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

Water-Resources Investigations Report 02-4067

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

**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.]*

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

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**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:

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

**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 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-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 $mi^2$ (square miles) of its drainage basin are in Montgomery County, Maryland, and 16 $mi^2$ 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 Protection 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.

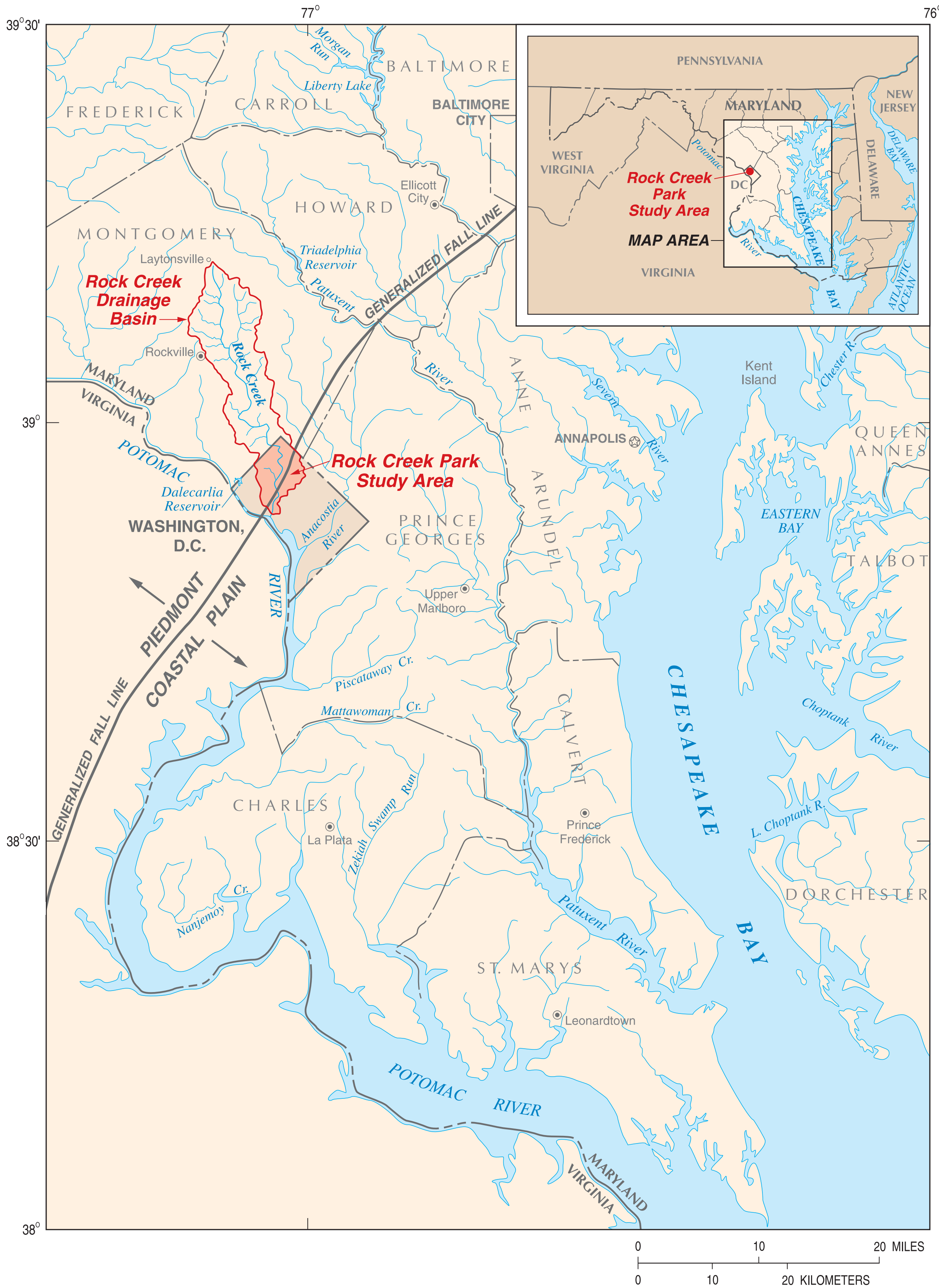


**Figure 1.** Location of Rock Creek drainage basin and Rock Creek Park study area, Washington, D.C.

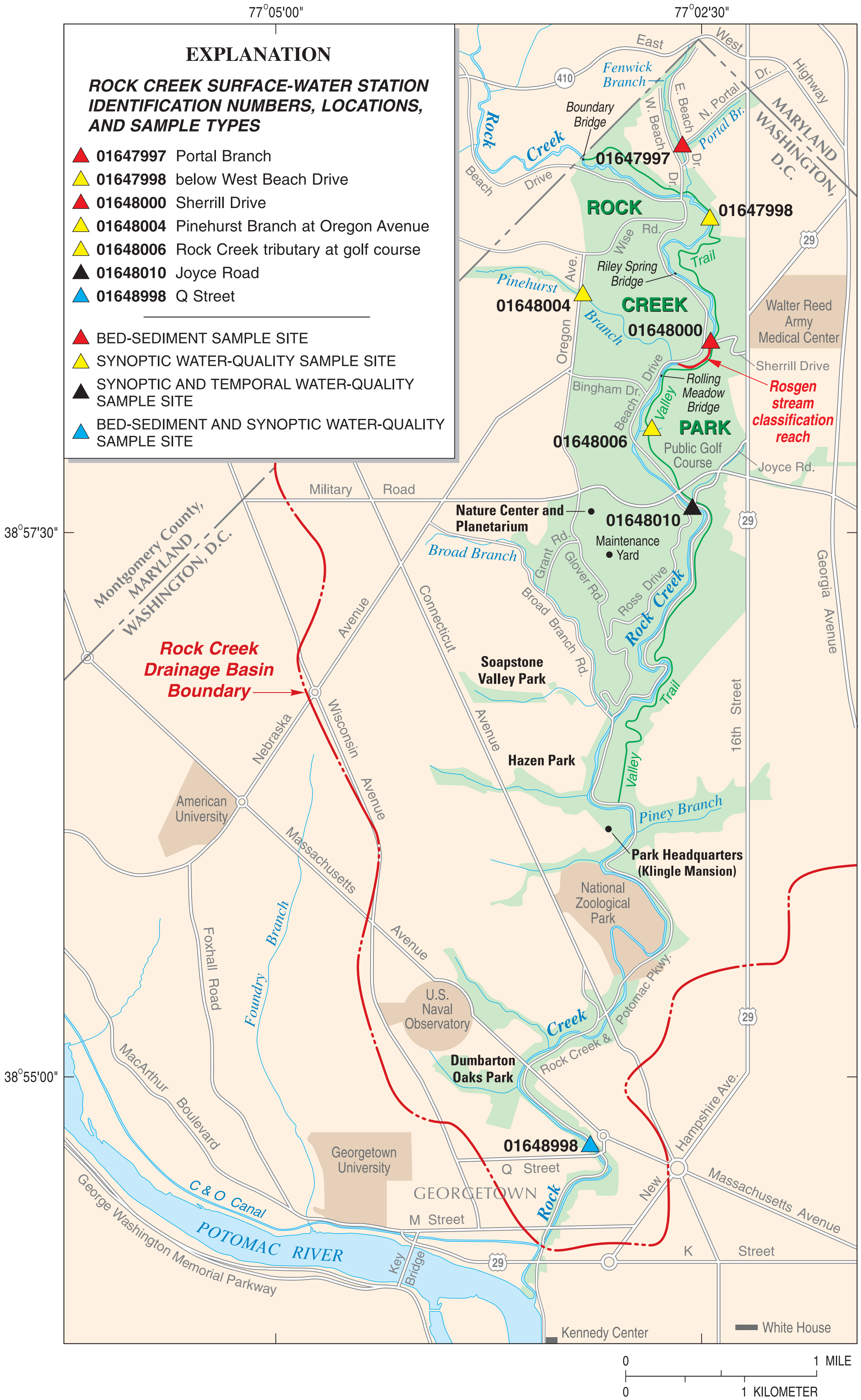


**Figure 2.** Locations of surface-water stations within the Rock Creek Park study area, Washington, D.C.

**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 $mi^2$, of which 15.9 $mi^2$ 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 $mi^2$ of drainage in Montgomery County that serve as the headwaters of Rock Creek. NPS manages 1,754 acres (2.74 $mi^2$) 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]

| | Washington, D.C. area | | Entire Rock Creek Basin | |
|---|---|---|---|---|
| **Land-use type** | **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 $mi^2$, 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 thermatic mapping (TM) imagery (collected in 1992), with a spatial resolution of 30 meters and supplemented by various ancillary data (Vogelmann and others, 2001).

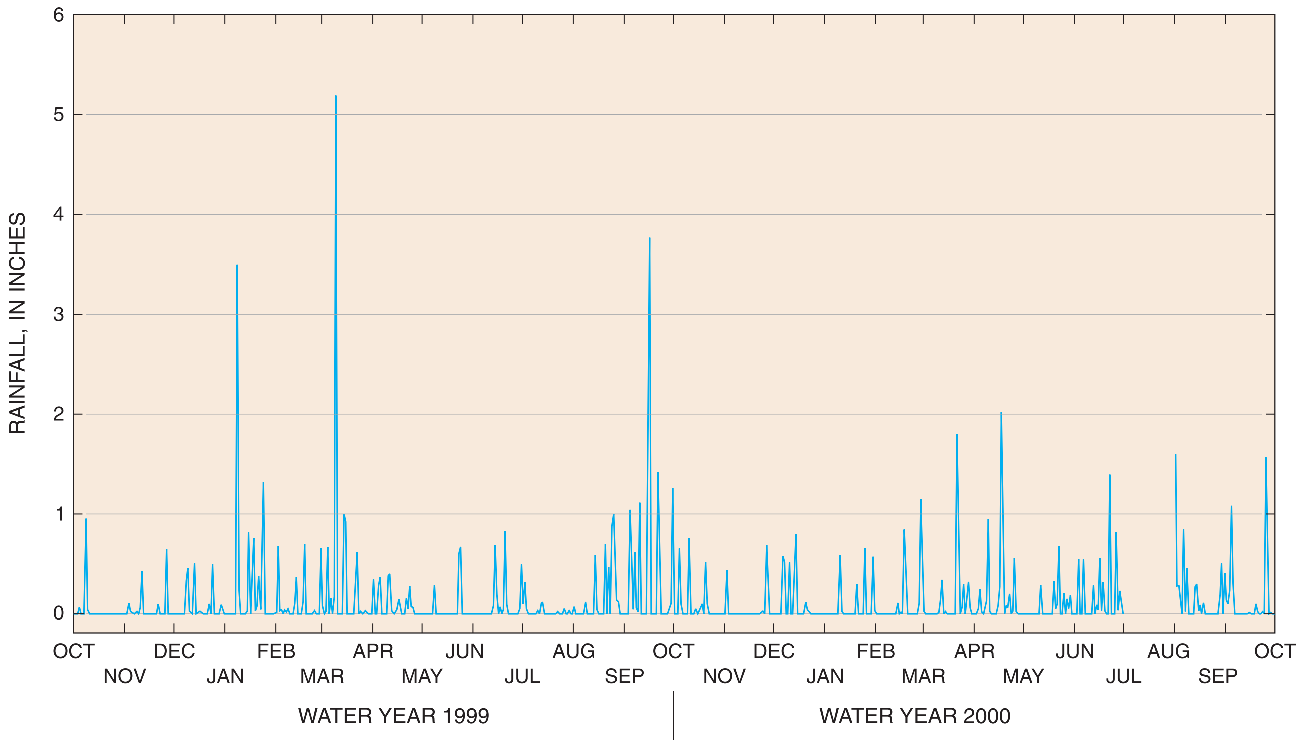


**Figure 3.** Precipitation data measured at Dalecarlia Reservoir near the Rock Creek Park study area, Washington, D.C., for water years 1999 and 2000. *(No data are available for July 2000.)*

## 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

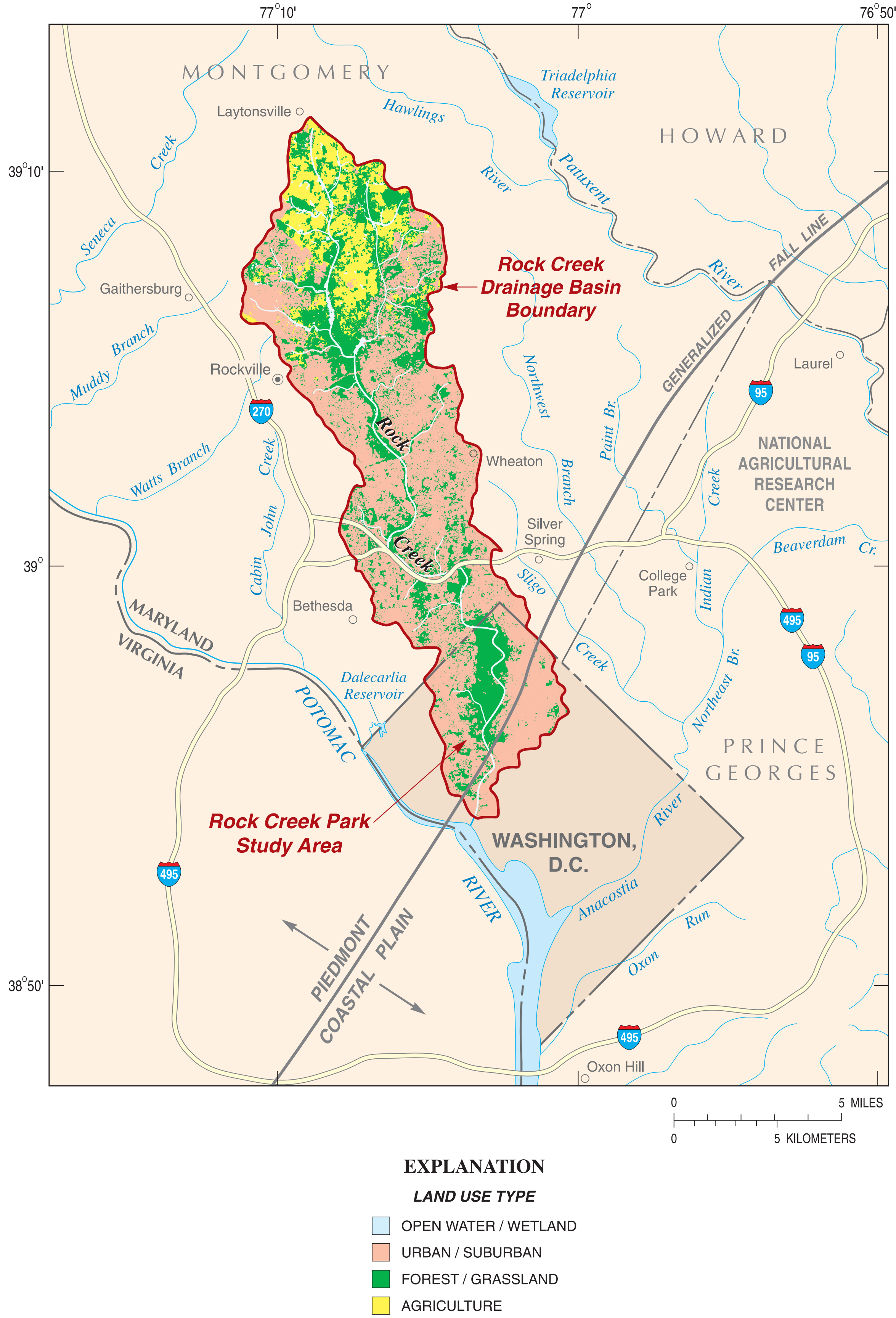


**Figure 4.** Land use in the Rock Creek Basin, Washington, D.C. and Montgomery County, Maryland.

**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 |
| Ethalfluralin | 60 | 80 | Dinitroaniline herbicide | Soybeans and vegetables |
| Ethoprop | – | – | Organophosphate insecticide, nematicide | 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 ascaricide, and molluscicide | Home gardens |
| Methomyl | 122 | 28 | 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*–chlorphenyl)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, nematicide, 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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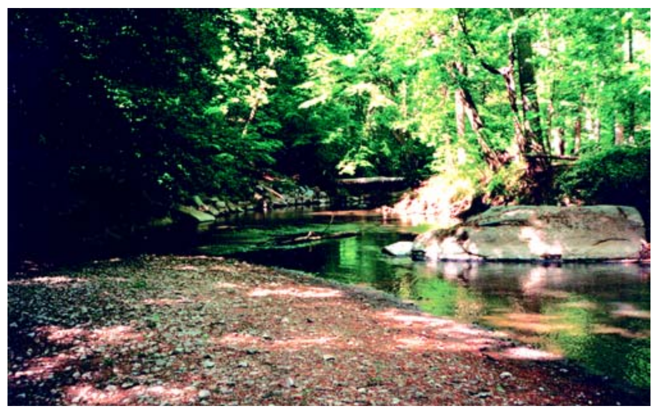


**Table 4**. *Pesticides applied to Rock Creek Golf Course, Washington, D.C., during water years 1999 and 2000*

[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)]

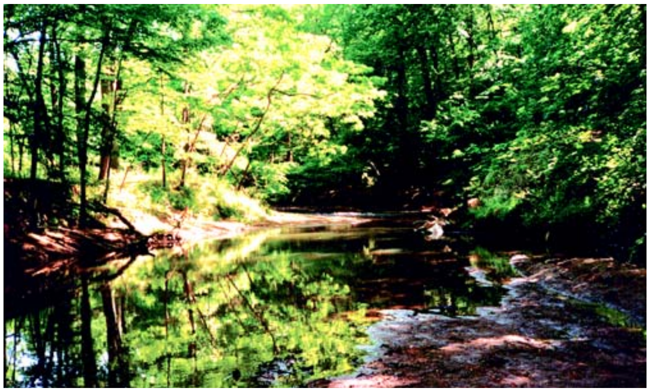
| USEPA regulation number | Application date | Active ingredient | Area applied |
|---|---|---|---|
| 524-343 | 10/01/1999 | Glyphosate | Rolling Meadow Bridge to board walk |
| 524-343 | 10/12/1999 | Glyphosate | Riley Spring Bridge and trail |
| 524-343 | 10/15/1999 | Glyphosate | Riley Spring Bridge - 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-µm (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 Carbopak–B solid-phase extraction cartridge followed by elution of the pesticides captured on the Carbopak–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 ($HNO_3$), and perchloric acid ($HClO_4$), 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 (*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 | |
| 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 |
| Ethalfluralin | <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): Sample data (pair 1 / pair 2 / pair 3) | Concentrations (µg/L) in replicate sample pairs (*n* = 3): Estimated standard deviation | Percent recoveries in field spike (*n* = 1) |
|---|---|---|---|---|
| Methylazinphos | <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 | – | – |
| *p,p'*–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 |
| *cis*–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]

| | | | Replicate sample pairs | |
|---|---|---|---|---|
| **Analytes** | **Units** | **Field blank** | **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 communs., 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 µg/L) above the reporting limit (0.07 µg/L); however no criteria for the protection of aquatic life for this chemical have been set (see appendix B2).

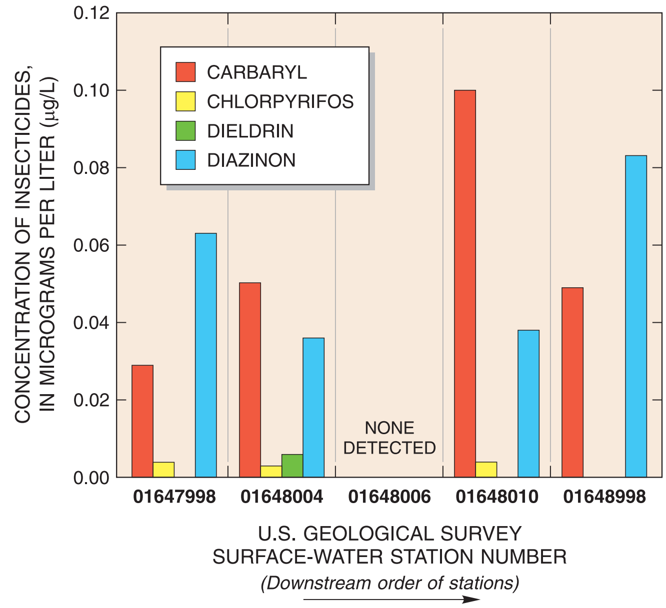



**Figure 5.** Concentrations of insecticides detected in synoptic water-quality samples in the Rock Creek Park study area, Washington, D.C., June 1999.

### 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 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 | – | – | – | 1.0 | – | ND | ND | 0 |
| α–HCH [4] | – | – | – | – | – | ND | ND | NC |
| 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 |
| Ethalfluralin | – | – | – | – | – | 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 |
| Methylazinphos | – | – | – | – | – | 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 |
| *p,p*'–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 |
| *cis*–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] CMC | CCC | 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: Synoptic sampling, June 1999 | Temporal sampling at station 01648010 | Number of samples above any aquatic criteria |
|---|---|---|---|---|---|---|---|---|
| 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

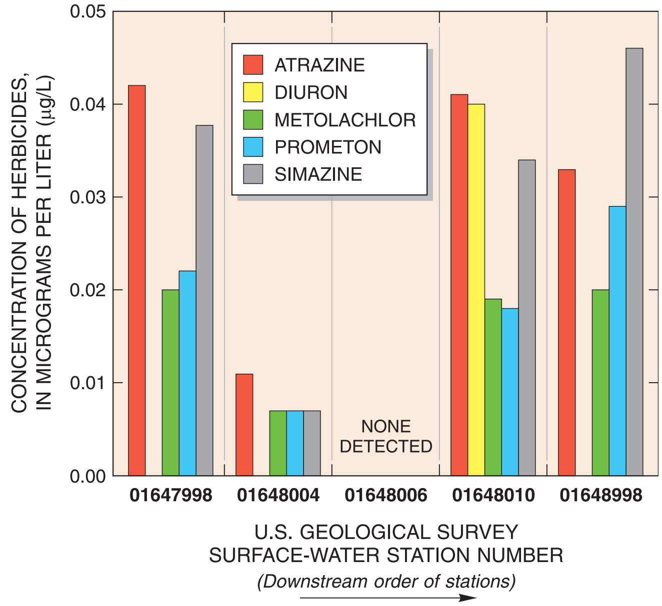



**Figure 6.** Concentrations of herbicides detected in synoptic water-quality samples in the Rock Creek Park study area, Washington, D.C., June 1999.

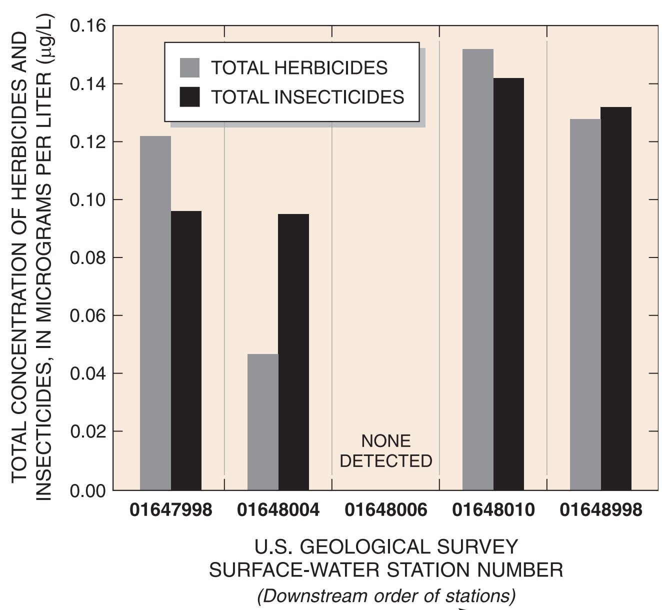



**Figure 7.** Total concentrations of herbicides and insecticides detected in synoptic water-quality samples in the Rock Creek Park study area, Washington, D.C., June 1999.

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.

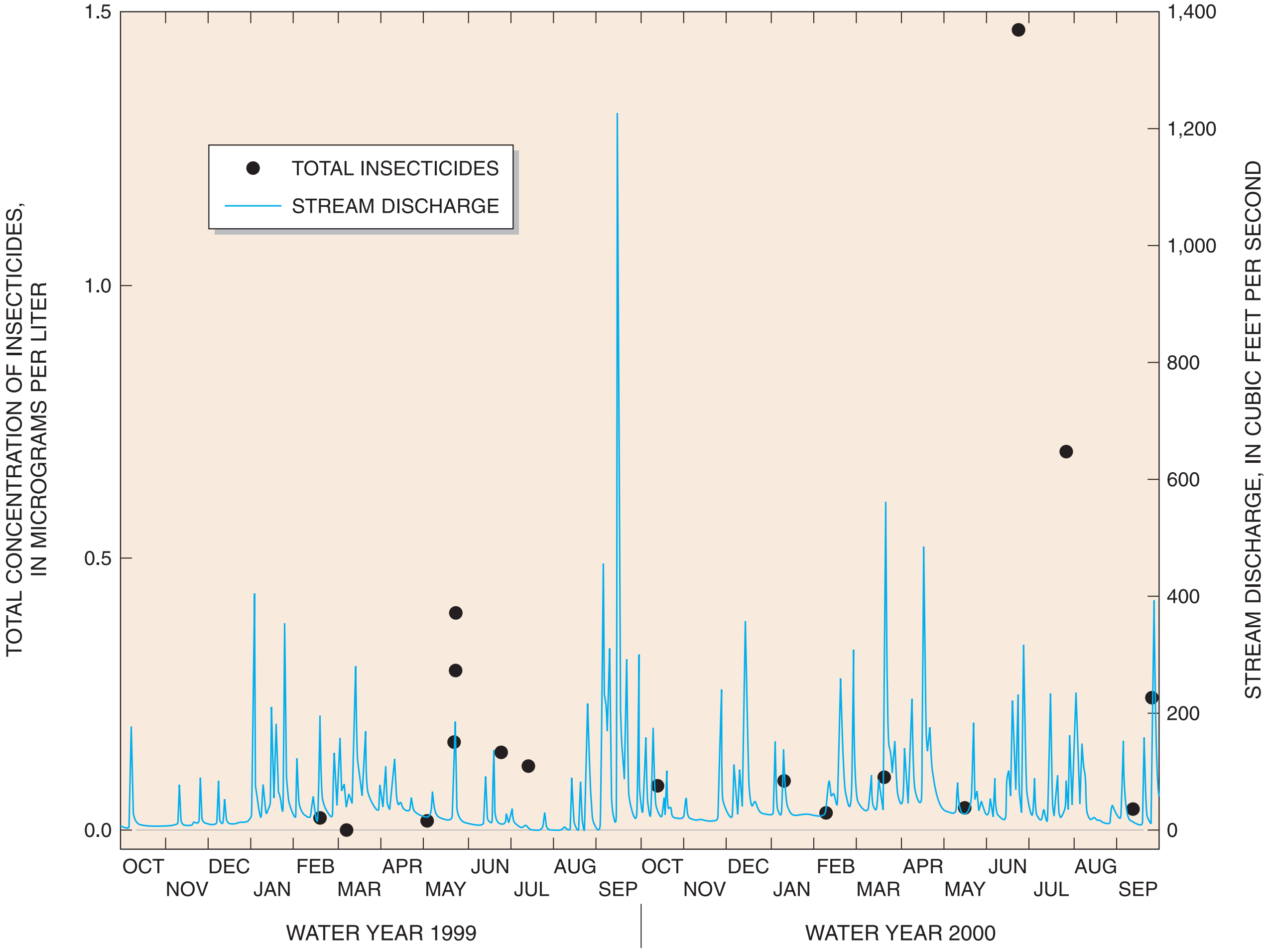



**Figure 8.** Stream discharge and total concentrations of insecticides at Rock Creek at Joyce Road (station 01648010) for water years 1999 and 2000 in the Rock Creek Park study area, Washington, D.C.

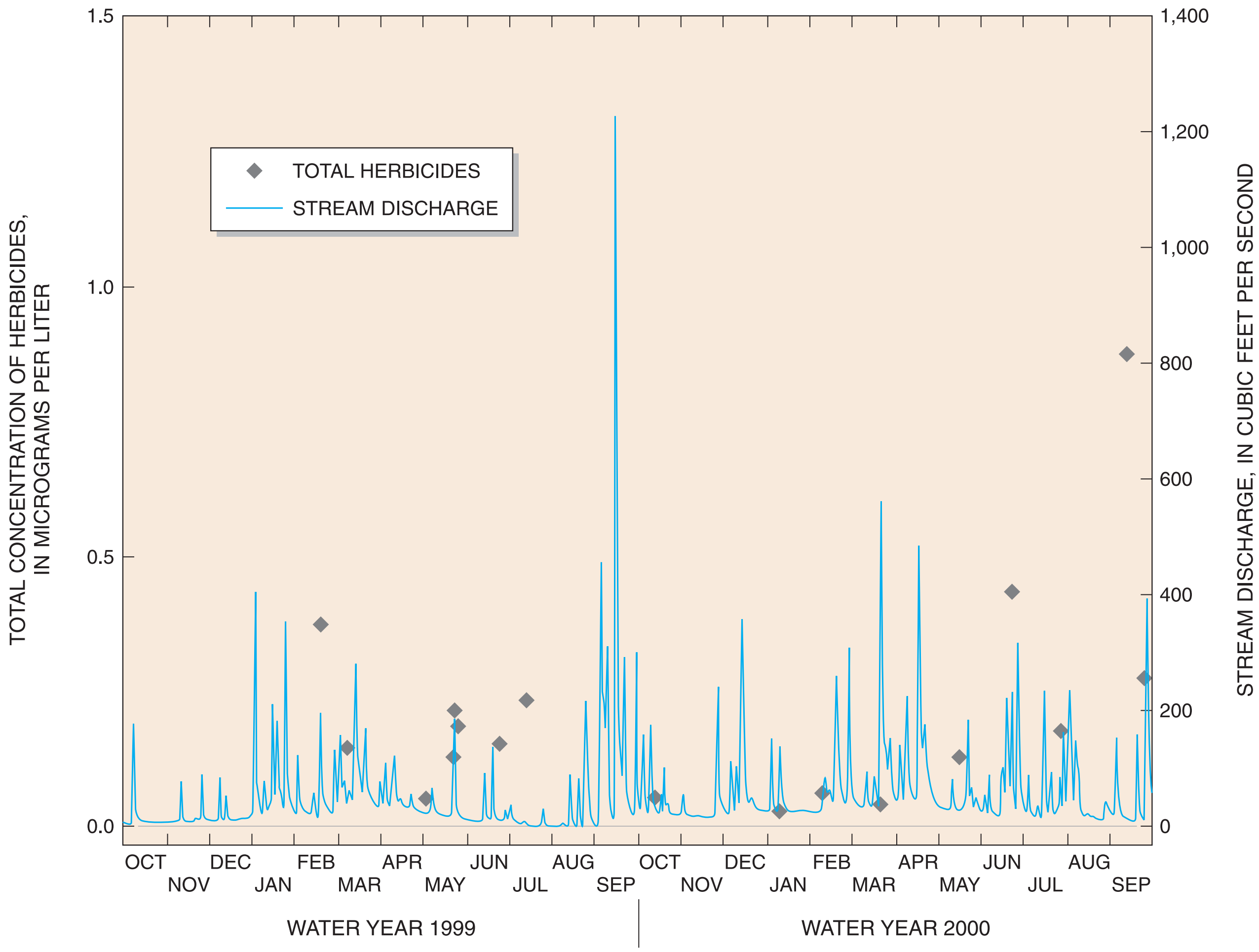



**Figure 9.** Stream discharge and total concentrations of herbicides at Rock Creek at Joyce Road (station 01648010) for water years 1999 and 2000 in the Rock Creek Park study area, Washington, D.C.

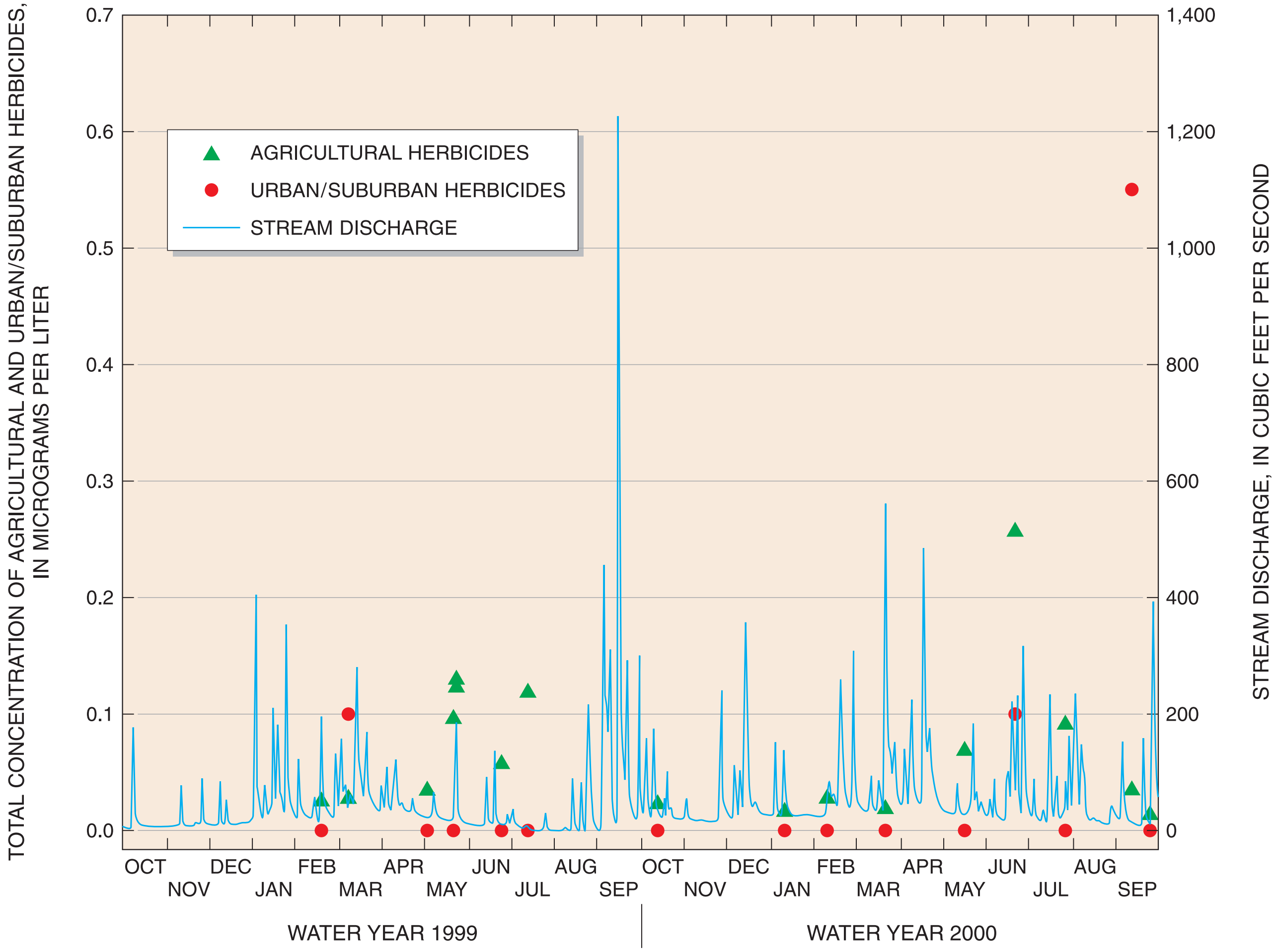



**Figure 10.** Stream discharge and total concentrations of herbicides used predominantly in urban/suburban (2,4-D and MCPA) or agricultural (atrazine, cyanazine, and metolachlor) environments for Rock Creek at Joyce Road (station 01648010) for water years 1999 and 2000 in the Rock Creek Park study area,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

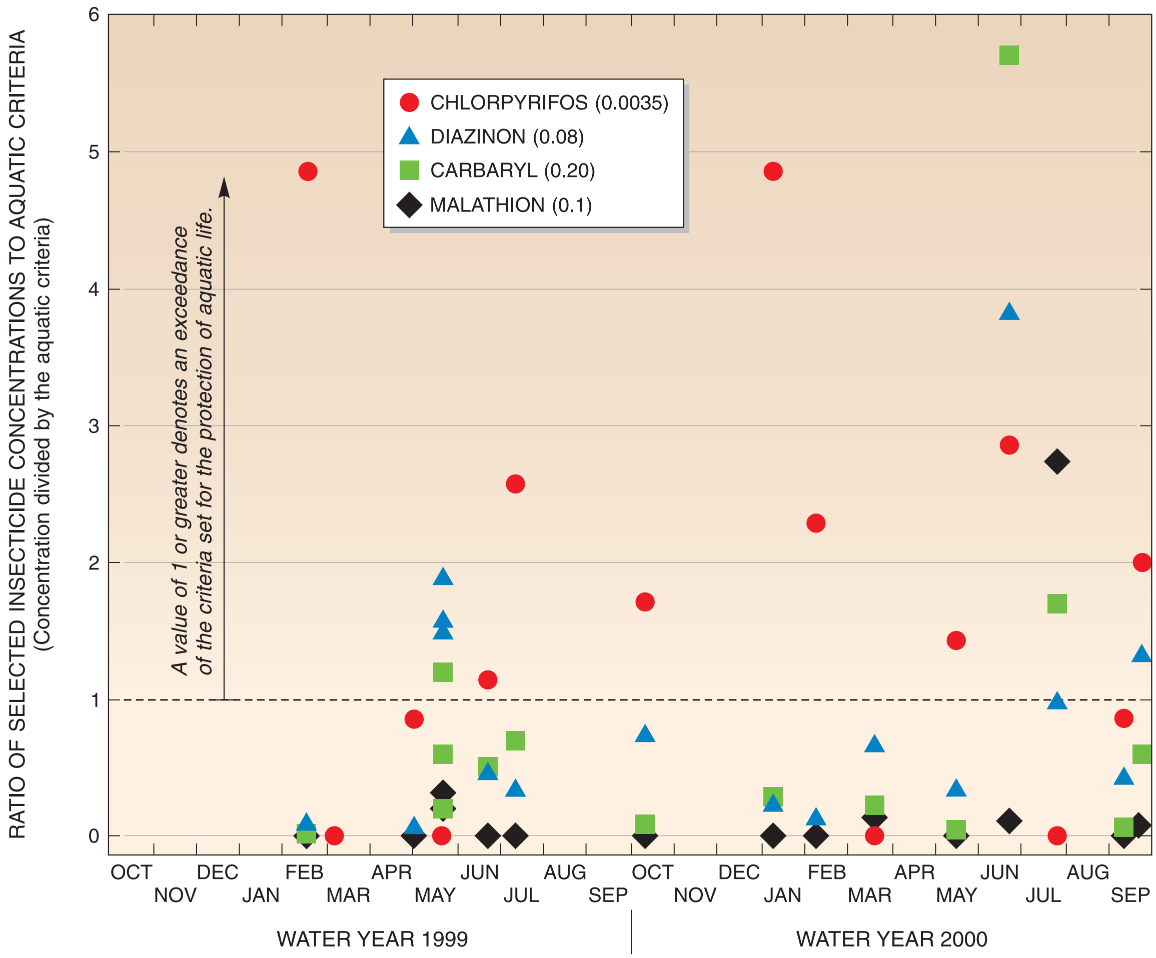
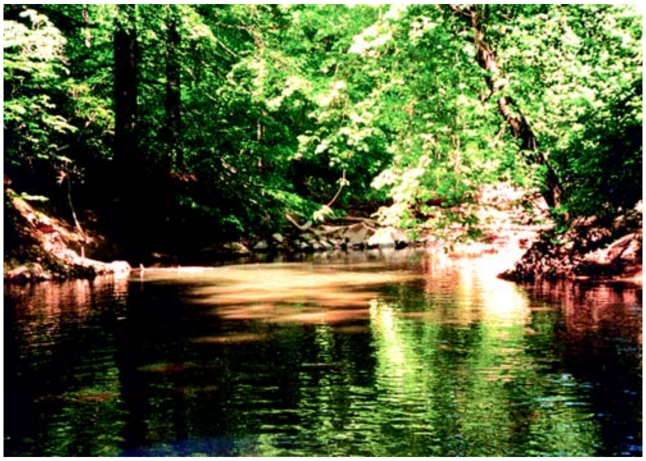



**Figure 11.** Ratios of selected insecticide concentrations to their respective aquatic criteria for samples collected from Rock Creek at Joyce Road (station 01648010) from October 1999 through September 2000 in the Rock Creek Park study area, Washington, D.C. *(Aquatic criteria are presented in table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

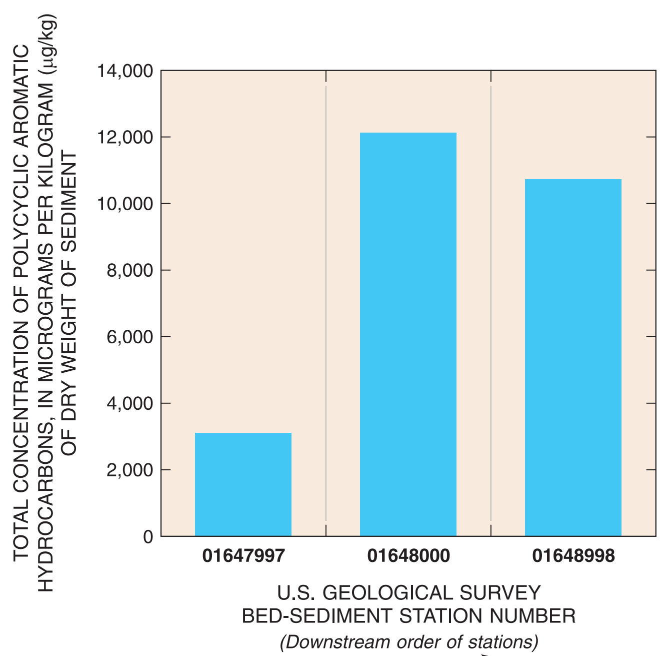



**Figure 12.** Total concentrations of polycyclic aromatic hydrocarbons at the bed-sediment stations sampled in the Rock Creek Park study area, Washington, D.C., August 1999.

**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]

| 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** | |
| **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 |
| *p*-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

| 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 | |
| **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 (*cis*- plus *trans*-) | 2.26 | 4.79 | 4.50 | 8.87 | 4 | 13 | 13 | 3 |
| *o,p*'–DDD [1] | – | – | – | – | <1 | 3 | <1 | NC |
| *p,p*'–DDD [2] | 1.22 | 7.81 | 3.54 | 8.51 | **E** 2 | 4 | **E** 6 | 3 |
| *o,p*'–DDE [3] | – | – | – | – | <1 | <1 | <1 | NC |
| *p,p*'–DDE [4] | 2.07 | – | 1.42 | 6.75 | 2 | 4 | 7 | 3 |
| *p,p*'–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

| 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 | |
| | | | | **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-*n*-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 |

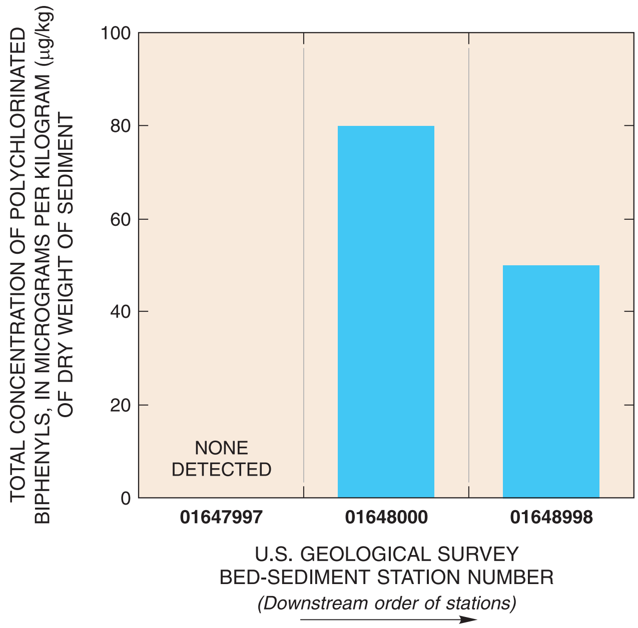



**Figure 13.** Total concentrations of polychlorinated biphenyls at the bed-sediment stations sampled in the Rock Creek Park study area, Washington, D.C., August 1999.

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 harmful 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-bi*s*(*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,

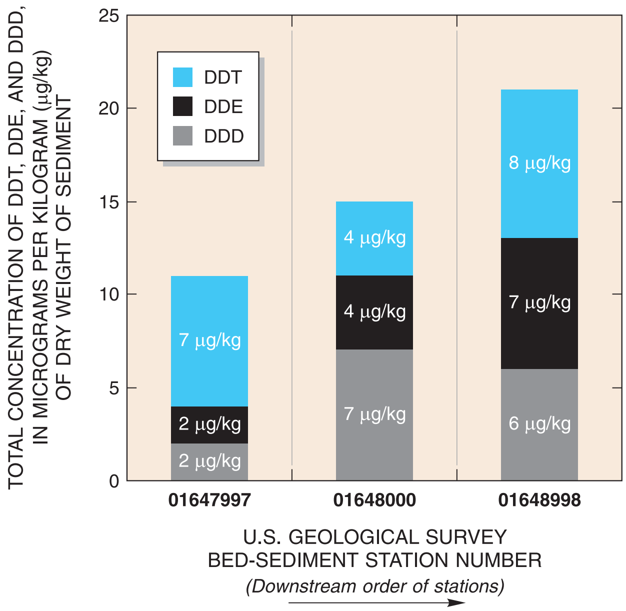



**Figure 14.** Total concentrations of DDT, DDE, and DDD at the bed-sediment stations sampled in the Rock Creek Park study area, Washington, D.C., August 1999.

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 $ft^3/s$ (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 $mi^2$ of the 62 $mi^2$ 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) | Ethalfluralin, 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 (μg/L) | Linuron, water, dissolved (μg/L) (2050) [6] | Linuron, water, dissolved (μg/L) (2001) [6] | Malathion, water, dissolved (μg/L) | MCPA, [10] water, dissolved (μg/L) | MCPB, [11] water, dissolved (μg/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) | Methylazinphos, 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) | *p,p'*–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; µS/cm, microsiemens per centimeter; °C, degrees Celsius; µg/L, micrograms per liter; mm, millimeters; $ft^3/s$, 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 (μS/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 | – | – | – | – | – | – |
| 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 |
| – | – | – | – | – | 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 | – | – | – | – | – |
| 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 | *m*–Dichlorobenzene (µg/kg) | Nitrobenzene (µg/kg) | Nitrobenzene–d5 (surrogate, percent) | *o*–Dichlorobenzene (µg/kg) |
|---|---|---|---|---|
| 01647997 | <50 | <50 | 43 | <50 |
| 01648000 | <50 | <50 | 67 | <50 |
| 01648998 | <100 | <100 | 51 | <100 |

| Station number | *p*–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-*n*-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 | *N*–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) | *o,p´*–Methoxychlor (µg/kg) | *p,p´*–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) | *o,p´*–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 | *o,p´*–DDE [2] (µg/kg) | *o,p´*–DDT [3] (µg/kg) | Oxychlordane (µg/kg) | *p,p´*–DDD [4] (µg/kg) |
|---|---|---|---|---|
| 01647997 | <1 | <2 | <1 | **E** 2 |
| 01648000 | <1 | <2 | 2 | 4 |
| 01648998 | <1 | <2 | 2 | **E** 6 |

| Station number | *p,p´*–DDE [5] (µg/kg) | *p,p´*–DDT [6] (µg/kg) | Polychlorinated biphenyls (PCBs) (µg/kg) | *p*–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.

3. 1,1,1–Trichloro–2–(*o*–chlorophenyl)–2–(*p*–chlorophenyl)ethane.

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

5. 1,1–Dichloro–2,2–bis(*p*–chlorophenyl)ethylene.

6. 1,1,1–Trichloro–2,2–bis(*p*–chlorophenyl)ethane.

| Butylbenzyl phthalate (µg/kg) | Dimethyl phthalate (µg/kg) | Di–*n*–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–*n*–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) | *trans*–Chlordane (µg/kg) | *trans*–Nonachlor (µg/kg) | *trans*–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 |
| Ethalfluralin | 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–Methylanthracene | 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 |
| *N*–Nitrosodi–*n*–propylamine | 49431 | 621-64-7 | 50 | µg/kg |
| *N*–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 |
| *o,p'*–DDD [4] | 49325 | 53-19-0 | 1 | µg/kg |
| *o,p'*–DDE [5] | 49327 | 3424-82-6 | 1 | µg/kg |
| *o,p'*–DDT [6] | 49329 | 789-02-6 | 2 | µg/kg |
| *o,p'*–Methoxychlor | 49347 | 30667-99-3 | 5 | µg/kg |
| Oxychlordane | 49318 | 27304-13-8 | 1 | µg/kg |
| *p,p'*–DDD [7] | 49326 | 72-54-8 | 1 | µg/kg |
| *p,p'*–DDE [8] | 49328 | 72-55-9 | 1 | µg/kg |
| *p,p'*–DDT [9] | 49330 | 50-29-3 | 2 | µg/kg |
| *p,p'*–Methoxychlor | 49346 | 72-43-5 | 5 | µg/kg |
| *p*–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 |
| *trans*–Chlordane | 49321 | 5103-74-2 | 1 | µg/kg |
| *trans*–Nonachlor | 49317 | 39765-80-5 | 1 | µg/kg |
| *trans*–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–Diethylanaline | Alachlor |
| α–HCH [1] | Lindane [2] |
| 3–Hydroxycarbofuran | Carbofuran |
| *o,p*'–DDD [3] and *p,p*'–DDD [4] | DDT [5] |
| *o,p*'–DDE [6] and *p,p*'–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.