USGS
science for a changing world

recd 9/24/01

Streamflow, Surface-Water Quality, and Quality of Streambed Sediments in Little Buck Creek and Little Eagle Creek, Indianapolis, Indiana, 1990–94

Water-Resources Investigations Report 00-4289

Prepared in cooperation with the Indianapolis Department of Public Works

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of Interior
U.S. Geological Survey

Streamflow, Surface-Water Quality, and Quality of Streambed Sediments in Little Buck Creek and Little Eagle Creek, Indianapolis, Indiana, 1990–94

By David C. Voelker and Timothy C. Willoughby

Water-Resources Investigations Report 00-4289

Prepared in cooperation with the
Indianapolis Department of Public Works

Indianapolis, Indiana

2001

U.S. Department of the Interior
GALE A. NORTON, SECRETARY

U.S. Geological Survey
Charles G. Groat, Director

For additional information, write to:
District Chief
U.S. Geological Survey
5957 Lakeside Boulevard
Indianapolis, IN 46278-1996

Copies of this report can be purchased from:
U.S. Geological Survey
Branch of Information Services
Box 25286
Federal Center
Denver, CO 80225-0286

Contents

Figures

Tables

Tables—Continued

Conversion Factors, Vertical Datum, and Abbreviations

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square foot (ft^2)	.09290	square meter
square mile (mi^2)	2.590	square kilometer
cubic foot per second (ft^3/s)	.02832	cubic meter per second
cubic foot per second per square mile ($ft^3/s/mi^2$)	.01093	cubic meter per second per square kilometer
ton, short (2,000 lb)	.9072	megagram
pound, avoirdupois (lb)	.4536	kilogram
pound per day (lb/d)	.4536	kilogram per day

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

$$°F = (1.8 \times °C) + 32$$

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Altitude, as used in this report, refers to distance above or below sea level.

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25°C).

Concentrations of chemical constituents **in water** are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L). Milligrams per liter is a unit expressing the concentration of chemical constituents in solution as weight (milligrams) of solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to one milligram per liter. For concentrations less than 7,000 mg/L, the numerical value is the same as for concentrations in parts per million.

Concentrations of chemical constituents **in sediment** are given in milligrams per kilogram (mg/Kg) or micrograms per kilogram (µg/Kg).

Other abbreviations used in this report:

DPW - Indianapolis Department of Public Works

LOWESS - Locally weighted scatterplot smoothing technique

mm - millimeter

Total discharge - The sum of the daily mean discharges for the study period

USEPA - U.S. Environmental Protection Agency

USGS - U.S. Geological Survey

Streamflow, Surface-Water Quality, and Quality of Streambed Sediments in Little Buck Creek and Little Eagle Creek, Indianapolis, Indiana, 1990–94

By David C. Voelker *and* Timothy C. Willoughby

Abstract

Water samples were collected monthly from February 1990 through February 1992 at two stream sites on Little Buck Creek and at two stream sites on Little Eagle Creek in Indianapolis, Indiana, to describe the water quality of the two streams. Samples were collected during storms in 1993 and 1994 to describe water-quality conditions when runoff resulted in increased streamflow. Samples of streambed sediments were collected in 1990, during a period of low flow, to describe the chemistry of the sediments in the stream channel at the sampling sites.

In Little Buck Creek, measurements or concentrations of water temperature, nitrite plus nitrate, phosphorus, dissolved organic carbon, iron, and manganese were significantly larger in samples collected at the upstream site than in samples collected at the downstream site. Measurements of instantaneous streamflow, specific conductance, pH and concentrations of total alkalinity, total solids, dissolved solids, calcium, magnesium, sodium, potassium, chloride, and sulfate, however, were significantly larger in samples from the downstream site.

In the Little Eagle Creek drainage basin, measurements of specific conductance and pH and concentrations of total solids, dissolved solids, ammonia, dissolved organic carbon, calcium, magnesium, sodium, potassium, chloride, and sulfate were significantly larger in samples from the upstream site than in samples collected at the downstream site. Measurements of instantaneous streamflow and water temperature and concentrations of nitrite plus nitrate and suspended organic carbon, however, were significantly larger at the downstream site.

Specific conductance; pH; and concentrations of total alkalinity, dissolved solids, calcium, magnesium, sodium, and chloride were significantly larger in water samples collected from the downstream site on Little Buck Creek than in samples collected from the downstream site on Little Eagle Creek. Concentrations of 20-day biochemical oxygen demand, ammonia, nitrite, ammonia plus organic nitrogen, dissolved organic carbon, suspended organic carbon, potassium, fluoride, chromium, iron, manganese, zinc, suspended sediment, and suspended sediment (percent finer than 0.062 mm) were significantly larger in samples collected from the downstream site on Little Eagle Creek than in samples collected from the downstream site on Little Buck Creek.

The pesticide diazinon was detected at all four sites in storm samples analyzed primarily for organic compounds. Eight organic compounds were detected in the storm samples. Streambed sediments were sampled to determine the concentrations of selected organic compounds and metals in the streambed. Seventeen organic compounds were detected, of which the pesticides chlordane, dieldrin, diazinon, and malathion were detected at all four sites.

Introduction

The City of Indianapolis encompasses most of Marion County and is the largest city in Indiana. Land that was once agricultural or woodland is being developed for residential, commercial, and industrial use. Two drainage basins in Indianapolis undergoing urban growth are Little Buck Creek and Little Eagle Creek drainage basins. Urbanization of drainage basins can increase the concentrations of nutrients, metals, suspended sediment, and organic compounds in the receiving waters (Lazaro, 1979; Athayde, 1983). Little information is available to describe surface-water and streambed-sediment quality for drainage basins where urban growth is occurring in Indianapolis, and such information is needed to make informed decisions about urban development. This study was conducted by the U.S. Geological Survey (USGS) in cooperation with the City of Indianapolis Department of Public Works (DPW).

This report describes the results of a study to determine the surface-water and streambed-sediment quality for an upstream and a downstream site in each of the Little Buck Creek and Little Eagle Creek drainage basins. The report provides surface-water and streambed-sediment-quality data for these sites. The report also provides analyses of the data to (1) describe temporal variations in water quality at each site, (2) describe variations in water quality within each drainage basin and between drainage basins, (3) calculate mean annual loads of selected constituents for each site and (4) describe variations in streambed-sediment quality at each site. Streamflow data are presented and described to assist with the interpretation of the water-quality data.

Methods of Data Collection and Analysis

Water samples and ancillary data were collected monthly at four sites: two each on Little Buck Creek and Little Eagle Creek during 1990 through 1992. For both streams, an upstream and a downstream site were selected for sampling. A storm sample was collected at each site in 1993 and again in 1994 at the downstream site in the Little Eagle Creek drainage basin.

Streamflow

Streamflow-gaging stations were constructed at each site, except at the downstream site on Little Eagle Creek where a USGS streamflow-gaging station existed before the study. At each station, the elevation of the water surface, or stage, was measured continuously using a water-stage recorder, and the data were recorded every 5 minutes. The volume of streamflow was computed by use of a stage-discharge relation established for each gaging station according to the methods described by Rantz and others (1982). The streamflow data were published in the Indiana annual water-resources reports for water years 1990 through 1992 (Stewart and Nell, 1991; Stewart and Deiwert, 1992; and Stewart and others, 1993).

Surface-Water Quality

Water samples were collected monthly from February 1990 through February 1992 at each site, except for October 1991 when no sample was collected at Little Buck Creek near Indianapolis. Physical properties of the water were measured and samples were collected following USGS methods described by Ward and Harr (1990). Physical properties, which included water temperature, specific conductance, dissolved oxygen, and pH were measured in the field at the time of sample collection using a multi-parameter water-quality probe that was calibrated in the office before each use. Water samples were analyzed by the USGS National Water Quality Laboratory (NWQL) for biochemical oxygen demand, major ions, nutrients, metals, organic carbon, suspended sediment, dissolved solids, selected U.S. Environmental Protection Agency (USEPA) priority pollutants, and organic compounds. Total alkalinity and fecal coliform bacteria were determined by personnel in the USGS Indiana District Office.

Water samples were collected during at least one storm at each site after approximately 0.5 in. of precipitation in the drainage basin that was preceded by a relatively dry period. Storm samples were collected during August 1993 at both sites on Little Buck Creek and during December 1993 at both sites on Little Eagle Creek. Two additional storm samples were collected during April 1994 at the downstream site on Little Eagle Creek.

Streambed Sediments

Samples of streambed sediments were collected at each site during August 1990 during a period of low streamflow to describe the chemistry of the sediments. No standard method for obtaining representative samples of sediment in stream cross sections existed at the time of the study; therefore the following procedure was followed at each site. Approximately 40 subsamples were collected and composited from a variety of depositional areas along a 30-ft stream reach. The subsamples were collected to increase the probability of obtaining a representative sampling of compounds not distributed evenly in the stream channel. Streambed-sediment samples were collected using a large stainless-steel spoon while wading in the small shallow streams. The top 1 in. of surficial sediments was sampled, and the composited sediments were wet sieved through a 2-mm stainless-steel sieve, using water from the stream. The sieved material was transferred to a glass jar and allowed to settle overnight at 4°C. Supernatant water was removed via pipet; the remaining sediment was mixed and about 500 grams were placed in a baked glass jar, placed on ice, and shipped to the laboratory. Streambed sediments were analyzed for concentrations of metals, organic carbon, organophosphorus insecticides, organochlorine compounds, and base/neutral- and acid-extractable semivolatile organic compounds. Metals were analyzed at the USGS Sediment Partitioning Research Laboratory in Atlanta, Ga., and the remaining analyses were made at the NWQL.

Statistical Analysis

A Wilcoxon signed-rank test (Helsel and Hirsch, 1992, p. 142) was done to determine if there were significant differences between concentrations of constituents measured in waters collected at the upstream and downstream sites for each stream and between the downstream sites for both streams. Concentrations reported as less than the reporting limit were set at one-half the reporting limit. The statistical tests use ranked data; therefore any value could have been selected as long as it was less than the reporting limit. Kendall's Tau test (Helsel and Hirsch, 1992, p. 212) for significant correlation was used to determine if there were significant correlations between the constituent concentrations and streamflow measured at each of the downstream sites. For this report, a 5-percent level of significance (α=0.05) was selected for the statistical analyses. The probability of obtaining the computed test statistic (p-value), or one less likely, when the null hypothesis is true, also was calculated. The p-value derives from the data and measures the believability of the null hypothesis. The smaller the p-value, the less likely is the observed test statistic when the null hypothesis is true and the stronger the evidence for rejection of the null hypothesis. For the Wilcoxon signed-rank test, the null hypothesis is that the median difference between the parameter measured at the upstream and downstream sites and the median difference between the two downstream sites is equal to zero. For the Kendall's Tau test, the null hypothesis is that no correlation exists between the parameter measured and streamflow. At a significance level of 5 percent, the null hypothesis of 1 out of 20 tests will be rejected incorrectly. Because of the large number of hypothesis tests done in this study, some of the null hypotheses may be rejected solely because of the significance level.

A locally weighted scatterplot smoothing (LOWESS) technique (Helsel and Hirsch, 1992, p. 288) was used to determine seasonal trends for chemical constituents. The smoothness of the LOWESS curve is determined by the smoothness factor. The smoothness factor specifies the percentage of the data that is used in computing each point on the LOWESS curve. For this study, a smoothness factor of 35 percent was used.

Constituent Loads

The transport (mass discharge) of a constituent past a monitoring site in a given amount of time is referred to as the constituent load. Constituent loads for this report were estimated by the rating-curve method (Cohn and others, 1989; Crawford, 1991). Because some constituent concentrations included in this assessment were less than the method reporting limit, parameters of the rating curve were estimated by maximum-likelihood methods (Dempster and others, 1977; Wolynetz, 1979) or the linear attribution method (Chatterjee and McLeash, 1986). An estimate of the uncertainty in the estimated loads was obtained using the method described by Likes (1980) and Gilroy and others (1990) for maximum-likelihood estimates and by the jackknife method (Efron, 1982) for linear attribution estimates. A detailed description of these methods may be found in Crawford (1996).

Little Buck Creek

The drainage basin of Little Buck Creek is in the south-central part of Marion County (fig. 1) and has a drainage area of 16.8 mi^2 (Hoggatt, 1975). Little Buck Creek generally flows from east to west and discharges to the White River just north of Southport Road. The soils in the drainage basin are silty loam of Holocene Age (Sturm and Gilbert, 1978) that formed on thick, unconsolidated glacial deposits (Wier and Gray, 1961). In the eastern three-quarters of the basin, the unconsolidated deposits generally are clay and silt (glacial till); in the western one-quarter of the basin, the deposits generally are sand and gravel (glacial outwash) (Wier and Gray, 1961). The average thickness of the till is approximately 200 ft, and the average thickness of the outwash is approximately 100 ft (Hartke and others, 1980). The land surface underlain by till is rolling to gently rolling, and the land surface underlain by outwash is nearly flat.

Data were collected at the upstream site on Little Buck Creek near Southport (site 03353630) and at the downstream site near South Belmont Street near Indianapolis (site 03353637) (fig. 1). The upstream site has a drainage area of 5.75 mi^2, and the downstream site has a drainage area of 16.6 mi^2 (Stewart and others, 1993). In 1985, land use in the upstream part of the drainage basin was predominantly agricultural (3.08 mi^2 or 53.5 percent) and residential (1.97 mi^2 or 34.3 percent), with little commercial activity (0.01 mi^2 or 0.2 percent). Land use around the downstream site was predominantly residential (9.36 mi^2 or 56.3 percent) and agricultural (5.69 mi^2 or 34.3 percent). Commercial use was 0.33 mi^2 or 2.0 percent at the downstream site. Land use for both sites (table 1) was determined using aerial photographs taken during 1985 and 2-ft contour maps of land surface made in 1989. During the study, residential construction was occurring throughout the drainage basin, and some commercial construction was occurring in the downstream part of the drainage basin. There are no combined-sewer overflows or wastewater-treatment facilities upstream from sampling sites in the Little Buck Creek drainage basin.

Table 1. Land use in the Little Buck and Little Eagle Creek drainage basins near Indianapolis, Ind., 1985

Land characteristics	Site name and number			
	Little Buck Creek near Southport 03353630	Little Buck Creek near Indianapolis 03353637	Little Eagle Creek at 52nd Street at Indianapolis 03353551	Little Eagle Creek at Speedway 03353600
Drainage area (square miles)[a]	5.75	16.6	6.28	24.3
Land use	**Percentage of basin in land-use category[b]**			
Agricultural	53.5	34.3	30.4	24.4
Wooded	8.8	4.1	7.2	6.4
Undeveloped	3.2	1.9	4.4	6.8
Residential, rural[c]	9.9	7.8	3.8	3.7
Residential, low density[d]	3.4	4.4	2.9	3.2
Residential, medium density[e]	20.7	43.0	14.0	13.0
Residential, high density[f]	0	0	.1	3.8
Residential, multi-family	.3	1.1	5.7	9.0
Commercial and industrial	.2	2.0	29.3	27.3
Effective impervious areas	0	1.4	2.2	2.4

[a]Stewart and others, 1993.
[b]As determined from 1985 aerial photographs and 1989 contour maps.
[c]One unit per 2 to 5 acres.
[d]One unit per acre.
[e]Two to four units per acre.
[f]Four or more units per acre.

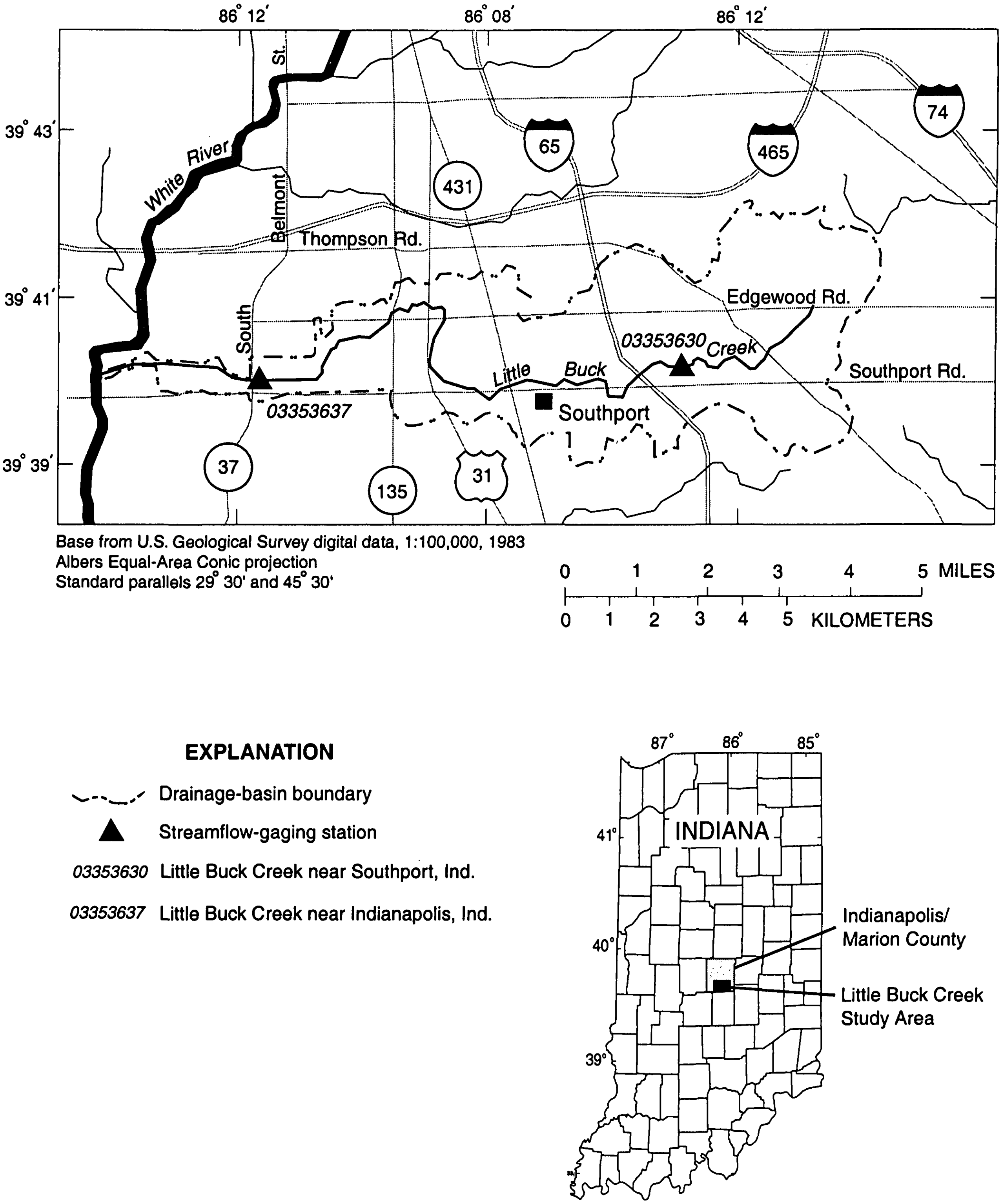


Figure 1. Data-collection sites on Little Buck Creek near Indianapolis, Ind.

Streamflow

Daily mean streamflow for Little Buck Creek ranged from 0 to 418 ft^3/s at the upstream site and from 0 to 1,390 ft^3/s at the downstream site during the 1990 through 1992 study period. Instantaneous streamflow at the time of sampling ranged from 0.03 to 126 ft^3/s at the upstream site and from 0.09 to 393 ft^3/s at the downstream site. Average streamflow in cubic feet per second per square mile of drainage basin was 1.63 $ft^3/s/mi^2$ at the upstream site and 1.52 $ft^3/s/mi^2$ at the downstream site during the study.

Precipitation also was measured at the gaging stations during the study. Although the data are incomplete (table 2), precipitation in the Little Buck Creek drainage basin totaled about 74 in. from February 1990 through February 1992. Runoff from precipitation in the drainage basin was about 46 in. at the upstream site and almost 43 in. at the downstream site from February 1990 through February 1992 (Stewart and Nell, 1991; Stewart and Deiwert, 1992; Stewart and others, 1993). Therefore, about 58 percent of the precipitation left the drainage basin as runoff during the study period.

Water Quality

Results of the analyses of water-quality samples collected monthly during the study for Little Buck Creek near Southport (table 15) and Little Buck Creek near Indianapolis (table 16) are in the back of the report. The 25th, 50th (median), and 75th quartiles for streamflow and selected constituents in samples from the two sites are shown in table 3.

Table 2. Monthly precipitation for the Little Buck and Little Eagle Creek drainage basins near Indianapolis, Ind., 1990–92

[--, indicates 5 or more days of missing data; numbers beneath site names are U.S. Geological Survey streamflow-gaging station identification numbers]

		Monthly precipitation (in inches) at streamflow-gaging stations			
Year	Month	Little Buck Creek near Southport 03353630	Little Buck Creek near Indianapolis 03353637	Little Eagle Creek at 52nd Street at Indianapolis 03353551	Little Eagle Creek at Speedway 03353600
1990	February	4.49	--	3.42	3.93
	March	3.25	--	2.38	3.55
	April	2.30	--	1.28	2.18
	May	8.90	--	8.22	6.31
	June	--	--	3.49[a]	3.08[a]
	July	--	--	3.09	4.65
	August	5.45	--	2.96[a]	3.14
	September	2.56	--	3.53[a]	1.86
	October	4.12	1.61[c]	4.44	4.16
	November	2.99	2.39	2.96	2.98
	December	7.02	6.46	7.36	5.98
1991	January	1.26	1.55	1.02	.81
	February	1.98	1.86	1.77	1.39
	March	6.07	--	5.01	5.25
	April	3.17	--	3.87	3.36
	May	2.94	--	3.70	3.18
	June	.42	2.09	.67	1.05
	July	2.15	2.41	1.67	1.32
	August	2.88	2.27	1.78	2.74
	September	.86	.92	1.08	1.68
	October	4.86	4.20	5.56	5.15
	November	4.07	3.18	2.12	2.89
	December	1.67[b]	1.46	1.35	1.10
1992	January	.10	--	1.12	.68
	February	.76	--	1.30	.68

[a]One day of missing data.
[b]Two days of missing data.
[c]Four days of missing data.

Table 3. Quartile statistics for measurements of properties and concentrations of selected constituents in samples collected from Little Buck Creek near Indianapolis, Ind., 1990–92

[p-value, the significance level attained by the data; ft^3/s, cubic foot per second; <, less than; °C, degree Celsius; µS/cm, microsiemen per centimeter at 25°C; mg/L, milligram per liter; BOD, biochemical oxygen demand; $CaCO_3$, calcium carbonate; mL, milliliter; µg/L, microgram per liter; mm, millimeter; numbers beneath site names are U.S. Geological Survey streamflow-gaging station identification numbers]

Constituent	Little Buck Creek near Southport 03353630			Little Buck Creek near Indianapolis 03353637			p-value
	Quartile			Quartile			
	25th	50th	75th	25th	50th	75th	
Streamflow (ft^3/s)	0.7	2.6	8.1	4.9	10.7	24.5	<0.001[a]
Water temperature (°C)	5.5	12.5	19.6	4.9	11.0	21.3	.038[a]
Specific conductance (µS/cm)	564	623	681	664	745	783	<.001[a]
Dissolved oxygen (mg/L)	8.1	11.6	12.7	9.0	11.0	12.2	1.000
pH (pH units)	7.8	7.9	8.1	7.9	8.0	8.2	.006[a]
20-day BOD (mg/L)	2.4	3.6	5.5	2.2	3.6	5.0	.168
Total alkalinity (mg/L as $CaCO_3$)	216	236	248	221	253	272	<.001[a]
Fecal coliform (colonies per 100 mL)	186	600	2,300	195	691	2,100	.965
Total solids (mg/L)	376	411	454	445	490	516	<.001[a]
Dissolved solids (mg/L)	298	394	434	417	464	494	<.001[a]
Ammonia (mg/L as nitrogen)	.01	.03	.04	.02	.03	.05	.494
Nitrite (mg/L as nitrogen)	.01	.02	.03	.01	.02	.03	.147
Ammonia plus organic nitrogen (mg/L as nitrogen)	.4	.5	.8	.3	.5	.6	.124
Nitrite plus nitrate (mg/L as nitrogen)	.6	1.2	1.7	.7	1.0	1.4	.004[a]
Phosphorus (mg/L as phosphorus)	.03	.04	.08	.02	.03	.06	.024[a]
Orthophosphate (mg/L as phosphorus)	.010	.023	.056	.010	.013	.025	.072
Dissolved organic carbon (mg/L)	3.5	3.9	5.2	2.9	3.2	4.6	<.001[a]
Suspended organic carbon (mg/L)	.3	.4	.8	.3	.3	.5	.095
Calcium (mg/L)	62	78	85	77	84	92	<.001[a]
Magnesium (mg/L)	19	24	26	24	26	28	<.001[a]
Sodium (mg/L)	19	26	29	36	44	46	<.001[a]
Potassium (mg/L)	1.4	1.6	2.4	1.7	2.0	2.4	.005[a]
Chloride (mg/L)	39	50	59	63	78	87	<.001[a]
Sulfate (mg/L)	33	36	42	38	48	53	<.001[a]
Fluoride (mg/L)	<.1	.2	.3	.1	.2	.2	.988
Arsenic (µg/L)	<1	1	1	<1	<1	1	.555
Barium (µg/L)	<100	<100	<100	<100	<100	<100	1.000
Cadmium (µg/L)	<1	<1	<1	<1	<1	<1	.500
Chromium (µg/L)	<1	1	2	<1	<1	2	.863
Copper (µg/L)	4	5	7	3	4	6	.992
Iron (µg/L)	280	360	700	165	210	330	.010[a]
Lead (µg/L)	2	2	3	1	2	4	.379
Manganese (µg/L)	50	70	80	40	50	55	.011[a]
Mercury (µg/L)	<.1	<.1	<.1	<.1	<.1	<.1	1.000
Zinc (µg/L)	<10	10	20	<10	10	10	.418
Suspended sediment (mg/L)	17	37	46	18	26	44	.708
Sediment, percent finer than 0.062 mm	33	62	71	23	48	72	.166

[a]Correlation coefficients are statistically significant at the 5-percent significance level.

Water temperature, nitrite plus nitrate, phosphorus, dissolved organic carbon, iron, and manganese had significantly larger measurements or concentrations in samples collected at the upstream site. At the downstream site, significantly larger measurements of instantaneous streamflow, specific conductance, and pH, and concentrations of total alkalinity, total solids, dissolved solids, calcium, magnesium, sodium, potassium, chloride, and sulfate were measured in the samples (table 3, fig. 2). Boxplots depicting concentrations for these constituents are provided in figure 3.

The median water temperatures were 12.5°C at the upstream site and 11.0°C at the downstream site. Specific conductance had median values of 623 µS/cm upstream and 745 µS/cm downstream. Median pH values were 7.9 upstream and 8.0 downstream. Median concentrations of dissolved oxygen were 11.6 mg/L upstream and 11.0 mg/L downstream. Dissolved oxygen was the only field-measured property that was not significantly different between the upstream and downstream sites (table 3).

Most nutrient concentrations were not significantly different between samples collected at the upstream and downstream sites. The median concentrations of ammonia (0.03 mg/L), nitrite (0.02 mg/L), and ammonia plus organic nitrogen (0.5 mg/L) were the same in samples collected from the upstream and downstream sites. Median concentrations of nitrite plus nitrate were 1.2 mg/L in samples from the upstream site and 1.0 mg/L in samples from the downstream site. Phosphorus concentrations had a median value of 0.04 mg/L upstream and 0.03 mg/L downstream. The median concentrations of orthophosphate were 0.023 mg/L upstream and 0.013 mg/L downstream.

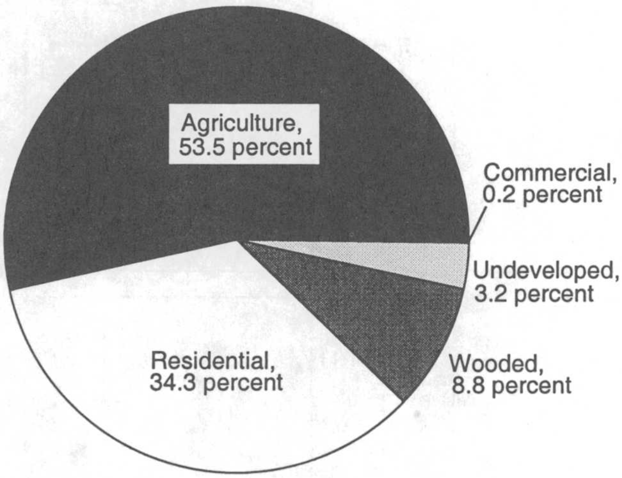
Concentrations of total and dissolved solids, calcium, magnesium, sodium, potassium, chloride, and sulfate were significantly larger in samples from the downstream site compared to samples from the upstream site (table 3, fig. 2). Total solids concentrations had a median of 411 mg/L upstream, compared to a median of 490 mg/L downstream; dissolved solids had a median of 394 mg/L upstream compared to a median of 464 mg/L downstream. Median calcium concentrations were 78 mg/L upstream, compared to 84 mg/L downstream. Median magnesium concentrations in the drainage basin were 24 mg/L upstream and 26 mg/L downstream; median sodium concentrations were 26 mg/L upstream and 44 mg/L downstream; median chloride concentrations were 50 mg/L upstream and 78 mg/L downstream. The median sulfate concentration was 36 mg/L upstream, compared with 48 mg/L downstream. The larger percentage of development for the downstream site compared to the upstream site may account for the larger concentration of calcium, sodium, and chloride. These chemicals are commonly used as deicing agents on roads, and the roads have a greater density in developed areas. Alternatively, the larger concentrations may indicate ground-water quality and may be the result of a larger ground-water component to streamflow during periods of low streamflow. This is supported by the presence of outwash materials at the downstream site as compared to the tills that predominate in the upstream reach.

Concentrations of DOC were significantly larger in samples collected from the upstream site compared to concentrations in samples from the downstream site. Median concentrations of DOC were 3.9 mg/L in samples from the upstream site and 3.2 mg/L at the downstream site (table 3).

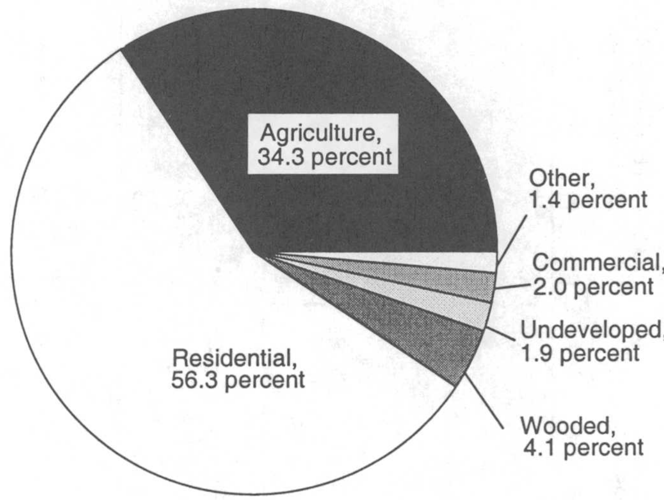
Concentrations of metals were not significantly different in samples from the upstream and downstream sites, except for iron and manganese. Median concentrations of iron were 360 µg/L upstream and 210 µg/L downstream. Median concentrations of manganese were 70 µg/L upstream and 50 µg/L downstream (table 3).

Relation of Constituents to Streamflow

Water-quality data collected at the downstream site (Little Buck Creek near Indianapolis) were tested to determine if there were statistically significant correlations between concentration and streamflow (table 4). Nitrite, nitrite plus nitrate, suspended organic carbon, chromium, copper, iron, lead, manganese, suspended sediment, and the percentage of suspended sediment finer than 0.062 mm had significant positive correlations between concentration and streamflow. Therefore, as streamflow increased, so did the concentration of these constituents. Water temperature, magnesium, sodium, chloride, and sulfate had significant negative correlations, indicating that the constituent concentration or parameter decreased as streamflow increased.



LAND USE
Little Buck Creek near Southport, Ind.



LAND USE
Little Buck Creek near Indianapolis, Ind.

Constituent concentration or property measurement significantly larger at Little Buck Creek near Southport, Ind. compared to Little Buck Creek near Indianapolis, Ind.

Water Temperature
Nitrite plus Nitrate Nitrogen
Phosphorus
Dissolved Organic Carbon
Iron
Manganese

Constituent concentration or property measurement significantly larger at Little Buck Creek near Indianapolis, Ind. compared to Little Buck Creek near Southport, Ind.

Instantaneous Discharge
Specific Conductance
pH
Total Alkalinity
Total Solids
Dissolved Solids
Calcium
Magnesium
Sodium
Potassium
Chloride
Sulfate

Figure 2. Land use and list of properties or constituents with significantly larger measurements or concentrations at one of the two sites in the Little Buck Creek drainage basin near Indianapolis, Ind., 1990–1992.

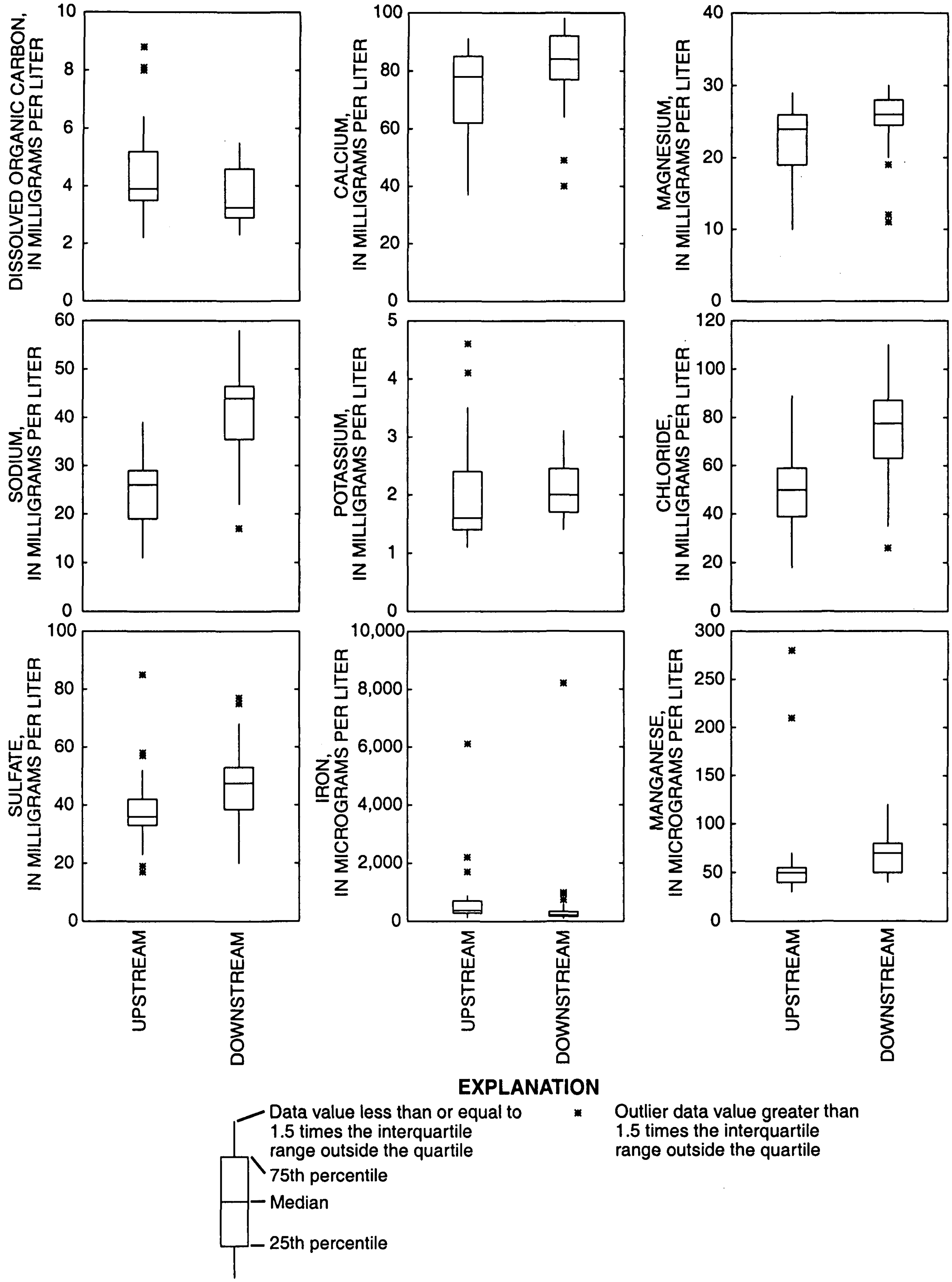


Figure 3. Distribution of property measurements or concentrations of selected constituents between the upstream (near Southport, Ind.) and downstream (near Indianapolis, Ind.) sites in the Little Buck Creek drainage basin, 1990–92.

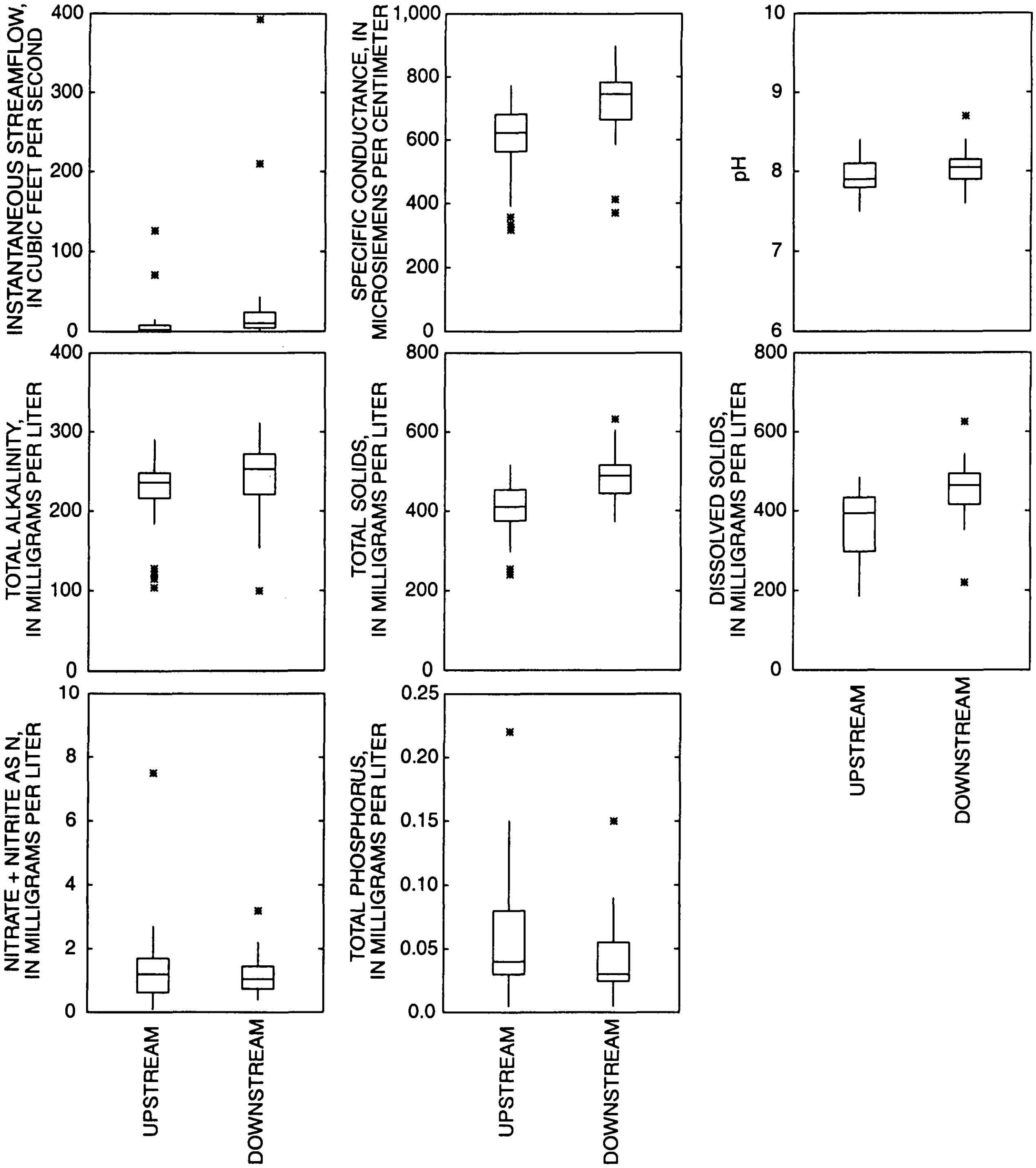


Figure 3. Distribution of property measurements or concentrations of selected constituents between the upstream (near Southport, Ind.) and downstream (near Indianapolis, Ind.) sites in the Little Buck Creek drainage basin, 1990–92–Continued.

Seasonal Variability

In samples from the downstream site, water temperature and concentrations of DOC and potassium increased during spring and summer and decreased during fall and winter (fig. 4). Phosphorus concentrations had a similar trend, although it was most evident at the upstream site (fig. 5).

Specific conductance, dissolved oxygen, pH, nitrite plus nitrate, calcium, sodium, and chloride had increased concentrations during fall and winter and decreased concentrations during spring and summer (fig. 4). The tendency for nutrient concentrations to increase during fall and winter may be related to decreased uptake by vegetation during the non-growing seasons. Increases in calcium, sodium, and chloride during fall and winter may be due to an increased ground-water component to flow during periods of low streamflow and may be related to their use as deicing agents on roadways; however, sodium and chloride had negative correlations with streamflow, indicating they are not components of runoff. Dissolved solids, magnesium, and manganese had similar trends of increased concentrations through fall and winter, although this was most evident at the upstream site (fig. 5).

Constituent Loads

Mean annual loads in pounds per day were determined for selected constituents in Little Buck Creek and listed, along with seasonal loads, in table 5 for the upstream site and table 6 for the downstream site. The data indicate that the largest loads are transported during spring and winter when streamflow generally is highest. Dissolved solids constitute the largest mean annual loads, averaging 20,000 lb/d at the upstream site and 69,000 lb/d at the downstream site. Suspended-sediment transport was 4,100 lb/d upstream compared with 26,000 lb/d downstream. The largest loads of individual constituents were calcium, chloride, sulfate, sodium, and magnesium. At the upstream site, mean annual loads of calcium were 2,900 lb/d, chloride 1,900 lb/d, sulfate 1,600 lb/d, sodium 980 lb/d, and magnesium 840 lb/d. At the downstream site, mean annual loads of calcium were 9,000 lb/d, chloride 7,500 lb/d, sulfate 4,900 lb/d, sodium 4,300 lb/d, and magnesium 2,600 lb/d. Mean annual nutrient loads ranged from 2.3 lb/d for nitrite to 100 lb/d for nitrite plus nitrate at the upstream site. Nitrite loads were 4.2 lb/d, and loads for nitrite plus nitrate were 200 lb/d at the downstream site.

Table 4. Statistical relations of selected properties and chemical constituents to streamflow for Little Buck Creek near Indianapolis, Ind., 1990–92

[p-value, the significance level attained by the data; °C, degree Celsius; μS/cm, microsiemen per centimeter at 25°C; mg/L, milligram per liter; $CaCO_3$, calcium carbonate; mL, milliliter; μg/L, microgram per liter; BOD, biochemical oxygen demand; <, less than; mm, millimeter; number beneath site name is U.S. Geological Survey streamflow-gaging station identification number]

Constituent	Little Buck Creek near Indianapolis 03353637	
	Correlation coefficient	p-value
Water temperature (°C)	-0.313	0.033[a]
Specific conductance (μS/cm)	-.179	.224
Dissolved oxygen (mg/L)	.022	.882
pH (pH units)	-.023	.879
20-day BOD (mg/L)	.272	.063
Total alkalinity (mg/L as $CaCO_3$)	-.248	.108
Fecal coliform (colonies per 100 mL)	.142	.333
Total solids (mg/L)	-.026	.862
Dissolved solids (mg/L)	-.026	.880
Ammonia (mg/L as nitrogen)	.279	.069
Nitrite (mg/L as nitrogen)	.351	.025[a]
Ammonia plus organic nitrogen (mg/L as nitrogen)	.265	.082
Nitrite plus nitrate (mg/L as nitrogen)	.362	.014[a]
Phosphorus (mg/L as phosphorus)	.288	.058
Orthophosphate (mg/L as phosphorus)	.089	.560
Dissolved organic carbon (mg/L)	.195	.187
Suspended organic carbon (mg/L)	.443	.004[a]
Calcium (mg/L)	-.161	.274
Magnesium (mg/L)	-.349	.021[a]
Sodium (mg/L)	-.291	.049[a]
Potassium (mg/L)	-.262	.080
Chloride (mg/L)	-.338	.022[a]
Sulfate (mg/L)	-.447	.003[a]
Fluoride (mg/L)	-.211	.186
Arsenic (μg/L)	.158	.338
Barium (μg/L)	.071	.673
Cadmium (μg/L)	.315	.068
Chromium (μg/L)	.433	.008[a]
Copper (μg/L)	.536	<.001[a]
Iron (μg/L)	.517	<.001[a]
Lead (μg/L)	.340	.026[a]
Manganese (μg/L)	.539	<.001[a]
Mercury (μg/L)	.163	.348
Zinc (μg/L)	.309	.057
Suspended sediment (mg/L)	.292	.047[a]
Suspended sediment, percent finer than 0.062 mm	.396	.007[a]

[a]Correlation coefficients are statistically significant at the 5-percent significance level.

Table 5. Mean annual and seasonal loads of selected water-quality constituents for Little Buck Creek near Southport, Ind., 1990–92

[lb/d, pound per day]

Constituent	Mean annual load (lb/d)	Standard deviation	Seasonal loads							
			Spring load (lb/d)	Standard deviation	Summer load (lb/d)	Standard deviation	Fall load (lb/d)	Standard deviation	Winter load (lb/d)	Standard deviation
Dissolved solids	20,000	1,200	32,000	2,100	6,000	260	10,000	540	29,000	1,900
Ammonia	6	5	12	10	2	2	2	2	7	8
Nitrite	2.3	.63	5.2	1.5	1.0	.37	.81	.34	2.2	.68
Ammonia plus organic nitrogen	40	9	79	19	14	3	17	4	50	14
Nitrite plus nitrate	100	27	171	48	30	6	52	12	150	41
Phosphorus	8	3	16	7	3	1	4	2	9	5
Orthophosphate	7	5	11	8	2	2	3	2	10	10
Dissolved organic carbon	280	36	460	60	96	12	150	23	390	61
Suspended organic carbon	89	31	180	61	23	6	34	13	110	52
Calcium	2,900	200	4,400	330	770	74	1,500	170	4,700	380
Magnesium	840	60	1,300	100	230	23	430	50	1,400	110
Sodium	980	77	1,400	120	240	26	540	66	1,600	150
Potassium	120	13	180	19	40	4	77	10	170	22
Chloride	1,900	170	2,600	250	430	55	1,000	150	3,300	340
Sulfate	1,600	140	2,100	210	370	45	890	120	2,700	280
Fluoride	10	2	16	3	3	0	5	1	14	2
Copper	.58	.17	.83	.23	.17	.04	.41	.14	.89	.31
Iron	44	16	90	34	22	11	19	11	44	18
Lead	.33	.18	.56	.3	.061	.016	.13	.043	.52	.34
Manganese	4.8	.57	8.7	1.1	.93	.11	1.7	.24	7.3	1.0
Suspended sediment	4,100	1,400	9,200	3,200	1,300	560	1,200	640	4,500	1,700

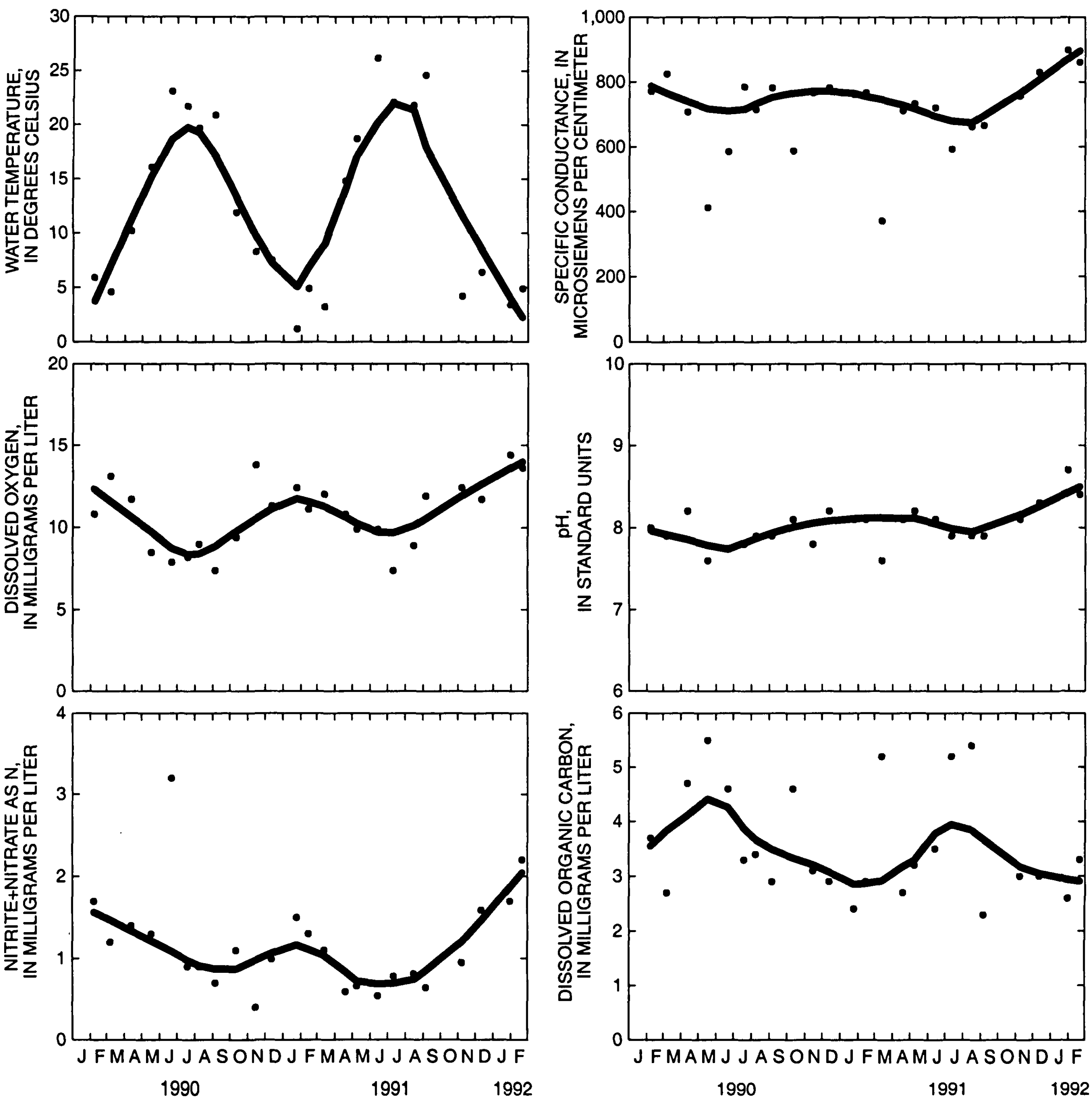


Figure 4. Seasonal variability of property measurements or concentrations of selected constituents in samples collected from Little Buck Creek near Indianapolis, Ind., 1990–92. The solid line is a locally weighted scatterplot smooth.

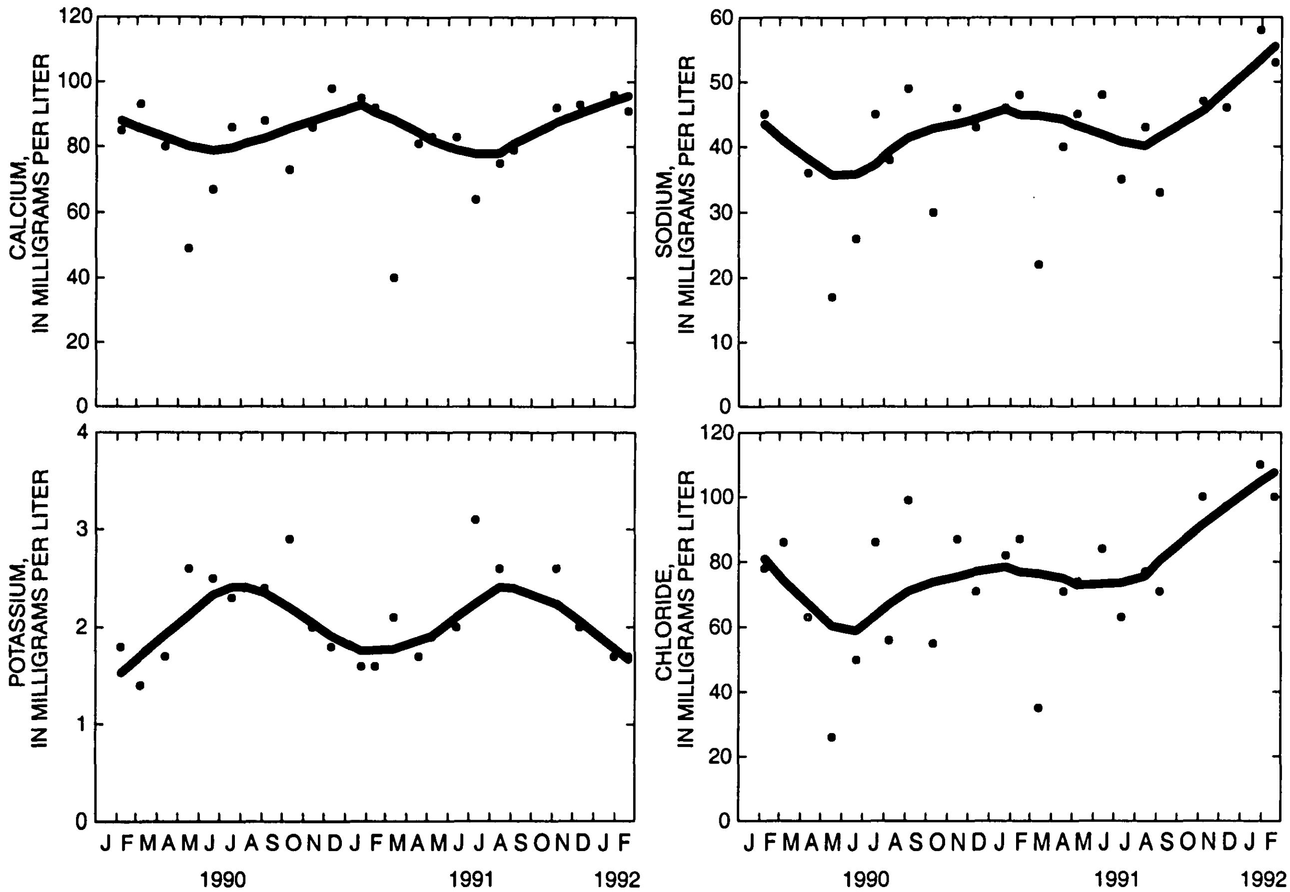


Figure 4. Seasonal variability of property measurements or concentrations of selected constituents in samples collected from Little Buck Creek near Indianapolis, Ind., 1990–92–Continued.

Storm Samples

Results of the analysis of samples collected from Little Buck Creek during a period of high streamflow in August 1993 after a storm are listed in table 19 at the back of the report. Samples were analyzed for approximately 160 organic compounds, including volatile and semi-volatile organic compounds and pesticides. Chlorpyrifos, malathion, and diazinon were detected in samples collected at both sites, and methoxychlor was detected in the sample from the upstream site (table 7). These compounds are components of pesticides used in residential and agricultural applications.

Quality of Streambed Sediments

Samples of streambed sediments were collected at both sites in Little Buck Creek. Samples were collected in August 1990 during a period of relatively low streamflow for easier access to the streambed sediments. Results of the analyses are listed in table 20 (organic compounds) and table 21 (metals) at the back of the report.

Eight organic compounds were detected in the streambed-sediment samples at concentrations equal to or greater than the laboratory reporting limit (table 8). All eight compounds were detected at the downstream site and are chlordane, p,p'-DDD, p,p'-DDE, p,p'-DDT, dieldrin, heptachlor epoxide, malathion, and diazinon. Of these eight compounds, p,p'-DDT and heptachlor epoxide were not reported in streambed sediments from the upstream site.

Analysis of concentrations of metals in streambed sediments of Little Buck Creek indicated that concentrations of aluminum, arsenic, cadmium, chromium, and selenium were larger in the sample collected at the upstream site than in the sample from the downstream site. Concentrations of copper, lead, mercury, titanium, and zinc were largest in the streambed-sediment sample from the downstream site (table 21).

Table 6. Mean annual and seasonal loads of selected water-quality constituents for Little Buck Creek near Indianapolis, Ind., 1990–92

[lb/d, pound per day]

			Seasonal loads							
Constituent	Mean annual load (lb/d)	Standard deviation	Spring load (lb/d)	Standard deviation	Summer load (lb/d)	Standard deviation	Fall load (lb/d)	Standard deviation	Winter load (lb/d)	Standard deviation
Dissolved solids	69,000	2,600	100,000	4,000	24,000	1,100	35,000	2,100	110,000	5,200
Ammonia	15	13	20	9	2	0	4	35	32	28
Nitrate	4.2	.95	8	1.8	2.1	.57	1.7	.61	4.9	1.5
Ammonia plus organic nitrogen	85	10	150	18	44	6	38	7	100	16
Nitrite plus nitrate	200	31	310	49	65	7	90	12	310	53
Phosphorus	16	9	23	8	5	1	6	3	29	23
Orthophosphate	9	5	14	5	2	1	2	2	15	13
Dissolved organic carbon	570	38	920	64	250	21	280	30	780	69
Suspended organic carbon	340	160	400	130	37	5	73	15	780	460
Calcium	9,000	210	14,000	360	3,300	100	4,500	180	14,000	420
Magnesium	2,600	55	3,900	99	990	28	1,300	47	3,900	110
Sodium	4,300	150	6,500	280	1,600	76	2,100	130	6,600	310
Potassium	300	10	430	14	140	5	180	9	430	20
Chloride	7,500	280	11,000	490	2,700	140	3,800	250	12,000	580
Sulfate	4,900	240	6,800	380	1,800	110	2,800	240	7,700	490
Fluoride	27	4	41	6	11	1	13	2	39	6
Copper	2.0	.39	2.9	.51	.39	.05	.66	.10	3.7	.86
Iron	99	65	170	100	32	13	34	18	150	120
Lead	3.6	6.6	3.8	4.0	.31	.013	.65	.63	9	20
Manganese	20	4	28	4	4	0	6	1	40	9
Suspended sediment	26,000	17,000	34,000	14,000	3,200	610	4,800	5,700	57,000	47,000

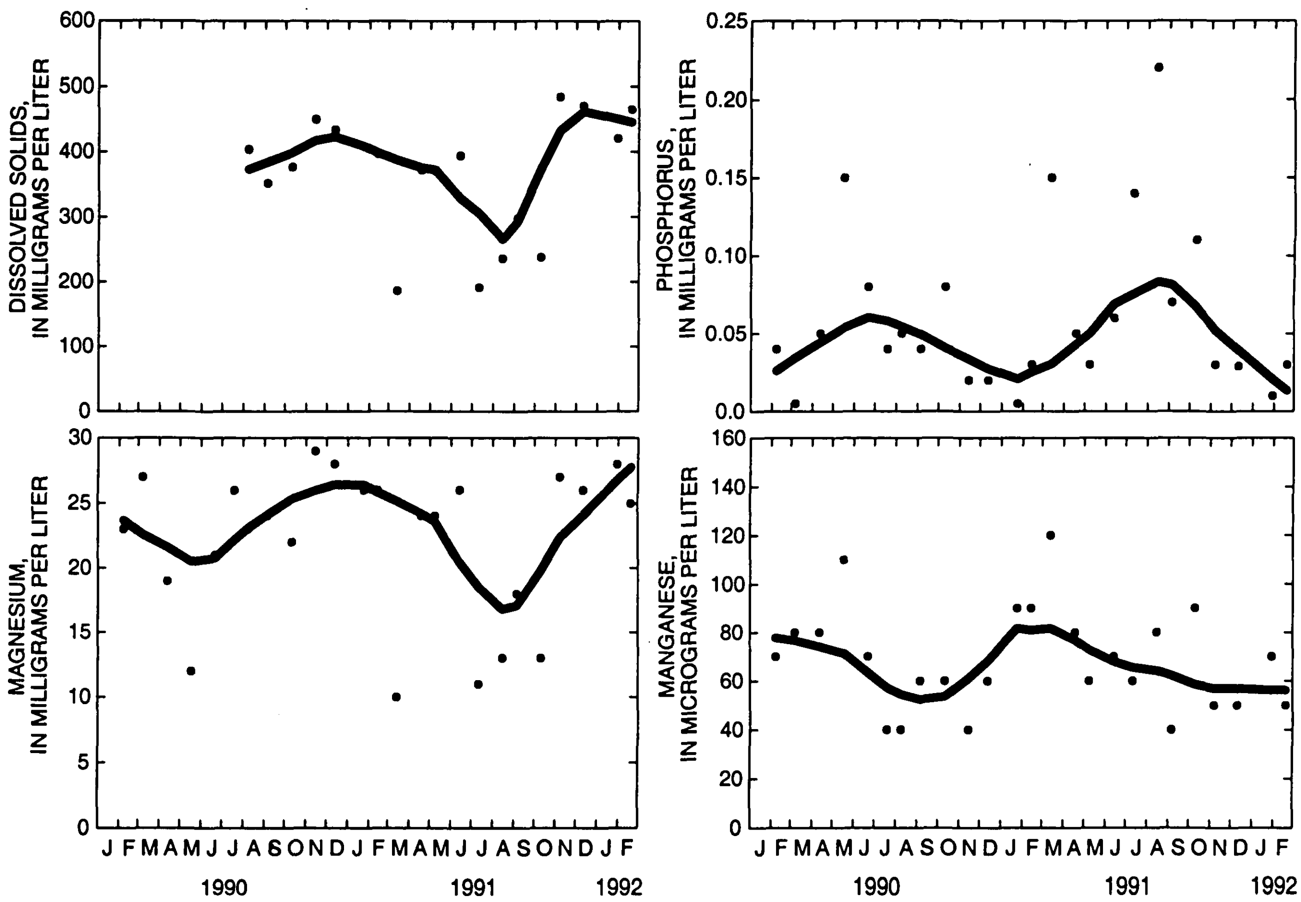


Figure 5. Seasonal variability of property measurements or concentrations of selected constituents in samples collected from Little Buck Creek near Southport, Ind., 1990–92. The solid line is a locally weighted scatterplot smooth.

Little Eagle Creek

The drainage basin of Little Eagle Creek is in the northwestern part of Marion County and has a drainage area of 26.9 mi^2 (Hoggatt, 1975). Little Eagle Creek generally flows from north to south and discharges to Eagle Creek near Speedway, Ind. (fig. 6). Soils in the drainage basin are silty loam of Holocene Age (Sturm and Gilbert, 1978) that formed on thick, unconsolidated deposits of glacial till (Wier and Gray, 1961). The average thickness of the till is approximately 150 ft in the northern part of the drainage basin and approximately 100 ft in the southern part of the drainage basin (Hartke and others, 1980). The land surface in the drainage basin is nearly flat to gently rolling.

Data were collected at the upstream site on Little Eagle Creek at 52nd Street at Indianapolis (site 03353551) and at the downstream site at 16th Street at Speedway (site 03353600) (fig. 6). The upstream site has a drainage area of 6.28 mi^2, and the downstream site has a drainage area of 24.3 mi^2 (Stewart and others, 1993). In 1985, land use in the northern part of the drainage basin was divided nearly equally among agricultural (30.4 percent), commercial (29.3 percent), and residential (26.5 percent) (table 1). Land use associated with the downstream site in the drainage basin was slightly more residential (32.7 percent) and slightly less commercial and industrial (27.3 percent) and agricultural (24.4 percent). During the study, several large residential and some commercial construction projects were occurring in the drainage basin, with the majority of these in the northern part of the drainage basin. There are no combined-sewer overflows or wastewater-treatment facilities in the drainage basin of Little Eagle Creek.

Streamflow

Daily mean streamflow in the drainage basin ranged from 0.15 to 542 ft^3/s at the upstream site and from 0.44 to 1,230 ft^3/s at the downstream site. Instantaneous streamflow at the time of sampling ranged from 0.31 to 324 ft^3/s at the upstream site and from

0.99 to 706 ft^3/s at the downstream site. Average streamflow in cubic feet per second per square mile was 1.79 $ft^3/s/mi^2$ at the upstream site and 1.32 $ft^3/s/mi^2$ at the downstream site during the study period.

The only long-term streamflow-gaging station in the study area was Little Eagle Creek at Speedway (03353600). Average monthly streamflows at this site during the study period generally were higher than the long-term streamflow (fig. 7) based on streamflow records for this gaging station collected since 1965 (Stewart and others, 1993). Mean monthly streamflows were substantially higher than the long-term averages during February, May, October, and December 1990, and March and October 1991. Substantially lower than average streamflows were measured from June through September 1991 and December 1991 through February 1992.

Precipitation in the drainage basin was measured at the two streamflow-gaging stations on Little Eagle Creek. Although the data are incomplete (table 2), precipitation in the drainage basin was approximately 74 in. Runoff from precipitation in the basin was about 47 in. at the upstream site and about 37 in. at the downstream site from February 1990 through February 1992 (Stewart and Nell, 1991; Stewart and Deiwert, 1992; Stewart and others, 1993). Therefore, about 50 percent of the precipitation left the drainage basin as runoff during the study period.

Water Quality

Results of the analyses of water-quality samples collected during the study for Little Eagle Creek at Indianapolis (table 17) and Little Eagle Creek at Speedway (table 18) are in the back of the report. The 25th, 50th, and 75th quartiles for streamflow and selected constituents in samples from the two sites are shown in table 9.

Measurements of specific conductance and pH and concentrations of total solids, dissolved solids, ammonia, dissolved organic carbon, calcium, magnesium, sodium, potassium, chloride, and sulfate were determined to be significantly larger in samples from the upstream site when compared to samples from the downstream site. Measurements of instantaneous streamflow and water temperature and concentrations of nitrite plus nitrate and suspended organic carbon were significantly larger in samples from the downstream site (table 9, fig. 8). Boxplots depicting the concentrations for these constituents are provided in figure 9.

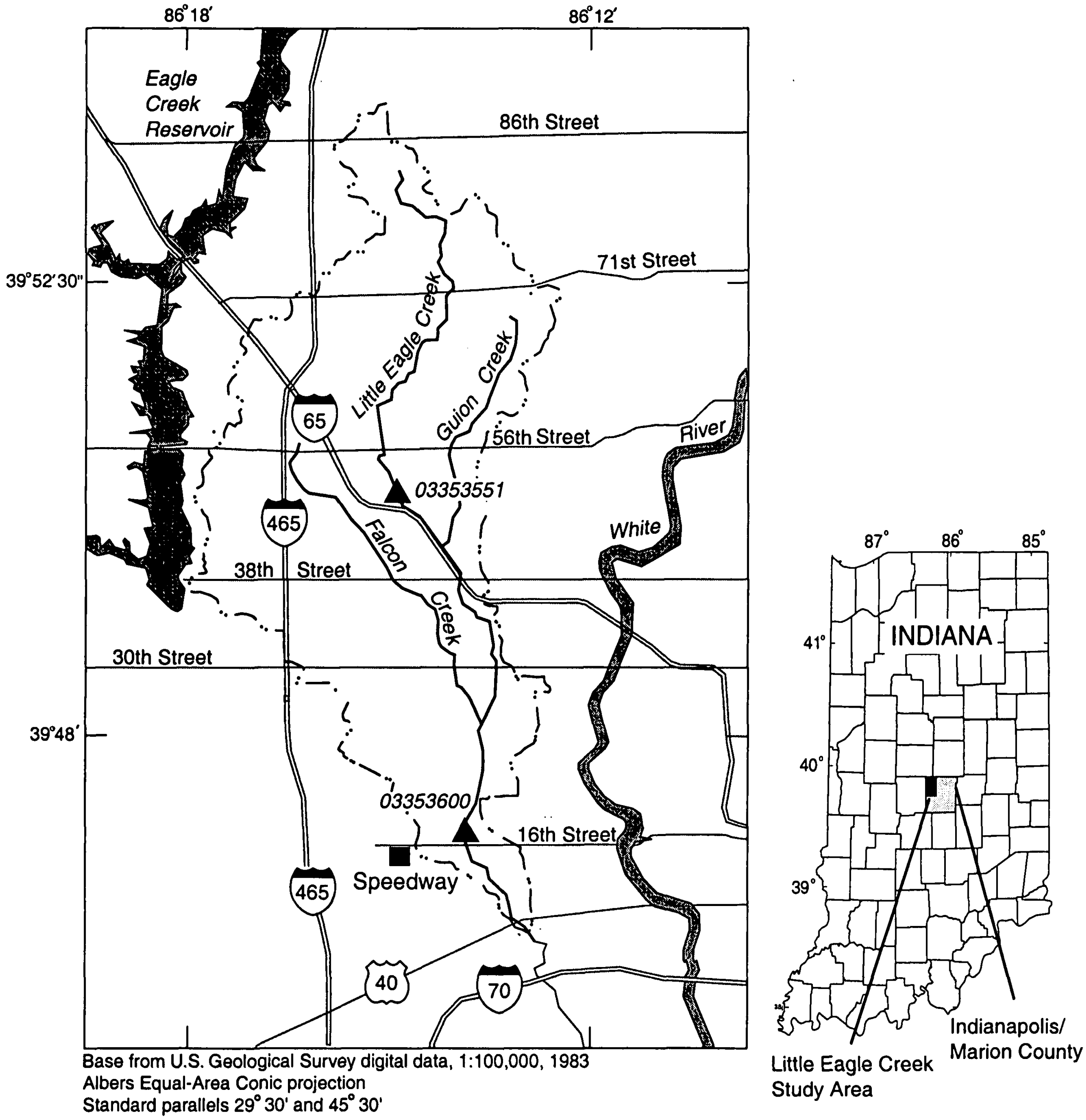
The median water temperature was 11.3°C at the upstream site and 12.4°C at the downstream site. Specific conductance had median values of 710 μS/cm in water from the upstream site and 658 μS/cm in water from the downstream site. Median concentrations of dissolved oxygen were 9.7 mg/L for the upstream site and 10.6 mg/L for the downstream site. Median pH values were 8.0 upstream and 7.8 downstream.

Most nutrient concentrations, except for ammonia and nitrite plus nitrate, were not significantly different between samples collected at the upstream and downstream sites in Little Eagle Creek (table 9). Median concentrations of ammonia were 0.13 mg/L in samples from the upstream site and 0.07 mg/L in samples from the downstream site. Median concentrations were 0.03 mg/L for nitrite and 0.7 mg/L for ammonia plus organic nitrogen in samples collected at both sites. Median concentrations of nitrite plus nitrate were 1.2 mg/L for the upstream site and 1.3 mg/L for the downstream site. Median phosphorus concentrations were 0.03 mg/L upstream and 0.04 mg/L downstream. Median concentrations of orthophosphate were 0.015 mg/L upstream and 0.012 mg/L downstream.

Calcium, magnesium, sodium, potassium, chloride, and sulfate had concentrations that were significantly larger at the upstream site (table 9). Median calcium concentrations were 83 mg/L and 78 mg/L; median magnesium concentrations were 25 mg/L and 23 mg/L; median sodium concentrations were 38 mg/L and 28 mg/L; median potassium concentrations were 2.7 mg/L and 2.4 mg/L; median chloride concentrations were 73 mg/L and 55 mg/L; and median sulfate concentrations were 63 mg/L and 56 mg/L at the upstream and downstream sites, respectively.

Concentrations of total and dissolved solids were significantly larger in samples collected at the upstream site compared to concentrations in samples from the downstream site (table 9). Total solids had a median concentration of 514 mg/L at the upstream site, compared with 455 mg/L at the downstream site. Dissolved solids had a median concentration of 475 mg/L upstream, compared to 408 mg/L downstream. Concentrations of suspended organic carbon were significantly larger at the downstream site (table 9), with a median concentration of 0.3 mg/L at the upstream site and 0.5 mg/L at the downstream site.

Concentrations of metals were not significantly different in samples collected from the upstream and downstream sites (table 9). Large concentrations of some metals may be the result of the many commercial and industrial operations present in the drainage basin.



Base from U.S. Geological Survey digital data, 1:100,000, 1983
Albers Equal-Area Conic projection
Standard parallels 29° 30′ and 45° 30′

EXPLANATION

Drainage-basin boundary

▲ Streamflow-gaging station

03353551 Little Eagle Creek at 52nd Street at Indianapolis, Ind.

03353600 Little Eagle Creek at 16th Street at Speedway, Ind.

0 1 2 3 4 5 MILES

0 1 2 3 4 5 KILOMETERS

Figure 6. Data-collection sites on Little Eagle Creek near Indianapolis, Ind.

Table 7. Concentrations of organic constituents detected in samples collected during storms at Little Buck and Little Eagle Creeks near Indianapolis, Ind., 1993–94
[USGS, U.S. Geological Survey; mm-dd-yyyy, month-day-year; hhmm, hours and minutes; µg/L, microgram per liter; <, less than; numbers in parentheses in column header are U.S. Geological Survey National Water Information System (NWIS) parameter codes]

Station name	USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Benzene, total (µg/L) (34030)	Bis (2-ethyl hexyl) phthalate, total (µg/L) (39100)	Chlorpyrifos, total recoverable (µg/L) (38932)	Cis-1,2-dichloroethene, total (µg/L) (77093)	Diazinon, total (µg/L) (39570)	Malathion, total (µg/L) (39530)	Methoxychlor, total (µg/L) (39480)	Methyl tert-butyl ether, total (µg/L) (78032)
Little Buck Creek near Southport, Ind.	03353630	08-12-1993	1430	< 0.2	< 5	0.02	< 0.2	2.6	0.02	0.03	< 1
Little Buck Creek near Indianapolis, Ind.	03353637	08-12-1993	1600	<.2	< 5	.01	<.2	.31	.07	<.01	< 1
Little Eagle Creek at 52nd Street at Indianapolis, Ind.	03353551	12-14-1993	1230	<.2	210	<.01	<.2	.01	<.01	<.01	< 1
Little Eagle Creek at 16th Street at Speedway, Ind.	03353600	12-14-1993	1345	.4	450	<.01	<.2	.04	<.01	<.01	< 1
		04-28-1994	1320	<.2	< 5	.01	.2	.02	.01	<.01	.2
		04-28-1994	1410	<.2	< 5	.01	.2	.02	.01	<.01	.2

Table 8. Concentrations of organic constituents in streambed sediments in Little Buck and Little Eagle Creeks near Indianapolis, Ind., August 1990

[USGS, U.S. Geological Survey; mm-dd-yyyy, month-day-year; hhmm, hours and minutes; µg/Kg, microgram per kilogram; <, less than; numbers in parentheses in column header are U.S. Geological Survey National Water Information System (NWIS) parameter codes]

Station name	USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Aldrin, total (µg/Kg) (39333)	Benzo (a) pyrene (µg/Kg) (34250)	Benzo (g,h,i) perylene (µg/Kg) (34524)	Chlordane, total (µg/Kg) (39351)	Chrysene (µg/Kg) (34232)	Diazinon, total (µg/Kg) (39571)	Dieldrin, total (µg/Kg) (39383)	Fluoranthene (µg/Kg) (34379)
Little Buck Creek near Southport, Ind.	03353630	08-28-1990	1415	< 0.1	< 400	< 400	2	< 400	5.8	0.4	< 200
Little Buck Creek near Indianapolis, Ind.	03353637	08-28-1990	1530	<.1	< 400	< 400	11	< 400	2.8	.5	< 200
Little Eagle Creek at 52nd Street at Indianapolis, Ind.	03353551	08-28-1990	0930	<.1	< 400	< 400	4	< 400	3.5	1.2	< 200
Little Eagle Creek at 16th Street at Speedway, Ind.	03353600	08-28-1990	1100	.4	430	810	29	760	2.4	2	640

Station name	USGS station number	Heptachlor epoxide, total (µg/Kg) (39423)	Indeno (1,2,3-cd) pyrene (µg/Kg) (34406)	Malathion, total (µg/Kg) (39531)	p, p'-DDD, recoverable (µg/Kg) (39363)	p-p' DDE, recoverable (µg/Kg) (39368)	p, p'-DDT, recoverable (µg/Kg) (39373)	PCB, total (µg/Kg) (39519)	Phenanthrene (µg/Kg) (34464)	Pyrene (µg/Kg) (34472)
Little Buck Creek near Southport, Ind.	03353630	< 0.1	< 400	0.2	0.1	0.1	< 0.1	< 1	< 200	< 200
Little Buck Creek near Indianapolis, Ind.	03353637	.1	< 400	.2	.2	.2	.1	< 1	< 200	< 200
Little Eagle Creek at 52nd Street at Indianapolis, Ind.	03353551	.1	< 400	.1	.1	<.1	<.1	< 1	< 200	< 200
Little Eagle Creek at 16th Street at Speedway, Ind.	03353600	< 1	750	.1	< 1	< 1	< 1	3	830	360

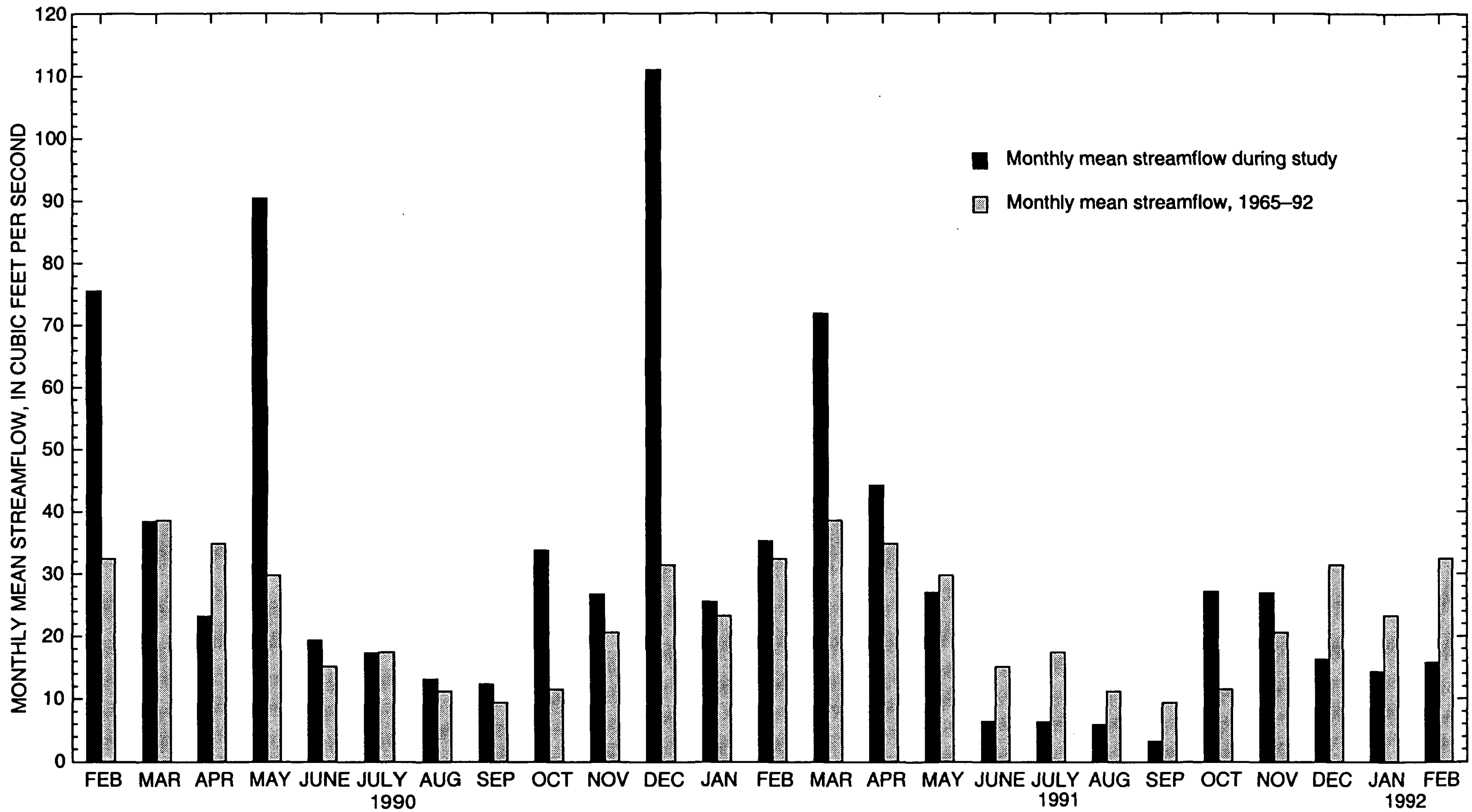
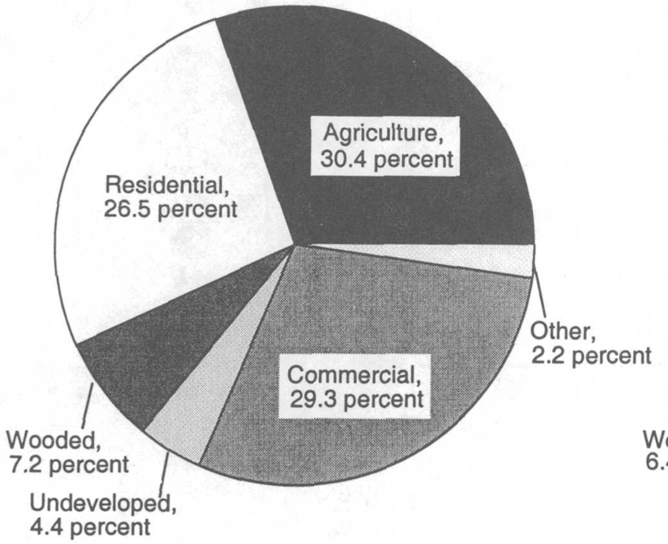
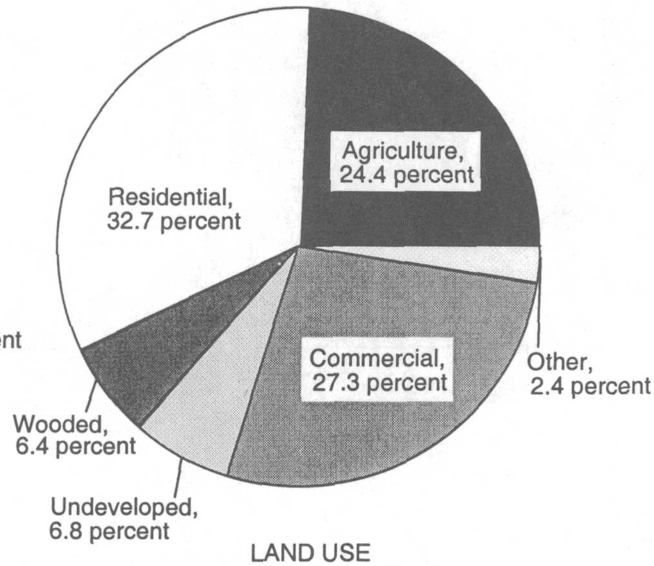


Figure 7. Monthly streamflow at Little Eagle Creek at 16th Street at Speedway, Ind. (site 03353600), 1990–1992.



LAND USE
Little Eagle Creek at 52nd Street at Indianapolis



LAND USE
Little Eagle Creek at Speedway

Constituent concentration or property measurement significantly larger at Little Eagle Creek at 52nd Street at Indianapolis, Ind. compared to Little Eagle Creek at 16th Street at Speedway, Ind.

Specific Conductance
pH
Total Solids
Dissolved Solids
Ammonia
Dissolved Organic Carbon
Calcium
Magnesium
Sodium
Potassium
Chloride
Sulfate

Constituent concentration or property measurement significantly larger at Little Eagle Creek at 16th Street at Speedway, Ind. compared to Little Eagle Creek at 52nd Street at Indianapolis, Ind.

Instantaneous Discharge
Water Temperature
Nitrite plus Nitrate Nitrogen
Suspended Organic Carbon

Figure 8. Land use and list of properties or constituents with significantly larger measurements or concentrations at one of the two sites in the Little Eagle Creek drainage basin near Indianapolis, Ind., 1990–1992.

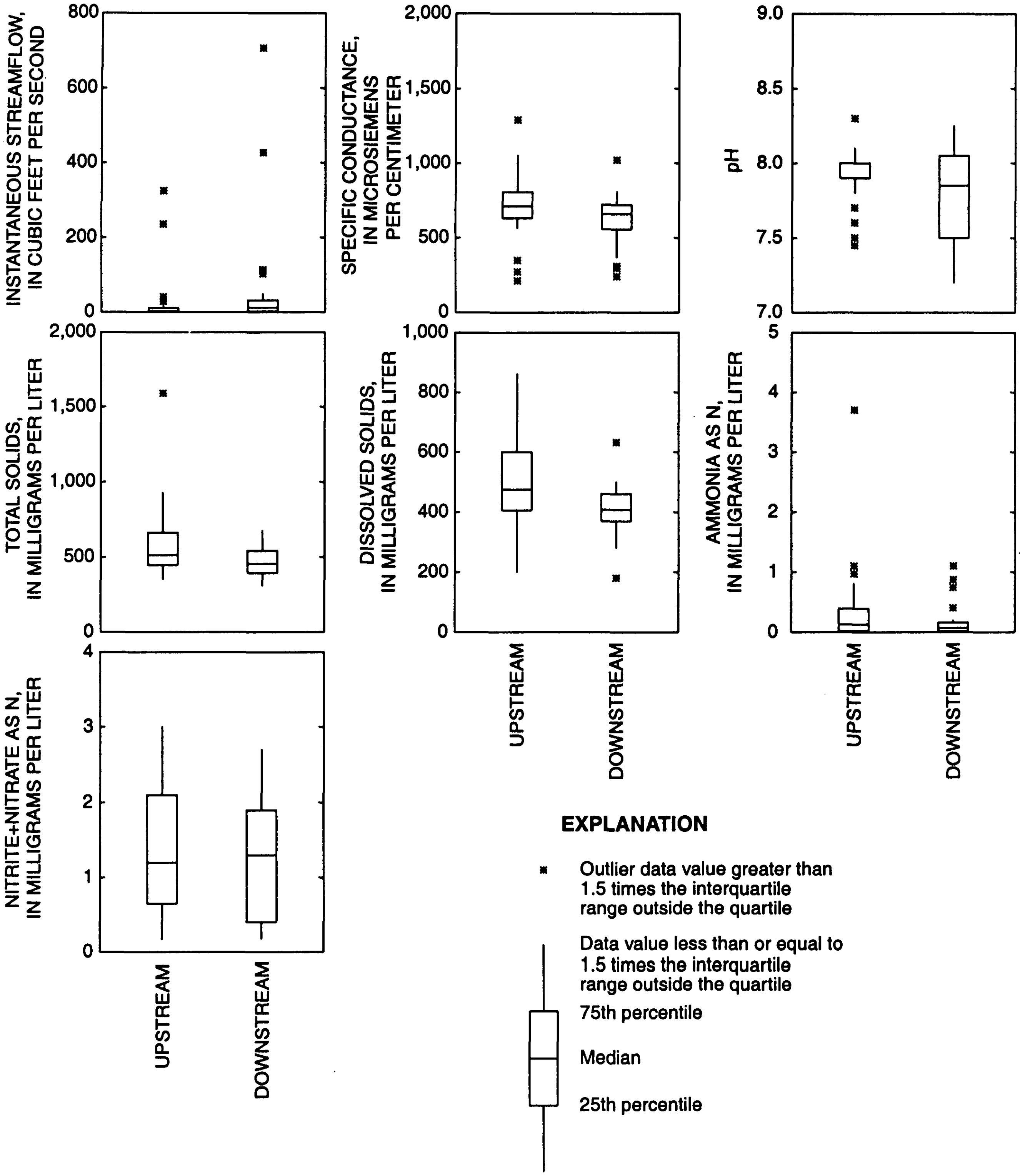


Figure 9. Distribution of property measurements or concentrations of selected constituents between the upstream (near Indianapolis, Ind.) and downstream (near Speedway, Ind.) sites in the Little Eagle Creek drainage basin, 1990–92.

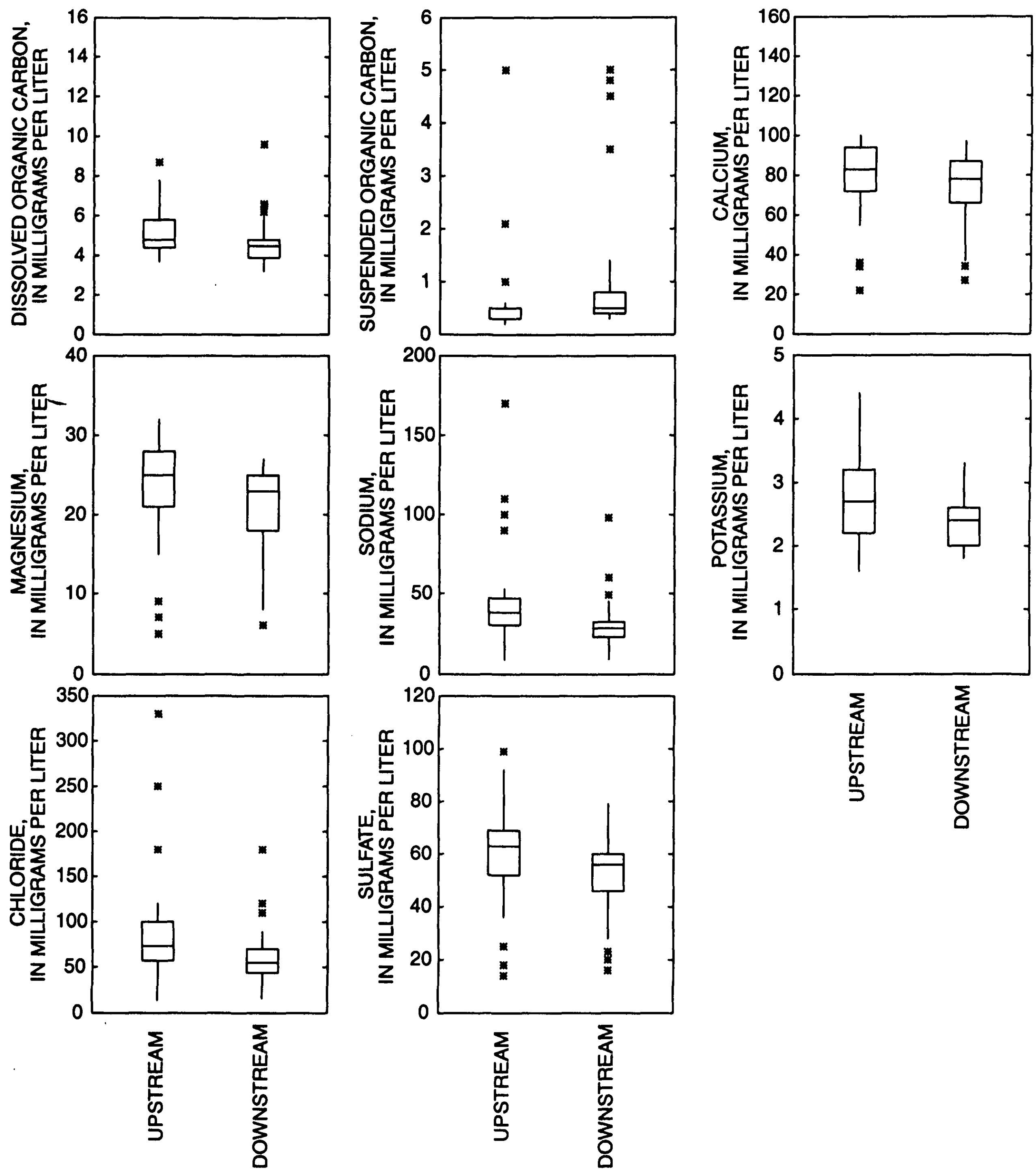


Figure 9. Distribution of property measurements or concentrations of selected constituents between the upstream (near Indianapolis, Ind.) and downstream (near Speedway, Ind.) sites in the Little Eagle Creek drainage basin, 1990–92–Continued.

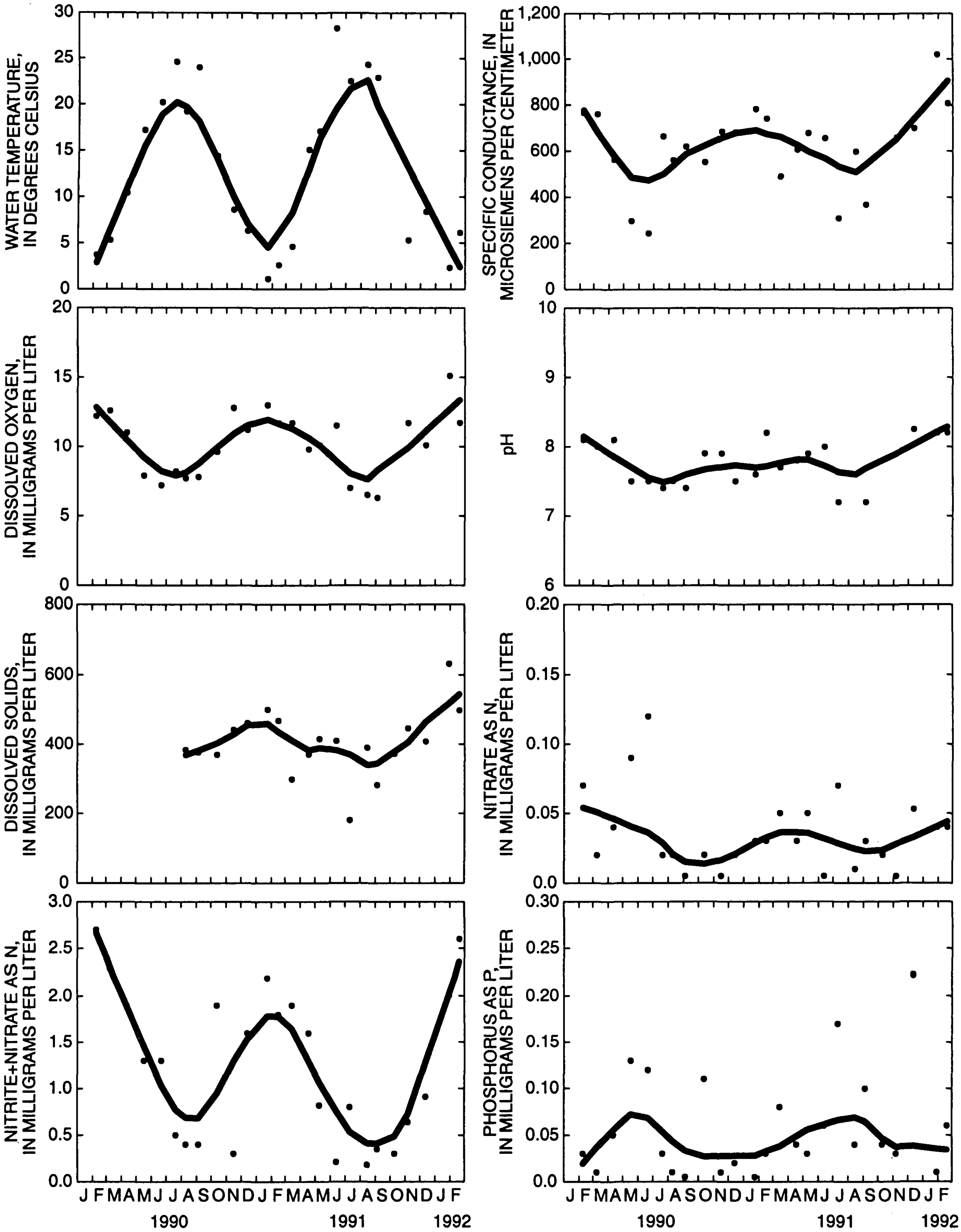


Figure 10. Seasonal variability of property measurements or concentrations of selected constituents in samples collected from Little Eagle Creek at 16th Street at Speedway, Ind., 1990–92. The solid line is a locally weighted scatterplot smooth.

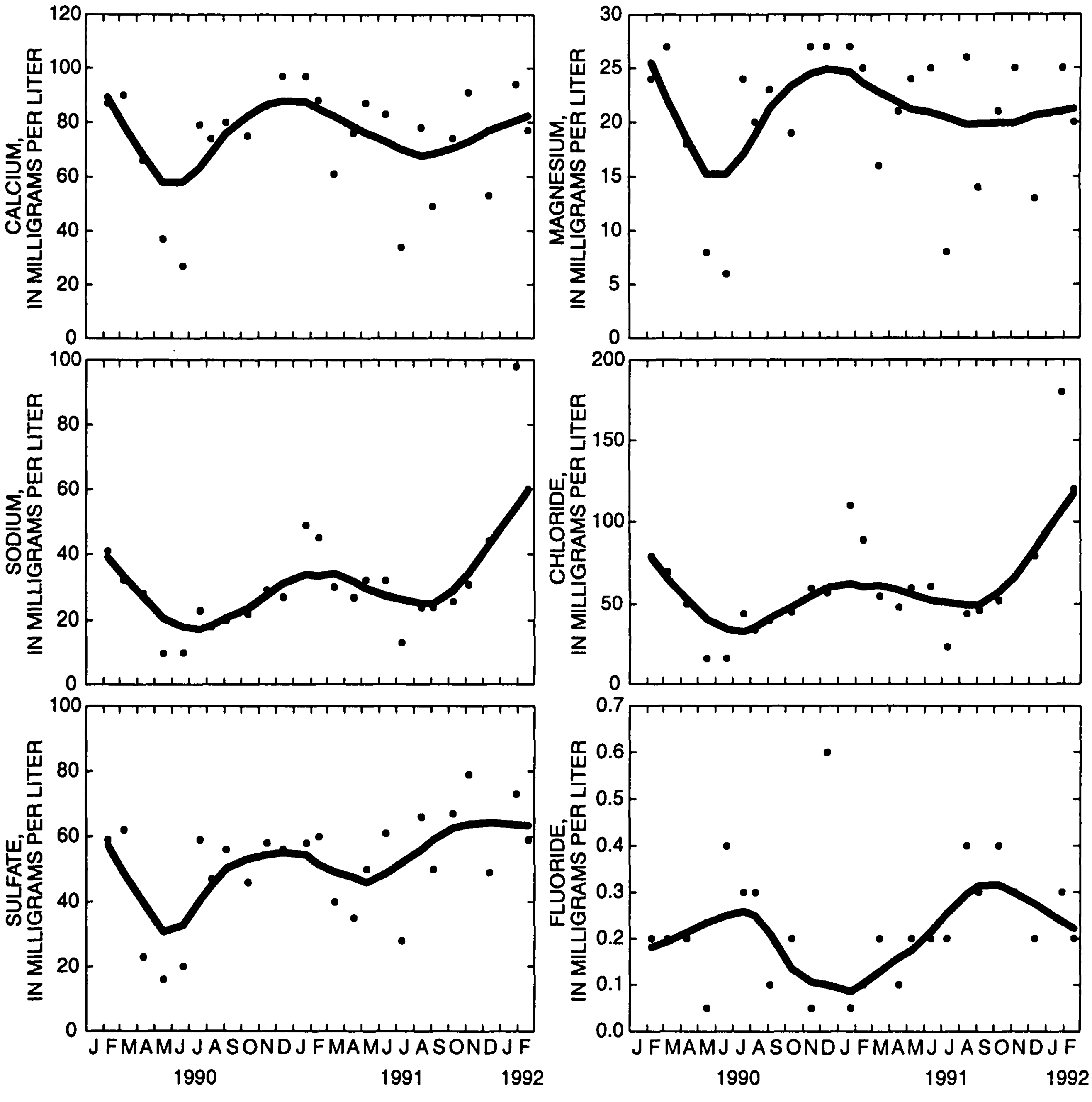


Figure 10. Seasonal variability of property measurements or concentrations of selected constituents in samples collected from Little Eagle Creek at 16th Street at Speedway, Ind., 1990–92–Continued.

Table 9. Quartile statistics for measurements of properties and concentrations of selected constituents in samples collected from Little Eagle Creek near Indianapolis, Ind., 1990–92

[p-value, the significance level attained by the data; ft^3/s, cubic foot per second; °C, degree Celsius; µS/cm, microsiemen per centimeter at 25° C; <, less than; mg/L, milligram per liter; BOD, biochemical oxygen demand; $CaCO_3$, calcium carbonate; mL, milliliter; µg/L, microgram per liter; mm, millimeter; numbers beneath site names are U.S. Geological Survey streamflow-gaging station identification numbers]

Constituent	Little Eagle Creek at 52nd Street at Indianapolis 03353551			Little Eagle Creek at 16th Street at Speedway 03353600			p-value
	Quartile			Quartile			
	25th	50th	75th	25th	50th	75th	
Streamflow (ft^3/s)	1.3	3.1	11	2.8	12	32	<0.001[a]
Water temperature (°C)	5.4	11.3	20.5	5.3	12.4	21.4	<.001[a]
Specific conductance (µS/cm)	630	710	806	557	658	720	<.001[a]
Dissolved oxygen (mg/L)	8.0	9.7	12.1	7.8	10.6	11.7	.746
pH (pH units)	7.9	8.0	8.0	7.5	7.8	8.0	.012[a]
20-day BOD (mg/L)	3.4	5.7	8.0	4.1	5.1	8.7	.403
Total alkalinity (mg/L as $CaCO_3$)	186	221	246	171	217	245	.777
Fecal coliform (colonies per 100 mL)	230	430	783	188	523	1,900	.116
Total solids (mg/L)	447	514	661	394	455	542	<.001[a]
Dissolved solids (mg/L)	406	475	600	370	408	461	<.001[a]
Ammonia (mg/L as nitrogen)	.02	.13	.39	.02	.07	.16	.018[a]
Nitrite (mg/L as nitrogen)	.01	.03	.06	.02	.03	.05	.330
Ammonia plus organic nitrogen (mg/L as nitrogen)	.5	.7	1.3	.6	.7	.9	.590
Nitrite plus nitrate (mg/L as nitrogen)	.6	1.2	2.1	.4	1.3	1.9	.004[a]
Phosphorus (mg/L as phosphorus)	.02	.03	.06	.02	.04	.08	.773
Orthophosphate (mg/L as phosphorus)	.010	.015	.020	.007	.012	.036	.763
Dissolved organic carbon (mg/L)	4.4	4.8	5.8	3.9	4.5	4.8	.020[a]
Suspended organic carbon (mg/L)	.3	.3	.5	.4	.5	.8	<.001[a]
Calcium (mg/L)	72	83	94	66	78	87	.013[a]
Magnesium (mg/L)	21	25	28	18	23	25	.001[a]
Sodium (mg/L)	30	38	47	23	28	32	<.001a
Potassium (mg/L)	2.2	2.7	3.2	2.0	2.4	2.6	.021[a]
Chloride (mg/L)	57	73	100	44	55	70	<.001[a]
Sulfate (mg/L)	52	63	69	46	56	60	<.001[a]
Fluoride (mg/L)	.2	.3	.3	.2	.2	.3	.258
Arsenic (µg/L)	<1	<1	1	<1	<1	1	1.000
Barium (µg/L)	<100	<100	100	<100	<100	<100	.625
Cadmium (µg/L)	<1	<1	<1	<1	<1	<1	1.000
Chromium (µg/L)	<1	2	3	<1	2	3	.236
Copper (µg/L)	4	5	7	3	5	7	.400
Iron (µg/L)	250	300	570	330	470	1,500	.118
Lead (µg/L)	1	2	4	2	3	8	.380
Manganese (µg/L)	40	60	90	70	80	90	.326
Mercury (µg/L)	<.1	<.1	<.1	<.1	<.1	<.1	1.000
Zinc (µg/L)	<10	10	20	<10	20	30	.961
Suspended sediment (mg/L)	12	28	45	27	39	56	.424
Suspended sediment, percent finer than 0.062 mm (mg/L)	33	61	81	40	64	89	.538

[a]Correlation coefficients are statistically significant at the 5-percent significance level.

Relation of Constituents to Streamflow

A statistical analysis of water-quality data collected at the downstream site (Little Eagle Creek at Speedway) was done to determine if there were significant correlations between concentration and streamflow (table 10). Concentrations of 20-day BOD, fecal coliform, ammonia, nitrite, nitrite plus nitrate, phosphorus, orthophosphate, suspended organic carbon, chromium, copper, iron, lead, zinc, suspended sediment, and suspended sediment (percent finer than 0.062 mm) had significantly positive correlations with streamflow. The concentration of these constituents increased with increased streamflow. Total alkalinity, magnesium, and sulfate had significantly negative correlations indicating that the concentrations decreased as streamflow increased.

Seasonal Variability

Seasonal trends were observed for several constituents when plotted using a LOWESS smoothing technique. Water temperature and concentrations of phosphorus and fluoride were largest in samples from the downstream site during spring and summer and were smallest during fall and winter (fig. 10). Concentrations of DOC and potassium had similar trends, although the trends were most evident at the upstream site (fig. 11).

Constituents that had increased concentrations or measurements in samples collected during fall and winter are specific conductance, dissolved oxygen, pH, dissolved solids, nitrite, nitrite plus nitrate, calcium, magnesium, sodium, chloride, and sulfate (fig. 10). Concentrations of ammonia had a similar trend that was most evident at the upstream site (fig. 11). Increased concentrations of nutrients during fall and winter may reflect the decreased uptake of nutrients by vegetation during the non-growing season. Increased calcium, sodium, and chloride concentrations during the winter may be the result of the use of these chemicals as deicing agents or the result of a larger ground-water component to streamflow during periods of low streamflow.

Table 10. Statistical relations of selected properties and chemical constituents to streamflow for Little Eagle Creek at 16th Street at Speedway, Ind., 1990–92

[p-value, the significance level attained by the data; °C, degree Celsius; µS/cm, microsiemen per centimeter at 25° C; mg/L, milligram per liter; $CaCO_3$, calcium carbonate; BOD, biochemical oxygen demand; mL, milliliter; µg/L, microgram per liter; <, less than; mm, millimeter; number beneath site name is U.S. Geological Survey streamflow-gaging station identification number]

Constituent	Little Eagle Creek at 16th Street at Speedway 03353600	
	Correlation coefficient	p-value
Water temperature (°C)	-0.200	0.172
Specific conductance (µS/cm)	-.095	.519
Dissolved oxygen (mg/L)	.033	.823
pH (pH units)	.159	.293
20-day BOD (mg/L)	.419	.004[a]
Total alkalinity (mg/L as $CaCO_3$)	-.483	.002[a]
Fecal coliform (colonies per 100 mL)	.332	.024[a]
Total solids (mg/L)	.179	.224
Dissolved solids (mg/L)	.023	.889
Ammonia (mg/L as nitrogen)	.363	.013[a]
Nitrite (mg/L as nitrogen)	.665	<.001[a]
Ammonia plus organic nitrogen (mg/L as nitrogen)	.275	.063
Nitrite plus nitrate (mg/L as nitrogen)	.430	.003[a]
Phosphorus (mg/L as phosphorus)	.427	.004[a]
Orthophosphate (mg/L as phosphorus)	.410	.006[a]
Dissolved organic carbon (mg/L)	.275	.058
Suspended organic carbon (mg/L)	.524	<.001[a]
Calcium (mg/L)	-.279	.052
Magnesium (mg/L)	-.442	.003[a]
Sodium (mg/L)	.064	.657
Potassium (mg/L)	-.227	.125
Chloride (mg/L)	.050	.726
Sulfate (mg/L)	-.480	<.001[a]
Fluoride (mg/L)	-.253	.102
Arsenic (µg/L)	.055	.736
Barium (µg/L)	.011	.946
Cadmium (µg/L)	.034	.841
Chromium (µg/L)	.530	<.001[a]
Copper (µg/L)	.509	.001[a]
Iron (µg/L)	.582	<.001[a]
Lead (µg/L)	.323	.034[a]
Manganese (µg/L)	.007	.962
Mercury (µg/L)	.232	.169
Zinc (µg/L)	.490	.002[a]
Suspended sediment (mg/L)	.357	.013[a]
Suspended sediment, percent finer than 0.062 mm	.428	.003[a]

[a]Correlation coefficients are statistically significant at the 5-percent significance level.

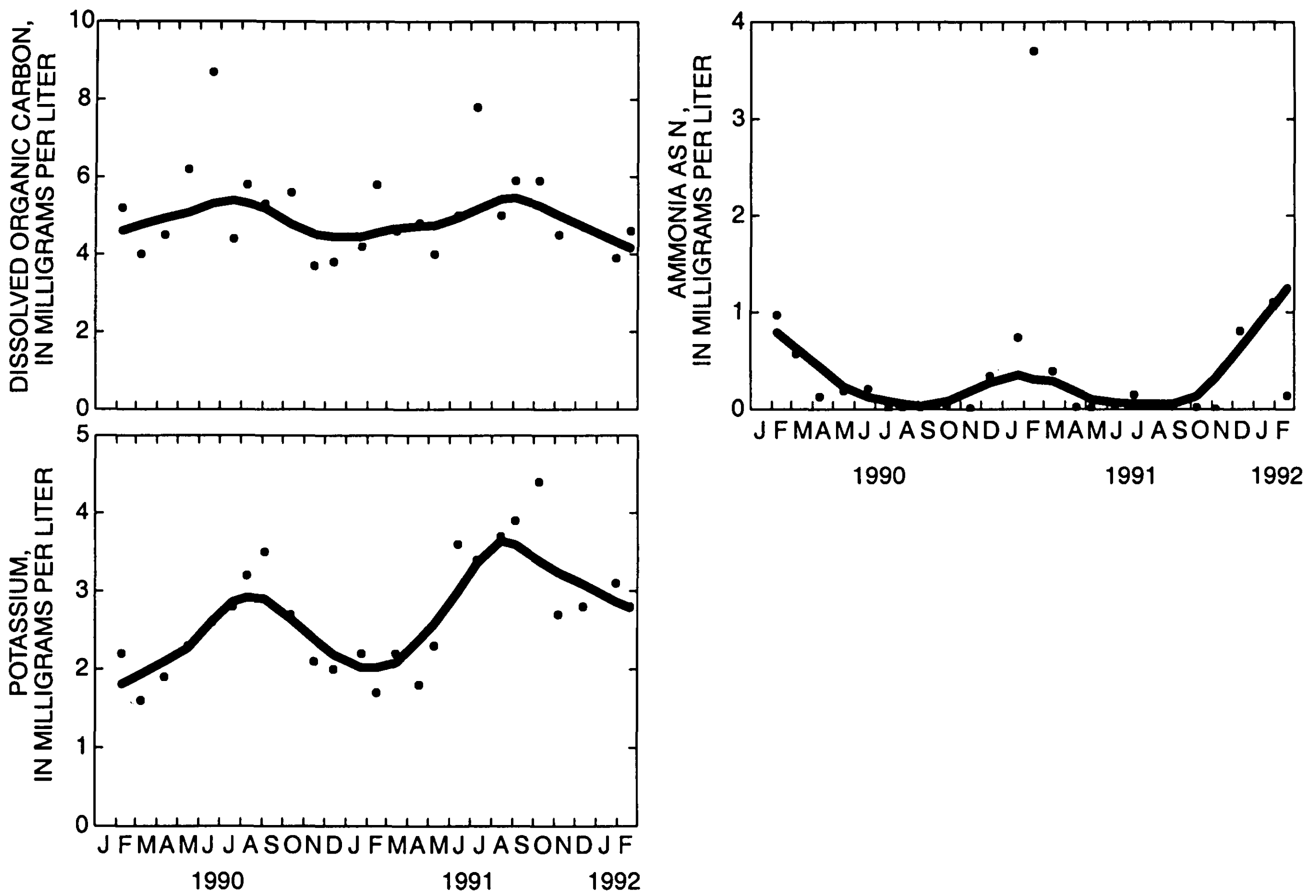


Figure 11. Seasonal variability in concentrations of selected constituents in samples collected from Little Eagle Creek at 52nd Street at Indianapolis, Ind., 1990–92. The solid line is a locally weighted scatterplot smooth.

Constituent Loads

Mean annual loads in Little Eagle Creek were determined for selected constituents and are listed, along with seasonal loads, in table 11 for the upstream site and table 12 for the downstream site. The largest loads are transported during spring and winter, when streamflow is highest. Dissolved solids constitute the largest loads, averaging 53,000 lb/d at the upstream site and 94,000 lb/d at the downstream site. Suspended-sediment transport was 17,000 lb/d upstream compared with 40,000 lb/d downstream. At the upstream site, calcium loads were 3,400 lb/d; sodium loads were 1,900 lb/d; chloride loads were 3,600 lb/d; and sulfate loads were 2,400 lb/d. At the downstream site, calcium loads were 9,700 lb/d; sodium loads were 4,300 lb/d; chloride loads were 8,200 lb/d; and sulfate loads were 6,200 lb/d. Magnesium loads were 870 lb/d at the upstream site and 2,500 lb/d at the downstream site. Nutrient loads ranged from 1.8 lb/d for orthophosphate to 120 lb/d for nitrite plus nitrate at the upstream site and from 12 lb/d for nitrite to 300 lb/d for nitrite plus nitrate at the downstream site. Iron loads were 880 lb/d upstream and 1,900 lb/d downstream.

Table 11. Mean annual and seasonal loads of selected water-quality constituents for Little Eagle Creek at 52nd Street at Indianapolis, Ind., 1990–92
[lb/d, pound per day]

Constituent	Mean annual load (lb/d)	Standard deviation	Seasonal loads							
			Spring load (lb/d)	Standard deviation	Summer load (lb/d)	Standard deviation	Fall load (lb/d)	Standard deviation	Winter load (lb/d)	Standard deviation
Dissolved solids	53,000	8,700	68,000	8,700	8,200	1,200	31,000	5,800	97,000	22,000
Ammonia	54	55	65	45	2	1	15	26	120	150
Nitrite	7	1	10	2	1	0	3	1	12	3
Ammonia plus organic nitrogen	94	35	110	34	14	5	62	37	170	79
Nitrite plus nitrate	120	16	170	20	17	3	61	12	220	37
Phosphorus	5.3	1.6	7.8	2	2.5	.64	5.0	2.3	5.7	2.2
Orthophosphate	1.8	.61	2.6	.85	.46	.11	1.3	.42	2.8	1.0
Dissolved organic carbon	370	20	490	24	120	6	310	27	510	35
Suspended organic carbon	120	25	150	28	13	1	65	10	220	56
Calcium	3,400	150	4,600	220	1,100	78	2,300	190	5,200	320
Magnesium	870	37	1,200	60	300	36	580	48	1,300	85
Sodium	1,900	270	2,700	410	440	68	1,000	270	3,100	570
Potassium	150	9	190	10	58	3	140	13	200	15
Chloride	3,600	530	4,800	750	830	130	2,100	560	6,200	1,100
Sulfate	2,400	140	2,900	180	790	77	2,000	210	3,700	300
Fluoride	13	3	17	4	4	1	11	3	19	4
Copper	.68	.12	1.1	.16	.17	.03	.47	.11	.97	.27
Iron	880	300	910	270	31	5	280	58	2,100	820
Lead	.79	.33	1.1	.44	.13	.04	.53	.2	1.3	.61
Manganese	22	7	24	5	1	0	10	3	49	21
Suspended sediment	17,000	8,600	23,000	10,000	1,600	380	6,600	2,300	33,000	21,000

Table 12. Mean annual and seasonal loads of selected water-quality constituents for Little Eagle Creek at 16th Street at Speedway, Ind., 1990–92
[lb/d, pound per day]

			Seasonal loads							
Constituent	Mean annual load (lb/d)	Standard deviation	Spring load (lb/d)	Standard deviation	Summer load (lb/d)	Standard deviation	Fall load (lb/d)	Standard deviation	Winter load (lb/d)	Standard deviation
Dissolved solids	94,000	7,600	140,000	12,000	22,000	2,100	57,000	5,900	140,000	17,000
Ammonia	60	35	76	38	4	2	27	24	120	85
Nitrite	12	2	20	4	3	0	8	1	17	3
Ammonia plus organic nitrogen	190	38	310	63	63	9	130	24	260	53
Nitrite plus nitrate	300	38	470	62	64	13	160	32	470	83
Phosphorus	18	5	26	7	8	2	19	9	18	7
Orthophosphate	23	13	18	8	5	2	33	23	33	21
Dissolved organic carbon	900	61	1,300	90	350	26	770	83	1,200	100
Suspended organic carbon	550	350	850	520	74	16	280	100	930	700
Calcium	9,700	370	15,000	660	2,900	130	5,700	380	14,000	710
Magnesium	2,500	87	3,800	160	810	50	1,400	91	3,600	180
Sodium	4,300	250	6,400	430	1,000	98	2,500	260	7,000	550
Potassium	390	15	580	24	160	7	320	20	490	25
Chloride	8,200	430	12,000	710	1,800	160	4,800	450	14,000	960
Sulfate	6,200	290	8,500	450	2,000	110	4,500	360	9,400	560
Fluoride	38	7	58	11	15	2	26	4	49	9
Copper	2.4	.58	3.7	.87	.44	.06	1.5	.30	3.7	1.1
Iron	1,900	690	2,700	860	170	36	780	200	3,500	1,700
Lead	2.9	1.2	4.4	1.7	.39	.11	1.5	.51	5.0	2.4
Manganese	42	19	59	21	4	3	14	8	84	54
Suspended sediment	40,000	16,000	71,000	28,000	5,500	1,000	14,000	3,400	66,000	31,000

Storm Samples

Samples were collected once in December 1993 at both sites in Little Eagle Creek and twice in April 1994 at the downstream site during periods of high streamflow after storms. The results of the analyses of these samples are presented in table 19 at the back of the report. Diazinon and bis (2-ethyl hexyl) phthalate were detected in samples collected at both sites. Benzene, chlorpyrifos, malathion, cis-1,2-dichloroethene, and methyl tert-butyl ether were detected only in samples collected at the downstream site (table 7). Chlorpyrifos, diazinon, and malathion are pesticides that are used in lawn-care and agricultural applications. Benzene and methyl tert-butyl ether are associated with gasoline; cis-1,2-dichloroethene is a solvent for organic materials; and bis (2-ethyl hexyl) phthalate is a plasticizer.

Quality of Streambed Sediments

Samples of streambed sediments were collected at both sites in Little Eagle Creek. Samples were collected in August 1990 during a period of low streamflow. Results of the analyses are listed in table 20 (organic compounds) and table 21 (metals) at the back of the report.

Fifteen organic compounds were detected in the streambed-sediment samples at concentrations equal to or greater than the reporting limit (table 8). Compounds detected in samples from both sites are chlordane, dieldrin, malathion, and diazinon. Only samples from the upstream site had detectable concentrations of p,p'-DDD and heptachlor epoxide. Benzo(a)pyrene; chrysene; fluoranthene; indeno(1,2,3-CD)pyrene; phenanthrene; pyrene; benzo(g,h,i)perylene; aldrin; and PCB's were detected only in samples from the downstream site. Thirteen organic compounds were detected in streambed-sediment samples from the downstream site, which is slightly more industrialized. Six organic compounds were detected in samples from the upstream site.

Analysis of metals in the streambed sediments at both sites in Little Eagle Creek indicated that concentrations of antimony, arsenic, cobalt, chromium, iron, manganese, mercury, silver, titanium, and zinc were larger in samples collected at the upstream site compared to samples from the downstream site. Concentrations of cadmium, copper, lead, and selenium were highest in sediment samples from the downstream site (table 21).

Comparison of Little Buck and Little Eagle Creeks

This section describes the comparison between the Little Buck Creek and Little Eagle Creek drainage basins. Comparison between the streams was based upon analyses of data collected from the downstream sites in each drainage basin.

Land Use

At the downstream sites, land use in the Little Buck Creek drainage basin was 56.3 percent residential and 34.3 percent agricultural, with only 2.0 percent commercial land use. In comparison, land use in the Little Eagle Creek drainage basin was 32.7 percent residential, 27.3 percent commercial, and 24.4 percent agricultural (table 1). These differences in land use may account for some of the variation in water quality between the streams.

Streamflow

During the study period, more streamflow was measured in Little Buck Creek than in Little Eagle Creek. The average streamflow during the 1990—92 study period was 1.52 $ft^3/s/mi^2$ in the Little Buck Creek drainage basin and 1.32 $ft^3/s/mi^2$ in the Little Eagle Creek drainage basin. Runoff was almost 43 in. in the Little Buck Creek drainage basin and about 37 in. in the Little Eagle Creek drainage basin during 1990—92. A statistical analysis, however, indicated no statistical difference in the instantaneous streamflows at the time of sample collection (table 13). Therefore, differences in water quality between the two streams do not relate to streamflow but rather may indicate that other factors, such as land use, ground-water quality, or geology of the drainage basins, may affect water quality.

Water Quality

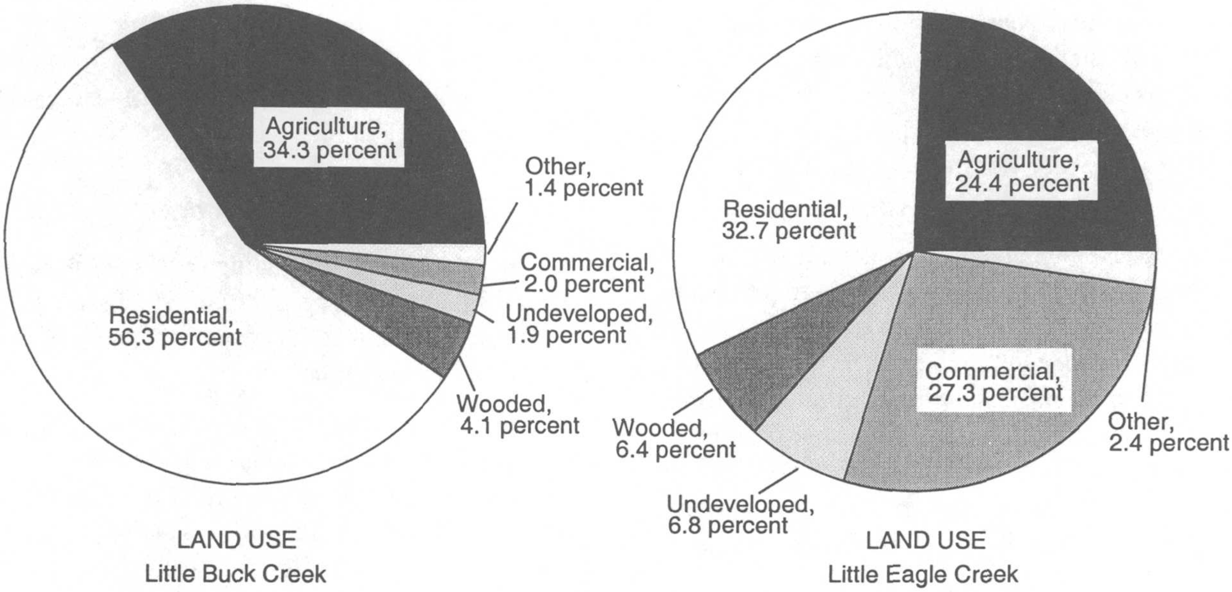
For the downstream sites on Little Buck Creek and Little Eagle Creek, the ranges and median values for water-quality parameters and constituents are listed in table 13. Comparisons of these concentrations are displayed graphically in the boxplots in figure 13. Specific conductance, pH, and concentrations of total alkalinity, dissolved solids, calcium, magnesium, sodium, and chloride were significantly larger in water samples collected from the downstream site on Little Buck Creek than in samples collected from the downstream site on Little Eagle Creek (table 13, fig. 12).

Table 13. Quartile statistics for measurements of properties and concentrations of selected constituents for samples collected at the downstream sites in the Little Buck Creek and Little Eagle Creek drainage basins near Indianapolis, Ind., 1990–92

[p-value, the significance level attained by the data; ft^3/s, cubic foot per second; °C, degrees Celsius; µS/cm, microsiemen per centimeter at 25°C; <, less than; mg/L, milligram per liter; BOD, biochemical oxygen demand; $CaCO_3$, calcium carbonate; mL, milliliter; µg/L, microgram per liter; mm, millimeter; numbers beneath site names are U.S. Geological Survey streamflow-gaging station identification numbers]

Constituent	Little Buck Creek near Indianapolis 03353637			Little Eagle Creek at 16th Street at Speedway 03353600			p-value
	Quartile			Quartile			
	25th	50th	75th	25th	50th	75th	
Streamflow (ft^3/s)	4.9	10.7	24.5	2.8	12	32	0.782
Water temperature (°C)	4.9	11.0	21.3	5.3	12.4	21.4	.335
Specific conductance (µS/cm)	664	745	783	557	658	720	<.001[a]
Dissolved oxygen (mg/L)	9.0	11.0	12.2	7.8	10.6	11.7	.064
pH (pH units)	7.9	8.0	8.2	7.5	7.8	8.0	<.001[a]
20-day BOD (mg/L)	2.2	3.6	5.0	4.1	5.1	8.7	.004[a]
Total alkalinity (mg/L as $CaCO_3$)	221	253	272	171	217	245	<.001[a]
Fecal coliform (colonies per 100 mL)	195	691	2,100	188	523	1,900	.780
Total solids (mg/L)	445	490	516	394	455	542	.123
Dissolved solids (mg/L)	417	464	494	370	408	461	.009[a]
Ammonia (mg/L as nitrogen)	.02	.03	.05	.02	.07	.16	<.001[a]
Nitrite (mg/L as nitrogen)	.01	.02	.03	.02	.03	.05	.002[a]
Ammonia plus organic nitrogen (mg/L as nitrogen)	.3	.5	.6	.6	.7	.9	<.001[a]
Nitrite plus nitrate (mg/L as nitrogen)	.7	1.0	1.4	.4	1.3	1.9	.283
Phosphorus (mg/L as phosphorus)	.02	.03	.06	.02	.04	.08	.389
Orthophosphate (mg/L as phosphorus)	.010	.013	.025	.007	.012	.036	.777
Dissolved organic carbon (mg/L)	2.9	3.2	4.6	3.9	4.5	4.8	<.001[a]
Suspended organic carbon (mg/L)	.3	.3	.5	.4	.5	.8	.010[a]
Calcium (mg/L)	77	84	92	66	78	87	.008[a]
Magnesium (mg/L)	24	26	28	18	23	25	<.001[a]
Sodium (mg/L)	36	44	46	23	28	32	<.001[a]
Potassium (mg/L)	1.7	2.0	2.4	2.0	2.4	2.6	<.001[a]
Chloride (mg/L)	63	78	87	44	55	70	.012[a]
Sulfate (mg/L)	38	48	53	46	56	60	.098
Fluoride (mg/L)	.1	.2	.2	.2	.2	.3	.008[a]
Arsenic (µg/L)	<1	<1	1	<1	<1	1	.938
Barium (µg/L)	<100	<100	<100	<100	<100	<100	.500
Cadmium (µg/L)	<1	<1	<1	<1	<1	<1	1.000
Chromium (µg/L)	<1	<1	2	<1	2	3	.025[a]
Copper (µg/L)	3	4	6	3	5	7	.848
Iron (µg/L)	165	210	330	330	470	1,500	<.001[a]
Lead (µg/L)	1	2	4	2	3	8	.202
Manganese (µg/L)	40	50	55	70	80	90	<.001[a]
Mercury (µg/L)	<.1	<.1	<.1	<.1	<.1	<.1	:750
Zinc (µg/L)	<10	10	10	<10	20	30	.004[a]
Suspended sediment (mg/L)	18	26	44	27	39	56	.043[a]
Suspended sediment, percent finer than 0.062 mm	23	48	72	40	64	89	<.001[a]

[a]Correlation coefficients are statistically significant at the 5-percent significance level.



Constituent concentration or property measurement significantly larger at Little Buck Creek near Indianapolis, Ind. compared to Little Eagle Creek at 16th Street at Indianapolis, Ind.

Specific Conductance
pH
Total Alkalinity
Dissolved Solids
Calcium
Magnesium
Sodium
Chloride

Constituent concentration or property measurement significantly larger at Little Eagle Creek at 16th Street at Indianapolis, Ind. compared to Little Buck Creek near Indianapolis, Ind.

20-day Biological Oxygen Demand
Ammonia
Nitrite
Ammonia plus Organic Nitrogen
Dissolved Organic Carbon
Suspended Organic Carbon
Potassium
Fluoride
Chromium
Iron
Manganese
Zinc
Suspended Sediment
Suspended Sediment, percent less than 0.062 millimeters

Figure 12. Land use and list of properties or constituents with significantly larger measurements or concentrations between the downstream sites in the Little Buck Creek and Little Eagle Creek drainage basins near Indianapolis, Ind., 1990–1992.

Although statistically larger in water samples from Little Buck Creek compared to concentrations in samples from Little Eagle Creek, concentrations of sodium and chloride were frequently larger in the Little Eagle Creek drainage basin during January, February, and March. These results may indicate the use of these chemicals as deicing agents on the roadways or the result of ground-water input to the streams that is affected by the geology of the drainage basins.

Concentrations of 20-day BOD, ammonia, nitrite, ammonia plus organic nitrogen, dissolved organic carbon, suspended organic carbon, potassium, fluoride, chromium, iron, manganese, zinc, suspended sediment, and suspended sediment (percent finer than 0.062 mm) were significantly larger in samples from the downstream site on Little Eagle Creek than in samples from the downstream site on Little Buck Creek (fig. 12, table 13). Comparisons of these concentrations are displayed graphically in the boxplots in figure 14.

The larger nutrient concentrations in samples from Little Eagle Creek may result from lawn care in the commercial and residential areas of the drainage basin, although agriculture is more predominant in the Little Buck Creek drainage basin. Larger concentrations of metals may be related to runoff from commercial and industrial areas, which are more predominant in the Little Eagle Creek drainage basin.

Constituent Loads

Mean annual loads for selected constituents were compared between the two downstream sites for each stream (table 14). Mean annual loads generally were largest in Little Eagle Creek, partially a result of about a 25-percent greater streamflow in that drainage basin during the period of study. Estimated loads of nitrite, ammonia plus organic nitrogen, orthophosphate, iron, and manganese were more than twice as large in Little Eagle Creek as compared to Little Buck Creek.

Storm Samples

The complete data set from the storm samples are presented in table 19 at the back of the report. In the Little Buck Creek drainage basin, chlorpyrifos, malathion, and diazinon were detected at the upstream and downstream sites, and methoxychlor was detected at the upstream site (table 7). In the Little Eagle Creek drainage basin, bis (2-ethyl hexyl) phthalate and diazinon were detected at the upstream and downstream sites. Chlorpyrifos, malathion, cis-1,2-dichloroethene, methyl tert-butyl ether, and benzene were only detected at the downstream site. Concentrations of diazinon were significantly larger in the Little Buck Creek drainage basin. Concentrations of bis (2-ethyl hexyl) phthalate, a plasticizer, were significantly larger in the Little Eagle Creek drainage basin.

Quality of Streambed Sediments

Streambed sediment samples were collected in August 1990, during a period of relatively low flow. Streambed-sediment data are presented in tables 20 and 21 at the back of the report.

Seventeen organic compounds were detected in four streambed-sediment samples at concentrations equal to or greater than the reporting limit (table 8). Compounds detected at all four sites include chlordane, dieldrin, diazinon, and malathion. Three sites had detectable concentrations of heptachlor epoxide; p,p'-DDD and p,p'-DDE were each detected at two sites; and aldrin, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, fluoranthene, indeno(1,2,3-CD) pyrene, phenanthrene, pyrene, p,p'-DDT, and PCB's were detected at one site each. Sites in the most urban areas were the ones with the most organic compounds detected in streambed sediments. Little Eagle Creek at Speedway had 13 detectable organic compounds; Little Buck Creek near Indianapolis had 8; Little Eagle Creek at 52nd Street and Little Buck Creek near Southport each had 6 organic compounds detected in the streambed sediments.

Concentrations of metals were similar in the streambed sediments of both streams. With only a few exceptions, concentrations of metals in streambed sediments of the Little Eagle Creek drainage basin were slightly larger than or equal to those of the Little Buck Creek drainage basin (table 21). Large metal concentrations may relate to runoff from commercial areas where various industries that use these constituents are in operation.

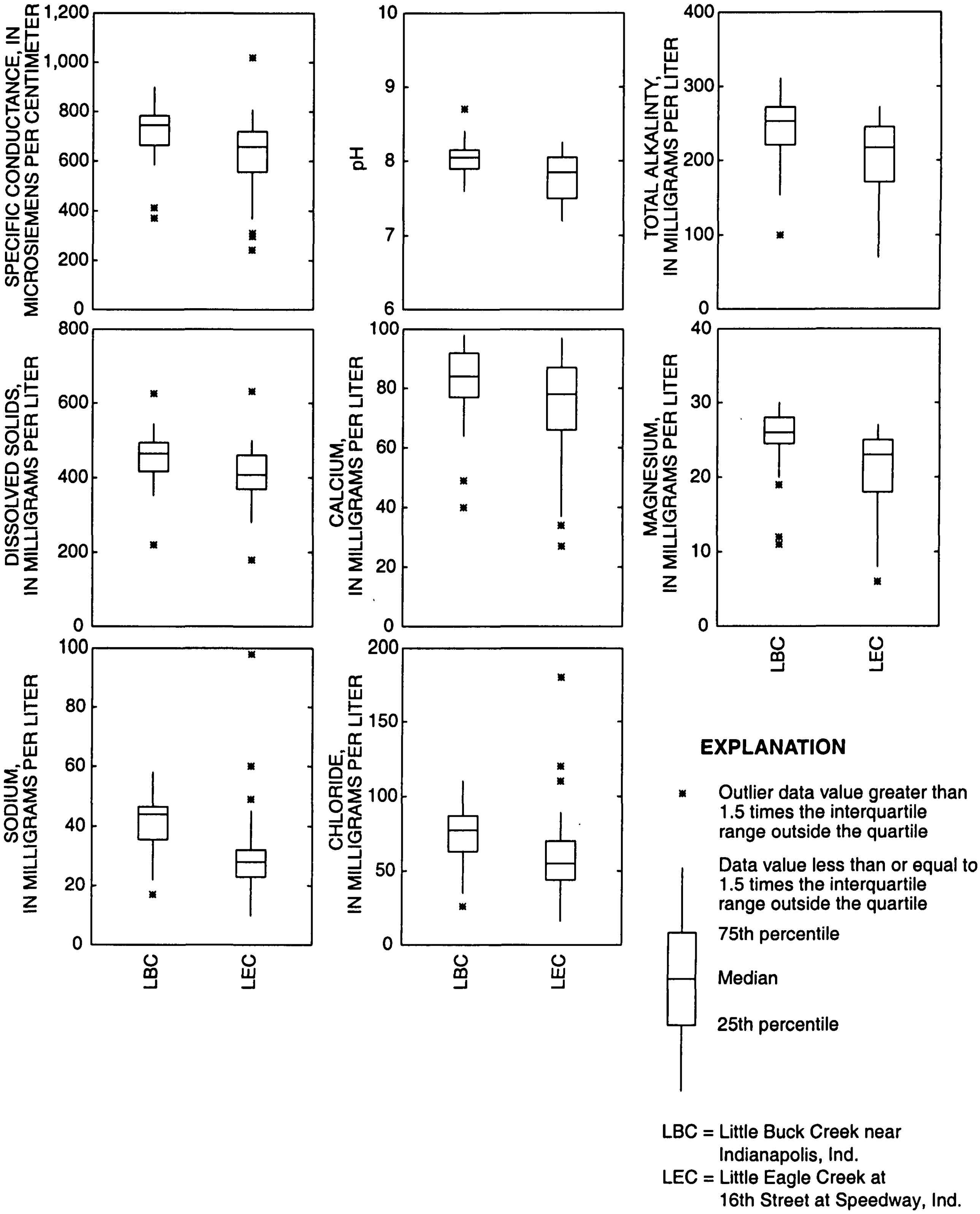


Figure 13. Distribution of property measurements or concentrations of selected constituents, showing those that are largest in Little Buck Creek near Indianapolis, Ind., 1990–92.

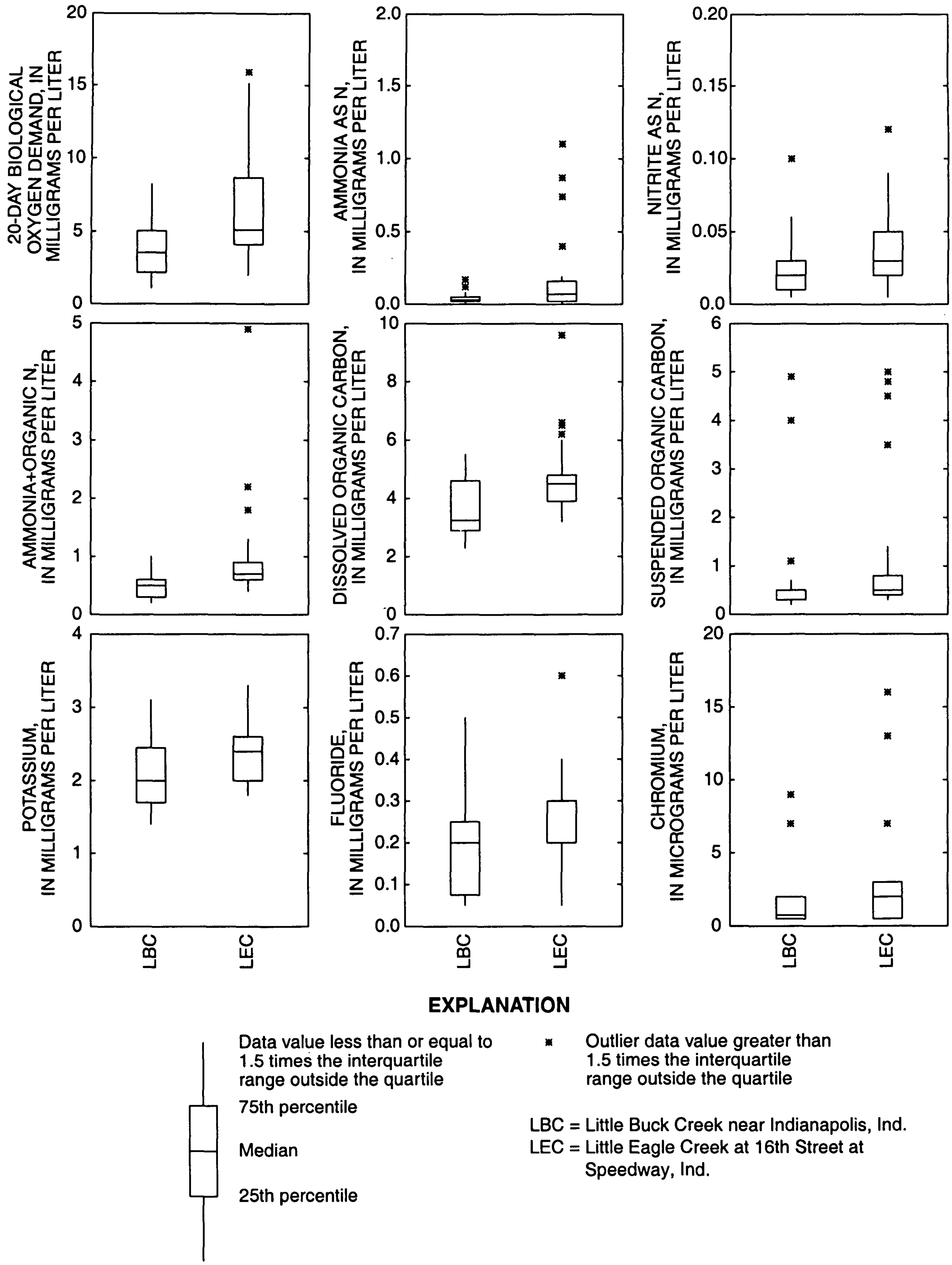


Figure 14. Distribution of concentrations of selected constituents, showing those that are largest in Little Eagle Creek at 16th Street at Speedway, Ind., 1990–92.

Table 14. Mean annual loads of selected water-quality constituents at the downstream sites in the Little Buck Creek and Little Eagle Creek drainage basins near Indianapolis, Ind., 1990–92
[lb/d, pound per day]

	Little Buck Creek near Indianapolis 03353637		Little Eagle Creek at 16th Street at Speedway 03353600	
Constituent	Mean annual load (lb/d)	Standard deviation	Mean annual load (lb/d)	Standard deviation
Dissolved solids	69,000	2,600	94,000	7,600
Ammonia	15	13	60	35
Nitrite	4.2	.95	12	2
Ammonia plus organic nitrogen	85	10	190	38
Nitrite plus nitrate	200	31	300	38
Phosphorus	16	9	18	5
Orthophosphate	9	5	23	13
Dissolved organic carbon	570	38	900	61
Suspended organic carbon	340	160	550	350
Calcium	9,000	210	9,700	370
Magnesium	2,600	55	2,500	87
Sodium	4,300	150	4,300	250
Potassium	300	10	390	15
Chloride	7,500	280	8,200	430
Sulfate	4,900	240	6,200	290
Fluoride	27	4	38	7
Copper	2.0	.39	2.4	.58
Iron	99	65	1,900	690
Lead	3.6	6.6	2.9	1.2
Manganese	20	4	42	19
Suspended sediment	26,000	17,000	40,000	16,000

Summary

Water samples were collected monthly from February 1990 through February 1992 in two drainage basins in Indianapolis. An upstream and a downstream site were sampled in the Little Buck Creek and Little Eagle Creek drainage basins. Storm-event samples were collected in 1993 and 1994 to describe the water-quality conditions when runoff resulted in increased streamflow following a period of relatively dry weather. Streambed sediments were collected in 1990 during a period of low flow to describe their chemistry. Aerial photographs taken in 1985 indicated that the Little Buck Creek drainage basin was predominantly residential (56.3 percent) and agricultural (34.3 percent), with only 2 percent commercial land use, compared with the Little Eagle Creek drainage basin, which was 32.7 percent residential, 27.3 percent commercial, and 24.4 percent agricultural. Both drainage basins were undergoing development during the study period.

Based on long-term streamflow records from the downstream site on Little Eagle Creek (at Speedway), mean monthly flows during the study period were generally larger than the long-term average flow. Although instantaneous discharge at the time of sampling was not significantly different between Little Buck Creek and Little Eagle Creek, there was more total streamflow in the Little Eagle Creek drainage basin than in the Little Buck Creek drainage basin during the study period.

In the Little Buck Creek drainage basin, measurements of water temperature and concentrations of nitrite plus nitrate, phosphorus, dissolved organic carbon, iron, and manganese were significantly larger at the upstream site in the drainage basin. At the downstream site, significantly larger measurements of instantaneous streamflow, specific conductance, and pH, and concentrations of total alkalinity, total solids, dissolved solids, calcium, magnesium, sodium, potassium, chloride, and sulfate were determined. At the downstream site in the Little Buck Creek drainage basin, nitrite, nitrite plus nitrate, suspended organic carbon, chromium, copper, iron, lead, manganese, suspended sediment, and suspended sediment (percent finer than 0.062 mm) had significant positive correlations with streamflow. Water temperature, magnesium, sodium, chloride, and sulfate concentrations had significant negative correlations with streamflow.

Also in the Little Buck Creek drainage basin, water temperature, dissolved organic carbon, phosphorus, and potassium were higher during spring and summer and lower during fall and winter. Specific conductance, dissolved oxygen, and pH, and concentrations of nitrite plus nitrate, dissolved solids, calcium, magnesium, sodium, chloride, and manganese were larger during fall and winter and lower during spring and summer. Mean annual load calculations indicate that the largest loads are transported during winter and spring when streamflow tends to be highest.

In the Little Eagle Creek drainage basin, measurements of specific conductance and pH and concentrations of total solids, dissolved solids, ammonia, dissolved organic carbon, calcium, magnesium, sodium, potassium, chloride, and sulfate were determined to be significantly larger in samples from the upstream site when compared with samples from the downstream site. Measurements of instantaneous streamflow and water temperature, and concentrations of nitrite plus nitrate and suspended organic carbon were significantly larger in samples from the downstream site. At the downstream site, concentrations of 20-day BOD, fecal coliform, ammonia, nitrite, nitrite plus nitrate, phosphorus, orthophosphate, suspended organic carbon, chromium, copper, iron, lead, zinc, suspended sediment, and suspended sediment (percent finer than 0.062 mm) had significant positive correlations with streamflow. Total alkalinity, magnesium, and sulfate had significant negative correlations with streamflow.

Also in the Little Eagle Creek drainage basin, water temperature, dissolved organic carbon, phosphorus, potassium, and fluoride were higher during spring and summer and lower during fall and winter. Specific conductance, dissolved oxygen, pH, dissolved solids, nitrite, nitrite plus nitrate, calcium, magnesium, sodium, chloride, and sulfate concentrations generally increased during fall and winter and decreased during spring and summer. Mean annual load calculations indicate that the highest loads are transported during winter and spring when streamflow tends to be highest.

A statistical comparison of water quality in Little Buck Creek and Little Eagle Creek indicated that specific conductance, pH, and concentrations of total alkalinity, dissolved solids, calcium, magnesium, sodium, and chloride were significantly larger in Little Buck Creek. Little Eagle Creek had significantly larger concentrations of 20-day BOD, ammonia, nitrite, ammonia plus organic nitrogen, dissolved organic carbon, suspended organic carbon, potassium, fluoride, chromium, iron, manganese, zinc, suspended sediment, and suspended sediment (percent finer than 0.062 mm). Mean annual loads generally were largest in the Little Eagle Creek drainage basin, although most constituent loads were comparable between drainage basins. This was probably due to the larger amount of streamflow in Little Eagle Creek during the study period.

Instantaneous streamflow at the time of sampling was similar between the Little Buck Creek and Little Eagle Creek drainage basins. Therefore, much of the variation in water quality might be related to the differences in land use between the drainage basins; land use was described as a principal factor in affecting the water-quality changes between the upstream and downstream sites. The large nutrient concentrations in samples from Little Eagle Creek may result from lawn-care services in the commercial and residential parts of the drainage basin, although agriculture is more predominant in the Little Buck Creek drainage basin. Large concentrations of calcium, sodium, and chloride at the downstream sites may be the result of using these chemicals as deicing agents on roadways or possibly the result of a larger ground-water component to streamflow during periods of low streamflow.

Storm samples were analyzed primarily for organic compounds, of which diazinon was detected at all four sites in the study area. In the Little Buck Creek drainage basin, chlorpyrifos, diazinon, and malathion were detected at both sites, and methoxychlor was detected at the upstream site. In the Little Eagle Creek drainage basin, bis (2-ethyl hexyl) phthalate and diazinon were detected at both sites. Benzene; cis-1,2-dichloroethene; chlorpyrifos; malathion; and methyl tert-butyl ether were only detected at the downstream site.

Streambed sediments were sampled to determine the concentrations of selected organic compounds and metals in the streambed. Seventeen organic compounds were detected in the streambed-sediment samples, of which chlordane, dieldrin, malathion, and diazinon were detected at all four sites. Little Eagle Creek at Speedway had 13 detectable organic compounds; Little Buck Creek near Indianapolis had 8; Little Eagle Creek at 52nd Street and Little Buck Creek near Southport each had 6 organic compounds detected in the sediments. Concentrations of metals were similar in the streambed sediments of both streams, with the Little Eagle Creek drainage basin having some concentrations slightly larger than those in the Little Buck Creek drainage basin.

References

Athayde, Dennis, 1983, Preliminary results of the nationwide urban runoff program, *in* Conference on Urban Effects on Water Quality and Quantity, Conference proceedings of October 20 and 21, 1983, Document 84/06: Illinois Department of Energy and Natural Resources, p. 6—14.

Chatterjee, Samprit, and McLeish, D.L., 1986, Fitting least squares regression models to censored data by least squares and maximum likelihood methods: Communications in Statistics—Theory and Methods, v. 15, no. 11, p. 3227—3243.

Cohn, T.A., Delong, L.L., Gilroy, E.J., Hirsch, R.M., and Wells, D.K., 1989, Estimating constituent loads: Water Resources Research, v. 25, no. 5, p. 937—942.

Crawford, C.G., 1991, Estimation of suspended-sediment rating curves and mean suspended-sediment loads: Journal of Hydrology, v. 129, p. 331—348.

———1996, Estimating mean constituent loads in rivers by the rating-curve and flow duration, rating-curve methods: Bloomington, Ind., Indiana University, Ph.D. dissertation, 245 p.

Dempster, A.P., Laird, N.M., and Rubin, D.B., 1977, Maximum likelihood and incomplete data via the EM algorithm: Journal of the Royal Statistical Society, Series B, v. 39, no. 1, p. 1—22.

Efron, Bradley, 1982, The jackknife, the bootstrap and other re-sampling plans: Philadelphia, Society for Industrial and Applied Mathematics, 92 p.

Gilroy, E.J., Hirsch, R.M., and Cohn, T.A., 1990, Mean square error of regression-based constituent transport estimates: Water Resources Research, v. 26, p. 2069—2077.

Hartke, E.J., Ault, C.H., Austin, G.S., Becker, L.E., Bleuer N.K., Herring W.C., and Moore, M.C., 1980, Geology for environmental planning in Marion County, Indiana: Bloomington, Ind., Indiana Geological Survey Special Report 19, 53 p.

Helsel, D.R., and Hirsch, R.M., 1992, Statistical methods in water resources—Studies in environmental science, no. 49: New York, Elsevier Publishers Inc., 522 p.

Hoggatt, R.E., 1975, Drainage areas of Indiana streams: U.S. Geological Survey, 231 p.

Lazaro, T.R., 1979, Urban hydrology, a multidisciplinary perspective: Ann Arbor, Mich., Ann Arbor Science, 249 p.

Likes, Jiri, 1980, Variance of the MVUE for lognormal variance: Technometrics, v. 22, no. 2, p. 253—258.

Rantz, S.E., and others, 1982, Measurement and computation of streamflow, volume 1—Measurement of stage and discharge: U.S. Geological Survey Water-Supply Paper 2175, 284 p.

Stewart, J.A., and Nell, G.E., 1991, Water resources data Indiana water year 1990: U.S. Geological Survey Water-Data Report IN-90-1, 340 p.

Stewart, J.A., and Deiwert, C.E., 1992, Water resources data Indiana water year 1991: U.S. Geological Survey Water-Data Report IN-91-1, 349 p.

Stewart, J.A., Keeton, C.R., Benedict, B.L., and Hammil, C.E., 1993, Water resources data Indiana water year 1992: U.S. Geological Survey Water-Data Report IN-92-1, 346 p.

Sturm, R.H., and Gilbert, R.H., 1978, Soil survey of Marion County, Indiana: U.S. Department of Agriculture, Soil Conservation Service, and Purdue University Agricultural Experiment Station, 63 p.

Ward, J.R., and Harr, C.A., eds., 1990, Methods for the collection and processing of surface water and bed-material samples for physical and chemical analysis: U.S. Geological Survey Open-File Report 90-140, 71 p.

Wier, C.E., and Gray, H.H., 1961, Regional geologic map, Indianapolis sheet: Bloomington, Ind., Indiana Geological Survey, 1 sheet, scale 1:250,000.

Wolynetz, M.S., 1979, Algorithm 139—Maximum likelihood estimation in a linear model with confined and censored data: Applied Statistics, v. 28, p. 195—206.

Supplemental Data

Table 15. Water-quality data for monthly samples collected at site 03353630—Little Buck Creek near Southport, Ind., 1990–92

[mm-dd-yyyy, date in month-day-year format; hhmm, hours and minutes; deg C, degree Celsius; µS/cm, microsiemen per centimeter; mg/L, milligram per liter; $CaCO_3$, calcium carbonate; E, estimated value; µm-mf, micrometer-microfiltered; mL, milliliter; --, not measured or determined; N, nitrogen; P, phosphorus; K, values estimated from non-ideal colony counts; <, less than; >, greater than; C, carbon; µg/L, milligram per liter; mm, millimeter; all concentrations reported as total constituents unless otherwise noted]

Date (mm-dd-yyyy)	Time (hhmm)	Discharge (cubic feet per second)	Temperature (deg C)	Specific conductance (µS/cm)	Oxygen, dissolved (mg/L)	pH, field (standard units)	20-day biochemical oxygen demand (mg/L)	Alkalinity (mg/L as $CaCO_3$)
02-07-1990	1300	15	5.5	639	11.6	8.0	4.1	224
03-07-1990	1400	2.9	5.6	681	14.9	8.0	3.6	254
04-12-1990	1135	12	6.6	610	13.4	8.1	10	216
05-17-1990	1430	71	18.3	358	8.2	7.5	7.8	128
06-21-1990	0915	8.1	19.6	564	8.1	7.7	5.5	184
07-19-1990	1120	.7	22.3	638	8.4	7.9	4.7	234
08-08-1990	1400	1.3	20.3	611	8.9	8.0	2.1	242
09-05-1990	1200	.37	22.7	601	7.3	7.7	3.6	236
10-11-1990	1315	12.5	13.3	584	9.4	7.8	4.6	233
11-14-1990	1150	1.3	6.0	693	13.2	8.0	2.9	282
12-12-1990	1400	2.6	7.6	681	12.7	8.1	2.7	290
01-24-1991	0950	E4	.1	644	12.9	7.8	1.9	261
02-13-1991	1110	6.1	2.9	634	11.7	8.0	2.4	253
03-13-1991	1415	126	3.0	318	11.8	7.5	6.2	121
04-18-1991	0930	5.6	12.5	628	10.3	7.9	3.3	244
05-08-1991	1415	1.9	19.8	615	12.2	8.2	3.5	248
06-13-1991	1100	.16	21.7	623	6.3	7.6	1.5	--
07-11-1991	0900	.6	21.4	335	7.0	7.8	E4.9	104
08-15-1991	0930	.47	18.9	393	6.6	7.7	14	115
09-05-1991	1030	.22	19.3	489	7.3	7.8	3.8	--
10-10-1991	1000	.03	14.7	412	6.8	7.9	E9.8	--
11-07-1991	1040	.72	3.1	719	12.2	8.1	1.9	242
12-11-1991	1515	2.3	6.5	715	14.1	8.4	1.0	236
01-30-1992	1040	4.5	1.9	772	14.2	8.4	1.0	245
02-20-1992	1015	9.2	4.2	736	12.6	8.2	6.7	228

Table 15. Water-quality data for monthly samples collected at site 03353630—Little Buck Creek near Southport, Ind., 1990–92—Continued

Date (mm-dd-yyyy)	Fecal coliform, 0.7 μm-mf (colonies per 100 mL)	Solids residue at 105 deg C (mg/L)	Solids residue at 180 deg C, dissolved (mg/L)	Nitrogen ammonia (mg/L as N)	Nitrogen nitrite (mg/L as N)	Nitrogen ammonia plus organic (mg/L as N)	Nitrogen nitrite plus nitrate (mg/L as N)	Phos-phorus (mg/L as P)	Phos-phorus ortho, (mg/L as P)
02-07-1990	300	427	--	0.03	0.02	0.9	2.0	0.04	0.026
03-07-1990	K3	431	--	.01	.01	.4	1.2	<.01	.007
04-12-1990	77	392	--	.01	.02	.5	1.9	.05	.009
05-17-1990	1,980	376	--	.13	.06	.9	1.7	.15	.158
06-21-1990	8,000	493	--	.09	.15	.7	7.5	.08	.055
07-19-1990	600	391	--	<.01	.01	.5	1.4	.04	.008
08-08-1990	500	433	404	.02	.02	.4	1.2	.05	.018
09-05-1990	490	334	352	.02	<.01	.9	.4	.04	.026
10-11-1990	1,270	411	377	.05	.03	.6	1.5	.08	.057
11-14-1990	40	462	450	.01	<.01	.4	.3	.02	.057
12-12-1990	188	462	434	.03	.02	.2	1.2	.02	.010
01-24-1991	2,500	427	408	.04	.02	.4	1.7	<.01	.011
02-13-1991	4,000	399	397	.03	.01	.4	1.5	.03	.020
03-13-1991	1,130	321	186	.15	.04	1.0	1.4	.15	.110
04-18-1991	--	398	372	.03	.03	.5	1.1	.05	.018
05-08-1991	185	391	371	.04	.03	.6	.54	.03	.015
06-13-1991	520	412	394	.05	.02	.5	.66	.06	.042
07-11-1991	K20,300	241	191	.04	.03	1.1	.62	.14	.086
08-15-1991	K8,790	299	236	.14	.06	1.3	.44	.22	.049
09-05-1991	2,600	326	298	.02	.01	.6	.15	.07	.036
10-10-1991	73	255	238	.04	<.01	.8	.09	.11	.060
11-07-1991	120	500	485	<.01	<.01	.4	1.2	.03	.015
12-11-1991	1,430	506	471	.01	.02	.3	1.9	.03	--
01-30-1992	2,100	454	421	.01	.01	.2	2.3	.01	.004
02-20-1992	600	517	465	.01	.02	.4	2.7	.03	.007

Table 15. Water-quality data for monthly samples collected at site 03353630—Little Buck Creek near Southport, Ind., 1990–92—Continued

Date (mm-dd-yyyy)	Carbon organic, dissolved (mg/L as C)	Carbon organic, suspended (mg/L as C)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Fluoride (mg/L)
02-07-1990	3.9	0.3	77	23	27	1.6	54	41	0.2
03-07-1990	2.9	.3	82	27	27	1.1	60	44	.3
04-12-1990	3.6	.5	62	19	20	1.2	45	33	<.1
05-17-1990	6.4	3.0	44	12	12	2.6	20	17	<.1
06-21-1990	5.8	1.2	69	21	18	2.1	39	35	.4
07-19-1990	3.6	.8	78	26	25	1.6	48	40	.3
08-08-1990	4.4	.4	74	23	26	1.8	45	30	.1
09-05-1990	4.2	.4	73	24	26	2.1	46	34	<.1
10-11-1990	4.7	.5	75	22	25	2.4	51	36	.3
11-14-1990	4.0	.3	87	29	33	1.5	61	36	<.1
12-12-1990	3.8	.3	91	28	29	1.5	59	41	.3
01-24-1991	2.2	.4	86	26	29	1.3	59	39	<.1
02-13-1991	2.8	.7	84	26	27	1.3	55	42	<.1
03-13-1991	5.9	>5	37	10	13	2.3	22	23	.1
04-18-1991	3.1	.4	78	24	26	1.4	47	33	<.1
05-08-1991	3.7	--	81	24	28	1.5	51	33	.2
06-13-1991	3.5	.3	85	26	26	1.9	50	35	.2
07-11-1991	8.0	.8	38	11	11	3.0	18	19	.2
08-15-1991	8.1	1.4	44	13	16	4.1	28	35	<.1
09-05-1991	5.2	.5	62	18	19	3.5	36	48	.2
10-10-1991	8.8	.9	48	13	14	4.6	25	33	.4
11-07-1991	4.1	.3	91	27	39	2.7	89	85	.4
12-11-1991	3.5	.3	87	26	34	1.6	71	58	.2
01-30-1992	2.6	.6	91	28	37	1.2	77	57	.2
02-20-1992	3.3	.4	85	25	34	1.4	73	52	.2

Table 15. Water-quality data for monthly samples collected at site 03353630—Little Buck Creek near Southport, Ind., 1990–92—Continued

Date (mm-dd-yyyy)	Arsenic (μg/L)	Barium (μg/L)	Cadmium (μg/L)	Chromium (μg/L)	Copper (μg/L)	Iron (μg/L)	Lead (μg/L)	Manga-nese (μg/L)	Zinc (μg/L)
02-07-1990	<1	200	<1	2	7	700	5	70	90
03-07-1990	1	200	<1	<1	<1	400	2	80	30
04-12-1990	<1	<100	3	2	4	870	2	80	20
05-17-1990	1	<100	<1	6	12	6,100	8	110	40
06-21-1990	1	<100	<1	2	7	1,700	3	70	100
07-19-1990	1	<100	<1	1	5	320	2	40	10
08-08-1990	1	<100	<1	2	3	360	1	40	10
09-05-1990	2	<100	<1	2	4	320	2	60	20
10-11-1990	1	<100	<1	1	11	720	3	60	10
11-14-1990	<1	<100	<1	1	7	280	3	40	<10
12-12-1990	<1	100	<1	<1	5	260	1	60	<10
01-24-1991	<1	<100	<1	2	4	380	2	90	<10
02-13-1991	<1	<100	<1	<1	4	430	2	90	<10
03-13-1991	1	<100	<1	4	10	120	7	120	20
04-18-1991	<1	<100	<1	2	5	730	2	80	<10
05-08-1991	1	<100	<1	<1	4	310	2	60	<10
06-13-1991	2	<100	<1	<1	5	280	2	70	<10
07-11-1991	2	<100	<1	1	7	610	2	60	<10
08-15-1991	2	<100	<1	1	6	2,200	--	80	20
09-05-1991	1	<100	<1	2	3	270	7	40	<10
10-10-1991	<1	<100	<1	1	5	420	3	90	30
11-07-1991	1	<100	<1	<1	--	240	2	50	<10
12-11-1991	<1	<100	<1	<1	--	280	<1	50	20
01-30-1992	<1	<100	1	<1	5	290	19	70	20
02-20-1992	<1	200	<1	2	5	230	1	50	10

Table 15. Water-quality data for monthly samples collected at site 03353630—Little Buck Creek near Southport, Ind., 1990–92—Continued

Date (mm-dd-yyyy)	Mercury (µg/L)	Sediment, suspended (mg/L)	Sediment, suspended (sieve diameter percent finer than 0.062 mm)
02-07-1990	<0.1	46	61.7
03-07-1990	<.1	40	28.8
04-12-1990	<.1	37	66.3
05-17-1990	<.1	125	97.2
06-21-1990	<.1	43	92.8
07-19-1990	<.1	29	70.0
08-08-1990	<.1	72	38.7
09-05-1990	<.1	16	69.5
10-11-1990	<.1	50	56.6
11-14-1990	<.1	37	31.0
12-12-1990	<.1	4	16.1
01-24-1991	<.1	35	38.1
02-13-1991	<.1	20	51.4
03-13-1991	<.1	88	94.3
04-18-1991	<.1	32	69.2
05-08-1991	<.1	68	14.7
06-13-1991	<.1	16	62.5
07-11-1991	<.1	17	66.2
08-15-1991	<.1	41	87.0
09-05-1991	<.1	8	71.0
10-10-1991	<.1	7	100
11-07-1991	<.1	3	88.9
12-11-1991	<.1	41	28.9
01-30-1992	<.1	31	32.7
02-20-1992	<.1	51	19.6

Table 16. Water-quality data for monthly samples collected at site 03353637—Little Buck Creek near Indianapolis, Ind., 1990–92

[mm-dd-yyyy, date in month-day-year format; hhmm, hours and minutes; deg C, degree Celsius; µS/cm, microsiemen per centimeter; mg/L, milligram per liter; $CaCO_3$, calcium carbonate; E, estimated value; µm-mf, micrometer-microfiltered; mL, milliliter; --, not measured or determined; N, nitrogen; P, phosphorus; K, values estimated from non-ideal colony counts; <, less than; >, greater than; C, carbon; µg/L, milligram per liter; mm, millimeter; all concentrations reported as total constituents unless otherwise noted]

Date (mm-dd-yyyy)	Time (hhmm)	Discharge (cubic feet per second)	Temper-ature (deg C)	Specific conduct-ance (µS/cm)	Oxygen, dissolved (mg/L)	pH, field (standard units)	20-day biochemical oxygen demand (mg/L)	Alkalinity (mg/L as $CaCO_3$)
02-07-1990	0930	36	5.9	771	10.8	8.0	3.26	246
03-07-1990	1030	13	4.6	825	13.1	7.9	3.08	272
04-12-1990	1435	29	10.2	708	11.7	8.2	4.43	234
05-17-1990	1100	210	16.1	413	8.5	7.6	E7.8	154
06-21-1990	1200	20	23.1	586	7.9	7.8	4.5	189
07-19-1990	0815	4.4	21.7	785	8.2	7.8	3.4	260
08-08-1990	1100	7.5	19.7	715	9.0	7.9	1.3	267
09-05-1990	0900	3.0	20.9	783	7.4	7.9	2.1	276
10-11-1990	1030	44	11.9	589	9.4	8.1	5.0	218
11-14-1990	1415	5.4	8.3	768	13.8	7.8	2.2	294
12-12-1990	1100	11	7.5	783	11.3	8.2	2.5	311
01-24-1991	1300	17	1.2	763	12.4	8.1	1.1	281
02-13-1991	1430	36	4.9	768	11.1	8.1	3.7	277
03-13-1991	1030	390	3.2	371	12.0	7.6	E6.2	100
04-18-1991	1115	19	14.8	712	10.8	8.1	3.01	252
05-08-1991	1215	10	18.7	734	9.9	8.2	4.0	269
06-13-1991	1400	3.9	26.2	721	9.9	8.1	6.6	--
07-11-1991	1200	6.1	22.1	594	7.4	7.9	4.35	185
08-15-1991	1145	1.1	21.8	662	8.9	7.9	5.07	221
09-05-1991	1215	.09	24.6	667	11.9	7.9	2.0	--
11-07-1991	1315	2.5	4.2	756	12.4	8.1	1.95	254
12-11-1991	1235	6.9	6.4	831	11.7	8.3	2.17	252
01-30-1992	1230	9.6	3.4	899	14.4	8.7	8.23	263
02-20-1992	1200	16	4.9	861	13.6	8.4	6.57	247

Table 16. Water-quality data for monthly samples collected at site 03353637—Little Buck Creek near Indianapolis, Ind., 1990–92—Continued

Date (mm-dd-yyyy)	Fecal coliform, 0.7 μm-mf (colonies per 100 mL)	Solids residue at 105 deg C (mg/L)	Solids residue at 180 deg C, dissolved (mg/L)	Nitrogen ammonia (mg/L as N)	Nitrogen nitrite (mg/L as N)	Nitrogen ammonia plus organic (mg/L as N)	Nitrogen nitrite plus nitrate (mg/L as N)	Phosphorus (mg/L as P)	Phosphorus ortho, (mg/L as P)
02-07-1990	620	503	--	0.04	0.03	0.7	1.7	0.06	0.030
03-07-1990	87	514	--	<.01	.01	.2	1.2	.01	.013
04-12-1990	114	374	--	.02	.02	.7	1.4	.04	.013
05-17-1990	193,000	633	--	.12	.06	1.0	1.3	.15	.134
06-21-1990	8330	442	--	.05	.10	.5	3.2	.06	.048
07-19-1990	1,400	475	--	<.01	.02	.6	.90	.03	.013
08-08-1990	667	475	465	.03	.02	.6	.90	.03	.022
09-05-1990	300	531	464	.02	.01	.6	.70	.01	.012
10-11-1990	2,400	438	383	.05	.02	.6	1.1	.09	.008
11-14-1990	48	503	489	.01	<.01	.4	.40	.02	.008
12-12-1990	1,230	502	491	.05	.03	.3	.99	.04	<.010
01-24-1991	310	490	494	.08	.01	.3	1.5	.01	.020
02-13-1991	1,670	499	493	.04	.01	.6	1.3	.03	.011
03-13-1991	3,100	489	220	.17	.04	.8	1.1	.15	.121
04-18-1991	210	438	417	.02	.02	.4	.59	.02	.012
05-08-1991	715	449	443	.02	.02	.5	.66	.03	.015
06-13-1991	900	448	434	.02	.01	1.0	.54	.04	.008
07-11-1991	4,200	385	353	.04	.03	.6	.78	.07	.031
08-15-1991	3,330	460	421	.06	.04	.5	.81	.05	.016
09-05-1991	1,800	441	417	.04	.01	.3	.64	.03	.022
11-07-1991	180	519	503	.03	<.01	.3	.95	.03	.025
12-11-1991	107	604	626	.02	.01	.2	1.6	.03	--
01-30-1992	160	518	544	<.01	.01	.2	1.7	<.01	.007
02-20-1992	440	519	520	.02	.02	.4	2.2	.03	.009

Table 16. Water-quality data for monthly samples collected at site 03353637—Little Buck Creek near Indianapolis, Ind., 1990–92—Continued

Date (mm-dd-yyyy)	Carbon organic, dissolved (mg/L as C)	Carbon organic, suspended (mg/L as C)	Calcium (mg/L)	Magne-sium (mg/L)	Sodium (mg/L)	Potas-sium (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Fluoride (mg/L)
02-07-1990	3.7	0.4	85	25	45	1.8	78	48	0.2
03-07-1990	2.7	.2	93	30	41	1.4	86	53	.2
04-12-1990	4.7	.4	80	25	36	1.7	63	27	<.1
05-17-1990	5.5	4.9	49	12	17	2.6	26	20	<.1
06-21-1990	4.6	.7	67	20	26	2.5	50	39	.3
07-19-1990	3.3	.2	86	28	45	2.3	86	53	.3
08-08-1990	3.4	.3	81	24	38	2.4	56	36	.3
09-05-1990	2.9	.2	88	29	49	2.4	99	53	<.1
10-11-1990	4.6	.4	73	20	30	2.9	55	38	.1
11-14-1990	3.1	.3	86	29	46	2.0	87	47	<.1
12-12-1990	2.9	.6	98	29	43	1.8	71	44	.5
01-24-1991	2.4	.5	95	28	46	1.6	82	47	<.1
02-13-1991	2.9	.5	92	27	48	1.6	87	49	.1
03-13-1991	5.2	4.0	40	11	22	2.1	35	25	.2
04-18-1991	2.7	.3	81	25	40	1.7	71	36	<.1
05-08-1991	3.2	.3	83	26	45	1.9	74	44	.1
06-13-1991	3.5	1.1	83	28	48	2.0	84	49	.2
07-11-1991	5.2	.3	64	19	35	3.1	63	48	.2
08-15-1991	5.4	.3	75	25	43	2.6	77	47	.2
09-05-1991	2.3	.3	79	26	33	2.4	71	56	.2
11-07-1991	3.0	.3	92	28	47	2.6	100	75	.3
12-11-1991	3.0	.2	93	27	46	2.0	97	77	.3
01-30-1992	2.6	.3	96	29	58	1.7	110	68	.2
02-20-1992	3.3	.5	91	26	53	1.7	100	63	.2

Table 16. Water-quality data for monthly samples collected at site 03353637—Little Buck Creek near Indianapolis, Ind., 1990–92—Continued

Date (mm-dd-yyyy)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Manga-nese (µg/L)	Zinc (µg/L)
02-07-1990	<1	300	<1	2	24	980	34	60	30
03-07-1990	3	200	<1	<1	6	190	2	70	<10
04-12-1990	<1	<100	5	2	4	570	2	50	10
05-17-1990	3	<100	<1	9	19	8,200	14	210	60
06-21-1990	1	<100	<1	1	6	730	3	50	10
07-19-1990	1	<100	<1	<1	4	200	1	40	<10
08-08-1990	1	<100	<1	2	3	180	<1	30	<10
09-05-1990	1	100	<1	1	3	210	2	50	10
10-11-1990	2	200	<1	2	8	930	15	40	<10
11-14-1990	<1	<100	<1	2	4	280	1	40	<10
12-12-1990	<1	<100	<1	<1	4	270	2	50	<10
01-24-1991	<1	<100	<1	1	6	260	2	70	<10
02-13-1991	<1	<100	<1	<1	3	380	3	70	10
03-13-1991	2	<100	2	7	23	90	12	280	50
04-18-1991	<1	<100	<1	<1	3	210	<1	40	10
05-08-1991	<1	<100	<1	<1	6	220	2	50	10
06-13-1991	<1	100	<1	1	4	140	6	30	<10
07-11-1991	1	<100	<1	<1	5	260	<1	50	20
08-15-1991	<1	<100	<1	<1	3	130	3	30	<10
09-05-1991	<1	<100	<1	<1	2	110	5	40	10
11-07-1991	1	<100	<1	<1	--	140	<1	40	<10
12-11-1991	<1	<100	<1	<1	--	150	1	30	30
01-30-1992	<1	<100	<1	<1	6	190	1	40	10
02-20-1992	<1	<100	<1	1	5	190	3	50	<10

Table 16. Water-quality data for monthly samples collected at site 03353637—Little Buck Creek near Indianapolis, Ind., 1990–92—Continued

Date (mm-dd-yyyy)	Mercury (µg/L)	Sediment, suspended (mg/L)	Sediment, suspended (sieve diameter percent finer than 0.062 mm)
02-07-1990	<0.1	91	72.3
03-07-1990	<.1	27	78.9
04-12-1990	.2	25	76.9
05-17-1990	<.1	315	72.0
06-21-1990	<.1	27	86.6
07-19-1990	<.1	45	22.0
08-08-1990	<.1	68	19.3
09-05-1990	<.1	41	26.2
10-11-1990	<.1	43	67.7
11-14-1990	<.1	39	22.8
12-12-1990	<.1	11	57.5
01-24-1991	<.1	18	47.3
02-13-1991	<.1	24	48.0
03-13-1991	<.1	339	81.1
04-18-1991	<.1	16	75.9
05-08-1991	<.1	44	12.5
06-13-1991	<.1	21	36.0
07-11-1991	<.1	7	62.9
08-15-1991	<.1	14	37.3
09-05-1991	<.1	24	22.1
11-07-1991	<.1	7	55.9
12-11-1991	<.1	26	19.9
01-30-1992	<.1	17	31.5
02-20-1992	<.1	30	23.3

Table 17. Water-quality data for monthly samples collected at site 03352551—Little Eagle Creek at 52nd Street at Indianapolis, Ind., 1990–92

[mm-dd-yyyy, date in month-day-year format; hhmm, hours and minutes; deg C, degree Celsius; µS/cm, microsiemen per centimeter; mg/L, milligram per liter; $CaCO_3$, calcium carbonate; E, estimated value; µm-mf, micrometer-microfiltered; mL, milliliter; --, not measured or determined; N, nitrogen; P, phosphorus; K, values estimated from non-ideal colony counts; <, less than; >, greater than; C, carbon; µg/L, milligram per liter; mm, millimeter; all concentrations reported as total constituents unless otherwise noted]

Date (mm-dd-yyyy)	Time (hhmm)	Discharge (cubic feet per second)	Temperature (deg C)	Specific conductance (µS/cm)	Oxygen, dissolved (mg/L)	pH, field (standard units)	20-day biochemical oxygen demand (mg/L)	Alkalinity (mg/L as $CaCO_3$)
02-08-1990	1300	11	5.4	806	12.7	8.0	9.7	235
03-08-1990	0900	3.1	4.5	803	11.8	8.0	6.6	246
04-11-1990	1150	18	9.9	597	11.7	8.0	8.3	172
05-16-1990	1200	24	16.4	272	8.0	7.5	10.1	108
06-20-1990	0930	320	20.	213	7.3	7.45	11.1	59
07-20-1990	0800	.71	23.	703	7.3	7.9	3.2	224
08-09-1990	1215	.71	20.5	665	8.9	8.0	2.5	201
09-04-1990	0940	.51	20.5	710	7.3	7.8	3.4	216
10-12-1990	1045	5.4	11.3	630	9.7	8.0	3.6	234
11-15-1990	0950	1.3	6.3	777	11.0	8.1	2.0	280
12-13-1990	1400	3.4	6.4	721	13.2	8.3	7.2	276
01-23-1991	1015	2.6	.1	845	13.0	8.1	6.7	278
02-14-1991	0800	E7.8	2.7	795	11.3	8.0	12.2	214
03-14-1991	0945	28	2.4	566	12.2	7.6	5.9	157
04-17-1991	0815	9.1	12.5	640	9.5	8.0	3.1	219
05-09-1991	0930	1.8	16	679	8.2	7.9	3.38	244
06-12-1991	1300	1.7	23	1,290	9.4	8.0	3.6	--
07-10-1991	1015	41	22.3	349	7.3	7.7	11.4	76
08-14-1991	0910	.31	20.7	629	6.1	7.9	3.38	207
09-04-1991	1015	.65	22.1	634	6.1	7.8	4.42	254
10-09-1991	1015	.46	12.5	1,050	8.5	8.1	3.17	--
11-06-1991	1015	1.5	3.5	743	12.6	8.3	2.13	240
12-12-1991	1030	2.4	6.7	957	11.9	7.96	8.0	278
01-29-1992	1030	5.6	2.1	1,040	13.2	8.3	5.7	221
02-19-1992	1015	13	5.8	1,030	12.1	8.0	5.67	186

Table 17. Water-quality data for monthly samples collected at site 03352551—Little Eagle Creek at 52nd Street at Indianapolis, Ind., 1990–92—Continued

Date (mm-dd-yyyy)	Fecal coliform, 0.7 µm-mf (colonies per 100 mL)	Solids residue at 105 deg C (mg/L)	Solids residue at 180 deg C, dissolved (mg/L)	Nitrogen ammonia (mg/L as N)	Nitrogen nitrite (mg/L as N)	Nitrogen ammonia plus organic (mg/L as N)	Nitrogen nitrite plus nitrate (mg/L as N)	Phos-phorus (mg/L as P)	Phos-phorus ortho, (mg/L as P)
02-08-1990	370	561	--	0.97	0.04	1.5	3.0	0.03	0.016
03-08-1990	67	514	--	.57	.03	.4	2.5	<.01	.005
04-11-1990	220	409	--	.13	.06	.6	2.3	.08	.016
05-16-1990	29,000	1,590	--	.19	.12	.9	1.2	.14	.004
06-20-1990	17,000	790	--	.21	.12	.8	1.0	.16	.176
07-20-1990	420	420	--	.01	.01	.8	.8	.02	.005
08-09-1990	500	481	475	.02	.02	.9	.5	.02	.012
09-04-1990	700	536	442	.02	<.01	.5	.3	.06	.015
10-12-1990	1,770	447	420	.04	.02	.5	1.9	.08	.045
11-15-1990	90	501	500	.01	<.01	.4	1.1	<.01	.007
12-13-1990	240	482	475	.34	.04	1.4	1.7	.02	<.010
01-23-1991	380	595	548	.74	.04	4.2	2.4	<.01	.020
02-14-1991	733	539	496	3.7	.23	5.9	2.1	.03	.020
03-14-1991	370	561	--	.97	.04	1.5	3.0	.03	.016
04-17-1991	67	514	--	.57	.03	.4	2.5	<.01	.005
05-09-1991	220	409	--	.13	.06	.6	2.3	.08	.016
06-12-1991	29,000	1,590	--	.19	.12	.9	1.2	.14	.004
07-10-1991	17,000	790	--	.21	.12	.8	1.0	.16	.176
08-14-1991	420	420	--	.01	.01	.8	.8	.02	.005
09-04-1991	500	481	475	.02	.02	.9	.5	.02	.012
10-09-1991	700	536	442	.02	<.01	.5	.3	.06	.015
11-06-1991	1,770	447	420	.04	.02	.5	1.9	.08	.045
12-12-1991	90	501	500	.01	<.01	.4	1.1	<.01	.007
01-29-1992	240	482	475	.34	.04	1.4	1.7	.02	<.010
02-19-1992	380	595	548	.74	.04	4.2	2.4	<.01	.020

Table 17. Water-quality data for monthly samples collected at site 03352551—Little Eagle Creek at 52nd Street at Indianapolis, Ind., 1990–92—Continued

Date (mm-dd-yyyy)	Carbon organic, dissolved (mg/L as C)	Carbon organic, suspended (mg/L as C)	Calcium (mg/L)	Magne-sium (mg/L)	Sodium (mg/L)	Potas-sium (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Fluoride (mg/L)
02-08-1990	5.2	0.2	89	25	47	2.2	87	65	0.2
03-08-1990	4.0	.3	88	28	41	1.6	82	63	.2
04-11-1990	4.5	.6	69	19	32	1.9	58	25	<.1
05-16-1990	6.2	>5	34	7	9.3	2.3	14	14	<.1
06-20-1990	8.7	>5	22	4.9	9.6	2.6	17	18	.3
07-20-1990	4.4	.3	82	25	27	2.8	55	66	.4
08-09-1990	5.8	.3	74	22	32	3.2	64	59	.3
09-04-1990	5.3	.3	81	25	41	3.5	91	69	.1
10-12-1990	5.6	.5	80	21	30	2.7	56	52	.3
11-15-1990	3.7	.3	94	30	37	2.1	73	61	<.1
12-13-1990	3.8	.3	96	27	32	2.0	66	60	.6
01-23-1991	4.2	.3	100	29	51	2.2	100	61	<.1
02-14-1991	5.8	.3	55	15	39	1.7	120	64	.1
03-14-1991	4.6	.2	89	25	47	2.2	87	65	.2
04-17-1991	4.8	.3	88	28	41	1.6	82	63	.2
05-09-1991	4.0	.6	69	19	32	1.9	58	25	<.1
06-12-1991	5.0	>5	34	7	9.3	2.3	14	14	<.1
07-10-1991	7.8	>5	22	4.9	9.6	2.6	17	18	.3
08-14-1991	5.0	.3	82	25	27	2.8	55	66	.4
09-04-1991	5.9	.3	74	22	32	3.2	64	59	.3
10-09-1991	5.9	.3	81	25	41	3.5	91	69	.1
11-06-1991	4.5	.5	80	21	30	2.7	56	52	.3
12-12-1991	4.7	.3	94	30	37	2.1	73	61	<.1
01-29-1992	3.9	.3	96	27	32	2.0	66	60	.6
02-19-1992	4.6	.3	100	29	51	2.2	100	61	<.1

Table 17. Water-quality data for monthly samples collected at site 03352551—Little Eagle Creek at 52nd Street at Indianapolis, Ind., 1990–92—Continued

Date (mm-dd-yyyy)	Arsenic (μg/L)	Barium (μg/L)	Cadmium (μg/L)	Chromium (μg/L)	Copper (μg/L)	Iron (μg/L)	Lead (μg/L)	Manga-nese (μg/L)	Zinc (μg/L)
02-08-1990	<1	200	<1	3	6	610	25	90	30
03-08-1990	1	<100	<1	<1	4	260	2	90	20
04-11-1990	1	100	<1	3	7	2,000	2	70	70
05-16-1990	2	200	2	25	26	27,000	29	510	130
06-20-1990	2	<100	<1	19	19	20,000	21	520	140
07-20-1990	1	<100	<1	<1	4	210	1	30	20
08-09-1990	1	<100	<1	2	4	280	2	30	10
09-04-1990	1	<100	<1	<1	4	210	1	30	10
10-12-1990	1	200	<1	1	5	450	3	50	10
11-15-1990	<1	<100	<1	<1	3	280	2	40	<10
12-13-1990	<1	100	<1	<1	3	190	1	60	<10
01-23-1991	<1	<100	<1	2	4	250	2	100	10
02-14-1991	<1	<100	<1	<1	3	310	<1	40	<10
03-14-1991	<1	<100	<1	3	7	2,500	4	80	20
04-17-1991	<1	<100	<1	3	6	310	2	40	10
05-09-1991	<1	<100	<1	<1	5	180	1	60	<10
06-12-1991	1	100	<1	7	6	570	4	30	<10
07-10-1991	1	<100	<1	7	19	4,100	18	150	40
08-14-1991	1	<100	<1	<1	9	220	--	50	20
09-04-1991	1	100	<1	2	4	250	3	40	<10
10-09-1991	<1	<100	<1	10	5	470	1	40	<10
11-06-1991	5	<100	<1	<1	--	230	<1	50	<10
12-12-1991	<1	<100	<1	<1	--	250	9	60	50
01-29-1992	<1	<100	<1	<1	7	300	2	150	20
02-19-1992	<1	<100	<1	4	4	550	2	70	20

Table 17. Water-quality data for monthly samples collected at site 03352551—Little Eagle Creek at 52nd Street at Indianapolis, Ind., 1990–92—Continued

Date (mm-dd-yyyy)	Mercury (µg/L)	Sediment, suspended (mg/L)	Sediment suspended, (sieve diameter percent finer than 0.062 mm)
02-08-1990	<0.1	58	84.7
03-08-1990	<.1	27	71.9
04-11-1990	<.1	39	93.9
05-16-1990	.1	703	91.1
06-20-1990	.1	633	89.7
07-20-1990	<.1	45	30.2
08-09-1990	<.1	81	37.5
09-04-1990	<.1	11	90.0
10-12-1990	<.1	38	55.5
11-15-1990	<.1	61	29.0
12-13-1990	<.1	25	77.5
01-23-1991	<.1	18	33.1
02-14-1991	<.1	9	73.8
03-14-1991	<.1	44	91.5
04-17-1991	<.1	13	61.3
05-09-1991	<.1	35	11.4
06-12-1991	<.1	11	58.0
07-10-1991	<.1	125	74.4
08-14-1991	.1	12	60.9
09-04-1991	<.1	9	61.5
10-09-1991	<.1	10	81.4
11-06-1991	<.1	8	26.4
12-12-1991	.1	45	15.4
01-29-1992	<.1	28	47.8
02-19-1992	<.1	20	23.6

Table 18. Water-quality data for monthly samples collected at site 03353600—Little Eagle Creek at 16th Street at Speedway, Ind., 1990–92

[mm-dd-yyyy, date in month-day-year format; hhmm, hours and minutes; deg C, degree Celsius; µS/cm, microsiemen per centimeter; mg/L, milligram per liter; $CaCO_3$, calcium carbonate; E, estimated value; µm-mf, micrometer-microfiltered; mL, milliliter; --, not measured or determined; N, nitrogen; P, phosphorus; K, values estimated from non-ideal colony counts; <, less than; >, greater than; C, carbon; µg/L, milligram per liter; mm, millimeter; all concentrations reported as total constituents unless otherwise noted]

Date (mm-dd-yyyy)	Time (hhmm)	Discharge (cubic feet per second)	Temperature (deg C)	Specific conductance (µS/cm)	Oxygen, dissolved (mg/L)	pH, field (standard units)	20-day biochemical oxygen demand (mg/L)	Alkalinity (mg/L as $CaCO_3$)
02-08-1990	1000	24	3.7	765	12.2	8.1	E8.9	233
03-08-1990	1130	8.3	5.3	760	12.6	8.0	5.4	257
04-11-1990	1505	49	10.4	563	11.0	8.1	8.67	171
05-16-1990	1540	710	17.2	297	7.9	7.5	8.5	110
06-20-1990	1330	430	20.2	243	7.2	7.5	10.2	85
07-20-1990	1015	2.4	24.6	664	8.2	7.4	5.1	226
08-09-1990	0945	2.3	19.2	561	7.7	7.5	2.0	210
09-04-1990	1250	1.5	24.0	620	7.8	7.4	4.1	245
10-12-1990	1320	24	14.4	553	9.6	7.9	4.1	214
11-15-1990	1230	2.8	8.6	685	12.8	7.9	5	260
12-13-1990	1110	7.8	6.3	682	11.2	7.5	3.2	272
01-23-1991	1415	12	1.1	783	13.0	7.6	6.7	270
02-14-1991	1145	22	2.6	741	11.7	8.2	5.5	229
03-14-1991	1230	E110	4.6	491	11.7	7.7	4.9	163
04-17-1991	1015	32	15.1	607	9.8	7.8	3.85	220
05-09-1991	1130	7.8	17.1	679	10.1	7.9	3.18	251
06-12-1991	1530	2.6	28.3	657	11.5	8.0	4.8	--
07-10-1991	1330	110	22.5	310	7.0	7.2	E15.1	70
08-14-1991	1200	.99	24.3	599	6.5	7.6	4.22	203
09-04-1991	1345	3.0	22.9	369	6.3	7.2	E13.8	--
10-09-1991	1215	1.3	--	--	--	--	3.13	--
11-06-1991	1300	3.5	5.3	660	11.7	7.9	2.9	234
12-12-1991	1400	100	8.4	699	10.1	8.3	E15.9	136
01-29-1992	1300	15	2.3	1,020	15.1	8.2	K8.83	212
02-19-1992	1245	27	6.1	807	11.7	8.2	5.33	177

Table 18. Water-quality data for monthly samples collected at site 03353600—Little Eagle Creek at 16th Street at Speedway, Ind., 1990–92—Continued

Date (mm-dd-yyyy)	Fecal coliform, 0.7 μm-mf (colonies per 100 mL)	Solids residue at 105 deg C (mg/L)	Solids residue at 180 deg C, dissolved (mg/L)	Nitrogen ammonia (mg/L as N)	Nitrogen nitrite (mg/L as N)	Nitrogen ammonia plus organic (mg/L as N)	Nitrogen nitrite plus nitrate (mg/L as N)	Phos-phorus (mg/L as P)	Phos-phorus ortho, (mg/L as P)
02-08-1990	430	542	--	0.87	0.07	1.8	2.7	0.03	0.029
03-08-1990	K30	488	--	.16	.02	.9	2.3	.01	.004
04-11-1990	523	362	--	.08	.04	.6	1.9	.05	.013
05-16-1990	48,500	605	--	.14	.09	1.1	1.3	.13	.135
06-20-1990	19,250	675	--	.14	.12	.7	1.3	.12	.121
07-20-1990	667	410	--	<.01	.02	.7	.50	.03	.005
08-09-1990	460	394	383	.02	.02	.5	.40	.01	.004
09-04-1990	200	537	376	.04	<.01	.7	.40	<.01	.006
10-12-1990	1,300	393	369	.06	.02	.6	1.9	.11	.044
11-15-1990	80	444	442	.01	<.01	.4	.30	.01	.006
12-13-1990	100	469	461	.07	.02	.7	1.6	.02	<.010
01-23-1991	1,030	542	500	.74	.03	4.9	2.2	<.01	.010
02-14-1991	240	495	468	.4	.03	.8	1.8	.03	<.010
03-14-1991	2,300	345	298	.19	.05	.8	1.9	.08	.046
04-17-1991	380	388	370	.03	.03	.4	1.6	.04	.018
05-09-1991	523	438	415	.02	.05	.8	.82	.03	.009
06-12-1991	730	433	409	.02	<.01	.5	.21	.06	.008
07-10-1991	--	310	180	.16	.07	1.3	.80	.17	.053
08-14-1991	7,330	--	389	.05	.01	.6	.18	.04	.013
09-04-1991	110,000	308	281	.02	.03	.9	.35	.10	.026
10-09-1991	K10	407	372	.08	.02	.4	.3	.04	.012
11-06-1991	177	466	446	.02	<.01	.4	.64	.03	.260
12-12-1991	8,000	597	408	.18	.05	1.3	.91	.22	--
01-29-1992	60	640	632	1.1	.04	2.2	2.0	.01	.005
02-19-1992	1,500	608	498	.06	.04	.6	2.6	.06	.016

Table 18. Water-quality data for monthly samples collected at site 03353600—Little Eagle Creek at 16th Street at Speedway, Ind., 1990–92—Continued

Date (mm-dd-yyyy)	Carbon organic, dissolved (mg/L as C)	Carbon organic, suspended (mg/L as C)	Calcium (mg/L)	Magne-sium (mg/L)	Sodium (mg/L)	Potas-sium (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Fluoride (mg/L)
02-08-1990	4.0	0.4	87	24	41	2.3	79	59	0.2
03-08-1990	3.2	.3	90	27	32	1.8	70	62	.2
04-11-1990	4.8	.8	66	18	28	1.9	50	23	.2
05-16-1990	6.0	4.8	37	8	9.7	2.4	16	16	<.1
06-20-1990	6.5	>5	27	6	9.8	2.5	16	20	.4
07-20-1990	3.9	.7	79	24	23	2.5	44	59	.3
08-09-1990	4.1	.4	74	20	18	2.4	34	47	.3
09-04-1990	3.7	.5	80	23	20	2.4	40	56	.1
10-12-1990	4.3	.5	75	19	22	2.9	45	46	.2
11-15-1990	4.6	.3	86	27	29	2.4	60	58	<.1
12-13-1990	3.4	.4	97	27	27	2.0	57	56	.6
01-23-1991	4.8	.8	97	27	49	2.2	110	58	<.1
02-14-1991	3.8	.4	88	25	45	2.0	89	60	.1
03-14-1991	4.5	3.5	61	16	30	2.0	55	40	.2
04-17-1991	4.1	.7	76	21	27	1.9	48	35	.1
05-09-1991	3.9	.5	87	24	32	2.3	60	50	.2
06-12-1991	3.2	.5	83	25	32	2.3	61	61	.2
07-10-1991	6.6	1.4	34	8	13	3.1	23	28	.2
08-14-1991	4.6	.4	78	26	24	3.1	44	66	.4
09-04-1991	9.6	1.0	49	14	24	3.3	46	50	.3
10-09-1991	5.0	.4	74	21	26	2.9	52	67	.4
11-06-1991	4.6	.4	91	25	31	2.6	67	79	.3
12-12-1991	6.2	4.5	53	13	44	2.0	80	49	.2
01-29-1992	3.8	.6	94	25	98	2.9	180	73	.3
02-19-1992	4.5	.7	77	20	60	2.4	120	59	.2

Table 18. Water-quality data for monthly samples collected at site 03353600—Little Eagle Creek at 16th Street at Speedway, Ind., 1990–92—Continued

Date (mm-dd-yyyy)	Arsenic (μg/L)	Barium (μg/L)	Cadmium (μg/L)	Chromium (μg/L)	Copper (μg/L)	Iron (μg/L)	Lead (μg/L)	Manganese (μg/L)	Zinc (μg/L)
02-08-1990	<1	200	<1	3	7	1,500	10	90	30
03-08-1990	<1	200	<1	<1	<1	360	3	90	20
04-11-1990	1	100	<1	3	7	1,800	3	70	30
05-16-1990	2	<100	2	16	20	22,000	22	330	100
06-20-1990	1	<100	<1	13	20	14,000	16	350	110
07-20-1990	1	<100	<1	<1	3	310	1	90	<10
08-09-1990	1	<100	<1	1	3	330	2	80	<10
09-04-1990	1	<100	2	2	6	560	9	100	40
10-12-1990	1	<100	<1	1	5	890	2	50	20
11-15-1990	<1	<100	<1	2	3	260	1	50	<10
12-13-1990	<1	100	<1	<1	3	300	2	80	<10
01-23-1991	<1	<100	<1	2	3	260	2	80	20
02-14-1991	<1	<100	<1	1	4	430	2	80	10
03-14-1991	1	<100	<1	3	8	2,900	6	80	20
04-17-1991	<1	<100	<1	2	4	760	2	60	<10
05-09-1991	<1	<100	<1	<1	4	330	2	80	20
06-12-1991	<1	100	<1	<1	5	230	3	60	<10
07-10-1991	2	<100	<1	3	15	3,100	7	<10	20
08-14-1991	2	<100	<1	<1	3	440	--	90	<10
09-04-1991	2	<100	<1	3	5	620	8	110	20
10-09-1991	<1	<100	<1	2	5	470	4	70	<10
11-06-1991	1	<100	<1	<1	--	320	5	70	20
12-12-1991	<1	<100	<1	7	--	5,700	37	260	120
01-29-1992	<1	<100	<1	<1	10	410	5	70	30
02-19-1992	<1	<100	<1	3	7	620	3	70	20

Table 18. Water-quality data for monthly samples collected at site 03353600—Little Eagle Creek at 16th Street at Speedway, Ind., 1990–92—Continued

Date (mm-dd-yyyy)	Mercury (µg/L)	Sediment suspended (mg/L)	Sediment suspended (sieve diameter percent finer than 0.062 mm)
02-07-1990	<0.1	37	95.8
03-07-1990	<.1	45	60.21
04-12-1990	.1	42	97.7
05-17-1990	<.1	491	89.4
06-21-1990	.5	443	95.4
07-19-1990	<.1	39	63.4
08-08-1990	<.1	57	34.6
09-05-1990	<.1	50	63.5
10-11-1990	<.1	39	81.2
11-14-1990	<.1	56	43.5
12-12-1990	.1	31	74.1
01-24-1991	<.1	30	25.3
02-13-1991	<.1	18	78.7
03-13-1991	<.1	64	95.3
04-18-1991	<.1	22	76.7
05-08-1991	<.1	50	14.7
06-13-1991	<.1	13	35.4
07-11-1991	<.1	81	88.6
08-15-1991	<.1	27	39.7
09-05-1991	<.1	13	56.5
10-10-1991	<.1	15	62.2
11-07-1991	<.1	8	81.5
12-11-1991	<.1	209	91.6
01-30-1992	<.1	28	39.9
02-20-1992	<.1	45	19.3

Table 19. Water-quality data for storm-event samples collected at sites on Little Buck Creek and Little Eagle Creek near Indianapolis, Ind., 1993–94

[USGS, U.S. Geological Survey; mm-dd-yyyy, date in month-day-year format; hhmm, hours and minutes; mm, millimeter; Hg, mercury; mg/L, milligram per liter; µS/cm, microsiemen per centimeter; deg C, degree Celsius; N, nitrogen; P, phosphorus; C, carbon; --, not measured or determined; µm-mf, micrometer-microfiltered; mL, milliliter; µg/L, milligram per liter; <, less than; CN, cyanide; mm, millimeter; all concentrations reported as total constituents unless otherwise noted]

USGS station number	Station name	Date (mm-dd-yyyy)	Time (hhmm)	Discharge (cubic feet per second)	Temperature, air (deg C)	Temperature, water (deg C)	Specific conductance (µS/cm)	Barometric pressure (mm Hg)	Oxygen, dissolved (mg/L)
03353630	Little Buck Creek near Southport, Ind.	08-12-1993	1430	13	27.0	21.8	476	744	8.2
03353637	Little Buck Creek near Indianapolis, Ind.	08-12-1993	1600	36	27.0	22.4	302	744	7.8
03353551	Little Eagle Creek at 52nd Street at Indianapolis, Ind.	12-14-1993	1230	33	5.2	4.7	348	750	13.5
03353600	Little Eagle Creek at Speedway, Ind.	12-14-1993	1345	135	5.1	5.4	442	750	12.6
		04-28-1994	1320	6.5	16.6	15.2	630	760	9.3
		04-28-1994	1410	22	16.6	15.2	630	760	9.3

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	pH, field (standard units)	20-day biochemical oxygen demand (mg/L)	Fecal coliform, 0.7 µm-mf (colonies per 100 mL)	Solids residue at 180 deg C, dissolved (mg/L)	Solids residue at 105 deg C (mg/L)	Nitrogen ammonia (mg/L as N)	Nitrogen nitrite plus nitrate (mg/L as N)	Nitrogen nitrite (mg/L as N)	Phosphorus ortho, (mg/L as P)
03353630	08-12-1993	1430	8.0	E8	21,000	270	370	--	--	--	--
03353637	08-12-1993	1600	7.8	8	17,000	158	340	--	.50	--	--
03353551	12-14-1993	1230	7.9	9	1,200	255	280	.10	.59	.04	.06
03353600	12-14-1993	1345	8.0	12	2,200	312	324	.10	.65	.04	.02
	04-28-1994	1320	8.0	--	2,000	330	450	.14	.70	.06	<.01
	04-28-1994	1410	8.0	--	3,200	357	460	.22	.71	.06	.03

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Carbon organic dissolved (mg/L as C)	Carbon organic particulate (mg/L as C)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Fluoride (mg/L)	Aluminum (µg/L)	Antimony (µg/L)
03353630	08-12-1993	1430	4.9	3.0	52	17	3	20	31	24	0.3	1,200	<1
03353637	08-12-1993	1600	5.4	2.2	29	7.7	1.7	14	20	16	.2	990	<1
03353551	12-14-1993	1230	4.9	.5	53	14	1.9	18	28	34	.1	2,700	2.0
03353600	12-14-1993	1345	9.2	.6	60	17	2.3	25	39	41	.2	1,400	1.0
	04-28-1994	1320	--	.7	69	21	2.8	42	78	45	.2	390	1.0
	04-28-1994	1410	--	--	66	20	2.8	40	70	44	.2	670	1.0

Table 19. Water-quality data for storm-event samples collected at sites on Little Buck Creek and Little Eagle Creek near Indianapolis, Ind., 1993–94—Continued

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Arsenic (µg/L)	Barium (µg/L)	Beryllium (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Cyanide (mg/L as CN)	Iron (µg/L)	Lead (µg/L)	Manganese (µg/L)	Mercury (µg/L)
03353630	08-12-1993	1430	3	<100	<10	<1	<1	11	--	2,100	4	230	<0.1
03353637	08-12-1993	1600	2	<100	<10	<1	<1	7	--	1,300	8	140	<.1
03353551	12-14-1993	1230	2	<100	<10	<1	11	9	<.01	4,500	8	260	.4
03353600	12-14-1993	1345	2	<100	<10	<1	3	10	<.01	2,800	10	190	<.1
	04-28-1994	1320	2	100	<10	<1	3	10	--	730	6	110	.1
	04-28-1994	1410	2	100	<10	<1	2	15	--	1,300	4	130	.2

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Nickel (µg/L)	Selenium (µg/L)	Silver (µg/L)	Zinc (µg/L)	1,2,5,6-Dibenzanthracene (µg/L)	1,2-Diphenylhydrazine (µg/L)	2,4,6-Trichlorophenol (µg/L)	2,4-Dimethylphenol (µg/L)	2,4-Dichlorophenol (µg/L)	2,4-Dinitrophenol (µg/L)	2,4-Dinitrotoluene (µg/L)
03353630	08-12-1993	1430	4	<1	<1	20	<10	<5	<20	<5	<5	<20	<5
03353637	08-12-1993	1600	3	<1	<1	20	<10	<5	<20	<5	<5	<20	<5
03353551	12-14-1993	1230	7	<1	<1	80	<10	<5	<20	<5	<5	<20	<5
03353600	12-14-1993	1345	5	<1	<1	50	<10	<5	<20	<5	<5	<20	<5
	04-28-1994	1320	3	<1	<1	30	<10	<5	<20	<5	<5	<20	<5
	04-28-1994	1410	4	<1	<1	30	<10	<5	<20	<5	<5	<20	<5

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	2,6-Dinitrotoluene (µg/L)	2-Chloroethyl-vinylether (µg/L)	2-Chloronaphthalene (µg/L)	2-Chlorophenol (µg/L)	2-Nitrophenol (µg/L)	3,3'-Dichlorobenzidine (µg/L)	4,6-Dinitrochlorocresol (µg/L)	4-Bromophenylphenylether (µg/L)	4-Chlorophenylphenylether (µg/L)	4-Nitrophenol (µg/L)	Acenaphthene (µg/L)
03353630	08-12-1993	1430	<5	<1	<5	<5	<5	<20	<30	<5	<5	<30	<5
03353637	08-12-1993	1600	<5	<1	<5	<5	<5	<20	<30	<5	<5	<30	<5
03353551	12-14-1993	1230	<5	<1	<5	<5	<5	<20	<30	<5	<5	<30	<5
03353600	12-14-1993	1345	<5	<1	<5	<5	<5	<20	<30	<5	<5	<30	<5
	04-28-1994	1320	<5	<1	<5	<5	<5	<20	<30	<5	<5	<30	<5
	04-28-1994	1410	<5	<1	<5	<5	<5	<20	<30	<5	<5	<30	<5

Table 19. Water-quality data for storm-event samples collected at sites on Little Buck Creek and Little Eagle Creek near Indianapolis, Ind., 1993–94—Continued

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Acenaphthalene (µg/L)	Acrolein (µg/L)	Aldrin (µg/L)	Anthracene (µg/L)	Nitrobenzene (µg/L)	Benzidine (µg/L)	Benzo (a) pyrene (µg/L)	Benzo (b) fluoranthene (µg/L)	Benzo (k) fluoranthene (µg/L)	Benzo (a) anthracene (µg/L)	Benzo (ghi) perylene (µg/L)
03353630	08-12-1993	1430	<5	<20	<0.01	<5	<5	<40	<10	<10	<10	<10	<10
03353637	08-12-1993	1600	<5	<20	<.01	<5	<5	<40	<10	<10	<10	<10	<10
03353551	12-14-1993	1230	<5	<20	<.01	<5	<5	<40	<10	<10	<10	<10	<10
03353600	12-14-1993	1345	<5	<20	<.01	<5	<5	<40	<10	<10	<10	<10	<10
	04-28-1994	1320	<5	<20	<.01	<5	<5	<40	<10	<10	<10	<10	<10
	04-28-1994	1410	<5	<20	<.01	<5	<5	<40	<10	<10	<10	<10	<10

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Bis (2-chloroethoxy) methane (µg/L)	Bis (2-chloroethyl) ether (µg/L)	Bis (2-chloroisopropyl) ether (µg/L)	Bis (2-ethyl hexyl) phthalate (µg/L)	Carbophenothion (µg/L)	Chlordane (µg/L)	Chlorpyrifos (µg/L)	Chrysene (µg/L)	Hexachlorocyclopentadiene (µg/L)	4H-cyclopenta (def) phenanthrene (µg/L)
03353630	08-12-1993	1430	<5	<5	<5	<10	<0.01	<.1	0.02	<10	<5	<0.01
03353637	08-12-1993	1600	<5	<5	<5	<10	<.01	<.1	.01	<10	<5	<.01
03353551	12-14-1993	1230	<5	<5	<5	210	<.01	<.1	<.01	<10	<5	<.01
03353600	12-14-1993	1345	<5	<5	<5	450	<.01	<.1	<.01	<10	<5	<.01
	04-28-1994	1320	<5	<5	<5	<10	<.01	<.1	.01	<10	<5	<.01
	04-28-1994	1410	<5	<5	<5	<10	<.01	<.1	.01	<10	<5	<.01

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Diazinon (µg/L)	Dieldrin (µg/L)	Diethyl phthalate (µg/L)	Dimethyl-phthalate (µg/L)	Di-N-butyl-phthalate (µg/L)	Di-N-octyl-phthalate (µg/L)	Disulfoton (µg/L)	Endosulfan I (µg/L)	Endrin (µg/L)	Ethion (µg/L)	Fluoranthene (µg/L)
03353630	08-12-1993	1430	2.60	<0.01	<5	<5	<5	<10	<0.01	<0.01	<0.01	<0.01	<5
03353637	08-12-1993	1600	.31	<.01	<5	<5	<5	<10	<.01	<.01	<.01	<.01	<5
03353551	12-14-1993	1230	.01	<.01	<5	<5	<5	<10	<.01	<.01	<.01	<.01	<5
03353600	12-14-1993	1345	.04	<.01	<5	<5	<5	<10	<.01	<.01	<.01	<.01	<5
	04-28-1994	1320	.02	<.01	<5	<5	<5	<10	<.01	<.01	<.01	<.01	<5
	04-28-1994	1410	.02	<.01	<5	<5	<5	<10	<.01	<.01	<.01	<.01	<5

Table 19. Water-quality data for storm-event samples collected at sites on Little Buck Creek and Little Eagle Creek near Indianapolis, Ind., 1993–94—Continued

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Fluorene (µg/L)	Fonofos (dyfonate) (µg/L)	Hepta-chlor epoxide (µg/L)	Hepta-chlor (µg/L)	Hexa-chloro-benzene (µg/L)	Indeno (1,2,3-cd) pyrene (µg/L)	Iso-phorone (µg/L)	Lindane (µg/L)	Malathion (µg/L)	Meth-oxychlor (µg/L)
03353630	08-12-1993	1430	<5	<0.01	<0.01	<0.01	<5	<10	<5	<0.01	0.02	0.03
03353637	08-12-1993	1600	<5	<.01	<.01	<.01	<5	<10	<5	<.01	.07	<.01
03353551	12-14-1993	1230	<5	<.01	<.01	<.01	<5	<10	<5	<.01	<.01	<.01
03353600	12-14-1993	1345	<5	<.01	<.01	<.01	<5	<10	<5	<.01	<.01	<.01
	04-28-1994	1320	<5	<.01	<.01	<.01	<5	<10	<5	<.01	.01	<.01
	04-28-1994	1410	<5	<.01	<.01	<.01	<5	<10	<5	<.01	.01	<.01

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Methyl-para-thion (µg/L)	Mirex (µg/L)	N-Butyl-benzyl phthalate (µg/L)	N-Nitro-sodi-methyl-amine (µg/L)	N-Nitro-sodi-N-propyl-amine (µg/L)	N-Nitro-sodi-phe-nyl-amine (µg/L)	p,p'-DDD (µg/L)	p,p'-DDE (µg/L)	p,p'-DDT (µg/L)	Para-chloro-meta-cresol (µg/L)	Para-thion (µg/L)
03353630	08-12-1993	1430	<0.01	<0.01	<5	<5	<5	<5	<0.01	<0.01	<0.01	<30	<0.01
03353637	08-12-1993	1600	<.01	<.01	<5	<5	<5	<5	<.01	<.01	<.01	<30	<.01
03353551	12-14-1993	1230	<.01	<.01	<5	<5	<5	<5	<.01	<.01	<.01	<30	<.01
03353600	12-14-1993	1345	<.01	<.01	<5	<5	<5	<5	<.01	<.01	<.01	<30	<.01
	04-28-1994	1320	<.01	<.01	<5	<5	<5	<5	<.01	<.01	<.01	<30	<.01
	04-28-1994	1410	<.01	<.01	<5	<5	<5	<5	<.01	<.01	<.01	<30	<.01

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	PCB (µg/L)	Poly-chlorinated napthalene (µg/L)	Penta-chloro-phenol (µg/L)	Perthane (µg/L)	Phenan-threne (µg/L)	Phenol (µg/L)	Phorate (µg/L)	Pyrene (µg/L)	Toxa-phene (µg/L)	Xylene (µg/L)
03353630	08-12-1993	1430	<0.1	<0.1	<30	<0.1	<5	<5	<0.01	<5	<1	<0.2
03353637	08-12-1993	1600	<.1	<.1	<30	<.1	<5	<5	<.01	<5	<1	<.2
03353551	12-14-1993	1230	<.1	<.1	<30	<.1	<5	<5	<.01	<5	<1	<.2
03353600	12-14-1993	1345	<.1	<.1	<30	<.1	<5	<5	<.01	<5	<1	<.2
	04-28-1994	1320	<.1	<.1	<30	<.1	<5	<5	<.01	<5	<1	<.2
	04-28-1994	1410	<.1	<.1	<30	<.1	<5	<5	<.01	<5	<1	<.2

Table 19. Water-quality data for storm-event samples collected at sites on Little Buck Creek and Little Eagle Creek near Indianapolis, Ind., 1993–94—Continued

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	1,1,1-Trichloro-ethane (µg/L)	1,1,2-Trichloro-ethane (µg/L)	1,1-Di-chloro-ethane (µg/L)	1,1-Di-chloro-ethylene (µg/L)	1,1-Di-chloro-propene (µg/L)	1,2,3-Tri-chloro-propane (µg/L)	1,2-Di-bromo-ethane (µg/L)	1,2-Di-chloro-ethane (µg/L)	1,2-Di-chloro-propane (µg/L)
03353630	08-12-1993	1430	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
03353637	08-12-1993	1600	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
03353551	12-14-1993	1230	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
03353600	12-14-1993	1345	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
	04-28-1994	1320	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2
	04-28-1994	1410	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<.2

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Trans-1,2-di-chloro-ethene (µg/L)	2,2-Dichloro-propane (µg/L)	Acrylo-nitrile (µg/L)	1,2,3-Tri-chloro-benzene (µg/L)	1,2,4-Tri-chloro-benzene (µg/L)	1,2,4-Tri-methyl-benzene (µg/L)	1,3,5-Tri-methyl-benzene (µg/L)	1,3-Di-chloro-benzene (µg/L)	1,4-Di-chloro-benzene (µg/L)
03353630	08-12-1993	1430	<0.2	<0.2	<20	<0.2	<5	<0.2	<0.2	<5	<5
03353637	08-12-1993	1600	<.2	<.2	<20	<.2	<5	<.2	<.2	<5	<5
03353551	12-14-1993	1230	<.2	<.2	<20	<.2	<5	<.2	<.2	<5	<5
03353600	12-14-1993	1345	<.2	<.2	<20	<.2	<5	<.2	<.2	<5	<5
	04-28-1994	1320	<.2	<.2	<20	<.2	<5	<.2	<.2	<5	<5
	04-28-1994	1410	<.2	<.2	<20	<.2	<5	<.2	<.2	<5	<5

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Isopropyl-benzene (µg/L)	N-butyl-benzene (µg/L)	N-propyl-benzene (µg/L)	1,2-Dichloro-benzene (µg/L)	sec-Butyl-benzene (µg/L)	tert-Butyl-benzene (µg/L)	Benzene (µg/L)	Bromo-benzene (µg/L)	Bromo-form (µg/L)
03353630	08-12-1993	1430	<0.2	<0.2	<0.2	<5	<0.2	<0.2	<0.2	<0.2	<0.2
03353637	08-12-1993	1600	<.2	<.2	<.2	<5	<.2	<.2	<.2	<.2	<.2
03353551	12-14-1993	1230	<.2	<.2	<.2	<5	<.2	<.2	<.2	<.2	<.2
03353600	12-14-1993	1345	<.2	<.2	<.2	<5	<.2	<.2	.40	<.2	<.2
	04-28-1994	1320	<.2	<.2	<.2	<5	<.2	<.2	<.2	<.2	<.2
	04-28-1994	1410	<.2	<.2	<.2	<5	<.2	<.2	<.2	<.2	<.2

Table 19. Water-quality data for storm event samples collected at sites on Little Buck Creek and Little Eagle Creek near Indianapolis, Ind., 1993–94—Continued

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Carbon tetra-chloride (µg/L)	Chloro-benzene (µg/L)	Chloro-dibromo-methane (µg/L)	Chloro-ethane (µg/L)	Chloro-form (µg/L)	Cis-1,2-di-chloro-ethene (µg/L)	Cis-1,3-di-chloro-propene (µg/L)	Dibromo-chloro-propane (µg/L)	Dibromo-methane (µg/L)
03353630	08-12-1993	1430	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<1	<0.2
03353637	08-12-1993	1600	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2
03353551	12-14-1993	1230	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2
03353600	12-14-1993	1345	<.2	<.2	<.2	<.2	<.2	<.2	<.2	<1	<.2
	04-28-1994	1320	<.2	<.2	<.2	<.2	<.2	.2	<.2	<1	<.2
	04-28-1994	1410	<.2	<.2	<.2	<.2	<.2	.2	<.2	<1	<.2

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Bromo-dichloro-methane (µg/L)	Dichloro-difluoro-methane (µg/L)	1,1,1,2-Tetra-chloro-ethane (µg/L)	1,1,2,2-Tetra-chloro-ethane (µg/L)	Hexa-chloro-ethane (µg/L)	Ethyl benzene (µg/L)	Trichloro-trifluoro-ethane (µg/L)	Hexa-chloro-butadiene (µg/L)	Bromo-chloro-methane (µg/L)
03353630	08-12-1993	1430	<0.2	<0.2	<0.2	<0.2	<5	<0.2	<0.5	<5	<0.2
03353637	08-12-1993	1600	<.2	<.2	<.2	<.2	<5	<.2	<.5	<5	<.2
03353551	12-14-1993	1230	<.2	<.2	<.2	<.2	<5	<.2	<.5	<5	<.2
03353600	12-14-1993	1345	<.2	<.2	<.2	<.2	<5	<.2	<.5	<5	<.2
	04-28-1994	1320	<.2	<.2	<.2	<.2	<5	<.2	<.2	<5	<.2
	04-28-1994	1410	<.2	<.2	<.2	<.2	<5	<.2	<.2	<5	<.2

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Methyl tert-butyl ether (µg/L)	Methyl bromide (µg/L)	Methyl chloride (µg/L)	Methylene chloride (µg/L)	Naphthalene (µg/L)	O-chloro-toluene (µg/L)	P-iso-propyl-toluene (µg/L)	1,3-Di-chloro-propane (µg/L)	Styrene (µg/L)
03353630	08-12-1993	1430	<1	<0.2	<0.2	<0.2	<5	<0.2	<0.2	<0.2	<0.2
03353637	08-12-1993	1600	<1	<.2	<.2	<.2	<5	<.2	<.2	<.2	<.2
03353551	12-14-1993	1230	<1	<.2	<.2	<.2	<5	<.2	<.2	<.2	<.2
03353600	12-14-1993	1345	<1	<.2	<.2	<.2	<5	<.2	<.2	<.2	<.2
	04-28-1994	1320	.2	<.2	<.2	<.2	<5	<.2	<.2	<.2	<.2
	04-28-1994	1410	.2	<.2	<.2	<.2	<5	<.2	<.2	<.2	<.2

Table 19. Water-quality data for storm event samples collected at sites on Little Buck Creek and Little Eagle Creek near Indianapolis, Ind., 1993–94—Continued

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Tetra-chloro-ethylene (µg/L)	P-chloro-toluene (µg/L)	Toluene (µg/L)	Trans-1,3-dichloro-propene (µg/L)	Trichloro-ethylene (µg/L)	Trichloro-fluoro-methane (µg/L)	Vinyl chloride (µg/L)	Sediment, suspended (mg/L)	Sediment, suspended (sieve diameter percent finer than 0.062 mm)
03353630	08-12-1993	1430	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	124	81
03353637	08-12-1993	1600	<.2	<.2	<.2	<.2	<.2	<.2	<.2	172	60
03353551	12-14-1993	1230	<.2	<.2	<.2	<.2	<.2	<.2	<.2	177	87
03353600	12-14-1993	1345	<.2	<.2	<.2	<.2	<.2	<.2	<.2	203	78
	04-28-1994	1320	<.2	<.2	<.2	<.2	<.2	<.2	<.2	70	76
	04-28-1994	1410	<.2	<.2	<.2	<.2	<.2	<.2	<.2	72	77

Table 20. Chemical constituent data for organic constituents in streambed sediments at sites on Little Buck Creek and Little Eagle Creek near Indianapolis, Ind., August 1990

[USGS, U.S. Geological Survey; mm-dd-yyyy, date in month-day-year format; hhmm, hours and minutes; deg C, degree Celsius; µS/cm, microsiemen per centimeter; mg/L, milligram per liter; µg/Kg, microgram per kilogram; --, not measured or determined; <, less than; all concentrations reported as total constituents unless otherwise noted]

USGS station number	Station name	Date (mm-dd-yyyy)	Time (hhmm)	Temperature (deg C)	Specific conductance (µS/cm)	Oxygen, dissolved (mg/L)	pH, field (standard units)
03353630	Little Buck Creek near Southport, Ind.	08-28-1990	1415	25.2	688	8.8	8.0
03353637	Little Buck Creek near Indianapolis, Ind.	08-28-1990	1530	27.3	751	10.3	8.0
03353551	Little Eagle Creek at 52nd Street at Indianapolis, Ind.	08-28-1990	0930	23.3	678	7.2	7.1
03353600	Little Eagle Creek at Speedway, Ind.	08-28-1990	1100	25.6	588	7.7	7.7

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	1,2,5,6-Dibenz-anthracene (µg/Kg)	1,2,4-Tri-chloro-benzene (µg/Kg)	1,2-Di-chloro-benzene (µg/Kg)	1,3-Di-chloro-benzene (µg/Kg)	1,4-Di-chloro-benzene (µg/Kg)	2,4,6-Tri-chloro-phenol (µg/Kg)	2,4-Di-chloro-phenol (µg/Kg)	2,4-Di-nitro-phenol (µg/Kg)	2,4-Dinitro-toluene (µg/Kg)
03353630	08-28-1990	1415	<400	<200	<200	<200	<200	<600	<200	<600	<200
03353637	08-28-1990	1530	<400	<200	<200	<200	<200	<600	<200	<600	<200
03353551	08-28-1990	0930	<400	<200	<200	<200	<200	<600	<200	<600	<200
03353600	08-28-1990	1100	<400	<200	<200	<200	<200	<600	<200	<600	<200

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	2-(2,4-Dichloro-phenoxy) propanoic acid	2,6-Dinitro-toluene (µg/Kg)	2-Chloro-naphthalene (µg/Kg)	2-Chloro-phenol (µg/Kg)	2-Nitro-phenol (µg/Kg)	4,6-Di-nitro-chloro-cresol (µg/Kg)	4-Bromo-phenyl-phenyl-ether (µg/Kg)	4-Chloro-phenyl-phenyl-ether (µg/Kg)	4-Nitro-phenol (µg/Kg)	Acenaph-thene (µg/Kg)
03353630	08-28-1990	1415	<200	<200	<200	<200	<200	<600	<200	<200	<600	<200
03353637	08-28-1990	1530	<200	<200	<200	<200	<200	<600	<200	<200	<600	<200
03353551	08-28-1990	0930	<200	<200	<200	<200	<200	<600	<200	<200	<600	<200
03353600	08-28-1990	1100	<200	<200	<200	<200	<200	<600	<200	<200	<600	<200

Table 20. Chemical constituent data for organic constituents in streambed sediments at sites on Little Buck Creek and Little Eagle Creek near Indianapolis, Ind., August 1990—Continued

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Acenaph-thalene (µg/Kg)	Aldrin (µg/Kg)	Anthra-cene (µg/Kg)	Benzo(a) anthracene (µg/Kg)	Benzo (a) pyrene (µg/Kg)	Benzo (b) fluor-anthene (µg/Kg)	Benzo (k) fluor-anthene (µg/Kg)	Benzo (ghi) perylene (µg/Kg)	Bis (2-chloro-ethoxy) methane (µg/Kg)	Bis (2-chloro-ethyl) ether (µg/Kg)
03353630	08-28-1990	1415	<200	<0.1	<200	<400	<400	<400	<400	<400	<200	<200
03353637	08-28-1990	1530	<200	<.1	<200	<400	<400	<400	<400	<400	<200	<200
03353551	08-28-1990	0930	<200	<.1	<200	<400	<400	<400	<400	<400	<200	<200
03353600	08-28-1990	1100	<200	.4	<200	<400	400	<400	<400	800	<200	<200

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Bis (2-chloro-isopropyl) ether (µg/Kg)	Bis (2-ethyl-hexyl) phthalate (µg/Kg)	Chlor-dane (µg/Kg)	Chrysene (µg/Kg)	Diazinon (µg/Kg)	Dieldrin (µg/Kg)	Diethyl phthalate (µg/Kg)	Dimethyl-phthalate (µg/Kg)	Di-N-butyl-phthalate (µg/Kg)	Di-N-octyl-phthalate (µg/Kg)
03353630	08-28-1990	1415	<200	<200	2	<400	5.8	0.4	<200	<200	<200	<400
03353637	08-28-1990	1530	<200	<200	11	<400	2.8	.5	<200	<200	<200	<400
03353551	08-28-1990	0930	<200	<200	4	<400	3.5	1.2	<200	<200	<200	<400
03353600	08-28-1990	1100	<200	<200	29	800	2.4	2.0	<200	<200	<200	<400

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Endo-sulfan I (µg/Kg)	Endrin (µg/Kg)	Ethion (µg/Kg)	Fluor-anthene (µg/Kg)	Fluorene (µg/Kg)	Hepta-chlor epoxide (µg/Kg)	Heptachlor (µg/Kg)	Hexa-chloro-benzene (µg/Kg)	Hexa-chloro-butadiene (µg/Kg)	Hexa-chloro-cyclo-penta-diene (µg/Kg)
03353630	08-28-1990	1415	<0.1	<0.1	<0.1	<200	<200	<0.1	<0.1	<200	<200	<200
03353637	08-28-1990	1530	<.1	<.1	<.1	<200	<200	.1	<.1	<200	<200	<200
03353551	08-28-1990	0930	<.1	<.1	<.1	<200	<200	.1	<.1	<200	<200	<200
03353600	08-28-1990	1100	<1	<1	<.1	600	<200	<1	<1	<200	<200	<200

Table 20. Chemical constituent data for organic constituents in streambed sediments at sites on Little Buck Creek and Little Eagle Creek near Indianapolis, Ind., August 1990—Continued

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	Hexa-chloro-ethane (µg/Kg)	Indeno (1,2,3-CD) pyrene (µg/Kg)	Isophorone (µg/Kg)	Lindane (µg/Kg)	Malathion (µg/Kg)	Meth-oxychlor (µg/Kg)	Methyl-parathion (µg/Kg)	Methyl-trithion (µg/Kg)	Mirex (µg/Kg)	Naphtha-lene (µg/Kg
03353630	08-28-1990	1415	<200	<400	<200	<0.1	0.2	<1	<0.1	<0.1	<0.1	<200
03353637	08-28-1990	1530	<200	<400	<200	<.1	.2	<1	<.1	<.1	<.1	<200
03353551	08-28-1990	0930	<200	<400	<200	<.1	.1	<1	<.1	<.1	<.1	<200
03353600	08-28-1990	1100	<200	800	<200	<1.0	.1	<10	<.1	<.1	<1.0	<200

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	N-Butyl-benzyl phthalate (µg/Kg)	Nitro-benzene (µg/Kg)	N-Nitro-sodi-methyl-amine (µg/Kg)	N-Nitro-sodi-N-pro-pylamine (µg/Kg)	N-Nitro-sodi-phe-nylamine (µg/Kg)	p,p'-DDD (µg/Kg)	p,p'-DDE (µg/Kg)	p,p'-DDT (µg/Kg)	Para-chloro-meta-cresol (µg/Kg)	Parathion (µg/Kg)
03353630	08-28-1990	1415	<200	<200	<200	<200	<200	0.1	0.1	<0.1	<600	<0.1
03353637	08-28-1990	1530	<200	<200	<200	<200	<200	.2	.2	.1	<600	<.1
03353551	08-28-1990	0930	<200	<200	<200	<200	<200	.1	<.1	<.1	<600	<.1
03353600	08-28-1990	1100	<200	<200	<200	<200	<200	<1.0	<1.0	<1.0	<600	<.1

USGS station number	Date (mm-dd-yyyy)	Time (hhmm)	PCB (µg/Kg)	Poly-chlorinated napthalene (µg/Kg)	Penta-chloro-phenol (µg/Kg)	Perthane (µg/Kg)	Phenan-threne (µg/Kg)	Phenol (µg/Kg)	Pyrene (µg/Kg)	Toxaphene (µg/Kg)	Trithion (µg/Kg)
03353630	08-28-1990	1415	<1	<1	<600	<1	<200	<200	<200	<10	<0.1
03353637	08-28-1990	1530	<1	<1	<600	<1	<200	<200	<200	<10	<.1
03353551	08-28-1990	0930	<1	<10	<600	<1	<200	<200	<200	<10	<.1
03353600	08-28-1990	1100	3	<10	<600	<10	800	<200	400	<10	<.1

Table 21. Concentrations of metals and total organic carbon in streambed sediments at sites on Little Buck Creek and Little Eagle Creek near Indianapolis, Ind., August 1990

[USGS, U.S. Geological Survey; mm, millimeter; %, percent; ppm, part per million]

Station name	USGS station number	Size fraction of sample (mm)	Percent of sample	Aluminum (% by weight)	Antimony (ppm)	Arsenic (ppm)	Cadmium (ppm)	Chromium (ppm)	Cobalt (ppm)	Copper (ppm)
Little Buck Creek near Southport, Ind.	03353630	< 2	98	3.4	0.1	3.9	0.6	24	5	4
		< 63	2	5.3	.8	19.6	1	63	13	27
Little Buck Creek near Indianapolis, Ind.	03353637	< 2	96	2.9	.1	3.3	.5	21	5	5
		< 63	4	4.6	.6	11.2	1.1	51	11	27
Little Eagle Creek at 52nd Street at Indianapolis, Ind.	03353551	< 2	99	2.9	.4	7.4	.3	29	6	6
		< 63	1	5.5	.8	17	.8	68	16	28
Little Eagle Creek at Speedway, Ind.	03353600	< 2	98	2.9	.3	3.6	.5	28	5	7
		< 63	2	4.4	.7	10.3	1.1	52	11	30

USGS station number	Size fraction of sample (mm)	Iron (% by weight)	Lead (ppm)	Manganese (% by weight)	Mercury (ppm)	Nickel (ppm)	Selenium (ppm)	Silver (ppm)	Titanium (% by weight)	Zinc (ppm)	Total organic carbon (% by weight)
03353630	< 2	1.3	7	0.04	0.01	10	0.2	< 0.1	0.13	24	0.2
	< 63	3.3	30	.12	.07	34	.7	< 0.1	.36	130	2.6
03353637	< 2	1.3	8	.04	.02	10	.1	< 0.1	.15	27	.2
	< 63	2.7	36	.08	.07	28	.6	.3	.31	130	2.2
03353551	< 2	2.3	11	.06	.02	12	.3	.3	.27	52	.7
	< 63	3.5	32	.11	<.01	42	1	.4	.34	124	2.7
03353600	< 2	1.4	36	.04	.01	12	.4	<.1	.16	40	.1
	< 63	2.6	50	.07	.09	29	.9	.1	.30	157	2.8

STREAMFLOW, SURFACE-WATER QUALITY, AND QUALITY OF STREAMBED SEDIMENTS IN LITTLE BUCK CREEK AND LITTLE EAGLE CREEK, INDIANAPOLIS, INDIANA, 1990–94—U.S. Geological Survey WRIR Report 00-4289

Printed on recycled paper