Quantity and Quality of Base Flow and Stormwater Runoff in Independence, Missouri--October 1991 to February 1993

By GREGG K. SCHALK

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CONVERSION FACTORS

Multiply	By	To obtain
inch	25.4	millimeter
foot	0.3048	meter
acre	0.4047	hectare
cubic foot per second	0.02832	cubic meter per second
pound, avoirdupois	0.4536	kilogram
cubic foot	0.02832	cubic meter
square mile	2.589	square kilometer

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) as follows:

$$°F = (1.8 \times °C) + 32$$

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Abstract

Samples were collected in October 1991 and January to February 1992 at 193 sampling sites to characterize base flow in Independence, Missouri. From all samples collected at the base-flow sampling sites, 5 samples exceeded a pH of 9.0, total chlorine was detected in 45 samples, total detergents were detected in 1 sample, and total copper and total phenols were not detected in any samples.

Samples were collected from July 1992 to February 1993 at five stormwater-runoff sampling sites draining single-family, multi-family, commercial, and light-industrial land uses. Fecal coliform ranged from 500 to 290,000 colonies per 100 milliliters and fecal streptococci ranged from 1,900 to 500,000 colonies per 100 milliliters in 35 first-flush samples collected from 15 storms at the 5 sampling sites. The fecal coliform to fecal streptococci ratio averaged 0.9 and ranged from 0.01 to 4.1.

At each stormwater-runoff sampling site, three flow-weighted composite samples were collected and analyzed for physical properties, common constituents, trace elements, pesticides, volatile organic compounds, and acidic, basic, and neutral semi-volatile organic compounds. Runoff loads were calculated for each constituent detected. The chemical oxygen demand ranged from 36 to 1,600 milligrams per liter. Biochemical oxygen demand ranged from 15 to greater than 650 milligrams per liter. Dissolved solids concentrations ranged from 34 milligrams per liter at a commercial site to 14,700 milligrams per liter at a light-industrial site that had large unsheltered piles of road salt. For all sites suspended solid concentrations ranged from 38 to 1,200 milligrams per liter.

Antimony, beryllium, selenium, and thallium were not detected, and silver was detected once. Mercury was detected with concentrations of 0.1, 0.2, and 0.3 microgram per liter. The following ranges of trace element concentrations (micrograms per liter) were detected: arsenic (1 to 10), cadmium (less than 1 to 40), chromium (less than 1 to 99), copper (8 to 130), lead (20 to 800), nickel (3 to 37), and zinc (110 to 6,200).

Pesticides detected include chlordane, *p,p'*-DDD, *p,p'*-DDT, diazinon, dieldrin, lindane, and Aroclor 1254. Thirteen of the 63 volatile organic compounds analyzed were detected 27 times with concentrations ranging from 0.2 to 5.1 micrograms per liter. Acidic, basic, and neutral semi-volatile organic compounds detected include di-2-ethylhexyl phthalate, fluoranthene, phenanthrene, and pyrene.

INTRODUCTION

During 1990 the U.S. Environmental Protection Agency (USEPA) mandated that all cities with a population of 100,000 or greater be required to submit a stormwater discharge permit application under the National Pollution Discharge Elimination System (NPDES) program. The purpose of the permit is to establish an approach to control pollutants in stormwater (U.S. Environmental Protection Agency, 1990). The permit application requires characterization of water discharges to the municipal storm sewer system. The U.S. Geological Survey (USGS), in cooperation with the city of Independence, Missouri, began a study in July 1991 to:

1. Characterize the quantity and quality of water discharging (base flow) from selected conveyances within the city limits of Independence during dry-weather periods.
2. Characterize the quantity and quality of stormwater runoff from five selected homogenous land-use basins in Independence.

Purpose and Scope

The purpose of this report is to document site descriptions, data collection techniques, and laboratory analytical methods and to present the water quantity and quality results collected from base-flow sampling from October 1991 to February 1992 and from stormwater runoff from July 1992 to February 1993.

The scope of this report includes measurements of discharge, specific conductance, pH, and water temperature and concentrations of total chlorine, total copper, total detergent, and total phenols from 226 samples collected at 193 sites preceding 72 hours of dry weather. This report also includes results from stormwater runoff analyzed for bacteria, physical properties, common constituents, trace elements, pesticides, volatile organic compounds, and semi-volatile acidic, basic, and neutral methylene chloride extractable organic compounds (hereafter referred to in this report as acidic, basic, and neutral organic compounds) from 15 storm samples from 5 urban land-use sites. Stormwater runoff volume and loads were calculated for each storm at each site. Volume and loads were simulated using data from this report and methods described by Driver and Tasker (1990).

Description of Study Area

The city of Independence (fig. 1) is located in the west-central part of Missouri and lies on the eastern side of the Kansas City metropolitan area adjacent to the eastern city limits of Kansas City, Missouri. During 1990 the population of Independence was 112,301 (City of Independence, 1993).

Independence occupies about 78 mi^2 (square miles) and is primarily a suburban community with commercial areas developed along the arterial streets. Independence is composed of 59 percent urban land and 41 percent non-urban land (agricultural and undeveloped land). Of the urban land 61 percent is single-family residential, 6.1 percent is commercial, and 2.4 percent is multi-family residential. The only heavy industrial area is limited to the Lake City Army Ammunition Plant, which is 12.6 percent of the urban land use. Light industrial land uses cover 1.9 percent of the urban land use, and a vacant-surface, industrial underground site covers 2.2 percent of urban land use. The remaining 14 percent of the urban land use includes public facilities, municipal waste facilities, and golf courses.

The average annual precipitation for the area is 35.2 in. (inches; National Oceanic and Atmospheric Administration, 1991). Of the annual precipitation, an average of 24.4 in. occurs during April through September. The mean minimum January temperature in the study area is 17.2 °F (degrees Fahrenheit), and the mean daily maximum July temperature is 88.5 °F. The 24-hour, 2-year recurrence-interval rainfall is 3.5 in. (Hershfield, 1961).

All of the larger streams in Independence drain north into the Missouri River. These larger streams include Fire Prairie Creek, Little Blue River, Mill Creek, Rock Creek, and Sugar Creek (fig. 1). The Little Blue River and its tributaries drain about two-thirds of the city. The tributary streams of the Little Blue River that drain Independence include Adair Creek, Bundschu Creek, Burr Oak Creek, Crackerneck Creek, East Fork Little Blue River, and Spring Branch Creek (fig. 1). Ditches, gutters, curbs, swales, and ephemeral stream tributaries drain a major part of the developed area to the perennial streams. Subterranean storm sewers drain newly developed areas, main arterial roads, and densely populated areas.

Acknowledgments

The author expresses appreciation to Dick Champion, director of the Independence Water

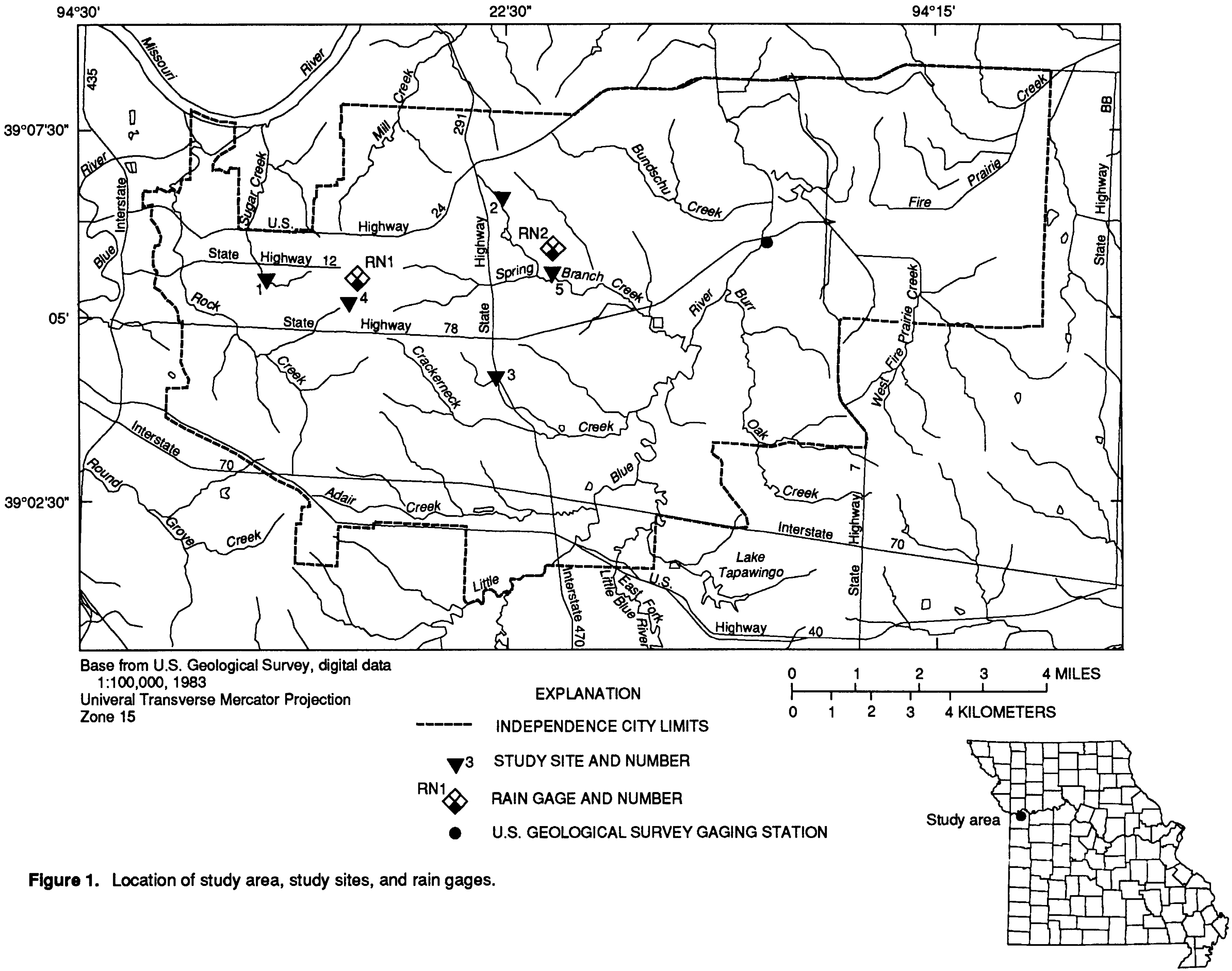


Figure 1. Location of study area, study sites, and rain gages.

Pollution Control Department; Steve Spydell, Independence Water Pollution Control Department; personnel from the Independence Water Pollution Control Sewer Maintenance Department for assistance in construction of the sampling site; and Jane Henry, Independence Water Pollution Control Laboratory for the coordination of the biochemical oxygen demand analysis. University of Missouri 4-H extension center, Independence, and private citizens allowed data collection equipment on their property.

BASE-FLOW SAMPLING METHODS

To determine quantity of water discharging and selected constituent concentrations during base flow (referred to by the USEPA as dry-weather screening) into the streams of Independence, samples were collected in all basins. These samples were collected after 72 hours of no precipitation to ensure that water sampled was not from stormwater runoff.

Site Selection

Because perennial streams and other open-channel conveyances drain most of Independence, a systematic procedure was developed to locate sampling sites based on these drainage characteristics. This procedure identified sites in conveyances with base flow. Sample sites were selected at the farthest downstream point in each stream basin that had a cross section adequate for a discharge measurement. Site selection continued upstream until no flow was present. Upstream sample sites were located at flowing outfalls, upstream from flowing outfalls, at the mouth of flowing tributaries, upstream from flowing tributaries, and at selected sites along the stream. Base-flow sampling sites were established at 193 points in the city limits of Independence (fig. 2).

Data Collection

Discharge and water-quality data were collected at the 193 samples sites (fig. 2). Discharge, specific conductance, pH, water temperature, and concentrations of total chlorine, total copper, total detergents, and total phenols were measured either onsite or within 48 hours of sample collection. Discharge was measured using either volumetric methods or by a pygmy current meter (Rantz and others, 1982). Specific conductance was measured within 48 hours after sample collection at the USGS in Independence with a meter calibrated in the range encompassing the water sample and reported in microsiemens per centimeter at 25 °C (degrees Celsius). The pH of the water was measured at the time of collection with an electronic meter calibrated in the pH range of 4.0 to 10.0. Water temperature was measured at the time of collection using a mercury thermometer and reported to the nearest 0.5 °C.

Concentrations of total chlorine, total copper, total detergents, and total phenols were measured using colorimetric reagents and methods developed by the Hach Company[1]. Total chlorine concentrations were determined at the time of collection. Concentrations of total copper, total detergents, and total phenols were determined at the USGS in Independence within 48 hours from the time of sample collection. The Hach methods are considered semiquantitative because no quality assurance samples were collected to verify the precision and accuracy of the analytical methods.

STORMWATER-RUNOFF SAMPLING METHODS

To determine the quantity and quality of stormwater runoff, discharge and rainfall depths were measured and water-quality and quality assurance samples were collected and analyzed. Constituent loads were computed for each constituent detected. The data collected for this study are stored in the USGS National Water Data Storage and Retrieval System (WATSTORE).

Site Selection

Sites 1 to 5 (fig. 1) were selected for the purpose of monitoring water quantity and quality from stormwater runoff from specific land uses

[1]Use of trade or firm names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

within Independence (table 1, at the back of this report). Site 1 is downstream from a single-family housing area, site 2 from a multi-family housing area, sites 3 and 4 from commercial areas, and site 5 from a light industrial area. Selection of each study site was based on homogenous land use, suitable hydrologic controls for a reliable stage to discharge rating, and accessibility and safety.

Drainage and impervious areas for the study sites were computed from the topographic planning maps on file with the city of Independence and site visits. Land-use percentages were computed using a geographical information system data base of land-use coverages compiled by Independence and visits for sites 1 to 4. Site 5 land-use data were computed using topographic planning maps and site visits.

Site 1 (fig. 1) is downstream from a fully developed single-family housing area. The basin drains 86 percent single-family housing, 4 percent commercial, 4 percent multi-family housing, 3 percent light industrial, and 3 percent public facilities. The approximate population density in the basin is 3,810 persons per square mile (City of Independence, 1993). Street gutters, ditches, and natural open channels are the primary conveyances that drain this basin. The stage to discharge relation is controlled by a culvert at high flow and by the stream channel at low flow.

Site 2 (fig. 1) is downstream from a multi-family housing area. This basin primarily has residential dwellings consisting of apartments and duplexes. The basin drains 69 percent single and multi-family housing, 17 percent commercial, and 14 percent vacant land. The population density in the basin is approximately 5,062 persons per square mile (City of Independence, 1993). Street gutters and underground storm sewers are the primary conveyances that drain this basin. The stage to discharge relation is controlled by a culvert at high flow and by the stream channel at low flow.

Site 3 (fig. 1) is downstream from a commercial area. This basin has various types of commercial facilities, including a large retail store, two strip malls, several restaurants, convenience stores, a car wash, and a storage facility. State Highway 291 crosses the basin. The basin drains 62 percent commercial land use, 24 percent single-family housing, 9 percent multi-family housing, and 5 percent public facilities. The population density in the basin is approximately 2,324 persons per square mile (City of Independence, 1993). Gutters and underground storm sewers are the main conveyances that drain the area. The stage to discharge relation is controlled by a culvert at high flow and by the stream channel at low flow.

Site 4 is downstream from the downtown commercial area of Independence. The basin drains approximately 53 percent single-family housing, 24 percent commercial, 16 percent public facilities, 5 percent light industry, and 2 percent multi-family housing. The population density in the basin is approximately 3,739 persons per square mile (City of Independence, 1993). Gutters and underground storm sewers are the main conveyances that drain the area. The stage to discharge relation is controlled by a culvert at high flow and by the stream channel at low flow.

Site 5 is downstream from a light industrial area. The basin drains 71 percent light industry, 22 percent vacant ground, and 7 percent salt-pile storage area for road deicing. No residential housing exists in this basin. Overland flow, gutters, and underground storm sewers are the main conveyances that drain the area. For this site, the stage to discharge relation control is a man-made grass-lined channel.

Data Collection

Continuous-streamflow records at the five stormwater-runoff sampling sites were collected with a float and stilling-well combination (Buchanan and Somers, 1978). Continuous stream stage was recorded in 5-minute increments. Stage also was collected manually while sampling stormwater runoff. Stage data were collected at 0.01-ft (foot) increments. Stream stage was related to current-meter streamflow measurements (Buchanan and Somers, 1976) and to indirect measurement computations (Benson and Dalrymple, 1967) to prepare stage-discharge ratings (Kennedy, 1983). Indirect measurement computations for culverts (Bodhaine, 1976) were made at sites 1, 2, 3, and 4. Indirect measurement computations using the slope-area method (Dalrymple and Benson, 1967) were made at site 5.

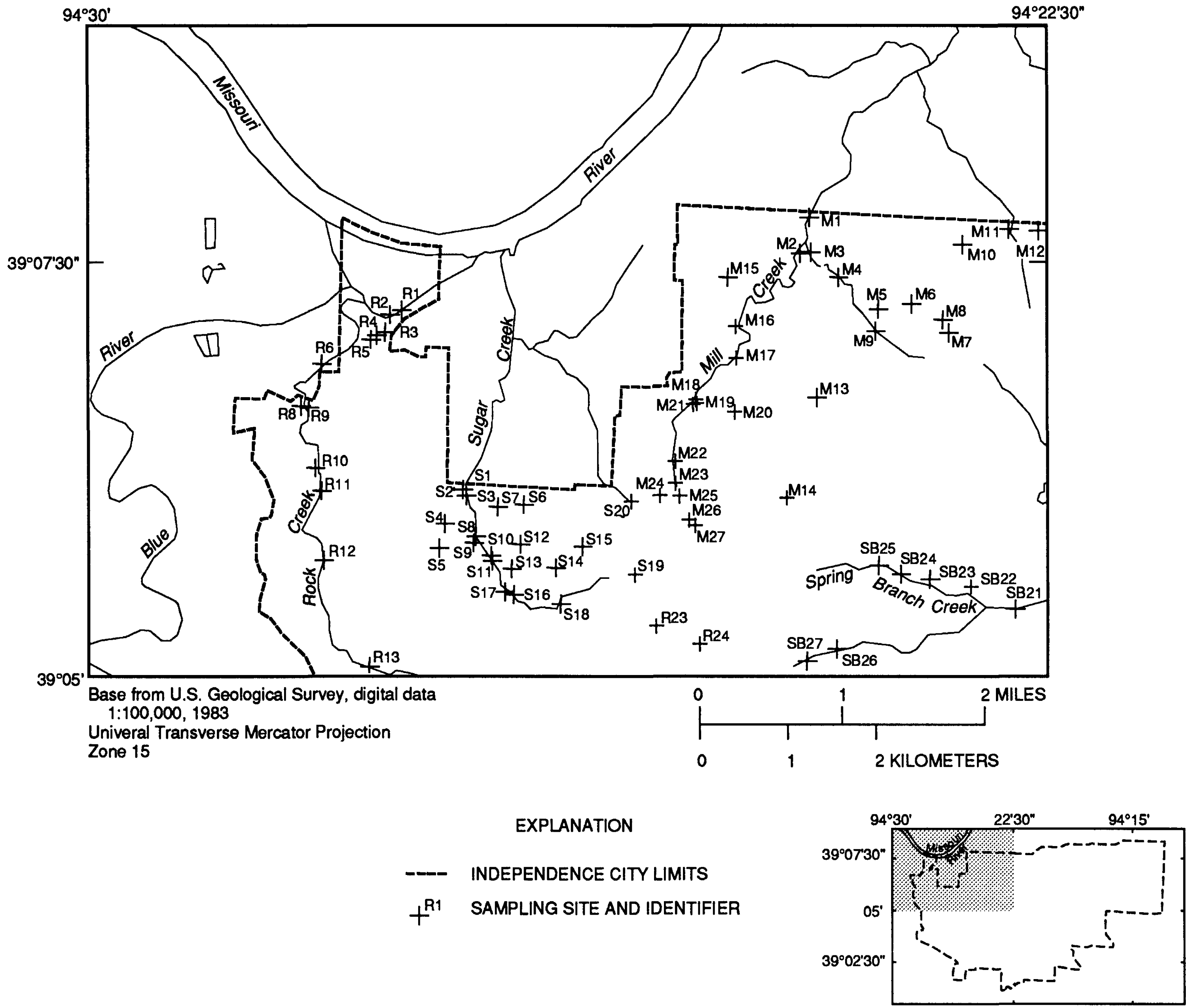
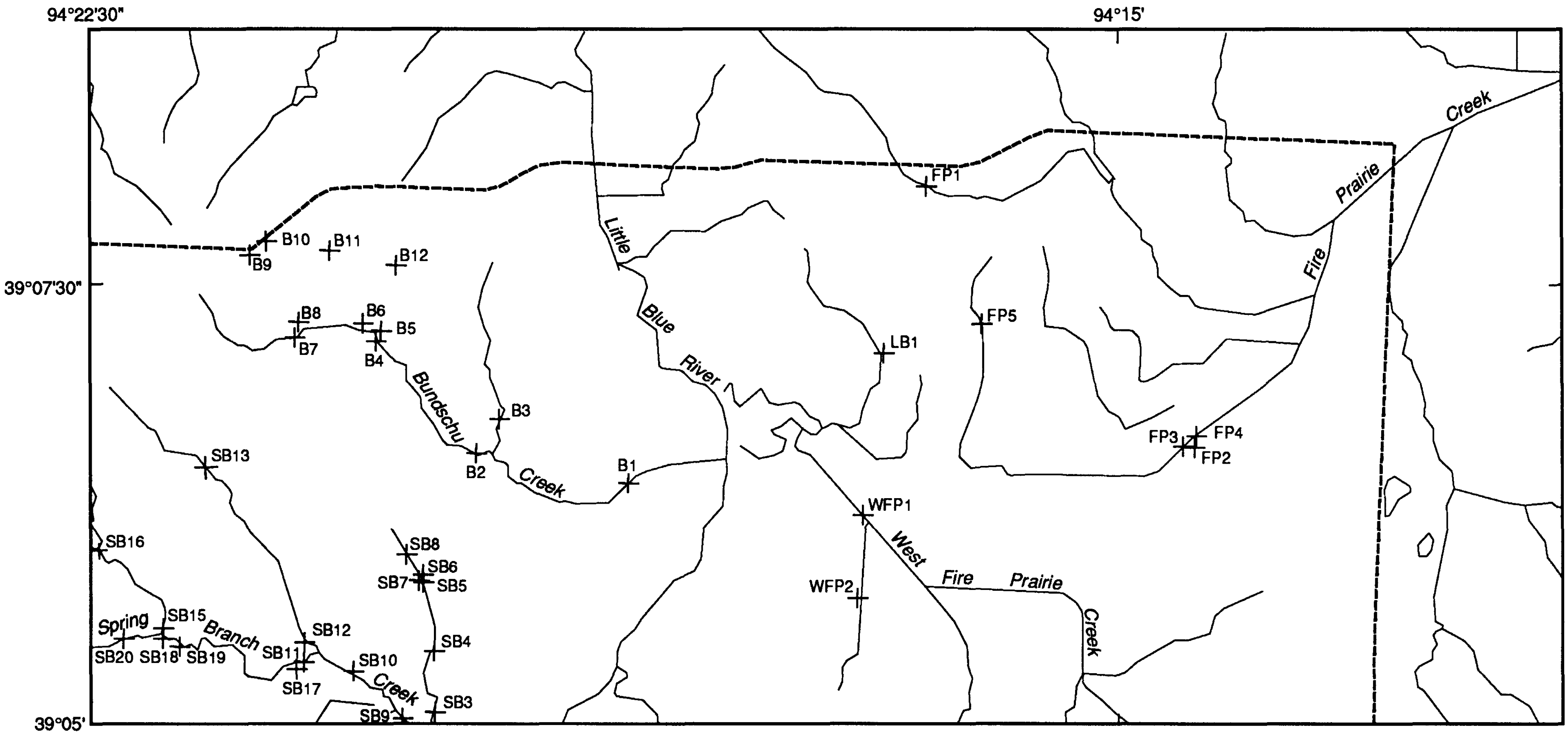


Figure 2. Location of base-flow sampling sites.



Base from U.S. Geological Survey, digital data
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Univeral Transverse Mercator Projection
Zone 15

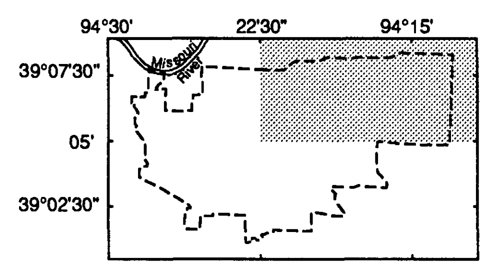


Figure 2. Location of base-flow sampling sites--Continued.

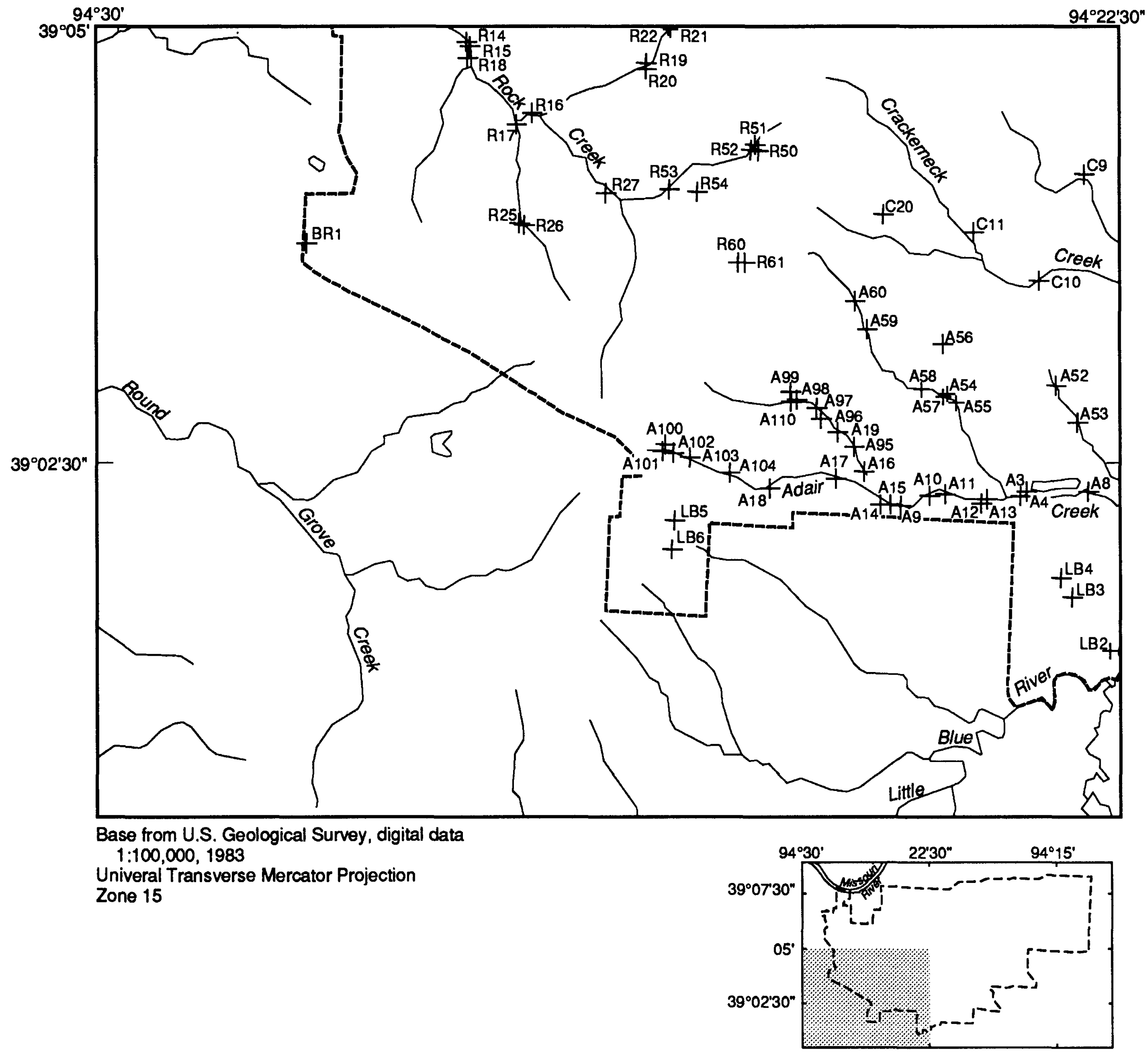
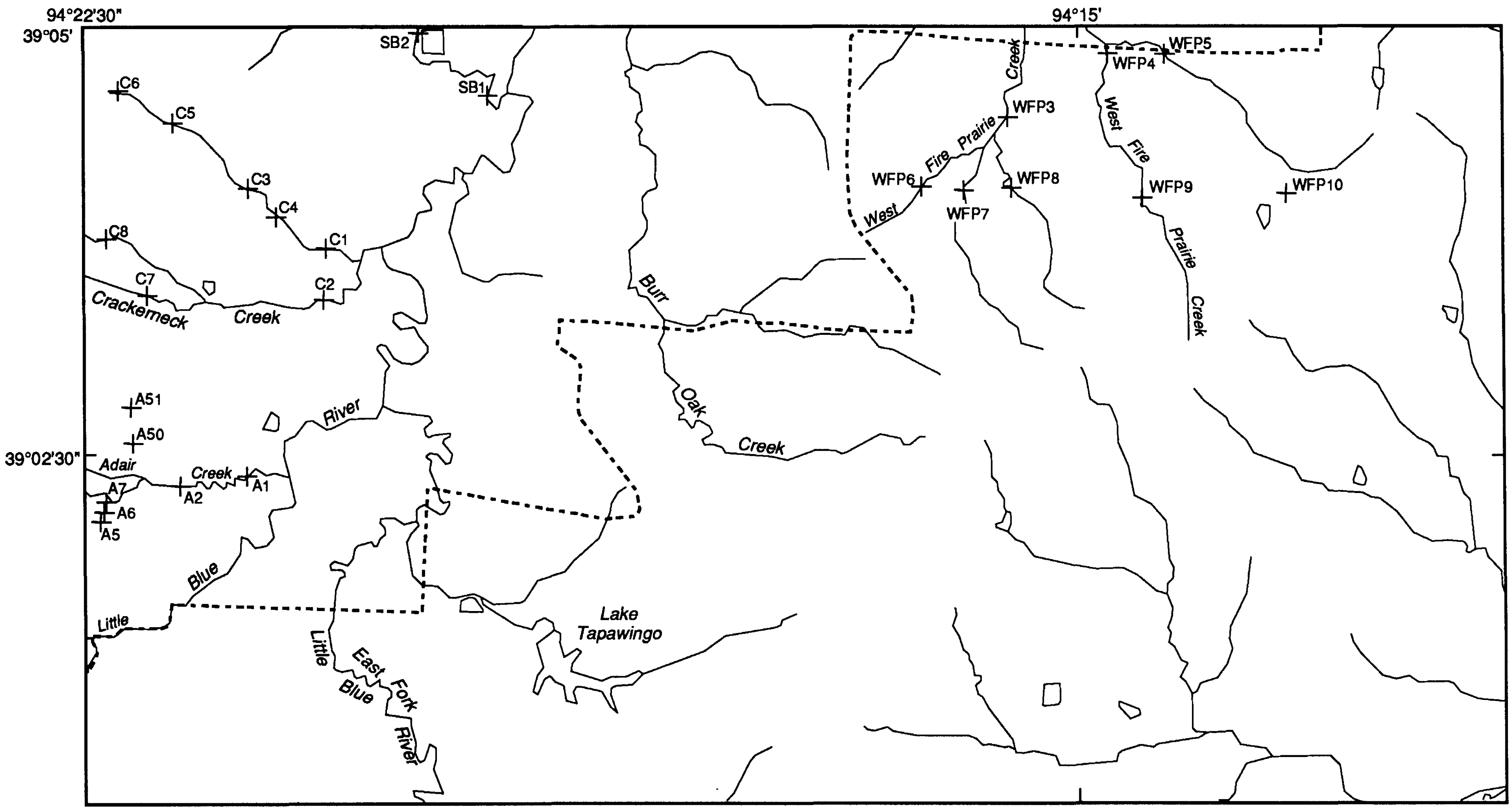


Figure 2. Location of base-flow sampling sites--Continued.



Base from U.S. Geological Survey, digital data
1:100,000, 1983
Univeral Transverse Mercator Projection
Zone 15

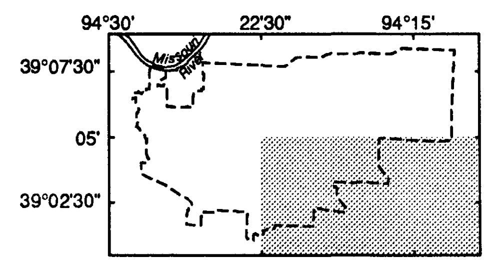


Figure 2. Location of base-flow sampling sites--Continued.

Continuous rainfall data were collected at two USGS sites, RN1 and RN2 (fig. 1). Rainfall data-collection sites were chosen to represent depths of rainfall at the sampling sites (table 1). Criteria for selecting rain gage locations included geographical location and overhead clearance above rain gage. The instrumentation for a rain gage included a 5-minute-interval analog data recorder connected to a float inside a rainfall collection pipe. Rainfall data were collected at 0.01-in. increments.

Stormwater runoff was sampled at least 72 hours after the previous storm of 0.1 in. or more of rain. Samples were either collected at one location in the stream or at several locations across the stream at equal width increments. Stormwater-runoff samples were collected using a hand-held bottle.

Stormwater-runoff samples for physical properties, inorganic compounds, and organic compounds were of two types. Within the first 30 minutes of runoff, samples were collected for bacteria, total chlorine, cyanide, phenols, and oil and grease in the approved bottle (tables 2 and 3, at the back of this report; the sample for bacteria analysis was collected in a sterilized polyethylene bottle). Collectively, these samples are classified as the first-flush sample. Within the first 30 minutes and also throughout the duration of the runoff, a discrete sample was collected for a flow-weighted-composite sample. The discrete sample was collected directly into a 1-gal (gallon) narrow-mouth brown glass bottle for analyses of all constituents except volatile organic compounds. The discrete sample for volatile organic compound analysis was collected in a 40-mL (milliliter) brown septum-capped bottle. To compute the volume of each discrete sample to be included in the flow-weighted-composite sample, the following method used was based on the mid-interval method of subdividing described by Porterfield (1977) and adjusted to account for variable time intervals:

$$v(n) = \frac{q(n)}{Q} \times V(t) \qquad (1)$$

where v(n) is the volume of discrete sample to be added to the composite sample;

q(n) is the total volume of discharge that occurred from one-half the time since the previous sample until one-half the time to the next sample. The first sample volume is computed from the beginning of the storm-water runoff to one-half the time to the second sample. The last sample volume is computed from one-half the time since the previous sample to the end of the stormwater runoff;

Q is total volume of stormwater runoff; and

V(t) is total composite volume required.

The 1-gal discrete samples were composited at the USGS, Independence, within 24 hours of collection to obtain the flow-weighted composite sample. This sample was split into subsamples using a cone splitter and a churn splitter for the different preservation and analytical methods. The cone splitter was used to initially split the composite sample into 10 subsamples within a 3 percent equal volume and suspended sediment concentration (Ward and Harr, 1990). From these 10 subsamples, samples for organic compounds were split using the cone splitter and samples for inorganic compounds were split using the churn splitter. The 40-mL discrete samples for volatile organic compound analysis were composited at the USGS, Arvada, Colorado.

Volume and Loads

A volume is the total quantity of water contributed from a basin by stormwater runoff passing a designated point in a given period of time. A volume was calculated for the duration of stormwater runoff using the discharge hydrograph. A load is the total quantity of a particular constituent contributed from a basin by stormwater runoff passing a sample point in a given time.

Simulated stormwater-runoff volumes in cubic feet and stormwater-runoff constituent loads in pounds were calculated using the regional regression models for the stormwater-runoff volume and loads presented in Driver and Tasker (1990). Site specific, climatic, and storm characteristic data from this report were used with the regression models to simulate stormwater-runoff volume and loads. For each site the physical and land-use information needed to simulate a stormwater-runoff volume or load included drainage area, percentage of impervious area, population density, and percentage of land use, including residential, commercial, industrial, and nonurban. The climatic characteristics needed to simulate a stormwater-runoff volume or load were total storm rainfall, maximum 24-hour precipitation intensity that had a 2-year recurrence interval, mean annual rainfall, mean annual nitrogen load in precipitation, and mean minimum January temperature. For this study, stormwater-runoff volume and loads were simulated using measured total rainfall from storms sampled. The approximate mean annual nitrogen load in precipitation is 13.3 pounds per acre [National Atmospheric Deposition Program (IR-7)/National Trends Network, 1982-91]. The regression models simulated stormwater-runoff loads for chemical oxygen demand, dissolved and suspended solids, total nitrogen, total ammonia plus organic nitrogen, and total cadmium, copper, lead, and zinc.

Laboratory Analysis

Water temperature, fecal coliform, fecal streptococci, and concentrations of total chlorine, total cyanide, total phenols, and total oil and grease were determined for the first-flush sample. Water temperature and total chlorine concentration were determined at the time of sample collection using methods described for base-flow sampling. Fecal coliform and fecal streptococci colony densities were determined using membrane-filter methods described in Britton and Greeson (1989) at the USGS in Independence. Samples for total phenols and total oil and grease were analyzed by the USGS, Arvada, Colorado, using the methods and detection limits listed in table 2. Total cyanide was analyzed by Enseco Rocky Mountain Analytical Laboratory, Arvada, Colorado, using the methods and detection limits listed in table 3.

The physical properties and chemical constituent analyses, methods, and detection limits used by the USGS, Arvada, Colorado for the flow-weighted-composite samples are listed in table 2. Total antimony, total silver, and total thallium concentrations in the flow-weighted-composite sample were analyzed by Enseco Rocky Mountain Analytical Laboratory using methods and detection limits listed in table 3. The 5-day biochemical oxygen demand (hereafter referred to as biochemical oxygen demand) sample from the flow-weighted composite sample was split into a 1-L (liter) polyethylene bottle and analyzed at the city of Independence Water Pollution Control Laboratory, using the USEPA method 405.1 (5 days at 20 °C; U.S. Environmental Protection Agency, 1983) within 24 hours of sample collection.

Chemical constituents reported as total, total recoverable, or whole-water recoverable were analyzed from unfiltered samples. Dissolved constituents from the flow-weighted composite samples were determined from water samples filtered through a 0.45-μm (micrometer) filter using a peristaltic pump.

Analyses of the flow-weighted-composite samples for specific conductance, pH, alkalinity and bicarbonate concentrations were done at the USGS in Independence. Specific conductance and pH were determined by methods described in the base-flow sampling methods. Alkalinity and bicarbonate concentrations were determined by incremental titrations with 0.16 N (normal) sulfuric acid past the inflection point of the titration curve that occurs at a pH of about 4.5.

Quality Assurance Samples

The representativeness of sample collection and handling was assessed by analyzing equipment and trip blanks, replicate samples, and matrix spiked sample sets. An equipment blank was analyzed for all properties and constituents listed in tables 2 and 3, except for biochemical oxygen demand.

Organic- and inorganic-free blank water was passed through all sample collection processing devices and treated as a regular flow-weighted composite sample. All constituent concentrations analyzed for in the equipment blank were less than the detection limit, except for the chemical oxygen demand [96 mg/L (milligrams per liter)], dissolved calcium (0.03 mg/L), dissolved phosphorus (0.03 mg/L), total ammonia as nitrogen (0.12 mg/L), suspended solids at 105 °C (5 mg/L), total organic carbon (27 mg/L), chromium [3 µg/L (micrograms per liter)], and methylene chloride (0.03 mg/L). The cleaning procedure used for equipment, rinsing with methanol, probably resulted in the large chemical oxygen demand and total organic carbon concentrations. On recognition of the data anomalies, the cleaning procedure was modified to exclude the use of methanol.

A trip blank was analyzed for volatile organic compounds to determine if diffusion of these compounds occurred through the septum caps during shipping and storage. A trip blank is a sample of organic-free water filled and shipped with the empty sample collection bottles and taken to the study sites with the collection bottles, never opened onsite, and returned to the laboratory with the samples. One trip blank was analyzed for samples collected at site 3 on July 9, 1992. All constituents were less than the detection limits, except for methylene chloride, which had a concentration of 0.5 µg/L (detection limit was 0.2 µg/L).

Analysis of replicate samples was used to assess the precision of sample collection from sample splitters, shipping and storage, and laboratory analyses (M.W. Sandstrom, U.S. Geological Survey, written commun., 1990). Replicate samples for inorganic analyses were split from a flow-weighted-composite sample using a churn splitter. The data for the inorganic replicate samples are listed in table 4, at the back of this report.

Matrix spiked sample sets were analyzed to determine analytical recoveries for the different conditions that a sample undergoes. Matrix spiked sample sets for pesticides and acidic, basic, and neutral organic compounds included two replicate field spiked samples, a replicate laboratory spiked sample, and a replicate unspiked sample. A matrix spiked sample set for volatile organic compounds included a replicate laboratory spiked sample and a replicate unspiked sample. All samples were split from a flow-weighted composite sample using a cone splitter and spiked with a selected set of analytes of known concentrations onsite for replicate field spiked samples and at the laboratory for laboratory spiked samples. Comparison of the two replicate field spiked samples was used to assess the precision of the sample collection from the cone splitter, shipping and storage conditions, and laboratory analyses. Degradation during shipping also can be assessed from the results of a replicate laboratory spiked sample and a replicate field spiked sample. The replicate unspiked sample is analyzed to determine the ambient constituent concentrations. If a constituent is detected in the unspiked sample, the concentration is then subtracted from the constituent concentration determined in the other three replicate spiked samples to compute the percent recoveries. Concentrations and percent recoveries for the matrix spiked sample sets for pesticides are listed in tables 5 and 6, at the back of this report. Results for the matrix spiked sample sets for acidic, basic, and neutral organic compounds are listed in table 7, at the back of this report, and results for the matrix spiked sample sets for volatile organic compounds are listed in table 8, at the back of this report.

BASE-FLOW DATA

A total of 226 samples were collected at 193 sites (fig. 2). Some sites were sampled more than once because concentrations of selected constituents were previously detected in a sample or were expected to be present from certain land uses. For each sample, discharge, specific conductance, pH, water temperature, total chlorine, total copper, total detergents, and total phenols were determined. A summary of the results is listed in table 9, at the back of this report. The maximum discharge, 10.1 ft^3/s (cubic feet per second), was measured near the mouth of Rock Creek (fig. 2). The pH of five samples exceeded 9.0 and these samples had a range of discharge from 0.003 to 0.15 ft^3/s and a range of specific conductance from 507 to 773 µS/cm (microsiemens per centimeter at 25 °C). Total chlorine was detected 45 times at 39 sites, with a maximum concentration of 0.9 mg/ L. Total copper and total phenols were not detected at any of the sites. Total detergents were detected at site S19 (fig. 2) with a concentration of 0.3 mg/L at a discharge of 0.02 ft^3/s. The results for the base-flow samples are listed in table 10, at the back of this report.

Stormwater-Runoff Sampling Data

The following sections contain data from stormwater-runoff sample collection at sites 1 to 5 from July 9, 1992, through February 11, 1993. These sections discuss rainfall, bacteria, inorganic and organic compound concentrations, and observed and simulated loads.

Rainfall and Discharge Characteristics

The rainfall and discharge characteristics for the storms sampled from sites 1 to 5 are listed in table 11, at the back of this report. Rainfall intensities and discharge hydrographs of the storms sampled are shown in figures 3 to 7. All of the storms sampled had more than 0.10 in. rainfall. At the time of sampling there had been less than 0.10 in. of rainfall in the 72 hours preceding the storm, except for the stormwater runoff sampled at site 3 beginning on July 9, 1992 (which had 0.10 in. of rainfall). The rainfall depths for the storms sampled ranged from 0.22 to 0.98 in. Rainfall depths for the storms at site 3 on July 9 to 10, 1992, were collected from the rain gage at site RN1 and the depth at site 2 on July 22, 1992, was collected from an onsite non-recording rain gage, because of equipment malfunction at rain gage RN2 at the time of the storms. Rainfall durations ranged from 20 to 324 minutes. The storm sampled at sites 1 and 4 on February 11, 1993, was preceded by 9 in. of snow that had almost melted at the time of the storm. The percentage of discharge from precipitation during sampled storms ranged from 6 percent at site 1 to 66 percent at site 3.

Bacteria

Analyses of bacteria from sites 1 to 5 are listed in table 12, at the back of this report. Fecal coliform ranged from 500 col/100 mL (colonies per 100 milliliters) at site 4 to 290,000 col/100 mL at site 1; 14 of 35 estimated colony counts at all sites were based on non-ideal colony counts. Fecal streptococci ranged from 1,900 col/100 mL at site 2 to 500,000 col/100 mL at site 1; 8 of 35 estimated colony counts at all sites were based on non-ideal colony counts. A fecal coliform to fecal streptococci ratio of 4.0 or more indicates human wastes and a ratio of 0.7 or less indicates animal waste (Henry and Heinke, 1989). The ratio from 35 bacteria samples averaged 0.9. The minimum fecal coliform to fecal streptococci ratio was 0.01 at site 5, and the maximum fecal coliform to fecal streptococci ratio was 4.1 at site 5. The discharge at the time of bacteria sample collection ranged from 0.31 ft^3/s at site 5 to 260 ft^3/s at site 3.

Constituent Concentrations

For the first-flush samples total chlorine concentrations ranged from less than 0.1 to 0.2 mg/L with two detections from seven samples (table 12). Total cyanide was not detected in 13 first-flush samples. Total phenols ranged from less than 1 to 7 µg/L for 13 samples with 12 detections. Total oil and grease ranged from less than 1 to 16 µg/L for 13 samples with 8 detections. Discharge at the time of sample collection for the first-flush samples ranged from 0.40 ft^3/s at site 5 to 260 ft^3/s at site 3.

The values of selected physical properties and constituent concentrations of the flow-weighted composite samples are listed in table 13, at the back of this report. Specific conductance ranged from 68 µS/cm at site 3 to 26,500 µS/cm at site 5. The chemical oxygen demand for all sites ranged from 36 µg/L to 1,600 µg/L at site 3. The biochemical oxygen demand ranged from 13 mg/L at site 3 to greater than 650 mg/L at site 1. Dissolved solids

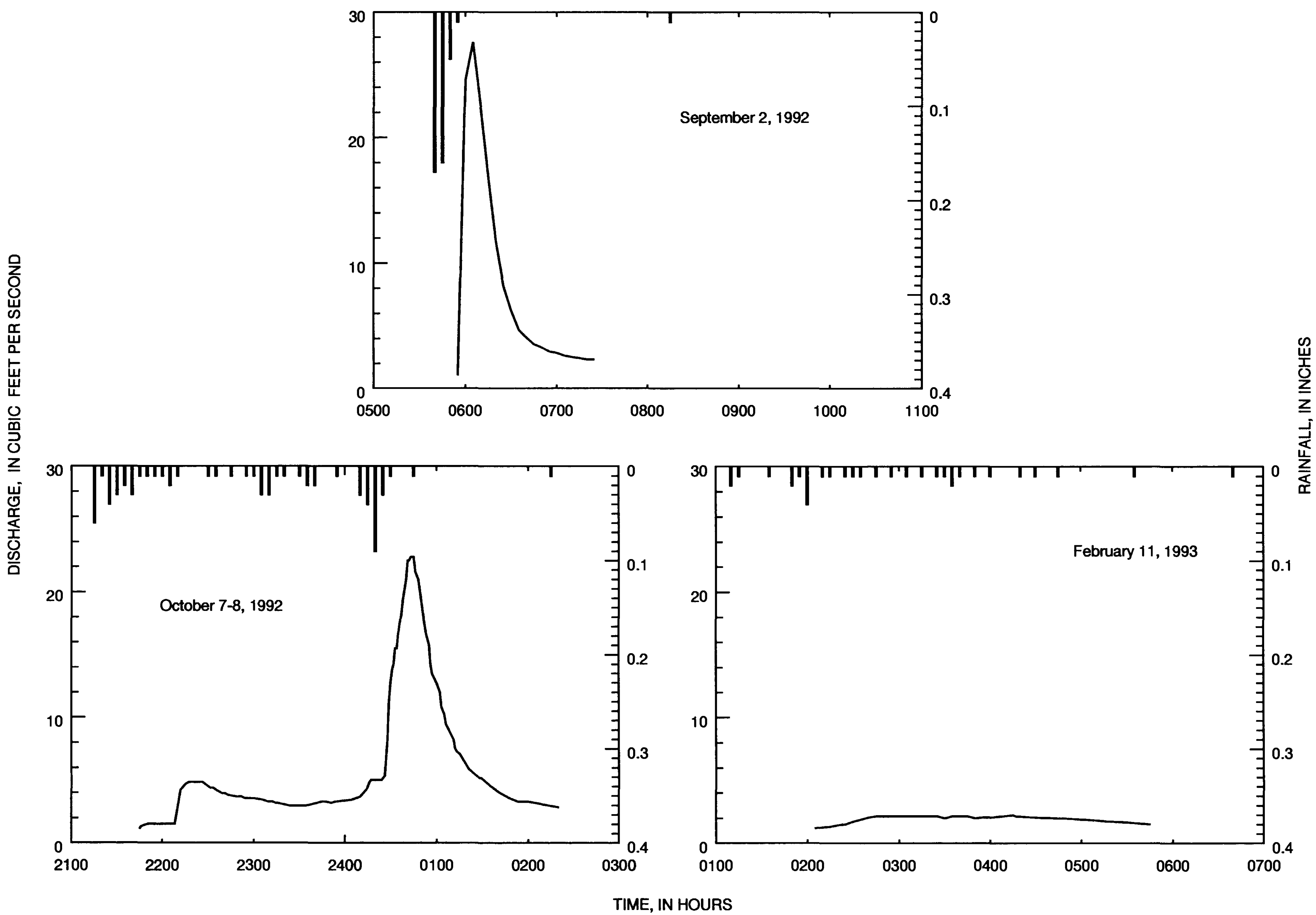


Figure 3. Rainfall intensities and discharge hydrographs for each storm event sampled at site 1.

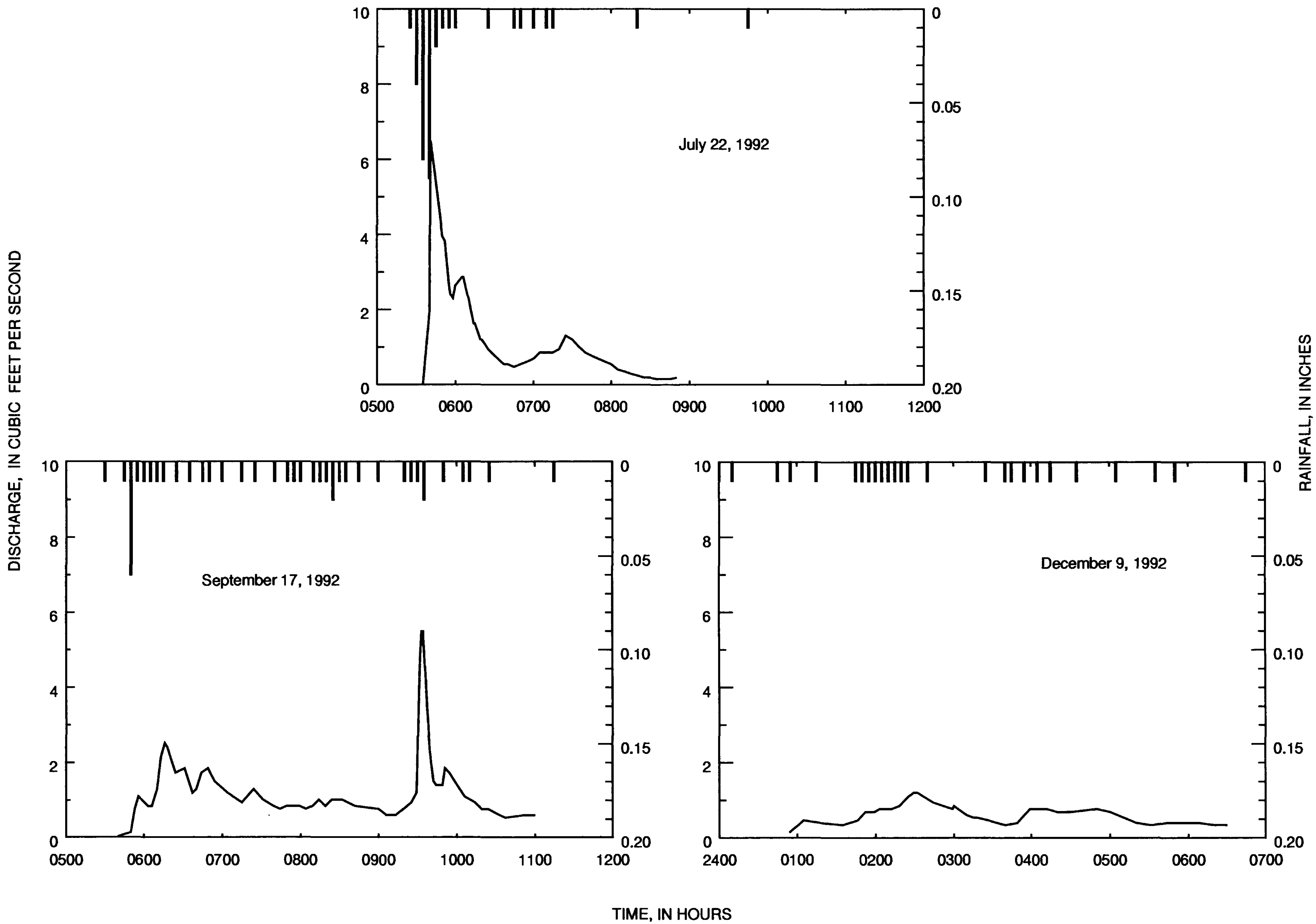


Figure 4. Rainfall intensities and discharge hydrographs for each storm event sampled at site 2.

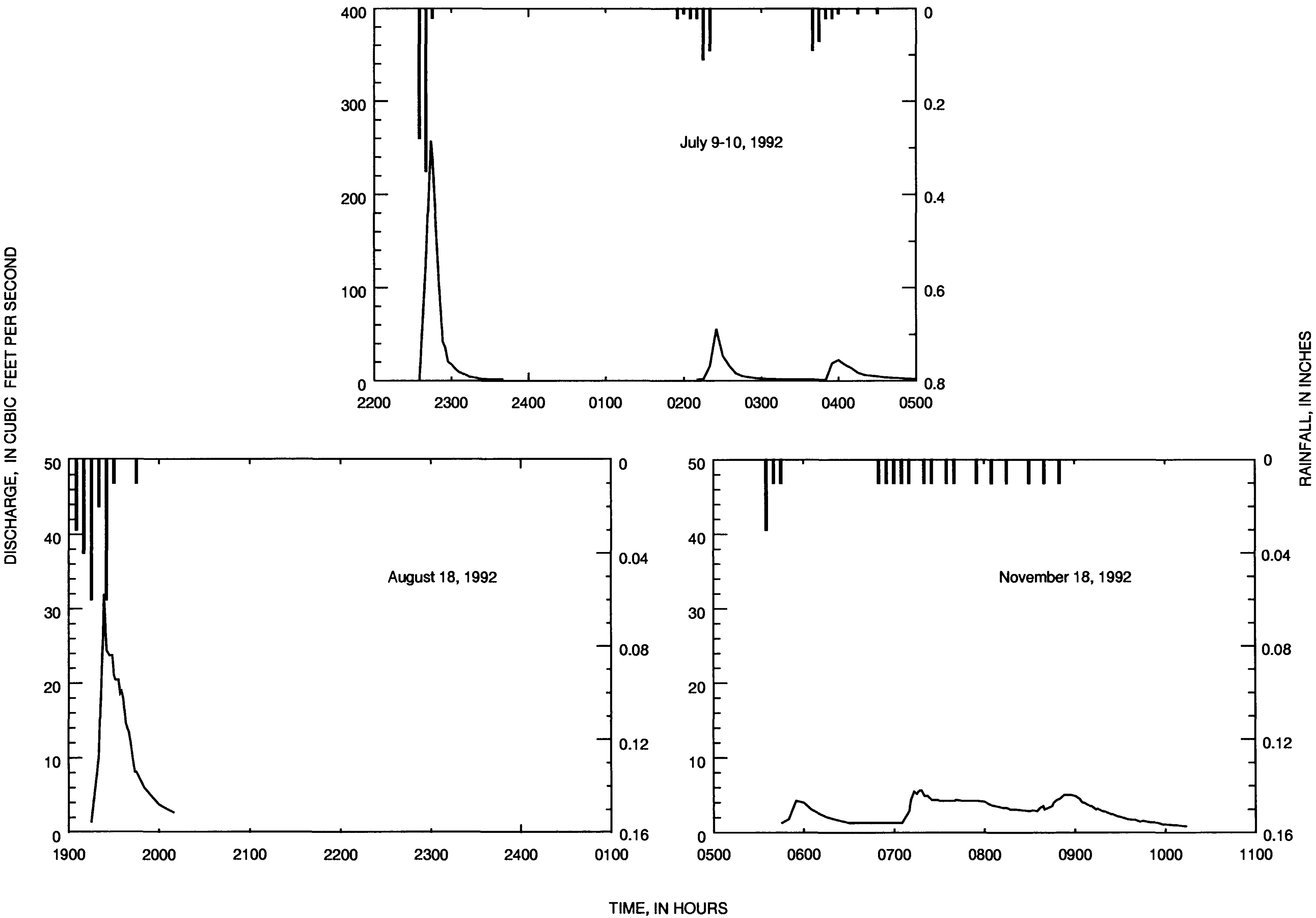


Figure 5. Rainfall intensities and discharge hydrographs for each storm event sampled at site 3.

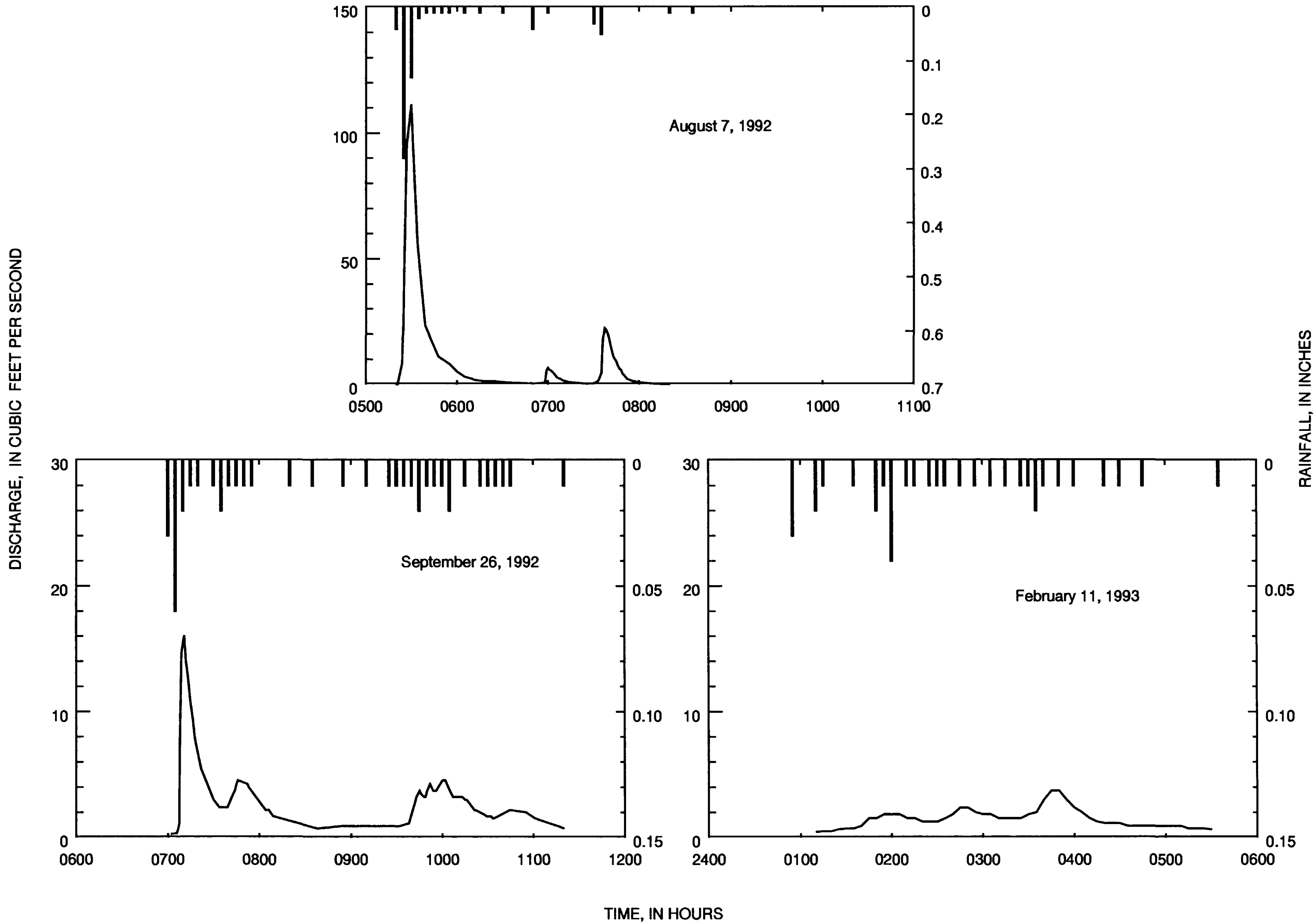


Figure 6. Rainfall intensities and discharge hydrographs for each storm event sampled at site 4.

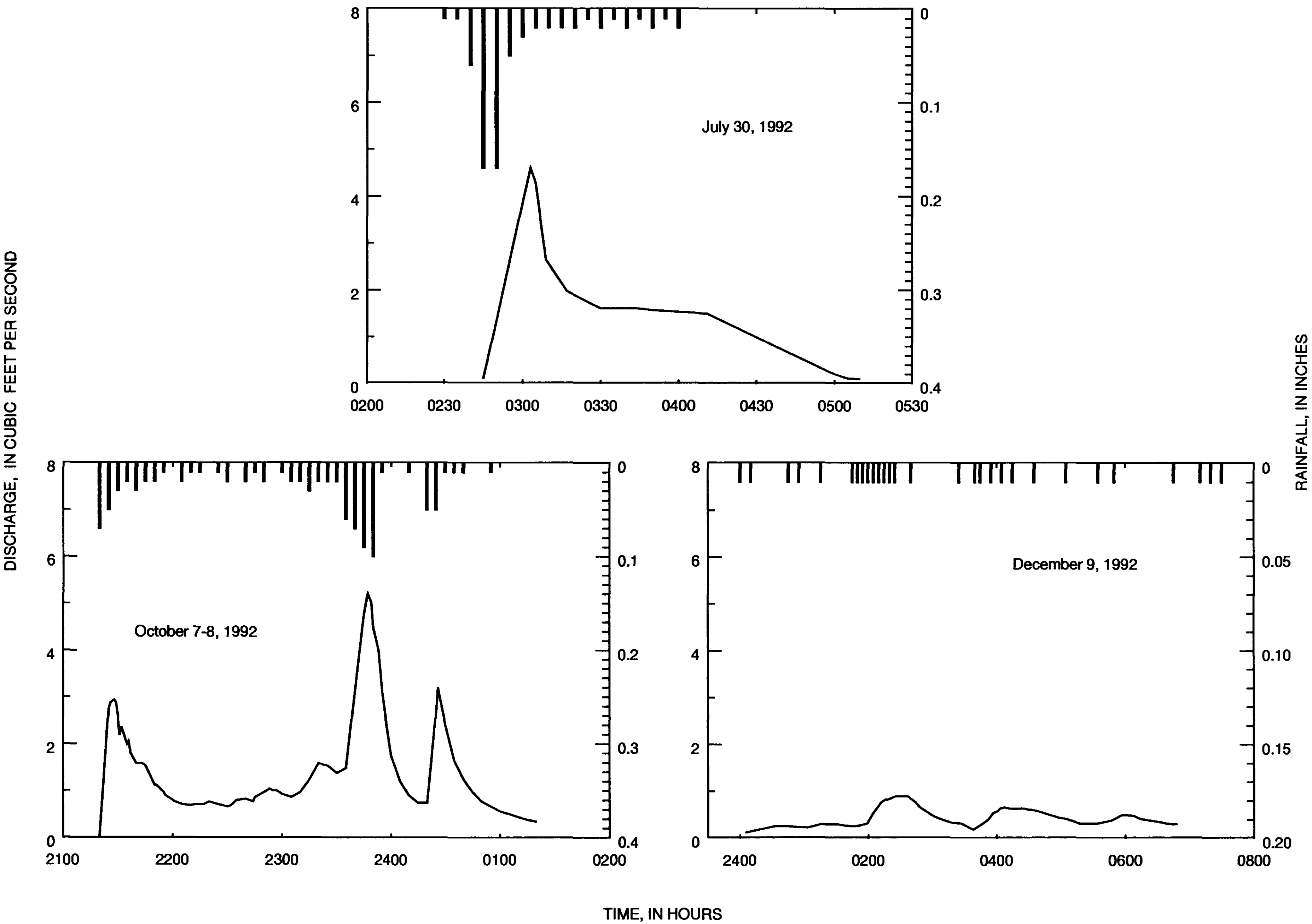


Figure 7. Rainfall intensities and discharge hydrographs for each storm event sampled at site 5.

concentrations ranged from 34 mg/L at site 3 to 14,700 mg/L at site 5. The site 5 basin includes large unsheltered piles of road salt. Total suspended solids concentrations ranged from 38 mg/L at site 3 to 1,200 mg/L at site 5. Nitrite plus nitrate as nitrogen concentrations ranged from less than 0.05 mg/L at site 1 to 1.5 mg/L at site 4. Total ammonia as nitrogen concentrations ranged from less than 0.01 mg/L at site 1 to 1.0 mg/L at site 3. Mean total ammonia plus organic nitrogen as nitrogen concentrations ranged from 0.2 mg/L at site 5 to 3.3 mg/L at site 1. Mean total phosphorus concentrations ranged from 0.12 mg/L at site 5 to 1.3 mg/L at site 1 and dissolved phosphorus concentrations ranged from less than 0.01 mg/L at sites 1 and 5 to 0.42 mg/L at site 3. Mean total organic carbon concentrations ranged from 12 to 410 mg/L at site 3. Total cyanide concentrations were detected twice at the detection limit of 0.01 mg/L at site 5.

Trace Elements

The sources of trace elements in streams are associated with both natural occurring chemical weathering and human activities (Viessman and Hammer, 1985). Concentrations for the whole-water recoverable trace element analyses for the flow-weighted composite samples are presented in table 14, at the back of this report. Antimony, beryllium, selenium, and thallium were not detected. The mercury concentration was 0.2 µg/L at site 4 and 0.1 and 0.3 µg/L at site 5. The following trace elements were detected (concentrations are listed in parentheses): arsenic (1 to 10 µg/L), cadmium (less than 1 to 40 µg/L), chromium (less than 1 to 99 µg/L), copper (8 to 130 µg/L), lead (20 to 800 µg/L), nickel (3 to 37 µg/L), and zinc (110 to 6,200 µg/L). The largest concentrations of arsenic and chromium occurred at site 1. The largest mean concentrations of cadmium, lead, mercury, nickel, and zinc occurred at site 5. The only detection of silver was at site 4 with a concentration of 12 µg/L.

Pesticides

The results of the whole-water recoverable analyses for the pesticides from the flow-weighted composite samples are presented in table 15, at the back of this report. The concentrations are compared to Missouri water-quality criteria for human health protection-fish consumption (Missouri Department of Natural Resources, 1991b). Chlordane concentrations of 0.1, 0.2, and 0.4 µg/L at site 1 and two detections of 0.1 µg/L at site 2 exceeded the water-quality criteria of 0.00048 µg/L. At site 1, cis-chlordane and trans-chlordane had concentrations of 0.1 µg/L. At site 4, concentrations of *p,p'*-DDD and *p,p'*-DDT were at the detection limit of 0.1 µg/L, which exceeded the water-quality criteria of 0.00024 µg/L. Concentrations of diazinon were 0.2 and 1.0 µg/L at site 1; concentrations of 0.1 µg/L were detected twice at site 2; concentrations of 0.2 and 0.1 µg/L were detected at site 3; and a concentration of 0.2 µg/L was detected at site 4. A dieldrin concentration of 0.05 µg/L at site 1 exceeded the water-quality criteria of 0.000076 µg/L. Lindane was detected at the detection limit of 0.03 µg/L at site 4. The polychlorinated biphenyl Aroclor 1248 concentration of 2.4 µg/L at site 4 exceeded the water-quality criteria of 0.000045 µg/L.

Volatile Organic Compounds

Of the 63 volatile organic compounds analyzed, 13 compounds were detected a total of 27 times. The results of the whole-water recoverable analyses of the flow-weighted composite samples from sites 1 to 5 are listed in table 16, at the back of this report. The concentrations of volatile organic compounds ranged from 0.2 to 5.1 µg/L. Naphthalene was detected with the largest concentration of 5.1 µg/L at site 2 and was detected a total of five times at sites 1, 2, 3, and 4. Ten compounds were detected at site 2, and nine of the detections were from the same flow-weighted composite sample. Site 3 had eight detections of volatile organic compounds. The following compounds were detected at sites 1 to 5 during this study: benzene; *n*-butylbenzene; dichlorodifluoromethane; ethylbenzene; *p*-isopropyltolune; 1,3,5-trimethylbenzene (mesitylene); dichloromethane (methylene chloride); naphthalene; *n*-propylbenzene; 1,2,4-trimethylbenzene (pseudocumene); styrene; toluene; and xylene. Concentrations of volatile organic compounds detected did not exceed any of the listed water-quality criteria for human health protection-fish consumption (Missouri Department of Natural Resources, 1992).

Acidic, Basic, and Neutral Semi-Volatile Organic Compounds

The results of the whole-water recoverable analyses for the acidic, basic, and neutral semi-volatile organic compounds from the composite samples are presented in table 17, at the back of this report. Concentrations of these compounds were compared to Missouri water-quality criteria for human health protection-fish consumption (Missouri Department of Natural Resources, 1992). Concentrations of di-2-ethylhexyl phthalate were 6.0 μg/L at site 1; 6, 7, and 8 μg/L at site 2; and 10 μg/L at site 3, and all concentrations exceeded the water-quality criteria of 5.9 μg/L. A concentration of di-2-ethylhexyl phthalate was at the detection limit of 5 μg/L at site 5. Di-2-ethylhexyl phthalate is one of the most widely used plasticizers (Smith and others, 1988). Concentrations of fluoranthene were 18 μg/L at site 1, 15 μg/L at site 4, and 10 μg/L at site 5. Concentrations of phenanthrene were 7 μg/L at sites 1 and 4, and 6 μg/L at site 5. Concentrations of pyrene were 13 μg/L at site 1, 11 μg/L at site 4, and 7 μg/L at site 5. The detections of fluoranthene, phenanthrene, and pyrene occurred in the same flow-weighted-composite sample for each site. Fluoranthene, phenanthrene, and pyrene, classified as polycyclic aromatic hydrocarbons, can originate in surface water from atmospheric deposition, surface runoff, and industrial and municipal wastewater effluents (Smith and others, 1988).

Volume and Loads

The observed volume in cubic feet and loads in pounds for each site for every constituent with at least one detection and simulations for storm volume and loads calculated with the Driver and Tasker (1990) equations are listed in tables 18 to 22, at the back of this report. The observed and simulated volume and loads were compared to the second storm sampled at each site using the following equation:

$$\frac{\text{Simulated value} - \text{Observed value}}{\text{Observed value}} \times 100 = \text{percent difference} \quad (2)$$

For the storms sampled on October 7, 1992, at site 1, chemical oxygen demand, total phosphorus, copper, and zinc loads had less than a 50 percent difference between the observed and the simulated values. For the storms sampled on September 7, 1992, at site 2, dissolved solids and dissolved phosphorus loads had less than a 50 percent difference between observed and simulated values. For the storms sampled at site 3 on August 18, 1992, volume, chemical oxygen demand, total ammonia plus organic nitrogen, total nitrogen, total phosphorus, cadmium, and zinc loads had a 50 percent or less difference between the observed and simulated values. For the storm sampled on September 26, 1992, at site 4, the difference between the simulated volume and all the simulated loads and the observed volume and loads was greater than 60 percent. For the storm sampled at site 5 on October 7, 1992, the simulated and observed loads were less than 50 percent for chemical oxygen demand, suspended solids, and lead.

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TABLES

Table 1. Selected data for study sites and drainage basins and location of rain gages

[--, no data; NPDES, National Pollution Discharge Elimination System]

Sampling site number (fig. 1)	NPDES permit site number	U.S. Geological Survey station number	Name of sampling site	Latitude-longitude location, in degrees, minutes, seconds	Drainage area, in square miles	Predominant land use in drainage area	Percentage of area covered by impervious surface
[a]1	I7	06893635	Sugar Creek tributary	390529 0942644	0.454	Single-family residential	42
[b]2	I2	06893950	Spring Branch tributary	390636 0942234	.161	High-density residential	29
[b]3	I3	06893930	Crackerneck Creek tributary	390409 0942241	.177	Strip commercial	62
[a]4	I4	06893596	Unnamed Rock Creek tributary	390509 0942516	.224	Office space/ commercial	61
[b]5	I5	06893960	Unnamed Spring Branch tributary	390533 0942142	.046	Light industrial	35
RN1	--	39053009-4250701	Rooftop at downtown post office	390530 0942507	--	--	--
RN2	--	39055409-4214101	City storage lot at Independence Avenue and Turner Road	390554 0942141	--	--	--

[a] Rain gage data from RN1 were used for site.
[b] Rain gage data from RN2 were used for site except where specified.

Table 2. Methods, detection limits, preservations, and bottle types used for determination of constituent concentrations at the U.S. Geological Survey, Arvada, Colorado

[T, total; analytical method number I references U.S. Geological Survey methods and methods number prefixes; µS/cm, microsiemens per centimeter at 25 degrees Celsius; P250, 250-milliliter polyethylene; NA, not applicable; mg/L, milligrams per liter; H_2SO_4, sulfuric acid; °C, degrees Celsius; P1000, 1000-milliliter polyethylene; GB125, 125-milliliter brown glass; D, dissolved; AA, atomic absorption; HNO_3, nitric acid; PA250, 250-milliliter polyethylene, acid rinsed; $CaCO_3$, calcium carbonate; ET, electrometric titration; IC, ion-exchange chromatography; P500, 500-milliliter polyethylene; S, suspended; ASF, automated-segmented flow, colorimetric; PB125, 125-milliliter brown polyethylene; Cd, cadmium; WWR, whole-water recoverable; NaOH, sodium hydroxide; analytical method number E references U.S. Environmental Protection Agency methods; GFAA, graphite furnace atomic absorption; µg/L, micrograms per liter; DCP, direct-current plasma; K_2CrO_3, potassium dichromate; GA250, 250-milliliter glass, acid rinsed; analytical method number O references U.S. Geological Survey methods and methods number prefixes; H_3PO_4/-$CuSO_4$, phosphoric acid/copper sulfate; GB1000; 1,000-milliliter brown glass; BHC, benzene hexachloride; GC/ECD, gas chromatography/electron capture detector; DDD, 1,1-Dichloro-2,2-bis(*p*-Chlorophenyl)ethane; DDE, Dichloro diphenyl dichloroethylene; DDT, dichloro diphenyl trichloroethane; PCB, polychlorinated biphenyl; GC/MS, gas chromatography/mass spectrometric detector; HCl, hydrochloric acid; GB40, 40-milliliter brown glass septum vial; all physical properties and constituents were analyzed from flow-weighted composite samples unless noted otherwise]

Property or constituent	Phase	Analytical method number	Method	Detection limit	Preservation	Bottle type
		PHYSICAL PROPERTIES				
Specific conductance	T	[a]I-2781-85	Electrometric	1 µS/cm	Untreated	P250
pH	T	[a]I-2587-85	Electrometric	.1 unit	Untreated	P250
		COMMON CONSTITUENTS				
Chemical oxygen demand	T	[a]I-3561-85	Spectrometric	10 mg/L	H_2SO_4, 4 °C	GB125
Calcium	D	[a]I-1152-85	AA	.1 mg/L	HNO_3	PA250
Magnesium	D	[a]I-1447-85	AA	.1 mg/L	HNO_3	PA250
Sodium	D	[a]I-1735-85	AA	.1 mg/L	HNO_3	PA250
Potassium	D	[a]I-1630-85	AA	.1 mg/L	HNO_3	PA250
Alkalinity, as $CaCO_3$	D	[a]I-2030-85	ET	1.0 mg/L	Untreated	P250
Hardness, as $CaCO_3$	D	NA	Computed	NA	NA	NA
Sulfate	D	[a]I-2057-85	IC	.1 mg/L	HNO_3	PA250
Chloride	D	[a]I-2057-85	IC	.1 mg/L	HNO_3	PA250
Solids, residue at 180 °C	D	[a]I-1750-85	Gravimetric	1.0 mg/L	Untreated	P500
Solids, residue at 105 °C	S	[a]I-3765-85	Gravimetric	1.0 mg/L	Untreated	P500
Solids, sum of constituents	D	NA	Computed	NA	NA	NA
Nitrite as nitrogen	T	[b]I-4540-90	Diazotization, ASF	.01 mg/L	H_2SO_4, 4 °C	PB125
	D	[b]I-2540-90	Diazotization, ASF	.01 mg/L	H_2SO_4, 4 °C	PB125
Nitrite plus nitrate as nitrogen	T	[b]I-4545-90	Cd-reduction, diazotization, ASF	.05 mg/L	H_2SO_4, 4 °C	PB125
	D	[b]I-2545-90	Cd-reduction, diazotization, ASF	.05 mg/L	H_2SO_4, 4 °C	PB125
Ammonia as nitrogen	T	[b]I-4522-90	Salicylate-hypochlorite, ASF	.01 mg/L	H_2SO_4, 4 °C	PB125
	D	[b]I-2522-90	Salicylate-hypochlorite, ASF	.01 mg/L	H_2SO_4, 4 °C	PB125
Ammonia plus organic nitrogen	T	[b]I-4515-91	Salicylate-hypochlorite, ASF	.2 mg/L	H_2SO_4, 4 °C	PB125
Organic nitrogen	T	NA	Computed	NA	H_2SO_4, 4 °C	PB125
Phosphorus	T	[c]I-4610-91	Phosphomolybdate, ASF	.01 mg/L	H_2SO_4, 4 °C	PB125
	D	[c]I-2610-91	Phosphomolybdate, ASF	.01 mg/L	H_2SO_4, 4 °C	PB125
Cyanide	WWR	[a]I-4302-85	Barbituric acid, ASF	.01 mg/L	NaOH, 4 °C	P250
		TRACE ELEMENTS				
Arsenic	WWR	[d]E-206.2	GFAA	1.0 µg/L	HNO_3	PA250
Beryllium	WWR	[a]I-3095-85	AA	10 µg/L	HNO_3	PA250
Cadmium	WWR	[a]I-3135-85	AA	10 µg/L	HNO_3	PA250
	WWR	[b]I-4138-89	GFAA	1.0 µg/L	HNO_3	PA250
Chromium	WWR	[a]I-3236-85	AA	10 µg/L	HNO_3	PA250
	WWR	[b]I-3229-87	DCP	1.0 µg/L	HNO_3	PA250
Copper	WWR	[a]I-3270-85	AA	10 µg/L	HNO_3	PA250
	WWR	[b]I-4274-89	GFAA	1.0 µg/L	HNO_3	PA250
Lead	WWR	[a]I-3399-85	AA	100 µg/L	HNO_3	PA250
	WWR	[b]I-4403-89	GFAA	1.0 µg/L	HNO_3	PA250
Mecury	WWR	[a]I-3462-85	Cold-vapor AA	.1 µg/L	K_2CrO_3/HNO_3	GA250

Table 2. Methods, detection limits, preservation, and bottle types used for determination of constituent concentrations at the U.S. Geological Survey, Arvada, Colorado--Continued

Property or constituent	Phase	Analytical method number	Method	Detection limit	Preservation	Bottle type
			TRACE ELEMENTS--Continued			
Nickel	WWR	[a]I-3499-85	AA	100 µg/L	HNO_3	PA250
	WWR	[b]I-4503-89	GFAA	1.0 µg/L	HNO_3	PA250
Selenium	WWR	[d]E-270.2	GFAA	1.0 µg/L	HNO_3	PA250
Silver	WWR	[b]I-4724-89	GFAA	1.0 µg/L	HNO_3	PA250
Zinc	WWR	[a]I-3900-85	AA	10 µg/L	HNO_3	PA250
			ORGANIC			
Organic carbon	T	[e]O-3100-83	Wet oxidation	0.1 mg/L	H_2SO_4, 4 °C	GB125
Oils and grease[f]	T	[e]O-3108-83	Extraction gravimetric	1.0 mg/L	H_2SO_4	GB1000
Phenols[f]	T	[e]O-3110-83	Colorimetric	1.0 µg/L	$H_3PO_4/CuSO_4$, 4 °C	GB1000
			PESTICIDES			
Aldrin	WWR	[g]E-608-91	GC/ECD	0.04 µg/L	4 °C	GB1000
Alpha BHC	WWR	[g]E-608-91	GC/ECD	.3 µg/L	4 °C	GB1000
Beta BHC	WWR	[g]E-608-91	GC/ECD	.03 µg/L	4 °C	GB1000
Delta BHC	WWR	[g]E-608-91	GC/ECD	.09 µg/L	4 °C	GB1000
Chlordane	WWR	[g]E-608-91	GC/ECD	.1 µg/L	4 °C	GB1000
cis-chlordane	WWR	[g]E-608-91	GC/ECD	.1 µg/L	4 °C	GB1000
trans-chlordane						
p,p'-DDD	WWR	[g]E-608-91	GC/ECD	.1 µg/L	4 °C	GB1000
p,p'-DDE	WWR	[g]E-608-91	GC/ECD	.04 µg/L	4 °C	GB1000
p,p'-DDT	WWR	[g]E-608-91	GC/ECD	.1 µg/L	4 °C	GB1000
Diazinon	WWR	[g]E-608-91	GC/ECD	.1 µg/L	4 °C	GB1000
Dieldrin	WWR	[g]E-608-91	GC/ECD	.02 µg/L	4 °C	GB1000
Alpha-endosulfan	WWR	[g]E-608-91	GC/ECD	.1 µg/L	4 °C	GB1000
Beta-endosulfan	WWR	[g]E-608-91	GC/ECD	.04 µg/L	4 °C	GB1000
Endosulfan sulfate	WWR	[g]E-608-91	GC/ECD	.6 µg/L	4 °C	GB1000
Endrin	WWR	[g]E-608-91	GC/ECD	.06 µg/L	4 °C	GB1000
Endrin aldehyde	WWR	[g]E-608-91	GC/ECD	.2 µg/L	4 °C	GB1000
Heptachlor	WWR	[g]E-608-91	GC/ECD	.03 µg/L	4 °C	GB1000
Heptachlor epoxide	WWR	[g]E-608-91	GC/ECD	.8 µg/L	4 °C	GB1000
Lindane	WWR	[g]E-608-91	GC/ECD	.03 µg/L	4 °C	GB1000
PCB, Aroclor 1016	WWR	[g]E-608-91	GC/ECD	.1 µg/L	4 °C	GB1000
PCB, Aroclor 1221	WWR	[g]E-608-91	GC/ECD	1 µg/L	4 °C	GB1000
PCB, Aroclor 1232	WWR	[g]E-608-91	GC/ECD	.1 µg/L	4 °C	GB1000
PCB, Aroclor 1242	WWR	[g]E-608-91	GC/ECD	.1 µg/L	4 °C	GB1000
PCB, Aroclor 1248	WWR	[g]E-608-91	GC/ECD	.1 µg/L	4 °C	GB1000
PCB, Aroclor 1254	WWR	[g]E-608-91	GC/ECD	.1 µg/L	4 °C	GB1000
PCB, Aroclor 1260	WWR	[g]E-608-91	GC/ECD	.1 µg/L	4 °C	GB1000
Toxaphene	WWR	[g]E-608-91	GC/ECD	2 µg/L	4 °C	GB1000
			VOLATILE ORGANIC COMPOUNDS			
			Substituted Methane			
Bromomethane	WWR	[h]E-524.2	GC/MS	0.2 µg/L	HCl, 4 °C	GB40
Dibromomethane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Bromoform	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Bromochloromethane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Dibromochloromethane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Chloromethane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Dichloromethane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Trichloromethane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Tetrachloromethane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Dichlorobromomethane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Dichlorodifluoromethane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Trichlorofluoromethane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
			Substituted Ethane			
Chloroethane	WWR	[h]E-524.2	GC/MS	0.2 µg/L	HCl, 4 °C	GB40
1,2-Dibromoethane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
1,1-Dichloroethane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
1,2-Dichloroethane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40

Table 2. Methods, detection limits, preservation, and bottle types used for determination of constituent concentrations at the U.S. Geological Survey, Arvada, Colorado--Continued

Property or constituent	Phase	Analytical method number	Method	Detection limit	Preservation	Bottle type
VOLATILE ORGANIC COMPOUNDS--Continued						
Substituted Ethane--Continued						
1,1,1-Trichloroethane	WWR	[h]E-524.2	GC/MS	0.2 µg/L	HCl, 4 °C	GB40
1,1,2-Trichloroethane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
1,1,1,2-Tetrachloroethane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
1,1,2,2-Tetrachloroethane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Trichlorotrifluoroethane	WWR	[h]E-524.2	GC/MS	.5 µg/L	HCl, 4 °C	GB40
Substituted Ethene						
Chloroethene	WWR	[h]E-524.2	GC/MS	0.2 µg/L	HCl, 4 °C	GB40
1,1-Dichloroethene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
cis-1,2-Dichloroethene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
trans-1,2-Dichloroethene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
1,1,2-Trichloroethene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
1,1,2,2-Tetrachloroethene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Substituted Propane						
1,2-Dichloropropane	WWR	[h]E-524.2	GC/MS	0.2 µg/L	HCl, 4 °C	GB40
1,3-Dichloropropane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
2,2-Dichloropropane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
1,2,3-Trichloropropane	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
1,2-Dibromo-3-chloropropane	WWR	[h]E-524.2	GC/MS	1.0 µg/L	HCl, 4 °C	GB40
Substituted Propene						
1,1-Dichloropropene	WWR	[h]E-524.2	GC/MS	0.2 µg/L	HCl, 4 °C	GB40
cis-1,3-Dichloropropene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
trans-1,3-Dichloropropene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Substituted Butene						
Hexachlorobutadiene	WWR	[h]E-524.2	GC/MS	0.2 µg/L	HCl, 4 °C	GB40
Benzene Derivative						
Benzene	WWR	[h]E-524.2	GC/MS	0.2 µg/L	HCl, 4 °C	GB40
Bromobenzene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Chlorobenzene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
1,2-Dichlorobenzene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
1,3-Dichlorobenzene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
1,4-Dichlorobenzene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
1,2,3-Trichlorobenzene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
1,2,4-Trichlorobenzene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Xylenes, total	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
1,2,4-Trimethylbenzene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
1,3,5-Trimethylbenzene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Ethylbenzene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
n-Propylbenzene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
n-Butylbenzene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
(1-Methylethyl)benzene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
(1,1-Dimethylethyl)benzene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
(1-Methylpropyl)benzene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Styrene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Toluene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
2-Chlorotoluene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
4-Chlorotoluene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
p-Isopropyltoluene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Naphthalene	WWR	[h]E-524.2	GC/MS	.2 µg/L	HCl, 4 °C	GB40
Ether						
2-Chloroethylvinyl ether	WWR	[h]E-524.2	GC/MS	1.0 µg/L	HCl, 4 °C	GB40
Methyl-tertiary-butyl ether	WWR	[h]E-524.2	GC/MS	1.0 µg/L	HCl, 4 °C	GB40

Table 2. Methods, detection limits, preservation, and bottle types used for determination of constituent concentrations at the U.S. Geological Survey, Arvada, Colorado--Continued

Property or constituent	Phase	Analytical method number	Method	Detection limit	Preservation	Bottle type
VOLATILE ORGANIC COMPOUNDS--Continued						
Aldehyde						
Acrolein	WWR	[h]E-524.2	GC/MS	20 µg/L	HCl, 4 °C	GB40
Nitrile						
Acrylonitrile	WWR	[h]E-524.2	GC/MS	20 µg/L	HCl, 4 °C	GB40
ACIDIC, BASIC, AND NEUTRAL SEMI-VOLATILE ORGANIC COMPOUNDS[1]						
Substituted Benzene						
1,2-Dichlorobenzene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
1,3-Dichlorobenzene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
1,4-Dichlorobenzene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
1,2,4-Trichlorobenzene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Hexachlorobenzene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Nitrobenzene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
2,4-Dinitrotoluene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
2,6-Dinitrotoluene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Substituted Phenol						
Phenol	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
2-Chlorophenol	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
2-Nitrophenol	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
4-Nitrophenol	WWR	[b]O-3116-87	GC/MS	30 µg/L	4 °C	GB1000
2,4-Dichlorophenol	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
2,4-Dimethylphenol	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
2,4-Dimitrophenol	WWR	[b]O-3116-87	GC/MS	20 µg/L	4 °C	GB1000
4-Chloro-3-methylphenol	WWR	[b]O-3116-87	GC/MS	30 µg/L	4 °C	GB1000
2,4,6-Trichlorophenol	WWR	[b]O-3116-87	GC/MS	20 µg/L	4 °C	GB1000
4-Methyl-4,6-dinitrophenol	WWR	[b]O-3116-87	GC/MS	30 µg/L	4 °C	GB1000
Pentachlorophenol	WWR	[b]O-3116-87	GC/MS	30 µg/L	4 °C	GB1000
Polycyclic Aromatic Hydrocarbon						
Naphthalene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Acenaphthylene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Acenaphthene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Fluorene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Anthracene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Phenanthrene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Fluoranthene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Pyrene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Benzo[*a*]anthracene	WWR	[b]O-3116-87	GC/MS	10 µg/L	4 °C	GB1000
Chrysene	WWR	[b]O-3116-87	GC/MS	10 µg/L	4 °C	GB1000
Benzo[*a*]pyrene	WWR	[b]O-3116-87	GC/MS	10 µg/L	4 °C	GB1000
Benzo[*b*]fluoranthene	WWR	[b]O-3116-87	GC/MS	10 µg/L	4 °C	GB1000
Benzo[*k*]fluoranthene	WWR	[b]O-3116-87	GC/MS	10 µg/L	4 °C	GB1000
Benzo[*g,h,i*]perylene	WWR	[b]O-3116-87	GC/MS	10 µg/L	4 °C	GB1000
Indeno[1,2,3-*cd*]pyrene	WWR	[b]O-3116-87	GC/MS	10 µg/L	4 °C	GB1000
Dibenzo[*a,h*]anthracene	WWR	[b]O-3116-87	GC/MS	10 µg/L	4 °C	GB1000
Phthalic Acid Ester, *n*-Nitroso Compound, Isophorone, and 1,2-diphenylhydrazine						
Dimethyl phthalate	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Diethyl phthalate	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Di-*n*-butyl phthalate	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
n-Butylbenzyl phthalate	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Di-*n*-octyl phthalate	WWR	[b]O-3116-87	GC/MS	10 µg/L	4 °C	GB1000
Di-2-ethylhexyl phthalate	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
n-Nitrosodimethylamine	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
n-Nitrosodi-n-propylamine	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
n-Nitrosodiphenylamine	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Isophorone	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
1,2-Diphenylhydrazine	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000

Table 2. Methods, detection limits, preservation, and bottle types used for determination of constituent concentrations at the U.S. Geological Survey, Arvada, Colorado--Continued

Property or constituent	Phase	Analytical method number	Method	Detection limit	Preservation	Bottle type
ACIDIC, BASIC, AND NEUTRAL SEMI-VOLATILE ORGANIC COMPOUNDS--Continued						
Halogenated Compound						
Hexachloroethane	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
bis(2-Chloroethyl) ether	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
bis(2-Chloroisopropyl) ether	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
bis(2-Chloroethoxy) methane	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Hexachlorobutadiene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Hexachlorocyclopentadiene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
4-Bromophenyl phenyl ether	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
4-Chlorophenyl phenyl ether	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
2-Chloronaphthalene	WWR	[b]O-3116-87	GC/MS	5 µg/L	4 °C	GB1000
Substituted Biphenyl						
4,4'-Diaminobiphenyl	WWR	[b]O-3116-87	GC/MS	40 µg/L	4 °C	GB1000
4,4'-Diamino-3,3'-dichlorobiphenyl	WWR	[b]O-3116-87	GC/MS	20 µg/L	4 °C	GB1000

[a] Fishman and Friedman (1989).
[b] Methods of analysis from Fishman (1993).
[c] Patton and Truitt (1992).
[d] U.S. Environmental Protection Agency (1983).
[e] Wershaw and others (1983).
[f] Analyzed for discrete samples.
[g] U.S. Environmental Agency (1991).
[h] U.S. Environmental Agency (1988).
[i] Methylene chloride extractable organic compounds.

Table 3. Methods, detection limits, preservations, and bottle types used for determination of constituent concentrations at the Enseco Rocky Mountain Analytical Laboratory, Arvada, Colorado

[µg/L, micrograms per liter; HNO_3, nitric acid; PA250, 250-milliliter polyethylene, acid rinsed; mg/L, milligrams per liter; NaOH, sodium hydroxide; °C, degrees Celsius; P250, 250-milliliter polyethylene]

Constituent	Phase	Sample type	U.S. Environmental Protection Agency analytical method number[a]	Detection limit	Perservation	Bottle type
Antimony	Total	Composite	204.2	10 µg/L	HNO_3	PA250
Silver	Total	Composite	272.2	.5 µg/L	HNO_3	PA250
Thallium	Total	Composite	279.2	5.0 µg/L	HNO_3	PA250
Cyanide	Total	First flush	335.3	.01 mg/L	NaOH, 4 °C	P250

[a] U.S. Environmental Protection Agency, 1983.

Table 4. Values of selected physical properties and constituent concentrations in stormwater-runoff replicate samples from sites 2 and 4

[µS/cm, microseimens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; °C, degrees Celsius; --, no data]

Replicate number	Site number (fig. 1)	Date	Time	Ending date	Ending time	Specific conductance (µS/cm)	Chemical oxygen demand (mg/L)	Bio-chemical oxygen demand (mg/L)	Calcium dissolved, as Ca (mg/L)	Magnesium dissolved, as Mg (mg/L)
1	2	12-09-92	0118	12-09-92	0608	858	480	30	48	5.8
2		12-09-92	0123	--	--	855	67	--	45	5.5
1	4	02-11-93	0245	02-11-93	0445	311	210	44	24	1.5
2		02-11-93	0345	--	--	306	--	--	--	--

Replicate number	Site number (fig. 1)	Sodium dissolved, as Na (mg/L)	Potassium dissolved, as K (mg/L)	Alkalinity, as $CaCO_3$ (mg/L)	Sulfate dissolved, as SO_4 (mg/L)	Chloride dissolved, as Cl (mg/L)	Dissolved solids, residue at 180 °C (mg/L)	Suspended solids, residue at 105 °C (mg/L)	Dissolved solids, sum of constituents (mg/L)	Nitrite as N, total (mg/L)	Nitrite as N, dissolved (mg/L)
1	2	110	2.5	110	27	160	458	107	419	<0.01	--
2		110	2.3	109	28	170	455	--	426	<.01	--
1	4	19	1.8	89	21	26	131	112	145	--	0.01
2		--	--	--	--	--	133	142	--	--	<.01

Table 4. Values of selected physical properties and constituent concentrations in stormwater-runoff replicate samples from sites 2 and 4–Continued

Replicate number	Site number (fig. 1)	Nitrite plus nitrate total, as N (mg/L)	Nitrite plus nitrate dissolved, as N (mg/L)	Ammonia total, as N (mg/L)	Ammonia dissolved, as N (mg/L)	Ammonia plus organic nitrogen total, as N (mg/L)	Organic nitrogen total, as N (mg/L)	Phosphorus total, as P (mg/L)	Phosphorus dissolved, as P (mg/L)	Arsenic total, as As (µg/L)	Beryllium, whole-water recoverable, as Be (µg/L)
1	2	0.58	--	0.34	--	1.4	1.1	0.31	0.10	2	<10
2		.57	--	.35	--	1.4	1.1	.32	.10	2	--
1	4	--	1.5	--	0.51	1.5	--	.28	.08	2	<10
2		--	.84	--	.82	1.8	--	.27	.06	2	<10

Replicate number	Site number (fig. 1)	Cadmium, whole-water recoverable as Cd (µg/L)	Chromium, whole-water recoverable as Cr (µg/L)	Copper, whole-water recoverable as Cu (µg/L)	Lead, whole-water recoverable as Pb (µg/L)	Nickel, whole-water recoverable as Ni (µg/L)	Selenium, total as Se (µg/L)	Silver, whole-water recoverable as Ag (µg/L)	Silver,[a] total as Ag (µg/L)	Zinc, whole-water recoverable as Zn (µg/L)
1	2	4	8	8	31	6	<2	<1	<1.0	110
2		--	--	--	--	--	<2	--	--	--
1	4	2	24	17	110	7	<2	<1	<.50	300
2		2	24	18	99	7	<2	<1	--	290

[a]Analyzed by Enseco Rocky Mountain Analytical Laboratory, Arvada, Colorado.

Table 5. Concentration and percent recovery of pesticides in matrix spiked sample sets from site 1, September 2, 1992

[All concentrations in micrograms per liter; percent recovery = (spiked sample concentration - unspiked sample concentration) x 100 percent/(spike mixture concentration/(10 x sample volume)); <, less than BHC; benzene hexachloride; DDD, 1,1-Dichloro-2,2-bis(*p*-chlorophenyl)ethane; DDE, Dichloro diphenyl dichloroethylene; DDT, Dichloro diphenyl trichloroethane; NA, not applicable]

Pesticide	Unspiked sample concentration	Spike mixture concentration[a]	Field spiked sample[b]		Replicate field spiked sample[c]		Lab spiked sample[d]	
			Concentration	Percent recovery	Concentration	Percent recovery	Concentration	Percent recovery
Aldrin	<0.04	10	0.76	74	0.84	76	0.29	26
Alpha BHC	<.03	10	.77	75	.93	84	.86	78
Beta BHC	<.03	10	.89	86	1.2	108	.96	88
Delta BHC	<.09	10	.66	64	.95	85	.71	65
Chlordane	.4	0	<.1	NA	<.1	NA	<.1	NA
cis-Chlordane	.1	0	<.1	NA	<.1	NA	<.1	NA
trans-Chlordane	.1	0	<.1	NA	<.1	NA	<.1	NA
p,p'-DDD	<.1	60	3.0	48	5.0	75	4.4	67
p,p'-DDE	<.04	20	1.6	78	1.7	76	1.8	82
p,p'-DDT	<.1	60	4.0	65	4.2	63	4.6	70
Dieldrin	.05	20	1.6	78	2.1	94	2.0	91
Alpha-endosulfan	<.1	20	2.0	97	2.0	90	1.4	64
Beta-endosulfan	<.04	20	1.5	73	2.0	90	1.8	82
Endosulfan sulfate	<.6	60	4.8	77	<.60	<9	5.9	90
Endrin	<.06	20	1.8	87	2.3	103	2.3	105
Endrin aldehyde	<.2	60	<.2	<3	<.2	<3	3.9	59
Heptachlor	<.03	10	.69	67	.85	76	.96	88
Heptachlor epoxide	<.8	10	.8	77	1.0	90	.90	82
Lindane	<.03	10	.72	70	.94	84	.92	84
PCB, Aroclor 1016	<.1	0	<1.0	NA	<1.0	NA	<1.0	NA
PCB, Aroclor 1221	<1.0	0	<1.0	NA	<1.0	NA	<1.0	NA
PCB, Aroclor 1232	<.1	0	<1.0	NA	<1.0	NA	<1.0	NA
PCB, Aroclor 1242	<.1	0	<1.0	NA	<1.0	NA	<1.0	NA
PCB, Aroclor 1248	<.1	0	<1.0	NA	<1.0	NA	<1.0	NA
PCB, Aroclor 1254	<.1	0	<1.0	NA	<1.0	NA	<1.0	NA
PCB, Aroclor 1260	<.1	0	<.1	NA	<.1	NA	<.1	NA
Toxaphene	<2	0	<2	NA	<2	NA	<2	NA

[a] Sample volume is 0.0001 liter.
[b] Sample volume is 0.969 liter.
[c] Sample volume is 0.899 liter.
[d] Sample volume is 0.912 liter.

Table 6. Concentration and percent recovery of pesticides in matrix spiked sample sets from site 1, February 11, 1993

[All concentrations in micrograms per liter; percent recovery = (spiked sample concentration - unspiked sample concentration) x 100 percent/(spike mixture concentration/(10 x sample volume)); <, less than; BHC, benzene hexachloride; DDD, 1,1-Dichloro-2,2-bis(*p*-chlorophenyl)ethane; DDE, Dichloro diphenyl dichloroethylene; DDT, Dichloro diphenyl trichloroethane; NA, not applicable]

Pesticide	Unspiked sample concentration	Spike mixture concentration[a]	Field spiked sample[b]		Replicate field spiked sample[c]		Replicate lab spiked sample[d]	
			Concentration	Percent recovery	Concentration	Percent recovery	Concentration	Percent recovery
Aldrin	<0.04	10	0.98	97	0.84	83	0.86	85
Alpha BHC	<.03	10	1.0	99	.92	91	.88	87
Beta BHC	<.03	10	1.2	119	1.0	99	1.0	99
Delta BHC	<.09	10	1.0	99	1.0	99	.90	89
Chlordane	.1	0	<.1	NA	<.1	NA	<.1	NA
cis-Chlordane	<.1	0	<.1	NA	<.1	NA	<.1	NA
trans-Chlordane	<.1	0	<.1	NA	<.1	NA	<.1	NA
p,p'-DDD	<.1	60	6.4	106	5.2	86	5.6	92
p,p'-DDE	<.04	20	1.8	89	1.4	69	1.8	89
p,p'-DDT	<.1	60	6.2	102	5.0	82	5.4	89
Dieldrin	<.02	20	1.6	79	1.6	79	1.0	49
Alpha-endosulfan	<.1	20	1.8	89	1.6	79	1.4	69
Beta-endosulfan	<.04	20	1.6	79	1.6	79	1.6	79
Endosulfan sulfate	<.6	60	7.0	116	5.0	82	5.0	82
Endrin	<.06	20	2.0	99	1.8	89	1.6	79
Endrin aldehyde	<.2	60	1.2	20	1.2	20	4.2	69
Heptachlor	<.03	10	1.0	99	.84	83	.88	87
Heptachlor epoxide	<.8	10	1.2	119	1.0	99	1.0	99
Lindane	<.03	10	1.0	99	.84	83	.94	93
PCB, Aroclor 1016	<.1	0	<1.0	NA	<1.0	NA	<1.0	NA
PCB, Aroclor 1221	<1.0	0	<1.0	NA	<1.0	NA	<1.0	NA
PCB, Aroclor 1232	<.1	0	<1.0	NA	<1.0	NA	<1.0	NA
PCB, Aroclor 1242	<.1	0	<1.0	NA	<1.0	NA	<1.0	NA
PCB, Aroclor 1248	<.1	0	<1.0	NA	<1.0	NA	<1.0	NA
PCB, Aroclor 1254	<.1	0	<1.0	NA	<1.0	NA	<1.0	NA
PCB, Aroclor 1260	<.1	0	<.1	NA	<.1	NA	<.1	NA
Toxaphene	<2	0	<2	NA	<2	NA	<2	NA

[a] Sample volume is 0.0001 liter.
[b] Sample volume is 0.990 liter.
[c] Sample volume is 0.991 liter.
[d] Sample volume is 0.989 liter.

Table 7. Concentration and percent recovery of acidic, basic, and neutral semi-volatile organic compounds in matrix spiked sample sets from site 3, August 18, 1992

[All concentrations in micrograms per liter; percent recovery = (spiked sample concentration - unspiked sample concentration) x 100 percent/(spiked mixture concentration/(10 x sample volume)); <, less than; NA, not applicable]

Compound	Unspiked sample concentration	Spike mixture concentration[a]	Field spiked sample[b]		Replicate field spiked sample[b]		Replicate lab spiked sample[b]	
			Concentration	Percent recovery	Concentration	Percent recovery	Concentration	Percent recovery
Substituted Benzene								
1,2-Dichlorobenzene	<5	200	10	50	9	45	11	55
1,3-Dichlorobenzene	<5	200	8	40	7	35	10	50
1,4-Dichlorobenzene	<5	200	8	40	8	40	10	50
1,2,4-Trichlorobenzene	<5	200	11	55	12	60	12	60
Hexachlorobenzene	<5	200	12	60	8	40	15	75
Nitrobenzene	<5	200	13	65	15	75	15	75
2,4-Dinitrotoluene	<5	200	6	30	6	30	18	90
2,6-Dinitrotoluene	<5	200	13	65	15	75	17	85
Substituted Phenol								
Phenol	<5	500	<5	<10	9	18	21	42
2-Chlorophenol	<5	500	27	54	33	66	34	68
2-Nitrophenol	<5	500	29	58	37	74	37	74
4-Nitrophenol	<30	2,500	49	19	63	25	55	22
2,4-Dichlorophenol	<5	500	35	70	41	82	40	80
2,4-Dimethylphenol	<5	500	43	86	51	102	51	102
2,4-Dinitrophenol	<20	1,500	64	43	100	67	90	60
4-Chloro-3-methylphenol	<30	2,500	180	72	220	88	210	84
2,4,6-Trichlorophenol	<20	1,500	95	63	120	80	110	73
4-Methyl-4,6-dinitrophenol	<30	2,500	97	39	150	60	110	44
Pentachlorophenol	<30	2,500	150	60	210	84	190	76
Polycyclic Aromatic Hydrocarbon								
Naphthalene	<5	200	13	65	14	70	14	70
Acenaphthylene	<5	200	10	50	11	55	13	65
Acenaphthene	<5	200	13	65	14	70	14	70
Fluorene	<5	200	14	70	15	75	15	75
Anthracene	<5	200	11	55	8	40	13	65
Phenanthrene	<5	200	14	70	14	70	15	75
Fluoranthene	<5	200	8	40	7	35	7	35
Pyrene	<5	200	6	30	<5	<25	<5	<25
Benzo[*a*]anthracene	<10	200	<10	<50	<10	<50	12	60
Chrysene	<10	200	<10	<50	<10	<50	13	65
Benzo[*a*]pyrene	<10	200	<10	<50	<10	<50	<10	<50
Benzo[*b*]fluoranthene	<10	200	<10	<50	<10	<50	<10	<50
Benzo[*k*]fluoranthene	<10	200	<10	<50	<10	<50	<10	<50
Benzo[*g,h,i*]perylene	<10	200	26	130	18	90	36	180
Indeno[*1,2,3-cd*]pyrene	<10	200	27	135	19	95	39	195
Dibenzo[*a,h*]anthracene	<10	200	27	135	17	85	38	190

Table 7. Concentration and percent recovery of acidic, basic, and neutral semi-volatile organic compounds in matrix spiked sample sets from site 3, August 18, 1992 —Continued

Compound	Unspiked sample concentration	Spike mixture concentration[a]	Field spiked sample[b]		Field spiked replicate sample[b]		Lab spiked replicate sample[b]	
			Concentration	Percent recovery	Concentration	Percent recovery	Concentration	Percent recovery
Phthalic Acid Ester, *n*-Nitroso Compound, Isophorone, and 1,2-diphenylhydrazine								
Dimethyl phthalate	<5	200	11	55	13	65	16	80
Diethyl phthalate	<5	200	16	80	18	90	19	95
Di-*n*-butyl phthalate	<5	200	12	60	13	65	12	60
n-Butylbenzyl phthalate	<5	200	21	105	18	90	21	105
Di-*n*-octyl phthalate	<10	200	14	70	10	50	18	90
Di-2-ethylhexyl phthalate	<5	200	19	95	16	80	21	105
n-Nitrosodimethylamine	<5	200	8	40	8	40	9	45
n-Nitrosodi-n-propylamine	<5	200	16	80	17	85	17	85
n-Nitrosodiphenylamine	<5	200	12	60	13	65	13	65
Isophorone	<5	200	<5	<25	<5	<25	8	40
1,2-Diphenylhydrazine	<5	200	13	65	14	70	14	70
Halogenated Compound								
Hexachloroethane	<5	200	9	45	7	35	9	45
bis(2-Chloroethyl) ether	<5	200	13	65	14	70	14	70
bis(2-Chloroisopropyl) ether	<5	200	16	80	17	85	18	90
bis(2-Chloroethoxy)methane	<5	200	16	80	17	85	17	85
Hexachlorobutadiene	<5	200	11	55	11	55	9	45
Hexachlorocyclopentadiene	<5	200	<5	<25	<5	<25	<5	<25
4-Bromophenyl phenyl ether	<5	200	<5	<25	<5	<25	<5	<25
4-Chlorophenly phenyl ether	<5	200	17	85	18	90	17	85
2-Chloronaphthalene	<5	200	13	65	14	70	13	65
Substituted Biphenyl								
4,4'-Diaminobiphenyl	<40	200	<40	NA	<40	NA	<40	NA
4,4'-Diamino-3,3'-dichlorobiphenyl	<20	200	<20	<100	<20	<100	<20	<100

[a] Sample volume is 0.0001 liter.
[b] Sample volume is 1.0 liter.

Table 8. Concentration and percent recovery of volatile organic compounds in matrix spiked sample sets from site 2, December 9, 1992

[All concentrations in micrograms per liter; percent recovery = (Lab spiked sample concentration - unspiked sample concentration) x 100 percent/(spiked mixture concentration/(10 x sample volume)); <, less than; sample volume is 40 milliliters]

Compound	Unspiked sample concentration	Spiked mixture concentration	Lab spiked sample	
			Concentration	Percent recovery
Bromomethane	<0.2	4.8	6.8	57
Bromoform	<.2	5.8	13	90
Dibromochloromethane	<.2	6.1	13	85
Chloromethane	<.2	3.5	10	114
Dichloromethane	<.2	7.9	16	81
Trichloromethane	<.2	5.2	10	77
Tetrachloromethane	<.2	5.4	12	89
Dichlorobromomethane	<.2	5.7	12	84
Trichlorofluoromethane	<.2	2.6	5.7	88
Chloroethane	<.2	4.1	9.5	93
1,1-Dichloroethane	<.2	4.9	10	82
1,2-Dichloroethane	<.2	5.0	11	88
1,1,1-Trichloroethane	<.2	4.4	11	100
1,1,2-Trichloroethane	<.2	5.4	12	89
1,1,2,2-Tetrachloroethane	<.2	5.0	12	96
Chloroethene	<.2	3.5	7.9	90
1,1-Dichloroethene	<.2	4.3	8.6	80
cis-1,2-Dichloroethene	<.2	5.1	10	78
trans-1,2-Dichloroethene	<.2	5.0	9.1	73
1,1,2-Trichloroethene	<.2	5.3	11	83
1,1,2,2-Tetrachloroethene	<.2	5.6	12	86
1,2-Dichloropropane	<.2	5.1	11	86
cis-1,3-Dichloropropene	<.2	4.8	10	83
trans-1,3-Dichloropropene	<.2	6.1	14	92
Benzene	<.2	5.1	11	86
Chlorobenzene	<.2	5.9	12	81
Ethylbenzene	<.2	6.1	12	79
Toluene	<.2	6.1	13	85

Table 9. Statistical summary of physical properties and constituent concentrations in water samples collected at base-flow sampling sites in October 1991 and January to February 1992

[ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; mg/L, milligram per liter; <, less than; µg/L, microgram per liter; NA, not applicable; pH, in standard units]

Constituent or physical property	Detection limit	Number of occurrences greater than detection limit[a]	Number of sites with occurrences greater than detection limit[b]	Mean of occurrences greater than detection limit	Minimum	Maximum
Discharge	0.001 ft^3/s	[c]219	187	0.126	<0.001	10.1
Specific conductance	.5 µS/cm	[d]225	192	899	325	2,530
pH	4.0 to 10.0	[e]222	189	[f]7.9	6.7	9.8
Temperature	50 °C	[e]222	189	9.3	.5	24.0
Chlorine, total	.1 mg/L	[g]45	39	.23	<.1	.90
Copper, total	.1 µg/L	0	0	NA	<.1	<.1
Detergents, total	.05 mg/L	1	1	.3	<.05	.3
Phenols, total	.02 mg/L	0	0	NA	<.02	<.02

[a] Two-hundred twenty-six total samples.
[b] One hundred ninety-three total sites.
[c] Discharge was not measured for one sample.
[d] One sample not analyzed.
[e] Four samples not analyzed.
[f] If pH is not normally distributed, mean pH will not satisfactorily summarize the typical hydrogen ion concentration.
[g] Three samples not analyzed.

Table 10. Values of selected physical properties and constituent concentrations of water samples collected during base-flow conditions

[A, Adair Creek; B, Bundschu Creek; BR, Blue River; C, Crackerneck Creek; FP, Fire Prairie Creek; LB, Little Blue River; M, Mill Creek; R, Rock Creek; S, Sugar Creek; SB, Spring Branch Creek; WFP, West Fire Prairie Creek; ft^3/s, cubic feet per second; °C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microseimens per centimeter at 25 degrees Celsius; <, less than; --, no data]

Site number (fig. 2)	Date	Time	Discharge (ft^3/s)	Specific conductance (µS/cm)	pH (units)	Temperature (°C)	Total chlorine[a] (mg/L)	Total copper[a] (mg/L)	Total detergents[a] (mg/L)	Total phenols[a] (mg/L)
A1	01-29-92	1105	0.79	802	8.0	2.0	<0.10	<0.1	<0.05	<0.02
A2	01-29-92	1330	.73	772	8.1	2.0	<.10	<.1	<.05	<.02
A3	01-29-92	1425	.007	971	8.0	10.0	<.10	<.1	<.05	<.02
A4	01-29-92	1430	.48	795	--	--	.10	<.1	<.05	<.02
A5	01-30-92	0800	.002	1,240	7.6	10.5	<.10	<.1	<.05	<.02
	01-31-92	0800	.02	1,250	7.7	8.5	<.10	<.1	<.05	<.02
A6	01-30-92	0835	.005	849	7.8	6.5	<.10	<.1	<.05	<.02
A7	01-30-92	0845	.01	658	8.1	6.5	<.10	<.1	<.05	<.02
A8	01-30-92	1030	.82	810	8.1	2.5	<.10	<.1	<.05	<.02
A9	01-30-92	1230	.17	1,160	7.8	9.5	<.10	<.1	<.05	<.02
	01-31-92	0855	.007	1,140	8.0	7.5	<.10	<.1	<.05	<.02
A10	01-30-92	1300	<.001	775	8.4	9.0	.15	<.1	<.05	<.02
	01-31-92	0845	<.001	772	8.2	5.5	<.10	<.1	<.05	<.02
A11	01-30-92	1320	.005	953	8.0	3.0	<.10	<.1	<.05	<.02
	01-31-92	0835	.006	960	8.2	2.5	<.10	<.1	<.05	<.02
A12	01-30-92	1330	.005	1,240	8.2	10.5	<.10	<.1	<.05	<.02
	01-31-92	0825	.003	1,230	8.3	4.5	<.10	<.1	<.05	<.02
A13	01-30-92	1350	.44	839	8.4	8.0	<.10	<.1	<.05	<.02
A14	01-30-92	1425	.04	1,000	7.8	9.0	<.10	<.1	<.05	<.02
	01-31-92	0905	.03	1,000	8.2	8.5	<.10	<.1	<.05	<.02
A15	01-30-92	1430	.27	831	8.4	8.5	<.10	<.1	<.05	<.02
A16	01-30-92	1500	.10	918	8.1	8.0	<.10	<.1	<.05	<.02
A17	01-30-92	1515	.09	875	8.0	5.5	<.10	<.1	<.05	<.02
	01-31-92	0915	.08	910	8.5	4.5	<.10	<.1	<.05	<.02
A18	01-31-92	0945	.05	902	8.3	3.5	<.10	<.1	<.05	<.02
A19	01-31-92	1030	.06	1,030	8.3	8.5	<.10	<.1	<.05	<.02
A50	01-30-92	1000	.04	773	8.0	4.0	<.10	<.1	<.05	<.02
A51	01-30-92	1040	.02	584	7.8	4.5	<.10	<.1	<.05	<.02
	01-31-92	0800	.01	745	7.6	10.0	.15	<.1	<.05	<.02
A52	01-30-92	1130	.04	972	7.8	5.0	<.10	<.1	<.05	<.02
A53	01-30-92	1245	.03	978	8.1	5.0	.10	<.1	<.05	<.02
A54	01-30-92	1300	.003	982	7.9	5.5	<.10	<.1	<.05	<.02
A55	01-30-92	1315	.10	768	8.3	6.0	<.10	<.1	<.05	<.02
A56	01-30-92	1350	.01	753	7.0	18.0	.30	<.1	<.05	<.02
A57	01-30-92	1415	.004	754	7.0	10.0	<.10	<.1	<.05	<.02
A58	01-30-92	1435	.08	769	8.5	6.5	<.10	<.1	<.05	<.02
A59	01-30-92	1500	.02	778	7.9	9.0	<.10	<.1	<.05	<.02
A60	01-30-92	1530	.009	848	8.1	8.5	<.10	<.1	<.05	<.02
A95	01-31-92	1240	.06	916	8.5	13.5	<.10	<.1	<.05	<.02
A96	01-31-92	1210	.003	1,020	8.2	11.5	.15	<.1	<.05	<.02
A97	01-31-92	1150	.10	960	8.2	6.0	<.10	<.1	<.05	<.02
A98	01-31-92	1120	.031	1,000	8.0	10.0	<.10	<.1	<.05	<.02
	02-03-92	0840	.04	958	8.2	11.0	<.10	<.1	<.05	<.02
	02-03-92	1300	.04	907	8.1	11.5	<.10	<.1	<.05	<.02
A99	01-31-92	1110	.02	891	7.5	7.0	<.10	<.1	<.05	<.02
	02-03-92	0900	.03	664	8.0	8.0	.10	<.1	<.05	<.02
	02-03-92	1315	.03	653	8.5	10.0	<.10	<.1	<.05	<.02

Table 10. Values of selected physical properties and constituent concentrations of water samples collected during base-flow conditions--Continued

Site number (fig. 2)	Date	Time	Discharge (ft^3/s)	Specific conductance (μS/cm)	pH (units)	Temperature (°C)	Total chlorine[a] (mg/L)	Total copper[a] (mg/L)	Total detergents[a] (mg/L)	Total phenols[a] (mg/L)
A100	01-31-92	0855	0.03	670	7.5	7.5	<0.10	<0.1	<0.05	<0.02
A101	01-31-92	0910	.005	1,440	7.9	4.0	<.10	<.1	<.05	<.02
A102	01-31-92	0925	.003	1,120	8.1	6.0	<.10	<.1	<.05	<.02
A103	01-31-92	0950	.02	1,020	7.8	5.0	<.10	<.1	<.05	<.02
A104	01-31-92	1015	.02	966	8.3	5.5	<.10	<.1	<.05	<.02
	02-03-92	0930	.02	931	8.2	7.0	<.10	<.1	<.05	<.02
	02-03-92	1330	.02	911	8.2	7.0	.20	<.1	<.05	<.02
A110	02-03-92	0915	.004	1,390	8.2	7.0	<.10	<.1	<.05	<.02
	02-03-92	1315	.004	1,350	8.3	8.0	<.10	<.1	<.05	<.02
B1	10-17-91	0800	.18	696	7.8	12.0	<.10	<.1	<.05	<.02
B2	10-17-91	0850	.10	778	8.0	11.5	<.10	<.1	<.05	<.02
B3	10-17-91	0930	.24	685	7.9	11.5	<.10	<.1	<.05	<.02
B4	10-17-91	1005	.16	828	7.6	13.0	.30	<.1	<.05	<.02
B5	10-17-91	1025	.03	867	7.9	12.5	<.10	<.1	<.05	<.02
B6	10-17-91	1040	.006	894	7.8	13.5	<.10	<.1	<.05	<.02
B7	10-17-91	1110	.02	637	8.3	14.5	<.10	<.1	<.05	<.02
B8	10-17-91	1125	.03	878	7.9	17.0	<.10	<.1	<.05	<.02
B9	10-17-91	1140	.01	840	8.1	17.0	<.10	<.1	<.05	<.02
B10	10-17-91	1200	.02	680	7.6	16.0	<.10	<.1	<.05	<.02
B11	10-17-91	1300	.02	1,010	7.4	17.5	.20	<.1	<.05	<.02
B12	10-17-91	1330	.04	892	7.3	17.5	<.10	<.1	<.05	<.02
	10-18-91	0800	--	895	--	--	--	<.1	<.05	<.02
BR1	02-03-92	1445	.01	1,200	8.1	8.5	<.10	<.1	<.05	<.02
C1	10-21-91	0840	.08	898	7.9	7.5	<.10	<.1	<.05	<.02
C2	10-21-91	0920	.11	836	7.7	8.0	<.10	<.1	<.05	<.02
C3	10-21-91	1020	.12	920	7.7	9.0	<.10	<.1	<.05	<.02
C4	10-21-91	1055	<.001	738	--	--	<.10	<.1	<.05	<.02
C5	10-21-91	--	.04	1,140	7.7	13.0	<.10	<.1	<.05	<.02
C6	10-21-91	1325	.01	1,300	7.6	17.0	<.10	<.1	<.05	<.02
	10-22-91	0800	.01	2,480	--	--	--	<.1	<.05	<.02
C7	10-22-91	0912	.05	1,040	7.6	13.0	.10	<.1	<.05	<.02
C8	10-22-91	0950	.05	886	7.9	12.0	<.10	<.1	<.05	<.02
C9	10-22-91	1050	.05	822	7.9	16.0	<.10	<.1	<.05	<.02
	10-23-91	1345	.04	720	7.4	22.5	<.10	<.1	<.05	<.02
C10	10-22-91	1225	.04	730	7.4	14.0	.20	<.1	<.05	<.02
C11	10-22-91	1325	.04	560	7.8	11.0	.30	<.1	<.05	<.02
C20	10-23-91	0945	<.001	782	7.8	16.0	<.10	<.1	<.05	<.02
FP1	02-07-92	1000	.14	600	8.1	.5	.15	<.1	<.05	<.02
FP2	02-04-92	0950	<.001	430	7.9	4.0	<.10	<.1	<.05	<.02
FP3	02-04-92	1000	.10	452	8.0	3.5	<.10	<.1	<.05	<.02
FP4	02-04-92	1030	.13	457	7.9	4.0	<.10	<.1	<.05	<.02
FP5	02-06-92	1100	.006	498	7.8	6.0	<.10	<.1	<.05	<.02
LB1	02-07-92	0915	.060	625	8.0	.5	<.10	<.1	<.05	<.02
LB2	02-11-92	0900	.02	684	7.8	3.0	<.10	<.1	<.05	<.02
LB3	02-11-92	1020	.02	691	7.9	3.0	<.10	<.1	<.05	<.02
LB4	02-11-92	1055	.04	684	7.7	5.5	<.10	<.1	<.05	<.02

Table 10. Values of selected physical properties and constituent concentrations of water samples collected during base-flow conditions–Continued

Site number (fig. 2)	Date	Time	Discharge (ft^3/s)	Specific conductance (μS/cm)	pH (units)	Temperature (°C)	Total chlorine[a] (mg/L)	Total copper[a] (mg/L)	Total detergents[a] (mg/L)	Total phenols[a] (mg/L)
LB5	02-03-92	1100	0.001	1,230	8.2	6.5	<0.10	<0.1	<0.05	<0.02
	02-03-92	1530	.001	1,240	8.2	7.0	<.10	<.1	<.05	<.02
LB6	02-03-92	1112	.001	902	8.5	7.0	<.10	<.1	<.05	<.02
	02-03-92	1530	.001	904	8.5	7.0	.50	<.1	<.05	<.02
M1	01-21-92	1000	.43	825	8.4	1.5	<.10	<.1	<.05	<.02
M2	01-21-92	1030	.14	796	8.5	2.0	.10	<.1	<.05	<.02
M3	01-21-92	1100	.15	896	8.1	3.5	<.10	<.1	<.05	<.02
M4	01-21-92	1120	.09	926	8.3	.5	<.10	<.1	<.05	<.02
M5	01-21-92	1300	.03	1,030	8.4	1.5	<.10	<.1	<.05	<.02
M6	01-21-92	1330	.03	1,100	8.3	3.5	<.10	<.1	<.05	<.02
M7	01-21-92	1420	.003	1,310	7.7	5.5	<.10	<.1	<.05	<.02
M8	01-21-92	1430	.02	1,480	8.2	.5	<.10	<.1	<.05	<.02
M9	01-21-92	1545	.06	907	8.3	2.5	<.10	<.1	<.05	<.02
M10	01-24-92	0735	.001	1,200	7.4	.5	<.10	<.1	<.05	<.02
M11	01-24-92	0800	.03	770	7.8	2.0	<.10	<.1	<.05	<.02
M12	01-24-92	0845	.01	722	7.4	.5	<.10	<.1	<.05	<.02
M13	01-24-92	1045	.04	640	7.6	3.0	<.10	<.1	<.05	<.02
M14	01-27-92	0945	.06	1,040	7.7	8.5	<.10	<.1	<.05	<.02
M15	01-27-92	1125	.001	1,130	7.7	5.5	<.10	<.1	<.05	<.02
M16	01-27-92	1330	.01	883	7.5	7.0	<.10	<.1	<.05	<.02
M17	01-27-92	1415	.13	865	8.3	5.0	<.10	<.1	<.05	<.02
M18	01-27-92	--	.05	1,030	8.4	7.5	<.10	<.1	<.05	<.02
M19	01-27-92	1510	.01	1,000	7.8	8.0	<.10	<.1	<.05	<.02
	01-28-92	0815	.01	981	8.0	2.0	.70	<.1	<.05	<.02
M20	01-28-92	0843	.01	1,040	8.0	2.0	<.10	<.1	<.05	<.02
M21	01-28-92	0913	.005	886	8.4	3.0	<.10	<.1	<.05	<.02
M22	01-28-92	1015	.03	1,320	7.9	2.0	<.10	<.1	<.05	<.02
M23	01-28-92	1045	.003	1,130	8.2	4.5	<.10	<.1	<.05	<.02
	01-29-92	0820	.002	1,130	8.0	5.0	<.10	<.1	<.05	<.02
M24	01-29-92	0800	.001	1,030	7.1	7.5	<.10	<.1	<.05	<.02
M25	01-29-92	0845	.004	1,360	7.6	8.5	<.10	<.1	<.05	<.02
	01-30-92	0815	.004	1,380	7.7	10.0	<.10	<.1	<.05	<.02
M26	01-28-92	0930	.001	1,250	7.7	4.5	<.10	<.1	<.05	<.02
	01-30-92	0830	<.01	1,320	7.7	5.5	<.10	<.1	<.05	<.02
M27	01-29-92	0945	.01	1,260	8.0	7.5	<.10	<.1	<.05	<.02
	01-30-92	0900	.01	1,290	8.0	7.5	<.10	<.1	<.05	<.02
R1	10-08-91	1020	10.1	901	6.8	21.0	.10	<.1	<.05	<.02
R2	10-08-91	1030	.14	489	6.9	13.5	<.10	<.1	<.05	<.02
R3	10-08-91	1050	.02	829	7.1	11.5	.20	<.1	<.05	<.02
R4	10-08-91	1110	--	908	7.3	24.0	<.10	<.1	<.05	<.02
R5	10-08-91	1130	.10	528	7.3	15.0	.10	<.1	<.05	<.02
R6	10-08-91	1310	.19	660	7.3	15.0	.20	<.1	<.05	<.02
R8	10-09-91	0850	.05	1,090	6.9	14.5	<.10	<.1	<.05	<.02
R9	10-09-91	0900	.03	982	6.8	14.5	<.10	<.1	<.05	<.02
R10	10-09-91	1010	.16	662	7.6	15.0	<.10	<.1	<.05	<.02
R11	10-09-91	1010	.02	1,070	7.8	16.0	<.10	<.1	<.05	<.02
R12	10-09-91	1140	.05	650	7.4	16.0	<.10	<.1	<.05	<.02

Table 10. Values of selected physical properties and constituent concentrations of water samples collected during base-flow conditions–Continued

Site number (fig. 2)	Date	Time	Discharge (ft^3/s)	Specific conductance (μS/cm)	pH (units)	Temperature (°C)	Total chlorine[a] (mg/L)	Total copper[a] (mg/L)	Total detergents[a] (mg/L)	Total phenols[a] (mg/L)
R13	10-09-91	1345	0.02	618	7.1	17.5	<0.10	<0.1	<0.05	<0.02
R14	10-09-91	1450	.05	637	7.6	21.5	.10	<.1	<.05	<.02
R15	10-10-91	0830	.03	863	7.6	13.5	<.10	<.1	<.05	<.02
R16	10-10-91	1000	.67	788	7.4	13.5	<.10	<.1	<.05	<.02
R17	10-10-91	1040	.01	550	8.5	16.0	.15	<.1	<.05	<.02
R18	10-10-91	1110	.02	788	8.0	15.0	.30	<.1	<.05	<.02
R19	10-10-91	1253	.09	932	8.0	14.5	<.10	<.1	<.05	<.02
R20	10-10-91	1245	.04	665	8.0	17.5	.30	<.1	<.05	<.02
	10-11-91	1010	.04	546	8.5	18.5	.80	<.1	<.05	<.02
R21	10-10-91	1335	.09	881	8.0	16.0	<.10	<.1	<.05	<.02
R22	10-10-91	1350	.008	847	7.7	15.5	<.10	<.1	<.05	<.02
R23	10-10-91	1410	.04	771	7.9	19.5	.10	<.1	<.05	<.02
	10-11-91	1050	.03	728	7.4	17.5	<.10	<.1	<.05	<.02
R24	10-10-91	1445	.03	1,560	7.3	17.0	.10	<.1	<.05	<.02
	10-11-91	1035	.03	1,560	7.3	18.0	<.10	<.1	<.05	<.02
R25	10-11-91	0945	.007	875	7.9	13.5	<.10	<.1	<.05	<.02
R26	10-11-91	0945	.01	772	8.0	13.5	<.10	<.1	<.05	<.02
R27	10-11-91	1125	.01	704	7.7	19.0	.20	<.1	<.05	<.02
R50	10-16-91	1220	.003	776	8.1	12.5	<.10	<.1	<.05	<.02
R51	10-16-91	1235	.04	830	7.9	15.0	<.10	<.1	<.05	<.02
R52	10-16-91	1245	.03	825	7.9	15.0	<.10	<.1	<.05	<.02
R53	10-16-91	1415	.03	922	7.9	12.5	<.10	<.1	<.05	<.02
R54	10-16-91	--	.03	875	8.1	12.0	<.10	<.1	<.05	<.02
R60	02-27-92	0934	.024	533	7.6	18.5	.15	<.1	<.05	<.02
	02-27-92	1516	.02	537	7.6	19.5	.10	<.1	<.05	<.02
R61	02-27-92	0910	.003	773	9.8	10.0	.10	<.1	<.05	<.02
	02-27-92	1454	.009	829	8.7	11.0	.10	<.1	<.05	<.02
S1	01-15-92	1245	.20	596	6.8	2.0	.10	<.1	<.05	<.02
S2	01-15-92	1245	.04	694	7.3	.5	<.10	<.1	<.05	<.02
S3	01-15-92	0830	.19	574	6.7	3.0	.10	<.1	<.05	<.02
S4	01-15-92	1340	.001	1,080	6.8	.5	<.10	<.1	<.05	<.02
S5	01-15-92	1400	.001	1,260	7.0	3.0	<.10	<.1	<.05	<.02
S6	01-16-92	0830	<.20	1,230	8.1	1.0	<.10	<.1	<.05	<.02
S7	01-16-92	0920	<.01	1,280	8.0	.5	<.10	<.1	<.05	<.02
S8	01-16-92	1000	<.10	670	8.0	1.5	<.10	<.1	<.05	<.02
S9	01-16-92	1030	<.10	642	7.6	3.5	<.10	<.1	<.05	<.02
S10	01-16-92	1100	<.20	--	8.2	2.0	<.10	<.1	<.05	<.02
S11	01-16-92	1120	<.01	853	7.8	7.0	.15	<.1	<.05	<.02
	01-17-92	0845	.009	858	7.5	7.0	.15	<.1	<.05	<.02
S12	01-16-92	1200	<.001	1,010	7.5	3.0	<.10	<.1	<.05	<.02
S13	01-17-92	0915	.23	674	8.2	7.5	<.10	<.1	<.05	<.02
S14	01-17-92	1020	.06	698	8.1	12.5	.40	<.1	<.05	<.02
S15	01-17-92	1100	.04	979	7.6	9.0	<.10	<.1	<.05	<.02
S16	01-17-92	1145	.007	854	8.0	1.5	.20	<.1	<.05	<.02
S17	01-22-92	0830	.01	507	9.2	12.0	.20	<.1	<.05	<.02
	01-17-92	1230	.01	550	9.3	11.0	.50	<.1	<.05	<.02
	01-21-92	0830	.01	534	9.4	10.5	.50	<.1	<.05	<.02
S18	01-17-92	1300	.006	1,040	8.1	4.0	<.10	<.1	<.05	<.02

Table 10. Values of selected physical properties and constituent concentrations of water samples collected during base-flow conditions--Continued

Site number (fig. 2)	Date	Time	Discharge (ft^3/s)	Specific conductance (μS/cm)	pH (units)	Temperature (°C)	Total chlorine[a] (mg/L)	Total copper[a] (mg/L)	Total detergents[a] (mg/L)	Total phenols[a] (mg/L)
S19	01-17-92	1330	0.02	1,210	7.7	11.0	<0.10	<0.1	0.30	<0.02
S20	01-21-92	0915	.15	527	9.2	15.5	.90	<.1	<.05	<.02
SB1	10-08-91	1030	.38	864	7.8	12.0	<.10	<.1	<.05	<.02
SB2	10-08-91	1130	.40	772	7.8	12.5	<.10	<.1	<.05	<.02
SB3	10-08-91	1210	.08	667	8.1	14.0	<.10	<.1	<.05	<.02
SB4	10-08-91	1245	.10	671	8.2	14.5	<.10	<.1	<.05	<.02
SB5	10-08-91	1345	.08	686	7.9	16.5	.10	<.1	<.05	<.02
SB6	10-08-91	1415	.05	694	7.9	18.0	<.10	<.1	<.05	<.02
SB7	10-08-91	1435	.02	750	8.1	17.0	.10	<.1	<.05	<.02
SB8	10-09-91	0900	.07	711	8.2	13.5	<.10	<.1	<.05	<.02
SB9	10-09-91	1140	.33	703	7.6	15.5	<.10	<.1	<.05	<.02
SB10	10-09-91	1300	.24	734	7.7	15.0	<.10	<.1	<.05	<.02
SB11	10-09-91	1400	.15	821	7.9	16.0	<.10	<.1	<.05	<.02
SB12	10-09-91	1445	.38	667	7.7	17.5	<.10	<.1	<.05	<.02
SB13	10-10-91	0955	<.03	506	8.8	15.5	<.10	<.1	<.05	<.02
SB15	10-10-91	1415	.07	1,250	7.8	16.5	<.10	<.1	<.05	<.02
SB16	10-10-91	1320	.02	546	7.6	19.5	<.10	<.1	<.05	<.02
SB17	10-11-91	0850	.14	858	7.5	13.0	<.10	<.1	<.05	<.02
SB18	10-11-91	0930	.08	1,160	7.9	13.5	--	<.1	<.05	<.02
SB19	10-11-91	1010	.02	576	8.0	13.5	<.10	<.1	<.05	<.02
SB20	10-11-91	1045	.06	1,220	8.0	14.5	<.10	<.1	<.05	<.02
SB21	10-11-91	1120	.04	1,730	8.3	14.0	<.10	<.1	<.05	<.02
SB22	10-15-91	0933	.02	2,530	8.0	12.0	<.10	<.1	<.05	<.02
SB23	10-15-91	1030	.006	912	8.1	13.0	<.10	<.1	<.05	<.02
SB24	10-15-91	1110	.02	1,540	8.2	14.0	<.10	<.1	<.05	<.02
SB25	10-15-91	1215	.08	1,600	8.6	13.5	<.10	<.1	<.05	<.02
SB26	10-15-91	1435	.01	1,040	8.0	14.0	<.10	<.1	<.05	<.02
SB27	10-16-91	0920	.02	1,080	8.1	10.0	<.10	<.1	<.05	<.02
WFP1	02-05-92	0855	.16	325	8.7	1.5	<.10	<.1	<.05	<.02
WFP2	02-05-92	0920	1.02	693	8.2	.5	<.10	<.1	<.05	<.02
WFP3	02-05-92	1010	.29	1,000	8.3	.5	<.10	<.1	<.05	<.02
WFP4	02-05-92	1030	.15	513	8.1	1.0	<.10	<.1	<.05	<.02
WFP5	02-05-92	1045	.26	531	8.4	1.0	<.10	<.1	<.05	<.02
WFP6	02-06-92	0810	.03	922	7.8	1.0	<.10	<.1	<.05	<.02
WFP7	02-06-92	0845	.23	1,320	8.2	1.5	<.10	<.1	<.05	<.02
WFP8	02-06-92	0920	.10	616	7.9	1.5	<.10	<.1	<.05	<.02
WFP9	02-06-92	1000	.05	532	8.2	1.5	<.10	<.1	<.05	<.02
WFP10	02-06-92	1020	.08	413	7.4	6.5	<.10	<.1	<.05	<.02

[a] Concentrations are considered semi-quantitative.

Table 11. Rainfall and discharge characteristics for three storms at each of the stormwater-runoff sampling sites

Site number (fig. 1)	Storm duration: Beginning rainfall Date	Storm duration: Beginning rainfall Time	Storm duration: End of runoff Date	Storm duration: End of runoff Time	Rainfall total (inches)	Total runoff volume (inches)	Rainfall-runoff coefficient	Maximum 20-minute total (inches)	Peak flow (cubic feet per second)	Rainfall duration (minutes)	Runoff duration (minutes)	Time from start of storm rainfall to maximum streamflow (minutes)	Time since previous storm[a] (hours)
1	09-02-92	0540	09-02-92	0725	[b]0.39	0.04	0.10	0.39	27.6	20	90	25	159
	10-07-92	2115	10-08-92	0220	[b].52	.09	.17	.19	22.8	210	275	208	274
	02-11-93	0055	02-11-93	0545	[b].33	.02	.06	.07	2.2	230	220	110	[d]700
2	07-22-92	0530	07-22-92	0850	[e].51	.04	.08	--	6.8	105	195	11	150
	09-17-92	0530	09-17-92	1100	[d].42	.06	.14	.09	5.8	295	320	243	195
	12-09-92	0000	12-09-92	0630	[c].25	.03	.12	.04	1.2	324	336	149	315
3	07-09-92	2235	07-10-92	0505	[b].93	.61	.66	.65	258	250	245	10	59
	08-18-92	1900	08-18-92	2010	[c].32	.09	.28	.18	32	35	55	23	274
	11-18-92	0540	11-18-92	1014	[c].22	.11	.50	.05	5.6	190	270	97	144
4	08-07-92	0520	08-07-92	0820	[b].67	.19	.28	.47	111	135	180	10	114
	09-29-92	0700	08-07-92	1120	[b].41	.07	.17	.12	16.0	225	258	11	127
	02-11-93	0055	02-11-93	0525	[b].33	.04	.12	.07	3.7	230	260	170	[d]700
5	07-30-92	0230	07-30-92	0510	[d].71	.12	.17	.45	4.6	90	145	33	81
	10-07-92	2120	10-08-92	0120	[d].98	.19	.19	.32	5.2	200	240	147	274
	12-09-92	0000	12-09-92	0648	[d].25	.10	.40	.04	.9	324	403	145	315

[a] Minimum storm depth is 0.10 inch.
[b] Rainfall measured from rain gage RN 1 (table 1).
[c] Rainfall measured from rain gage RN 2 (table 1).
[d] Previous precipitation was 9 inches of snow.
[e] Total rainfall measured from a non-recording gage onsite.

Table 12. Values of selected physical properties and constituent concentrations from first-flush samples collected at the stormwater-runoff sampling sites

[Q, discharge; ft^3/s, cubic feet per second; °C, degrees Celsius; col/100 mL, colonies per 100 milliliters; mg/L, milligrams per liter; µg/L, micrograms per liter; K, non-ideal colony count; <, less than; discharge, temperature, bacteria, and total chlorine were determined by the U.S. Geological Survey, Independence, Missouri; total cyanide was determined by Enseco Rocky Mountain Analytical Laboratory, Arvada, Colorado; total phenols and oil and grease were determined by the U.S. Geological Survey, Arvada, Colorado]

Site number (fig. 1)	Date	Time	Q (ft^3/s)	Temperature, air (°C)	Temperature, water (°C)	Coliform, fecal, (col/100 mL)	Streptococci, fecal (col/100 mL)	Chlorine, total, Hach method (mg/L)	Cyanide, total (mg/L)	Phenols, total (µg/L)	Oil and grease, total recoverable (mg/L)
1	09-02-92	0558	4.0	--	--	290,000	218,000	--	<0.010	2	1
	09-02-92	0610	34.0	--	--	K157,000	500,000	--	--	--	--
	09-02-92	0700	2.6	--	--	90,000	108,000	--	--	--	--
	10-07-92	2214	4.6	15.0	17.5	62,700	340,000	0.15	<.010	1	<1
	10-07-92	2254	3.6	15.0	17.0	84,000	92,700	--	--	--	--
	10-07-92	2334	3.0	15.0	17.0	37,300	108,000	--	--	--	--
	10-08-92	0034	17.4	14.0	16.0	K143,000	76,700	--	--	--	--
	02-11-93	0250	2.20	--	8.5	5,670	12,400	<.10	--	--	--
	02-11-93	0417	2.20	--	--	5,600	6,070	--	--	--	--
2	07-22-92	0543	6.2	--	20.5	K20,000	K10,000	<.10	<10.0	4	16
	07-22-92	0712	.90	--	--	K19,000	K27,000	--	--	--	--
	09-17-92	0600	.80	--	--	147,000	140,000	<.10	<.010	3	4
	09-17-92	0620	2.00	--	--	77,500	99,100	--	--	--	--
	09-17-92	0641	1.30	--	--	62,000	123,000	--	--	--	--
	09-17-92	0936	4.40	--	--	78,000	65,400	--	--	--	--
	12-09-92	0118	.40	4.0	6.0	6,600	K1,900	<.10	<.010	7	3
3	07-09-92	2244	260	--	--	--	--	--	<10.0	<1	<1
	08-18-92	1917	10.4	--	26.5	K219,000	K233,000	<.10	<.010	--	--
	08-18-92	1924	19.0	--	--	19,200	58,000	--	--	--	--
	08-18-92	1935	10.5	--	--	7,940	36,000	--	--	--	--
	11-18-92	0715	5.2	5.0	7.5	100,000	55,000	--	<.010	4	3
4	08-07-92	0526	70	--	--	13,000	28,200	--	<10.0	6	<1
	08-07-92	0552	10.5	--	--	23,200	57,000	--	--	--	--
	09-26-92	0710	19.0	--	--	11,000	18,800	.20	<.010	4	7
	09-26-92	0807	2.9	--	--	K14,200	19,400	--	--	--	--
	09-26-92	0952	5.1	--	--	K13,800	K21,200	--	--	--	--
	02-11-93	0250	2.4	--	9.0	K1,600	4,400	--	--	1	<1
	02-11-93	0336	2.2	--	--	K500	2,300	--	--	--	--

Table 12. Values of selected physical properties and constituent concentrations from first-flush samples collected at the stormwater-runoff sampling sites—Continued

Site number (fig. 1)	Date	Time	Q (ft^3/s)	Temperature, air (°C)	Temperature, water (°C)	Coliform, fecal, (col/100 mL)	Streptococci, fecal (col/100 mL)	Chlorine, total, Hach method (mg/L)	Cyanide, total (mg/L)	Phenols, total (µg/L)	Oil and grease, total recoverable (mg/L)
5	07-30-92	0250	2.0	--	23.0	K9,000	K15,000	--	<10.0	3	2
	07-30-92	0350	1.60	--	--	22,000	K258,000	--	--	--	--
	07-30-92	0455	.31	--	--	K12,000	K340,000	--	--	--	--
	10-07-92	2128	3.1	--	17.5	K1,200	92,000	--	<.010	2	<1
	10-07-92	2210	.68	--	--	K3,800	48,700	--	--	--	--
	12-09-92	0212	.77	4.0	3.0	K106,000	78,000	--	<.010	2	3
	12-09-92	0402	.61	--	--	20,000	4,870	--	--	--	--
	12-09-92	0600	.50	--	--	4,100	2,500	--	--	--	--

Table 13. Values of selected physical properties and constituent concentrations in flow-weighted-composite samples at the stormwater-runoff sampling sites

[SC, specific conductance; µS/cm, microseimens per centimeter at 25 degrees Celsius; pH, in standard units; COD, chemical oxygen demand; mg/L, milligrams per liter; BOD, 5-day biochemical oxygen demand; Ca^{+2}, dissolved calcium; Mg^{+2}, dissolved magnesium; Na^{+1}, dissolved sodium; K^{+1}, dissolved potassium; HCO_3^{-1}, bicarbonate; CO_3^{-2}, carbonate; Alk, alkalinity, incremental titration, total; $CaCO_3$, calcium carbonate; Alk (EP), alkalinity, end point titration to pH 4.5, total; Alk (L); alkalinity, laboratory; H, hardness, total; SO_4^{-2}, sulfate, dissolved; Cl^{-1}, chloride, dissolved; DS, dissolved solids; °C, degrees Celsius; SS, total suspended solids; NO_2^{-2}, nitrite as nitrogen; $NO_2 + NO_3$, nitrite plus nitrate as nitrogen; NH_3^+, ammonia as nitrogen; NH_3^+ + ON, ammonia plus organic nitrogen, total as nitrogen; ON, organic nitrogen, total; P, phosphorus; TOC, total organic carbon; CN^{-1}, cyanide; biochemical oxygen demand analyzed by the City of Independence Water Pollution Control; >, greater than; <, less than]

Site number (fig. 1)	Date	Time	Ending date	Ending time	SC, onsite[a] (µS/cm)	SC, laboratory (µS/cm)	COD (mg/L)	BOD[b] (mg/L)	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	Na^{+1} (mg/L)
1	09-02-92	0558	09-02-92	0637	158	187	1,200	>650	18	1.7	5.1
	10-07-92	2214	10-08-92	0148	213	227	140	63	27	2.8	7.3
	02-11-93	0245	02-11-93	0517	665	680	130	34	73	8.1	50
2	07-22-92	0543	07-22-92	0822	147	160	190	>46	20	1.7	5.1
	09-17-92	0600	09-17-92	0936	167	187	96	17	23	2.2	6.0
	12-09-92	0118	12-09-92	0608	615	858	480	30	48	5.8	110
3	07-09-92	2244	07-10-92	0510	68	78	36	13	8.1	.5	1.4
	08-18-92	1917	08-18-92	1935	148	191	1,600	>220	21	1.1	4.8
	11-18-92	0715	11-18-92	0912	--	140	150	72	18	1.0	3.6
4	08-07-92	0526	08-07-92	0756	214	241	56	15	28	2.5	8.3
	09-26-92	0710	09-26-92	1101	296	310	57	--	41	3.5	13
	02-11-93	0245	02-11-93	0445	246	311	210	44	24	1.5	19
5	07-30-92	0250	07-30-92	0455	14,100	14,600	140	<16	96	3.4	2,900
	10-07-92	2128	10-07-92	2347	8,010	8,030	270	93	53	2.5	1,600
	12-09-92	0212	12-09-92	0600	26,500	24,000	69	100	140	6.2	5,800

Table 13. Values of selected physical properties and constituent concentrations in flow-weighted-composite samples at the stormwater-runoff sampling sites–Continued

Site number (fig. 1)	K^{+1} (mg/L)	HCO_3^{-1} (mg/L)	CO_3^{-2} (mg/L)	Alk (mg/L as $CaCO_3$)	Alk (EP) (mg/L as $CaCO_3$)	Alk (L) (mg/L as $CaCO_3$)	H (mg/L as $CaCO_3$)	SO_4^{-2} (mg/L)	Cl^{-1} (mg/L)	DS, residue at 180 °C (mg/L)	SS, residue at 105 °C (mg/L)	DS, sum of constituents (mg/L)	NO_2^{-2}, total (mg/L)
1	3.2	81	0	66	83	140	52	13	7.7	101	1,180	89	<0.01
	4.9	60	0	49	49	70	79	22	12	143	456	106	<.01
	3.5	180	0	150	150	130	220	77	81	381	130	385	--
2	1.8	59	0	48	49	70	57	13	8.6	99	202	79	<.01
	2.1	68	0	56	58	68	67	11	11	130	153	89	<.01
	2.5	130	0	110	100	110	140	27	160	458	107	419	<.01
3	1.5	32	0	27	29	49	22	3.8	1.9	34	221	33	<.01
	3.1	46	0	38	38	77	57	19	5.4	125	90	77	<.01
	1.2	--	--	--	--	57	49	8.1	4.8	75	38	71	<.01
4	2.5	77	0	63	63	79	80	23	18	130	548	120	<.01
	2.1	86	0	71	71	91	120	29	22	175	86	153	<.01
	1.8	90	0	74	74	89	66	21	26	131	112	145	--
5	2.9	250	0	200	180	60	250	12	4,500	8,500	1,200	7,640	<.01
	.4	38	0	31	31	110	140	110	2,100	4,510	352	3,880	.02
	3.6	94	1	80	80	140	380	420	8,100	14,700	612	14,500	.01

Table 13. Values of selected physical properties and constituent concentrations in flow-weighted-composite samples at the stormwater-runoff sampling sites–Continued

Site number (fig 1)	NO_2, dissolved (mg/L)	$NO_2 + NO_3$, total (mg/L)	$NO_2 + NO_3$, dissolved (mg/L)	NH_3^+, total (mg/L)	NH_3^+, dissolved (mg/L)	NH_3^+ + ON (mg/L)	ON (mg/L)	P, total (mg/L)	P, dissolved (mg/L)	TOC (mg/L)	CN^{-1}, total (mg/L)
1	--	<0.05	--	<0.01	--	3.3	3.3	1.3	<0.01	250	<0.01
	--	.80	--	.29	--	1.2	.9	.60	.33	39	<.01
	<0.01	--	0.81	--	0.81	1.7	--	.25	.06	26	<.01
2	--	.59	--	.26	--	.6	.3	.27	.11	66	<.01
	--	.75	--	.15	--	.6	.4	.33	.16	28	<.01
	--	.58	--	.34	--	1.4	1.1	.31	.10	26	<.01
3	--	.38	--	.41	--	1.4	1.0	.29	.06	12	<.01
	--	1.0	--	1.0	--	2.9	1.9	.49	.42	410	<.01
	--	.90	--	.43	--	1.1	.7	.18	.03	39	<.01
4	--	.94	--	.34	--	1.4	1.1	.60	.15	24	<.01
	--	1.3	--	.29	--	.7	.4	.20	.09	14	<.01
	.01	--	1.5	--	.51	1.5	--	.28	.08	30	<.01
5	--	.50	--	.33	--	.6	.3	.65	.03	22	.01
	--	.42	--	.37	--	.9	.5	.50	.10	68	<.01
	--	.43	--	.40	--	.2	<.2	.12	<.01	--	.01

[a] Analyzed by the U.S. Geological Survey, Independence, Missouri.
[b] Analyzed by the City of Independence Water Pollution Control, Independence, Missouri.

Table 14. Concentrations of trace elements in flow-weighted-composite samples at the stormwater-runoff sampling sites

[Constituent concentrations analyzed by the U.S. Geological Survey, Arvada, Colorado, unless otherwise specified; concentrations are whole-water recoverable, unless indicated; concentrations are in micrograms per liter; Sb, antimony, total; As, arsenic, total; Be, beryllium; Cd, cadmium; Cr, chromium; Cu, copper; Pb, lead; Hg, mercury; Ni, nickel; Se, selenium, total; Ag, silver; Tl, thallium, total; Zn, zinc; <, less than; --, no data]

Site number (fig. 1)	Date	Time	Ending date	Ending time	Sb[a], total	As, total	Be	Cd[b]	Cd[c]	Cr[d]	Cr[c]	Cu[b]
1	09-02-92	0558	09-02-92	0637	<20.0	10	<10	5	<10	99	40	95
	10-07-92	2214	10-08-92	0148	<10.0	2	<10	1	<10	6	20	52
	02-11-93	0245	02-11-93	0517	<20.0	3	<10	3	<10	21	<10	19
2	07-22-92	0543	07-22-92	0822	<10.0	2	<10	1	<10	<1	<10	10
	09-17-92	0600	09-17-92	0936	<10.0	3	<10	1	<10	5	<10	9
	12-09-92	0118	12-09-92	0608	<10.0	2	<10	4	<10	8	10	8
3	07-09-92	2244	07-10-92	0510	<10.0	2	<10	1	<10	17	20	18
	08-18-92	1917	08-18-92	1935	<10.0	1	<10	1	<10	9	40	19
	11-18-92	0715	11-18-92	0912	<20.0	1	<10	<1	<10	--	<10	9
4	08-07-92	0526	08-07-92	0756	<10.0	4	<10	2	--	9	--	130
	09-26-92	0710	09-26-92	1101	<10.0	3	<10	<1	<10	2	20	31
	02-11-93	0245	02-11-93	0445	<20.0	2	<10	2	<10	24	10	17
5	07-30-92	0250	07-30-92	0455	<10.0	6	<10	40	60	23	40	45
	10-07-92	2128	10-07-92	2347	<10.0	2	<10	15	30	14	20	22
	12-09-92	0212	12-09-92	0600	<10.0	3	<10	22	60	41	20	24

Table 14. Concentrations of trace elements in flow-weighted-composite samples at the stormwater-runoff sampling sites–Continued

Site number (fig. 1)	Cu[c]	Pb	Pb[c]	Hg	Ni	Ni[c]	Se	Ag	Ag,[a] total	Tl,[a] total	Zn
1	130	260	300	<0.1	32	<100	<1	<1	<1.0	<5	860
	50	60	<100	<.1	10	<100	<2	<1	<.5	<5	250
	20	59	100	<.1	7	<100	<2	<1	<.5	<10	240
2	10	42	<100	<.1	7	<100	<2	<1	<.5	<5	280
	10	41	<100	<.1	8	<100	<2	<1	<.5	<10	200
	<10	31	<100	<.1	6	<100	<2	<1	<1.0	<10	110
3	20	86	<100	<.1	7	<100	<2	<1	<1.0	<10	230
	20	39	<100	<.1	6	<100	<1	<1	<5.0	<10	290
	<10	20	<100	<.1	4	<100	<2	<1	<.5	<5	110
4	--	100	--	.2	12	--	<1	<1	<.5	<5	410
	30	26	<100	<.1	3	<100	<2	12	<.5	<10	140
	20	110	100	<.1	7	<100	<2	<1	<.5	<10	300
5	60	800	800	.3	37	100	<5	<1	<1.0	<10	6,200
	30	290	400	<.1	19	<100	<2	<1	<.5	<10	2,200
	50	500	800	.1	23	200	<2	<1	<10.0	<50	3,600

[a] Analyzed by Enseco Rocky Mountain Analytical Laboratory, Arvada, Colorado.
[b] Analyzed using graphic furnace atomic absorption.
[c] Analyzed using direct atomic absorption.
[d] Analyzed using direct current plasma.

Table 15. Concentrations of pesticides in flow-weighted-composite samples at the stormwater-runoff sampling sites

[Constituent concentrations analyzed by the U.S. Geological Survey, Arvada, Colorado; constituents are whole-water recoverable, unless indicated; concentrations are in micrograms per liter; BHC, benzene hexachloride; DDD, 1,1-Dichloro-2,2-bis(*p*-Chlorophenyl)ethane; DDE, Dichloro diphenyl dichloroethylene; DDT, Dichloro diphenyl trichloroethane; PCB, polychlorinated biphenyl; <, less than]

Site number (fig. 1)	Date	Time	Ending date	Ending time	Aldrin	Alpha BHC	Beta BHC	Delta BHC	Chlordane	cis-Chlordane
1	09-02-92	0558	09-02-92	0637	<0.04	<0.03	<0.03	<0.09	0.4	0.1
	10-07-92	2214	10-08-92	0148	<.04	<.03	<.03	<.09	.2	<.1
	02-11-93	0245	02-11-93	0517	<.04	<.03	<.03	<.09	.1	<.1
2	07-22-92	0543	07-22-92	0822	<.04	<.03	<.03	<.09	.1	<.1
	09-17-92	0600	09-17-92	0936	<.04	<.03	<.03	<.09	<.1	<.1
	12-09-92	0118	12-09-92	0608	<.04	<.03	<.03	<.09	.1	<.1
3	07-09-92	2244	07-10-92	0510	<.04	<.03	<.03	<.09	<.1	<.1
	08-18-92	1917	08-18-92	1935	<.04	<.03	<.03	<.09	<.1	<.1
	11-18-92	0715	11-18-92	0912	<.04	<.03	<.03	<.09	<.1	<.1
4	08-07-92	0526	08-07-92	0756	<.04	<.03	<.03	<.09	<.1	<.1
	09-26-92	0710	09-26-92	1101	<.04	<.03	<.03	<.09	<.1	<.1
	02-11-93	0245	02-11-93	0445	<.04	<.03	<.03	<.09	<.1	<.1
5	07-30-92	0250	07-30-92	0455	<.04	<.03	<.03	<.09	<.1	<.1
	10-07-92	2128	10-07-92	2347	<.04	<.03	<.03	<.09	<.1	<.1
	12-09-92	0212	12-09-92	0600	<.04	<.03	<.03	<.09	<.1	<.1

Table 15. Concentrations of pesticides in flow-weighted-composite samples at the stormwater-runoff sampling sites–Continued

Site number (fig. 1)	trans-Chlordane	*p,p'*-DDD	*p,p'*-DDE	*p,p'*-DDT	Diazinon	Dieldrin	Alpha-endosulfan	Beta-endosulfan	Endosulfan sulfate	Endrin	Endrin aldehyde
1	0.1	<0.1	<0.04	<0.1	1.0	0.05	<0.1	<0.04	<0.6	<0.06	<0.2
	<.1	<.1	<.04	<.1	.2	<.02	<.1	<.04	<.6	<.06	<.2
	<.1	<.1	<.04	<.1	<.1	<.02	<.1	<.04	<.6	<.06	<.2
2	<.1	<.1	<.04	<.1	.1	<.02	<.1	<.04	<.6	<.06	<.2
	<.1	<.1	<.04	<.1	.1	<.02	<.1	<.04	<.6	<.06	<.2
	<.1	<.1	<.04	<.1	<.1	<.02	<.1	<.04	<.6	<.06	<.2
3	<.1	<.1	<.04	<.1	.2	<.02	<.1	<.04	<.6	<.06	<.2
	<.1	<.1	<.04	<.1	.1	<.02	<.1	<.04	<.6	<.06	<.2
	<.1	<.1	<.04	<.1	<.1	<.02	<.1	<.04	<.6	<.06	<.2
4	<.1	<.1	<.04	<.1	.2	<.02	<.1	<.04	<.6	<.06	<.2
	<.1	<.1	<.04	<.1	<.1	<.02	<.1	<.04	<.6	<.06	<.2
	<.1	.1	<.04	.1	<.1	<.02	<.1	<.04	<.6	<.06	<.2
5	<.1	<.1	<.04	<.1	<.1	<.02	<.1	<.04	<.6	<.06	<.2
	<.1	<.1	<.04	<.1	<.1	<.02	<.1	<.04	<.6	<.06	<.2
	<.1	<.1	<.04	<.1	<.1	<.02	<.1	<.04	<.6	<.06	<.2

Table 15. Concentrations of pesticides in flow-weighted-composite samples at the stormwater-runoff sampling sites–Continued

Site number (fig. 1)	Heptachlor	Heptachlor epoxide	Lindane	PCB, Aroclor 1016	PCB, Aroclor 1221	PCB, Aroclor 1232	PCB, Aroclor 1242	PCB, Aroclor 1248	PCB, Aroclor 1254	PCB, Aroclor 1260	Toxaphene
1	<0.03	<0.8	<0.03	<0.1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<2
	<.03	<.8	<.03	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
	<.03	<.8	<.03	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
2	<.03	<.8	<.03	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
	<.03	<.8	<.03	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
	<.03	<.8	<.03	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
3	<.03	<.8	<.03	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
	<.03	<.8	<.03	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
	<.03	<.8	<.03	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
4	<.03	<.8	<.03	<.1	<1	<.1	<.1	2.4	<.1	<.1	<2
	<.03	<.8	<.03	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
	<.03	<.8	.03	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
5	<.03	<.8	<.03	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
	<.03	<.8	<.03	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2
	<.03	<.8	<.03	<.1	<1	<.1	<.1	<.1	<.1	<.1	<2

Table 16. Concentrations of volatile organic compounds in flow-weighted-composite samples at the stormwater-runoff sampling sites

[Constituent concentrations analyzed at the U.S. Geological Survey, Arvada, Colorado; concentrations are in micrograms per liter and are whole-water recoverable; <, less than; --, no data]

Site number (fig. 1)	Date	Time	Ending date	Ending time	Bromo-methane	Di-bromo-methane	Bromo-form	Bromo-chloro-methane	Dibromo-chloro-methane	Chloro-methane	Dichloro-methane	Trichloro-methane	Tetra-chloro-methane	Dichloro-bromo-methane
1	09-02-92	0558	09-02-92	0637	<0.2	<0.2	<0.2	--	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	10-07-92	2214	10-08-92	0148	<.2	<.2	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2
	02-11-93	0245	02-11-93	0517	<.2	<.2	<.2	<0.2	<.2	<.2	<.2	<.2	<.2	<.2
2	07-22-92	0543	07-22-92	0822	<.2	<.2	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2
	09-17-92	0600	09-17-92	0936	<.2	<.2	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2
	12-09-92	0118	12-09-92	0608	<.2	<.2	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2
3	07-09-92	2244	07-10-92	0510	<.2	<.2	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2
	08-18-92	1917	08-18-92	1935	<.2	<.2	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2
	11-18-92	0715	11-18-92	0912	<.2	<.2	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2
4	08-07-92	0526	08-07-92	0756	<.2	<.2	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2
	09-26-92	0710	09-26-92	1101	<.2	<.2	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2
	02-11-93	0245	02-11-93	0445	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
5	07-30-92	0250	07-30-92	0455	<.2	<.2	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2
	10-07-92	2128	10-07-92	2347	<.2	<.2	<.2	--	<.2	<.2	.2	<.2	<.2	<.2
	12-09-92	0212	12-09-92	0600	<.2	<.2	<.2	--	<.2	<.2	<.2	<.2	<.2	<.2

Table 16. Concentrations of volatile organic compounds in flow-weighted-composite samples at the stormwater-runoff sampling sites–Continued

Site number (fig. 1)	Dichloro-difluoro-methane	Tri-chloro-fluoro-methane	Chloro-ethane	1,2-Dibromo-ethane	1,1-Dichloro-ethane	1,2-Dichloro-ethane	1,1,1-Tri-chloro-ethane	1,1,2-Tri-chloro-ethane	1,1,1,2-Tetra-chloro-ethane	1,1,2,2-Tetra-chloro-ethane	Trichloro-trifluoro-ethane	Chloro-ethene	1,1-Dichloro-ethene	cis-1,2-Dichloro-ethene
1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	--	<0.2	<0.2	<0.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	--	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<0.5	<.2	<.2	<.2
2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	--	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	--	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	--	<.2	<.2	<.2
3	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	--	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	--	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	--	<.2	<.2	<.2
4	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	--	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	--	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.5	<.2	<.2	<.2
5	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	--	<.2	<.2	<.2
	<.3	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	--	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	--	<.2	<.2	<.2

Table 16. Concentrations of volatile organic compounds in flow-weighted-composite samples at the stormwater-runoff sampling sites--Continued

Site number (fig. 1)	trans-1,2 Dichloro-ethene	1,1,2-Tri-chloro-ethene	1,1,2,2-Tetra-chloro-ethene	1,2-Dichloro-propane	1,3-Dichloro-propane	2,2-Dichloro-propane	1,2,3-Tri-chloro-propane	1,2-Dibromo-3-chloro-propane	1,1-Dichloro-propene	cis-1,3-Dichloro-propene	trans-1,3-Dichloro-propene	Hexa-chloro-butadiene	Benzene	Bromo-benzene
1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<1.0	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	<.2	<.2	<.2	<.2	.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	<.2	<.2	<.2	<.2	<.2	<.2
2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	<.2	<.2	<.2	<.2	.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	<.2	<.2	<.2	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	<.2	<.2	<.2	<.2	<.2	<.2
3	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	<.2	<.2	<.2	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	<.2	<.2	<.2	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	<.2	<.2	<.2	<.2	<.2	<.2
4	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	<.2	<.2	<.2	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	<.2	<.2	<.2	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	<.2	<.2	<.2	<.2	<.2	<.2
5	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	<.2	<.2	<.2	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	<.2	<.2	<.2	<.2	.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	<.2	<.2	<.2	<.2	<.2	<.2

Table 16. Concentrations of volatile organic compounds in flow-weighted-composite samples at the stormwater-runoff sampling sites–Continued

Site number (fig. 1)	Chloro-benzene	1,2-Dichloro-benzene	1,3-Dichloro-benzene	1,4-Dichloro-benzene	1,2,3-Tri-chloro-benzene	1,2,4-Tri-chloro-benzene	Xylenes, total	1,2,4-Tri-methyl-benzene	1,3,5-Tri-methyl-benzene	Ethyl-benzene	*n*-Propyl-benzene	*n*-Butyl-benzene	(1-Methyl-ethyl)-benzene	(1,1-Di-methyl-ethyl)-benzene
1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
2	<.2	<.2	<.2	<.2	<.2	<.2	2.3	5.0	1.0	.4	.3	.6	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
3	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	1.8	1.4	.4	<.3	.2	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
4	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	.6	<.2	<.2	<.2	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
5	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2

Table 16. Concentrations of volatile organic compounds in flow-weighted-composite samples at the stormwater-runoff sampling sites–Continued

Site number (fig. 1)	(1-Methyl-propyl)-benzene	Styrene	Toluene	2-Chloro-toluene	4-Chloro-toluene	*p*-Isopropyl-toluene	Naphtha-lene	2-Chloro-ethyl vinyl ether	Methyl-tertiary-butyl ether	Acrolein	Acrylo-nitrile
1	<0.2	<0.2	<0.2	<0.2	<0.2	0.3	<0.2	<1.0	--	<20	<20
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	--	<20	<20
	<.2	<.2	<.2	<.2	<.2	<.2	.2	<1.0	<1.0	<20	<20
2	<.2	<.2	1.3	<.2	<.2	<.2	5.1	<1.0	--	<20	<20
	<.2	<.2	<.2	<.2	<.2	<.2	.2	<1.0	--	<20	<20
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	--	<20	<20
3	<.2	<.2	.2	<.2	<.2	<.2	<.2	<1.0	--	<20	<20
	<.2	<.2	.4	<.2	<.2	<.2	.9	<1.0	--	<20	<20
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	--	<20	<20
4	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	--	<20	<20
	<.2	.2	<.2	<.2	<.2	<.2	.6	<1.0	--	<20	<20
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	<1.0	<20	<20
5	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	--	<20	<20
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	--	<20	<20
	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1.0	--	<20	<20

Table 17. Concentrations of acidic, basic, and neutral semi-volatile organic compounds in flow-weighted-composite samples at the stormwater-runoff sampling sites

[Constituent concentrations analyzed at the U.S. Geological Survey, Arvada, Colorado; concentrations are in micrograms per liter and are whole-water recoverable; <, less than]

Site number (fig. 1)	Date	Time	Ending date	Ending time	1,2-Di-chloro-benzene	1,3-Di-chloro-benzene	1,4-Di-chloro-benzene	1,2,4-Tri-chloro-benzene	Hexa-chloro-benzene	Nitro-benzene
1	09-02-92	0558	09-02-92	0637	<5	<5	<5	<5	<5	<5
	10-07-92	2214	10-08-92	0148	<5	<5	<5	<5	<5	<5
	02-11-93	0245	02-11-93	0517	<5	<5	<5	<5	<5	<5
2	07-22-92	0543	07-22-92	0822	<5	<5	<5	<5	<5	<5
	09-17-92	0600	09-17-92	0936	<5	<5	<5	<5	<5	<5
	12-09-92	0118	12-09-92	0608	<5	<5	<5	<5	<5	<5
3	07-09-92	2244	07-10-92	0510	<5	<5	<5	<5	<5	<5
	08-18-92	1917	08-18-92	1935	<5	<5	<5	<5	<5	<5
	11-18-92	0715	11-18-92	0912	<5	<5	<5	<5	<5	<5
4	08-07-92	0526	08-07-92	0756	<5	<5	<5	<5	<5	<5
	09-26-92	0710	09-26-92	1101	<5	<5	<5	<5	<5	<5
	02-11-93	0245	02-11-93	0445	<5	<5	<5	<5	<5	<5
5	07-30-92	0250	07-30-92	0455	<5	<5	<5	<5	<5	<5
	10-07-92	2128	10-07-92	2347	<5	<5	<5	<5	<5	<5
	12-09-92	0212	12-09-92	0600	<5	<5	<5	<5	<5	<5

Table 17. Concentrations of acidic, basic, and neutral semi-volatile organic compounds in flow-weighted-composite samples at the stormwater-runoff sampling sites–Continued

Site number (fig. 1)	2,4-Dinitro-toluene	2,6-Dinitro-toluene	Phenol	2-Chloro-phenol	2-Nitro-phenol	4-Nitro-phenol	2,4-Di-chloro-phenol	2,4-Di-methyl-phenol	2,4-Di-nitro-phenol	4-Chloro-3-methyl-phenol
1	<5	<5	<5	<5	<5	<30	<5	<5	<20	<30
	<5	<5	<5	<5	<5	<30	<5	<5	<20	<30
	<5	<5	<5	<5	<5	<30	<5	<5	<20	<30
2	<5	<5	<5	<5	<5	<30	<5	<5	<20	<30
	<5	<5	<5	<5	<5	<30	<5	<5	<20	<30
	<5	<5	<5	<5	<5	<30	<5	<5	<20	<30
3	<5	<5	<5	<5	<5	<30	<5	<5	<20	<30
	<5	<5	<5	<5	<5	<30	<5	<5	<20	<30
	<5	<5	<5	<5	<5	<30	<5	<5	<20	<30
4	<5	<5	<5	<5	<5	<30	<5	<5	<20	<30
	<5	<5	<5	<5	<5	<30	<5	<5	<20	<30
	<5	<5	<5	<5	<5	<30	<5	<5	<20	<30
5	<5	<5	<5	<5	<5	<30	<5	<5	<20	<30
	<5	<5	<5	<5	<5	<30	<5	<5	<20	<30
	<5	<5	<5	<5	<5	<30	<5	<5	<20	<30

Table 17. Concentrations of acidic, basic, and neutral semi-volatile organic compounds in flow-weighted-composite samples at the stormwater-runoff sampling sites–Continued

Site number (fig. 1)	2,4,6-Tri-chloro-phenol	4-Methyl-4,6-dinitro-phenol	Penta-chloro-phenol	Naph-thalene	Acenaph-thylene	Acenaph-thene	Fluorene	Anthra-cene	Phenan-threne	Fluor-anthene
1	<20	<30	<30	<5	<5	<5	<5	<5	<5	<5
	<20	<30	<30	<5	<5	<5	<5	<5	<5	<5
	<20	<30	<30	<5	<5	<5	<5	<5	7	18
2	<20	<30	<30	<5	<5	<5	<5	<5	<5	<5
	<20	<30	<30	<5	<5	<5	<5	<5	<5	<5
	<20	<30	<30	<5	<5	<5	<5	<5	<5	<5
3	<20	<30	<30	<5	<5	<5	<5	<5	<5	<5
	<20	<30	<30	<5	<5	<5	<5	<5	<5	<5
	<20	<30	<30	<5	<5	<5	<5	<5	<5	<5
4	<20	<30	<30	<5	<5	<5	<5	<5	<5	<5
	<20	<30	<30	<5	<5	<5	<5	<5	<5	<5
	<20	<30	<30	<5	<5	<5	<5	<5	7	15
5	<20	<30	<30	<5	<5	<5	<5	<5	<5	<5
	<20	<30	<30	<5	<5	<5	<5	<5	<5	<5
	<20	<30	<30	<5	<5	<5	<5	<5	6	10

Table 17. Concentrations of acidic, basic, and neutral semi-volatile organic compounds in flow-weighted-composite samples at the stormwater-runoff sampling sites–Continued

Site number (fig. 1)	Pyrene	Benzo[*a*]-anthra-cene	Chrysene	Benzo[*a*]-pyrene	Benzo[*b*]-fluor-anthene	Benzo[*k*]-fluor-anthene	Benzo-[*g,h,i*]-perylene	Indeno-[*1,2,3-cd*]-pyrene	Dibenzo [*a,h*]-anthracene	Dimethyl phthalate
1	<5	<10	<10	<10	<10	<10	<10	<10	<10	<5
	<5	<10	<10	<10	<10	<10	<10	<10	<10	<5
	13	<10	<10	<10	<10	<10	<10	<10	<10	<5
2	<5	<10	<10	<10	<10	<10	<10	<10	<10	<5
	<5	<10	<10	<10	<10	<10	<10	<10	<10	<5
	<5	<10	<10	<10	<10	<10	<10	<10	<10	<5
3	<5	<10	<10	<10	<10	<10	<10	<10	<10	<5
	<5	<10	<10	<10	<10	<10	<10	<10	<10	<5
	<5	<10	<10	<10	<10	<10	<10	<10	<10	<5
4	<5	<10	<10	<10	<10	<10	<10	<10	<10	<5
	<5	<10	<10	<10	<10	<10	<10	<10	<10	<5
	11	<10	<10	<10	<10	<10	<10	<10	<10	<5
5	<5	<10	<10	<10	<10	<10	<10	<10	<10	<5
	<5	<10	<10	<10	<10	<10	<10	<10	<10	<5
	7	<10	<10	<10	<10	<10	<10	<10	<10	<5

Table 17. Concentrations of acidic, basic, and neutral semi-volatile organic compounds in flow-weighted-composite samples at the stormwater-runoff sampling sites--Continued

Site number (fig. 1)	Diethyl phthalate	Di-*n*-butyl phthalate	*n*-Butyl-benzyl phthalate	Di-n-octyl-phthalate	Di-2-ethyl-hexyl phthalate	*n*-Nitro-sodimethyl-amine	*n*-Nitro-sodi-n-propyl-amine	*n*-Nitro-sodi-phenylamine	Isophorone	1,2-Di-phenyl-hydrazine
1	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5
	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5
	<5	<5	<5	<10	6	<5	<5	<5	<5	<5
2	<5	<5	<5	<10	6	<5	<5	<5	<5	<5
	<5	<5	<5	<10	7	<5	<5	<5	<5	<5
	<5	<5	<5	<10	8	<5	<5	<5	<5	<5
3	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5
	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5
	<5	<5	<5	<10	10	<5	<5	<5	<5	<5
4	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5
	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5
	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5
5	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5
	<5	<5	<5	<10	<5	<5	<5	<5	<5	<5
	<5	<5	<5	<10	5	<5	<5	<5	<5	<5

Table 17. Concentrations of acidic, basic, and neutral semi-volatile organic compounds in flow-weighted-composite samples at the stormwater-runoff sampling sites–Continued

Site number (fig. 1)	Hexa-chloro-ethane	bis(2-Chloro-ethyl) ether	bis(2-Chloroiso-propyl) ether	bis(2-Chloro-ethoxy)-methane	Hexa-chloro-butadiene	Hexa-chloro-cyclopent-adiene	4-Bromo-phenyl phenyl ether	4-Chloro-phenyl phenyl ether	2-Chloro-naphth-alene	4,4'-Diamino-biphenyl	4,4'-Diamino-3,3'dichloro-biphenyl
1	<5	<5	<5	<5	<5	<5	<5	<5	<5	<40	<20
	<5	<5	<5	<5	<5	<5	<5	<5	<5	<40	<20
	<5	<5	<5	<5	<5	<5	<5	<5	<5	<40	<20
2	<5	<5	<5	<5	<5	<5	<5	<5	<5	<40	<20
	<5	<5	<5	<5	<5	<5	<5	<5	<5	<40	<20
	<5	<5	<5	<5	<5	<5	<5	<5	<5	<40	<20
3	<5	<5	<5	<5	<5	<5	<5	<5	<5	<40	<20
	<5	<5	<5	<5	<5	<5	<5	<5	<5	<40	<20
	<5	<5	<5	<5	<5	<5	<5	<5	<5	<40	<20
4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<40	<20
	<5	<5	<5	<5	<5	<5	<5	<5	<5	<40	<20
	<5	<5	<5	<5	<5	<5	<5	<5	<5	<40	<20
5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<40	<20
	<5	<5	<5	<5	<5	<5	<5	<5	<5	<40	<20
	<5	<5	<5	<5	<5	<5	<5	<5	<5	<40	<20

Table 18. Stormwater-runoff volume and constituent loads at site 1

[Simulated values were calculated using methods described by Driver and Tasker (1990); °C, degrees Celsius; >, greater than; $CaCO_3$, calcium carboate; ND, not detected; --, no data]

Constituent	Storm loads, in pounds		
	09-02-92	10-07-92	02-11-93
Volume, in cubic feet	45,300	91,500	25,600
Volume, simulated, in cubic feet	99,000	140,000	82,000
Chemical oxygen demand	3,400	800	210
Chemical oxygen demand, simulated	493	640	430
Biochemical oxygen demand, 5-day at 20 °C	>1,800	360	54
Calcium, dissolved	51	150	120
Magnesium, dissolved	4.8	16	13
Sodium, dissolved	14	42	80
Potassium, dissolved	9.0	28	5.6
Bicarbonate	230	340	290
Alkalinity, total as $CaCO_3$	190	280	240
Sulfate, dissolved	37	120	120
Chloride, dissolved	22	68	130
Dissolved solids, residue at 180 °C	286	817	609
Dissolved solids, simulated	1,100	1,500	920
Suspended solids, residue at 105 °C	3,340	2,600	208
Suspended solids, simulated	610	870	490
Nitrite plus nitrate as nitrogen, total	ND	4.6	--
Nitrite plus nitrate as nitrogen, dissolved	--	--	1.3
Ammonia as nitrogen, total	ND	1.6	--
Ammonia as nitrogen, dissolved	--	--	1.3
Ammonia plus organic nitrogen, total	9.3	6.8	2.7
Ammonia plus organic nitrogen, simulated	14	18	12
Organic nitrogen, total	9.3	5.2	--
Nitrogen, total	9.3	11.4	4.0
Nitrogen, simulated total	18	23	15
Phosphorus, total	3.7	3.4	.40
Phosphorus, simulated total	2.2	3.0	1.9
Phosphorus, dissolved	ND	1.9	.10
Phosphorus, simulated dissolved	.40	.52	.34
Arsenic, whole-water recoverable	.028	.01	.005
Cadmium, whole-water recoverable	.01	.006	.005
Cadmium, simulated total	.012	.016	.009
Chromium, whole-water recoverable	.28	.03	.033
Copper, whole-water recoverable	.27	.30	.030
Copper, simulated total	.17	.19	.15
Lead, whole-water recoverable	.74	.34	.094
Lead, simulated total	.66	.84	.57
Nickel, whole-water recoverable	.090	.057	.01
Zinc, whole-water recoverable	2.4	1.4	.38
Zinc, simulated total	1.1	1.4	1.0
Organic carbon, total	710	220	42
Chlordane, whole-water recoverable	.001	.001	.0002
cis-Chlordane,whole-water recoverable	.0003	ND	ND
trans-Chlordane, whole-water recoverable	.0003	ND	ND
Diazinon, whole-water recoverable	.003	.001	ND
Dieldrin, whole-water recoverable	.0001	ND	ND
Benzene, whole-water recoverable	ND	.001	ND
p-Isopropyltoluene, whole-water recoverable	.0008	ND	ND
Naphthalene, whole-water recoverable	ND	ND	.0003
Di-2-ethylexyl phthalate, whole-water recoverable	ND	ND	.01
Fluoranthene,whole-water recoverable	ND	ND	.03
Phenanthrene, whole-water recoverable	ND	ND	.01
Pyrene, whole-water recoverable	ND	ND	.02

Table 19. Stormwater-runoff volume and constituent loads at site 2

[Simulated values were calculated using methods described by Driver and Tasker (1990); °C, degrees Celsius; >, greater than; $CaCO_3$, calcium carbonate; ND, not detected; --, no data]

Constituent	Storm loads, in pounds		
	07-22-92	09-17-92	12-09-92
Volume, in cubic feet	13,200	21,600	11,800
Volume, simulated, in cubic feet	48,400	38,800	21,600
Chemical oxygen demand	157	129	354
Chemical oxygen demand, simulated	323	272	173
Biochemical oxygen demand, 5-day at 20 °C	>37.6	23.3	22
Calcium, dissolved	16	31	35
Magnesium, dissolved	1.4	2.2	4.27
Sodium, dissolved	4.2	8	81
Potassium, dissolved	1.5	2.8	1.8
Bicarbonate,	49	92	96
Alkalinity, total as $CaCO_3$	40	76	81
Sulfate, dissolved	10.7	15	20
Chloride, dissolved	7.1	15	120
Dissolved solids, residue at 180 °C	82	175	337
Dissolved solids, simulated	241	196	112
Suspended solids, residue at 105 °C	166	206	79
Suspended solids, simulated	493	388	205
Nitrite plus nitrate as nitrogen, total	.49	1.0	.43
Ammonia as nitrogen, total	.21	.20	.25
Ammonia plus organic nitrogen, total	.5	.8	1.0
Ammonia plus organic nitrogen, simulated total	6.7	5.6	3.5
Organic nitrogen, total	.3	0.6	.8
Nitrogen, total	1.0	1.8	1.4
Nitrogen, simulated total	6.9	5.7	3.5
Phosphorus, total	.22	.45	.23
Phosphorus, simulated total	1.3	1.0	.63
Phosphorus, dissolved	.09	.22	.07
Phosphorus, simulated dissolved	.20	.16	.10
Arsenic, whole-water recoverable	.002	.004	.001
Cadmium, whole-water recoverable	.0008	.001	.003
Cadmium, simulated total	.004	.003	.0019
Chromium, whole-water recoverable	ND	.007	.006
Copper, whole-water recoverable	.0082	.01	.006
Copper, simulated total	.08	.071	.055
Lead, whole-water recoverable	.035	.055	.023
Lead, simulated total	.47	.40	.26
Nickel, whole-water recoverable	.006	.01	.004
Zinc, whole-water recoverable	.23	.27	.081
Zinc, simulated total	.50	.42	.28
Organic carbon, total	54	38	19
Chlordane, whole-water recoverable	.00008	ND	.00007
Diazinon, whole-water recoverable	.00008	.0001	ND
Benzene, whole-water recoverable	.0002	ND	ND
n-Butylbenzene, whole-water recoverable	.0005	ND	ND
Ethylbenzene, whole-water recoverable	.0003	ND	ND
Mesitylene, whole-water recoverable	.0008	ND	ND
Naphthalene, whole-water recoverable	.0042	ND	ND
n-Propylbenzene, whole-water recoverable	.0002	ND	ND
Pseudocumene, whole-water recoverable	.004	ND	ND
Toluene, whole-water recoverable	.0011	ND	ND
Xylene, whole-water recoverable	.0019	ND	ND
Di-2-ethylexyl phthalate, whole-water recoverable	.005	.009	.006

Table 20. Stormwater-runoff volume and constituent loads at site 3

[Simulated values were calculated using methods described by Driver and Tasker (1990); °C, degrees Celsius; >, greater than; $CaCO_3$, calcium carbonate; ND, not detected; --, no data]

Constituent	Storm loads, in pounds		
	07-09-92	08-18-92	11-18-92
Volume, in cubic feet	252,000	36,500	46,100
Volume, simulated in cubic feet	150,000	45,000	29,500
Chemical oxygen demand	570	3600	430
Chemical oxygen demand, simulated	925	363	260
Biochemical oxygen demand, 5-day at 20 °C	200	>500	200
Calcium, dissolved	130	48	52
Magnesium, dissolved	8	2.5	3
Sodium, dissolved	22	11	10
Potassium, dissolved	24	7.0	3.5
Bicarbonate	510	100	--
Alkalinity, total as $CaCO_3$	428	86	--
Sulfate, dissolved	60	43	23
Chloride, dissolved	30	12	14
Dissolved solids, residue at 180 °C	540	280	220
Dissolved solids, simulated	1,390	440	300
Suspended solids, residue at 105 °C	3,500	200	110
Suspended solids, simulated	1,270	340	220
Nitrite plus nitrate as nitrogen, total	6.0	2.3	2.6
Ammonia as nitrogen, total	6.5	2.3	1.2
Ammonia plus organic nitrogen, total	22	6.6	3.2
Ammonia plus organic nitrogen, simulated total	18	7.0	5.0
Organic nitrogen, total	16	4.3	2.0
Nitrogen, total	28	8.9	5.8
Nitrogen, simulated total	21	7.9	5.6
Phosphorus, total	4.6	1.1	.52
Phosphorus, simulated total	3.5	1.2	.83
Phosphorus, dissolved	.94	.96	.09
Phosphorus, simulated dissolved	.59	.22	.16
Arsenic, whole-water recoverable	.03	.002	.003
Cadmium, whole-water recoverable	.02	.002	ND
Cadmium, simulated total	.01	.003	.002
Chromium, whole-water recoverable	.27	.02	--
Copper, whole-water recoverable	.29	.043	.03
Copper, simulated total	.20	.12	.099
Lead, whole-water recoverable	1.4	.089	.058
Lead, simulated total	1.5	.62	.46
Nickel, whole-water recoverable	.1	.01	.01
Zinc, whole-water recoverable	3.6	.66	.32
Zinc, simulated total	1.8	.76	.57
Organic carbon, total	190	930	110
Diazinon, whole-water recoverable	.003	.0002	ND
Ethylbenzene, whole-water recoverable	ND	.0007	ND
Mesitylene, whole-water recoverable	ND	.0009	ND
Naphthalene, whole-water recoverable	ND	.002	ND
n-Propylbenzene, whole-water recoverable	ND	.0005	ND
Pseudocumene, whole-water recoverable	ND	.0032	ND
Toluene, whole-water recoverable	.003	.0009	ND
Xylene, whole-water recoverable	ND	.0041	ND
Di-2-ethylexyl phthalate, whole-water recoverable	ND	ND	.029

Table 21. Stormwater-runoff volume and constituent loads at site 4

[Simulated values were calculated using methods described by Driver and Tasker (1990); °C, degrees Celsius; $CaCO_3$, calcium carbonate; ND, not detected; --, no data]

Constituent	Storm loads, in pounds		
	08-07-92	09-26-92	02-11-93
Volume, in cubic feet	97,700	38,400	23,200
Volume, simulated in cubic feet	120,000	71,000	56,000
Chemical oxygen demand	340	140	300
Chemical oxygen demand, simulated	820	530	440
Biochemical oxygen demand, 5-day at 20 °C	89	--	64
Calcium, dissolved	170	98	35
Magnesium, dissolved	15	8.4	2.2
Sodium, dissolved	51	31	28
Potassium, dissolved	15	5.0	2.6
Bicarbonate	470	210	130
Alkalinity, total as $CaCO_3$	380	170	110
Sulfate, dissolved	140	70	30
Chloride, dissolved	110	53	38
Dissolved solids, residue at 180 °C	790	420	190
Dissolved solids, simulated	1,300	760	600
Suspended solids, residue at 105 °C	3,300	210	110
Suspended solids, simulated	950	520	400
Nitrite nitrogen, dissolved	--	--	.01
Nitrite plus nitrate as nitrogen, total	5.7	3.1	--
Nitrite plus nitrate as nitrogen, dissolved	--	--	2.2
Ammonia as nitrogen, total	2.1	.70	--
Ammonia as nitrogen, dissolved	--	--	.74
Ammonia plus organic nitrogen, total	8.5	2	2.2
Ammonia plus organic nitrogen, simulated total	16	10	8.5
Organic nitrogen, total	6.7	.98	--
Nitrogen, total	14.2	5	4.4
Nitrogen, simulated total	19	12	9.9
Phosphorus, total	3.7	.48	.41
Phosphorus, simulated total	2.9	1.8	1.4
Phosphorus, dissolved	.92	.2	.1
Phosphorus, simulated dissolved	.50	.32	.26
Arsenic, whole-water recoverable	.02	.007	.003
Cadmium, whole-water recoverable	.01	ND	.003
Cadmium, simulated total	.009	.005	.004
Chromium, whole-water recoverable	.05	.005	.035
Copper, whole-water recoverable	.79	.074	.025
Copper, simulated total	.20	.15	.14
Lead, whole-water recoverable	.61	.062	.16
Lead, simulated total	1.2	.79	.66
Mercury, whole-water recoverable	.001	ND	ND
Nickel, whole-water recoverable	.073	.007	.01
Silver, whole-water recoverable	ND	.029	ND
Zinc, whole-water recoverable	2.5	.34	.43
Zinc, simulated total	1.6	1.1	.90
Organic carbon, total	150	34	43
Lindane, whole-water recoverable	ND	ND	.00004
p,p'-DDT, whole-water recoverable	ND	ND	.0001
p,p'-DDD, whole-water recoverable	ND	ND	.0001
Diazinon, whole-water recoverable	.001	ND	ND
PCB, Aroclor 1248, whole-water recoverable	.015	ND	ND
Pseudocumene, whole-water recoverable	ND	.001	ND
Styrene, whole-water recoverable	ND	.0005	ND
Fluoranthene, whole-water recoverable	ND	ND	.022
Phenanthrene, whole-water recoverable	ND	ND	.01
Pyrene, whole-water recoverable	ND	ND	.016

Table 22. Stormwater-runoff volume and constituent loads at site 5

[Simulated values were calculated using methods described by Driver and Tasker (1990); °C, degrees Celsius; <, less than; $CaCO_3$, calcium carbonate; ND, not detected; --, no data]

Constituent	Storm loads, in pounds		
	07-30-92	10-07-92	12-09-92
Volume, in cubic feet	12,800	19,800	10,200
Volume, simulated in cubic feet	28,000	40,000	8,600
Chemical oxygen demand	110	330	44
Chemical oxygen demand, simulated	130	170	50
Biochemical oxygen demand, 5-day at 20 °C	<13	120	65
Calcium, dissolved	77	66	89
Magnesium, dissolved	2.7	3.1	3.9
Sodium, dissolved	2,300	2,000	3,700
Potassium, dissolved	2.3	.5	2.3
Bicarbonate	200	47	60
Alkalinity, total as $CaCO_3$	160	38	51
Sulfate, dissolved	9.7	140	270
Chloride, dissolved	3,600	2,600	5,200
Dissolved solids, residue at 180 °C	6,800	5,600	9,400
Dissolved solids, simulated	87	120	28
Suspended solids, residue at 105 °C	970	440	390
Suspended solids, simulated	316	470	87
Nitrite as nitrogen, total	ND	.02	.006
Nitrite plus nitrate as nitrogen, total	.40	.52	.27
Ammonia as nitrogen, total	.27	.46	.25
Ammonia plus organic nitrogen, total	.5	1.1	.1
Ammonia plus organic nitrogen, simulated total	3.8	5.1	1.5
Organic nitrogen, total	.2	.6	ND
Nitrogen, total	.9	1.6	.4
Nitrogen, simulated total	3.2	4.4	1.2
Phosphorus, total	.52	.62	.08
Phosphorus, simulated total	.85	1.2	.30
Phosphorus, dissolved	.02	.12	ND
Phosphorus, simulated dissolved	.12	.17	.048
Cyanide, total	.008	ND	.006
Arsenic, whole-water recoverable	.005	.002	.002
Cadmium, whole-water recoverable	.032	.19	.014
Cadmium, simulated total	.0013	.002	.0004
Chromium, whole-water recoverable	.019	.017	.026
Copper, whole-water recoverable	.036	.027	.015
Copper, simulated total	.052	.061	.030
Lead, whole-water recoverable	.64	.36	.32
Lead, simulated total	.19	.25	.08
Mercury, whole-water recoverable	.0002	ND	.00006
Nickel, whole-water recoverable	.030	.020	.015
Zinc, whole-water recoverable	5.0	2.7	2.3
Zinc, simulated total	.34	.43	.15
Organic carbon, total	18	84	--
Benzene, whole-water recoverable	ND	.0002	ND
Dichlorodifluoromethane, whole-water recoverable	ND	.0004	ND
Dichloromethane, whole-water recoverable	ND	.0002	ND
Di-2-ethylexyl phthalate, whole-water recoverable	ND	ND	.003
Fluoranthene, whole-water recoverable	ND	ND	.006
Phenanthrene, whole-water recoverable	ND	ND	.004
Pyrene, whole-water recoverable	ND	ND	.004