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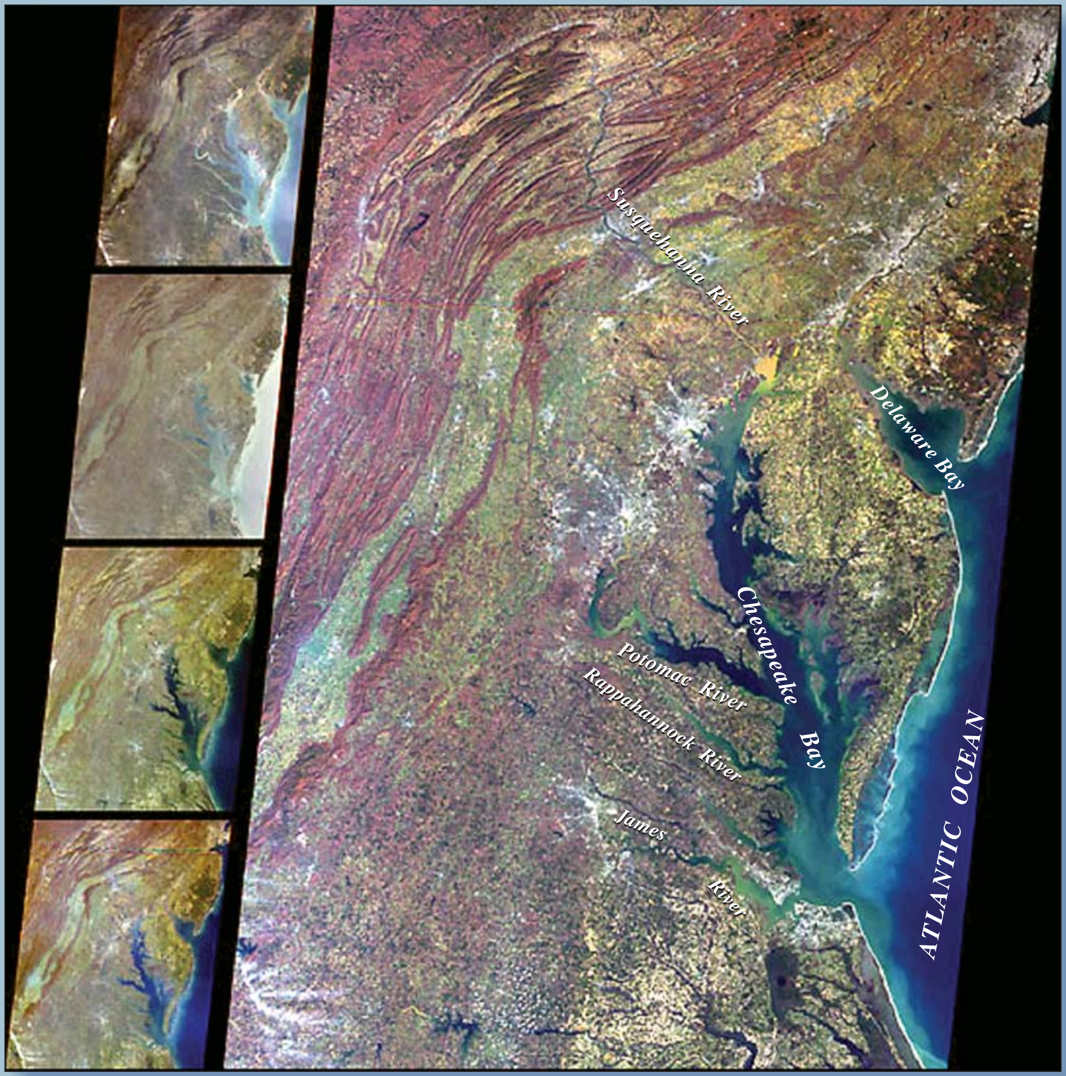
Summary of Suspended-Sediment Data for Streams Draining the Chesapeake Bay Watershed, Water Years 1952–2002

Scientific Investigations Report 2004-5056



U.S. Department of the Interior
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Cover. Multi-angle Imaging SpectroRadiometer (MISR) images of the Chesapeake Bay, Delaware Bay, and the Appalachian Mountains acquired March 24, 2000 during a Terra satellite orbit.
(Note the visible sediment export from the Susquehanna River to the Chesapeake Bay.)

[Photo from the National Aeronautics and Space Administration (NASA) NASA/GSFC/JPL, MISR Science Team]

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Summary of Suspended-Sediment Data for Streams Draining the Chesapeake Bay Watershed, Water Years 1952–2002

by Allen C. Gellis, William S.L. Banks, Michael J. Langland, and Sarah K. Martucci

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Reston, Virginia
2005

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

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Conversion Factors

Multiply	By	To obtain
Length		
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
mile, nautical (nmi)	1.852	kilometer
yard (yd)	0.9144	meter
Area		
acre	4,047	square meter
acre	0.4047	hectare
acre	0.4047	square hectometer
acre	0.004047	square kilometer
square foot (ft^2)	929.0	square centimeter
square foot (ft^2)	0.09290	square meter
square inch (in^2)	6.452	square centimeter
section (640 acres or 1 square mile)	259.0	square hectometer
square mile (mi^2)	259.0	hectare
square mile (mi^2)	2.590	square kilometer
Flow rate		
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
cubic foot per second per square mile [$(ft^3/s)/mi^2$]	0.01093	cubic meter per second per square kilometer
Mass		
ton, short (2,000 lb)	0.9072	megagram
ton, long (2,240 lb)	1.016	megagram
ton per day (ton/d)	0.9072	metric ton per day
ton per day (ton/d)	0.9072	megagram per day
ton per day per square mile [$(ton/d)/mi^2$]	0.3503	megagram per day per square kilometer
ton per year (ton/yr)	0.9072	megagram per year
ton per year (ton/yr)	0.9072	metric ton per year

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L).

Note to USGS users: Use of hectare (ha) as an alternative name for square hectometer (hm^2) is restricted to the measurement of small land or water areas. Use of liter (L) as a special name for cubic decimeter (dm^3) is restricted to the measurement of liquids and gases. No prefix other than milli should be used with liter. Metric ton (t) as a name for megagram (Mg) should be restricted to commercial usage, and no prefixes should be used with it.

Summary of Suspended-Sediment Data for Streams Draining the Chesapeake Bay Watershed, Water Years 1952–2002

By Allen C. Gellis, William S.L. Banks, Michael J. Langland, *and* Sarah K. Martucci

Abstract

U.S. Geological Survey suspended-sediment data from 1952 to 2002 from selected stream-gaging stations draining the nontidal parts of the Chesapeake Bay Watershed were summarized to identify areas in the Watershed with high suspended-sediment loads, yields, and concentrations. The suspended-sediment load data were separated into two periods, 1952–1984 and 1985–2001. In 1985, the Chesapeake Bay Program began recommending sediment regulations, so 1985 represents an important break in the data. The instantaneous suspended-sediment concentration data were examined for the period 1985–2002.

Suspended-sediment load data collected from 43 stations from 1952–1984, with a minimum of 3 years of record, indicated that the two highest average annual suspended-sediment loads were for stations on the main stem of the Potomac and Susquehanna Rivers. The highest average annual sediment yields and discharge-weighted sediment concentrations were for streams draining the metropolitan Washington, D.C. area, possibly related to urbanization. Data from 1985 through 2001 that were collected from 35 stations with a minimum of 3 years of record showed that the highest average annual suspended-sediment loads were also on the main stem of the Potomac and Susquehanna Rivers. Four of the six highest average annual sediment yields and discharge-weighted sediment concentrations for 1985–2001 were for stations draining to the Conestoga River, a tributary of the Susquehanna River.

Examination of percentiles (10^{th}, 50^{th}, and 90^{th}) of instantaneous suspended-sediment concentrations for 51 stations with a minimum of 3 years of data and at least 10 samples in a year indicated that streams that drain to the Conestoga River had the highest suspended-sediment concentrations. Sediment-transport curves for the 51 stations were separated into classes by drainage-area size. Five of the eight drainage-area classes showed that streams draining the Susquehanna River Basin had the highest suspended-sediment concentrations. Three of the Susquehanna River Basin drainage-area classes were in the Conestoga River Basin. Agriculture is the dominant land use in the Conestoga River Basin and may be an important source of sediment leading to the high sediment yields and instantaneous suspended-sediment concentrations, but further research is needed to quantify the importance of agriculture in relation to other sources of sediment in the Conestoga River Basin.

Introduction

The Chesapeake Bay is the largest estuary in the United States, draining over 64,000 mi^2 (square miles). Much of the habitat in the Chesapeake Bay is degraded because of sediment (Langland and others, 1995). Suspended sediment in the water column can decrease the light available for submerged aquatic vegetation (SAV), and excess sediment can bury benthic habitats. Nutrients and toxic materials that contaminate habitats can also attach to suspended sediment (Darrell and others, 1999). Goals to reduce sediment loads by the year 2010 have been established by the U.S. Environmental Protection Agency (USEPA). To achieve these goals and reduce suspended-sediment loads and suspended-sediment concentrations in the Chesapeake Bay, identification of source areas of sediment is necessary. Watershed sediment sources can be separated into sediment originating from upland land uses (such as agriculture, mining, and construction) and sediment eroded from channel corridors (such as the channel bed and banks).

The U.S. Geological Survey (USGS) collected suspended sediment to determine daily sediment loads at selected stream-gaging stations in the Chesapeake Bay Watershed from water years (WY) 1952 through 1999 (fig. 1, table 1). A WY is defined as October 1 of the previous

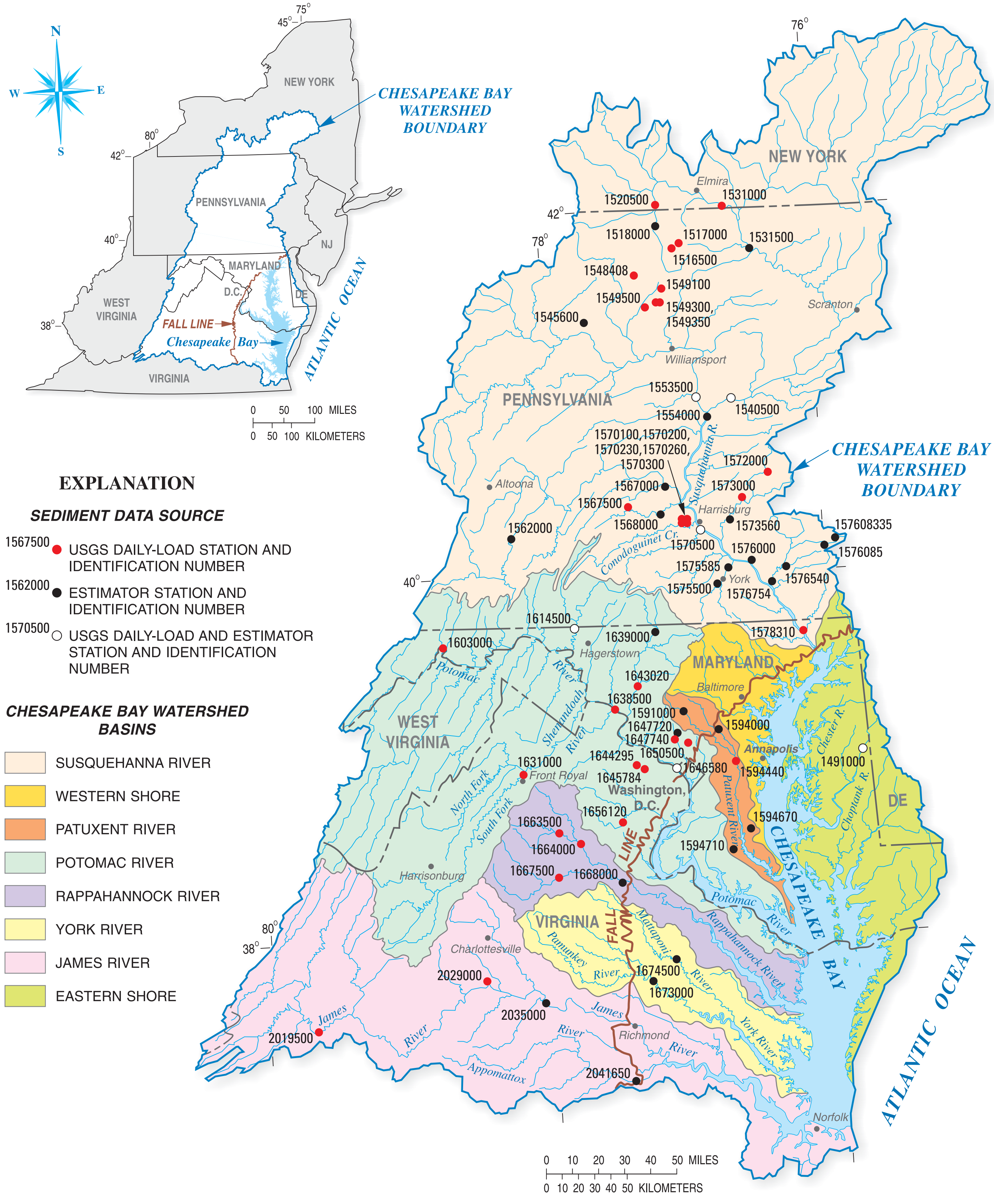


Figure 1. Location of 65 stations in the Chesapeake Bay Watershed with at least 3 years of water year suspended-sediment load record from 1952 through 2001. *(The data source for computation of suspended sediment is shown as either reported from daily-load stations or Estimator stations.)*

Table 1. *Period of record for suspended-sediment loads and instantaneous suspended-sediment concentrations used in this report, drainage areas of collection stations, and sources used in the computation of suspended-sediment loads*

[USGS daily refers to daily load sediment stations, Estimator is sediment data from the ESTIMATOR model, and RIM is sediment data from the River Input Monitoring stations. Water Year is from October 1 of the previous year to September 30 of the current year]

Station name	Station identification number	Period of record for annual loads (water year)	Annual load computation sources	Period of record for instantaneous suspended-sediment data (water year)	Drainage area, square miles
Eastern Shore					
Nassawango Creek near Snow Hill, MD	01485500			1999–2002	44.9
Nanticoke River near Bridgeville, DE	01487000			1994–2002	75.4
Choptank River near Greensboro, MD	01491000		Estimator/ USGS daily/ RIM	1985–2002	113
Chesterville Branch near Crumpton, MD	01493112	1972–2001		1996–2002	6.12
Susquehanna River					
Corey Creek near Mainesburg, PA	01516500	1955, 1957, 1960–1967	USGS daily		12.2
Elk Run near Mainesburg, PA	01517000	1955–1956, 1958, 1960–1962, 1966–1967	USGS daily		10.2
Tioga River at Tioga, PA	01518000	1973–1978	Estimator		282
Tioga River at Lindley, NY	01520500	1975–1980	USGS daily		771
Chemung River at Chemung, NY	01531000	1975–1977	USGS daily		2,506
Susquehanna River at Towanda, PA	01531500	1985–1996	Estimator	1985–1993	7,797
Susquehanna River at Danville, PA	01540500	1975–1996	Estimator/ USGS daily	1985–1995	11,220
Young Womans Creek near Renovo, PA	01545600	1973–1979, 1981, 1983, 1985–1992	Estimator		46.2
Wilson Creek above Sand Run near Antrim, PA	01548408	1979–1981, 1985–1996	USGS daily		6,847
Blockhouse Creek Tributary at Liberty, PA	01549100	1973–1977	USGS daily		1.08
Blockhouse Creek at Buttonwood, PA	01549300	1973–1977	USGS daily		22.3
Steam Valley Run at Buttonwood, PA	01549350	1973–1977	USGS daily		5.34
Blockhouse Creek near English Center, PA	01549500	1973–1977	USGS daily		37.7
West Branch Susquehanna River at Lewisburg, PA	01553500	1975–1984	USGS daily	1985–1995	6,847
Susquehanna River at Sunbury, PA	01554000	1973–1977	Estimator		18,306
East Mahantango Creek at Klingerstown, PA	01555400			1993–2000	44.7
Bobs Creek near Pavia, PA	01559795			1993–2000	16.6
Raystown Branch Juniata River at Saxton, PA	01562000	1988–1992	Estimator	1985–1993	756
Juniata River at Newport, PA	01567000	1985–1996	Estimator		3,355
Bixler Run near Loysville, PA	01567500	1955–1970	USGS daily		15
Sherman Creek at Shermans Dale, PA	01568000	1985–1996	Estimator	1985–1995	207
Conodoguinet Creek near Hogestown, PA	01570000			1985–2002	470
Conodoguinet Creek Tributary No. 1 near Enola, PA	01570100	1971–1976	USGS daily		0.77
Conodoguinet Creek Tributary No. 2 near Enola, PA	01570200	1973–1976	USGS daily		0.76
Conodoguinet Creek Tributary No. 2A near Enola, PA	01570230	1973–1976	USGS daily		0.7
Conodoguinet Creek Tributary No. 2B near Enola, PA	01570260	1973–1976	USGS daily		0.65
Conodoguinet Creek Tributary No. 3 near Enola, PA	01570300	1970–1976	USGS daily		0.38
Susquehanna River at Harrisburg, PA	01570500	1964–1966, 1968, 1972–1991	Estimator/ USGS daily		24,100
Paxton Creek near Penbrook, PA	01571000			1985–1994	11.2
Cedar Run at Eberlys Mill, PA	01571490			1993–1997	12.6

Table 1. *Period of record for suspended-sediment loads and instantaneous suspended-sediment concentrations used in this report, drainage areas of collection stations, and sources used in the computation of suspended-sediment loads*—Continued

Station name	Station identification number	Period of record for annual loads (water year)	Annual load computation sources	Period of record for instantaneous suspended-sediment data (water year)	Drainage area, square miles
Susquehanna River—Continued					
Lower Little Swatara Creek at Pine Grove, PA	01572000	1982–1984	USGS daily		34.3
Swatara Creek at Harper Tavern, PA	01573000	1960, 1977–1979	USGS daily		337
Swatara Creek near Hershey, PA	01573560	1985–1989	Estimator		483
Brush Run, Site 2, near McSherrystown, PA	01573810			1985–1991	0.38
West Conewago Creek near Manchester, PA	01574000			1985–1994	510
Codorus Creek near York, PA	01575500	1985–1989	Estimator	1985–1990	222
Codorus Creek at Pleasureville, PA	01575585	1985–1989	Estimator	1985–1994	267
Susquehanna River at Marietta, PA	01576000	1985–1996	Estimator		25,998
Little Conestoga Creek site 3A near Morgantown, PA	0157608335	1986, 1988–1991	Estimator		1.00
Mill Creek at Eshelman Mill Road near Lyndon, PA	01576540	1993–1995	Estimator		54
Conestoga River at Conestoga, PA	01576754	1985–1996	USGS daily		470
Susquehanna River at Conowingo, MD	01578310	1980–2001	Estimator/ USGS daily	1985–2002	27,100
Little Conestoga Creek near Churchtown, PA	01576085	1985–1992	Estimator	1985–1995	6
Big Spring Run near Willow Street, PA	01576521			1993–2001	1.77
North Fork Unnamed Tributary to Big Spring Run at Lampeter, PA	01576527			1993–2001	0.36
Unnamed Tributary to Big Spring Run at Lampeter, PA	01576529			1993–2001	1.42
Mill Creek at Eshelman Mill Road near Lyndon, PA	01576540			1992–1995	54.2
Conestoga River at Conestoga, PA	01576754			1985–1995	470
Pequea Creek at Martic Forge, PA	01576787			1985–1995	148
Bald Eagle Creek near Fawn Grove, PA	01577400			1986–1990	0.43
Patuxent River					
Patuxent River near Unity, MD	01591000	1986, 1990, 1993, 1995	Estimator	1986–2000	35
Little Patuxent River at Savage, MD	01594000	1987, 1988, 1990	Estimator	1985–2000	98
Patuxent River near Bowie, MD	01594440	1985–2001	USGS daily/ RIM	1985–2002	348
Western Branch at Upper Marlboro, MD	01594526			1986–2000	89.7
Hunting Creek near Huntingtown, MD	01594670	1989–1992	Estimator	1986–1998	9.4
Killpeck Creek at Huntersville, MD	01594710	1986–1989, 1991, 1994–1996	Estimator	1986–1997	3.26
Potomac River					
North Branch Potomac River near Cumberland, MD	01603000	1966–1978, 1981–1982	Estimator/ USGS daily		877
Conococheague Creek at Fairview, MD	01614500	1968–1980, 1993–1996	USGS daily	1985–2001	495
Muddy Creek at Mount Clinton, VA	01621050			1993–2001	14.2
South Fork Shenandoah River at Front Royal, VA	01631000	1954–1956	USGS daily	1985–2001	1,642
North Fork Shenandoah River near Strasburg, VA	01634000			1985–2001	
Potomac River at Point of Rocks, MD	01638500	1961–1992	USGS daily		9,651
Monocacy River at Bridgeport, MD	01639000	1989–1995	Estimator/ USGS daily		173

Table 1. *Period of record for suspended-sediment loads and instantaneous suspended-sediment concentrations used in this report, drainage areas of collection stations, and sources used in the computation of suspended-sediment loads*—Continued

Station name	Station identification number	Period of record for annual loads (water year)	Annual load computation sources	Period of record for instantaneous suspended-sediment data (water year)	Drainage area, square miles
Potomac River—Continued					
Monocacy River at Reichs Ford Bridge near Frederick, MD	01643020	1961–1966, 1968–1983, 1985–1992	USGS daily		817
Smilax Branch at Reston, VA	01644295	1972–1975	USGS daily		0.32
Snakeden Branch at Reston, VA	01645784	1974–1978	USGS daily		0.79
Potomac River at Chain Bridge at Washington, D.C. [1]	01646580	1979–2001	Estimator/ USGS daily/ RIM	1985–2002	11,570
North Branch Rock Creek near Norbeck, MD	01647720	1972–1976	Estimator		9.73
North Branch Rock Creek near Rockville, MD	01647740	1968–1977	USGS daily		12.5
Northwest Branch Anacostia River near Colesville, MD	01650500	1963–1975	USGS daily		21.1
Accotink Creek near Annandale, VA	01654000			1985–2001	23.5
Cedar Run near Aden, VA	01656100			1985–1988, 1996–1999	155
Cedar Run at Route 646 near Aden, VA	01656120	1997–1999	USGS daily	1996–2000	175
South Fork Quantico Creek near Independent Hill, VA	01658500			1985–2001	7.64
Cannon Creek near Garrisonville, VA	01660380			1994–1997	10.2
Beaverdam Run near Garrisonville, VA	01660500			1997–2001	12.7
Rappahannock River					
Hazel River at Rixeyville, VA	01663500	1953–1955	USGS daily		287
Rappahannock River at Remington, VA	01664000	1953–1993	USGS daily		620
Rapidan River near Culpeper, VA	01667500	1952–1965	USGS daily		472
Rappahannock River near Fredericksburg, VA	01668000	1989–2001	RIM		1,596
York River					
Pamunkey River near Hanover, VA	01673000	1976–1980, 1991–2001	Estimator/RIM	1985–2001	1,081
Mattaponi River near Beulahville, VA	01674500	1991–2001	RIM	1985–1988 1989–2001	601
James River					
James River at Buchanan, VA	02019500	1952–1956	USGS daily		2,075
James River at Scottsville, VA	02029000	1952–1956	USGS daily		4,584
James River at Cartersville, VA	02035000	1974–1983, 1987–2001	Estimator/RIM		6,259
Appomattox River at Matoaca, VA	02041650	1990–2001	RIM		1,340

[1] Discharge is measured at Potomac River near Washington D.C., Little Falls Pumping Station (01646500), 1.2 miles upstream of Chain Bridge.

calendar year to September 30 of the current calendar year. The methods of suspended-sediment sampling and daily-load computation may have differed for each station, including frequency of suspended-sediment sampling, instruments used to collect suspended sediment, and methods used to compute suspended-sediment load. The last active daily-load sediment station ceased operation in 1999 (Cedar Run at Route 646 near Aden, Virginia). Instantaneous suspended-sediment data were collected at the daily-load stations. Instantaneous suspended-sediment data were also collected as part of water-quality sampling programs, such as the National Stream Quality Accounting Network (NASQAN), but suspended-sediment daily loads were never computed. Langland and others (1995) used a load-estimator model (ESTIMATOR) to compute monthly and annual suspended-sediment loads from the instantaneous suspended-sediment data for 127 sites in the Chesapeake Bay Watershed where daily loads had not previously been computed. Beginning in 1985, the USGS began estimating monthly and annual suspended-sediment loads using the ESTIMATOR model for nine major tributaries to the Chesapeake Bay, referred to as the River Input Monitoring (RIM) stations (Darrell and others, 1999).

Purpose and Scope

The USGS is engaged in several studies to identify sediment sources and sediment transport to the Chesapeake Bay. The purpose of this report is to provide a comprehensive summary of USGS data on suspended-sediment loads and concentrations from 1952 through 2002 for selected stream-gaging stations draining the nontidal parts of the Chesapeake Bay Watershed, and to identify areas in the Chesapeake Bay Watershed with high suspended-sediment loads, yields, and concentrations. The sediment data described in this report will provide useful information to Chesapeake Bay water-resources managers for identifying major source areas of sediment by drainage basin.

Previous Studies

Several studies relating sediment yield to land use have been conducted in the Chesapeake Bay Watershed (Guy and Ferguson, 1962; Jones, 1966; Williams and Reed, 1972). To assess possible sediment sources on a regional scale, Williams and Reed (1972) investigated sediment yields at 33 USGS stream-gaging stations in the Susquehanna River Basin, using data from 1962 to 1967. For basins draining more than 100 mi^2, sediment yield was related to mining, geologic history, and physiographic region (Williams and Reed, 1972). The highest sediment yields (greater than 200 $tons/mi^2$, or tons per square mile) occurred in the glaciated portions of the Appalachian Low Plateau Province, coal-mining areas of the Valley and Ridge Province, and the Piedmont Province. The lowest sediment yields were found in subbasins of the Valley and Ridge Province draining more than 25 percent limestone. Internal drainage, presumably of karst topography, was cited as the cause for the low sediment yields in the limestone terrain.

Jones (1966) evaluated sediment data from a paired-basin study, Corey Creek (12.2 mi^2) and Elk Run (10.2 mi^2) in northern Pennsylvania, to determine the effects of land treatment on sediment yields. The Corey Creek Basin was chosen for extensive conservation treatments. Elk Run, a similar basin where only minor conservation treatments were applied, served as an external control to evaluate possible hydrologic changes resulting from treatments in Corey Creek. Sediment loads over the study period (1954 through 1960) decreased 11 percent in Corey Creek relative to Elk Run. Conservation practices such as converting land cover from cropland to grass were cited as the main cause for the decrease in sediment loads in Corey Creek. Extensive water-diversion terraces, installed in 19 percent of the Corey Creek Basin to reduce runoff and sediment transport, had little effect on reducing sediment loads and caused a sharp rise in sediment yields during construction (Jones, 1966).

Several other studies provide estimates of sediment yields from land disturbance in the Chesapeake Bay Watershed region. Guy and Ferguson (1962) reported yields of 25,000 to 50,000 $tons/mi^2$ resulting from construction work around Washington, D.C. Wolman (1967) also reported sediment yields exceeding 100,000 $tons/mi^2$ from construction activities in the Washington, D.C. area. Roberts and Pierce (1976) suggested that the Patuxent River more than doubled its sediment yield after urbanization (408 to 983 $tons/mi^2$).

Brown and others (1988) used ^{10}Be (an isotope of beryllium) to estimate soil erosion in 48 basins of the eastern United States, including 10 basins that drain to the Chesapeake Bay. For the entire data set, the highest rates of erosion were observed in the streams in the Piedmont Physiographic Province and the lowest rates were observed in streams in the Coastal Plain Province. The difference in erosion rates between Piedmont and Coastal Plain streams was attributed to differences in land use and stream gradient. Farming, which has occurred in the Piedmont Province for two centuries, has disturbed the topsoil and has led to high rates of soil erosion, as well as sediment with higher concentrations of ^{10}Be. Compared to Coastal Plain streams, the higher slopes in Piedmont watersheds have also contributed to higher erosion rates. Annual pre-colonization sediment yield for the Piedmont was estimated to be 34.3 $tons/mi^2$, a value that is similar to modern undisturbed basin sediment yields (Brown and others, 1988).

Langland and others (1995) used suspended-sediment data collected from 127 nontidal sites draining the Chesapeake Bay Watershed to examine the influence of land cover on total suspended solids (TSS) and suspended-sediment concentrations. They found that the largest median concentration of suspended sediment was in the upper Potomac River Basin, and that the highest concentrations of suspended sediment were in the Susquehanna River Basin. Correlations of annual sediment yields to land use, computed with a log-linear multiple regression model, indicated that basins with the highest percentage of agriculture had the highest sediment yields. Basins with the highest percentage of forest cover had the lowest sediment yields.

Suspended-sediment concentrations analyzed for four of the RIM stations from 1985 through 1996 (Susquehanna, Potomac, Patuxent, and Choptank Rivers) (Darrell and others, 1999) showed the Patuxent River had the highest median suspended-sediment concentrations (45 mg/L, or milligrams per liter). The Potomac River had the highest median-annual sediment yield (175 tons/mi^2) (Darrell and others, 1999).

Methods of Study

Two types of suspended-sediment data were analyzed in this report, suspended-sediment loads and instantaneous suspended-sediment concentrations. The data were acquired from a variety of sources. Suspended-sediment load data were obtained from: (1) daily sediment stations operating in the Chesapeake Bay Watershed (USGS Water Resources Data Reports for Maryland (1962–93), New York (1975–80), Pennsylvania (1952–86), and Virginia (1952–99)), (2) ESTIMATOR model runs (Langland and others, 1995), (3) RIM stations (Belval and Sprague, 1999), (4) the USGS National Water Information System (NWIS) data base, and (5) the USGS web site for suspended-sediment data (U.S. Geological Survey, 2003). Instantaneous measurements of suspended-sediment concentration and discharge were compiled from NWIS.

In this report, the term "watershed" is used to describe the entire area that drains to the Chesapeake Bay. The term "basin" is used to describe drainages within the Chesapeake Bay Watershed that are associated with major rivers: the Choptank, James, Patuxent, Potomac, Rappahannock, Susquehanna, and York Rivers. Drainage areas within basins are referred to as "subbasins." Tables and plots of the suspended-sediment data are presented according to major drainage basin.

Suspended-sediment loads obtained from USGS daily suspended-sediment load stations and the ESTIMATOR model results were summed by WY and averaged to calculate an average annual suspended-sediment load for each station. All annual data presented in this report are based on WY, rather than calendar year, and only years with 12 complete months of data were used. Only stations with at least 3 complete WYs of record were included in this study, and the years did not have to be consecutive. If for a given WY a station had loads reported by both a daily-load station and from the ESTIMATOR model, only the data from the daily-load station were used. Suspended-sediment load data were normalized by drainage area to calculate sediment yield (tons/mi^2). Guy (1964) determined that the discharge-weighted concentration of sediment for a storm event was a better dependent variable than sediment load for factors that affect storm period sediment transport, so WY suspended-sediment loads also were normalized by WY runoff to calculate a discharge-weighted sediment concentration (mg/L). WY runoff was obtained from NWIS or USGS Water Resources Data Reports for Maryland, New York, Pennsylvania, and Virginia (1952–99).

Suspended-sediment load, yield, and concentration data were analyzed for two periods—1984 and earlier, and 1985 and later. In 1985, the Chesapeake Bay Program began recommending sediment and nutrient regulation, so 1985 represents an important break in the data.

To determine if average WY suspended-sediment loads, yields, and discharge-weighted sediment concentrations at each station for their respective collection periods were representative of longer-term flow conditions, the average WY mean-daily discharge was calculated for the sediment-collection period and compared to the mean-daily discharge for the entire period of streamflow record. Information on historical streamflow records was obtained from NWIS.

The Chesapeake Bay River Input Monitoring (RIM) program was established in the mid–1980s to quantify loads and long-term trends in suspended sediment entering the tidal part of the Chesapeake Bay Basin from its nine major tributaries (Appomattox, Choptank, James, Mattaponi, Pamunkey, Patuxent, Potomac, Rappahannock, and Susquehanna) (Darrell and others, 1999). The RIM stations are near the "Fall Line," a natural boundary between the Piedmont and Coastal Plain Physiographic Provinces in the eastern United States, where there is a relatively large change in elevation (fig. 1). This line roughly represents the boundary between the tidal and nontidal parts of each river. The RIM stations monitor approximately 78 percent of the streamflow entering Chesapeake Bay from the nontidal part of its watershed (Darrell and others, 1999). The RIM sediment data for the period 1985 through 2001 were examined as part of this report.

Suspended-sediment concentrations in tributaries to the Chesapeake Bay were determined from samples collected using methods described by Edwards and Glysson (1988). In most cases, this involved the use of depth-integrating samplers deployed by either the Equal-Width Increment or Equal-Discharge Increment techniques, or with automatic samplers (Edwards and Glysson, 1988). Analyses of suspended-sediment concentrations and particle-size distributions were performed by methods described by the American Society for Testing and Materials (ASTM, 1999), Knott and others (1992), and Guy (1969). Porterfield (1972) and Koltun and others (1994) describe the methodology that was used for computing daily suspended-sediment loads. Daily suspended-sediment loads obtained for this report were generally computed by the subdivision technique (Porterfield, 1972) but other methods, such as the sediment rating curve-flow duration method (Porterfield, 1972), may also have been used. In the subdivision method, individual samples of suspended-sediment concentrations are plotted and a continuous trace of suspended-sediment concentration is drawn between concentration values.

The relation between instantaneous water discharge and suspended-sediment concentration is referred to as a sediment-transport curve (Glysson, 1987). In the computation of suspended-sediment loads, sediment-transport curves were used to estimate suspended-sediment concentrations for periods when samples were not sufficient to define concentration by time. During periods of low flow, the average daily suspended-sediment concentration (mg/L) is multiplied by the average discharge (ft^3/s, or cubic feet per second) and a coefficient (0.0027) to compute sediment in tons per day. During periods of higher flows or rapidly varying flows, the suspended-sediment concentrations and water discharge are divided into smaller periods. The mid-interval or mean interval of suspended sediment and discharge for each period are multiplied together and by 0.0027 to compute a sediment load for each period. Loads computed for each period are summed to obtain a daily load. Porterfield (1972) states that the visual procedure to construct continuous temporal concentration curves is the most common and accurate method when supplemented with sediment-transport curves.

The ESTIMATOR model uses a linear regression method, whereby the line of best fit developed from the relation of mean-daily discharge to suspended sediment or TSS is used to calculate suspended-sediment load (Cohn and others, 1989, 1992). With this method, a curvilinear relation between measurements of stream discharge and suspended-sediment loads is derived on a logarithmic scale. The empirical relation is applied to stream discharges for periods of interest (monthly or annual). Langland and others (1995) used the ESTIMATOR model to quantify monthly and annual suspended-sediment loads for 127 sites in the Chesapeake Bay Watershed. Monthly and annual loads for the RIM stations also were calculated with the ESTIMATOR model.

Average annual suspended-sediment loads, sediment yields, and discharge-weighted sediment concentrations in this report are displayed spatially for two time periods—1984 and earlier, and from 1985 through 2001, using a geographical information system (GIS). The RIM station data, which are representative of a major portion of the Chesapeake Bay Watershed, are shown separately to illustrate sediment transport at the major watershed scale. Data from the RIM network were used to calculate sediment loads starting in 1985; therefore, only the period from 1985 through 2001 is displayed.

In this report, instantaneous measurements of suspended-sediment concentrations were analyzed and interpreted through examination of the distribution (percentiles) of suspended-sediment concentrations and analysis of sediment-transport curves. Only sediment data and discharge data from 1985–2002 were used to compute percentiles and sediment-transport curves. In addition, only stations with a minimum of 3 complete years of data and 10 or more suspended-sediment samples in a given year were used. Percentiles (10^{th}, 50^{th}, and 90^{th}) for instantaneous measurements of suspended sediment were determined using standard statistical software (SAS Institute Inc., Version 6, 1994).

To determine whether the suspended-sediment samples were biased towards either a low- or high-flow condition, mean-daily discharge values measured on days when suspended-sediment samples were collected were compared to mean-daily discharge values for all the years meeting the criteria listed above that contained suspended-sediment data. Mean-daily discharges were retrieved from the NWIS data base. A two-sided, Mann-Whitney-Wilcoxon test (Helsel and Hirsch, 1992) was used to determine if the ranked mean-daily discharges differed in the two populations—the sample population of mean-daily discharges on days when suspended-sediment samples were collected and the population of mean-daily discharge values for all the years that contained sediment data. The null hypothesis that the distribution of data of the two populations was similar was rejected at the 95-percent confidence level (*alpha* = 0.05).

Sediment-transport curves have been used to determine impaired streams and undisturbed or reference streams (Simon and others, 2001; Troendle and others, 2002). Troendle and others (2002) created pooled dimensionless sediment-transport curves for 160 reference sites in the western United States. A dimensionless transport curve is created by normalizing each discharge value by the discharge at bankfull flow and each suspended-sediment value by the suspended-sediment concentration at bankfull flow. Bankfull flow is the discharge that occurs every 1.5 years. The dimensionless transport curve for Coon Creek, Wyoming, a timber-harvested basin, was shown to depart significantly from the reference transport curve, and was considered impaired.

Sediment-transport curves were generated for all stations in this study with at least 3 complete years of data and at least 10 suspended-sediment samples in a given year. The sediment-transport curves are shown with a line of best fit, determined using a standard computer-graphing package (SIGMAPLOT, SPSS, Inc., Version 7.0, 2001) to indicate the general trend in the data. It was not determined whether the slope of the line of best fit was statistically different from zero.

When plotted together, sediment-transport curves for different rivers may indicate rivers that have higher suspended-sediment concentrations at a given discharge. Because drainage area is a controlling factor in runoff and sediment transport, in order to compare sediment-transport curves between rivers with different contributing areas, sediment-transport curves were separated by drainage-area classes. A metric scale provided order-of-magnitude divisions to classify drainage areas. Based on the number of sites and ensuring that no class had fewer than four sites, the following classes were used:

Class A	> 25,000–70,200 km^2 (square kilometers)	(>9,650–27,100 mi^2; square miles)
Class B	> 2,500–25,000 km^2	(>965–9,650 mi^2)
Class C	> 1,000–2,500 km^2	(>386–965 mi^2)
Class D	> 500–1,000 km^2	(>193–386 mi^2)
Class E	> 250–500 km^2	(>96.5–193 mi^2)
Class F	> 100–250 km^2	(>38.6–96.5 mi^2)
Class G	> 20–100 km^2	(>7.70–38.6 mi^2)
Class H	> 0.93–20 km^2	(0.36–7.70 mi^2)

There is still a broad range of drainage areas in each class. To minimize any influence of area, discharge was normalized by drainage area.

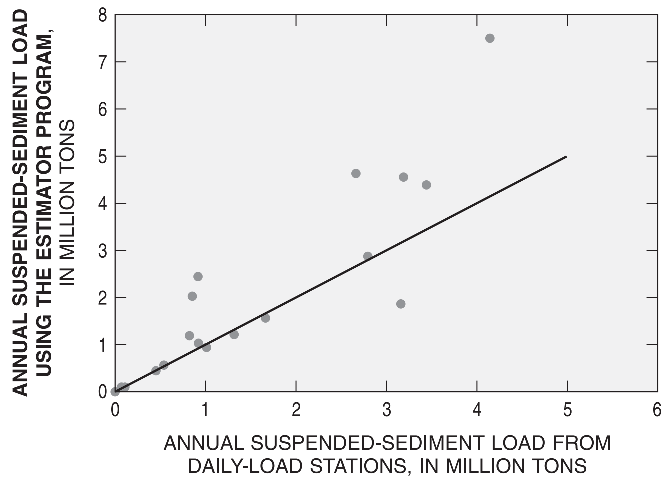


Figure 2. Average annual water year suspended-sediment load computed at daily-load stations compared with loads computed with the Estimator program for water years 1973 through 1993.

Limitations of Data and Methods of Analysis

Nine of the stations that operated from 1973 through 1993 have suspended-sediment loads computed as daily loads and suspended-sediment loads computed by the ESTIMATOR method, for selected years, constituting a total of 36 years of comparable data. The individual records for each station were not obtained, but the daily suspended-sediment loads were most likely computed by the subdivision method; however, at times the flow duration method may have been used. Differences in load computations may occur between the subdivision method and the ESTIMATOR method. Walling (1977) reported load overestimates of 280 percent when using a linear-regression method compared to the subdivision method. In contrast to these findings, Horowitz (2003) reported that the linear (or polynomial) regression method tends to under-predict high suspended-sediment concentrations, but can generate annual suspended-sediment load estimates within 20 percent. In this analysis, a comparison using both methods shows that ESTIMATOR has a tendency to calculate higher suspended-sediment loads than the method used for the daily-load computations, which were most likely calculated using the subdivision method (fig. 2). Figure 2 shows that the difference in suspended-sediment loads computed by ESTIMATOR and daily suspended-sediment loads is greater at the higher suspended-sediment loads.

Sediment-load computations at the four Virginia RIM stations (Pamunkey River near Hanover, Virginia, station 01673000; Mattaponi River at Beulahville, Virginia, station 01674500; James River at Cartersville, Virginia, station 02035000; and Appomattox River at Matoaca, Virginia, station 02041650) (fig. 1, table 1) were based on TSS data. Gray and others (2000) showed that the TSS method tends to under-predict concentrations when the sand content of the sample exceeds about one-quarter of the sediment by weight. Therefore, load estimations based on TSS at the Virginia RIM stations could be underestimated.

Another major limitation is sample-collection methodology. At times, samplers other than isokinetic samplers, such as point samplers and bottles, may have been used to collect suspended sediment. Although samples should be collected at a minimum of 10 verticals in a cross section (Edwards and Glysson, 1988), sometimes a single vertical may have been used. Typically, several bottles are collected in association with a cross-sectional sample. Each bottle is sent to the laboratory for analysis of suspended-sediment concentration and composited to obtain a value. Bottles have sometimes been composited in the field with equipment such as a churn or cone splitter to obtain a single concentration. Because sample-collection methodology varied over time and space, it is difficult to quantify the errors associated with using methods other than those recommended by Edwards and Glysson (1988).

Sampling frequency is another important factor that can affect the accuracy of the annual suspended-sediment load computation. Because most rivers transport 80 to 90 percent of their annual load during storm runoff events (Meade and others, 1990), sediment sampling at high flows is favorable for a good sediment record. Continuous suspended-sediment sampling during the storm runoff hydrograph is also favorable for producing an accurate continuous sediment trace. The relation of suspended-sediment samples to high flows was not examined for the suspended-sediment load data.

Summary of Sediment Loads, Yields, and Discharge-Weighted Sediment Concentrations

Sixty-five stations with at least 3 complete years of record were selected for analysis of suspended-sediment load data (figs. 1 and 3). The greatest number of stations functioning concurrently (27) were in operation from 1989–91 (fig. 3). The station with the longest record is the Rappahannock River at Remington, Virginia (station 01664000), with 40 years of data (fig. 3). The distribution of drainage areas for all sediment stations operating from 1952 through 2001 (n = 65) indicates that the most sediment stations operating at any time were in basins draining between 100 and 500 mi^2, whereas the least number of sediment stations operating at any time were in basins draining 50 and 100 mi^2 (fig 4). Suspended-sediment loads are highly correlated to drainage area and to average annual mean-daily discharge for the sediment collection period (figs. 5a–b). Drainage area shows a weak, inverse relation to sediment yield and to discharge-weighted sediment concentration (figs. 5c–d). Schumm (1977) and Walling (1983) described decreasing sediment yield with increasing basin area as more sites in a basin become available for sediment storage.

River Input Monitoring Station Data, 1985–2001

The RIM stations provide data on suspended-sediment loads delivered to the tidal parts of the Chesapeake Bay Watershed. The RIM station data for 1985 through 2001 show that the Potomac and Susquehanna Rivers had the two highest suspended-sediment loads (fig. 6a, table 2). When normalized by either drainage area or average annual runoff, the highest average annual sediment yields and average annual discharge-weighted sediment concentrations were in the Rappahannock and Potomac Rivers (figs. 6 b–c, and table 2). Although the Susquehanna River at Conowingo, Maryland (station 01578310) drains a large area (27,100 mi^2), the Susquehanna River at Conowingo, Maryland, has three large dams upstream that are trapping about two-thirds of the suspended-sediment load (Langland and Hainly, 1997), thereby lowering the river's sediment yields. The Choptank, Mattaponi, and Appomattox Rivers had the lowest average annual suspended-sediment loads, sediment yields, and discharge-weighted sediment concentrations (fig. 6c, table 2).

Suspended-Sediment Data, 1952 through 1984

Forty-three stations operating from 1952 through 1984 had suspended-sediment load data with 3 or more years of record (figs. 7 a–c, table 3). Almost one-half of the stations (20) had average annual mean-daily discharge during the study period that was within 10 percent of the average annual mean-daily discharge for the entire period of record. Sixteen stations had average annual mean-daily discharges greater than 10 percent (10.5 to 27.3 percent) of the average WY mean-daily discharges for their respective periods of record. This could indicate that sediment loads for these stations could be higher under average flow conditions. Seven stations had average annual mean-daily discharge that was less than 10 percent (-11 to -23 percent) of the average annual mean-daily discharge for the period of record. At these stations, sediment loads could be lower than under average flow conditions. In summary, about one-half (46.5 percent) of the sediment data was not biased toward lower or higher flow conditions. About 37 percent of the sediment data were collected under flow conditions that were greater than 10 percent of the average mean-daily flow, and 16.3 percent of the sediment data were collected under flow conditions that were less than 10 percent of the average mean-daily flow.

For 1952 through 1984, the highest average annual suspended-sediment load was at the Potomac River at Chain Bridge, Washington, D.C. (2.92 x 10^6 tons/yr, or tons per year) (table 4). The next three highest average annual suspended-sediment loads were at stations on the Susquehanna River (Susquehanna River at Harrisburg, Pennsylvania, 2.88 x 10^6 tons/yr; Susquehanna River at Sunbury, Pennsylvania, 2.19 x 10^6 tons/yr; and Susquehanna River at Conowingo, Maryland, 1.64 x 10^6 tons/yr) (fig. 7a, tables 3–4). Suspended-sediment load is highly correlated to drainage area. The stations with the highest suspended-sediment loads also drain the largest area (table 3).

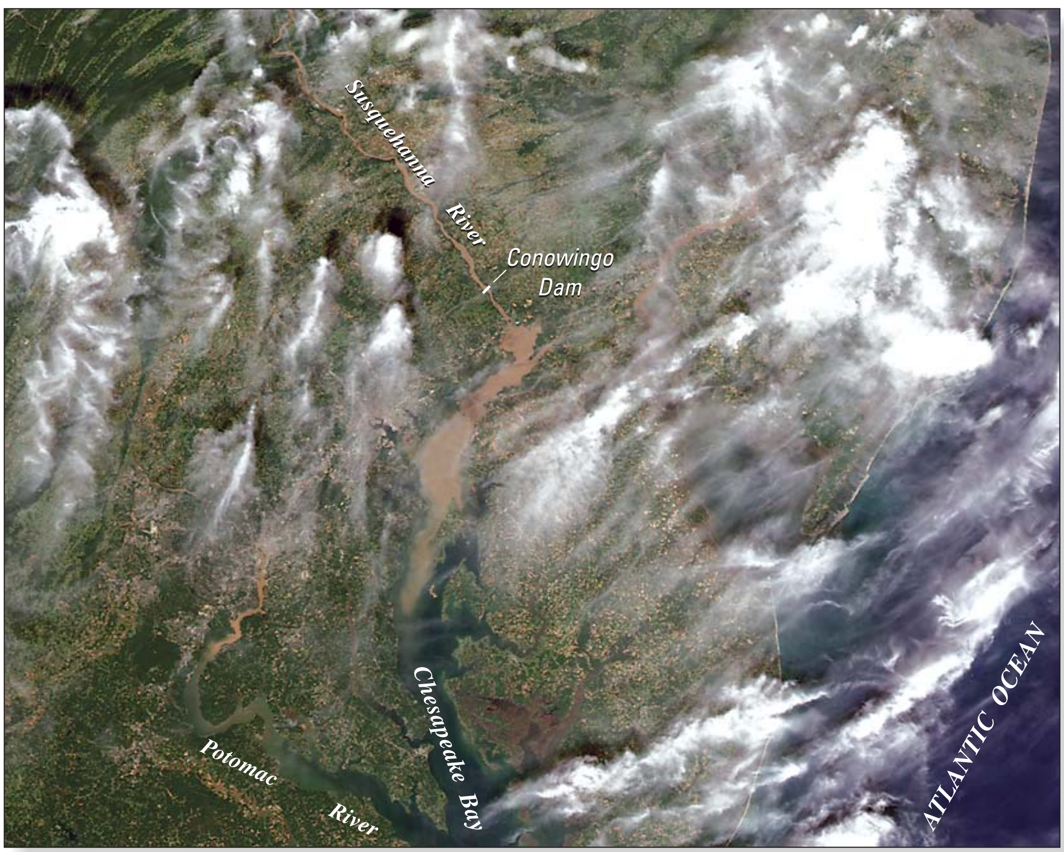
Normalizing average annual suspended-sediment loads by drainage area and runoff showed that streams in the Washington, D.C. area had the three highest sediment yields and discharge-weighted sediment concentrations (Snakeden Branch at Reston, Virginia–1,140 tons/mi^2/yr, or tons per square mile per year, 653 mg/L; Smilax Branch at Reston, Virginia–989 tons/mi^2/yr, 585 mg/L; and Northwest Branch Anacostia River near Colesville, Maryland–702 tons/mi^2/yr, 660 mg/L) (figs. 7b–c; tables 3–4). The high sediment yields and sediment concentrations in the Washington, D.C. area could reflect construction and urbanization during the study period (Guy and Ferguson, 1962; Wolman, 1967).

The lowest average annual sediment yields and discharge-weighted sediment concentrations for stations with data collected between 1952–1984 were from Young Womans Creek in Pennsylvania (7.6 tons/mi^2/yr, 4.3 mg/L), the Choptank River on Maryland's Eastern Shore (21.9 tons/mi^2/yr, 16.0 mg/L), and the Pamunkey River in Virginia (22.3 tons/mi^2/yr, 20.2 mg/L) (figs. 3 b–c, table 3). The Young Womans Creek watershed in Pennsylvania is entirely forested (Hainly and Loper, 1997).

Suspended-Sediment Data, 1985 through 2001

Thirty-five stations had suspended-sediment load data from 1985 through 2001 with 3 or more years of record (figs. 8 a–c, table 5). Most of the stations (57 percent) had average annual mean-daily discharge for the collection period within plus or minus 10 percent of the average annual mean-daily discharge for the entire period of record. About one-third of the stations (31 percent) had an average annual mean-daily discharge that was 10 to 20 percent (-10 to -20 percent) lower than the mean-daily discharge for the period of record. Only three stations, Monocacy River at Bridgeport, Maryland (14.9 percent), Little Conestoga Creek site 3A near Morgantown (10.9 percent), and Conococheague Creek at Fairview, Maryland (48.2 percent), had average annual mean-daily discharges that were higher than 10 percent of the mean-daily discharge for the period of record. For these two stations, suspended-sediment loads may be higher than those measured during average flow conditions.

For the period 1985 through 2001, stations on the Potomac River had the highest and third highest average annual suspended-sediment load (Potomac River at Chain Bridge, Washington, D.C., 1.84 x 10^6 tons/yr, and Potomac River at Point of Rocks, Maryland, 1.13 x 10^6 tons/yr, respectively) (fig. 8a, tables 5–6). The Potomac River at Chain Bridge is the RIM station for the Potomac River Basin. The second highest average annual suspended-sediment load was at the Susquehanna River at Marietta, Pennsylvania (1.70 x 10^6 tons/yr). This site is upstream of major reservoirs that may trap and remove sediment (table 6). When normalized by drainage area and runoff, four of the five highest average annual sediment yields and discharge-weighted sediment concentrations are for stations that drain to the Susquehanna River in Pennsylvania (Little Conestoga Creek near Churchtown, Pennsylvania; Little Conestoga Creek site 3 near Morgantown, Pennsylvania; Mill Creek at Eshelman Mill Road near Lyndon, Pennsylvania; and Raystown Branch Juniata River at Saxton, Pennsylvania) (figs. 8a–c, tables 5–6). Three of the four Pennsylvania stations are in the Conestoga River Basin (two stations on Little Conestoga Creek and one on Mill Creek). The Conestoga River Basin drains primarily agricultural land, which may be influencing the high sediment yields and concentrations.



Photograph showing the high suspended-sediment concentrations caused by a large storm, Hurricane Ivan, which affected parts of the Chesapeake Bay Watershed from September 17-18, 2004. (NASA Terra satellite image of the Chesapeake Bay Watershed region taken on September 21, 2004, obtained from NASA Internet site *http://earthobservatory.nasa.gov/NaturalHazards/shownh.php3?img_id=12456*; accessed October 21, 2004). Note the brownish turbid waters of the Susquehanna and Potomac Rivers, and upper Chesapeake Bay. A sample collected at the Susquehanna River at Conowingo, Maryland on September 20, 2004 at 0900 yielded a suspended-sediment concentration of 3,685 milligrams per liter.

Photograph showing the release of water from the Conowingo Dam on the Susquehanna River in Maryland, September 21, 2004 at 10:00 AM as a result of Hurricane Ivan. When this photograph was taken, discharge at the Susquehanna River near Conowingo, Maryland (USGS station number 01578310) was 348,000 cubic feet per second. (Photograph courtesy of Wendy McPherson, USGS).

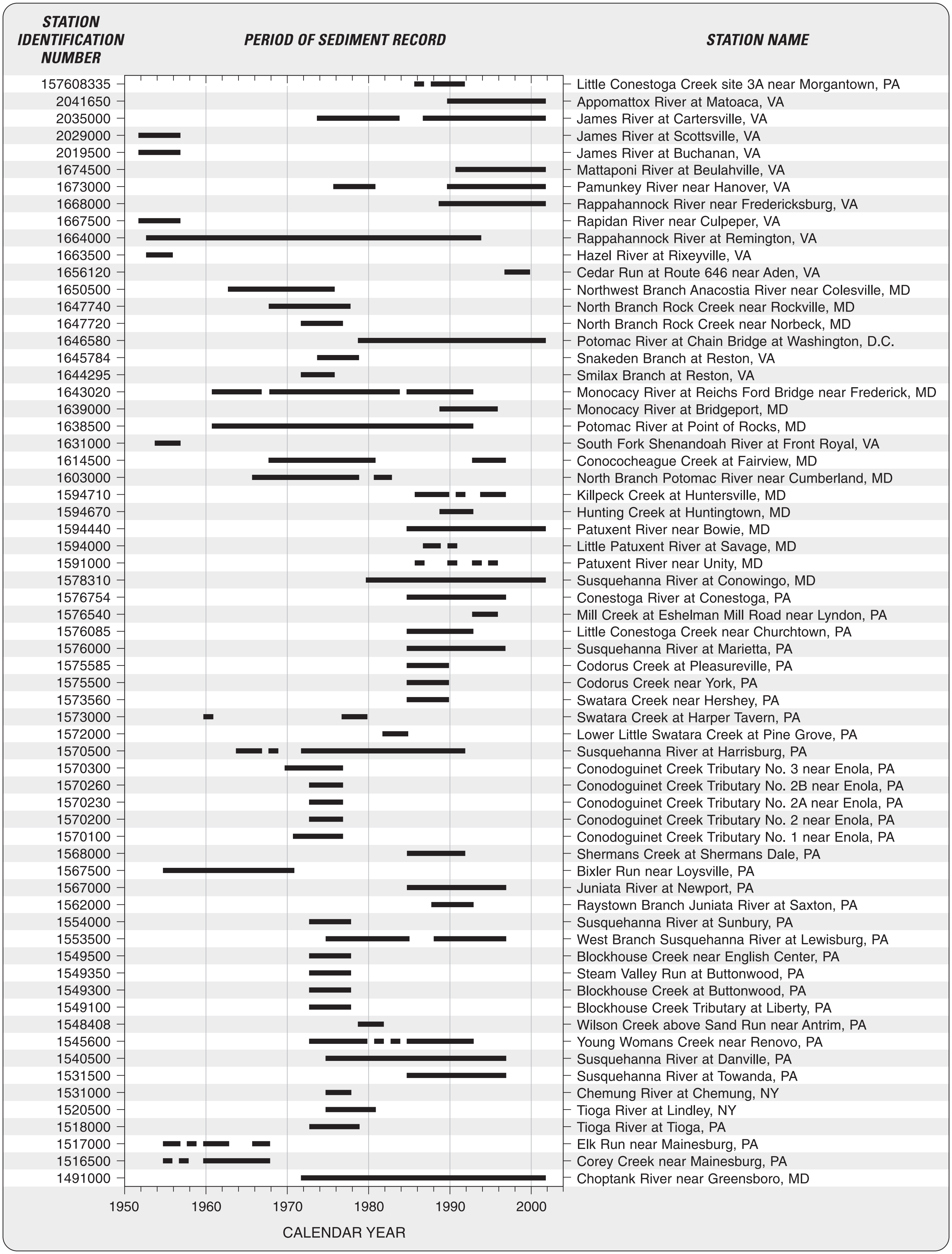


Figure 3. Listing of sediment stations in the Chesapeake Bay Watershed with at least 3 years of record from water years 1952 through 2001.

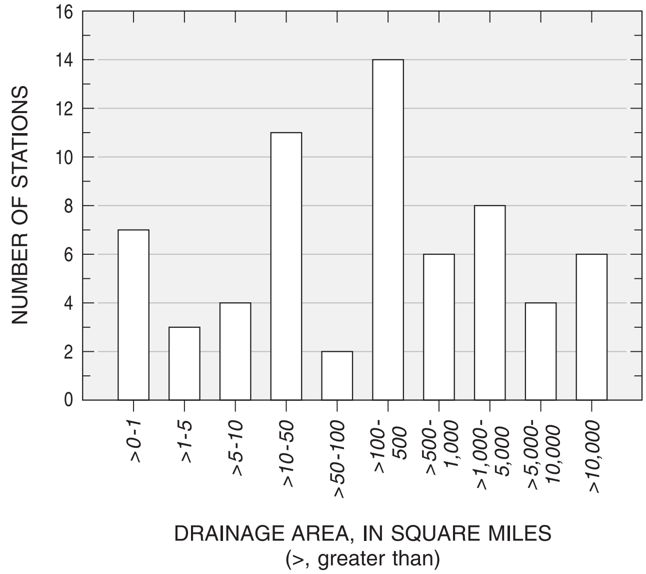


Figure 4. Distribution of drainage areas for 65 sediment stations in the Chesapeake Bay Watershed with at least 3 years of sediment record from 1952 through 2001.

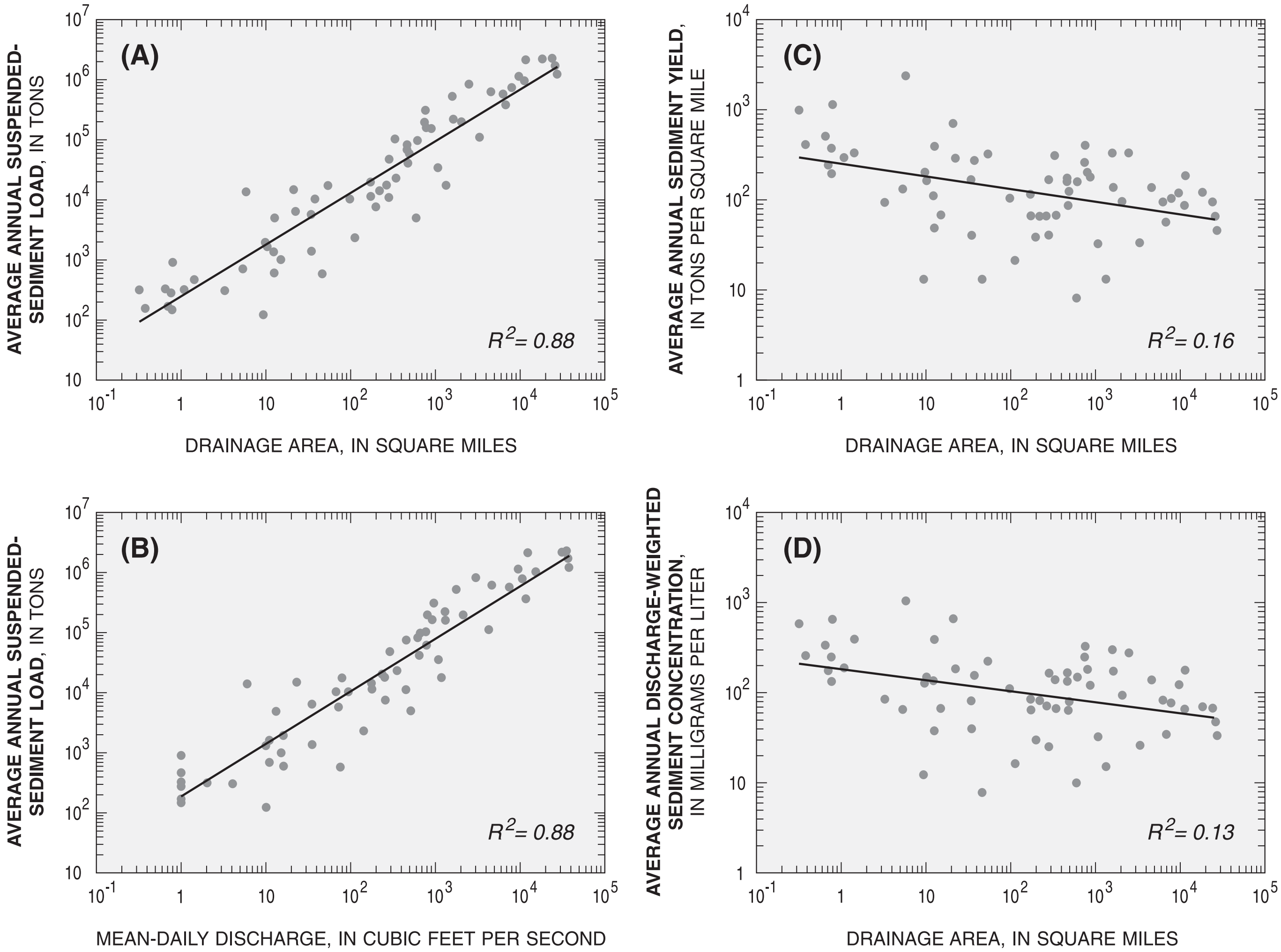


Figure 5. Relation of **(A)** average annual suspended-sediment load to drainage area, **(B)** average annual suspended-sediment load to mean-daily discharge, **(C)** average annual sediment yield to drainage area, and **(D)** average annual discharge-weighted sediment concentration to drainage area for 65 sediment stations in the Chesapeake Bay Watershed with at least 3 years of record from 1952 through 2001.

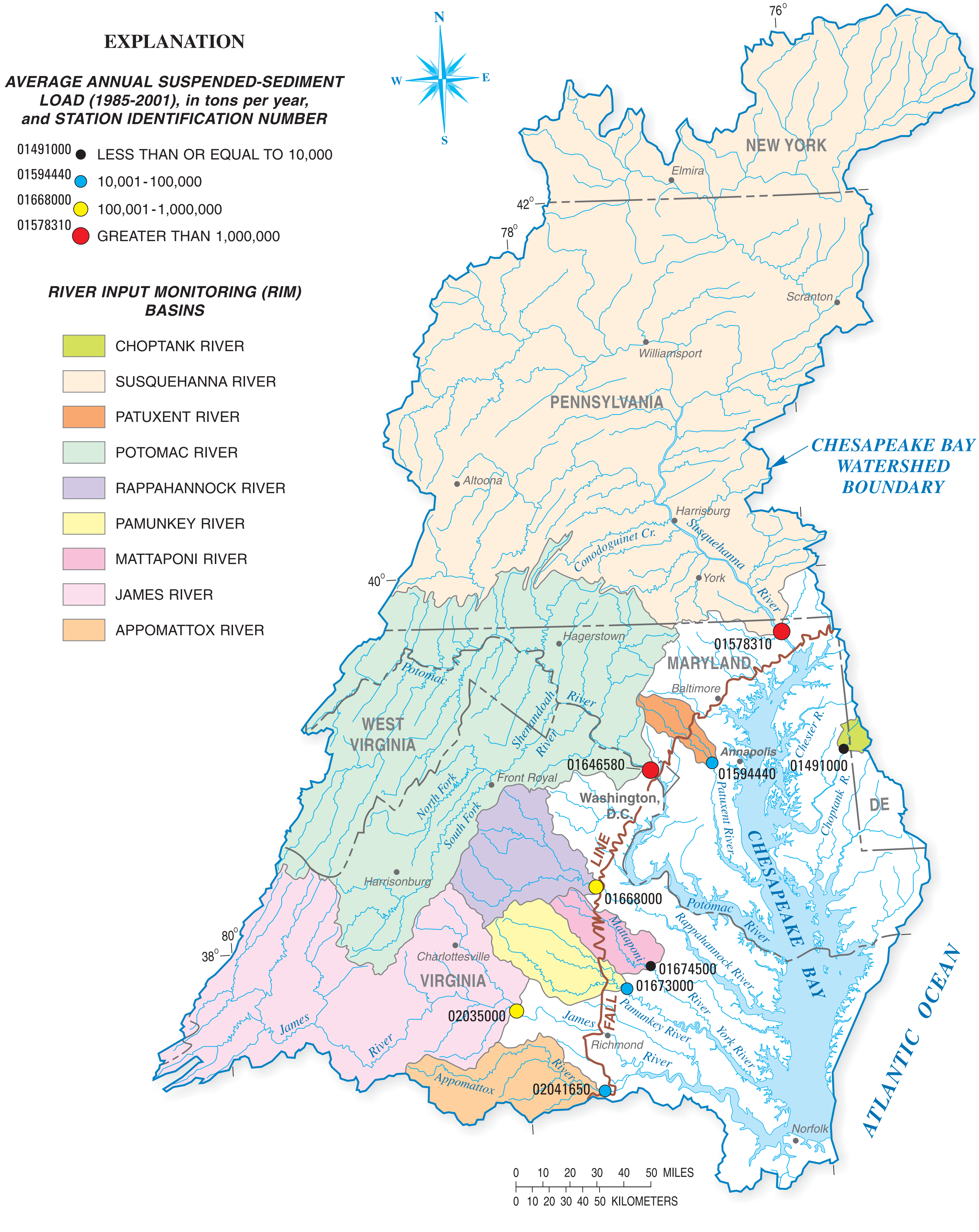


Figure 6a. Average annual suspended-sediment load from 1985 through 2001 for nine River Input Monitoring (RIM) stations in the Chesapeake Bay Watershed. *(Refer to table 2 for listing of stations.)*

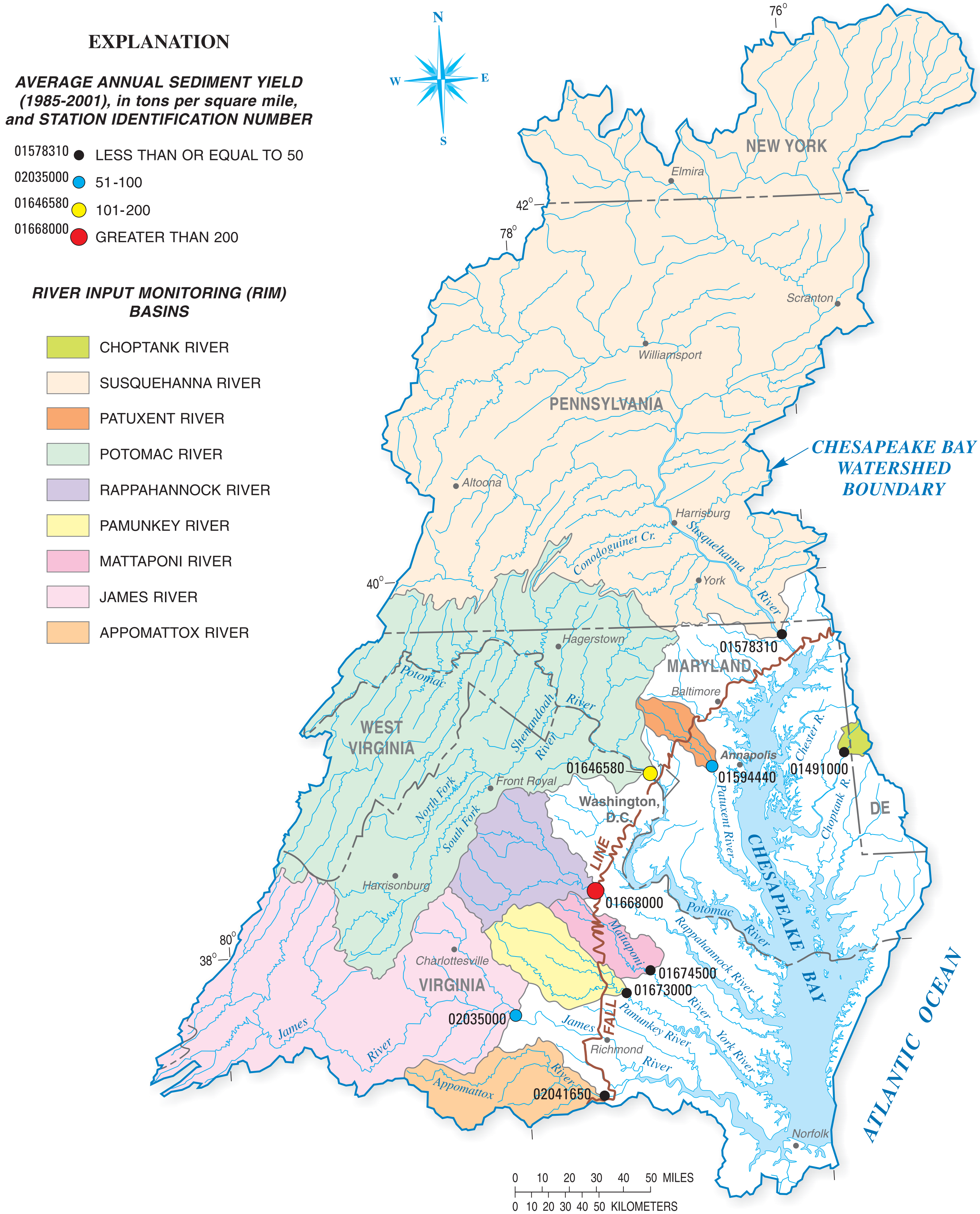


Figure 6b. Average annual sediment yield from 1985 through 2001 for nine River Input Monitoring (RIM) stations in the Chesapeake Bay Watershed. *(Refer to table 2 for listing of stations.)*

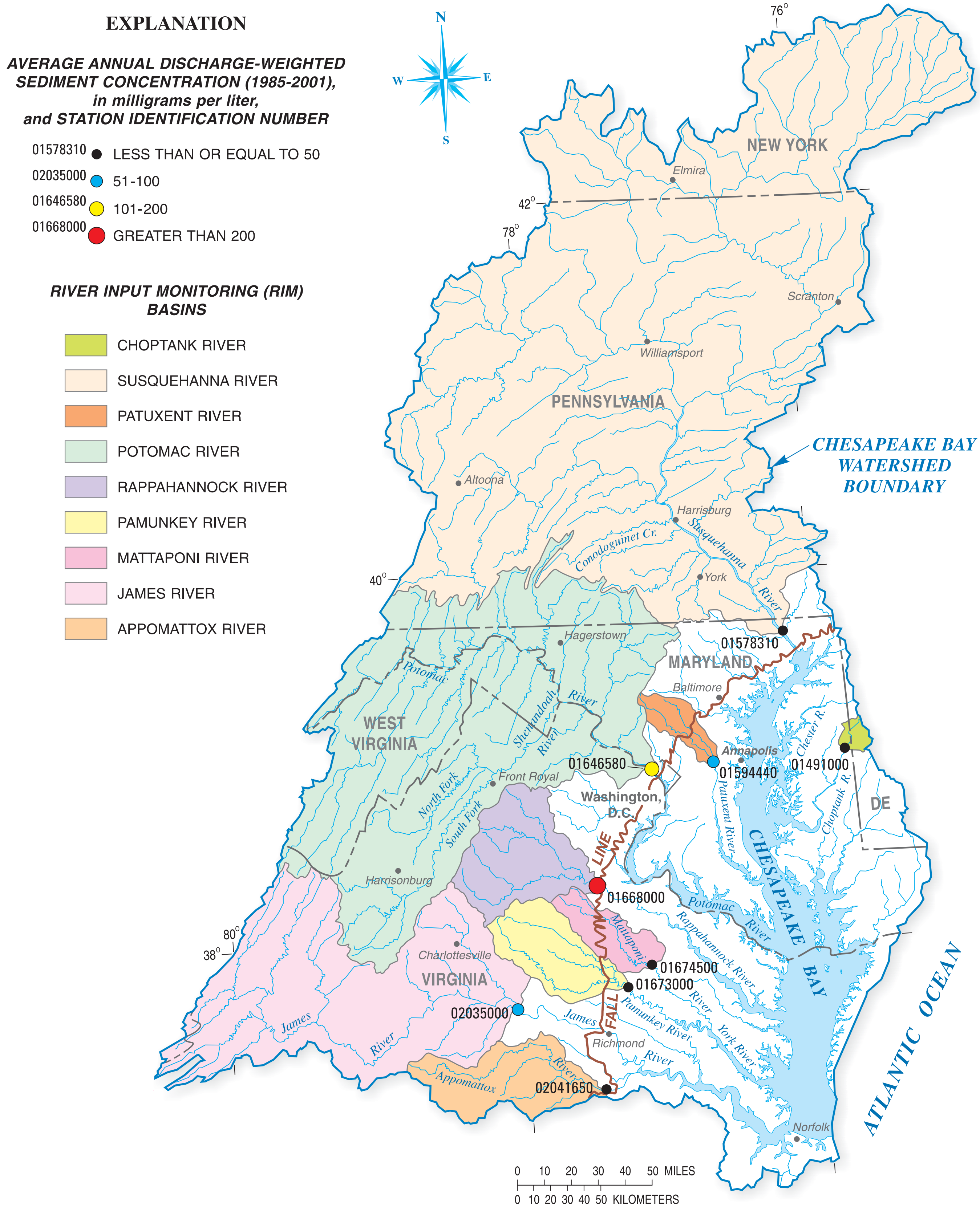


Figure 6c. Average annual discharge-weighted sediment concentration from 1985 through 2001 for nine River Input Monitoring (RIM) stations in the Chesapeake Bay Watershed. *(Refer to table 2 for listing of stations.)*

Table 2. *Summary of sediment data collected from River Input Monitoring stations, 1985 through 2001*

[mg/L, milligrams per liter; Water Year is from October 1 of the previous year to September 30 of the current year.]

Period of record for sediment collection (water year)	Station name	Station identification number	Drainage area (square miles)	Average water year suspended-sediment load (tons)	Average water year discharge-weighted sediment concentration (mg/L)
1985–2001	Choptank River near Greensboro, MD	01491000	113	2,310	17.3
1985–2001	Susquehanna River at Conowingo, MD	01578310	27,100	1,110,000	29.9
1985–2001	Patuxent River near Bowie, MD	01594440	348	23,400	67.1
1985–2001	Potomac River at Chain Bridge at Washington, D.C. [1]	01646580	11,570	1,840,000	157
1989–2001	Rappahannock River near Fredericksburg, VA*	01668000	1,596	527,000	299
1990–2001	Pamunkey River near Hanover, VA*	01673000	1,081	39,400	38.5
1991–2001	Mattaponi River at Beulahville, VA*	01674500	601	5,030	10.0
1987–2001	James River at Cartersville, VA*	02035000	6,259	608,000	83.4
1990–2001	Appomattox River at Matoaca, VA*	02041650	1,340	17,800	15.1

Period of record for discharge data	Station name	Station identification number	Average water year sediment yield, (tons per square mile)	Mean daily discharge for sediment collection period, (cubic feet per second)	Mean daily discharge for period of record, (cubic feet per second)
1949–2002	Choptank River near Greensboro, MD	01491000	20.4	135	132
1968–2002	Susquehanna River at Conowingo, MD	01578310	40.8	37,588	39,791
1978–2002	Patuxent River near Bowie, MD	01594440	67.3	355	367
1931–2002	Potomac River at Chain Bridge at Washington, D.C. [1]	01646580	159	11,938	11,256
1908–2001	Rappahannock River near Fredericksburg, VA*	01668000	330	1,788	1,674
1942–2001	Pamunkey River near Hanover, VA*	01673000	36.5	1,039	1,010
1942–1987, 1990–2001	Mattaponi River at Beulahville, VA*	01674500	8.4	512	577
1900–2001	James River at Cartersville, VA*	02035000	97.2	7,404	7,161
1979–2001	Appomattox River at Matoaca, VA*	02041650	13.3	1,195	1,347

* Indicates total suspended solids were collected at the station.

[1] Discharge is measured at Potomac River near Washington D.C., Little Falls Pumping Station (01646500), 1.2 miles upstream of Chain Bridge.

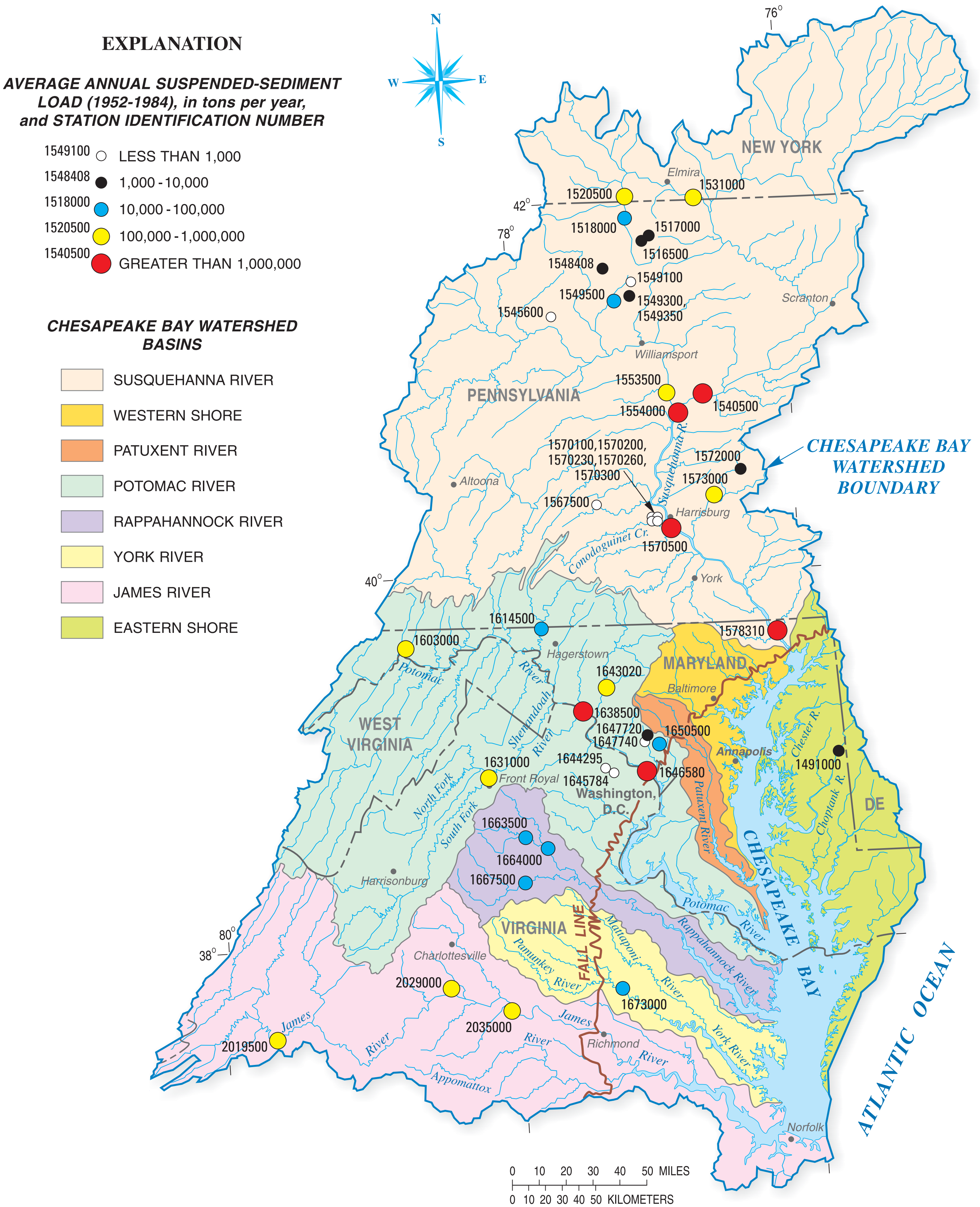


Figure 7a. Average annual suspended-sediment load from 1952 through 1984 for 43 stations in the Chesapeake Bay Watershed with at least 3 years of record. *(Refer to table 3 for listing of stations.)*

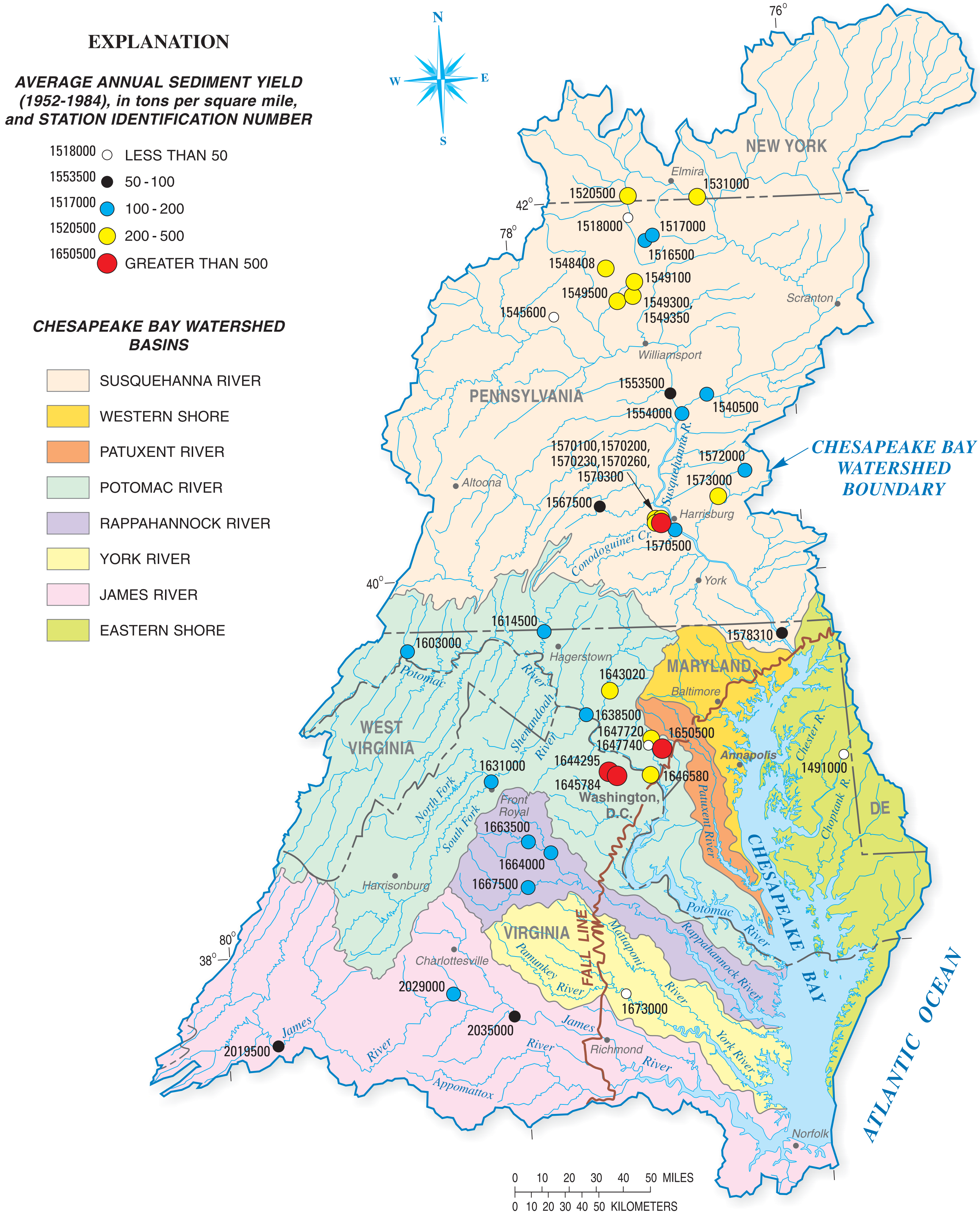


Figure 7b. Average annual sediment yield from 1952 through 1984 for 43 stations in the Chesapeake Bay Watershed with at least 3 years of record. *(Refer to table 3 for listing of stations.)*

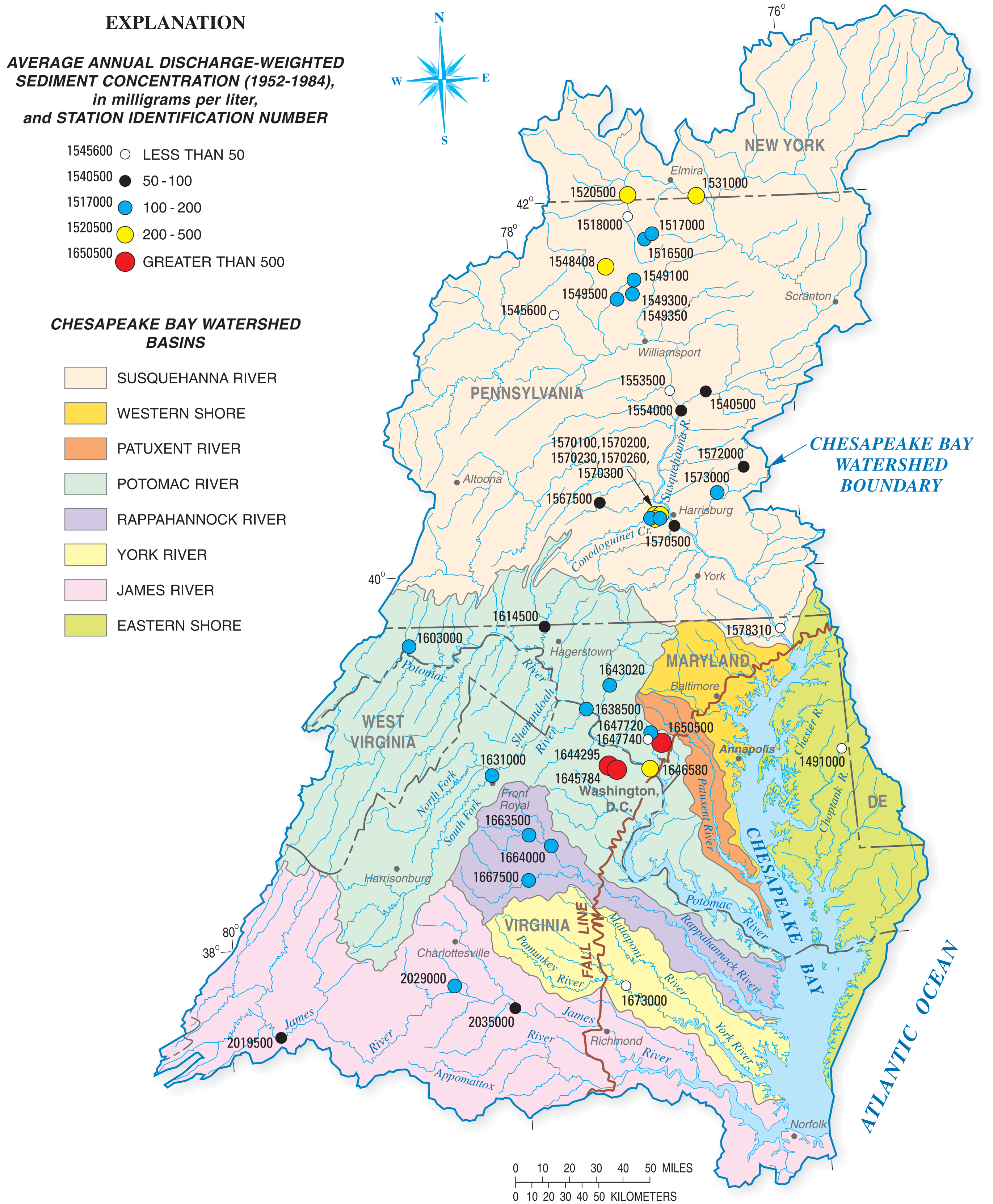


Figure 7c. Average annual discharge-weighted sediment concentration from 1952 through 1984 for 43 stations in the Chesapeake Bay Watershed with at least 3 years of record. *(Refer to table 3 for listing of stations.)*

Table 3. *Summary of sediment data for water years 1952 through 1984*

[USGS daily refers to daily-load sediment stations, Estimator is sediment data from the Estimator model, and RIM is sediment data from the River Input Monitoring Stations. Water Year is from October 1 of the previous year to September 30 of the current year; mg/L, milligrams per liter]

Period of record for sediment collection (water year)	Annual load computation sources	Station name	Station identification number	Drainage area (square miles)
Eastern Shore				
1972–1984	USGS daily/RIM	Choptank River near Greensboro, MD	01491000	113
Susquehanna River				
1955–1957, 1960–1967	USGS daily	Corey Creek near Mainesburg, PA	01516500	12.2
1955–1956, 1958, 1960–1962, 1966–1967	USGS daily	Elk Run near Mainesburg, PA	01517000	10.2
1973–1978	Estimator	Tioga River at Tioga, PA	01518000	282
1975–1980	USGS daily	Tioga River at Lindley, NY	01520500	771
1975–1977	USGS daily	Chemung River at Chemung, NY	01531000	2,506
1975–1984	Estimator	Susquehanna River at Danville, PA	01540500	11,220
1973–1979, 1981, 1983	Estimator/USGS daily	Young Womans Creek near Renovo, PA	01545600	46.2
1979–1981	USGS daily	Wilson Creek above Sand Run near Antrim, PA	01548408	12.6
1973–1977	USGS daily	Blockhouse Creek Tributary at Liberty, PA	01549100	1.08
1973–1977	USGS daily	Blockhouse Creek at Buttonwood, PA	01549300	22.3
1973–1977	USGS daily	Steam Valley Run at Buttonwood, PA	01549350	5.34
1973–1977	USGS daily	Blockhouse Creek near English Center, PA	01549500	37.7
1975–1984	USGS daily/Estimator	West Branch Susquehanna River at Lewisburg, PA	01553500	6,847
1973–1977	Estimator	Susquehanna River at Sunbury, PA	01554000	18,306
1955–1970	USGS daily	Bixler Run near Loysville, PA	01567500	15
1971–1976	USGS daily	Conodoguinet Creek Tributary No. 1 near Enola, PA	01570100	0.77
1973–1976	USGS daily	Conodoguinet Creek Tributary No. 2 near Enola, PA	01570200	0.76
1973–1976	USGS daily	Conodoguinet Creek Tributary No. 2A near Enola, PA	01570230	0.7
1973–1976	USGS daily	Conodoguinet Creek Tributary No. 2B near Enola, PA	01570260	0.65
1970–1976	USGS daily	Conodoguinet Creek Tributary No. 3 near Enola, PA	01570300	0.38
1964–1966, 1968, 1972–1984	Estimator/USGS daily	Susquehanna River at Harrisburg, PA	01570500	24,100
1982–1984	USGS daily	Lower Little Swatara Creek at Pine Grove, PA	01572000	34.3
1960, 1977–1979	USGS daily	Swatara Creek at Harper Tavern, PA	01573000	337
1980–1984	Estimator/USGS daily	Susquehanna River at Conowingo, MD	01578310	27,100
Potomac River				
1966–1978, 1981–1982	USGS daily	North Branch Potomac River near Cumberland, MD	01603000	877
1968–1980	USGS daily	Conococheague Creek at Fairview, MD	01614500	495
1954–1956	USGS daily	South Fork Shenandoah River at Front Royal, VA	01631000	1,642
1961–1984	USGS daily	Potomac River at Point of Rocks, MD	01638500	9,651
1961–1966, 1968–1983	USGS daily	Monocacy River at Reichs Ford Bridge near Frederick, MD	01643020	817
1972–1975	USGS daily	Smilax Branch at Reston, VA	01644295	0.32
1974–1978	USGS daily	Snakeden Branch at Reston, VA	01645784	0.79
1979–1984	Estimator/ USGS daily	Potomac River at Chain Bridge at Washington, D.C. [1]	01646580	11,570
1972–1976	Estimator	North Branch Rock Creek near Norbeck, MD	01647720	9.73
1968–1977	USGS daily	North Branch Rock Creek near Rockville, MD	01647740	12.5
1963–1975	USGS daily	Northwest Branch Anacostia River near Colesville, MD	01650500	21.1

[1] Discharge is measured at Potomac River near Washington D.C., Little Falls Pumping Station (01646500), 1.2 miles upstream of Chain Bridge.

Average water year sediment load (tons)	Average water year discharge-weighted sediment concentration (mg/L)	Average water year sediment yield (tons per square mile)	Mean daily discharge for sediment period (cubic feet per second)	Mean daily discharge for period of record (cubic feet per second)	Period of streamflow record	Difference of study period mean daily discharge to period of record (in percent)	Station identification number
2,480	16.0	21.9	156	132	1949–2002	18.4	01491000
1,360	138	111	10.0	12.5	1955–2001	-19.9	01516500
1,650	149	162	11.2	11.0	1955–1978	2.0	01517000
11,200	25.2	39.8	451	380	1939–2001	18.7	01518000
310,400	325	403	969	812	1931–1994	19.3	01520500
828,300	275	331	3,056	2,578	1907–1909, 1912, 1916–2001	18.5	01531000
1,431,000	85.2	128	17,052	15,266	1906–2001	11.7	01540500
352	4.3	7.6	83.1	73.5	1966–2001	13.1	01545600
4,930	386	392	13.0	13.0	1979–1981	-0.2	01548408
317	190	293	1.7	1.7	1973–1977	-0.2	01549100
6,420	184	288	35.5	35.5	1973–1977	-0.1	01549300
700	65.7	131	10.8	10.8	1973–1977	0.3	01549350
10,300	155	272	67.2	58.4	1941–2001	15.0	01549500
432,000	35.7	63	12,284	10,796	1940–2001	13.8	01553500
2,192,000	69.7	120	31,964	26,626	1938–2001	20.0	01554000
999	67.3	66.6	15.1	19.5	1955–2001	-22.7	01567500
150	133	194	1.1	1.1	1970–1976	3.6	01570100
283	250	373	1.2	1.2	1973–1976	-4.0	01570200
170	177	243	1.0	1.0	1973–1976	-0.1	01570230
329	335	506	1.0	1.0	1973–1976	-0.3	01570260
160	258	410	0.6	0.6	1970–1976	0.6	01570300
2,880,000	81.3	120	35,979	34,212	1891–2001	5.2	01570500
5,730	81.4	167	71.5	58.2	1920–1932, 1982–1984	22.9	01572000
104,000	139	309	761	572	1920–2001	33.1	01573000
1,636,000	44.8	60.4	37,031	39,791	1968–2002	-6.9	01578310
157,000	121	179	1,318	1,287	1930–2002	2.4	01603000
65,900	90.1	133	743	597	1929–1991, 1993–2002	24.4	01614500
225,000	174	137	1,309	1,591	1931–2001	-17.7	01631000
1,145,000	118	119	9,884	9,437	1896–2002	4.7	01638500
187,000	196	229	965	939	1943–2002	2.7	01643020
316	585	989	0.55	0.4	1968–1978	30.8	01644295
903	653	1,140	1.40	1.4	1974–1978	0.3	01645784
2,918,000	224	252	13,234	11,256	1931–2002	17.6	01646580
1,950	128	201	15.6	11.8	1967–1977	31.8	01647720
601	37.9	48.0	16.1	16.1	1968–1977	0.0	01647740
14,800	660	702	22.8	22.4	1924–1983, 1999–2001	1.8	01650500

Table 3. *Summary of sediment data for water years 1952 through 1984—Continued*

Period of record for sediment collection (water year)	Annual load computation sources	Station name	Station identification number	Drainage area (square miles)
Rappahannock River				
1953–1955	USGS daily	Hazel River at Rixeyville, VA	01663500	287
1953–1984	USGS daily	Rappahannock River at Remington, VA	01664000	620
1952–1956	USGS daily	Rapidan River near Culpeper, VA	01667500	472
Pamunkey River				
1976–1980	Estimator	Pamunkey River near Hanover, VA	01673000	1,081
James River				
1952–1956	USGS daily	James River at Buchanan, VA	02019500	2,075
1952–1956	USGS daily	James River at Scottsville, VA	02029000	4,584
1974–1983	Estimator	James River at Cartersville, VA	02035000	6,259

Average water year sediment load (tons)	Average water year discharge-weighted sediment concentration (mg/L)	Average water year sediment yield (tons per square mile)	Mean daily discharge for sediment period (cubic feet per second)	Mean daily discharge for period of record (cubic feet per second)	Period of streamflow record	Difference of study period mean daily discharge to period of record (in percent)	Station identification number
47,800	164	166	295	338	1943–1992	-12.6	01663500
98,300	148	158	676	693	1943–2001	-2.4	01664000
74,000	166	157	453	535	1931–2002	-15.4	01667500
24,100	20.2	22.3	1,211	1,010	1942–2001	19.9	01673000
198,000	93.7	95.4	2,146	2,452	1911–2001	-12.5	02019500
623,700	136.9	136	4,623	5,208	1925–2001	-11.2	02029000
417,200	56.7	66.7	7,470	7,161	1900–2001	4.3	02035000

Table 4. *Rankings of sediment loads, yields, and discharge-weighted sediment concentrations, from highest (1) to lowest (43) values, for stations operating from water years 1952 through 1984*

Station name	Station identification numbers	Suspended-sediment load ranking	Sediment yield ranking	Discharge-weighted sediment concentration ranking
Choptank River near Greensboro, MD	1491000	28	42	42
Corey Creek near Mainesburg, PA	1516500	31	33	22
Elk Run near Mainesburg, PA	1517000	30	22	19
Tioga River at Tioga, PA	1518000	23	40	40
Tioga River at Lindley, NY	1520500	11	6	6
Chemung River at Chemung, NY	1531000	7	9	7
Susquehanna River at Danville, PA	1540500	5	29	30
Young Womans Creek near Renovo, PA	1545600	36	43	43
Wilson Creek above Sand Run near Antrim, PA	1548408	27	7	4
Blockhouse Creek Tributary at Liberty, PA	1549100	38	11	12
Blockhouse Creek at Buttonwood, PA	1549300	25	12	13
Steam Valley Run at Buttonwood, PA	1549350	34	28	35
Blockhouse Creek near English Center, PA	1549500	24	13	18
West Branch Susquehanna River at Lewisburg, PA	1553500	9	37	39
Susquehanna River at Sunbury, PA	1554000	3	30	33
Bixler Run near Loysville, PA	1567500	32	36	34
Conodoguinet Creek Tributary No. 1 near Enola, PA	1570100	43	18	24
Conodoguinet Creek Tributary No. 2 near Enola, PA	1570200	40	8	9
Conodoguinet Creek Tributary No. 2A near Enola, PA	1570230	41	15	14
Conodoguinet Creek Tributary No. 2B near Enola, PA	1570260	37	4	5
Conodoguinet Creek Tributary No. 3 near Enola, PA	1570300	42	5	8
Susquehanna River at Harrisburg, PA	1570500	2	31	32
Lower Little Swatara Creek at Pine Grove, PA	1572000	26	20	31
Swatara Creek at Harper Tavern, PA	1573000	16	10	21
Susquehanna River at Conowingo, MD	1578310	4	38	37
North Branch Potomac River near Cumberland, MD	1603000	15	19	26
Conococheague Creek at Fairview, MD	1614500	19	27	29
South Fork Shenandoah River at Front Royal, VA	1631000	12	25	15
Potomac River at Point of Rocks, MD	1638500	6	32	27
Monocacy River at Reichs Ford Bridge near Frederick, MD	1643020	14	16	11
Smilax Branch at Reston, VA	1644295	39	2	3
Snakeden Branch at Reston, VA	1645784	33	1	2
Potomac River at Chain Bridge at Washington, D.C.	1646580	1	14	10
North Branch Rock Creek near Norbeck, MD	1647720	29	17	25
North Branch Rock Creek near Rockville, MD	1647740	35	39	38
Northwest Branch Anacostia River near Colesville, MD	1650500	22	3	1
Hazel River at Rixeyville, VA	1663500	20	21	17
Rappahannock River at Remington, VA	1664000	17	23	20
Rapidan River near Culpeper, VA	1667500	18	24	16
Pamunkey River near Hanover, VA	1673000	21	41	41
James River at Buchanan, VA	2019500	13	34	28
James River at Scottsville, VA	2029000	8	26	23
James River at Cartersville, VA	2035000	10	35	36

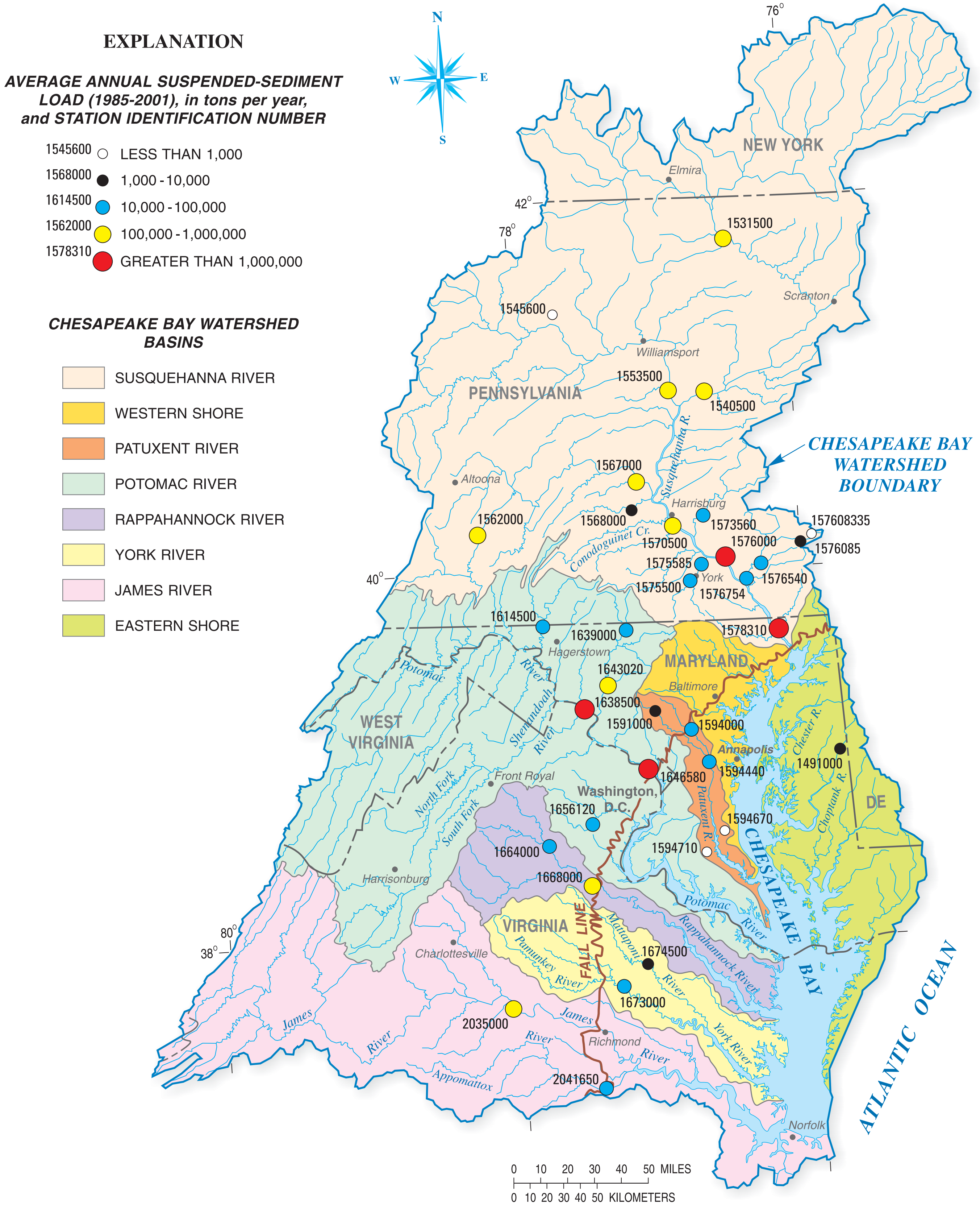


Figure 8a. Average annual suspended-sediment load from 1985 through 2001 for 35 stations in the Chesapeake Bay Watershed with at least 3 years of record. *(Refer to table 5 for listing of stations.)*

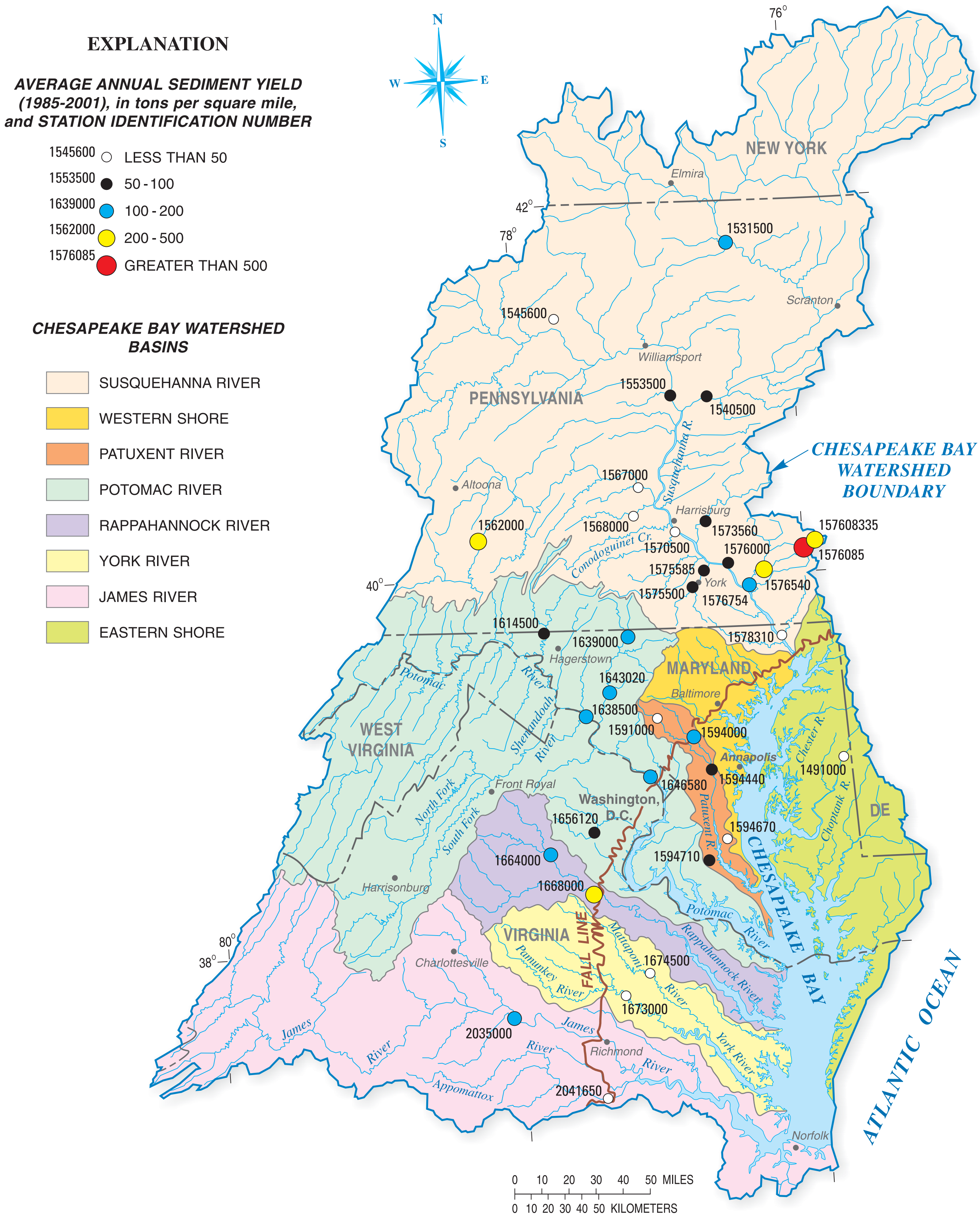


Figure 8b. Average annual sediment yield from 1985 through 2001 for 35 stations in the Chesapeake Bay Watershed with at least 3 years of record. *(Refer to table 5 for listing of stations.)*

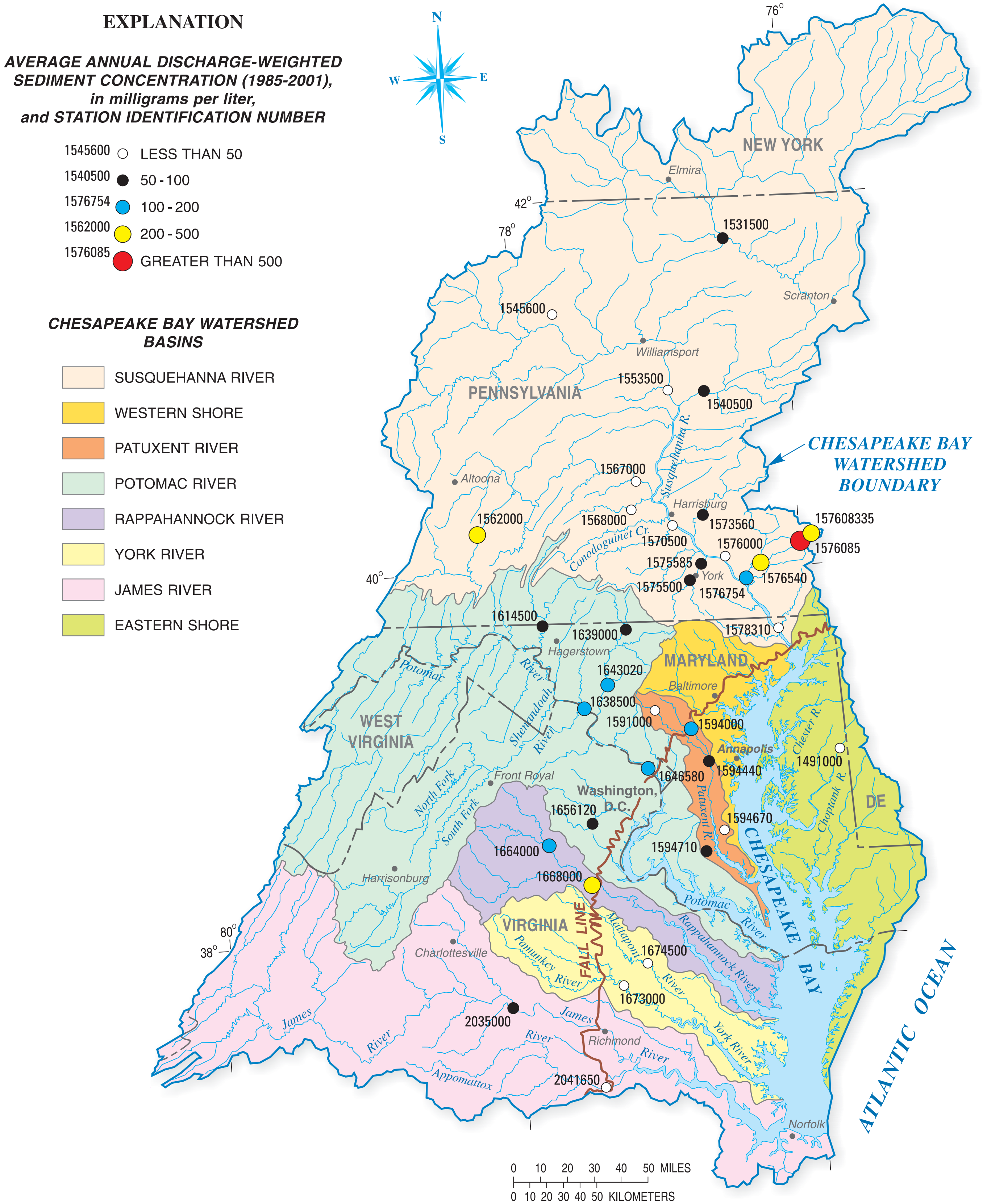


Figure 8c. Average annual discharge-weighted sediment concentration from 1985 through 2001 for 35 stations in the Chesapeake Bay Watershed with at least 3 years of record. *(Refer to table 5 for listing of stations.)*

Table 5. *Summary of sediment data for water years 1985 through 2001*

[USGS daily refers to daily-load sediment stations, Estimator is sediment data from the Estimator model, and RIM is sediment data from the River Input Monitoring Stations. Water Year is from October 1 of the previous year to September 30 of the current year; mg/L, milligrams per liter]

Period of record for sediment collection (water year)	Annual load computation sources	Station name	Station identification number	Drainage area (square miles)
Eastern Shore				
1985–2001	Estimator/ USGS daily /RIM	Choptank River near Greensboro, MD	01491000	113
Susquehanna River				
1985–1996	Estimator	Susquehanna River at Towanda, PA [1]	01531500	7,797
1985–1996	USGS daily/Estimator	Susquehanna River at Danville, PA [1]	01540500	11,220
1985–1992	Estimator	Young Womans Creek near Renovo, PA	01545600	46.0
1989–1996	Estimator	West Branch Susquehanna River at Lewisburg, PA [1]	01553500	6,847
1988–1992	Estimator	Raystown Branch Juniata River at Saxton, PA	01562000	756
1985–1996	Estimator	Juniata River at Newport, PA [1]	01567000	3,355
1985–1996	Estimator	Sherman Creek at Shermans Dale, PA [1]	01568000	200
1985–1991	Estimator	Susquehanna River at Harrisburg, PA [1]	01570500	24,100
1985–1989	Estimator	Swatara Creek near Hershey, PA [1]	01573560	483
1985–1989	Estimator	Codorus Creek near York, PA [1]	01575500	222
1985–1989	Estimator	Codorus Creek at Pleasureville, PA [1]	01575585	267
1985–1996	Estimator	Susquehanna River at Marietta, PA [1]	01576000	25,998
1985–1992	Estimator	Little Conestoga Creek near Churchtown, PA	01576085	5.82
1993–1995	Estimator	Mill Creek at Eshelman Mill Road near Lyndon, PA	01576540	54.0
1985–1998, 2001	Estimator	Conestoga River at Conestoga, PA [1]	01576754	470
1985–2001	Estimator/ USGS daily	Susquehanna River at Conowingo, MD	01578310	27,100
1986, 1988–1991	Estimator	Little Conestoga Creek site 3A near Morgantown, PA	0157608335	1.42
Patuxent River				
1986, 1990, 1993, 1995	Estimator	Patuxent River near Unity, MD	01591000	34.8
1987, 1988, 1990	Estimator	Little Patuxent River at Savage, MD	01594000	98.4
1985–2001	USGS daily/RIM	Patuxent River near Bowie, MD	01594440	348
1989–1992	Estimator	Hunting Creek near Huntingtown, MD	01594670	9.38
1986–1989, 1991, 1994–1996	Estimator	Killpeck Creek at Huntersville, MD	01594710	9
Potomac River				
1993–1996	Estimator	Conococheague Creek at Fairview, MD	01614500	494
1985–1992	USGS daily	Potomac River at Point of Rocks, MD	01638500	9,651
1989–1995	Estimator/ USGS daily	Monocacy River at Bridgeport, MD	01639000	173
1985–1992	USGS daily	Monocacy River at Reichs Ford Bridge near Frederick, MD	01643020	817
1985–2001	RIM data	Potomac River at Chain Bridge at Washington, D.C. [2]	01646580	11,570
1997–1999	USGS daily	Cedar Run at Route 646 near Aden, VA	01656120	175

[1] USGS sediment samples were augmented with sediment data collected by Susquehanna River Basin Commission.

[2] Discharge is measured at Potomac River near Washington D.C., Little Falls Pumping Station (01646500), 1.2 miles upstream of Chain Bridge.

Average water year sediment load (tons)	Average water year discharge-weighted sediment concentration (mg/L)	Average water year sediment yield (tons per square mile)	Mean daily discharge for sediment period (cubic feet per second)	Mean daily discharge for period of record (cubic feet per second)	Period of streamflow record	Difference of study period mean daily discharge to period of record (in percent)	Station identification number
2,310	17.3	20.4	135	132	1949–2002	2.3	01491000
808,000	77.3	104	10,600	10,600	1914–2001	0	01531500
778,000	54.5	69.3	14,500	15,300	1906–2001	-5.2	01540500
840	12.6	18.2	67.6	73.5	1966–2001	-8.1	01545600
352,000	33.4	51.4	10,700	10,800	1940–2001	-0.9	01553500
196,000	247	259	807	921.0	1912–2001	-12.4	01562000
110,000	26.2	33.0	4,280	4,300	1900–2001	-0.5	01567000
7,640	29.8	38.2	260.0	292.0	1930–2001	-11.0	01568000
765,000	25.3	31.8	30,700	34,200	1891–2001	-10.2	01570500
41,400	64.4	85.6	652	781	1976–2001	-16.5	01573560
14,400	81.8	64.6	178	223	1941–1996	-20.1	01575500
17,800	70.8	66.5	255	254	1985–1989	0.2	01575585
1,700,000	47.2	65.4	36,600	37,000	1932–2001	-1.1	01576000
6,100	1,044	1,050	5.9	7.3	1983–1995	-18.9	01576085
17,400	223	321	79	81	1993–1998	-1.5	01576540
81,800	133	173.9	625	640	1985–2001	-2.4	01576754
1,107,000	29.9	40.8	37,600	39,800	1968–2002	-5.5	01578310
470	391	331	1.2	1.1	1985–1991	10.9	0157608335
1,380	40.2	39.6	34.8	38.8	1945–2002	-10.2	01591000
10,200	111	104	94	109	1940–1958, 1976–1980, 1986–2002	-13.9	01594000
23,000	66.0	66.2	355	367	1978–2002	-3.3	01594440
122	12.3	13.0	10.1	10.5	1989–1997	-4.2	01594670
304	84.9	32.4	3.6	3.9	1986–1997	-6.7	01594710
45,500	52.2	92	885	597	1929–1991, 1993–2002	48.2	01614500
1,128,000	136	117	8,430	9,440	1896–2002	-10.7	01638500
19,800	84.7	115	238	207	1943–2002	14.9	01639000
108,000	138	133	797	939	1943–2002	-15.1	01643020
1,844,000	157	159	11,900	11,300	1931–2002	5.3	01646580
11,500	64.9	66	179	179	1997–1999	0	01656120

Table 5. *Summary of sediment data for water years 1985 through 2001—Continued*

Period of record for sediment collection (water year)	Annual load computation sources	Station name	Station identification number	Drainage area (square miles)
Rappahannock River				
1985–1993	USGS daily	Rappahannock River at Remington,VA	01664000	620
1989–2001	RIM data	Rappahannock River near Fredericksburg, VA*	01668000	1,596
Pamunkey River				
1990–2001	RIM data	Pamunkey River near Hanover, VA*	01673000	1,081
Mattaponi River				
1991–2001	RIM data	Mattaponi River near Beulahville, VA*	01674500	601
James River				
1987–2001	Estimator/ RIM data	James River at Cartersville, VA*	02035000	6,259
Appomattox River				
1990–2001	RIM data	Appomattox River at Matoaca, VA*	02041650	1,340

* Indicates total suspended solids used.

Average water year sediment load (tons)	Average water year discharge-weighted sediment concentration (mg/L)	Average water year sediment yield (tons per square mile)	Mean daily discharge for sediment period (cubic feet per second)	Mean daily discharge for period of record (cubic feet per second)	Period of streamflow record	Difference of study period mean daily discharge to period of record (in percent)	Station identification number
96,800	152	156	645	693	1943–2001	-6.9	01664000
527,000	299	330	1,790	1,670	1908–2001	7.2	01668000
39,400	38.5	36.5	1,040	1,010	1942–2001	3.0	01673000
5,030	10.0	8.4	512	577	1942–1987, 1990–2001	-11.3	01674500
720,000	98.7	115	7,400	7,160	1900–2001	3.4	02035000
17,800	15.1	13.3	1,200	1,350	1970–2001	-11.1	02041650

Table 6. *Rankings of sediment loads, yields, and discharge-weighted sediment concentrations, from highest (1) to lowest (43) values, for stations operating from water years 1985 through 2001*

Station name	Station identification number	Suspended-sediment load ranking	Sediment yield ranking	Discharge-weighted sediment concentration ranking
Susquehanna River at Conowingo, MD	01578310	4	24	27
Susquehanna River at Marietta, PA	01576000	2	21	23
Susquehanna River at Harrisburg, PA	01570500	7	30	30
Susquehanna River at Danville, PA	01540500	6	17	21
Potomac River at Chain Bridge at Washington, D.C.	01646580	1	7	6
West Branch Susquehanna River at Lewisburg, PA	01553500	10	23	26
Susquehanna River at Towanda, PA	01531500	5	14	16
Potomac River at Point of Rocks, MD	01638500	3	10	9
James River at Cartersville, VA*	02035000	8	11	12
Juniata River at Newport, PA	01567000	12	28	29
Rappahannock River near Fredericksburg, VA*	01668000	9	3	3
Appomattox River at Matoaca, VA*	02041650	22	33	32
Pamunkey River near Hanover, VA*	01673000	18	27	25
Conococheague Creek at Fairview, MD	01614500	16	15	22
Raystown Branch Juniata River at Saxton, PA	01562000	11	5	4
Monocacy River at Reichs Ford Bridge near Frederick, MD	01643020	13	9	8
Swatara Creek near Hershey, PA	01573560	17	16	20
Rappahannock River at Remington, VA	01664000	14	8	7
Conestoga River at Conestoga, PA	01576754	15	6	10
Mattaponi River at Beulahville, VA*	01674500	29	35	35
Patuxent River near Bowie, MD	01594440	19	19	18
Sherman Creek at Shermans Dale, PA	01568000	27	26	28
Codorus Creek at Pleasureville, PA	01575585	21	18	17
Monocacy River at Bridgeport, MD	01639000	20	12	14
Cedar Run at Route 646 near Aden, VA	01656120	25	20	19
Codorus Creek near York, PA	01575500	24	22	15
Choptank River near Greensboro, MD	01491000	30	31	31
Little Patuxent River at Savage, MD	01594000	26	13	11
Mill Creek at Eshelman Mill Road near Lyndon, PA	01576540	23	4	5
Young Womans Creek near Renovo, PA	01545600	32	32	33
Patuxent River near Unity, MD	01591000	31	25	24
Hunting Creek near Huntingtown, MD	01594670	35	34	34
Little Conestoga Creek near Churchtown, PA	01576085	28	1	1
Killpeck Creek at Huntersville, MD	01594710	34	29	13
Little Conestoga Creek site 3A near Morgantown, PA	0157608335	33	2	2

* Indicates total suspended solids were collected at the station.

Instantaneous Suspended-Sediment Concentrations

From October 1, 1984 through September 30, 2002, 51 stations had at least 3 years of instantaneous suspended-sediment concentrations with at least 10 measurements in each year (fig. 9), totaling 25,572 instantaneous measurements of suspended sediment. No stations meeting these criteria were found in West Virginia or New York. Drainage-area sizes for the 51 stations ranged from 0.36 to over 27,000 mi^2.

Seven of the 51 stations showed no statistical difference between the median mean-daily discharges on the days when suspended-sediment samples were collected and the median mean-daily discharge for the entire period of sediment record (p-values greater than or equal to 0.05) (table 7). At 42 of the remaining 44 stations, the median of mean-daily discharges was higher for the sample population (table 7).

The 10^{th}, 50^{th}, and 90^{th} percentiles of suspended-sediment concentration were calculated for each station (figs. 10 a–c, table 7). The five sediment stations with the highest suspended-sediment concentrations at the 10^{th} percentile were for rivers draining to the Susquehanna River in Pennsylvania (Brush Run, site 2, near McSherrystown; Codorus Creek at Pleasureville; Conestoga River at Conestoga; and Little Conestoga Creek near Churchtown), and one station draining to the Potomac River in Virginia (Cannon Creek near Garrisonville) (fig. 10a, tables 7–8). The 10^{th} percentile of suspended-sediment concentrations may reflect low-flow conditions. Three of the five sediment stations with the highest suspended-sediment concentration at the 50^{th} percentile included the same stations in Pennsylvania as the 10^{th} percentile (Conestoga River at Conestoga, Codorus Creek at Pleasureville, and Little Conestoga Creek near Churchtown), another station in Pennsylvania (Paxton Creek near Penbrook), and one station in Maryland draining to the Patuxent River (Killpeck Creek at Huntersville, Maryland) (fig. 10b, tables 7–8). At the 90^{th} percentile, the five highest suspended-sediment concentrations included four stations in Pennsylvania draining to the Susquehanna River (Bald Eagle Creek near Fawn Grove, Little Conestoga Creek near Churchtown, Mill Creek at Eshelman Mill Road near Lyndon, and Pequea Creek at Martic Forge), and the same station in Maryland with high sediment concentration at the 50^{th} percentile, draining to the Patuxent River (Killpeck Creek at Huntersville, Maryland) (fig. 10c, tables 7–8). The Little Conestoga Creek near Churchtown was the highest for the 10^{th}, 50^{th}, and 90^{th} percentiles (figs. 10 a–c, tables 5 and 8). The lowest suspended-sediment concentration at the 10^{th}, 50^{th}, and 90^{th} percentiles was at Bobs Creek near Pavia, Pennsylvania, in the Susquehanna River Basin, which drains close to 100 percent forested land (Langland and others, 1999) (figs. 10a–c, tables 5 and 8).

Sediment-Transport Curves

Suspended-sediment transport curves were generated for the 51 stations in the Chesapeake Bay Watershed with at least 3 complete years of data and at least 10 suspended-sediment samples in a given year (figs. 9, 11 a–e, and table 7). The least-squares regression coefficient generated for all plots ranges from 0.02 to 0.81 and averages 0.48 (figs. 11 a–e, table 7). The scatter in the sediment-transport curves illustrates that one or more factors other than discharge are controlling suspended-sediment concentrations. The scatter in sediment-transport curves can be related to a number of factors including seasonality, land use, hysteresis, and natural climatic variability (Walling and Webb, 1982).

Normalizing instantaneous discharge by drainage area and plotting the transport curves by drainage-area classes (fig. 12) shows that for the larger drainage areas (classes A and B, see page 10), the best-fit lines plot close together (figs. 12 a–b), and have similar suspended-sediment concentrations with respect to the normalized discharge. The Susquehanna River at Conowingo, Maryland (Class A) and the West Branch Susquehanna River at Lewisburg, Pennsylvania (Class B) show the lowest suspended-sediment concentrations at higher normalized discharges (figs. 12 a–b). The graph of Class C rivers shows the Conestoga River at Conestoga, Pennsylvania, with high suspended-sediment concentrations at high normalized discharges (fig. 12c). The graph of Class D rivers shows two stations draining to the Susquehanna River with high suspended-sediment concentrations at median to high normalized discharges (Codorus Creek at Pleasureville, Pennsylvania, and Codorus Creek near York, Pennsylvania) (fig. 12d). The graph of Class E rivers shows Pequea Creek at Martic Forge, Pennsylvania, with the highest suspended-sediment concentrations at nearly all normalized discharges (fig. 12e). Pequea Creek is a tributary to the Susquehanna River. The graph of Class F rivers shows Mill Creek, a tributary to the Conestoga River, with the highest suspended-sediment concentrations at median to high discharges (fig. 12f). The graph of Class G rivers shows several rivers grouped together with high suspended-sediment concentrations at medium to high normalized discharges: Muddy Creek and Cannon Creek in the Potomac River Basin, and Cedar Run and Paxton Creek in the Susquehanna River Basin (fig. 12g). The lowest suspended-sediment concentrations for Class G rivers are at Bobs Creek near Pavia, Pennsylvania (fig. 12g). For Class H, five rivers plot close together and show high suspended-sediment concentrations at high normalized discharges in the Susquehanna River Basin (Little Conestoga Creek, Bald Eagle Creek, Big Spring Run, and an unnamed tributary to Big Spring Run, Pennsylvania) and Killpeck Creek near Huntersville, Maryland, in the Patuxent River Basin (fig. 12).

For five of the eight drainage area classes of rivers (Classes C, D, E, F, and H), five stations that drain to the Susquehanna River have the highest suspended-sediment concentrations at high discharges (Class C–Conestoga River, Class D–Codorus Creek, Class E–Pequea Creek, Class F–Mill Creek, and Class H–Little Conestoga Creek). Three of the five stations drain to the Conestoga River in Pennsylvania (Little Conestoga Creek near Churchtown; Mill Creek at Eshelman Mill Road near Lyndon; and Conestoga River at Conestoga).

Table 7. *Summary of instantaneous suspended-sediment concentration data for stations used in this report for water years 1985 through 2002, including 10th, 50th, and 90th percentiles*

[Wilcoxon P-value, sediment transport equation (slope, intercept, and regression coefficient), and drainage area class are also shown. The Mann-Whitney-Wilcoxon tests the difference between the mean-daily discharge on days of suspended-sediment samples versus the mean-daily discharge for the entire water years of sediment record. P-values less than 0.05 indicate the two populations are statistically different; mg/L, milligrams per liter, ft^3/s, cubic feet per second; R^2 -Pearson product-moment correlation coefficient]

Station name	Station identification number	Years of record	Number of samples	Area (square miles)	10th percentile suspended-sediment concentration (mg/L)
Eastern Shore					
Nassawango Creek near Snow Hill, MD	01485500	1999–2002	94	44.9	3
Nanticoke River near Bridgeville, DE	01487000	1994–2002	149	75.4	3
Choptank River near Greensboro, MD	01491000	1985–2002	502	113	2
Chesterville Branch near Crumpton, MD	01493112	1996–2002	92	6.12	5
Susquehanna River					
Susquehanna River at Towanda, PA	01531500	1985–1993	152	7,797	5
Susquehanna River at Danville, PA	01540500	1985–1995	492	11,220	7
West Branch Susquehanna River at Lewisburg, PA	01553500	1985–1995	443	6,847	2
East Mahantango Creek at Klingerstown, PA	01555400	1993–2000	89	44.7	4
Bobs Creek near Pavia, PA	01559795	1993–2000	61	16.6	1
Raystown Branch Juniata River at Saxton, PA	01562000	1985–1993	121	756	1
Juniata River at Newport, PA	01567000	1985–1995	215	3,354	3
Sherman Creek at Shermans Dale, PA	01568000	1985–1995	204	207	5
Conodoguinet Creek near Hogestown, PA	01570000	1985–2002	98	470	3
Susquehanna River at Harrisburg, PA	01570500	1985–1995	322	24,100	5
Paxton Creek near Penbrook, PA	01571000	1985–1994	425	11.2	6
Cedar Run at Eberlys Mill, PA	01571490	1993–1997	99	12.6	15
Swatara Creek near Hershey, PA	01573560	1985–1994	221	483	8
Brush Run Site 2 near McSherrystown, PA	01573810	1985–1991	985	0.38	19
West Conewago Creek near Manchester, PA	01574000	1985–1994	247	510	10
Codorus Creek near York, PA	01575500	1985–1990	203	222	10
Codorus Creek at Pleasureville, PA	01575585	1985–1994	431	267	19
Susquehanna River at Marietta, PA	01576000	1987–1994	245	25,990	8
Little Conestoga Creek near Churchtown, PA	01576085	1985–1995	1,104	5.82	53
Big Spring Run near Willow Street, PA	01576521	1993–2001	400	1.77	7
North Fork Unnamed Tributary to Big Spring Run at Lampeter, PA	01576527	1993–2001	354	0.36	5
Unnamed tributary to Big Spring Run near Lampeter, PA	01576529	1993–2001	415	1.42	4
Mill Creek at Eshelman Mill Road near Lyndon, PA	01576540	1992–1995	149	54.2	11
Conestoga River at Conestoga, PA	01576754	1985–1995	783	470	23
Pequea Creek at Martic Forge, PA	01576787	1985–1995	106	148	17
Bald Eagle Creek near Fawn Grove, PA	01577400	1986–1990	430	0.43	4.5
Susquehanna River at Conowingo, MD	01578310	1985–2002	660	27,100	5.5
Patuxent River					
Patuxent River near Unity, MD	01591000	1986-2000	410	34.8	2
Little Patuxent River at Savage, MD	01594000	1985-2000	454	98.4	2
Patuxent River near Bowie, MD	01594440	1985-2002	654	348	10
Western Branch at Upper Marlboro, MD	01594526	1986-2000	419	89.7	7
Hunting Creek near Huntingtown, MD	01594670	1986-1998	316	9.38	4
Killpeck Creek at Huntersville, MD	01594710	1986-1997	427	3.26	6

50th percentile suspended-sediment concentration (mg/L)	90th percentile suspended-sediment concentration (mg/L)	Median discharge of population (ft^3/s)	Median discharge of sample (ft^3/s)	Mann-Whitney-Wilcoxon P-value	Sediment Transport Curve: Slope	Sediment Transport Curve: Intercept	Sediment Transport Curve: Regression coefficient (R^2)	Drainage area class *	Station identification number
11	35	23	64	0	0.27	0.54	0.19	F	01485500
26	196	82	125	0	0.72	-0.16	0.24	F	01487000
10	47	82	150	0	0.61	-0.37	0.57	E	01491000
15	143	6	7	0	0.81	0.46	0.56	H	01493112
32	243	6,000	19,500	0	1.02	-2.78	0.67	B	01531500
20	140	9,115	19,500	0	0.91	-2.32	0.61	A	01540500
10	66	7,010	14,350	0	0.93	-2.70	0.63	B	01553500
8	96	32	27	0.559	0.49	0.33	0.40	F	01555400
3	8	9	13	0.692	0.22	0.33	0.15	G	01559795
8	34.5	410	400	0.197	0.75	-1.00	0.43	C	01562000
34	136	2,380	4,840	0	0.99	-2.28	0.61	B	01567000
24	210	143	309	0	0.83	-0.78	0.56	D	01568000
8	164	327	450	0.001	0.95	-1.53	0.66	C	01570000
25	138	21,000	39,700	0	0.95	-2.95	0.68	A	01570500
186	1,370	6	12	0	0.88	0.55	0.61	G	01571000
74	166	12	14	0.080	0.60	0.99	0.21	G	01571490
39	450	433	970	0	1.16	-1.85	0.68	C	01573560
105	617	0.03	1	0	0.29	1.92	0.16	H	01573810
63	397	286	777	0	0.73	-0.36	0.47	C	01574000
40	557	129	197	0	1.13	-1.07	0.63	D	01575500
189	733	193	329	0	1.18	-1.16	0.64	D	01575585
49	192	24,600	63,000	0	1.00	-3.10	0.70	A	01576000
548	3,140	4	10	0	0.90	1.30	0.62	H	01576085
74.5	840	2	3	0	1.09	1.36	0.32	H	01576521
49.5	611	0.2	0.7	0	0.46	1.96	0.13	H	01576527
39	643	1.1	1.4	0	1.04	1.52	0.36	H	01576529
117	2,090	47	69	0.002	1.41	-0.68	0.73	F	01576540
201	1,450	439	790	0	1.22	-1.67	0.66	C	01576754
184	2,070	138	204	0.012	1.52	-1.52	0.48	E	01576787
172.5	2,365	0.3	0.4	0	1.02	2.08	0.43	H	01577400
16	85	25,200	58,300	0	0.63	-1.77	0.55	A	01578310
24	496	26	85	0	0.82	-0.21	0.42	G	01591000
167.5	904	75	262	0	1.53	-1.92	0.81	E	01594000
42.5	217	222	444	0	0.72	-0.30	0.40	D	01594440
161	582	52	309	0	0.92	-0.20	0.67	F	01594526
23	85	7	33	0	0.43	0.69	0.34	G	01594670
267	1,520	3	15	0	1.19	0.74	0.68	H	01594710

Table 7. *Summary of instantaneous suspended-sediment concentration data for stations used in this report for water years 1985 through 2002, including 10th, 50th, and 90th percentiles*—Continued

Station name	Station identification number	Years of record	Number of samples	Area (square miles)	10th percentile suspended-sediment concentration (mg/L)
Potomac River					
Conococheague Creek at Fairview, MD	01614500	1985–2001	397	494	7
Muddy Creek at Mount Clinton, VA	01621050	1993–2001	74	14.2	4
South Fork Shenandoah River at Front Royal, VA	01631000	1985–2001	120	1,642	2
North Fork Shenandoah River near Strasburg, VA	01634000	1985–2001	112	768	2
Monocacy River at Bridgeport, MD	01639000	1985–1996	132	173	4
Potomac River at Chain Bridge at Washington, D.C.	01646580	1985–2002	177	11,570	3
Accotink Creek near Annandale, VA	01654000	1985–2001	50	23.5	2
Cedar Run near Aden, VA	01656100	1985–1988, 1996–1999	1,502	155	5
Cedar Run at Route 646 near Aden, VA	01656120	1996–2000	1,854	175	6
South Fork Quantico Creek near Independent Hill, VA	01658500	1985–2001	3,331	7.64	5
Cannon Creek near Garrisonville, VA	01660380	1994–1997	441	10.2	18
Beaverdam Run near Garrisonville, VA	01660500	1997–2001	1,194	12.7	9
Pamunkey River					
Pamunkey River near Hanover, VA	01673000	1985–2001	120	1,081	3
Mattaponi River					
Mattaponi River near Beulahville, VA	01674500	1985–1988, 1989–2001	113	601	3

50th percentile suspended-sediment concentration (mg/L)	90th percentile suspended-sediment concentration (mg/L)	Median discharge of population (ft^3/s)	Median discharge of sample (ft^3/s)	Mann-Whitney-Wilcoxon P-value	Sediment Transport Curve: Slope	Intercept	Regression coefficient (R^2)	Drainage area class *	Station identification number
81	365	350	2,230	0	0.83	-0.87	0.47	C	01614500
20.5	165	5	5	0.797	0.81	0.77	0.35	G	01621050
10.5	157	987	1,600	0	1.18	-2.77	0.70	B	01631000
13	215	315	789	0	1.07	-1.91	0.68	C	01634000
74	460	75	565	0	0.55	0.24	0.55	E	01639000
11	170	27,700	41,900	0.802	0.87	-2.11	0.57	A	01646580
5	27	10	8	0.181	0.17	0.63	0.02	G	01654000
16	86	69	171	0	0.29	0.66	0.40	E	01656100
19	95	146	165	0.216	0.27	0.77	0.32	E	01656120
18	160	4	6	0	0.36	1.05	0.31	H	01658500
150	617	12	42	0	1.00	0.43	0.54	G	01660380
25	82	5	7	0	0.17	1.27	0.06	G	01660500
10	71.5	510	651	0.036	0.78	-1.01	0.58	B	01673000
8	27	315	425	0.050	0.46	-0.24	0.45	C	01674500

* Class A > 25,000–70,200 km^2 (square kilometers) — > 9,650–27,100 mi^2 (square miles)
Class B > 2,500–25,000 km^2 — > 965–9,650 mi^2
Class C > 1,000–2,500 km^2 — > 386–965 mi^2
Class D > 500–1,000 km^2 — > 193–386 mi^2
Class E > 250–500 km^2 — > 96.5–193 mi^2
Class F > 100–250 km^2 — > 38.6–96.5 mi^2
Class G > 20–100 km^2 — > 7.70–38.6 mi^2
Class H > 0.93–20 km^2 — 0.36–7.70 mi^2

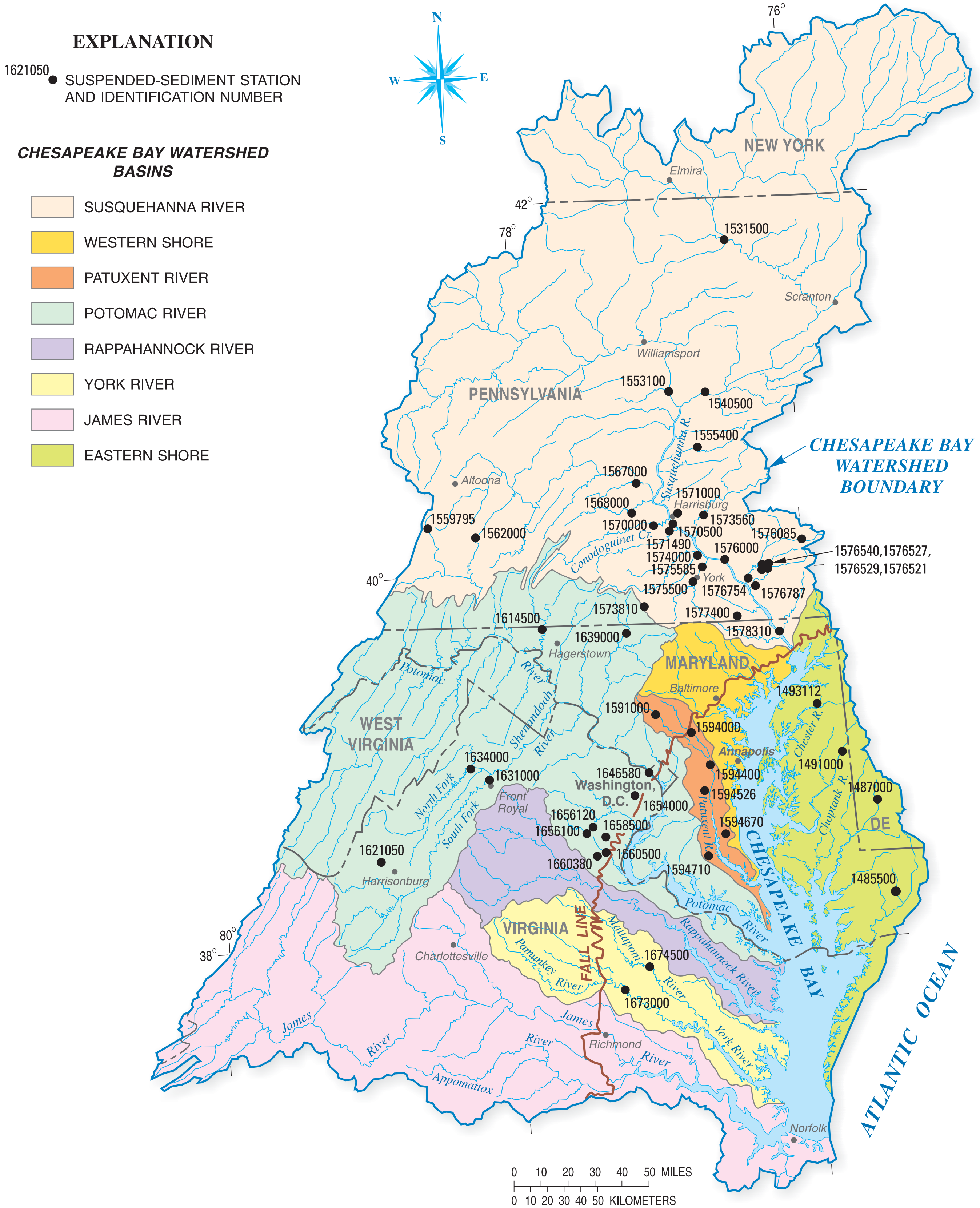


Figure 9. Location of stations in the Chesapeake Bay Watershed used in the analysis of instantaneous suspended-sediment concentration on percentiles and sediment-transport curves from 1985 through 2002. *(Each station had at least 3 years of record and at least 10 suspended-sediment samples per year. Refer to table 7 for listing of stations.)*

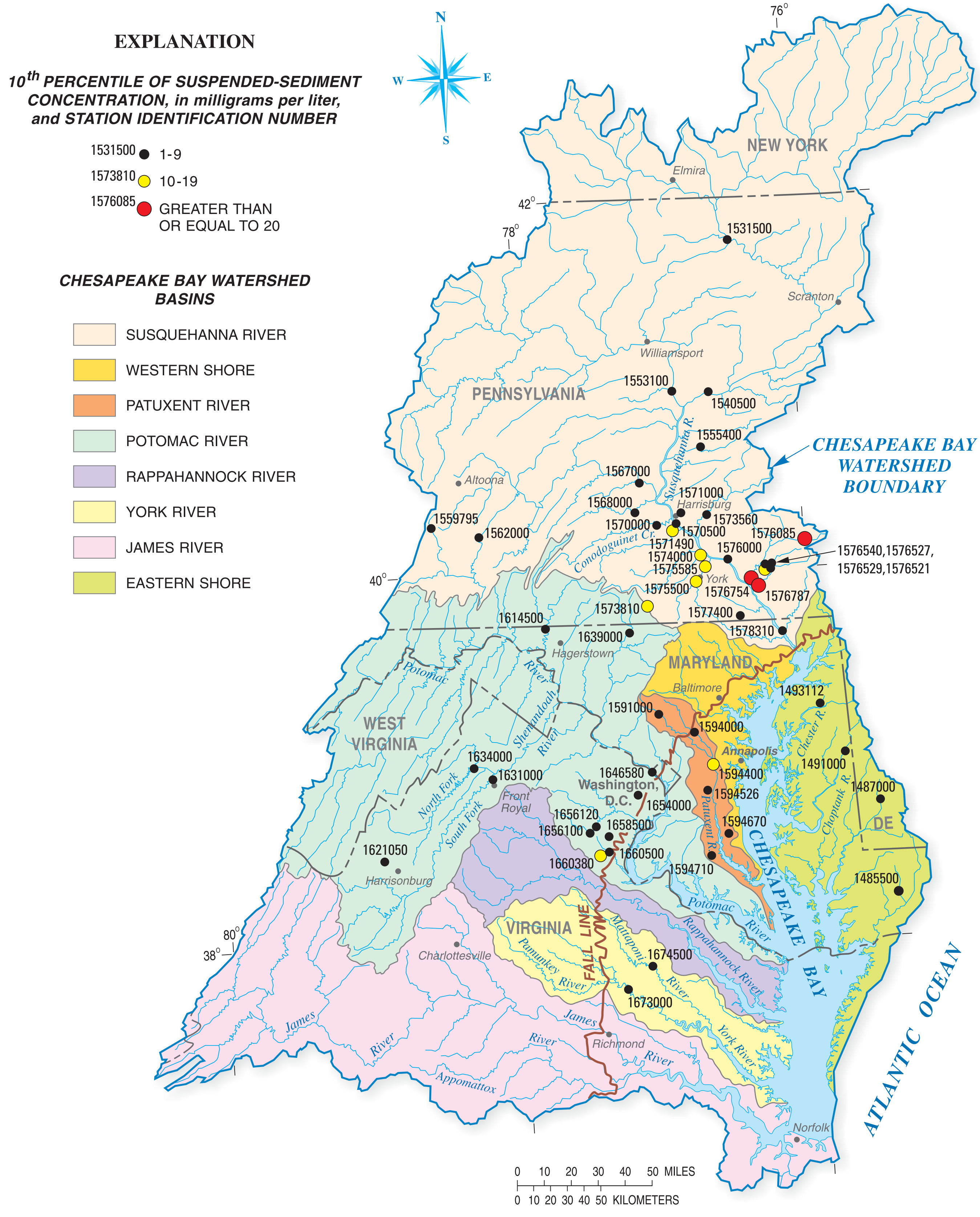


Figure 10a. The 10th percentile of suspended-sediment concentration for 51 stations draining the Chesapeake Bay Watershed with at least 3 years of record and at least 10 samples in a given year. *(Refer to table 7 for listing of stations.)*

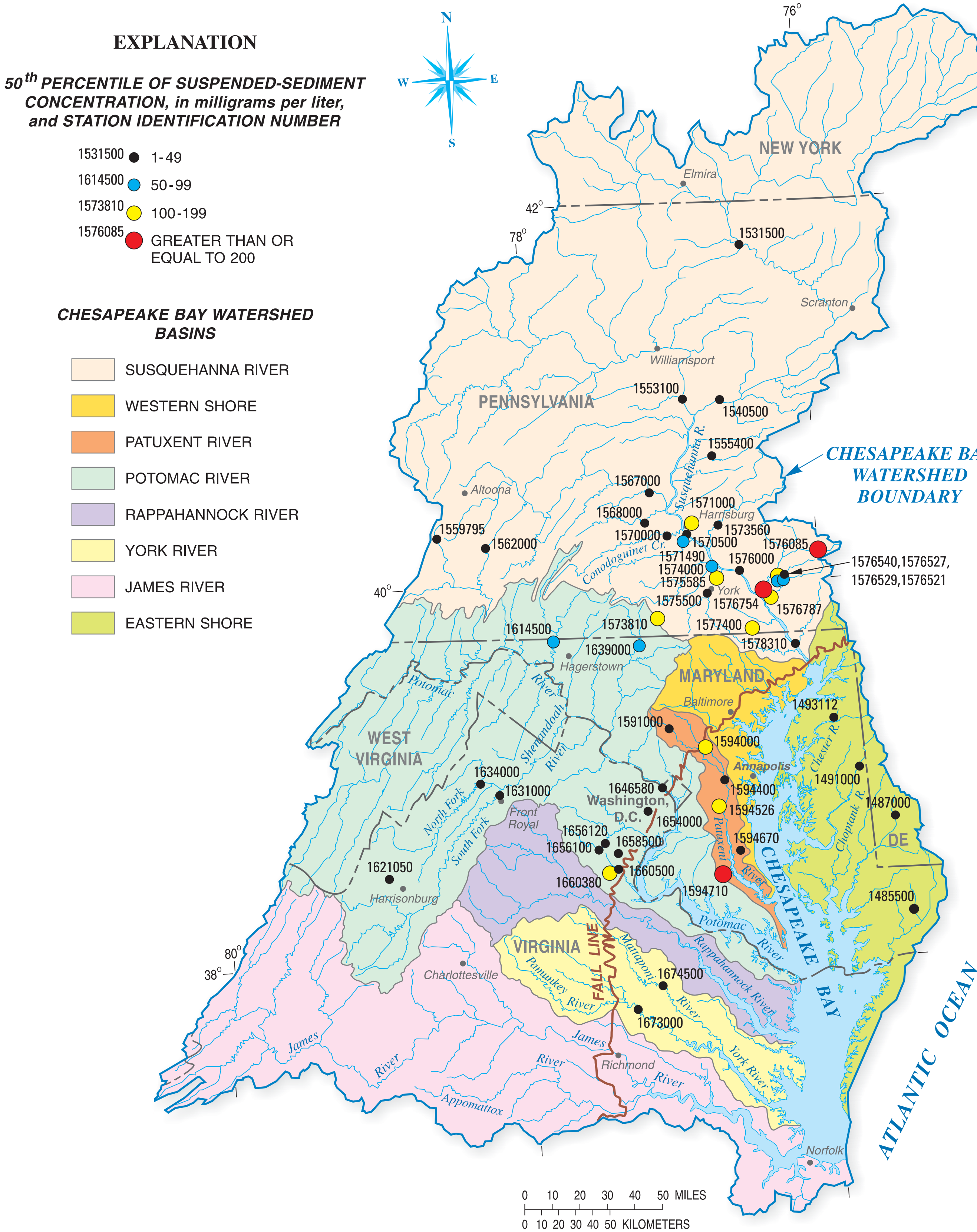


Figure 10b. The median (50th percentile) of suspended-sediment concentration for 51 stations draining the Chesapeake Bay Watershed with at least 3 years of record and at least 10 samples in a given year. *(Refer to table 7 for listing of stations.)*

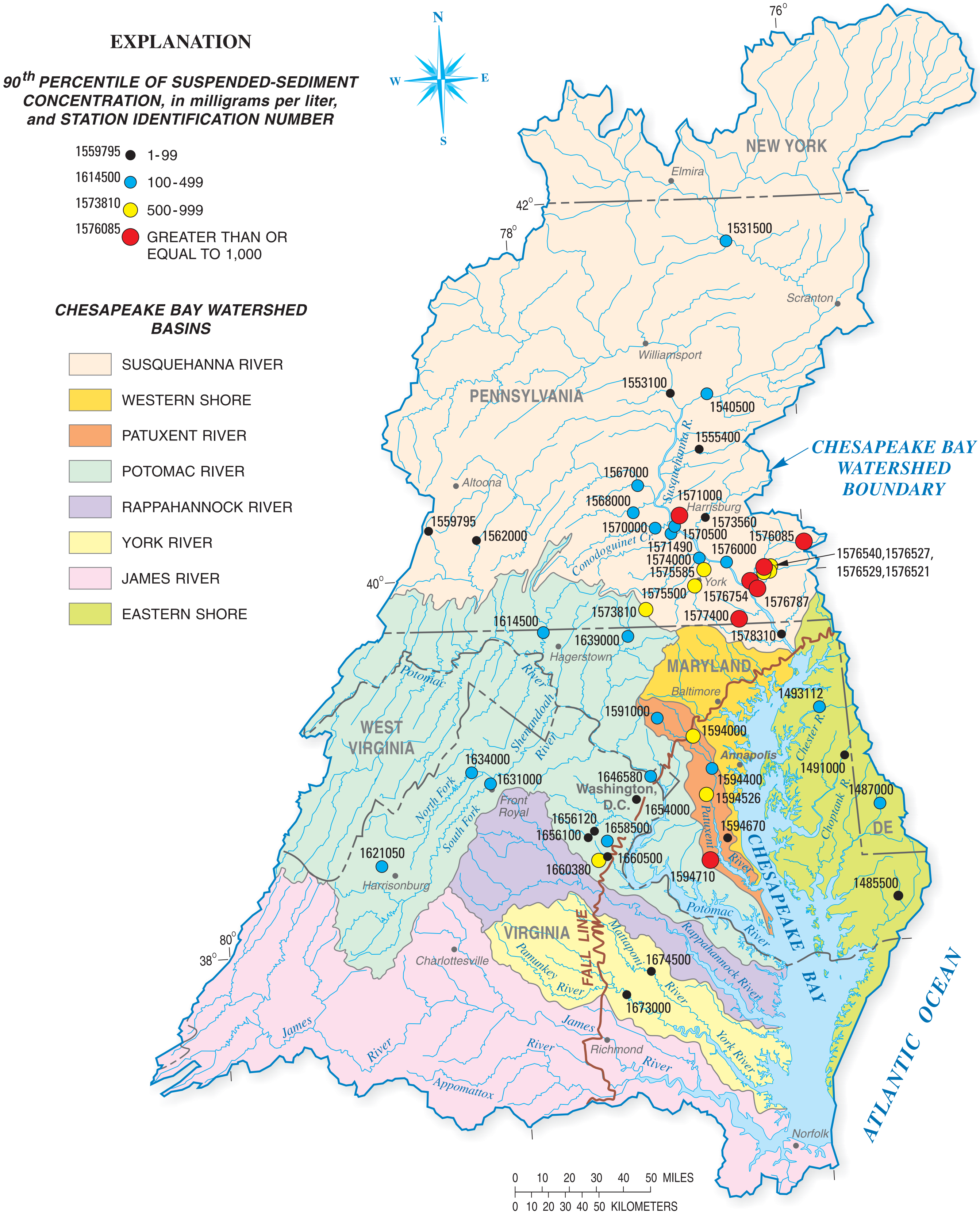


Figure 10c. The 90th percentile of suspended-sediment concentration for 51 stations draining the Chesapeake Bay Watershed with at least 3 years of record and at least 10 samples in a given year. *(Refer to table 7 for listing of stations.)*

Table 8. *Rankings of 10^{th}, 50^{th}, and 90^{th} percentiles of suspended-sediment concentrations from highest (1) to lowest (51) values*

Station name	Station identification number	Rank 10^{th} percentile	Rank 50^{th} percentile	Rank 90^{th} percentile
Nassawango Creek near Snow Hill, MD	01485500	36	40	47
Nanticoke River near Bridgeville, DE	01487000	36	26	26
Choptank River near Greensboro, MD	01491000	43	43	46
Chesterville Branch near Crumpton, MD	01493112	23	38	34
Susquehanna River at Towanda, PA	01531500	23	25	22
Susquehanna River at Danville, PA	01540500	15	33	35
West Branch Susquehanna River at Lewisburg, PA	01553500	43	43	45
East Mahantango Creek at Klingerstown, PA	01555400	32	46	38
Bobs Creek near Pavia, PA	01559795	50	51	51
Raystown Branch Juniata River at Saxton, PA	01562000	50	46	48
Juniata River at Newport, PA	01567000	36	24	37
Sherman Creek at Shermans Dale, PA	01568000	23	29	25
Conodoguinet Creek near Hogestown, PA	01570000	36	46	31
Susquehanna River at Harrisburg, PA	01570500	23	27	36
Paxton Creek near Penbrook, PA	01571000	19	5	7
Cedar Run at Eberlys Mill, PA	01571490	7	15	29
Swatara Creek near Hershey, PA	01573560	13	22	19
Brush Run Site 2 near McSherrystown, PA	01573810	3	12	12
West Conewago Creek near Manchester, PA	01574000	9	17	20
Codorus Creek near York, PA	01575500	9	21	16
Codorus Creek at Pleasureville, PA	01575585	3	4	10
Susquehanna River at Marietta, PA	01576000	13	19	27
Little Conestoga Creek near Churchtown, PA	01576085	1	1	1
Big Spring Run near Willow Street, PA	01576521	15	14	9
North Fork Unnamed Tributary to Big Spring Run at Lampeter, PA	01576527	23	18	14
Unnamed Tributary to Big Spring Run near Lampeter, PA	01576529	32	22	11
Mill Creek at Eshelman Mill Road near Lyndon, PA	01576540	8	11	3
Conestoga River at Conestoga, PA	01576754	2	3	6
Pequea Creek at Martic Forge, PA	01576787	6	6	4
Bald Eagle Creek near Fawn Grove, PA	01577400	31	7	2
Susquehanna River at Conowingo, MD	01578310	22	36	41
Patuxent River near Unity, MD	01591000	43	29	17
Little Patuxent River at Savage, MD	01594000	43	8	8
Patuxent River near Bowie, MD	01594440	9	20	23
Western Branch at Upper Marlboro, MD	01594526	15	9	15
Hunting Creek near Huntingtown, MD	01594670	32	31	41
Killpeck Creek at Huntersville, MD	01594710	19	2	5
Conococheague Creek at Fairview, MD	01614500	15	13	21
Muddy Creek at Mount Clinton, VA	01621050	32	32	30
South Fork Shenandoah River at Front Royal, VA	01631000	43	42	33
North Fork Shenandoah River near Strasburg, VA	01634000	43	39	24
Monocacy River at Bridgeport, MD	01639000	32	15	18
Potomac River at Chain Bridge at Washington, D.C.	01646580	36	40	28
Accotink Creek near Annandale, VA	01654000	43	50	49
Cedar Run near Aden, VA	01656100	23	36	40
Cedar Run at Route 646 near Aden, VA	01656120	19	34	39
South Fork Quantico Creek near Independent Hill, VA	01658500	23	35	32
Cannon Creek near Garrisonville, VA	01660380	5	10	12
Beaverdam Run near Garrisonville, VA	01660500	12	27	43
Pamunkey River near Hanover, VA	01673000	36	43	44
Mattaponi River near Beulahville, VA	01674500	36	46	49

Eastern Shore

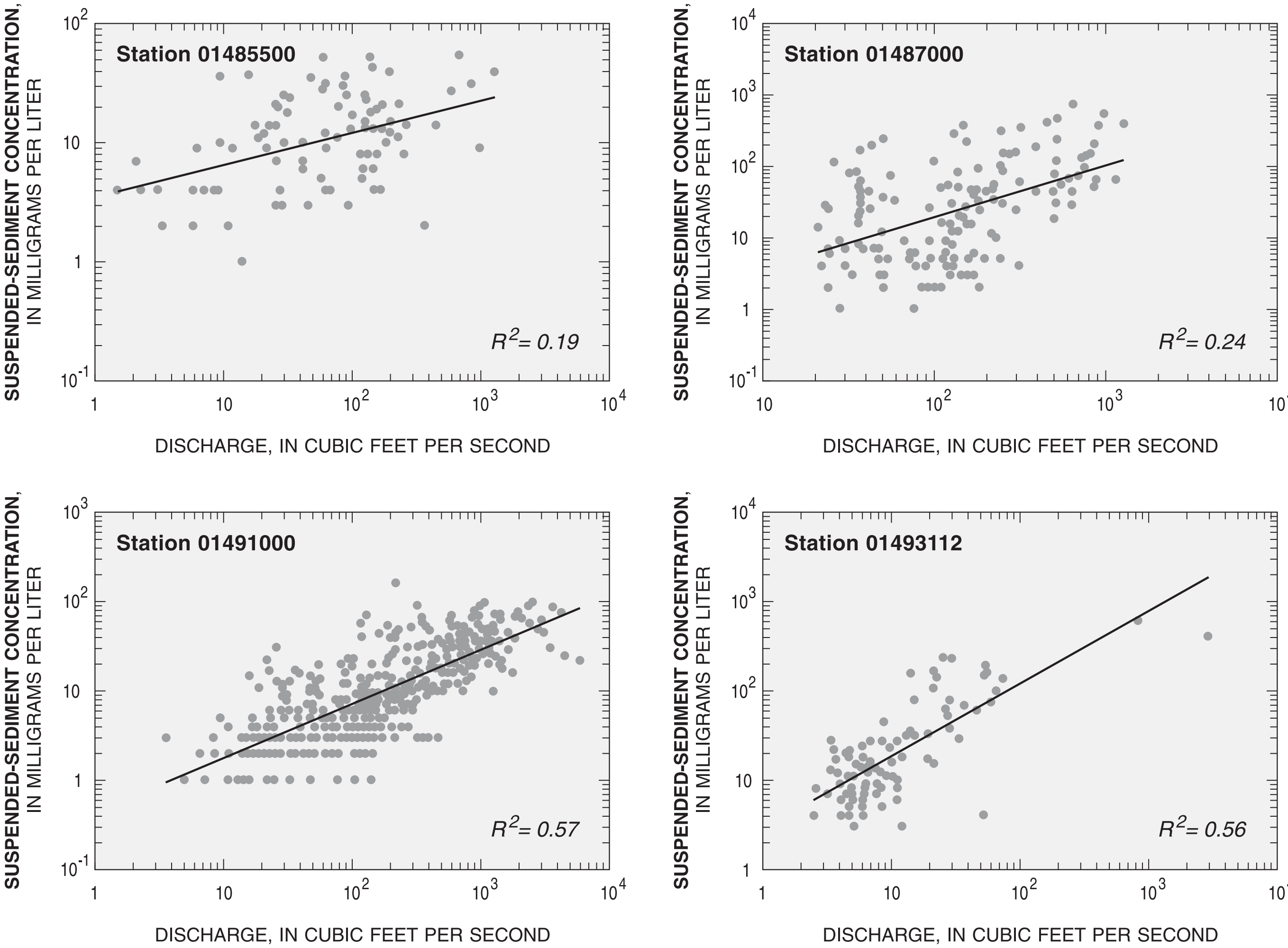


Figure 11a. Sediment-transport curves for the stream-gaging stations on the Eastern Shore of Maryland and Delaware. *(Refer to table 7 for listing of stations.)*

Susquehanna River

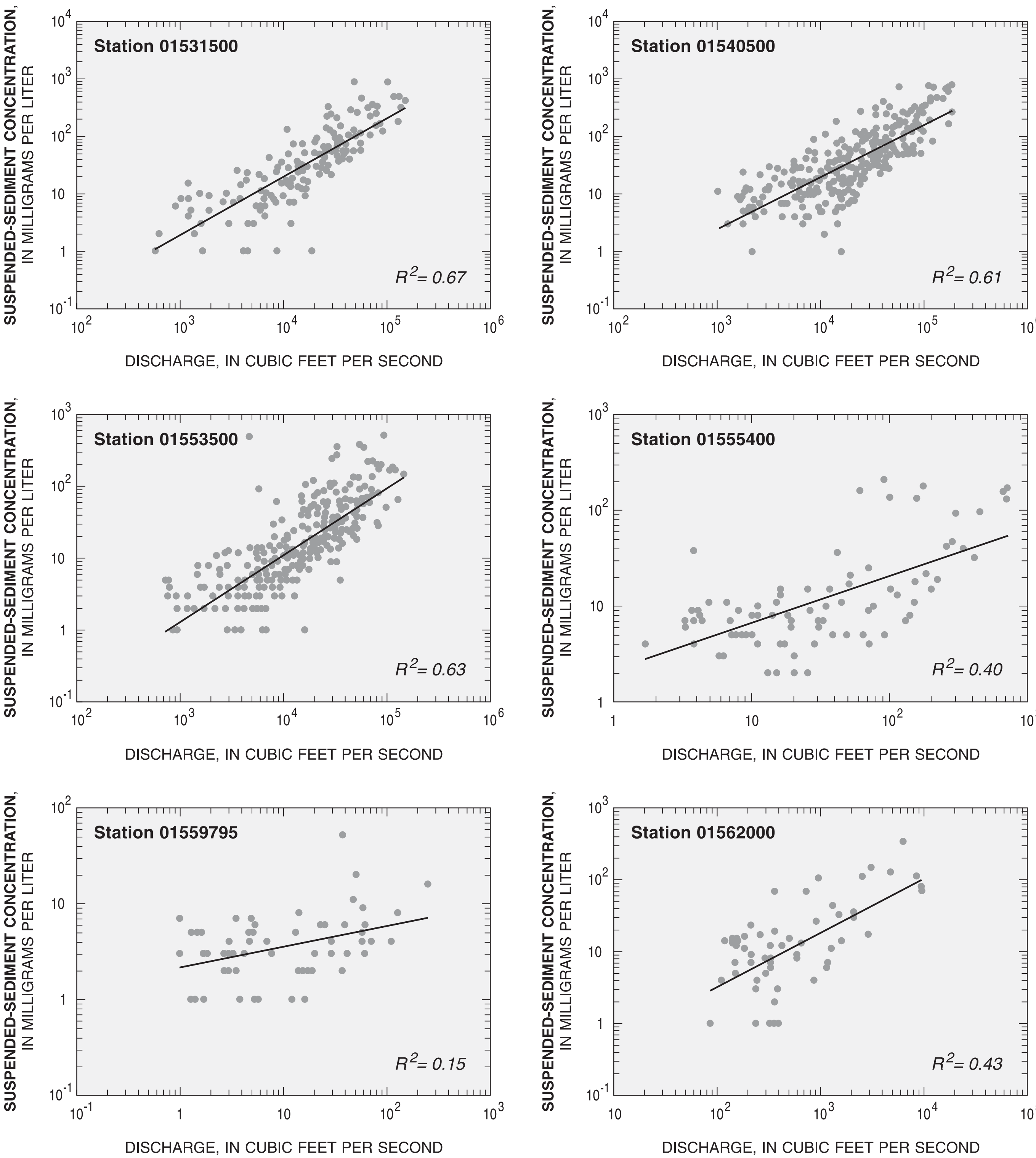


Figure 11b. Sediment-transport curves for the stream-gaging stations in the Susquehanna River Basin. *(Refer to table 7 for listing of stations.)*

Susquehanna River -- Continued

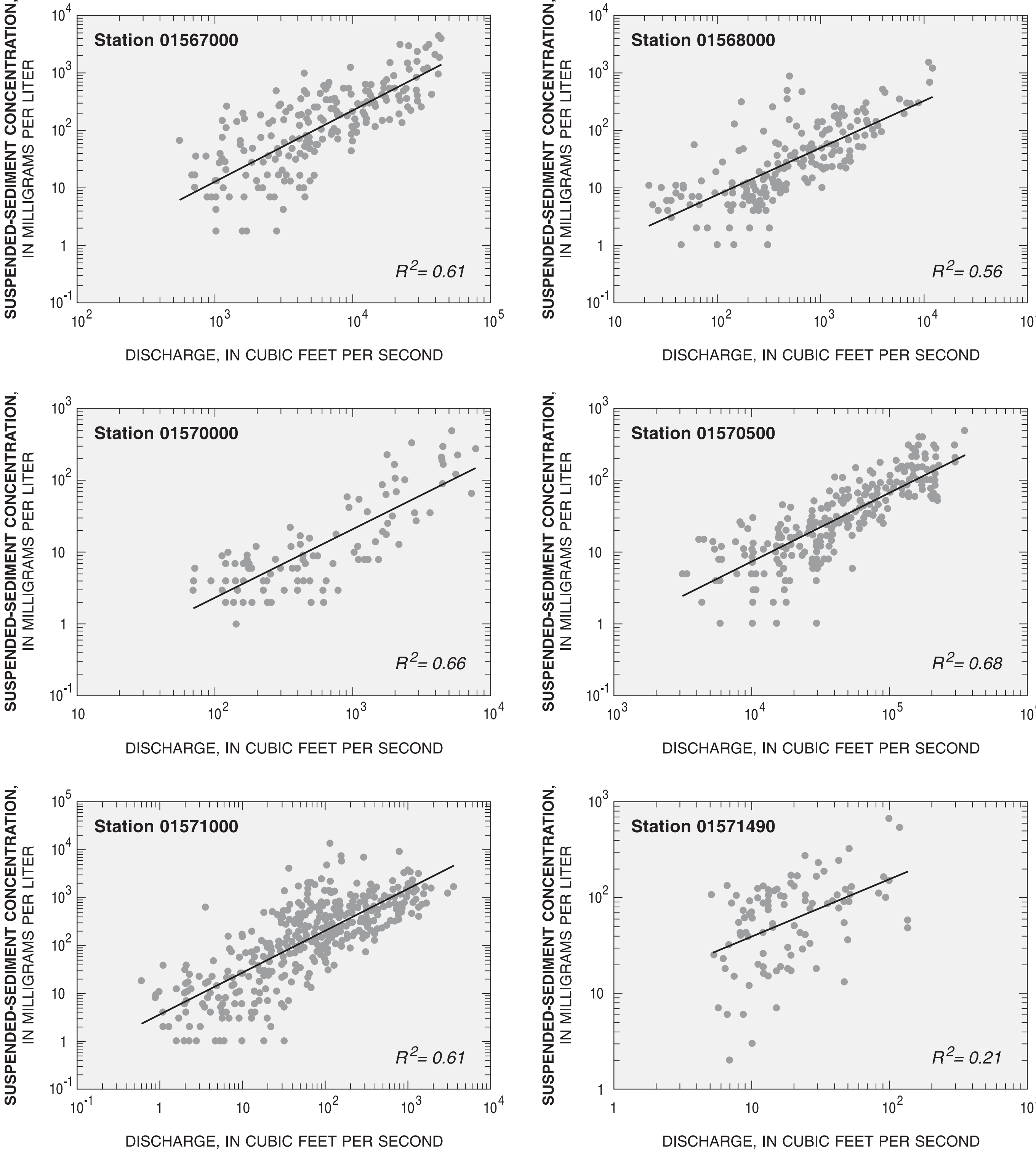


Figure 11b. Sediment-transport curves for the stream-gaging stations in the Susquehanna River Basin. -- Continued.

Susquehanna River -- Continued

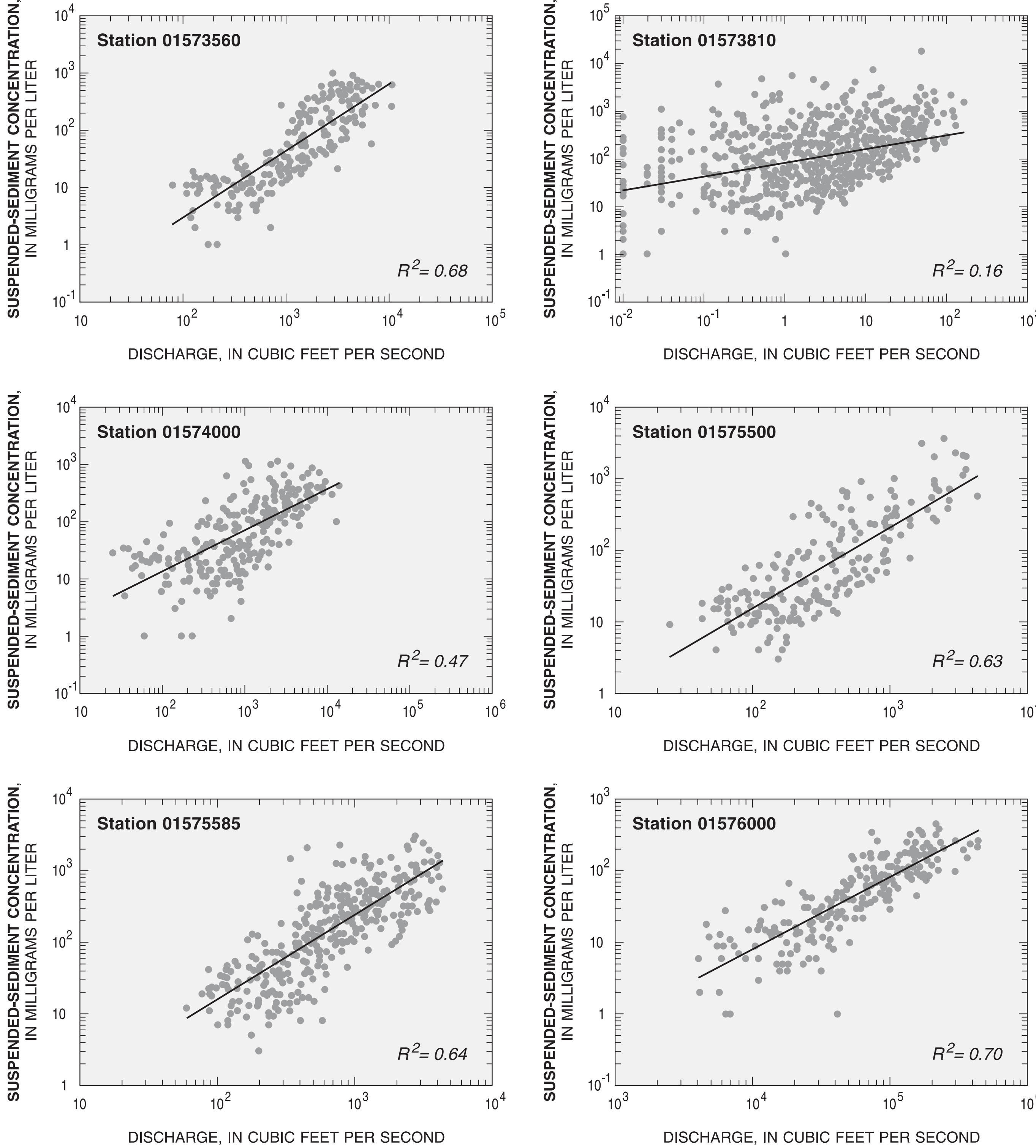


Figure 11b. Sediment-transport curves for the stream-gaging stations in the Susquehanna River Basin. -- Continued.

Susquehanna River -- Continued

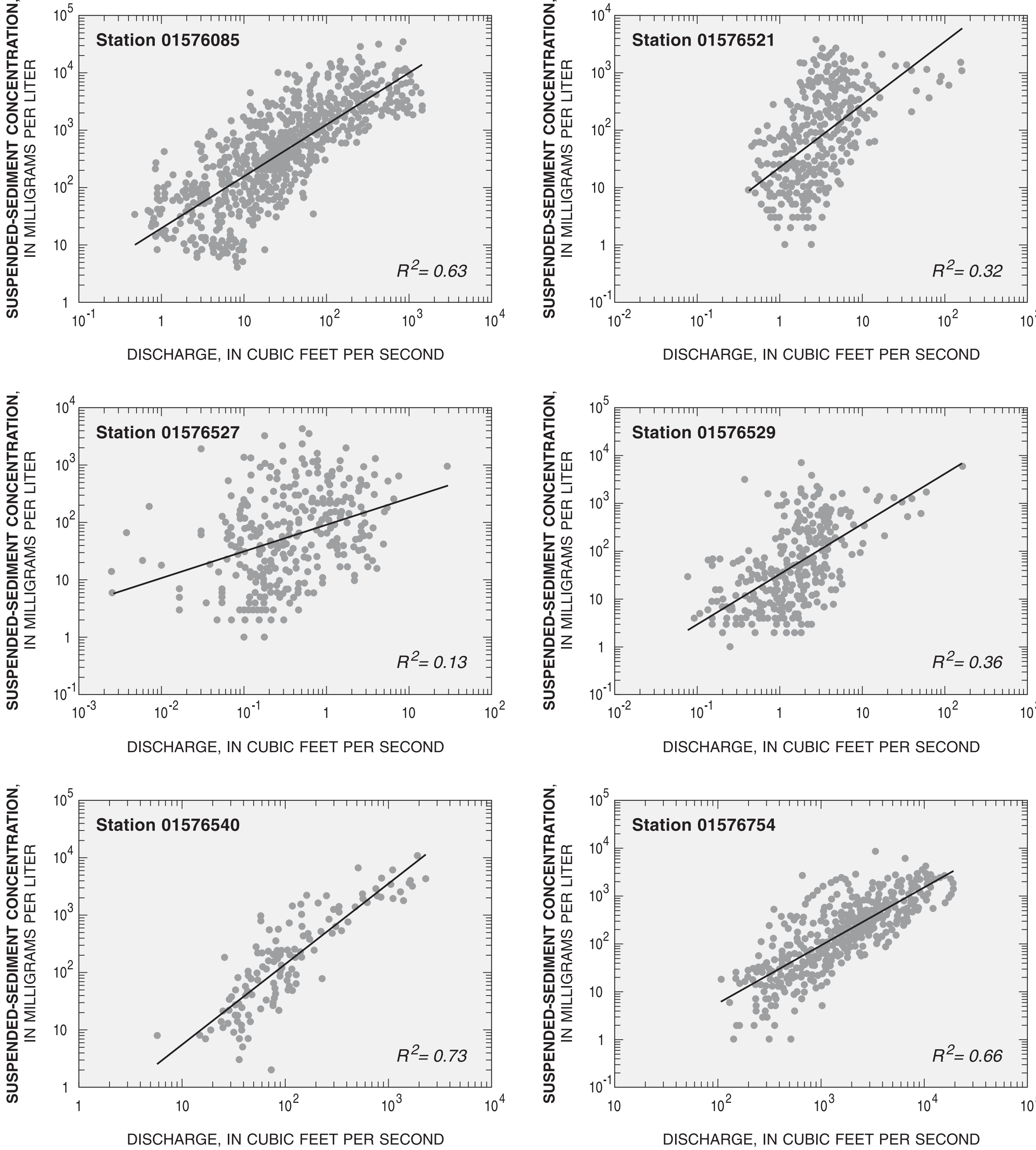


Figure 11b. Sediment-transport curves for the stream-gaging stations in the Susquehanna River Basin. -- Continued.

Susquehanna River -- Continued

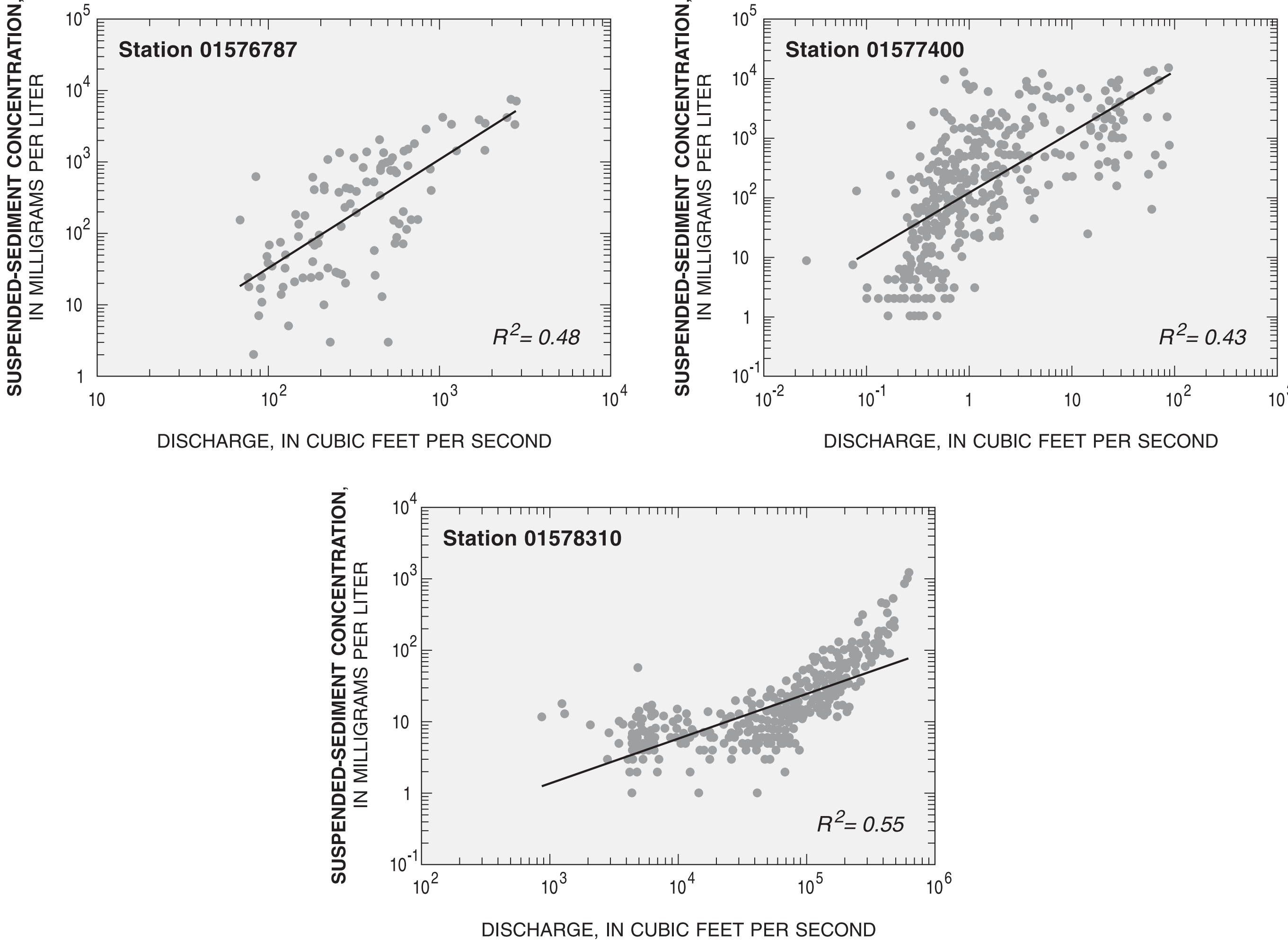


Figure 11b. Sediment-transport curves for the stream-gaging stations in the Susquehanna River Basin. -- Continued.

Patuxent River

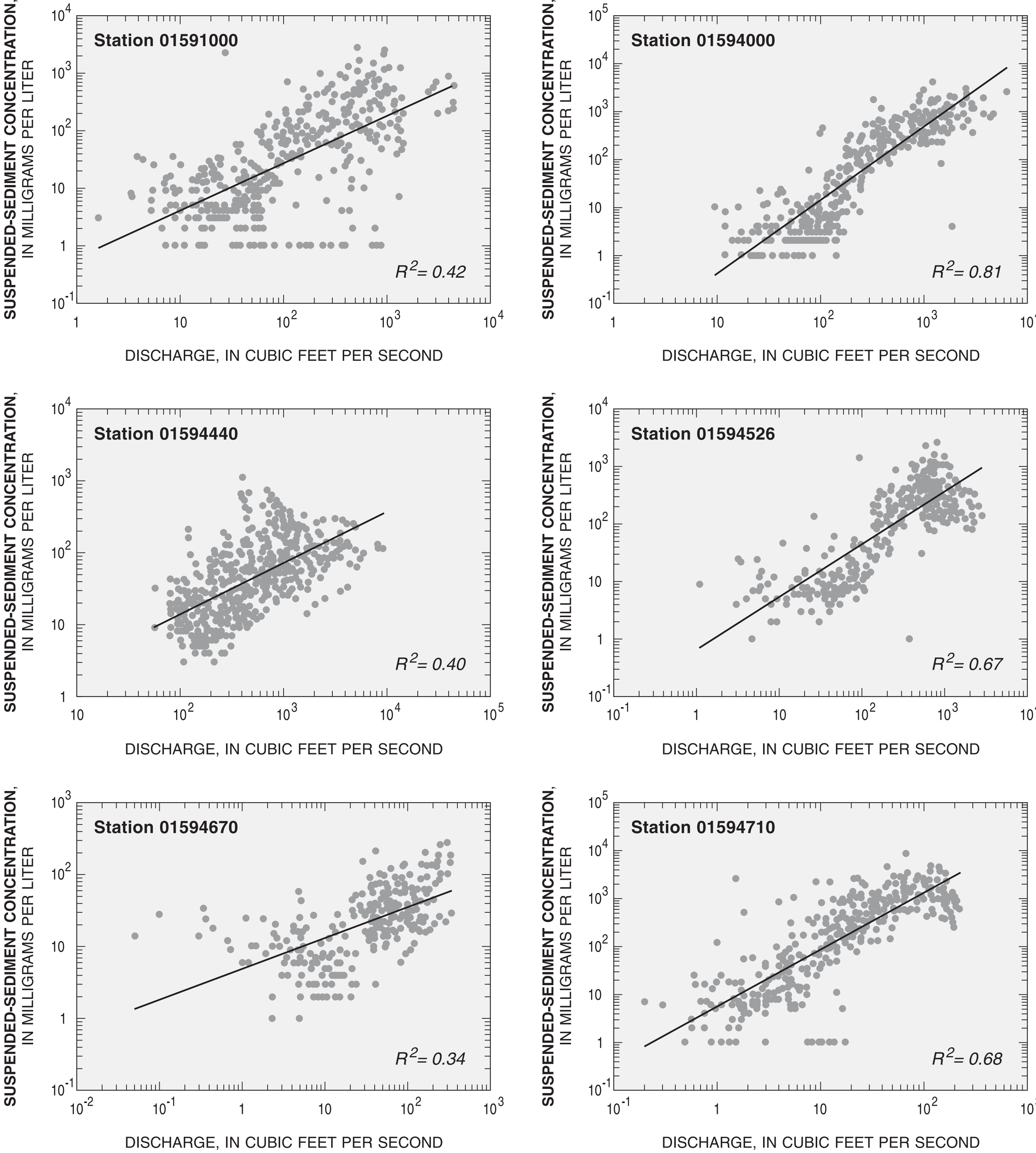


Figure 11c. Sediment-transport curves for the stream-gaging stations in the Patuxent River Basin. *(Refer to table 7 for listing of stations.)*

Potomac River

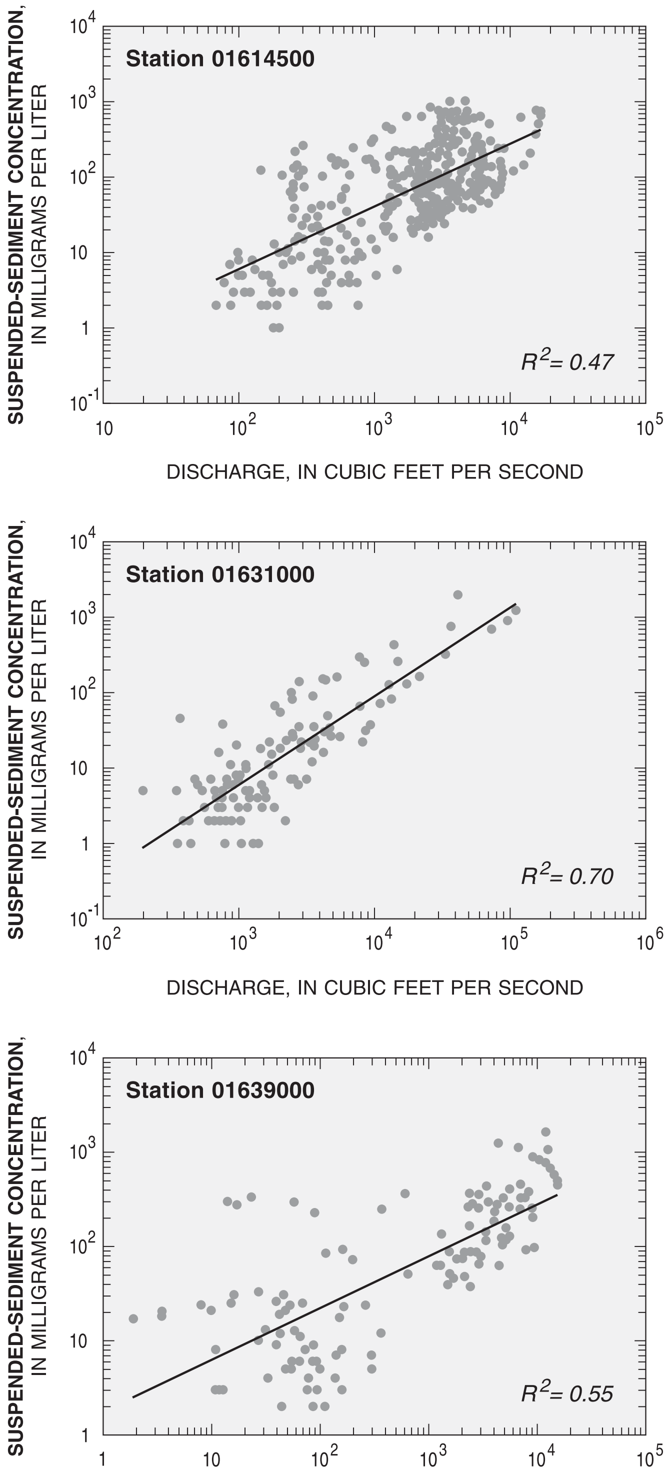


Figure 11d. Sediment-transport curves for the stream-gaging stations in the Potomac River Basin. *(Refer to table 7 for listing of stations.)*

Potomac River -- Continued

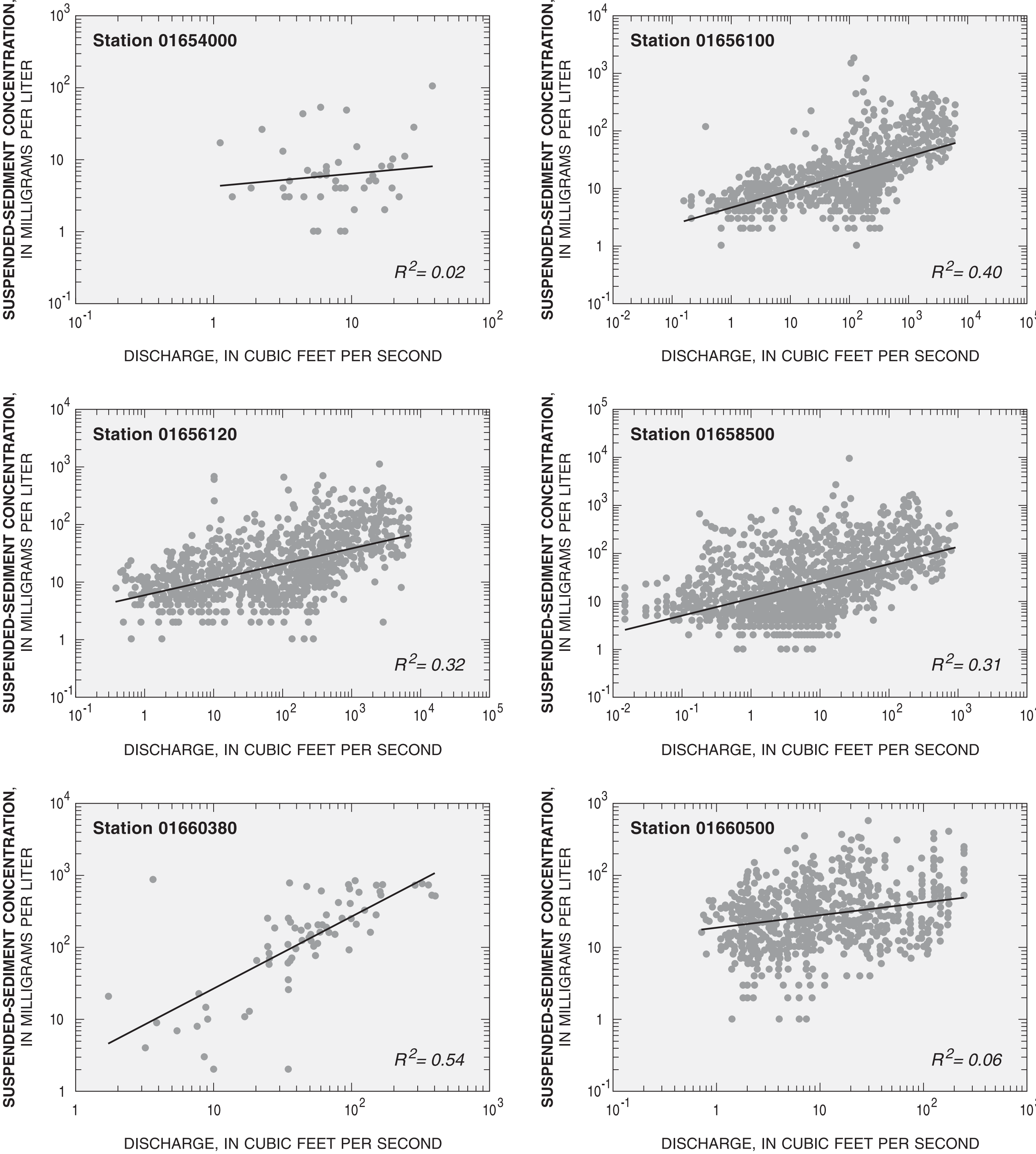


Figure 11d. Sediment-transport curves for the stream-gaging stations in the Potomac River Basin. -- Continued.

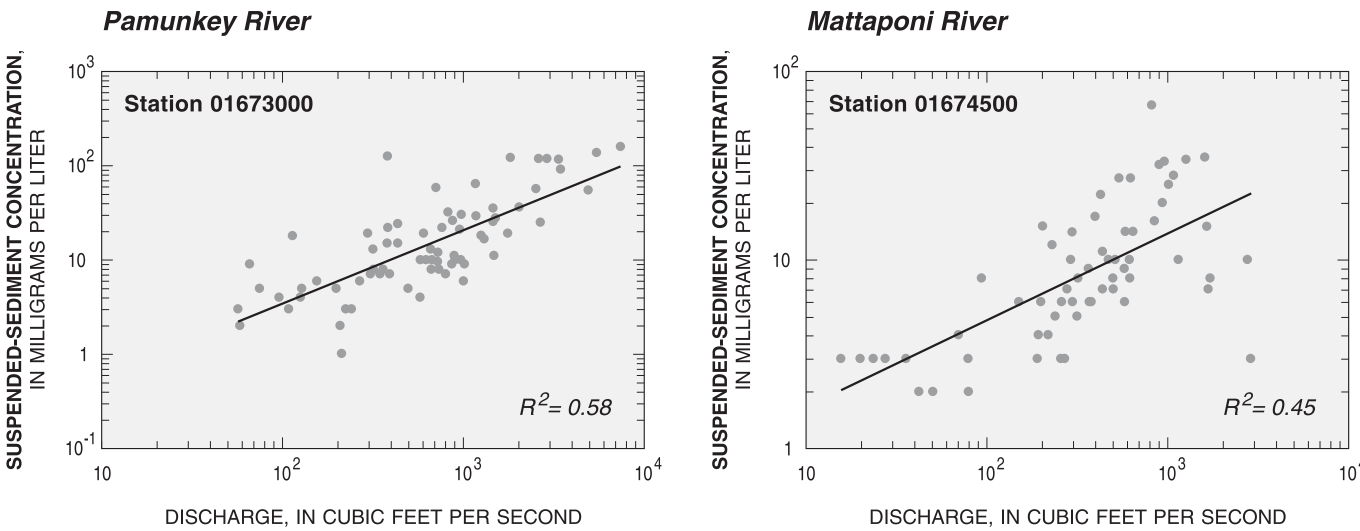


Figure 11e. Sediment-transport curves for the stream-gaging stations in the Pamunkey and Mattaponi River Basins. *(Refer to table 7 for listing of stations.)*

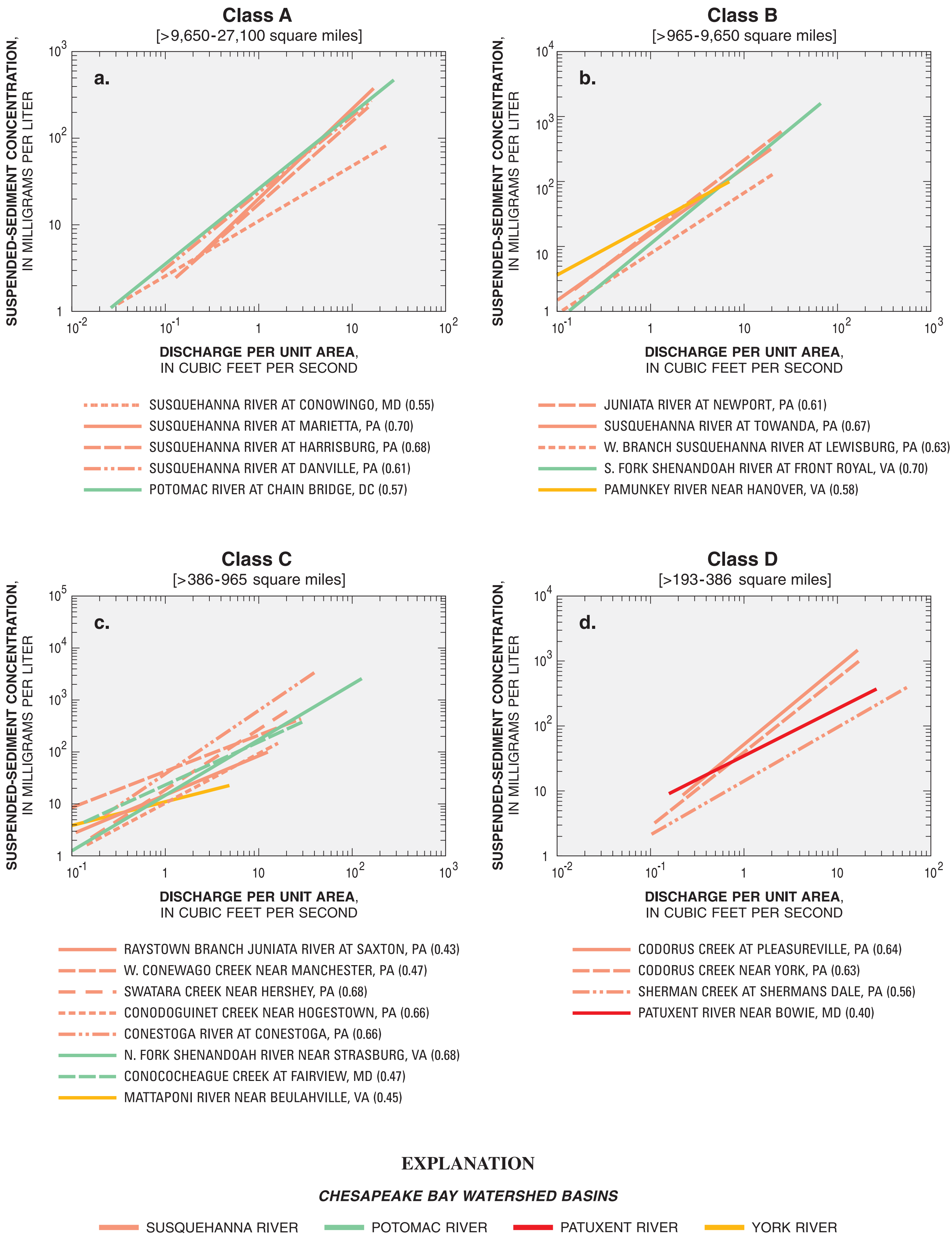


Figure 12. Sediment-transport curves normalized by drainage area separated into eight classes of drainage area: **a.** Class A, **b.** Class B, **c.** Class C, and **d.** Class D in the Chesapeake Bay Watershed. *(R^2 values are shown in parentheses.)*

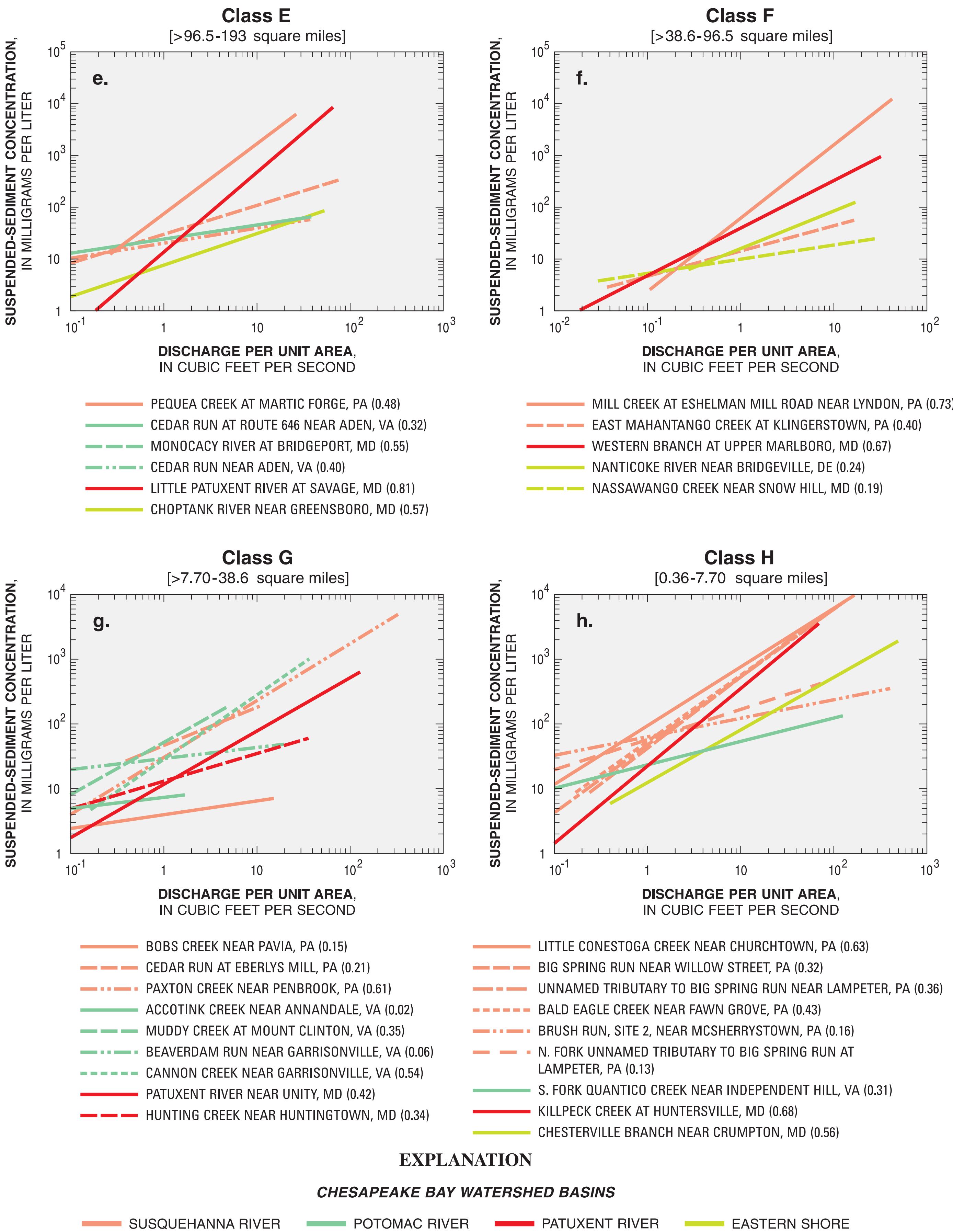


Figure 12. Sediment-transport curves normalized by drainage area separated into eight classes of drainage area: **e.** Class E, **f.** Class F, **g.** Class G, and **h.** Class H in the Chesapeake Bay Watershed. *(R^2 values are shown in parentheses.)* -- Continued.

Summary and Conclusions

Much of the habitat in the Chesapeake Bay Watershed is degraded because of sediment. Determining potential source areas of sediment in the Watershed is an important component in reduction of erosion and sediment transport. This report describes historical annual suspended-sediment loads, yields, and discharge-weighted concentrations, and instantaneous suspended-sediment concentrations compiled from 65 stations operating from 1952–2002 in the 64,000-square-mile Chesapeake Bay Watershed. Suspended-sediment load, yield, and discharge-weighted sediment concentration data were separated into two periods, 1952–84 and 1985–2001. In 1985, the Chesapeake Bay Program began recommending sediment regulations, so 1985 represents an important break in the data. The size of drainage areas for sediment stations where annual suspended-sediment loads were collected ranged from 0.36 to 27,100 square miles. Areas draining 100 to 500 square miles had the most sediment stations operating at any time, and areas draining 50 to 100 square miles had the least sediment stations operating from 1952 through 2001. Suspended-sediment load data compiled for this report were typically computed using two methods, the subdivision method, which was used at daily-load stations, and the linear-regression or ESTIMATOR method, which was used to compute monthly and annual loads. A comparison of both methods for nine stations totaling 36 years of record indicates that the ESTIMATOR method has a tendency to compute higher suspended-sediment loads than the subdivision method.

Average annual suspended-sediment loads are strongly, positively correlated to both drainage area ($R^2 = 0.88$) and average annual mean-daily discharge ($R^2 = 0.88$) for the sediment-collection period (1952–2001). Size of the drainage area shows a weak, inverse relation to both average annual sediment yield ($R^2 = -0.17$) and average annual discharge-weighted sediment concentration ($R^2 = -0.17$). This inverse relation is expected as more sediment storage sites become available as drainage-area size increases.

The Chesapeake Bay River Input Monitoring Program was established in the mid–1980s to quantify loads and long-term trends in suspended sediment entering the tidal part of the Chesapeake Bay Basin from its nine major tributaries (Appomattox, Choptank, James, Mattaponi, Pamunkey, Patuxent, Potomac, Rappahannock, and Susquehanna). The nine River Input Monitoring stations drain 78 percent of the Chesapeake Bay Watershed, and the data collected at these stations allowed suspended-sediment transport analysis at a large scale. The River Input Monitoring station data for 1985 through 2001 indicated that the Potomac and Susquehanna Rivers had the highest average annual suspended-sediment loads. The Rappahannock and Potomac Rivers had the highest average annual sediment yields and discharge-weighted sediment concentrations. The Choptank, Mattaponi, and Appomattox Rivers had the three lowest average annual sediment loads, sediment yields, and discharge-weighted sediment concentrations.

For stations operating from 1952–84 (n = 43), two of the five highest suspended-sediment loads were on the Potomac River (Chain Bridge at Washington, D.C. and at Point of Rocks, Maryland). Three of the five highest average annual suspended-sediment loads from 1952–84 were for stations on the Susquehanna River (at Harrisburg, Pennsylvania; at Sunbury, Pennsylvania; and at Conowingo, Maryland). The highest average annual suspended-sediment loads were for rivers that drain the largest area. The sediment load at the Susquehanna River at Conowingo is affected by three upstream reservoirs that reduce the delivery of sediment to this station; if the reservoirs were not in place, the average annual suspended-sediment loads would likely be higher.

Similar rankings were produced by normalizing average annual suspended-sediment loads by drainage area to produce an average annual sediment yield and normalizing each annual suspended-sediment load by annual runoff to produce an average annual discharge-weighted sediment concentration. The similarity in ranking is because runoff is highly correlated to drainage area. The highest sediment yields and discharge-weighted sediment concentrations from 1952–84 were for streams draining the suburban Washington, D.C. area (Snakeden Branch at Reston, Virginia; Smilax Branch at Reston, Virginia; and Northwest Branch Anacostia River near Colesville, Maryland). The lowest average annual sediment yields and discharge-weighted sediment concentrations for stations with data collected through 1984 were at Young Womans Creek near Renovo, Pennsylvania; Choptank River near Greensboro, Maryland; and the Pamunkey River near Hanover, Virginia. The high sediment yields for streams draining the metropolitan Washington, D.C. region may reflect urbanization and construction practices that were occurring in these basins when the stations were operating (1963–78).

At stations operating from 1985 through 2001 (n = 35), four of the five highest average suspended-sediment loads were the same as for stations operating from 1952–84 (Potomac River at Chain Bridge at Washington, D.C.; Potomac River at Point of Rocks, Maryland; Susquehanna River at Marietta, Pennsylvania; and Susquehanna River at Conowingo, Maryland). Four of the six highest average annual sediment yields and discharge-weighted sediment concentrations for the period 1985–2001 were for stations in Lancaster County, Pennsylvania, draining to the Conestoga River, a tributary to the Susquehanna River (Conestoga River at Conestoga, Pennsylvania; Little Conestoga Creek near Churchtown, Pennsylvania; Little Conestoga Creek site 3A, near Morgantown, Pennsylvania; and Mill Creek at Eshelman Mill Road near Lyndon, Pennsylvania). The Rappahannock River near Fredericksburg, Virginia, had the third highest average annual sediment yield and discharge-weighted sediment concentration, and Raystown Branch Juniata River at Saxton, Pennsylvania, a tributary of the Susquehanna River, had the fifth highest average annual sediment yield and discharge-weighted sediment concentration.

Percentiles of suspended sediment (10^{th}, 50^{th}, and 90^{th})

were examined for 51 stations with at least 3 years of data and at least 10 samples in a given year. The four highest suspended-sediment concentrations at the 10th percentile (ranging from 18 to 53 milligrams per liter) were in rivers draining to the Susquehanna River in Pennsylvania (Brush Run, site 2, near McSherrystown; Codorus Creek at Pleasureville; Conestoga River at Conestoga; and Little Conestoga Creek near Churchtown. The 10th percentile of suspended-sediment concentration reflects low-flow conditions. Three of the five sediment stations with the highest 50th percentile of suspended-sediment concentration (ranging from 186 to 548 milligrams per liter) included the same stations in the Susquehanna River Basin as at the 10th percentile (Codorus Creek at Pleasureville; Conestoga River at Conestoga; and Little Conestoga Creek near Churchtown), another station in Pennsylvania (Paxton Creek near Penbrook), and one station in Maryland draining to the Patuxent River (Killpeck Creek at Huntersville, Maryland). At the 90th percentile, the five highest suspended-sediment concentrations (ranging from 1,520 to 3,140 milligrams per liter) were for stations draining the Susquehanna River Basin in Pennsylvania (Little Conestoga Creek near Churchtown; Pequea Creek at Martic Forge; Bald Eagle Creek near Fawn Grove; and Mill Creek at Eshelman Mill Road near Lyndon) and Killpeck Creek at Huntersville, Maryland, in the Patuxent River Basin.

Sediment-transport curves generated for eight classes of drainage areas for 51 stations show that the Susquehanna River Basin had the highest suspended-sediment concentrations in five of the eight classes:

- Class C [>386–965 square miles]—Conestoga River,
- Class D [>193–386 square miles]—Codorus Creek,
- Class E [>96.5–193 square miles] Pequea Creek,
- Class F [>38.6–96.5 square miles]—Mill Creek, and
- Class H [0.36-7.70 square miles]—Little Conestoga Creek.

Three of these five stations drain to the Conestoga River (Little Conestoga Creek near Churchtown, Pennsylvania; Mill Creek near Eshelman Mill Road near Lyndon, Pennsylvania; and Conestoga River at Conestoga, Pennsylvania). Cannon Creek near Garrisonville, Virginia, showed the highest suspended-sediment concentrations at high discharges for Class G (>7.70-38.6 square miles).

Suspended-sediment loads are highly correlated with area, and therefore, rankings of loads for stations in the Chesapeake Bay Watershed will reflect drainage-area size. Normalizing suspended-sediment loads by drainage area and annual runoff provides additional information on erosion and sediment delivery in each basin. In general, the highest average annual sediment yields were in rivers draining to the Susquehanna River. In the Susquehanna River Basin, the highest sediment yields and discharge-weighted sediment concentrations were in the Conestoga River Basin. The Conestoga River Basin drains primarily agricultural areas, but other sources of sediment, such as from bank erosion, also may be important in this basin.

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