippi River at Clinton, Iowa	UM 520.3	D,D
Mississippi River at Keokuk, Iowa	UM 363.1	D,D
Mississippi River near Winfield, Mo.	UM 239.2	D,D
Mississippi River at Thebes, Ill.	UM 44.0	D,D
<u>Lower Mississippi River</u>		
Mississippi River below Vicksburg, Miss.	LM 433.4	D,D
Mississippi River near St. Francisville, La.	LM 266.2	D,D
Mississippi River below Belle Chasse, La.	LM 73.1	D,D
<u>Tributaries</u>		
Minnesota River at Mile 3.5, Minn.	MN 3.5	D,D
Illinois River at Hardin, Ill.	IL 21.8	D,D
Missouri River at St. Charles, Mo.	MO 29.4	D,D
Ohio River at Olmsted, Ill.	OH 965.0	P,P
<u>Tributary surface-grab samples</u>		
<u>Other tributaries</u>		
St. Croix River at Mile 0.5, Wis.	SC 0.5	G
Chippewa River at Mile 1.7, Wis.	CH 1.7	G
Wisconsin River at Mile 1.0, Wis.	WI 1.0	G
Rock River at Mile 1.0, Ill.	RK 1.0	G
Iowa River at Mile 1.0, Iowa	IA 1.0	G
Des Moines River at Mile 1.0, Iowa	DM 1.0	G
Kaskaskia River at Mile 1.5, Ill.	KA 1.5	G
White River at Mile 1.2, Ark.	WH 1.2	G
Arkansas River at Mile 0.0, Ark.	AR 0.0	G
Yazoo River at Mile 9.0, Miss.	YZ 9.0	G

Table 3.--Sampling sites on the Mississippi River and some of its tributaries for the April-May 1992 cruise--continued

Sampling site name	River mile ¹	Samples collected A,B ²
<u>Pool composited surface grab samples</u>		
Mississippi River in Pool 2	UM 816.1-821.1	S
Mississippi River in Pool 6	UM 714.9-721.1	S
Mississippi River in Pool 8	UM 682.1-684.7	S
Mississippi River in Pool 12	UM 558.2-560.7	S
Mississippi River in Pool 15	UM 484.0-487.8	S
Mississippi River in Pool 18	UM 411.8-414.5	S
Mississippi River in Pool 21	UM 326.6-331.4	S
Mississippi River in Pool 25	UM 241.5-243.1	S

¹ River mile codes are UM = Upper Mississippi River miles measured upstream from confluence with Ohio River; LM = Lower Mississippi River miles measured upstream from Head of Passes, La.; OH = Ohio River miles measured downstream from Pittsburgh, Pa. (Ohio-Mississippi confluence is OH 981.5, UM 0.0 and LM 953.8); IL, Illinois River; MO, Missouri River; SC, St. Croix River; CH, Chippewa River; WI, Wisconsin River; RK, Rock River; IA, Iowa River; DM, Des Moines River; KA, Kaskaskia River; WH, White River; AR, Arkansas River; and YZ, Yazoo River; all measured in miles upstream from confluence with Mississippi River.

² For laterally composited sampling, A and B are samples taken from alternate verticals on a single sampling transect using one or two of the following methods:

D is a depth-integrated composite sample;

P is a pumped composite sample taken from one-half river depth (or 5 meters, whichever was less).

For surface-grab sampling, the sample represented one of the following:

G is a tributary surface-grab sample;

S is a pool composite surface-grab sample.

metal, major anion, alkalinity, nutrient, and dissolved organic-carbon (DOC) determinations.

The remaining portion of the depth-integrated composite samples A and B were combined and processed, as described by Leenheer and others (1989), to separate the suspended particulate matter into specific particle-size fractions. The particles greater than 1 μm were first removed using a continuous-flow Teflon-coated Sharples super centrifuge (Sharples Model AS-12). The effluent from the centrifuge was then processed through a tangential-flow ultrafilter to remove particles larger than 0.005 μm . The separated particulate fractions from the centrifuge and ultrafilter were retained for characterization by sequential chemical extraction and elemental analysis (see Hayes, 1993). The membranes used in the ultrafilter were made of deacetylated cellulose. Trace-metal adsorption studies indicated that no significant adsorption occurs on this type of membrane material (Leenheer and others, 1989). The ultrafilter system, without membrane filter plates in place, was cleaned by pumping 10 L of deionized water through the system between each sampling site. Twenty liters of dilute ultrapure nitric acid solution (pH 3.0 to 3.5) was processed through new filter membranes between samples to reduce possible contamination. A stack of five new filter plates was typically used at each site to provide suitable processing times and to eliminate carryover between sites. Effluent from the ultrafilter, called ultrafilter permeate, was subsampled for trace metals, mercury, and nutrient determinations. Analytical results for the ultrafilter permeate samples provide an indication of the fraction of metals--particularly iron, manganese, and aluminum--that are associated with colloidal-sized particulate material (Kennedy and others, 1974).

Low-Velocity Sampling

Whenever river current velocity was less than 0.5 m/s, depth-integrated samples could not be collected efficiently or accurately using the collapsible bag sampler; therefore, two alternative methods of sampling were proposed and evaluated during the October-November 1991 cruise. The first involved pumping unfiltered water from one-half of the river depth (or 5 m, whichever depth was less). As with the bag sampler, the volume pumped at each vertical was proportional to the measured discharge and provided the 100 L needed to obtain sufficient mass of suspended sediment. A pneumatic, double-diaphragm, Teflon pump (Wilden MI/UP/TF/TF/TF) coupled with 3/8-in. Teflon tubing was used to collect the sample at a rate of about 3 L per minute (Leenheer and others, 1989; Moody and Meade, 1994a). During the April-May 1992 cruise, this discharge-weighted pump sampling method was used exclusively to collect a pump composite sample. Samples collected in this way are referred to as P in tables 1-3.

The second method evaluated during the October-November 1991 cruise involved using an all-plastic Kemmerer sampler (similar in design to the Foerst sampler; see Brown and others, 1974) to collect point samples at one to eight different depths, depending on the total depth; individual collection points were separated by 1 to 1.5 m. Samples collected in this way provided only enough water (about 20 L) for dissolved inorganic

constituents and the requisite quantity for suspended sediments, 100 L, was provided by the discharge-weighted pump sampling strategy described above. Samples collected in this way are referred to as composite K in tables 1-3. In all cases when the water velocity was sufficient, the collapsible-bag sampler was used to collect about 20 L of river water, comprising a depth-integrated sample as described above.

The low-volume depth-integrated bag sample or the Kemmerer bottle sample was churned and split into the same type of subsamples and processed identically as the depth-integrated composite sample; however, the remainder of the sample was not processed through the centrifuge and ultrafilter. The large-volume pumped sample for the October-November 1991 cruise was also subsampled, the subsamples processed in the same manner, and the remainder of the sample processed through the centrifuge and ultrafilter. The sediment material was retained, and samples of the ultrafilter permeate were taken for analysis. Several sampling sites in the July-August 1991 and April-May 1992 cruises had only pumped composite samples taken. In these cases, the pumped composite sample was subsampled and processed in the same manner as the depth-integrated composite samples.

Tributary Surface-Grab Samples

Surface-grab samples were collected near the mouths of 10 major tributaries to the Mississippi River, excluding the Ohio, Missouri, Illinois and Minnesota Rivers where laterally composited samples were taken. The samples from the St. Croix, Chippewa, Wisconsin, Rock, Iowa, Des Moines, Kaskaskia, White, Arkansas, and Yazoo Rivers were surface-grab samples (instead of laterally composited samples) primarily due to time constraints. The tributary surface-grab samples, referred to as G in tables 1-3, were collected using two 20-L polyethylene carboys at a single location upstream from the confluence with the Mississippi River. The carboys were rinsed three times with deionized water and twice with tributary river water prior to taking the sample.

The two 20-L surface-grab samples were composited, subsampled, and processed as described for the depth-integrated composite sample. The remaining whole-water portion was only processed through the ultrafilter using three filter plates. Therefore, the sediment from the ultrafilter represented the particle size fractions less than 63 μm and greater than 0.005 μm . An ultrafilter permeate sample was also collected from the effluent of the ultrafilter.

Pool Composited Surface-Grab Samples

Pool composited surface-grab water samples were collected from 25 of 26 pools of the Upper Mississippi River. Sampling of the pools was distributed between the three cruises except for Pools 2 and 8, which were sampled during each cruise. Pool 17 was not

sampled because of equipment failure; there is no Pool 23. Tables 1-3 indicate during which cruise each pool was sampled.

Discharge-weighted sampling strategies could not be used in the backwater regions of the navigation pools because of the very low water velocities and shallow depths. Instead, 1-L surface-grab samples were collected at the same locations as the bed sediment samples (additional details are provided in an U.S. Geological Survey Open-File Report to be published entitled "Hydrologic, sedimentologic, and chemical data describing surficial bed sediments and water in the navigation pools of the Upper Mississippi River, July 1991-April 1992", edited by J.A. Moody) and were combined into a single composite sample for each pool. Fifteen to twenty surface-grab samples were collected along two to five transects across each pool.

The 20-L surface-grab composites from the backwater regions of the navigation pools, referred to as S in tables 1-3, were churned and split into subsamples for the same analyses as for the laterally composited samples. The representative samples were processed and preserved as before. The portion of the sample left after subsampling was not processed through the centrifuge or ultrafilter and was discarded.

SAMPLE PROCESSING

In general, separate subsamples were taken for metals, mercury, anions, nutrients, and DOC from unfiltered, laterally composited samples A and B, tributary surface-grab samples (G), and pool composited surface-grab samples (S). These subsamples were processed in the same manner regardless of the method of collection.

The trace-metal subsample was vacuum filtered to remove greater than 0.40- μ m particulate matter by using an all-Teflon filter apparatus. A precise protocol was followed for the filtration: (1) the filter funnel was thoroughly cleaned and rinsed with deionized water; (2) a new 0.40- μ m nominal pore-size, 47-mm-diameter Nuclepore polycarbonate-membrane filter was placed on the filter support and precleaned by drawing 50 mL of 0.1 percent (volume/volume) ultrapure nitric acid rinse solution through into a waste bottle; (3) the filter was rinsed by drawing 100 mL of deionized water through the filter into the waste bottle; (4) about 25 mL of the shaken subsample composite was filtered to prerinse the sample bottle and also effectively load the filter with particles; (5) the remainder of the subsample, about 225 mL, was filtered into the sample bottle; and (6) the filtered sample was preserved with 1 mL of concentrated ultrapure nitric acid (or to a pH less than 2) using a Teflon dispensing bottle. A single membrane was used to filter the entire subsample. The filter cake was retained for future experiments.

The mercury 125-mL subsample was filtered into a precleaned glass bottle, following the protocol outlined in the preceding paragraph, and preserved with 5 mL of a solution of 4 percent potassium dichromate in concentrated ultrapure nitric acid. The

addition of the dichromate preservative was always made at a remote location on board ship to minimize the risk of chromium contamination to other trace-metal samples.

The major anion and alkalinity subsamples were collected in a single 250-mL polyethylene bottle and immediately chilled to about 4°C without the addition of a preservative. These unfiltered water samples were iced and transported inside insulated coolers to the laboratory. An aliquot for major anions determination was filtered through a 0.45- μ m pore size, 25-mm-diameter polysulfone-membrane syringe filter. A sample aliquot for alkalinity titration was decanted from a chilled, unfiltered, and settled subsample.

The nutrient subsample was collected in a 250-mL polyethylene holding bottle. The subsample was pressure-filtered with nitrogen gas by using a stainless-steel barrel filtration unit (with a 0.45- μ m nominal pore size, 47-mm-diameter silver filter) into a clean 250-mL opaque polyethylene bottle. On the first cruise (July-August 1991), two types of subsamples were collected: one that was chilled on ice and analyzed within 3 days on board ship, and a second one that was frozen and shipped to Denver, Colo., for analysis. During the October-November 1991 cruise, the filtered subsamples were shipped chilled, next-day service, to Denver for analysis within a week. On the April-May 1992 cruise, the filtered subsamples were frozen and shipped to Denver for analysis within a month. The addition of the mercuric chloride preservative was considered inappropriate because of possible mercury contamination of the mercury subsample and because it (and other preservatives) introduces unwanted analytical technicalities. Hence, all nutrient subsamples were unpreserved.

The DOC subsample was pressure-filtered using the same silver filter and barrel filter apparatus described above for the nutrient subsample. The subsample was filtered into a clean, 125-mL, baked amber glass bottle and immediately chilled to 4°C.

Three separate 125-mL samples for metals, mercury, and nutrient determinations were also taken from the ultrafilter permeate of laterally composited samples and tributary surface-grab samples. For the metals subsample, 1 mL of concentrated ultrapure nitric acid was added as a preservative after collection; 5 mL of potassium dichromate nitric acid solution was added to the mercury subsample as a preservative; the nutrient subsample was chilled or frozen (see above description for nutrients).

ANALYTICAL METHODS

Most of the elements were determined by a combination of analytical techniques including inductively coupled plasma-mass spectrometry (ICP-MS), inductively coupled plasma-atomic emission spectroscopy (ICP-AES), cold vapor-atomic fluorescence spectroscopy (CV-AFS), and flame-atomic absorption spectroscopy (F-AAS). Method detection limits (definition of detection limit as given in Skogerboe and Grant, 1970) for each analyte and the techniques used to measure them are compiled in table 4.

Table 4.--Analytical techniques and detection limits

[ICP-MS, inductively coupled plasma-mass spectrometry; ICP-AES, inductively coupled plasma-atomic emission spectroscopy; CV-AFS, cold vapor-atomic fluorescence spectroscopy; F-AAS, flame-atomic absorption spectroscopy; IC, ion chromatography; CFA, photometric air-segmented continuous flow analysis; AET, automated electrometric titration; OIR, oxidation-infrared detection; detection limit, calculated at the 99-percent confidence level using the method outlined by Skogerboe and Grant, 1970; $\mu\text{g/L}$, microgram per liter; mg/L , milligram per liter; mg N/L , milligram nitrogen per liter; mg P/L , milligram phosphorus per liter]

Analyte	Analytical method	Detection limit	Units
Aluminum	ICP-MS	0.2	$\mu\text{g/L}$
Ammonium	CFA	0.006	mg N/L
Arsenic	ICP-MS	0.6	$\mu\text{g/L}$
Barium	ICP-MS	0.1	$\mu\text{g/L}$
Beryllium	ICP-MS	0.02	$\mu\text{g/L}$
Bicarbonate	AET	0.2	mg/L
Boron	ICP-MS	0.4	$\mu\text{g/L}$
Cadmium	ICP-MS	0.1	$\mu\text{g/L}$
Calcium	ICP-AES	0.001	mg/L
Carbonate	AET	0.2	mg/L
Chloride	IC	0.02	mg/L
Chromium	ICP-MS	0.2	$\mu\text{g/L}$
Cobalt	ICP-MS	0.008	$\mu\text{g/L}$
Copper	ICP-MS	0.02	$\mu\text{g/L}$
Dissolved organic-carbon	OIR	0.1	mg/L
Iron	ICP-AES	0.005	mg/L
Lead	ICP-MS	0.06	$\mu\text{g/L}$
Lithium	ICP-MS	0.03	$\mu\text{g/L}$
Magnesium	ICP-AES	0.001	mg/L
Manganese	ICP-MS	0.06	$\mu\text{g/L}$
Mercury ¹	CV-AFS	0.004	$\mu\text{g/L}$
Molybdenum	ICP-MS	0.09	$\mu\text{g/L}$
Nickel	ICP-MS	0.03	$\mu\text{g/L}$
Nitrate	CFA	0.01	mg N/L
Nitrite	CFA	0.01	mg N/L
Orthophosphate	CFA	0.01	mg P/L
Potassium	F-AAS	0.05	mg/L
Silica	ICP-AES	0.04	mg/L
Sodium	ICP-AES	0.006	mg/L
Strontium	ICP-AES	0.0002	mg/L
Sulfate	IC	0.02	mg/L
Thallium	ICP-MS	0.05	$\mu\text{g/L}$
Uranium	ICP-MS	0.06	$\mu\text{g/L}$
Vanadium	ICP-MS	0.07	$\mu\text{g/L}$
Zinc	ICP-MS	0.08	$\mu\text{g/L}$

¹ The detection limit for mercury was 0.008 $\mu\text{g/L}$ during the analysis of samples from the July-August 1991 cruise.

A Perkin Elmer-Sciex ICP-MS Model 500 was configured and optimized for trace-metal analyses as previously described (Taylor and Garbarino, 1991; Garbarino and Taylor, 1994). The trace-elements determined were aluminum, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, lithium, manganese, molybdenum, nickel, thallium, uranium, vanadium, and zinc. Concentrations listed in tables of this report for these analytes are based on the average of five sequential determinations.

Calcium, iron, magnesium, silica (as SiO₂), sodium, and strontium concentrations were measured using a Jarrell-Ash AtomComp 975 ICP-AES. The analytical system and methodology have been described previously by Garbarino and Taylor (1979, 1980) and Skougstad and others (1979). Concentrations listed in tables of this report for these analytes are based on the average of three sequential determinations.

Potassium was determined by F-AAS using an air-acetylene reducing flame. The instrument used was an Instrumentation Laboratory Model 751 running in the single element mode. The details of the method can be found in Skougstad and others (1979). Potassium concentrations listed in tables of this report are based on duplicate determinations.

Mercury was determined using an automated CV-AFS analyzer manufactured by PSA Instruments. The method has been described by Roth (1994). Mercury concentrations listed in tables of this report are based on the average of duplicate determinations.

Chloride and sulfate were determined by an automated ion chromatographic (IC) technique. A customized instrument based on the Dionex Model 2000i was used for these analyses. The method has been described by Fishman and Pyen, 1979, and in a U.S. Geological Survey Open-File Report to be published by T.I. Brinton, R.C. Antweiler, and H.E. Taylor entitled "Method for the determination of chloride, nitrate, and sulfate in natural waters using ion chromatography". Chloride and sulfate concentrations listed in tables of this report are based on a single determination.

Ammonium, nitrate, nitrite, and orthophosphate (collectively termed nutrients) were determined using an Alpkem Model RFA 300 air-segmented continuous-flow colorimetric nutrient analyzer (CFA). A complete description of the analytical techniques used can be found in Antweiler and others (1994). Nutrient concentrations listed in tables of this report are based on the average of three individual determinations.

Dissolved organic-carbon was determined using an automated Oceanography International Total Organic Analyzer. Quantification was based on the oxidation of organic carbon to carbon dioxide and nondispersive infrared measurement (OIR). Complete details of the method may be found in Wershaw and others (1983). Standard solutions of known carbon concentrations were prepared from potassium hydrogen phthalate and used for quality-control purposes. Results obtained for these non-certified reference standards are not compiled in the quality-control tables. DOC concentrations listed in tables of this report are based on the average of duplicate determinations.

Total alkalinity, as bicarbonate and carbonate, was determined using an automated Radiometer Titrator and sulfuric acid titrant. Bicarbonate and carbonate concentrations were calculated from the end points at pH 8.3 for carbonate and pH 4.5 for bicarbonate (Skougstad and others, 1979). Bicarbonate and carbonate concentrations listed in tables of this report are based on a single titration.

The time lapse between sampling and analysis was minimized. Water samples for a particular cruise were analyzed together, as a set, in a random fashion. Analytical results were reagent-blank (laboratory blank) subtracted and background corrected, whenever appropriate, regardless of the analytical technique. Field-blank results were not subtracted from any of the data tabulated in this report.

QUALITY ASSURANCE

The quality of the analytical results was monitored by collecting numerous field blanks and analyzing certified reference standards extensively throughout the analyses of the samples. Deionized-water field blanks were used to identify possible sources of contamination incurred during sample collection or processing. Reference standards were used to monitor the accuracy of the analyses.

Field Blank Samples

At least twice during each sampling cruise, field blanks were collected by processing about 30 to 60 L of shipboard deionized water through the entire sample collection, subsampling, and sample-processing procedures in an effort to identify possible sources of sample contamination. Prior to processing the field blank, a sample of the shipboard deionized water was obtained. Samples were taken of deionized water as it was processed through the depth-integrating bag sampler (containing a Teflon bag), the nickel sieve, a glass 2,000-mL graduated cylinder (used for collection-efficiency measurements and listed as sieve/cylinder in tables 5-7), the 8- and 20-L Teflon-coated churn splitters, and the 20-L carboys used for collecting the tributary samples. The remainder of the deionized water in the churns was processed through the centrifuge and the ultrafilter fitted with new filter plates. Samples of centrifuge effluent and ultrafilter permeate were taken. Finally, deionized water was filtered through Nuclepore polycarbonate and silver filters to obtain filter blanks. All the field blank samples were preserved following identical protocols of their corresponding sample types. Trace- and major-element concentrations measured in field blank samples collected during each cruise are tabulated in tables 5-7. Nutrient and DOC concentrations measured in field blank samples collected during all three cruises are listed in table 8. Chloride and sulfate concentrations measured in field blank samples collected during all three cruises are listed in table 9. Carbonate and bicarbonate concentrations were not determined for field blanks.

Tabulated Field Blank Results

The following tables list the analyte concentrations measured in field blanks collected during the July-August 1991, October-November 1991, and April-May 1992 cruises. For each cruise the field blank concentrations are tabulated for dissolved trace-elements and major-elements, dissolved nutrients and organic carbon, and major anions.

Trace- and Major-Element Results for All Three Cruises

Table 5.--Trace- and major-element results for field blank samples collected during the July-August 1991 cruise

[µg/L, microgram per liter; mg/L, milligram per liter; --, not analyzed; <, less than the detection limit]

Blank processed through:	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Beryllium (µg/L)	Boron (µg/L)	Cadmium (µg/L)	Calcium (mg/L)	Chromium (µg/L)
	Date: 07-23-91							
Nanopure system	<0.2	<0.6	<0.1	0.05	<0.4	<0.1	0.03	<0.2
Sieve/cylinder	7.4	<0.6	0.8	0.02	<0.4	<0.1	2.52	<0.2
Churn splitter	4.5	0.63	0.9	<0.02	<0.4	<0.1	2.31	<0.2
Centrifuge	5.5	<0.6	1.7	0.03	<0.4	1.6	2.58	0.3
Ultrafilter	2.5	<0.6	1.7	0.08	1.1	0.6	2.58	<0.2
Nuclepore filter	<0.2	<0.6	<0.1	0.03	<0.4	<0.1	0.05	<0.2
Tributary carboy	5.0	<0.6	0.9	<0.02	<0.4	<0.1	2.18	<0.2
	Date: 08-02-91							
Sieve/cylinder ¹	2.4	<0.6	0.5	<0.02	<0.4	<0.1	0.97	<0.2
Churn splitter	3.9	<0.6	0.6	<0.02	<0.4	<0.1	1.04	<0.2
Centrifuge	3.2	<0.6	0.9	<0.02	<0.4	<0.1	1.02	<0.2
Ultrafilter	1.4	<0.6	0.8	0.07	0.5	<0.1	1.18	<0.2
Nuclepore filter	2.7	<0.6	1.1	0.04	1.5	<0.1	1.02	<0.2
Tributary carboy	5.7	<0.6	0.9	0.06	0.7	<0.1	1.25	<0.2
Blank processed through:	Cobalt (µg/L)	Copper (µg/L)	Iron (mg/L)	Lead (µg/L)	Lithium (µg/L)	Magnesium (mg/L)	Manganese (µg/L)	Mercury (µg/L)
	Date: 07-23-91							
Nanopure system	<0.008	<0.02	<0.005	<0.06	<0.03	0.01	<0.06	0.024
Sieve/cylinder	<0.008	<0.02	0.008	<0.06	0.39	1.25	1.85	--
Churn splitter	<0.008	<0.02	<0.005	<0.06	0.32	1.13	1.99	0.031
Centrifuge	<0.008	12.40	0.007	0.43	0.41	1.23	2.63	--
Ultrafilter	<0.008	0.30	0.008	<0.06	0.37	1.26	4.15	0.027
Nuclepore filter	<0.008	<0.02	0.008	<0.06	<0.03	0.02	0.14	0.030
Tributary carboy	<0.008	<0.02	<0.005	<0.06	0.31	0.94	3.56	0.039
	Date: 08-02-91							
Sieve/cylinder ¹	<0.008	<0.02	<0.005	<0.06	0.19	0.40	1.81	--
Churn splitter	<0.008	<0.02	<0.005	<0.06	0.17	0.44	2.00	--
Centrifuge	<0.008	0.02	0.006	<0.06	0.17	0.42	2.25	--
Ultrafilter	<0.008	<0.02	<0.005	<0.06	0.18	0.48	2.44	0.027
Nuclepore filter	<0.008	<0.02	0.008	<0.06	0.23	0.42	2.93	0.044
Tributary carboy	<0.008	<0.02	<0.005	<0.06	0.21	0.52	3.12	0.022

Table 5.--Trace- and major-element results for field blank samples collected during the July-August 1991 cruise--continued

Blank processed through:	Molybdenum (µg/L)	Nickel (µg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Strontium (mg/L)	Thallium (µg/L)	Uranium (µg/L)
	Date: 07-23-91							
Nanopure system	<0.09	<0.03	<0.05	0.05	<0.006	<0.0002	<0.05	<0.06
Sieve/cylinder	0.03	0.36	0.13	0.47	0.66	0.009	<0.05	<0.06
Churn splitter	<0.09	0.10	0.15	0.56	0.53	0.009	<0.05	<0.06
Centrifuge	<0.09	0.90	--	0.54	0.64	0.009	<0.05	<0.06
Ultrafilter	0.10	0.26	0.14	0.51	0.59	0.009	<0.05	<0.06
Nuclepore filter	<0.09	0.04	<0.05	<0.04	<0.006	<0.0002	<0.05	<0.06
Tributary carboy	<0.09	<0.03	0.14	0.39	0.48	0.009	<0.05	<0.06
	Date: 08-02-91							
Sieve/cylinder ¹	<0.09	0.06	0.06	0.65	0.73	0.004	<0.05	<0.06
Churn splitter	<0.09	0.03	0.08	0.64	0.79	0.004	<0.05	<0.06
Centrifuge	<0.09	0.73	0.07	0.57	0.75	0.004	<0.05	<0.06
Ultrafilter	<0.09	0.83	0.09	0.66	0.88	0.004	<0.05	<0.06
Nuclepore filter	0.10	<0.03	0.07	0.70	0.78	0.004	<0.05	0.06
Tributary carboy	<0.09	0.13	0.13	0.83	1.10	0.004	<0.05	<0.06
	Date: 07-23-91							
Nanopure system	0.18	0.40						
Sieve/cylinder	0.09	2.49						
Churn splitter	<0.07	2.42						
Centrifuge	0.74	4.15						
Ultrafilter	0.27	2.66						
Nuclepore filter	0.11	0.59						
Tributary carboy	<0.07	2.48						
	Date: 08-02-91							
Sieve/cylinder ¹	0.17	2.75						
Churn splitter	0.05	2.85						
Centrifuge	0.22	3.20						
Ultrafilter	<0.07	2.80						
Nuclepore filter	0.33	3.60						
Tributary carboy	0.11	3.94						

¹ Nanopure system field blank not collected for 08-02-91.

Table 6.--Trace- and major-element results for field blank samples collected during the October-November 1991cruise

[µg/L, microgram per liter; mg/L, milligram per liter; --, not analyzed; <, less than the detection limit; D, depth integrated; P, pumped]

Blank processed through:	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Beryllium (µg/L)	Boron (µg/L)	Cadmium (µg/L)	Calcium (mg/L)	Chromium (µg/L)
	Date: 10-28-91							
Nanopure system	<0.2	<0.6	<0.1	<0.02	19.6	<0.1	0.07	<0.2
Sieve/cylinder, D	3.6	<0.6	0.5	<0.02	1.8	<0.1	0.97	<0.2
Sieve/cylinder, P	15.7	<0.6	0.5	<0.02	10.6	<0.1	0.07	<0.2
Churn splitter	17.6	<0.6	0.6	<0.02	9.7	<0.1	0.09	<0.2
Nuclepore filter	2.4	<0.6	1.3	<0.02	3.0	<0.1	1.41	<0.2
Tributary carboy	0.2	<0.6	0.3	<0.02	29.1	<0.1	0.16	<0.2
	Date: 11-12-91							
Nanopure system	2.2	<0.6	<0.1	<0.02	11.0	<0.1	0.01	<0.2
Centrifuge	7.9	<0.6	0.2	<0.02	12.2	0.3	0.10	<0.2
Ultrafilter	1.8	<0.6	<0.1	<0.02	9.9	<0.1	0.04	<0.2
Nuclepore filter	0.8	<0.6	0.1	<0.02	<0.4	<0.1	0.02	<0.2
Tributary carboy	6.0	<0.6	<0.1	<0.02	13.2	<0.1	0.07	<0.2
Blank processed through:	Cobalt (µg/L)	Copper (µg/L)	Iron (mg/L)	Lead (µg/L)	Lithium (µg/L)	Magnesium (mg/L)	Manganese (µg/L)	Mercury (µg/L)
	Date: 10-28-91							
Nanopure system	0.01	2.92	<0.005	0.28	0.07	0.01	0.28	--
Sieve/cylinder, D	0.01	0.51	0.007	0.13	2.47	1.30	1.87	0.003
Sieve/cylinder, P	0.05	3.12	0.013	0.32	0.78	<0.001	2.23	--
Churn splitter	0.02	1.88	0.023	0.30	0.80	0.01	2.35	--
Nuclepore filter	0.03	1.33	<0.005	<0.06	2.46	1.46	2.41	0.012
Tributary carboy	0.02	2.42	<0.005	0.22	0.07	0.01	0.84	0.008
	Date: 11-12-91							
Nanopure system	0.02	3.23	<0.005	0.53	0.21	<0.001	0.48	0.010
Centrifuge	0.01	2.45	0.008	0.22	1.29	0.01	1.07	--
Ultrafilter	<0.008	0.20	<0.005	0.07	1.13	<0.001	0.39	0.013
Nuclepore filter	<0.008	0.03	<0.005	0.11	<0.03	<0.001	0.07	0.009
Tributary carboy	0.02	2.72	<0.005	0.42	0.33	0.02	0.81	0.009

Table 6.--Trace- and major-element results for field blank samples collected during the October-November 1991 cruise--continued

Blank processed through:	Molybdenum (µg/L)	Nickel (µg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Strontium (mg/L)	Thallium (µg/L)	Uranium (µg/L)
	Date: 10-28-91							
Nanopure system	<0.09	<0.03	<0.05	0.36	0.08	<0.0002	<0.05	<0.06
Sieve/cylinder, D	<0.09	0.23	<0.05	1.13	3.45	<0.0002	<0.05	<0.06
Sieve/cylinder, P	0.12	2.49	<0.05	2.45	1.28	0.001	<0.05	<0.06
Churn splitter	<0.09	0.60	<0.05	2.48	1.33	0.001	<0.05	<0.06
Nuclepore filter	<0.09	0.25	<0.05	1.26	3.58	0.002	<0.05	<0.06
Tributary carboy	<0.09	0.09	<0.05	0.92	0.07	0.001	<0.05	<0.06
	Date: 11-12-91							
Nanopure system	<0.09	0.06	--	2.60	0.24	0.001	<0.05	<0.06
Centrifuge	0.12	0.29	<0.05	2.79	2.21	0.001	<0.05	<0.06
Ultrafilter	<0.09	0.15	<0.05	2.77	2.00	0.001	<0.05	<0.06
Nuclepore filter	<0.09	<0.03	<0.05	0.05	<0.006	0.001	<0.05	<0.06
Tributary carboy	<0.09	<0.03	<0.05	2.92	0.55	0.001	<0.05	<0.06
Blank processed through:								
	Vanadium (µg/L)	Zinc (µg/L)						
	Date: 10-28-91							
Nanopure system	<0.07	1.08						
Sieve/cylinder, D	<0.07	3.31						
Sieve/cylinder, P	0.35	2.02						
Churn splitter	<0.07	2.81						
Nuclepore filter	<0.07	2.56						
Tributary carboy	<0.07	1.34						
	Date: 11-12-91							
Nanopure system	<0.07	1.42						
Centrifuge	<0.07	1.46						
Ultrafilter	<0.07	0.26						
Nuclepore filter	<0.07	0.62						
Tributary carboy	<0.07	1.07						

Table 7.--Trace- and major-element results for field blank samples collected during the April-May 1992 cruise

[µg/L, microgram per liter; mg/L, milligram per liter; --, not analyzed; <, less than the detection limit]

Blank processed through:	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Beryllium (µg/L)	Boron (µg/L)	Cadmium (µg/L)	Calcium (mg/L)	Chromium (µg/L)
	Date: 04-11-92							
Nanopure system	2.52	<0.6	<0.1	0.06	1.7	<0.1	0.01	<0.2
Sieve/cylinder	3.99	<0.6	<0.1	0.03	2.2	<0.1	0.04	<0.2
Churn splitter	4.07	<0.6	0.6	0.19	6.2	0.3	0.05	5.6
Centrifuge	9.14	<0.6	5.5	0.05	2.1	0.3	0.24	<0.2
Ultrafilter	1.79	<0.6	0.3	<0.02	1.9	<0.1	0.76	<0.2
Nuclepore filter	1.84	<0.6	<0.1	<0.02	1.9	<0.1	0.03	<0.2
	Date: 05-09-92							
Nanopure system	11.22	<0.6	<0.1	0.04	63.6	<0.1	0.03	<0.2
Sieve/cylinder	13.39	<0.6	<0.1	0.02	18.9	<0.1	0.02	<0.2
Churn splitter	16.76	<0.6	<0.1	<0.02	18.3	<0.1	0.04	<0.2
Centrifuge	9.94	<0.6	0.2	0.04	23.3	<0.1	0.18	<0.2
Ultrafilter	5.89	<0.6	0.3	0.07	27.9	<0.1	0.49	<0.2
Nuclepore filter	9.74	<0.6	<0.1	0.06	18.4	<0.1	0.05	<0.2
Blank processed through:	Cobalt (µg/L)	Copper (µg/L)	Iron (mg/L)	Lead (µg/L)	Lithium (µg/L)	Magnesium (mg/L)	Manganese (µg/L)	Mercury (µg/L)
	Date: 04-11-92							
Nanopure system	0.017	8.85	0.007	0.52	0.12	0.004	0.58	--
Sieve/cylinder	<0.008	1.52	0.006	0.21	0.46	0.01	1.01	0.021
Churn splitter	0.149	1.84	0.010	0.96	0.37	0.02	1.13	0.026
Centrifuge	0.022	3.87	0.021	0.27	0.66	0.07	1.51	--
Ultrafilter	0.014	0.48	<0.005	<0.06	0.87	0.31	1.39	0.024
Nuclepore filter	0.011	1.42	<0.005	0.15	0.32	0.009	0.42	0.029
	Date: 05-09-92							
Nanopure system	<0.008	0.64	0.005	0.24	0.73	0.01	0.49	0.021
Sieve/cylinder	0.017	1.28	0.007	0.37	2.29	<0.001	0.78	0.019
Churn splitter	0.032	1.22	0.009	0.31	2.34	0.004	0.97	0.021
Centrifuge	0.020	1.38	0.009	0.29	2.22	0.03	0.78	--
Ultrafilter	0.042	0.88	<0.005	0.07	2.56	0.16	0.74	0.022
Nuclepore filter	<0.008	0.80	0.009	0.20	2.28	0.007	0.95	0.024

Table 7.--Trace- and major-element results for field blank samples collected during the April-May 1992 cruise--continued

Blank processed through:	Molybdenum (µg/L)	Nickel (µg/L)	Potassium (mg/L)	Silica (mg/L)	Sodium (mg/L)	Strontium (mg/L)	Thallium (µg/L)	Uranium (µg/L)
	Date: 04-11-92							
Nanopure system	<0.09	<0.03	<0.05	1.04	0.37	0.001	0.06	<0.06
Sieve/cylinder	<0.09	0.43	<0.05	1.07	1.23	<0.0002	<0.05	<0.06
Churn splitter	0.48	0.54	<0.05	1.13	1.20	<0.0002	0.45	0.53
Centrifuge	<0.09	0.38	0.06	1.05	2.21	<0.0002	<0.05	<0.06
Ultrafilter	<0.09	0.15	0.08	1.10	2.37	0.002	<0.05	<0.06
Nucleopore filter	<0.09	<0.03	<0.05	1.10	0.63	<0.0002	0.06	<0.06
	Date: 05-09-92							
Nanopure system	<0.09	0.04	<0.05	2.20	3.61	<0.0002	<0.05	<0.06
Sieve/cylinder	<0.09	0.06	0.06	2.49	11.02	<0.0002	<0.05	<0.06
Churn splitter	<0.09	0.15	0.07	2.45	10.58	<0.0002	<0.05	<0.06
Centrifuge	<0.09	0.26	0.09	2.64	10.90	<0.0002	<0.05	<0.06
Ultrafilter	0.13	0.15	0.11	2.60	10.96	0.002	<0.05	<0.06
Nucleopore filter	<0.09	0.25	0.08	2.50	10.80	0.001	<0.05	<0.06
<hr/>								
Blank processed through:	Vanadium (µg/L)	Zinc (µg/L)						
	Date: 04-11-92							
Nanopure system	<0.07	1.52						
Sieve/cylinder	<0.07	0.83						
Churn splitter	11.71	1.44						
Centrifuge	0.33	2.83						
Ultrafilter	<0.07	0.87						
Nucleopore filter	<0.07	0.14						
	Date: 05-09-92							
Nanopure system	<0.07	0.87						
Sieve/cylinder	<0.07	1.96						
Churn splitter	0.43	1.03						
Centrifuge	<0.07	0.76						
Ultrafilter	<0.07	2.05						
Nucleopore filter	<0.07	1.68						

Nutrient and Dissolved Organic-Carbon Results for All Three Cruises

Table 8.--Nutrient and dissolved organic-carbon results for field blanks collected during the July-August 1991, October-November 1991, and April-May 1992 cruises

[mg N/L, milligram nitrogen per liter; mg P/L, milligram phosphorus per liter; mg C/L, milligram carbon per liter; --, not reported; <, less than the detection limit]

Blank processed through:	Date	Ammonium (mg N/L)	Nitrate (mg N/L)	Nitrite (mg N/L)	Ortho-phosphate (mg P/L)	Dissolved organic-carbon (mg C/L)
<u>July-August 1991 cruise</u>						
Silver filter	07-23-91	0.02	0.03	<0.01	<0.01	0.40
Tributary carboy	07-23-91	0.02	0.07	<0.01	<0.01	0.60
Silver filter	08-02-91	0.01	<0.01	0.01	0.02	0.20
<u>October-November 1991 cruise</u>						
Silver filter	10-12-91	0.02	0.44	<0.01	0.01	0.36
Nanopure system	10-28-91	0.04	0.19	0.01	0.01	--
Silver filter	10-28-91	0.01	<0.01	0.01	0.01	0.28
Ultrafilter permeate	10-28-91	0.01	0.28	0.01	<0.01	0.46
Nanopure system	11-12-91	--	--	--	--	0.29
Sieve-graduated cylinder-churn	11-12-91	--	--	--	--	0.70
<u>April-May 1992 cruise</u>						
Nanopure system	04-11-92	<0.006	0.008	0.003	<0.002	0.05
Silver filter	04-11-92	<0.006	0.011	0.002	0.004	0.24
Sieve-graduated cylinder	04-11-92	0.011	0.016	0.002	<0.002	0.26
Churn	04-11-92	0.007	0.015	<0.002	<0.002	0.30
Ultrafilter permeate	04-11-92	0.015	0.339	0.003	<0.002	--
Tributary carboy	04-11-92	0.031	0.049	0.004	<0.002	0.31
Silver filter	04-20-92	<0.006	0.015	0.006	0.002	0.28
Nanopure system	05-09-92	0.007	0.068	<0.002	<0.002	0.02
Silver filter	05-09-92	0.016	0.105	0.005	0.005	0.22
Sieve-graduated cylinder-churn	05-09-92	0.016	0.105	0.005	0.005	0.11
Ultrafilter permeate	05-09-92	0.019	0.127	0.007	0.007	--
Tributary carboy	05-09-92	<0.006	0.002	0.004	<0.002	0.30

Chloride and Sulfate Results for All Three Cruises

Table 9.--Chloride and sulfate results for field blanks collected during the July-August 1991, October-November 1991, and April-May 1992 cruises

[mg/L, milligram per liter; <, less than the detection limit]

Sample	Chloride (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
	July 23, 1991		August 2, 1991	
Nanopure	0.05	<0.02	0.14	0.47
Churn splitter A	1.06	2.78	0.47	1.59
Churn splitter B	0.98	2.64	0.45	1.53
Tributary carboy	1.03	2.57	0.55	1.64
	October 28, 1991		November 12, 1991	
Nanopure	0.06	<0.02	0.17	0.02
Churn splitter	1.32	0.05	0.04	0.05
Tributary carboy	0.05	0.02	0.33	0.02
	April 11, 1992		May 9, 1992	
Nanopure	0.10	0.02	2.04	0.29
Sieve-cylinder	0.88	0.02	2.01	0.24

Quality-Control Samples

The accuracy of the sample data was ensured by analyzing standard reference materials periodically within a set of samples. Reference standards routinely comprised at least 10 percent of an analytical batch. Different standard reference materials were used for each analytical method. Two reference standards having analyte concentrations that bracketed the expected analyte concentrations routinely were used. Results obtained for some of the reference standards used for quality control during the analysis of samples are provided here. Quality-control data for trace-element determinations by ICP-MS and CV-AFS that coincided with the analyses of water samples collected during the July-August 1991, October-November 1991, and April-May 1992 cruises are listed in tables 10-12. Quality-control data for calcium, iron, magnesium, potassium, silica, sodium, and strontium determinations by ICP-AES and F-AAS that coincided with the analyses of water samples collected during the July-August 1991, October-November 1991, and April-May 1992 cruises are listed in tables 13-15. Nitrate, nitrite, ammonium, and orthophosphate quality-control results obtained by CFA during the analyses of water samples collected during the July-August 1991, October-November 1991, and April-May 1992 cruises are listed in table 16. Quality-control data for chloride, sulfate, and alkalinity (as CaCO_3) determinations by IC and AET that coincided with the analyses of water samples collected during the July-August 1991, October-November 1991, and April-May 1992 cruises are listed in table 17.

The average and standard deviations listed in tables 10-17 are based on the number of analyses (N) indicated and represent the level of accuracy and precision maintained throughout the analysis of samples from a given cruise. Quality-control results for DOC analyses were not tabulated here; however, the level of analytical precision that can be expected for DOC results is less than 1 percent relative standard deviation at 10 mg/L. Samples were reanalyzed whenever the experimental reference standard mean was greater than two standard deviations of the published reference standard mean.

Tabulated Quality-Control Results

The following tables list the results obtained for quality-control reference standards analyzed with samples collected during the July-August 1991, October-November 1991, and April-May 1992 cruises. For each cruise the results for the quality-control standards are tabulated for dissolved trace-elements and major-elements, dissolved nutrients and organic carbon, and major anions.

Trace-Element Results for All Three Cruises

Table 10.--Quality-control data for trace-element determinations corresponding to the analysis of water samples collected during the July-August 1991 cruise

[µg/L, microgram per liter; --, not determined; concentrations in parentheses are uncertified values; all analytes except mercury were determined by inductively coupled plasma-mass spectrometry; mercury was determined by cold vapor-atomic fluorescence spectrometry; N is the number of analyses]

Analyte	Published mean (µg/L)	Published standard deviation	Analytical mean (µg/L)	Analytical standard deviation
USGS STANDARD REFERENCE WATER SAMPLE T103, N=11				
Aluminum -----	127	38	125	4
Arsenic -----	3.2	0.9	3.3	0.6
Barium -----	40.5	3.2	39.2	0.7
Beryllium -----	4.8	1.0	4.9	0.3
Boron -----	120	39	104	5
Cadmium -----	1.7	0.4	2.0	0.1
Chromium -----	5.5	1.3	5.9	0.6
Cobalt -----	5.2	3.1	3.3	0.1
Copper -----	83.3	5.7	73.0	2.6
Lead -----	7.7	2.1	9.9	0.3
Lithium -----	32.5	3.1	27.6	1.1
Manganese -----	9.0	2.1	7.2	0.2
Molybdenum -----	36.5	4.6	34.3	0.8
Nickel -----	6.7	2.5	7.0	0.5
Vanadium -----	40.4	4.1	45.2	1.6
Zinc -----	26.5	4.1	22.5	0.8
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY REFERENCE MATERIAL 1643B (DILUTED 1:10), N=13				
Barium -----	45	2	4.1	0.2
Beryllium -----	19	2	2.3	0.2
Boron -----	(96)	--	10	2
Cadmium -----	20	1	2.4	0.1
Chromium -----	18.9	0.4	2.0	0.6
Cobalt -----	26	1	3.1	0.1
Copper -----	22	0.4	2.4	0.2
Lead -----	24	0.7	2.2	0.1
Manganese -----	28	2	3.5	0.2
Molybdenum -----	86	3	9.7	0.4
Nickel -----	50	3	5.4	0.4
Thallium -----	8.1	0.2	0.75	0.06
Vanadium -----	46	0.4	8.6	1.5
Zinc -----	67	2	8.9	0.5

Table 10.--Quality-control data for trace-element determinations corresponding to the analysis of water samples collected during the July-August 1991 cruise--
continued

Analyte	Published mean (µg/L)	Published standard deviation	Analytical mean (µg/L)	Analytical standard deviation
USGS STANDARD REFERENCE WATER SAMPLE HG-7, N=35 (DILUTED 1:10)				
Mercury -----	0.22	0.06	0.019	0.002
USGS STANDARD REFERENCE WATER SAMPLE HG-10, N=35 (DILUTED 1:10)				
Mercury -----	1.40	0.08	0.146	0.005
NATIONAL RESEARCH COUNCIL OF CANADA REFERENCE MATERIAL SLRS-1, N=4				
Uranium -----	0.28	0.03	0.32	0.02

Table 11.--Quality-control data for trace-element determinations corresponding to the analysis of water samples collected during the October-November 1991 cruise

[$\mu\text{g/L}$, microgram per liter; --, not determined; concentrations in parentheses are uncertified values; all analytes except mercury were determined by inductively coupled plasma-mass spectrometry; mercury was determined by cold vapor-atomic fluorescence spectrometry; N is the number of analyses]

Analyte	Published mean ($\mu\text{g/L}$)	Published standard deviation	Analytical mean ($\mu\text{g/L}$)	Analytical standard deviation
USGS STANDARD REFERENCE WATER SAMPLE T103, N=12				
Aluminum -----	127	38	130	18
Arsenic -----	3.2	0.9	3.5	0.3
Barium -----	40.5	3.2	40.1	0.6
Beryllium -----	4.8	1.0	4.8	0.6
Boron -----	120	39	105	14
Cadmium -----	1.7	0.4	2.0	0.2
Chromium -----	5.5	1.3	6.1	0.8
Cobalt -----	5.2	3.1	3.5	0.3
Copper -----	83.3	5.7	74.9	5.9
Lead -----	7.7	2.1	9.8	0.3
Lithium -----	32.5	3.1	28.6	3.5
Manganese -----	9.0	2.1	7.7	0.6
Molybdenum -----	36.5	4.6	35.9	1.4
Nickel -----	6.7	2.5	6.2	1.0
Vanadium -----	40.4	4.1	49.6	3.5
Zinc -----	26.5	4.1	22.7	1.5
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY REFERENCE MATERIAL 1643B (DILUTED 1:10), N=12				
Barium -----	45	2	4.3	0.2
Beryllium -----	19	2	2.3	0.2
Boron -----	(96)	--	12	2
Cadmium -----	20	1	2.4	0.1
Chromium -----	18.9	0.4	2.2	0.4
Cobalt -----	26	1	3.3	0.2
Copper -----	22	0.4	2.6	0.2
Lead -----	24	0.7	2.2	0.1
Manganese -----	28	2	3.7	0.2
Molybdenum -----	86	3	10.2	0.5
Nickel -----	50	3	5.3	0.4
Thallium -----	8.1	0.2	0.76	0.04
Vanadium -----	46	0.4	9.6	0.8
Zinc -----	67	2	9.1	0.5

Table 11.--Quality-control data for trace-element determinations corresponding to the analysis of water samples collected during the October-November 1991 cruise--continued

Analyte	Published mean (µg/L)	Published standard deviation	Analytical mean (µg/L)	Analytical standard deviation
USGS STANDARD REFERENCE WATER SAMPLE HG-7, (DILUTED 1:10), N=22				
Mercury -----	0.22	0.06	0.020	0.002
USGS STANDARD REFERENCE WATER SAMPLE HG-10, (DILUTED 1:10), N=22				
Mercury -----	1.40	0.08	0.148	0.005
NATIONAL RESEARCH COUNCIL OF CANADA REFERENCE MATERIAL SLRS-1, N=4				
Uranium -----	0.28	0.03	0.31	0.03

Table 12.--Quality-control data for trace-element determinations corresponding to the analysis of water samples collected during the April-May 1992 cruise

[$\mu\text{g/L}$, microgram per liter; --, not determined; concentrations in parentheses are uncertified values; all analytes except mercury were determined by inductively coupled plasma-mass spectrometry; mercury was determined by cold vapor-atomic fluorescence spectrometry; N is the number of analyses]

Analyte	Published mean ($\mu\text{g/L}$)	Published standard deviation	Analytical mean ($\mu\text{g/L}$)	Analytical standard deviation
USGS STANDARD REFERENCE WATER SAMPLE T103, N=11				
Aluminum -----	127	38	118	9
Arsenic -----	3.2	0.9	3.2	0.5
Barium -----	40.5	3.2	39.6	0.7
Beryllium -----	4.8	1.0	4.5	0.4
Boron -----	120	39	94.4	7.2
Cadmium -----	1.7	0.4	1.8	0.3
Chromium -----	5.5	1.3	3.8	0.5
Cobalt -----	5.2	3.1	2.9	0.3
Copper -----	83.3	5.7	72.6	4.8
Lead -----	7.7	2.1	9.2	0.3
Lithium -----	32.5	3.1	26.0	1.6
Manganese -----	9.0	2.1	4.1	0.3
Molybdenum -----	36.5	4.6	37.4	1.5
Nickel -----	6.7	2.5	--	--
Vanadium -----	40.4	4.1	36.4	3.1
Zinc -----	26.5	4.1	19.2	1.2
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY REFERENCE MATERIAL 1643B (DILUTED 1:10), N=12				
Barium -----	45	2	4.2	0.2
Beryllium -----	19	2	2.5	0.2
Boron -----	(96)	--	11	1
Cadmium -----	20	1	2.5	0.2
Chromium -----	18.9	0.4	1.5	0.5
Cobalt -----	26	1	3.4	0.2
Copper -----	22	0.4	2.6	0.2
Lead -----	24	0.7	2.1	0.1
Manganese -----	28	2	3.7	0.3
Molybdenum -----	86	3	11.8	0.4
Nickel -----	50	3	5.4	0.9
Thallium -----	8.1	0.2	0.71	0.06
Vanadium -----	46	0.4	7.2	1.2
Zinc -----	67	2	8.9	0.6

**Table 12.--Quality-control data for trace-element determinations corresponding to the analysis of water samples collected during the April-May 1992 cruise--
continued**

Analyte	Published mean ($\mu\text{g/L}$)	Published standard deviation	Analytical mean ($\mu\text{g/L}$)	Analytical standard deviation
USGS STANDARD REFERENCE WATER SAMPLE HG-7, (DILUTED 1:10), N=21				
Mercury -----	0.22	0.06	0.021	0.003
USGS STANDARD REFERENCE WATER SAMPLE HG-10, (DILUTED 1:10), N=21				
Mercury -----	1.40	0.08	0.142	0.004
NATIONAL RESEARCH COUNCIL OF CANADA REFERENCE MATERIAL SLRS-1, N=4				
Uranium -----	0.28	0.03	0.27	0.07

Major-Element Results for All Three Cruises

Table 13.--Quality-control data for major-element determinations corresponding to the analysis of water samples collected during the July-August 1991 cruise

[mg/L, milligram per liter; all analytes except potassium were determined by inductively coupled plasma-atomic emission spectrometry; potassium was determined by flame-atomic absorption spectroscopy; N is the number of analyses]

Analyte	Published mean (mg/L)	Published standard deviation	Analytical mean (mg/L)	Analytical standard deviation
USGS STANDARD REFERENCE WATER SAMPLE T101, N=9				
Calcium -----	72.5	2.4	75.8	4.0
Iron -----	0.191	0.018	0.197	0.017
Magnesium -----	52.6	2.2	54.8	2.8
Silica -----	6.97	.47	7.4	0.3
Sodium -----	96.8	4.1	102	5
Strontium -----	1.20	0.088	1.25	0.063
USGS STANDARD REFERENCE WATER SAMPLE T103, N=8				
Calcium -----	54.7	2.0	57.3	3.8
Iron -----	0.041	0.0076	0.0392	0.0005
Magnesium -----	30.5	1.2	32.0	1.9
Silica -----	7.5	0.2	8.0	0.4
Sodium -----	107	5.0	114	7
Strontium -----	0.743	0.034	0.790	0.051
USGS STANDARD REFERENCE WATER SAMPLE T111, N=5				
Potassium -----	2.67	0.3	2.7	0.2

Table 14.--Quality-control data for major-element determinations corresponding to the analysis of water samples collected during the October-November 1991 cruise

[mg/L, milligram per liter; all analytes except potassium were determined by inductively coupled plasma-atomic emission spectrometry; potassium was determined by flame-atomic absorption spectroscopy; N is the number of analyses]

Analyte	Published mean (mg/L)	Published standard deviation	Analytical mean (mg/L)	Analytical standard deviation
USGS STANDARD REFERENCE WATER SAMPLE T101, N=12				
Calcium -----	72.5	2.4	73.6	2.0
Iron -----	0.191	0.018	0.198	0.005
Magnesium -----	52.6	2.2	56.3	0.8
Silica -----	6.97	.47	7.30	0.08
Sodium -----	96.8	4.1	100	8
Strontium -----	1.20	0.088	1.25	0.033
USGS STANDARD REFERENCE WATER SAMPLE T103, N=12				
Calcium -----	54.7	2.0	54.8	1.7
Magnesium -----	30.5	1.2	31.6	0.6
Silica -----	7.5	0.2	7.76	0.13
Sodium -----	107	5.0	108	9
Strontium -----	0.743	0.034	0.777	0.025
USGS STANDARD REFERENCE WATER SAMPLE T111, N=4				
Potassium -----	2.67	0.3	2.7	0.2

Table 15.--Quality-control data for major-element determinations corresponding to the analysis of water samples collected during the April-May 1992 cruise

[mg/L, milligram per liter; all analytes except potassium were determined by inductively coupled plasma-atomic emission spectrometry; potassium was determined by flame-atomic absorption spectroscopy; N is the number of analyses]

Analyte	Published mean (mg/L)	Published standard deviation	Analytical mean (mg/L)	Analytical standard deviation
USGS STANDARD REFERENCE WATER SAMPLE T101, N=12				
Calcium -----	72.5	2.4	74.0	0.9
Iron -----	0.191	0.018	0.209	0.004
Magnesium -----	52.6	2.2	58.5	1.0
Silica -----	6.97	0.47	7.53	0.16
Sodium -----	96.8	4.1	99.0	3.8
Strontium -----	1.20	0.088	1.25	0.016
USGS STANDARD REFERENCE WATER SAMPLE T103, N=11				
Calcium -----	54.7	2.0	54.9	1.2
Iron -----	0.041	0.0076	0.0443	0.0022
Magnesium -----	30.5	1.2	32.5	0.6
Silica -----	7.5	0.2	7.90	0.24
Sodium -----	107	5.0	105	3
Strontium -----	0.743	0.034	0.774	0.012
USGS STANDARD REFERENCE WATER SAMPLE T111, N=5				
Potassium -----	2.67	0.3	2.7	0.2

Nutrient Results for All Three Cruises

Table 16.--Quality-control data for nutrient determinations corresponding to the analysis of water samples collected during the July-August 1991, October-November 1991, and April-May 1992 cruises

[Nutrients determined using a photometric air-segmented continuous flow analyzer; mg N/L, milligram nitrogen per liter; mg P/L, milligram phosphorus per liter; --, not reported]

Analyte	Published mean	Published standard deviation	Analytical mean	Analytical standard deviation	Number of analyses
USGS STANDARD REFERENCE WATER SAMPLE N-30 (NONPRESERVED)					
<u>July-August 1991</u>					
Ammonium (mg N/L) -----	0.210	0.005	0.18	0.05	23
Nitrate plus nitrite (mg N/L) -	0.442	0.012	0.43	0.05	30
Nitrite (mg N/L) -----	--	--	0.17	0.01	14
Orthophosphate (mg P/L) ----	0.260	0.006	0.26	0.01	23
USGS STANDARD REFERENCE WATER SAMPLE N-31 (NONPRESERVED)					
Ammonium (mg N/L) -----	0.580	0.007	0.57	0.08	21
Nitrate plus nitrite (mg N/L) -	1.510	0.017	1.33	0.20	30
Nitrite (mg N/L) -----	--	--	0.31	0.02	12
Orthophosphate (mg P/L) ----	1.592	0.069	--	--	--
USGS STANDARD REFERENCE WATER SAMPLE N-30 (NONPRESERVED)					
<u>October-November 1991</u>					
Ammonium (mg N/L) -----	0.210	0.005	0.21	0.01	55
Nitrate plus nitrite (mg N/L) -	0.442	0.012	0.44	0.02	55
Nitrite (mg N/L) -----	--	--	0.18	0.01	43
Orthophosphate (mg P/L) ----	0.260	0.006	0.28	0.01	55
USGS STANDARD REFERENCE WATER SAMPLE N-31 (NONPRESERVED)					
Ammonium (mg N/L) -----	0.580	0.007	0.59	0.02	52
Nitrate plus nitrite (mg N/L) -	1.510	0.017	1.51	0.07	52
Nitrite (mg N/L) -----	--	--	0.32	0.02	41
Orthophosphate (mg P/L) ----	1.592	0.069	1.62	0.04	52
USGS STANDARD REFERENCE WATER SAMPLE N-30 (NONPRESERVED)					
<u>April-May 1992</u>					
Ammonium (mg N/L) -----	0.210	0.005	0.199	0.006	28
Nitrate plus nitrite (mg N/L) -	0.442	0.012	0.421	0.030	40
Nitrite (mg N/L) -----	--	--	0.188	0.003	21
Orthophosphate (mg P/L) ----	0.260	0.006	0.297	0.005	12
USGS STANDARD REFERENCE WATER SAMPLE N-32 (NONPRESERVED)					
Ammonium (mg N/L) -----	0.040	0.021	0.033	0.003	28
Nitrate plus nitrite (mg N/L) -	0.148	0.024	0.143	0.026	30
Nitrite (mg N/L) -----	--	--	0.036	0.001	17
Orthophosphate (mg P/L) ----	0.091	0.010	0.097	0.003	30

Alkalinity, Chloride, and Sulfate Results for All Three Cruises

Table 17.--Quality-control data for alkalinity, chloride, and sulfate determinations corresponding to the analysis of water samples collected during the July-August 1991, October-November 1991, and April-May 1992 cruises

[Chloride and sulfate were determined using ion chromatography; alkalinity was measured using automated electrometric titration; mg/L, milligram per liter; SRWS, U.S. Geological Survey Standard Reference Water Sample; N is the number of analyses; NA, not analyzed]

Analyte	Published mean (mg/L)	Published standard deviation	July-August 1991		October-November 1991		April-May 1992	
			Analytical mean (mg/L)	Analytical standard deviation	Analytical mean (mg/L)	Analytical standard deviation	Analytical mean (mg/L)	Analytical standard deviation
SRWS M104			N=14		N=7		N=10	
Chloride	69.2	2.8	71.5	1.0	71.6	1.3	71.4	1.1
Sulfate	225	16	228	3.2	228	4.3	227	3.5
SRWS M112			N=7		N=3		N=5	
Chloride	46.0	2.8	49.0	1.2	48.2	1.2	49.7	0.7
Sulfate	25.0	1.5	24.6	1.2	23.4	2.0	25.6	0.5
SRWS M120			N=7		N=4		N=5	
Chloride	7.60	0.67	7.6	0.12	7.7	0.1	7.6	0.4
Sulfate	155.0	5.2	156	3.5	161	3	158	3
SRWS M94			N=5		N=5		NA	
Alkalinity as CaCO ₃	245	8	245	0.6	245	0.6		
SRWS M102			N=12		N=18		N=18	
Alkalinity as CaCO ₃	176	4	176	0.6	176	0.6	176	0.4
SRWS M86			NA		NA		N=6	
Alkalinity as CaCO ₃	151	4					151	0.7

CONCENTRATION RESULTS

The analytical concentrations reported for dissolved trace-elements and major-elements, nutrients, and major anions are organized by sampling cruise in that order. The dissolved-constituent loads are organized in the same manner.

Laterally Composited Samples

Dissolved aluminum, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, mercury, molybdenum, nickel, potassium, silica, sodium, strontium, thallium, uranium, vanadium, and zinc concentrations in laterally composited water samples collected from the Mississippi River and the Minnesota, Illinois, Missouri, and Ohio Rivers during the July-August 1991, October-November 1991, and April-May 1992 cruises are listed in tables 18, 25, and 32. Dissolved ammonium, nitrate, nitrite, orthophosphate, total soluble phosphorus, and dissolved organic-carbon concentrations in laterally composited water samples collected from the Mississippi River and the Minnesota, Illinois, Missouri, and Ohio Rivers during the July-August 1991, October-November 1991, and April-May 1992 cruises are listed in tables 19, 26, and 33. Dissolved bicarbonate, carbonate, chloride, and sulfate concentrations in laterally composited water samples collected from the Mississippi River and the Minnesota, Illinois, Missouri, and Ohio Rivers during the July-August 1991, October-November 1991, and April-May 1992 cruises are listed in tables 20, 27, and 34.

The aforementioned tables provide analyte concentrations for composite A and composite B. The method of collection for the laterally composited samples is provided in tables 1-3; depth-integrated composite, pumped composite, or point sampled laterally composited were obtained during selected cruises. Data from composite A and composite B may be used as an indication of the sampling precision or as a comparison of different methods of collection. In addition, these tables provide the analyte concentrations measured in the ultrafilter permeate samples. Ultrafilter permeate samples represent water that has been processed to contain particles less than 0.005 μm in mean diameter. Major anion and alkalinity subsamples of the ultrafilter permeate were not collected.

All the samples were analyzed in a random fashion, reagent blank subtracted, and background corrected. Results that were less than the detection limit are identified by the less than symbol, <, preceding the method detection-limit value. Parameters that were not determined for a particular sample or that were in error are identified by --.

Surface-Grab Samples

Dissolved aluminum, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, mercury, molybdenum, nickel, potassium, silica, sodium, strontium, thallium, uranium, vanadium,

and zinc concentrations in tributary surface-grab water samples collected from the St. Croix, Chippewa, Wisconsin, Rock, Iowa, Des Moines, Kaskaskia, White, Arkansas, and Yazoo Rivers during the July-August 1991, October-November 1991, and April-May 1992 cruises are listed in tables 21, 28, and 35. The dissolved concentrations for these same analytes in pool surface-grab water samples collected from Pools 1, 2, 5, 5a, 7, 8, 10, 14, 20, and 22 during the July-August 1991 cruise (table 22), from Pools 2, 3, Upper Lake Pepin, Lower Lake Pepin, 8, 9, 11, 13, 16, 19, 24, and 26 during the October-November 1991 cruise (table 29), and from Pools 2, 6, 8, 12, 15, 18, 21, and 25 during the April-May 1992 cruise (table 36) also are tabulated. Dissolved ammonium, nitrate, nitrite, orthophosphate, and dissolved organic-carbon concentrations measured in surface-grab water samples collected from these tributaries and pools during the July-August 1991, October-November 1991, and April-May 1992 cruises are listed in tables 23, 30, and 37. Dissolved bicarbonate, carbonate, chloride, and sulfate concentrations measured in surface-grab water samples collected from these tributaries and pools during the July-August 1991, October-November 1991, and April-May 1992 cruises are listed in tables 24, 31, and 38.

The aforementioned tables provide analyte concentrations for a composite surface-grab sample for every tributary and pool sampled. The collection of pool samples was distributed between all three cruises; samples from Pools 2 and 8 were collected during each cruise as a measure of the concentration variability and sampling precision between cruises. Analyte concentrations measured in the ultrafilter permeate from the tributary sites are provided; however, ultrafilter permeate samples were not taken for pool samples.

Specific conductance was measured for all samples collected from the Mississippi River and some of its tributaries. Specific conductance values for samples from sites on the Mississippi River and the Minnesota, Illinois, Missouri, and Ohio Rivers can be found in a report by Moody and Meade (1994b). Specific conductance values for the St. Croix, Chippewa, Wisconsin, Rock, Iowa, Des Moines, Kaskaskia, White, Arkansas, and Yazoo Rivers for all three cruises are listed in table 46.

Results that were less than the detection limit are identified by the less than symbol, <, preceding the method detection limit value (see table 4 for detection limits). Parameters that were not determined for a particular sample or that were omitted because of error are identified by --.

Tabulated Concentrations for Dissolved Trace-Elements, Major-Elements, Nutrients, Organic Carbon, Bicarbonate, Carbonate, Chloride, and Sulfate in Laterally Composited and Surface-Grab Samples

The following tables list the analyte concentrations measured in laterally composited samples and surface-grab samples collected from the Mississippi River and some of its tributaries during the July-August 1991, October-November 1991, and April-May 1992 cruises. For each cruise the concentrations are tabulated for dissolved trace-elements and major-elements, dissolved nutrients and organic carbon, and major anions.

July-August 1991 Cruise

Table 18.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the July-August 1991 cruise

[$\mu\text{g/L}$, microgram per liter; mg/L , milligram per liter; --, not determined; <, less than the detection limit; A, depth-integrated composite A sample; B, depth-integrated composite B sample; method for collection of composite A and composite B varied between collection sites and is specified in table 1]

Date 1991	Site name	Aluminum (µg/L)			Arsenic (µg/L)			Barium (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
07-05	Mississippi R. above St. Anthony Falls, Minn.	2.9	2.9	3.8	3.1	2.4	2.6	47.5	46.2	43.0
07-08	Mississippi R. at Hastings, Minn.	2.2	4.5	2.5	3.4	3.6	3.0	68.9	70.6	67.8
07-10	Mississippi R. near Pepin, Wis.	2.1	2.4	2.2	2.7	3.0	2.8	59.8	61.5	59.6
07-12	Mississippi R. at Trempealeau, Wis.	2.6	4.5	3.4	2.1	1.9	2.2	53.2	53.9	52.7
07-15	Mississippi R. below Lock and Dam 9, Wis.	2.6	2.4	2.9	2.1	1.5	1.5	56.5	55.1	56.8
07-18	Mississippi R. at Clinton, Iowa	2.8	2.1	2.1	1.8	2.2	1.9	56.0	58.2	56.2
07-21	Mississippi R. at Keokuk, Iowa	2.7	3.6	3.0	2.3	2.0	1.6	62.4	64.5	64.6
07-24	Mississippi R. near Winfield, Mo.	4.3	4.0	8.0	1.5	2.1	2.4	67.4	68.3	66.9
07-29	Mississippi R. at Thebes, Ill.	7.0	5.5	5.9	2.8	3.0	3.4	88.0	86.2	87.2
Lower Mississippi River										
08-03	Mississippi R. below Vicksburg, Miss.	13	6.0	6.2	2.3	2.5	2.4	67.9	67.2	65.2
08-05	Mississippi R. near St. Francisville, La.	5.5	9.6	5.7	2.7	3.0	2.3	68.6	70.6	69.9
08-07	Mississippi R. below Belle Chasse, La.	12	--	7.0	2.3	--	2.4	71.4	--	70.0
Tributaries										
07-06	Minnesota R. at Mile 3.5, Minn.	2.8	2.4	4.5	4.1	4.9	4.4	84.7	82.6	81.7
07-25	Illinois R. at Hardin, Ill.	--	13	12	--	3.9	4.1	--	64.6	64.6
07-27	Missouri R. at St. Charles, Mo.	7.1	5.4	6.6	4.0	3.9	4.3	138.2	135.7	135.3
07-30	Ohio R. at Olmsted, Ill.	8.5	10	9.8	1.9	1.3	1.2	29.1	28.1	27.4

Table 18.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the July-August 1991 cruise--continued

Date 1991	Site name	Beryllium (µg/L)			Boron (µg/L)			Cadmium (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
07-05	Mississippi R. above St. Anthony Falls, Minn.	<0.02	0.06	<0.02	32.9	34.8	31.3	<0.1	<0.1	0.2
07-08	Mississippi R. at Hastings, Minn.	0.03	<0.02	<0.02	62.5	67.0	64.2	<0.1	<0.1	<0.1
07-10	Mississippi R. near Pepin, Wis.	<0.02	<0.02	<0.02	54.0	57.0	52.8	<0.1	<0.1	<0.1
07-12	Mississippi R. at Trempealeau, Wis.	0.05	<0.02	0.03	43.9	54.0	53.9	<0.1	<0.1	<0.1
07-15	Mississippi R. below Lock and Dam 9, Wis.	<0.02	0.03	0.06	50.0	43.6	47.1	<0.1	<0.1	<0.1
07-18	Mississippi R. at Clinton, Iowa	<0.02	<0.02	<0.02	43.8	40.9	39.3	<0.1	<0.1	<0.1
07-21	Mississippi R. at Keokuk, Iowa	0.04	0.05	<0.02	40.8	40.5	40.0	<0.1	<0.1	<0.1
07-24	Mississippi R. near Winfield, Mo.	<0.02	<0.02	<0.02	41.5	44.5	38.7	<0.1	<0.1	--
07-29	Mississippi R. at Thebes, Ill.	<0.02	<0.02	<0.02	72.7	65.4	68.9	<0.1	<0.1	0.1
Lower Mississippi River										
08-03	Mississippi R. below Vicksburg, Miss.	0.03	0.04	0.05	54.2	52.8	53.2	<0.1	<0.1	<0.1
08-05	Mississippi R. near St. Francisville, La.	0.02	<0.02	0.02	48.2	53.8	53.3	<0.1	<0.1	<0.1
08-07	Mississippi R. below Belle Chasse, La.	<0.02	--	<0.02	58.5	--	57.2	<0.1	--	<0.1
Tributaries										
07-06	Minnesota R. at Mile 3.5, Minn.	<0.02	--	0.03	76.9	80.7	79.6	<0.1	<0.1	0.3
07-25	Illinois R. at Hardin, Ill.	--	<0.02	0.05	--	157.9	174.3	--	<0.1	0.3
07-27	Missouri R. at St. Charles, Mo.	<0.02	0.06	0.04	121.0	108.3	124.7	<0.1	<0.1	0.1
07-30	Ohio R. at Olmsted, Ill.	0.02	<0.02	<0.02	37.2	45.7	42.6	<0.1	<0.1	<0.1

Table 18.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the July-August 1991 cruise--continued

Date 1991	Site name	Calcium (mg/L)			Chromium (µg/L)			Cobalt (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
07-05	Mississippi R. above St. Anthony Falls, Minn.	50.6	49.0	46.4	<0.2	1.2	<0.2	0.05	0.07	0.09
07-08	Mississippi R. at Hastings, Minn.	86.8	86.9	86.9	<0.2	<0.2	1.0	<0.01	<0.01	0.04
07-10	Mississippi R. near Pepin, Wis.	62.5	75.6	67.8	<0.2	<0.2	<0.2	0.02	<0.01	0.02
07-12	Mississippi R. at Trempealeau, Wis.	59.2	56.9	60.7	<0.2	1.6	1.3	0.07	0.11	0.09
07-15	Mississippi R. below Lock and Dam 9, Wis.	58.2	57.8	59.8	1.1	1.1	1.0	0.17	0.02	0.06
07-18	Mississippi R. at Clinton, Iowa	56.9	55.8	56.5	1.1	<0.2	<0.2	0.12	0.12	0.06
07-21	Mississippi R. at Keokuk, Iowa	55.4	56.3	55.5	<0.2	<0.2	<0.2	0.13	0.17	0.10
07-24	Mississippi R. near Winfield, Mo.	58.9	57.3	55.0	<0.2	1.2	<0.2	0.06	0.06	0.11
07-29	Mississippi R. at Thebes, Ill.	58.1	58.0	59.1	1.3	<0.2	<0.2	0.07	0.05	0.10
Lower Mississippi River										
08-03	Mississippi R. below Vicksburg, Miss.	45.7	45.6	47.3	1.3	<0.2	1.2	<0.01	0.07	<0.01
08-05	Mississippi R. near St. Francisville, La.	47.5	44.9	45.3	<0.2	<0.2	1.4	0.02	0.08	0.06
08-07	Mississippi R. below Belle Chasse, La.	43.9	--	52.7	<0.2	--	<0.2	0.08	--	<0.01
Tributaries										
07-06	Minnesota R. at Mile 3.5, Minn.	92.7	107.1	87.3	<0.2	<0.2	<0.2	<0.01	<0.01	0.14
07-25	Illinois R. at Hardin, Ill.	--	58.3	61.1	--	<0.2	<0.2	--	0.42	0.42
07-27	Missouri R. at St. Charles, Mo.	58.5	59.8	60.0	<0.2	<0.2	1.4	0.15	0.02	0.06
07-30	Ohio R. at Olmsted, Ill.	27.2	27.4	26.6	<0.2	<0.2	1.2	0.04	0.14	0.01

Table 18.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the July-August 1991 cruise--continued

Date 1991	Site name	Copper (µg/L)			Iron (mg/L)			Lead (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
07-05	Mississippi R. above St. Anthony Falls, Minn.	1.17	3.37	1.66	0.012	0.013	<0.005	<0.06	<0.06	0.16
07-08	Mississippi R. at Hastings, Minn.	1.74	1.92	1.89	<0.005	<0.005	<0.005	<0.06	0.10	<0.06
07-10	Mississippi R. near Pepin, Wis.	1.64	1.91	1.91	0.005	0.008	0.009	<0.06	<0.06	0.18
07-12	Mississippi R. at Trempealeau, Wis.	1.55	1.65	2.01	0.007	0.007	0.008	<0.06	<0.06	<0.06
07-15	Mississippi R. below Lock and Dam 9, Wis.	1.76	1.67	1.84	<0.005	0.009	0.009	<0.06	<0.06	<0.06
07-18	Mississippi R. at Clinton, Iowa	1.61	1.52	1.79	<0.005	<0.005	<0.005	<0.06	<0.06	<0.06
07-21	Mississippi R. at Keokuk, Iowa	1.64	1.66	1.60	<0.005	<0.005	<0.005	<0.06	<0.06	<0.06
07-24	Mississippi R. near Winfield, Mo.	1.81	1.87	2.30	<0.005	<0.005	<0.005	<0.06	<0.06	0.16
07-29	Mississippi R. at Thebes, Ill.	1.91	1.75	2.01	0.005	<0.005	<0.005	<0.06	<0.06	<0.06
Lower Mississippi River										
08-03	Mississippi R. below Vicksburg, Miss.	1.79	1.56	1.89	0.009	<0.005	<0.005	<0.06	<0.06	<0.06
08-05	Mississippi R. near St. Francisville, La.	1.71	1.99	2.15	<0.005	<0.005	<0.005	<0.06	0.06	<0.06
08-07	Mississippi R. below Belle Chasse, La.	1.80	—	2.17	<0.005	—	<0.005	<0.06	—	0.08
Tributaries										
07-06	Minnesota R. at Mile 3.5, Minn.	2.03	1.94	2.29	<0.005	<0.005	0.007	0.11	<0.06	<0.06
07-25	Illinois R. at Hardin, Ill.	--	2.12	2.03	—	<0.005	<0.005	—	0.15	0.11
07-27	Missouri R. at St. Charles, Mo.	2.01	1.53	2.00	<0.005	<0.005	<0.005	0.13	<0.06	0.06
07-30	Ohio R. at Olmsted, Ill.	1.07	1.32	1.22	<0.005	<0.005	<0.005	<0.06	<0.06	<0.06

Table 18.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the July-August 1991 cruise--continued

Date 1991	Site name	Lithium (µg/L)			Magnesium (mg/L)			Manganese (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
07-05	Mississippi R. above St. Anthony Falls, Minn.	5.27	5.02	5.22	17.4	17.2	16.2	1.14	1.11	0.89
07-08	Mississippi R. at Hastings, Minn.	19.03	19.99	18.89	33.3	33.4	33.2	2.00	2.36	0.68
07-10	Mississippi R. near Pepin, Wis.	16.20	16.56	14.95	24.2	28.1	25.6	0.97	1.14	0.36
07-12	Mississippi R. at Trempealeau, Wis.	12.63	14.37	14.50	22.2	21.6	22.7	0.87	1.31	0.42
07-15	Mississippi R. below Lock and Dam 9, Wis.	13.18	11.09	12.19	22.0	21.8	22.6	0.92	0.92	0.56
07-18	Mississippi R. at Clinton, Iowa	10.20	10.45	10.23	21.9	21.7	22.0	0.94	0.91	0.43
07-21	Mississippi R. at Keokuk, Iowa	8.70	8.93	9.43	22.7	22.8	22.9	0.78	0.96	0.28
07-24	Mississippi R. near Winfield, Mo.	9.24	9.06	8.79	21.7	21.1	20.3	0.55	0.43	0.33
07-29	Mississippi R. at Thebes, Ill.	16.25	15.14	16.50	22.1	21.2	21.4	0.57	0.34	0.23
Lower Mississippi River										
08-03	Mississippi R. below Vicksburg, Miss.	8.28	8.27	8.00	15.7	15.6	15.6	1.38	0.42	0.55
08-05	Mississippi R. near St. Francisville, La.	7.32	8.29	7.84	15.4	14.7	14.8	0.54	0.79	0.33
08-07	Mississippi R. below Belle Chasse, La.	8.53	--	8.26	14.9	--	17.4	1.49	--	0.69
Tributaries										
07-06	Minnesota R. at Mile 3.5, Minn.	28.94	28.69	28.80	36.6	42.3	35.5	2.22	2.46	1.00
07-25	Illinois R. at Hardin, Ill.	--	6.28	6.66	--	28.6	28.6	--	1.13	0.22
07-27	Missouri R. at St. Charles, Mo.	39.30	33.70	36.53	20.8	21.2	21.4	0.60	0.45	0.19
07-30	Ohio R. at Olmsted, Ill.	1.89	2.22	2.00	6.9	6.9	6.8	0.32	0.38	0.20

Table 18.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the July-August 1991 cruise--continued

Date 1991	Site name	Mercury (µg/L)			Molybdenum (µg/L)			Nickel (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
07-05	Mississippi R. above St. Anthony Falls, Minn.	<0.008	<0.008	<0.008	1.5	1.5	1.3	0.60	--	0.24
07-08	Mississippi R. at Hastings, Minn.	<0.008	<0.008	<0.008	3.2	3.6	3.3	0.11	0.31	0.08
07-10	Mississippi R. near Pepin, Wis.	<0.008	<0.008	<0.008	2.9	2.9	2.7	1.01	1.20	0.69
07-12	Mississippi R. at Trempealeau, Wis.	<0.008	<0.008	<0.008	2.4	2.6	2.5	0.83	--	1.44
07-15	Mississippi R. below Lock and Dam 9, Wis.	<0.008	<0.008	<0.008	2.5	2.1	2.4	1.93	0.41	0.79
07-18	Mississippi R. at Clinton, Iowa	<0.008	<0.008	<0.008	2.3	2.1	2.2	0.90	1.05	0.62
07-21	Mississippi R. at Keokuk, Iowa	<0.008	<0.008	<0.008	2.2	2.4	2.4	0.86	0.37	0.26
07-24	Mississippi R. near Winfield, Mo.	<0.008	0.010	<0.008	2.5	2.6	2.4	0.27	--	0.67
07-29	Mississippi R. at Thebes, Ill.	<0.008	<0.008	<0.008	3.4	3.3	3.7	1.32	0.45	0.51
Lower Mississippi River										
08-03	Mississippi R. below Vicksburg, Miss.	0.009	<0.008	0.012	2.8	2.8	2.6	1.20	1.29	0.82
08-05	Mississippi R. near St. Francisville, La.	0.009	<0.008	0.012	2.4	2.9	2.6	0.45	--	1.57
08-07	Mississippi R. below Belle Chasse, La.	0.018	--	<0.008	2.7	—	3.1	1.43	—	<0.03
Tributaries										
07-06	Minnesota R. at Mile 3.5, Minn.	<0.008	<0.008	<0.008	4.4	4.2	4.3	0.33	<0.03	3.35
07-25	Illinois R. at Hardin, Ill.	--	<0.008	<0.008	--	8.6	8.2	—	2.74	3.34
07-27	Missouri R. at St. Charles, Mo.	<0.008	<0.008	<0.008	5.0	4.2	4.8	1.76	0.28	1.10
07-30	Ohio R. at Olmsted, Ill.	<0.008	<0.008	<0.008	2.6	2.8	2.5	0.78	0.63	1.00

Table 18.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the July-August 1991 cruise--continued

Date 1991	Site name	Potassium (mg/L)			Silica (mg/L)			Sodium (mg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
		Upper Mississippi River								
07-05	Mississippi R. above St. Anthony Falls, Minn.	2.4	2.4	2.2	13.1	12.8	12.1	6.8	6.6	6.2
07-08	Mississippi R. at Hastings, Minn.	3.8	3.6	3.6	21.7	21.7	21.7	15.1	15.1	15.0
07-10	Mississippi R. near Pepin, Wis.	3.1	3.1	3.2	16.9	20.0	17.6	10.6	12.5	11.3
07-12	Mississippi R. at Trempealeau, Wis.	3.0	2.9	2.9	15.6	15.1	15.9	9.9	9.6	10.1
07-15	Mississippi R. below Lock and Dam 9, Wis.	2.8	2.8	2.8	13.5	13.4	14.0	9.6	9.5	9.8
07-18	Mississippi R. at Clinton, Iowa	2.9	2.8	2.9	11.1	11.0	11.0	9.6	9.4	9.5
07-21	Mississippi R. at Keokuk, Iowa	2.8	3.1	2.8	7.3	7.4	7.4	10.6	10.6	10.5
07-24	Mississippi R. near Winfield, Mo.	3.2	3.0	2.9	7.9	7.8	7.6	9.9	9.6	9.2
07-29	Mississippi R. at Thebes, Ill.	3.9	3.9	3.9	6.2	6.2	6.3	23.4	23.3	23.9
		Lower Mississippi River								
08-03	Mississippi R. below Vicksburg, Miss.	3.3	3.3	3.2	5.8	5.8	5.7	15.8	15.8	16.3
08-05	Mississippi R. near St. Francisville, La.	3.3	3.2	3.2	6.6	6.6	6.6	16.0	15.3	15.4
08-07	Mississippi R. below Belle Chasse, La.	3.5	—	3.5	7.6	—	8.7	27.2	—	32.0
		Tributaries								
07-06	Minnesota R. at Mile 3.5, Minn.	5.0	4.6	6.3	24.8	27.4	23.0	15.1	17.3	14.3
07-25	Illinois R. at Hardin, Ill.	—	4.5	4.3	—	0.3	0.1	—	45.4	46.7
07-27	Missouri R. at St. Charles, Mo.	5.8	5.8	5.9	9.5	9.6	9.6	54.6	55.8	56.0
07-30	Ohio R. at Olmsted, Ill.	1.9	1.9	1.8	0.7	0.6	0.5	9.2	9.3	8.9

Table 18.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the July-August 1991 cruise--continued

Date 1991	Site name	Strontium (mg/L)			Thallium (µg/L)			Uranium (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
07-05	Mississippi R. above St. Anthony Falls, Minn.	0.112	0.109	0.103	<0.05	<0.05	<0.05	1.51	1.34	1.21
07-08	Mississippi R. at Hastings, Minn.	0.267	0.269	0.268	<0.05	0.09	<0.05	7.18	6.85	6.51
07-10	Mississippi R. near Pepin, Wis.	0.185	0.222	0.201	0.06	0.06	<0.05	5.23	5.40	5.64
07-12	Mississippi R. at Trempealeau, Wis.	0.170	0.163	0.173	<0.05	<0.05	<0.05	4.63	4.74	4.67
07-15	Mississippi R. below Lock and Dam 9, Wis.	0.159	0.157	0.162	<0.05	<0.05	<0.05	4.82	4.20	4.30
07-18	Mississippi R. at Clinton, Iowa	0.147	0.199	0.145	<0.05	<0.05	<0.05	4.17	3.91	4.41
07-21	Mississippi R. at Keokuk, Iowa	0.143	0.224	0.142	<0.05	<0.05	<0.05	4.12	4.40	3.67
07-24	Mississippi R. near Winfield, Mo.	0.177	0.148	0.142	<0.05	<0.05	<0.05	3.83	3.79	3.86
07-29	Mississippi R. at Thebes, Ill.	0.220	0.220	0.223	<0.05	<0.05	<0.05	4.15	3.92	4.18
Lower Mississippi River										
08-03	Mississippi R. below Vicksburg, Miss.	0.178	0.177	0.183	<0.05	<0.05	<0.05	2.37	2.45	2.03
08-05	Mississippi R. near St. Francisville, La.	0.186	0.177	0.178	<0.05	0.05	<0.05	2.12	1.93	2.30
08-07	Mississippi R. below Belle Chasse, La.	0.182	--	0.216	<0.05	--	0.05	2.10	--	1.97
Tributaries										
07-06	Minnesota R. at Mile 3.5, Minn.	0.318	0.367	0.299	0.08	<0.05	<0.05	10.85	10.72	11.29
07-25	Illinois R. at Hardin, Ill.	--	0.191	0.201	--	0.12	0.06	—	1.54	1.49
07-27	Missouri R. at St. Charles, Mo.	0.406	0.415	0.416	0.09	<0.05	<0.05	5.17	5.21	5.01
07-30	Ohio R. at Olmsted, Ill.	0.119	0.119	0.116	<0.05	<0.05	<0.05	0.40	0.30	0.38

Table 18.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the July-August 1991 cruise--continued

Date 1991	Site name	Vanadium (µg/L)			Zinc (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
<u>Upper Mississippi River</u>							
07-05	Mississippi R. above St. Anthony Falls, Minn.	<0.07	--	0.37	2.27	--	4.47
07-08	Mississippi R. at Hastings, Minn.	2.17	3.17	5.59	1.68	--	1.82
07-10	Mississippi R. near Pepin, Wis.	2.44	2.75	2.19	1.81	3.03	1.99
07-12	Mississippi R. at Trempealeau, Wis.	0.74	--	5.73	1.79	2.88	2.95
07-15	Mississippi R. below Lock and Dam 9, Wis.	5.93	5.40	5.30	1.38	1.13	1.69
07-18	Mississippi R. at Clinton, Iowa	--	1.28	1.64	2.22	1.32	3.35
07-21	Mississippi R. at Keokuk, Iowa	2.05	2.53	3.50	1.29	1.06	1.39
07-24	Mississippi R. near Winfield, Mo.	3.45	--	3.66	1.16	1.58	2.08
07-29	Mississippi R. at Thebes, Ill.	--	3.10	3.86	3.73	1.30	2.04
<u>Lower Mississippi River</u>							
08-03	Mississippi R. below Vicksburg, Miss.	--	0.78	4.70	1.27	1.42	1.60
08-05	Mississippi R. near St. Francisville, La.	<0.07	--	5.27	1.29	1.04	1.01
08-07	Mississippi R. below Belle Chasse, La.	1.66	--	2.69	1.11	--	1.62
<u>Tributaries</u>							
07-06	Minnesota R. at Mile 3.5, Minn.	4.19	2.31	4.19	5.08	2.48	3.19
07-25	Illinois R. at Hardin, Ill.	--	3.91	3.94	--	2.34	2.53
07-27	Missouri R. at St. Charles, Mo.	5.10	2.25	7.73	2.44	1.68	3.58
07-30	Ohio R. at Olmsted, Ill.	<0.07	0.67	3.55	0.45	0.92	2.44

Table 19.--Concentration data for dissolved nutrients and dissolved organic-carbon in laterally composited water samples collected from the Mississippi River and some of its tributaries during the July-August 1991 cruise

[mg N/L, milligram nitrogen per liter; mg P/L, milligram phosphorus per liter; mg C/L, milligram carbon per liter; --, not determined; <, less than the detection limit; A, depth-integrated composite A sample; B, depth-integrated composite B sample; method of collection of composites A and B varied between collection sites and is specified in table 1; analyses of total soluble phosphorus performed by Mark Nanny, University of Illinois]

Date 1991	Site name	Ammonium (mg N/L)				Nitrate (mg N/L)			
		A	B	B ¹	Ultra- filter per- meate	A	B	B ¹	Ultra- filter per- meate
<u>Upper Mississippi River</u>									
07-05	Mississippi R. above St. Anthony Falls, Minn.	<0.01	<0.01	0.02	<0.01	0.63	0.60	0.74	0.92
07-08	Mississippi R. at Hastings, Minn.	0.02	<0.01	0.04	<0.01	3.99	4.09	4.07	4.17
07-10	Mississippi R. near Pepin, Wis.	0.02	0.02	0.03	<0.01	3.12	--	3.54	--
07-12	Mississippi R. at Trempealeau, Wis.	0.04	0.02	0.02	0.01	2.23	1.94	2.78	1.88
07-15	Mississippi R. below Lock and Dam 9, Wis.	0.03	0.04	0.02	0.01	1.88	2.06	2.32	2.01
07-18	Mississippi R. at Clinton, Iowa	--	--	0.03	--	1.83	1.31	2.17	1.30
07-21	Mississippi R. at Keokuk, Iowa	--	--	0.03	--	2.68	2.37	2.49	2.32
07-24	Mississippi R. near Winfield, Mo.	--	--	0.02	--	3.66	3.33	3.42	3.41
07-29	Mississippi R. at Thebes, Ill.	<0.01	<0.01	0.03	<0.01	2.46	2.48	2.59	2.44
<u>Lower Mississippi River</u>									
08-03	Mississippi R. below Vicksburg, Miss.	--	--	<0.01	--	--	--	1.74	--
08-05	Mississippi R. near St. Francisville, La.	--	--	<0.01	--	--	--	1.82	--
08-07	Mississippi R. below Belle Chasse, La.	--	--	0.02	--	--	--	1.84	--
<u>Tributaries</u>									
07-06	Minnesota R. at Mile 3.5, Minn.	0.06	0.06	0.08	<0.01	6.63	6.70	6.83	7.81
07-25	Illinois R. at Hardin, Ill.	--	--	0.06	--	--	2.00	1.50	1.96
07-27	Missouri R. at St. Charles, Mo.	0.03	0.05	0.02	0.04	0.96	0.98	1.07	0.95
07-30	Ohio R. at Olmsted, Ill.	<0.01	<0.01	<0.01	<0.01	0.19	0.21	0.22	0.35

Table 19.--Concentration data for dissolved nutrients and dissolved organic-carbon in laterally composited water samples collected from the Mississippi River and some of its tributaries during the July-August 1991 cruise--continued

Date 1991	Site name	Nitrite (mg N/L)				Orthophosphate (mg P/L)			
		A	B	B ¹	Ultra- filter per- meate	A	B	B ¹	Ultra- filter per- meate
Upper Mississippi River									
07-05	Mississippi R. above St. Anthony Falls, Minn.	0.011	<0.005	0.010	<0.005	0.094	0.081	0.030	0.072
07-08	Mississippi R. at Hastings, Minn.	0.074	0.056	0.060	0.055	0.171	0.162	0.080	0.117
07-10	Mississippi R. near Pepin, Wis.	0.094	0.092	0.100	0.091	0.136	0.131	0.085	0.125
07-12	Mississippi R. at Trempealeau, Wis.	0.071	0.084	0.060	0.072	0.118	0.123	0.050	0.101
07-15	Mississippi R. below Lock and Dam 9, Wis.	--	--	0.040	--	0.081	0.094	0.070	0.090
07-18	Mississippi R. at Clinton, Iowa	0.051	0.040	0.025	0.025	0.089	0.086	0.050	0.071
07-21	Mississippi R. at Keokuk, Iowa	0.029	0.031	0.020	0.025	0.086	0.086	0.040	0.056
07-24	Mississippi R. near Winfield, Mo.	0.014	0.014	0.020	0.017	0.083	0.080	0.050	0.088
07-29	Mississippi R. at Thebes, Ill.	0.010	0.010	0.015	0.015	0.125	0.118	0.060	0.127
Lower Mississippi River									
08-03	Mississippi R. below Vicksburg, Miss.	--	--	0.010	--	--	--	0.055	--
08-05	Mississippi R. near St. Francisville, La.	--	--	0.010	--	--	--	0.080	--
08-07	Mississippi R. below Belle Chasse, La.	--	--	0.010	--	--	--	0.120	--
Tributaries									
07-06	Minnesota R. at Mile 3.5, Minn.	0.059	0.071	0.080	0.083	0.180	0.181	0.040	0.168
07-25	Illinois R. at Hardin, Ill.	--	0.132	0.130	0.141	--	0.126	0.040	0.108
07-27	Missouri R. at St. Charles, Mo.	0.012	0.008	0.010	0.015	0.139	0.140	0.080	0.135
07-30	Ohio R. at Olmsted, Ill.	0.080	0.080	0.080	0.070	0.038	0.013	0.010	0.010

Table 19.--Concentration data for dissolved nutrients and dissolved organic-carbon in laterally composited water samples collected from the Mississippi River and some of its tributaries during the July-August 1991 cruise--continued

Date 1991	Site name	Total soluble phosphorus (mg P/L)				Ultra- filter per- meate	Dissolved organic-carbon ² (mg C/L)
		A	B	B ¹	A		
<u>Upper Mississippi River</u>							
07-05	Mississippi R. above St. Anthony Falls, Minn.	--	--	--	--		11.2
07-08	Mississippi R. at Hastings, Minn.	--	--	--	0.171		9.1
07-10	Mississippi R. near Pepin, Wis.	--	--	--	0.156		9.0
07-12	Mississippi R. at Trempealeau, Wis.	--	--	--	0.162		8.6
07-15	Mississippi R. below Lock and Dam 9, Wis.	--	--	--	0.105		7.8
07-18	Mississippi R. at Clinton, Iowa	--	--	--	--		7.7
07-21	Mississippi R. at Keokuk, Iowa	--	--	--	0.086		6.7
07-24	Mississippi R. near Winfield, Mo.	--	--	--	0.118		6.2
07-29	Mississippi R. at Thebes, Ill.	--	--	--	0.006		5.4
<u>Lower Mississippi River</u>							
08-03	Mississippi R. below Vicksburg, Miss.	--	--	0.083	--		3.6
08-05	Mississippi R. near St. Francisville, La.	--	--	0.092	--		3.9
08-07	Mississippi R. below Belle Chasse, La.	--	--	--	0.016		3.8
<u>Tributaries</u>							
07-06	Minnesota R. at Mile 3.5, Minn.	--	--	--	0.184		6.6
07-25	Illinois R. at Hardin, Ill.	--	--	--	0.159		4.1
07-27	Missouri R. at St. Charles, Mo.	--	--	--	0.111		2.9
07-30	Ohio R. at Olmsted, Ill.	--	--	--	0.010		2.0

¹ This set of composite B samples was frozen prior to analysis.

² These results were obtained from J.A. Leenheer and others, 1994.

Table 20.--Concentration data for dissolved bicarbonate, carbonate, chloride, and sulfate in laterally composited water samples collected from the Mississippi River and some of its tributaries during the July-August 1991 cruise

[mg/L, milligram per liter; --, not determined; A, depth-integrated composite A sample; B, depth-integrated composite B sample; method of collection of composites A and B varied between collection sites and is specified in table 1]

Date 1991	Site name	Bicarbonate (mg/L)		Carbonate (mg/L)		Chloride (mg/L)		Sulfate (mg/L)	
		A	B	A	B	A	B	A	B
Upper Mississippi River									
07-05	Mississippi R. above St. Anthony Falls, Minn.	193	193	1.9	1.9	11	10	22	19
07-08	Mississippi R. at Hastings, Minn.	232	229	2.3	2.3	18	18	100	96
07-10	Mississippi R. near Pepin, Wis.	199	199	2.0	2.0	14	15	74	75
07-12	Mississippi R. at Trempealeau, Wis.	184	184	1.8	1.8	14	14	67	64
07-15	Mississippi R. below Lock and Dam 9, Wis.	190	188	<0.5	0.9	14	14	64	64
07-18	Mississippi R. at Clinton, Iowa	187	--	0.9	--	14	14	58	58
07-21	Mississippi R. at Keokuk, Iowa	191	193	2.4	1.0	17	17	55	55
07-24	Mississippi R. near Winfield, Mo.	190	189	1.9	1.9	17	17	49	49
07-29	Mississippi R. at Thebes, Ill.	196	196	2.0	0.5	20	21	75	78
Lower Mississippi River									
08-03	Mississippi R. below Vicksburg, Miss.	159	--	1.2	--	16	15	47	43
08-05	Mississippi R. near St. Francisville, La.	160	--	1.6	--	17	17	44	45
08-07	Mississippi R. below Belle Chasse, La.	151	--	<0.5	--	36	--	52	--
Tributaries									
07-06	Minnesota R. at Mile 3.5, Minn.	252	252	2.5	2.5	20	19	153	153
07-25	Illinois R. at Hardin, Ill.	225	--	2.3	--	65	--	81	--
07-27	Missouri R. at St. Charles, Mo.	200	201	2.0	2.0	24	23	154	149
07-30	Ohio R. at Olmsted, Ill.	85	84	<0.5	<0.5	10	11	27	28

Table 21.--Concentration data for dissolved trace- and major-elements in surface-grab water samples collected from selected tributaries of the Mississippi River during the July-August 1991 cruise

[Sampling site upstream from the Mississippi River confluence; see fig. 1 for locations of the sampling sites; µg/L, microgram per liter; mg/L, milligram per liter; --, not determined; <, less than the detection limit]

Date 1991	Site name	Aluminum (µg/L)		Arsenic (µg/L)		Barium (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
07-08	St. Croix River at Mile 0.5, Wis.	11.8	5.0	0.7	<0.6	17.9	16.4
07-10	Chippewa River at Mile 1.7, Wis.	13.8	--	0.8	--	10.6	--
07-15	Wisconsin River at Mile 1.0, Wis.	19.4	18.8	1.0	<0.6	15.1	14.5
07-20	Rock River at Mile 1.0, Ill.	7.0	9.0	2.0	2.3	47.4	48.6
07-20	Iowa River at Mile 1.0, Iowa	3.2	4.5	2.1	1.8	96.6	94.0
07-22	Des Moines River at Mile 1.0, Iowa	4.3	5.0	2.7	3.2	93.9	93.3
07-28	Kaskaskia River at Mile 1.5, Ill.	11.8	2.6	2.6	2.9	41.0	40.6
08-01	White River at Mile 1.2, Ark.	4.2	3.8	<0.6	0.6	39.0	37.8
08-01	Arkansas River at Mile 0.0, Ark.	3.5	3.8	1.7	1.3	91.5	91.4
08-02	Yazoo River at Mile 3.0, Miss.	4.3	3.3	2.5	1.5	42.6	40.4

Date 1991	Site name	Beryllium (µg/L)		Boron (µg/L)		Cadmium (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
07-08	St. Croix River at Mile 0.5, Wis.	<0.02	<0.02	16.4	11.5	<0.1	<0.1
07-10	Chippewa River at Mile 1.7, Wis.	<0.02	--	11.9	--	<0.1	--
07-15	Wisconsin River at Mile 1.0, Wis.	0.13	<0.02	15.7	17.9	<0.1	<0.1
07-20	Rock River at Mile 1.0, Ill.	0.03	0.05	55.4	56.8	<0.1	<0.1
07-20	Iowa River at Mile 1.0, Iowa	<0.02	<0.02	35.0	37.5	<0.1	<0.1
07-22	Des Moines River at Mile 1.0, Iowa	0.06	0.03	44.2	41.0	<0.1	<0.1
07-28	Kaskaskia River at Mile 1.5, Ill.	<0.02	<0.02	95.7	87.8	<0.1	<0.1
08-01	White River at Mile 1.2, Ark.	0.07	<0.02	16.0	12.7	<0.1	<0.1
08-01	Arkansas River at Mile 0.0, Ark.	<0.02	0.02	57.7	60.3	<0.1	<0.1
08-02	Yazoo River at Mile 3.0, Miss.	0.05	0.04	17.5	21.1	<0.1	<0.1

Date 1991	Site name	Calcium (mg/L)		Chromium (µg/L)		Cobalt (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
07-08	St. Croix River at Mile 0.5, Wis.	23.5	22.7	0.3	<0.2	0.11	0.07
07-10	Chippewa River at Mile 1.7, Wis.	18.0	--	<0.2	--	0.10	--
07-15	Wisconsin River at Mile 1.0, Wis.	26.0	25.4	<0.2	1.1	0.14	0.10
07-20	Rock River at Mile 1.0, Ill.	38.0	37.9	<0.2	1.0	0.49	0.51
07-20	Iowa River at Mile 1.0, Iowa	55.1	54.2	<0.2	1.2	0.11	0.10
07-22	Des Moines River at Mile 1.0, Iowa	76.4	72.5	1.1	<0.2	<0.01	0.02
07-28	Kaskaskia River at Mile 1.5, Ill.	20.2	19.8	0.9	<0.2	0.19	0.20
08-01	White River at Mile 1.2, Ark.	36.6	36.7	1.0	<0.2	0.02	<0.01
08-01	Arkansas River at Mile 0.0, Ark.	51.0	50.6	1.3	1.5	0.11	0.11
08-02	Yazoo River at Mile 3.0, Miss.	11.9	11.6	0.3	1.0	0.02	<0.01

Table 21.--Concentration data for dissolved trace- and major-elements in surface-grab water samples collected from selected tributaries of the Mississippi River during the July-August 1991 cruise--continued

Date 1991	Site name	Copper (µg/L)		Iron (mg/L)		Lead (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
07-08	St. Croix River at Mile 0.5, Wis.	1.39	4.96	0.411	0.040	0.10	0.12
07-10	Chippewa River at Mile 1.7, Wis.	1.18	—	0.102	—	<0.06	—
07-15	Wisconsin River at Mile 1.0, Wis.	1.15	1.15	0.011	0.006	<0.06	0.08
07-20	Rock River at Mile 1.0, Ill.	1.48	1.70	<0.005	<0.005	0.12	0.13
07-20	Iowa River at Mile 1.0, Iowa	1.16	1.31	<0.005	<0.005	0.12	<0.06
07-22	Des Moines River at Mile 1.0, Iowa	1.34	1.41	<0.005	<0.005	<0.06	<0.06
07-28	Kaskaskia River at Mile 1.5, Ill.	2.33	2.20	0.012	<0.005	<0.06	<0.06
08-01	White River at Mile 1.2, Ark.	0.62	0.61	0.007	<0.005	<0.06	<0.06
08-01	Arkansas River at Mile 0.0, Ark.	0.88	1.04	<0.005	<0.005	<0.06	<0.06
08-02	Yazoo River at Mile 3.0, Miss.	1.11	1.37	<0.005	<0.005	<0.06	<0.06

		Lithium (µg/L)		Magnesium (mg/L)		Manganese (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
07-08	St. Croix River at Mile 0.5, Wis.	1.44	1.08	8.0	7.8	8.67	4.90
07-10	Chippewa River at Mile 1.7, Wis.	0.68	—	6.8	—	1.98	—
07-15	Wisconsin River at Mile 1.0, Wis.	0.74	0.75	12.3	12.0	2.26	0.63
07-20	Rock River at Mile 1.0, Ill.	2.59	2.49	40.6	40.4	1.43	1.17
07-20	Iowa River at Mile 1.0, Iowa	4.97	4.64	24.1	23.8	0.52	0.62
07-22	Des Moines River at Mile 1.0, Iowa	11.15	11.00	23.5	22.3	0.41	0.47
07-28	Kaskaskia River at Mile 1.5, Ill.	1.29	1.30	5.9	5.8	354.50	336.10
08-01	White River at Mile 1.2, Ark.	0.75	0.62	13.1	13.3	0.44	0.49
08-01	Arkansas River at Mile 0.0, Ark.	4.37	4.32	12.9	12.7	62.09	71.60
08-02	Yazoo River at Mile 3.0, Miss.	1.14	1.18	3.9	3.8	43.35	47.10

		Mercury (µg/L)		Molybdenum (µg/L)		Nickel (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
07-08	St. Croix River at Mile 0.5, Wis.	<0.008	<0.008	0.3	0.3	0.84	<0.03
07-10	Chippewa River at Mile 1.7, Wis.	—	<0.008	0.2	—	0.06	—
07-15	Wisconsin River at Mile 1.0, Wis.	<0.008	<0.008	0.6	0.4	1.13	0.52
07-20	Rock River at Mile 1.0, Ill.	<0.008	<0.008	1.7	2.2	1.50	1.80
07-20	Iowa River at Mile 1.0, Iowa	<0.008	<0.008	2.7	2.5	<0.03	0.32
07-22	Des Moines River at Mile 1.0, Iowa	<0.008	<0.008	3.5	3.5	0.05	<0.03
07-28	Kaskaskia River at Mile 1.5, Ill.	<0.008	<0.008	6.1	5.3	1.51	1.76
08-01	White River at Mile 1.2, Ark.	0.009	0.012	0.8	0.9	<0.03	<0.03
08-01	Arkansas River at Mile 0.0, Ark.	<0.008	<0.008	1.3	1.3	0.93	1.35
08-02	Yazoo River at Mile 3.0, Miss.	<0.008	<0.008	0.8	0.6	2.15	1.29

Table 21.--Concentration data for dissolved trace- and major-elements in surface-grab water samples collected from selected tributaries of the Mississippi River during the July-August 1991 cruise--continued

Date 1991	Site name	Potassium (mg/L)		Silica (mg/L)		Sodium (mg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
07-08	St. Croix River at Mile 0.5, Wis.	1.1	1.0	11.7	11.4	3.1	3.0
07-10	Chippewa River at Mile 1.7, Wis.	1.2	—	10.3	—	3.6	—
07-15	Wisconsin River at Mile 1.0, Wis.	1.9	1.9	0.6	0.6	5.9	5.7
07-20	Rock River at Mile 1.0, Ill.	3.0	2.9	0.1	<0.04	21.2	21.2
07-20	Iowa River at Mile 1.0, Iowa	2.6	2.5	5.8	5.6	13.3	13.0
07-22	Des Moines River at Mile 1.0, Iowa	2.9	2.7	16.9	16.0	7.6	7.2
07-28	Kaskaskia River at Mile 1.5, Ill.	5.7	6.5	7.4	7.4	9.1	9.2
08-01	White River at Mile 1.2, Ark.	1.5	1.3	4.3	4.4	5.2	5.2
08-01	Arkansas River at Mile 0.0, Ark.	3.1	3.1	4.2	4.1	66.6	65.7
08-02	Yazoo River at Mile 3.0, Miss.	2.2	2.2	8.3	8.2	5.5	5.4

		Strontium (mg/L)		Thallium (µg/L)		Uranium (µg/L)	
07-08	St. Croix River at Mile 0.5, Wis.	0.045	0.045	<0.05	<0.05	0.06	<0.06
07-10	Chippewa River at Mile 1.7, Wis.	0.038	—	<0.05	—	<0.06	—
07-15	Wisconsin River at Mile 1.0, Wis.	0.039	0.039	<0.05	<0.05	0.32	0.30
07-20	Rock River at Mile 1.0, Ill.	0.090	0.091	<0.05	<0.05	1.13	1.23
07-20	Iowa River at Mile 1.0, Iowa	0.162	0.159	0.06	<0.05	2.97	3.07
07-22	Des Moines River at Mile 1.0, Iowa	0.206	0.195	<0.05	<0.05	5.66	5.80
07-28	Kaskaskia River at Mile 1.5, Ill.	0.067	0.067	<0.05	<0.05	0.15	0.09
08-01	White River at Mile 1.2, Ark.	0.052	0.052	<0.05	<0.05	0.67	0.48
08-01	Arkansas River at Mile 0.0, Ark.	0.364	0.361	<0.05	<0.05	0.96	1.01
08-02	Yazoo River at Mile 3.0, Miss.	0.067	0.065	<0.05	<0.05	0.23	0.19

		Vanadium (µg/L)		Zinc (µg/L)	
07-08	St. Croix River at Mile 0.5, Wis.	1.72	0.56	1.17	3.95
07-10	Chippewa River at Mile 1.7, Wis.	1.02	—	1.01	—
07-15	Wisconsin River at Mile 1.0, Wis.	0.52	3.71	0.78	0.95
07-20	Rock River at Mile 1.0, Ill.	1.99	5.48	1.51	2.31
07-20	Iowa River at Mile 1.0, Iowa	2.08	5.16	0.90	1.01
07-22	Des Moines River at Mile 1.0, Iowa	5.92	2.42	1.01	0.52
07-28	Kaskaskia River at Mile 1.5, Ill.	6.01	0.67	0.70	0.93
08-01	White River at Mile 1.2, Ark.	3.02	<0.07	0.44	0.25
08-01	Arkansas River at Mile 0.0, Ark.	3.68	4.33	1.77	1.02
08-02	Yazoo River at Mile 3.0, Miss.	1.66	3.27	1.43	0.87

Table 22.--Concentration data for dissolved trace- and major-elements in surface-grab water samples collected from selected pools of the Upper Mississippi River during the July-August 1991 cruise

[See fig. 2 for locations of the sampling sites; $\mu\text{g/L}$, microgram per liter; mg/L , milligram per liter; --, not determined; <, less than the detection limit]

Date 1991	Site name	Aluminum ($\mu\text{g/L}$)	Arsenic ($\mu\text{g/L}$)	Barium ($\mu\text{g/L}$)	Beryllium ($\mu\text{g/L}$)	Boron ($\mu\text{g/L}$)
07-04	Mississippi R. in Pool 1	2.2	3.0	48.2	0.05	36.1
07-07	Mississippi R. in Pool 2	2.5	3.2	70.7	0.02	65.3
07-11	Mississippi R. in Pool 5	3.1	1.7	57.8	<0.02	49.6
07-11	Mississippi R. in Pool 5A	1.7	2.1	58.0	<0.02	45.3
07-13	Mississippi R. in Pool 7	6.3	2.3	51.4	<0.02	43.1
07-14	Mississippi R. in Pool 8	2.4	2.7	52.9	0.05	46.2
07-16	Mississippi R. in Pool 10	2.8	1.7	55.5	0.04	39.5
07-19	Mississippi R. in Pool 14	3.5	2.5	57.5	0.04	42.1
07-22	Mississippi R. in Pool 20	4.2	3.0	73.8	<0.02	45.4
07-23	Mississippi R. in Pool 22	4.5	2.7	67.6	0.03	45.6
		Cadmium ($\mu\text{g/L}$)	Calcium (mg/L)	Chromium ($\mu\text{g/L}$)	Cobalt ($\mu\text{g/L}$)	Copper ($\mu\text{g/L}$)
07-04	Mississippi R. in Pool 1	<0.1	48.6	<0.2	0.08	1.25
07-07	Mississippi R. in Pool 2	<0.1	71.7	<0.2	0.12	1.42
07-11	Mississippi R. in Pool 5	<0.1	69.9	<0.2	<0.01	1.48
07-11	Mississippi R. in Pool 5A	<0.1	68.6	<0.2	<0.01	1.36
07-13	Mississippi R. in Pool 7	<0.1	63.8	<0.2	0.02	1.36
07-14	Mississippi R. in Pool 8	<0.1	67.8	<0.2	0.02	1.49
07-16	Mississippi R. in Pool 10	<0.1	64.3	<0.2	0.01	2.42
07-19	Mississippi R. in Pool 14	<0.1	62.9	<0.2	0.06	1.69
07-22	Mississippi R. in Pool 20	<0.1	59.6	<0.2	0.10	1.31
07-23	Mississippi R. in Pool 22	<0.1	57.7	0.2	0.26	1.43
		Iron (mg/L)	Lead ($\mu\text{g/L}$)	Lithium ($\mu\text{g/L}$)	Magnesium (mg/L)	Manganese ($\mu\text{g/L}$)
07-04	Mississippi R. in Pool 1	0.011	<0.06	6.17	17.5	0.70
07-07	Mississippi R. in Pool 2	0.006	<0.06	19.03	28.0	3.16
07-11	Mississippi R. in Pool 5	0.005	<0.06	14.38	26.7	1.63
07-11	Mississippi R. in Pool 5A	<0.005	<0.06	13.17	26.1	2.64
07-13	Mississippi R. in Pool 7	0.013	<0.06	11.98	23.9	5.07
07-14	Mississippi R. in Pool 8	<0.005	<0.06	12.61	25.4	1.51
07-16	Mississippi R. in Pool 10	0.006	<0.06	10.53	24.6	2.04
07-19	Mississippi R. in Pool 14	<0.005	<0.06	10.39	24.4	1.05
07-22	Mississippi R. in Pool 20	<0.005	<0.06	9.97	23.1	0.64
07-23	Mississippi R. in Pool 22	<0.005	<0.06	9.79	23.0	1.31

Table 22.--Concentration data for dissolved trace- and major-elements in surface-grab water samples collected from selected pools of the Upper Mississippi River during the July-August 1991 cruise--continued

Date 1991	Site name	Mercury (µg/L)	Molybdenum (µg/L)	Nickel (µg/L)	Potassium (mg/L)	Silica (mg/L)
07-04	Mississippi R. in Pool 1	<0.008	1.8	1.60	2.7	12.2
07-07	Mississippi R. in Pool 2	<0.008	3.4	0.79	3.8	18.5
07-11	Mississippi R. in Pool 5	<0.008	2.4	<0.03	3.3	18.0
07-11	Mississippi R. in Pool 5A	--	2.5	<0.03	1.6	17.6
07-13	Mississippi R. in Pool 7	<0.008	2.1	<0.03	3.1	16.9
07-14	Mississippi R. in Pool 8	<0.008	2.3	<0.03	3.2	16.9
07-16	Mississippi R. in Pool 10	0.008	2.2	<0.03	3.0	13.7
07-19	Mississippi R. in Pool 14	<0.008	2.3	0.31	3.0	11.0
07-22	Mississippi R. in Pool 20	<0.008	2.6	0.39	2.9	9.1
07-23	Mississippi R. in Pool 22	<0.008	2.8	0.96	3.3	6.7
		Sodium (mg/L)	Strontium (mg/L)	Thallium (µg/L)	Uranium (µg/L)	Vanadium (µg/L)
07-04	Mississippi R. in Pool 1	7.2	0.110	<0.05	1.56	0.72
07-07	Mississippi R. in Pool 2	12.2	0.223	<0.05	6.98	3.90
07-11	Mississippi R. in Pool 5	11.7	0.199	<0.05	4.78	1.99
07-11	Mississippi R. in Pool 5A	11.4	0.197	<0.05	5.64	1.56
07-13	Mississippi R. in Pool 7	10.5	0.179	<0.05	4.42	0.51
07-14	Mississippi R. in Pool 8	11.1	0.189	<0.05	4.56	0.93
07-16	Mississippi R. in Pool 10	10.7	0.532	<0.05	3.82	2.44
07-19	Mississippi R. in Pool 14	11.4	0.157	<0.05	3.96	2.62
07-22	Mississippi R. in Pool 20	9.8	0.155	<0.05	4.37	4.44
07-23	Mississippi R. in Pool 22	10.5	0.146	<0.05	3.96	5.05
		Zinc (µg/L)				
07-04	Mississippi R. in Pool 1	1.40				
07-07	Mississippi R. in Pool 2	3.36				
07-11	Mississippi R. in Pool 5	1.57				
07-11	Mississippi R. in Pool 5A	1.18				
07-13	Mississippi R. in Pool 7	1.27				
07-14	Mississippi R. in Pool 8	1.01				
07-16	Mississippi R. in Pool 10	1.22				
07-19	Mississippi R. in Pool 14	1.36				
07-22	Mississippi R. in Pool 20	3.03				
07-23	Mississippi R. in Pool 22	1.69				

Table 23.—Concentration data for dissolved nutrients and dissolved organic-carbon in surface-grab water samples collected from selected tributaries and pools of the Mississippi River during the July-August 1991 cruise

[Sampling site upstream from the Mississippi River confluence; see figs. 1 and 2 for locations of sampling sites; mg N/L, milligram nitrogen per liter; mg P/L, milligram phosphorus per liter; mg C/L, milligrams carbon per liter; --, not determined; <, less than the detection limit]

Date 1991	Site name	Ammonium (mg N/L)			Nitrate (mg N/L)			Nitrite (mg N/L)		
		Surface grab	Surface grab, frozen	Ultra- filter per- meate	Surface grab	Surface grab, frozen	Ultra- filter per- meate	Surface grab	Surface grab, frozen	Ultra- filter per- meate
<u>Tributaries</u>										
07-08	St. Croix R. at Mile 0.5, Wis.	0.06	0.06	0.03	0.36	0.33	0.23	0.011	<0.005	0.010
07-10	Chippewa R. at Mile 1.7, Wis.	<0.01	<0.01	--	0.15	0.36	--	<0.005	0.010	--
07-15	Wisconsin R. at Mile 1.0, Wis.	--	<0.01	--	--	<0.01	<0.01	--	<0.005	0.008
07-20	Rock R. at Mile 1.0, Ill.	--	0.05	--	0.47	0.75	0.51	0.037	0.030	0.038
07-20	Iowa R. at Mile 1.0, Iowa	--	<0.01	--	4.55	5.02	4.94	0.055	0.050	0.050
07-22	Des Moines R. at Mile 1.0, Iowa	--	0.02	--	9.91	8.63	9.38	0.030	0.030	0.034
07-28	Kaskaskia R. at Mile 1.5, Ill.	0.04	0.03	0.04	1.63	1.70	1.60	0.048	0.050	0.063
08-01	White R. at Mile 1.2, Ark.	--	<0.01	--	--	<0.01	--	--	0.010	--
08-01	Arkansas R. at Mile 0.0, Ark.	--	<0.01	--	--	<0.01	--	--	<0.005	--
08-02	Yazoo R. at Mile 3.0, Miss.	--	0.03	--	--	0.54	--	--	0.020	--
<u>Pools</u>										
07-04	Mississippi R. in Pool 1	<0.01	0.03	--	0.82	0.92	--	<0.005	0.010	--
07-07	Mississippi R. in Pool 2	<0.01	0.06	--	4.48	4.32	--	0.065	0.060	--
07-11	Mississippi R. in Pool 5	0.04	0.03	--	--	3.11	--	0.077	0.080	--
07-11	Mississippi R. in Pool 5A	<0.01	<0.01	--	--	3.31	--	0.065	0.070	--
07-13	Mississippi R. in Pool 7	0.03	0.02	--	1.69	2.72	--	0.060	0.050	--
07-14	Mississippi R. in Pool 8	0.02	0.02	--	2.10	2.65	--	--	0.050	--
07-16	Mississippi R. in Pool 10	0.06	0.02	--	1.76	2.15	--	--	0.030	--
07-19	Mississippi R. in Pool 14	--	0.04	--	1.22	1.79	--	0.038	0.030	--
07-22	Mississippi R. in Pool 20	--	0.04	--	3.86	3.94	--	0.019	0.020	--
07-23	Mississippi R. in Pool 22	--	0.04	--	2.62	2.62	--	0.015	0.020	--

Table 23.--Concentration data for dissolved nutrients and dissolved organic-carbon in surface-grab water samples collected from selected tributaries and pools of the Mississippi River during the July-August 1991 cruise--continued

Date 1991	Site name	Orthophosphate		Dissolved organic- carbon	
		(mg P/L)		(mg C/L)	
		Surface grab	Surface grab, frozen	Ultra- filter per- meate	Surface grab
<u>Tributaries</u>					
07-08	St. Croix R. at Mile 0.5, Wis.	--	0.020	--	13.5
07-10	Chippewa R. at Mile 1.7, Wis.	0.042	0.040	--	9.8
07-15	Wisconsin R. at Mile 1.0, Wis.	--	0.010	<0.005	7.2
07-20	Rock R. at Mile 1.0, Ill.	0.030	0.010	<0.005	4.0
07-20	Iowa R. at Mile 1.0, Iowa	0.026	<0.005	<0.005	2.9
07-22	Des Moines R. at Mile 1.0, Iowa	0.100	0.020	0.088	3.8
07-28	Kaskaskia R. at Mile 1.5, Ill.	0.109	0.110	0.100	5.1
08-01	White R. at Mile 1.2, Ark.	--	0.010	--	1.8
08-01	Arkansas R. at Mile 0.0, Ark.	--	0.010	--	3.6
08-02	Yazoo R. at Mile 3.0, Miss.	--	0.070	--	3.4
<u>Pools</u>					
07-04	Mississippi R. in Pool 1	0.093	0.050	--	13.0
07-07	Mississippi R. in Pool 2	0.177	0.050	--	--
07-11	Mississippi R. in Pool 5	0.097	0.035	--	9.5
07-11	Mississippi R. in Pool 5A	0.103	0.035	--	9.9
07-13	Mississippi R. in Pool 7	0.114	0.050	--	9.6
07-14	Mississippi R. in Pool 8	0.074	0.055	--	9.6
07-16	Mississippi R. in Pool 10	0.073	0.025	--	9.1
07-19	Mississippi R. in Pool 14	0.061	0.020	--	8.9
07-22	Mississippi R. in Pool 20	0.080	0.030	--	7.1
07-23	Mississippi R. in Pool 22	0.079	0.025	--	7.9

Table 24.--Concentration data for dissolved bicarbonate, carbonate, chloride, and sulfate in surface-grab water samples collected from selected tributaries and pools of the Mississippi River during the July-August 1991 cruise

[Sampling site upstream from the Mississippi River confluence; see figs. 1 and 2 for locations of the sampling sites; mg/L, milligram per liter; --, not determined; <, less than the detection limit]

Date 1991	Site name	Bicarbonate (mg/L)	Carbonate (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
<u>Tributaries</u>					
07-08	St. Croix R. at Mile 0.5, Wis.	88	1.7	--	3.4
07-10	Chippewa R. at Mile 1.7, Wis.	61	1.3	3.8	5.2
07-15	Wisconsin R. at Mile 1.0, Wis.	118	0.6	9.2	81
07-20	Rock R. at Mile 1.0, Ill.	233	0.6	43	47
07-20	Iowa R. at Mile 1.0, Iowa	194	1.9	27	42
07-22	Des Moines R. at Mile 1.0, Iowa	227	2.3	19	41
07-28	Kaskaskia R. at Mile 1.5, Ill.	61	<0.5	9.1	26
08-01	Arkansas R. at Mile 0.0, Ark.	171	<0.5	91	41
08-01	White R. at Mile 1.2, Ark.	161	0.8	6.7	7.3
08-02	Yazoo R. at Mile 3.0, Miss.	52	<0.5	3.4	8.1
<u>Pools</u>					
07-04	Mississippi R. in Pool 1	189	1.9	11	23
07-07	Mississippi R. in Pool 2	--	--	16	93
07-11	Mississippi R. in Pool 5	189	1.9	15	70
07-11	Mississippi R. in Pool 5A	197	1.0	15	73
07-13	Mississippi R. in Pool 7	178	1.8	13	62
07-14	Mississippi R. in Pool 8	185	1.9	14	65
07-16	Mississippi R. in Pool 10	183	1.8	14	61
07-19	Mississippi R. in Pool 14	185	1.9	16	57
07-22	Mississippi R. in Pool 20	199	2.0	18	53
07-23	Mississippi R. in Pool 22	194	2.0	18	55

October-November 1991 Cruise

Table 25.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the October-November 1991 cruise

[$\mu\text{g/L}$, microgram per liter; mg/L , milligram per liter; --, not determined; <, less than the detection limit; A, depth-integrated composite A sample; B, depth-integrated composite B sample; method for collection of composite A and composite B varied between collection sites and is specified in table 2]

Date 1991	Site name	Aluminum (µg/L)			Arsenic (µg/L)			Barium (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
10-07	Mississippi R. above St. Anthony Falls, Minn.	5.9	3.9	4.2	2.9	2.5	2.5	53.6	51.8	52.6
10-10	Mississippi R. at Hastings, Minn.	--	4.5	4.8	2.9	2.7	2.5	63.0	61.6	62.2
10-13	Mississippi R. near Pepin, Wis.	4.5	4.9	4.2	2.8	2.8	2.6	52.1	50.2	50.3
10-15	Mississippi R. at Trempealeau, Wis.	5.3	5.4	4.3	2.5	2.0	2.2	41.8	40.4	41.2
10-18	Mississippi R. below Lock and Dam 9, Wis.	44.3	29.6	4.0	2.1	1.6	2.0	42.8	43.0	42.3
10-22	Mississippi R. at Clinton, Iowa	9.6	--	3.1	1.8	1.7	2.0	43.2	42.3	43.0
10-27	Mississippi R. at Keokuk, Iowa	3.3	3.0	3.3	2.1	2.1	1.8	48.3	49.9	48.4
10-30	Mississippi R. near Winfield, Mo.	--	4.8	3.0	2.1	2.1	2.5	50.7	51.1	53.6
11-05	Mississippi R. at Thebes, Ill.	5.0	4.7	3.6	2.3	2.2	2.5	77.1	76.5	75.1
Lower Mississippi River										
11-09	Mississippi R. below Vicksburg, Miss.	10.5	4.1	4.2	1.7	1.9	1.8	64.9	64.0	66.5
11-11	Mississippi R. near St. Francisville, La.	4.0	3.8	3.8	1.8	1.8	1.8	67.0	65.2	64.2
11-13	Mississippi R. below Belle Chasse, La.	3.6	5.2	3.4	1.7	2.0	1.7	67.8	67.0	63.2
Tributaries										
10-08	Minnesota R. at Mile 3.5, Minn.	6.2	5.4	6.5	3.0	3.1	2.5	81.5	79.8	78.4
10-31	Illinois R. at Hardin, Ill.	3.4	3.0	3.1	3.1	2.8	2.8	48.1	48.1	46.9
11-03	Missouri R. at St. Charles, Mo.	6.0	5.4	4.7	2.9	2.4	2.5	91.9	92.8	92.3
11-06	Ohio R. at Olmsted, Ill.	4.7	4.4	3.1	1.4	1.3	1.2	33.4	33.7	33.3

Table 25.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the October-November 1991 cruise--continued

Date 1991	Site name	Beryllium (µg/L)			Boron (µg/L)			Cadmium (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
10-07	Mississippi R. above St. Anthony Falls, Minn.	<0.02	<0.02	<0.02	41.0	41.4	42.1	<0.1	<0.1	<0.1
10-10	Mississippi R. at Hastings, Minn.	<0.02	0.07	<0.02	64.8	88.5	77.7	<0.1	<0.1	0.2
10-13	Mississippi R. near Pepin, Wis.	<0.02	<0.02	0.05	49.8	57.1	53.6	<0.1	<0.1	<0.1
10-15	Mississippi R. at Trempealeau, Wis.	<0.02	0.02	<0.02	38.2	50.2	41.9	<0.1	<0.1	<0.1
10-18	Mississippi R. below Lock and Dam 9, Wis.	<0.02	<0.02	0.04	39.1	53.1	46.9	<0.1	<0.1	<0.1
10-22	Mississippi R. at Clinton, Iowa	0.04	0.02	0.04	51.6	50.6	33.6	<0.1	<0.1	0.1
10-27	Mississippi R. at Keokuk, Iowa	<0.02	<0.02	0.08	38.4	42.4	53.5	<0.1	<0.1	<0.1
10-30	Mississippi R. near Winfield, Mo.	<0.02	<0.02	<0.02	46.6	40.5	44.4	<0.1	<0.1	<0.1
11-05	Mississippi R. at Thebes, Ill.	<0.02	<0.02	<0.02	89.3	89.1	88.0	<0.1	<0.1	<0.1
Lower Mississippi River										
11-09	Mississippi R. below Vicksburg, Miss.	0.04	<0.02	<0.02	75.0	68.7	67.9	<0.1	<0.1	<0.1
11-11	Mississippi R. near St. Francisville, La.	<0.02	<0.02	<0.02	71.3	69.2	69.0	<0.1	<0.1	<0.1
11-13	Mississippi R. below Belle Chasse, La.	0.03	<0.02	<0.02	67.6	76.3	65.2	<0.1	<0.1	<0.1
Tributaries										
10-08	Minnesota R. at Mile 3.5, Minn.	<0.02	0.06	0.07	96.6	115.2	140.1	<0.1	<0.1	<0.1
10-31	Illinois R. at Hardin, Ill.	0.03	<0.02	<0.02	154.4	144.6	142.0	<0.1	<0.1	<0.1
11-03	Missouri R. at St. Charles, Mo.	<0.02	<0.02	<0.02	114.0	123.0	108.8	<0.1	<0.1	<0.1
11-06	Ohio R. at Olmsted, Ill.	<0.02	<0.02	<0.02	60.2	64.7	67.3	<0.1	<0.1	<0.1

Table 25.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the October-November 1991 cruise--continued

Date 1991	Site name	Calcium (mg/L)			Chromium (µg/L)			Cobalt (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
10-07	Mississippi R. above St. Anthony Falls, Minn.	56.9	56.1	56.6	<0.2	0.8	<0.2	0.13	0.11	0.12
10-10	Mississippi R. at Hastings, Minn.	72.6	78.8	76.8	0.2	0.4	0.3	0.21	0.09	<0.01
10-13	Mississippi R. near Pepin, Wis.	60.8	62.4	63.8	0.7	0.9	<0.2	0.13	0.13	<0.01
10-15	Mississippi R. at Trempealeau, Wis.	50.8	52.9	52.5	<0.2	0.2	0.9	0.05	0.02	0.08
10-18	Mississippi R. below Lock and Dam 9, Wis.	52.4	54.1	54.5	1.1	0.4	0.5	0.15	0.09	0.08
10-22	Mississippi R. at Clinton, Iowa	51.6	51.8	49.2	0.3	0.2	0.4	0.15	0.10	0.12
10-27	Mississippi R. at Keokuk, Iowa	50.6	50.5	52.9	<0.2	<0.2	0.3	0.05	0.11	0.09
10-30	Mississippi R. near Winfield, Mo.	50.9	49.8	50.0	1.0	<0.2	<0.2	0.19	0.09	0.14
11-05	Mississippi R. at Thebes, Ill.	52.4	52.9	52.7	0.2	0.9	0.3	0.08	0.11	0.06
Lower Mississippi River										
11-09	Mississippi R. below Vicksburg, Miss.	37.2	35.6	33.6	<0.2	0.6	<0.2	0.02	0.07	0.11
11-11	Mississippi R. near St. Francisville, La.	34.4	35.3	35.8	<0.2	0.6	0.7	0.11	0.09	0.09
11-13	Mississippi R. below Belle Chasse, La.	36.9	37.9	35.2	0.6	<0.2	0.8	0.12	0.06	0.10
Tributaries										
10-08	Minnesota R. at Mile 3.5, Minn.	103.1	109.4	112.3	<0.2	0.2	0.3	0.11	<0.01	<0.01
10-31	Illinois R. at Hardin, Ill.	59.6	59.1	58.1	1.0	<0.2	<0.2	0.20	0.15	0.12
11-03	Missouri R. at St. Charles, Mo.	54.4	55.5	53.6	0.6	0.8	0.7	0.05	0.06	<0.01
11-06	Ohio R. at Olmsted, Ill.	30.5	30.8	31.2	<0.2	<0.2	0.7	0.02	0.08	0.12

Table 25.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the October-November 1991 cruise--continued

Date 1991	Site name	Copper (µg/L)			Iron (mg/L)			Lead (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
10-07	Mississippi R. above St. Anthony Falls, Minn.	0.88	0.94	1.21	0.061	0.038	0.006	<0.06	0.10	0.06
10-10	Mississippi R. at Hastings, Minn.	1.70	1.67	1.59	0.073	<0.005	0.006	--	<0.06	0.13
10-13	Mississippi R. near Pepin, Wis.	1.87	1.81	2.05	0.010	0.005	0.009	0.11	<0.06	0.09
10-15	Mississippi R. at Trempealeau, Wis.	1.40	1.77	1.69	0.018	0.020	0.008	0.08	<0.06	<0.06
10-18	Mississippi R. below Lock and Dam 9, Wis.	1.67	1.76	1.64	0.048	0.032	<0.005	0.07	0.07	<0.06
10-22	Mississippi R. at Clinton, Iowa	2.28	1.80	1.79	<0.005	0.019	<0.005	0.07	<0.06	0.08
10-27	Mississippi R. at Keokuk, Iowa	1.61	1.51	1.84	<0.005	<0.005	<0.005	0.12	0.09	0.10
10-30	Mississippi R. near Winfield, Mo.	2.79	1.57	1.56	0.095	<0.005	<0.005	0.35	0.12	0.10
11-05	Mississippi R. at Thebes, Ill.	1.90	1.95	1.75	<0.005	<0.005	<0.005	0.13	0.14	0.13
Lower Mississippi River										
11-09	Mississippi R. below Vicksburg, Miss.	2.10	1.86	1.89	0.005	<0.005	<0.005	0.15	0.18	0.09
11-11	Mississippi R. near St. Francisville, La.	1.82	1.82	2.15	<0.005	<0.005	<0.005	0.09	0.11	0.13
11-13	Mississippi R. below Belle Chasse, La.	2.05	2.32	1.99	<0.005	<0.005	<0.005	0.17	0.11	0.21
Tributaries										
10-08	Minnesota R. at Mile 3.5, Minn.	1.55	1.83	1.91	0.010	<0.005	<0.005	0.07	0.09	0.09
10-31	Illinois R. at Hardin, Ill.	2.30	2.02	1.68	<0.005	<0.005	<0.005	0.27	0.27	0.16
11-03	Missouri R. at St. Charles, Mo.	1.46	1.51	1.59	<0.005	<0.005	<0.005	0.16	0.16	0.13
11-06	Ohio R. at Olmsted, Ill.	1.46	1.41	1.55	<0.005	<0.005	<0.005	0.16	0.15	0.26

Table 25.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the October-November 1991 cruise--continued

Date 1991	Site name	Lithium (µg/L)			Magnesium (mg/L)			Manganese (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
<u>Upper Mississippi River</u>										
10-07	Mississippi R. above St. Anthony Falls, Minn.	8.79	8.60	8.93	23.1	22.6	23.4	10.50	6.72	0.69
10-10	Mississippi R. at Hastings, Minn.	17.19	22.78	19.96	31.5	32.2	31.5	--	3.12	0.83
10-13	Mississippi R. near Pepin, Wis.	13.24	13.95	14.30	24.5	25.0	24.2	2.32	1.78	0.46
10-15	Mississippi R. at Trempealeau, Wis.	9.73	11.38	9.66	20.8	20.3	21.0	2.84	2.24	0.97
10-18	Mississippi R. below Lock and Dam 9, Wis.	9.49	12.02	11.29	21.1	21.0	21.0	9.59	4.86	0.42
10-22	Mississippi R. at Clinton, Iowa	10.40	9.68	6.94	20.5	20.6	20.7	2.23	4.28	0.28
10-27	Mississippi R. at Keokuk, Iowa	6.25	6.50	8.52	22.6	22.6	22.2	0.69	0.67	0.30
10-30	Mississippi R. near Winfield, Mo.	7.35	6.63	6.81	22.3	22.2	22.3	--	1.43	0.44
11-05	Mississippi R. at Thebes, Ill.	19.37	19.54	19.12	22.4	22.2	22.4	2.00	1.30	0.39
<u>Lower Mississippi River</u>										
11-09	Mississippi R. below Vicksburg, Miss.	10.55	9.21	8.97	12.7	12.8	12.3	1.75	1.19	0.69
11-11	Mississippi R. near St. Francisville, La.	9.49	9.07	9.55	12.2	12.4	12.6	1.14	1.00	0.54
11-13	Mississippi R. below Belle Chasse, La.	9.11	10.15	9.00	12.6	12.4	12.1	1.34	1.18	0.65
<u>Tributaries</u>										
10-08	Minnesota R. at Mile 3.5, Minn.	34.00	40.94	48.97	49.1	49.2	50.9	2.80	5.38	1.07
10-31	Illinois R. at Hardin, Ill.	6.58	6.24	5.77	26.3	26.4	26.3	4.07	1.55	0.26
11-03	Missouri R. at St. Charles, Mo.	39.61	41.59	38.35	21.5	21.8	21.1	1.67	2.16	1.07
11-06	Ohio R. at Olmsted, Ill.	3.73	3.83	3.99	10.1	10.2	10.1	1.28	1.32	0.70

Table 25.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the October-November 1991 cruise--continued

Date 1991	Site name	Mercury (µg/L)			Molybdenum (µg/L)			Nickel (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
10-07	Mississippi R. above St. Anthony Falls, Minn.	<0.004	<0.004	<0.004	2.2	2.1	2.3	0.06	<0.03	0.28
10-10	Mississippi R. at Hastings, Minn.	0.009	<0.004	<0.004	3.6	3.5	3.4	--	<0.03	<0.03
10-13	Mississippi R. near Pepin, Wis.	0.009	<0.004	0.023	2.6	2.9	2.8	<0.03	0.12	<0.03
10-15	Mississippi R. at Trempealeau, Wis.	0.005	<0.004	<0.004	2.1	1.9	2.1	<0.03	<0.03	<0.03
10-18	Mississippi R. below Lock and Dam 9, Wis.	<0.004	<0.004	--	2.1	2.0	2.0	<0.03	<0.03	<0.03
10-22	Mississippi R. at Clinton, Iowa	<0.004	<0.004	<0.004	1.8	1.8	2.0	--	0.08	0.45
10-27	Mississippi R. at Keokuk, Iowa	0.007	<0.004	<0.004	2.1	2.1	1.9	0.09	--	<0.03
10-30	Mississippi R. near Winfield, Mo.	0.015	<0.004	<0.004	2.1	2.1	2.2	<0.03	0.03	0.74
11-05	Mississippi R. at Thebes, Ill.	0.005	<0.004	<0.004	3.6	3.4	3.5	0.93	0.65	0.57
Lower Mississippi River										
11-09	Mississippi R. below Vicksburg, Miss.	0.004	0.005	<0.004	2.6	2.7	3.1	0.09	0.30	2.09
11-11	Mississippi R. near St. Francisville, La.	<0.004	0.014	<0.004	2.8	2.6	2.8	--	0.57	0.44
11-13	Mississippi R. below Belle Chasse, La.	<0.004	<0.004	<0.004	2.3	2.4	2.3	0.70	0.51	0.62
Tributaries										
10-08	Minnesota R. at Mile 3.5, Minn.	<0.004	<0.004	<0.004	4.7	4.7	4.8	0.80	<0.03	<0.03
10-31	Illinois R. at Hardin, Ill.	0.006	0.006	--	7.0	7.3	6.6	1.91	2.02	1.07
11-03	Missouri R. at St. Charles, Mo.	<0.004	<0.004	<0.004	3.5	3.3	3.1	<0.03	<0.03	<0.03
11-06	Ohio R. at Olmsted, Ill.	0.010	0.020	<0.004	3.9	4.0	3.8	<0.03	0.45	0.09

Table 25.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the October-November 1991 cruise--continued

Date 1991	Site name	Potassium (mg/L)			Silica (mg/L)			Sodium (mg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
		Upper Mississippi River								
10-07	Mississippi R. above St. Anthony Falls, Minn.	3.6	3.7	3.7	11.8	11.5	11.8	8.7	8.4	8.5
10-10	Mississippi R. at Hastings, Minn.	4.6	4.7	--	14.3	14.5	14.4	17.7	21.7	20.7
10-13	Mississippi R. near Pepin, Wis.	3.8	3.9	3.8	17.4	18.0	17.3	11.8	12.8	13.7
10-15	Mississippi R. at Trempealeau, Wis.	3.2	3.1	3.1	15.4	14.9	15.4	10.0	10.9	10.5
10-18	Mississippi R. below Lock and Dam 9, Wis.	3.1	3.1	3.0	13.6	13.5	13.5	9.8	10.9	11.1
10-22	Mississippi R. at Clinton, Iowa	2.9	2.9	2.9	11.3	11.4	11.3	10.9	10.9	9.7
10-27	Mississippi R. at Keokuk, Iowa	3.3	3.2	3.2	9.3	9.4	9.3	12.7	13.0	14.2
10-30	Mississippi R. near Winfield, Mo.	3.3	3.3	3.3	9.6	9.4	9.4	13.6	13.7	13.5
11-05	Mississippi R. at Thebes, Ill.	4.4	4.4	4.3	8.5	8.5	8.5	35.0	36.1	36.3
		Lower Mississippi River								
11-09	Mississippi R. below Vicksburg, Miss.	3.5	3.6	3.6	6.3	6.3	6.1	35.6	32.0	26.9
11-11	Mississippi R. near St. Francisville, La.	3.6	3.5	3.6	6.1	6.2	6.4	30.0	32.8	34.5
11-13	Mississippi R. below Belle Chasse, La.	3.5	3.5	3.4	6.3	6.3	6.1	44.1	48.6	41.7
		Tributaries								
10-08	Minnesota R. at Mile 3.5, Minn.	5.5	5.4	5.3	21.1	20.7	21.2	23.4	28.3	28.9
10-31	Illinois R. at Hardin, Ill.	4.4	4.3	4.4	5.5	5.5	5.5	45.6	45.9	45.4
11-03	Missouri R. at St. Charles, Mo.	5.2	5.2	5.2	8.8	9.0	8.8	57.8	62.3	60.1
11-06	Ohio R. at Olmsted, Ill.	2.3	2.3	2.3	3.2	2.9	3.0	19.0	19.1	19.8

Table 25.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the October-November 1991 cruise--continued

Date 1991	Site name	Strontium (mg/L)			Thallium (µg/L)			Uranium (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
10-07	Mississippi R. above St. Anthony Falls, Minn.	0.136	0.133	0.136	<0.05	<0.05	<0.05	3.18	3.1	3.10
10-10	Mississippi R. at Hastings, Minn.	0.211	0.228	0.224	<0.05	<0.05	<0.05	7.15	7.1	7.06
10-13	Mississippi R. near Pepin, Wis.	0.166	0.169	0.177	<0.05	<0.05	0.06	5.45	5.4	5.64
10-15	Mississippi R. at Trempealeau, Wis.	0.131	0.136	0.134	<0.05	<0.05	<0.05	4.24	3.7	3.94
10-18	Mississippi R. below Lock and Dam 9, Wis.	0.128	0.133	0.135	<0.05	<0.05	<0.05	3.79	3.6	3.72
10-22	Mississippi R. at Clinton, Iowa	0.119	0.119	0.114	<0.05	<0.05	0.06	3.15	2.9	3.23
10-27	Mississippi R. at Keokuk, Iowa	0.119	0.118	0.123	<0.05	<0.05	<0.05	2.77	2.9	2.56
10-30	Mississippi R. near Winfield, Mo.	0.123	0.123	0.123	<0.05	<0.05	<0.05	2.66	2.6	2.97
11-05	Mississippi R. at Thebes, Ill.	0.259	0.261	0.259	<0.05	<0.05	<0.05	3.05	2.8	3.06
Lower Mississippi River										
11-09	Mississippi R. below Vicksburg, Miss.	0.200	0.189	0.179	<0.05	<0.05	<0.05	1.48	1.3	1.34
11-11	Mississippi R. near St. Francisville, La.	0.186	0.190	0.193	<0.05	<0.05	<0.05	1.43	1.3	1.38
11-13	Mississippi R. below Belle Chasse, La.	0.203	0.208	0.191	<0.05	<0.05	<0.05	1.37	1.3	1.32
Tributaries										
10-08	Minnesota R. at Mile 3.5, Minn.	0.362	0.388	0.394	<0.05	<0.05	<0.05	14.66	14.7	15.21
10-31	Illinois R. at Hardin, Ill.	0.236	0.235	0.231	<0.05	<0.05	<0.05	1.13	1.1	1.12
11-03	Missouri R. at St. Charles, Mo.	0.452	0.459	0.444	<0.05	<0.05	<0.05	4.13	4.1	4.01
11-06	Ohio R. at Olmsted, Ill.	0.163	0.165	0.166	<0.05	<0.05	<0.05	0.42	0.3	0.44

Table 25.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the October-November 1991 cruise--continued

Date 1991	Site name	Vanadium (µg/L)			Zinc (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
<u>Upper Mississippi River</u>							
10-07	Mississippi R. above St. Anthony Falls, Minn.	1.50	2.96	1.20	2.29	3.34	4.78
10-10	Mississippi R. at Hastings, Minn.	2.51	3.00	2.75	4.81	4.31	7.53
10-13	Mississippi R. near Pepin, Wis.	3.79	4.22	2.60	3.50	3.10	4.26
10-15	Mississippi R. at Trempealeau, Wis.	1.44	2.44	3.85	2.61	1.58	2.87
10-18	Mississippi R. below Lock and Dam 9, Wis.	4.52	3.11	3.29	1.61	1.36	1.95
10-22	Mississippi R. at Clinton, Iowa	3.11	2.79	3.05	1.69	2.30	2.23
10-27	Mississippi R. at Keokuk, Iowa	1.94	2.34	3.15	2.31	1.13	1.53
10-30	Mississippi R. near Winfield, Mo.	4.75	1.82	2.65	2.86	1.29	2.12
11-05	Mississippi R. at Thebes, Ill.	2.95	4.35	3.05	3.33	1.96	2.12
<u>Lower Mississippi River</u>							
11-09	Mississippi R. below Vicksburg, Miss.	1.84	2.83	1.90	2.12	3.25	1.66
11-11	Mississippi R. near St. Francisville, La.	1.89	2.92	3.13	2.88	1.58	1.30
11-13	Mississippi R. below Belle Chasse, La.	3.26	2.33	3.59	1.41	1.61	4.67
<u>Tributaries</u>							
10-08	Minnesota R. at Mile 3.5, Minn.	3.05	4.00	4.21	9.75	4.66	4.84
10-31	Illinois R. at Hardin, Ill.	4.69	2.38	2.50	4.28	4.08	3.15
11-03	Missouri R. at St. Charles, Mo.	3.86	4.31	3.86	2.96	2.48	2.78
11-06	Ohio R. at Olmsted, Ill.	<0.07	0.66	2.40	1.54	2.13	1.03

Table 26.--Concentration data for dissolved nutrients and dissolved organic-carbon in laterally composited water samples collected from the Mississippi River and some of its tributaries during the October-November 1991 cruise

[mg N/L, milligram nitrogen per liter; mg P/L, milligram phosphorus per liter; mg C/L, milligram carbon per liter; --, not determined; <, less than the detection limit; A, depth-integrated composite A sample; B, depth-integrated composite B sample; method of collection of composites A and B varied between collection sites and is specified in table 2; analyses of total soluble phosphorus performed by Mark Nanny, University of Illinois]

Date 1991	Site name	Ammonium (mg N/L)			Nitrate (mg N/L)			Nitrite (mg N/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
10-07	Mississippi R. above St. Anthony Falls, Minn.	<0.02	<0.02	<0.02	0.87	0.86	0.83	0.01	0.01	0.02
10-10	Mississippi R. at Hastings, Minn.	<0.02	<0.02	<0.02	3.20	3.24	3.28	0.03	0.03	0.03
10-13	Mississippi R. near Pepin, Wis.	<0.02	0.02	0.04	2.61	2.59	2.62	0.04	0.04	0.04
10-15	Mississippi R. at Trempealeau, Wis.	<0.02	<0.02	<0.02	1.95	1.95	1.97	0.03	0.02	0.02
10-18	Mississippi R. below Lock and Dam 9, Wis.	<0.02	<0.02	<0.02	1.65	1.62	1.68	0.02	0.02	0.02
10-22	Mississippi R. at Clinton, Iowa	0.02	0.02	<0.02	1.53	1.49	1.27	0.03	0.01	0.02
10-27	Mississippi R. at Keokuk, Iowa	0.07	0.08	0.04	1.58	1.69	1.70	0.01	0.02	0.02
10-30	Mississippi R. near Winfield, Mo.	0.04	0.04	0.04	1.75	1.74	1.76	0.02	0.02	0.02
11-05	Mississippi R. at Thebes, Ill.	0.09	0.09	<0.02	1.39	1.39	1.23	0.03	0.03	0.04
Lower Mississippi River										
11-09	Mississippi R. below Vicksburg, Miss.	<0.02	<0.02	<0.02	0.73	0.74	0.74	0.03	0.03	0.03
11-11	Mississippi R. near St. Francisville, La.	<0.02	0.02	<0.02	0.72	0.74	0.70	0.02	0.02	0.02
11-13	Mississippi R. below Belle Chasse, La.	0.02	<0.02	0.02	0.75	0.76	0.84	0.01	<0.01	0.01
Tributaries										
10-08	Minnesota R. at Mile 3.5, Minn.	<0.02	<0.02	<0.02	6.97	6.98	6.94	0.02	0.02	0.02
10-31	Illinois R. at Hardin, Ill.	0.10	0.10	<0.02	2.27	2.30	2.28	0.08	0.08	0.10
11-03	Missouri R. at St. Charles, Mo.	0.05	0.05	<0.02	0.44	0.42	0.43	0.01	0.01	0.02
11-06	Ohio R. at Olmsted, Ill.	0.06	0.06	<0.02	0.44	0.44	0.51	0.01	0.01	0.02

**Table 26.--Concentration data for dissolved nutrients and dissolved organic-carbon in laterally composited water samples collected from the Mississippi River and some of its tributaries during the October-November 1991 cruise--
continued**

Date 1991	Site name	Orthophosphate			Total soluble phosphorus			Dissolved organic- carbon		
		(mg P/L)			(mg P/L)			(mg C/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
<u>Upper Mississippi River</u>										
10-07	Mississippi R. above St. Anthony Falls, Minn.	0.05	0.04	0.02	--	--	0.04	11.4	11.4	--
10-10	Mississippi R. at Hastings, Minn.	0.11	0.11	0.09	--	--	0.12	9.9	9.8	--
10-13	Mississippi R. near Pepin, Wis.	0.13	0.14	0.13	--	--	0.16	12.5	12.0	--
10-15	Mississippi R. at Trempealeau, Wis.	0.10	0.09	0.08	--	--	0.10	11.4	11.7	--
10-18	Mississippi R. below Lock and Dam 9, Wis.	0.08	0.08	0.07	--	--	0.09	9.0	8.8	--
10-22	Mississippi R. at Clinton, Iowa	0.08	0.07	0.02	--	--	0.07	8.2	8.2	--
10-27	Mississippi R. at Keokuk, Iowa	0.08	0.09	0.06	--	--	0.08	7.1	--	--
10-30	Mississippi R. near Winfield, Mo.	0.09	0.09	0.08	--	--	0.09	6.8	6.9	--
11-05	Mississippi R. at Thebes, Ill.	0.12	0.12	0.04	--	--	0.07	5.0	5.0	--
<u>Lower Mississippi River</u>										
11-09	Mississippi R. below Vicksburg, Miss.	0.06	0.06	0.04	--	--	0.05	4.1	4.1	--
11-11	Mississippi R. near St. Francisville, La.	0.06	0.06	0.04	--	--	0.05	3.9	3.9	--
11-13	Mississippi R. below Belle Chasse, La.	0.07	0.07	0.08	--	--	0.08	3.6	3.7	--
<u>Tributaries</u>										
10-08	Minnesota R. at Mile 3.5, Minn.	0.09	0.09	0.08	--	--	0.11	7.8	7.5	--
10-31	Illinois R. at Hardin, Ill.	0.18	0.18	0.14	--	--	0.14	4.8	4.8	--
11-03	Missouri R. at St. Charles, Mo.	0.09	0.09	0.06	--	--	--	3.1	3.1	--
11-06	Ohio R. at Olmsted, Ill.	0.04	0.03	<0.01	--	--	0.03	2.4	2.3	--

Table 27.--Concentration data for dissolved bicarbonate, carbonate, chloride, and sulfate in laterally composited water samples collected from the Mississippi River and some of its tributaries during the October-November 1991 cruise

[mg/L, milligram per liter; --, not determined; A, depth-integrated composite A sample; B, depth-integrated composite B sample; method of collection of composites A and B varied between collection sites and is specified in table 2]

Date 1991	Site name	Bicarbonate (mg/L)		Carbonate (mg/L)		Chloride (mg/L)		Sulfate (mg/L)	
		A	B	A	B	A	B	A	B
Upper Mississippi River									
10-07	Mississippi R. above St. Anthony Falls, Minn.	224	225	2.2	2.3	15	15	34	34
10-10	Mississippi R. at Hastings, Minn.	265	266	2.7	2.7	28	28	75	75
10-13	Mississippi R. near Pepin, Wis.	216	215	1.1	1.1	18	18	54	54
10-15	Mississippi R. at Trempealeau, Wis.	185	186	0.9	0.9	15	15	41	40
10-18	Mississippi R. below Lock and Dam 9, Wis.	--	195	--	2.0	15	15	40	40
10-22	Mississippi R. at Clinton, Iowa	191	190	1.9	1.9	14	15	35	36
10-27	Mississippi R. at Keokuk, Iowa	199	--	2.0	--	20	20	38	38
10-30	Mississippi R. near Winfield, Mo.	190	196	1.9	<0.5	20	20	38	38
11-05	Mississippi R. at Thebes, Ill.	190	190	1.9	1.9	28	28	93	93
Lower Mississippi River									
11-09	Mississippi R. below Vicksburg, Miss.	119	119	1.2	1.2	33	33	55	54
11-11	Mississippi R. near St. Francisville, La.	132	118	<0.5	0.6	36	36	54	54
11-13	Mississippi R. below Belle Chasse, La.	123	122	1.2	<0.5	54	53	52	52
Tributaries									
10-08	Minnesota R. at Mile 3.5, Minn.	347	347	4.1	3.5	36	36	156	156
10-31	Illinois R. at Hardin, Ill.	200	200	1.0	1.0	63	63	78	77
11-03	Missouri R. at St. Charles, Mo.	184	184	1.8	1.8	19	19	160	161
11-06	Ohio R. at Olmsted, Ill.	87	89	<0.5	<0.5	20	21	49	51

Table 28.--Concentration data for dissolved trace- and major-elements in surface-grab water samples collected from selected tributaries of the Mississippi River during the October-November 1991 cruise

[Sampling site upstream from the Mississippi River confluence; see fig. 1 for locations of the sampling sites; µg/L, microgram per liter; mg/L, milligram per liter; --, not determined; <, less than the detection limit]

Date 1991	Site name	Aluminum (µg/L)		Arsenic (µg/L)		Barium (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
10-10	St. Croix River at Mile 0.5, Wis.	10.7	6.0	1.0	1.3	17.0	15.8
10-12	Chippewa River at Mile 1.7, Wis.	16.2	8.0	<0.6	0.7	10.9	10.4
10-19	Wisconsin River at Mile 1.0, Wis.	6.0	4.4	<0.6	0.8	21.9	21.7
10-24	Rock River at Mile 1.0, Ill.	13.2	22.6	2.0	2.2	67.4	63.6
10-25	Iowa River at Mile 1.0, Iowa	20.2	4.3	2.2	1.7	84.6	83.4
10-28	Des Moines River at Mile 1.0, Iowa	2.2	1.9	1.5	1.7	82.7	80.9
11-04	Kaskaskia River at Mile 1.5, Ill.	7.0	3.8	3.3	3.1	44.2	41.1
11-08	White River at Mile 1.2, Ark.	210.2	3.4	0.6	1.1	36.8	35.0
11-08	Arkansas River at Mile 0.0, Ark.	13.6	3.3	1.1	1.0	58.9	57.3
11-10	Yazoo River at Mile 3.0, Miss.	3.8	4.2	1.3	1.3	34.9	31.6

Date 1991	Site name	Beryllium (µg/L)		Boron (µg/L)		Cadmium (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
10-10	St. Croix River at Mile 0.5, Wis.	<0.02	<0.02	18.9	17.5	<0.1	<0.1
10-12	Chippewa River at Mile 1.7, Wis.	0.02	<0.02	17.5	15.2	<0.1	<0.1
10-19	Wisconsin River at Mile 1.0, Wis.	<0.02	<0.02	17.8	18.2	<0.1	<0.1
10-24	Rock River at Mile 1.0, Ill.	<0.02	0.02	51.7	70.1	<0.1	<0.1
10-25	Iowa River at Mile 1.0, Iowa	<0.02	<0.02	50.2	62.8	<0.1	<0.1
10-28	Des Moines River at Mile 1.0, Iowa	<0.02	<0.02	78.7	78.7	<0.1	<0.1
11-04	Kaskaskia River at Mile 1.5, Ill.	<0.02	<0.02	122.2	113.8	<0.1	<0.1
11-08	White River at Mile 1.2, Ark.	<0.02	<0.02	17.3	12.7	<0.1	<0.1
11-08	Arkansas River at Mile 0.0, Ark.	<0.02	<0.02	40.8	40.3	<0.1	<0.1
11-10	Yazoo River at Mile 3.0, Miss.	<0.02	<0.02	24.0	23.5	<0.1	<0.1

Date 1991	Site name	Calcium (mg/L)		Chromium (µg/L)		Cobalt (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
10-10	St. Croix River at Mile 0.5, Wis.	22.5	21.4	1.1	0.8	0.12	0.12
10-12	Chippewa River at Mile 1.7, Wis.	18.1	17.2	<0.2	0.6	0.09	0.09
10-19	Wisconsin River at Mile 1.0, Wis.	27.5	30.8	<0.2	<0.2	0.12	0.11
10-24	Rock River at Mile 1.0, Ill.	63.8	68.0	<0.2	0.6	0.43	0.49
10-25	Iowa River at Mile 1.0, Iowa	48.8	50.3	<0.2	<0.2	0.18	0.17
10-28	Des Moines River at Mile 1.0, Iowa	59.4	59.6	<0.2	0.5	0.41	0.40
11-04	Kaskaskia River at Mile 1.5, Ill.	27.6	25.1	0.7	<0.2	0.55	0.35
11-08	White River at Mile 1.2, Ark.	21.7	20.5	0.9	<0.2	0.26	0.04
11-08	Arkansas River at Mile 0.0, Ark.	20.7	19.3	<0.2	<0.2	0.10	0.11
11-10	Yazoo River at Mile 3.0, Miss.	10.7	9.6	0.5	<0.2	0.12	0.06

Table 28.--Concentration data for dissolved trace- and major-elements in surface-grab water samples collected from selected tributaries of the Mississippi River during the October-November 1991 cruise--continued

Date 1991	Site name	Copper (µg/L)		Iron (mg/L)		Lead (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
10-10	St. Croix River at Mile 0.5, Wis.	1.12	1.07	0.264	0.048	<0.06	<0.06
10-12	Chippewa River at Mile 1.7, Wis.	1.18	1.02	0.149	0.030	0.10	<0.06
10-19	Wisconsin River at Mile 1.0, Wis.	0.82	0.86	0.048	<0.005	<0.06	<0.06
10-24	Rock River at Mile 1.0, Ill.	1.17	1.49	0.006	<0.005	<0.06	0.07
10-25	Iowa River at Mile 1.0, Iowa	0.97	0.98	0.023	<0.005	0.07	<0.06
10-28	Des Moines River at Mile 1.0, Iowa	1.32	1.20	<0.005	<0.005	0.15	0.09
11-04	Kaskaskia River at Mile 1.5, Ill.	2.93	1.67	0.054	0.023	0.11	0.19
11-08	White River at Mile 1.2, Ark.	1.54	1.16	0.196	0.007	0.34	0.12
11-08	Arkansas River at Mile 0.0, Ark.	1.67	1.41	0.028	0.013	0.11	0.10
11-10	Yazoo River at Mile 3.0, Miss.	1.60	1.91	<0.005	<0.005	<0.06	0.18

		Lithium (µg/L)		Magnesium (mg/L)		Manganese (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
10-10	St. Croix River at Mile 0.5, Wis.	1.38	1.26	7.8	7.6	7.29	0.98
10-12	Chippewa River at Mile 1.7, Wis.	1.00	0.70	6.6	6.6	6.81	4.79
10-19	Wisconsin River at Mile 1.0, Wis.	0.74	0.75	13.4	15.1	5.52	0.78
10-24	Rock River at Mile 1.0, Ill.	2.20	3.09	37.8	37.9	15.01	33.96
10-25	Iowa River at Mile 1.0, Iowa	6.04	7.15	25.3	24.5	16.02	0.64
10-28	Des Moines River at Mile 1.0, Iowa	15.78	15.03	30.4	30.1	3.50	0.63
11-04	Kaskaskia River at Mile 1.5, Ill.	1.87	1.70	9.0	8.5	245.80	205.70
11-08	White River at Mile 1.2, Ark.	0.54	0.35	7.2	7.0	24.67	11.08
11-08	Arkansas River at Mile 0.0, Ark.	2.68	2.62	6.0	5.7	11.26	10.47
11-10	Yazoo River at Mile 3.0, Miss.	0.98	1.02	3.6	3.4	5.98	5.18

		Mercury (µg/L)		Molybdenum (µg/L)		Nickel (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
10-10	St. Croix River at Mile 0.5, Wis.	<0.004	<0.004	0.3	0.3	0.34	0.18
10-12	Chippewa River at Mile 1.7, Wis.	<0.004	<0.004	0.3	0.2	<0.03	<0.03
10-19	Wisconsin River at Mile 1.0, Wis.	<0.004	<0.004	0.4	0.5	1.23	0.17
10-24	Rock River at Mile 1.0, Ill.	<0.004	<0.004	1.7	1.7	0.41	<0.03
10-25	Iowa River at Mile 1.0, Iowa	0.006	<0.004	2.3	2.2	0.40	<0.03
10-28	Des Moines River at Mile 1.0, Iowa	0.008	<0.004	5.5	4.7	1.71	0.10
11-04	Kaskaskia River at Mile 1.5, Ill.	0.005	0.013	6.9	5.9	2.25	1.39
11-08	White River at Mile 1.2, Ark.	<0.004	<0.004	0.2	0.3	0.83	0.37
11-08	Arkansas River at Mile 0.0, Ark.	<0.004	<0.004	0.9	0.7	2.28	1.98
11-10	Yazoo River at Mile 3.0, Miss.	<0.004	<0.004	0.5	0.5	0.97	1.07

Table 28.--Concentration data for dissolved trace- and major-elements in surface-grab water samples collected from selected tributaries of the Mississippi River during the October-November 1991 cruise--continued

Date 1991	Site name	Potassium (mg/L)		Silica (mg/L)		Sodium (mg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
10-10	St. Croix River at Mile 0.5, Wis.	1.5	1.5	14.5	14.0	3.2	3.0
10-12	Chippewa River at Mile 1.7, Wis.	1.5	1.5	10.5	10.5	5.1	4.6
10-19	Wisconsin River at Mile 1.0, Wis.	2.0	2.0	1.8	1.6	8.3	10.5
10-24	Rock River at Mile 1.0, Ill.	3.9	3.8	2.2	2.3	21.6	25.3
10-25	Iowa River at Mile 1.0, Iowa	4.0	4.0	0.2	0.1	24.9	28.5
10-28	Des Moines River at Mile 1.0, Iowa	3.8	3.9	0.6	0.6	26.2	27.3
11-04	Kaskaskia River at Mile 1.5, Ill.	10.5	9.8	8.9	8.8	17.1	16.0
11-08	White River at Mile 1.2, Ark.	2.6	2.5	8.0	7.3	3.4	3.2
11-08	Arkansas River at Mile 0.0, Ark.	3.1	3.0	5.0	4.9	48.0	45.5
11-10	Yazoo River at Mile 3.0, Miss.	3.2	3.0	7.3	7.2	6.4	5.8

Date 1991	Site name	Strontium (mg/L)		Thallium (µg/L)		Uranium (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
10-10	St. Croix River at Mile 0.5, Wis.	0.041	0.039	<0.05	<0.05	0.14	0.13
10-12	Chippewa River at Mile 1.7, Wis.	0.037	0.035	<0.05	<0.05	0.12	0.13
10-19	Wisconsin River at Mile 1.0, Wis.	0.042	0.049	<0.05	<0.05	0.31	0.36
10-24	Rock River at Mile 1.0, Ill.	0.106	0.113	<0.05	<0.05	1.13	1.12
10-25	Iowa River at Mile 1.0, Iowa	0.177	0.180	<0.05	<0.05	2.20	2.18
10-28	Des Moines River at Mile 1.0, Iowa	0.316	0.312	<0.05	<0.05	7.20	6.73
11-04	Kaskaskia River at Mile 1.5, Ill.	0.091	0.084	<0.05	<0.05	0.45	0.28
11-08	White River at Mile 1.2, Ark.	0.037	0.036	<0.05	<0.05	0.24	0.20
11-08	Arkansas River at Mile 0.0, Ark.	0.164	0.154	<0.05	<0.05	0.49	0.45
11-10	Yazoo River at Mile 3.0, Miss.	0.065	0.059	<0.05	<0.05	0.09	0.09

Date 1991	Site name	Vanadium (µg/L)		Zinc (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
10-10	St. Croix River at Mile 0.5, Wis.	3.54	2.59	0.83	2.12
10-12	Chippewa River at Mile 1.7, Wis.	1.14	1.84	1.93	1.85
10-19	Wisconsin River at Mile 1.0, Wis.	0.64	<0.07	0.82	2.41
10-24	Rock River at Mile 1.0, Ill.	3.12	5.05	2.85	2.83
10-25	Iowa River at Mile 1.0, Iowa	1.15	1.26	2.09	1.65
10-28	Des Moines River at Mile 1.0, Iowa	1.47	2.90	1.67	1.34
11-04	Kaskaskia River at Mile 1.5, Ill.	4.91	2.72	2.10	3.39
11-08	White River at Mile 1.2, Ark.	3.24	0.22	1.85	2.27
11-08	Arkansas River at Mile 0.0, Ark.	1.02	0.83	1.71	1.53
11-10	Yazoo River at Mile 3.0, Miss.	1.71	0.19	1.69	1.11

Table 29.--Concentration data for dissolved trace- and major-elements in surface-grab water samples collected from selected pools of the Upper Mississippi River during the October-November 1991 cruise

[See fig. 2 for locations of the sampling sites; µg/L, microgram per liter; mg/L, milligram per liter; --, not determined; <, less than the detection limit]

Date 1991	Site name	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Beryllium (µg/L)	Boron (µg/L)
10-09	Mississippi R. in Pool 2	4.0	2.7	61.9	0.07	77.4
10-11	Mississippi R. in Pool 3	122.1	2.2	48.8	0.03	64.2
10-14	Mississippi R. in Pool 4, Upper Lake Pepin	6.7	2.3	53.3	<0.02	52.4
10-12	Mississippi R. in Pool 4, Lower Lake Pepin	6.1	2.7	51.3	<0.02	63.3
10-17	Mississippi R. in Pool 8	4.1	2.4	39.7	0.08	93.2
10-19	Mississippi R. in Pool 9	74.6	2.2	42.0	<0.02	48.6
10-20	Mississippi R. in Pool 11	142.0	1.8	43.9	0.03	33.1
10-21	Mississippi R. in Pool 13	11.5	1.7	41.8	0.03	48.4
10-24	Mississippi R. in Pool 16	12.5	1.5	48.1	<0.02	44.3
10-26	Mississippi R. in Pool 19	4.0	2.2	48.7	<0.02	39.3
10-29	Mississippi R. in Pool 24	6.8	2.3	53.7	0.02	56.0
11-01	Mississippi R. in Pool 26	3.9	2.2	54.0	<0.02	61.3
		Cadmium (µg/L)	Calcium (mg/L)	Chromium (µg/L)	Cobalt (µg/L)	Copper (µg/L)
10-09	Mississippi R. in Pool 2	<0.1	78.4	0.5	<0.01	1.58
10-11	Mississippi R. in Pool 3	<0.1	60.7	0.7	0.19	1.85
10-14	Mississippi R. in Pool 4, Upper Lake Pepin	<0.1	62.0	<0.2	0.18	1.66
10-12	Mississippi R. in Pool 4, Lower Lake Pepin	<0.1	64.2	0.3	<0.01	2.34
10-17	Mississippi R. in Pool 8	<0.1	55.2	14.6	<0.01	1.68
10-19	Mississippi R. in Pool 9	<0.1	53.9	0.3	0.06	1.84
10-20	Mississippi R. in Pool 11	<0.1	48.4	0.6	0.21	1.84
10-21	Mississippi R. in Pool 13	<0.1	51.6	0.3	0.13	1.90
10-24	Mississippi R. in Pool 16	<0.1	49.9	0.3	0.20	1.62
10-26	Mississippi R. in Pool 19	<0.1	48.9	<0.2	0.13	1.82
10-29	Mississippi R. in Pool 24	<0.1	52.7	<0.2	0.10	1.93
11-01	Mississippi R. in Pool 26	<0.1	51.4	0.3	0.13	2.27
		Iron (mg/L)	Lead (µg/L)	Lithium (µg/L)	Magnesium (mg/L)	Manganese (µg/L)
10-09	Mississippi R. in Pool 2	0.008	0.06	19.93	31.8	11.02
10-11	Mississippi R. in Pool 3	0.252	0.41	14.97	23.9	44.40
10-14	Mississippi R. in Pool 4, Upper Lake Pepin	0.030	0.25	13.24	25.8	1.82
10-12	Mississippi R. in Pool 4, Lower Lake Pepin	0.010	<0.06	15.96	24.8	2.33
10-17	Mississippi R. in Pool 8	<0.005	<0.06	10.47	21.0	0.11
10-19	Mississippi R. in Pool 9	0.067	0.13	11.34	20.9	11.68
10-20	Mississippi R. in Pool 11	0.205	0.36	7.28	20.9	37.02
10-21	Mississippi R. in Pool 13	0.008	0.06	9.98	20.5	1.84
10-24	Mississippi R. in Pool 16	0.007	<0.06	6.70	23.2	1.16
10-26	Mississippi R. in Pool 19	<0.005	0.12	6.44	22.0	0.81
10-29	Mississippi R. in Pool 24	<0.005	0.15	8.77	21.6	3.53
11-01	Mississippi R. in Pool 26	<0.005	0.15	8.50	21.3	1.77

Table 29.--Concentration data for dissolved trace- and major-elements in surface-grab water samples collected from selected pools of the Upper Mississippi River during the October-November 1991 cruise--continued

Date 1991	Site name	Mercury (µg/L)	Molybdenum (µg/L)	Nickel (µg/L)	Potassium (mg/L)	Silica (mg/L)
10-09	Mississippi R. in Pool 2	<0.004	3.5	<0.03	4.6	14.6
10-11	Mississippi R. in Pool 3	<0.004	2.4	<0.03	3.6	14.2
10-14	Mississippi R. in Pool 4, Upper Lake Pepin	<0.004	2.9	1.42	3.7	15.0
10-12	Mississippi R. in Pool 4, Lower Lake Pepin	<0.004	2.8	<0.03	3.8	16.7
10-17	Mississippi R. in Pool 8	<0.004	2.1	<0.03	3.2	14.2
10-19	Mississippi R. in Pool 9	0.004	1.8	<0.03	3.3	13.7
10-20	Mississippi R. in Pool 11	--	1.8	0.75	3.0	11.2
10-21	Mississippi R. in Pool 13	<0.004	1.8	<0.03	3.1	11.0
10-24	Mississippi R. in Pool 16	0.004	1.8	2.02	3.2	8.7
10-26	Mississippi R. in Pool 19	0.006	1.9	0.80	3.3	9.2
10-29	Mississippi R. in Pool 24	<0.004	2.1	<0.03	3.6	9.1
11-01	Mississippi R. in Pool 26	<0.004	2.3	<0.03	3.4	9.0
		Sodium (mg/L)	Strontium (mg/L)	Thallium (µg/L)	Uranium (µg/L)	Vanadium (µg/L)
10-09	Mississippi R. in Pool 2	21.2	0.230	0.05	7.07	3.14
10-11	Mississippi R. in Pool 3	15.4	0.168	<0.05	4.68	3.81
10-14	Mississippi R. in Pool 4, Upper Lake Pepin	13.5	0.168	<0.05	5.37	1.84
10-12	Mississippi R. in Pool 4, Lower Lake Pepin	14.2	0.175	<0.05	5.34	3.03
10-17	Mississippi R. in Pool 8	11.1	0.139	<0.05	3.74	--
10-19	Mississippi R. in Pool 9	10.7	0.131	<0.05	3.65	2.91
10-20	Mississippi R. in Pool 11	9.2	0.109	<0.05	2.92	3.42
10-21	Mississippi R. in Pool 13	10.5	0.119	<0.05	3.15	3.16
10-24	Mississippi R. in Pool 16	11.7	0.108	<0.05	2.96	3.20
10-26	Mississippi R. in Pool 19	11.7	0.115	<0.05	2.64	1.98
10-29	Mississippi R. in Pool 24	14.9	0.129	<0.05	2.67	3.23
11-01	Mississippi R. in Pool 26	15.7	0.129	0.06	2.61	3.36
		Zinc (µg/L)				
10-09	Mississippi R. in Pool 2	3.92				
10-11	Mississippi R. in Pool 3	4.08				
10-14	Mississippi R. in Pool 4, Upper Lake Pepin	6.54				
10-12	Mississippi R. in Pool 4, Lower Lake Pepin	11.41				
10-17	Mississippi R. in Pool 8	1.04				
10-19	Mississippi R. in Pool 9	1.88				
10-20	Mississippi R. in Pool 11	2.67				
10-21	Mississippi R. in Pool 13	1.40				
10-24	Mississippi R. in Pool 16	1.94				
10-26	Mississippi R. in Pool 19	6.57				
10-29	Mississippi R. in Pool 24	2.24				
11-01	Mississippi R. in Pool 26	1.73				

Table 30.--Concentration data for dissolved nutrients and dissolved organic-carbon in surface-grab water samples collected from selected pools and tributaries of the Mississippi River during the October-November 1991 cruise

[Sampling site upstream from the Mississippi River confluence; see figs. 1 and 2 for locations of sampling sites; mg N/L, milligram nitrogen per liter; mg P/L, milligram phosphorus per liter; mg C/L, milligrams carbon per liter; --, not determined; <, less than the detection limit]

		Ammonium (mg N/L)		Nitrate (mg N/L)		Nitrite (mg N/L)	
		Ultra- filter		Ultra- filter		Ultra- filter	
Date		Surface	per-	Surface	per-	Surface	per-
1991	Site name	grab	meate	grab	meate	grab	meate
<u>Tributaries</u>							
10-10	St. Croix R. at Mile 0.5, Wis.	0.05	0.03	0.37	0.48	0.04	0.04
10-12	Chippewa R. at Mile 1.7, Wis.	<0.02	<0.02	0.55	0.71	0.01	0.01
10-19	Wisconsin R. at Mile 1.0, Wis.	<0.02	<0.02	0.21	0.26	0.01	0.01
10-24	Rock R. at Mile 1.0, Ill.	<0.02	<0.02	1.45	1.48	0.01	0.01
10-25	Iowa R. at Mile 1.0, Iowa	0.04	0.03	2.36	2.40	0.01	0.01
10-28	Des Moines R. at Mile 1.0, Iowa	0.02	<0.02	1.01	0.99	0.03	0.03
11-04	Kaskaskia R. at Mile 1.5, Ill.	0.14	0.15	0.81	0.94	0.05	0.05
11-08	White R. at Mile 1.2, Ark.	0.02	<0.02	0.30	0.51	0.01	0.01
11-08	Arkansas R. at Mile 0.0, Ark.	0.06	0.02	0.23	0.33	0.01	0.01
11-10	Yazoo R. at Mile 3.0, Miss.	0.06	<0.02	0.48	0.66	0.01	0.01
<u>Pools</u>							
10-09	Mississippi R. in Pool 2	<0.02	--	3.37	--	0.02	--
10-11	Mississippi R. in Pool 3	<0.02	--	2.07	--	0.03	--
10-14	Mississippi R. in Pool 4, Upper Lake Pepin	0.02	--	2.33	--	0.02	--
10-12	Mississippi R. in Pool 4, Lower Lake Pepin	0.02	--	2.58	--	0.03	--
10-17	Mississippi R. in Pool 8	<0.02	--	1.80	--	0.02	--
10-19	Mississippi R. in Pool 9	<0.02	--	1.64	--	0.02	--
10-20	Mississippi R. in Pool 11	<0.02	--	1.46	--	0.01	--
10-21	Mississippi R. in Pool 13	<0.02	--	1.51	--	0.01	--
10-24	Mississippi R. in Pool 16	0.04	--	1.42	--	0.01	--
10-26	Mississippi R. in Pool 19	0.06	--	1.57	--	0.01	--
10-29	Mississippi R. in Pool 24	0.07	--	1.57	--	0.02	--
11-01	Mississippi R. in Pool 26	0.08	--	1.66	--	0.02	--

Table 30.--Concentration data for dissolved nutrients and dissolved organic-carbon in surface-grab water samples collected from selected tributaries and pools of the Mississippi River during the October-November 1991 cruise--continued

Date 1991	Site name	Orthophosphate		Dissolved organic- carbon
		(mg P/L)		(mg C/L)
		Surface grab	Ultra- filter per- meate	Surface grab
<u>Tributaries</u>				
10-10	St. Croix R. at Mile 0.5, Wis.	0.03	0.02	15.8
10-12	Chippewa R. at Mile 1.7, Wis.	0.03	0.02	12.3
10-19	Wisconsin R. at Mile 1.0, Wis.	0.01	<0.01	8.2
10-24	Rock R. at Mile 1.0, Ill.	0.11	0.09	6.0
10-25	Iowa R. at Mile 1.0, Iowa	0.03	0.01	3.7
10-28	Des Moines R. at Mile 1.0, Iowa	0.01	<0.01	5.8
11-04	Kaskaskia R. at Mile 1.5, Ill.	0.33	0.31	--
11-08	White R. at Mile 1.2, Ark.	0.03	0.02	4.8
11-08	Arkansas R. at Mile 0.0, Ark.	0.03	0.02	5.2
11-10	Yazoo R. at Mile 3.0, Miss.	0.04	0.02	4.5
<u>Pools</u>				
10-09	Mississippi R. in Pool 2	0.11	--	11.4
10-11	Mississippi R. in Pool 3	0.08	--	12.6
10-14	Mississippi R. in Pool 4, Upper Lake Pepin	0.09	--	12.2
10-12	Mississippi R. in Pool 4, Lower Lake Pepin	0.12	--	12.6
10-17	Mississippi R. in Pool 8	0.09	--	10.8
10-19	Mississippi R. in Pool 9	0.08	--	9.3
10-20	Mississippi R. in Pool 11	0.06	--	8.5
10-21	Mississippi R. in Pool 13	0.07	--	8.3
10-24	Mississippi R. in Pool 16	0.07	--	8.3
10-26	Mississippi R. in Pool 19	0.08	--	7.9
10-29	Mississippi R. in Pool 24	0.10	--	7.8
11-01	Mississippi R. in Pool 26	0.10	--	7.3

Table 31.--Concentration data for dissolved bicarbonate, carbonate, chloride, and sulfate in surface-grab water samples collected from selected tributaries and pools of the Mississippi River during the October-November 1991 cruise

[Sampling site upstream from the Mississippi River confluence; see figs. 1 and 2 for locations of the sampling sites; mg/L, milligram per liter; --, not determined; <, less than the detection limit]

Date 1991	Site name	Bicarbonate (mg/L)	Carbonate (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
<u>Tributaries</u>					
10-10	St. Croix R. at Mile 0.5, Wis.	90	<0.5	3.3	4.5
10-12	Chippewa R. at Mile 1.7, Wis.	66	1.3	5.5	7.2
10-19	Wisconsin R. at Mile 1.0, Wis.	131	0.7	13	14
10-24	Rock R. at Mile 1.0, Ill.	275	4.2	40	48
10-25	Iowa R. at Mile 1.0, Iowa	184	1.8	41	50
10-28	Des Moines R. at Mile 1.0, Iowa	207	1.6	38	87
11-04	Kaskaskia R. at Mile 1.5, Ill.	88	<0.5	16	39
11-08	Arkansas R. at Mile 0.0, Ark.	63	0.9	76	27
11-08	White R. at Mile 1.2, Ark.	88	<0.5	4.1	7.2
11-10	Yazoo R. at Mile 3.0, Miss.	43	0.9	5.3	8.5
<u>Pools</u>					
10-09	Mississippi R. in Pool 2	264	4.0	28	78
10-11	Mississippi R. in Pool 3	213	2.1	20	53
10-14	Mississippi R. in Pool 4, Upper Lake Pepin	222	2.8	21	56
10-12	Mississippi R. in Pool 4, Lower Lake Pepin	219	2.2	19	56
10-17	Mississippi R. in Pool 8	188	1.9	14	40
10-19	Mississippi R. in Pool 9	192	1.0	14	38
10-20	Mississippi R. in Pool 11	194	1.9	13	32
10-21	Mississippi R. in Pool 13	190	1.9	15	36
10-24	Mississippi R. in Pool 16	206	2.1	20	38
10-26	Mississippi R. in Pool 19	228	<0.5	20	38
10-29	Mississippi R. in Pool 24	191	--	20	38
11-01	Mississippi R. in Pool 26	189	1.9	19	36

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Table 32.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the April-May 1992 cruise

[$\mu\text{g/L}$, microgram per liter; mg/L , milligram per liter; --, not determined; <, less than the detection limit; A, depth-integrated composite A sample; B, depth-integrated composite B sample; method for collection of composite A and composite B varied between collection sites and is specified in table 3]

Date 1992	Site name	Aluminum (µg/L)			Arsenic (µg/L)			Barium (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
04-06	Mississippi R. above St. Anthony Falls, Minn.	5.0	4.8	3.3	1.1	1.6	1.3	42.6	42.7	42.4
04-10	Mississippi R. at Hastings, Minn.	2.7	--	2.8	0.8	0.9	<0.6	54.8	52.5	53.9
04-12	Mississippi R. near Pepin, Wis.	3.6	2.9	2.2	1.1	0.7	1.0	43.2	44.5	44.7
04-14	Mississippi R. at Trempealeau, Wis.	6.0	7.2	5.1	1.1	0.9	1.3	33.3	34.4	34.6
04-17	Mississippi R. below Lock and Dam 9, Wis.	3.6	4.2	2.0	0.9	1.0	<0.6	34.4	33.7	33.5
04-19	Mississippi R. at Clinton, Iowa	2.4	3.5	2.6	<0.6	<0.6	1.3	32.5	34.5	32.6
04-23	Mississippi R. at Keokuk, Iowa	5.0	4.7	4.0	1.3	1.6	0.7	59.9	59.3	55.3
04-26	Mississippi R. near Winfield, Mo.	3.8	4.6	2.7	1.1	1.1	1.2	61.6	61.0	57.7
05-01	Mississippi R. at Thebes, Ill.	12.9	9.1	5.2	1.1	1.7	2.1	77.3	76.7	77.9
Lower Mississippi River										
05-06	Mississippi R. below Vicksburg, Miss.	4.5	4.7	4.9	1.5	1.6	1.3	54.6	53.5	52.9
05-08	Mississippi R. near St. Francisville, La.	12.3	8.9	4.2	1.3	1.3	1.6	55.4	52.9	52.3
05-10	Mississippi R. below Belle Chasse, La.	10.5	5.0	6.4	1.2	1.3	1.2	54.7	55.0	53.7
Tributaries										
04-08	Minnesota R. at Mile 3.5, Minn.	2.4	2.1	2.2	0.9	<0.6	0.9	69.7	67.6	70.4
04-27	Illinois R. at Hardin, Ill.	3.2	3.3	3.0	1.9	1.6	0.9	54.3	53.3	53.5
04-29	Missouri R. at St. Charles, Mo.	--	3.4	3.6	1.0	2.3	2.0	84.7	86.2	86.8
05-03	Ohio R. at Olmsted, Ill.	9.4	--	6.8	1.2	--	<0.6	38.7	--	37.1

Table 32.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the April-May 1992 cruise--continued

Date 1992	Site name	Beryllium (µg/L)			Boron (µg/L)			Cadmium (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
04-06	Mississippi R. above St. Anthony Falls, Minn.	<0.02	<0.02	0.03	25.4	25.1	27.1	<0.1	<0.1	0.3
04-10	Mississippi R. at Hastings, Minn.	<0.02	0.04	<0.02	50.4	47.1	46.1	<0.1	<0.1	<0.1
04-12	Mississippi R. near Pepin, Wis.	0.04	<0.02	<0.02	33.9	36.3	35.6	<0.1	<0.1	<0.1
04-14	Mississippi R. at Trempealeau, Wis.	0.03	0.02	0.03	28.6	28.8	27.6	<0.1	<0.1	<0.1
04-17	Mississippi R. below Lock and Dam 9, Wis.	0.03	0.03	0.06	22.6	23.6	23.2	<0.1	<0.1	<0.1
04-19	Mississippi R. at Clinton, Iowa	<0.02	0.02	<0.02	23.3	21.3	22.0	<0.1	<0.1	<0.1
04-23	Mississippi R. at Keokuk, Iowa	<0.02	<0.02	<0.02	30.1	28.7	31.6	<0.1	<0.1	<0.1
04-26	Mississippi R. near Winfield, Mo.	<0.02	0.06	<0.02	30.0	27.4	31.8	<0.1	0.2	<0.1
05-01	Mississippi R. at Thebes, Ill.	<0.02	<0.02	<0.02	43.7	48.0	45.4	<0.1	<0.1	<0.1
Lower Mississippi River										
05-06	Mississippi R. below Vicksburg, Miss.	<0.02	<0.02	<0.02	40.9	39.7	41.2	<0.1	<0.1	<0.1
05-08	Mississippi R. near St. Francisville, La.	0.03	0.08	<0.02	41.6	42.8	40.8	<0.1	<0.1	<0.1
05-10	Mississippi R. below Belle Chasse, La.	<0.02	<0.02	0.06	41.3	40.7	36.5	<0.1	<0.1	0.3
Tributaries										
04-08	Minnesota R. at Mile 3.5, Minn.	<0.02	0.04	<0.02	59.5	64.5	56.6	0.1	<0.1	<0.1
04-27	Illinois R. at Hardin, Ill.	<0.02	<0.02	<0.02	103.2	112.7	100.3	<0.1	<0.1	0.1
04-29	Missouri R. at St. Charles, Mo.	0.04	<0.02	<0.02	42.6	43.4	51.3	<0.1	<0.1	<0.1
05-03	Ohio R. at Olmsted, Ill.	0.04	—	<0.02	40.3	—	38.4	<0.1	—	<0.1

Table 32.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the April-May 1992 cruise--continued

Date 1992	Site name	Calcium (mg/L)			Chromium (µg/L)			Cobalt (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
04-06	Mississippi R. above St. Anthony Falls, Minn.	52.1	50.6	50.9	<0.2	<0.2	0.7	0.10	0.12	0.09
04-10	Mississippi R. at Hastings, Minn.	75.8	71.5	76.2	<0.2	1.2	<0.2	0.26	0.33	0.16
04-12	Mississippi R. near Pepin, Wis.	62.4	62.3	61.2	0.7	<0.2	0.3	0.04	0.09	0.11
04-14	Mississippi R. at Trempealeau, Wis.	50.5	50.6	51.6	0.3	0.8	0.3	<0.01	0.09	<0.01
04-17	Mississippi R. below Lock and Dam 9, Wis.	50.0	48.2	49.8	<0.2	<0.2	0.8	0.03	0.11	<0.01
04-19	Mississippi R. at Clinton, Iowa	45.4	45.1	44.6	0.2	<0.2	<0.2	0.09	0.15	0.15
04-23	Mississippi R. at Keokuk, Iowa	47.9	49.0	47.2	1.6	0.4	1.3	0.07	0.05	0.04
04-26	Mississippi R. near Winfield, Mo.	52.2	52.0	50.1	0.8	1.1	1.9	0.08	0.06	<0.01
05-01	Mississippi R. at Thebes, Ill.	50.6	49.9	50.1	1.3	1.5	1.5	<0.01	0.03	<0.01
Lower Mississippi River										
05-06	Mississippi R. below Vicksburg, Miss.	43.4	42.3	42.3	2.2	1.1	1.1	<0.01	<0.01	<0.01
05-08	Mississippi R. near St. Francisville, La.	41.7	41.1	42.5	1.1	1.2	<0.2	0.03	0.01	<0.01
05-10	Mississippi R. below Belle Chasse, La.	41.3	41.9	41.1	2.7	1.2	2.7	0.01	<0.01	<0.01
Tributaries										
04-08	Minnesota R. at Mile 3.5, Minn.	101.4	103.9	104.8	1.1	0.6	0.5	<0.01	<0.01	<0.01
04-27	Illinois R. at Hardin, Ill.	74.7	72.7	73.0	1.5	1.9	1.5	<0.01	0.12	0.03
04-29	Missouri R. at St. Charles, Mo.	43.9	45.1	42.4	0.7	0.2	2.3	<0.01	<0.01	<0.01
05-03	Ohio R. at Olmsted, Ill.	43.0	--	43.5	0.6	--	2.6	<0.01	--	<0.01

Table 32.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the April-May 1992 cruise--continued

Date 1992	Site name	Copper (µg/L)			Iron (mg/L)			Lead (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
04-06	Mississippi R. above St. Anthony Falls, Minn.	1.14	0.90	1.20	0.052	0.057	0.013	<0.06	<0.06	<0.06
04-10	Mississippi R. at Hastings, Minn.	1.72	1.53	1.75	0.017	0.035	0.009	<0.06	<0.06	<0.06
04-12	Mississippi R. near Pepin, Wis.	1.46	1.45	1.53	0.023	0.023	0.006	0.12	<0.06	<0.06
04-14	Mississippi R. at Trempealeau, Wis.	1.31	1.36	1.51	0.041	0.040	0.016	<0.06	<0.06	<0.06
04-17	Mississippi R. below Lock and Dam 9, Wis.	1.11	1.23	1.18	0.035	0.034	0.007	<0.06	<0.06	0.23
04-19	Mississippi R. at Clinton, Iowa	1.07	1.27	1.61	0.021	0.028	0.008	0.11	<0.06	<0.06
04-23	Mississippi R. at Keokuk, Iowa	1.91	1.88	2.33	0.011	<0.005	<0.005	<0.06	<0.06	<0.06
04-26	Mississippi R. near Winfield, Mo.	1.78	1.74	1.77	0.006	0.006	<0.005	<0.06	<0.06	<0.06
05-01	Mississippi R. at Thebes, Ill.	2.08	2.17	2.36	0.007	0.010	<0.005	<0.06	<0.06	<0.06
Lower Mississippi River										
05-06	Mississippi R. below Vicksburg, Miss.	2.28	2.03	2.86	<0.005	0.008	<0.005	<0.06	0.06	0.07
05-08	Mississippi R. near St. Francisville, La.	2.56	2.48	2.24	0.011	0.011	<0.005	<0.06	<0.06	<0.06
05-10	Mississippi R. below Belle Chasse, La.	2.78	2.31	3.06	0.012	<0.005	0.006	<0.06	<0.06	0.23
Tributaries										
04-08	Minnesota R. at Mile 3.5, Minn.	1.57	1.70	1.57	0.006	0.006	<0.005	<0.06	<0.06	<0.06
04-27	Illinois R. at Hardin, Ill.	2.86	2.64	2.65	<0.005	0.008	<0.005	0.24	0.09	<0.06
04-29	Missouri R. at St. Charles, Mo.	2.37	2.22	2.87	0.017	<0.005	<0.005	<0.06	0.08	0.09
05-03	Ohio R. at Olmsted, Ill.	1.92	--	1.99	<0.005	--	<0.005	<0.06	--	0.15

Table 32.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the April-May 1992 cruise--continued

		Lithium (µg/L)			Magnesium (mg/L)			Manganese (µg/L)		
		Ultra- filter per- meate			Ultra- filter per- meate			Ultra- filter per- meate		
Date 1992	Site name	A	B		A	B		A	B	
<u>Upper Mississippi River</u>										
04-06	Mississippi R. above St. Anthony Falls, Minn.	6.59	6.27	6.46	19.3	19.2	18.8	18.30	15.16	15.67
04-10	Mississippi R. at Hastings, Minn.	18.37	17.20	18.01	31.0	29.4	31.1	7.43	10.39	1.61
04-12	Mississippi R. near Pepin, Wis.	12.69	13.37	13.14	24.6	24.6	24.1	1.74	1.62	0.29
04-14	Mississippi R. at Trempealeau, Wis.	9.18	9.47	8.91	19.3	19.4	19.8	3.87	3.80	0.58
04-17	Mississippi R. below Lock and Dam 9, Wis.	7.18	7.78	7.81	19.6	18.9	19.2	1.91	1.98	0.41
04-19	Mississippi R. at Clinton, Iowa	6.68	6.27	6.22	17.9	18.2	17.7	1.38	1.43	0.42
04-23	Mississippi R. at Keokuk, Iowa	4.94	5.10	5.18	18.9	19.3	18.5	0.96	0.82	0.50
04-26	Mississippi R. near Winfield, Mo.	5.90	5.17	5.85	20.0	20.0	18.9	0.89	0.91	0.52
05-01	Mississippi R. at Thebes, Ill.	8.16	8.83	8.39	17.9	17.5	17.6	—	0.82	0.51
<u>Lower Mississippi River</u>										
05-06	Mississippi R. below Vicksburg, Miss.	5.45	5.66	5.74	13.9	13.6	13.7	0.49	0.45	0.36
05-08	Mississippi R. near St. Francisville, La.	5.60	5.47	5.68	13.3	13.2	13.6	1.22	0.80	0.56
05-10	Mississippi R. below Belle Chasse, La.	6.05	5.51	4.96	13.2	13.4	13.1	0.86	0.44	0.46
<u>Tributaries</u>										
04-08	Minnesota R. at Mile 3.5, Minn.	30.11	32.21	28.28	45.4	45.5	46.4	1.57	2.06	0.33
04-27	Illinois R. at Hardin, Ill.	5.75	5.99	5.70	33.9	33.0	33.1	1.27	1.13	0.31
04-29	Missouri R. at St. Charles, Mo.	9.74	11.89	12.26	12.5	12.9	12.2	1.24	0.51	0.74
05-03	Ohio R. at Olmsted, Ill.	3.60	—	3.53	12.8	—	12.7	0.97	—	0.33

Table 32.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the April-May 1992 cruise--continued

Date 1992	Site name	Mercury (µg/L)			Molybdenum (µg/L)			Nickel (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
04-06	Mississippi R. above St. Anthony Falls, Minn.	<0.004	<0.004	<0.004	1.6	1.6	1.7	1.29	1.44	0.79
04-10	Mississippi R. at Hastings, Minn.	<0.004	0.004	<0.004	3.3	3.0	3.0	<0.03	--	<0.03
04-12	Mississippi R. near Pepin, Wis.	0.005	<0.004	<0.004	2.2	2.2	2.2	<0.03	--	1.63
04-14	Mississippi R. at Trempealeau, Wis.	<0.004	0.006	--	1.6	1.6	1.5	<0.03	<0.03	<0.03
04-17	Mississippi R. below Lock and Dam 9, Wis.	<0.004	<0.004	<0.004	1.4	1.3	1.4	<0.03	0.96	<0.03
04-19	Mississippi R. at Clinton, Iowa	<0.004	<0.004	<0.004	1.0	1.3	1.2	<0.03	0.11	1.37
04-23	Mississippi R. at Keokuk, Iowa	<0.004	<0.004	0.004	1.5	1.6	1.5	0.22	1.03	2.22
04-26	Mississippi R. near Winfield, Mo.	<0.004	<0.004	<0.004	1.7	1.7	1.6	--	<0.03	0.05
05-01	Mississippi R. at Thebes, Ill.	<0.004	<0.004	<0.004	2.1	2.3	2.1	<0.03	0.31	0.13
Lower Mississippi River										
05-06	Mississippi R. below Vicksburg, Miss.	<0.004	<0.004	<0.004	2.4	2.2	2.1	<0.03	<0.03	<0.03
05-08	Mississippi R. near St. Francisville, La.	0.008	<0.004	<0.004	2.1	2.3	2.2	1.05	0.51	<0.03
05-10	Mississippi R. below Belle Chasse, La.	<0.004	0.012	<0.004	2.2	2.1	2.3	<0.03	<0.03	<0.03
Tributaries										
04-08	Minnesota R. at Mile 3.5, Minn.	0.009	<0.004	<0.004	3.8	3.8	3.6	--	<0.03	0.42
04-27	Illinois R. at Hardin, Ill.	<0.004	<0.004	<0.004	5.2	4.9	5.1	<0.03	1.73	<0.03
04-29	Missouri R. at St. Charles, Mo.	<0.004	<0.004	<0.004	2.1	2.1	2.2	<0.03	<0.03	0.47
05-03	Ohio R. at Olmsted, Ill.	<0.004	--	0.004	2.6	--	2.6	1.03	--	<0.03

Table 32.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the April-May 1992 cruise--continued

Date 1992	Site name	Potassium (mg/L)			Silica (mg/L)			Sodium (mg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
04-06	Mississippi R. above St. Anthony Falls, Minn.	2.7	2.9	3.0	7.4	6.9	7.2	7.5	7.0	7.4
04-10	Mississippi R. at Hastings, Minn.	3.1	3.3	3.0	9.5	8.8	9.6	15.4	14.7	15.8
04-12	Mississippi R. near Pepin, Wis.	3.0	2.6	3.0	11.2	11.2	11.0	10.8	10.8	10.4
04-14	Mississippi R. at Trempealeau, Wis.	2.2	2.3	2.2	10.5	10.4	10.8	9.0	8.9	9.2
04-17	Mississippi R. below Lock and Dam 9, Wis.	2.1	2.6	2.1	8.7	8.3	8.9	8.0	7.6	8.6
04-19	Mississippi R. at Clinton, Iowa	2.3	2.6	2.6	7.5	7.3	7.2	8.7	8.4	8.2
04-23	Mississippi R. at Keokuk, Iowa	2.7	2.8	2.6	7.1	7.4	7.3	9.0	9.6	9.9
04-26	Mississippi R. near Winfield, Mo.	3.1	3.1	3.1	7.9	7.9	8.0	9.4	9.5	9.8
05-01	Mississippi R. at Thebes, Ill.	3.4	3.3	3.4	8.7	8.7	8.7	15.6	16.1	16.4
Lower Mississippi River										
05-06	Mississippi R. below Vicksburg, Miss.	3.2	2.8	3.1	7.0	6.8	6.9	16.1	15.4	15.2
05-08	Mississippi R. near St. Francisville, La.	2.9	2.9	3.0	6.8	6.7	7.0	16.4	15.6	16.3
05-10	Mississippi R. below Belle Chasse, La.	3.1	3.2	2.8	6.9	7.1	6.9	19.1	19.7	19.5
Tributaries										
04-08	Minnesota R. at Mile 3.5, Minn.	3.6	3.4	3.5	14.0	14.5	14.5	17.2	18.9	18.8
04-27	Illinois R. at Hardin, Ill.	3.2	3.3	2.9	5.6	5.4	5.4	41.1	39.1	40.2
04-29	Missouri R. at St. Charles, Mo.	4.1	3.8	4.0	9.4	9.6	9.2	19.6	20.8	19.7
05-03	Ohio R. at Olmsted, Ill.	2.6	—	2.6	5.4	—	5.7	12.9	—	13.2

Table 32.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the April-May 1992 cruise--continued

Date 1992	Site name	Strontium (mg/L)			Thallium (µg/L)			Uranium (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
Upper Mississippi River										
04-06	Mississippi R. above St. Anthony Falls, Minn.	0.110	0.107	0.108	<0.05	<0.05	<0.05	2.64	2.96	2.39
04-10	Mississippi R. at Hastings, Minn.	0.218	0.204	0.218	<0.05	<0.05	<0.05	7.98	8.11	7.95
04-12	Mississippi R. near Pepin, Wis.	0.163	0.163	0.162	<0.05	<0.05	<0.05	7.05	7.15	6.48
04-14	Mississippi R. at Trempealeau, Wis.	0.124	0.126	0.129	<0.05	<0.05	<0.05	3.89	3.92	3.80
04-17	Mississippi R. below Lock and Dam 9, Wis.	0.116	0.113	0.119	<0.05	<0.05	0.16	4.08	3.99	3.36
04-19	Mississippi R. at Clinton, Iowa	0.100	0.098	0.099	<0.05	<0.05	<0.05	2.53	3.03	2.76
04-23	Mississippi R. at Keokuk, Iowa	0.108	0.110	0.105	<0.05	<0.05	<0.05	2.35	2.46	2.07
04-26	Mississippi R. near Winfield, Mo.	0.122	0.121	0.118	<0.05	<0.05	<0.05	3.34	3.43	2.68
05-01	Mississippi R. at Thebes, Ill.	0.175	0.176	0.178	<0.05	<0.05	<0.05	2.74	2.75	2.56
Lower Mississippi River										
05-06	Mississippi R. below Vicksburg, Miss.	0.177	0.175	0.173	0.09	0.08	0.09	1.56	1.39	1.44
05-08	Mississippi R. near St. Francisville, La.	0.172	0.170	0.172	<0.05	<0.05	0.06	1.37	1.24	1.32
05-10	Mississippi R. below Belle Chasse, La.	0.166	0.167	0.166	0.06	0.07	0.14	1.43	1.39	1.46
Tributaries										
04-08	Minnesota R. at Mile 3.5, Minn.	0.333	0.347	0.348	<0.05	<0.05	<0.05	17.52	14.44	16.50
04-27	Illinois R. at Hardin, Ill.	0.211	0.206	0.209	0.08	<0.05	0.09	1.82	1.65	1.87
04-29	Missouri R. at St. Charles, Mo.	0.239	0.242	0.230	0.06	0.06	0.07	2.50	2.43	2.37
05-03	Ohio R. at Olmsted, Ill.	0.205	—	0.204	<0.05	—	0.15	0.64	—	0.69

Table 32.--Concentration data for dissolved trace- and major-elements in laterally composited water samples collected from the Mississippi River and some of its tributaries during the April-May 1992 cruise--continued

Date 1992	Site name	Vanadium (µg/L)			Zinc (µg/L)		
		A	B	Ultra- filter per- meate	A	B	Ultra- filter per- meate
<u>Upper Mississippi River</u>							
04-06	Mississippi R. above St. Anthony Falls, Minn.	0.13	0.22	1.70	1.70	1.60	1.38
04-10	Mississippi R. at Hastings, Minn.	1.03	3.61	<0.07	2.19	2.47	2.37
04-12	Mississippi R. near Pepin, Wis.	--	<0.07	1.40	2.81	2.62	7.09
04-14	Mississippi R. at Trempealeau, Wis.	1.30	2.15	1.19	1.50	--	1.66
04-17	Mississippi R. below Lock and Dam 9, Wis.	<0.07	0.20	2.33	1.15	1.64	1.42
04-19	Mississippi R. at Clinton, Iowa	--	<0.07	0.56	1.04	2.36	1.89
04-23	Mississippi R. at Keokuk, Iowa	4.53	2.36	4.03	0.77	2.81	3.19
04-26	Mississippi R. near Winfield, Mo.	2.93	3.46	5.34	6.51	2.34	1.06
05-01	Mississippi R. at Thebes, Ill.	4.68	5.31	5.05	3.18	1.74	1.23
<u>Lower Mississippi River</u>							
05-06	Mississippi R. below Vicksburg, Miss.	6.07	3.60	3.67	0.96	--	1.07
05-08	Mississippi R. near St. Francisville, La.	3.28	3.59	1.47	1.06	0.69	0.85
05-10	Mississippi R. below Belle Chasse, La.	7.32	4.03	6.90	1.57	0.95	1.54
<u>Tributaries</u>							
04-08	Minnesota R. at Mile 3.5, Minn.	3.87	2.94	2.57	2.47	1.31	1.98
04-27	Illinois R. at Hardin, Ill.	4.61	5.50	4.45	7.78	6.15	4.29
04-29	Missouri R. at St. Charles, Mo.	3.52	2.85	7.17	1.32	1.51	0.88
05-03	Ohio R. at Olmsted, Ill.	1.90	--	5.95	1.10	--	1.87

Table 33.--Concentration data for dissolved nutrients and dissolved organic-carbon in laterally composited water samples collected from the Mississippi River and some of its tributaries during the April-May 1992 cruise

[mg N/L, milligram nitrogen per liter; mg P/L, milligram phosphorus per liter; mg C/L, milligram carbon per liter; --, not determined; <, less than the detection limit; Composite, only composite A was analyzed; method of collection of composite A is specified in table 3; analyses of total soluble phosphorus performed by Mark Nanny, University of Illinois]

Date 1992	Site name	Ammonium (mg N/L)		Nitrate (mg N/L)		Nitrite (mg N/L)	
		Composite	Ultra- filter	Composite	Ultra- filter	Composite	Ultra- filter
			per- meate		per- meate		per- meate
Upper Mississippi River							
04-06	Mississippi R. above St. Anthony Falls, Minn.	<0.005	<0.005	0.82	0.83	0.009	0.010
04-10	Mississippi R. at Hastings, Minn.	0.023	0.020	4.73	4.81	0.025	0.026
04-12	Mississippi R. near Pepin, Wis.	0.045	0.042	4.02	4.14	0.022	0.022
04-14	Mississippi R. at Trempealeau, Wis.	0.010	0.008	3.15	3.27	0.017	0.019
04-17	Mississippi R. below Lock and Dam 9, Wis.	<0.005	<0.005	1.91	1.71	0.012	0.011
04-19	Mississippi R. at Clinton, Iowa	<0.005	<0.005	1.17	1.16	0.009	0.011
04-23	Mississippi R. at Keokuk, Iowa	0.105	0.006	3.90	3.79	0.052	0.069
04-26	Mississippi R. near Winfield, Mo.	0.060	0.021	4.45	4.44	0.056	0.056
05-01	Mississippi R. at Thebes, Ill.	0.033	<0.005	3.70	3.62	0.073	0.080
Lower Mississippi River							
05-06	Mississippi R. below Vicksburg, Miss.	<0.005	<0.005	2.68	2.57	0.005	0.008
05-08	Mississippi R. near St. Francisville, La.	<0.005	<0.005	2.42	2.40	0.007	0.005
05-10	Mississippi R. below Belle Chasse, La.	<0.005	<0.005	2.20	2.16	0.006	0.006
Tributaries							
04-08	Minnesota R. at Mile 3.5, Minn.	0.027	0.013	9.70	8.90	0.027	0.028
04-27	Illinois R. at Hardin, Ill.	0.148	0.085	5.48	5.41	0.135	0.127
04-29	Missouri R. at St. Charles, Mo.	0.036	< 0.005	1.81	1.59	0.048	0.059
05-03	Ohio R. at Olmsted, Ill.	0.012	< 0.005	2.53	2.47	0.017	0.023

Table 33.--Concentration data for dissolved nutrients and dissolved organic-carbon in laterally composited water samples collected from the Mississippi River and some of its tributaries during the April-May 1992 cruise--continued

		Orthophosphate		Total soluble phosphorus		Dissolved organic-carbon	
		(mg P/L)		(mg P/L)		(mg C/L)	
Date			Ultra-filter		Ultra-filter		Ultra-filter
1992	Site name	Composite	per-meate	Composite	per-meate	Composite	per-meate
Upper Mississippi River							
04-06	Mississippi R. above St. Anthony Falls, Minn.	<0.002	<0.002	--	0.010	9.8	--
04-10	Mississippi R. at Hastings, Minn.	0.006	0.004	--	0.020	8.2	--
04-12	Mississippi R. near Pepin, Wis.	0.009	0.011	--	0.030	8.3	--
04-14	Mississippi R. at Trempealeau, Wis.	0.009	0.015	--	0.025	7.8	--
04-17	Mississippi R. below Lock and Dam 9, Wis.	0.005	<0.002	--	0.015	7.2	--
04-19	Mississippi R. at Clinton, Iowa	0.009	<0.002	--	--	6.9	--
04-23	Mississippi R. at Keokuk, Iowa	0.078	0.025	--	0.065	6.2	--
04-26	Mississippi R. near Winfield, Mo.	0.081	0.063	--	0.065	5.9	--
05-01	Mississippi R. at Thebes, Ill.	0.089	0.063	--	0.065	5.4	--
Lower Mississippi River							
05-06	Mississippi R. below Vicksburg, Miss.	0.067	0.059	--	--	3.8	--
05-08	Mississippi R. near St. Francisville, La.	0.066	0.064	--	0.065	3.8	--
05-10	Mississippi R. below Belle Chasse, La.	0.106	0.109	--	0.105	3.8	--
Tributaries							
04-08	Minnesota R. at Mile 3.5, Minn.	0.010	0.006	--	0.035	6.1	--
04-27	Illinois R. at Hardin, Ill.	0.170	0.152	--	0.135	3.3	--
04-29	Missouri R. at St. Charles, Mo.	0.065	0.024	--	0.035	5.4	--
05-03	Ohio R. at Olmsted, Ill.	0.037	0.032	--	0.030	3.0	--

Table 34.--Concentration data for dissolved bicarbonate, carbonate, chloride, and sulfate in laterally composited water samples collected from the Mississippi River and some of its tributaries during the April-May 1992 cruise

[mg/L, milligram per liter; --, not determined; A, depth-integrated composite A sample; B, depth-integrated composite B sample; method of collection of composites A and B varied between collection sites and is specified in table 3]

Date		Bicarbonate (mg/L)		Carbonate (mg/L)		Chloride (mg/L)		Sulfate (mg/L)	
1992	Site name	A	B	A	B	A	B	A	B
Upper Mississippi River									
04-06	Mississippi R. above St. Anthony Falls, Minn.	201	200	2.0	2.0	12	12	27	26
04-10	Mississippi R. at Hastings, Minn.	251	--	1.3	--	25	24	80	77
04-12	Mississippi R. near Pepin, Wis.	--	206	--	2.1	19	18	59	56
04-14	Mississippi R. at Trempealeau, Wis.	169	169	1.7	1.7	15	15	43	43
04-17	Mississippi R. below Lock and Dam 9, Wis.	170	--	1.7	--	14	14	39	39
04-19	Mississippi R. at Clinton, Iowa	157	157	1.6	1.6	14	14	33	32
04-23	Mississippi R. at Keokuk, Iowa	172	173	<0.5	<0.5	18	17	22	21
04-26	Mississippi R. near Winfield, Mo.	175	176	<0.5	<0.5	18	--	38	--
05-01	Mississippi R. at Thebes, Ill.	168	162	<0.5	3.3	20	20	50	48
Lower Mississippi River									
05-06	Mississippi R. below Vicksburg, Miss.	129	129	<0.5	<0.5	20	18	48	42
05-08	Mississippi R. near St. Francisville, La.	125	126	0.6	0.6	20	20	48	48
05-10	Mississippi R. below Belle Chasse, La.	--	137	--	2.8	25	25	50	48
Tributaries									
04-08	Minnesota R. at Mile 3.5, Minn.	311	309	1.6	3.1	32	32	148	148
04-27	Illinois R. at Hardin, Ill.	243	242	1.2	2.4	68	68	82	83
04-29	Missouri R. at St. Charles, Mo.	143	144	0.7	<0.5	12	12	56	56
05-03	Ohio R. at Olmsted, Ill.	108	--	<0.5	--	19	--	77	--

Table 35.--Concentration data for dissolved trace- and major-elements in surface-grab water samples collected from selected tributaries of the Mississippi River during the April-May 1992 cruise

[Sampling site upstream from the Mississippi River confluence; see fig. 1 for locations of the sampling sites; µg/L, microgram per liter; mg/L, milligram per liter; --, not determined; <, less than the detection limit]

Date 1992	Site name	Aluminum (µg/L)		Arsenic (µg/L)		Barium (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
04-11	St. Croix River at Mile 0.5, Wis.	22.7	10.7	1.1	<0.6	13.8	13.4
04-12	Chippewa River at Mile 1.7, Wis.	23.0	15.3	0.7	<0.6	10.1	9.6
04-17	Wisconsin River at Mile 1.0, Wis.	8.0	5.6	<0.6	<0.6	18.8	18.3
04-20	Rock River at Mile 1.0, Ill.	4.0	3.1	0.9	<0.6	56.7	54.9
04-21	Iowa River at Mile 1.0, Iowa	3.7	3.2	1.4	1.7	95.4	93.6
04-24	Des Moines River at Mile 1.0, Iowa	6.6	5.7	1.1	<0.6	79.9	79.0
04-30	Kaskaskia River at Mile 1.5, Ill.	4.5	4.3	2.4	2.1	58.7	55.7
05-05	White River at Mile 1.2, Ark.	4.7	4.7	<0.6	<0.6	31.3	30.2
05-05	Arkansas River at Mile 0.0, Ark.	8.9	2.9	1.2	1.6	63.2	73.7
05-07	Yazoo River at Mile 9.0, Miss.	9.4	3.6	0.8	1.0	40.8	39.6

Date 1992	Site name	Beryllium (µg/L)		Boron (µg/L)		Cadmium (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
04-11	St. Croix River at Mile 0.5, Wis.	<0.02	0.02	11.1	10.6	<0.1	<0.1
04-12	Chippewa River at Mile 1.7, Wis.	<0.02	<0.02	8.3	8.6	<0.1	<0.1
04-17	Wisconsin River at Mile 1.0, Wis.	<0.02	<0.02	12.4	14.3	<0.1	<0.1
04-20	Rock River at Mile 1.0, Ill.	<0.02	<0.02	28.4	30.6	0.2	0.2
04-21	Iowa River at Mile 1.0, Iowa	0.03	<0.02	24.4	24.0	<0.1	<0.1
04-24	Des Moines River at Mile 1.0, Iowa	0.03	<0.02	40.9	40.5	0.1	<0.1
04-30	Kaskaskia River at Mile 1.5, Ill.	<0.02	<0.02	109.9	113.0	<0.1	<0.1
05-05	White River at Mile 1.2, Ark.	<0.02	<0.02	13.4	11.9	<0.1	<0.1
05-05	Arkansas River at Mile 0.0, Ark.	<0.02	<0.02	44.9	46.3	<0.1	<0.1
05-07	Yazoo River at Mile 9.0, Miss.	0.07	0.03	21.7	21.5	<0.1	<0.1

Date 1992	Site name	Calcium (mg/L)		Chromium (µg/L)		Cobalt (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
04-11	St. Croix River at Mile 0.5, Wis.	17.1	16.9	<0.2	<0.2	0.04	0.08
04-12	Chippewa River at Mile 1.7, Wis.	11.8	12.4	<0.2	<0.2	0.06	0.04
04-17	Wisconsin River at Mile 1.0, Wis.	20.6	20.7	<0.2	<0.2	0.09	0.08
04-20	Rock River at Mile 1.0, Ill.	62.9	60.8	<0.2	1.7	0.13	0.15
04-21	Iowa River at Mile 1.0, Iowa	60.1	59.2	<0.2	0.5	0.03	0.01
04-24	Des Moines River at Mile 1.0, Iowa	70.9	72.6	1.1	1.4	0.06	<0.01
04-30	Kaskaskia River at Mile 1.5, Ill.	45.7	45.3	1.1	1.6	0.24	0.05
05-05	White River at Mile 1.2, Ark.	25.6	25.2	0.9	1.0	0.04	<0.01
05-05	Arkansas River at Mile 0.0, Ark.	33.9	34.9	0.8	<0.2	<0.01	0.06
05-07	Yazoo River at Mile 9.0, Miss.	12.4	11.8	<0.2	<0.2	0.10	0.09

Table 35.--Concentration data for dissolved trace- and major-elements in surface-grab water samples collected from selected tributaries of the Mississippi River during the April-May 1992 cruise--continued

Date 1992	Site name	Copper (µg/L)		Iron (mg/L)		Lead (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
04-11	St. Croix River at Mile 0.5, Wis.	0.97	0.95	0.322	0.048	<0.06	<0.06
04-12	Chippewa River at Mile 1.7, Wis.	0.92	0.93	0.178	0.060	<0.06	<0.06
04-17	Wisconsin River at Mile 1.0, Wis.	1.18	1.33	0.140	0.020	<0.06	<0.06
04-20	Rock River at Mile 1.0, Ill.	1.32	1.65	<0.005	<0.005	<0.06	<0.06
04-21	Iowa River at Mile 1.0, Iowa	1.66	1.56	0.007	0.005	<0.06	0.10
04-24	Des Moines River at Mile 1.0, Iowa	1.94	1.73	<0.005	<0.005	0.46	<0.06
04-30	Kaskaskia River at Mile 1.5, Ill.	2.15	2.51	<0.005	<0.005	<0.06	<0.06
05-05	White River at Mile 1.2, Ark.	0.88	1.05	<0.005	<0.005	<0.06	0.07
05-05	Arkansas River at Mile 0.0, Ark.	2.99	3.98	0.008	<0.005	0.07	0.07
05-07	Yazoo River at Mile 9.0, Miss.	2.30	2.51	0.016	<0.005	<0.06	<0.06

Date 1992	Site name	Lithium (µg/L)		Magnesium (mg/L)		Manganese (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
04-11	St. Croix River at Mile 0.5, Wis.	1.28	1.13	6.1	6.2	41.53	35.99
04-12	Chippewa River at Mile 1.7, Wis.	0.54	0.63	4.5	4.7	9.06	8.16
04-17	Wisconsin River at Mile 1.0, Wis.	0.68	0.87	9.4	9.5	4.66	1.61
04-20	Rock River at Mile 1.0, Ill.	1.89	2.19	35.9	34.4	0.77	0.54
04-21	Iowa River at Mile 1.0, Iowa	3.69	3.73	19.7	19.6	1.53	0.79
04-24	Des Moines River at Mile 1.0, Iowa	11.88	11.71	22.7	23.4	1.25	0.69
04-30	Kaskaskia River at Mile 1.5, Ill.	2.00	2.13	20.2	19.9	103.90	118.10
05-05	White River at Mile 1.2, Ark.	0.30	0.34	11.0	10.9	0.68	0.52
05-05	Arkansas River at Mile 0.0, Ark.	3.34	3.28	8.5	8.6	0.66	0.48
05-07	Yazoo River at Mile 9.0, Miss.	1.27	1.40	4.5	4.4	26.68	24.26

Date 1992	Site name	Mercury (µg/L)		Molybdenum (µg/L)		Nickel (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
04-11	St. Croix River at Mile 0.5, Wis.	<0.004	0.008	0.3	0.4	0.88	<0.03
04-12	Chippewa River at Mile 1.7, Wis.	<0.004	<0.004	0.2	0.2	<0.03	0.07
04-17	Wisconsin River at Mile 1.0, Wis.	<0.004	<0.004	0.6	0.4	0.09	0.97
04-20	Rock River at Mile 1.0, Ill.	<0.004	<0.004	1.6	1.6	1.35	2.39
04-21	Iowa River at Mile 1.0, Iowa	<0.004	<0.004	1.6	1.5	<0.03	<0.03
04-24	Des Moines River at Mile 1.0, Iowa	<0.004	<0.004	3.2	3.3	0.23	<0.03
04-30	Kaskaskia River at Mile 1.5, Ill.	<0.004	<0.004	6.4	6.6	1.25	0.55
05-05	White River at Mile 1.2, Ark.	<0.004	<0.004	0.6	0.5	<0.03	<0.03
05-05	Arkansas River at Mile 0.0, Ark.	0.004	<0.004	1.2	1.2	<0.03	<0.03
05-07	Yazoo River at Mile 9.0, Miss.	0.018	<0.004	0.8	0.8	1.90	2.15

Table 35.--Concentration data for dissolved trace- and major-elements in surface-grab water samples collected from selected tributaries of the Mississippi River during the April-May 1992 cruise--continued

Date 1992	Site name	Potassium (mg/L)		Silica (mg/L)		Sodium (mg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
04-11	St. Croix River at Mile 0.5, Wis.	1.2	1.4	11.7	11.3	2.7	2.6
04-12	Chippewa River at Mile 1.7, Wis.	1.5	1.2	8.9	9.6	3.2	3.4
04-17	Wisconsin River at Mile 1.0, Wis.	2.7	2.2	7.6	7.8	7.5	8.1
04-20	Rock River at Mile 1.0, Ill.	3.0	2.9	4.5	4.2	13.4	13.6
04-21	Iowa River at Mile 1.0, Iowa	3.1	3.0	9.0	9.1	10.4	10.2
04-24	Des Moines River at Mile 1.0, Iowa	2.9	2.9	12.4	12.5	10.8	10.6
04-30	Kaskaskia River at Mile 1.5, Ill.	4.3	4.1	4.7	5.0	24.5	24.1
05-05	White River at Mile 1.2, Ark.	1.4	1.7	7.2	7.2	2.0	1.9
05-05	Arkansas River at Mile 0.0, Ark.	3.0	3.1	0.1	0.1	55.7	57.9
05-07	Yazoo River at Mile 9.0, Miss.	2.4	2.3	9.0	8.9	8.8	8.6

Date 1992	Site name	Strontium (mg/L)		Thallium (µg/L)		Uranium (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
04-11	St. Croix River at Mile 0.5, Wis.	0.031	0.031	<0.05	<0.05	0.06	0.08
04-12	Chippewa River at Mile 1.7, Wis.	0.025	0.026	<0.05	<0.05	<0.06	<0.06
04-17	Wisconsin River at Mile 1.0, Wis.	0.036	0.037	<0.05	<0.05	0.11	0.13
04-20	Rock River at Mile 1.0, Ill.	0.105	0.103	<0.05	<0.05	1.62	1.45
04-21	Iowa River at Mile 1.0, Iowa	0.139	0.133	<0.05	<0.05	2.08	1.99
04-24	Des Moines River at Mile 1.0, Iowa	0.214	0.217	0.09	0.05	6.67	6.35
04-30	Kaskaskia River at Mile 1.5, Ill.	0.140	0.139	0.09	0.10	1.64	1.44
05-05	White River at Mile 1.2, Ark.	0.034	0.033	<0.05	0.08	0.30	0.32
05-05	Arkansas River at Mile 0.0, Ark.	0.245	0.256	0.06	<0.05	0.91	0.91
05-07	Yazoo River at Mile 9.0, Miss.	0.075	0.072	<0.05	<0.05	<0.06	<0.06

Date 1992	Site name	Vanadium (µg/L)		Zinc (µg/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
04-11	St. Croix River at Mile 0.5, Wis.	<0.07	<0.07	3.73	1.24
04-12	Chippewa River at Mile 1.7, Wis.	0.30	0.58	0.88	0.59
04-17	Wisconsin River at Mile 1.0, Wis.	0.09	0.15	2.33	2.00
04-20	Rock River at Mile 1.0, Ill.	<0.07	4.88	1.66	2.43
04-21	Iowa River at Mile 1.0, Iowa	1.69	2.82	0.55	1.36
04-24	Des Moines River at Mile 1.0, Iowa	3.50	4.27	1.71	1.40
04-30	Kaskaskia River at Mile 1.5, Ill.	4.05	5.23	1.53	0.80
05-05	White River at Mile 1.2, Ark.	2.50	2.87	0.90	0.50
05-05	Arkansas River at Mile 0.0, Ark.	2.54	0.80	0.68	1.21
05-07	Yazoo River at Mile 9.0, Miss.	<0.07	<0.07	1.05	0.18

Table 36.--Concentration data for dissolved trace- and major-elements in surface-grab water samples collected from selected pools of the Upper Mississippi River during the April-May 1992 cruise

[See fig. 2 for locations of the sampling sites; $\mu\text{g/L}$, microgram per liter; mg/L , milligram per liter; --, not determined; <, less than the detection limit]

Date 1992	Site name	Aluminum ($\mu\text{g/L}$)	Arsenic ($\mu\text{g/L}$)	Barium ($\mu\text{g/L}$)	Beryllium ($\mu\text{g/L}$)	Boron ($\mu\text{g/L}$)
04-09	Mississippi R. in Pool 2	2.9	<0.6	55.0	0.04	51.2
04-13	Mississippi R. in Pool 6	5.8	0.6	35.2	0.02	28.7
04-16	Mississippi R. in Pool 8	5.0	0.9	34.8	<0.02	23.3
04-18	Mississippi R. in Pool 12	4.6	1.4	32.6	0.05	22.5
04-20	Mississippi R. in Pool 15	52.9	<0.6	36.6	<0.02	20.8
04-22	Mississippi R. in Pool 18	8.7	1.8	42.2	<0.02	24.9
04-24	Mississippi R. in Pool 21	8.1	1.1	58.6	0.04	28.6
04-25	Mississippi R. in Pool 25	29.0	1.9	55.2	<0.02	30.5
		Cadmium ($\mu\text{g/L}$)	Calcium (mg/L)	Chromium ($\mu\text{g/L}$)	Cobalt ($\mu\text{g/L}$)	Copper ($\mu\text{g/L}$)
04-09	Mississippi R. in Pool 2	<0.1	75.5	1.5	0.13	1.58
04-13	Mississippi R. in Pool 6	<0.1	51.3	<0.2	<0.01	1.39
04-16	Mississippi R. in Pool 8	<0.1	50.0	<0.2	0.05	1.04
04-18	Mississippi R. in Pool 12	<0.1	43.2	<0.2	0.24	1.33
04-20	Mississippi R. in Pool 15	<0.1	44.6	<0.2	0.10	1.33
04-22	Mississippi R. in Pool 18	<0.1	47.8	<0.2	0.14	2.32
04-24	Mississippi R. in Pool 21	<0.1	48.2	0.8	0.13	1.87
04-25	Mississippi R. in Pool 25	<0.1	51.6	1.4	0.13	1.72
		Iron (mg/L)	Lead ($\mu\text{g/L}$)	Lithium ($\mu\text{g/L}$)	Magnesium (mg/L)	Manganese ($\mu\text{g/L}$)
04-09	Mississippi R. in Pool 2	0.018	0.06	17.81	30.8	18.89
04-13	Mississippi R. in Pool 6	0.043	<0.06	9.96	19.7	3.71
04-16	Mississippi R. in Pool 8	0.053	<0.06	7.74	19.5	5.70
04-18	Mississippi R. in Pool 12	0.024	0.08	5.89	18.0	22.28
04-20	Mississippi R. in Pool 15	0.011	<0.06	5.74	18.0	1.64
04-22	Mississippi R. in Pool 18	0.014	<0.06	4.96	21.2	5.50
04-24	Mississippi R. in Pool 21	0.011	<0.06	5.81	19.1	1.24
04-25	Mississippi R. in Pool 25	0.034	<0.06	5.58	19.9	3.53

Table 36.--Concentration data for dissolved trace- and major-elements in surface-grab water samples collected from selected pools of the Upper Mississippi River during the April-May 1992 cruise--continued

Date 1992	Site name	Mercury (µg/L)	Molybdenum (µg/L)	Nickel (µg/L)	Potassium (mg/L)	Silica (mg/L)
04-09	Mississippi R. in Pool 2	0.005	2.8	<0.03	3.1	9.7
04-13	Mississippi R. in Pool 6	<0.004	1.7	<0.03	2.3	10.7
04-16	Mississippi R. in Pool 8	<0.004	1.4	0.08	2.5	9.2
04-18	Mississippi R. in Pool 12	<0.004	1.1	2.06	2.7	6.8
04-20	Mississippi R. in Pool 15	<0.004	1.3	<0.03	2.7	6.6
04-22	Mississippi R. in Pool 18	<0.004	1.2	1.46	2.7	6.1
04-24	Mississippi R. in Pool 21	<0.004	1.6	1.22	2.7	7.3
04-25	Mississippi R. in Pool 25	<0.004	1.4	0.58	3.1	7.8
		Sodium (mg/L)	Strontium (mg/L)	Thallium (µg/L)	Uranium (µg/L)	Vanadium (µg/L)
04-09	Mississippi R. in Pool 2	15.0	0.216	<0.05	8.08	3.97
04-13	Mississippi R. in Pool 6	8.7	0.127	<0.05	4.18	0.16
04-16	Mississippi R. in Pool 8	8.7	0.120	<0.05	4.13	<0.07
04-18	Mississippi R. in Pool 12	8.0	0.091	<0.05	2.41	<0.07
04-20	Mississippi R. in Pool 15	8.2	0.096	<0.05	3.18	<0.07
04-22	Mississippi R. in Pool 18	9.0	0.098	<0.05	2.81	0.20
04-24	Mississippi R. in Pool 21	9.2	0.109	<0.05	2.40	2.93
04-25	Mississippi R. in Pool 25	10.2	0.117	<0.05	2.45	4.38
		Zinc (µg/L)				
04-09	Mississippi R. in Pool 2	2.42				
04-13	Mississippi R. in Pool 6	3.40				
04-16	Mississippi R. in Pool 8	1.13				
04-18	Mississippi R. in Pool 12	1.58				
04-20	Mississippi R. in Pool 15	1.90				
04-22	Mississippi R. in Pool 18	1.51				
04-24	Mississippi R. in Pool 21	1.23				
04-25	Mississippi R. in Pool 25	11.00				

Table 37.--Concentration data for dissolved nutrients and dissolved organic-carbon in surface-grab water samples collected from selected tributaries and pools of the Mississippi River during the April-May 1992 cruise

[Sampling site upstream from the Mississippi River confluence; see figs. 1 and 2 for locations of sampling sites; mg N/L, milligram nitrogen per liter; mg P/L, milligram phosphorus per liter; mg C/L, milligrams carbon per liter; --, not determined; <, less than the detection limit]

Date 1992	Site name	Ammonium (mg N/L)		Nitrate (mg N/L)		Nitrite (mg N/L)	
		Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate	Surface grab	Ultrafilter permeate
Tributaries							
04-11	St. Croix R. at Mile 0.5, Wis.	0.027	0.026	0.33	0.30	0.004	0.003
04-12	Chippewa R. at Mile 1.7, Wis.	< 0.005	< 0.005	0.40	0.40	0.007	0.007
04-17	Wisconsin R. at Mile 1.0, Wis.	< 0.005	< 0.005	0.75	0.76	0.007	0.007
04-20	Rock R. at Mile 1.0, Ill.	0.048	0.044	3.42	5.01	0.030	0.044
04-21	Iowa R. at Mile 1.0, Iowa	0.177	0.166	7.92	7.81	0.078	0.071
04-24	Des Moines R. at Mile 1.0, Iowa	0.036	< 0.005	6.67	6.60	0.024	0.027
04-30	Kaskaskia R. at Mile 1.5, Ill.	0.113	0.050	0.68	0.28	0.058	0.024
05-05	White R. at Mile 1.2, Ark.	0.010	< 0.005	0.15	0.15	0.005	0.004
05-05	Arkansas R. at Mile 0.0, Ark.	< 0.005	< 0.005	< 0.04	< 0.04	0.003	< 0.002
05-07	Yazoo R. at Mile 9.0, Miss.	< 0.005	< 0.005	0.63	0.59	0.004	0.004
Pools							
04-09	Mississippi R. in Pool 2	0.014	--	5.02	--	0.024	--
04-13	Mississippi R. in Pool 6	0.010	--	3.27	--	0.018	--
04-16	Mississippi R. in Pool 8	0.005	--	2.82	--	0.017	--
04-18	Mississippi R. in Pool 12	0.007	--	1.40	--	0.013	--
04-20	Mississippi R. in Pool 15	0.035	--	2.16	--	0.018	--
04-22	Mississippi R. in Pool 18	0.033	--	2.96	--	0.026	--
04-24	Mississippi R. in Pool 21	0.070	--	3.89	--	0.051	--
04-25	Mississippi R. in Pool 25	0.057	--	3.38	--	0.054	--

Table 37.--Concentration data for dissolved nutrients and dissolved organic-carbon in surface-grab water samples collected from selected tributaries and pools of the Mississippi River during the April-May 1992 cruise--continued

		Orthophosphate		Dissolved organic- carbon
		(mg P/L)		(mg C/L)
Date		Surface	Ultrafilter	Surface
1992	Site name	grab	permeate	grab
<u>Tributaries</u>				
04-11	St. Croix R. at Mile 0.5, Wis.	0.013	0.004	9.8
04-12	Chippewa R. at Mile 1.7, Wis.	0.015	0.006	8.4
04-17	Wisconsin R. at Mile 1.0, Wis.	0.011	< 0.002	7.2
04-20	Rock R. at Mile 1.0, Ill.	0.034	0.045	4.9
04-21	Iowa R. at Mile 1.0, Iowa	0.095	0.114	4.3
04-24	Des Moines R. at Mile 1.0, Iowa	0.088	0.074	4.5
04-30	Kaskaskia R. at Mile 1.5, Ill.	0.101	0.085	7.1
05-05	White R. at Mile 1.2, Ark.	0.013	0.011	3.1
05-05	Arkansas R. at Mile 0.0, Ark.	0.006	< 0.002	4.0
05-07	Yazoo R. at Mile 9.0, Miss.	0.034	0.028	3.8
<u>Pools</u>				
04-09	Mississippi R. in Pool 2	0.007	--	8.0
04-13	Mississippi R. in Pool 6	0.012	--	7.9
04-16	Mississippi R. in Pool 8	0.012	--	7.3
04-18	Mississippi R. in Pool 12	0.011	--	6.8
04-20	Mississippi R. in Pool 15	0.021	--	6.5
04-22	Mississippi R. in Pool 18	0.037	--	6.1
04-24	Mississippi R. in Pool 21	0.073	--	5.7
04-25	Mississippi R. in Pool 25	0.072	--	6.2

Table 38.--Concentration data for dissolved bicarbonate, carbonate, chloride, and sulfate in surface-grab water samples collected from selected tributaries and pools of the Mississippi River during the April-May 1992 cruise

[Sampling site upstream from the Mississippi River confluence; see figs. 1 and 2 for locations of the sampling sites; mg/L, milligram per liter; <, less than the detection limit]

Date 1992	Site name	Bicarbonate (mg/L)	Carbonate (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
<u>Tributaries</u>					
04-11	St. Croix R. at Mile 0.5, Wis.	71	<0.5	3.0	4.4
04-12	Chippewa R. at Mile 1.7, Wis.	45	0.9	4.3	5.4
04-17	Wisconsin R. at Mile 1.0, Wis.	85	0.2	12	14
04-20	Rock R. at Mile 1.0, Ill.	253	3.9	33	45
04-21	Iowa R. at Mile 1.0, Iowa	185	1.9	23	35
04-24	Des Moines R. at Mile 1.0, Iowa	207	1.0	19	66
04-30	Kaskaskia R. at Mile 1.5, Ill.	156	<0.5	28	83
05-05	Arkansas R. at Mile 0.0, Ark.	96	<0.5	82	41
05-05	White R. at Mile 1.2, Ark.	115	0.6	4.0	3.9
05-07	Yazoo R. at Mile 9.0, Miss.	58	<0.5	6.2	10.3
<u>Pools</u>					
04-09	Mississippi R. in Pool 2	252	2.5	24	77
04-13	Mississippi R. in Pool 6	174	1.7	15	43
04-16	Mississippi R. in Pool 8	167	1.7	14	40
04-18	Mississippi R. in Pool 12	157	2.4	14	36
04-20	Mississippi R. in Pool 15	157	1.6	15	34
04-22	Mississippi R. in Pool 18	176	2.7	19	36
04-24	Mississippi R. in Pool 21	175	0.9	18	37
04-25	Mississippi R. in Pool 25	173	1.7	18	37

TRANSPORT RESULTS FOR Laterally COMPOSITED SAMPLES

Transport is the mass per unit time of a dissolved chemical constituent transported by the river. Transport values in kilograms per day (kg/d) are calculated by multiplying the analyte concentration by the discharge measured during the sample collection, in m³/s, and a unit conversion factor (86.4 when the concentration is in mg/L and 0.0864 when the concentration is in µg/L). Water discharges were measured at 12 Mississippi River sampling sites and sites for the Minnesota, Illinois, Missouri, and Ohio Rivers during the three cruises by Moody and Meade (1994b) and are listed in table 39. The water discharges were measured during the collection of laterally composited samples only. Consequently, transport for all the other tributaries have not been tabulated here, but may be estimated by using the concentration data provided in the appropriate tables and the water discharges obtained from other sources (see table 39). Transport can not be calculated for the backwater region of the navigation pools of the Upper Mississippi River because there is insufficient water flow data.

Dissolved aluminum, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, lithium, magnesium, manganese, mercury, molybdenum, nickel, potassium, silica, sodium, strontium, thallium, uranium, vanadium, and zinc transported at the 12 sites of the Mississippi River and the Minnesota, Illinois, Missouri, and Ohio Rivers during the July-August 1991, October-November 1991, and April-May 1992 cruises are listed in tables 40, 42, and 44. Dissolved nutrients (as nitrogen associated with ammonium, nitrate, and nitrite and as phosphorus associated with orthophosphate), dissolved anions (bicarbonate, carbonate, chloride, sulfate), and dissolved organic-carbon transport at the 12 sites of the Mississippi River and the Minnesota, Illinois, Missouri, and Ohio Rivers during the July-August 1991, October-November 1991, and April-May 1992 cruises are provided in tables 41, 43, and 45. All transports were calculated using the average analyte concentrations from composite A and composite B for each site except for aluminum and manganese. Aluminum and manganese transports were calculated from the concentration measured for the ultrafilter permeate because the concentrations measured in the depth-integrated composite samples are generally much higher than the ultrafilter permeate. The differences for manganese are quite prominent throughout the entire reach of the Mississippi River; the differences for aluminum are less prominent except for selected sampling sites. Aluminum, iron, manganese, and several other elements are often associated with clay-sized particles that are not removed from the dissolved phase during routine filtration using a 0.4-µm pore diameter membrane filter (Kennedy and others, 1974). Aluminum and manganese transports are therefore based on the concentrations measured in the ultrafilter permeate to more accurately represent the mass transported in the dissolved aqueous phase.

Analyte transport was not calculated for sampling sites having analyte concentrations that were less than the detection limit. Sites meeting these criteria are identified with an asterisk (*). In all cases, transport values represent an estimate of the amount of dissolved analyte transported by the river at a given sampling site at the time of collection.

Table 39.--Water discharge at sampling sites of the Mississippi River and some of its tributaries during the July-August 1991, October-November 1991, and April-May 1992 cruises

[Water discharge, in cubic meter per second (m³/s), measured by Moody and Meade (1994b) unless otherwise noted; --, does not apply; ~, estimated discharge]

Mississippi River and tributary sites	River miles		Water discharge (m ³ /s)		
	Upstream from mouth of Ohio River	Upstream from Head of Passes, La.	July-August 1991 cruise	October-November 1992 cruise	April-May 1992 cruise
<u>Upper Mississippi River</u>					
Mississippi River above St. Anthony Falls, Minn.	858	1,812	470	220	310
Mississippi River at Hastings, Minn.	812	1,766	980	350	570
Mississippi River near Pepin, Wis.	764	1,718	1,350	510	950
Mississippi River at Trempealeau, Wis.	714	1,668	1,440	660	1,330
Mississippi River below Lock and Dam 9, Wis.	640	1,594	1,590	690	1,590
Mississippi River at Clinton, Iowa	520	1,474	1,850	940	2,320
Mississippi River at Keokuk, Iowa	363	1,317	2,050	1,410	4,220
Mississippi River near Winfield, Mo.	239	1,193	2,730	1,230	5,070
Mississippi River at Thebes, Ill.	44	998	4,390	3,870	10,500
<u>Lower Mississippi River</u>					
Mississippi River below Vicksburg, Miss.	--	433	8,750	10,700	21,700
Mississippi River near St. Francisville, La.	--	266	6,190	8,950	15,100
Mississippi River below Belle Chasse, La.	--	73	4,340	8,840	14,500
<u>Main tributaries</u>					
Minnesota River at Mile 3.5, Minn.	844	1,798	600	130	5260
Illinois River at Hardin, Ill.	218	1,172	260	520	860
Missouri River at St. Charles, Mo.	195	1,149	1,100	1,350	3,560
Ohio River at Olmsted, Ill.	0	954	2,410	2,480	6,150
<u>Other tributaries</u>					
St. Croix River at St. Croix Falls, Wis. ¹	811	1,765	260	95	5320
Chippewa River at Durand, Wis. ¹	763	1,717	160	161	5300
Wisconsin River at Muscoda, Wis. ¹	631	1,585	145	161	368
Rock River near Joslin, Ill. ¹	479	1,433	68	82	337
Iowa River at Wapello, Iowa ¹	434	1,388	200	74	685
Des Moines River at Keosauqua, Iowa ¹	361	1,315	623	39	719
Kaskaskia River near Venedy Station, Ill. ¹	117	1,071	7	10	31
White River at Clarendon, Ark. ²	--	599	374	1,220	920
Arkansas River at Dam 2, Ark. ³	--	582	480	1,620	710
Yazoo River below Steele Bayou, Miss. ⁴	--	437	640	540	~70

¹ Daily mean discharge based on U.S. Geological Survey measurement at gaging station closest to the mouth of the tributary.

² Discharge provided by U.S. Army Corps of Engineers, Memphis District for the White River at Clarendon, Ark., about 142 kilometers upstream from the mouth.

³ Discharge at 0800 hours over Dam 2 on the Arkansas River, approximately 56 kilometers upstream from the mouth.

⁴ Discharge is an estimate based on the measurement of discharge at Redwood, Miss., that is closest in time to the sampling date, plus the discharge at Steele Bayou.

⁵ Discharge was measured at the mouth by J.A. Moody.

**Tabulated Transports for Dissolved Trace-Elements, Major-Elements, Nutrients,
Organic Carbon, Bicarbonate, Carbonate, Chloride, and Sulfate**

The following tables list the analyte transport (mass transported per unit time in kg/d) of selected dissolved constituents by the Mississippi River and some of its tributaries during the July-August 1991, October-November 1991, and April-May 1992 cruises.

July-August 1991 Cruise

Table 40.--Dissolved trace- and major-element transport in the Mississippi River and some of its tributaries during the July-August 1991 cruise

[kg/d, kilogram per day; *, transport was not calculated because measured concentration was less than the analyte detection limit]

Date		Transport (kg/d)					
1991	Site name	Aluminum	Arsenic	Barium	Beryllium	Boron	Cadmium
<u>Upper Mississippi River</u>							
07-05	Mississippi R. above St. Anthony Falls, Minn.	154	111	1,900	2.5	1,380	*
07-08	Mississippi R. at Hastings, Minn.	212	294	5,900	2.7	5,480	*
07-10	Mississippi R. near Pepin, Wis.	257	330	7,020	*	6,420	*
07-12	Mississippi R. at Trempealeau, Wis.	423	250	6,660	6.0	6,090	*
07-15	Mississippi R. below Lock and Dam 9, Wis.	398	246	7,670	4.4	6,430	*
07-18	Mississippi R. at Clinton, Iowa	336	314	9,130	*	6,770	*
07-21	Mississippi R. at Keokuk, Iowa	531	385	11,200	7.7	7,200	*
07-24	Mississippi R. near Winfield, Mo.	1,890	425	16,000	*	10,100	*
07-29	Mississippi R. at Thebes, Ill.	2,240	1,110	33,000	*	26,200	*
<u>Lower Mississippi River</u>							
08-03	Mississippi R. below Vicksburg, Miss.	4,690	1,820	51,000	28.2	40,400	*
08-05	Mississippi R. near St. Francisville, La.	3,050	1,520	37,200	11.3	27,268	*
08-07	Mississippi R. below Belle Chasse, La.	2,620	878	26,800	*	21,900	*
<u>Tributaries</u>							
07-06	Minnesota R. at Mile 3.5, Minn.	233	232	4,340	*	4,090	*
07-25	Illinois R. at Hardin, Ill.	270	88.2	1,450	*	3,550	*
07-27	Missouri R. at St. Charles, Mo.	627	372	13,020	5.5	10,900	*
07-30	Ohio R. at Olmsted, Ill.	2,040	333	5,960	5.1	8,630	*

Table 40.--Dissolved trace- and major-element transport in the Mississippi River and some of its tributaries during the July-August 1991 cruise--continued

Date		Transport (kg/d)					
1991	Site name	Calcium	Chromium	Cobalt	Copper	Iron	Lead
<u>Upper Mississippi River</u>							
07-05	Mississippi R. above St. Anthony Falls, Minn.	2,021,000	47.0	2.4	92.2	502	*
07-08	Mississippi R. at Hastings, Minn.	7,350,000	*	*	155	*	8.8
07-10	Mississippi R. near Pepin, Wis.	8,000,000	*	1.8	205	764	*
07-12	Mississippi R. at Trempealeau, Wis.	7,220,000	199	11.0	199	877	*
07-15	Mississippi R. below Lock and Dam 9, Wis.	7,960,000	152	13.0	236	1,240	*
07-18	Mississippi R. at Clinton, Iowa	9,008,000	174	18.6	250	*	*
07-21	Mississippi R. at Keokuk, Iowa	9,900,000	*	26.7	292	*	*
07-24	Mississippi R. near Winfield, Mo.	13,700,000	294	15.0	433	*	*
07-29	Mississippi R. at Thebes, Ill.	22,000,000	505	23.3	694	1,900	*
<u>Lower Mississippi River</u>							
08-03	Mississippi R. below Vicksburg, Miss.	34,500,000	970	50.9	1,270	6,650	*
08-05	Mississippi R. near St. Francisville, La.	24,700,000	*	26.1	990	*	32.6
08-07	Mississippi R. below Belle Chasse, La.	16,500,000	*	30.7	676	*	*
<u>Tributaries</u>							
07-06	Minnesota R. at Mile 3.5, Minn.	5,180,000	*	*	103	*	5.6
07-25	Illinois R. at Hardin, Ill.	1,310,000	*	9.4	47.6	*	3.4
07-27	Missouri R. at St. Charles, Mo.	5,620,000	*	7.8	168	*	12.3
07-30	Ohio R. at Olmsted, Ill.	5,690,000	*	19.0	249	*	*

Table 40.--Dissolved trace- and major-element transport in the Mississippi River and some of its tributaries during the July-August 1991 cruise--continued

Date		Transport (kg/d)					
1991	Site name	Lithium	Magnesium	Manganese	Mercury	Molybdenum	Nickel
<u>Upper Mississippi River</u>							
07-05	Mississippi R. above St. Anthony Falls, Minn.	209	702,000	36.1	*	62.2	24.3
07-08	Mississippi R. at Hastings, Minn.	1,650	2,820,000	57.6	*	287	18.1
07-10	Mississippi R. near Pepin, Wis.	1,900	3,020,000	42.0	*	332	128
07-12	Mississippi R. at Trempealeau, Wis.	1,680	2,720,000	52.2	*	315	103
07-15	Mississippi R. below Lock and Dam 9, Wis.	1,670	3,004,000	76.9	*	311	161
07-18	Mississippi R. at Clinton, Iowa	1,650	3,480,000	68.7	*	355	156
07-21	Mississippi R. at Keokuk, Iowa	1,560	4,027,000	49.6	*	405	108
07-24	Mississippi R. near Winfield, Mo.	2,160	5,054,000	77.8	2.4	591	63.1
07-29	Mississippi R. at Thebes, Ill.	5,950	8,220,000	87.2	*	1,280	335
<u>Lower Mississippi River</u>							
08-03	Mississippi R. below Vicksburg, Miss.	6,260	11,800,000	416	6.8	2,130	938
08-05	Mississippi R. near St. Francisville, La.	4,170	8,054,000	176	4.8	1,420	241
08-07	Mississippi R. below Belle Chasse, La.	3,200	5,580,000	259	6.7	1,007	536
<u>Tributaries</u>							
07-06	Minnesota R. at Mile 3.5, Minn.	1,490	2,047,000	51.8	*	224	16.9
07-25	Illinois R. at Hardin, Ill.	141	643,000	4.94	*	193	61.5
07-27	Missouri R. at St. Charles, Mo.	3,470	2,000,000	18.1	*	438	96.6
07-30	Ohio R. at Olmsted, Ill.	427	1,430,000	41.6	*	563	147

Table 40.--Dissolved trace- and major-element transport in the Mississippi River and some of its tributaries during the July-August 1991 cruise--continued

Date		Transport (kg/d)					
1991	Site name	Potassium	Silica	Sodium	Strontium	Thallium	Uranium
<u>Upper Mississippi River</u>							
07-05	Mississippi R. above St. Anthony Falls, Minn.	97,200	526,000	271,000	4,480	*	57.9
07-08	Mississippi R. at Hastings, Minn.	315,000	1,840,000	1,280,000	22,700	7.5	594
07-10	Mississippi R. near Pepin, Wis.	362,000	2,130,000	1,330,000	23,500	6.4	616
07-12	Mississippi R. at Trempealeau, Wis.	368,000	1,910,000	1,210,000	20,700	*	582
07-15	Mississippi R. below Lock and Dam 9, Wis.	388,000	1,850,000	1,310,000	21,700	*	620
07-18	Mississippi R. at Clinton, Iowa	458,000	1,760,000	1,520,000	27,600	*	646
07-21	Mississippi R. at Keokuk, Iowa	530,000	1,306,000	1,880,000	32,500	*	754
07-24	Mississippi R. near Winfield, Mo.	734,000	1,860,000	2,309,000	38,300	*	899
07-29	Mississippi R. at Thebes, Ill.	1,480,000	2,340,000	8,860,000	83,300	*	1,530
<u>Lower Mississippi River</u>							
08-03	Mississippi R. below Vicksburg, Miss.	2,470,000	4,390,000	11,900,000	134,000	*	1,820
08-05	Mississippi R. near St. Francisville, La.	1,740,000	3,530,000	8,350,000	97,070	27.4	1,080
08-07	Mississippi R. below Belle Chasse, La.	1,305,000	2,860,000	10,200,000	68,300	*	788
<u>Tributaries</u>							
07-06	Minnesota R. at Mile 3.5, Minn.	247,000	1,350,000	841,000	17,800	4.0	559
07-25	Illinois R. at Hardin, Ill.	100,000	6,220	1,020,000	4,290	2.6	34.5
07-27	Missouri R. at St. Charles, Mo.	555,000	906,000	5,240,000	39,000	8.6	494
07-30	Ohio R. at Olmsted, Ill.	391,000	135,000	1,920,000	24,800	*	73.0

Table 40.--Dissolved trace- and major-element transport in the Mississippi River and some of its tributaries during the July-August 1991 cruise--continued

Date		Transport (kg/d)	
1991	Site name	Vanadium	Zinc
<u>Upper Mississippi River</u>			
07-05	Mississippi R. above St. Anthony Falls, Minn.	*	92.1
07-08	Mississippi R. at Hastings, Minn.	226	142
07-10	Mississippi R. near Pepin, Wis.	300	280
07-12	Mississippi R. at Trempealeau, Wis.	92.3	290
07-15	Mississippi R. below Lock and Dam 9, Wis.	778	173
07-18	Mississippi R. at Clinton, Iowa	205	282
07-21	Mississippi R. at Keokuk, Iowa	405	208
07-24	Mississippi R. near Winfield, Mo.	814	323
07-29	Mississippi R. at Thebes, Ill.	1,180	953
<u>Lower Mississippi River</u>			
08-03	Mississippi R. below Vicksburg, Miss.	591	1,020
08-05	Mississippi R. near St. Francisville, La.	*	622
08-07	Mississippi R. below Belle Chasse, La.	622	417
<u>Tributaries</u>			
07-06	Minnesota R. at Mile 3.5, Minn.	168	196
07-25	Illinois R. at Hardin, Ill.	87.7	52.5
07-27	Missouri R. at St. Charles, Mo.	349	196
07-30	Ohio R. at Olmsted, Ill.	139	142

Table 41.--Dissolved nutrients, major anions, and organic carbon transport in the Mississippi River and some of its tributaries during the July-August 1991 cruise

[kg/d, kilograms per day; nitrate, nitrite, and ammonium transports are in kg/d as nitrogen; orthophosphate transport is in kg/d as phosphorus; dissolved organic-carbon (DOC) transport is in kg/d as carbon; --, not determined; *, transport was not calculated because measured concentration was less than the analyte detection limit]

Date 1991	Site name	Transport (kg/d)					
		Ammonium	Nitrate	Nitrite	Ortho- phosphate	Bicarbonate	Carbonate
<u>Upper Mississippi River</u>							
07-05	Mississippi R. above St. Anthony Falls, Minn.	*	25,000	447	3,550	7,840,000	77,200
07-08	Mississippi R. at Hastings, Minn.	1,700	342,000	5,504	14,100	19,500,000	195,000
07-10	Mississippi R. near Pepin, Wis.	2,320	361,000	10,800	15,400	23,040,000	232,000
07-12	Mississippi R. at Trempealeau, Wis.	3,730	259,000	9,640	15,000	22,900,000	224,000
07-15	Mississippi R. below Lock and Dam 9, Wis.	4,808	271,000	*	12,020	26,000,000	124,000
07-18	Mississippi R. at Clinton, Iowa	*	251,000	7,270	14,000	29,900,000	144,000
07-21	Mississippi R. at Keokuk, Iowa	*	447,000	5,310	15,200	34,007,000	301,100
07-24	Mississippi R. near Winfield, Mo.	*	824,000	3,302	19,200	44,700,000	448,000
07-29	Mississippi R. at Thebes, Ill.	*	937,000	3,790	46,100	74,300,000	474,000
<u>Lower Mississippi River</u>							
08-03	Mississippi R. below Vicksburg, Miss.	*		*		120,200,000	907,200
08-05	Mississippi R. near St. Francisville, La.	*		*		85,600,000	856,000
08-07	Mississippi R. below Belle Chasse, La.	*		*		56,600,000	
<u>Tributaries</u>							
07-06	Minnesota R. at Mile 3.5, Minn.	3,110	346,000	3,370	9,360	13,060,000	130,000
07-25	Illinois R. at Hardin, Ill.	*	44,900	2,960	2,830	5,050,000	51,700
07-27	Missouri R. at St. Charles, Mo.	3,800	92,200	950	13,200	19,060,000	190,080
07-30	Ohio R. at Olmsted, Ill.	*	41,600	16,600	5,310	17,600,000	

Table 41.--Dissolved nutrients, major anions, and organic carbon transport in the Mississippi River and some of its tributaries during the July-August 1991 cruise--continued

Date		Transport (kg/d)		
1991	Site name	Chloride	Sulfate	DOC
<u>Upper Mississippi River</u>				
07-05	Mississippi R. above St. Anthony Falls, Minn.	426,000	832,000	455,000
07-08	Mississippi R. at Hastings, Minn.	1,520,000	8,300,000	770,000
07-10	Mississippi R. near Pepin, Wis.	1,680,000	8,620,000	105,000
07-12	Mississippi R. at Trempealeau, Wis.	1,740,000	8,150,000	1,070,000
07-15	Mississippi R. below Lock and Dam 9, Wis.	1,920,000	8,790,000	1,072,000
07-18	Mississippi R. at Clinton, Iowa	2,240,000	9,270,000	1,230,000
07-21	Mississippi R. at Keokuk, Iowa	3,010,000	9,740,000	1,190,000
07-24	Mississippi R. near Winfield, Mo.	4,010,000	11,600,000	1,460,000
07-29	Mississippi R. at Thebes, Ill.	7,780,000	29,020,000	2,050,000
<u>Lower Mississippi River</u>				
08-03	Mississippi R. below Vicksburg, Miss.	11,700,000	34,020,000	2,720,000
08-05	Mississippi R. near St. Francisville, La.	9,092,000	23,800,000	2,080,000
08-07	Mississippi R. below Belle Chasse, La.	13,500,000	19,500,000	--
<u>Tributaries</u>				
07-06	Minnesota R. at Mile 3.5, Minn.	1,011,000	7,930,000	342,000
07-25	Illinois R. at Hardin, Ill.	1,460,000	1,820,000	92,100
07-27	Missouri R. at St. Charles, Mo.	2,230,000	14,400,000	276,000
07-30	Ohio R. at Olmsted, Ill.	2,190,000	5,730,000	416,000

October-November 1991 Cruise

Table 42.--Dissolved trace- and major-element transport in the Mississippi River and some of its tributaries during the October-November 1991 cruise

[kg/d, kilogram per day; *, transport was not calculated because measured concentration was less than the analyte detection limit]

Date		Transport (kg/d)					
1991	Site name	Aluminum	Arsenic	Barium	Beryllium	Boron	Cadmium
<u>Upper Mississippi River</u>							
10-07	Mississippi R. above St. Anthony Falls, Minn.	79.8	50.6	1,000	*	784	*
10-10	Mississippi R. at Hastings, Minn.	145	84.9	1,880	2.1	2,320	*
10-13	Mississippi R. near Pepin, Wis.	185	125	2,250	*	2,360	*
10-15	Mississippi R. at Trempealeau, Wis.	245	129	2,360	1.2	2,530	*
10-18	Mississippi R. below Lock and Dam 9, Wis.	238	111	2,570	*	2,760	*
10-22	Mississippi R. at Clinton, Iowa	252	140	3,470	2.5	4,150	*
10-27	Mississippi R. at Keokuk, Iowa	402	256	5,980	*	4,920	*
10-30	Mississippi R. near Winfield, Mo.	319	227	5,410	*	4,630	*
11-05	Mississippi R. at Thebes, Ill.	1,204	752	25,700	*	29,800	*
<u>Lower Mississippi River</u>							
11-09	Mississippi R. below Vicksburg, Miss.	3,880	1,660	59,500	41.4	66,400	*
11-11	Mississippi R. near St. Francisville, La.	2,940	1,380	51,100	*	54,300	*
11-13	Mississippi R. below Belle Chasse, La.	2,600	1,440	51,500	21.0	55,000	*
<u>Tributaries</u>							
10-08	Minnesota R. at Mile 3.5, Minn.	73.0	34.3	906	0.7	1,190	*
10-31	Illinois R. at Hardin, Ill.	139	133	2,160	1.2	6,720	*
11-03	Missouri R. at St. Charles, Mo.	548	306	10,800	*	13,800	*
11-06	Ohio R. at Olmsted, Ill.	664	292	7,190	*	13,400	*

Table 42.--Dissolved trace- and major-element transport in the Mississippi River and some of its tributaries during the October-November 1991 cruise--continued

Date		Transport (kg/d)					
1991	Site name	Calcium	Chromium	Cobalt	Copper	Iron	Lead
<u>Upper Mississippi River</u>							
10-07	Mississippi R. above St. Anthony Falls, Minn.	1,070,000	15.7	2.2	17.3	943	1.9
10-10	Mississippi R. at Hastings, Minn.	2,290,000	9.4	4.6	51.0	2,190	*
10-13	Mississippi R. near Pepin, Wis.	2,720,000	34.7	5.7	81.1	346	5.0
10-15	Mississippi R. at Trempealeau, Wis.	2,970,000	12.1	2.1	90.9	1,080	4.6
10-18	Mississippi R. below Lock and Dam 9, Wis.	3,190,000	43.5	7.0	103	2,390	4.1
10-22	Mississippi R. at Clinton, Iowa	4,190,000	22.2	10.2	166	1,540	6.1
10-27	Mississippi R. at Keokuk, Iowa	6,160,000	*	9.9	190	*	12.8
10-30	Mississippi R. near Winfield, Mo.	5,350,000	106	15.1	232	10,140	24.9
11-05	Mississippi R. at Thebes, Ill.	17,600,000	188	32.7	642	*	45.5
<u>Lower Mississippi River</u>							
11-09	Mississippi R. below Vicksburg, Miss.	33,600,000	559	39.5	1,830	4,990	155
11-11	Mississippi R. near St. Francisville, La.	26,900,000	460	76.1	1,410	*	77.6
11-13	Mississippi R. below Belle Chasse, La.	28,600,000	476	67.8	1,670	*	105
<u>Tributaries</u>							
10-08	Minnesota R. at Mile 3.5, Minn.	1,190,000	2.6	1.2	19.0	111	0.9
10-31	Illinois R. at Hardin, Ill.	2,670,000	43.3	8.0	97.1	*	12.2
11-03	Missouri R. at St. Charles, Mo.	6,410,000	83.8	6.5	173	*	18.5
11-06	Ohio R. at Olmsted, Ill.	6,570,000	*	10.7	307	*	33.4

Table 42.--Dissolved trace- and major-element transport in the Mississippi River and some of its tributaries during the October-November 1991 cruise--continued

Date		Transport (kg/d)					
1991	Site name	Lithium	Magnesium	Manganese	Mercury	Molybdenum	Nickel
<u>Upper Mississippi River</u>							
10-07	Mississippi R. above St. Anthony Falls, Minn.	165	435,000	13.1	*	41.0	1.1
10-10	Mississippi R. at Hastings, Minn.	604	964,000	25.1	0.3	108	*
10-13	Mississippi R. near Pepin, Wis.	599	1,092,000	20.3	0.4	122	5.2
10-15	Mississippi R. at Trempealeau, Wis.	604	1,170,000	55.3	0.3	114	*
10-18	Mississippi R. below Lock and Dam 9, Wis.	645	1,260,000	25.0	*	122	*
10-22	Mississippi R. at Clinton, Iowa	815	1,670,000	22.7	*	142	6.2
10-27	Mississippi R. at Keokuk, Iowa	777	2,750,000	36.5	0.9	258	10.4
10-30	Mississippi R. near Winfield, Mo.	743	2,360,000	46.8	1.6	220	3.6
11-05	Mississippi R. at Thebes, Ill.	6,500	7,460,000	130	1.7	1,160	264
<u>Lower Mississippi River</u>							
11-09	Mississippi R. below Vicksburg, Miss.	9,130	11,800,000	638	4.3	2,450	182
11-11	Mississippi R. near St. Francisville, La.	7,170	9,500,000	418	10.8	2,100	439
11-13	Mississippi R. below Belle Chasse, La.	7,350	9,540,000	496	*	1,820	463
<u>Tributaries</u>							
10-08	Minnesota R. at Mile 3.5, Minn.	421	552,000	12.0	*	53.1	8.9
10-31	Illinois R. at Hardin, Ill.	288	1,180,000	11.7	0.3	322	88.3
11-03	Missouri R. at St. Charles, Mo.	4,740	2,520,000	125	*	397	*
11-06	Ohio R. at Olmsted, Ill.	810	2,170,000	150	3.2	848	96.2

Table 42.—Dissolved trace- and major-element transport in the Mississippi River and some of its tributaries during the October-November 1991 cruise--continued

Date		Transport (kg/d)					
1991	Site name	Potassium	Silica	Sodium	Strontium	Thallium	Uranium
<u>Upper Mississippi River</u>							
10-07	Mississippi R. above St. Anthony Falls, Minn.	69,100	221,000	162,000	2,560	*	59.7
10-10	Mississippi R. at Hastings, Minn.	142,000	436,000	595,000	6,630	*	216
10-13	Mississippi R. near Pepin, Wis.	170,000	780,000	542,000	7,380	*	240
10-15	Mississippi R. at Trempealeau, Wis.	181,000	866,000	598,000	7,660	*	230
10-18	Mississippi R. below Lock and Dam 9, Wis.	187,000	811,000	620,000	7,820	*	224
10-22	Mississippi R. at Clinton, Iowa	237,000	919,000	882,000	9,630	*	249
10-27	Mississippi R. at Keokuk, Iowa	392,000	1,140,000	1,570,000	14,500	*	349
10-30	Mississippi R. near Winfield, Mo.	350,000	1,009,000	1,440,000	13,060	*	282
11-05	Mississippi R. at Thebes, Ill.	1,480,000	2,850,000	11,900,000	86,900	*	986
<u>Lower Mississippi River</u>							
11-09	Mississippi R. below Vicksburg, Miss.	3,270,000	5,820,000	31,200,000	179,700	*	1,310
11-11	Mississippi R. near St. Francisville, La.	2,740,000	4,770,000	24,200,000	145,000	*	1,060
11-13	Mississippi R. below Belle Chasse, La.	2,660,000	4,830,000	35,400,000	157,000	*	1,040
<u>Tributaries</u>							
10-08	Minnesota R. at Mile 3.5, Minn.	61,000	234,000	290,300	4,210	*	165
10-31	Illinois R. at Hardin, Ill.	196,000	248,000	2,054,000	10,600	*	50.2
11-03	Missouri R. at St. Charles, Mo.	608,000	1,040,000	7,002,000	53,100	*	480
11-06	Ohio R. at Olmsted, Ill.	500,000	648,000	4,090,000	35,200	*	84.7

Table 42.--Dissolved trace- and major-element transport in the Mississippi River and some of its tributaries during the October-November 1991 cruise--continued

Date		Transport (kg/d)	
1991	Site name	Vanadium	Zinc
<u>Upper Mississippi River</u>			
10-07	Mississippi R. above St. Anthony Falls, Minn.	42.4	53.5
10-10	Mississippi R. at Hastings, Minn.	83.3	138
10-13	Mississippi R. near Pepin, Wis.	176	146
10-15	Mississippi R. at Trempealeau, Wis.	111	120
10-18	Mississippi R. below Lock and Dam 9, Wis.	229	89.0
10-22	Mississippi R. at Clinton, Iowa	240	162
10-27	Mississippi R. at Keokuk, Iowa	261	209
10-30	Mississippi R. near Winfield, Mo.	350	221
11-05	Mississippi R. at Thebes, Ill.	1,220	883
<u>Lower Mississippi River</u>			
11-09	Mississippi R. below Vicksburg, Miss.	2,160	2,480
11-11	Mississippi R. near St. Francisville, La.	1,860	1,720
11-13	Mississippi R. below Belle Chasse, La.	2,140	1,150
<u>Tributaries</u>			
10-08	Minnesota R. at Mile 3.5, Minn.	39.6	80.9
10-31	Illinois R. at Hardin, Ill.	159	188
11-03	Missouri R. at St. Charles, Mo.	476	317
11-06	Ohio R. at Olmsted, Ill.	141	394

Table 43.--Dissolved nutrients, major anions, and organic carbon transport in the Mississippi River and some of its tributaries during the October-November 1991 cruise

[kg/d, kilograms per day; nitrate, nitrite, and ammonium transports are in kg/d as nitrogen; orthophosphate transport is in kg/d as phosphorus; dissolved organic-carbon (DOC) transport is in kg/d as carbon; --, not determined; *, transport was not calculated because measured concentration was less than the analyte detection limit]

Date 1991	Site name	Transport (kg/d)					
		Ammonium	Nitrate	Nitrite	Ortho- phosphate	Bicarbonate	Carbonate
<u>Upper Mississippi River</u>							
10-07	Mississippi R. above St. Anthony Falls, Minn.	*	16,400	190	855	4,270,000	42,800
10-10	Mississippi R. at Hastings, Minn.	*	97,400	907	3,330	8,029,000	81,600
10-13	Mississippi R. near Pepin, Wis.	881	114,000	1,760	5,950	9,500,000	48,500
10-15	Mississippi R. at Trempealeau, Wis.	*	112,000	1,430	5,440	10,630,000	51,600
10-18	Mississippi R. below Lock and Dam 9, Wis.	*	98,040	1,200	4,800	11,700,000	120,000
10-22	Mississippi R. at Clinton, Iowa	1,620	122,000	1,620	6,085	15,400,000	154,000
10-27	Mississippi R. at Keokuk, Iowa	9,140	199,000	1,830	10,360	24,200,000	244,000
10-30	Mississippi R. near Winfield, Mo.	4,250	185,000	2,120	9,560	20,510,000	202,000
11-05	Mississippi R. at Thebes, Ill.	30,090	465,000	10,030	40,120	63,500,000	635,000
<u>Lower Mississippi River</u>							
11-09	Mississippi R. below Vicksburg, Miss.	*	679,000	27,700	55,400	109,900,000	1,108,000
11-11	Mississippi R. near St. Francisville, La.	15,500	564,000	15,500	46,400	96,700,000	464,000
11-13	Mississippi R. below Belle Chasse, La.	15,300	577,000	7,640	53,500	93,600,000	916,000
<u>Tributaries</u>							
10-08	Minnesota R. at Mile 3.5, Minn.	*	78,300	225	1,010	3,900,000	42,700
10-31	Illinois R. at Hardin, Ill.	4,490	102,700	3,590	8,087	8,980,000	44,900
11-03	Missouri R. at St. Charles, Mo.	5,830	50,160	1,170	10,500	21,500,000	210,000
11-06	Ohio R. at Olmsted, Ill.	12,800	94,300	2,140	7,500	18,800,000	*

Table 43.--Dissolved nutrients, major anions, and organic carbon transport in the Mississippi River and some of its tributaries during the October-November 1991 cruise--continued

Date		Transport (kg/d)		
1991	Site name	Chloride	Sulfate	DOC
<u>Upper Mississippi River</u>				
10-07	Mississippi R. above St. Anthony Falls, Minn.	285,000	646,000	217,000
10-10	Mississippi R. at Hastings, Minn.	847,000	2,270,000	298,000
10-13	Mississippi R. near Pepin, Wis.	793,000	2,380,000	540,000
10-15	Mississippi R. at Trempealeau, Wis.	859,000	2,320,000	661,000
10-18	Mississippi R. below Lock and Dam 9, Wis.	899,000	2,400,000	530,000
10-22	Mississippi R. at Clinton, Iowa	1,180,000	2,880,000	666,000
10-27	Mississippi R. at Keokuk, Iowa	2,440,000	4,630,000	865,000
10-30	Mississippi R. near Winfield, Mo.	2,120,000	4,038,000	728,000
11-05	Mississippi R. at Thebes, Ill.	9,360,000	31,100,000	1,670,000
<u>Lower Mississippi River</u>				
11-09	Mississippi R. below Vicksburg, Miss.	30,480,000	50,340,000	3,790,000
11-11	Mississippi R. near St. Francisville, La.	27,800,000	41,800,000	3,020,000
11-13	Mississippi R. below Belle Chasse, La.	40,860,000	39,700,000	2,790,000
<u>Tributaries</u>				
10-08	Minnesota R. at Mile 3.5, Minn.	404,400	1,750,000	85,900
10-31	Illinois R. at Hardin, Ill.	2,830,000	3,480,000	216,000
11-03	Missouri R. at St. Charles, Mo.	2,220,000	18,700,000	362,000
11-06	Ohio R. at Olmsted, Ill.	4,390,000	10,710,000	504,000

April-May 1992 Cruise

Table 44.--Dissolved trace- and major-element transport in the Mississippi River and some of its tributaries during the April-May 1992 cruise

[kg/d, kilogram per day; *, transport was not calculated because measured concentration was less than the analyte detection limit]

Date		Transport (kg/d)					
1992	Site name	Aluminum	Arsenic	Barium	Beryllium	Boron	Cadmium
<u>Upper Mississippi River</u>							
04-06	Mississippi R. above St. Anthony Falls, Minn.	88.4	37	1,140	*	676	*
04-10	Mississippi R. at Hastings, Minn.	138	44	2,640	2.0	2,403	*
04-12	Mississippi R. near Pepin, Wis.	180	71	3,600	3.6	2,880	*
04-14	Mississippi R. at Trempealeau, Wis.	586	113	3,890	2.8	3,300	*
04-17	Mississippi R. below Lock and Dam 9, Wis.	275	129	4,680	4.1	3,180	*
04-19	Mississippi R. at Clinton, Iowa	521	*	6,706	4.9	4,480	*
04-23	Mississippi R. at Keokuk, Iowa	1,460	517	21,700	*	10,700	*
04-26	Mississippi R. near Winfield, Mo.	1,180	465	26,800	26.7	12,600	71.1
05-01	Mississippi R. at Thebes, Ill.	4,720	1,230	69,700	*	41,500	*
<u>Lower Mississippi River</u>							
05-06	Mississippi R. below Vicksburg, Miss.	9,190	2,960	102,000	*	75,700	*
05-08	Mississippi R. near St. Francisville, La.	5,480	1,730	70,700	71.6	55,200	*
05-10	Mississippi R. below Belle Chasse, La.	8,018	1,590	68,900	*	51,500	*
<u>Tributaries</u>							
04-08	Minnesota R. at Mile 3.5, Minn.	49	21	1,540	0.8	1,390	2.8
04-27	Illinois R. at Hardin, Ill.	223	128	4,000	*	8,020	*
04-29	Missouri R. at St. Charles, Mo.	1,110	509	26,300	13.4	13,200	*
05-03	Ohio R. at Olmsted, Ill.	3,610	630	20,600	23.2	21,400	*

Table 44.--Dissolved trace- and major-element transport in the Mississippi River and some of its tributaries during the April-May 1992 cruise--continued

Date		Transport (kg/d)					
1992	Site name	Calcium	Chromium	Cobalt	Copper	Iron	Lead
<u>Upper Mississippi River</u>							
04-06	Mississippi R. above St. Anthony Falls, Minn.	1,380,000	*	3.0	27.3	1,460	*
04-10	Mississippi R. at Hastings, Minn.	3,630,000	56.9	14.4	80.0	1,270	*
04-12	Mississippi R. near Pepin, Wis.	5,120,000	56.9	5.1	119	1,890	9.5
04-14	Mississippi R. at Trempealeau, Wis.	5,800,000	59.8	10.6	154	4,620	*
04-17	Mississippi R. below Lock and Dam 9, Wis.	6,740,000	*	9.4	161	4,680	*
04-19	Mississippi R. at Clinton, Iowa	9,060,000	48.3	24.2	234	4,970	21.7
04-23	Mississippi R. at Keokuk, Iowa	17,600,000	373	21.1	690	4,120	*
04-26	Mississippi R. near Winfield, Mo.	22,800,000	412	30.6	769	2,610	*
05-01	Mississippi R. at Thebes, Ill.	45,500,000	1,230	24.7	1,920	7,470	*
<u>Lower Mississippi River</u>							
05-06	Mississippi R. below Vicksburg, Miss.	80,400,000	3,060	*	4,050	14,090	119
05-08	Mississippi R. near St. Francisville, La.	54,100,000	1,460	25.1	3,290	14,400	*
05-10	Mississippi R. below Belle Chasse, La.	52,300,000	2,430	16.0	3,200	14,700	*
<u>Tributaries</u>							
04-08	Minnesota R. at Mile 3.5, Minn.	2,306,000	19.2	*	36.7	132	*
04-27	Illinois R. at Hardin, Ill.	5,480,000	125	9.1	204	557	12.2
04-29	Missouri R. at St. Charles, Mo.	13,700,000	146	*	707	5,350	23.7
05-03	Ohio R. at Olmsted, Ill.	22,900,000	330	*	1,020	*	*

Table 44.--Dissolved trace- and major-element transport in the Mississippi River and some of its tributaries during the April-May 1992 cruise--continued

Date		Transport (kg/d)					
1992	Site name	Lithium	Magnesium	Manganese	Mercury	Molybdenum	Nickel
<u>Upper Mississippi River</u>							
04-06	Mississippi R. above St. Anthony Falls, Minn.	172	515,000	420	*	42.1	36.5
04-10	Mississippi R. at Hastings, Minn.	876	1,490,000	79.3	0.2	154	*
04-12	Mississippi R. near Pepin, Wis.	1,070	2,019,000	23.8	0.4	182	*
04-14	Mississippi R. at Trempealeau, Wis.	1,070	2,220,000	66.6	0.7	184	*
04-17	Mississippi R. below Lock and Dam 9, Wis.	1,030	2,640,000	56.3	*	190	132
04-19	Mississippi R. at Clinton, Iowa	1,300	3,620,000	84.2	*	233	22.1
04-23	Mississippi R. at Keokuk, Iowa	1,830	6,960,000	182	*	573	228
04-26	Mississippi R. near Winfield, Mo.	2,420	8,740,000	228	*	742	*
05-01	Mississippi R. at Thebes, Ill.	7,700	16,020,000	463	*	1,980	279
<u>Lower Mississippi River</u>							
05-06	Mississippi R. below Vicksburg, Miss.	10,400	25,800,000	675	*	4,290	*
05-08	Mississippi R. near St. Francisville, La.	7,230	17,300,000	730	10.5	2,870	1020
05-10	Mississippi R. below Belle Chasse, La.	7,260	16,700,000	576	15.7	2,680	*
<u>Tributaries</u>							
04-08	Minnesota R. at Mile 3.5, Minn.	700	1,020,000	7.4	0.2	85.7	*
04-27	Illinois R. at Hardin, Ill.	436	2,490,000	23.0	*	376	129
04-29	Missouri R. at St. Charles, Mo.	3,330	3,910,000	228	*	643	*
05-03	Ohio R. at Olmsted, Ill.	1,910	6,800,000	175	*	1,390	547

Table 44.--Dissolved trace- and major-element transport in the Mississippi River and some of its tributaries during the April-May 1992 cruise--continued

Date		Transport (kg/d)					
1992	Site name	Potassium	Silica	Sodium	Strontium	Thallium	Uranium
<u>Upper Mississippi River</u>							
04-06	Mississippi R. above St. Anthony Falls, Minn.	73,900	191,000	194,000	2,909	*	75.0
04-10	Mississippi R. at Hastings, Minn.	157,000	449,000	740,000	10,400	*	396
04-12	Mississippi R. near Pepin, Wis.	232,000	918,000	884,000	13,400	*	583
04-14	Mississippi R. at Trempealeau, Wis.	259,000	1,201,000	1,027,000	14,400	*	449
04-17	Mississippi R. below Lock and Dam 9, Wis.	325,000	1,170,000	1,068,000	15,700	*	554
04-19	Mississippi R. at Clinton, Iowa	489,000	1,490,000	1,710,000	19,800	*	557
04-23	Mississippi R. at Keokuk, Iowa	1,004,000	2,640,000	3,380,000	39,600	*	877
04-26	Mississippi R. near Winfield, Mo.	1,360,000	3,460,000	4,140,000	53,200	*	1,480
05-01	Mississippi R. at Thebes, Ill.	3,004,000	7,870,000	14,300,000	159,000	*	2,480
<u>Lower Mississippi River</u>							
05-06	Mississippi R. below Vicksburg, Miss.	5,630,000	13,010,000	29,600,000	331,000	165	2,780
05-08	Mississippi R. near St. Francisville, La.	3,760,000	8,810,000	20,900,000	224,000	*	1,710
05-10	Mississippi R. below Belle Chasse, La.	3,920,000	8,780,000	24,400,000	209,000	79.0	1,770
<u>Tributaries</u>							
04-08	Minnesota R. at Mile 3.5, Minn.	77,600	320,000	405,000	7,640	*	359
04-27	Illinois R. at Hardin, Ill.	241,000	406,000	2,980,000	15,500	5.6	129
04-29	Missouri R. at St. Charles, Mo.	1,210,000	2,920,000	6,210,000	74,050	18.3	757
05-03	Ohio R. at Olmsted, Ill.	1,380,000	2,860,000	6,860,000	109,000	*	339

Table 44.--Dissolved trace- and major-element transport in the Mississippi River and some of its tributaries during the April-May 1992 cruise--continued

Date		Transport (kg/d)	
1992	Site name	Vanadium	Zinc
<u>Upper Mississippi River</u>			
04-06	Mississippi R. above St. Anthony Falls, Minn.	4.7	44.1
04-10	Mississippi R. at Hastings, Minn.	114	115
04-12	Mississippi R. near Pepin, Wis.	*	222
04-14	Mississippi R. at Trempealeau, Wis.	198	173
04-17	Mississippi R. below Lock and Dam 9, Wis.	27.7	191
04-19	Mississippi R. at Clinton, Iowa	*	341
04-23	Mississippi R. at Keokuk, Iowa	1,260	653
04-26	Mississippi R. near Winfield, Mo.	1,400	1,940
05-01	Mississippi R. at Thebes, Ill.	4,520	2,230
<u>Lower Mississippi River</u>			
05-06	Mississippi R. below Vicksburg, Miss.	9,080	1,802
05-08	Mississippi R. near St. Francisville, La.	4,490	1,140
05-10	Mississippi R. below Belle Chasse, La.	7,130	1,580
<u>Tributaries</u>			
04-08	Minnesota R. at Mile 3.5, Minn.	76.5	42.4
04-27	Illinois R. at Hardin, Ill.	375	518
04-29	Missouri R. at St. Charles, Mo.	978	434
05-03	Ohio R. at Olmsted, Ill.	1,008	583

Table 45.--Dissolved nutrients, major anions, and organic carbon transport in the Mississippi River and some of its tributaries during the April-May 1992 cruise

[kg/d, kilograms per day; nitrate, nitrite, and ammonium transports are in kg/d as nitrogen; orthophosphate transport is in kg/d as phosphorus; dissolved organic-carbon (DOC) transport is in kg/d as carbon; --, not determined; *, transport was not calculated because measured concentration was less than the analyte detection limit]

Date 1992	Site name	Transport (kg/d)					
		Ammonium	Nitrate	Nitrite	Ortho- phosphate	Bicarbonate	Carbonate
<u>Upper Mississippi River</u>							
04-06	Mississippi R. above St. Anthony Falls, Minn.	*	22,000	241	*	5,370,000	53,600
04-10	Mississippi R. at Hastings, Minn.	1,130	233,000	1,230	295	12,400,000	64,020
04-12	Mississippi R. near Pepin, Wis.	3,690	330,000	1,806	739	16,900,000	172,000
04-14	Mississippi R. at Trempealeau, Wis.	1,150	362,000	1,950	1,034	19,400,000	195,000
04-17	Mississippi R. below Lock and Dam 9, Wis.	*	262,000	1,650	687	23,400,000	234,000
04-19	Mississippi R. at Clinton, Iowa	*	234,000	1,804	1,804	31,500,000	321,000
04-23	Mississippi R. at Keokuk, Iowa	38,300	1,420,000	19,000	28,400	62,900,000	*
04-26	Mississippi R. near Winfield, Mo.	26,300	1,950,000	24,500	35,500	76,900,000	*
05-01	Mississippi R. at Thebes, Ill.	29,900	3,350,000	66,100	80,590	149,000,000	2,990,000
<u>Lower Mississippi River</u>							
05-06	Mississippi R. below Vicksburg, Miss.	*	5,036,000	9,400	126,000	242,000,000	*
05-08	Mississippi R. near St. Francisville, La.	*	3,160,000	9,150	86,300	164,000,000	784,000
05-10	Mississippi R. below Belle Chasse, La.	*	2,760,000	7,540	133,000	172,000,000	3,520,000
<u>Tributaries</u>							
04-08	Minnesota R. at Mile 3.5, Minn.	606	218,000	606	225	6,960,000	52,800
04-27	Illinois R. at Hardin, Ill.	11,000	407,200	10,031	12,600	18,020,000	134,000
04-29	Missouri R. at St. Charles, Mo.	11,070	557,000	14,800	20,000	44,100,000	215,000
05-03	Ohio R. at Olmsted, Ill.	6,380	1,340,000	9,033	19,700	57,400,000	*

Table 45.--Dissolved nutrients, major anions, and organic carbon transport in the Mississippi River and some of its tributaries during the April-May 1992 cruise--continued

Date		Transport (kg/d)		
1991	Site name	Chloride	Sulfate	DOC
<u>Upper Mississippi River</u>				
04-06	Mississippi R. above St. Anthony Falls, Minn.	321,000	709,800	262,000
04-10	Mississippi R. at Hastings, Minn.	1,206,000	3,860,000	404,000
04-12	Mississippi R. near Pepin, Wis.	1,520,000	4,720,000	681,000
04-14	Mississippi R. at Trempealeau, Wis.	1,720,000	4,940,000	896,000
04-17	Mississippi R. below Lock and Dam 9, Wis.	1,920,000	5,360,000	989,000
04-19	Mississippi R. at Clinton, Iowa	2,806,000	6,510,000	1,380,000
04-23	Mississippi R. at Keokuk, Iowa	6,380,000	7,840,000	2,260,000
04-26	Mississippi R. near Winfield, Mo.	7,880,000	16,600,000	2,580,000
05-01	Mississippi R. at Thebes, Ill.	18,100,000	44,400,000	4,900,000
<u>Lower Mississippi River</u>				
05-06	Mississippi R. below Vicksburg, Miss.	35,700,000	84,600,000	7,120,000
05-08	Mississippi R. near St. Francisville, La.	26,100,000	62,700,000	4,960,000
05-10	Mississippi R. below Belle Chasse, La.	31,400,000	61,600,000	4,760,000
<u>Tributaries</u>				
04-08	Minnesota R. at Mile 3.5, Minn.	719,000	3,320,000	137,000
04-27	Illinois R. at Hardin, Ill.	5,053,000	6,130,000	245,000
04-29	Missouri R. at St. Charles, Mo.	3,690,000	17,200,000	1,660,000
05-03	Ohio R. at Olmsted, Ill.	10,096,000	40,910,000	1,590,000

SPECIFIC CONDUCTANCE FOR SELECTED TRIBUTARIES OF THE MISSISSIPPI RIVER

Specific conductance values for surface-grab water samples from the St. Croix, Chippewa, Wisconsin, Rock, Iowa, Des Moines, Kaskaskia, White, Arkansas, and Yazoo Rivers for all three cruises are listed in table 46.

Table 46.--Specific conductance for tributary surface-grab water samples collected from selected tributaries of the Mississippi River during the July-August 1991, October-November 1991, and April-May 1992 cruises

[Sampling site upstream from the Mississippi River confluence; see fig. 1 for locations of the sampling sites; $\mu\text{S}/\text{cm}$, microsiemens per centimeter; --, not measured]

Date	Site name	Specific conductance ($\mu\text{S}/\text{cm}$)
		Surface grab
07-08-91	St. Croix River at Mile 0.5, Wis.	--
07-10-91	Chippewa River at Mile 1.7, Wis.	145
07-15-91	Wisconsin River at Mile 1.0, Wis.	240
07-20-91	Rock River at Mile 1.0, Ill.	565
07-20-91	Iowa River at Mile 1.0, Iowa	565
07-22-91	Des Moines River at Mile 1.0, Iowa	553
07-28-91	Kaskaskia River at Mile 1.5, Ill.	218
08-01-91	White River at Mile 1.2, Ark.	285
08-01-91	Arkansas River at Mile 0.0, Ark.	652
08-02-91	Yazoo River at Mile 3.0, Miss.	120
10-10-91	St. Croix River at Mile 0.5, Wis.	174
10-12-91	Chippewa River at Mile 1.7, Wis.	151
10-19-91	Wisconsin River at Mile 1.0, Wis.	280
10-24-91	Rock River at Mile 1.0, Ill.	635
10-25-91	Iowa River at Mile 1.0, Iowa	525
10-28-91	Des Moines River at Mile 1.0, Iowa	583
11-04-91	Kaskaskia River at Mile 1.5, Ill.	--
11-08-91	White River at Mile 1.2, Ark.	175
11-08-91	Arkansas River at Mile 0.0, Ark.	420
11-10-91	Yazoo River at Mile 3.0, Miss.	117

Table 46.--Specific conductance for tributary surface-grab water samples collected from selected tributaries of the Mississippi River during the July-August 1991, October-November 1991, and April-May 1992 cruises--continued

Date	Site name	Specific conductance (μ S/cm)
		Surface grab
04-11-92	St. Croix River at Mile 0.5, Wis.	150
04-12-92	Chippewa River at Mile 1.7, Wis.	120
04-17-92	Wisconsin River at Mile 1.0, Wis.	222
04-20-92	Rock River at Mile 1.0, Ill.	635
04-21-92	Iowa River at Mile 1.0, Iowa	485
04-24-92	Des Moines River at Mile 1.0, Iowa	582
04-30-92	Kaskaskia River at Mile 1.5, Ill.	--
05-05-92	White River at Mile 1.2, Ark.	202
05-05-92	Arkansas River at Mile 0.0, Ark.	508
05-07-92	Yazoo River at Mile 9.0, Miss.	143

SUMMARY

The Mississippi River can be divided into two distinct reaches. The northern reach of the river, extending from Minneapolis, Minn., to just north of St. Louis, Mo., is composed of a series of 26 lock and dam structures that impede the river's flow through highly agricultural regions. In contrast, the reach extending from St. Louis, Mo., south to the Gulf of Mexico, is composed of a free-flowing river cutting through highly industrialized and populated regions. These different environments can influence the concentration of selected dissolved inorganic constituents and dissolved organic-carbon in the river system.

For most constituents, concentrations measured at each site were dependent on water discharge; higher water discharge produced lower concentrations. A notable exception is dissolved nutrients where concentrations at selected sites were greatest in samples collected during the April-May 1992 cruise. In addition, nitrate concentrations at sites on the uppermost reach of the river were twice those at sites on the lower reaches. Similarly, silica concentrations at sampling sites north of Keokuk, Iowa, were at least twice those measured for Vicksburg, Miss., south to Belle Chasse, La. However, in

contrast with the nutrients, silica concentrations were less during the April-May 1992 cruise than during the July-August and October-November 1991 cruises.

The concentrations of the major cations (calcium, magnesium, potassium, sodium) were relatively constant for a particular sampling site of the Mississippi River during all three cruises; the greatest concentrations were measured at sites located in the Upper Mississippi River (especially Hastings, Minn., and Pepin, Wis.). Major anion (bicarbonate, carbonate, chloride, and sulfate) concentrations were also relatively constant.

Trace-metal concentrations (for example cadmium, chromium, lead, mercury, and thallium) measured in the majority of samples collected during all three cruises were below method detection limits (see table 4). However, in several instances, trace-metal concentrations increased in the vicinity of large population centers. Dissolved aluminum and manganese concentrations were generally greater in the 0.40 μm pore-size filtrate than the 0.005 μm pore-size ultrafilter permeate. Dissolved organic-carbon concentrations in the Upper Mississippi River were 2-3 times greater than the Lower Mississippi River; there was very little seasonal variation.

The transport of a dissolved constituent is the product of the constituent's concentration and the water discharge at a given site. Water discharge increased steadily from Minneapolis, Minn., to Vicksburg, Miss., and was the predominate variable in the equation for calculating the transport of a particular constituent. Tributary inputs to elemental concentrations are apparent at collection sites just downstream of the confluence and where the tributary water discharge is significant. In terms of the fraction of discharge at the confluence with the Mississippi River, the Minnesota, Illinois, and Missouri Rivers contribute significantly to the total transport of selected dissolved inorganic constituents in the Upper Mississippi River, regardless of the season, as does the Ohio River in the Lower Mississippi River. Transport contributions from other tributaries such as the St. Croix, Chippewa, Wisconsin, Rock, Iowa, Des Moines, Kaskaskia, White, Arkansas, and Yazoo are usually significantly less because of the relative magnitude of their water discharge.

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