DESCRIPTION OF SEDIMENT DATA COLLECTED BY THE U.S. GEOLOGICAL SURVEY IN SMALL WATERSHEDS IN COAL-MINING AREAS OF THE EASTERN UNITED STATES, 1980-84

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FACTORS FOR CONVERTING INCH-POUND UNITS TO METRIC (INTERNATIONAL SYSTEM) UNITS

Multiply inch-pound unit	By	To obtain metric units
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
acre	0.4047	hectares (ha)

To convert degree Fahrenheit (°F) to degree Celsius (°C)

$$(0.556)\,(°F - 32°) = °C$$

DESCRIPTION OF SEDIMENT DATA COLLECTED BY THE U.S. GEOLOGICAL SURVEY IN SMALL WATERSHEDS IN COAL-MINING AREAS OF THE EASTERN UNITED STATES, 1980-84

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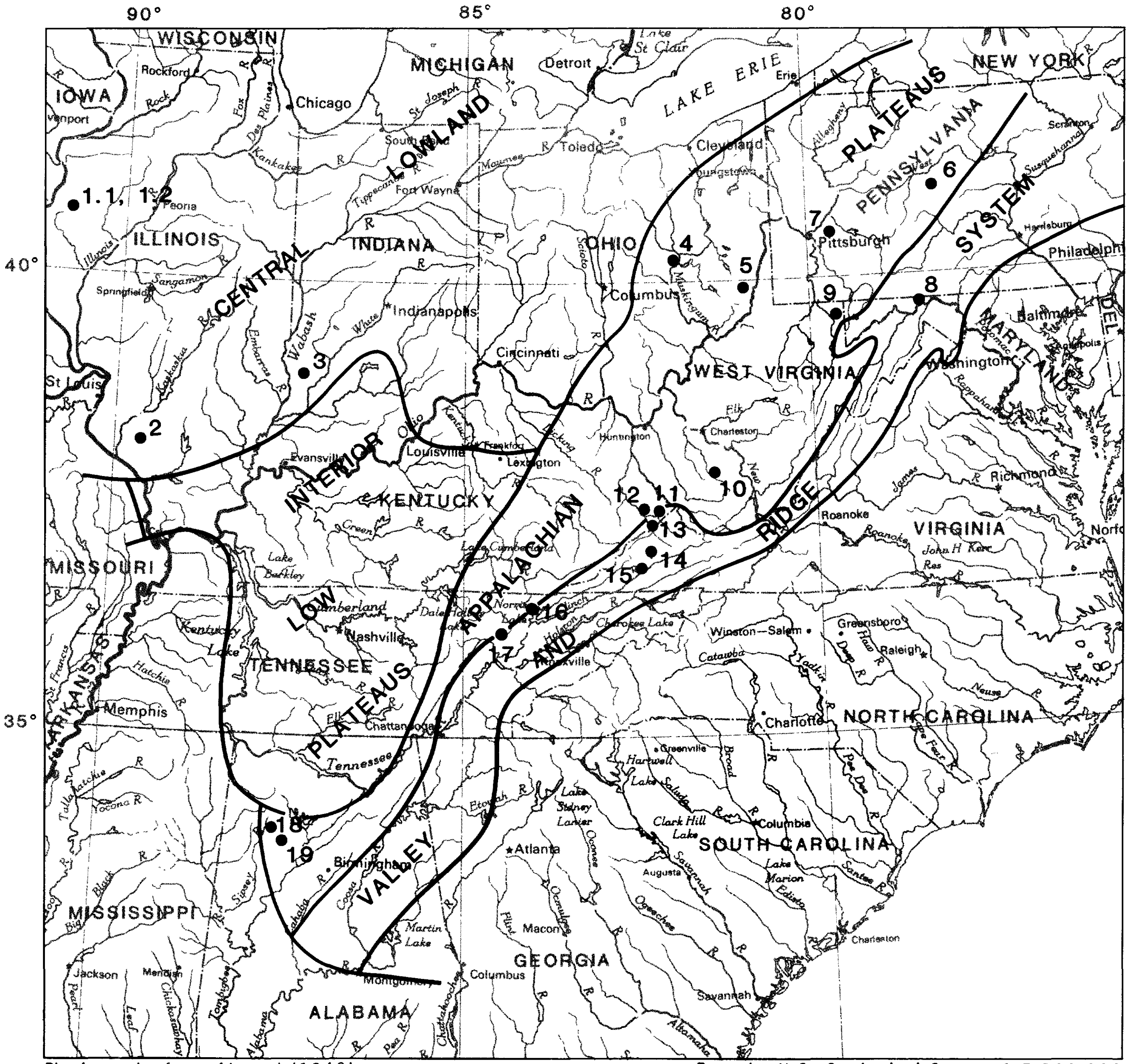
ABSTRACT

Hydrologic data were collected by the U.S. Geological Survey from 20 small watersheds in the surface-mining areas of the eastern United States from 1980 through 1984 as part of the Survey's coal-hydrology program. Each data set includes sediment-concentration, streamflow, and precipitation data collected at 5- or 15-minute intervals. One reason for collecting the data was to test the sediment component of a watershed model. However, adequate testing requires reliable calibration data collected at several points during the rise and fall of hydrographs of several storms. Therefore, the quantity and quality of the data sets needed to be described to determine which sets could be used to test a model adequately. The data sets are described in a table that presents information about watershed characteristics, period of record, and amount of useful sediment data. Also, similar data sets collected by 10 Survey project offices during other Survey programs are described in a similar table.

INTRODUCTION

Background

Hydrologic data were collected by the U.S. Geological Survey in 20 small watersheds in the surface-mining areas of the eastern United States from 1980 through 1984 (fig. 1). The data were to be used to (1) describe the hydrology of mined and unmined watersheds and (2) test the ability of digital models to simulate runoff processes from the same watersheds. The data were collected by 10 project offices of the Survey in the coal-hydrology project "Research modeling in coal areas". In this study, the data were used to describe the hydrology of the watersheds and to test two watershed models for their ability to simulate streamflow. Other components of the models, such as the sediment component, were not tested.



Physiography from Atwood (1940)

Base by U.S. Geological Survey 1:7,500,000

0 100 200 300 400 MILES

EXPLANATION

Boundary of physiographic province

14 ● Watershed location and number

Figure 1.-- Locations of the watersheds in which sediment data were collected.

One reason for collecting the suspended-sediment concentration, streamflow, precipitation, and other data during the "research modeling" studies was to test the sediment component of a watershed model. However, adequate testing requires reliable calibration data collected at several points during the rise and fall of hydrographs of several storms. Therefore, the quantity and quality of the data sets needed to be described to determine which sets could be used to test a model adequately.

The description of the sediment-data sets could benefit studies besides ones that test models. Researchers, for example, may want to use the data to study some aspect of the sedimentation process. Therefore, the description of the data sets should include information about the watershed as well as a description of the data available.

The data are more useful if it is readily available to potential users. The sediment-concentration data would be most readily available in a computer file that could be accessed by all Survey offices. Sediment discharges calculated to aid future model testing also would be desirable.

Purpose and Scope

Suspended-sediment-concentration data from the project, "Research modeling in coal areas" were described in this report if they met three criteria: (1) The data-collection procedure and laboratory analysis must indicate that the data are sufficiently accurate. (2) The sediment concentration and concurrent streamflow data must have been collected throughout the rise and fall of the hydrograph, and (3) The sediment concentration and streamflow hydrographs must respond reasonably to rainfall.

Other data collected during the "research modeling" studies are described and listed. The physiographic setting and watershed characteristics of the sediment data sets are described. The period of record for data sets of sediment concentration, streamflow, and precipitation are also given. Also, other sediment-data sets collected by the 10 project offices of the Survey other than during the "research modeling" studies are listed.

Description of Area

Three physiographic subprovinces lie within the study area. These are the glaciated Central Lowlands of Illinois and Indiana, the Appalachian Plateau of Kentucky, West Virginia, and Pennsylvania, and the Valley and Ridge system in Tennessee and Virginia (fig. 1). The following description of these subprovinces is from Atwood (1940). All three areas are underlain by Pennsylvanian-age bedrock. The bedrock in the Central Lowland consists of carbonate-rich marine deposits and is formed by alternating layers of shale, sandstone, limestone, and coal. The watersheds in the Lowland generally have flat to gently rolling topography on Illinoian till. The bedrock of the Appalachian Plateau and the Valley and Ridge System are of continental origin. The Appalachian Plateau consists of relatively flat sedimentary rocks that dip gently to the west. The area appears mountainous because of stream dissection. The Appalachian Ridge and Valley subprovince lies between the western Appalachian mountains and the eastern Appalachian mountains. The subprovince is 80 to 100 miles wide and is characterized by gently rolling topography between parallel ridges.

Variations in temperature, precipitation, and snowfall are evident in the study area. The following description of the climate for the study area is from the National Oceanic and Atmospheric Administration (1974). The climatic differences reflect latitude, storm patterns, and the influence of mountains. All watersheds, particularly those in the midwest, are influenced by west-to-east weather disturbances. Tropical storms are more important sources of weather for the watersheds in the southern and eastern states.

Temperature and precipitation decrease and snowfall increases from south to north. For example, the average minimum and maximum monthly temperatures for the watersheds in Alabama are 45° and 80° F. The same temperatures for watersheds in Pennsylvania are 30° and 75° F. Rainfall averages about 55 inches at the watersheds in Alabama and decreases to about 40 inches in Pennsylvania. The majority of rainfall in most of the States occurs in late winter and spring, but summer thunderstorms often deliver a significant amount of rainfall locally. Snowfall ranges from near zero in Alabama to about 50 inches in the mountains of West Virginia.

The mountains influence not only snowfall but temperature and rainfall as well. Temperature decreases about 3° F per 1,000 ft increase in elevation. Rainfalls and snowfalls are greater on the windward (west) side of the mountains and decrease rapidly on the leeward (east) side.

More detailed descriptions of the individual watersheds are on file in the Reston Virginia office of the U.S. Geological Survey (F. A. Kilpatrick and others, USGS, written commun. 1985).

Acknowledgments

The author thanks project chiefs involved in the coal-hydrology program of the U.S. Geological Survey who contributed sediment data and provided information about the data sets.

DESCRIPTION OF DATA FROM "RESEARCH MODELING" STUDIES

A significant amount of information is available for the 20 sediment-data sets. To condense the information, the data are listed in a summary table (table 1). The first two pages of the table refer to the first 9 data sets whereas the last two pages refer to the remaining 10 sets. Information supplied by Kilpatrick and others, (USGS, written commun. 1985) is a significant source of material for the table, particularly for the descriptions of the watersheds.

The column called "Number of storm periods" includes the number of periods containing one or more consecutive storms that had sufficient sediment concentration and streamflow data to define the hydrographs adequately. To determine the number, the data were evaluated in three ways: First, project personnel involved in collecting the data were contacted. They were asked which of the data they collected were of sufficient quality to be representative of the watershed. They were also asked about the quality of the relation they developed between sediment concentration sampled by the automatic pumping sampler and actual concentration in the stream. Sediment-concentration data reported in table 1 adequately represent the sediment characteristics of the watershed as well as the actual sediment concentration in the stream. Second, the laboratory analyses of sediment concentration sent to the author by each district were checked to ensure that any analyses marked as questionable were not reported. Third, the sediment concentration and streamflow data for each storm period reported in table 1 were plotted on the same graph to determine if (1) an adequate amount of concentration and streamflow data were collected throughout the rise and fall of the hydrograph and (2) the concentration and streamflow hydrographs responded reasonably to rainfall. An adequate amount of sediment concentration data was defined as at least six concentration samples (more if the storms are large) were obtained during the rise and fall of the concentration hydrograph. Also, streamflow data had to be available from just before the start of the storm to at least near its end. A reasonable response to rainfall means that the same general patterns in the concentration and streamflow hydrographs are evident during each storm period.

The number of storm periods indicates the quantity of useful sediment data available for each watershed. More sediment data are available than indicated by the table, but these data either do not cover the entire concentration hydrograph or do not have concurrent streamflow data readily available. About the same number of storm periods occur during the spring, summer, and fall, with only a few occurring during the winter.

The sediment, streamflow, and precipitation data described by the table have been input to the National Water Data Storage and Retrieval System (WATSTORE). WATSTORE is operated by the Geological Survey and is composed of individual data files such as the Daily Values File (one data value per day) and Unit Values File (several data values per day). All sediment-concentration-data have been input to the Unit Values File using a 5-minute time step. The same concentration data were combined with streamflow data from the Unit Values File to calculate sediment discharge. The daily quantities of sediment discharge from the storm periods were entered into the Daily Values File.

Table 1.--Description of sediment data sets from "Research modeling" studies

[Creek(Cr); tributary(trib); near(nr); number(no); square mile(mi^2); milligrams per liter(mg/l)]

Basin number	Station number, name, and location	Drainage area (mi^2)	Land use	Topography	Soil description
1.1	05584683 Grindstone Cr trib no 1 nr Doddsville, Ill.	0.22	69% crops 16% forest 12% pasture	Nearly flat uplands between narrow valleys	Loessial soils
1.2	05584682 Grindstone Cr trib no 2 nr Doddsville, Ill.	0.17	57% crops 35% forest 4% pasture	Nearly flat uplands between narrow valleys	Loessial soils
2	05595270 Plum Cr trib nr Sparta, Ill.	0.6	Progressive change from from agriculture to mining	Gently rolling	Originally loessial soils
3	03342110 Hooker Cr nr Lewis, Ind.	2.71	85% agriculture 15% forest	Nearly flat uplands between narrow valleys	Loessial soils over till
4	03139940 Little Mill Cr nr Coshocton, Ohio	1.44	59% pasture 21% forest 16% crops	Rolling uplands. Valley not well defined	Silt loams developed from bedrock
5	03113950 Bend Fork trib nr Belmont, Ohio	0.70	Progressive change from agriculture to mining	Rolling ridgetops and moderately steep valleys	Silt loams developed from bedrock
6	01541880 Rolling Stone Run nr Sylvan Grove Pa.	0.53	>50% unreclaimed mining (pine forest) Rest is trees and grass	One long valley with about 12% slopes	Valley floor is crust formed from spoil piles. About 40% is silt loams
7	03046145 Whitethorn Cr nr Crabtree, Pa.	1.47	Mostly cropland and pasture. Small amounts of mining and forest	Rolling hills with 16% slopes	Silt-loam soils
8	01601275 Trotters Run nr Georges Cr, Md.	2.14	79% forest 18% pasture 3% active mining	Steep slopes; narrow valleys	Stony silt-loam soils
9	03070310 Conner Run nr Valley Point, W. Va.	0.38	45% reclaimed 45% wetland forest 9% pasture	Steep slopes; valley widens and flattens near outlet	All soils are silty clay loams Reclaimed soils also have rock fragments.

Table 1.--Description of sediment data sets from "Research modeling" studies--Continued

Basin number	Period of Record (month/year) Begin date —streamflow— End date Begin date —precipitation— End date Begin date —suspended sediment— End date 10-80 10-81 10-82 10-83 10-84	Number of storm periods	Average number of samples per storm period[1]	Maximum sediment concent-ration (mg/l)	Sediment pond(s) present	Remarks
1.1	10/80—12/81 10/80—4/83 (one sample on 6/81)	1	11	11,500	No	Data collected until mining began in basin. Streams eroded into bedrock
1.2	7/82—4/83 10/80—4/83 8/82—4/83	0	--	38,000	No	Data collected until mining began in basin. Streams eroded into bedrock
2	3/81—9/83 3/81—9/83 7/81—5/83	2	8	47,200	Yes	After 4/83, only 0.03 mi^2 drained past station
3	10/80—6/83 10/80—6/83 10/80—6/83	16	10	12,000	No	
4	3/82—4/84 4/82—4/84 6/82—4/84	4	9	12,200	No	Coal processing plant at head-waters which used a small amount streamflow
5	4/82—4/84 4/82—4/84 7/82—4/84	2	8	290	Yes	
6	7/82—5/84 7/82—5/84 7/82—10/83	3	12	7,320	No	No definite channel except at gage. Flow changes slowly; sediment concentration rapidly
7	7/82—2/84 7/82—2/84 7/82—10/83	2	12	12,700	No	Major source of sediment is from abandoned mines at headwaters
8	5/82—12/83 5/82—12/83 5/82—12/83	3	9	919	Yes	Streamflow data not readily avail-able. Sediment discharges calcu-lated by WATSTORE program H475
9	1/82—10/83 5/82—10/83 1/82—10/83	12	30	4,070	Yes	Haul road affects sediment concentration. Most storms are small

Table 1.--Description of sediment data sets from "Research modeling" studies--Continued

Basin number	Station number, name, and location	Drainage area (mi^2)	Land use	Topography	Soil description
10	03193778 Little Cr nr Chelyan, W. Va.	1.44	10% reclaimed 90% forested	Steep slopes and deep valleys	Natural soils are loams. Reclaimed soils have rock fragments
11	03213630 Right Fork of Hurricane Cr nr Stopover, Ky.	0.82	66% forest 32% reclaimed	Steep-sided valley	Natural soils are well drained and formed from acid bedrock
12	03207962 Dicks Fork at Phyllis, Ky.	0.82	100% forest	do.	Soils are well drained and formed from acid bedrock
13	03207915 Elkfoot Branch nr Nigh, Ky.	0.70	90% forest 10% reclaimed and unreclaimed mining	do.	Do.
14	03208034 Grisson Cr nr Council, Va.	2.82	80% forest 20% tobacco and grazing	do.	Stony silt loams
15	03208036 Barton Fork nr Council, Va.	1.23	80% forest 20% unreclaimed mining	do.	Stony silt loams and mine spoil
16	03403718 Crabapple Branch nr La Follette, Tenn.	1.07	100% forest	do.	Valley and upland soils are well drained. Upland soils are cobbly
17	361341084253900 Shack Cr at Hembree, Tenn.	5.08	Mostly forest. Some reclaimed and unreclaimed mining	do.	Soils are alluvial or colluvial based
18	0244532701 Boxes Cr nr Howard, Ala.	1.72	79% forest 13% reclaimed 6% pasture	Flat uplands and narrow, steep-sided valleys	Soils are mostly loams
19	0246248201 Little Yellow Cr trib nr Corona, Ala.	0.77	82% forest 16% pasture	Narrow ridges and steep-sided, narrow valleys	Soils are mostly sandy loams

Table 1.--Description of sediment data sets from "Reasearch modeling" studies--Continued

Basin number	Period of Record (month/year): streamflow (Begin date–End date)	precipitation (Begin date–End date)	suspended sediment (Begin date–End date)	Number of storm periods	Average number of samples per storm period[1]	Maximum sediment concent-ration (mg/l)	Sediment ponds present	Remarks
10	5/82–10/83	6/82–10/83	6/82–10/83	4	16	34,000	Yes	Sediment loads are high because of a landslide near stream
11	10/80–9/83	10/80–9/83	10/80–9/83	?	?	?	No	Contour mining. District was not able to provide sediment data for stormflows
12	7/75–5/84	11/82–7/83	8/82–9/83	?	?	?	No	Do.
13	10/80–7/83	10/80–7/83	10/80–7/83	?	?	?	Yes	Do.
14	7/81–9/83	1/82–9/83	8/81–9/83	7	12	13,000	No	
15	7/81–9/83	7/81–9/83	8/81–9/83	2	12	24,000	Yes	Area of underground mining contributed high sediment concentrations.
16	6/81–3/84	4/82–3/84	6/81–3/84	14	20	2,100	No	Haul road is primary source of sediment. Sediment discharges to be input to WATSTORE by district.
17	12/81–3/84	3/80–3/84	12/81–3/84	43	17	55,000	Yes	High concentrations from spoil. Sediment discharges to be input to WATSTORE by district.
18	8/82–1/84	7/82–1/84	8/82–1/84	8	19	10,100	Yes	Steep, somewhat gullied reclaimed area.
19	11/82–1/84	11/82–1/84	10/82–1/84	4	15	2,000	No	

[1]A number greater than 15 usually indicates most of the samples are during the latter part of the recession

Sediment discharge for the storm periods was calculated by two Fortran programs (written by the author) that incorporated subprograms from the IMSL[1] library and ISSCO (Integrated Software Systems Corporation) to plot the data. The first program used sediment-concentration and streamflow data in Unit-Values-File format to generate plots of the data. The plots were used to determine if streamflow and sediment-concentration data were sufficiently complete to accurately calculate sediment discharge for storm periods. If the data were sufficiently complete, then the second program was used to calculate sediment discharge. The measured concentration data were used by the second program to generate continuous sediment- oncentration hydrographs that intersect each measured data point. Then the program evaluated the concentration hydrographs at 5-minute intervals. Using the "mean-interval" method (Porterfield, 1972, p. 49), the 5-minute concentrations were multiplied by 5-minute streamflow data and a conversion factor to calculate sediment discharge. All 15-minute streamflow data were interpolated to 5-minute data by the program. Only the sediment discharges were entered into WATSTORE. The continuous, 5-minute sediment concentrations and streamflows calculated by the second program were not entered into WATSTORE.

DESCRIPTION OF DATA FROM OTHER STUDIES

Survey offices that had done "Research modeling" studies were asked about the availability and content of other sediment data sets that were collected in a manner similar to those collected for the "Research modeling" studies. The main similarity required was that the data sets have concurrent streamflow, sediment concentration, and precipitation records. Several data sets were available, and they are described in table 2.

This table contains less information about the data sets; however, the potential user of the data should be able to determine if a specific data set is useful. For additional information, the Survey office that collected the data should be contacted. The addresses and phone numbers of the districts which collected data for tables 1 and 2 are given in the following list:

District Chief
U.S. Geological Survey
520 19th Avenue
Tuscaloosa, Alabama 35401
phone: 205-752-8104

District Chief
U.S. Geological Survey
Champaign County Bank Plaza
102 East Main Street, 4th Floor
Urbana, Illinois 61801
phone: 217-398-5353

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

District Chief
U.S. Geological Survey
6023 Guion Road
Indianapolis, Indiana 46254
phone: 317-927-8640

District Chief
U.S. Geological Survey
208 Carroll Building
8600 La Salle Road
Towson, Maryland 21204
phone: 301-828-1535

District Chief
U.S. Geological Survey
P.O. BOX 1107
4th Floor, Federal Building
228 Walnut Street
Harrisburg, Pennsylvania 17108
phone: 717-782-4514

District Chief
U.S. Geological Survey
200 West Grace Street
Room 304
Richmond, Virginia 23220
phone: 804-771-2427

District Chief
U.S Geological Survey
Room 572, Federal Building
600 Federal Place
Louisville, Kentucky 40202
phone: 502-582-5241

District Chief
U.S. Geological Survey
975 West Third Avenue
Columbus, Ohio 43212
phone: 614-469-5553

District Chief
U.S. Geological Survey
A-413 Federal Building
U.S. Court House
Nashville, Tennessee 37203
phone: 615-251-5424

District Chief
U.S. Geological Survey
603 Morris Street
Charleston, West Virginia 25301
phone: 304-347-5130

Table 2.--Description of other sediment data sets

[tributary (trib); hour (hr); unit values (UV); daily values (DV); branch (br); Creek (cr); near (nr); Fork (fk); square mile (mi^2)]

Data-set number	Station name and location	Drainage area (mi^2)	Land use	Period of record and/or number of storms
1	02453835 Trinity Cr nr Carbon Hill Ala.	2.6	21% mined Rest is mostly forest	12/78 - 6/81
2	02462600 Blue Cr nr Oakman, Ala.	5.3	5% mined 95% forest	1/77 - 7/82 7 storm periods
3	02462990 Yellow Cr nr Northport, Ala.	8.2	100% forest	10/76 - 9/81 12 storm periods
4	02463900 Bear Cr nr Samantha, Ala.	15	100% forest	12/76 - 4/81 5 storm periods
5	02464146 Turkey Cr nr Tuscaloosa, Ala.	6.2	93% forest 7% mined	2/80 - 7/83 4 storm periods
6-9	Lawson Cr trib 1-4 at Sheffield nuclear waste site, Ill.	all <1	Landfill of nuclear waste	6-8 storms per basin
10	03360125 Pond Cr nr Coal City, Ind.	2.2	80% unreclaimed 20% agriculture	2/81 - 9/82 5 storms
11-12	Kane Br and Elton Br on Beaver Cr, Ky.	all <1	Kane: 10% mined, 90% forest Elton: 100% forest	approximately 1955 - 63 1970 - 73
13-15	Three sites in Shade River basin, Ohio	1 37 40	all are partially mined	6/84 - 12/86
16	Wheeling Cr, Ohio	100	Mining in basin	12/82 - 12/86
17	Anna S mine, Pa.	34 acres	Reclaimed	20 storms
18	P and N mine, Pa.	5 acres	Active mining	60 storms
19	P and N mine, Pa.	2.3 acres	Active mining	15 storms
20	Irvin mine, Pa.	22 acres	Reclaimed	7 storms
21	Stuart mine, Pa.	4.2 acres	Reclaimed	30 storms
22-23	Stoney Fk (03070455) and Stoney Fk trib (03070420), Pa.	7.5 <7.5	about 10% mined 90% forest or agriculture	1977 - current year about 200 storms/basin
24	W. Va. highway project	various	various	1979 - 80 10 storms

Table 2.--Description of other sediment data sets--Continued

Data-set number	Availability of data	Remarks
1	Precipitation and sediment concentration in UV file. Discharge on paper tapes.	Topography consists of broad valleys and some hills in uplands. Soils are sandy.
2	Discharge, precipitation, and sediment concentration in UV file	Topography consists of incised valleys and hilly uplands. Soils are sandy. Some daily sediment discharges are available in DV file.
3	do.	Do.
4	do.	Do.
5	do.	Topography consists of incised valleys and rolling uplands. Daily concentrations available for period of record.
6-9	do.	Collected 30 full particle size samples and collected bed-material samples from the four tributaries.
10	do.	Five sediment discharges in DV file. Many internal drainages.
11-12	Some data entered into UV file during a modeling project. Rest of data on strip charts	Data is associated with reports PP 427 A, B, and C. Sediment concentration data collected through tubes at different elevations.
13-15	Data processing is beginning	Storm samples collected every ½ hr on 1 mi^2 basin, every hr on 37 mi^2 and 40 mi^2 basins.
16	Data processing into WATSTORE is beginning	Fifteen-minute data are collected. 1983 water year is only year so far with significant amount of data.
17	Streamflow, sediment, and precipitation will be put into UV file.	No particle-size analysis available.
18	do.	Eight full particle-size analyses available.
19	do.	Six full particle-size analyses available.
20	do.	Two full particle-size analyses available.
21	do.	Eight full particle-size analyses available.
22-23	Data available in annual reports	Report available for 1977-80 data. Streamflow and sediment data are at 15-minute intervals. Precipitation data on charts.
24	DV available but UV of streamflow and precipitation on paper tape	Rising limb of sediment hydrograph often missed in data collection.

 (p. 15 follows)

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Porterfield, George, 1972, Computation of fluvial-sediment discharge: Techniques of Water-Resources Investigations, Book 3, Chapter C3, 66 p.

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