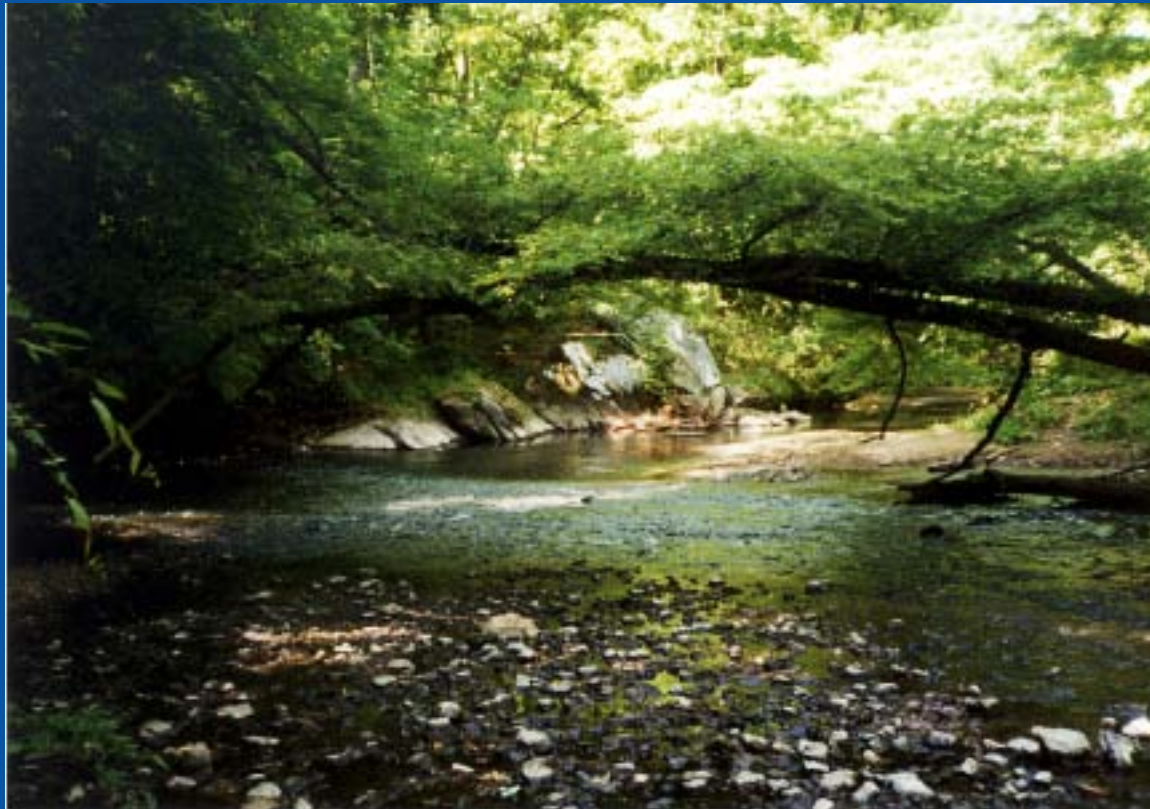


In cooperation with the
National Park Service

Water Quality, Sediment Quality, and Stream-Channel Classification of Rock Creek, Washington, D.C., 1999-2000

Water-Resources Investigations Report 02-4067



Cover. Photo of Rock Creek at Sherrill Drive, Washington, D.C., May 21, 1999

[Cover photo and photos in the report were taken by Edward J. Doheny of the U.S. Geological Survey on May 21, 1999 at Sherrill Drive as part of the documentation for the Rosgen stream-channel classification of Rock Creek.]

Water Quality, Sediment Quality, and Stream-Channel Classification of Rock Creek, Washington, D.C., 1999-2000

by Anita L. Anderson, Cherie V. Miller,¹ Lisa D. Olsen, Edward J. Doheny, and Daniel J. Phelan

¹*Corresponding author.*

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In cooperation with the
National Park Service

U.S. Department of the Interior

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Conversion Factors and Vertical Datum

	Multiply	By	To obtain
	inch (in.)	2.54	centimeter
	inch (in.)	25.4	millimeter
	foot (ft)	0.3048	meter
	mile (mi)	1.609	kilometer
	acre	4,047	square meter
	acre	0.004047	square kilometer
	square mile (mi ²)	259	hectare
	square mile (mi ²)	2.59	square kilometer
	cubic foot per second (ft ³ /s)	0.02832	cubic meter per second
	pound (lb)	0.4536	kilogram
	ton, short (2,000 lb)	907.2	kilogram

Temperatures in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) by using the following equation:

$$^{\circ}\text{F} = (^{\circ}\text{C} \times 1.8) + 32$$

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

Chemical concentration in water is expressed in milligrams per liter (mg/L) or micrograms per liter (µg/L).

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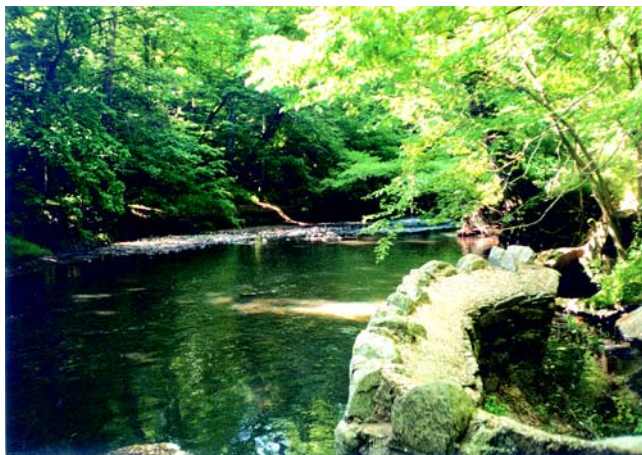
Abstract

Rock Creek Park is within the National Capital Region in Washington, D.C., and is maintained by the National Park Service. Part of Montgomery County, Maryland, and part of the District of Columbia drain into Rock Creek, which is a tributary of the Potomac River. Water quality in Rock Creek is important to biotic life in and near the creek, and in the Potomac River Basin and the Chesapeake Bay. The water quality of the Rock Creek Basin has been affected by continued urban and agricultural growth and development. The U.S. Geological Survey, in cooperation with the National Park Service, investigated water quality and sediment quality in Rock Creek over a 2-year period (1998–2000), and performed a stream-channel classification to determine the distribution of bottom sediment in Rock Creek.

This report presents and evaluates water quality and bottom sediment in Rock Creek for water years 1999 (October 1, 1998 to September 30, 1999) and 2000 (October 1, 1999 to September 30, 2000). A synoptic surface-water assessment was conducted at five stations from June 23 to June 25, 1999, a temporal surface-water assessment was conducted at one station from February 18, 1999 to September 26, 2000, and bed-sediment samples were collected and assessed from three stations from August 17 to August 19, 1999. The synoptic surface-water assessment included pesticides (parent compounds and selected transformation products), field parameters, nutrients, and major ions. The temporal surface-water assessment included pesticides (parent compounds and selected transformation products) and field parameters. The bed-sediment assessment included trace elements and organic compounds (including low- and high-molecular weight polycyclic aromatic hydrocarbons, polychlorinated biphenyls, pesticides, and phtha-

lates). Some, but not all, of the pesticides known to be used in the area were included in the synoptic water-quality assessment, the temporal water-quality assessment, and the bed-sediment assessment. In addition to the water-quality and sediment-quality assessments, a Rosgen stream-channel classification was performed on a 900-foot-long segment of Rock Creek.

In the synoptic water-quality assessment, two pesticides were found to be above published criteria for the protection of aquatic life. In the temporal water-quality assessment, four pesticides were found to be above criteria for the protection of aquatic life. In the bed-sediment assessment, 8 trace elements, 12 polycyclic aromatic hydrocarbons, 6 pesticides or transformation products, 1 phthalate compound, and total polychlorinated biphenyls were found to be above criteria for the protection of aquatic life. In the Rosgen classification, a comparison to a previous classification for this segment showed an increase in sands and other fine-grained sediments in the creek bed.



Introduction

Rock Creek Park is an urban park maintained by the National Park Service (NPS) and is located within the National Capital Region, Washington, D.C. (fig. 1). Rock Creek Park is approximately 9.3 mi (miles) long and up to 1 mi wide, and comprises 1,754 acres at the lower end of the Rock Creek Basin, which is a subbasin of the Potomac River. The total length of Rock Creek (in Maryland and Washington, D.C.) is approximately 33 mi of meandering stream (fig. 1). The creek flows from its source near Laytonsville, Maryland to the Potomac River in Washington, D.C. Approximately 60 mi² (square miles) of its drainage basin are in Montgomery County, Maryland, and 16 mi² are in Washington, D.C. Rock Creek Park extends from the Maryland–Washington D.C. boundary downstream to the confluence of Rock Creek and the Potomac River.

Two park areas, Rock Creek Park and the Rock Creek and Potomac Parkway, make up the study area. U.S. Geological Survey (USGS) sampling station number 01648998 is located near Q Street and the Rock Creek and Potomac Parkway. All other sampling stations are located in Rock Creek Park (fig. 2). In this report, the two park areas are referred to collectively as “Rock Creek Park.”

Pesticides used on the Rock Creek Golf Course and in Rock Creek Park are controlled by NPS. Ongoing growth and development in the Washington, D.C. area have led to increased concentrations (above background levels) of nutrients, pesticides, and toxic and hazardous materials in streamwater and sediments (Donnelly and Ferrari, 1998). Intensive development in Montgomery County, Maryland has caused an increase in the use of pesticides, fertilizers, and other toxic and hazardous materials in the Rock Creek Basin (Maryland Department of Agriculture, 1993, 1996, 1999). Although pesticides are beneficial for controlling unwanted organisms, they may adversely affect aquatic life and human health. Many pesticides are soluble in water and can enter surface-water bodies in dissolved form, either in storm runoff or through ground-water discharge. Some pesticides can bind to soil particles, which may be transported to surface-water bodies through soil erosion. Pesticides bound to soil particles can remain suspended in the water column, or become incorporated into bed sediment after settling.

The U.S. Environmental Protection Agency (USEPA) has established criteria for the protection of aquatic life, but only for a limited list of contaminants (U.S. Environmental Protection Agency, 1999). Other sources of criteria for water quality and sediment quality include the Canadian water-quality and sediment-quality guidelines for the protection of aquatic life (Canadian Council of Ministers of the Environment, 1999), the Great Lakes Criteria for the Protec-

tion of Aquatic Life (International Joint Commission United States and Canada, 1989), and Sediment Assessment Guidelines for Florida Coastal Waters (MacDonald, 1994). The USEPA has also established maximum contaminant levels (MCLs) for drinking water (U.S. Environmental Protection Agency, 2001). All of these criteria provide suggested threshold levels of selected contaminants, which are the lowest levels where probable effects to aquatic life and human health may occur, and chronic levels, for which effects are less likely but may occur over longer time scales (after years of exposure). Water-quality and sediment-quality data assessed in this study were compared to established guidelines, including drinking-water standards, even though Rock Creek is not used as a source of drinking water.

Purpose and Scope

The purpose of this report is to provide baseline water-quality data needed by park managers to plan protection strategies for Rock Creek Park. A synoptic surface-water assessment was conducted from June 23, 1999 to June 25, 1999, a temporal surface-water assessment was conducted from February 18, 1999 to September 26, 2000, and bed-sediment samples were collected from August 17, 1999 to August 19, 1999. The synoptic surface-water assessment included pesticides (parent compounds and selected transformation products), field parameters, nutrients, and major ions. The temporal surface-water assessment included pesticides (parent compounds and selected transformation products) and field parameters. The bed-sediment assessment included trace elements and organic compounds, including low- and high-molecular-weight polycyclic aromatic hydrocarbons (PAHs), total polychlorinated biphenyls (PCBs), pesticides (parent compounds and selected transformation products), and phthalates. Some, but not all, of the pesticides known to be used in the area were included in the synoptic water-quality assessment, the temporal water-quality assessment, and the bed-sediment assessment. In addition to the water-quality and sediment-quality assessments, a Rosgen stream classification was performed on a 900-ft (foot) segment of Rock Creek (fig. 2).

Samples analyzed in this report were collected from seven locations along Rock Creek. Synoptic water-quality samples were collected from five locations to determine the baseline water quality of the creek. Temporal water-quality samples were collected 16 times from a single location over a period of 20 months (during water years 1999 and 2000)^A, and included base-flow and stormflow samples. Bed-sediment samples were collected from three locations along Rock Creek to determine the accumulation of trace elements and organic compounds in the creek bed. Sample-collection dates, station identification numbers, and sampling locations are shown in table 1.

^A. A water year is defined as October 1 to September 30 of any given year.

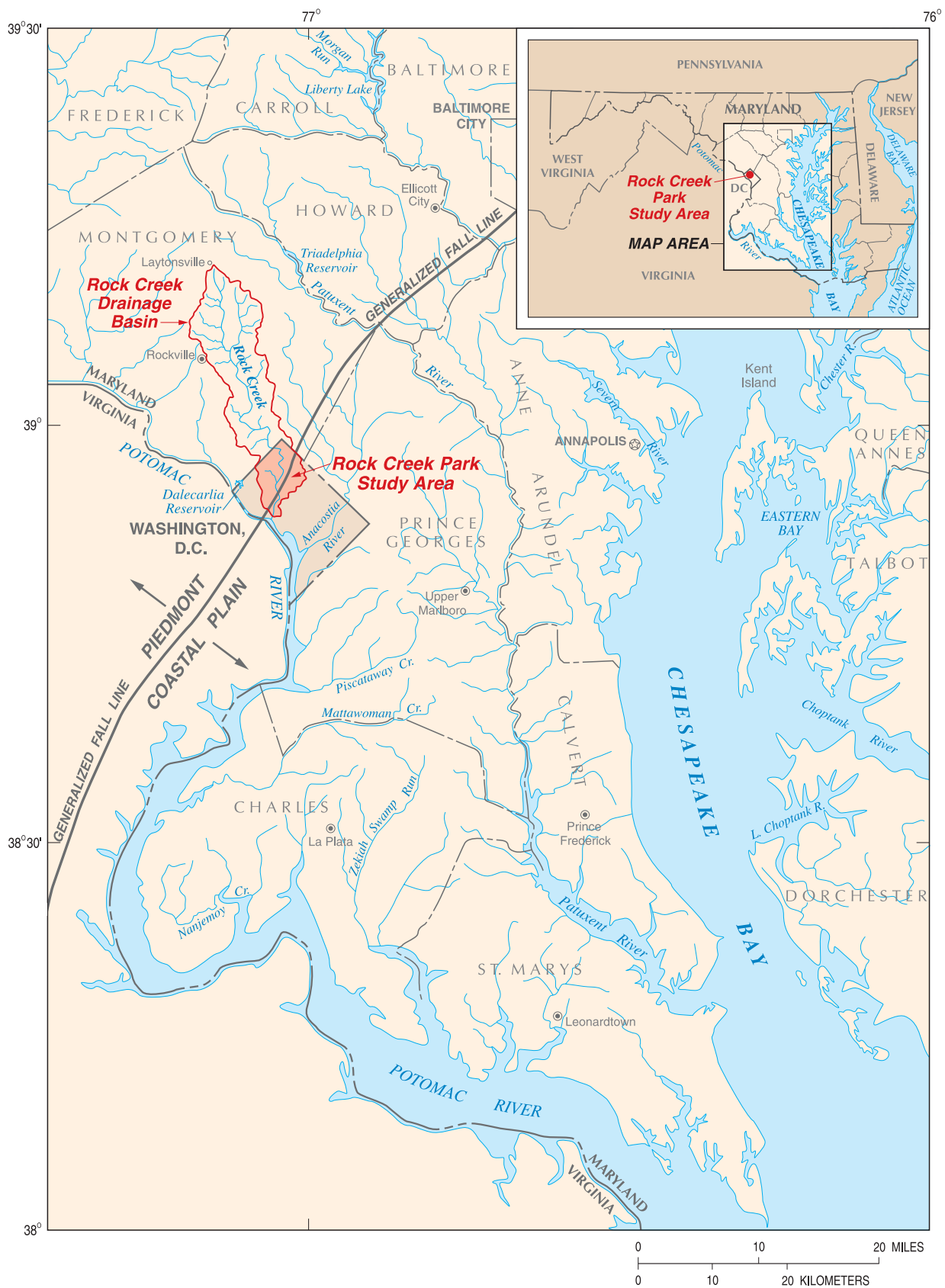


Figure 1. Location of Rock Creek drainage basin and Rock Creek Park study area, Washington, D.C.

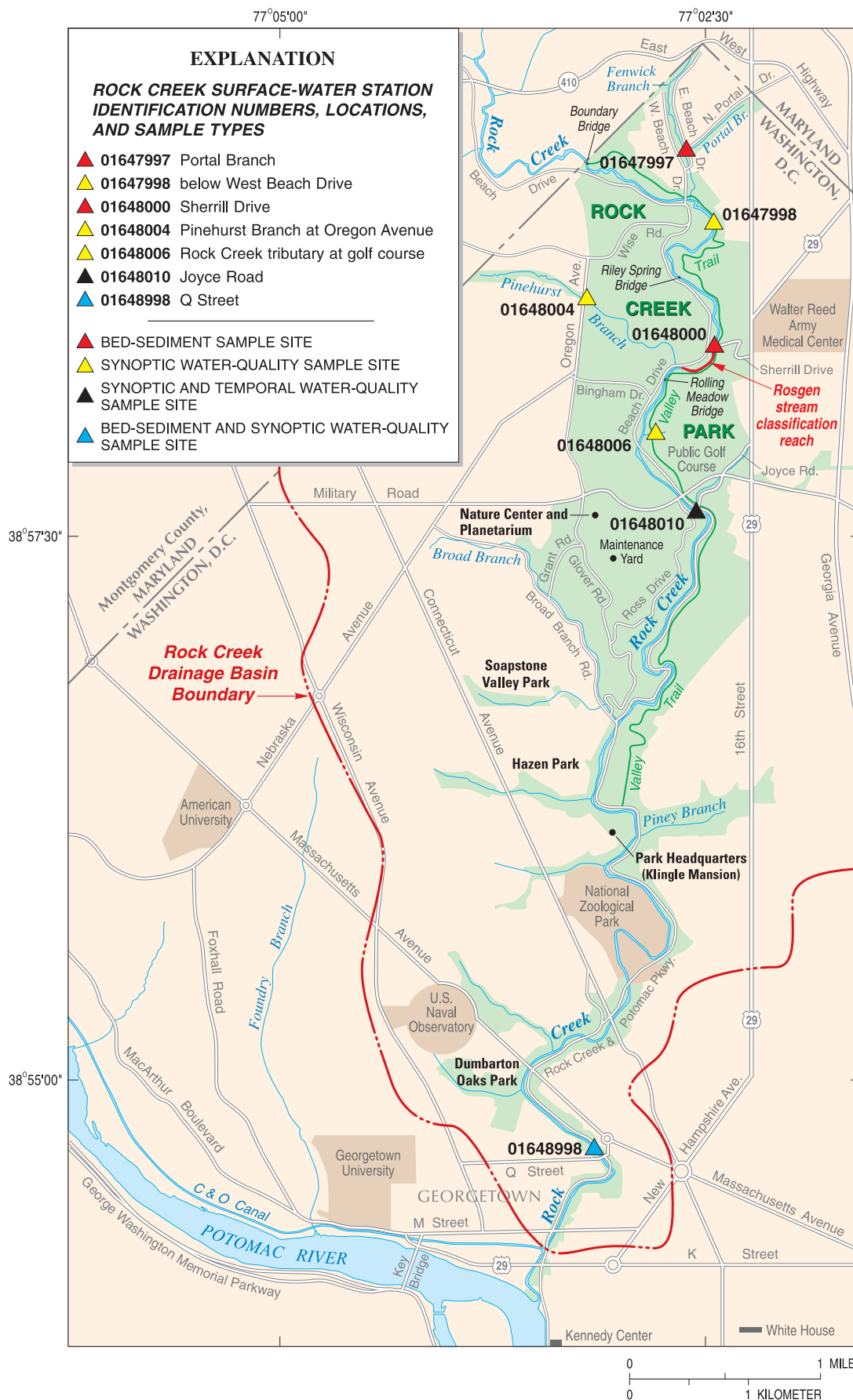


Figure 2. Locations of surface-water stations within the Rock Creek Park study area, Washington, D.C.

Table 1. *Sample-collection dates, station identification numbers, and locations for synoptic water-quality, temporal water-quality, and bed-sediment samples collected from Rock Creek, Washington, D.C., during water years 1999 and 2000*

[° ' " , degrees, minutes, seconds]

Date	Location	Station identification number	Latitude (° ' ")	Longitude (° ' ")	U.S. Geological Survey laboratory schedule	Sample type
Synoptic water-quality samples						
06/23/1999	below West Beach Drive	01647998	38 58 58	077 02 24	2001, 2050, 2701, 2702	pesticides, nutrients, major ions
06/24/1999	Pinehurst Branch at Oregon Avenue	01648004	38 58 34	077 03 07	2001, 2050, 2701, 2702	pesticides, nutrients, major ions
06/24/1999	Rock Creek tributary at Golf Course	01648006	38 58 00	077 02 46	2001, 2050, 2701, 2702	pesticides, nutrients, major ions
06/25/1999	Joyce Road	01648010	38 51 36	077 02 31	2001, 2050, 2701, 2702	pesticides, nutrients, major ions
06/23/1999	Q Street	01648998	38 54 41	077 03 07	2001, 2050, 2701, 2702	pesticides, nutrients, major ions
Water Year 1999 temporal water-quality samples						
02/18/1999	Joyce Road - winter flood	01648010	38 51 36	077 02 31	2001, 2050	pesticides
03/09/1999	Joyce Road - winter base flow	01648010	38 51 36	077 02 31	2001, 2050	pesticides
05/04/1999	Joyce Road - spring base flow	01648010	38 51 36	077 02 31	2001, 2050	pesticides
05/23/1999	Joyce Road - spring flood 1	01648010	38 51 36	077 02 31	2001, 2050	pesticides
05/24/1999	Joyce Road - spring flood 2	01648010	38 51 36	077 02 31	2001, 2050	pesticides
05/24/1999	Joyce Road - spring flood 3	01648010	38 51 36	077 02 31	2001, 2050	pesticides
07/14/1999	Joyce Road - summer base flow	01648010	38 51 36	077 02 31	2001, 2050	pesticides
Water Year 2000 temporal water-quality samples						
10/13/1999	Joyce Road - fall base flow	01648010	38 51 36	077 02 31	2001, 2050	pesticides
01/10/2000	Joyce Road - winter storm	01648010	38 51 36	077 02 31	2001, 2050	pesticides
02/09/2000	Joyce Road - winter base flow	01648010	38 51 36	077 02 31	2001, 2050	pesticides
03/21/2000	Joyce Road - spring storm	01648010	38 51 36	077 02 31	2001, 2050	pesticides
05/16/2000	Joyce Road - spring base flow	01648010	38 51 36	077 02 31	2001, 2050	pesticides
06/22/2000	Joyce Road - summer storm	01648010	38 51 36	077 02 31	2001, 2050	pesticides
07/26/2000	Joyce Road - summer storm	01648010	38 51 36	077 02 31	2001, 2050	pesticides
09/11/2000	Joyce Road - fall base flow	01648010	38 51 36	077 02 31	2001, 2050	pesticides
09/26/2000	Joyce Road - fall storm	01648010	38 51 36	077 02 31	2001, 2050	pesticides
Bed-sediment samples						
08/19/1999	Portal Branch	01647997	38 59 22	077 02 33	2400, 2500	trace elements, organics
08/18/1999	Sherrill Drive	01648000	38 58 21	077 02 25	2400, 2500	trace elements, organics
08/17/1999	Q Street	01648998	38 54 41	077 03 07	2400, 2500	trace elements, organics

Previous Investigations

An early report on water quality in Rock Creek (Sherman and Horner, 1935) documented progressive contamination in Rock Creek from the Maryland boundary to the mouth of the Potomac River. Many of Sherman and Horner's recommendations were implemented in later years, and stream conditions seemed to be improving (CH2M Hill, 1979). A 1966 investigation by the Federal Water Pollution Control Administration described the water quality of Rock Creek and the effects of waste outfalls in Montgomery County, Maryland and Washington, D.C., and showed high counts of total coliforms, fecal coliforms, and fecal streptococci in the lower Rock Creek drainage basin (CH2M Hill, 1979).

The effects of urbanization on streamflow and sediment transport in the Rock Creek and Anacostia River Basins of Montgomery County from 1962 to 1974 were described by Yorke and Herb (1978). They reported large amounts of suspended sediment transported from construction sites, and evaluated the effectiveness of sediment-control practices in areas undergoing development. At the time, average annual yields of suspended sediment calculated for construction sites ranged from 7 to 100 tons per acre.

A stormwater and water-quality management study by CH2M Hill (1977) described streams in Montgomery County that failed to meet Maryland water-quality criteria for water-contact recreation and aquatic life for each major branch or tributary to Rock Creek. An extensive basin conservation study by CH2M Hill (1979) described the flood hydrology, erosion and flood-control strategies, and plans for water-quality assessment and management within the Rock Creek Basin.

From 1992 to 1996, the USGS performed a basin-wide assessment of the occurrence of pesticides in surface waters in the Potomac River Basin (Ator and others, 1998) as part of the National Water-Quality Assessment (NAWQA) program. This study determined that the concentrations of pesticides and nutrients in streams of the Potomac River Basin were among the highest in the Nation at various sites, and were generally related to agricultural or urban/suburban land use in the contributing basins. However, the concentrations of pesticides in streams and ground water of the Potomac River Basin measured during the NAWQA assessment were generally not threatening to human health or most ecosystems, based on 1998 standards. Stream habitat and fish communities were found to be most degraded in streams draining intensively agricultural or urban/suburban areas (Ator and others, 1998). Although the Rock Creek Basin is within the Potomac River Basin, none of the sites studied during the 1998 NAWQA assessment were within the Rock Creek Basin.

In 1999, ground- and surface-water samples were collected in the upper Rock Creek Basin of Montgomery County and described by Duigon and others (2000). The effect of ground water on nitrate loads to streams was described, and nitrate concentrations were appreciably higher in ground-water samples in which atrazine was present at concentrations greater than 0.1 µg/L (micrograms per liter)

(Duigon and others, 2000).

The Montgomery County Department of Environmental Protection (DEP) Streams and Basin Program evaluated the general health of county waters and biological habitat in 1996, and determined that each major branch or tributary to Rock Creek in Montgomery County failed to meet Maryland water-quality criteria (Montgomery County Department of Environmental Protection, 1997). The lower Rock Creek drainage basin drains directly into the Rock Creek study area, and includes four sub-basins. The Lower Mainstem East-West Highway sub-basin had a preliminary sub-basin/stream condition of "fair," the Donnybrook Tributary had a preliminary sub-basin/stream condition of "poor," the Coquelin Run had a preliminary sub-basin/stream condition of "fair," and the Lower Mainstem had a sub-basin/stream condition of "poor" (Montgomery County Department of Environmental Protection, 1997). The Lower Mainstem and Donnybrook Tributary had been assigned "poor" stream conditions because of excessive scouring, bank stability problems, and excessive sediment deposition (Montgomery County Department of Environmental Protection, 1997).

Many programs are currently (2002) underway in Montgomery County to analyze and improve water quality. These include a basin restoration feasibility study by DEP, a similar study by the city of Rockville, and a restoration effort by the National Naval Medical Center to restore Stoney Creek, which is a tributary to Rock Creek that flows through the Federal property where the medical center is located (Montgomery County Department of Environmental Protection, 1997).

After progressive contamination of Rock Creek from the Maryland boundary to the mouth of the Potomac River was reported in 1935, conditions were believed to have improved (Aalto and others, 1969; Maryland Department of Agriculture, 1993). Some studies (Yorke and Herb, 1978; CH2M Hill, 1979) showed that water-quality and sedimentation problems remained, however, and additional studies to assess the water quality in Rock Creek have since been conducted.

Current Investigation

The USGS began a study, in cooperation with NPS, to determine the water and sediment quality of Rock Creek in February 1999. Synoptic water-quality, temporal water-quality, and bed-sediment samples were collected from February 1999 through September 2000. Quality-control samples were also collected to evaluate the quality of sampling methods. Constituents analyzed for the study included PAHs, PCBs, pesticides, phthalates, and trace elements.

On May 18, 2000, a fish-kill event occurred in Rock Creek that was under investigation by USEPA as of August 2000. Data from subsequent USEPA water-quality sampling were being analyzed and investigated to determine the cause of this event. A surface-water sample was collected by USGS on May 16, 2000 from station 01648010 (fig. 2). Based on the data from this sample, the pesticides

analyzed during this study are not believed to have caused the fish kill.

Description of Study Area

The Rock Creek study area (fig. 1) is a heavily urbanized basin within the Potomac River Basin. The creek channel winds approximately 33 mi from its source near Laytonsville, Maryland to the Potomac River (CH2M Hill, 1979). Rock Creek and the Chesapeake and Ohio (C&O) Canal converge 0.25 mi upstream from the Potomac River (fig. 2). The C&O Canal and adjacent lands comprise the Chesapeake and Ohio Canal National Historic Park, which extends 184 mi upstream from its confluence with Rock Creek northward to Cumberland, Maryland, paralleling the Potomac River. The C&O Canal drains a small part of southern Montgomery County, which is not within the Rock Creek Basin, so the Rock Creek Basin effectively ends at the C&O Canal, rather than at the Potomac River.

The Rock Creek Basin drains approximately 76.5 mi², of which 15.9 mi² are within Washington, D.C., south of the Maryland–Washington, D.C. boundary. North of the Maryland–Washington, D.C. boundary, there are approximately 60.6 mi² of drainage in Montgomery County that serve as the headwaters of Rock Creek. NPS manages 1,754 acres (2.74 mi²) or about 17 percent of all the land within the Rock Creek Basin in Washington, D.C. (CH2M Hill, 1979). The strongest regional effects on water quality in Rock Creek are believed to be the increase in urban development along with the increase in stormwater runoff over the impervious surfaces in the basin.

Geology The Rock Creek Basin lies almost entirely within the upland section of the Piedmont Physiographic Province. The rocks underlying the basin are metamorphosed sedimentary and igneous rocks of Cambrian to Ordovician age that have been intensely folded, deformed, and recrystallized, so that there is negligible intergranular porosity (Duigon and others, 2000). The primary types of bedrock in the basin are complex schists, tonalites, and granodiorites (Darton, 1950). The most detailed geologic investigation of the Rock Creek Basin in Washington, D.C. is by Fleming and others (1994).

Bedrock in most areas of the Piedmont is covered by a mantle of regolith, rock debris, transported sediments, and soil (Darton, 1950), which generally has high intergranular porosity (Duigon and others, 2000). Permeability of the saprolite is variable, but commonly greatest just above the unweathered bedrock (Nutter and Otton, 1969).

There are a few locations in the higher elevations of the basin where there are remnants of the Cretaceous Coastal Plain deposits, which are made up of unconsolidated gravels, sands, silts, and clays. Unconsolidated alluvium deposits of Holocene age, comprising gravel, sand, silt, and clay, are located along the stream channel. The thickness of these Holocene deposits varies by 5–10 ft throughout the study area (Fleming and others, 1994). The alluvial plain may also include recent flood deposits.

Hydrology The hydrology of the Rock Creek Basin is affected by natural processes and anthropogenic activities.

Precipitation causes direct runoff to the creek or infiltrates the ground to recharge the water table. About two-thirds of the water that falls as precipitation in the Piedmont region of central Maryland is returned to the atmosphere directly by evaporation or is taken up and transpired by plants (Dine and others, 1995). In the Rock Creek Basin, the large increases in impervious land surface have likely increased the amount of rainfall runoff, thereby decreasing the amount of rainfall that reaches the water table, thus decreasing evapotranspiration and ground-water recharge. Ground water flows through the fractures in the bedrock and through the overburden sediments to discharge directly to Rock Creek and nearby springs, where the water table intersects the land surface. Ground-water discharge maintains the base flow in the creek when there is no precipitation.

Washington, D.C. is supplied with drinking water by the U.S. Army Corps of Engineers Washington Aquaduct, which withdraws from the Potomac River near the western boundary of Washington, D.C. Many of the urban and suburban areas of Montgomery County in the Rock Creek Basin are supplied with drinking water by the Washington Suburban Sanitary Commission (WSSC), which also withdraws from the Potomac River. No major water suppliers in the Rock Creek Basin withdraw ground water for public use; however, private residences and small businesses in some of the northern and more rural reaches of the basin use wells for water supply and agriculture. There are no discharges of treated wastewater to the Rock Creek Basin in either Montgomery County, Maryland or Washington, D.C. Most water that enters the basin through the public water-supply system also leaves the basin by way of the WSSC wastewater treatment system (Judy Wheeler, U.S. Geological Survey, oral commun., 2000).

There are two flood-control reservoirs within the entire Rock Creek drainage basin. Lake Needwood on Rock Creek and Lake Bernard Frank on North Branch Rock Creek have acted as sediment and nutrient traps since their construction in the 1960s (Duigon and others, 2000; Maryland–National Capital Park and Planning Commission, 1999). Both of these reservoirs are located outside the study area in Montgomery County, Maryland.

Precipitation Annual precipitation, as measured by the National Oceanic and Atmospheric Administration at Dalecarlia Reservoir in Washington, D.C., is usually lowest in the spring to early summer and highest in late summer and fall. The total precipitation values for selected months in 1999 were: 1.56 in. (inches) for May, 2.54 in. for June, 0.81 in. for July, 4.54 in. for August, and 11.05 in. for September. The total precipitation values for selected months in 2000 were: 2.04 in. for May, 5.04 in. for June, no data collected for July, 5.5 in. for August, and 4.62 in. for September (National Oceanic and Atmospheric Administration, 1999, 2000). These are months when pesticides are typically applied in this area. A few intense rainfall events occurred during the spring and fall of water year 1999; however, most of the year was characterized by intermittent

Table 2. *Land-use statistics for the Rock Creek Basin in the Washington, D.C. area, and the entire Rock Creek Basin in Washington, D.C. and Montgomery County, Maryland*

[From the USGS 30-minute resolution land-use data set, Vogelmann and others, 2001]

Land-use type	Washington, D.C. area		Entire Rock Creek Basin	
	square miles	percent total area	square miles	percent total area
Open Water/Wetlands				
Open water	0.0	0.0	0.3	0.4
Woody wetlands	0.0	0.1	0.8	1.1
Emergent herbaceous wetlands	0.0	0.1	0.2	0.3
Subtotal	0.0	0.2	1.4	1.8
Urban/Suburban				
Low intensity residential	6.6	41.9	27.5	36.0
High intensity residential	1.8	11.3	1.9	2.4
Commercial/industrial/transportation	1.2	7.7	5.4	7.1
Subtotal	9.7	61.0	34.8	45.5
Forest/Grassland				
Transitional	0.0	0.0	0.2	0.3
Deciduous/evergreen forest	4.2	26.4	18.7	24.4
Mixed forest	1.3	8.4	5.4	7.0
Subtotal	5.5	34.8	24.2	31.6
Agricultural				
Pasture/hay	0.0	0.0	10.1	13.2
Row crops	0.0	0.0	2.0	2.6
Urban recreational grasses	0.6	4.1	4.0	5.2
Subtotal	0.6	4.1	16.1	21.0
Total area ¹	15.9	100.0	76.5	100.0

¹ Totals may not equal the sum of the individual land uses due to rounding.

rainfall events of less intensity. During water year 2000, rain fell on an intermittent basis throughout the year, with no intense episodes similar to those in water year 1999. Rainfall amounts measured at Dalecarlia Reservoir near the Rock Creek study area during water years 1999 and 2000 are shown in figure 3.

Land-Use Patterns Rock Creek Park is predominantly surrounded by urban and suburban areas in the lower basin of Rock Creek. The only open land of any appreciable extent consists of parkland, recreational areas, cemeteries, or institutional grounds (CH2M Hill, 1979). In this report, only four classes of land use are delineated. “Open water/wetlands” includes all fluvial and lacustrine environments. “Urban/suburban” includes all businesses, residential neighborhoods, and other developed property. “Forest/grassland” includes all woodlands, fields, and other natural habitats. “Agricultural” includes pastures, row crops, and

open grassy areas.

The USGS 30-minute resolution land-use data set (Vogelmann and others, 2001) shows that the lower part of the basin (about 16 mi², south of the Maryland–Washington, D.C. boundary) is approximately 4 percent agricultural, 35 percent forest/grassland, and 61 percent urban/suburban (table 2). The entire Rock Creek Basin is approximately 21 percent agricultural, 32 percent forest/grassland, and 46 percent urban/suburban (table 2). Urban/suburban development and agricultural land uses cover most of the area in the entire Rock Creek Basin. The distribution of land-use types in the entire Rock Creek Basin is shown in figure 4. The data for table 2 and figure 4 were derived from the National Land Cover Data set, which was compiled from Landsat satellite thematic mapping (TM) imagery (collected in 1992), with a spatial resolution of 30 meters and supplemented by various ancillary data (Vogelmann and others, 2001).

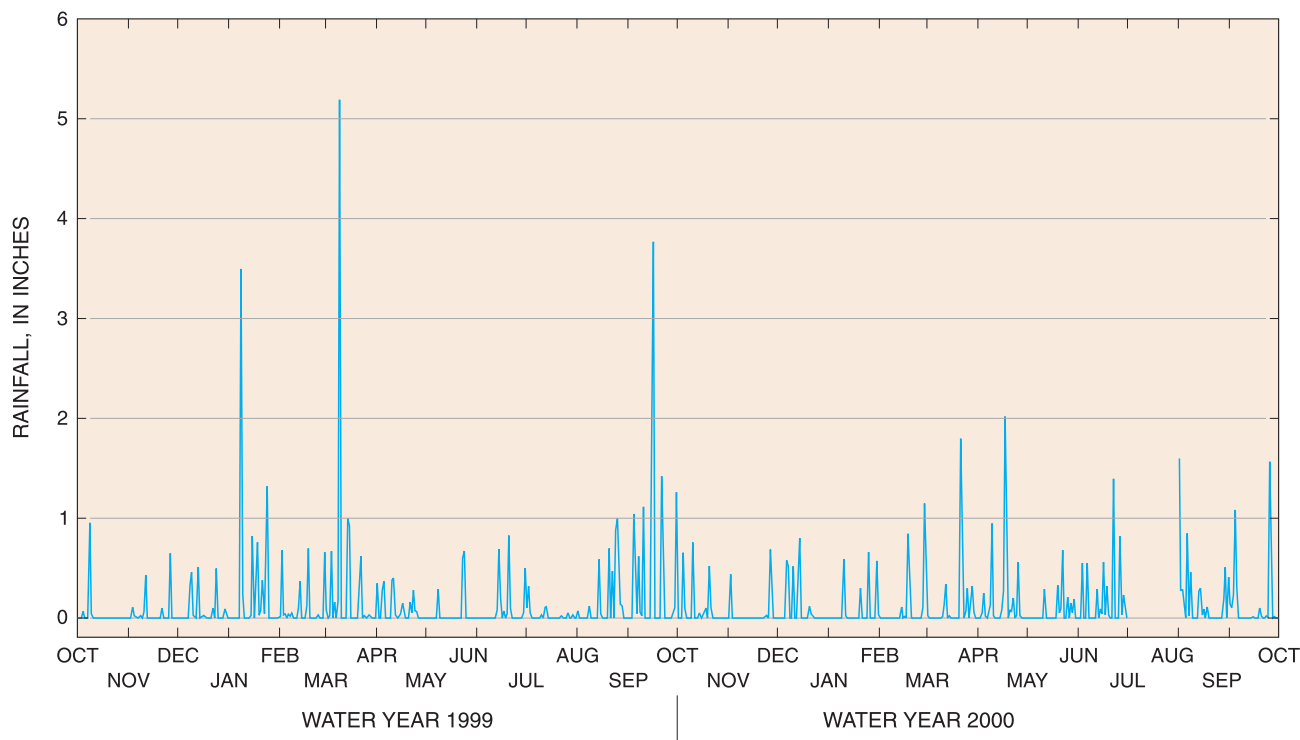


Figure 3. Precipitation data measured at Dalecarlia Reservoir near the Rock Creek Park study area, Washington, D.C., for water years 1999 and 2000. (No data are available for July 2000.)

Sources of Fertilizers and Pesticides to Rock Creek Park

Numerous factors may affect differences in pesticide occurrence and concentrations in Rock Creek. Pesticide use for agricultural purposes is quantified in 3-year intervals at the County level by the Maryland Department of Agriculture (table 3), but data are limited for residential and general use by the public. Unregulated pesticide use, such as by consumer households, is largely undocumented. There are also differences between agricultural and urban/suburban land uses in the types and patterns of pesticides applied. Another factor that may affect the occurrence of pesticides in the Rock Creek Basin is the location and timing of precipitation. The high amount of paved land in urban/suburban areas may increase the chance of runoff during high rainfall or periods of extended irrigation.

Rock Creek Park is surrounded by many private homes as well as some small businesses. Pesticide yield is likely to be highest in urban/suburban areas of moderate population density, where lots have relatively large proportions of turf grass and gardens, and pest control may be used (Hoffman and others, 2000). Areas farther north of the Maryland–Washington, D.C. boundary have a higher proportion of agricultural land use than urban/suburban land use. Agricultural areas generally have lower population densities and a smaller proportion of paved surfaces when compared to

urban/suburban areas. Pesticide and fertilizer usage for agricultural areas with row crops can be high compared to nonagricultural areas; however, urban areas have also been shown to be appreciable sources of some pesticides (Larson and others, 1997).

Potential Sources Outside the Park In the northern third of the Rock Creek Basin, the area surrounding Rock Creek is predominantly agricultural. Pesticides are applied to agricultural fields in many different ways, including aerial spraying, near-ground spraying, direct application to plants, and soil incorporation, to control insects and unwanted plants. Most agricultural pesticides are applied when they can have the greatest desired effect. Herbicides are usually applied just before planting to kill off old vegetation and a few weeks after the crop begins to sprout to target emerging weeds. Insecticides are generally applied at specific times, targeting specific insects at critical points in their life cycles (Larson and others, 1997).

Organochlorine compounds, such as chlordane and 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane (DDT), and other pesticides have been used in the past to control pests. Since restrictions on organochlorine pesticides went into effect during the 1970s (such as the ban on DDT), organophosphate pesticide usage has increased. The compounds in use today vary according to their chemical structure, rate

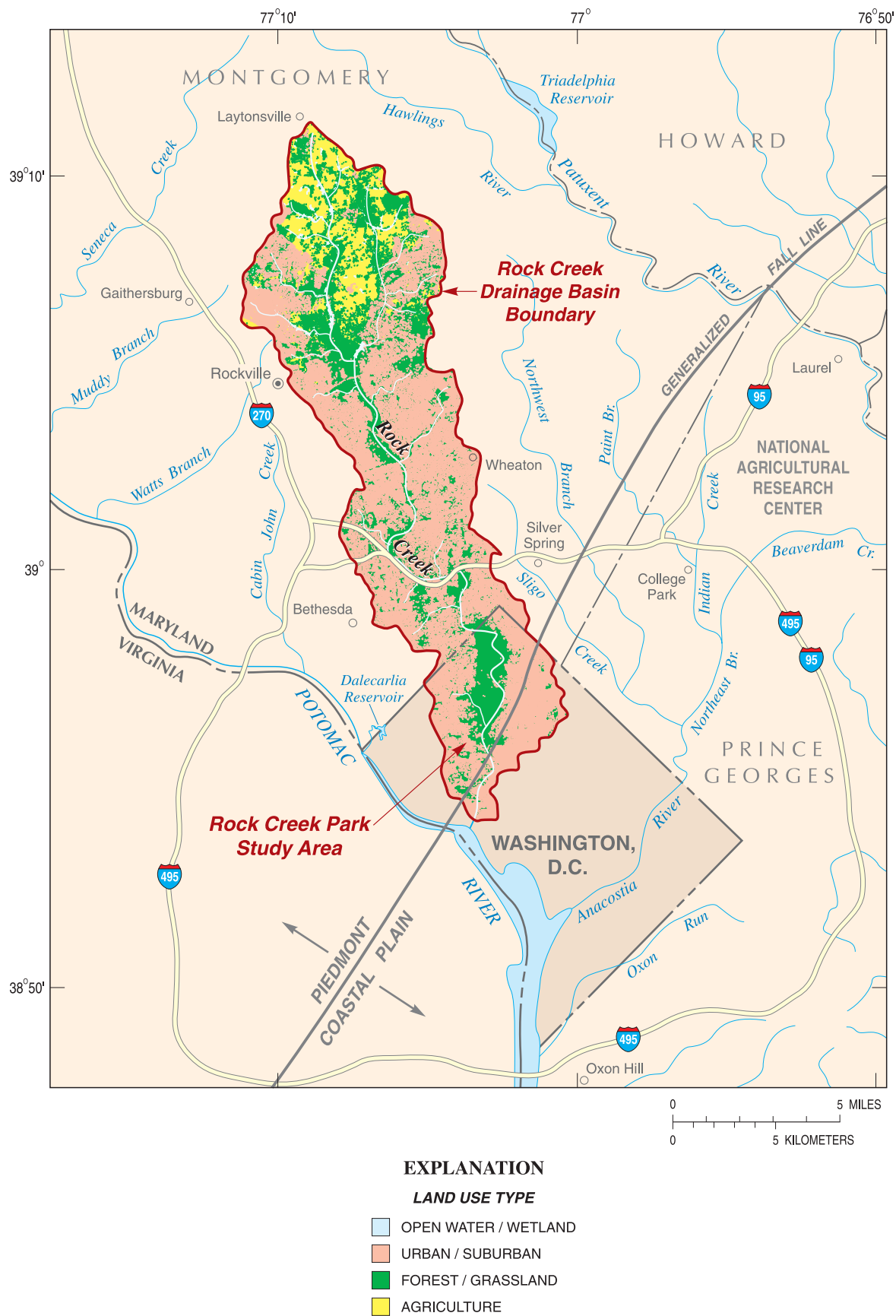


Figure 4. Land use in the Rock Creek Basin, Washington, D.C. and Montgomery County, Maryland.

Table 3. Estimated usage of selected pesticides in agricultural applications in Montgomery County, Maryland, 1994 and 1997

[Estimates are based on reports of combined pesticide usage by farm operators, certified private restricted-use pesticide applicators, commercially licensed and public agencies, and non-licensed, non-farm segments of the population (Maryland Department of Agriculture, 1996 and 1999). This usage does not include residential and other non-documented usage; –, usage unknown or undocumented]

Pesticide	Pounds of active ingredients per year by agriculture		Chemical class	Common usage
	1994	1997		
2,4,5-T ¹	–	–	Herbicide	General weed control
2,4-D ²	12,953	28,387	Chlorinated phenoxy herbicide (hormone type)	Agriculture and turfgrass
2,4-DB ³	5	–	Hormone-type herbicide	Alfalfa and soybeans
Acetochlor	332	–	Chloracetamide herbicide	Vegetables and vineyards
Acifluorfen	31	–	Herbicide	Soybeans, peanuts, and rice
Alachlor	15,747	1,967	Acetanilide herbicide	Corn, drybeans, peanuts, soybeans
Aldicarb	–	–	Carbamate insecticide, acaricide, and nematicide	Agriculture
Aldrin	–	–	Insecticide	Discontinued usage
Atrazine	16,182	13,365	Triazine herbicide	Corn, turfgrass, and some residential use
Azinphos-methyl	29	107	Organophosphorus insecticide	Fruits, vegetables, and ornamentals
Benfluralin	–	–	Dinitroaniline herbicide	Agriculture and turfgrass
Bentazon	250	–	Herbicide	Vegetables, lawns, soybeans, and corn
Bromacil	–	22	Uracil herbicide	Weed/brush control, non-crop
Bromoxynil	–	–	Herbicide	Weed control
Butylate	86	–	Herbicide	Corn
Carbaryl	1,229	4,145	Carbamate insecticide	Agriculture and ornamentals
Carbofuran	2,430	1,248	Carbamate insecticide, nematicide	Systemic broad spectrum
Chlordane	–	–	Insecticide	Discontinued usage
Chlorothalonil	5,228	9,529	Fungicide	Vegetables, turf, and ornamentals
Chlorpyrifos	54,468	5,257	Insecticide	Agriculture and residential (pets)
Clopyralid	305	299	Post-emergent herbicide	Crops, pasture, and rangeland
Copper and copper salts	329,667	4,132	Fungicide, bactericide	Vegetables
Cyanazine	2,399	–	Triazine herbicide	Cotton and corn
Dacthal	–	–	Herbicide	Lawns (to kill crabgrass)
Diazinon	1,747	739	Phosphorothioate insecticide, nematicide	Fruits, vegetables, and ornamentals
Dicamba	1,421	3,332	Benzoic acid herbicide	Crops and right-of-ways
Dichlobenil	72	10	Benzonitrile herbicide	Orchards, vineyards, ornamentals, and right-of-ways
Dichlorprop	–	–	Herbicide	Aquatic weeds, rangeland, and right-of-ways
Dieldrin	–	–	Insecticide	Discontinued usage
Dinoseb	–	–	Dinitrophenol herbicide	Fruit trees

¹. 2,4,5-Trichlorophenoxyacetic acid.

². (2,4-Dichlorophenoxy)acetic acid.

³. 4-(2,4-Dichlorophenoxy)butyric acid.

Table 3. *Estimated usage of selected pesticides in agricultural applications in Montgomery County, Maryland, 1994 and 1997—Continued*

Pesticide	Pounds of active ingredients per year by agriculture		Chemical class	Common usage
	1994	1997		
Disulfoton	—	—	Organophosphate insecticide, acaricide	Systemic control for vegetables and ornamentals
Diuron	1,006	82	Substituted urea herbicide	Cotton, orchards, vineyards, ornamentals, and gardens
DDT ⁴	—	—	Insecticide	Discontinued usage
DNOC ⁵	—	—	Insecticide, fungicide, herbicide, and defoliant	Apples and peaches
Endosulfan	83	6	Insecticide and acaricide	Fruits, vegetables, and ornamentals
Endrin	—	—	Organochlorine insecticide	Discontinued usage
EPTC ⁶	—	—	Herbicide	Vegetables
Ethalfuralin	60	80	Dinitroaniline herbicide	Soybeans and vegetables
Ethoprop	—	—	Organophosphate insecticide, nematocide	Vegetables and turf
Fenuron	—	—	Herbicide	Woody plants
Fonofos	—	—	Insecticide	Soil pests
Glyphosphate	—	15,192	Non-selective postemergent herbicide	Weed control and right-of-ways
Heptachlor	—	—	Insecticide	Discontinued usage
Lindane (γ -HCH) ⁷	3	2	Organochlorine insecticide	Tobacco, fruits, and domestic usage
Linuron	1,036	650	Substituted urea herbicide	Agriculture
MCPA ⁸	14	821	Phenoxy herbicide (hormone type)	Small grains and turf
MCPB ⁹	—	—	Herbicide	Weed control
Malathion	200	139	Organophosphate insecticide	Fruits, vegetables, and ornamentals (and pet dip)
Methiocarb	—	82	Carbamate insecticide	Home gardens
Methomyl	122	28	ascaricide, and molluscicide Insecticide	Vegetables, ornamentals, and fly control at feedlots
Methoxychlor	—	10	Diphenyl chloride insecticide	Residential use to control houseflies, black flies, and mosquitoes
Methyl azinphos	—	—	Organophosphate insecticide	Fruits, ornamentals, and shade trees
Methyl parathion	—	—	Organophosphate insecticide	Cotton, corn, alfalfa, and soybeans
Metolachlor	13,522	7,930	Chloracetanilide	Corn and soybeans
Metribuzin	58	124	Triazinone herbicide	Rowcrops

⁴. 1,1,1-Trichloro-2,2-bis(*p*-chlorophenyl)ethane and 1,1,1-trichloro-2,2-bis(*o*-chlorophenyl)ethane.

⁵. 4,6-Dinitro-*o*-cresol.

⁶. *s*-Ethyl dipropylthiocarbamate.

⁷. Lindane is a technical mixture consisting primarily of γ -HCH (γ -1,2,3,4,5,6-hexachlorocyclohexane).

⁸. 4-(4-Chloro-2-methylphenoxy) acetic acid.

⁹. 4-(4-Chloro-2-methylphenoxy) butanoic acid.

Table 3. *Estimated usage of selected pesticides in agricultural applications in Montgomery County, Maryland, 1994 and 1997—Continued*

Pesticide	Pounds of active ingredients per year by agriculture		Chemical class	Common usage
	1994	1997		
Molinate	—	—	Herbicide	Agriculture
Napropamide	—	—	Herbicide	Orchards, vineyards, vegetables, and ornamentals
Neburon	—	—	Herbicide	Agriculture
Norflurazon	—	—	Herbicide	Agriculture
Oryzalin	389	867	Dinitroaniline herbicide	Fruit trees, vineyards, turf, and ornamentals
Oxamyl	10	1	Carbamate insecticide, nematocide, and acaricide	Agriculture and ornamentals
Parathion	6	17	Organophosphate insecticide	Agriculture
Pebulate	—	—	Herbicide	Agriculture
Pendimethalin	19,997	12,521	Dinitroaniline herbicide	Cotton, vegetables, ornamentals, and industrial grounds maintenance
Permethrin	27,832	4,280	Pyrethroid insecticide	Orchards, vineyards, ornamentals, and livestock
Phorate	—	—	Insecticide	Agriculture
Pichloram	—	—	Herbicide	Right-of-ways (non-agricultural)
Prometon	310	958	Non-selective herbicide	Right-of-ways (non-agricultural)
Pronamide	—	—	Herbicide	Agriculture and ornamentals
Propachlor	—	—	Herbicide	Corn and grains
Propanil	1,042	206	Anilide herbicide	Rice
Propargite	—	—	Acaricide	Fruit trees and ornamentals
Propham	—	—	Herbicide	Agriculture and turfgrass
Propoxur	3	741	Carbamate insecticide	Fruits, vegetables, and ornamentals
Simazine	3,915	5,233	Triazine herbicide	Lawns, fairways, aquatic control, corn, and vegetables
Silvex	—	—	Herbicide	Agriculture and turf (for woody growth)
Tebuthiuron	33	—	Herbicide	Right-of-ways
Terbacil	2	7	Herbicide	Fruits
Terbufos	—	—	Organophosphate insecticide and Nematicide	Corn
Thiobencarb	—	—	Herbicide	Agriculture
Triclopyr	646	1,556	Systemic herbicide	Turf and right-of-ways
Trifluralin	1,074	2,201	Dinitroaniline herbicide	Corn, soybeans, and right-of ways
Total pounds of pesticides applied for agriculture in Montgomery County (including others not in this list and not analyzed in this study).	2,292,499	350,740		

of application, and transport potential, but are generally more soluble and shorter-lived than historically used pesticides (Larson and others, 1997; Maryland Department of Agriculture, 1996, 1999). A pesticide may be transported in dissolved form or bound to soil particles (Nowell and others, 1999). Pesticides can then enter the atmosphere, vadose zone, aquifer, or a surface-water body (Nowell and others, 1999). Pesticides generally move from fields to surface-water bodies in runoff by either overland sheet-flow or in manmade or erosion-created drainage channels. Storm runoff can also cause erosion of previously contaminated soil, which can then be transported and redistributed downstream. All of these transport mechanisms may contribute to the degradation of water quality in Rock Creek.

Potential Sources Within the Park Rock Creek Park houses a public 18-hole golf course that extends westward from 16th Street to Beach Drive, which runs adjacent to Rock Creek, and from Military Road northward to Sherrill Drive (fig. 2). This golf course is maintained entirely by NPS. The hilly terrain of the golf course can increase the potential for runoff during extended irrigation and rainfall events at the site near the golf course compared to the other sampling sites in this study. During water year 1999 (October 1, 1998 to September 30, 1999) and water year 2000 (October 1, 1999 to September 30, 2000), various insecticides and herbicides were applied to the Rock Creek Golf Course. Application dates of each of these pesticides along with areas of application are listed in table 4.

Station number 01648006 is located on a tributary in a draw that drains the 14th, 15th, and 16th holes of the golf course. Runoff from this part of the golf course may be carried into Rock Creek through the tributary located in this draw. Each of the pesticides listed in table 4 were applied to the greens, tees, collars, and approaches of all 18 holes of the golf course, with the exception of an application of chlorothalonil on June 27, 1999. This application was made only on tees 1–7, 13, and 18. Therefore, this application would not have been transported directly into Rock Creek through this tributary.

Pesticides were also applied by NPS on areas of the park outside the golf course where exotic (non-native) species of plants are known to exist. A detailed list of the pesticides applied by NPS in water years 1999 and 2000 and general areas of application is included in tables 5 and 6. The concentrations of the pesticides applied to the park by NPS vary according to the type of pesticide used. All concentrations were within recommended application criteria.

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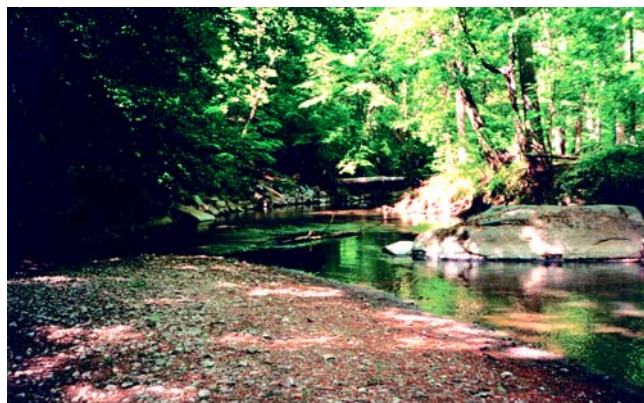


Table 4. Pesticides applied to Rock Creek Golf Course, Washington, D.C., during water years 1999 and 2000

[Data on file at U.S. Geological Survey Office, Baltimore, Maryland. Cross-referenced with California Department of Pesticide Regulation in conjunction with U.S. Environmental Protection Agency (USEPA)]

USEPA regulation number	Application date	Active ingredient	Area applied
Water Year 1999			
264-480	10/01/1998	Iprodione	Greens 1-18
707-245	05/03/1999	Dithiopyr	Collars & approaches
264-480	05/06/1999	Iprodione	Greens 1-18
50534-209	06/01/1999	Chlorothalonil	Greens 1-18
264-335	06/08/1999	Carbaryl	Greens 1-18
50534-209	06/22/1999	Chlorothalonil	Greens 1-18
100-741	06/22/1999	Propiconazole	Greens 1-18
50534-209	06/27/1999	Chlorothalonil	Tees 1-7, 13, 18
264-515	06/30/1999	Aluminum tris	Greens 1-18
707-87	06/30/1999	Mancozeb	Greens 1-18
50534-209	07/20/1999	Chlorothalonil	Greens 1-18
100-796	07/20/1999	Propionic acid	Greens 1-18
264-335	08/03/1999	Carbaryl	Greens 1-18
100-741	08/03/1999	Propiconazole	Greens 1-18
50534-209	08/24/1999	Chlorothalonil	Greens 1-18
Water Year 2000			
50534-209	12/09/1999	Chlorothalonil	Greens 1-18
1001-63	06/01/2000	Thiophanate methyl	Greens 1-18
264-335	06/02/2000	Carbaryl	Greens 1-18
707-87	06/23/2000	Mancozeb	Greens 1-18
707-87	07/06/2000	Mancozeb	Tees 1-18
10182-400	07/07/2000	λ -cyhalothrin	Greens 1-18
264-480	07/07/2000	Iprodione	Tees 1-18
50534-209	07/07/2000	Chlorothalonil	Greens 1-18
1001-63	07/31/2000	Thiophanate methyl	Greens 1-18
10182-400	07/31/2000	λ -cyhalothrin	Greens 1-18
707-87	08/02/2000	Mancozeb	Greens 1-18
50534-209	08/15/2000	Chlorothalonil	Greens 1-18

Table 5. Pesticides applied to Rock Creek Park, Washington, D.C., during water year 1999

[Data on file at U.S. Geological Survey Office, Baltimore, Maryland. Cross-referenced with California Department of Pesticide Regulation in conjunction with U.S. Environmental Protection Agency (USEPA)]

USEPA regulation number	Application date †	Active ingredient	Area applied
62719-40	01/21/1999	Triclopyr	Soapstone Valley Trail
62719-40	01/26/1999	Triclopyr	Soapstone Valley Trail
62719-40	02/05/1999	Triclopyr	Western Ridge Trail
62719-37	02/11/1999	Triclopyr	Pinehurst Branch
62719-37	02/16/1999	Triclopyr	Pinehurst Branch
62719-37	02/19/1999	Triclopyr	Pinehurst Branch
594-308	03/01/1999	Glyphosate	Nature Center meadow
594-308	03/02/1999	Glyphosate	Black Horse Trail
524-343	03/02/1999	Glyphosate	Black Horse Trail
62719-37	03/05/1999	Triclopyr	Pinehurst Branch
62719-37	04/07/1999	Triclopyr	Boundary Bridge
594-308	04/07/1999	Glyphosate	Boundary Bridge
524-343	04/07/1999	Glyphosate	Boundary Bridge
62719-37	06/25/1999	Triclopyr	Beach Drive near Bringham Drive
594-308	07/01/1999	Glyphosate	East Beach Drive at Kalmia Bridge
594-308	07/12/1999	Glyphosate	East Beach Drive
524-343	07/12/1999	Glyphosate	East Beach Drive -Fenwick Branch
594-308	07/16/1999	Glyphosate	East Beach Drive
524-343	07/19/1999	Glyphosate	East Beach Drive
594-308	07/21/1999	Glyphosate	East Beach Drive
594-308	07/23/1999	Glyphosate	East Beach Drive
524-343	07/23/1999	Glyphosate	East Beach Drive near Redbud Drive
524-343	07/27/1999	Glyphosate	East Beach Drive near Sycamore Street
524-343	07/29/1999	Glyphosate	East Beach Drive near Portal Street
594-308	07/29/1999	Glyphosate	East Beach Drive
594-308	07/29/1999	Glyphosate	West Beach Drive
594-308	07/30/1999	Glyphosate	West Beach Drive
524-343	07/30/1999	Glyphosate	East Beach Drive - west bank
62719-37	08/02/1999	Triclopyr	Dumbarton Oaks Park
594-308	08/02/1999	Glyphosate	West Beach Drive
62719-37	08/03/1999	Triclopyr	Dumbarton Oaks Park
594-308	08/03/1999	Glyphosate	West Beach Drive
62719-37	08/04/1999	Triclopyr	Dumbarton Oaks Park
594-308	08/04/1999	Glyphosate	North Portal Drive
594-308	08/05/1999	Glyphosate	Kudzu sites
62719-40	08/06/1999	Triclopyr	South Portal Drive
594-308	08/06/1999	Glyphosate	North Portal Drive
594-308	08/09/1999	Glyphosate	North Portal Drive
524-343	08/09/1999	Glyphosate	North Portal Bank of Fenwick Branch
62719-37	08/10/1999	Triclopyr	Dumbarton Oaks Park
594-308	08/10/1999	Glyphosate	North Portal Drive - South Portal Drive

† No data available from water year 1999 prior to January 1, 1999.

Table 5. *Pesticides applied to Rock Creek Park, Washington, D.C., during water year 1999—*
Continued

USEPA regulation number	Application date †	Active ingredient	Area applied
524-343	08/10/1999	Glyphosate	North Portal Bank and South Portal Bank
594-308	08/11/1999	Glyphosate	South Portal Drive
524-343	08/11/1999	Glyphosate	South Portal Drive near East Beach Drive
594-308	08/12/1999	Glyphosate	South Portal Drive
594-308	08/12/1999	Glyphosate	Dumbarton Oaks Park
62719-37	08/13/1999	Triclopyr	Dumbarton Oaks Park
594-308	08/13/1999	Glyphosate	South Portal Drive
524-343	08/13/1999	Glyphosate	South Portal Drive
62719-37	08/16/1999	Triclopyr	Dumbarton Oaks Park
524-343	08/16/1999	Glyphosate	Bingham Drive
62719-37	08/17/1999	Triclopyr	Dumbarton Oaks Park
594-308	08/17/1999	Glyphosate	Riley Spring Bridge
524-343	08/17/1999	Glyphosate	Riley Spring Bridge
594-308	08/18/1999	Glyphosate	Riley Spring Bridge
524-343	08/18/1999	Glyphosate	Riley Spring Bridge
594-308	08/19/1999	Glyphosate	Dumbarton Oaks Park
62719-40	08/23/1999	Triclopyr	Dumbarton Oaks Park
62719-37	08/23/1999	Triclopyr	Beach Drive along creek
62719-37	8/23/1999	Triclopyr	Dumbarton Oaks Park
594-308	08/23/1999	Glyphosate	Dumbarton Oaks Park
594-308	08/25/1999	Glyphosate	Bend in Creek near Hydro Dam
62719-40	09/01/1999	Triclopyr	Dumbarton Oaks Park
594-308	09/01/1999	Glyphosate	Dumbarton Oaks Park
594-308	09/01/1999	Glyphosate	Wise Road
62719-40	09/02/1999	Triclopyr	Dumbarton Oaks Park
62719-37	09/02/1999	Triclopyr	Dumbarton Oaks Park
594-308	09/02/1999	Glyphosate	West Beach Drive
524-343	09/02/1999	Glyphosate	Riley Spring Bridge
62719-37	09/03/1999	Triclopyr	Dumbarton Oaks Park
62719-37	09/13/1999	Triclopyr	Dumbarton Oaks Park
594-308	09/13/1999	Glyphosate	Wise Road
524-343	09/13/1999	Glyphosate	Riley Spring Bridge - Fenwick Branch
524-343	09/13/1999	Glyphosate	Dumbarton Oaks Park
62719-40	09/14/1999	Triclopyr	Dumbarton Oaks Park
62719-37	09/14/1999	Triclopyr	Dumbarton Oaks Park
594-308	09/14/1999	Glyphosate	West Beach Drive Bridge
524-343	09/14/1999	Glyphosate	Riley Spring Bridge near West Beach Drive
594-308	09/20/1999	Glyphosate	Beach Drive at Boundary Bridge
524-343	09/20/1999	Glyphosate	Riley Spring Bridge along Beach Drive
62719-37	09/23/1999	Triclopyr	Dumbarton Oaks Park
524-343	09/23/1999	Glyphosate	Boundary Bridge - west bank
524-343	09/23/1999	Glyphosate	Rolling Meadow Bridge to mouth of Pinehurst
524-343	09/23/1999	Glyphosate	Dumbarton Oaks Park
62719-37	09/24/1999	Triclopyr	Dumbarton Oaks Park
524-343	09/24/1999	Glyphosate	Rolling Meadow Bridge to Sherrill Drive

Table 6. Pesticides applied to Rock Creek Park, Washington, D.C., during water year 2000

[Data on file at U.S. Geological Survey Office, Baltimore, Maryland. Cross-referenced with California Department of Pesticide Regulation in conjunction with U.S. Environmental Protection Agency (USEPA)]

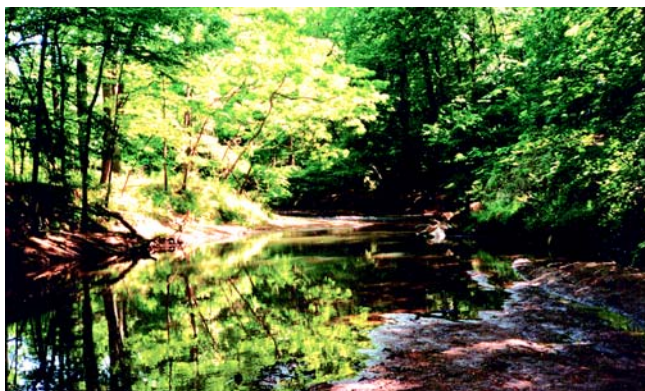
USEPA regulation number	Application date	Active ingredient	Area applied
524-343	10/01/1999	Glyphosate	Rolling Meadow Bridge to board walk
524-343	10/12/1999	Glyphosate	Riley Spring Bridge and trail
524-343	10/15/1999	Glyphosate	Riley Spring Bridge - Flood plain
594-308	10/19/1999	Glyphosate	Riley Spring Bridge
524-343	10/19/1999	Glyphosate	Riley Spring Bridge - Flood plain
524-343	10/22/1999	Glyphosate	Riley Spring Bridge - Flood plain
524-343	10/22/1999	Glyphosate	Maintenance Area - Flood plain
524-343	10/22/1999	Glyphosate	Pinehurst Branch at West Beach Drive
524-343	10/26/1999	Glyphosate	Pinehurst Branch at West Beach Drive
62719-37	10/27/1999	Triclopyr	Creek edge from Beach Drive to Boundary Bridge
524-343	10/27/1999	Glyphosate	Boundary Bridge and West Beach Drive
62719-37	10/28/1999	Triclopyr	Creek edge from Beach Drive to Boundary Bridge
524-343	10/28/1999	Glyphosate	Boundary Bridge and West Beach Drive
524-343	11/01/1999	Glyphosate	Boundary Bridge
524-343	03/06/2000	Glyphosate	Ranunculus plots - Flood plain
524-343	03/06/2000	Glyphosate	Boundary Bridge
524-343	03/09/2000	Glyphosate	Pinehurst Branch
62719-40	04/27/2000	Triclopyr	Nature Center
524-343	05/01/2000	Glyphosate	Boundary Bridge at West Beach Drive
524-343	05/01/2000	Glyphosate	Boundary Bridge at West Beach Drive
524-343	05/02/2000	Glyphosate	Wise Road
524-343	05/02/2000	Glyphosate	Wise Road
524-343	06/30/2000	Glyphosate	Rolling Meadow Bridge
62719-37	06/30/2000	Triclopyr	Rolling Meadow Bridge
624-343	07/06/2000	Glyphosate	Rolling Meadow Bridge to Sherrill Drive
62719-37	07/06/2000	Triclopyr	Rolling Meadow Bridge to Sherrill Drive
524-343	07/07/2000	Glyphosate	Rock Creek near Sherrill Drive
62719-37	07/07/2000	Triclopyr	Rock Creek near Sherrill Drive
524-343	07/10/2000	Glyphosate	Rock Creek near Sherrill Drive
62719-37	07/10/2000	Triclopyr	Rock Creek near Sherrill Drive
524-343	07/13/2000	Glyphosate	Rock Creek near Riley Spring Bridge
62719-37	07/13/2000	Triclopyr	Rock Creek near Riley Spring Bridge
524-343	07/14/2000	Glyphosate	Rock Creek near Riley Spring Bridge
62719-37	07/14/2000	Triclopyr	Rock Creek near Riley Spring Bridge
62719-40	07/18/2000	Triclopyr	Melvin Hazen part of test plots
524-343	07/18/2000	Glyphosate	Riley Spring Bridge near Beach Drive
62719-37	07/18/2000	Triclopyr	Riley Spring Bridge near Beach Drive
62719-40	07/21/2000	Triclopyr	Waterfront Park near harbor parking lot
524-343	08/04/2000	Glyphosate	Riley Spring Bridge near creek and valley trail
62719-37	08/04/2000	Triclopyr	Riley Spring Bridge near creek and valley trail
62719-37	08/04/2000	Triclopyr	Riley Spring Bridge near Valley Trail
594-308	08/04/2000	Glyphosate	Riley Spring Bridge near Valley Trail
62719-40	08/08/2000	Triclopyr	Sherrill Drive to Riley Spring Bridge

Table 6. *Pesticides applied to Rock Creek Park, Washington, D.C., during water year 2000—Continued*

USEPA regulation number	Application date	Active ingredient	Area applied
594-308	08/08/2000	Glyphosate	Valley Trail near West Beach Drive
62719-37	08/08/2000	Triclopyr	Valley Trail near West Beach Drive
524-343	08/09/2000	Glyphosate	Rock Creek Edge near Fenwick Bridge
62719-37	08/09/2000	Triclopyr	Rock Creek Edge near Fenwick Bridge
62719-40	08/10/2000	Triclopyr	Dumbarton Oaks Park
594-308	08/14/2000	Glyphosate	Maintenance yard to Fenwick Bridge
62719-37	08/14/2000	Triclopyr	Fenwick Bridge near maintenance yard
62719-40	08/15/2000	Triclopyr	Fenwick Bridge near maintenance yard
524-343	08/15/2000	Glyphosate	West Beach Drive near Fenwick Bridge
62719-37	08/15/2000	Triclopyr	West Beach Drive near Fenwick Bridge
524-343	08/17/2000	Glyphosate	Fenwick Bridge - north bank
62719-37	08/17/2000	Triclopyr	Fenwick Bridge - north bank
594-308	08/17/2000	Glyphosate	Fenwick Bridge near West Beach Drive
62719-37	08/17/2000	Triclopyr	Fenwick Bridge near West Beach Drive
524-343	08/21/2000	Glyphosate	Rock Creek near Beach Bridge - flood plain
62719-37	08/21/2000	Triclopyr	Rock Creek near Beach Bridge - flood plain
594-308	08/21/2000	Glyphosate	Path, horse trail and interior flood plain
62719-37	08/21/2000	Triclopyr	Path, horse trail and interior flood plain
524-343	08/22/2000	Glyphosate	Rock Creek near West Beach Bridge - flood plain
62719-37	08/22/2000	Triclopyr	Rock Creek near West Beach Bridge - flood plain
594-308	08/22/2000	Glyphosate	Path, interior flood plain
62719-37	08/22/2000	Triclopyr	Path, interior flood plain
594-308	08/25/2000	Glyphosate	Dumbarton Oaks Park
62719-37	08/25/2000	Triclopyr	Dumbarton Oaks Park
594-308	08/28/2000	Glyphosate	Glover Road near Ross Drive
594-308	08/30/2000	Glyphosate	Ross Drive
594-308	08/31/2000	Glyphosate	Ross Drive
594-308	09/05/2000	Glyphosate	Ross Drive
594-308	09/06/2000	Glyphosate	Flood plain
62719-37	09/06/2000	Triclopyr	Flood plain
594-308	09/06/2000	Glyphosate	Beach Drive
594-308	09/07/2000	Glyphosate	Bingham Drive to bike trail
62719-37	09/07/2000	Triclopyr	Bingham Drive to bike trail
594-308	09/08/2000	Glyphosate	Dumbarton Oaks Park
62719-37	09/08/2000	Triclopyr	Dumbarton Oaks Park
594-308	09/11/2000	Glyphosate	Grant Road, Bingham Drive and Military Road
62719-37	09/11/2000	Triclopyr	Grant Road, Bingham Drive and Military Road
594-308	09/11/2000	Glyphosate	Dumbarton Oaks Park
62719-37	09/11/2000	Triclopyr	Dumbarton Oaks Park
524-343	09/12/2000	Glyphosate	Rock Creek to Beach Bridge - flood plain
62719-37	09/12/2000	Triclopyr	Rock Creek to Beach Bridge - flood plain
594-308	09/12/2000	Glyphosate	Wise Road
62719-37	09/12/2000	Triclopyr	Wise Road

Table 6. *Pesticides applied to Rock Creek Park, Washington, D.C., during water year 2000—Continued*

USEPA regulation number	Application date	Active ingredient	Area applied
524-343	09/13/2000	Glyphosate	Flood plain (wet areas)
62719-37	09/13/2000	Triclopyr	Flood plain (wet areas)
594-308	09/13/2000	Glyphosate	Flood plain
52719-37	09/13/2000	Triclopyr	Flood plain
594-308	09/14/2000	Glyphosate	Dumbarton Oaks Park
62719-37	09/14/2000	Triclopyr	Dumbarton Oaks Park
594-308	09/18/2000	Glyphosate	Boundary Bridge - north end
62719-37	09/18/2000	Triclopyr	Boundary Bridge - north end
594-308	09/20/2000	Glyphosate	Boundary Bridge - north end
62719-37	09/20/2000	Triclopyr	Boundary Bridge - north end
594-308	09/21/2000	Glyphosate	Dumbarton Oaks Park
62719-37	09/21/2000	Triclopyr	Dumbarton Oaks Park
594-308	09/22/2000	Glyphosate	Boundary Bridge near trail
62719-37	09/22/2000	Triclopyr	Boundary Bridge near trail
524-343	09/27/2000	Glyphosate	Wise Road near West Beach Drive
62719-37	09/27/2000	Triclopyr	Wise Road near West Beach Drive
594-308	09/27/2000	Glyphosate	West Beach Drive near Riley Spring Bridge
62719-37	09/27/2000	Triclopyr	West Beach Drive near Riley Spring Bridge
524-343	09/28/2000	Glyphosate	Wise Road near West Beach Drive
62719-37	09/28/2000	Triclopyr	Wise Road near West Beach Drive
524-343	09/28/2000	Glyphosate	Dumbarton Oaks near bridge and trail
62719-37	09/28/2000	Triclopyr	Dumbarton Oaks near bridge and trail
594-308	09/28/2000	Glyphosate	Tree Island along Cart Trail
62719-37	09/28/2000	Triclopyr	Tree Island along Cart Trail
594-308	09/28/2000	Glyphosate	West Beach Drive near Riley Spring Bridge
62719-37	09/28/2000	Triclopyr	West Beach Drive near Riley Spring Bridge
524-343	09/29/2000	Glyphosate	Wise Road near West Beach Drive
62719-37	09/29/2000	Triclopyr	Wise Road near West Beach Drive
594-308	09/29/2000	Glyphosate	West Beach Drive near Riley Spring Bridge
62719-37	09/29/2000	Triclopyr	West Beach Drive near Riley Spring Bridge



Methods of Investigation

Streamflow rates, basic field parameters, and samples for analysis of pesticides, nutrients, and major ions were collected from seven sites in Rock Creek Park (fig. 2). Synoptic water-quality samples were collected from five sites (01647998, 01648004, 01648006, 01648010, and 01648998) and analyzed for pesticides (parent compounds and selected transformation products), field parameters, nutrients, and major ions, in accordance with USGS protocols (Wilde and others, 1998). Temporal water-quality samples were collected at station 01648010 and analyzed for pesticides (parent compounds and selected transformation products) and field parameters. Bed-sediment samples were collected from three sites (01647997, 01648000, and 01648998) and analyzed for trace elements (including metals) and organic compounds (including low- and high-molecular weight PAHs, PCBs, pesticides, and phthalates). Sampling dates and locations are listed and shown in table 1 and figure 2, respectively.

Site Selection

Sampling sites were selected after reviewing topographic maps and reviewing the drainage pattern unique to Rock Creek Park. Four stations were selected along the mainstem of Rock Creek to assess the water and sediment quality in the mainstem of the river. In downstream order, these stations are 01647998, 01648000, 01648010, and 01648998. The downstream sampling site (01648998) was selected to determine the final concentration of selected analytes before Rock Creek merges with the Potomac River. Three stations (01647997, 01648004, and 01648006) on tributaries to Rock Creek were selected to target small drainage basins within Rock Creek Park, and to assess potential contaminant movement from the golf course and the surrounding neighborhoods. Station 01648006 targeted the small drainage basin that included the golf course (fig. 2).

Sampling and Field Methods

Surface-water samples (synoptic and temporal) were collected using equal-width integrated sampling techniques and composited in a cone splitter, a USGS device for collecting representative sub-samples from large volume samples. Samples for the analysis of nutrients in whole water were preserved with concentrated sulfuric acid. Samples for dissolved-phase constituents were filtered through a 0.45- μ m (micrometer) polycarbonate capsule filter. Samples were shipped on ice overnight to the USGS National Water-Quality Laboratory (NWQL) in Denver, Colorado and refrigerated until analysis. Field measurements were taken concurrently with water-quality sample collection. Specific conductance, pH, dissolved oxygen, and temperature were determined with a calibrated YSI 6600-0 multimeter following methods presented in Wilde and Radtke (1998). All sample-collection and quality-assurance methods used for surface-water sampling are documented in the USGS National Field Manual (Wilde and others, 1998).

Bed sediment was collected at stations 01647997, 01648000, and 01648998 using a scoop made of inert materials to skim the top centimeter of bed sediment from multiple deposition zones within the designated stream reach. Stream reaches for each station were approximately 300 ft long. The samples from each station were composited into a glass jar and then transported on ice to the USGS laboratory for analysis. Samples were sieved in the field to remove coarse material. Samples for trace-element analyses were sieved through a 63-micron nylon filter, and samples for organic-compound analyses were sieved through a 2-mm (millimeter) stainless-steel sieve. All sample-collection techniques used for bed-sediment sampling are documented in Radtke (1998).

Analytical Methods

Nitrogen and phosphorus were analyzed by colorimetric methods using air-segmented continuous-flow analyzers^B, operated with pecked sampling and bubble-gated detectors (Patton and Wade, 1997). Kjeldahl nitrogen (organic nitrogen plus ammonia) and total phosphorus were pre-digested batchwise (Patton and Truit, 1992; Fishman, 1993). All laboratory methods are documented and verified for bias, accuracy, and precision with standard-reference materials and participation in the USGS Office of Water Quality sample-testing program (Maloney and others, 1994; Pritt and Raese, 1995).

Pesticides and pesticide transformation products in surface water were determined by two different analytical techniques. In one method, pesticides were extracted onto a C-18 solid-phase cartridge then eluted from the cartridge and analyzed by capillary-column Gas Chromatography-Mass Spectrometry (GC/MS) with selected-ion monitoring. Recoveries of surrogate compounds in this study using the

^B. Alpkem Corporation, Clackamas, Oregon

GC/MS method ranged from 70 to 120 percent. In the second method, samples were passed through a Carbpak-B solid-phase extraction cartridge followed by elution of the pesticides captured on the Carbpak-B and photodiode-array detection in conjunction with High-Performance Liquid Chromatography (HPLC). Base/neutral compounds were eluted separately from acid compounds. Recoveries of surrogate compounds in the HPLC method ranged from 56 to 131 percent. More information on quality-assurance methods is available in Zaugg and others (1995) and Werner and others (1996). Pesticide concentrations presented in this report have not been corrected for analytical recovery.

Organochlorine pesticides and PCBs in bed sediments were first isolated by Soxhlet extraction using dichloromethane. Compounds were then analyzed by dual-capillary-column Gas Chromatography with Electron-Capture Detection (GC/ECD) (Furlong and others, 1996). Known concentrations of surrogate organic compounds were added to each sample to determine the efficiency of each analysis. The percent recovery is the ratio of the analyzed concentration divided by the known concentration, multiplied by 100 percent. Recoveries of surrogate compounds for the GC/ECD method ranged from 43 to 83 percent; therefore, concentrations reported for the organic compounds in bed sediment may be systematically underrepresented. Concentrations of pesticides and PCBs are generally reported without quantitatively correcting for bias that may be represented by the surrogate recoveries.

Concentrations of trace elements in bed sediment were determined by block digestion in Teflon vessels with concentrated acids—hydrochloric acid (HCl), nitric acid (HNO₃), and perchloric acid (HClO₄), and analysis by Inductively Coupled Plasma–Mass Spectroscopy (ICP–MS). Mercury was determined by the cold vapor method (Briggs and Meier, 1999).

Quality Assurance and Quality Control

Quality-control (QC) samples were collected during the synoptic and temporal surface-water sampling events to document bias and variability in the data resulting from the collection, processing, shipping, and handling of samples by field and laboratory personnel according to procedures in Wilde and others (1998). QC included field blanks, replicate samples, and spiked samples. Field blanks were collected to identify potential sources of contamination during sampling and to assess bias in the concentrations of target analytes. Replicate samples were used to quantify variability. Spiked samples for pesticides were used to determine if there was a loss or gain of target analytes because of matrix effects in the sample or because of loss during holding times.

Data summaries from field blanks, replicate samples, and spiked field samples for pesticides and nutrients in surface water are presented in tables 7 and 8. For pesticide analyses, four field blanks, three sets of replicate samples, and one field spike were collected (table 7). All of the pesticide concentrations in the blanks were lower than their reporting limits. Pesticide concentrations for many of the replicate

sample pairs were also lower than the detection limits, but an estimate of standard deviation was made for all instances where pesticides were detected (table 7). Recoveries for pesticides in field spikes ranged from 45 to 166 percent, with most values between 80 and 120 percent (table 7). For nutrients and major ions, one field blank and one set of replicate samples were collected. With the exception of total Kjeldahl nitrogen and chloride, the concentrations in the blanks were lower than their reporting limits. The relative percent difference for the replicate sample pairs was calculated as the difference between the two concentrations divided by the average of the two concentrations, multiplied by 100 percent (table 8). Estimated standard deviations (table 7) ranged from 0.0 to 0.0086 µg/L, and relative percent differences (table 8) ranged from 0.0 percent to 2.9 percent, with the exception of fluoride (with a relative percent difference of 40 percent) and dissolved iron (with a relative percent difference of 15 percent). The high relative percent difference for fluoride is likely because both detections in the replicate sample pair (0.2 and 0.3 mg/L) are very close to the reporting limit (0.16 mg/L) for this analyte. These quality-assurance data indicate that adequate quality-control measures were used in the collection of synoptic water-quality, temporal water-quality, and bed-sediment samples.

Stream-Channel Classification

Rosgen (1994) developed a classification system for natural rivers that groups different types of rivers according to their dimension, pattern, profile, and composition. Stream types are classified based on bankfull width-to-depth ratio, entrenchment ratio, water-surface slope, sinuosity, and median particle diameter of the channel materials. The Rosgen stream-channel classification system provides an effective tool to describe the landforms and channel dimensions within a river valley, and it is often used to aid in investigations of sediment supply, stream sensitivity to disturbance, recovery potential of natural channels, channel response to changes in flow regime, and fish-habitat potential (Rosgen, 1994; Rosgen, 1996).

In May 1999, the channel reach downstream of the streamflow-gaging station on Rock Creek at Sherrill Drive (01648000) was evaluated according to the Rosgen classification system. An approximate 900-ft-long reach was selected for field survey and analysis. The reach was limited to approximately 900 ft because of appreciable changes in channel width, cross-sectional area, and water-surface slope farther downstream.

The reach cross-section was surveyed for determination of data variables that are required for Rosgen stream-channel classification (table 9), including bankfull channel width, mean and maximum bankfull depths, and the entrenchment ratio (Rosgen, 1994; Rosgen, 1996). The cross-section location was labeled and marked with rebar at the endpoints for future identification by NPS.

Field sites for the Rosgen stream-channel classification were established in the reach with the site farthest upstream located at the outside staff gage for the streamflow-gaging station, and the site farthest downstream located at the lower

Table 7. *Quality-assurance and quality-control data for pesticide analyses and selected transformation products in surface-water samples collected from February 1999 through September 2000, Rock Creek, Washington, D.C.*

[Field blanks were collected, and for cases of multiple reporting limits, all reporting limits are given. The standard deviation (SD) is estimated from pairs of duplicate samples where the concentrations were above the reporting limit. The formula for the estimated SD is from Taylor (1987). Where values were less than the reporting limit, the replicate pairs are indicated as "ND." All units of concentration are in µg/L (micrograms per liter); *n*, number of samples; <, less than; –, no data available]

Analyte	Concentrations (µg/L) in field blanks (<i>n</i> = 4)	Concentrations (µg/L) in replicate sample pairs (<i>n</i> = 3)			Percent recoveries in field spike (<i>n</i> = 1)
		Sample data (pair 1 / pair 2 / pair 3)	Estimated standard deviation		
2,4,5-T ¹	<0.04	ND / ND / ND	–		100
2,4-D ²	<0.15 , <0.11	ND / ND / ND	–		105
2,4-DB ³	<0.24 , <0.10	ND / ND / ND	–		106
2,6-Diethylaniline	<0.003	ND / ND / ND	–		89
3-Hydroxycarbofuran	<0.01 , <0.11	ND / ND / ND	–		–
Acetochlor	<0.002	ND / ND / ND	–		115
Acifluorfen	<0.04 , <0.09	ND / ND / ND	–		71
Alachlor	<0.002	ND / ND / ND	–		129
Aldicarb sulfone	<0.10	ND / ND / ND	–		–
Aldicarb sulfoxide	<0.02	ND / ND / ND	–		–
Aldicarb	<0.55 , <0.21	ND / ND / ND	–		–
α-HCH ⁴	<0.002	ND / ND / ND	–		104
Atrazine	<0.001	0.040, 0.041 / 0.011, 0.011 / ND	0.0005		92
Benfluralin	<0.002	ND / ND / ND	–		101
Bentazon	<0.01 , <0.04	ND / ND / ND	–		97
Bromacil	<0.04 , <0.06	ND / ND / ND	–		–
Bromoxynil	<0.04	ND / ND / ND	–		89
Butylate	<0.002	ND / ND / ND	–		132
Carbaryl	<0.01 , <0.07	0.094, 0.100 / 0.086, 0.088 / 0.120, 0.100	0.0086		114
Carbofuran	<0.12 , <0.29	ND / ND / ND	–		–

1. 2,4,5-Trichlorophenoxyacetic acid.

2. (2,4-Dichlorophenoxy)acetic acid.

3. 4-(2,4-Dichlorophenoxy)butyric acid.

4. α-1,2,3,4,5,6-Hexachlorocyclohexane.

end of the classification reach. At each field site used for the stream-channel classification, a modified-Wolman 100-piece pebble count was made according to the percentages of riffles, pools, and runs in the reach (Leopold and others, 1964; Rosgen, 1994; Rosgen, 1996). The 50-percent size fraction from the count typically is used in the classification system as the mean bed-material type for classification of the reach.

A field survey was conducted to determine the water-surface and channel-bed slopes in the reach. Elevations of

breaks in the bank slopes that appeared to be indicative of the bankfull stage and discharge were surveyed (Leopold and others, 1964; Leopold, 1994).

Channel sinuosity, which is the ratio of stream length to valley length, was also determined for this classification. The stream length was measured at the thalweg (deepest part) of the channel during the field survey of the reach. The valley length for the classification reach was physically measured as a nearly straight-line distance between the lower and upper end-points of the reach.

Table 7. *Quality-assurance and quality-control data for pesticide analyses and selected transformation products in surface-water samples collected from February 1999 through September 2000, Rock Creek, Washington, D.C.—Continued*

Analyte	Concentrations (µg/L) in field blanks (n = 4)	Concentrations (µg/L) in replicate sample pairs (n = 3)		Percent recoveries in field spike (n = 1)
		Sample data (pair 1 / pair 2 / pair 3)	Estimated standard deviation	
Chloramben, methyl ester	<0.14	– / – / –	–	–
Chloramben	<0.42	ND / ND / ND	–	–
Chlorothalonil	<0.48	ND / ND / ND	–	–
Chlorpyrifos	<0.004	0.004, 0.005 / 0.0030, 0.003 / 0.007, 0.008	0.0006	105
Cynazine	<0.004	ND / ND / ND	–	127
Dacthal, monoacid	<0.02 , <0.04	ND / ND / ND	–	109
Dacthal	<0.002	ND / ND / ND	–	112
Desethylatrazine	<0.002	0.070, 0.066 / 0.006, 0.007 / 0.012, 0.012	0.0019	78
Diazinon	<0.002	0.038, 0.036 / 0.036, 0.034 / 0.106, 0.106	0.0012	107
Dicamba	<0.04	ND / ND / ND	–	89
Dichlobenil	<1.20 , <0.07	ND / ND / ND	–	–
Dichlorprop	<0.03	ND / ND / ND	–	110
Dieldrin	<0.001	0.006, 0.006 / ND / ND	0.0	88
Dinoseb	<0.04 , <0.14 , <0.06	ND / ND / ND	–	84
Disulfoton	<0.017	ND / ND / ND	–	69
Diuron	<0.02 , <0.06	0.04, 0.05 / ND / ND	0.0071	–
DNOC ⁵	<0.42	ND / ND / ND	–	80
EPTC ⁶	<0.002	ND / ND / ND	–	98
Ethalfuralin	<0.004	ND / ND / ND	–	110
Ethoprop	<0.003	ND / ND / ND	–	92
Fenuron	<0.01 , <0.07	ND / ND / ND	–	–
Fluometuron	<0.04 , <0.06	ND / ND / ND	–	–
Fonofos	<0.003	ND / ND / ND	–	91
Lindane	<0.004	ND / ND / ND	–	108
Linuron	<0.002	ND / ND / ND	–	–
Malathion	<0.005	0.006, 0.005 / ND / ND	0.0007	122
MCPA ⁷	<0.17	<0.17, 0.04 / ND / ND	–	114
MCPB ⁸	<0.14 , <0.13	ND / ND / ND	–	94
Methiocarb	<0.03	ND / ND / ND	–	–
Methomyl	<0.17 , <0.02	ND / ND / ND	–	–

5. 4,6-Dinitro-*o*-cresol.

6. *s*-Ethyl dipropylthiocarbamate.

7. 4-(4-Chloro-2-methylphenoxy)acetic acid.

8. 4-(4-Chloro-2-methylphenoxy)butanoic acid.

Table 7. *Quality-assurance and quality-control data for pesticide analyses and selected transformation products in surface-water samples collected from February 1999 through September 2000, Rock Creek, Washington, D.C.—Continued*

Analyte	Concentrations (µg/L) in field blanks (n = 4)	Concentrations (µg/L) in replicate sample pairs (n = 3)		Percent recoveries in field spike (n = 1)
		Sample data (pair 1 / pair 2 / pair 3)	Estimated standard deviation	
Methylaziphos	<0.001	ND / ND / ND	—	—
Methylparathion	<0.006	ND / ND / ND	—	90
Metolachlor	<0.002	0.019, 0.018 / 0.007, 0.007 / 0.014, 0.013	0.0006	109
Metribuzin	<0.004	ND / ND / ND	—	107
Molinate	<0.004	ND / ND / ND	—	106
Napropamide	<0.003	ND / ND / ND	—	104
Neburon	<0.01 , <0.07	ND / ND / ND	—	—
Norflurazon	<0.02 , <0.04	ND / ND / ND	—	—
Oryzalin	<0.31	ND / ND / ND	—	—
Oxamyl	<0.02	ND / ND / ND	—	—
<i>p,p'</i> -DDE ⁹	<0.006	ND / ND / ND	—	54
Parathion	<0.004	ND / ND / ND	—	147
Pebulate	<0.004	ND / ND / ND	—	106
Pendimethalin	<0.004	0.012, 0.013 / ND / ND	0.0007	120
<i>cis</i> -Permethrin	<0.005	ND / ND / ND	—	45
Phorate	<0.002	ND / ND / ND	—	79
Picloram	<0.05	ND / ND / ND	—	69
Prometon	<0.018	0.018, 0.017 / 0.007, 0.006 / 0.012, 0.012	0.0006	109
Pronamide	<0.003	ND / ND / ND	—	120
Propachlor	<0.007	ND / ND / ND	—	137
Propanil	<0.004	ND / ND / ND	—	111
Propargite	<0.013	ND / ND / ND	—	136
Propham	<0.04	ND / ND / ND	—	—
Propoxur	<0.04 , <0.08	ND / ND / ND	—	—
Silvex	<0.02 , <0.06	ND / ND / ND	—	99
Simazine	<0.005	0.034, 0.032 / 0.007, 0.007 / 0.018, 0.017	0.0009	108
Tebuthiuron	<0.010	ND / ND / ND	—	166
Terbacil	<0.007	ND / ND / ND	—	162
Terbufos	<0.013	ND / ND / ND	—	97
Thiobencarb	<0.002	ND / ND / ND	—	99
Simazine	<0.005	0.034, 0.032 / 0.007, 0.007 / 0.018, 0.017	0.0009	108
Triallate	<0.001	ND / ND / ND	—	96
Triclopyr	<0.25	0.23 , 0.15 / ND / ND	0.057	112
Trifluralin	<0.002	0.003, 0.003 / <0.002, 0.004 / ND	0.0015	104

⁹. 1,1-Dichloro-2,2-bis(*p*-chlorophenyl)ethylene.

Table 8. *Quality-assurance and quality-control data for the nutrient and major ion analyses in synoptic and temporal surface-water samples from Rock Creek, Washington, D.C.*

[A single field blank was collected. The relative percent difference was calculated as the difference between duplicate values, divided by the average of those values, multiplied by 100 percent. "Nitrogen, ammonia plus organic nitrogen" is also known as "Kjeldahl nitrogen;" N, nitrogen; P, phosphorus; mg/L, milligrams per liter; µg/L, micrograms per liter]

Analytes	Units	Field blank	Replicate sample pairs	
			Sample data	Relative percent difference (percent)
Nitrogen, ammonia plus organic nitrogen (dissolved as N)	mg/L	<0.1	0.37, .37	0
Nitrogen, ammonia plus organic nitrogen (total as N)	mg/L	.1	.35, .35	0
Nitrogen, ammonia (dissolved as N)	mg/L	< .02	.053, .053	0
Nitrogen, nitrate plus nitrite (dissolved as N)	mg/L	< .05	.633, .633	0
Nitrogen, nitrite (dissolved as N)	mg/L	< .010	.022, .022	0
Phosphorus (dissolved as P)	mg/L	< .004	.020, .020	0
Phosphorus, phosphate, ortho (dissolved as P)	mg/L	< .010	.021, .021	0
Phosphorus (total as P)	mg/L	< .004	.047, .047	0
Calcium (dissolved)	mg/L	< .02	29.4, 29.7	1.0
Magnesium (dissolved)	mg/L	< .01	10.1, 10.1	0
Potassium (dissolved)	mg/L	< .1	3.4, 3.5	2.9
Sodium (dissolved)	mg/L	< .1	24.6, 24.4	.8
Chloride (dissolved)	mg/L	.9	57.2, 58.2	1.7
Fluoride (dissolved)	mg/L	< .16	.3, .2	40
Silica (dissolved)	mg/L	< .1	10.7, 10.8	.9
Sulfate (dissolved)	mg/L	< .1	18.4, 18.5	.5
Iron (dissolved)	µg/L	<10	70, 60	15
Manganese (dissolved)	µg/L	<3	104, 105	1.0

Table 9. *Data-variable values measured in Rosgen stream-channel classification, data analyses, and interpretation*

[ft, feet; ft/ft, feet per foot; mm, millimeter; <, less than; >, greater than; %, percent]

Variables	Values	Units
Water surface slope	0.0019	ft/ft
Sinuosity	1.48	ft/ft
Mean channel material size	<2.0	mm
Bankfull width	72	ft
Flood-prone width	>200	ft
Entrenchment ratio	>2.2	ft/ft
Mean bankfull depth	6.39	ft
Maximum bankfull depth	8.58	ft
Width/depth ratio	11.3	ft/ft
Percentage of riffles in reach	10.5	%
Percentage of pools in reach	65.4	%
Percentage of runs in reach	25.0	%

Water-Quality Data

Pesticides that were applied to the Rock Creek Golf Course by the NPS concessioner during water years 1999 and 2000 included iprodione, dithiopyr, chlorothalonil, carbaryl, propiconazole, aluminum tris, mancozeb, propionic acid, thiophanate methyl, and lambda-cyhalothrin (table 4). Of these pesticides, only chlorothalonil and carbaryl were analyzed in this study. Chlorothalonil was not detected in any samples; however, carbaryl was detected in three surface-water samples (table 7). All of these detections for carbaryl were above recommended water-quality criteria for the protection of aquatic life (Canadian Council of Ministers of the Environment, 1999).

Pesticides approved for application by the Rock Creek Park staff during water years 1999 and 2000 included triclopyr, glyphosate, ammonium amidosulfate, dimethylarsinic acid, and sodium dimethylarsinate (William Yeaman, National Park Service, written commun., 2001). Of these pesticides, triclopyr and glyphosate were applied to control the spread of exotic species growing in the park (tables 5 and 6). Glyphosate was not analyzed in this study. Triclopyr was analyzed and detected in two temporal water-quality samples collected from station 01648010 (E 0.23 to 0.67 $\mu\text{g/L}$) above the reporting limit (0.07 $\mu\text{g/L}$); however no criteria for the protection of aquatic life for this chemical have been set (see appendix B2).

Synoptic Surface-Water Sampling

Insecticides detected in the synoptic water-quality samples included carbaryl, chlorpyrifos, dieldrin, and diazinon (fig. 5; appendix A1). Carbaryl was analyzed by NWQL using two different methods because of overlap in the analytical schedules. One method (schedule 2050, appendix B2) analyzes pesticides in filtered water by extraction using a Carbopak B SPE cartridge with analysis by HPLC (Werner and others, 1996). The other method (schedule 2001, appendix B1) analyzes pesticides in filtered water by extraction using a C-18 SPE cartridge with analysis by GC/MS (Zaugg and others, 1995). Both of these methods of analysis are approved by the USGS. The two methods differ in reporting limits and thus have different rates of detection for carbaryl, but the concentrations of carbaryl in both methods were consistent. Carbaryl was detected at site 01648004, but not at site 01648006.

Station 01648006 is immediately downgradient of the golf course. Carbaryl had been applied to all 18 tees of the golf course on June 8, 1999, approximately 2 weeks prior to synoptic sampling. A hydrograph of rainfall indicates that there were three precipitation events between the application of carbaryl and the synoptic water-quality sample collection (fig. 3)—0.06 in. of rain fell on June 14, 1999, 0.47 in. of rain fell on June 15, 1999, and 0.07 in. of rain fell on June 17, 1999 (National Oceanic and Atmospheric Administration, 1999). These values are lower than the maximum amounts shown in figure 3, and results did not indicate any

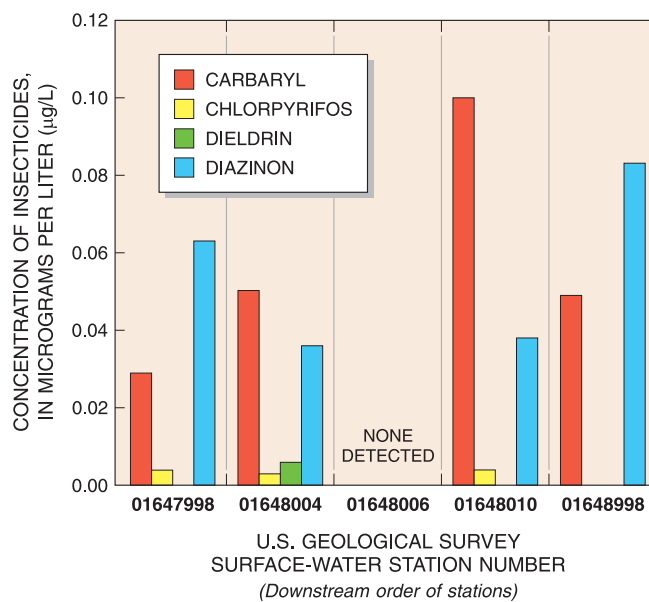


Figure 5. Concentrations of insecticides detected in synoptic water-quality samples in the Rock Creek Park study area, Washington, D.C., June 1999.

changes in the concentrations of carbaryl in Rock Creek that would correlate to the application at the golf course. Station 01648004, where carbaryl was detected, is on the Pinehurst Branch, a tributary upgradient of the golf course. Carbaryl has a half-life of approximately 10 days, making its detection indicative of a recent application (Extension Toxicology Network, 2001). Carbaryl is a commonly used insecticide for agriculture and ornamental gardens, making multiple sources of this chemical likely.

Chlorpyrifos was detected at three of the five synoptic water-quality stations (01647998, 01648004, and 01648010). Two of these stations (01647998 and 01648010) had concentrations above established freshwater criteria (table 10; fig. 5). Station 01647998 is below West Beach Drive, and station 01648010 is where Joyce Road crosses the creek south of the golf course. Chlorpyrifos was not detected at station 01648006 (Rock Creek tributary at Golf Course) or station 01648998 (Q Street).

Dieldrin was detected at station 01648004, but the concentration was not above established freshwater criteria (table 10; fig. 5). Dieldrin was not detected at the other four synoptic water-quality stations (01647998, 01648006, 01648010, and 01648998).

Diazinon was detected at four of the five synoptic water-quality stations (01647998, 01648004, 01648010, and 01648998). One of these stations (01648998) had a concentration that was above established freshwater criteria (table 10; fig. 2). This station is located the farthest down-

Table 10. Summary of contaminants in surface water at Rock Creek Park, Washington, D.C., during water years 1999 and 2000, and water-quality criteria for the protection of aquatic life

[References and abbreviations: *A*, U.S. Environmental Protection Agency (USEPA) freshwater criteria recommended for protection of aquatic life (USEPA, 1999), including short-term exposure criteria, Criteria Maximum Concentration (CMC), and chronic exposure criteria, Criterion Continuous Concentration (CCC); *B*, USEPA (2001), maximum contaminant level (MCL); *C*, Canadian Council of Ministers of the Environment, 1999; *D*, International Joint Commission United States and Canada (1989), Great Lakes criteria from the Great Lakes Water-Quality Agreement of 1978; —, no data available; ND, not detected; NC, no criteria established for this contaminant; NA, not analyzed; <, less than; E, estimated value (concentration was below the reporting limit and warrants less confidence). Synoptic sampling includes samples collected from 5 stations in June 1999. Temporal sampling includes 16 samples collected over a 2-year period at station 01648010. Concentration units are in micrograms per liter.]

Analyte	USEPA freshwater criteria ^A		USEPA MCL ^B	Canadian water-quality guidelines for the protection of aquatic life ^C	Great Lakes criteria for the protection of aquatic life ^D	Range of concentrations found in Rock Creek		Number of samples above any aquatic criteria
	CMC	CCC				Synoptic sampling, June 1999	Temporal sampling at station 01648010	
2,4,5-T ¹	—	—	—	—	—	ND	ND	NC
2,4-D ²	—	—	70	—	—	<0.15	<0.11 - 0.55	NC
2,4-DB ³	—	—	—	—	—	ND	ND	NC
2,6-Diethyl- aniline	—	—	—	—	—	ND	ND	NC
3-Hydroxy- carbofuran	—	—	—	—	—	ND	ND	NC
Acetochlor	—	—	—	—	—	ND	ND	NC
Acifluorfen	—	—	—	—	—	ND	ND	NC
Alachlor	—	—	2	—	—	ND	ND	NC
Aldicarb sulfone	—	—	—	—	—	ND	ND	NC
Aldicarb sulfoxide	—	—	—	—	—	ND	ND	NC
Aldicarb α -HCH ⁴	—	—	—	1.0	—	ND	ND	0
Atrazine	—	—	3	1.8	—	<0.001 - 0.042	<0.001 - 0.145	0
Benfluralin	—	—	—	—	—	ND	<0.002 - 0.004	NC
Bentazon	—	—	—	—	—	ND	ND	NC
Bromacil	—	—	—	5.0	—	ND	ND	0
Bromoxynil	—	—	—	5.0	—	ND	ND	0
Butylate	—	—	—	—	—	ND	ND	NC
Carbaryl	—	—	—	.2	—	<0.003 - 0.05	<0.003 - 1.14	3
Carbofuran	—	—	40	1.8	—	ND	ND	0

¹. 2,4,5-Trichlorophenoxyacetic acid.

². (2,4-Dichlorophenoxy)acetic acid.

³. 4-(2,4-Dichlorophenoxy)butyric acid.

⁴. α -1,2,3,4,5,6-Hexachlorocyclohexane.

Table 10. Summary of contaminants in surface water at Rock Creek Park, Washington, D.C., during water years 1999 and 2000, and water-quality criteria for the protection of aquatic life—Continued

Analyte	USEPA freshwater criteria ^A		USEPA MCL ^B	Canadian water-quality guidelines for the protection of aquatic life ^C	Great Lakes criteria for the protection of aquatic life ^D	Range of concentrations found in Rock Creek		Number of samples above any aquatic criteria
	CMC	CCC				Synoptic sampling, June 1999	Temporal sampling at station 01648010	
Chloramben, methyl ester	—	—	—	—	—	ND	ND	NC
Chloramben	—	—	—	—	—	ND	ND	NC
Chlorothalonil	—	—	—	0.18	—	ND	ND	0
Chlorpyrifos	—	—	—	.0035	—	<0.004 - 0.004	<0.004 - 0.017	10
Cynazine	—	—	—	2.0	—	ND	<0.004 - 0.009	0
Dacthal	—	—	—	—	—	ND	<0.002 - E 0.002	NC
Desethyl- atrazine	—	—	—	—	—	<0.002 - E 0.07	E 0.010 - E 0.084	NC
Diazinon	—	—	—	—	0.08	<0.002 - E 0.083	E 0.003 - 0.307	6
Dicamba	—	—	—	10	—	ND	ND	0
Dichlobenil	—	—	—	—	—	ND	ND	NC
Dichlorprop	—	—	—	—	—	ND	ND	NC
Dieldrin	0.24	0.056	—	—	—	<0.001 - 0.006	ND	0
Aldrin plus Dieldrin ⁵	—	—	—	—	.001	—	—	1
Dinoseb	—	—	7	.05	—	ND	ND	0
Disulfoton	—	—	—	—	—	ND	ND	NC
Diuron	—	—	—	—	—	<0.02 - 0.04	<0.02 - E 0.03	NC
DNOC ⁶	—	—	—	—	—	ND	<0.42 - E 0.33	NC
EPTC ⁷	—	—	—	—	—	ND	ND	NC
Ethalfuralin	—	—	—	—	—	ND	ND	NC
Ethoprop	—	—	—	—	—	ND	ND	NC
Fenuron	—	—	—	—	—	ND	ND	NC
Fluometuron	—	—	—	—	—	ND	ND	NC
Fonofos	—	—	—	—	—	ND	ND	NC
Glyphosate	—	—	700	65	—	NA	NA	0
Lindane	.9	—	.2	.01	.01	ND	ND	0

⁵ Aldrin is quickly transformed to dieldrin in the natural environment, so often only dieldrin is analyzed.

⁶ 4,6-Dinitro-*o*-cresol.

⁷ *s*-Ethyl dipropylthiocarbamate.

Table 10. *Summary of contaminants in surface water at Rock Creek Park, Washington, D.C., during water years 1999 and 2000, and water-quality criteria for the protection of aquatic life—Continued*

Analyte	USEPA freshwater criteria ^A		USEPA MCL ^B	Canadian water-quality guidelines for the protection of aquatic life ^C	Great Lakes criteria for the protection of aquatic life ^D	Range of concentrations found in Rock Creek		Number of samples above any aquatic criteria
	CMC	CCC				Synoptic sampling, June 1999	Temporal sampling at station 01648010	
Linuron	—	—	—	7.0	—	ND	ND	0
Malathion	—	0.1	—	—	—	ND	<0.005 - 0.274	1
MCPA ⁸	—	—	—	2.6	—	ND	ND	0
MCPB ⁹	—	—	—	—	—	ND	<0.17 - E 0.10	NC
Methiocarb	—	—	—	—	—	ND	ND	NC
Methomyl	—	—	—	—	—	ND	ND	NC
Methylazinos	—	—	—	—	—	ND	ND	NC
Methylparathion	—	—	—	—	—	ND	ND	NC
Metolachlor	—	—	—	7.8	—	<0.002 - 0.02	0.01 - 0.115	0
Metribuzin	—	—	—	1.0	—	ND	ND	0
Molinate	—	—	—	—	—	ND	ND	NC
Napropamide	—	—	—	—	—	ND	<0.003 - 0.033	NC
Neburon	—	—	—	—	—	ND	ND	NC
Norflurazon	—	—	—	—	—	ND	ND	NC
Oryzalin	—	—	—	—	—	ND	ND	NC
Oxamyl	—	—	200	—	—	ND	ND	NC
<i>p,p'</i> -DDE ¹⁰	—	—	—	—	—	ND	ND	NC
DDT plus metabolites ¹¹	—	—	—	—	0.003	ND	ND	0
Parathion	0.065	.013	—	—	—	ND	ND	0
Pebulate	—	—	—	—	—	ND	ND	NC
Pendimethalin	—	—	—	—	—	<0.004 - E 0.012	<0.004 - 0.036	NC
<i>cis</i> -Permethrin	—	—	—	—	—	ND	ND	NC
Phorate	—	—	—	—	—	ND	ND	NC
Picloram	—	—	500	29	—	ND	ND	0
Prometon	—	—	—	—	—	<0.018 - 0.029	E 0.004 - 0.072	NC

^{8.} 4-(4-Chloro-2-methylphenoxy)acetic acid.

^{9.} 4-(4-Chloro-2-methylphenoxy)butanoic acid.

^{10.} 1,1,-Dichloro-2,2-bis(*p*-chlorophenyl)ethylene.

^{11.} 1,1,1-Trichloro-2,2-bis(*p*-chlorophenyl)ethane.

Table 10. *Summary of contaminants in surface water at Rock Creek Park, Washington, D.C., during water years 1999 and 2000, and water-quality criteria for the protection of aquatic life—Continued*

Analyte	USEPA freshwater criteria ^A		USEPA MCL ^B	Canadian water-quality guidelines for the protection of aquatic life ^C	Great Lakes criteria for the protection of aquatic life ^D	Range of concentrations found in Rock Creek		Number of samples above any aquatic criteria
	CMC	CCC				Synoptic sampling, June 1999	Temporal sampling at station 01648010	
Propyzamide	—	—	—	—	—	ND	ND	NC
Propachlor	—	—	—	—	—	ND	ND	NC
Propanil	—	—	—	—	—	ND	ND	NC
Propargite	—	—	—	—	—	ND	ND	NC
Propham	—	—	—	—	—	ND	ND	NC
Propoxur	—	—	—	—	—	ND	ND	NC
Silvex	—	—	50	—	—	ND	ND	NC
Simazine	—	—	4	10	—	<0.005 - 0.046	<0.005 - 0.083	0
Tebuthiuron	—	—	—	1.6	—	ND	<0.010 - 0.010	0
Terbacil	—	—	—	—	—	ND	ND	NC
Terbufos	—	—	—	—	—	ND	ND	NC
Thiobencarb	—	—	—	—	—	ND	ND	NC
Triallate	—	—	—	.24	—	ND	ND	0
Triclopyr	—	—	—	—	—	ND	<0.250 - 0.260	NC
Trifluralin	—	—	—	.20	—	<0.002 - 0.003	<0.002 - 0.006	0

stream of the five synoptic water-quality stations. This concentration may indicate that diazinon has accumulated in the sediment near the downstream station.

Herbicides detected at four of the five stations (01647998, 01648004, 01648010, and 01648998) in the synoptic survey included atrazine, metolachlor, prometon, and simazine (fig. 6; appendix A1), whereas diuron was detected only at station 01648010. These chemicals were not directly applied to Rock Creek Park or Rock Creek Golf Course by NPS, and they are more extensively used in agricultural areas than in urban/suburban areas (table 3). Each of these chemicals is moderately to highly persistent in water, with half-lives ranging from 4–6 weeks to 1 year (Extension Toxicology Network, 2001). None of the herbicides found in surface water during the synoptic sampling were found in concentrations that were greater than established freshwater criteria for the protection of aquatic life (table 10); however, there are no established freshwater criteria for diuron or prometon (table 10; appendix A1).

The total concentrations of insecticides and herbicides measured at the five synoptic water-quality stations are presented in figure 7. No pesticides were detected at station 01648006, which is in a small tributary draining directly from the golf course into Rock Creek. Therefore, the pesticides that were applied to Rock Creek Golf Course were not observed in the synoptic water-quality samples. The differences in pesticide concentrations among the five synoptic stations were not appreciable enough to make any conclusions about the spatial variability in water quality. There were no noticeable correlations between pesticide usage in the basins and observed concentrations in the stream segments.

Field measurements, major ions, and nutrients were measured at the five synoptic water-quality stations. These measurements included discharge, dissolved oxygen, pH, specific conductance, air and water temperature, major ions, nitrogen, phosphorus, iron, manganese, and suspended sediment. There were no unusually high concentrations or

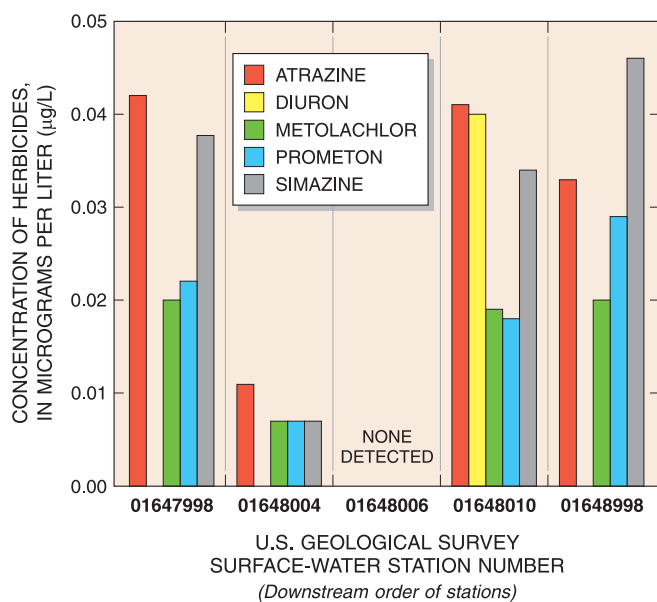


Figure 6. Concentrations of herbicides detected in synoptic water-quality samples in the Rock Creek Park study area, Washington, D.C., June 1999.

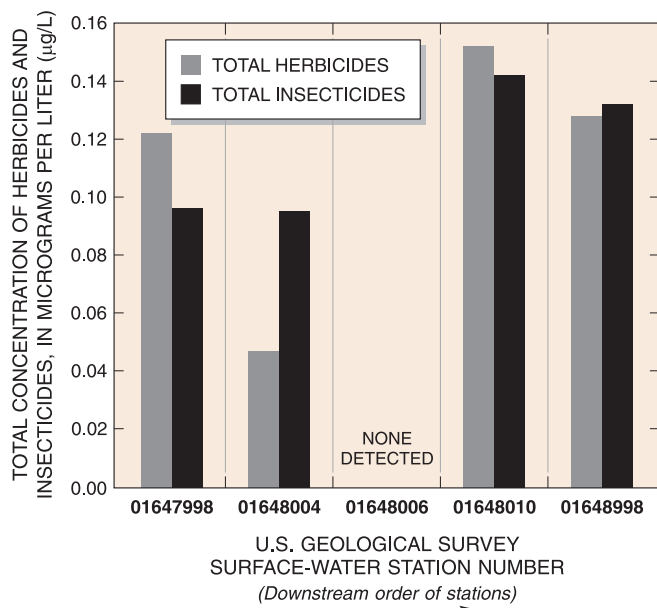


Figure 7. Total concentrations of herbicides and insecticides detected in synoptic water-quality samples in the Rock Creek Park study area, Washington, D.C., June 1999.

measurements for any of these parameters (appendix A2). These measurements were based on a single base-flow synoptic sampling event and do not account for variations that may occur seasonally or during storm events.

Temporal Surface-Water Sampling

Station 01648010, located where Joyce Road crosses Rock Creek, was sampled for pesticides over a range of flow conditions from February 18, 1999 through September 26, 2000. Insecticides that were detected at the highest concentrations and most frequently at this station were chlorpyrifos, diazinon, carbaryl, and malathion. Chlorpyrifos and diazinon are used for a variety of purposes in agricultural and urban/suburban areas, including the control of cockroaches, ants, fleas, and other insects in residential housing. Malathion is used to control mosquitoes, flies, and other insects (Extension Toxicology Network, 2001). Insecticide concentrations were above the freshwater criteria in numerous samples. Herbicides that were detected at the highest concentrations and most frequently at this station were atrazine, metolachlor, prometon, and simazine (table 10; appendix A1).

Time-series plots of discharge at station 01648010 with overlays of the concentrations of total insecticides and total herbicides measured in surface water are shown in figures 8 and 9. The seasonal behavior of both groups of chemicals also are shown. Whereas there appears to be some measurable level of pesticides year round, there still is a strong indication of seasonality, whereby higher concentrations are observed for both groups of pesticides from May through July. This result corresponds well to the growing season for agriculture and to the general timing of residential lawn treatments. A strong seasonal component for pesticide concentrations in the Potomac River Basin was also observed during the NAWQA urban/suburban and agricultural pesticide studies (Ator and others, 1998). River discharge appears to be less significant when analyzing the concentrations of pesticides in Rock Creek than periods of pesticide application.

A time-series plot of discharge with an overlay of the total concentrations of herbicides from two groups—those that are used most commonly in an urban setting (2,4-D and MCPA), and those used most commonly in an agricultural setting (atrazine, cyanazine, and metolachlor)—is shown in figure 10. These usages are not exclusive, except for metolachlor, but provide good general indicators of the types of usage in the basin (Hoffman and others, 2000). The seasonal behavior of herbicides in Rock Creek is also apparent in this plot, although the maximum concentrations for each group occurred at different times of the year. The urban-use herbicides had two small peaks, one in early spring of 1999, one in mid-summer of 2000, and one large peak in early autumn of 2000. The sporadic peaks of the urban-use herbicides likely reflect residential lawn and garden treatments, which may vary during the year. Agricultural herbicides consistently peaked in spring and early summer during the regular crop-growing season, which corresponds with the times of greatest application.

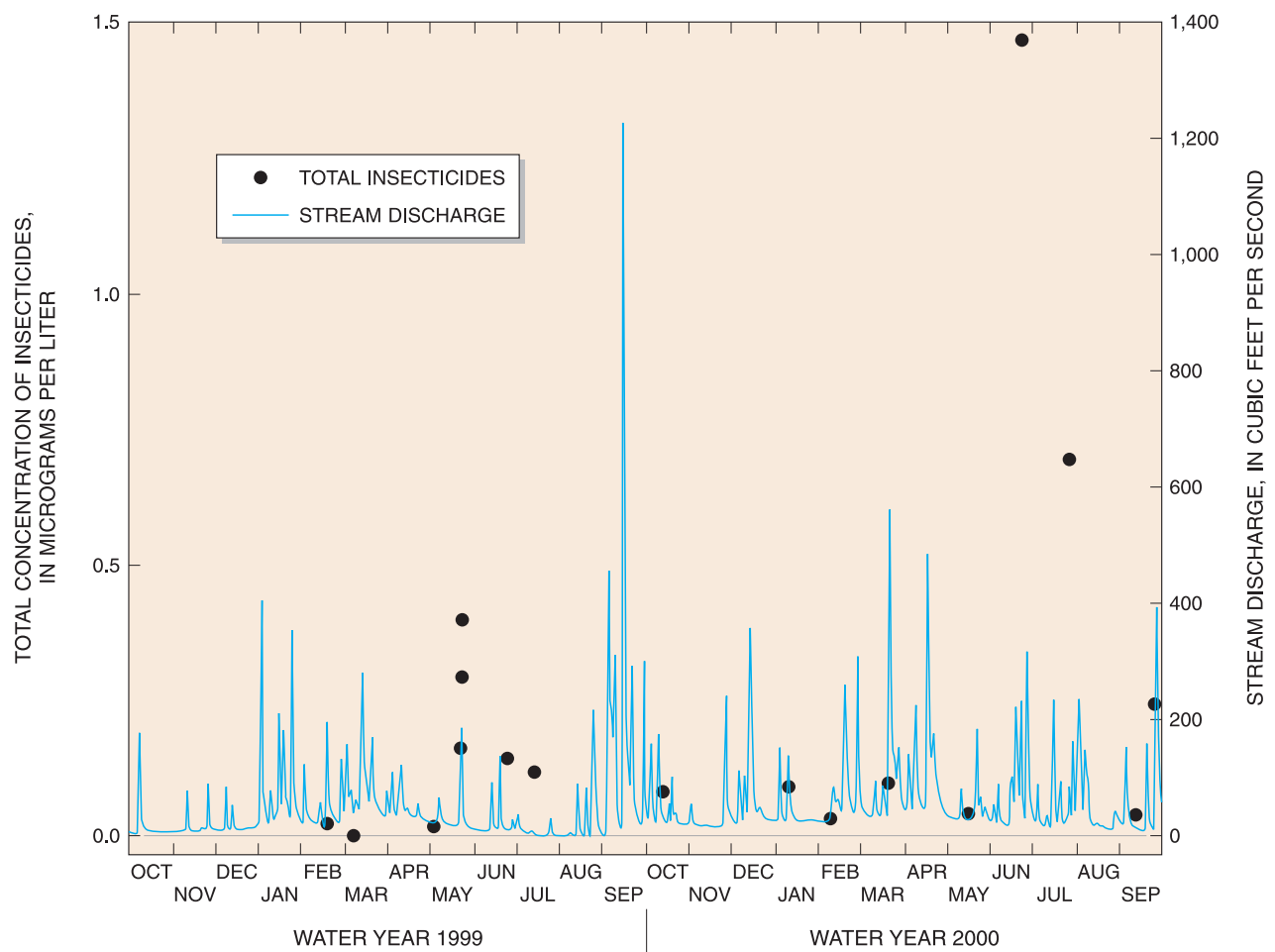


Figure 8. Stream discharge and total concentrations of insecticides at Rock Creek at Joyce Road (station 01648010) for water years 1999 and 2000 in the Rock Creek Park study area, Washington, D.C.

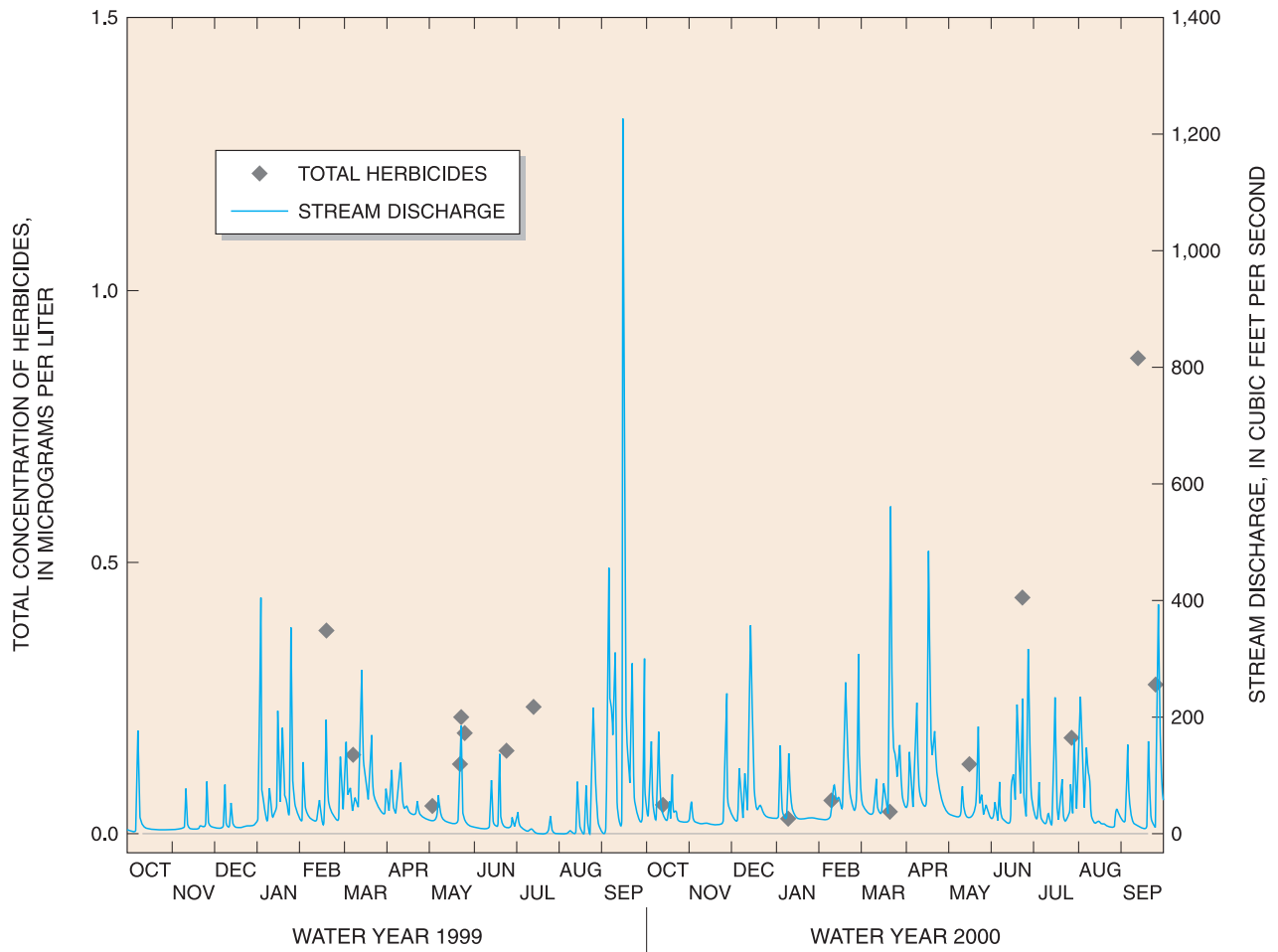


Figure 9. Stream discharge and total concentrations of herbicides at Rock Creek at Joyce Road (station 01648010) for water years 1999 and 2000 in the Rock Creek Park study area, Washington, D.C.

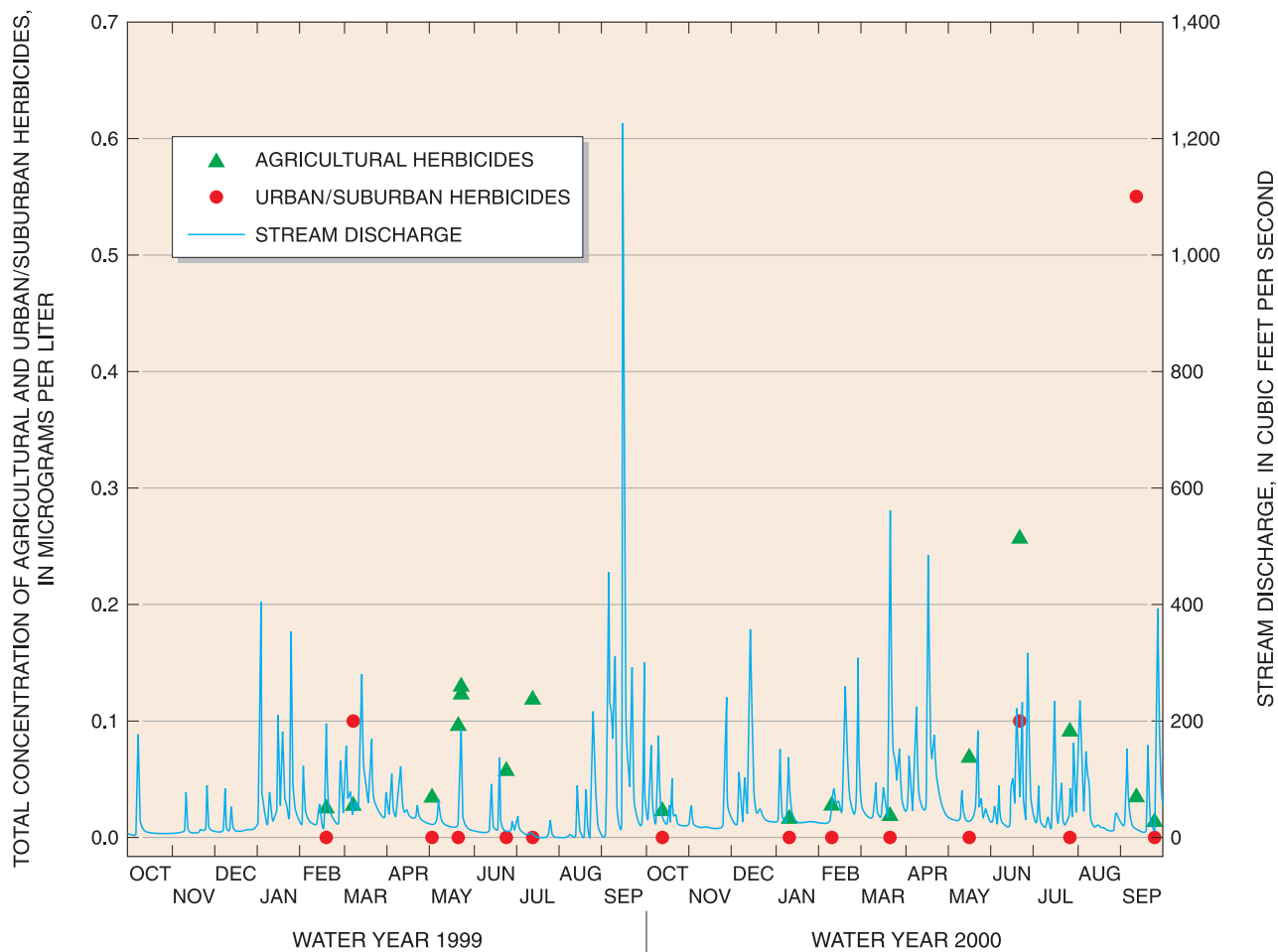


Figure 10. Stream discharge and total concentrations of herbicides used predominantly in urban/suburban (2,4-D and MCPA) or agricultural (atrazine, cyanazine, and metolachlor) environments for Rock Creek at Joyce Road (station 01648010) for water years 1999 and 2000 in the Rock Creek Park study area, Washington, D.C.

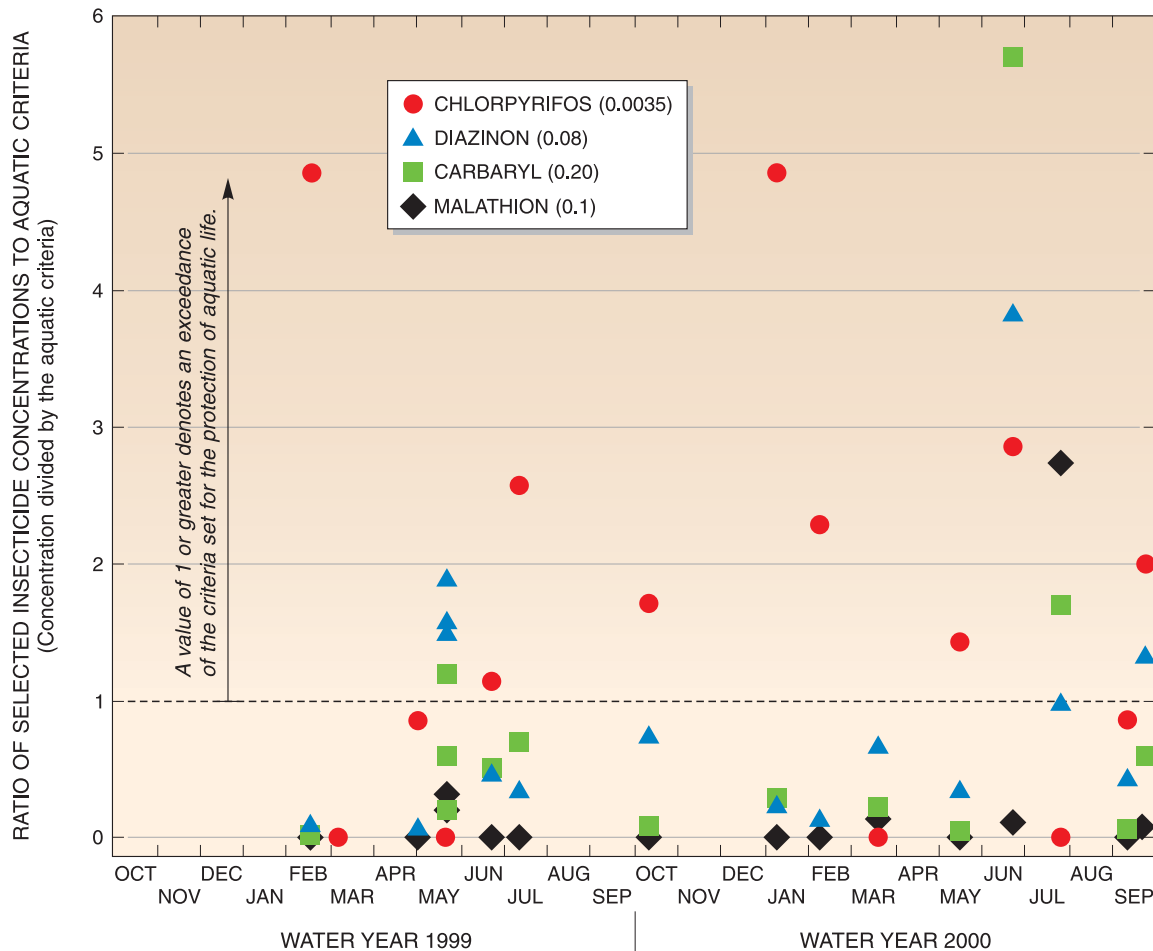


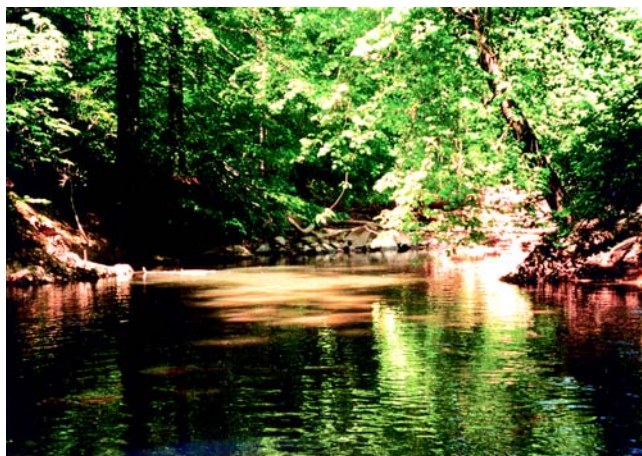
Figure 11. Ratios of selected insecticide concentrations to their respective aquatic criteria for samples collected from Rock Creek at Joyce Road (station 01648010) from October 1999 through September 2000 in the Rock Creek Park study area, Washington, D.C. (Aquatic criteria are presented in table 10 and are given here in parentheses for each compound in micrograms per liter.)

A plot of the exceedance ratios of chlorpyrifos, diazinon, carbaryl, and malathion above aquatic life criteria over the 2-year study period is shown in figure 11. The exceedance ratios on the y-axis are calculated as the pesticide concentration measured on any particular day normalized to the aquatic life criteria for each pesticide. Values equal to 1 indicate that the pesticide concentration is equal to the aquatic criteria, and values greater than 1 indicate that the pesticide concentration was above the criteria.

During water years 1999 and 2000, the peak detection times and concentrations above the aquatic criteria for diazinon, carbaryl, and malathion occurred during the late spring to early summer months of May and June. As discussed previously, these peak concentrations most likely correspond to peak application times for agricultural and

residential use of these chemicals. The concentrations of chlorpyrifos above the aquatic criteria occurred more randomly throughout the study period and indicate that usage for this chemical is not seasonal, and is possibly from multiple sources.

The Rock Creek Basin is a mixture of urban/suburban and agricultural land use. Other studies generally show that urban/suburban areas tend to have higher insecticide concentrations, and agricultural areas tend to be higher in herbicides (Barbash and others, 1997; Hoffman and others, 2000). Approximately equal total concentrations of herbicides and insecticides (over the 20-month sampling period) were found during this study, indicating that the water quality in Rock Creek is affected by the surrounding land use.



Sediment-Quality Data

Bed-sediment samples were collected at stations 01647997, 01648000, and 01648998 in Rock Creek in August 1999. The station farthest upstream (01647997) is on the Portal Branch, which is a tributary that drains into Rock Creek (fig. 2). Station 01648000 is located on the mainstem of Rock Creek, just north of the golf course, and station 01648998, which is also on the mainstem of Rock Creek, is the station farthest downstream. Organic compound and trace-element data in bed-sediment samples are summarized in table 11. Published sediment-quality guidelines for the protection of aquatic life in freshwater environments, as well as the number of samples with concentrations above these sediment criteria, are included in the table.

PAH compounds are formed in the environment primarily during combustion processes, such as the burning of fossil fuels, wood, trash, or garbage (Agency for Toxic Substances and Disease Registry, 2001). Many PAH compounds occur naturally, but they are generally found in higher concentrations in urban areas where there are more sources of combustion (such as automobiles, coal, and wood burning) and chemical manufacturing. PAH compounds are released into the atmosphere as vapors or small particles, and enter the basins either as atmospheric deposition or in runoff from urban areas. These compounds tend to be insoluble in water and reside in the particulate phase in aquatic environments. Thus, suspended and bed sediments may act as reservoirs of PAHs in aquatic systems (Agency for Toxic Substances and Disease Registry, 2001).

The total concentrations of PAHs found at each station are shown in figure 12. The station farthest upstream (01647997) had the lowest measured concentration of PAHs. This station (01647997) is on the Portal Branch. The two stations on the mainstem of Rock Creek (01648000 and 01648998) had similar concentrations of total PAHs, and the concentrations at both of these stations were higher than

those detected in the upstream station (01647997). The PAHs in the sediments in Rock Creek may be sorbed to sediment particles and transported downstream, which may explain the higher concentrations at the downstream stations, where more sediment has accumulated.

Sediment-quality criteria for the protection of aquatic life from published sources also are included in table 11. MacDonald (1994) and Long and Morgan (1990) give two thresholds of criteria. The TEL (threshold effect level) is the lowest level where effects may be expected from chronic exposure (occurring over an extended period of time, usually 7 years to a lifetime) to that compound. The PEL (probable effect level) is a higher concentration where effects on benthic biota are more likely from acute exposure (usually characterized as lasting no longer than a day). The Canadian sediment quality guidelines (Canadian Council of Ministers of the Environment, 1999) provide similar or interim criteria for freshwater benthic biota, some of which are shared with the marine values for the TEL and PEL. These data provide an assessment based on the literature on toxicity of various compounds or trace elements to different biota, and will vary as new information becomes available.

All of the low- and high-molecular weight PAH compounds that were analyzed in Rock Creek bed sediments were found at two of the three stations, and most of these compounds were found in concentrations above at least one of the sediment criteria (table 11). Sediment criteria are available for only 6 of the 16 low-molecular-weight PAHs

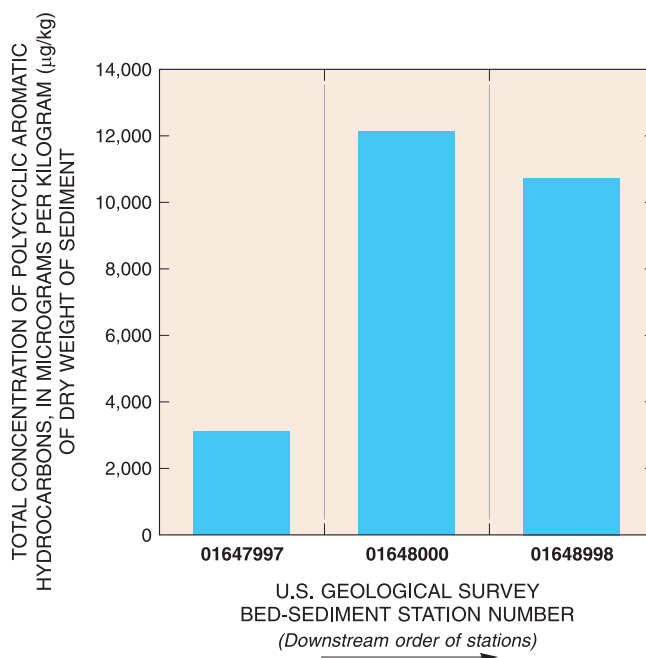


Figure 12. Total concentrations of polycyclic aromatic hydrocarbons at the bed-sediment stations sampled in the Rock Creek Park study area, Washington, D.C., August 1999.

Table 11. *Summary of contaminants in bed sediment at Rock Creek Park, Washington, D.C., and published sediment-quality criteria for the protection of aquatic life*

[References and abbreviations: *A*, Long and Morgan (1990) and MacDonald (1994) sediment assessment guidelines for Florida coastal waters, including the threshold effects level (TEL), which is the lowest concentration that might cause effects from chronic exposure, and the probable effects level (PEL), which is the concentration at which acute effects are more likely; *B*, Canadian Council of Ministers of the Environment (1999) interim freshwater sediment quality guidelines (ISQG) and PEL; –, no data available; E, estimated value (concentration was below the reporting limit and warrants less confidence); NC, no criteria established for this contaminant; <, less than; **LMW PAHs**, low-molecular-weight polycyclic aromatic hydrocarbons; **HMW PAHs**, high-molecular-weight polycyclic aromatic hydrocarbons; **PCBs**, polychlorinated biphenyls; µg/kg, microgram per kilogram; mg/kg, milligram per kilogram; sediment samples were collected from stations 01647997, 01648000 and 01648998 in August 1999]

	Sediment assessment guidelines for Florida coastal waters ^A		Canadian water-quality guidelines for the protection of aquatic life ^B		Concentrations of contaminants at three sediment stations in Rock Creek			Number of samples above any sediment criteria
Analyte	TEL	PEL	ISQG	PEL	01647997	01648000	01648998	
LOW-MOLECULAR-WEIGHT POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)								
4,5-Methylene-phenanthrene	–	–	–	–	E 20	130	120	NC
Anthraquinone	–	–	–	–	100	380	280	NC
Acenaphthene	6.71	88.9	6.71	88.9	<50	E 10	E 30	2
Acenaphthylene	5.87	128	5.87	128	E 40	70	E 60	3
Acridine	–	–	–	–	<50	60	E 40	NC
2-Methyl-anthracene	–	–	–	–	E 10	E 20	E 20	NC
Anthracene	46.9	245	46.9	245	60	160	190	3
Carbazole	–	–	–	–	E 10	130	110	NC
<i>p</i> -Cresol	–	–	–	–	<50	80	400	NC
Dibenzothiophene	–	–	–	–	E 20	60	E 50	NC
Fluorene	21.1	144	21.2	144	< 50	E 30	E 40	2
1-Methyl-phenanthrene	–	–	–	–	<50	E 30	E 30	NC
2,6-Dimethyl-naphthalene	–	–	–	–	<50	E 30	E 40	NC
Naphthalene	34.6	391	34.6	391	<50	E 40	<100	1
Phenanthrene	86.7	544	41.9	515	240	930	830	3
Phenol	–	–	–	–	<50	E 30	E 40	NC
Total LMW PAHs	312	1,442	–	–	500	2,190	2,280	3

Table 11. *Summary of contaminants in bed sediment at Rock Creek Park, Washington, D.C., and published sediment-quality criteria for the protection of aquatic life—Continued*

	Sediment assessment guidelines for Florida coastal waters ^A		Canadian water-quality guidelines for the protection of aquatic life ^B		Concentrations of contaminants at three sediment stations in Rock Creek			Number of samples above any sediment criteria
Analyte	TEL	PEL	ISQG	PEL	01647997	01648000	01648998	
HIGH-MOLECULAR-WEIGHT POLYCYCLIC AROMATIC HYDROCARBONS (µg/kg)								
Benz(a)anthracene	74.8	693	31.7	385	210	690	660	3
Benzo(a)pyrene	88.8	763	31.9	782	240	880	810	3
Benzo[b]fluoranthene	—	—	—	—	160	820	880	NC
Benzo[ghi]perylene	—	—	—	—	140	640	420	NC
Benzo[k]fluoranthene	—	—	—	—	160	820	880	NC
Chrysene	108	846	57.1	862	260	1,200	1,000	3
Dibenz(a,h) anthracene	6.22	135	6.22	135	E 40	140	210	3
Fluoranthene	113	1,494	111	2355	500	2,000	1,600	3
Indeno[1,2,3-cd] pyrene	—	—	—	—	180	750	550	NC
Pyrene	153	1,398	53.0	875	410	1,600	1200	3
Total HMW PAHs	655	6,676	—	—	2,300	9,540	8,210	3
Total PAHs	1,684	16,770	—	—	2,800	11,730	10,490	3
TOTAL POLYCHLORINATED BIPHENYLS (µg/kg)								
Total PCBs	21.6	189	34.1	277	<50	80	50	2

Table 11. Summary of contaminants in bed sediment at Rock Creek Park, Washington, D.C., and published sediment-quality criteria for the protection of aquatic life—Continued

Analyte	Sediment assessment guidelines for Florida coastal waters ^A		Canadian water-quality guidelines for the protection of aquatic life ^B		Concentrations of contaminants at three sediment stations in Rock Creek			Number of samples above any sediment criteria
	TEL	PEL	ISQG	PEL	01647997	01648000	01648998	
PESTICIDES (µg/kg)								
Aldrin	—	—	—	—	<1	<1	<1	NC
Chlordane (<i>cis</i> - plus <i>trans</i> -)	2.26	4.79	4.50	8.87	4	13	13	3
<i>o,p'</i> -DDD ¹	—	—	—	—	<1	3	<1	NC
<i>p,p'</i> -DDD ²	1.22	7.81	3.54	2 8.51	E 6	4	E	3
<i>o,p'</i> -DDE ³	—	—	—	—	<1	<1	<1	NC
<i>p,p'</i> -DDE ⁴	2.07	—	1.42	6.75	2	4	7	3
<i>p,p'</i> -DDT ⁵	1.19	4.77	1.19	4.77	7	4	8	3
Total DDT	3.89	51.7	—	—	11	15	21	3
Dieldrin	.715	4.3	2.85	6.67	2	3	3	3
Endosulfan	—	—	—	—	<1	<1	<1	NC
Endrin	—	—	2.67	62.4	<2	<2	<2	0
Heptachlor	—	—	—	—	<1	<1	<1	NC
Heptachlor epoxide	—	—	.60	2.74	<1	2	2	2
Lindane	.32	.99	.94	1.38	<1	<1	<1	0
Mirex	—	—	—	—	<1	<1	<1	NC

¹. 1,1-Dichloro-2-(*o*-chlorophenyl)-2-(*p*-chlorophenyl)ethane.

². 1,1-Dichloro-2,2-bis(*p*-chlorophenyl)ethane.

³. 1,1-Dichloro-2-(*o*-chlorophenyl)-2-(*p*-chlorophenyl)ethylene.

⁴. 1,1-Dichloro-2,2-bis(*p*-chlorophenyl)ethylene.

⁵. 1,1,1-Trichloro-2,2-bis(*p*-chlorophenyl)ethane.

Table 11. *Summary of contaminants in bed sediment at Rock Creek Park, Washington, D.C., and published sediment-quality criteria for the protection of aquatic life—Continued*

	Sediment assessment guidelines for Florida coastal waters ^A		Canadian water-quality guidelines for the protection of aquatic life ^B		Concentrations of contaminants at three sediment stations in Rock Creek			Number of samples above any sediment criteria
Analyte	TEL	PEL	ISQG	PEL	01647997	01648000	01648998	
PHthalATES (µg/kg)								
Bis(2-ethylhexyl) phthalate	182	2,647	—	—	420	2,200	2,100	3
Butylbenzyl phthalate	—	—	—	—	E 30	90	E 50	NC
Diethyl phthalate	—	—	—	—	E 10	E 20	<100	NC
Dimethyl phthalate	—	—	—	—	<50	<50	<100	NC
Dioctylphthalate	—	—	—	—	60	<50	180	NC
Di- <i>n</i> -butyl phthalate	—	—	—	—	E 30	90	E 50	NC
Total Phthalates	—	—	—	—	550	2,400	2,380	NC
TRACE ELEMENTS (mg/kg)								
Arsenic	7.24	41.6	5.90	17.0	5.70	6.90	7.40	2
Cadmium	.676	4.21	.60	3.5	1.30	1.20	1.50	3
Chromium	52.3	160	37.3	90.0	110	150	160	3
Copper	18.7	108	35.7	197	150	130	170	3
Lead	30.2	112	35.0	91.3	110	98	150	3
Mercury	.13	.696	.17	.486	.21	1.40	.32	3
Nickel	15.9	42.8	—	—	70	94	99	3
Silver	.733	1.77	—	—	.50	.60	.50	0
Zinc	124	271	123	315	410	370	450	3

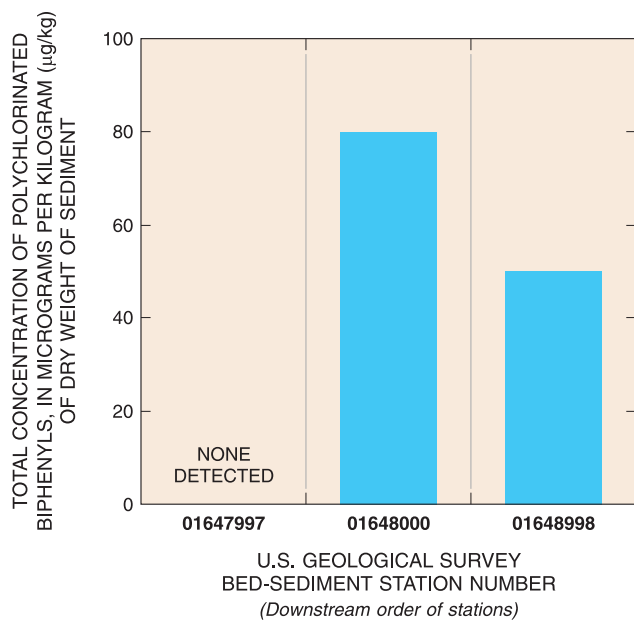


Figure 13. Total concentrations of polychlorinated biphenyls at the bed-sediment stations sampled in the Rock Creek Park study area, Washington, D.C., August 1999.

that were analyzed. Concentrations of these six low-molecular-weight PAHs were above their respective TELs at all three stations from which bed sediments were collected; however, the concentration of only one of these compounds (phenanthrene) was above the PEL at stations 01648000 and 01648998. Sediment criteria are available for only 6 of the 10 high-molecular-weight PAHs that were analyzed. Concentrations of all six of these high-molecular-weight PAHs were above their respective TELs at all three stations. Concentrations were above the PELs for benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthracene, and indeno[1,2,3-cd]pyrene at station 01648000, and for benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, and fluoranthracene at station 01648998. These concentrations indicate that the toxicity to aquatic life may be higher at downstream stations (01648000 and 01648998) than toxicity at the Portal Branch (station 01647997).

PCBs are synthetic organic compounds; there are no known natural sources of PCBs in the environment (Agency for Toxic Substances and Disease Registry, 2001). PCBs most commonly enter the environment from leaking electrical fixtures, where they have been used in the past as non-flammable insulating materials. PCBs are relatively soluble in water, but also can attach to sediment particles and organic matter. These compounds have a strong potential for bioaccumulation and biomagnification (Agency for Toxic Substances and Disease Registry, 2001). Production of PCBs was stopped in 1997 because of documented harm-

ful effects, but a number of transformers and other types of electrical equipment that contain PCBs have not been decommissioned. PCBs were detected in bed sediment at the two mainstem stations (01648000 and 01648998), but not at station 01647997 (fig. 13). The concentrations of PCBs at both of the mainstem stations were above the TEL but not the PEL for bed sediment.

Selected pesticides and transformation products were also analyzed in the bed-sediment samples collected from all three stations. Complete results are presented in appendixes A3 and A4, and a summary of parent compounds and their transformation products are presented in appendix C. A summary of the concentrations of selected pesticides and transformation products that were analyzed in the bed-sediment samples is listed in table 11. Chlordane (*cis*- plus *trans*-) concentrations were above only the TEL in the sample collected from station 01647997. Chlordane concentrations were above both the TEL and the PEL in samples collected from stations 01648000 and 01648998. 1,1-Dichloro-2,2-bis(*p*-chlorophenyl)ethane (DDD) and dieldrin concentrations were above only the TEL in samples collected from all three stations. 1,1-Dichloro-2,2-bis(*p*-chlorophenyl)ethylene (DDE) concentrations were above both the TEL and the PEL in the sample collected from station 01648998, but only above the TEL in samples collected from stations 01647997 and 01648000. DDT concentrations were above both the TEL and the PEL in samples collected at all three bed sediment stations. Heptachlor epoxide concentrations were above only the TEL in samples collected from stations 01648000 and 01648998. All of these compounds are toxic organochlorines that have been either banned or discontinued for usage. Therefore, they are "legacy" compounds, or transformation products of these compounds, from earlier applications. A summary of the total DDT compounds (DDT, DDE, and DDD) that were found at each of the bed-sediment stations at Rock Creek is shown in figure 14. The concentration of DDT at station 01647997 is greater than the sum of its two transformation products, DDE and DDD; however, the concentration of DDT at stations 01648000 and 01648998 is lower than the sum of its transformation products.

Overall, the two mainstem stations (01648000 and 01648998) appear to have higher concentrations of DDT and its transformation products (15 and 21 µg/kg, or micrograms per kilogram) than station 01647997 (11 µg/kg). The total organic carbon concentration was lower at station 01647997 (2.7 percent) when compared to concentrations at the two mainstem stations (4.3 and 5.7 percent). The total concentrations of DDT, DDE, and DDD at each station correlate well with the percentage of total organic carbon in the sediment (Pearson correlation coefficient, *r* equals 0.988). These concentrations indicate that these three compounds are likely associated with the organic fraction of the sediments.

Phthalate compounds are a group of manmade chemicals that are commonly used in the production of plastic materials. They can also be used as ingredients in paints, inks,

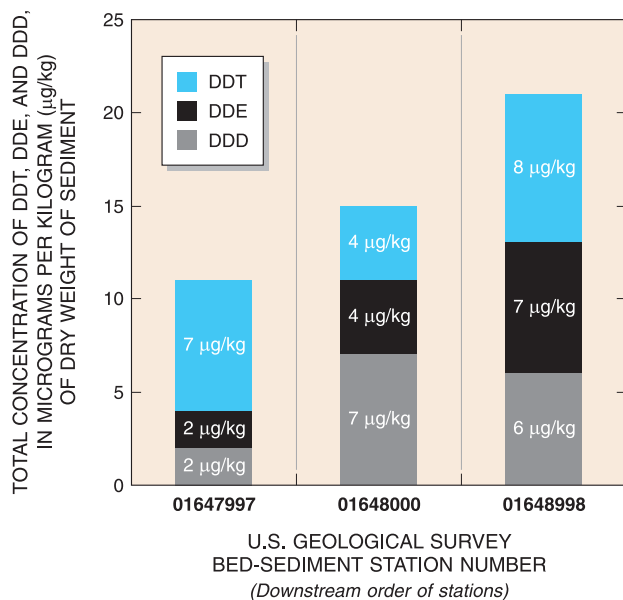


Figure 14. Total concentrations of DDT, DDE, and DDD at the bed-sediment stations sampled in the Rock Creek Park study area, Washington, D.C., August 1999.

pesticides, cosmetics, and a number of other industrial products. These compounds are generally released to the environment from factories or landfills and waste disposal sites. Phthalates are very particle-reactive and tend to accumulate in sediments. Aquatic criteria currently are only available for bis(2-ethylhexyl)phthalate. In Rock Creek sediments, this phthalate compound was above the TEL at all three stations (01647997, 01648000, and 01648998). The two mainstem stations had concentrations that were close to but not above the PELs.

Concentrations of trace elements were measured at the three bed-sediment stations in Rock Creek. Trace elements can come from a variety of natural and manmade sources, but they generally tend to be higher in populated areas (Daskalakis and O'Conner, 1995; Rice, 1999). Enrichment of lead, copper, mercury, zinc, and sometimes cadmium and chromium is common in urban streams. Some trace elements, such as copper, arsenic, and zinc, can have agricultural sources as well.

The concentrations of metals in bed sediment were above the TEL at all three bed-sediment sampling stations for all of the heavy metals except arsenic and silver. The criteria were above the PEL at least once each for chromium, copper, lead, mercury, nickel, and zinc. Arsenic concentrations were close to the TEL at all three stations. In general, the spatial distribution of the concentrations of trace elements did not follow the same pattern that was evident for organic compounds. Chromium and nickel appeared to have higher concentrations in the two mainstem stations, but

there are not enough data to determine if this difference is statistically significant.

Data Analysis and Comparison of Stream-Channel Classifications

Bankfull indicators from the longitudinal survey were plotted, and a line was drawn through the bankfull indicator elevations and extended to the location of the staff gage at the streamflow-gaging station. The line indicated a bankfull stage of 6.75 ft, gage datum, as of May 1999. Based on data, the stage-discharge rating for the station indicates a bankfull discharge of about 1,530 ft³/s (cubic feet per second). This discharge corresponds to a flood event of approximately 1.4 years, based on analysis of the flood peaks that have occurred since the upstream lakes were constructed in the basin beginning in 1966 (data on file, U.S. Geological Survey, Baltimore, Maryland).

Longitudinal and cross-sectional data were then used to calculate the variables necessary for classification. These variables are summarized in table 9. Based on the slope, width/depth ratio, entrenchment ratio, sinuosity, and mean channel material size, the reach was classified as a C5 channel according to the Rosgen stream-channel classification system. This classification indicates that this reach of Rock Creek can be described as a single thread channel that is slightly entrenched, with a moderate width/depth ratio and high sinuosity. The predominant channel material is sand. The applicability of this Rosgen classification depends upon the stability of the stream channel, the dynamic nature of recharge to Rock Creek, the large amount of impervious surfaces in the basin, and the partial regulation of the flows from Lake Needwood and Lake Bernard Frank upstream of the streamflow-gaging station in Montgomery County, Maryland. Regulation of the flows currently affects about 25 mi² of the 62 mi² of the basin upstream of the streamflow-gaging station (James and others, 2001).

An earlier Rosgen stream-channel classification had been performed in the same reach for NPS by a consultant in 1989 (Douglas Curtis, National Park Service, written commun., 2001). In the 1989 classification, the reach was classified as a C3 channel (Douglas Curtis, National Park Service, written commun., 2001), and the predominant channel material was cobbles. A comparison of the 1989 and 1999 Rosgen evaluations indicate the presence of additional deposits of sand that are being stored in the reach and currently overlay the older cobble channel materials.

Summary and Conclusions

In 1999, the U.S. Geological Survey began an investigation of the water quality and sediment quality of Rock Creek (in the Washington, D.C. area) in cooperation with the National Park Service, to determine the effect of surrounding land use. From February 1999 through September 2000, synoptic water-quality, temporal (over a 20-month period) water-quality, and bed-sediment samples were collected and analyzed. Eighty-six pesticide compounds (parent compounds and selected transformation products) were analyzed in the synoptic and temporal water-quality samples. A total of 17 polycyclic aromatic hydrocarbons, 21 pesticides, 6 phthalates, 10 trace elements, and polychlorinated biphenyls (total) were analyzed from the bed-sediment samples.

Of the pesticide compounds in the synoptic and temporal water-quality samples, five were detected at concentrations above the published recommended criteria for the protection of aquatic life: carbaryl, chlorpyrifos, diazinon, dieldrin, and malathion. Of the 17 polycyclic aromatic hydrocarbons analyzed in bed-sediment samples, 12 were detected at concentrations above the published recommended criteria for the protection of aquatic life: acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene, benz(a)anthracene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, and pyrene. All pesticides and pesticide transformation products that were above the aquatic criteria in bed sediments are currently banned and provide evidence of past usage: chlordane; 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane (DDT); 1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethylene (DDE); 1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethane (DDD); dieldrin; and heptachlor epoxide. Various phthalate compounds were also found in bed sediment and at least one of these compounds, bis(2-ethylhexyl)phthalate, may indicate a risk to the health of benthic biota. The trace elements that were measured in bed sediment were above the threshold effect level at all three stations for all of the heavy metals except arsenic and silver, and above the probable effect level at least once each for chromium, copper, lead, mercury, nickel, and zinc. Aluminum and iron concentrations also appeared to be very similar among the three bed-sediment stations, indicating similar matrices in the bed sediments.

Data from this study indicate that there are a number of contaminants in Rock Creek with concentrations that are above established criteria for the protection of aquatic life, both in the water column and in bed sediment. The additive and possibly synergistic effects of these contaminants on the biota are beyond the scope of this report. Information on the long-term chronic effects of many of these contaminants is limited. The results of this study strongly indicate that the water and sediment quality may adversely affect the biota in this environment; however, the biota in Rock Creek were not assessed in this study.

The Rock Creek Basin is approximately 46 percent urban/suburban and 21 percent agricultural. Almost all of the agricultural land use is in the upper part of the basin north of Rock Creek Park. Land use in the lower part of the basin, south of the Maryland–Washington, D.C. boundary, is approximately 61 percent urban/suburban. The results of the current study indicate that both urban and agricultural land use have influenced the water and sediment quality of Rock Creek within the park boundaries. Pesticides are likely coming from multiple sources, and it is difficult to make correlations between specific sources and the concentrations of these compounds that are found in the river and sediments.

In May 1999, a reach of approximately 900 feet near station 01648000, near Sherrill Drive, was classified according to the Rosgen system of stream-channel classification. At this time, Rock Creek was classified as a C5 channel according to the Rosgen system. A previous classification of this same reach, performed in 1989, had classified this reach as a C3 channel according to the Rosgen system. These two classifications indicate that sands and other fine-grained sediments, probably transported from development within the basin, are being deposited in Rock Creek and currently overlie the original cobble channel materials. These sediments may act as an ongoing reservoir for polycyclic aromatic hydrocarbons, polychlorinated biphenyls, pesticides and their transformation products, phthalates, and trace elements, presenting a long-term source of these compounds to the biota in Rock Creek.

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Appendixes A through C follow

Appendix A1. *Results of analyses for dissolved pesticides for synoptic water-quality samples collected in June 1999, and temporal water-quality samples collected from February 18, 1999 through September 26, 2000 in surface water in Rock Creek, Washington, D.C.*

[Filtered samples were filtered using a 0.7-micron Gelman filter. USGS, U.S. Geological Survey; µg/L, micrograms per liter; <, less than; α, alpha; E, estimated value less than the method reporting level; –, no data available]

USGS station number	USGS station name	Date	Time	2,4,5-T, ¹ water, dissolved (µg/L)	2,4-D, ² water, dissolved (µg/L)	2,4-DB, ³ water, dissolved (µg/L)	2,6-Diethyl- aniline, water, dissolved (µg/L)	3-Hydroxy- carbofuran, water, dissolved (µg/L)
SYNOPTIC SAMPLING								
1647998	Rock Creek below West Beach Drive, Washington, D.C.	06/23/1999	1800	<0.04	<0.15	<0.24	<0.003	<0.29
1648004	Pinehurst Branch at Oregon Avenue, Washington, D.C.	06/24/1999	1510	< .04	< .15	< .24	< .003	< .01
1648006	Rock Creek tributary at Golf Course, Washington, D.C.	06/24/1999	1010	< .04	< .15	< .24	< .003	< .01
1648010	Rock Creek at Joyce Road, Washington, D.C.	06/25/1999	0930	< .04	< .15	< .24	< .003	< .06
1648998	Rock Creek Q Street, Washington, D.C.	06/23/1999	1150	< .04	< .15	< .24	< .003	< .52
TEMPORAL SAMPLING								
1648010	Rock Creek at Joyce Road, Washington, D.C.	02/18/1999	1115	<0.04	<0.40	<0.24	<0.003	<0.01
1648010	Rock Creek at Joyce Road, Washington, D.C.	03/09/1999	1018	< .04	.10	< .24	< .003	< .01
1648010	Rock Creek at Joyce Road, Washington, D.C.	05/04/1999	1130	< .04	< .15	< .24	< .003	< .45
1648010	Rock Creek at Joyce Road, Washington, D.C.	05/23/1999	0045	< .04	< .76	< .24	< .003	< .44
1648010	Rock Creek at Joyce Road, Washington, D.C.	05/24/1999	1100	< .04	< .81	< .24	< .003	< .62

¹. 2,4,5-Trichlorophenoxyacetic acid.

². (2,4-Dichlorophenoxy)acetic acid.

³. 4-(2,4-Dichlorophenoxy)butyric acid.

Acetochlor, water, dissolved (µg/L)	Acifluorfen, water, dissolved (µg/L)	Alachlor, water, dissolved (µg/L)	Aldicarb sulfone, water, dissolved (µg/L)	Aldicarb sulfoxide, water, dissolved (µg/L)	Aldicarb, water, dissolved (µg/L)	α-HCH, ⁴ water, dissolved (µg/L)	USGS station number
<0.002	<0.04	<0.002	<0.38	<0.30	<3.17	<0.002	1647998
< .002	< .04	< .002	< .10	< .02	< .55	< .002	1648004
< .002	< .04	< .002	< .10	< .02	< .55	< .002	1648006
< .002	< .04	< .002	< .10	< .02	< .55	< .002	1648010
< .002	< .04	< .002	< .10	< .02	<4.47	< .002	1648998
<0.002	<0.04	<0.002	<0 .10	<0.02	<0.55	<0.002	1648010
< .002	< .04	< .002	< .10	< .02	< .55	< .002	1648010
< .002	< .04	< .002	< .77	< .02	< .55	< .002	1648010
< .002	< .04	< .002	< .88	< .02	< .55	< .002	1648010
< .002	< .04	< .012	< .10	< .02	< .89	< .002	1648010

⁴. α-1,2,3,4,5,6-Hexachlorocyclohexane.

Appendix A1. *Results of analyses for dissolved pesticides for synoptic water-quality samples collected in June 1999, and temporal water-quality samples collected from February 18, 1999 through September 26, 2000 in surface water in Rock Creek, Washington, D.C.*
—Continued

USGS station number	USGS station name	Date	Time	2,4,5-T, ¹ water, dissolved (µg/L)	2,4-D, ² water, dissolved (µg/L)	2,4-DB, ³ water, dissolved (µg/L)	2,6-Diethyl- aniline, water, dissolved (µg/L)	3-Hydroxy- carbofuran, water, dissolved (µg/L)
TEMPORAL SAMPLING—Continued								
1648010	Rock Creek at Joyce Road, Washington, D.C.	05/24/1999	1145	<0.04	<0.95	<0.24	<0.003	<0.24
1648010	Rock Creek at Joyce Road, Washington, D.C.	07/14/1999	0920	< .04	< .15	< .24	< .003	< .69
1648010	Rock Creek at Joyce Road, Washington, D.C.	10/13/1999	0930	< .04	< .11	< .10	< .003	< .13
1648010	Rock Creek at Joyce Road, Washington, D.C.	01/10/2000	1430	< .04	< .32	< .10	< .003	< .11
1648010	Rock Creek at Joyce Road, Washington, D.C.	02/09/2000	1300	< .04	< .26	< .10	< .003	< .11
1648010	Rock Creek at Joyce Road, Washington, D.C.	03/21/2000	1200	< .04	< .39	< .10	< .003	< .17
1648010	Rock Creek at Joyce Road, Washington, D.C.	05/16/2000	1145	< .04	< .11	< .10	< .003	< .16
1648010	Rock Creek at Joyce Road, Washington, D.C.	06/22/2000	1000	< .04	< .73	< .10	< .003	< .11
1648010	Rock Creek at Joyce Road, Washington, D.C.	07/26/2000	0900	< .04	< .34	< .16	< .003	<41.6
1648010	Rock Creek at Joyce Road, Washington, D.C.	09/11/2000	1230	< .04	< .11	< .10	< .003	< .30
1648010	Rock Creek at Joyce Road, Washington, D.C.	09/26/2000	0945	< .04	.55	< .10	< .003	< .11

Acetochlor, water, dissolved (µg/L)	Acifluorfen, water, dissolved (µg/L)	Alachlor, water, dissolved (µg/L)	Aldicarb sulfone, water, dissolved (µg/L)	Aldicarb sulfoxide, water, dissolved (µg/L)	Aldicarb, water, dissolved (µg/L)	α-HCH, ⁴ water, dissolved (µg/L)	USGS station number
<0.002	<0.04	<0.014	<0.10	<0.02	<0.55	<0.002	1648010
< .002	< .04	< .002	< .10	< .02	< .55	< .002	1648010
< .002	< .09	< .002	<1.05	< .02	< .67	< .002	1648010
< .002	< .09	< .002	< .10	< .02	<1.66	< .002	1648010
< .002	< .09	< .002	< .10	< .18	< .21	< .002	1648010
< .002	< .09	< .002	< .10	< .02	<2.26	< .002	1648010
< .002	< .09	< .002	< .11	< .02	< .22	< .002	1648010
.013	< .09	< .002	< .27	< .15	< .38	< .002	1648010
< .002	< .09	< .002	<4.29	< .02	<12.1	< .002	1648010
< .002	< .09	< .002	< .10	< .45	< .21	< .002	1648010
< .002	< .09	< .002	< .30	< .33	< .23	< .002	1648010

Appendix A1. *Results of analyses for dissolved pesticides for synoptic water-quality samples collected in June 1999, and temporal water-quality samples collected from February 18, 1999 through September 26, 2000 in surface water in Rock Creek, Washington, D.C.*
—Continued

USGS station number	Atrazine, water, dissolved (µg/L)	BDMC, ⁵ surrogate (percent)	Benfluralin, water, dissolved (µg/L)	Bentazon, water, dissolved (µg/L)	Bromacil, water, dissolved (µg/L)	Bromoxynil, water, dissolved (µg/L)	Butylate, water, dissolved (µg/L)
SYNOPTIC SAMPLING—Continued							
1647998	0.042	97	<0.002	<0.01	<0.44	<0.04	<0.002
1648004	.011	88	< .003	< .01	< .04	< .04	< .002
1648006	< .001	90	< .002	< .01	< .04	< .04	< .002
1648010	.041	150	< .002	< .01	< .18	< .04	< .002
1648998	.033	90	< .002	< .01	< .49	< .13	< .002
TEMPORAL SAMPLING—Continued							
1648010	0.010	94	<0.002	<0.01	<0.40	<0.04	<0.002
1648010	.017	E 131	< .002	< .01	< .04	< .04	< .002
1648010	.023	56	< .002	< .01	< .13	< .04	< .002
1648010	.058	73	< .002	< .01	<1.09	< .04	< .002
1648010	.064	127	E .002	< .01	< .50	< .04	< .002
1648010	.065	124	E .003	< .01	< .10	< .04	< .002
1648010	.087	66	< .002	< .01	< .45	< .04	< .002
1648010	.013	69	< .002	< .04	< .12	< .04	< .002
1648010	.011	100	< .002	< .04	< .15	< .04	< .002
1648010	.016	105	.002	< .04	< .21	< .04	< .002
1648010	.010	85	.004	< .04	< .23	< .04	< .002
1648010	.039	78	< .002	< .04	< .06	< .04	< .002
1648010	.145	109	< .002	< .04	< .29	< .04	< .002
1648010	.063	111	< .002	< .04	< .67	< .04	< .002
1648010	.023	91	< .002	< .04	< .19	< .04	< .002
1648010	< .001	127	< .002	< .04	< .06	< .04	< .002

⁵. 4-Bromo-3,5-dimethylphenyl-*n*-methylcarbamate.

Carbaryl, water, dissolved (µg/L) (2050) ⁶	Carbaryl, water, dissolved (µg/L) (2001) ⁶	Carbofuran, water, dissolved (µg/L) (2050) ⁶	Carbofuran, water, dissolved (µg/L) (2001) ⁶	Chloramben, methyl ester, water, dissolved (µg/L)	Chlorothalonil, water, dissolved (µg/L)	Chlorpyrifos, water, dissolved (µg/L)	USGS station number
<0.01	E 0.029	<0.12	<0.003	—	<0.48	0.004	1647998
.05	E .088	< .12	< .003	—	< .48	E .003	1648004
< .01	< .003	< .12	< .003	—	< .48	< .004	1648006
< .01	E .10	< .12	< .003	—	< .48	.004	1648010
< .01	E .049	< .12	< .003	—	< .48	< .004	1648998
<0.01	<0.003	<0.26	<0.003	—	<0.48	0.017	1648010
< .01	< .003	< .12	< .003	—	< .48	< .004	1648010
< .01	E .008	< .12	< .003	—	< .48	E .003	1648010
< .01	E .041	< .12	< .003	—	< .48	< .004	1648010
.12	E .17	< .12	< .003	—	< .48	< .017	1648010
.24	E .41	< .12	< .003	—	< .48	< .020	1648010
E .03	E .14	< .12	< .003	—	< .48	.009	1648010
< .07	E .015	< .29	< .003	—	< .48	.006	1648010
< .07	E .055	< .29	< .003	<0.14	< .48	.017	1648010
< .07	E .012	< .29	< .003	< .14	< .48	E .008	1648010
< .07	E .042	< .29	< .003	< .14	< .48	< .004	1648010
< .07	E .007	< .29	< .003	< .14	< .48	.005	1648010
1.14	E 1.7	< .29	< .003	< .14	< .48	.010	1648010
.34	E .52	< .29	< .006	< .14	< .48	< .004	1648010
< .07	E .009	< .29	< .003	< .14	< .48	E .003	1648010
.12	E .22	< .29	< .003	< .14	< .48	.007	1648010

⁶ U.S. Geological Survey National Water-Quality Laboratory analytical schedule numbers.

Appendix A1. *Results of analyses for dissolved pesticides for synoptic water-quality samples collected in June 1999, and temporal water-quality samples collected from February 18, 1999 through September 26, 2000 in surface water in Rock Creek, Washington, D.C.*
—Continued

USGS station number	Cyanazine, water, dissolved (µg/L)	Dacthal monoacid, dissolved (µg/L)	Dacthal, dissolved (µg/L)	Desethyl- atrazine, water, dissolved (µg/L)	Diazinon-d10, surrogate, (percent)	Diazinon, water, dissolved (µg/L)	Dicamba, water, dissolved (µg/L)
SYNOPTIC SAMPLING—Continued							
1647998	<0.004	<0.02	<0.002	E 0.043	99	0.063	<0.04
1648004	< .004	< .02	< .002	E .006	74	.036	< .04
1648006	< .004	< .02	< .002	< .002	112	< .002	< .04
1648010	< .004	< .02	< .002	E .070	104	.038	< .04
1648998	< .004	< .02	< .002	E .021	105	.083	< .04
TEMPORAL SAMPLING—Continued							
1648010	<0.004	<0.02	<0.002	E 0.010	91	0.007	<0.04
1648010	< .004	< .02	< .002	E .043	92	E .003	< .04
1648010	< .004	< .02	< .002	E .084	98	.006	< .04
1648010	.008	< .02	< .002	E .064	105	.120	< .04
1648010	.009	< .02	< .002	E .030	101	.152	< .04
1648010	< .004	< .13	< .002	E .044	94	.127	< .04
1648010	< .004	< .02	< .002	E .063	134	.028	< .04
1648010	< .004	< .04	< .002	E .038	120	.060	< .10
1648010	< .004	< .04	< .002	E .034	120	.019	< .04
1648010	< .004	< .04	E .002	E .058	106	.011	< .04
1648010	< .004	< .04	< .002	E .033	97	.054	< .67
1648010	< .007	< .04	< .002	E .062	87	.028	< .04
1648010	< .004	< .04	< .002	E .023	113	.307	< .04
1648010	< .004	< .04	< .002	E .029	120	.079	< .29
1648010	< .004	< .04	< .002	E .058	114	.035	< .04
1648010	< .004	< .04	< .002	E .012	109	.106	< .04

Dichlobenil, water, dissolved (µg/L)	Dichlorprop, water, dissolved (µg/L)	Dieldrin, water, dissolved (µg/L)	Dinoseb, water, dissolved (µg/L)	Disulfoton, water, dissolved (µg/L)	Diuron, water, dissolved (µg/L)	DNOC, ⁷ water, dissolved (µg/L)	USGS station number
<1.20	<0.03	<0.001	<0.04	<0.017	<0.17	< 0.42	1647998
<1.20	< .03	.006	< .04	< .017	< .02	< .42	1648004
<1.20	< .03	< .001	< .04	< .017	< .02	< .42	1648006
<1.20	< .03	< .001	< .04	< .017	.04	< .42	1648010
<1.20	< .03	< .001	< .04	< .017	< .02	< .42	1648998
<1.20	<0.53	<0.001	<0.04	<0.017	<0.02	E 0.33	1648010
<1.20	< .03	< .001	< .04	< .017	< .02	< .42	1648010
<1.20	< .03	< .001	< .04	< .017	< .02	< .42	1648010
<1.20	< .03	< .001	< .04	< .017	< .02	< .42	1648010
<1.20	< .11	< .001	< .04	< .017	< .02	< .42	1648010
<1.20	< .03	< .001	< .04	< .017	< .02	< .42	1648010
<1.20	< .03	< .001	< .04	< .017	< .02	< .42	1648010
< .07	< .03	< .001	< .06	< .017	< .06	< .42	1648010
< .07	< .03	< .001	< .06	< .017	< .06	< .42	1648010
< .07	< .03	< .001	< .06	< .017	< .06	< .42	1648010
< .07	< .12	< .001	< .06	< .017	< .06	< .42	1648010
< .07	< .03	< .001	< .06	< .017	E .03	< .42	1648010
< .07	< .17	< .001	< .06	< .017	< .06	< .42	1648010
< .92	<2.08	< .001	< .06	< .017	< .18	< .42	1648010
< .07	< .03	< .001	< .06	< .017	< .06	< .42	1648010
< .07	< .03	< .001	< .06	< .017	< .06	< .42	1648010

⁷. 4,6-Dinitro-*o*-cresol.

Appendix A1. *Results of analyses for dissolved pesticides for synoptic water-quality samples collected in June 1999, and temporal water-quality samples collected from February 18, 1999 through September 26, 2000 in surface water in Rock Creek, Washington, D.C.—*
—Continued

USGS station number	EPTC, ⁸ water, dissolved (µg/L)	Ethalfuralin, water, dissolved (µg/L)	Ethoprop, water, dissolved (µg/L)	Fenuron, water, dissolved (µg/L)	Fluometuron, water, dissolved (µg/L)	Fonofos, water, dissolved (µg/L)
SYNOPTIC SAMPLING—Continued						
1647998	<0.002	<0.004	<0.003	<0.10	<0.04	<0.003
1648004	< .002	< .004	< .003	< .01	< .04	< .003
1648006	< .002	< .004	< .003	< .01	< .04	< .003
1648010	< .002	< .004	< .003	< .01	< .04	< .003
1648998	< .002	< .004	< .003	< .11	< .04	< .003
TEMPORAL SAMPLING—Continued						
1648010	<0.002	<0.004	<0.003	<0.01	<0.37	<0.003
1648010	< .002	< .004	< .003	< .01	< .04	< .003
1648010	< .002	< .004	< .003	< .01	< .04	< .003
1648010	< .006	< .004	< .003	< .01	< .04	< .003
1648010	< .018	< .004	< .003	<3.40	< .04	< .003
1648010	< .010	< .004	< .003	<2.44	< .04	< .003
1648010	< .002	< .004	< .003	< .01	< .04	< .003
1648010	< .002	< .004	< .003	< .07	< .06	< .003
1648010	< .002	< .004	< .003	< .07	< .19	< .003
1648010	< .002	< .004	< .003	< .07	< .06	< .003
1648010	< .002	< .004	< .003	< .07	< .06	< .003
1648010	< .002	< .004	< .003	< .07	< .06	< .003
1648010	< .002	< .004	< .003	< .07	< .10	< .003
1648010	< .002	< .004	< .003	< .29	< .06	< .003
1648010	< .002	< .004	< .003	< .07	< .06	< .003
1648010	< .002	< .004	< .003	< .07	< .27	< .003

⁸. s-Ethyl dipropylthiocarbamate.

α -HCH-d6, ⁹ surrogate (percent)	Lindane, water, dissolved ($\mu\text{g/L}$)	Linuron, water, dissolved ($\mu\text{g/L}$) (2050) ⁶	Linuron, water, dissolved ($\mu\text{g/L}$) (2001) ⁶	Malathion, water, dissolved ($\mu\text{g/L}$)	MCPA, ¹⁰ water, dissolved ($\mu\text{g/L}$)	MCPB, ¹¹ water, dissolved ($\mu\text{g/L}$)	USGS station number
101	<0.004	<0.02	<0.002	<0.005	<0.17	<0.14	1647998
115	< .004	< .02	< .002	< .005	< .17	< .14	1648004
88	< .004	< .02	< .002	< .005	< .17	< .14	1648006
91	< .004	< .02	< .002	< .005	< .17	< .14	1648010
105	< .004	< .02	< .002	< .005	< .17	< .14	1648998
85	<0.004	<0.02	<0.002	<0.025	<0.17	<0.14	1648010
70	< .004	< .02	< .002	< .005	< .17	< .14	1648010
98	< .004	< .02	< .002	< .005	< .17	< .14	1648010
97	< .004	< .02	< .002	< .005	< .17	< .14	1648010
84	< .004	< .18	< .002	.020	< .17	< .14	1648010
79	< .004	< .02	< .002	.031	< .17	< .14	1648010
94	< .004	< .02	< .002	< .005	< .17	< .14	1648010
110	< .004	< .09	< .002	< .005	< .17	< .13	1648010
108	< .004	< .09	< .002	< .005	< .17	< .13	1648010
97	< .004	< .09	< .002	< .005	< .17	< .13	1648010
78	< .004	< .09	< .002	.014	< .17	< .13	1648010
79	< .004	< .09	< .002	< .005	< .17	< .13	1648010
96	< .004	< .09	< .002	.010	E .10	< .13	1648010
106	< .004	< .09	< .002	.274	< .17	< .13	1648010
108	< .004	< .09	< .002	< .005	< .17	< .13	1648010
108	< .004	< .11	< .002	.006	< .17	< .13	1648010

⁹. α -1,2,3,4,5,6-Hexachlorocyclohexane-d6.

¹⁰. 4-(4-Chloro-2-methylphenoxy)acetic acid.

¹¹. 4-(4-Chloro-2-methylphenoxy)butanoic acid.

Appendix A1. *Results of analyses for dissolved pesticides for synoptic water-quality samples collected in June 1999, and temporal water-quality samples collected from February 18, 1999 through September 26, 2000 in surface water in Rock Creek, Washington, D.C.*
—Continued

USGS station number	Methiocarb, water, dissolved (µg/L)	Methomyl, water, dissolved (µg/L)	Methylaziphos, water, dissolved (µg/L)	Methylparathion, water, dissolved (µg/L)	Metolachlor, water, dissolved (µg/L)	Metribuzin, water, dissolved (µg/L)
SYNOPTIC SAMPLING—Continued						
1647998	<0.03	<0.64	<0.001	<0.006	0.020	<0.004
1648004	< .03	< .02	< .001	< .006	.007	< .004
1648006	< .03	< .02	< .001	< .006	< .002	< .004
1648010	< .03	< .02	< .001	< .006	.019	< .004
1648998	< .03	< .39	< .001	< .006	.020	< .004
TEMPORAL SAMPLING—Continued						
1648010	<0.03	<0.02	<0.001	<0.006	0.018	<0.004
1648010	< .03	< .02	< .001	< .006	.013	< .004
1648010	< .03	< .12	< .001	< .006	.014	< .004
1648010	< .03	<1.06	< .019	< .006	.032	< .004
1648010	< .03	<1.13	< .028	< .006	.058	< .004
1648010	< .03	< .40	< .025	< .006	.060	< .004
1648010	< .03	< .87	< .001	< .006	.033	< .004
1648010	< .03	< .28	< .001	< .006	.012	< .004
1648010	< .03	<1.01	< .001	< .006	.008	< .020
1648010	< .03	< .02	< .001	< .006	.013	< .015
1648010	< .03	< .72	< .020	< .006	.010	< .004
1648010	< .03	< .62	< .010	< .006	.031	< .004
1648010	< .03	<1.70	< .001	< .006	.115	< .004
1648010	< .03	< .02	< .001	< .006	.030	< .004
1648010	< .03	< .16	< .001	< .006	.014	< .004
1648010	< .23	< .55	< .001	< .006	.014	< .004

Molinate, water, dissolved (µg/L)	Napropamide, water, dissolved (µg/L)	Neburon, water, dissolved (µg/L)	Norflurazon, water, dissolved (µg/L)	Oryzalin, water, dissolved (µg/L)	Oxamyl, water, dissolved (µg/L)	<i>p,p'</i> -DDE, ¹² water, dissolved (µg/L)	USGS station number
<0.004	<0.003	<0.01	<0.02	<0.31	<0.02	<0.006	1647998
< .004	< .003	< .01	< .02	< .31	< .02	< .006	1648004
< .004	< .003	< .01	< .02	< .31	< .02	< .006	1648006
< .004	< .003	< .01	< .02	< .31	< .02	< .006	1648010
< .004	< .003	< .01	< .02	< .43	< .02	< .006	1648998
<0.004	<0.003	<0.01	<0.02	<0.31	<0.02	<0.006	1648010
< .004	< .003	< .01	< .02	< .31	< .02	< .006	1648010
< .004	< .003	< .01	< .02	< .31	< .02	< .006	1648010
< .004	< .003	< .01	< .02	< .31	< .02	< .006	1648010
< .004	.033	< .16	< .02	< .31	< .59	< .006	1648010
< .004	–	< .22	< .02	< .40	< .02	< .006	1648010
< .004	< .003	< .01	< .02	< .46	< .02	< .006	1648010
< .004	< .003	< .07	< .04	< .31	< .08	< .006	1648010
< .004	< .003	< .07	< .04	< .31	< .28	< .006	1648010
< .004	< .003	< .07	< .04	< .31	< .02	< .006	1648010
< .004	< .003	< .07	< .04	< .31	< .62	< .006	1648010
< .004	< .003	< .07	< .04	< .31	< .02	< .006	1648010
< .004	< .003	< .10	< .04	< .31	< .34	< .006	1648010
< .004	< .003	< .30	< .04	< .31	< .02	< .006	1648010
< .004	< .003	< .07	< .04	< .31	< .37	< .006	1648010
< .004	< .003	< .07	< .04	< .31	< .56	< .006	1648010

¹². 1,1-Dichloro-2,2-bis(*p*-chlorophenyl)ethylene.

Appendix A1. *Results of analyses for dissolved pesticides for synoptic water-quality samples collected in June 1999, and temporal water-quality samples collected from February 18, 1999 through September 26, 2000 in surface water in Rock Creek, Washington, D.C.*
—Continued

USGS station number	Parathion, water, dissolved (µg/L)	Pebulate, water, dissolved (µg/L)	Pendimethalin, water, dissolved (µg/L)	cis-Permethrin, water, dissolved (µg/L)	Phorate, water, dissolved (µg/L)	Picloram, water, dissolved (µg/L)
SYNOPTIC SAMPLING—Continued						
1647998	<0.004	<0.004	<0.004	<0.005	<0.002	<0.05
1648004	< .004	< .004	E .012	< .005	< .002	< .05
1648006	< .004	< .004	< .004	< .005	< .002	< .05
1648010	< .004	< .004	< .004	< .005	< .002	< .05
1648998	< .004	< .004	< .004	< .005	< .002	< .05
TEMPORAL SAMPLING—Continued						
1648010	<0.004	<0.004	<0.004	<0.005	<0.002	<0.05
1648010	< .004	< .004	< .004	< .005	< .002	< .05
1648010	< .004	< .004	< .004	< .005	< .002	< .05
1648010	< .004	< .004	< .004	< .005	< .002	< .37
1648010	< .004	< .004	< .019	< .005	< .002	< .18
1648010	< .004	< .004	< .018	< .005	< .002	< .05
1648010	< .004	< .004	< .004	< .005	< .002	< .05
1648010	< .004	< .004	< .004	< .005	< .002	< .05
1648010	< .004	< .004	< .004	< .005	< .002	< .05
1648010	< .004	< .004	< .004	< .005	< .002	< .05
1648010	< .004	< .004	.036	< .005	< .002	< .05
1648010	< .004	< .004	< .010	< .005	< .002	< .13
1648010	< .004	< .004	.027	< .005	< .002	< .05
1648010	< .004	< .004	< .010	< .005	< .002	< .05
1648010	< .004	< .004	< .004	< .005	< .002	< .05
1648010	< .004	< .004	< .004	< .005	< .002	< .05

Prometon, water, dissolved (µg/L)	Propyzamide, water, dissolved (µg/L)	Propachlor, water, dissolved (µg/L)	Propanil, water, dissolved (µg/L)	Propargite, water, dissolved (µg/L)	Propham, water, dissolved (µg/L)	USGS station number
0.022	<0.003	<0.007	<0.004	<0.013	<0.11	1647998
E .007	< .003	< .007	< .004	< .013	< .10	1648004
< .018	< .003	< .007	< .004	< .013	< .04	1648006
.018	< .003	< .007	< .004	< .013	< .04	1648010
.029	< .003	< .007	< .004	< .013	< .13	1648998
E 0.005	<0.003	<0.007	<0.004	<0.013	<0.04	1648010
E .004	< .003	< .007	< .004	< .013	< .04	1648010
E .004	< .003	< .007	< .004	< .013	< .04	1648010
E .009	< .003	< .007	< .004	< .013	< .15	1648010
.022	< .003	< .007	< .004	< .013	< .92	1648010
.032	< .003	< .007	< .004	< .013	< .20	1648010
.029	< .003	< .007	< .004	< .013	< .04	1648010
E .011	< .003	< .007	< .004	< .013	< .12	1648010
E .009	< .003	< .007	< .004	< .013	< .04	1648010
E .011	< .003	< .007	< .004	< .013	< .04	1648010
E .005	< .003	< .007	< .004	< .013	< .04	1648010
E .011	< .003	< .007	< .004	< .013	< .04	1648010
.058	< .020	< .007	< .004	< .013	< .66	1648010
.072	< .020	< .007	< .004	< .013	< .31	1648010
E .013	< .003	< .007	< .004	< .013	< .04	1648010
E .012	< .003	< .007	< .004	< .013	< .04	1648010

Appendix A1. *Results of analyses for dissolved pesticides for synoptic water-quality samples collected in June 1999, and temporal water-quality samples collected from February 18, 1999 through September 26, 2000 in surface water in Rock Creek, Washington, D.C.*
—Continued

USGS station number	Propoxur, water, dissolved (µg/L)	Silvex, water, dissolved (µg/L)	Simazine, water, dissolved (µg/L)	Tebuthiuron, water, dissolved (µg/L)	Terbacil, water, dissolved (µg/L)
SYNOPTIC SAMPLING—Continued					
1647998	<0.04	<0.02	0.038	<0.010	<0.007
1648004	< .04	< .02	.007	< .010	< .007
1648006	< .04	< .02	< .005	< .010	< .007
1648010	< .04	< .02	.034	< .010	< .007
1648998	< .13	< .02	.046	< .010	< .007
TEMPORAL SAMPLING—Continued					
1648010	<0.11	<0.02	0.009	<0.010	<0.007
1648010	< .04	< .02	.009	E .006	< .007
1648010	< .04	< .02	.009	.010	< .007
1648010	< .98	< .02	.021	< .016	< .007
1648010	< .55	< .02	.021	< .010	< .007
1648010	< .04	< .02	.022	< .010	< .007
1648010	< .04	< .02	.083	< .010	< .007
1648010	< .08	< .06	.010	E .006	< .007
1648010	< .08	< .06	< .005	< .010	< .007
1648010	< .08	< .06	.020	< .010	< .007
1648010	< .08	< .06	.008	< .010	< .007
1648010	< .08	< .06	.016	< .010	< .007
1648010	< .29	< .06	.012	< .010	< .007
1648010	< .19	< .06	.010	< .010	< .007
1648010	< .37	< .06	.014	E .004	< .007
1648010	< .18	< .06	.018	< .010	< .007

Terbufos, water, dissolved (µg/L)	Thiobencarb, water, dissolved (µg/L)	Triallate, water, dissolved (µg/L)	Triclopyr, water, dissolved (µg/L)	Trifluralin, water, dissolved (µg/L)	USGS station number
<0.013	<0.002	<0.001	<0.25	<0.002	1647998
< .013	< .002	< .001	< .25	E .003	1648004
< .013	< .002	< .001	< .25	< .002	1648006
< .013	< .002	< .001	< .25	< .002	1648010
< .013	< .002	< .001	< .25	< .002	1648998
<0.013	<0.002	<0.001	<0.25	<0.002	1648010
< .013	< .002	< .001	< .25	E .002	1648010
< .013	< .002	< .001	< .25	E .002	1648010
< .013	< .002	< .001	< .25	< .002	1648010
< .013	< .002	< .001	< .25	E .003	1648010
< .013	< .002	< .001	< .25	E .003	1648010
< .013	< .002	< .001	< .67	< .002	1648010
< .013	< .002	< .001	< .25	< .002	1648010
< .013	< .002	< .001	< .25	< .002	1648010
< .013	< .002	< .001	< .25	< .002	1648010
< .013	< .002	< .001	< .25	.006	1648010
< .013	< .002	< .001	< .25	< .002	1648010
< .013	< .002	< .001	< .25	E .002	1648010
< .013	< .002	< .001	< .25	< .002	1648010
< .013	< .002	< .001	.26	< .002	1648010
< .013	< .002	< .001	E .23	< .002	1648010

Appendix A2. Results of analyses for nutrients, major ions, and field parameters for synoptic sampling in June 1999, and temporal sampling from February 18, 1999 through September 26, 2000 in surface water from Rock Creek, Washington, D.C.

[USGS, U.S. Geological Survey; mg/L, milligrams per liter; μ S/cm, microsiemens per centimeter; °C, degrees Celsius; μ g/L, micrograms per liter; mm, millimeters; ft³/s, cubic feet per second; E, estimated value lower than the reporting level; –, missing value; “Nitrogen, ammonia plus organic nitrogen” is also known as “Kjeldahl nitrogen.”]

USGS station number	USGS station name	Date	Time	Instantaneous discharge (ft ³ /s)
SYNOPTIC SAMPLING				
1647998	Rock Creek below West Beach Drive, Washington, D.C.	06/23/1999	1800	18
1648004	Pinehurst Branch at Oregon Avenue, Washington, D.C.	06/24/1999	1510	.07
1648006	Rock Creek tributary at Golf Course, Washington, D.C.	06/24/1999	1010	.01
1648010	Rock Creek at Joyce Road, Washington, D.C.	06/25/1999	0930	11
1648998	Rock Creek Q Street, Washington, D.C.	06/23/1999	1150	21
TEMPORAL SAMPLING				
1648010	Rock Creek at Joyce Road, Washington, D.C.	02/18/1999	1115	415
1648010	Rock Creek at Joyce Road, Washington, D.C.	03/09/1999	1018	39
1648010	Rock Creek at Joyce Road, Washington, D.C.	05/04/1999	1130	24
1648010	Rock Creek at Joyce Road, Washington, D.C.	05/23/1999	0045	103
1648010	Rock Creek at Joyce Road, Washington, D.C.	05/24/1999	1100	430
1648010	Rock Creek at Joyce Road, Washington, D.C.	05/24/1999	1145	480
1648010	Rock Creek at Joyce Road, Washington, D.C.	07/14/1999	0920	6.1
1648010	Rock Creek at Joyce Road, Washington, D.C.	10/13/1999	0930	35
1648010	Rock Creek at Joyce Road, Washington, D.C.	01/10/2000	1430	276
1648010	Rock Creek at Joyce Road, Washington, D.C.	02/09/2000	1300	32
1648010	Rock Creek at Joyce Road, Washington, D.C.	03/21/2000	1200	402
1648010	Rock Creek at Joyce Road, Washington, D.C.	05/16/2000	1145	24
1648010	Rock Creek at Joyce Road, Washington, D.C.	06/22/2000	1000	149
1648010	Rock Creek at Joyce Road, Washington, D.C.	07/26/2000	0900	124
1648010	Rock Creek at Joyce Road, Washington, D.C.	09/11/2000	1230	13
1648010	Rock Creek at Joyce Road, Washington, D.C.	09/26/2000	0945	364

Oxygen, dissolved (mg/L)	pH, field (standard units)	Specific conductance (μ S/cm)	Air temperature (°C)	Water temperature (°C)	USGS station number
7.2	7.9	367	23.5	21.7	1647998
4.3	7.5	503	22.7	19.6	1648004
8.3	7.3	92	18.9	15.7	1648006
7.3	7.8	381	23.7	20.9	1648010
8.3	7.8	289	26.0	20.4	1648998
10.7	7.5	268	5.5	7.4	1648010
12.4	7.0	380	-3.0	2.6	1648010
9.8	8.1	402	17.5	13.9	1648010
9.2	6.9	382	17.0	19.5	1648010
6.8	7.0	207	21.0	19.1	1648010
5.5	7.0	232	21.0	19.6	1648010
8.4	7.6	481	19.0	20.9	1648010
10.3	7.8	227	10.5	14.3	1648010
11.6	6.1	197	9.0	6.8	1648010
15.6	7.7	1,380	12.5	0.1	1648010
12.2	7.4	247	5.5	7.3	1648010
9.3	7.9	340	21.0	17.3	1648010
6.1	7.2	118	24.4	23.3	1648010
–	7.4	229	22.7	20.5	1648010
8.9	7.9	292	25.5	28.8	1648010
9.2	7.2	115	11.0	14.2	1648010

Appendix A2. *Results of analyses for nutrients, major ions, and field parameters for synoptic sampling in June 1999, and temporal sampling from February 18, 1999 through September 26, 2000 in surface water from Rock Creek, Washington, D.C.—Continued*

USGS station number	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Sodium, dissolved (mg/L as Na)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)
SYNOPTIC SAMPLING—Continued						
1647998	28.3	9.58	3.3	24.8	56.3	0.2
1648004	45.8	15.2	4.3	22.5	62.5	0.1
1648006	7.98	2.36	1.7	5.1	4.2	<0.1
1648010	29.4	10.1	3.4	24.6	57.2	0.3
1648998	24.7	7.57	3.7	16.4	33.8	0.2
TEMPORAL SAMPLING—Continued						
1648010	—	—	—	—	—	—
1648010	—	—	—	—	—	—
1648010	—	—	—	—	—	—
1648010	—	—	—	—	—	—
1648010	—	—	—	—	—	—
1648010	—	—	—	—	—	—
1648010	—	—	—	—	—	—
1648010	—	—	—	—	—	—
1648010	—	—	—	—	—	—
1648010	—	—	—	—	—	—
1648010	—	—	—	—	—	—
1648010	—	—	—	—	—	—
1648010	—	—	—	—	—	—
1648010	—	—	—	—	—	—
1648010	—	—	—	—	—	—

Silica, dissolved (mg/L as SiO ₂)	Sulfate, dissolved (mg/L as SO ₄)	Nitrogen, ammonia plus organic nitrogen, dissolved (mg/L as N)	Nitrogen, ammonia plus organic nitrogen, total (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as N)	USGS station number
10.2	18.4	0.38	0.39	0.066	1647998
23.4	32.9	.28	.32	.044	1648004
16.6	2.7	E .10	.11	< .020	1648006
10.7	18.4	.37	.35	.053	1648010
8.4	16.9	.28	.33	.037	1648998
—	—	—	—	—	1648010
—	—	—	—	—	1648010
—	—	—	—	—	1648010
—	—	—	—	—	1648010
—	—	—	—	—	1648010
—	—	—	—	—	1648010
—	—	—	—	—	1648010
—	—	—	—	—	1648010
—	—	—	—	—	1648010
—	—	—	—	—	1648010
—	—	—	—	—	1648010
—	—	—	—	—	1648010
—	—	—	—	—	1648010
—	—	—	—	—	1648010

Appendix A2. *Results of analyses for nutrients, major ions, and field parameters for synoptic sampling in June 1999, and temporal sampling from February 18, 1999 through September 26, 2000 in surface water from Rock Creek, Washington, D.C.—Continued*

USGS station number	Nitrogen, nitrate plus nitrite, dissolved (mg/L as N)	Nitrogen, nitrite, dissolved (mg/L as N)	Phosphorus, dissolved (mg/L as P)	Phosphorus, phosphate, ortho, dissolved (mg/L as P)	Phosphorus, total, (mg/L as P)
SYNOPTIC SAMPLING—Continued					
1647998	0.611	0.022	0.025	0.023	0.058
1648004	.584	.014	.085	.064	.100
1648006	1.54	< .010	.021	.023	.024
1648010	.633	.022	.020	.021	.047
1648998	.531	.016	.031	.025	.044
TEMPORAL SAMPLING—Continued					
1648010	—	—	—	—	—
1648010	—	—	—	—	—
1648010	—	—	—	—	—
1648010	—	—	—	—	—
1648010	—	—	—	—	—
1648010	—	—	—	—	—
1648010	—	—	—	—	—
1648010	—	—	—	—	—
1648010	—	—	—	—	—
1648010	—	—	—	—	—
1648010	—	—	—	—	—
1648010	—	—	—	—	—
1648010	—	—	—	—	—
1648010	—	—	—	—	—
1648010	—	—	—	—	—

Residue, 180 degrees Celsius, dissolved (mg/L)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Sediment, suspended (mg/L)	Sediment, suspended, percent finer than .062 mm	USGS station number
258	180	104	—	—	1647998
312	10	56	—	—	1648004
103	20	E 2	—	—	1648006
235	70	104	—	—	1648010
193	130	53	—	—	1648998
—	—	—	—	—	1648010
—	—	—	—	—	1648010
—	—	—	—	—	1648010
—	—	—	—	—	1648010
—	—	—	—	—	1648010
—	—	—	—	—	1648010
—	—	—	15	—	1648010
—	—	—	6	—	1648010
—	—	—	149	76	1648010
—	—	—	6	—	1648010
—	—	—	305	—	1648010
—	—	—	17	—	1648010
—	—	—	128	—	1648010
—	—	—	38	—	1648010
—	—	—	15	—	1648010
—	—	—	314	77	1648010

Appendix A3. Results of analyses for organic compounds measured in samples of bed sediment collected from Rock Creek, Washington, D.C., August 1999

[All samples are bottom material, whole sediment sieved to less than 2 millimeters, dry weight. Recoveries of surrogate compounds (given by percent) from the analyses are included in the results; g/kg, grams per kilogram; µg/kg, micrograms per kilogram; <, less than; E, estimated value less than the method reporting level; M, presence of material verified but not quantified; α, alpha; β, beta]

Station number	Station name	Date	Time	Carbon, organic plus inorganic (g/kg as C)
01647997	Portal Branch at North Portal Drive, Washington, D.C.	08/19/1999	1130	5.7
01648000	Rock Creek at Sherrill Drive, Washington, D.C.	08/18/1999	1400	24
01648998	Rock Creek Q Street, Washington, D.C.	08/17/1999	1115	27

Station number	2,2'-Biquinoline (µg/kg)	3,5-Xylenol (µg/kg)	4-Bromophenyl phenyl ether (µg/kg)	4-Chlorophenyl phenyl ether (µg/kg)
01647997	<50	<50	<50	<50
01648000	<50	<50	<50	<50
01648998	<100	<100	<100	<100

Station number	4,5-Methylenephenanthrene (µg/kg)	Anthraquinone (µg/kg)	1-Methyl-9H-fluorene (µg/kg)	Fluorene (µg/kg)
01647997	E 20	100	<50	M
01648000	130	380	<50	E 30
01648998	120	280	<100	E 40

Acenaphthene (µg/kg)	Acenaphthylene (µg/kg)	Acridine (µg/kg)	Aldrin (µg/kg)	Station number
<50	E 40	<50	<1	01647997
E 10	70	60	<1	01648000
E 30	E 60	E 40	<1	01648998

α-HCH-d6 (surrogate, percent)	α-HCH (µg/kg)	2-Methylanthracene (µg/kg)	Anthracene (µg/kg)	Station number
74	<1	E 10	60	01647997
57	<1	E 20	160	01648000
57	<1	E 20	190	01648998

Azobenzene (µg/kg)	Benz(a)anthracene (µg/kg)	1,2,4-Trichlorobenzene (µg/kg)	Hexachlorobenzene (µg/kg)	Station number
<50	210	<50	<1	01647997
<50	690	<50	<1	01648000
<100	660	<100	<1	01648998

Appendix A3. *Results of analyses for organic compounds measured in samples of bed sediment collected from Rock Creek, Washington, D.C., August 1999—Continued*

Station number	<i>m</i> -Dichlorobenzene (µg/kg)	Nitrobenzene (µg/kg)	Nitrobenzene-d5 (surrogate, percent)	<i>o</i> -Dichlorobenzene (µg/kg)
01647997	<50	<50	43	<50
01648000	<50	<50	67	<50
01648998	<100	<100	51	<100

Station number	<i>p</i> -Dichlorobenzene (µg/kg)	Pentachloronitrobenzene (µg/kg)	Benzo[a]pyrene (µg/kg)	Benzo[b]fluoranthene (µg/kg)
01647997	<50	<50	240	270
01648000	<50	<50	880	1,300
01648998	<100	<100	810	1,200

Station number	Benzo[ghi]perylene (µg/kg)	Benzo[k]fluoranthene (µg/kg)	Benzo[c]cinnoline (µg/kg)	β-HCH (µg/kg)
01647997	140	160	<50	<1
01648000	640	820	<50	<1
01648998	420	880	<50	<1

2-Fluorobiphenyl (surrogate, percent)	Bis(2-chloroethyl)ether (µg/kg)	Carbazole (µg/kg)	Chloroneb (µg/kg)	Station number
51	<50	E 10	<5	01647997
67	<50	130	<5	01648000
52	<100	110	<5	01648998

Chrysene (µg/kg)	cis-Chlordane (µg/kg)	cis-Nonachlor (µg/kg)	cis-Permethrin (µg/kg)	Station number
260	2	<1	<5	01647997
1,200	7	2	<5	01648000
1,000	7	2	<5	01648998

Dacthal (µg/kg)	Dibenz[ah]anthracene (µg/kg)	Dieldrin (µg/kg)	N-Nitrosodi-<i>n</i>-propylamine (µg/kg)	Station number
<5	E 40	2	<50	01647997
<5	140	3	<50	01648000
<5	210	3	<100	01648998

Appendix A3. *Results of analyses for organic compounds measured in samples of bed sediment collected from Rock Creek, Washington, D.C., August 1999—Continued*

Station number	<i>N</i> -Nitrosodiphenylamine (µg/kg)	Endosulfan (µg/kg)	Endrin (µg/kg)	Fluoranthene (µg/kg)
01647997	<50	<1	<2	500
01648000	<50	<1	<2	2,000
01648998	<100	<1	<2	1,600

Station number	Heptachlor epoxide (µg/kg)	Heptachlor (µg/kg)	Indeno[1,2,3-cd]pyrene (µg/kg)	Isodrin (µg/kg)
01647997	<1	<1	180	<1
01648000	2	<1	750	<1
01648998	2	<1	550	<1

Station number	Isophorone (µg/kg)	Isoquinoline (µg/kg)	Lindane (µg/kg)	4-Chloro-3-methylphenol (µg/kg)
01647997	<50	<50	<1	<50
01648000	<50	<50	<1	<50
01648998	<100	<100	<1	<100

Bis(2-chloroethoxy) methane (µg/kg)	<i>o,p'</i>-Methoxychlor (µg/kg)	<i>p,p'</i>-Methoxychlor (µg/kg)	Mirex (µg/kg)	Station number
<50	<5	<5	<1	01647997
<50	<6	<5	<1	01648000
<100	<5	<5	<1	01648998

1,2-Dimethylnaphthalene (µg/kg)	1,6-Dimethylnaphthalene (µg/kg)	2,3,6-Trimethylnaphthalene (µg/kg)	2,6-Dimethylnaphthalene (µg/kg)	Station number
<50	<50	<50	<50	01647997
<50	<50	<50	E 30	01648000
<100	<100	<100	E 40	01648998

2-Chloronaphthalene (µg/kg)	2-Ethylnaphthalene (µg/kg)	Naphthalene (µg/kg)	<i>o,p'</i>-DDD ¹ (µg/kg)	Station number
<50	<50	<50	<1	01647997
<50	<50	E 40	3	01648000
<100	<100	<100	<1	01648998

¹. 1,1-Dichloro-2-(*o*-chlorophenyl)-2-(*p*-chlorophenyl)ethane.

Appendix A3. *Results of analyses for organic compounds measured in samples of bed sediment collected from Rock Creek, Washington, D.C., August 1999—Continued*

Station number	<i>o,p'</i> -DDE ² (µg/kg)	<i>o,p'</i> -DDT ³ (µg/kg)	Oxychlordane (µg/kg)	<i>p,p'</i> -DDD ⁴ (µg/kg)
01647997	<1	<2	<1	E 2
01648000	<1	<2	2	4
01648998	<1	<2	2	E 6

Station number	<i>p,p'</i> -DDE ⁵ (µg/kg)	<i>p,p'</i> -DDT ⁶ (µg/kg)	Polychlorinated biphenyls (PCBs) (µg/kg)	<i>p</i> -Cresol (µg/kg)
01647997	2	7	<50	<50
01648000	4	4	80	80
01648998	7	8	50	400

Station number	Pentachloroanisole (µg/kg)	1-Methylphenanthrene (µg/kg)	Phenanthrene (µg/kg)	Phenanthridine (µg/kg)
01647997	<1	<50	240	<50
01648000	<1	E 30	930	E 10
01648998	<1	E 30	830	<100

Station number	C8-Alkylphenol (µg/kg)	2-Chlorophenol (µg/kg)	Phenol (µg/kg)	Bis(2-ethylhexyl)ester (µg/kg)
01647997	<50	<50	<50	420
01648000	<50	<50	E 30	2,200
01648998	<100	<100	E 40	2,100

^{2.} 1,1-Dichloro-2-(*o*-chlorophenyl)-2-(*p*-chlorophenyl)ethylene.

^{5.} 1,1-Dichloro-2,2-bis(*p*-chlorophenyl)ethylene.

^{3.} 1,1,1-Trichloro-2-(*o*-chlorophenyl)-2-(*p*-chlorophenyl)ethane.

^{6.} 1,1,1-Trichloro-2,2-bis(*p*-chlorophenyl)ethane.

^{4.} 1,1-(Dichloro-2,2-bis(*p*-chlorophenyl)ethane.

Butylbenzyl phthalate (µg/kg)	Dimethyl phthalate (µg/kg)	Di- <i>n</i> -butyl phthalate (µg/kg)	Diethyl phthalate (µg/kg)	Station number
1,300	<50	E 30	E 10	01647997
150	<50	90	E 20	01648000
120	<100	E 50	<100	01648998

Di- <i>n</i> -octyl phthalate (µg/kg)	1-Methylpyrene (µg/kg)	Pyrene (µg/kg)	Quinoline (µg/kg)	Station number
60	E 20	410	<50	01647997
<50	50	1,600	<50	01648000
180	E 40	1,200	<100	01648998

Terphenyl-d14 (surrogate, percent)	Dibenzothiophene (µg/kg)	2,4-Dinitrotoluene (µg/kg)	2,6-Dinitrotoluene (µg/kg)	Station number
83	E 20	<50	<50	01647997
76	60	<50	<50	01648000
62	E 50	<100	<100	01648998

Toxaphene (µg/kg)	<i>trans</i> -Chlordane (µg/kg)	<i>trans</i> -Nonachlor (µg/kg)	<i>trans</i> -Permethrin (µg/kg)	Station number
<200	2	1	<5	01647997
<200	6	5	<6	01648000
<200	6	4	17	01648998

Appendix A4. *Results of analyses for trace elements, major elements, and inorganic and organic carbon measured in samples of bed sediment collected from Rock Creek, Washington, D.C., August 1999*

[All samples are bottom material, whole sediment sieved to less than 2 millimeters, dry weight. Recoveries of surrogate compounds (given by percent) from the analyses are included in the results; µg/g, micrograms per gram; <, less than]

Station number	Station name	Date	Time	Calcium (percent as Ca)
01647997	Portal Branch at North Portal Drive, Washington, D.C.	08/19/1999	1135	0.75
01648000	Rock Creek at Sherrill Drive, Washington, D.C.	08/18/1999	1405	1.4
01648998	Rock Creek Q Street, Washington, D.C.	08/17/1999	1120	1.4

Station number	Magnesium (percent as Mg)	Potassium (percent as K)	Sodium (percent as Na)	Sulfur (percent as S)
01647997	0.86	1.7	0.31	0.14
01648000	1.4	1.4	.34	.17
01648998	1.5	1.3	.36	.25

Station number	Phosphorus (percent as P)	Carbon, inorganic, (percent as C)	Carbon, organic plus inorganic, (percent as C)	Carbon, organic, (percent as C)
01647997	0.12	0.11	2.8	2.7
01648000	.14	.09	4.4	4.3
01648998	.17	.13	5.8	5.7

Aluminum (percent as Al)	Antimony (µg/g as Sb)	Arsenic (µg/g as As)	Barium (µg/g as Ba)	Station number
9.0	2.3	5.7	590	01647997
8.4	2.7	6.9	510	01648000
8.1	3.3	7.4	500	01648998

Beryllium (µg/g as Be)	Bismuth (µg/g as Bi)	Cadmium (µg/g as Cd)	Cerium (µg/g as Ce)	Station number
4.5	<1	1.3	180	01647997
4.2	<1	1.2	140	01648000
3.6	<1	1.5	120	01648998

Chromium (µg/g as Cr)	Cobalt (µg/g as Co)	Copper (µg/g as Cu)	Europium (µg/g as Eu)	Station number
110	25	150	3	01647997
150	30	130	3	01648000
160	32	170	2	01648998

Appendix A4. *Results of analyses for trace elements, major elements, and inorganic and organic carbon measured in samples of bed sediment collected from Rock Creek, Washington, D.C., August 1999—Continued*

Station number	Gallium (µg/g as Ga)	Gold (µg/g as Au)	Holmium (µg/g as Ho)	Iron (percent as Fe)
01647997	23	<1	3	5.4
01648000	21	<1	2	5.6
01648998	20	<1	2	5.6

Station number	Lanthanum (µg/g as La)	Lead (µg/g as Pb)	Lithium (µg/g as Li)	Manganese (µg/g as Mn)
01647997	97	110	46	790
01648000	74	98	34	1,700
01648998	64	150	32	1,900

Station number	Mercury (µg/g as Hg)	Molybdenum (µg/g as Mo)	Neodymium (µg/g as Nd)	Nickel (µg/g as Ni)
01647997	0.21	12	85	70
01648000	1.4	9.0	64	94
01648998	.32	7.7	55	99

Niobium (µg/g as Nb)	Scandium (µg/g as Sc)	Selenium (µg/g as Se)	Silver (µg/g as Ag)	Strontium (µg/g as Sr)	Station number
13	16	0.8	0.5	100	01647997
11	23	.9	.6	110	01648000
10	22	1.0	.5	110	01648998

Tantalum (µg/g as Ta)	Thallium (µg/g as Tl)	Tin (µg/g as Sn)	Titanium (percent as Ti)	Vanadium (µg/g as V)	Station number
3	<1	7	0.54	120	01647997
2	<1	7	.52	140	01648000
2	<1	8	.43	140	01648998

Ytterbium (µg/g as Yb)	Yttrium (µg/g as Y)	Zinc (µg/g as Zn)	Thorium (µg/g as Th)	Uranium (µg/g as U)	Station number
7	72	410	20	5.0	01647997
5	54	370	14	3.6	01648000
4	47	450	12	3.3	01648998

Appendix B1. *Laboratory code constituents and parameters for schedule 2001, dissolved pesticides in water, from the U.S. Geological Survey National Water-Quality Laboratory (NWQL), Denver, Colorado, 2001*

[USGS, U.S. Geological Survey; CAS, Chemical Abstracts Service registry numbers; µg/L, micrograms per liter; –, no data available]

Parameter name	USGS parameter code	CAS number	Reporting limit	Reporting unit
2,6-Diethylaniline	82660	579-66-8	0.0017	µg/L
Acetochlor	49260	34256-82-1	.0041	µg/L
Alachlor	46342	15972-60-8	.0024	µg/L
α-HCH ¹	34253	319-84-6	.0046	µg/L
α-HCH-d6 (surrogate) ²	91065	–	.1	percent
2,6-Diethylaniline	82660	579-66-8	.0017	µg/L
Atrazine	39632	1912-24-9	.007	µg/L
Azinphos-methyl	82686	86-50-0	.05	µg/L
Benfluralin	82673	1861-40-1	.01	µg/L
Butylate	04028	2008-41-5	.002	µg/L
Carbaryl	82680	63-25-2	.041	µg/L
Carbofuran	82674	1563-66-2	.02	µg/L
Chlorpyrifos	38933	2921-88-2	.005	µg/L
cis-Permethrin	82687	54774-45-7	.006	µg/L
Cyanazine	04041	21725-46-2	.018	µg/L
Dacthal	82682	1861-32-1	.003	µg/L
Deethylatrazine	04040	6190-65-4	.006	µg/L
Diazinon	39572	333-41-5	.005	µg/L
Diazinon-d10 (surrogate)	91063	100155-47-3	.1	percent
Dieldrin	39381	60-57-1	.0048	µg/L
Disulfoton	82677	298-04-4	.021	µg/L
EPTC ³	82668	759-94-4	.002	µg/L
Ethalfuralin	82663	55283-68-6	.009	µg/L
Ethoprophos	82672	13194-48-4	.005	µg/L
Fonofos	04095	944-22-9	.0027	µg/L
Lindane	39341	58-89-9	.004	µg/L
Linuron	82666	330-55-2	.035	µg/L
Malathion	39532	121-75-5	.027	µg/L
Metolachlor	39415	51218-45-2	.013	µg/L
Metribuzin	82630	21087-64-9	.006	µg/L
Molinate	82671	2212-67-1	.0016	µg/L
Napropamide	82684	15299-99-7	.007	µg/L
p,p'-DDE ⁴	34653	72-55-9	.0025	µg/L
Parathion	39542	56-38-2	.007	µg/L
Parathion-methyl	82667	298-00-0	.006	µg/L
Pebulate	82669	1114-71-2	.0016	µg/L
Pendimethalin	82683	40487-42-1	.01	µg/L
Phorate	82664	298-02-2	.011	µg/L
Prometon	04037	1610-18-0	.015	µg/L
Propachlor	04024	1918-16-7	.01	µg/L
Propanil	82679	709-98-8	.011	µg/L

Appendix B1. *Laboratory code constituents and parameters for schedule 2001, dissolved pesticides in water, from the U.S. Geological Survey National Water-Quality Laboratory (NWQL), Denver, Colorado, 2001*
—Continued

Parameter name	USGS parameter code	CAS number	Reporting limit	Reporting unit
Propargite	82685	2312-35-8	0.023	µg/L
Propyzamide	82676	23950-58-5	.0041	µg/L
Simazine	04035	122-34-9	.011	µg/L
Tebuthiuron	82670	34014-18-1	.016	µg/L
Terbacil	82665	5902-51-2	.034	µg/L
Terbufos	82675	13071-79-9	.017	µg/L
Terbuthylazine	04022	5915-41-3	.1	µg/L
Thiobencarb	82681	28249-77-6	.0048	µg/L
Triallate	82678	2303-17-5	.0023	µg/L
Trifluralin	82661	1582-09-8	.009	µg/L

1. α -1,2,3,4,5,6-Hexachlorocyclohexane.
2. α -1,2,3,4,5,6-Hexachlorocyclohexane-d6.
3. *s*-Ethyl dipropylthiocarbamate.
4. 1,1-Dichloro-2,2-bis(*p*-chlorophenyl)ethylene.

Appendix B2. *Laboratory code constituents and parameters for schedule 2050, dissolved pesticides in water, from the U.S. Geological Survey National Water-Quality Laboratory (NWQL), Denver, Colorado, 2001*

[USGS, U.S. Geological Survey; CAS, Chemical Abstracts Service registry numbers; µg/L, micrograms per liter]

Parameter name	USGS parameter code	CAS number	Reporting limit	Reporting unit
2,4,5-T ¹	39742	93-76-5	0.04	µg/L
2,4-D ²	39732	94-75-7	.11	µg/L
2,4-DB ³	38746	94-82-6	.1	µg/L
3-Hydroxycarbofuran	49308	16655-82-6	.11	µg/L
BDMC (surrogate) ⁴	99835	672-99-1	.1	percent
Acifluorfen	49315	50594-66-6	.05	µg/L
Aldicarb	49312	116-06-3	.21	µg/L
Aldicarb sulfone	49313	1646-88-4	.2	µg/L
Aldicarb sulfoxide	49314	1646-87-3	.02	µg/L
Bentazon	38711	25057-89-0	.035	µg/L
Bromacil	04029	314-40-9	.09	µg/L
Bromoxynil	49311	1689-84-5	.07	µg/L
Carbaryl	49310	63-25-2	.024	µg/L
Carbofuran	49309	1563-66-2	.29	µg/L
Chloramben, methyl ester	61188	7286-84-2	.14	µg/L
Chlorothalonil	49306	1897-45-6	.13	µg/L
Clopyralid	49305	1702-17-6	.42	µg/L
Dacthal monoacid	49304	887-54-7	.07	µg/L
Dicamba	38442	1918-00-9	.043	µg/L
Dichlobenil	49303	1194-65-6	.049	µg/L
Dichlorprop	49302	120-36-5	.05	µg/L
Dinoseb	49301	88-85-7	.09	µg/L
Diuron	49300	330-54-1	.056	µg/L
DNOC ⁷	49299	534-52-1	.42	µg/L
Fenuron	49297	101-42-8	.07	µg/L
Fluometuron	38811	2164-17-2	.06	µg/L
Linuron	38478	330-55-2	.021	µg/L
MCPA ⁵	38482	94-74-6	.08	µg/L
MCPB ⁶	38487	94-81-5	.13	µg/L
Methiocarb	38501	2032-65-7	.07	µg/L
Methomyl	49296	16752-77-5	.02	µg/L
Neburon	49294	555-37-3	.017	µg/L
Norflurazon	49293	27314-13-2	.042	µg/L
Oryzalin	49292	19044-88-3	.28	µg/L
Oxamyl	38866	23135-22-0	.02	µg/L
Picloram	49291	1918-02-1	.09	µg/L
Propham	49236	122-42-9	.09	µg/L
Propoxur	38538	114-26-1	.12	µg/L
Silvex	39762	93-72-1	.025	µg/L
Triclopyr	49235	55335-06-3	.07	µg/L

^{1.} 2,4,5-Trichlorophenoxyacetic acid.

^{2.} (2,4-Dichlorophenoxy)acetic acid.

^{3.} 4-(2,4-Dichlorophenoxy)butyric acid.

^{4.} 4-Bromo-3,5-dimethylphenyl-*n*-methylcarbamate.

^{5.} 4-(4-Chloro-2-methylphenoxy)acetic acid.

^{6.} 4-(4-Chloro-2-methylphenoxy)butanoic acid.

^{7.} 4,6-Dinitro-*o*-cresol.

Appendix B3. *Laboratory code constituents and parameters for schedule 2420, trace elements in bed sediment, from the U.S. Geological Survey National Water-Quality Laboratory (NWQL), Denver, Colorado, 2001*

[USGS, U.S. Geological Survey; CAS, Chemical Abstracts Service registry numbers; µg/g, micrograms per gram; –, no data available]

Parameter name	USGS parameter code	CAS number	Reporting limit	Reporting unit
Aluminum	34790	7429-90-5	0.005	percent
Antimony	34795	7440-36-0	.1	µg/g
Arsenic	34800	7440-38-2	.1	µg/g
Barium	34805	7440-39-3	1	µg/g
Beryllium	34810	7440-41-7	.1	µg/g
Bismuth	34816	7440-69-9	1	µg/g
Cadmium	34825	7440-43-9	.1	µg/g
Calcium	34830	7440-70-2	.005	percent
Cerium	34835	7440-45-1	1	µg/g
Chromium	34840	7440-47-3	1	µg/g
Cobalt	34845	7440-48-4	1	µg/g
Copper	34850	7440-50-8	1	µg/g
Europium	34855	7440-53-1	1	µg/g
Gallium	34860	7440-55-3	1	µg/g
Gold	34870	7440-57-5	1	µg/g
Holmium	34875	7440-60-0	1	µg/g
Inorganic carbon	49269	–	.01	percent
Iron	34880	7439-89-6	.005	percent
Lanthanum	34885	7439-91-0	1	µg/g
Lead	34890	7439-92-1	1	µg/g
Lithium	34895	7439-93-2	1	µg/g
Magnesium	34900	7439-95-4	.005	percent
Manganese	34905	7439-96-5	4	µg/g
Mercury	34910	7439-97-6	.02	µg/g
Molybdenum	34915	7439-98-7	.5	µg/g
Neodymium	34920	7440-00-8	1	µg/g
Nickel	34925	7440-02-0	2	µg/g
Niobium	34930	7440-03-01	4	µg/g
Organic carbon	49266	–	.01	percent
Phosphorus	34935	7723-14-0	.005	percent
Potassium	34940	7440-09-7	.005	percent
Scandium	34945	7440-20-2	2	µg/g
Selenium	34950	7782-49-2	.1	µg/g
Silver	34955	7440-22-4	.1	µg/g
Sodium	34960	7440-23-5	.005	percent
Strontium	34965	7440-24-6	2	µg/g
Sulfur	34970	7704-34-9	.05	percent
Tantalum	34975	7440-25-7	1	µg/g
Thallium	04064	7440-28-0	1	µg/g
Thorium	34980	7440-29-1	1	µg/g

Appendix B3. *Laboratory code constituents and parameters for schedule 2420, trace elements in bed sediment, from the U.S. Geological Survey National Water-Quality Laboratory (NWQL), Denver, Colorado, 2001—Continued*

Parameter name	USGS parameter code	CAS number	Reporting limit	Reporting unit
Tin	34985	7440-31-5	1	µg/g
Titanium	49274	7440-32-6	.005	percent
Total carbon	49267	—	.01	percent
Uranium	35000	7440-61-1	.1	µg/g
Vanadium	35005	7440-62-2	2	µg/g
Ytterbium	35015	7440-64-4	1	µg/g
Yttrium	35010	7440-65-5	1	µg/g
Zinc	35020	7440-66-6	2	µg/g

Appendix B4. *Laboratory code constituents and parameters for schedule 2500,
organic compounds in bed sediment, from the U.S. Geological Survey
National Water-Quality Laboratory (NWQL), Denver, Colorado, 2001*

[USGS, U.S. Geological Survey; CAS, Chemical Abstracts Service registry numbers; µg/kg, micrograms per kilogram; g, gram;
g/kg, grams per kilogram; α, alpha; β, beta; –, no data available; N/A, not applicable]

Parameter name	USGS parameter code	CAS number	Reporting limit	Reporting unit
1,2,4-Trichlorobenzene	49438	120-82-1	50	µg/kg
1,2-Dichlorobenzene	49439	95-50-1	50	µg/kg
1,2-Dimethylnaphthalene	49403	573-98-8	50	µg/kg
1,3-Dichlorobenzene	49441	541-73-1	50	µg/kg
1,4-Dichlorobenzene	49442	106-46-7	50	µg/kg
1,6-Dimethylnaphthalene	49404	575-43-9	50	µg/kg
1-Methyl-9H-fluorene	49398	1730-37-6	50	µg/kg
1-Methylphenanthrene	49410	832-69-9	50	µg/kg
1-Methylpyrene	49388	2381-21-7	50	µg/kg
2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl (PCB 207, surrogate)	N/A	52663-79-3	.1	percent
2,2',3,4,4',5,6,6'-Octachlorobiphenyl (surrogate)	49276	74472-52-9	.1	percent
2,2'-Biquinoline	49391	119-91-5	50	µg/kg
2,3,5,6-Tetramethylphenol	49414	527-35-5	50	µg/kg
2,3,6-Trimethylnaphthalene	49405	829-26-5	50	µg/kg
2,4,6-Trichlorophenol	49415	88-06-2	50	µg/kg
2,4,6-Trimethylphenol	49416	527-60-6	50	µg/kg
2,4-Dichlorophenol	49417	120-83-2	50	µg/kg
2,4-Dinitrophenol	49418	51-28-5	50	µg/kg
2,4-Dinitrotoluene	49395	121-14-2	50	µg/kg
2,6-Dimethylnaphthalene	49406	581-42-0	50	µg/kg
2,6-Dinitrotoluene	49396	606-20-2	50	µg/kg
2-Chloronaphthalene	49407	91-58-7	50	µg/kg
2-Chlorophenol	49467	95-57-8	50	µg/kg
2-Ethylnaphthalene	49948	939-27-5	50	µg/kg
2-Fluorobiphenyl (surrogate)	49279	321-60-8	.1	percent
2-Methylantracene	49435	613-12-7	50	µg/kg
2-Nitrophenol	49420	88-75-5	50	µg/kg
3,5-Dichlorobiphenyl (surrogate)	49277	34883-41-5	.1	percent
3,5-Dimethylphenol	49421	108-68-9	50	µg/kg
4,6-Dinitro-2-methylphenol	49419	534-52-1	50	µg/kg
4-Bromophenylphenylether	49454	101-55-3	50	µg/kg
4-Chloro-3-methylphenol	49422	59-50-7	50	µg/kg
4-Chlorophenyl phenyl ether	49455	7005-72-3	50	µg/kg
4-Nitrophenol	49423	100-02-7	50	µg/kg
4,5-Methylenephenanthrene	49411	203-64-5	50	µg/kg
Acenaphthene	49429	83-32-9	50	µg/kg
Acenaphthylene	49428	208-96-8	50	µg/kg
Acridine	49430	260-94-6	50	µg/kg
Aldrin	49319	309-00-2	1	µg/kg
α-Endosulfan	49332	959-98-8	1	µg/kg

Appendix B4. *Laboratory code constituents and parameters for schedule 2500,
organic compounds in bed sediment, from the U.S. Geological Survey
National Water-Quality Laboratory (NWQL), Denver, Colorado, 2001—Continued*

Parameter name	USGS parameter code	CAS number	Reporting limit	Reporting unit
α -HCH ¹	49338	319-84-6	1	µg/kg
α -HCH-d6 (surrogate) ²	49275	—	.1	percent
Anthracene	49434	120-12-7	50	µg/kg
Anthraquinone	49437	84-65-1	50	µg/kg
Azobenzene	49443	103-33-3	50	µg/kg
Benz[a]anthracene	49436	56-55-3	50	µg/kg
Benzo[a]pyrene	49389	50-32-8	50	µg/kg
Benzo[b]fluoranthene	49458	205-99-2	50	µg/kg
Benzo[c]cinnoline	49468	230-17-1	50	µg/kg
Benzo[ghi]perylene	49408	191-24-2	50	µg/kg
Benzo[k]fluoranthene	49397	207-08-9	50	µg/kg
β -HCH ³	49339	319-85-7	1	µg/kg
Bis(2-chloroethoxy)methane	49401	111-91-1	50	µg/kg
Bis(2-chloroethyl)ether	49456	111-44-4	50	µg/kg
Bis(2-chloroisopropyl)ether	49457	108-60-1	50	µg/kg
Bis(2-ethylhexyl)phthalate	49426	117-81-7	50	µg/kg
Butylbenzyl phthalate	49427	85-68-7	50	µg/kg
C8-Alkylphenol	49424	—	50	µg/kg
Carbazole	49449	86-74-8	50	µg/kg
Chloroneb	49322	2675-77-6	5	µg/kg
Chrysene	49450	218-01-9	50	µg/kg
cis-Chlordane	49320	5103-71-9	1	µg/kg
cis-Nonachlor	49316	5103-73-1	1	µg/kg
cis-Permethrin	49349	54774-45-7	5	µg/kg
Dacthal	49324	1861-32-1	5	µg/kg
Di-n-butyl phthalate	49381	84-74-2	50	µg/kg
Di-n-octyl phthalate	49382	117-84-0	50	µg/kg
Dibenz[ah]anthracene	49461	53-70-3	50	µg/kg
Dibenzothiophene	49452	132-65-0	50	µg/kg
Dieldrin	49331	60-57-1	1	µg/kg
Diethyl phthalate	49383	84-66-2	50	µg/kg
Dimethyl phthalate	49384	131-11-3	50	µg/kg
Endrin	49335	72-20-8	2	µg/kg
Fluoranthene	49466	206-44-0	50	µg/kg
Fluorene	49399	86-73-7	50	µg/kg
Heptachlor	49341	76-44-8	1	µg/kg
Heptachlor epoxide	49342	1024-57-3	1	µg/kg
Hexachlorobenzene	49343	118-74-1	1	µg/kg
Hexachlorobutadiene	49448	87-68-3	50	µg/kg

^{1.} α -1,2,3,4,5,6-Hexachlorocyclohexane.

^{2.} α -1,2,3,4,5,6-Hexachlorocyclohexane-d6

^{3.} β -1,2,3,4,5,6-Hexachlorocyclohexane.

Appendix B4. *Laboratory code constituents and parameters for schedule 2500,
organic compounds in bed sediment, from the U.S. Geological Survey
National Water-Quality Laboratory (NWQL), Denver, Colorado, 2001—Continued*

Parameter name	USGS parameter code	CAS number	Reporting limit	Reporting unit
Hexachlorocyclopentadiene	49489	77-47-4	50	µg/kg
Hexachloroethane	49453	67-72-1	50	µg/kg
Indeno[1,2,3-cd]pyrene	49390	193-39-5	50	µg/kg
Isodrin	49344	465-73-6	1	µg/kg
Isophorone	49400	78-59-1	50	µg/kg
Isoquinoline	49394	119-65-3	50	µg/kg
Lindane	49345	58-89-9	1	µg/kg
Mirex	49348	2385-85-5	1	µg/kg
<i>N</i> -Nitrosodi- <i>n</i> -propylamine	49431	621-64-7	50	µg/kg
<i>N</i> -Nitrosodiphenylamine	49433	86-30-6	50	µg/kg
Naphthalene	49402	91-20-3	50	µg/kg
Nitrobenzene	49444	98-95-3	50	µg/kg
Nitrobenzene-d5 (surrogate)	49280	4165-60-0	.1	percent
<i>o,p'</i> -DDD ⁴	49325	53-19-0	1	µg/kg
<i>o,p'</i> -DDE ⁵	49327	3424-82-6	1	µg/kg
<i>o,p'</i> -DDT ⁶	49329	789-02-6	2	µg/kg
<i>o,p'</i> -Methoxychlor	49347	30667-99-3	5	µg/kg
Oxychlordane	49318	27304-13-8	1	µg/kg
<i>p,p'</i> -DDD ⁷	49326	72-54-8	1	µg/kg
<i>p,p'</i> -DDE ⁸	49328	72-55-9	1	µg/kg
<i>p,p'</i> -DDT ⁹	49330	50-29-3	2	µg/kg
<i>p,p'</i> -Methoxychlor	49346	72-43-5	5	µg/kg
<i>p</i> -Cresol	49451	106-44-5	50	µg/kg
Pentachloroanisole	49460	1825-21-4	1	µg/kg
Pentachloronitrobenzene	49446	82-68-8	50	µg/kg
Pentachlorophenol	49425	87-86-5	50	µg/kg
Phenanthrene	49409	85-01-8	50	µg/kg
Phenanthridine	49393	229-87-8	50	µg/kg
Phenol	49413	108-95-2	50	µg/kg
Polychlorinated biphenyls	49459	1336-36-3	50	µg/kg
Pyrene	49387	129-00-0	50	µg/kg
Quinoline	49392	91-22-5	50	µg/kg
Terphenyl-d14 (surrogate)	49278	1718-51-0	.1	percent
Total carbon	49272	—	.1	g/kg
Toxaphene	49351	8001-35-2	200	µg/kg
<i>trans</i> -Chlordane	49321	5103-74-2	1	µg/kg
<i>trans</i> -Nonachlor	49317	39765-80-5	1	µg/kg
<i>trans</i> -Permethrin	49350	51877-74-8	5	µg/kg

⁴. 1,1-Dichloro-2-(*o*-chlorophenyl)-2-(*p*-chlorophenyl)ethane.

⁵. 1,1-Dichloro-2-(*o*-chlorophenyl)-2-(*p*-chlorophenyl)ethylene.

⁶. 1,1,1-Trichloro-2-(*o*-chlorophenyl)-2-(*p*-chlorophenyl)ethane.

⁷. 1,1-Dichloro-2,2-bis(*p*-chlorophenyl)ethane.

⁸. 1,1-Dichloro-2,2-bis(*p*-chlorophenyl)ethylene.

⁹. 1,1,1-Trichloro-2,2-bis(*p*-chlorophenyl)ethane.

**Appendix B5. Laboratory code constituents and parameters for schedule 2701,
major ions in water, from the U.S. Geological Survey
National Water-Quality Laboratory (NWQL), Denver, Colorado, 2001**

[USGS, U.S. Geological Survey; CAS, Chemical Abstracts Service registry numbers;
mg/L, milligrams per liter; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter;
–, no data available]

Parameter name	USGS parameter code	CAS number	Reporting limit	Reporting unit
Calcium (dissolved)	00915	7440-70-2	0.011	mg/L
Chloride (dissolved)	00940	16887-00-6	.08	mg/L
Fluoride (dissolved)	00950	16984-48-8	.16	mg/L
Iron (dissolved)	01046	7439-89-6	10	µg/L
Magnesium (dissolved)	00925	7439-95-4	.008	mg/L
Manganese (dissolved)	01056	7439-96-5	3.2	µg/L
pH, laboratory	00403	–	.1	standard units
Potassium (dissolved)	00935	7440-09-7	.09	mg/L
Residue, 180 degrees Celsius	70300	–	10	mg/L
Silica (dissolved)	00955	7631-86-9	.09	mg/L
Sodium (dissolved)	00930	7440-23-5	.06	mg/L
Specific conductance, laboratory	90095	–	2.6	µS/cm
Sulfate (dissolved)	00945	14808-79-8	.11	mg/L

**Appendix B6. Laboratory code constituents and parameters for schedule 2702,
nutrients in water, from the U.S. Geological Survey
National Water-Quality Laboratory (NWQL), Denver, Colorado, 2001**

[USGS, U.S. Geological Survey; CAS, Chemical Abstracts Service registry numbers;
mg/L, milligrams per liter; –, no data available]

Parameter name	USGS parameter code	CAS number	Reporting limit	Reporting unit
Nitrogen, ammonia (dissolved as N)	00608	7664-41-7	0.041	mg/L
Nitrogen, ammonia plus organic nitrogen (dissolved as N)	00623	17778-88-0	.1	mg/L
Nitrogen, ammonia plus organic nitrogen (total as N)	00625	17778-88-0	.08	mg/L
Nitrogen, nitrite (dissolved as N)	00613	14797-65-0	.006	mg/L
Nitrogen, nitrite plus nitrate (dissolved as N)	00631	–	.047	mg/L
Phosphorus (dissolved as P)	00666	7723-14-0	.006	mg/L
Phosphorus (total as P)	00665	7723-14-0	.0037	mg/L
Phosphorus, phosphate, ortho (dissolved as P)	00671	14265-44-2	.018	mg/L

Appendix C. *Selected transformation products from pesticides discussed in this report*

[Part of the suite of pesticides and organic compounds that was measured in Rock Creek during 1999–2000]

Transformation product	Parent compound
Aldicarb sulfone	Aldicarb
Aldicarb sulfoxide	Aldicarb
Dacthal, monoacid	Dacthal
Dieldrin	Aldrin (Dieldrin was also applied as a pesticide)
2,6-Diethylaniline	Alachlor
α -HCH ¹	Lindane ²
3-Hydroxycarbofuran	Carbofuran
<i>o,p'</i> -DDD ³ and <i>p,p'</i> -DDD ⁴	DDT ⁵
<i>o,p'</i> -DDE ⁶ and <i>p,p'</i> -DDE ⁷	DDT ⁵
Desethylatrazine	Atrazine
Heptachlor epoxide	Heptachlor

¹. α -1,2,3,4,5,6-Hexachlorocyclohexane.

². Lindane is a technical mixture consisting primarily of γ -HCH (gamma-1,2,3,4,5,6-hexachlorocyclohexane), but may also contain α -HCH .

³. 1,1-Dichloro-2-(*o*-chlorophenyl)-2-(*p*-chlorophenyl)ethane.

⁴. 1,1-(Dichloro-2,2-bis(*p*-chlorophenyl)ethane.

⁵. 1,1,1-Trichloro-2,2-bis(*p*-chlorophenyl)ethane.

⁶. 1,1-Dichloro-2-(*o*-chlorophenyl)-2-(*p*-chlorophenyl)ethylene.

⁷. 1,1-(Dichloro-2,2-bis(*p*-chlorophenyl)ethylene.