TRIHALOMETHANE AND NONPURGEABLE TOTAL ORGANIC HALIDE FORMATION POTENTIALS FOR THE MISSISSIPPI RIVER AND SOME OF ITS TRIBUTARIES, JUNE-AUGUST 1991

by R.E. Rathbun and L.M. Bishop

U.S. GEOLOGICAL SURVEY

Open-File Report 93-158

Denver, Colorado
1993

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

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CONVERSION FACTORS

Multiply	By	To obtain
nanometer (nm)	3.937×10^{-8}	inch
micrometer (µm)	3.937×10^{-5}	inch
millimeter (mm)	3.937×10^{-2}	inch
meter (m)	3.937×10^{1}	inch
kilometer (km)	0.6214	mile
microgram per liter (µg/L)	6.243×10^{-8}	pound per cubic foot
milligram per liter (mg/L)	6.243×10^{-5}	pound per cubic foot
milliliter (mL)	3.531×10^{-5}	cubic foot
liter (L)	3.531×10^{-2}	cubic foot
cubic meter per second (m^3/s)	3.531×10^{1}	cubic foot per second

Temperature in degree Celsius (°C) may be converted to degree Fahrenheit (°F) using:

°F = °C(1.8) + 32.0.

Trihalomethane and Nonpurgeable Total Organic Halide Formation Potentials for the Mississippi River and Some of its Tributaries, June-August 1991

By R.E. Rathbun and L.M. Bishop

ABSTRACT

Trihalomethane and nonpurgeable total organic halide formation potentials were determined for the Mississippi River and some of its tributaries from water samples collected between June 23, 1991, and August 6, 1991. Formation potentials were measured for 12 sites along the Mississippi River between Minneapolis, Minnesota, and New Orleans, Louisiana, and for the Missouri and Ohio Rivers at sites 1.6 kilometers upstream from their confluences with the Mississippi River. Formation potentials were determined as a function of initial pH and initial free-chlorine concentration for one reaction time of 168.0 hours at a temperature of 25 degrees Celsius. The formation potentials also were determined as a function of reaction time over a 168.0-hour period for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 milligrams per liter. Ancillary measurements included determinations of pH as a function of reaction time, pH values at the end of the formation-potential experiments, dissolved organic-carbon and bromide concentrations, ultraviolet absorbances, and specific conductances. An analysis was done of the errors involved in determining the trihalomethane and nonpurgeable total organic halide concentrations in duplicate samples and in replicate analyses of the same sample. Results of the formation-potential determinations, the ancillary measurements, and the error analysis are listed in tables.

INTRODUCTION

The Mississippi River begins in Lake Itasca in north-central Minnesota and drains into the Gulf of Mexico 3,720 kilometers downstream at a point in Louisiana called Head of Passes. The river flows through Minnesota and Louisiana and forms parts of the borders of Wisconsin, Iowa, Illinois, Missouri, Kentucky, Tennessee, Arkansas, and Mississippi. Numerous cities, towns, and villages in these States use the Mississippi River as a source of drinking water. Other population centers along the river could begin to use the Mississippi River in the future as a drinking-water source as ground-water sources presently being used are depleted and as the number of people requiring drinking water increases.

To make water from the Mississippi River safe for drinking, the water first must be disinfected, usually with free chlorine to eliminate the possibility of the transmission of waterborne diseases such as typhoid fever. However, research (Rook, 1974; Bellar and others, 1974; Fleischacker and Randtke, 1983; and Johnson and Jensen, 1986) has indicated that chlorination of natural waters results in the formation of various by-products, some of which may be health hazards. Therefore, the potential for the formation of these by-products must be considered when the Mississippi River is used as a source of drinking water.

These by-product compounds are divided into two classes. The first class consists of the trihalomethane (THM) compounds, which are chlorinated and brominated derivatives of methane. The four compounds commonly included in this class are chloroform, bromodichloromethane, chlorodibromomethane, and bromoform. These compounds are volatile and can be determined by gas chromatography techniques. The second class consists of chlorinated and brominated compounds with molecular weights higher than those of the THM compounds. Compounds in this second class are more polar and generally nonvolatile. They are more difficult to determine as individual compounds; consequently, they commonly are determined together as a bulk parameter called the total organic halide (TOX) concentration. Because this measurement also includes the THM compounds, the samples usually are purged with an inert gas before analysis to remove the volatile THM compounds. This procedure results in the nonpurgeable total organic halide (NPTOX) concentration.

The U.S. Geological Survey Mississippi River project is a multidisciplinary study of the water-quality characteristics of the river. Specific topics of study include the distribution of agricultural pesticides and herbicides, trace metals, and industrial organic chemicals among the water, sediment, and biotic phases of the river system, and how these substances are transported by the river. Also of interest are the water-quality characteristics of the Mississippi River as related to its use as a source of drinking water. Water characteristics affecting this use of the river include constituents already present in the water as well as constituents that are formed when the water is chlorinated to make it safe for drinking. The objective of this report is to describe the results of the determination of disinfection by-products that could be formed when water from the Mississippi River is chlorinated to produce drinking water.

Purpose and Scope

This report presents the results of the determination of the potentials for the formation of THM and NPTOX compounds when samples of water from the Mississippi, Missouri, and Ohio Rivers were chlorinated. Formation potentials were determined for water from 12 sites along the Mississippi River between Minneapolis, Minn., and New Orleans, La., and for water from the Missouri and Ohio Rivers at sites 1.6 km upstream from their confluences with the Mississippi River. Water samples were collected between June 23, 1991, and August 6, 1991. Formation potentials were determined as a function of initial pH and initial free-chlorine concentration for one reaction time of 168.0 hours at a temperature of 25°C. Also, the formation potentials were determined as a function of reaction time over a 168.0-hour period for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 mg/L.

Acknowledgments

Water samples upon which this work was based were collected as a part of the U.S. Geological Survey Mississippi River project under the direction of R.H. Meade. J.A. Moody provided logistical support. Wayne Simoneaux and Craig Leboeuf piloted the research vessel ACADIANA, and Jean Hough was the cook. L.B. Barber II, Dolly Dieter, D.A. Goolsby, T.I. Noyes, and Charles Tabor assisted with the sampling. J.A. Moody and L.M. Bishop collected the Minneapolis, Minn., sample and G.S. Ellis and T.I. Noyes collected the New Orleans, La., sample. Appreciation is expressed to all these individuals.

PROCEDURE FOR DETERMINATION OF TRIHALOMETHANE AND NONPURGEABLE TOTAL ORGANIC HALIDE FORMATION POTENTIALS

Sampling Procedure

The 17-m research vessel ACADIANA, owned and operated by the Louisiana Universities Marine Consortium, was used for collecting samples. Grab samples of water were collected by dropping a stainless steel bucket off the port side of the ACADIANA. The bucket was rinsed once with river water before collecting the sample. Single samples usually were collected from the midpoint of the navigation channel. One exception was the Ohio River where there was a question about whether the various tributaries flowing into the Ohio River would be mixed at the sampling location. Consequently, a composite sample of equal volumes was collected from points located at 0.1, 0.5, and 0.9 of the width measured from the left edge of the water.

On the Mississippi River, the sampling locations generally were slightly upriver of the different metropolitan areas. General locations in terms of the metropolitan area and specific locations in terms of cumulative river kilometers upstream from Head of Passes, La., for the sampling sites, dates and times of sample collection, and water discharges at the sampling times are listed in table 1. All samples except the New Orleans, La., sample were collected on the upriver trip of the ACADIANA. The vessel did not go past New Orleans on the upriver trip; therefore, the New Orleans sample was collected later on the downriver trip. Location of the sampling sites is shown in figure 1.

The water sample was transferred from the bucket to a stainless-steel reservoir for pressure filtration. The water was filtered through low-extractable 0.45-µm membrane filters that were prerinsed with about 2 L of high-purity water from a Barnstead NANOPURE water system. The first 600 mL of sample water through the filter was discarded. The water collected at each site was filtered into six 1-L amber glass bottles with Teflon-lined caps. The sample bottles were chilled with ice until shipment to the laboratory in Arvada, Colo. Shipment was by overnight air freight in insulated coolers containing refrigerant cold packs. Water samples in the laboratory were stored at 4°C until the formation-potential experiments were done.

Formation-Potential Experiments

The formation potentials for the THM and NPTOX compounds were determined as a function of initial pH and initial free-chlorine concentration at 25°C for a reaction time of 168.0 hours. Initial pH values of 5.50, 7.50, and 10.00 and initial free-chlorine concentrations of 15.0, 30.0, and 50.0 mg/L were used, giving nine THM and nine NPTOX formation potentials for each water sample. These large initial free-chlorine concentrations were used to satisfy any initial chlorine demand of the water sample and to ensure a residual free-chlorine concentration at the end of the 168.0-hour reaction time. The 168.0-hour reaction time was used to cover the maximum possible time water might be in a distribution system before use. Formation potentials also were determined as a function of time during the 168.0-hour period for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 mg/L.

The formation-potential experiments were done in 40-mL amber glass vials with Teflon-faced septum caps. Initiation of an experiment consisted of adjusting the pH of the water sample to the desired initial pH using 0.1 normal and 1.0 normal sulfuric acid and sodium hydroxide. The

Table 1.--General location and cumulative river kilometers upstream from Head of Passes, La., for the sampling sites, dates and times of sampling, and water discharges

[m^3/s, cubic meters per second]

General location	Cumulative river kilometers	Date	Time (hours)	Water discharge[1] (m^3/s)
Minneapolis, Minn.	2,916.2	07-05-91	0917	410
LaCrosse, Wis.	2,666.9	07-02-91	0054	1,600
Dubuque, Iowa	2,470.7	07-01-91	0914	2,300
Davenport, Iowa	2,325.2	06-30-91	2219	2,600
Quincy, Ill.	2,067.6	06-29-91	2120	3,900
Missouri River	[2]1.6	06-28-91	2031	1,800
St. Louis, Mo.	1,825.1	06-28-91	1826	7,300
Cairo, Ill.	1,552.3	06-27-91	2034	7,800
Ohio River	[2]1.6	06-27-91	1903	4,000
Memphis, Tenn.	1,194.1	06-26-91	1525	13,400
Greenville, Miss.	877.1	06-25-91	1310	15,600
Natchez, Miss.	597.4	06-24-91	1605	17,600
Baton Rouge, La.	386.7	06-23-91	2343	16,000
New Orleans, La.	169.1	08-06-91	1630	4,340

[1] Discharge data from Moody and Meade (written commun., 1992).

[2] Sampling site 1.6 kilometers upstream from the confluence with the Mississippi River.

Figure 1. Location of sampling sites in the Mississippi River basin.

desired initial free-chlorine concentration was obtained by adding the appropriate volume of a reagent-grade sodium hypochlorite solution. The free-chlorine concentration of this solution was determined prior to the start of each experiment by using an amperometric titration procedure. Blank samples of each water sample were taken before the addition of the sodium hypochlorite solution.

Sample vials were filled completely so that no head space existed. Vials were placed in an incubator at 25°C. All 168.0-hour experiments were done with duplicate vials. At the end of 168.0 hours, the experiments were terminated by quenching the remaining free chlorine with a sodium thiosulfate solution for the THM experiments and sodium sulfite crystals for the NPTOX experiments. For the reaction-time experiments, samples were quenched at approximate times of 0, 2, 6, 12, 24, 48, 72, 120, and 168.0 hours.

Before quenching the NPTOX samples, 5.0 mL of sample was removed from each of the vials and used to estimate the residual free-chlorine concentrations. The concentration of residual free-chlorine was estimated using a Hach chlorine test kit, which has a range from 0 to 3.5 mg/L with 0.1-mg/L divisions. After acidification to a pH of about 2 with nitric acid, the NPTOX samples were purged for 10 minutes with ultrahigh-purity nitrogen gas to remove the THM compounds. Samples were stored in an incubator at 4°C until analysis.

Analysis of Trihalomethane Samples

Concentrations of the THM compounds in the samples were determined with a solvent-extraction procedure (Federal Register, 1979) with pentane as the solvent. The procedure was modified slightly in that the sample extractions were done directly in the sample vials to avoid having to transfer a sample containing volatile constituents. The procedure consisted of removing and discarding 4.5 mL of sample, adding 4.0 mL of pentane, and shaking for 1.5 minutes. The Burdick and Jackson brand of pentane especially formulated for THM analyses was used. The vials containing the water and pentane layers were stored upside down at 4°C until analysis. Storing the samples upside down precluded any loss of the pentane or the THM compounds from the sample vial during storage.

The pentane extracts were analyzed with a Hewlett-Packard 5880 A gas chromatograph with an electron-capture detector. A 12-m Hewlett-Packard, cross-linked methyl silicone-gum capillary column was used with the purged splitless technique. Retention times on this column were 0.92, 1.42, 2.49, and 4.77 minutes for chloroform, bromodichloromethane, chlorodibromomethane, and bromoform, respectively.

Volumes of the 40-mL sample vials were not precisely 40.0 mL and also were not constant. To adjust for variations in the vial volumes, the vials were weighed after each step of the extraction process, beginning with the empty vial and ending with the final sample/pentane step. These weights permitted determination of the exact water/pentane volume ratio for each sample. Then, the peak areas for each sample were adjusted from the volume ratio of that sample to the average volume ratio for the standard samples for that particular run. This procedure resulted in all samples and standards being adjusted to a single water/pentane ratio.

Standard samples of known concentrations of each of the four THM compounds were prepared according to established procedures (Federal Register, 1979). The procedure consists of adding each of the four THM compounds to methanol in a 10-mL volumetric flask. The amount added was determined approximately by volume and precisely by weighing on a five-place analytical balance. Two additional primary standards were prepared by serial dilution of this standard using gas-tight syringes. Secondary standards covering the expected range of sample concentrations were prepared by injecting microliter quantities of the primary standards into river water in 40-mL septum vials. River water was used to prepare the standards to eliminate any possible effect of the water chemistry on the efficiency of the extraction procedure. These secondary standards were treated exactly as the samples from the experiments except that sodium hypochlorite was not added to the standards. A new set of standards was prepared for each river-water sample.

A relatively large number of standards was necessary because the response of the electron-capture detector was somewhat nonlinear. Also, the standards had to cover a wide range of concentrations so that the peak areas of each of the four THM compounds in every sample were bracketed by the peak areas of the standards. The number of standards ranged from 16 for the Minneapolis sample to 12 for the New Orleans sample. These standards were analyzed twice each day, resulting in 46 to 52 percent of the samples analyzed each day being standards.

Analysis of Nonpurgeable Total Organic Halide Samples

Concentrations of the NPTOX compounds in the samples were determined using a Dohrmann DX-20 A TOX analyzer together with an AD-3 adsorption module. This procedure involved adsorption of the organic compounds from the water sample onto granular-activated carbon packed in glass columns. Two of these columns were used in series for each sample. Following adsorption of the sample, the contents of the columns were washed with 2 mL of potassium nitrate solution to remove inorganic halides. The granular-activated carbon then was removed from the columns and burned in a furnace at 800°C where the chlorinated and brominated compounds were converted to an equivalent amount of halide ions. These ions were titrated in a microcoulometric cell, resulting in the determination of the mass of NPTOX compounds in the original sample.

The high concentrations of NPTOX compounds resulting from the formation-potential experiments required dilution of the samples to get the concentration within the response range of the instrument. Samples were diluted with high-purity water from a Barnstead NANOPURE system, and a blank determination for this dilution water was done each day samples were run. Usually, 30 mL of mixture was prepared, with the amount of sample ranging from 5 to 25 mL, depending on the expected concentration. All aliquots were measured with Class A pipets, and 25 mL of this 30-mL sample was forced through the glass columns containing the granular activated carbon using ultrahigh-purity nitrogen gas.

Operation of the microcoulometric cell was verified at the beginning of each day by injections of a sodium chloride standard directly into the electrolyte of the cell. These verifications also were done any time during the day when it became necessary to change the cell electrolyte. Recovery of the instrument was checked at the beginning of each day by injections of a trichlorophenol standard onto granular activated-carbon ash in the instrument boat and subsequent analysis of the trichlorophenol standard. These recovery checks also were repeated any time during the day when it became necessary to change the cell electrolyte and on any other occasion when operation of the instrument might be questionable. If results of these checks deviated by more than ±10 percent from the expected values, steps were taken to improve the performance of the instrument by changing the cell electrolyte and the inlet and exit tube liners, and by cleaning the hatch area.

Determination of pH

Initial pH values of the water samples were 5.50, 7.50, and 10.00. Because these water samples were not buffered, the pH of the 5.50 and 7.50 water samples increased, and the pH of the 10.00 water samples decreased slightly when the basic sodium hypochlorite solution was added to provide the free-chlorine concentration. To determine the variation of the pH with time, the pH values of each of the nine combinations of initial pH and initial free-chlorine concentration were determined at reaction times of approximately 0, 24, 48, 72, 120, 144, and 168 hours.

Measurements were made using an Orion Model 811 pH meter with a 91-02 research-grade pH probe. These samples were prepared at the same time the vials for the formation-potential experiments were filled. Amber glass bottles having Teflon-lined caps, a volume of 70 mL, and a mouth wide enough to accommodate the pH and temperature probes of the instrument were used for this purpose. The pH meter was calibrated each day before the measurements were done. A two-point calibration using buffers of 6.86 and 10.00 was done so as to bracket all the experimental pH values.

The pH values of the THM formation-potential experiments also were determined after completion of the gas chromatographic analyses. The pentane was evaporated, and the pH of the remaining water was determined for each of the nine samples.

Determination of Dissolved Organic-Carbon and Bromide Concentrations

Dissolved organic-carbon (DOC) and bromide concentrations of the water samples were determined at the U.S. Geological Survey National Water Quality Laboratory in Arvada, Colo. DOC concentration was determined using the wet-oxidation method (Wershaw and others, 1987). Duplicate samples were analyzed for all samples except the Memphis sample. One of the six Memphis sample bottles froze during storage, resulting in insufficient water for the second analysis. Bromide concentrations were determined using segmented-flow automated colorimetry (Fishman and Friedman, 1989).

Determination of Specific Conductances

Specific conductances of the sample waters were measured using a Yellow Springs Instrument Company model 32 conductance meter. Temperature of the water samples was adjusted to 25.0°C so that no temperature correction was necessary.

Determination of Ultraviolet Absorbances

The ultraviolet (UV) absorbance of natural waters has been used as a predictor of the DOC concentration. Various UV wavelengths have been used (Buffle and others, 1978; Oliver and Thurman, 1981; Edzwald and others, 1985; Ceraso, 1987; Chadick and Amy, 1987; Moore, 1987). Therefore, UV absorbances of the water samples were determined at wavelengths of 254, 280, 330, and 400 nanometers. A Spectronics model 2000 spectrophotometer with a 50-mm cell was used for these determinations. Absorbances were measured for both the pH-adjusted water samples and the natural water samples.

RESULTS OF SAMPLE COLLECTION AND FORMATION-POTENTIAL EXPERIMENTS

Trihalomethane and Nonpurgeable Total Organic Halide Formation Potentials

The potentials for formation of THM and NPTOX compounds when the water samples were treated with free chlorine are expressed as the concentrations of these compounds formed in the experiments. Two types of results were obtained. The first type consisted of concentrations of the THM and NPTOX compounds formed during a reaction time of 168.0 hours for nine combinations of initial pH and initial free-chlorine concentration. The second type consisted of concentrations of the THM and NPTOX compounds formed as a function of time during the reaction time of 168.0 hours for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 mg/L. Typical results of the first type are shown in figure 2, which contains THM and NPTOX concentrations as a function of cumulative river kilometers upstream from Head of Passes, La., for an initial pH of 10.00 and an initial free-chlorine concentration of 30.0 mg/L. The DOC concentrations also are shown in figure 2. Typical results of the second type are shown in figure 3, which contains THM and NPTOX concentrations as a function of reaction time for several sampling sites along the Mississippi River.

All concentrations were corrected for blank contributions. Blank corrections for the THM compounds were significant only for chloroform. This correction ranged from 0.13 to 0.79 μg/L and averaged 0.45 μg/L for 52 determinations. Average blank corrections for the other three THM compounds were less than 0.01 μg/L. Blank corrections for the NPTOX concentrations ranged from 9.03 to 20.8 μg/L and averaged 14.0 μg/L for 44 determinations for samples from the Mississippi River. Corrections for the Missouri River water sample ranged from 4.98 to 8.84 μg/L and averaged 6.84 μg/L. Corrections for the Ohio River water sample ranged from 4.96 to 8.01 μg/L and averaged 7.62 μg/L.

The three chlorinated THM compounds (chloroform, bromodichloromethane, and chlorodibromomethane) were detected in all samples. Bromoform was not detected in 42 percent of the samples. The detection limit for bromoform for the analytical procedure used in this study was estimated to be about 0.01 μg/L.

For the first type of results, duplicate experiments were done for all nine combinations of initial pH and initial free-chlorine concentration for each water sample. All except two of these duplicate samples were analyzed for the THM formation potentials. The exceptions were the 7.50 initial pH, 30.0-mg/L initial free-chlorine concentration experiment for the Memphis water sample and the 7.50 initial pH, 15.0-mg/L initial free-chlorine concentration experiment for the Natchez water sample. One of the two THM vials for each of these experiments was broken, resulting in a lost sample. Some of the vials for the Minneapolis, LaCrosse, Dubuque, and Davenport water samples had no detectable free-chlorine concentrations at the end of the reaction time. The limit of detection of the procedure used for these free-chlorine measurements was 0.1 mg/L. Concentrations for these samples are flagged with an asterisk on tables 2-5 to indicate that these concentrations could have been affected by the lack of a free-chlorine residual at the end of the experiments.

Formation-potential determinations were done for two additional initial pH values (3.49 and 11.57) and two additional initial free-chlorine concentrations (7.50 and 90.0 mg/L) for the Dubuque water sample.

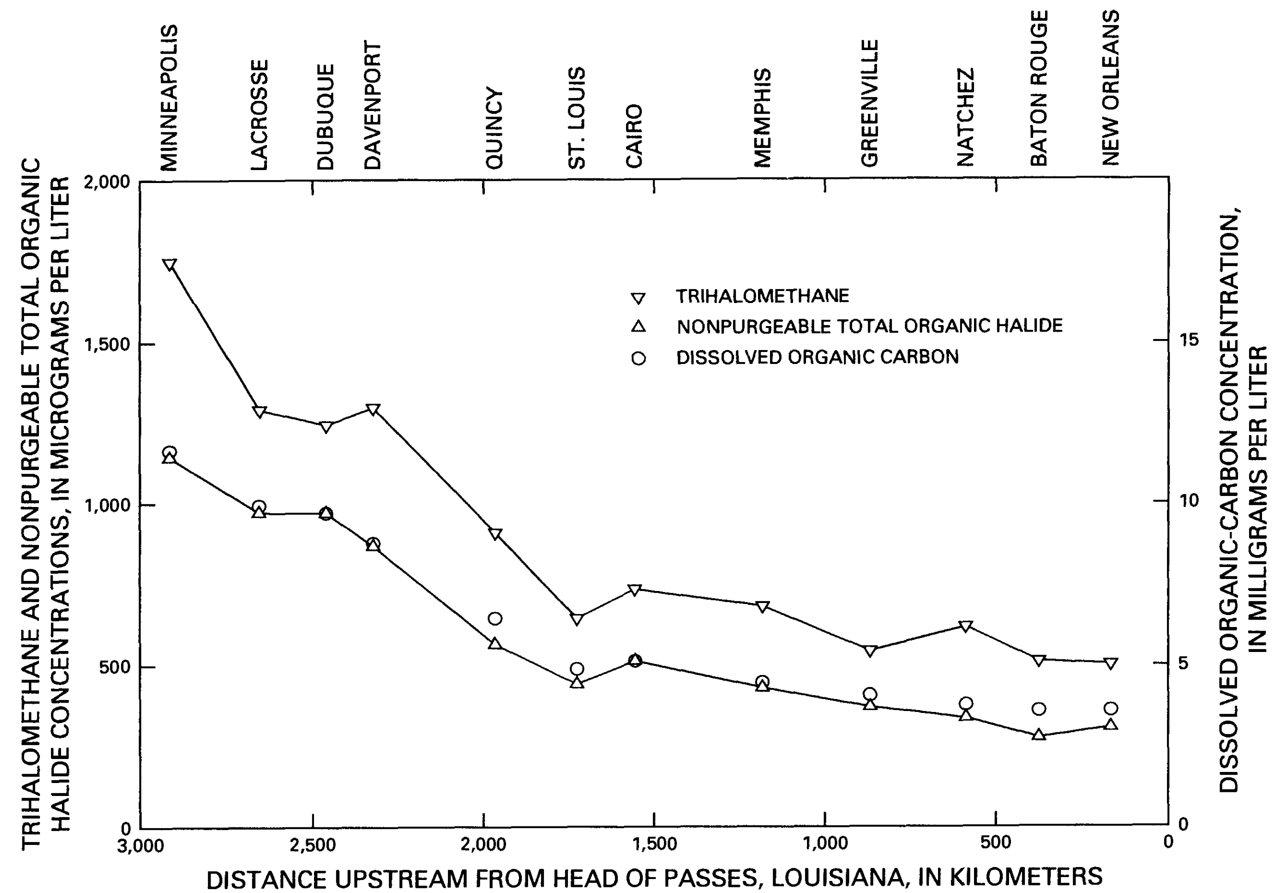

Figure 2. Trihalomethane, nonpurgeable total organic halide, and dissolved-organic carbon concentrations as a function of cumulative river kilometers upstream from Head of Passes, La.; initial pH of 10.00 and initial free-chlorine concentration of 30.0 milligrams per liter.

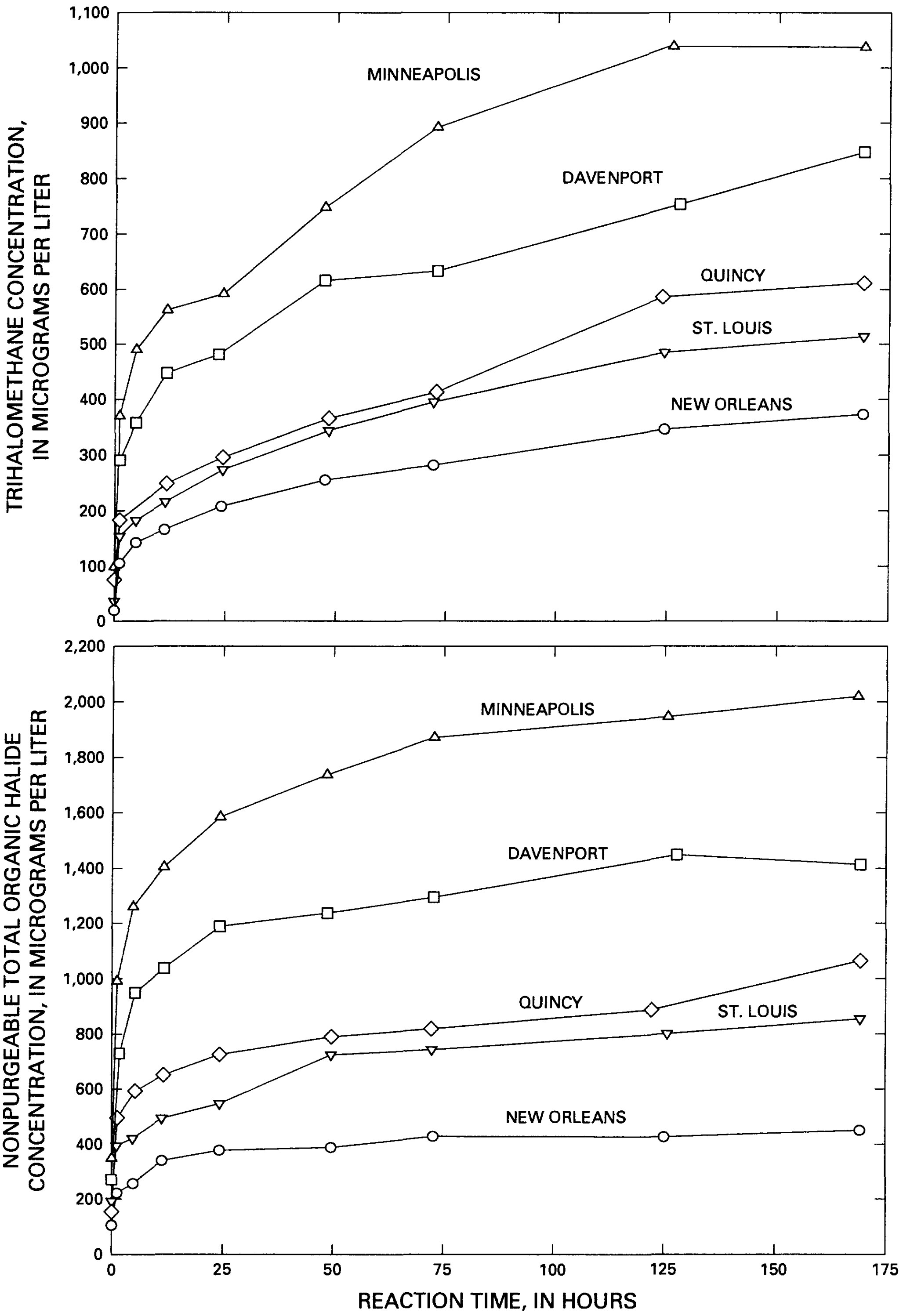

Figure 3. Trihalomethane and nonpurgeable total organic halide concentrations as a function of reaction time for several sampling sites along the Mississippi River; initial pH of 7.50 and initial free-chlorine concentration of 30.0 milligrams per liter.

Many of the duplicate samples for the NPTOX formation-potential determination were not analyzed because of time constraints. A THM sample requires approximately 7 minutes for analysis; an NPTOX sample requires approximately 45 minutes. The literature (Dressman and Stevens, 1983) indicates that replicate analyses for NPTOX determination are desirable because of the relatively poor reproducibility of the NPTOX procedure. Consequently, in the initial experiments of this study on the LaCrosse and Dubuque water samples, the emphasis was on replication of the same sample rather than analysis of the duplicate samples. After these experiments were conducted, it became apparent that reproducibility was better than indicated by the literature and also that replication of all samples was not feasible because of time constraints. Therefore, replication was limited to a few selected samples for water samples from the Minneapolis sample site downriver through the Ohio River sample site. In several instances where instrument problems occurred with the first of the duplicate samples, the second sample was analyzed and the result reported. As experience was gained with the NPTOX procedure, emphasis was shifted from replication of the same sample to analyses of the duplicate samples, and with the exception of the Natchez water sample, all the duplicate NPTOX samples were analyzed for water samples downriver of the Ohio River sample.

For the second type of results, duplicate experiments were done for a reaction time of 168.0 hours, single experiments for all other reaction times. The 0.00-hour reaction-time samples were samples taken and quenched immediately after addition of the sodium hypochlorite solution to the water sample. The time required to add the sodium hypochlorite solution to the water sample in a separatory funnel, to mix the contents, to fill the 0.00-hour time vials already containing the quenching agent, and to shake these vials was from 30 to 45 seconds.

The first type of results consisting of concentrations of the four THM compounds and the total THM and NPTOX concentrations for a reaction time of 168.0 hours and nine combinations of initial pH and free-chlorine concentration are listed in tables 2-15. Two of the reaction-time periods for the Cairo water sample were slightly different from 168.0 hours, as indicated on table 9, because the samples were quenched to stop the reaction in the wrong order.

The second type of results consisting of concentrations of the four THM compounds and the total THM and NPTOX concentrations as a function of reaction time for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 mg/L are listed in tables 16-27. These concentration-time experiments could not be done for the LaCrosse and Dubuque water samples because of bottle breakage during shipping and the resultant loss of water. The concentrations for the 168.0-hour reaction time for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 mg/L are parts of both the first and second types of results. Therefore, these concentrations are presented in both tables 2-15 and tables 16-27.

Table 2.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations for a reaction time of 168.0 hours as a function of initial pH and initial free-chlorine concentration, Mississippi River at Minneapolis, Minn., July 5, 1991

[µg/L, micrograms per liter; CL, free-chlorine concentration; mg/L, milligrams per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed]

Initial pH	Initial CL (mg/L)	Concentration (µg/L)						
		$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
							Rep 1	Rep 2
5.50	15.0	495	18.3	0.26	ND	514	1,680	NA
5.50	15.0	484	18.4	.26	ND	503	NA	NA
5.50	30.0	766	20.4	.24	ND	787	2,280	2,350
5.50	30.0	771	20.5	.24	ND	792	NA	NA
5.50	50.0	921	20.4	.32	ND	942	2,600	NA
5.50	50.0	929	19.9	.24	ND	949	NA	NA
7.50	15.0	672*	21.1*	.41*	ND*	694*	1,090*	NA*
7.50	15.0	679*	21.4*	.40*	ND*	701*	NA*	NA*
7.50	30.0	1,020	24.8	.26	ND	1,040	2,010	2,050
7.50	30.0	1,020	23.5	.29	ND	1,040	NA	NA
7.50	50.0	1,390	27.0	.43	ND	1,420	2,030	NA
7.50	50.0	1,340	26.0	.34	ND	1,370	NA	NA
10.00	15.0	952*	17.6*	.36*	ND*	970*	781*	NA*
10.00	15.0	946*	17.6*	.36*	ND*	964*	NA*	NA*
10.00	30.0	1,750	26.7	.44	ND	1,780	1,140	1,180
10.00	30.0	1,680	25.0	.41	ND	1,710	NA	NA
10.00	50.0	1,680	25.6	.42	ND	1,710	1,310	NA
10.00	50.0	1,640	24.6	.40	ND	1,660	NA	NA

*Free-chlorine concentration less than the detection limit at reaction time of 168.0 hours.

Table 3.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations for a reaction time of 168.0 hours as a function of initial pH and initial free-chlorine concentration, Mississippi River at LaCrosse, Wis., July 2, 1991

[µg/L, micrograms per liter; CL, free-chlorine concentration; mg/L, milligrams per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed]

Initial pH	Initial CL (mg/L)	Concentration (µg/L)						
		$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
							Rep 1	Rep 2
5.50	15.0	432	19.2	0.47	ND	452	1,410	1,560
5.50	15.0	416	18.4	.43	ND	435	NA	NA
5.50	30.0	595	19.6	.46	ND	615	1,890	1,930
5.50	30.0	587	19.4	.41	ND	607	NA	NA
5.50	50.0	737	20.2	.42	ND	758	2,000	2,140
5.50	50.0	759	20.7	.43	ND	780	NA	NA
7.50	15.0	618*	22.6*	.63*	ND*	641*	1060*	1,100*
7.50	15.0	611*	22.7*	.63*	ND*	634*	NA*	NA*
7.50	30.0	843	23.8	.65	ND	867	1,740	1,720
7.50	30.0	870	24.6	.66	ND	895	NA	NA
7.50	50.0	1,110	27.9	.67	ND	1,140	1,790	1,790
7.50	50.0	1,050	26.2	.66	ND	1,080	NA	NA
10.00	15.0	978*	23.1*	.78*	ND*	1,000*	815*	856*
10.00	15.0	1,000*	23.8*	.76*	ND*	1,020*	NA*	NA*
10.00	30.0	1,280	28.8	.77	.02	1,310	933	1,030
10.00	30.0	1,240	27.8	.76	.02	1,270	NA	NA
10.00	50.0	1,440	30.6	.68	.02	1,470	1,010	1,000
10.00	50.0	1,520	32.3	.82	.02	1,550	NA	NA

*Free-chlorine concentration less than the detection limit at reaction time of 168.0 hours.

Table 4.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations for a reaction time of 168.0 hours as a function of initial pH and initial free-chlorine concentration, Mississippi River at Dubuque, Iowa, July 1, 1991

[µg/L, micrograms per liter; CL, free-chlorine concentration; mg/L, milligrams per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed]

Initial pH	Initial CL (mg/L)	Concentration (µg/L)						
		$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
							Rep 1	Rep 2
3.49	30.0	245	9.27	0.25	0.23	255	2,570	2,600
3.49	30.0	248	9.29	.25	.21	258	NA	NA
5.50	15.0	386	15.4	.30	ND	402	1,420	1,380
5.50	15.0	424	17.0	.29	ND	441	NA	NA
5.50	30.0	587	18.7	.30	ND	606	1,910	1,890
5.50	30.0	572	18.1	.28	ND	590	NA	NA
5.50	50.0	769	20.2	.30	ND	790	2,050	2,010
5.50	50.0	708	18.2	.29	ND	726	NA	NA
7.50	15.0	545*	20.1*	.50*	ND*	566*	1,040*	1,020*
7.50	15.0	575*	21.1*	.48*	ND*	597*	NA*	NA*
7.50	30.0	856	24.3	.58	.04	881	1,540	1,530
7.50	30.0	868	24.6	.57	.09	893	NA	NA
7.50	50.0	1,120	26.8	.46	ND	1,150	1,620	1,750
7.50	50.0	1,090	26.4	.41	.02	1,120	NA	NA
10.00	7.50	366*	8.45*	.19*	ND*	375*	385*	408*
10.00	7.50	352*	8.16*	.19*	ND*	358*	NA*	NA*
10.00	15.0	794	17.5	.38	.04	812	766	683
10.00	15.0	798	18.0	.39	ND	816	NA	NA
10.00	30.0	1,260	25.9	.51	ND	1,290	976	999
10.00	30.0	1,210	25.0	.58	ND	1,240	NA	NA
10.00	50.0	1,490	28.4	.52	ND	1,520	1,170	1,140
10.00	50.0	1,420	26.8	.49	ND	1,450	NA	NA
10.00	90.0	1,530	26.9	.47	ND	1,560	1,140	1,150
10.00	90.0	1,540	27.4	.47	ND	1,570	NA	NA
11.57	30.0	938	2.95	.24	ND	941	612	647
11.57	30.0	989	3.11	.24	ND	992	NA	NA

*Free-chlorine concentration less than the detection limit at reaction time of 168.0 hours.

Table 5.—Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations for a reaction time of 168.0 hours as a function of initial pH and initial free-chlorine concentration, Mississippi River at Davenport, Iowa, June 30, 1991

[µg/L, micrograms per liter; CL, free-chlorine concentration; mg/L, milligrams per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed]

Initial pH	Initial CL (mg/L)	Concentration (µg/L)						
		$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
							Rep 1	Rep 2
5.50	15.0	416	20.0	0.46	ND	436	1,320	NA
5.50	15.0	421	20.0	.51	ND	442	NA	NA
5.50	30.0	600	22.2	.54	ND	623	1,550	1,610
5.50	30.0	569	21.2	.52	ND	591	NA	NA
5.50	50.0	739	23.4	.47	.09	763	1,830	NA
5.50	50.0	709	22.0	.44	.03	731	NA	NA
7.50	15.0	618*	25.7*	.73*	.04*	644*	962*	NA*
7.50	15.0	637*	25.9*	.74*	.04*	664*	NA*	NA*
7.50	30.0	819	28.5	.82	ND	848	1,430	1,410
7.50	30.0	815	28.4	.76	ND	844	NA	NA
7.50	50.0	1,050	29.0	.83	ND	1,080	1,550	NA
7.50	50.0	1,110	31.2	.89	.01	1,140	NA	NA
10.00	15.0	988	26.1	.83	.02	1,010	759	NA
10.00	15.0	976	24.8	.85	.01	1,000	NA	NA
10.00	30.0	1,280	30.4	.84	.02	1,310	871	887
10.00	30.0	1,260	29.8	.81	.02	1,290	NA	NA
10.00	50.0	1,450	31.6	.83	.02	1,480	943	NA
10.00	50.0	1,400	31.2	.88	.02	1,430	NA	NA

*Free-chlorine concentration less than the detection limit at reaction time of 168.0 hours.

Table 6.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations for a reaction time of 168.0 hours as a function of initial pH and initial free-chlorine concentration, Mississippi River at Quincy, Ill., June 29, 1991

[µg/L, micrograms per liter; CL, free-chlorine concentration; mg/L, milligrams per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed]

Initial pH	Initial CL (mg/L)	Concentration (µg/L)						
		$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
							Rep 1	Rep 2
5.50	15.0	290	19.8	0.89	ND	311	922	NA
5.50	15.0	278	18.7	.83	ND	298	NA	NA
5.50	30.0	365	20.4	.78	ND	386	1,110	1,050
5.50	30.0	361	20.7	.83	ND	383	NA	NA
5.50	50.0	429	21.8	.88	ND	452	1,210	NA
5.50	50.0	434	21.8	.90	ND	457	NA	NA
7.50	15.0	448	27.1	1.54	.07	477	727	NA
7.50	15.0	443	27.1	1.44	.02	472	NA	NA
7.50	30.0	590	29.7	1.33	ND	621	1,150	997
7.50	30.0	577	29.7	1.38	ND	608	NA	NA
7.50	50.0	686	29.2	1.27	ND	716	1,020	1,010
7.50	50.0	693	29.4	1.44	.03	724	NA	NA
10.00	15.0	709	27.4	1.75	.03	738	527	NA
10.00	15.0	690	26.8	1.72	.02	719	NA	NA
10.00	30.0	871	29.4	1.75	.02	902	593	569
10.00	30.0	884	30.4	2.01	.02	916	NA	NA
10.00	50.0	1,020	31.7	1.57	ND	1,050	580	NA
10.00	50.0	960	30.3	1.61	.02	992	NA	NA

Table 7.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations for a reaction time of 168.0 hours as a function of initial pH and initial free-chlorine concentration, Missouri River, June 28, 1991

[µg/L, micrograms per liter; CL, free-chlorine concentration; mg/L, milligrams per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; NA, not analyzed; IP, instrument problem]

Initial pH	Initial CL (mg/L)	Concentration (µg/L)						
		$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
							Rep 1	Rep 2
5.50	15.0	135	39.2	9.57	0.32	184	498	NA
5.50	15.0	139	40.2	9.55	.31	189	NA	NA
5.50	30.0	190	44.8	9.11	.24	244	581	NA
5.50	30.0	183	42.8	8.49	.18	234	600	NA
5.50	50.0	221	45.4	8.06	.19	275	628	NA
5.50	50.0	226	45.7	7.95	.17	280	NA	NA
7.50	15.0	232	57.7	13.8	.58	304	411	NA
7.50	15.0	223	56.6	13.7	.55	294	NA	NA
7.50	30.0	272	56.0	12.5	.44	341	518	NA
7.50	30.0	278	58.7	13.1	.47	350	483	NA
7.50	50.0	331	61.6	13.2	.45	406	528	NA
7.50	50.0	339	59.1	12.2	.40	411	NA	NA
10.00	15.0	320	55.9	14.8	1.08	392	253	NA
10.00	15.0	335	57.7	15.3	1.12	409	NA	NA
10.00	30.0	427	67.5	16.3	1.01	512	IP	NA
10.00	30.0	441	67.8	16.4	1.02	526	319	NA
10.00	50.0	455	67.8	16.0	.90	540	294	NA
10.00	50.0	419	63.9	15.1	.84	499	302	NA

Table 8.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations for a reaction time of 168.0 hours as a function of initial pH and initial free-chlorine concentration, Mississippi River at St. Louis, Mo., June 28, 1991

[µg/L, micrograms per liter; CL, free-chlorine concentration; mg/L, milligrams per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; NA, not analyzed; IP, instrument problem]

Initial pH	Initial CL (mg/L)	Concentration (µg/L)						
		$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
							Rep 1	Rep 2
5.50	15.0	219	36.8	5.52	0.14	261	727	NA
5.50	15.0	225	37.1	5.41	.12	268	NA	NA
5.50	30.0	277	38.0	4.89	.10	320	838	NA
5.50	30.0	281	38.0	4.77	.08	324	878	NA
5.50	50.0	347	43.1	5.14	.06	395	923	NA
5.50	50.0	337	41.8	4.85	.05	384	NA	NA
7.50	15.0	357	57.5	8.65	.17	423	624	NA
7.50	15.0	337	54.2	8.22	.16	400	NA	NA
7.50	30.0	458	58.4	8.15	.15	525	743	NA
7.50	30.0	442	56.2	7.67	.13	506	740	NA
7.50	50.0	504	58.5	7.69	.12	570	1,080	NA
7.50	50.0	483	56.0	7.46	.10	547	NA	NA
10.00	15.0	517	60.6	10.3	.38	588	379	NA
10.00	15.0	490	55.9	9.21	.34	555	NA	NA
10.00	30.0	575	62.0	9.24	.28	647	IP	NA
10.00	30.0	588	64.1	9.50	.29	662	463	NA
10.00	50.0	627	64.3	9.12	.25	701	518	NA
10.00	50.0	608	64.4	9.27	.26	682	NA	NA

Table 9.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations for a reaction time of 168.0 hours as a function of initial pH and initial free-chlorine concentration, Mississippi River at Cairo, Ill., June 27, 1991

[µg/L, micrograms per liter; CL, free-chlorine concentration; mg/l, milligrams per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed]

Initial pH	Initial CL (mg/L)	Concentration (µg/L)						
		$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
							Rep 1	Rep 2
5.50	15.0	[1]252	[1]24.4	[1]1.54	ND[1]	[1]278	[1]851	NA[1]
5.50	15.0	[1]248	[1]24.2	[1]1.53	ND[1]	[1]274	NA[1]	NA[1]
5.50	30.0	321	25.5	1.33	ND	348	1,050	NA
5.50	30.0	326	25.7	1.42	ND	353	1,060	NA
5.50	50.0	396	27.9	1.50	ND	425	1,070	NA
5.50	50.0	389	27.2	1.68	ND	418	NA	NA
7.50	15.0	[2]383	[2]33.6	[2]2.53	ND[2]	[2]419	[2]804	NA[2]
7.50	15.0	[2]398	[2]35.8	[2]2.71	ND[2]	[2]437	NA[2]	NA[2]
7.50	30.0	472	34.2	2.69	ND	509	771	NA
7.50	30.0	465	33.7	2.50	ND	501	878	NA
7.50	50.0	557	35.9	2.45	ND	595	883	NA
7.50	50.0	556	36.2	2.48	ND	595	NA	NA
10.00	15.0	603	37.4	3.16	.06	644	446	NA
10.00	15.0	598	37.3	3.14	.07	639	449	NA
10.00	30.0	690	39.2	3.00	.06	732	525	NA
10.00	30.0	698	39.6	3.00	.05	741	524	NA
10.00	50.0	770	40.7	2.96	.04	814	555	NA
10.00	50.0	743	39.3	2.87	.04	785	565	NA

[1] Reaction time of 167.3 hours rather than 168.0 hours.
[2] Reaction time of 168.1 hours rather than 168.0 hours.

Table 10.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations for a reaction time of 168.0 hours as a function of initial pH and initial free-chlorine concentration, Ohio River, June 27, 1991

[µg/L, micrograms per liter; CL, free-chlorine concentration; mg/L, milligrams per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed; IP, instrument problem]

Initial pH	Initial CL (mg/L)	Concentration (µg/L)						
		$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
							Rep 1	Rep 2
5.50	15.0	123	19.7	3.09	ND	146	416	NA
5.50	15.0	119	18.7	2.83	.04	141	NA	NA
5.50	30.0	160	21.0	2.67	ND	184	442	NA
5.50	30.0	170	21.3	2.60	ND	194	425	NA
5.50	50.0	214	22.3	2.45	ND	239	453	NA
5.50	50.0	219	22.7	2.50	ND	244	NA	NA
7.50	15.0	206	28.6	5.07	.08	240	324	NA
7.50	15.0	216	29.0	5.13	.09	250	NA	NA
7.50	30.0	234	27.2	4.47	.06	266	352	NA
7.50	30.0	246	27.9	4.48	.06	278	395	NA
7.50	50.0	307	29.0	4.38	.08	340	366	NA
7.50	50.0	322	30.2	4.57	.07	357	NA	NA
10.00	15.0	294	29.6	5.97	.18	330	189	NA
10.00	15.0	282	29.1	5.88	.19	317	NA	NA
10.00	30.0	320	28.9	5.41	.15	354	IP	NA
10.00	30.0	331	30.4	5.71	.16	367	216	NA
10.00	50.0	357	30.0	5.29	.13	392	241	NA
10.00	50.0	354	31.1	5.57	.14	391	NA	NA

Table 11.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations for a reaction time of 168.0 hours as a function of initial pH and initial free-chlorine concentration, Mississippi River at Memphis, Tenn., June 26, 1991

[μg/L, micrograms per liter; CL, free-chlorine concentration; mg/L, milligrams per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed; SL, sample lost because of vial breakage]

Initial pH	Initial CL (mg/L)	Concentration (μg/L)						
		$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
							Rep 1	Rep 2
5.50	15.0	241	55.9	2.93	ND	300	714	NA
5.50	15.0	233	53.9	2.89	.01	290	723	NA
5.50	30.0	310	62.3	3.32	ND	376	850	NA
5.50	30.0	310	58.8	3.02	ND	372	865	NA
5.50	50.0	375	65.7	2.96	ND	444	1,150	NA
5.50	50.0	358	61.3	2.75	ND	422	1,100	NA
7.50	15.0	366	82.2	4.91	.07	453	583	NA
7.50	15.0	363	82.8	5.01	.07	451	596	NA
7.50	30.0	SL	SL	SL	SL	SL	671	NA
7.50	30.0	435	83.7	4.89	.06	524	670	NA
7.50	50.0	523	88.4	4.62	.06	616	672	NA
7.50	50.0	523	88.9	4.64	.06	617	679	NA
10.00	15.0	527	87.0	5.63	.13	620	315	NA
10.00	15.0	507	87.7	5.81	.14	601	380	NA
10.00	30.0	610	94.9	5.68	.16	711	432	NA
10.00	30.0	582	86.6	5.08	.10	674	442	NA
10.00	50.0	622	92.2	5.41	.10	720	368	NA
10.00	50.0	641	93.3	5.42	.09	740	464	NA

Table 12.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations for a reaction time of 168.0 hours as a function of initial pH and initial free-chlorine concentration, Mississippi River at Greenville, Miss., June 25, 1991

[µg/L, micrograms per liter; CL, free-chlorine concentration; mg/L, milligrams per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed]

Initial pH	Initial CL (mg/L)	Concentration (µg/L)						
		$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
							Rep 1	Rep 2
5.50	15.0	206	26.3	2.80	ND	235	649	NA
5.50	15.0	210	26.4	2.79	ND	239	666	NA
5.50	30.0	263	28.0	2.69	ND	294	774	NA
5.50	30.0	271	28.4	2.64	ND	302	737	NA
5.50	50.0	332	29.8	2.64	.02	364	766	NA
5.50	50.0	325	29.7	2.64	ND	357	792	NA
7.50	15.0	342	35.8	4.11	.08	382	544	NA
7.50	15.0	343	37.6	4.41	.07	385	542	NA
7.50	30.0	450	41.4	4.78	.08	496	601	NA
7.50	30.0	440	39.8	4.49	.07	484	670	NA
7.50	50.0	503	39.1	4.09	.05	546	634	NA
7.50	50.0	503	38.4	3.98	.06	545	657	NA
10.00	15.0	490	40.0	5.43	.12	536	334	NA
10.00	15.0	488	38.2	5.03	.11	531	356	NA
10.00	30.0	529	39.4	4.96	.10	573	358	NA
10.00	30.0	520	37.7	4.73	.09	563	397	NA
10.00	50.0	603	41.5	4.90	.09	649	421	NA
10.00	50.0	591	40.2	4.79	.09	636	409	NA

Table 13.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations for a reaction time of 168.0 hours as a function of initial pH and initial free-chlorine concentration, Mississippi River at Natchez, Miss., June 24, 1991

[µg/L, micrograms per liter; CL, free-chlorine concentration; mg/L, milligrams per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed; SL, sample lost because of vial breakage]

Initial pH	Initial CL (mg/L)	Concentration (µg/L)						
		$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
							Rep 1	Rep 2
5.50	15.0	207	25.1	2.68	ND	235	613	NA
5.50	15.0	205	25.5	2.72	ND	233	NA	NA
5.50	30.0	250	25.1	2.31	ND	277	706	NA
5.50	30.0	263	26.1	2.38	ND	291	732	NA
5.50	50.0	331	28.6	2.37	ND	362	748	NA
5.50	50.0	321	27.6	2.28	ND	351	NA	NA
7.50	15.0	SL	SL	SL	SL	SL	526	NA
7.50	15.0	333	34.7	3.95	.05	372	NA	NA
7.50	30.0	390	34.9	3.80	ND	429	547	NA
7.50	30.0	396	35.2	3.80	ND	435	582	NA
7.50	50.0	487	37.3	4.03	.05	528	591	NA
7.50	50.0	487	37.0	3.98	.05	528	NA	NA
10.00	15.0	475	34.7	4.56	.13	514	324	NA
10.00	15.0	467	34.6	4.60	.12	506	NA	NA
10.00	30.0	560	37.1	4.61	.09	602	342	NA
10.00	30.0	581	38.8	4.89	.09	625	363	NA
10.00	50.0	651	38.0	4.53	.09	694	394	NA
10.00	50.0	690	41.3	4.95	.10	736	NA	NA

Table 14.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations for a reaction time of 168.0 hours as a function of initial pH and initial free-chlorine concentration, Mississippi River at Baton Rouge, La., June 23, 1991

[μg/L, micrograms per liter; CL, free-chlorine concentration; mg/L, milligrams per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed]

Initial pH	Initial CL (mg/L)	Concentration (μg/L)						
		$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
							Rep 1	Rep 2
5.50	15.0	210	26.3	2.72	ND	239	557	NA
5.50	15.0	213	27.5	2.91	ND	243	569	NA
5.50	30.0	249	24.3	2.19	ND	275	691	NA
5.50	30.0	260	26.7	2.52	ND	289	665	NA
5.50	50.0	289	26.7	2.24	ND	318	758	NA
5.50	50.0	274	25.4	2.12	ND	302	715	NA
7.50	15.0	342	37.4	4.33	.05	384	484	NA
7.50	15.0	321	33.6	3.78	.04	358	508	NA
7.50	30.0	388	36.2	3.96	.03	428	548	NA
7.50	30.0	390	37.8	4.34	.03	432	552	NA
7.50	50.0	464	35.0	3.54	ND	503	584	NA
7.50	50.0	505	41.5	4.28	.05	551	537	NA
10.00	15.0	437	36.0	4.74	.11	478	285	NA
10.00	15.0	467	38.2	4.97	.12	510	260	NA
10.00	30.0	463	34.7	4.27	.08	502	300	NA
10.00	30.0	507	38.3	4.67	.09	550	298	NA
10.00	50.0	569	40.7	4.69	.08	614	388	NA
10.00	50.0	550	39.9	4.64	.08	595	373	NA

Table 15.–Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations for a reaction time of 168.0 hours as a function of initial pH and initial free-chlorine concentration, Mississippi River at New Orleans, La., August 6, 1991

[µg/L, micrograms per liter; CL, free-chlorine concentration; mg/L, milligrams per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; NA, not analyzed]

Initial pH	Initial CL (mg/L)	Concentration (µg/L)						
		$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
							Rep 1	Rep 2
5.50	15.0	182	36.0	5.88	0.09	224	525	NA
5.50	15.0	180	35.8	5.81	.09	222	542	NA
5.50	30.0	225	36.9	5.34	.05	267	594	NA
5.50	30.0	225	36.8	5.33	.06	267	569	NA
5.50	50.0	258	35.2	4.65	.03	298	619	NA
5.50	50.0	260	36.4	4.87	.04	301	603	NA
7.50	15.0	270	46.8	8.77	.17	326	483	NA
7.50	15.0	274	48.8	9.20	.19	332	462	NA
7.50	30.0	320	50.2	9.03	.14	379	441	NA
7.50	30.0	320	48.9	8.73	.13	378	469	NA
7.50	50.0	386	49.8	8.26	.11	444	540	NA
7.50	50.0	393	50.8	8.38	.11	452	496	NA
10.00	15.0	379	50.0	10.3	.39	440	286	NA
10.00	15.0	376	48.2	10.0	.40	435	237	NA
10.00	30.0	448	55.9	10.9	.36	515	324	NA
10.00	30.0	432	53.1	10.2	.33	496	314	NA
10.00	50.0	488	56.3	10.4	.31	555	352	NA
10.00	50.0	500	56.9	10.6	.32	568	294	NA

Table 16.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations as a function of reaction time for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 milligrams per liter, Mississippi River at Minneapolis, Minn., July 5, 1991

[µg/L, micrograms per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed]

Reaction time (hours)	Concentration (µg/L)						
	$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
						Rep 1	Rep 2
0.00	107	3.59	0.06	ND	111	343	NA
2.00	366	13.0	.22	ND	379	994	NA
6.00	479	16.4	.20	ND	496	1,270	NA
12.00	551	18.0	.29	ND	569	1,410	NA
24.00	573	17.6	.30	ND	591	1,640	1,550
48.00	730	20.2	.39	ND	751	1,750	NA
72.00	869	22.6	.42	ND	892	1,880	NA
124.0	1,020	24.7	.36	ND	1,040	1,950	NA
168.0	1,020	24.8	.26	ND	1,040	2,010	2,050
168.0	1,020	23.5	.29	ND	1,040	NA	NA

Table 17.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations as a function of reaction time for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 milligrams per liter, Mississippi River at Davenport, Iowa, June 30, 1991

[µg/L, micrograms per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed]

Reaction time (hours)	Concentration (µg/L)						
	$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
						Rep 1	Rep 2
0.00	73.4	3.56	0.12	0.02	77.1	263	NA
2.00	280	15.3	.42	.02	296	729	NA
6.00	340	17.5	.50	.01	358	945	NA
12.00	421	21.1	.70	.02	443	1,040	NA
24.00	459	21.0	.49	.01	480	1,180	1,200
48.00	590	24.5	.79	ND	615	1,240	NA
72.00	610	24.5	.88	.01	635	1,300	NA
127.0	727	27.0	.67	ND	755	1,450	NA
168.0	819	28.5	.82	ND	848	1,430	1,410
168.0	815	28.4	.76	ND	844	NA	NA

Table 18.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations as a function of reaction time for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 milligrams per liter, Mississippi River at Quincy, Ill., June 29, 1991

[μg/L, micrograms per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed]

Reaction time (hours)	Concentration (μg/L)						
	$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
						Rep 1	Rep 2
0.00	71.9	4.53	0.23	ND	76.7	165	NA
2.00	172	13.6	.70	ND	186	489	NA
6.00	231	17.4	.98	ND	249	584	NA
12.00	272	19.3	1.03	ND	292	648	NA
24.00	341	22.6	.92	ND	365	727	NA
48.00	383	24.2	1.18	ND	408	798	NA
72.00	464	26.7	1.38	ND	492	834	NA
122.0	558	29.5	1.30	ND	589	900	NA
168.0	590	29.7	1.33	ND	621	1,150	997
168.0	577	29.7	1.38	ND	608	NA	NA

Table 19.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations as a function of reaction time for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 milligrams per liter, Missouri River, June 28, 1991

[μg/L, micrograms per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; NA, not analyzed]

Reaction time (hours)	Concentration (μg/L)						
	$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
						Rep 1	Rep 2
0.00	16.0	4.72	1.90	0.08	22.7	110	NA
2.00	55.7	24.4	7.42	.28	87.8	203	NA
6.00	73.5	30.4	8.82	.32	113	258	NA
12.00	99.1	36.5	10.4	.36	146	345	NA
24.00	129	39.4	10.4	.36	179	377	NA
48.00	179	47.0	11.5	.39	238	393	NA
72.00	201	49.9	13.2	.44	265	408	NA
120.0	265	57.6	12.9	.46	336	480	NA
168.0	272	56.0	12.5	.44	341	518	NA
168.0	278	58.7	13.1	.47	350	483	NA

Table 20.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations as a function of reaction time for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 milligrams per liter, Mississippi River at St. Louis, Mo., June 28, 1991

[µg/L, micrograms per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; NA, not analyzed]

Reaction time (hours)	Concentration (µg/L)						
	$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
						Rep 1	Rep 2
0.00	31.4	6.25	1.24	0.03	38.9	184	NA
3.00	121	26.6	4.78	.09	152	401	NA
6.00	146	30.5	5.43	.10	182	407	NA
12.00	180	34.2	5.93	.10	220	487	NA
24.00	232	39.7	6.82	.11	279	539	NA
48.00	290	45.4	7.24	.14	343	606	NA
72.00	340	49.5	7.67	.13	397	632	NA
126.0	423	57.4	7.90	.12	488	686	NA
168.0	458	58.4	8.15	.15	525	743	NA
168.0	442	56.2	7.67	.13	506	740	NA

Table 21.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations as a function of reaction time for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 milligrams per liter, Mississippi River at Cairo, Ill., June 27, 1991

[µg/L, micrograms per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed]

Reaction time (hours)	Concentration (µg/L)						
	$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
						Rep 1	Rep 2
0.00	32.8	3.05	0.29	ND	36.1	129	NA
2.00	125	15.5	1.32	ND	142	359	NA
6.00	156	19.0	1.61	ND	177	490	NA
12.00	200	22.0	1.71	ND	224	563	NA
24.00	257	25.1	2.03	ND	284	658	NA
48.00	311	27.8	2.21	ND	341	729	NA
72.00	377	31.6	2.36	ND	411	777	NA
124.0	426	32.1	2.50	ND	461	843	NA
168.0	472	34.2	2.69	ND	509	771	NA
168.0	465	33.7	2.50	ND	501	878	NA

Table 22.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations as a function of reaction time for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 milligrams per liter, Ohio River, June 27, 1991

[μg/L, micrograms per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; NA, not analyzed]

Reaction time (hours)	Concentration (μg/L)						
	$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
						Rep 1	Rep 2
0.00	17.8	3.27	0.56	0.01	21.6	88.7	NA
2.08	53.8	12.8	2.53	.04	69.2	179	NA
6.00	71.6	15.6	3.03	.04	90.3	219	NA
12.00	99.1	19.0	3.60	.06	122	246	NA
24.00	112	20.1	3.65	.05	136	271	NA
48.00	154	23.2	4.03	.05	181	298	NA
72.00	187	25.3	4.34	.06	217	327	NA
121.5	217	26.2	4.33	.05	248	364	NA
168.0	234	27.2	4.47	.06	266	352	NA
168.0	246	27.9	4.48	.06	278	395	NA

Table 23.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations as a function of reaction time for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 milligrams per liter, Mississippi River at Memphis, Tenn., June 26, 1991

[µg/L, micrograms per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; NS, no sample because of insufficient water; ND, not detected; NA, not analyzed; SL, sample lost because of vial breakage]

Reaction time (hours)	Concentration (µg/L)						
	$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
						Rep 1	Rep 2
NS	NS	NS	NS	NS	NS	NS	NS
2.00	114	32.6	2.57	.04	149	287	NA
6.00	146	42.5	3.12	.04	192	394	NA
12.00	178	48.8	3.54	.05	230	446	NA
24.00	231	57.9	4.52	.05	293	549	NA
48.00	290	68.4	4.30	.04	363	591	NA
72.00	315	68.8	4.38	.05	388	628	621
124.0	379	76.1	4.27	.05	459	617	667
168.0	SL	SL	SL	SL	SL	671	NA
168.0	435	83.7	4.89	.06	524	670	NA

Table 24.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations as a function of reaction time for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 milligrams per liter, Mississippi River at Greenville, Miss., June 25, 1991

[µg/L, micrograms per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed]

Reaction time (hours)	Concentration (µg/L)						
	$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
						Rep 1	Rep 2
0.00	26.9	3.66	0.57	ND	31.1	117	NA
2.00	95.0	16.0	2.15	ND	113	325	NA
6.00	135	21.4	2.92	ND	159	356	372
12.00	175	25.0	3.23	ND	203	442	NA
24.00	219	28.8	3.58	ND	251	478	NA
48.00	292	33.6	3.99	ND	330	540	NA
72.00	333	35.8	4.26	ND	373	568	NA
126.0	383	37.8	4.29	ND	425	592	NA
168.0	450	41.4	4.78	.08	496	601	NA
168.0	440	39.8	4.49	.07	484	670	NA

Table 25.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations as a function of reaction time for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 milligrams per liter, Mississippi River at Natchez, Miss., June 24, 1991

[μg/L, micrograms per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed]

Reaction time (hours)	Concentration (μg/L)						
	$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
						Rep 1	Rep 2
0.00	29.1	4.36	0.56	ND	34.0	79.7	NA
2.00	91.9	16.2	2.13	.04	110	226	NA
6.00	131	20.2	2.61	.04	154	347	NA
12.00	164	24.5	3.36	.05	192	381	NA
24.00	211	26.8	3.22	ND	241	435	NA
48.00	252	29.9	3.61	.05	286	483	NA
72.00	308	33.2	3.99	ND	345	500	NA
120.1	348	34.0	3.79	ND	386	536	NA
168.0	390	34.9	3.80	ND	429	547	NA
168.0	396	35.2	3.80	ND	435	582	NA

Table 26.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations as a function of reaction time for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 milligrams per liter, Mississippi River at Baton Rouge, La., June 23, 1991

[µg/L, micrograms per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; ND, not detected; NA, not analyzed]

Reaction time (hours)	Concentration (µg/L)						
	$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
						Rep 1	Rep 2
0.00	20.4	2.69	0.40	ND	23.5	121	NA
2.00	87.6	15.7	2.26	.03	106	275	NA
6.00	123	20.6	2.93	.04	147	287	NA
12.00	149	22.9	3.17	.04	175	396	NA
24.00	185	24.5	3.07	.04	213	378	NA
48.00	246	31.4	3.92	.06	281	478	NA
72.00	284	32.0	3.79	.03	320	509	NA
126.0	354	35.8	4.04	.04	394	559	NA
168.0	388	36.2	3.96	.03	428	548	NA
168.0	390	37.8	4.34	.03	432	552	NA

Table 27.--Concentrations of the four trihalomethane compounds and the total trihalomethane and nonpurgeable total organic halide concentrations as a function of reaction time for an initial pH of 7.50 and an initial free-chlorine concentration of 30.0 milligrams per liter, Mississippi River at New Orleans, La., August 6, 1991

[μg/L, micrograms per liter; $CHCl_3$, chloroform; $BrCHCl_2$, bromodichloromethane; $ClCHBr_2$, chlorodibromomethane; $CHBr_3$, bromoform; THM, trihalomethane; NPTOX, nonpurgeable total organic halide; Rep 1, replicate number 1; Rep 2, replicate number 2; NA, not analyzed]

Reaction time (hours)	Concentration (μg/L)						
	$CHCl_3$	$BrCHCl_2$	$ClCHBr_2$	$CHBr_3$	Total THM	NPTOX	
						Rep 1	Rep 2
0.00	20.4	3.85	0.92	0.16	25.3	102	NA
2.00	74.4	22.2	5.36	.09	102	233	NA
6.00	106	28.6	6.68	.11	141	249	NA
12.00	128	31.3	7.05	.12	166	340	NA
24.00	165	36.5	7.96	.14	210	373	NA
48.00	208	40.4	8.19	.14	257	387	NA
72.00	236	42.1	8.35	.14	287	439	NA
124.0	292	48.1	9.30	.19	350	433	NA
168.0	320	50.2	9.03	.14	379	441	NA
168.0	320	48.9	8.73	.13	378	469	NA

Ancillary Data

Values of pH as a Function of Reaction Time

Values of pH as a function of reaction time for the different combinations of initial pH and initial free-chlorine concentration are listed in tables 28-39. These pH values were not determined for the LaCrosse and Dubuque water samples because of insufficient water as a result of bottle breakage during shipping of the samples.

Table 28.--Variation of pH with reaction time for different combinations of initial pH and initial free-chlorine concentration, Mississippi River at Minneapolis, Minn., July 5, 1991

[CL, initial free-chlorine concentration; mg/L, milligrams per liter]

CL = 15.0 mg/L		CL = 30.0 mg/L		CL = 50.0 mg/L	
Reaction time (hours)	pH	Reaction time (hours)	pH	Reaction time (hours)	pH
0.00	5.50	0.00	5.50	0.00	5.50
4.15	6.51	3.50	6.55	3.10	6.83
24.52	6.59	24.53	6.53	24.50	6.70
52.65	6.64	52.15	6.60	51.63	6.73
74.78	6.90	74.77	6.79	74.75	6.88
121.7	7.00	121.6	6.85	121.5	6.92
147.4	7.27	147.4	6.94	147.3	6.97
171.0	7.63	171.0	6.99	171.0	6.92
0.00	7.50	0.00	7.50	0.00	7.50
4.27	8.19	5.03	8.18	3.70	8.47
26.05	8.03	27.25	7.97	26.33	8.20
52.78	8.07	53.42	8.07	52.10	8.27
76.32	8.07	77.43	7.97	76.42	8.11
123.0	8.16	124.2	8.05	123.3	8.13
148.9	8.19	150.0	8.08	149.1	8.11
172.6	8.20	173.8	8.04	172.9	8.07
0.00	10.00	0.00	10.00	0.00	10.00
1.23	9.92	1.25	9.95	1.25	9.97
24.60	9.79	24.60	9.77	24.67	9.76
50.12	9.86	49.77	9.85	49.42	9.85
74.83	9.78	74.82	9.76	75.07	9.75
121.6	9.77	121.6	9.74	121.6	9.72
147.3	9.74	147.3	9.69	147.4	9.69
171.2	9.66	171.3	9.60	171.5	9.59

Table 29.--Variation of pH with reaction time for different combinations of initial pH and initial free-chlorine concentration, Mississippi River at Davenport, Iowa, June 30, 1991

[CL, initial free-chlorine concentration; mg/L, milligrams per liter]

CL = 15.0 mg/L		CL = 30.0 mg/L		CL = 50.0 mg/L	
Reaction time (hours)	pH	Reaction time (hours)	pH	Reaction time (hours)	pH
0.00	5.50	0.00	5.50	0.00	5.50
4.12	6.42	3.85	6.63	3.55	6.99
23.18	6.32	22.85	6.51	22.48	6.80
54.55	6.35	54.23	6.51	54.00	6.77
75.70	6.51	75.80	6.60	75.82	6.82
125.5	6.51	125.3	6.59	125.0	6.83
169.1	6.44	169.5	6.35	170.2	6.48
0.00	7.50	0.00	7.50	0.00	7.50
4.75	8.24	5.18	8.25	4.33	8.55
23.68	8.08	23.90	8.06	22.97	8.38
55.27	8.04	55.75	7.97	54.88	8.29
77.38	8.06	78.12	7.99	77.55	8.27
126.2	8.07	126.6	8.00	125.8	8.26
168.1	7.98	169.1	7.96	169.1	8.13
0.00	10.00	0.00	10.00	0.00	10.00
2.22	9.92	1.88	9.94	1.60	9.93
20.75	9.74	20.47	9.75	20.18	9.80
52.73	9.66	52.50	9.70	52.27	9.72
75.72	9.67	75.78	9.68	75.83	9.70
123.7	9.65	123.4	9.67	123.2	9.70
170.0	9.70	170.7	9.67	171.4	9.71

Table 30.--Variation of pH with reaction time for different combinations of initial pH and initial free-chlorine concentration, Mississippi River at Quincy, Ill., June 29, 1991

[CL, initial free-chlorine concentration; mg/L, milligrams per liter]

CL = 15.0 mg/L		CL = 30.0 mg/L		CL = 50.0 mg/L	
Reaction time (hours)	pH	Reaction time (hours)	pH	Reaction time (hours)	pH
0.00	5.50	0.00	5.50	0.00	5.50
4.82	6.38	4.82	6.48	4.93	6.69
28.82	6.51	28.80	6.46	28.83	6.63
49.50	6.66	49.55	6.53	49.53	6.67
72.68	6.69	72.70	6.60	72.68	6.72
101.4	6.89	101.4	6.67	101.4	6.73
149.6	6.93	149.6	6.89	149.7	6.82
170.9	7.20	171.0	6.83	171.3	6.63
0.00	7.50	0.00	7.50	0.00	7.50
5.93	8.19	6.82	8.19	6.20	8.43
30.10	8.08	30.88	8.04	30.25	8.30
50.83	8.08	51.57	8.03	50.88	8.27
74.02	8.10	74.78	8.03	74.13	8.27
102.6	8.10	103.3	8.02	102.7	8.25
150.9	8.10	151.6	8.02	151.0	8.24
172.7	8.06	173.6	7.95	173.3	8.17
0.00	10.00	0.00	10.00	0.00	10.00
4.53	9.89	4.57	9.88	4.55	9.90
28.57	9.78	28.63	9.78	28.63	9.78
49.13	9.75	49.08	9.76	49.05	9.76
72.45	9.77	72.47	9.77	72.50	9.77
101.0	9.73	100.9	9.74	100.9	9.75
149.2	9.72	149.2	9.74	149.2	9.73
171.9	9.63	172.1	9.61	172.4	9.58

Table 31.–Variation of pH with reaction time for different combinations of initial pH and initial free-chlorine concentration, Missouri River, June 28, 1991

[CL, initial free-chlorine concentration; mg/L, milligrams per liter]

CL = 15.0 mg/L		CL = 30.0 mg/L		CL = 50.0 mg/L	
Reaction time (hours)	**pH**	**Reaction time (hours)**	**pH**	**Reaction time (hours)**	**pH**
0.00	5.50	0.00	5.50	0.00	5.50
2.18	6.43	2.17	6.54	2.13	6.79
29.60	6.39	29.37	6.49	29.13	6.72
51.98	6.48	51.98	6.55	51.95	6.73
76.95	6.59	76.90	6.61	76.83	6.75
101.6	6.63	101.7	6.63	101.6	6.81
125.6	6.70	125.5	6.68	125.5	6.93
171.3	6.79	171.2	6.78	171.2	7.18
0.00	7.50	0.00	7.50	0.00	7.50
3.28	8.18	4.12	8.16	3.42	8.42
30.02	8.03	30.68	7.99	29.73	8.24
53.08	8.08	54.00	8.06	53.27	8.28
77.93	8.12	78.75	8.11	77.98	8.29
102.7	8.08	103.5	8.11	102.7	8.28
126.6	8.11	127.4	8.14	126.6	8.27
172.3	8.17	173.1	8.18	172.3	8.31
0.00	10.00	0.00	10.00	0.00	10.00
2.10	9.91	2.22	9.91	2.13	9.92
28.17	9.56	28.08	9.61	27.72	9.63
52.02	9.60	52.18	9.62	52.03	9.64
76.60	9.58	76.73	9.62	76.58	9.63
101.4	9.53	101.5	9.57	101.4	9.57
125.2	9.52	125.3	9.55	125.1	9.54
171.0	9.51	171.1	9.58	170.9	9.53

Table 32.--Variation of pH with reaction time for different combinations of initial pH and initial free-chlorine concentration, Mississippi River at St. Louis, Mo., June 28, 1991

[CL, initial free-chlorine concentration; mg/L, milligrams per liter]

CL = 15.0 mg/L		CL = 30.0 mg/L		CL = 50.0 mg/L	
Reaction time (hours)	pH	Reaction time (hours)	pH	Reaction time (hours)	pH
0.00	5.50	0.00	5.50	0.00	5.50
4.35	6.54	4.33	6.58	4.38	6.87
27.05	6.63	27.07	6.59	27.03	6.86
51.92	6.66	51.92	6.64	51.90	6.89
75.17	6.74	75.17	6.74	75.13	6.93
124.7	6.75	124.6	6.87	124.6	6.98
147.6	6.91	147.7	7.04	147.7	7.06
172.2	6.99	172.2	7.20	172.1	7.10
0.00	7.50	0.00	7.50	0.00	7.50
5.65	8.15	6.65	8.22	5.83	8.41
28.32	8.11	29.23	8.15	28.40	8.37
53.18	8.12	54.10	8.14	53.28	8.36
76.52	8.14	77.40	8.14	76.62	8.36
125.9	8.15	126.8	8.14	125.9	8.36
149.0	8.18	150.0	8.16	149.1	8.37
173.3	8.19	174.2	8.14	173.3	8.34
0.00	10.00	0.00	10.00	0.00	10.00
4.42	9.86	4.43	9.88	4.53	9.88
27.00	9.71	27.00	9.75	27.00	9.76
51.85	9.68	51.87	9.72	51.90	9.73
75.20	9.66	75.23	9.71	75.22	9.71
124.5	9.65	124.5	9.68	124.5	9.70
147.7	9.66	147.7	9.71	147.8	9.73
171.8	9.59	171.8	9.65	171.7	9.65

Table 33.–Variation of pH with reaction time for different combinations of initial pH and initial free-chlorine concentration, Mississippi River at Cairo, Ill., June 27, 1991

[CL, initial free-chlorine concentration; mg/L, milligrams per liter]

CL = 15.0 mg/L		CL = 30.0 mg/L		CL = 50.0 mg/L	
Reaction time (hours)	pH	Reaction time (hours)	pH	Reaction time (hours)	pH
0.00	5.50	0.00	5.50	0.00	5.50
1.78	6.50	1.73	6.54	1.68	6.88
29.98	6.52	29.95	6.50	29.97	6.79
52.93	6.59	52.97	6.55	52.92	6.84
78.43	6.63	78.42	6.58	78.37	6.88
130.1	6.70	130.1	6.63	130.1	6.94
151.0	6.79	150.9	6.70	150.8	7.00
174.1	6.88	174.0	6.76	174.0	7.04
0.00	7.50	0.00	7.50	0.00	7.50
2.78	8.19	3.47	8.22	2.85	8.49
31.12	8.03	31.78	8.08	31.18	8.33
54.00	8.02	54.73	8.10	54.15	8.32
79.47	8.03	80.18	8.10	79.57	8.30
131.2	8.07	131.8	8.11	131.3	8.29
151.9	8.08	152.5	8.12	151.8	8.29
175.0	8.10	175.7	8.15	175.1	8.30
0.00	10.00	0.00	10.00	0.00	10.00
1.12	10.00	1.07	10.02	1.00	10.02
29.47	9.66	29.57	9.68	29.65	9.70
52.50	9.62	52.50	9.65	52.47	9.65
77.87	9.60	77.88	9.63	77.83	9.64
129.5	9.59	129.5	9.60	129.6	9.62
150.1	9.56	150.0	9.58	150.0	9.60
173.4	9.55	173.4	9.58	173.3	9.59

Table 34.--Variation of pH with reaction time for different combinations of initial pH and initial free-chlorine concentration, Ohio River, June 27, 1991

[CL, initial free-chlorine concentration; mg/L, milligrams per liter]

CL = 15.0 mg/L		CL = 30.0 mg/L		CL = 50.0 mg/L	
Reaction time (hours)	pH	Reaction time (hours)	pH	Reaction time (hours)	pH
0.00	5.50	0.00	5.50	0.00	5.50
4.17	6.61	4.08	6.89	4.05	7.36
25.72	6.63	25.63	6.85	25.57	7.26
46.18	6.71	46.07	6.87	45.97	7.27
70.38	6.78	70.27	6.90	70.17	7.30
102.4	6.85	102.3	6.93	102.2	7.31
129.0	6.93	128.9	6.96	128.8	7.34
172.1	6.99	172.0	7.00	171.9	7.40
0.00	7.50	0.00	7.50	0.00	7.50
5.10	8.31	5.77	8.43	5.17	8.75
26.58	8.17	27.23	8.28	26.60	8.62
46.98	8.14	47.58	8.26	46.90	8.60
71.17	8.14	71.77	8.24	71.08	8.57
103.3	8.13	103.9	8.21	103.2	8.53
129.8	8.12	130.4	8.20	129.8	8.52
172.9	8.17	173.6	8.21	172.9	8.50
0.00	10.00	0.00	10.00	0.00	10.00
1.65	10.05	1.57	10.08	1.52	10.10
23.12	9.64	23.03	9.70	22.97	9.70
43.38	9.62	43.28	9.69	43.18	9.70
67.55	9.59	67.45	9.66	67.35	9.67
99.68	9.57	99.58	9.63	99.52	9.64
126.2	9.54	126.1	9.62	126.0	9.66
169.4	9.48	169.4	9.60	169.3	9.61

Table 35.--Variation of pH with reaction time for different combinations of initial pH and initial free-chlorine concentration, Mississippi River at Memphis, Tenn., June 26, 1991

[CL, initial free-chlorine concentration; mg/L, milligrams per liter]

CL = 15.0 mg/L		CL = 30.0 mg/L		CL = 50.0 mg/L	
Reaction time (hours)	pH	Reaction time (hours)	pH	Reaction time (hours)	pH
0.00	5.50	0.00	5.50	0.00	5.50
1.47	6.48	1.40	6.68	1.30	7.09
33.15	6.51	33.08	6.64	33.00	6.99
53.75	6.59	53.70	6.70	53.60	7.06
77.20	6.65	77.12	6.72	77.03	7.08
149.5	6.72	149.4	6.74	149.3	7.19
170.2	6.76	170.2	6.79	170.0	7.22
0.00	7.50	0.00	7.50	0.00	7.50
2.37	8.20	3.28	8.29	2.32	8.58
34.08	8.07	35.00	8.14	34.10	8.44
54.67	8.06	55.58	8.15	54.65	8.42
78.15	8.05	79.08	8.14	78.17	8.38
150.4	8.01	151.3	8.19	150.4	8.35
171.1	8.02	172.0	8.21	171.0	8.34
0.00	10.00	0.00	10.00	0.00	10.00
0.90	10.02	0.80	10.04	0.72	10.06
32.75	9.66	32.85	9.70	32.78	9.67
53.23	9.62	53.18	9.65	53.13	9.65
76.77	9.58	76.75	9.58	76.70	9.61
149.0	9.56	149.0	9.56	148.9	9.61
169.6	9.55	169.5	9.54	169.4	9.59

Table 36.--Variation of pH with reaction time for different combinations of initial pH and initial free-chlorine concentration, Mississippi River at Greenville, Miss., June 25, 1991

[CL, initial free-chlorine concentration; mg/L, milligrams per liter]

CL = 15.0 mg/L		CL = 30.0 mg/L		CL = 50.0 mg/L	
Reaction time (hours)	pH	Reaction time (hours)	pH	Reaction time (hours)	pH
0.00	5.50	0.00	5.50	0.00	5.50
1.75	6.51	1.67	6.70	1.57	7.09
30.18	6.55	30.10	6.67	30.00	7.01
54.12	6.60	54.02	6.69	53.93	7.03
77.60	6.71	77.52	6.77	77.42	7.08
124.5	6.81	124.4	6.85	124.3	7.12
146.7	6.97	146.5	7.01	146.3	7.19
173.5	6.99	173.4	7.04	173.3	7.22
0.00	7.50	0.00	7.50	0.00	7.50
2.67	8.26	3.28	8.32	2.63	8.61
31.08	8.25	31.68	8.19	31.02	8.50
55.03	8.28	55.63	8.17	54.97	8.48
78.52	8.33	79.13	8.18	78.48	8.47
125.5	8.36	126.1	8.16	125.4	8.41
147.4	8.43	147.9	8.23	147.1	8.48
174.4	8.42	175.0	8.22	174.3	8.43
0.00	10.00	0.00	10.00	0.00	10.00
0.77	10.04	0.67	10.06	0.57	10.07
29.15	9.70	29.05	9.75	28.95	9.75
53.10	9.65	53.00	9.72	52.90	9.73
76.63	9.61	76.53	9.71	76.48	9.70
123.6	9.52	123.5	9.67	123.5	9.66
145.2	9.57	145.0	9.73	144.8	9.74
172.5	9.51	172.4	9.65	172.3	9.69

Table 37.--Variation of pH with reaction time for different combinations of initial pH and initial free-chlorine concentration, Mississippi River at Natchez, Miss., June 24, 1991

[CL, initial free-chlorine concentration; mg/L, milligrams per liter]

CL = 15.0 mg/L		CL = 30.0 mg/L		CL = 50.0 mg/L	
Reaction time (hours)	pH	Reaction time (hours)	pH	Reaction time (hours)	pH
0.00	5.50	0.00	5.50	0.00	5.50
1.88	6.52	1.80	6.71	1.73	7.12
29.95	6.51	29.88	6.68	29.80	7.03
54.95	6.60	54.85	6.76	54.75	7.04
77.37	6.69	77.27	6.84	77.22	7.08
102.4	6.72	102.3	6.89	102.2	7.09
126.6	6.78	126.5	6.95	126.4	7.12
170.6	6.87	170.5	7.04	170.4	7.17
0.00	7.50	0.00	7.50	0.00	7.50
2.75	8.23	3.37	8.31	2.68	8.61
30.82	8.10	31.42	8.19	30.78	8.49
55.83	8.10	56.48	8.17	55.78	8.47
78.22	8.12	78.87	8.20	78.22	8.49
103.3	8.11	103.9	8.16	103.2	8.44
127.4	8.11	128.0	8.15	127.3	8.43
171.4	8.14	172.0	8.17	171.4	8.43
0.00	10.00	0.00	10.00	0.00	10.00
0.90	10.05	0.80	10.06	0.70	10.08
28.98	9.71	28.88	9.72	28.82	9.74
54.00	9.68	53.88	9.68	53.87	9.73
76.42	9.69	76.35	9.69	76.27	9.74
101.4	9.63	101.3	9.62	101.2	9.67
125.5	9.63	125.4	9.59	125.3	9.67
169.6	9.62	169.5	9.59	169.4	9.65

Table 38.--Variation of pH with reaction time for different combinations of initial pH and initial free-chlorine concentration, Mississippi River at Baton Rouge, La., June 23, 1991

[CL, initial free-chlorine concentration; mg/L, milligrams per liter]

CL = 15.0 mg/L		CL = 30.0 mg/L		CL = 50.0 mg/L	
Reaction time (hours)	**pH**	**Reaction time (hours)**	**pH**	**Reaction time (hours)**	**pH**
0.00	5.50	0.00	5.50	0.00	5.50
2.08	6.48	2.00	6.69	1.90	6.97
30.00	6.48	29.88	6.65	29.78	6.91
54.17	6.56	54.05	6.69	53.95	7.02
78.83	6.58	78.72	6.72	78.62	7.11
125.6	6.58	125.5	6.80	125.4	7.20
146.3	6.63	146.2	6.89	146.1	7.29
170.3	6.79	170.2	7.00	170.1	7.34
0.00	7.50	0.00	7.50	0.00	7.50
2.90	8.27	3.33	8.34	2.87	8.61
30.82	8.13	31.23	8.20	30.73	8.48
54.98	8.15	55.42	8.20	54.93	8.46
79.75	8.14	80.17	8.16	79.67	8.43
126.5	8.15	126.9	8.15	126.4	8.41
147.1	8.17	147.6	8.17	147.0	8.43
171.1	8.22	171.5	8.18	171.0	8.42
0.00	10.00	0.00	10.00	0.00	10.00
0.98	10.07	0.90	10.07	0.82	10.09
28.78	9.75	28.68	9.77	28.58	9.81
53.00	9.73	52.97	9.74	52.87	9.78
77.80	9.68	77.70	9.72	77.60	9.77
124.4	9.66	124.3	9.70	124.2	9.74
145.1	9.69	145.0	9.73	144.9	9.77
169.1	9.66	169.0	9.69	168.9	9.74

Table 39.--Variation of pH with reaction time for different combinations of initial pH and initial free-chlorine concentration, Mississippi River at New Orleans, La., August 6, 1991

[CL, initial free-chlorine concentration; mg/L, milligrams per liter]

CL = 15.0 mg/L		CL = 30.0 mg/L		CL = 50.0 mg/L	
Reaction time (hours)	pH	Reaction time (hours)	pH	Reaction time (hours)	pH
0.00	5.50	0.00	5.50	0.00	5.50
1.95	6.42	1.87	6.59	1.77	6.94
26.72	6.44	26.63	6.60	26.53	6.90
46.33	6.50	46.25	6.70	46.15	6.93
78.50	6.53	78.42	6.80	78.32	6.95
122.8	6.60	122.7	6.99	122.6	7.02
170.8	6.59	170.7	7.02	170.6	7.10
0.00	7.50	0.00	7.50	0.00	7.50
2.85	8.24	3.17	8.31	2.78	8.61
27.60	8.10	27.92	8.21	27.53	8.52
47.22	8.10	47.58	8.21	47.20	8.51
79.40	8.09	79.72	8.22	79.33	8.48
123.8	8.15	124.1	8.26	123.7	8.54
171.7	8.13	172.0	8.22	171.7	8.48
0.00	10.00	0.00	10.00	0.00	10.00
0.72	10.03	0.62	10.04	0.52	10.06
25.47	9.69	25.37	9.72	25.27	9.75
45.15	9.63	45.05	9.67	45.00	9.68
77.28	9.60	77.20	9.64	77.13	9.66
121.6	9.67	121.5	9.70	121.4	9.73
169.6	9.60	169.6	9.65	169.4	9.66

Values of pH at the End of the Trihalomethane Formation-Potential Experiments

Values of pH at the end of the THMFP experiments for each of the different combinations of initial pH and initial free-chlorine concentration are listed in table 40.

Table 40.--Values of pH at the end of the trihalomethane formation-potential experiments

[CL, initial free-chlorine concentration; mg/L, milligrams per liter]

General location	Initial pH	CL (mg/L)		
		15.0	30.0	50.0
Minneapolis, Minn.	5.50	6.66	6.60	6.82
	7.50	8.02	7.91	8.32
	10.00	9.48	9.46	9.49
LaCrosse, Wis.	5.50	6.54	6.84	7.10
	7.50	7.98	8.12	8.57
	10.00	9.32	9.38	9.48
Dubuque, Iowa	5.50	6.46	6.68	7.03
	7.50	7.89	7.91	8.49
	10.00	9.36	9.38	9.44
Davenport, Iowa	5.50	7.28	7.40	7.71
	7.50	8.36	8.36	8.65
	10.00	9.27	9.29	9.37
Quincy, Ill.	5.50	6.77	6.88	7.36
	7.50	8.22	8.41	8.70
	10.00	9.52	9.69	9.55
Missouri River	5.50	7.24	7.45	7.61
	7.50	8.02	8.07	8.42
	10.00	9.13	9.12	9.27
St. Louis, Mo.	5.50	7.35	7.63	7.87
	7.50	8.37	8.32	8.64
	10.00	9.19	9.16	9.24
Cairo, Ill.	5.50	6.92	6.97	7.49
	7.50	8.24	8.41	8.78
	10.00	9.36	9.40	9.40

Table 40.--Values of pH at the end of the trihalomethane formation-potential experiments --Continued

General location	Initial pH	CL (mg/L)		
		15.0	30.0	50.0
Ohio River	5.50	7.58	7.33	8.16
	7.50	8.54	9.05	9.29
	10.00	9.56	9.70	9.80
Memphis, Tenn.	5.50	6.83	7.08	7.53
	7.50	8.28	8.65	9.06
	10.00	9.51	9.61	9.71
Greenville, Miss.	5.50	7.16	7.32	7.73
	7.50	8.38	8.65	9.04
	10.00	9.53	9.59	9.68
Natchez, Miss.	5.50	7.19	7.31	7.83
	7.50	8.38	8.69	9.06
	10.00	9.54	9.66	9.73
Baton Rouge, La.	5.50	6.82	6.97	7.35
	7.50	8.39	8.80	9.19
	10.00	9.72	9.81	9.91
New Orleans, La.	5.50	6.83	7.08	7.56
	7.50	8.46	8.84	9.18
	10.00	9.65	9.75	9.81

Dissolved Organic-Carbon and Bromide Concentrations and Specific Conductances

DOC and bromide concentrations for each of the water samples are listed in table 41. Replicate analyses were done for DOC for all samples except the Memphis sample. One bottle of this water sample froze during storage, resulting in insufficient water. Coefficients of variation of the replicate analyses ranged from ±0.00 to ±2.13 and averaged ±0.70 percent for 13 comparisons. Bromide concentrations ranged from less than the detection limit of 0.005 mg/L for the Minneapolis and Dubuque water samples to 0.070 mg/L for the Missouri River water sample. Specific conductances of the water samples also are listed in table 41.

Table 41.--Dissolved organic-carbon and bromide concentrations and specific conductances of the water samples

[DOC, dissolved organic carbon; Br, bromide; Rep 1, replicate number 1; Rep 2, replicate number 2; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; ND, not detected; NS, no sample because of insufficient water]

General location	Concentration			Specific conductance (µS/cm)
	DOC		Br (mg/L)	
	Rep 1 (mg/L)	Rep 2 (mg/L)		
Minneapolis, Minn.	12	12	ND	387
LaCrosse, Wis.	10	10	.010	497
Dubuque, Iowa	9.8	9.9	ND	414
Davenport, Iowa	8.4	8.6	.010	427
Quincy, Ill.	6.3	6.5	.019	474
Missouri River	3.7	3.7	.070	573
St. Louis, Mo.	4.9	5.0	.043	516
Cairo, Ill.	5.3	5.1	.016	441
Ohio River	2.3	2.4	.026	280
Memphis, Tenn.	4.4	NS	.031	439
Greenville, Miss.	4.1	4.1	.033	407
Natchez, Miss.	3.8	3.8	.026	404
Baton Rouge, La.	3.7	3.8	.028	403
New Orleans, La.	3.7	3.7	.043	436

Ultraviolet Absorbances

Ultraviolet absorbances of the natural water samples and the three pH-adjusted water samples were measured at 254, 280, 330, and 400 nm, and the results are listed in table 42. The pH values of the natural water samples were not determined precisely because of the need to prepare the pH-adjusted water samples as quickly as possible so as to limit exposure of the water to the laboratory atmosphere. Approximate measurements indicated that the natural water pH's were between about 7.5 and 8.0. Meaningful absorbance measurements were not obtained for the pH=10.00 condition for the Minneapolis water sample because a slight precipitate formed, resulting in a cloudy solution when the natural water pH was adjusted to 10.00. Also, only a few absorbance measurements could be made for the LaCrosse water sample because of insufficient water.

Table 42.--Ultraviolet absorbances of the water samples

[nm, nanometer; NW, natural water; PP, precipitate problem; NS, not determined because of insufficient water]

General location	pH	Ultraviolet absorbance, in absorbance units, at wavelengths			
		254 (nm)	280 (nm)	330 (nm)	400 (nm)
Minneapolis, Minn.	NW	2.074	1.491	0.623	0.176
	5.50	2.023	1.456	.595	.158
	7.50	2.064	1.489	.625	.176
	10.00	PP	PP	PP	PP
LaCrosse, Wis.	NW	1.717	1.248	.549	.159
	5.50	1.645	NS	NS	NS
	7.50	NS	NS	NS	NS
	10.00	1.724	NS	NS	NS
Dubuque, Iowa	NW	1.678	1.216	.532	.156
	5.50	1.626	1.173	.501	.136
	7.50	1.695	1.230	.537	.156
	10.00	1.643	1.199	.535	.164
Davenport, Iowa	NW	1.446	1.048	.424	.110
	5.50	1.411	1.019	.466	.138
	7.50	1.484	1.079	.441	.128
	10.00	1.386	1.007	.451	.124
Quincy, Ill.	NW	1.050	.762	.321	.093
	5.50	1.064	.765	.311	.081
	7.50	1.073	.779	.334	.095
	10.00	.965	.696	.298	.086
Missouri River	NW	.569	.418	.183	.056
	5.50	.590	.429	.186	.054
	7.50	.580	.426	.189	.055
	10.00	.552	.404	.179	.053
St. Louis, Mo.	NW	.774	.562	.240	.073
	5.50	.809	.578	.234	.065
	7.50	.772	.563	.236	.068
	10.00	.766	.557	.246	.077
Cairo, Ill.	NW	.862	.630	.266	.078
	5.50	.894	.644	.259	.077
	7.50	.878	.639	.267	.082
	10.00	.837	.616	.257	.080

Table 42.--Ultraviolet absorbances of the water samples --Continued

General location	pH	Ultraviolet absorbance, in absorbance units, at wavelengths			
		254 (nm)	280 (nm)	330 (nm)	400 (nm)
Ohio River	NW	.327	.240	.099	.031
	5.50	.371	.266	.102	.032
	7.50	.358	.266	.113	.039
	10.00	.329	.240	.103	.033
Memphis, Tenn.	NW	.690	.499	.217	.061
	5.50	.734	.524	.215	.058
	7.50	.700	.514	.225	.063
	10.00	.692	.504	.222	.066
Greenville, Miss.	NW	.643	.462	.203	.053
	5.50	.642	.465	.194	.049
	7.50	.664	.474	.207	.057
	10.00	.651	.469	.210	.070
Natchez, Miss.	NW	.606	.440	.183	.058
	5.50	.606	.435	.181	.048
	7.50	.613	.443	.185	.056
	10.00	.610	.445	.192	.057
Baton Rouge, La.	NW	.599	.436	.185	.052
	5.50	.598	.433	.181	.047
	7.50	.612	.445	.188	.056
	10.00	.600	.434	.193	.056
New Orleans, La.	NW	.537	.385	.157	.046
	5.50	.540	.386	.155	.044
	7.50	.535	.386	.160	.046
	10.00	.545	.388	.169	.053

Error Analysis

The coefficient of variation normalized with respect to the mean concentration and expressed as a percentage was used to indicate reproducibility between duplicate samples and replicate analyses of the same sample. This coefficient of variation was computed from

$$C_v = \pm\{[C_1^2 + C_2^2 - (C_1 + C_2)^2/2]/2\}^{0.5}\,100/C_{12} \qquad (1)$$

where

C_v is the coefficient of variation;
C_1 is concentration number 1;
C_2 is concentration number 2; and
C_{12} is the mean of concentrations 1 and 2.

Values of the coefficients of variation for the analysis of duplicate THM samples and both duplicate and replicate analyses of NPTOX samples are summarized in table 43. Minimum, maximum, and mean values of the coefficient of variation together with the number of pairs of values in each comparison are listed.

Table 43.--Minimum, maximum, and mean values of the coefficient of variation for analysis of duplicate trihalomethane samples and duplicate and replicate analyses of nonpurgeable total organic halide samples

[THM, trihalomethane; NPTOX, nonpurgeable total organic halide]

Sample type	Type of analysis	Number of pairs	Coefficient of variation, in percent		
			Minimum	Maximum	Mean
THM	Duplicate	124	±0.00	±4.63	±1.44
NPTOX	Duplicate	51	±.07	±11.54	±2.69
NPTOX	Replicate	33	±.00	±7.13	±2.02

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