SUSPENDED-SEDIMENT YIELDS FROM AN UNMINED AREA AND FROM MINED AREAS BEFORE AND AFTER RECLAMATION IN PENNSYLVANIA, JUNE 1978-SEPTEMBER 1983

By Lloyd A. Reed and Robert A. Hainly

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CONVERSION FACTORS AND ABBREVIATIONS

For the benefit of readers who prefer metric (International System) units rather than the inch-pound units in this report, the following conversion factors can be used:

Multiply inch-pound units	By	To obtain metric units
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
square foot (ft^2)	0.09294	square meter (m^2)
cubic foot (ft^3)	0.02832	cubic meter (m^3)
mile (mi)	1.609	kilometer (km)
acre	0.4047	hectare (ha)
square mile (mi^2)	2.590	square kilometers (km^2)
ton (short)	0.9072	megagrams (Mg)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
pound per cubic foot (lb/ft^3)	16.02	kilogram per cubic meter (kg/m^3)
ton per acre (ton/acre)	0.2058	kilogram per square meter (kg/km^2)
ton per square mile (ton/mi^2)	0.3502	megagram per square kilometer (Mg/km^2)

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ABSTRACT

The U.S. Geological Survey, in cooperation with the Pennsylvania Department of Environmental Resources, has collected hydrologic data from areas in Tioga, Clearfield, and Fayette Counties to determine the effects of surface coal mining on sediment yields. The data were collected from June 1978 through September 1983. Rainfall, streamflow, and suspended-sediment data were collected with automatic recording and sampling equipment. Data were collected in Tioga County from an agricultural area that was unaffected by mining and from a forested area prior to surface mining. Data were collected from two areas affected by active surface mining in Tioga County and from an area in Clearfield County being mined by the contour-surface method. Data also were collected from three areas, Tioga, Clearfield, and Fayette Counties, during and after reclamation. The efficiencies of sediment-control ponds in Clearfield and Fayette Counties also were determined.

The average annual sediment yield from the agricultural area in Tioga County, which was 35 percent forested, was 0.48 ton per acre per year, and the yield from the forested area prior to mining was 0.0036 ton per acre per year. The average annual sediment yields from the areas affected by active surface mining were 22 tons per acre from the improved haul road and 148 tons per acre from the unimproved haul road. The average annual sediment yield from the site in Clearfield County that had been prepared for mining was 6.3 tons per acre. The average annual sediment yield from the same site while it was being mined by the contour method was 5.5 tons per acre per year. The sediment-control pond reduced the average annual sediment yield to 0.50 ton per acre while the site was prepared for mining and to 0.14 ton per acre while the site was being mined. Because the active surface mining reduced the effective drainage area to the pond, the sediment yield decreased from 0.50 to 0.14 ton per acre.

Average annual suspended-sediment yields from the reclaimed site in Tioga County were 1.0 ton per acre during the first year, when vegetation was becoming established, and 0.037 ton per acre during the second year, when vegetation was well established. The average annual sediment yield below a 21.2-acre, reclaimed, surface mine in Clearfield County that had been mined by the contour method was 15 tons per acre during the first year when vegetation was becoming established. However, the average annual sediment yield below a sediment-control pond at this reclaimed site in Clearfield County was 0.30 ton per acre.

Data collected from a 4.2-acre reclaimed area that had been surface mined by the block-cut method in Fayette County showed that annual sediment yields

from the area were 77 tons per acre in 1981 (no vegetation), 32 tons per acre in 1982 (sparse vegetation), and 1.0 ton per acre in 1983 (well-established vegetation). The average annual yield below a sediment-control pond at the mine site in Fayette County was 0.19 ton per acre during the 27 months of data collection.

INTRODUCTION

Annual production of bituminous coal in Pennsylvania is about 85 million tons; 45 million tons is produced by surface mining from an affected area of 60,000 acres. During surface mining, large quantities of soil and rock are moved to expose the coal beds, and many temporary roadways are constructed. After the coal has been removed, the area is returned to the original surface contour by grading the rock overburden and replacing the soil. After the soil has been replaced, the area is limed, fertilized, and seeded to establish a vegetative cover. The time from the start of mining to regrading and establishing vegetation may range from as few as 2 to as many as 10 years or more.

There are two principal methods of surface mining: block-cut and contour. Block-cut mining is done perpendicular to the topographic contours and reclamation can proceed as mining progresses. Contour mining is done by excavating along topographic contours and moving the rock overburden downslope to expose the coal bed. Reclamation is normally delayed until all the coal has been removed, and this method results in the longest time between the start of mining and reclamation. Erosion of soils exposed during the mining and reclamation process may be extensive, and surface-mine operators are required to construct diversion terraces and sediment-control ponds to control excess sediment. Data for this study were collected in cooperation with the Pennsylvania Department of Environmental Resources.

Purpose and Scope

This report describes results of a study to (1) determine sediment yields from areas affected by surface mining in the bituminous coal fields of Pennsylvania, (2) determine sediment yields during different phases of mining, (3) measure the effectiveness of the sediment-control ponds, and (4) compare the sediment yields from areas affected by mining to yields from areas unaffected by mining.

Hydrologic data collected by the U.S. Geological Survey from June 1978 through September 1983, from 11 sites in or near the bituminous coal fields of Pennsylvania, were analyzed in this study. Five of the sites were in Tioga County, four were in Clearfield County, and two were in Fayette County. Figure 1 shows the bituminous coal fields in Pennsylvania and the areas where data were collected.

Methods of Study

Rainfall and streamflow data were collected with continuous-recording equipment using methods described by Carter and Davidian (1968). At most sites, a weir, a 24-in.-diameter pipe well, a stage recorder, an automatic suspended-sediment sampler, and a recording raingage were installed. At two sites, the sediment-control ponds were constructed to release water at two levels.

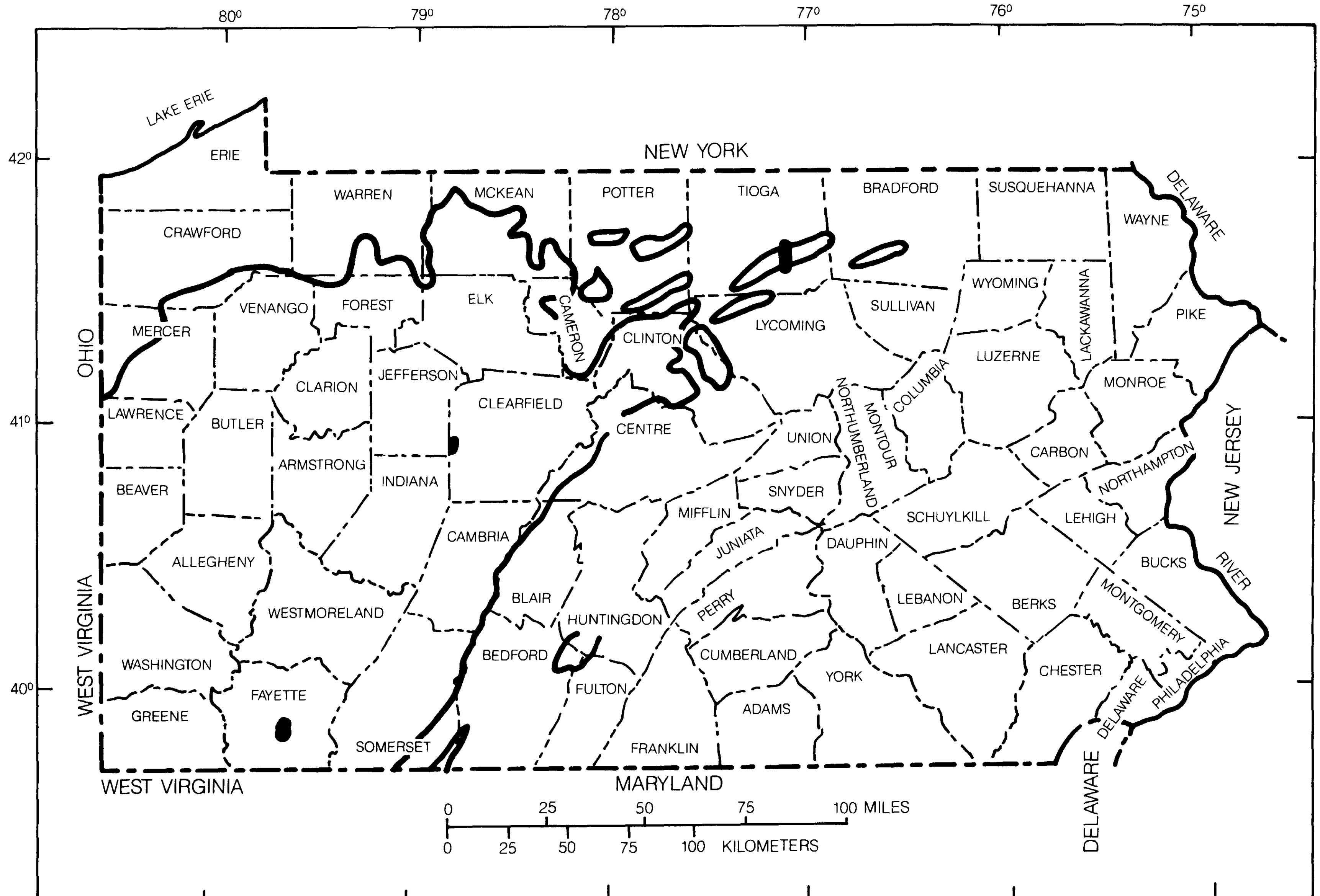

Figure 1.--Areas in Pennsylvania where sediment data were collected.

EXPLANATION

BOUNDARIES OF BITUMINOUS COAL FIELDS

AREAS WHERE DATA WERE COLLECTED

A 2-in. (inch) outlet was located about 4 ft (feet) above the bottom of the pond and maintained the water surface during low-flow conditions, and a 24-in. outlet was located about 8 ft above the bottom and released water during large storms. Pipe wells and stage recorders were installed in these two ponds.

During storm runoff, depth-integrated samples (Guy and Norman, 1970) were collected to compare with the automatic samples. The data were used to compute average annual suspended-sediment yields from each of the different land uses. For all the areas, average annual sediment yields were computed using the flow-duration, sediment-transport curve method described by Miller (1951). Data not previously published by the U.S. Geological Survey in the annual data reports for Pennsylvania are included in the appendix. Samples of soils exposed in the mining areas were collected and analyzed for particle-size composition. Several water samples collected for determination of suspended-sediment concentration were analyzed for particle-size distribution.

Description of Data-Collection Sites

Suspended-sediment data in this report were collected from an agricultural basin unaffected by surface mining in Tioga County. The basin has an area of 12.6 mi^2 (square miles), of which 65 percent is general agriculture (mostly pasture and hay) and 35 percent is forested. In Tioga County, sediment data also were collected from a 100-percent forested area before it was surface mined. These two sites were selected to show sediment yields from areas unaffected by surface mining. The other two sites in Tioga County were selected to show the effects of activities associated with surface mining. Data were collected from an area affected by an improved haul road, from an area affected by an unimproved haul road, and from a 32.4-acre area that had been reclaimed. Vegetation was about 2 in. high when data collection began at the reclaimed site in Tioga County.

In Clearfield County, data were collected from two surface mines and two sediment-control ponds. One surface mine encompasses 5.01 acres, and the other area encompasses 21.2 acres. Data were collected from the 5.01-acre mine site from the time it was prepared for contour mining until mining began (2 years) and for 1 year during mining. Data were collected from the sediment-control pond below the 5.01-acre mine site during all 3 years. Data collection at the 21.2-acre site began after the area had been reclaimed and continued for 6 months. When data collection began, the vegetation was about an inch high. Data were collected from the sediment-control pond below the 21.2-acre mine site for 4 months.

In Fayette County, data were collected from a surface mine that had been mined by the block-cut method. Soil had been spread on the area before data collection began, but the area was not seeded. During the first year of data collection, vegetation was sparse. The area was reseeded during the second year, and vegetation was well established by the end of data collection. All of the data collection sites are listed in table 1, and the data are included in the appendix of this report.

Table 1.--Data-collection sites

Station number	Station name	Location latitude	Location longitude	Drainage area (acres)	Period of record		Type of data collected (D = daily, S = storms only)	Major land use affecting sediment yields
01548408	Wilson Creek above Sand Run near Antrim	41°38'51"	77°18'26"	8,060	June 1978	September 1981	D	Generally agricultural
01548414	Reclaimed surface mine near Antrim	41°37'25"	77°18'35"	32.4	October 1981	September 1983	D	Reclaimed surface mine
01548417	Basswood Run above Hunter Drift	41°37'06"	77°18'40"	365	June 1978	September 1979	D	Forested
01548417	Basswood Run above Hunter Drift	41°37'06"	77°18'40"	180	October 1979	September 1980	D	Unimproved haul road
01548422	Rattler Run near Morris	41°36'36"	77°18'09"	205	June 1978	December 1980	D	Improved haul road
03033222	Reclaimed surface mine near McGees Mills	40°56'30"	78°47'25"	21.2	April 1983	July 1983	S	Reclaimed surface mine
03033223	Discharge from sediment-control pond at reclaimed surface mine near McGees Mills	40°56'31"	78°47'26"	24.0	April 1983	July 1983	S	Sediment-control pond
03033226	Discharge from diversion terrace at a surface mine near McGees Mills	40°56'54"	78°48'04"	5.01	May 1980	April 1983	D	Contour surface mine
03033227	Discharge from sediment-control pond below surface mine near McGees Mills	40°56'54"	78°48'05"	5.20	May 1980	April 1983	D	Sediment-control pond
03070412	Discharge from diversion terrace at a surface mine near Farmington	39°46'33"	79°33'32"	4.2	July 1981	September 1982	D	Reclaimed surface mine before vegetation was established
03070412	Discharge from diversion terrace at a surface mine near Farmington	39°46'33"	79°33'32"	4.2	October 1982	July 1983	S	Reclaimed surface mine after vegetation was established
03070413	Discharge from sediment-control pond at a surface mine near Farmington	39°46'34"	79°33'34"	17.9	September 1982	May 1983	S	Sediment-control pond

SUSPENDED-SEDIMENT YIELD FROM AN UNMINED AREA

Description

The Wilson Creek basin in Tioga County (fig. 2) encompasses three areas of different land uses. The northern part of the basin is an agricultural area, the central and southeastern parts are forested, and the southwestern part contains some active surface coal mines. Hydrologic data were collected from Wilson Creek upstream from Sand Run (fig. 2). The basin upstream from the data-collection site has an area of 12.6 mi^2 and is 65 percent agricultural and 35 percent forested. Nearly all the agriculture is north of the line shown in figure 2. The area south of the line generally is forested. Slopes in most of the agricultural area range from nearly flat at the top of some ridges to 8 percent; however, a few areas, used for pasture, have slopes as high as 35 percent. Soils in the agricultural area (U.S. Department of Agriculture, 1981) are channery loams formed from glacial deposits and belong to the Volusia-Mardin-Lordstown association. Corn is grown in the deeper soils, but most of the agriculture is pasture and hay.

Slopes in the forested area above the gaging station are generally 10 percent or greater, and some are as steep as 100 percent. Soils in the forested area also were formed from glacial deposits and belong to the Oquaga-Morris association. Most topsoils are loams. Subsoils are about 50 in. deep, have low infiltration rates, and are poorly drained. Layers of clay are common in the subsoils.

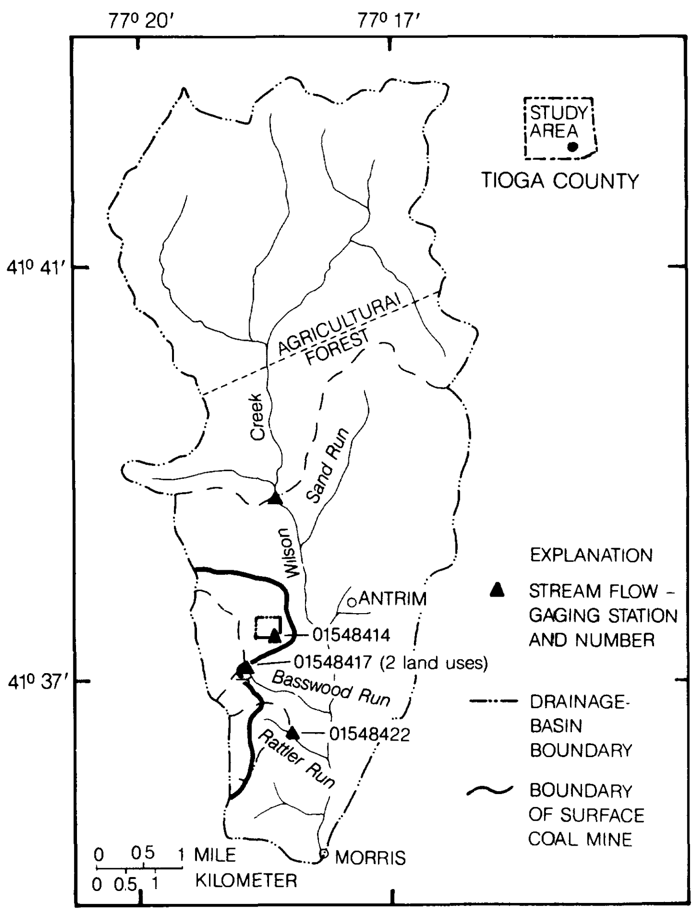

Figure 2.--Wilson Creek basin and the active surface coal mine, Tioga County.

Suspended-Sediment Yield

Suspended-sediment data were collected below the agricultural area from July 18, 1978, through September 30, 1980 (see appendix). The relation between daily mean water discharge and daily suspended-sediment discharge is shown in figure 3. A best-fit line was drawn through the points on figure 3 by computing the average sediment yield for equal increments of water discharge and drawing a curve through the group averages.

During the 1979 water year (the period from October 1, 1978, through September 30, 1979), water discharge totaled 5,450 ft^3/s-day (cubic feet per second-days--one ft^3/s-day is equal to 86,400 ft^3 of water) and for the 1980 water year it totaled 5,590 ft^3/s-day. Suspended-sediment discharge totaled 2,700 tons [(214 tons/mi^2) (tons per square mile)] during 1979 and 11,160 tons (886 tons/mi^2) during 1980. More than half the sediment yield (5,860 tons) in 1980 was produced by a storm that produced a peak water discharge of 4,640 ft^3/s (cubic feet per second). The storm washed out a main highway bridge upstream from the sampling site and damaged a bridge below it.

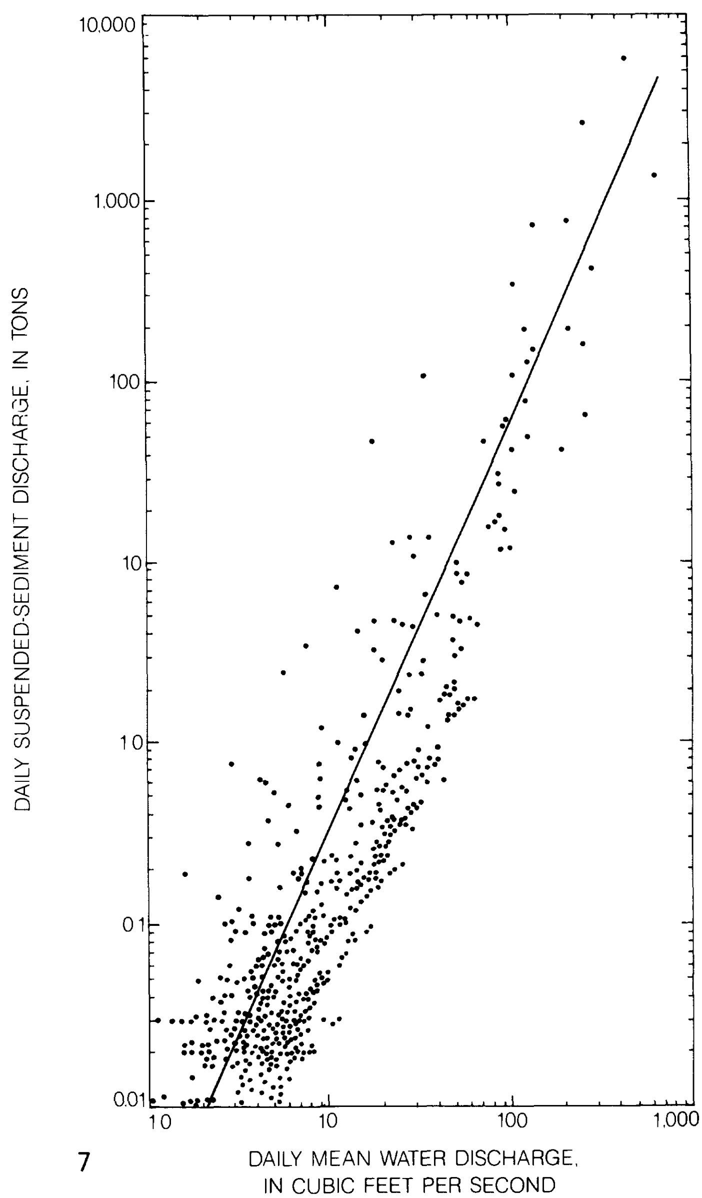

Figure 3.--Relation between daily mean water discharge and daily suspended-sediment discharge, Wilson Creek above Sand Run, July 18, 1978, through September 30, 1980.

The average annual sediment yield was computed for Wilson Creek above Sand Run using the flow-duration, sediment-transport curve method described by Miller (1951). The flow-duration curve for the period of record at Wilson Creek (fig. 4) was compared to the flow-duration curve at a nearby long-term index station, Pine Creek at Cedar Run. Two flow-duration curves were prepared for the long-term index station--one for the 52-year period of record and one for the same short-term period of record available for Wilson Creek above Sand Run. Factors required to adjust the short-term record at the index station to the long-term record at the index station were determined (unpublished report by Searcy, J. K., U.S. Geological Survey, 1958). The flow-duration curve for Wilson Creek above Sand Run was adjusted to long-term using the same factors. The adjusted flow-duration curve for Wilson Creek was then related to the sediment-rating curve (fig. 3), and an average annual yield of 307 tons/mi^2 [0.48 ton/acre (ton per acre)] was calculated.

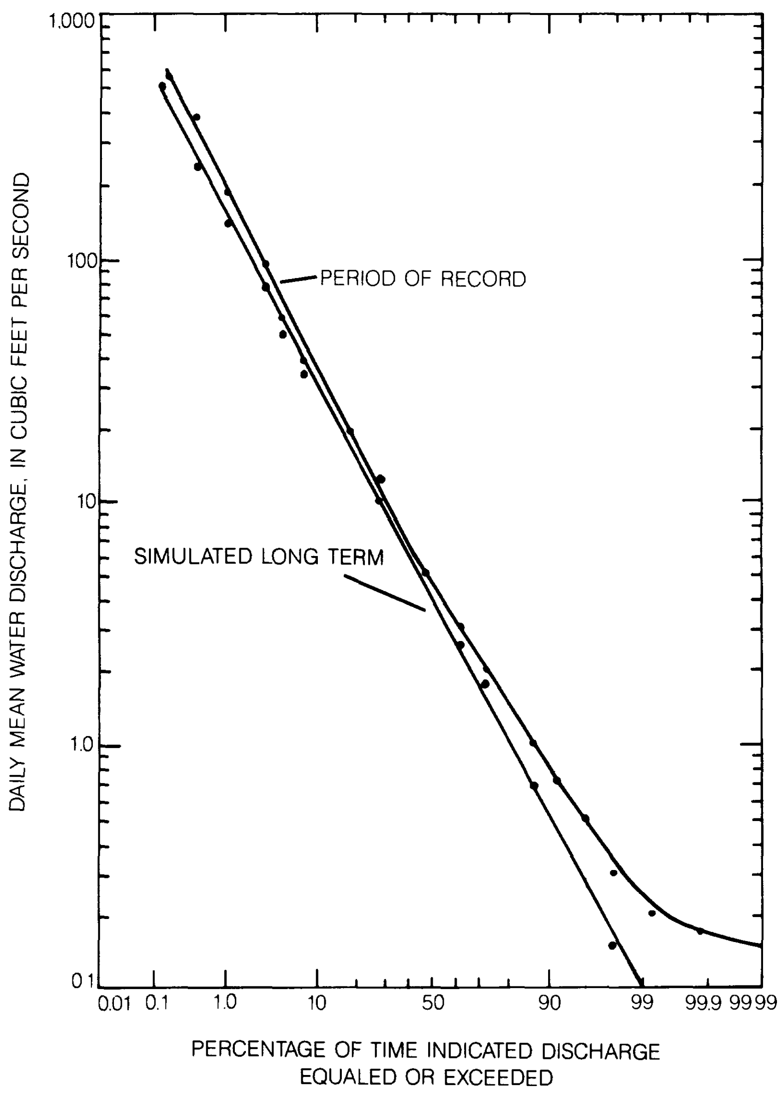

Figure 4.—Flow-duration curve for Wilson Creek above Sand Run, October 1, 1978, through September 30, 1980.

SUSPENDED-SEDIMENT YIELD FROM MINED AREAS BEFORE RECLAMATION

Surface Mine in Tioga County

Description

Hydrologic data were collected from an area affected by surface mining in Tioga County. The plateau west of Wilson Creek (fig. 5) contains coal measures that cover an area of about 1.3 mi^2 (850 acres). Most of the coal measures are drained by two tributaries to Wilson Creek. Prior to 1975, 95 percent of the area was forested and 5 percent was roads and mine spoil banks. The spoil banks were left from deep mining between 1870 and 1920 and from surface mining between 1940 and 1960. Most of the deep mining was confined to the Bloss coal, the thickest coal bed in the area. Removal of the Bloss coal left nearly all the area undermined and lowered the water table to the floor of the mine, about 60 ft under the surface of the plateau. Water that percolates to the mine is discharged by gravity-flow mine drains.

Soils in the area were formed from glacial deposits and belong to the Lordstown-Mardin association. Topsoils are thin and subsoils are stony loams about 50 in. deep. Prior to mining the soils were poorly drained, but, since deep mining, the soils in some areas are well drained. This is especially true in areas of subsidence. Slopes average about 5 percent.

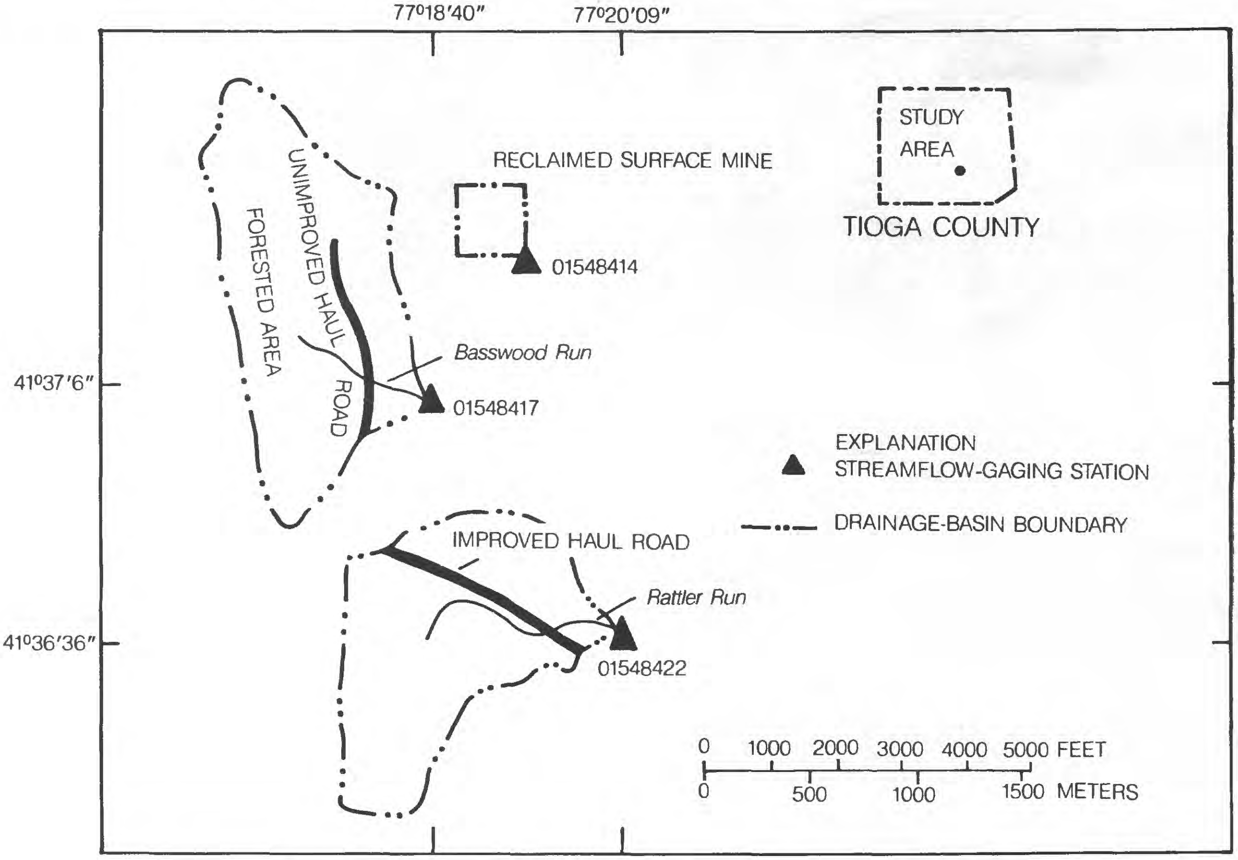

Figure 5.--Locations of gaging stations in Tioga County used to collect data during and after surface mining.

Suspended-Sediment Yield

Before mining

Basswood Run, above the Hunter Drift mine discharge, drains a 0.57-mi^2 forested area (fig. 5) that had been undermined by deep mining. Sediment data were collected from Basswood Run from July 1978 to August 1979, before the basin was disturbed by surface mining. During this period, the area was entirely forested, and there were no surface-mining activities or haul roads in the basin. Figure 6 shows a view of the basin upstream from the gaging station in April 1978. The deep mine was about 60 ft under the surface and was drained by an adit (Hunter Drift) that discharged to Basswood Run downstream from the gaging station. Therefore, most of the water discharge at the gaging station was surface runoff.

Figure 6.—Forested area in the Basswood Run basin before mining, April 1978.

The effect of the Hunter Drift on the streamflow of Basswood Run above Hunter Drift is illustrated in figure 7. Because of the absence of a groundwater component, the slope of the flow-duration curve for Basswood Run is much steeper than the curve for Wilson Creek upstream from Sand Run (fig. 4). Water flows in Basswood Run only about 40 percent of the time; the rest of the time, the stream is dry. Wilson Creek, however, had a water discharge of 7.0 ft^3/s [0.48 $(ft^3/s)/mi^2$ (cubic feet per second per square mile)] or more 40 percent of the time and was never dry. The high flows of the two streams are more comparable--water discharges of 9.8 and 16 $(ft^3/s)/mi^2$ are equaled or exceeded 1 percent of the time for Basswood Run and Wilson Creek, respectively.

The relation between daily mean water discharge and daily suspended-sediment discharge for Basswood Run above Hunter Drift from July 1, 1978, through August 31, 1979, is shown in figure 8. The average annual sediment yield of 2.3 tons/mi^2 (0.0036 ton/acre) from the forested Basswood Run basin was calculated using the method described previously. Factors influencing the low sediment yield from Basswood Run are the relatively flat slopes, leaf litter that covered the surface soils, and the large number of surface depressions. The surface depressions were caused by underground mine subsidence and by the uprooting of large trees during storms.

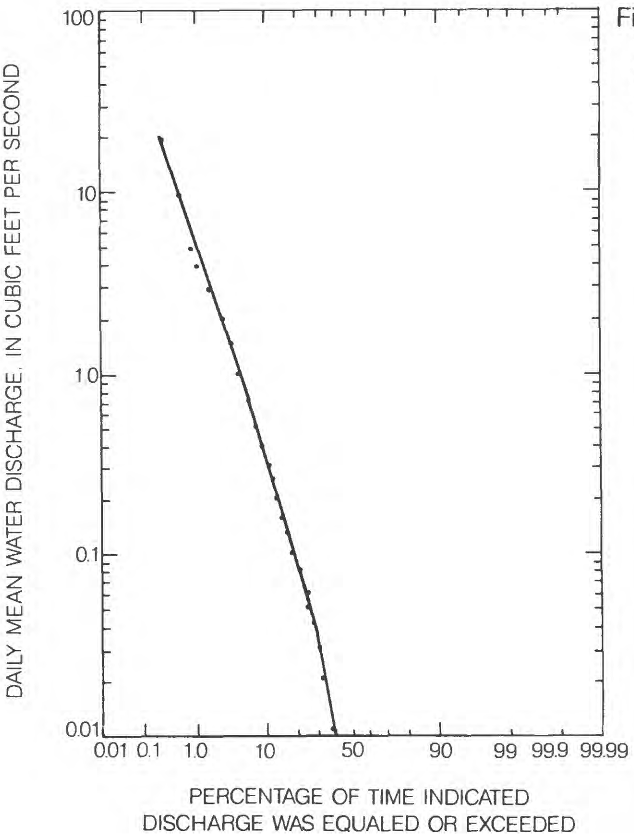

Figure 7.--Flow-duration curve for Basswood Run above Hunter Drift, September 1, 1978, through August 13, 1979.

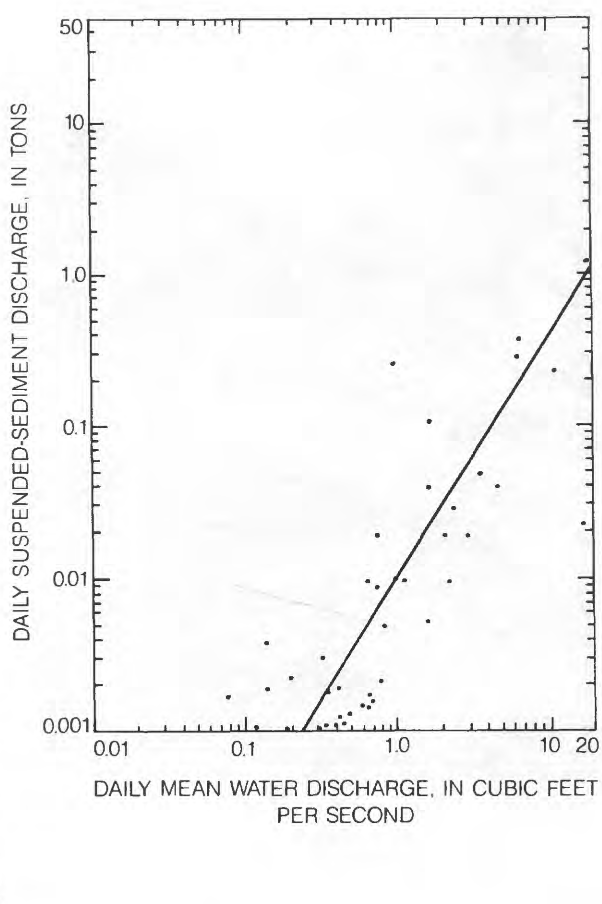

Figure 8.--Sediment-transport curve showing the relation between daily mean water discharge and suspended-sediment discharge, Basswood Run above Hunter Drift, July 1, 1978, through August 31, 1979.

During mining

Improved road--Sediment yields also were determined for an area affected by an improved haul road in the Rattler Run basin in Tioga County (fig. 5). State Route LR-58012 (fig. 9) was used to haul processed coal from the surface mines and had a compacted-elevated surface. Runoff from the road collected in roadside ditches and passed under the road in culverts. During winter, cinders were applied to the surface to prevent skidding. After heavy snows, the roadway was scraped; snow and cinders were pushed to the side. In the spring, ruts developed and the surface was repaired by grading the material from the edges back onto the traveled surface. A sealer usually was applied in the early summer to stabilize the surface and to control dust. Heavy truck traffic on the treated surface kept the surface layers compacted. During storms, fine material on and along the edges of the roadway was the primary source of sediment.

A streamflow-gaging and automatic sediment-sampling station was installed on Rattler Run, 380 ft below the roadway (fig. 9). The drainage area is about 205 acres and the area affected by the roadway is 1.2 acres. The slope of the basin averages 20 percent, and the roadway has about a 7.5 percent grade.

Figure 9.--Improved haul road (state route LR-58012) in the Rattler Run basin, March 1980.

Data were collected from June 14, 1978, through December 26, 1979. Figure 10 shows the relation between daily mean water discharge and daily suspended-sediment discharge for Rattler Run. The average annual sediment discharge from Rattler Run was calculated using the relation shown in figure 10 and a flow-duration curve developed from the first year of data. The average annual sediment discharge from the basin was determined to be 27.5 tons.

Average annual suspended-sediment yields from the forested area in the Rattler Run basin are assumed to be similar to those from the Basswood Run basin, or about 0.0036 tons/acre. Assuming the average annual sediment discharge from the 204-acre forested area in the Rattler Run basin was about 0.74 ton, the remaining 26.8 tons/yr (tons per year) was probably discharged from the improved haul road. Therefore, the average annual suspended-sediment yield from the 1.2-acre improved haul road was about 22 tons/acre.

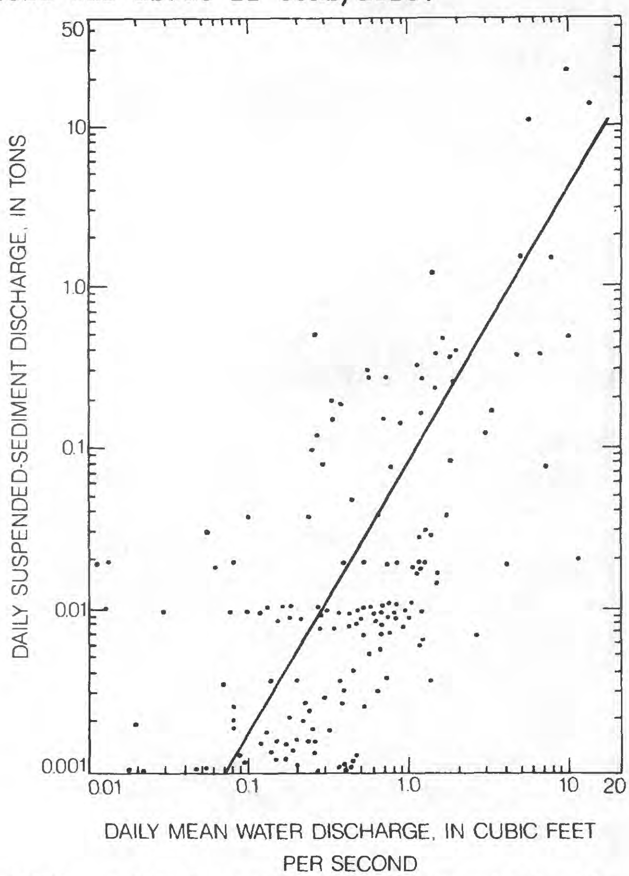

Figure 10.--Sediment-transport curve showing the relation between daily mean water discharge and daily suspended-sediment discharge, Rattler Run near Morris, June 14, 1978, through December 26, 1979.

Unimproved road--During September 1979, a haul road was constructed and surface mining began shortly thereafter in the basin drained by Basswood Run (fig. 5). The haul road was 2,500 ft long and 20 ft wide, the slope was 4 percent, and the roadway covered an area of 1.2 acres. The haul road (fig. 11) was constructed by grading the vegetation and about 1 foot of soil to the side. The exposed subsoils were used as the road surface. Figure 11 shows the haul road in March 1980 when the roadbed was thawing. As the subsoil thawed, haul trucks mixed the soil with water from melting snow and ice, creating deep ruts and the potential for excessive erosion. Surface-mining activities in the basin changed the drainage pattern, and the effective drainage area was reduced to 180 acres. The gaging station on Basswood Run above Hunter Drift was used to measure water and sediment discharge from the unimproved haul road.

Figure 11.--Unimproved haul road in the Basswood Run basin, March 1980.

Streamflow, suspended-sediment, and precipitation data were collected below the unimproved haul road from September 1, 1979, through August 31, 1980. Figure 12 shows the relation between daily mean water discharge and daily suspended-sediment discharge for the period. Average annual sediment yields from the basin were calculated for the 1-year period using the relation shown in figure 12 and the flow-duration curve. The annual sediment yield from the 180-acre drainage area was 1.1 tons/acre. The haul road was the most significant disturbed area in the basin; nearly all of the area affected by surface-mining, including most of the spoil piles that can be seen on figure 11, drained internally. If it is assumed that 90 percent of the sediment discharged during the period was from the haul road, then the sediment yield from the haul road was 148 tons/acre.

Sediment discharge past the gaging station from September 1, 1979, through August 31, 1980, totaled 198 tons. An additional 34 tons of sandy sediment was deposited in the 5-foot wide channel; the deposits averaged 6 in. deep between the haul road and the gaging station. This increased the total amount of soil lost during the period to 232 tons--about 1 in. of soil from the road. Most of the soil lost from the haul road was from tire ruts where the soil was loosened, crushed, and ground by the heavy equipment. Water tended to collect and flow in the ruts, transporting the soil material from the site.

The high sediment discharge from the haul road is illustrated by the precipitation, streamflow, and suspended-sediment concentration data for March 31, 1980 (fig. 13). Total precipitation was 0.75 in. and the maximum intensity was 0.23 in./hr (inches per hour). The mean streamflow for the day was 1.3 ft^3/s and the sediment load from the basin was 12 tons or 42 $tons/mi^2$. For the same storm, the mean streamflow in Wilson Creek above Sand Run was 137 ft^3/s and the sediment load was 144 tons (12 $tons/mi^2$). The mean water discharge-weighted suspended-sediment concentrations below the haul road and in Wilson Creek were 3,400 and 390 mg/L (milligrams per liter), respectively.

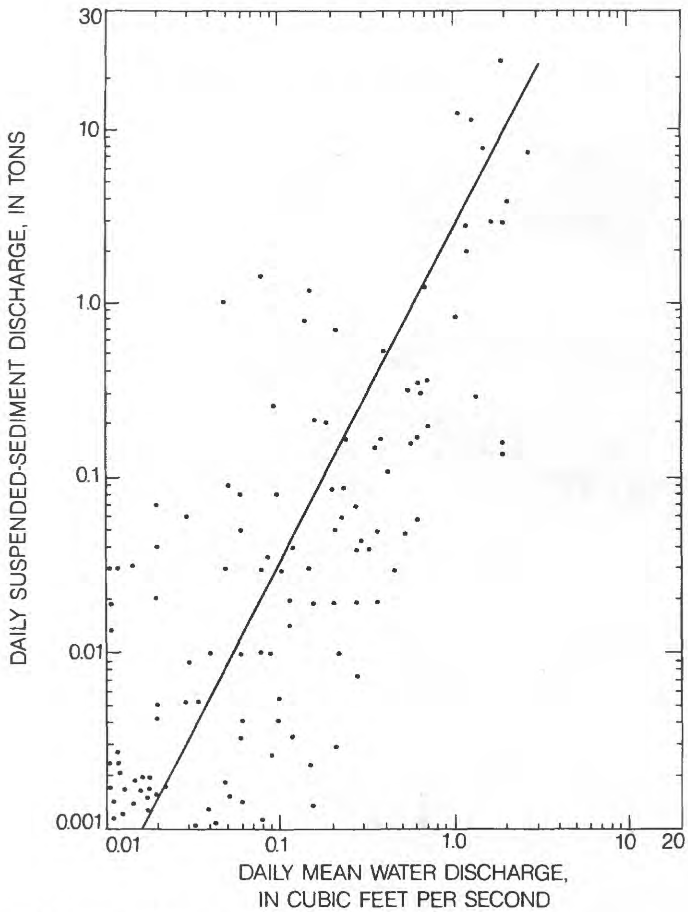

Figure 12.--Sediment-transport curve showing the relation between daily water discharge and daily suspended-sediment discharge, Basswood Run above Hunter Drift, September 1, 1979, through August 31, 1980.

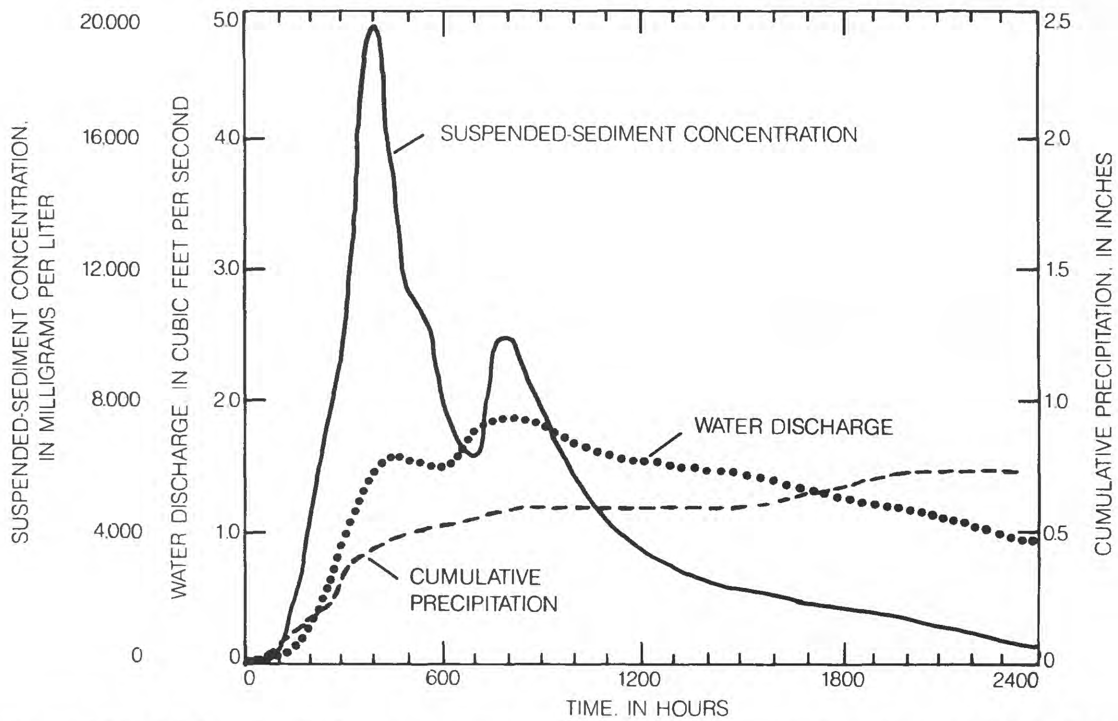

Figure 13.--Rainfall, water discharge, and suspended-sediment concentration, Basswood Run above Hunter Drift, March 31, 1980.

Contour Mine in Clearfield County

Description

Another area monitored during the study was a site in Clearfield County that was being surface mined by the contour method (fig. 14). The first step in contour mining is to establish a diversion terrace along the contour of the hill. The diversion terrace routes runoff from the affected area to a sediment-control pond. At this site, the diversion terrace and sediment-control pond were constructed and the area was cleared of large timber during October 1979. From October 1979 to the start of mining in September 1981, the total drainage area was 5.01 acres--4.00 acres were woodland (the timber had been harvested but the topsoil and leaf litter were still in place), 0.27 acre was an access road (exposed subsoil), 0.15 acre was the diversion terrace (exposed subsoil), and 0.59 acre was exposed subsoil in areas disturbed by logging and areas adjacent to the access road and the diversion terrace.

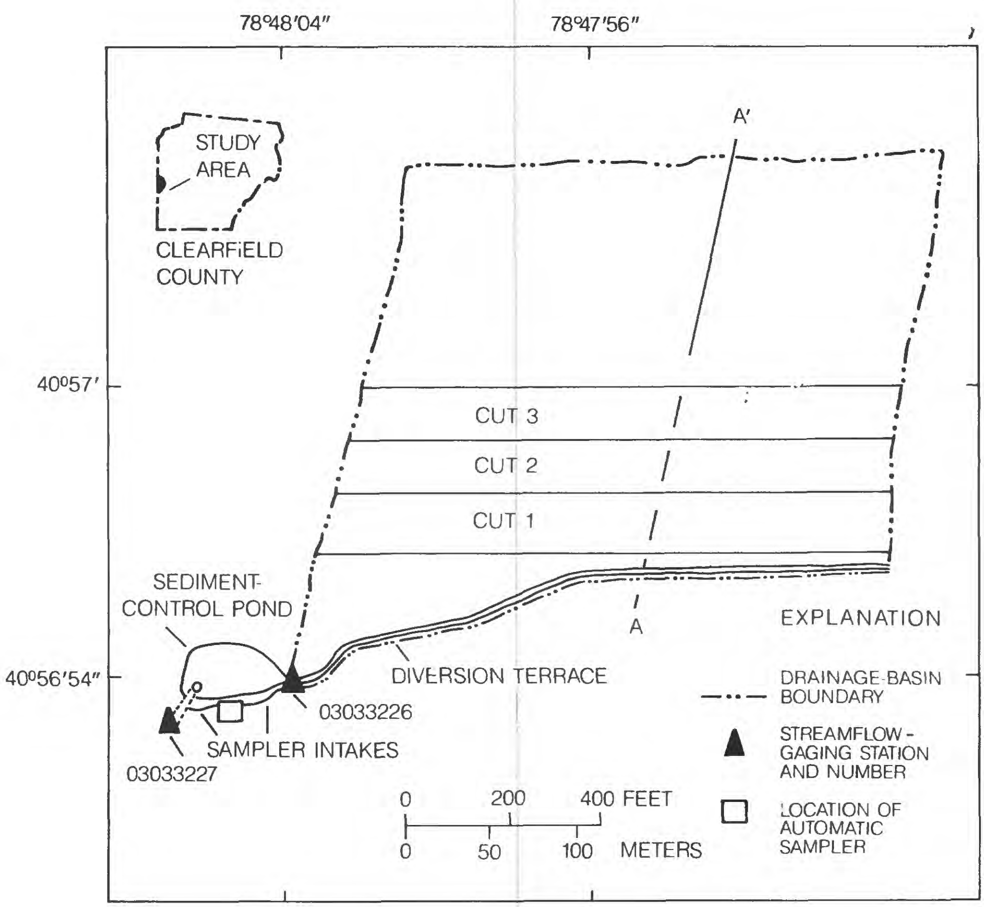

Figure 14.--Diversion terrace, sediment-control pond, and contour-mining activity at the Clearfield County site.

Soils in the area (U.S. Department of Agriculture, 1964) belong to the Gilpin-Wellston-Ernest association and are moderately erodible. The soils are classified (U.S. Department of Agriculture, 1964) as Ernest and Cavode very stony silt loams and as Dekalb very stony loams. Before mining, most of the soils had an organic layer of leaf litter and humus over the surface. The top soils were dark grayish-brown loams. The subsoils were brown and yellowish-brown loams and ranged in thickness from 3 to 20 ft. Slopes in the area average about 15 percent. The sediment-control pond, shown in figure 15, had a permanent storage capacity of 16,900 ft^3 (cubic feet) and a surface area of 4,400 ft^2 (square feet). The primary discharge was from a 12-in. outlet pipe. Storage capacity at the emergency spillway was 26,000 ft^3.

Collection of rainfall, water discharge, and suspended-sediment data began in May 1980. During storms, suspended-sediment samples of the water from the diversion terrace were collected every 15 minutes, and samples of the discharge from the sediment-control pond were collected every 30 minutes. Most samples were collected with an automatic sampler; however, depth-integrated samples were collected occasionally to check the automatic samples. The particle-size distribution was determined for several samples of the suspended sediment and for samples of the exposed soil and the overburden material.

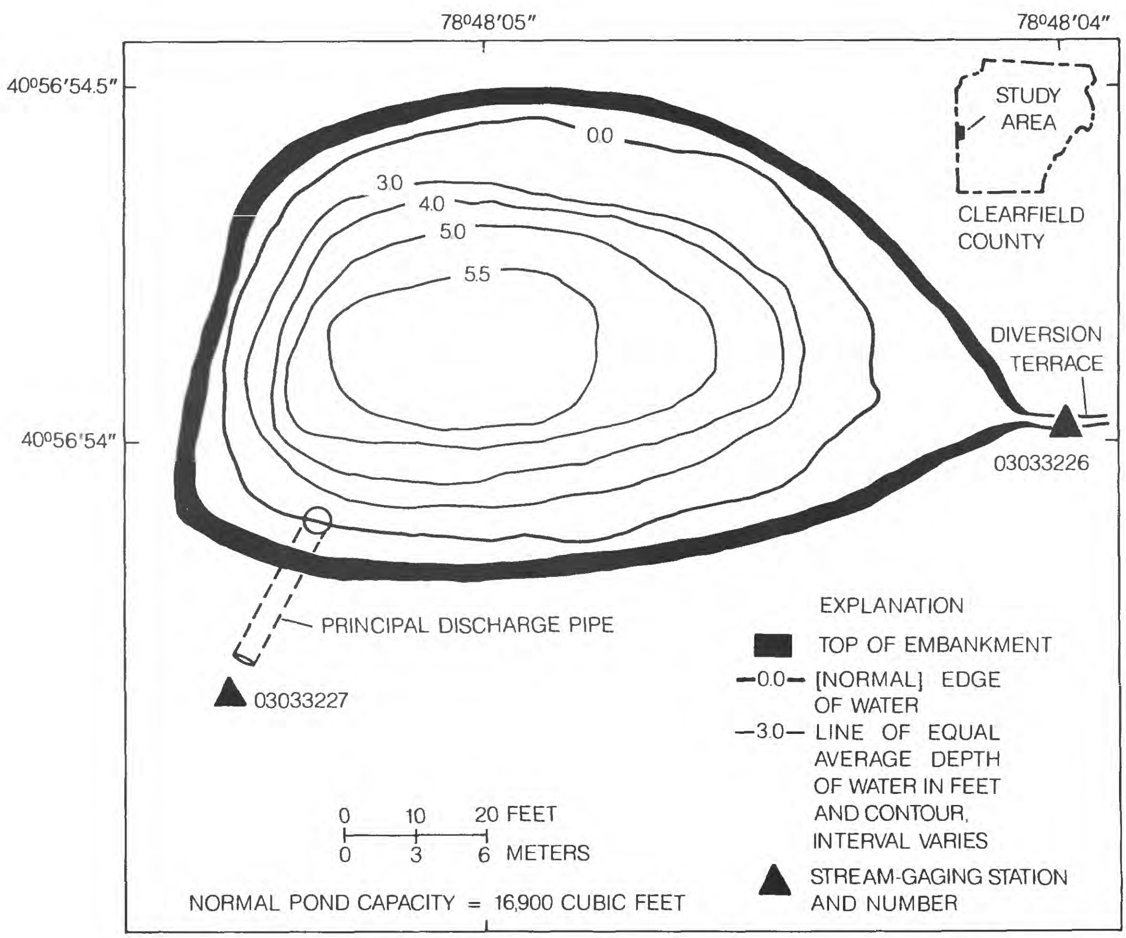

Figure 15.--Sediment-control pond at the contour mine in Clearfield County.

The particle-size distribution of the soil and suspended-sediment samples collected from the contour mine are summarized in table 2. All samples were analyzed to determine the percentages of coarse sand or larger material [larger than 0.5 mm (millimeter)], medium and fine sand (0.062 to 0.5 mm), silt (0.004 to 0.062 mm), coarse clay (0.002 to 0.004 mm), and clay finer than coarse clay (smaller than 0.002 mm). Eighty-four percent of the overburden material was coarse sand and larger particles, and only 3.9 percent was clay. Soil exposed on the access road contained 55 percent coarse sand and larger particles and 6.2 percent clay; and soil exposed in the diversion channel contained 60 percent coarse sand and larger particles and 13 percent clay. Thirteen samples of suspended sediment were collected from the diversion channel and analyzed for particle-size distribution. None contained more than 2 percent sand, and the average sand content was 0.5 percent. The average percentage of clay in the suspended-sediment samples collected from the diversion terrace was 58 percent--about 4 times the percentage in the soil exposed on the diversion terrace. These data indicate that most of the material transported by the diversion terrace was silt and clay, and that sand is either not eroded or is deposited before it reaches the gage.

Table 2.--Summary of the particle-size distribution of soil and suspended sediment in samples collected from the contour mine in Clearfield County

[Some figures do not add to 100 because of rounding]

Sampling location	Particle-size distribution				
	Sand		Silt	Clay	
	Coarse	Medium and fine		Coarse	Medium and fine
Overburden	84	5	7	1	3
Soil on access road	55	19	20	2	4
Soil in diversion channel	60	11	16	3	10
Suspended sediment from diversion channel	0	1	42	15	43

Suspended-Sediment Yield

Before mining

From May 1980 through September 1981, the contour-mine site remained idle. Suspended sediment discharged by the diversion terrace originated from the area where timber had been removed, from the access road, and from the diversion terrace. The relation between daily mean water discharge and daily suspended sediment discharged by the diversion terrace from May 1980 through September 1981 is shown in figure 16. During the 17 months, water and sediment discharge totaled 5.0 ft^3/s-day and 23 tons. Average annual sediment yields from the 5.01-acre area were calculated using the relations shown in figure 16 and an estimated flow-duration curve based on the flow-duration curve for Mahoning Creek at Punxsutawney. The average annual yield from the 5.01-acre area prepared for contour mining was 6.3 tons/acre.

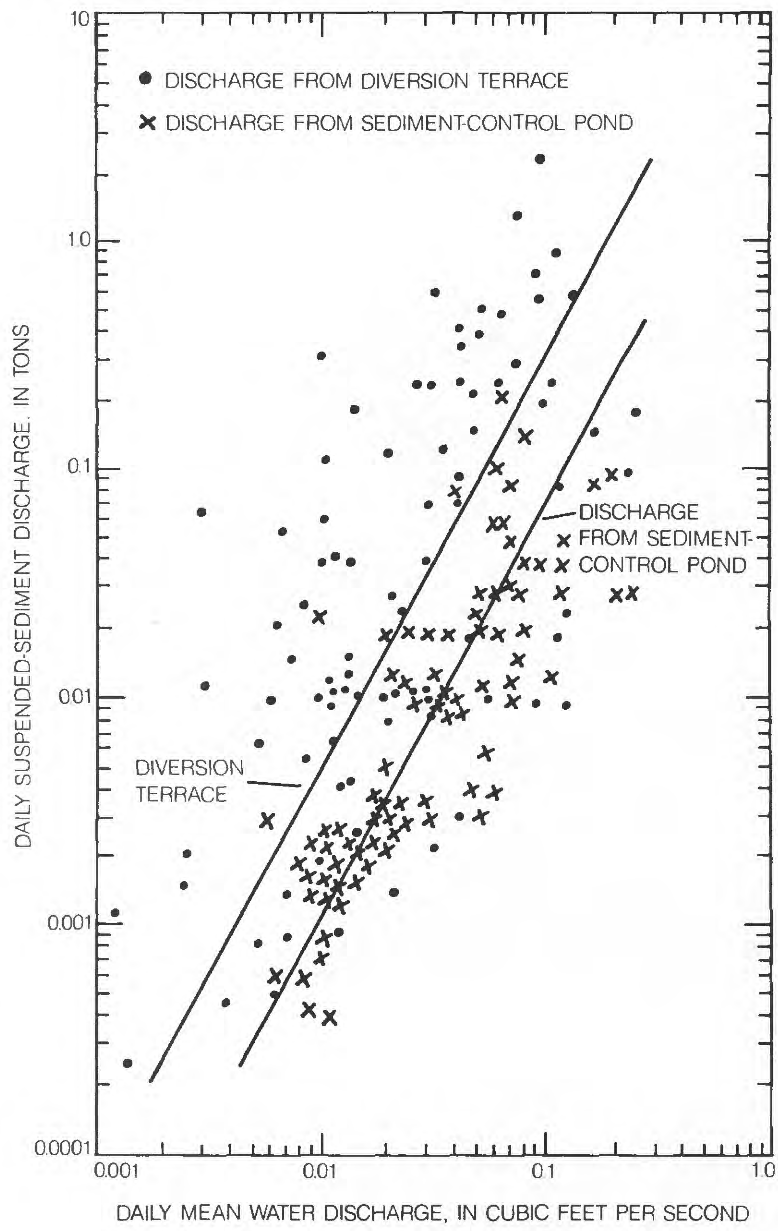

Figure 16. -- Sediment-transport curves showing the relation between daily mean water discharge and daily suspended-sediment discharge from the diversion terrace and from the sediment-control pond at the contour mine in Clearfield County, May 1980 through September 1981.

During mining

From October 1981 through April 1983, the site was mined by the contour method. When mining started, a pit, or first cut, was excavated parallel with and just upslope of the diversion terrace (fig. 14). The first cut was about 100 ft wide and was excavated to a depth exposing the coal bed. Soil and rock from the cut were hauled to a nearby area and stockpiled. After the coal was removed, the surface soil on the next upslope area was stockpiled and the rock overburden was moved downslope into the pit made by the first cut. Figure 17 shows a cross-section of the mining operation when the third cut was being made. Excavation of the first cut reduced the effective drainage area of the basin from 5.01 to 2.32 acres. The diversion terrace was lengthened 670 ft and its area increased to 0.23 acre; 0.14 acre was the access road (it had been shortened), 0.40 acre was exposed subsoil, and 1.55 acres was rock and spoil.

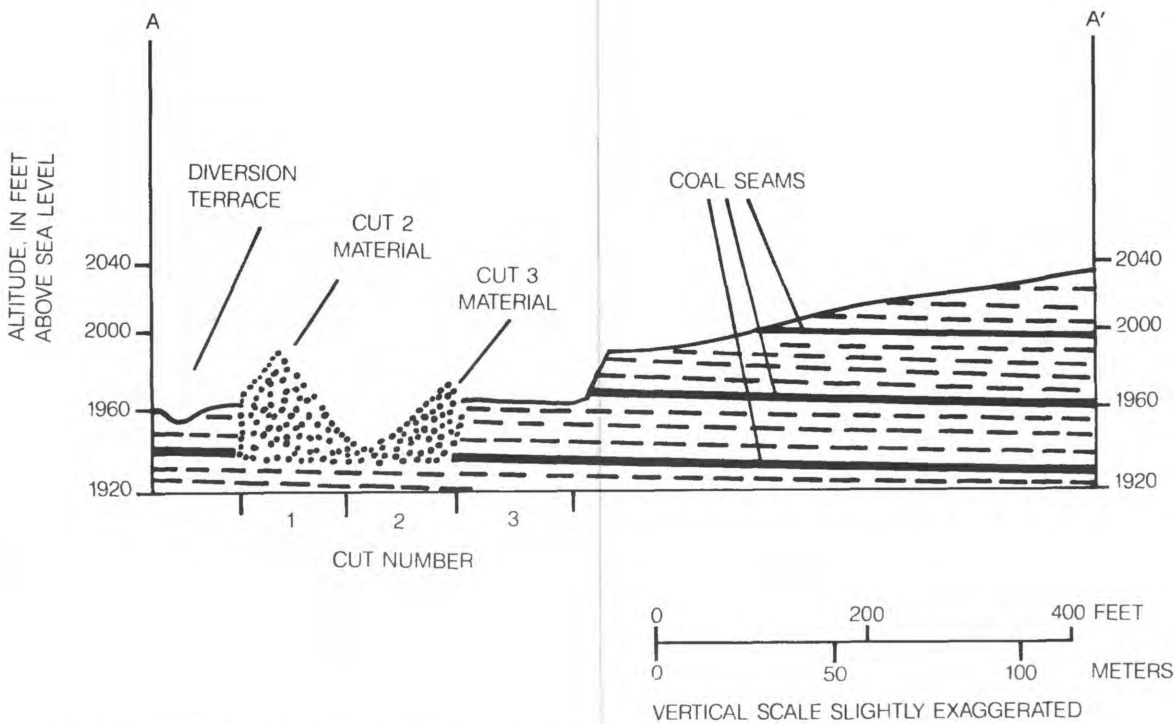

Figure 17.--Geologic section at the contour mind in Clearfield County after removal of the top seam of coal from the area of the third cut.

From October 1, 1981 through April 10, 1983, most of the sediment discharged from the site originated from the diversion terrace, the access road, and the adjacent disturbed areas. During this period of mining, water discharge to the sediment-control pond totaled 2.3 ft^3/s-day and the sediment discharge to the pond was 7.0 tons.

Figure 18 shows the relation between daily mean water discharge and daily sediment discharge from the diversion terrace for the 1982 water year (October 1, 1981, through September 30, 1982). Average annual sediment discharges were calculated from this relation and a flow-duration curve developed from the data collected from the diversion terrace for the 1982 water year and adjusted to long-term conditions. The average annual sediment discharge from the diversion terrace was 13 tons. Average annual suspended-sediment yields from the 2.32-acre area were 5.5 (tons/acre)/yr (tons per acre per year).

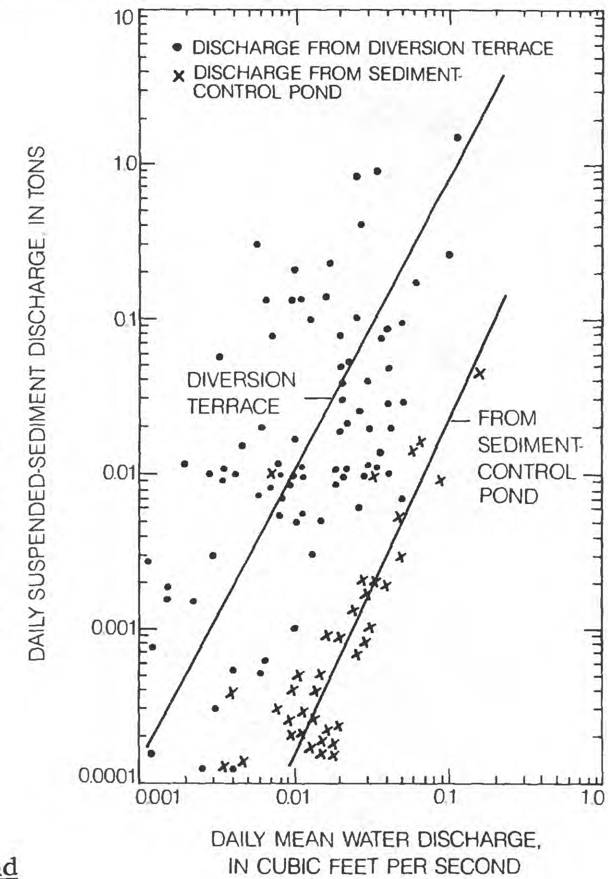

Figure 18.--Sediment transport curves showing the relation between daily mean water discharge and daily suspended-sediment discharge from the diversion terrace and from the sediment-control pond at the contour mine in Clearfield County, October 1, 1981, through September 30, 1982.

Effect of the sediment-control pond

The relation between daily mean water discharge and daily suspended sediment discharged out of the sediment-control pond from May 1980 through September 1981 also is shown in figure 16. During the 17 months, sediment discharge from the sediment-control pond was 1.91 tons (the trap efficiency was 92 percent). Average annual sediment yields from the 5.20-acre area at the outlet of the sediment-control pond were calculated using the relations shown in figure 16 and an estimated flow-duration curve based on the flow-duration curve of Mahoning Creek at Punxsutawney. The average annual yield below the sediment-control pond was 0.50 ton/acre.

Figure 18 shows the relation between daily mean water discharge and daily sediment discharge from the sediment-control pond for the 1982 water year. The total sediment discharge from the pond during the year was 0.16 ton. The average annual sediment discharge from the pond was 0.32 ton, and the yield from the 2.51-acre area was 0.14 (ton/acre)/yr. The data collected at the contour mine site before and during mining are summarized in table 3.

Table 3.--Summary of water and sediment discharges from the contour mine in Clearfield County, May 16, 1980, through April 10, 1983

[Concentrations are discharge-weighted mean concentrations for the indicated period; mg/L, milligrams per liter; (ft^3/s)-day, cubic feet per second-days]

	Discharge from diversion terrace			Outflow from sediment-control pond		
	Water discharge	Suspended sediment		Water discharge	Suspended sediment	
Period	(ft^3/s)-day	Average concentration (mg/L)	Discharge (tons)	(ft^3/s)-day	Average concentration (mg/L)	Discharge (tons)
May 16, 1980, through September 30, 1981	5.0	1,720	23	5.2	137	0.98
October 1, 1981, through September 30, 1982	1.7	1,430	6.5	2.0	28	.16
October 1, 1982, through April 10, 1983	.62	269	.45	.81	16	.04

Block-Cut Mine Area in Fayette County

Description

Another area monitored during the project was a site that was being surface mined by the block-cut method in Fayette County. Where surface mining is done by the block-cut method, the first cut is made at one end of the area perpendicular to the contour and generally from the bottom of the slope to the top of the hill. Rock and soil from the first cut are hauled to an adjacent area. After the coal has been removed from the first cut, the second cut is started. Soil from the second cut is stockpiled, but the rock overburden is placed in the first cut and graded to the original contour. Soil from the third cut is used to cover the overburden in the first cut, which is then reseeded. At that time reclamation work on the first cut is completed. Reclamation can occur concurrent with mining. However, in practice, there is usually a lag between the time reclamation can be done and when it is done. At this site, mining began shortly after the sediment-control pond and the diversion terrace had been constructed during April 1979. Mining proceeded rapidly until 10 acres had been mined and 5 acres had been reclaimed. Most mining activity at the site was discontinued then because of a decline in the demand for coal.

Soils are classified (U.S. Department of Agriculture, 1973) as Gilpin very stony loams and belong to the Gilpin-Wharton-Ernest association and are moderately erodible. Before mining, most of the soils had an organic layer of leaf litter and humus over the surface. The topsoils were dark grayish-brown channery silt loams and were as thick as 7 in. The subsoils were yellowish-brown silty clay loams and channery silty clay loams and were 24 to 36 in. thick.

The total area of the mine, including terraces and the sediment-control pond, was 17.9 acres (fig. 19). The south diversion channel occupied an area of 0.4 acre and drained an area of 3.8 acres. The total disturbed area was 4.2 acres, and the average slope was 17 percent. The average slope of the diversion channel was 3 percent. Although mining at the site ceased in the fall of 1980, reclamation work on the area drained by the south diversion continued. Soil had been spread on the entire 4.2-acre area before data collection began in July 1981 (fig. 20), but the area was not seeded until October 1981. The October seeding did not germinate and only about 10 percent of the area was covered with vegetation in the spring of 1982. On July 1, 1982, the area was reseeded, and, by September 1982, about 70 percent of the area was covered with vegetation. The following year, a good stand of vegetation was established. The particle-size distribution of the surface soils was 43 percent sand or larger particles, 31 percent silt, and 26 percent clay.

The north diversion channel occupied 0.6 acre and drained an additional 10.5 acres. The total area that it drained was 11.1 acres. During the period of data collection, the north diversion terrace drained an area of 3.7 acres that had been disturbed by mining; 0.3 acre was still wooded, and 6.5 acres drained to the pit. Top soil had not been spread on the 3.7-acre area; the surface consisted of subsoil and overburden rock during the period of data collection. The average slope of the area was 17 percent, and the average slope of the diversion channel was 3 percent. The sediment-control pond received drainage directly from 2.3 acres, and the pond surface occupied an additional 0.3 acre at the altitude of the emergency spillway.

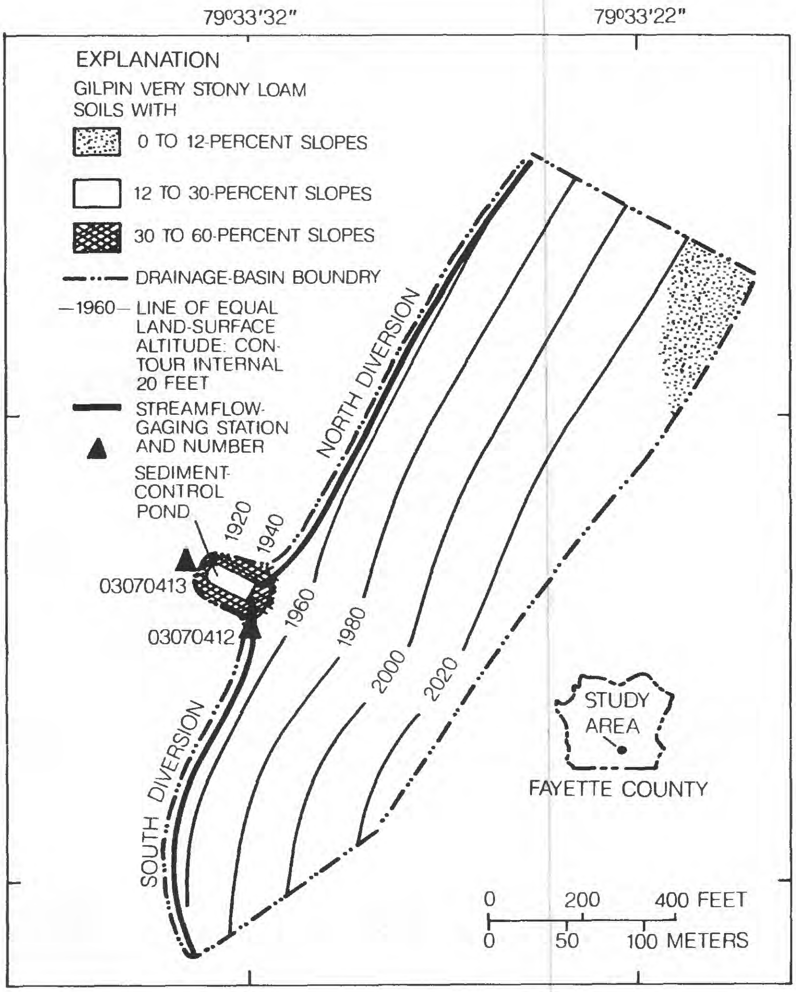

Figure 19.--The block-cut coal mine in Fayette County.

Figure 20.--An upslope view of the area drained by the south diversion terrace at the block-cut surface mine in Fayette County, July 12, 1981, before seeding.

Data collection began in July 1981 and continued through September 1983. A raingage was installed in the area drained by the south diversion (fig. 19), and a stage recorder and an automatic sediment-sampler were installed where the south diversion channel drains into the sediment-control pond. A weir and a nonrecording gage were installed in the north diversion channel, and samples were collected during several storms to compare the sediment loads from the north diversion with those from the south diversion. A stage recorder was installed in the sediment-control pond to record changes in the water level of the pond during storms. The change in pond stage was used with the stage-capacity curve for the pond to compute runoff volumes and runoff rates from the entire area during storms. A stage recorder and an automatic sediment-sampler also were installed downstream from the sediment-control pond.

The sediment-control pond (fig. 21) was constructed with a permanent pool capacity of 60,200 ft^3. The permanent pool capacity could be increased to 128,900 ft^3 by closing a 3-in. valve. With the valve open, the depth in the pond was 6 ft, but, if the pond were operated with the valve closed, the depth increased to 11 ft--the top of the 24-in. drop outlet. The capacity of the pond at the top of the emergency spillway was 174,500 ft^3.

Figure 21.--Sediment-control pond at the block-cut mine in Fayette County.

Several samples of suspended sediment were analyzed for particle-size distribution; the results are summarized in table 4. Eight of the samples were collected from the south diversion and three were collected at the discharge from the sediment-control pond. The samples of the discharge to the sediment-control pond averaged 50 percent clay, the sample of sediment deposited in the pond contained 52 percent clay, and the samples of the sediment-pond discharge averaged 53 percent clay. The trap efficiency of the sediment-control pond is partially dependent on the particle-size distribution of the inflowing sediments. Except for sand, the particle-size distribution of the sediment samples was similar. Samples of the discharge from the sediment-control pond analyzed for particle-size distribution generally were collected within 10 minutes of the peak inflow; consequently, most silt and clay remained in suspension.

Table 4.--Summary of the particle-size distribution of soil, suspended-sediment, and deposited-sediment samples collected from the block-cut mine in Fayette County

[Values are percentages of total]

Sampling location	Number of samples	Particle-size Distribution			
		Coarse sand	Fine sand	Silt	Clay
Reclamation soil	2	31	7	36	26
Discharge from south diversion	8	0	5	45	50
Discharge from north diversion	1	0	6	48	46
Discharge from sediment-control pond	3	0	0	47	53
Core sample of sediment deposited near the center of the sediment-control pond	1	0	1	47	52

Suspended-Sediment Yield

The relations between water and sediment discharge from the south diversion for each of the 3 years of data collection are shown on figure 22. Also shown are the data collected from the discharge from the sediment-control pond for the 3-year period. Annual yields were estimated from the 3 months of available data in 1981 and were calculated by the method described earlier for 1982 and 1983. The yields from the south diversion were 77 tons/acre in 1981 when there was no vegetation (fig. 20) and 32 tons/acre in 1982 when vegetation was sparse (fig. 23). Data for 1983 from this site are discussed in a section of this report on sediment yields after reclamation. The average annual yield from the sediment-control pond during 1982 was 0.19 ton/acre; the trap efficiency was about 99 percent.

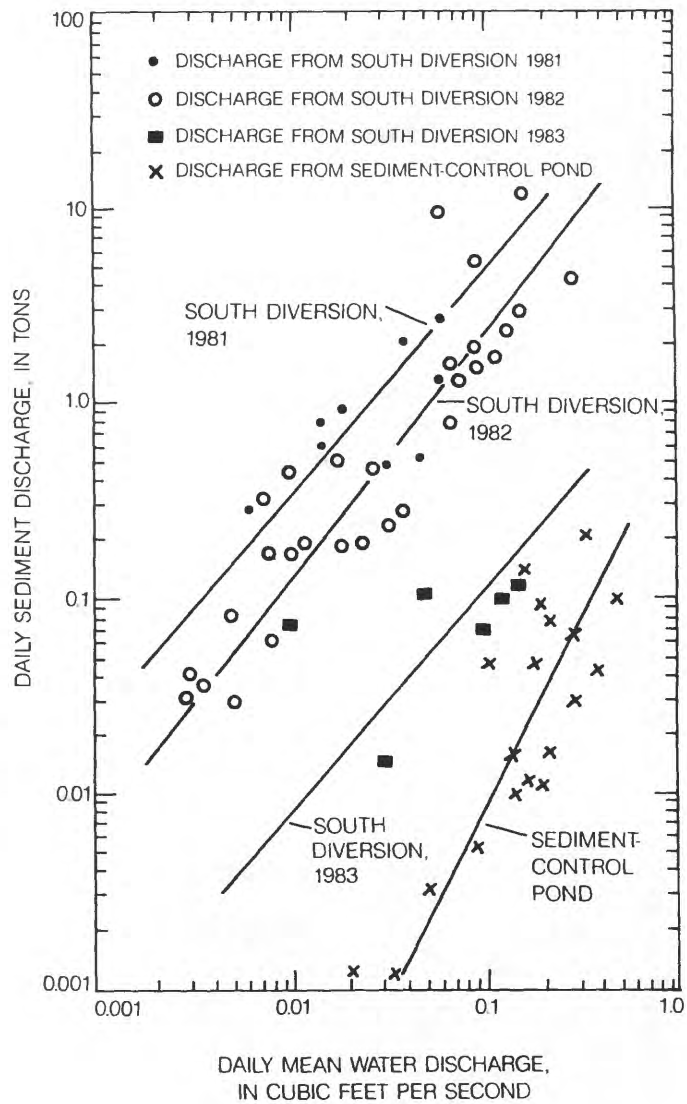

Figure 22.--Sediment-transport curves showing the relation between daily mean water discharge and daily suspended-sediment discharge from the south diversion tgerrace and from the sediment-control pond at the block-cut surface mine in Fayette County, July 1, 1981, through September 30, 1983.

Figure 23.--Upslope view of the area drained by the south diversion terrace at the block-cut surface mine in Fayette County, April 10, 1982.

Effect of Sediment-Control Pond

The pond was surveyed on December 30, 1980, and again on September 30, 1982, to determine the decrease in storage capacity resulting from sedimentation. On December 30, 1980, the average thickness of the sediment in the pond was 0.4 ft. Thickness of accumulated sediment in the pond on September 30, 1982 is represented by the core sample shown on figure 24. The decrease in storage capacity from April 1979, when the pond was constructed, through December 30, 1980, was 2,900 ft^3, and the decrease from December 30, 1980, through September 30, 1982, was 23,500 ft^3. Precipitation from April 1979 through December 30, 1980, was 80.43 in., and precipitation from December 30, 1980, through September 30, 1982, was 74.30 in. A core sample of the material deposited near the center of the sediment-control pond was collected on September 30, 1982, and analyzed for particle size and density. The depth of sediment at the site where the core was collected was 3.4 ft, and the core was 1 percent sand, 47 percent silt, and 52 percent clay. The density of the deposited sediment was 49.5 lb/ft^3 (pounds per cubic feet). If the core is assumed to be representative of the entire pond, the weight of the sediment deposited in the pond from December 30, 1980, through September 30, 1982, was 580 tons. The average annual sediment yield for the 21-month period was 31 tons/acre (average disturbed area was 10.8 acres). This high yield is partly the result of the extensive time between reclamation and the establishment of vegetation.

Figure 24.--One of the core samples collected from the sediment-control pond in Fayette County, September 30, 1982.

SUSPENDED-SEDIMENT YIELD FROM MINED AREAS AFTER RECLAMATION

Surface Mine in Tioga County

Rainfall, streamflow, and suspended-sediment data were collected below an area in Tioga County that had been surface mined and was being reclaimed (fig. 25). The site is a 32.4-acre area north of the Hunter Drift (fig. 5). Data were collected at the outlet of a diversion terrace from September 28, 1981, through September 30, 1983.

Description of Reclamation

In August 1981, the site was recontoured, diversion terraces were installed, soil was spread, and the area was seeded. After reclamation, the land-surface slope averaged about 5 percent, and the diversion terrace slope about 3 percent. In September 1981, vegetation on the site was about 2 in. high, and ground cover was about 20 percent. By August 1982, vegetation was 2 ft high, and ground cover was about 80 percent; and by August 1983, vegetation was well established over the entire area.

Figure 25.--The 32.4-acre reclaimed surface mine north of the Hunter Drift, November 18, 1981.

Suspended-Sediment Yields after Reclamation

Figure 26 shows the relation between daily mean water discharge and daily suspended-sediment discharge for the reclaimed site for the 1982 and 1983 water years. Figure 26 shows that storms that occurred during the 1983 water year produced smaller sediment discharges than those that occurred during the first year. The sediment yields were 1.0 ton/acre during the first year and 0.037 ton/acre during the second year. The yield during the second year was about 10-fold higher than the yields calculated for the forested area of Basswood Run prior to mining but significantly lower than the 0.48 ton/acre yield calculated from the agricultural area in the Wilson Creek basin.

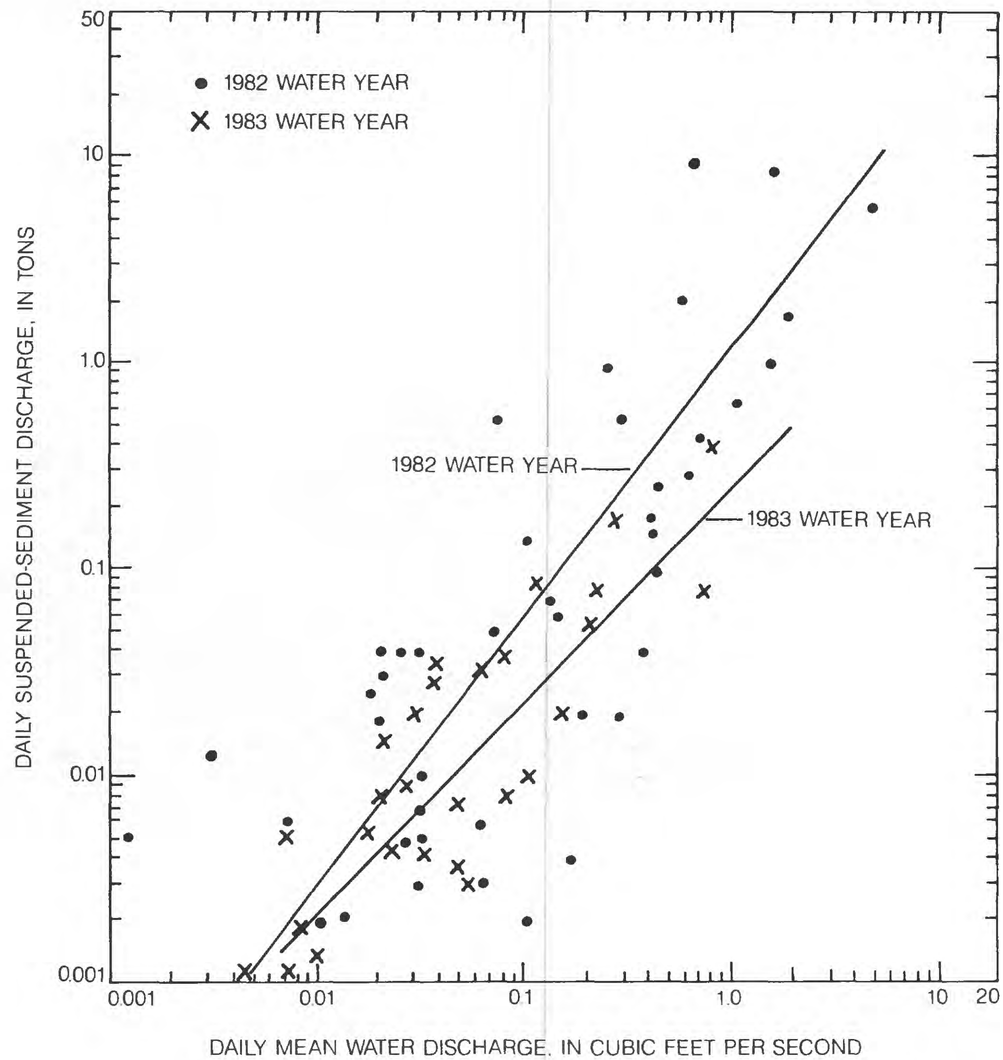

Figure 26.--Sediment-transport curves showing the relation between daily mean water discharge and suspended-sediment discharge from the 32.4-acre reclaimed surface mine in Tioga County, October 1, 1981, through September 30, 1982, and October 1, 1982, through September 30, 1983.

Contour Mine in Clearfield County

Rainfall, water discharge, and suspended-sediment data were collected from April 15 to September 30, 1983, from a 21.2-acre reclaimed surface mine in Clearfield County that had been mined by the contour method. The reclaimed area (fig. 27) is 3,700 ft southeast of the area described in the preceeding section. The data-collection equipment was moved to the new site, because mining was proceeding at a much slower rate than originally anticipated and because the estimated reclamation date at the original site was extended from 1983 to 1985.

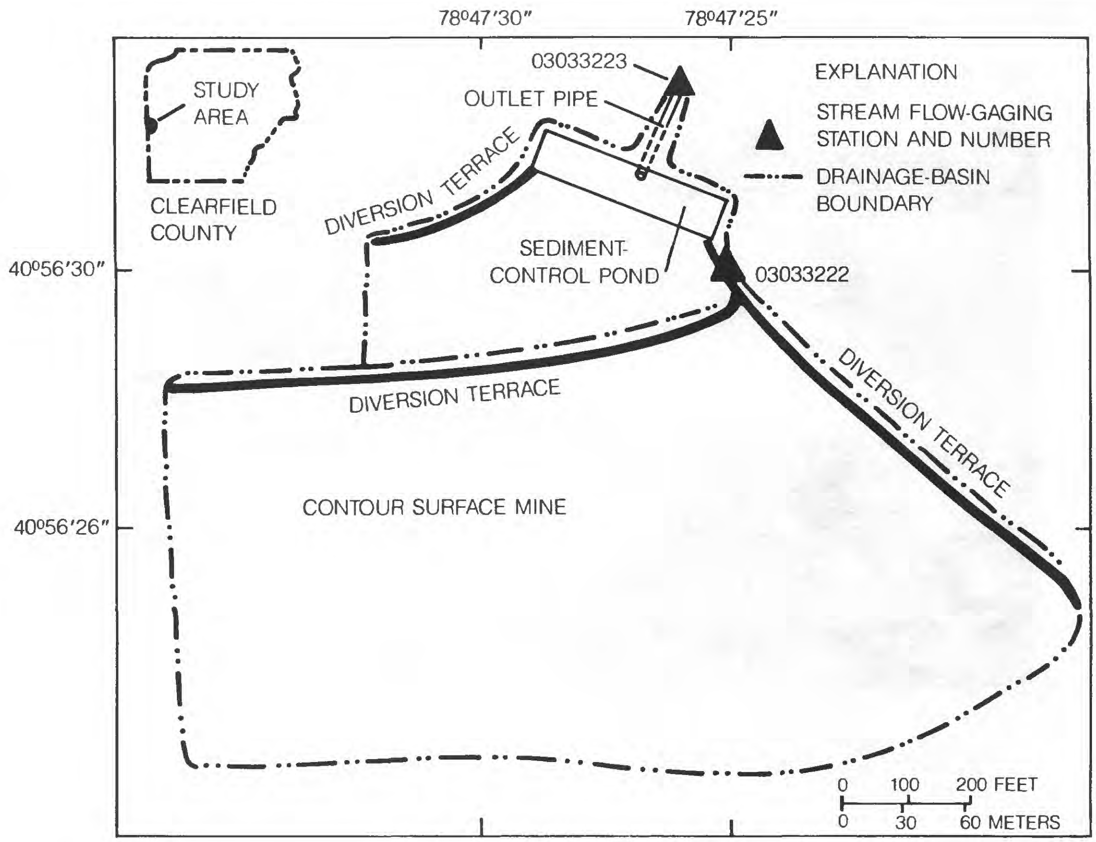

Figure 27.--Reclaimed 21.2-acre contour surface mine in Clearfield County.

The new sediment-control pond was 280 ft by 37 ft and had a permanent pool capacity of 43,000 ft^3, a capacity at the principal spillway of 104,000 ft^3, and a maximum capacity of 191,000 ft^3 at the level of the emergency spillway (fig. 28). The water level between the permanent pool and the principal spillway was controlled by a 2.0-in. drain pipe that could be closed to increase the permanent pool level to the level of the principal spillway, a 15-in. horizontal pipe through the embankment.

Figure 28.--Sediment-control pond at the reclaimed mine in Clearfield County, May 12, 1983.

The undisturbed soils at the mine were classified (U.S. Department of Agriculture, 1973) as Gilpin very stony loams of the Gilpin-Wharton-Ernest association and were moderately erodible. Before mining, the soils were classified (U.S. Department of Agriculture, 1964) as Ernest and Cavode very stony silt loams and Dekalb very stony loams and had an organic layer of leaf litter and humus over the surface. The topsoils were dark grayish-brown loams. The subsoils were brown and yellowish-brown loams and ranged in thickness from 3 to 20 ft. After mining the reclaimed soils were about 1.5 ft thick and the particle-size distribution was approximately 43 percent sand or larger particles, 31 percent silt, and 26 percent clay or smaller particles. The average land slope was 20 percent, and the slope of the diversion terrace was 7 percent. Figure 29 shows the eastern end of the reclaimed area on May 12, 1983.

Figure 29.--The eastern half of the reclaimed surface mine in Clearfield County, May 12, 1983.

Seven samples of the discharge from the diversion terrace and two samples of the discharge from the sediment-control pond were analyzed to determine the particle-size distribution of the suspended sediments. The suspended-sediment concentrations of samples from the diversion terrace ranged from 2,070 to 35,500 mg/L; the median was 13,000 mg/L. The particle-size distribution ranged from 1 to 23 percent sand or larger particles (median, 7), from 27 to 44 percent silt (median, 41), and from 40 to 68 percent clay (median, 50). One of the samples of the discharge from the sediment-control pond had a suspended-sediment concentration of 2,470 mg/L and consisted of 91 percent clay; the other had a suspended-sediment concentration of 4,500 mg/L and consisted of 79 percent clay. There was only a small amount of sand-sized material in the two samples.

Description of Reclamation

The surface mine had been reclaimed during the fall of 1982, and, when data collection began, the vegetation covered about 10 percent of the area and was 3 in. high. The original diversion terrace and sediment-control pond that had been built at this site were replaced during reclamation. The new diversion terrace was constructed on reclaimed soil, but the new sediment-control pond was built in an undisturbed area.

Suspended-Sediment Yield after Reclamation

Sediment data were collected from April 15 through September 30, 1983--a time when the area was becoming stabilized with vegetation. The relation between daily mean water discharge and daily suspended-sediment discharge is shown in figure 30. The average annual sediment discharge was 318 tons, and the average annual sediment yield was 15 tons/acre.

Effect of Sediment-Control Pond

Figure 30 also shows the plot of daily mean water discharge as a function of daily sediment discharge from the sediment-control pond. The average annual yield from the sediment-control pond was 0.30 ton/acre; the trap efficiency was 98 percent. The sediment-control pond was surveyed on July 15, 1983, and the sediment deposition from the time the pond was constructed in August 1982 was calculated to be 275 tons. This determination is comparable to the differences in average annual sediment yields computed for the inflow and outflow of the pond.

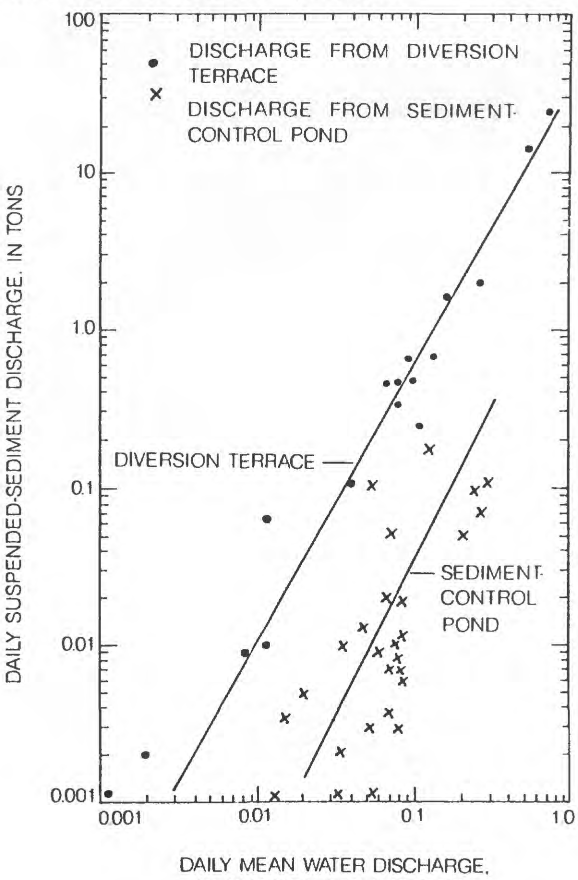

Figure 30.--Sediment-transport curves showing the relation between daily mean water discharge and daily suspended-sediment discharge from the reclaimed area and from the sediment-control pond at the reclaimed surface mine in Clearfield County, April 15 through September 30, 1983.

Block-Cut Mine in Fayette County

Description of Reclamation

On July 1, 1982, the area drained by the south diversion at the surface mine in Fayette County was seeded, and, by September 1982, about 70 percent of the area was covered with vegetation. The following year, a vigorous stand of vegetation was established. Vegetation was higher than 2 feet by the end of June (fig. 31), and nearly 100 percent of the area was covered.

Suspended-Sediment Yields after Reclamation

The relations between water and sediment discharge from the south diversion for 1983 is shown on figure 22. The yields from the south diversion were 1.0 ton/acre in 1983 when vegetation was well established. This yield was significantly less than the 77-tons/acre yield estimated from the data available for 1981 when the area was not protected by vegetation and the 32-tons/acre yield during 1982 when the area was only partially protected by vegetation.

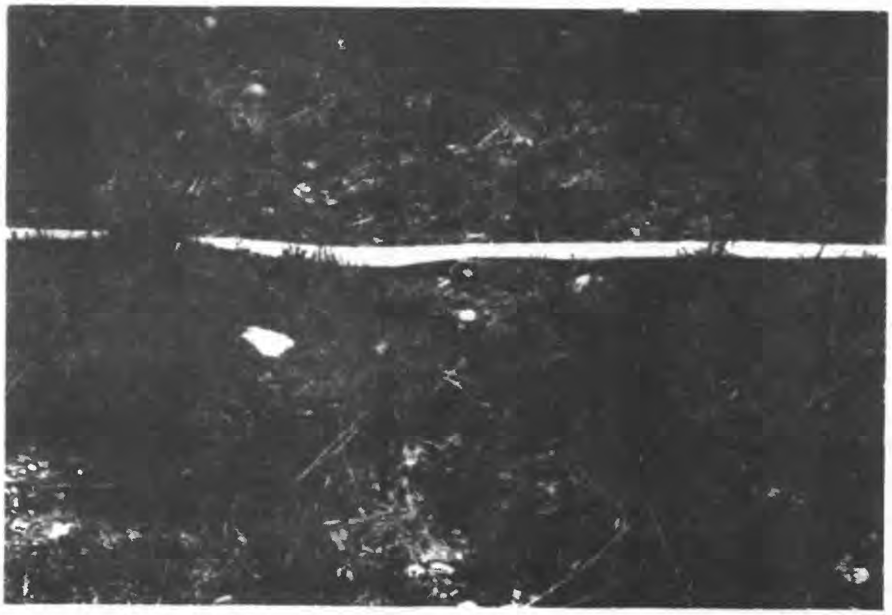

Figure 31.--Typical cover of vegetation on the area drained by the south diversion terrace at the block-cut surface mine in Fayette County, June 23, 1983.

COMPARISON OF SUSPENDED-SEDIMENT YIELDS FROM AN UNMINED AREA AND FROM MINED AREAS BEFORE AND AFTER RECLAMATION

Although there was considerable variation in the sediment yields between the different mine locations, a pattern of variation was evident. Sediment yields tended to increase sharply during initial land-clearing activities, decrease during active mining, and then increase again immediately after reclamation (table 5). Major sources of sediment apparently are the areas where the surface materials have been disturbed by traffic and grading, such as haul roads and newly-reclaimed areas. Yields from these areas were 100- to 300-fold greater than the yield from an agricultural area of hay, pasture, and some corn.

Table 5.--Average annual suspended-sediment yields from two unmined areas in Tioga County and areas in Tioga, Clearfield, and Fayette Counties associated with surface mining

Site	Drainage area (acres)	Major land use affecting sediment yields (use)	(acres)	Average annual sediment yield (tons per acre)
		Unmined areas		
		Tioga County		
Wilson Creek above Sand Run near Antrim	8,060	Generally agricultural	5,240	0.48
Basswood Run above Hunter Drift	365	Forested (prior to mining)	365	.0036
		Areas affected by active surface mining		
		Tioga County		
Rattler Run near Morris	205	Improved haul road	1.20	22
Basswood Run above Hunter Drift	180	Unimproved haul road	1.20	148
		Clearfield County		
Discharge from diversion terrace at surface mine near McGees Mills	5.01	Prepared for surface mining	5.01	6.3
Discharge from sediment-control pond below a surface mine near McGees Mills	5.20	Below sediment-control pond	5.20	.50
Discharge from diversion terrace at a surface mine near McGees Mills	2.32	Overburden piles and diversion terrace	2.32	5.5
Discharge from sediment-control pond below a surface mine near McGees Mills	2.51	Below sediment-control pond	2.51	.14

Table 5.--Average annual suspended-sediment yields from two unmined areas in Tioga County and areas in Tioga, Clearfield, and Fayette Counties associated with surface mining--Continued

Site	Drainage area (acres)	Major land use affecting sediment yields (use)	(acres)	Average annual sediment yield (tons per acre)
		Surface mines being reclaimed		
		Tioga County		
Reclaimed surface mine near Antrim	32.4	Moderate vegetation	32.4	1.0
Reclaimed surface mine near Antrim	32.4	Good vegetation	32.4	.037
		Clearfield County		
Reclaimed surface mine near McGees Mills	21.2	Moderate vegetation	21.2	15.
Discharge from sediment-control pond below reclaimed surface mine near McGees Mills	24.0	Below sediment-control pond	24.0	.30
		Fayette County		
Discharge from diversion terrace at surface mine near Farmington	4.2	Reclaimed area with no vegetation	4.2	77
Discharge from diversion terrace at surface mine near Farmington	4.2	Reclaimed area with sparse vegetation	4.2	32
Discharge from diversion terrace at surface mine near Farmington	4.2	Reclaimed area with good vegetation	4.2	1.0
Discharge from sediment-control pond below surface mine near Farmington	17.9	Below sediment-control pond	10.8	.19

SUMMARY AND CONCLUSIONS

Rainfall, streamflow, and suspended-sediment data were collected from June 1978 through September 1983 with automatic recording and sampling equipment from an unmined area and from several areas affected by surface mining. The unmined area is in Tioga County, and the surface mines are in Tioga, Clearfield, and Fayette Counties. Surface-mining activities at the sites where data were collected included (1) an improved haul road, (2) an unimproved haul road, (3) an area with 15-percent slopes from the time it was prepared for contour surface mining until mining had continued for 1 year, (4) a reclaimed area with 5-percent slopes, (5) an area with 20-percent slopes that had been recently reclaimed, and (6) an area in the process of being reclaimed that had been mined by the block-cut method. Data also were collected below three sediment-control ponds.

Average annual sediment yields were computed for the study areas by using the flow-duration, sediment-rating curve method. In Tioga County, the average annual suspended-sediment yield from an unmined 12.6-mi^2 agricultural area was 0.48 ton/acre, and the average annual yield from a 365-acre forested area prior to mining was 0.0036 ton/acre.

Average annual sediment yields, from June 1978 through August 1980, from areas affected by surface mining were 22 tons/acre from a 1.2-acre improved haul road and 148 tons/acre from a 1.2-acre unimproved haul road in Tioga County. From May 1980 through September 1981, average annual sediment yields were 6.3 tons/acre from a 5.01-acre area that was being prepared for mining in Clearfield County. From October 1981 through April 1983, average annual sediment yields from the same area were 5.5 tons/acre when it was being mined; however, mining decreased the effective drainage area to 2.32 acres. Average annual sediment yields below a sediment-control pond at the site reduced the sediment yield to 0.50 ton/acre while the site was prepared for mining and to 0.14 ton/acre while the site was being mined. The sediment-control pond had a permanent storage capacity of 16,900 ft^3 and a surface area of 4,400 ft^2.

Sediment yields from a 32.4-acre area being reclaimed in Tioga County were 1.0 ton/acre from October 1981 through September 1982, when vegetation was becoming established, and 0.037 ton/acre during the following year, when vegetation was well established. Sediment yields from a 21.2-acre area in Clearfield County that had been reclaimed were 15 tons/acre from April 15 through September 30, 1983, the time when vegetation was becoming established. The sediment-control pond at this site had a permanent pool capacity of 43,000 ft^3 and a capacity at the principal spillway of 104,000 ft^3. The average annual sediment yield below the sediment-control pond was reduced to 0.30 ton/acre.

Average annual sediment yields from an area in Fayette County that had been mined and was in the process of being reclaimed were: 77 tons/acre in 1981, when soil had been spread but there was no vegetation; 32 tons/acre in 1982, when there was sparse vegetation; and 1.0 ton/acre in 1983, when vegetation was well established. The sediment-control pond at the mine site in Fayette County was constructed with a permanent pool capacity of 60,200 ft^3, and the effective drainage area of the pond during the study was 10.8 acres. The average annual sediment discharge below the sediment-control pond was 0.19 ton/acre during the 27 months of data collection.

Several of the suspended-sediment samples collected from the discharges from the sites affected by surface mining were analyzed for particle-size distribution. The clay content of samples collected from the contour mine in Clearfield County averaged 58 percent; the clay content of samples collected from the reclaimed mine in Clearfield County, 50 percent; and the clay content of samples collected from the mine site being reclaimed in Fayette County, 50 percent.

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Appendix--Water and suspended-sediment discharge data from actively mined and reclaimed mined areas in Tioga, Clearfield, and Fayette Counties

03033226 Discharge from diversion terrace at a surface mine near McGees Mills

Location.--Lat 40°56'54", long 78°48'04", Clearfield County, 5 mi northwest of McGees Mills

Sediment discharge, suspended (tons/day), May 16, 1980, through April 10, 1983
[mg/L, milligrams per liter; ft^3/s, cubic feet per second]

Date	Mean water discharge (ft^3/s)	Mean concentration (mg/L)	Sediment discharge (tons/day)	Date	Mean water discharge (ft^3/s)	Mean concentration (mg/L)	Sediment discharge (tons/day)
May 16, 1980	0.01	8	0.0002	October 11	0.01	1,800	0.05
17	.01	10	.0003	25	.10	920	.25
18	.03	550	.04	26	.01	50	.001
19	.02	20	.001	28	.01	400	.01
20	.01	15	.0004				
21	.01	430	.02	November 8	.01	2,000	.05
22	.01	15	.0004	9	.01	2,400	.06
23	.01	12	.0003	23	.01	400	.01
24	.01	10	.0003	24	.04	800	.09
31	.01	15,000	.39	25	.01	20	.0005
June 2	.01	820	.02	27	.01	150	.004
3	.03	7,100	.62	28	.01	20	.0005
4	.01	20	.0005				
7	.07	6,940	1.3				
8	.06	1,090	.16	December 1	.02	200	.01
				2	.04	930	.10
9	.05	1,940	.24	3	.01	40	.001
10	.02	15	.0008	4	.01	20	.0005
11	.01	10	.0003	5	.01	12	.0003
12	.01	10	.0003				
15	.01	5,000	.19	6	.01	8	.0002
				7	.01	15	.0004
20	.003	8,600	.06	8	.01	80	.002
29	.01	12,200	.33	9	.03	120	.01
				10	.01	25	.0007
July 3	.03	12,400	1.1				
8	.07	15,100	2.9	11	.01	17	.0005
15	.06	15,000	2.2	12	.01	12	.0003
16	.08	9,300	2.0	13	.01	25	.0007
17	.03	48	.004				
18	.01	20	.0005	January 26, 1981	.01	50	.001
21	.01	650	.02	27	.01	30	.0008
22	.04	1,310	.13				
23	.01	20	.0005				
27	.0009	3,800	.009	February 1	.05	150	.02
29	.02	21,700	.88	12	.01	30	.0008
				13	.01	20	.0005
August 2	.09	5,000	1.3	16	.01	370	.01
3	.03	100	.01	17	.03	120	.01
4	.02	40	.002				
5	.02	20	.0008	18	.05	74	.01
6	.01	600	.02	19	.11	67	.02
				20	.25	300	.21
7	.01	30	.0008	21	.23	180	.11
8	.03	3,000	.21	22	.12	50	.02
9	.01	100	.003				
10	.01	400	.01	23	.12	280	.09
11	.02	350	.02	24	.09	20	.005
				25	.07	18	.003
12	.02	35	.002	26	.04	15	.002
13	.01	20	.0005	27	.02	12	.0006
14	.08	3,450	.79	28	.03	120	.01
15	.13	1,890	.65				
16	.06	40	.006				
				March 1	.01	10	.0003
17	.03	20	.001	2	.01	10	.0003
18	.02	10	.0005	3	.01	9	.0002
19	.01	10	.0003	4	.01	9	.0002
20	.01	10	.0003	5	.01	8	.0002
September 2	.007	2,900	.05	13	.01	50	.001
23	.0008	530	.001	14	.01	25	.0007
25	.001	74	.0002	15	.02	20	.001
				16	.01	15	.0004
				28	.01	100	.003
				29	.01	35	.0009
				30	.03	120	.01
				31	.01	18	.0005

Appendix--Water and suspended-sediment discharge data from actively mined and reclaimed mined areas in Tioga, Clearfield, and Fayette Counties--Continued

03033226 Discharge from diversion terrace at a surface mine near McGees Mills

Location.--Lat 40°56'54", long 78°48'04", Clearfield County, 5 mi northwest of McGees Mills

Sediment discharge, suspended (tons/day), May 16, 1980, through April 10, 1983
[mg/L, milligrams per liter; ft^3/s, cubic feet per second]

Date	Mean water discharge (ft^3/s)	Mean concentration (mg/L)	Sediment discharge (tons/day)	Date	Mean water discharge (ft^3/s)	Mean concentration (mg/L)	Sediment discharge (tons/day)
April 1, 1981	0.01	12	0.0003	August 29	0.01	30	0.0008
2	.03	120	.01	30	.01	18	.0005
3	.01	25	.0007				
5	.004	200	.002				
11	.01	250	.007	September 3	.01	3,200	.09
				4	.04	3,600	.39
12	.01	240	.006	8	.01	1,300	.03
13	.01	32	.0009	15	.01	1,700	.05
14	.05	220	.03				
15	.05	25	.003	October 1	.003	800	.006
16	.05	25	.003	2	.004	100	.001
				6	.008	350	.008
17	.04	20	.002	7	.01	100	.003
18	.02	15	.0008	18	.003	370	.003
19	.01	10	.0003				
20	.01	8	.0002	26	.01	370	.01
23	.01	80	.0022	27	.11	5,300	1.6
				28	.03	370	.03
24	.01	80	.0022	29	.01	20	.0005
25	.01	20	.0005				
26	.01	15	.0004				
27	.02	70	.004	November 5	.008	2,200	.05
28	.09	1,500	.37	6	.01	50	.001
				19	.004	1,000	.01
29	.16	360	.16	20	.006	80	.001
30	.12	20	.006	27	.01	200	.005
May 1	.06	15	.002				
2	.03	12	.001	December 2	.01	30	.0008
3	.02	10	.0005	3	.01	20	.0005
4	.01	8	.0002	8	.01	150	.004
6	.01	40	.001	23	.05	200	.03
				24	.02	30	.002
11	.02	2,400	.13	25	.01	10	.0003
12	.01	25	.0007				
13	.01	20	.0005				
14	.03	3,200	.26	January 4, 1982	.05	800	.11
15	.04	25	.003	5	.02	100	.005
				6	.01	10	.0003
16	.04	20	.002	7	.01	8	.0002
17	.01	15	.0004	30	.02	400	.02
18	.01	12	.0003	31	.10	1,000	.27
19	.01	14	.0004				
June 2	.01	1,200	.03	February 1	.03	100	.008
3	,01	740	.02	2	.02	20	.001
4	.04	2,200	.24	3	.01	8	.001
5	.01	20	.0005	4	.01	8	.0002
6	.01	15	.0004	15	.04	800	.09
9	.06	1,600	.26	16	.02	300	.02
10	.02	200	.01	17	.01	50	.001
11	.01	20	.0005	18	.01	10	.0003
14	.03	1,200	.10	23	.02	800	.04
15	.01	70	.002	24	.01	20	.0005
				25	.01	10	.0003
16	.06	3,300	.54				
17	.01	80	.002				
18	.01	20	.0005	March 11	.02	1,000	.05
19	.01	15	.0004	12	.03	300	.02
20	.01	10	.0003	13	.03	60	.005
				14	.02	20	.001
21	.01	830	.02	15	.03	10	.0008
22	.01	630	.02				
25	.05	3,300	.44	16	.03	10	.0008
				17	.04	500	.05
August 20	.09	2,500	.61	18	.02	60	.003
21	.02	460	.02	19	.03	500	.04
26	.04	3,800	.42	20	.02	20	.001
27	.01	45	.001				
28	.05	3,900	.52				

Appendix--Water and suspended-sediment discharge data from actively mined and reclaimed mined areas in Tioga, Clearfield, and Fayette Counties--Continued

03033226 Discharge from diversion terrace at a surface mine near McGees Mills

Location.--Lat 40°56'54", long 78°48'04", Clearfield County, 5 mi northwest of McGees Mills

Sediment discharge, suspended (tons/day), May 16, 1980, through April 10, 1983
[mg/L, milligrams per liter; ft^3/s, cubic feet per second]

Date	Mean water discharge (ft^3/s)	Mean concen-tration (mg/L)	Sediment discharge (tons/day)	Date	Mean water discharge (ft^3/s)	Mean concen-tration (mg/L)	Sediment discharge (tons/day)
March 21, 1982	0.04	200	0.02	November 3	0.03	140	0.01
22	.01	30	.0008	4	.002	10	.0001
23	.01	10	.0003	10	.001	40	.0002
24	.01	8	.0002	11	.008	550	.01
25	.02	100	.005	12	.02	10	.0005
26	.02	50	.003	20	.001	50	.0001
27	.01	10	.0003	21	.01	180	.005
28	.01	10	.0003	22	.01	90	.003
31	.02	1,000	.05	23	.01	10	.0003
				24	.004	10	.0001
April 1	.01	20	.0005				
3	.02	500	.03	28	.02	120	.005
4	.02	80	.004	29	.01	20	.0007
5	.01	10	.0003	30	.003	10	.0001
6	.01	8	.0002				
7	.01	8	.0002	December 15	.004	30	.0003
8	.02	200	.01	16	.02	100	.005
9	.02	20	.001	17	.002	10	.0001
10	.02	10	.0005	18	.01	30	.0009
11	.04	300	.03	19	.02	12	.0006
12	.04	80	.009	20	.004	15	.0002
13	.03	20	.002	21	.003	10	.0001
14	.01	10	.0003	22	.003	10	.0001
May 8	.007	4,400	.08				
22	.001	1,000	.003	January 11, 1983	.01	30	.0008
23	.01	8,400	.22	30	.01	20	.0005
24	.006	8,000	.14				
28	.03	10,000	.91	February 2	.03	150	.0122
				3	.01	20	.0005
29	.01	180	.005	4	.01	10	.0003
30	.004	1,300	.02	23	.01	20	.0005
31	.002	40	.0002	24	.01	20	.0005
June 5	.04	800	.08				
6	.01	13	.0004	March 10	.006	200	.003
10	.01	420	.01	11	.002	20	.0001
13	.02	5,200	.24	19	.004	200	.002
14	.003	30	.0002	20	.004	10	.0001
				21	.03	1,500	.10
16	.003	1,200	.01				
17	.002	2,200	.01	22	.004	30	.0003
28	.006	21,000	.32	23	.003	7	.0001
29	.01	2,900	.10	27	.02	1,500	.08
				28	.02	40	.002
July 3	.01	640	.02	29	.005	15	.0002
7	.003	6,900	.06				
27	.03	6,100	.42	30	.003	9	.0001
				31	.001	8	.0000
August 17	.03	13,000	.90				
20	.002	450	.002				
25	.01	5,400	.14	April 2	.001	8	.0000
				3	.004	10	.0001
September 2	.01	5,500	.15	4	.003	10	.0001
21	.006	450	.007	5	.001	10	.0000
22	.008	260	.006	6	.002	30	.0002
26	.0006	90	.0001				
27	.002	220	.001	7	.06	1,100	.18
28	.0003	100	.0001	8	.04	65	.007
				9	.03	85	.006
October 15	.001	330	.0009	10	.02	12	.0005
20	.007	430	.008				
31	.0007	330	.0006				

Appendix--Water and suspended-sediment discharge data from actively mined and reclaimed mined areas in Tioga, Clearfield, and Fayette Counties--Continued

03033227 Discharge from sediment-control pond below diversion terrace at surface mine near McGees Mills

Location.--Lat 40°56'54", long 78°48'05", Clearfield County, 5 mi northwest of McGees Mills

Sediment discharge, suspended (tons/day), May 12, 1980, through April 12, 1983
[mg/L, milligrams per liter; ft³/s, cubic feet per second]

Date	Mean water discharge (ft^3/s)	Mean concen-tration (mg/L)	Sediment discharge (tons/day)	Date	Mean water discharge (ft^3/s)	Mean concen-tration (mg/L)	Sediment discharge (tons/day)
May 12, 1980	0.08	190	0.04	November 27	0.01	40	0.001
13	.05	170	.02	28	.01	30	.0008
14	.04	160	.02				
15	.02	160	.008				
16	.01	150	.004	December 1	.02	30	.002
				2	.04	70	.008
17	.01	150	.004	3	.01	35	.0009
18	.04	240	.02	4	.01	30	.0008
21	.02	80	.004	5	.01	30	.0008
22	.01	60	.002				
31	.01	280	.01	6	.01	25	.0007
				7	.01	25	.0007
June 2	.01	120	.003	8	.01	30	.0008
3	.04	730	.08	9	.03	35	.003
4	.01	350	.01	10	.01	30	.0008
7	.005	600	.008				
8	.03	520	.04	11	.01	25	.0007
				12	.01	25	.0007
				13	.01	20	.0005
9	.03	300	.02				
10	.04	150	.02				
11	.01	65	.002	January 26, 1981	.01	10	.0003
12	.01	62	.002	27	.01	8	.0002
13	.01	60	.002				
15	.006	185	.003	February 11	.05	15	.002
16	.01	70	.002	12	.01	12	.0003
				13	.01	12	.0003
July 3	.03	200	.02	16	.01	9	.0002
8	.06	340	.06	17	.03	31	.002
15	.06	250	.04				
16	.08	300	.06	18	.05	30	.004
17	.03	100	.008	19	.11	35	.01
				20	.25	50	.03
22	.004	80	.0009	21	.23	45	.03
23	.01	60	.002	22	.12	40	.01
24	.01	50	.001				
30	.008	80	.002	23	.12	60	.02
				24	.09	50	.01
August 2	.07	170	.03	25	.07	45	.008
3	.04	93	.009	26	.04	45	.005
4	.02	50	.003	27	.02	40	.002
5	.02	50	.003	28	.03	40	.003
6	.01	45	.001				
7	.01	30	.0008	March 1	.01	39	.001
8	.03	140	.01	2	.01	38	.001
9	.01	50	.001	3	.01	38	.001
10	.01	50	.001	4	.01	36	.001
11	.02	93	.005	5	.01	36	.001
12	.02	70	.004	6	.01	34	.0009
13	.01	50	.001	7	.01	34	.0009
14	.06	350	.06	8	.01	32	.0009
15	.16	200	.09	9	.01	30	.0008
16	.05	60	.008	13	.01	25	.0007
17	.03	45	.004	14	.01	25	.0007
18	.02	30	.002	15	.02	20	.001
19	.01	25	.0007	16	.01	18	.0005
				28	.01	10	.0003
October 25	.09	180	.04	29	.01	8	.0002
26	.01	120	.003				
28	.01	80	.002	30	.03	15	.001
				31	.01	12	.0003
November 8	.01	74	.002	April 1	.01	12	.0003
9	.01	70	.002	2	.03	15	.001
23	.01	20	.0005	3	.01	10	.0003
24	.04	50	.005	4	.01	8	.0002
25	.01	30	.0008	5	.01	8	.0002

Appendix--Water and suspended-sediment discharge data from actively mined and reclaimed mined areas in Tioga, Clearfield, and Fayette Counties--Continued

03033227 Discharge from sediment-control pond below diversion terrace at surface mine near McGees Mills

Location.--Lat 40°56'54", long 78°48'05", Clearfield County, 5 mi northwest of McGees Mills

Sediment discharge, suspended (tons/day), May 12, 1980, through April 12, 1983
[mg/L, milligrams per liter; ft^3/s, cubic feet per second]

Date	Mean water discharge (ft^3/s)	Mean concen-tration (mg/L)	Sediment discharge (tons/day)	Date	Mean water discharge (ft^3/s)	Mean concen-tration (mg/L)	Sediment discharge (tons/day)
April 6, 1981	0.01	8	0.0002	September 4	0.05	170	0.02
9	.01	13	.0003	5	.01	75	.002
12	.01	32	.0009	8	.01	35	.0009
13	.02	35	.002	15	.01	30	.0008
14	.07	46	.009	17	.01	35	.0009
15	.06	30	.005	October 6	.007	40	.0008
16	.05	26	.004	7	.004	23	.0002
17	.04	23	.002	26	.01	20	.0008
18	.02	19	.001	27	.16	110	.05
19	.01	16	.0004	28	.03	110	.01
				29	.01	40	.001
20	.01	14	.0004				
21	.01	12	.0003				
23	.01	20	.0005	November 5	.007	30	.0006
24	.01	24	.0006	6	.02	35	.001
25	.01	21	.0006	7	.01	31	.0008
				20	.01	15	.0004
26	.01	17	.0005	27	.003	10	.0001
27	.01	15	.0004				
28	.07	140	.03				
29	.20	180	.10	December 2	.01	10	.0003
30	.12	130	.04	5	.01	7	.0002
				8	.01	20	.0005
May 1	.07	60	.01	9	.01	10	.0003
2	.04	47	.005	22	.01	10	.0003
3	.01	35	.0009				
4	.01	31	.0008	23	.09	38	.009
6	.01	23	.0006	24	.02	15	.0008
				25	.01	10	.0003
11	.03	93	.008	26	.01	8	.0002
12	.01	70	.002				
13	.01	50	.001				
14	.02	320	.02	January 1, 1982	.01	10	.0003
15	.05	90	.01	4	.06	40	.006
				5	.02	15	.0008
16	.04	90	.01	6	.02	10	.0005
17	.02	80	.004	7	.01	8	.0002
18	.01	70	.002				
19	.01	50	.001	8	.01	7	.0002
20	.01	45	.001	30	.03	40	.003
				31	.12	70	.02
June 2	.01	31	.0008				
3	.03	74	.006				
4	.06	220	.04	February 1	.03	40	.003
5	.01	80	.002	2	.02	15	.0008
6	.01	75	.002	3	.01	8	.0002
				4	.01	6	.0002
9	.07	260	.05	5	.01	5	.0001
10	.01	90	.002				
11	.01	80	.002	15	.04	20	.002
14	.03	130	.01	16	.02	10	.0005
15	.01	100	.003	17	.01	8	.0002
				18	.01	6	.0002
16	.07	460	.09	23	.02	10	.0005
17	.02	160	.008				
18	.02	120	.006	24	.01	10	.0003
19	.01	100	.003	25	.01	8	.0002
20	.01	90	.002				
				March 11	.02	10	.0005
21	.01	88	.002	12	.03	20	.002
22	.01	88	.002	13	.03	25	.002
25	.05	160	.02	14	.02	20	.001
26	.01	90	.002	15	.03	18	.002
July 20	.14	340	.13	16	.03	25	.002
21	.02	130	.007	17	.04	20	.002
26	.05	200	.03	18	.02	10	.0005
28	.06	350	.06	19	.03	15	.001
				20	.02	15	.0008

Appendix--Water and suspended-sediment discharge data from actively mined and reclaimed mined areas in Tioga, Clearfield, and Fayette Counties--Continued

03033227 Discharge from sediment-control pond below diversion terrace at surface mine near McGees Mills

Location.--Lat 40°56'54", long 78°48'05", Clearfield County, 5 mi northwest of McGees Mills

Sediment discharge, suspended (tons/day), May 12, 1980, through April 12, 1983
[mg/L, milligrams per liter; ft³/s, cubic feet per second]

Date	Mean water discharge (ft^3/s)	Mean concentration (mg/L)	Sediment discharge (tons/day)
March 21, 1982	0.04	15	.002
22	.01	12	.0003
23	.01	9	.0002
24	.01	8	.0002
25	.02	20	.001
26	.02	25	.001
27	.01	20	.0005
28	.01	15	.0004
31	.02	30	.002
April 1	.01	15	.0004
3	.02	25	.001
4	.02	15	.0008
5	.01	10	.0003
6	.01	25	.0007
7	.01	20	.0005
8	.02	15	.0008
9	.02	20	.001
10	.02	20	.001
11	.04	20	.002
14	.01	6	.0002
May 8	.02	8	.0004
9	.01	4	.0001
23	.02	30	.001
24	.01	20	.0005
28	.06	89	.01
29	.02	25	.001
30	.02	15	.0008
31	.01	10	.0003
June 1	.01	8	.0002
5	.07	88	.02
6	.02	25	.001
7	.01	12	.0003
8	.01	10	.0003
10	.01	18	.0005
12	.02	20	.001
13	.01	10	.0003
16	.01	18	.0005
28	.01	8	.0002
29	.02	55	.003
July 4	.01	50	.001
28	.02	17	.0009
August 17	.01	15	.0004
25	.01	8	.0002
September 2	.01	10	.0003
22	.01	8	.0002
27	.01	8	.0002
November 4	.04	20	.002
5	.005	10	.0001
11	.004	20	.0002
12	.01	10	.0004
13	.005	5	.0001
21	.01	10	.0003
22	.02	12	.0005
23	.01	10	.0003
24	.007	8	.0002
26	.003	5	.0001
27	.003	5	.0001
28	.02	20	.0009
November 29	0.03	10	0.0007
30	.006	5	.0001
December 1	.004	5	.0001
11	.004	10	.0001
12	.003	10	.0001
13	.002	10	.0001
14	.002	5	.0001
15	.002	5	.0001
16	.03	20	.002
17	.004	10	.0001
23	.02	20	.0008
24	.02	10	.0006
25	.006	5	.0001
26	.006	5	.0001
27	.006	5	.0001
28	.004	5	.0001
January 10, 1983	.003	5	.0001
11	.004	5	.0001
30	.02	10	.0004
31	.01	5	.0001
February 1	.005	5	.0001
2	.05	20	.003
3	.03	10	.0008
4	.01	5	.0001
5	.005	5	.0001
6	.005	5	.0001
19	.005	5	.0001
20	.005	5	.0001
21	.02	10	.0005
22	.008	10	.0002
23	.01	10	.0003
24	.006	10	.0002
25	.005	5	.0001
26	.005	5	.0001
27	.003	5	.0001
March 6	.0005	5	.0001
7	.001	5	.0001
8	.001	5	.0001
9	.001	5	.0001
10	.003	10	.0001
11	.001	10	.0001
12	.0005	5	.0001
19	.001	20	.0001
20	.001	10	.0001
21	.003	20	.0002
22	.001	10	.0001
23	.0005	5	.0001
27	.002	20	.0001
28	.002	15	.0001
29	.0008	10	.0001
30	.0003	8	.0001
April 3	.003	8	.0001
4	.003	8	.0001
6	.002	8	.0001
7	.05	40	.005
8	.03	20	.002
9	.02	10	.0005
10	.012	10	.0003
11	.01	10	.0003
12	.005	8	.0001

Appendix--Water and suspended-sediment discharge data from actively mined and reclaimed mined areas in Tioga, Clearfield, and Fayette Counties--Continued

03070412 Discharge from diversion terrace at surface mine near Farmington

Location.--Lat 39°46'33", long 79°33'32", Fayette County, 2 mi southeast of Farmington

Sediment discharge, suspended (tons/day), July 13, 1981, through July 23, 1983
[mg/L, milligrams per liter; ft^3/s, cubic feet per second]

Date	Mean water discharge (ft^3/s)	Mean concentration (mg/L)	Sediment discharge (tons/day)
July 13, 1981	0.02	20,000	0.81
16	.04	25,000	2.8
17	.01	7,000	.22
26	.04	19,200	2.0
27	.05	4,100	.51
28	.03	6,140	.56
29	.02	20,000	.81
August 2	.02	15,000	.61
15	.006	17,000	.28
16	.06	15,000	2.6
31	.02	18,000	.90
September 2	.06	7,800	1.3
3	.01	500	.01
4	.10	1,000	.27
8	.03	3,000	.22
15	.15	10,000	4.1
October 1	.03	3,000	.27
2	.001	500	.001
6	.02	2,000	.11
26	.01	5,000	.15
27	.09	8,400	2.0
28	.007	5,500	.10
November 6	.03	6,700	.61
9	.009	5,000	.12
27	.007	5,300	.10
December 1	.06	7,600	1.3
2	.004	4,600	.05
4	.002	3,700	.02
5	.009	6,200	.15
7	.02	7,800	.39
8	.06	8,200	1.4
22	.15	7,400	3.1
23	.22	6,700	4.0
January 4, 1982	.16	6,900	3.0
7	.008	4,500	.10
23	.25	7,400	5.1
24	.06	4,700	.70
31	.10	1,000	.27
February 1	.11	6,700	2.0
3	.06	4,000	.60
4	.03	4,000	.30
15	.03	4,500	.39
16	.10	9,300	2.5
17	.08	9,600	2.0
March 5	.07	8,400	1.5
11	.11	5,000	1.5
13	.005	3,000	.04
15	.006	4,000	.06
16	.17	26,000	12
20	.02	3,000	.20
25	.008	3,000	.06
26	.006	3,000	.05
27	.007	3,000	.06
31	.008	7,900	.17

Date	Mean water discharge (ft^3/s)	Mean concentration (mg/L)	Sediment discharge (tons/day)
April 3	0.01	6,200	0.17
6	.03	6,600	.58
7	.003	3,000	.02
9	.005	1,000	.01
10	.01	1,000	.03
11	.02	3,000	.13
May 20	.003	5,000	.04
21	.003	5,000	.04
22	.007	17,000	.32
24	.02	9,900	.50
28	.06	57,000	9.6
30	.003	6,000	.05
31	.005	6,000	.08
June 1	.004	4,000	.04
3	.004	8,000	.09
5	.10	5,800	1.5
13	.11	6,000	1.8
16	.10	19,000	5.1
17	.01	5,700	.17
19	.002	5,000	.03
28	.01	15,000	.45
29	.14	6,500	2.4
July 3	.31	5,000	4.2
9	.07	8,000	1.6
28	.08	7,000	1.4
August 5	.16	6,700	2.9
8	.09	7,000	1.8
11	.07	3,500	.66
17	.02	3,600	.18
25	.07	4,000	.74
September 2	.04	3,600	.37
3	.03	3,200	.29
21	.04	3,000	.34
22	.08	2,200	.47
26	.14	2,000	.75
December 1	.03	22	.002
April 6, 1983	.03	173	.01
8	.10	255	.07
9	.05	740	.10
15	.12	320	.10
29	.01	2,460	.07
May 2	.15	270	.11
19	.03	100	.008
22	.03	250	.02
June 3	.08	200	.04
July 20	.04	800	.09
23	.04	1,000	.11

Appendix--Water and suspended-sediment discharge data from actively mined and reclaimed mined areas in Tioga, Clearfield, and Fayette Counties--Continued

03070413 Discharge from sediment-control pond below surface mine near Farmington

Location.--Lat 39°46'34", long 79°33'34", Fayette County, 2 mi southeast of Farmington

Sediment discharge, suspended (tons/day), September 2, 1981, through May 21, 1983
[mg/L, milligrams per liter; ft^3/s, cubic feet per second]

Date	Mean water discharge (ft^3/s)	Mean concentration (mg/L)	Sediment discharge (tons/day)
September 2, 1981	0.20	160	0.08
15	.22	110	.07
16	.39	37	.04
17	.19	22	.01
18	.03	20	.002
19	.006	20	.0003
November 10	.14	50	.02
11	.05	22	.003
12	.02	20	.001
March 16, 1982	.46	1,800	2.2
17	.50	70	.09
June 15	.12	1	.0003
16	.36	210	.20
17	.30	80	.06
30	.22	34	.02
July 1	.16	30	.01
3	.11	190	.06
4	.17	120	.06
5	.13	25	.009
6	.09	20	.005
7	.03	10	.0008
August 8	.16	320	.14
May 21, 1983	.07	40	.008

Appendix--Water and suspended-sediment discharge data from actively mined and reclaimed mined areas in Tioga, Clearfield, and Fayette Counties--Continued

01548414 Discharge from reclaimed surface mine near Antrim

Location.--Lat 41°37'25", long 77°18'35", Tioga County, 2 mi southwest of Antrim

Sediment discharge, suspended (tons/day), October 1, 1981, through June 30, 1983
[mg/L, milligrams per liter; ft^3/s, cubic feet per second]

Date	Mean water discharge (ft^3/s)	Mean concentration (mg/L)	Sediment discharge (tons/day)	Date	Mean water discharge (ft^3/s)	Mean concentration (mg/L)	Sediment discharge (tons/day)
October 1, 1981	0.65	5600	9.8	October 7	0.001	30	0.0001
2	.14	160	.06	8	.007	260	.005
6	.25	760	.52	20	.02	260	.01
7	.06	20	.003	21	.007	53	.001
8	.04	10	.001				
				November 4	.15	49	.02
18	.03	37	.003	5	.02	5	.0003
26	.16	9	.004	12	.03	300	.02
27	1.6	2,000	8.8	13	.003	10	.0001
28	1.8	320	1.6	22	.05	20	.003
November 6	.10	7	.002	23	.02	10	.0005
15	.57	1,300	2.0	24	.008	5	.0001
16	.39	140	.15	29	.12	30	.009
19	.19	41	.02	30	.01	5	.0001
20	.44	84	.10				
				December 6	.04	360	.04
December 2	.06	18	.003	16	.20	100	.05
8	.06	37	.006	24	.05	140	.02
23	.37	40	.04				
24	.05	10	.001	January 10, 1983	.005	7	.0001
				11	.002	18	.0001
January 4, 1982	.28	26	.02	24	.005	15	.0002
31	.05	10	.001	29	.007	21	.0004
				30	.01	30	.0008
February 1	1.5	240	.98				
2	.13	200	.07	February 2	.10	37	.01
3	.03	120	.01	3	.78	190	.40
4	.69	220	.41				
March 13	.50	220	.30	March 10	.04	62	.007
14	.02	170	.009	20	.03	62	.005
26	1.0	230	.62	21	.27	230	.17
April 3	.01	10	.0003	April 3	.04	300	.03
				7	.03	110	.006
May 19	.001	1,800	.005	8	.003	10	.0001
20	.003	1,600	.01	10	.06	200	.03
22	.02	560	.03	15	.12	250	.08
23	.03	62	.005				
24	.03	860	.07	21	.01	48	.001
28	.04	46	.005	22	.005	30	.0004
				24	.22	130	.08
June 1	.29	680	.53	25	.01	18	.0005
3	.40	160	.18	26	.003	12	.0001
5	4.7	370	4.7	30	.03	120	.01
6	.24	62	.04				
10	.03	62	.005	May 1	.08	170	.04
				2	.03	99	.008
12	.01	74	.002	8	.03	49	.004
13	.06	18	.003	9	.005	7	.0001
16	.01	74	.002	19	.01	74	.002
17	.43	220	.25				
22	.02	74	.004	20	.002	37	.0002
29	.07	260	.05	22	.02	64	.003
				23	.01	28	.0008
July 21	.10	520	.14				
				June 4	.004	92	.001
August 8	.03	490	.04	19	.003	34	.0003
9	.02	740	.04	20	.08	37	.008
25	.02	560	.03	21	.002	15	.0001
				29	.73	38	.07
September 3	.007	32	.001	30	.004	9	.0001
22	.01	37	.001				
23	.02	37	.002				
27	.76	260	.54				

Appendix--Water and suspended-sediment discharge data from actively mined and reclaimed mined areas in Tioga, Clearfield, and Fayette Counties--Continued

03033222 Discharge from reclaimed surface mine near McGees Mills

Location.--Lat 40°56'30", long 78°47'25", Clearfield County, 5 mi northwest of McGees Mills

Sediment discharge, suspended (tons/day), April 24, through July 28, 1983
[mg/L, milligrams per liter; ft^3/sm cubic feet per second]

Date	Mean water discharge (ft^3/s)	Mean concentration (mg/L)	Sediment discharge (tons/day)
April 24, 1983	0.08	1,600	0.34
29	.01	2,100	.06
June 1	.08	2,260	.49
2	.11	1,000	.30
8	.001	400	.001
14	.002	500	.003
15	.10	2,500	.67
19	.11	1,600	.48
22	.28	2,600	1.9
23	.14	1,800	.68
July 20	.56	9,100	14
28	.73	12,000	24

Appendix--Water and suspended-sediment discharge data from actively mined and reclaimed mined areas in Tioga, Clearfield, and Fayette Counties--Continued

03033223 Discharge from sediment-control pond at reclaimed surface mine near McGees Mills

Location.--Lat 40°56'31", long 78°47'26", Clearfield County, 5 mi northwest of McGees Mills

Sediment discharge, suspended (tons/day), April 24 through July 24, 1983
[mg/L, milligrams per liter; ft^3/s, cubic feet per second]

Date	Mean water discharge (ft^3/s)	Mean concentration (mg/L)	Sediment discharge (tons/day)
April 24, 1983	0.04	20	0.002
25	.06	35	.006
26	.04	17	.002
27	.02	15	.0008
28	.005	14	.0002
29	.004	13	.0001
30	.003	12	.0001
May 1	.02	20	.001
2	.07	45	.008
14	.006	16	.0003
15	.007	22	.0004
16	.005	65	.0009
17	.06	53	.009
18	.08	50	.01
19	.08	52	.01
20	.08	40	.009
21	.07	30	.006
22	.07	100	.02
28	.08	12	.003
29	.08	36	.008
30	.08	45	.01
31	.08	25	.005
June 3	.06	40	.006
4	.07	110	.02
6	.07	30	.006
7	.06	20	.003
17	.02	11	.0006
20	.02	160	.008
21	.05	380	.05
28	.04	250	.03
29	.30	150	.12
30	.28	120	.09
July 24	.19	400	.20