STREAMFLOW AND WATER-QUALITY DATA FOR LITTLE CLEARFIELD CREEK BASIN, CLEARFIELD COUNTY, PENNSYLVANIA, DECEMBER 1987 - NOVEMBER 1988

By Kevin M. Kostelnik and Randall R. Durlin

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MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey, WRD
4th Floor, Federal Building
P.O. Box 1107
Harrisburg, Pennsylvania 17108-1107

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CONVERSION FACTORS AND ABBREVIATIONS

For the convenience of readers who may prefer metric (International System) units rather than the inch-pound units used in this report, values may be converted by using the following factors:

Multiply Inch-Pound Unit	By	To Obtain Metric Unit
	Length	
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	0.004047	square kilometer (km^2)
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)
	Volume	
gallon (gal)	3.785	liter (L)
	3,785	milliliter (mL)
	Temperature	
degree Fahrenheit (°F)	°C=5/9 (°F-32)	degree Celsius (°C)

Other Abbreviations

milligrams per liter (mg/L)
micrograms per liter (µg/L)

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

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ABSTRACT

Streamflow and water-quality data were collected throughout the Little Clearfield Creek basin, Clearfield County, Pennsylvania, from December 1987 through November 1988, to determine the existing quality of surface water over a range of hydrologic conditions. This data will assist the Pennsylvania Department of Environmental Resources during its review of coal-mine permit applications. A water-quality station near the mouth of Little Clearfield Creek provided continuous-record of stream stage, pH, specific conductance, and water temperature. Monthly water-quality samples collected at this station were analyzed for total and dissolved metals, nutrients, major cations, and suspended-sediment concentrations. Seventeen partial-record sites, located throughout the basin, were similarly sampled four times during the study. Streamflow and water-quality data obtained at these sites during a winter base flow, a spring storm event, a low summer base flow, and a more moderate summer base flow also are presented.

INTRODUCTION

Background

Acid mine drainage, which can degrade stream quality, has commonly been associated with surface mining throughout the coal regions of Pennsylvania. The Pennsylvania Department of Environmental Resources (PaDER) is responsible for maintaining acceptable water quality for both surface- and ground-water systems throughout Pennsylvania. The PaDER, Bureau of Mining and Reclamation, is involved with Cumulative Hydrologic Impact Assessments (CHIA) during their appraisal of mine permits in order to assess possible adverse environmental impacts resulting from existing and anticipated mining operations. The Bureau, therefore, requires that coal-mine permit applications contain information on the existing water-quality conditions for the applied areas.

The time frame associated with the review of coal-mine permit applications does not allow for extensive collection of water-quality and quantity data once a permit has been requested. Only a limited amount of background data can be collected and evaluated before the Bureau must respond to an application. Therefore, surface water-quality and quantity data bases for basins within the coal regions of Pennsylvania need to be established.

Purpose and Scope

This report presents hydrologic and water-quality data for the Little Clearfield Creek basin. This data was collected over a range of hydrologic conditions from December 7, 1987 through November 2, 1988. An in-depth interpretative analysis of these water-quality data is not within the scope of this report. The information presented here will be incorporated by the Bureau into a CHIA of the Little Clearfield Creek basin. The CHIA will involve a more detailed analysis of this water-quality data as well as the basin geology, biology, and cultural characteristics.

Acknowledgments

Mr. Theodore Haney's cooperation is greatly appreciated for granting permission for the installation of a continuous-record water-quality station on his property for the duration of this study.

DESCRIPTION OF STUDY AREA

Location

Little Clearfield Creek basin, located in Clearfield County, encompasses a 44.5-square-mile drainage area (fig. 1). This basin is within U.S. Geological Survey Hydrologic Unit 02050201. The surface-water drainage, dominated by Little Clearfield Creek, discharges into Clearfield Creek near Dimeling, Pa. The headwaters of Little Clearfield Creek, located along the southwestern part of the basin, include Watts Creek, Green Run, Stony Run, and McNeel Run as well as many unnamed tributaries.

Physiography and Geology

Little Clearfield Creek is located within the Appalachian Plateau physiographic province. The underlying geology is characteristic of the Allegheny and Conemaugh groups (Berg and others, 1980; 1983). The Upper and Lower Freeport coal seams have been extensively surface mined within the basin. Mining of the deeper Upper and Lower Kittaning coal seams has been more limited. Although reserve deposits of Freeport and Kittaning coals exist within the basin, the extent of future mining is difficult to predict (Pennsylvania Department of Environmental Resources, written commun., 1988).

A trellised drainage pattern has produced well-developed stream valleys. The topography is characterized by steep to moderate slopes. Basin elevations range from 1,150 feet above sea level near the basin outflow to about 1,930 feet at its highest point. The irregular channel has an overall length of about 20.1 miles and a slope averaging 18.6 feet per mile (Shaw, 1984; Shaw and Busch, 1970).

Air Temperature

The temperate climate associated with this study area is representative of the climatic conditions which dominate Pennsylvania. Air temperatures range from near 0 °C (32 °F) in December, January, and February, to nearly 40 °C (100 °F) in June, July, and August. Although freezing temperatures are common during the winter months, periodic warming trends tend to minimize the development of a persistent snowpack throughout the basin.

The steep hills within the basin shade certain reaches of Little Clearfield Creek. This shading condition, in combination with low winter air temperatures, periodically enhances the formation of anchor and shore ice, particularly along the lower stretches of Little Clearfield Creek.

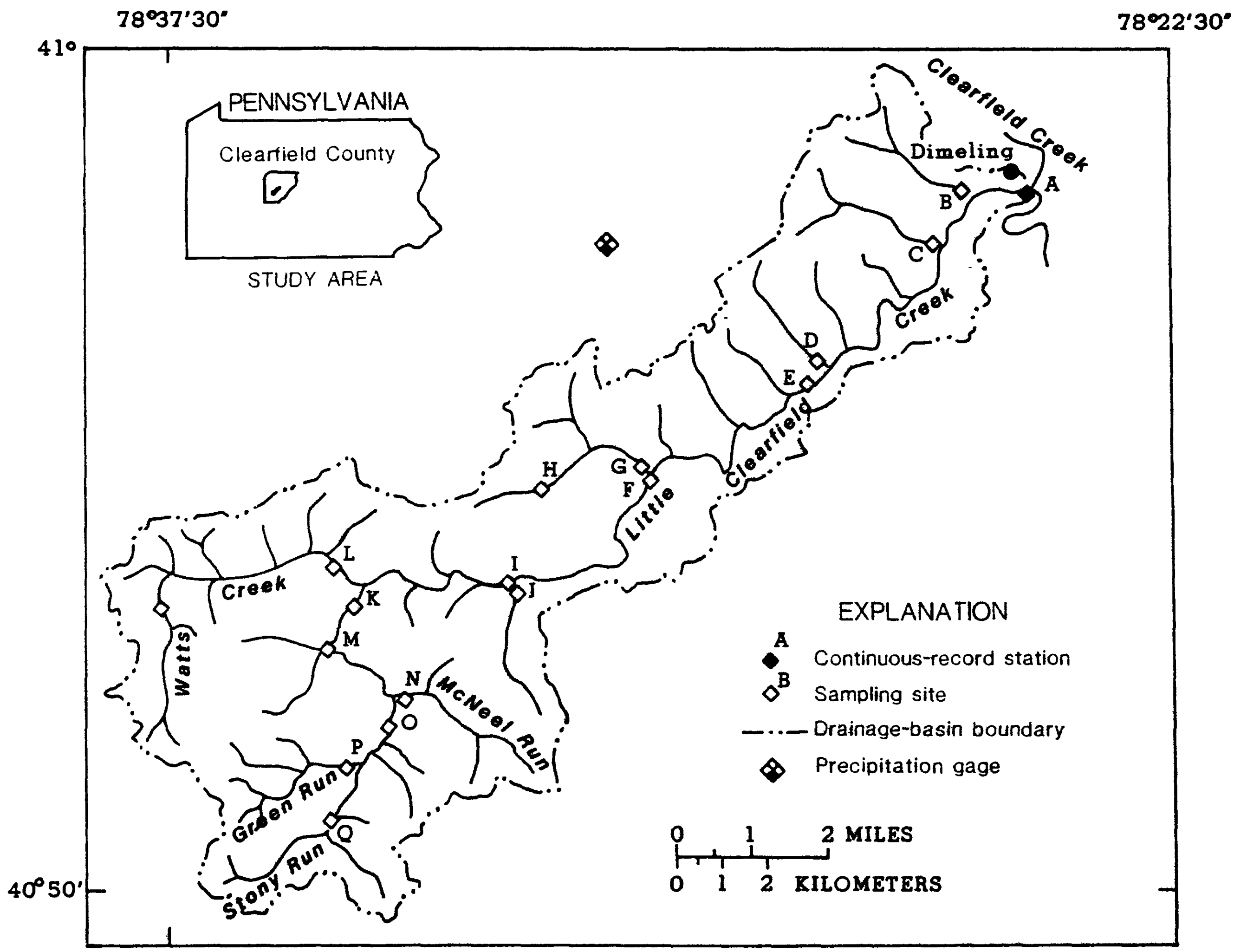

Figure 1.--Location of study area and sampling stations for Little Clearfield Creek basin.

Precipitation

Annual precipitation for the Little Clearfield Creek area averaged 38.9 inches from 1970 to 1987. Precipitation amounts were measured about 2 miles away from the basin at Curwensville Lake. For periods when precipitation data were unavailable for this station, data from stations at Madera or Clearfield were incorporated into this historic record (U.S. Department of Commerce, 1970-88). Precipitation for the 11-month period of study totaled 29.4 inches, 18 percent below historic records for the same corresponding 11-month period. The distribution of the 1988 monthly precipitation totals also differed from the historic monthly distribution (fig. 2). The normally high precipitation associated with June was absent during 1988. The streams in this basin reflected this lack of precipitation with substantially lower flows during this period. Higher than normal precipitation during February produced the peak flow during the investigation.

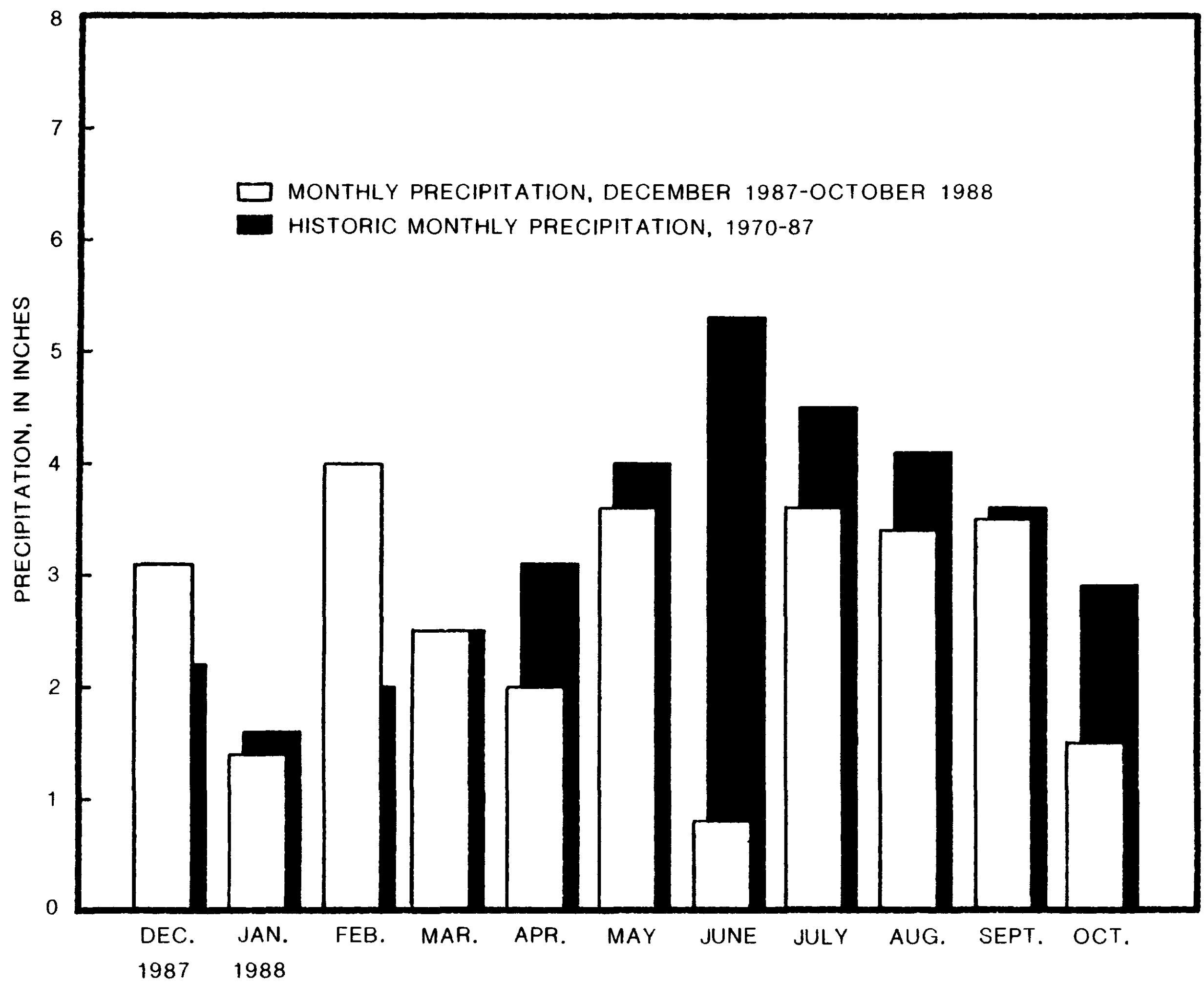

Figure 2.--Distribution of monthly precipitation for Little Clearfield Creek basin.

Land Use

About 75 percent of Little Clearfield Creek basin is covered by forest. Mixed hardwoods such as oak, maple, hemlock, and hickory dominate the vegetative community. These species commonly are associated with logging operations. Agricultural practices, namely pasture and dairy farming, account for about 25 percent of the basin's remaining land cover.

Surface-mining operations, which affect both land cover types, are the only major industrial activity in the study basin. Prior to 1981, mining operations affected about 21 percent of the total basin. Since that time an additional 18.5 percent of the basin has been permitted for surface mining (Pennsylvania Department of Environmental Resources, oral commun., 1989).

Water Use

No public water-supply systems are located within the Little Clearfield Creek basin. Local water sources are private wells utilizing ground water (Pennsylvania Department of Environmental Resources, written commun., 1988).

Little Clearfield Creek, considered one of the best cold water fishery streams in Clearfield County, was reclassified a High Quality Cold Water Fishery by the PaDER in September, 1987. The Pennsylvania Fish Commission currently stocks trout within several reaches of Little Clearfield Creek for sport fishermen. Naturally-reproducing trout populations also exist within the Little Clearfield Creek basin (Pennsylvania Department of Environmental Resources, written commun., 1988).

METHODS AND PROCEDURES

Sampling Design

An initial field reconnaissance of the study area helped determine the appropriate surface-water sampling locations. One continuous-record water-quality monitoring station was installed near the mouth of Little Clearfield Creek. Seventeen partial-record water-quality sampling sites were established throughout the basin on the main branch of Little Clearfield Creek and on several key tributaries. This sampling design provided an opportunity to assess the water quality throughout the drainage basin during a range of hydrologic conditions. The name of each sampling site, drainage areas, and its latitude and longitude are listed in table 1. The location of each sampling site is shown on figure 1.

The water-quality station on Little Clearfield Creek was instrumented to provide a continuous record of stream stage, pH, specific conductance, and water temperature. The station was visited monthly for the collection of water-quality samples and discharge measurements. This station was equipped with a Water-Stage Servo-Manometer Bubble Gage, which was coupled with an Analog Digital Recorder (ADR), to measure and record stream stage at 15-minute intervals. A U.S. Geological Survey Minimonitor recorded pH, specific

Table 1.--Description of sampling sites within Little Clearfield Creek basin

[mi², square mile]

ID	Station name	Latitude	Longitude	Drainage area (mi²)
A	Little Clearfield Creek at Dimeling	40°58'10"	78°24'35"	44.5
B	Laurel Run near Dimeling	40°58'04"	78°25'23"	1.65
C	Wallace Run near Dimeling	40°57'30"	78°25'53"	2.2
D	Unnamed Tributary at Oshanter	40°56'08"	78°27'42"	1.19
E	Little Clearfield Creek at Oshanter	40°55'52"	78°27'52"	35.2
F	Little Clearfield Creek at Olanta	40°54'58"	78°30'15"	31.0
G	Big Run at Olanta	40°54'57"	78°30'26"	3.3
H	Big Run near Olanta	40°54'41"	78°32'03"	0.93
I	Little Clearfield Creek at New Millport	40°53'38"	78°32'24"	24.1
J	Carson Run at New Millport	40°53'38"	78°32'22"	1.54
K	Gazzam Run at Kerrmoor	40°53'28"	78°34'51"	10.2
L	Watts Creek near Kerrmoor	40°53'58"	78°35'15"	6.6
M	Campbell Run near Kerrmoor	40°52'55"	78°35'18"	13.2
N	McNeal Run at Gazzam	40°52'19"	78°34'16"	2.56
O	Gazzam Run at Gazzam	40°51'59"	78°34'23"	6.30
P	Green Run near Gazzam	40°51'32"	78°35'04"	2.32
Q	Stony Run near Ansonville	40°50'57"	78°35'17"	2.34
R	Watts Creek near Cherry Corners	40°53'16"	78°37'42"	1.77

conductance, and temperature at 1-hour intervals. Refer to Craig (1983), and Ficken and Scott (1983), for a discussion of the operation and maintenance of these instruments.

The partial-record stations were visited four times from December 1987 through November 1988 to collect water-quality samples and discharge measurements during different hydrologic conditions. The continuous-record station was also sampled during these basinwide samplings.

All discharge measurements were performed according to U.S. Geological Survey procedures (Rantz and others, 1982). All water-quality samples were collected and preserved according to U.S. Geological Survey procedures (Brown and others, 1970; Skougstad and others, 1979).

The initial basinwide sampling at all stations was done on December 7-8, 1987. This sampling was done during winter base-flow conditions. The second set of samples was collected basinwide during a storm on May 18-19, 1988. The combination of a steady drizzle throughout the day with an occasional heavy shower saturated the soil profile producing substantial runoff. From observations made during this storm sampling, it is believed that all water-quality samples were collected along the rising limb of the hydrograph or very near peak flow. Samples were again collected basinwide on June 21-22, 1988, during summer base-flow conditions. These data represent extremely low base-flow conditions as a result of the lack of precipitation during June and July. The last substantial rainfall prior to this third sampling was the May 18-19 storm. The fourth basinwide sampling was done on August 17-18, 1988 during a late summer base flow. The base flow during this fourth sampling was higher than the base flow sampling of June.

Field Measurements

Field measurements associated with all water-quality sampling included pH, specific conductance, water temperature, and dissolved oxygen. Alkalinity and acidity titrations of the monthly samples collected at the continuous-record station were done in-field according to standard U.S. Geological Survey methods (U.S. Geological Survey, Pickering, R.J., written commun., 1981). The alkalinity and acidity results for the partial-record sites were determined by PaDER Water Quality Laboratory titrations. Field pH was measured with an Orion Ionalyzer Model 399A pH meter[1]. A Beckman Solu-Bridge Conductivity Meter[1] was utilized for specific conductance measurements. Water temperature was determined with a certified mercury thermometer. Dissolved oxygen measurements were determined with a Hydrolab Model 4041[1]. All field meters were calibrated daily according to the manufacturers' specifications prior to field measurements.

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

Sample Preparation

After collection, water-quality samples were divided into splits for the various analyses. Splits intended for dissolved constituents were filtered through 0.45 micrometer cellulose nitrate membranes. Splits intended for metals analyses, both total and dissolved, were preserved with nitric acid to reduce the sample pH to 2. All splits for nutrient analysis were preserved with mercuric chloride. All water-quality samples were stored in ice until delivered to the PaDER Water Quality Laboratory, usually within 24 to 48 hours after collection. Suspended-sediment samples were delivered for analysis to the U.S. Geological Survey's Pennsylvania Sediment Laboratory, Harrisburg Office.

Laboratory Schedules

Two laboratory analysis schedules were developed for this project. Monthly samples collected at the continuous-record station were submitted to the laboratory under lab schedule 432. This schedule included analyses for certain total and dissolved metals, base cations, major anions, and nutrients. The water-quality samples collected basinwide were submitted for laboratory analyses according to lab schedule 431. This schedule included analysis for total metals, total base cations, and total anions. The constituents and analysis techniques involved with each of these two schedules are listed in table 2.

Quality Assurance and Quality Control

A quality-assurance plan was developed and maintained to assure accurate and consistent laboratory results. Water-quality duplicate samples were collected throughout the study and submitted for analysis to test laboratory consistency. Duplicate water-quality samples collected and analyzed under identical procedures for two additional CHIA studies during the same period of study were used to provide a more thorough statistical evaluation of the laboratory analyses. A Wilcoxon Two-Sample Test, which compared the duplicate data as two independent groups, showed no evidence to indicate any significant difference between groups for any of the constituents. A more precise test of duplicate compatibility also was performed. The differences between duplicate pairs were calculated for each of the constituents. Ideal consistency and repeatability would result in a value of zero for each difference. A nonparametric signed-rank test was used to test whether the median difference of each constituent was significantly different from zero. The results, shown in table 3, indicate that at the 95-percent confidence level there was no significant difference between zero and the median difference of the duplicate pairs for all constituents except sulfate. The median difference for the duplicate pairs of sulfate was 2 mg/L (milligrams per liter). Although statistically significant because one duplicate group was routinely greater than the other, the difference was not large enough to be of practical significance. Therefore, an acceptable degree of laboratory repeatability was concluded.

Table 2.--Analytical techniques and laboratory schedules for water-quality samples

[mg/L, milligrams per liter; μg/L, micrograms per liter; μS/cm, microsiemens per centimeter at 25 °C]

Parameter	Code	Schedule	Analysis technique	Detection limit
Acidity, total as $CaCO_3$	00435	431,432	Titrimetric	0.1 mg/L
Alkalinity, total as $CaCO_3$	00410	431,432	Titrimetric	.1 mg/L
Aluminum, dissolved	01106	432	ICP emission	50 μg/L
Aluminum, total	01105	431,432	ICP emission	50 μg/L
Calcium, dissolved	00915	432	ICP emission	.03 mg/L
Chloride, total	00940	431,432	Ferricyanide	1 mg/L
Iron, dissolved	01046	432	ICP emission	10 μg/L
Iron, total	01045	431,432	ICP emission	10 μg/L
Magnesium, dissolved	00925	432	ICP emission	.01 mg/L
Manganese, dissolved	01056	432	ICP emission	10 μg/L
Manganese, total	01055	431,432	ICP emission	10 μg/L
Nitrite, dissolved as N	00613	432	Sulfanilamide	.01 mg/L
Nitrite + Nitrate, dissolved as N	00631	432	Cadmium reduction	.02 mg/L
pH	00400	431,432	Electrometric	Standard units
Phosphorus, dissolved ortho as P	00671	432	Ascorbic acid	.01 mg/L
Potassium, dissolved	00935	432	ICP emission	.135 mg/L
Sediment, suspended	80180	431,432	Filtration	1 mg/L
Sodium, total	00929	431	ICP emission	.2 μg/L
Sodium, dissolved	00930	432	ICP emission	.2 mg/L
Specific conductance	00095	431,432	Electrometric	1 μS/cm
Sulfate, total	00945	431,432	Methyl thymol blue	10 mg/L
Solids, suspended	00530	431,432	Glass-fiber	2 mg/L
Solids, dissolved	00515	431,432	Evaporation	2 mg/L
Zinc, dissolved	01090	432	ICP emission	10 μg/L
Zinc, total	01092	431,432	ICP emission	10 μg/L

Table 3.--Comparison of duplicate water-quality sample analyses

[mg/L, milligrams per liter; µg/L, micrograms per liter]

Constituent	Detection limit		Number of samples	Median difference
Acidity, total as $CaCO_3$	0.1	mg/L	12	0
Alkalinity, total as $CaCO_3$	.1	mg/L	13	0
Aluminum, total	50	µg/L	13	12
Calcium, dissolved	.03	mg/L	2	-2.3
Chloride, total	1	mg/L	14	0
Iron, total	10	µg/L	14	-1
Magnesium, dissolved	.01	mg/L	2	0
Manganese, total	10	µg/L	14	0.5
Nitrite, dissolved as N	.01	mg/L	2	0
Nitrite + Nitrate, dissolved	.02	mg/L	2	0
Phosphorus, dissolved ortho as P	.01	mg/L	2	0
Potassium, dissolved	.135	mg/L	2	.05
Sodium, total	.2	mg/L	14	-.5
Sulfate, total	10	mg/L	14	2
Solids, suspended	2	mg/L	14	-4
Solids, dissolved	2	mg/L	14	-2
Zinc, total	10	µg/L	14	0

The routine retrieval and evaluation of preliminary laboratory results identified questionable results at an early stage. Requests were submitted for the reanalysis of these samples. Depending on the constituents involved, the samples were either reanalyzed or the resulting calculations were checked and recalculated. No sample analyses were discarded due to questionable results.

Data Analysis

The water-quality data were reviewed and evaluated to ensure accuracy and validity of the laboratory results. These data have been rounded to the appropriate number of significant figures according to U.S. Geological Survey procedures (U.S. Department of the Interior, 1976). The laboratory results, water-quality field measurements, and stream-discharge calculations are presented in a variety of summary statistics. These statistics were performed by procedures outlined in P-STAT (1986) and SAS (1982). Graphical representation of the data were performed with TELAGRAF procedures (Issco, 1984).

STREAMFLOW

Monthly Discharge Records

Routine monthly discharge measurements were made at the continuous-record station on Little Clearfield Creek at Dimeling. Although 16 discharge measurements were available for determining the stage-discharge relation for this station, only those measurements associated with monthly water-quality samples are listed in table 4 along with their respective water-quality results. A step-backwater analysis was also performed to help define the stage-discharge relation (Davidian, 1984). This relation was computed according to U.S. Geological Survey methods described in Rantz and others (1982). Results of these computations were used to develop an expanded rating table for the stage-discharge relation for the period of study and are listed in table 5. Although the control section showed no significant shift during the period of study, the reliability of this rating table for future measurements will depend on the future stability of the control area.

Continuous-Discharge Record

The daily mean discharge for Little Clearfield Creek at Dimeling is listed in table 6. These daily mean values, computed from the continuous stream stage records, and the daily precipitation record at Curwensville Lake are shown in figure 3. The low flows at the station during June and July were directly related to the lack of substantial precipitation from mid-May to mid-July. The lowest flow for the period of record occurred in mid-August.

The peak flow for Little Clearfield Creek at Dimeling, for the period of record, occurred on February 2-3, 1988. Slight warming the first week of February coupled with a light but prolonged rainfall, melted the snowpack and flushed the stream channel of all accumulated ice. A water-quality sample was collected and discharge measurement made at the Dimeling station near the peak flow for this event.

Ice affected the stage-discharge relation from December 28 through February 2 and from February 14 through 19. Discharges were estimated for these periods, as well as for a period in November and December 1987, prior to the station's installation. Estimated discharges were computed on the basis of gage height observations, high water marks, field measurements, weather records, and hydrograph comparisons (Kennedy, 1983).

Partial-Record Discharges

The 17 partial-record sites were visited four times over the course of the project during different hydrologic conditions and events. The scope of this study did not permit for a thorough evaluation of the stage-discharge relation at each of these sites. Discharge measurements were made during each visit. These discharge measurements have been listed in tables 11, 12, 13, and 14 along with the respective water-quality data.

Table 4.--Monthly discharge measurements and water-quality samples at Little Clearfield Creek at Dimeling

[Deg C, degrees Celsius; ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 Deg C; mg/L, milligrams per liter; µg/L, micrograms per liter; L, laboratory result; <, less than]

Date	Time	Temperature, water, field (Deg C)	Streamflow, instantaneous, field (ft^3/s)	Specific conductance, field (µS/cm)	Oxygen, dissolved, field (mg/L)	pH, field (standard units)	Alkalinity total, field (mg/L as $CaCO_3$)	Acidity total, field (mg/L as $CaCO_3$)	Solids at 105 Deg C, dissolved (mg/L)	Solids at 105 Deg C, suspended (mg/L)	Nitrogen, Nitrite dissolved (mg/L as N)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)	Phosphorus ortho, dissolved (mg/L as P)	Calcium dissolved (mg/L as Ca)
DEC 1987														
30...	0945	0.0	24	362	14.0	7.7	48 L	0 L	308	2	<0.01	0.96	0.08	39
FEB 1988														
02...	1345	2.0	1,070	142	13.0	6.9	12	3.0	209	415	<0.01	0.96	0.01	11
MAR														
01...	1215	1.5	40	380	12.9	7.7	42	0.8	224	<2	<0.01	1.00	<0.01	41
APR														
07...	1130	9.5	108	320	11.4	7.7	36	2.1	186	18	<0.01	0.74	<0.01	38
28...	0900	7.5	23	440	12.0	7.9	57	0	352	6	<0.01	0.60	<0.01	57
JUN														
08...	1230	20.0	16	480	9.3	7.9	64	0 L	336	6	<0.01	0.40	0.01	67
JUL														
08...	0800	18.0	3.9	607	8.7	8.0	79	0 L	550	4	<0.01	0.2	<0.01	88
AUG														
09...	1200	25.0	3.4	640	8.7	8.0	69	0 L	458	6	<0.01	0.06	<0.01	93
OCT														
05...	1100	10.0	6.1	625	9.8	8.1	90	0 L	394	4	<0.01	0.04	<0.01	57
NOV														
03...	1030	3.5	7.2	585	12.7	7.8	65	0 L	334	<2	<0.01	0.1	<0.01	81

Table 4.--Monthly discharge measurements and water-quality samples at Little Clearfield Creek at Dimeling--Continued

Date	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)	Chloride, total (mg/L as Cl)	Sulfate, total (mg/L as SO_4)	Iron, total (µg/L as Fe)	Iron, dissolved (µg/L as Fe)	Manganese, total (µg/L as Mn)	Manganese, dissolved (µg/L as Mn)	Zinc, total (µg/L as Zn)	Zinc, dissolved (µg/L as Zn)	Aluminum, total (µg/L as Al)	Aluminum, dissolved (µg/L as Al)	Sediment, suspended, total (mg/L)
DEC 1987														
30...	13	3.9	1.7	8.0	130	380	60	260	230	<10	<10	<50	<50	13
FEB 1988														
02...	3.5	3.0	2.3	10	41	21,000	520	1,100	190	100	30	12,300	210	552
MAR														
01...	13	4.5	1.6	9.0	130	380	63	260	260	30	30	80	80	8
APR														
07...	13	3.8	1.6	8.0	69	1,300	110	270	220	40	30	490	<50	15
28...	18	4.2	1.7	7.0	160	420	230	260	250	<10	<10	60	60	3
JUN														
08...	20	4.6	2.0	9.0	170	350	<10	120	100	<10	<10	<50	<50	22
JUL														
08...	26	4.9	2.2	8.0	150	270	54	67	40	50	50	80	50	24
AUG														
09...	28	6.2	2.5	13	260	330	37	60	31	10	10	150	110	6
OCT														
05...	17	6.8	2.2	11	225	370	64	110	100	30	30	100	100	3
NOV														
03...	25	6.5	2.1	13	220	750	69	190	190	<10	<10	130	130	2

Table 5.--Expanded rating table for Little Clearfield Creek at Dimeling, November 1987 - November 1988

Gage height (inches)	Discharge (cubic feet per second) 0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.30	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.0	2.1
.40	2.2	2.4	2.6	2.7	2.9	3.1	3.4	3.6	3.8	4.0
.50	4.4	4.5	4.8	5.1	5.3	5.6	5.9	6.2	6.6	6.9
.60	7.2	7.5	7.9	8.2	8.6	9.0	9.4	9.8	10	10
.70	11	11	12	13	13	14	14	15	15	16
.80	17	17	18	19	20	20	21	22	23	24
.90	24	25	26	27	28	29	30	31	32	33
1.00	34	35	36	37	38	39	41	42	43	44
1.10	45	47	48	49	51	52	53	55	56	58
1.20	59	60	62	64	65	67	68	70	72	73
1.30	75	77	78	80	81	83	84	86	88	89
1.40	91	93	94	96	98	100	101	103	105	107
1.50	109	111	112	114	116	118	120	122	124	126
1.60	128	130	133	135	137	139	141	143	146	148
1.70	150	152	155	157	159	162	164	166	169	171
1.80	174	176	179	181	184	186	189	191	194	197
1.90	199	202	205	207	210	213	216	218	221	224
2.00	227	230	232	235	238	241	244	246	249	252
2.10	255	258	261	264	267	269	272	275	278	282
2.20	285	288	291	294	297	300	303	306	310	313
2.30	316	319	323	326	329	333	336	339	343	346
2.40	349	353	356	360	363	367	370	374	378	381
2.50	385	388	392	396	399	403	407	411	414	418
2.60	422	426	430	433	437	441	445	449	453	457
2.70	461	465	469	473	477	481	485	490	494	498
2.80	502	506	510	515	519	523	528	532	536	541
2.90	545	549	554	558	563	567	572	576	581	585
3.00	590	594	599	603	607	612	616	620	625	629
3.10	634	638	642	647	651	656	661	665	670	674
3.20	679	683	688	693	697	702	707	711	716	721
3.30	726	730	735	740	745	750	755	759	764	769
3.40	774	779	784	789	794	799	804	809	814	819
3.50	824	829	835	840	845	850	855	860	866	871
3.60	876	881	887	892	897	903	908	913	919	924
3.70	930	935	940	946	951	957	962	968	974	979
3.80	985	990	996	1,002	1,007	1,013	1,019	1,024	1,030	1,036
3.90	1,042	1,047	1,053	1,059	1,065	1,071	1,076	1,082	1,088	1,094

Table 5.--Expanded rating table for Little Clearfield Creek at Dimeling, November 1987 - November 1988--Continued

Gage height (inches)	Discharge (cubic feet per second) 0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
4.00	1,100	1,106	1,112	1,118	1,124	1,130	1,136	1,142	1,148	1,154
4.10	1,160	1,166	1,172	1,178	1,184	1,191	1,197	1,203	1,209	1,215
4.20	1,222	1,228	1,234	1,240	1,247	1,253	1,259	1,266	1,272	1,278
4.30	1,285	1,291	1,298	1,304	1,311	1,317	1,324	1,330	1,337	1,343
4.40	1,350	1,356	1,363	1,370	1,376	1,383	1,390	1,396	1,403	1,410
4.50	1,416	1,423	1,430	1,437	1,444	1,450	1,457	1,464	1,471	1,478
4.60	1,485	1,492	1,499	1,506	1,513	1,520	1,527	1,534	1,541	1,548
4.70	1,555	1,562	1,569	1,576	1,583	1,590	1,598	1,605	1,612	1,619
4.80	1,627	1,634	1,641	1,648	1,656	1,663	1,670	1,678	1,685	1,693
4.90	1,700	1,707	1,715	1,722	1,730	1,737	1,745	1,752	1,760	1,767
5.00	1,775	1,783	1,790	1,798	1,806	1,813	1,821	1,829	1,836	1,844
5.10	1,852	1,860	1,867	1,875	1,883	1,891	1,899	1,907	1,914	1,922
5.20	1,930	1,938	1,946	1,954	1,962	1,970	1,978	1,986	1,994	2,002
5.30	2,011	2,019	2,027	2,035	2,043	2,051	2,059	2,068	2,076	2,084
5.40	2,092	2,101	2,109	2,117	2,126	2,134	2,142	2,151	2,159	2,168
5.50	2,176	2,184	2,193	2,201	2,210	2,219	2,227	2,236	2,244	2,253
5.60	2,261	2,270	2,279	2,287	2,296	2,305	2,313	2,322	2,331	2,340
5.70	2,348	2,357	2,366	2,375	2,384	2,393	2,402	2,410	2,419	2,428
5.80	2,437	2,446	2,455	2,464	2,473	2,482	2,491	2,500	2,510	2,519
5.90	2,528	2,537	2,546	2,555	2,564	2,574	2,583	2,592	2,601	2,611
6.00	2,620	2,629	2,638	2,647	2,655	2,664	2,673	2,682	2,691	2,700
6.10	2,709	2,718	2,727	2,736	2,745	2,754	2,763	2,772	2,781	2,790
6.20	2,800	2,809	2,818	2,827	2,836	2,845	2,855	2,864	2,873	2,882
6.30	2,892	2,901	2,910	2,919	2,929	2,938	2,947	2,957	2,966	2,976
6.40	2,985	2,994	3,004	3,013	3,023	3,032	3,042	3,051	3,061	3,070
6.50	3,080	3,089	3,099	3,109	3,118	3,128	3,138	3,147	3,157	3,167
6.60	3,176	3,186	3,196	3,206	3,215	3,225	3,235	3,245	3,254	3,264
6.70	3,274	3,284	3,294	3,304	3,314	3,324	3,334	3,344	3,354	3,364
6.80	3,374	3,384	3,394	3,404	3,414	3,424	3,434	3,444	3,454	3,464
6.90	3,475	3,485	3,495	3,505	3,515	3,525	3,536	3,546	3,556	3,567
7.00	3,577	3,587	3,598	3,608	3,618	3,629	3,639	3,649	3,660	3,670
7.10	3,681	3,691	3,702	3,712	3,723	3,733	3,744	3,754	3,765	3,775
7.20	3,786	3,797	3,807	3,818	3,829	3,839	3,850	3,861	3,871	3,882
7.30	3,893	3,903	3,914	3,925	3,936	3,947	3,958	3,968	3,979	3,990
7.40	4,001	4,012	4,023	4,034	4,045	4,056	4,067	4,078	4,089	4,100

Table 6.--Daily mean discharge of Little Clearfield Creek at Dimeling, from November 16, 1987 through November 2, 1988

[e, estimated]

DAY	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1	---	e250	e50	e130	40	75	26	25	4.9	6.4	6.1	6.2	6.9
2	---	e100	e45	e820	37	76	24	24	5.2	5.4	5.0	6.2	6.9
3	---	e78	e35	511	50	67	22	24	5.1	4.8	4.3	7.2	---
4	---	e64	e30	429	134	84	22	24	4.8	4.4	33	7.3	---
5	---	e53	e23	293	103	75	23	21	4.5	4.2	28	6.1	---
6	---	e46	e21	220	92	66	30	18	4.0	4.2	13	5.9	---
7	---	e41	e20	163	101	104	26	17	3.9	4.9	8.9	5.9	---
8	---	e37	e19	140	90	119	22	16	3.9	4.7	7.1	5.9	---
9	---	e38	e18	101	117	101	22	19	4.1	3.7	6.4	5.9	---
10	---	e42	e18	83	192	88	47	18	3.3	3.5	6.0	6.0	---
11	---	e36	e17	76	142	77	40	15	3.3	3.1	5.4	6.9	---
12	---	e35	e17	63	118	67	33	14	3.4	3.1	4.9	7.7	---
13	---	e33	e17	56	132	61	32	14	3.5	2.9	28	7.1	---
14	---	e29	e16	e52	107	55	44	13	3.2	2.8	17	6.3	---
15	---	e70	e16	e48	89	50	35	12	3.2	2.2	9.8	5.9	---
16	e16	e100	e16	e46	74	46	44	12	3.0	2.1	7.7	5.9	---
17	e30	e80	e16	e44	64	43	42	12	3.0	1.9	25	5.9	---
18	e23	e60	e25	e44	59	40	72	12	2.7	2.4	31	6.0	---
19	e20	e50	e50	e52	57	39	376	11	16	7.2	16	6.3	---
20	e19	e150	e200	74	53	34	232	10	14	6.3	13	6.8	---
21	e17	e140	e100	138	45	33	153	9.6	39	4.7	12	6.3	---
22	e16	e100	e80	127	44	30	108	8.6	25	3.7	10	7.6	---
23	e15	e90	e72	84	43	28	84	8.1	11	4.8	10	10	---
24	e14	e70	e68	84	47	30	81	7.2	11	19	10	12	---
25	e14	e53	e66	63	50	27	67	7.0	10	8.5	9.5	18	---
26	e14	e41	e62	56	120	24	53	6.8	7.7	6.3	8.4	12	---
27	e13	e34	e64	51	149	23	46	6.2	10	6.4	7.6	9.4	---
28	e12	e30	e70	46	118	23	39	6.0	7.7	5.0	7.0	8.6	---
29	e80	e26	e64	42	101	24	35	5.7	6.5	12	6.6	8.2	---
30	e600	e24	e54	---	89	32	31	5.3	5.9	21	6.2	7.7	---
31	---	e30	e70	---	78	---	28	---	7.3	8.4	---	6.9	---
TOTAL	---	2,030	1,439	4,136	2,735	1,641	1,939	401.5	240.1	180.2	363.9	234.1	---
MEAN	---	65.5	46.4	143	88.2	54.7	62.5	13.4	7.75	5.81	12.7	7.55	---
MAX	---	250	200	820	192	119	376	25	39	21	33	18	---
MIN	---	24	16	42	37	23	22	5.3	2.7	1.9	4.3	5.9	---

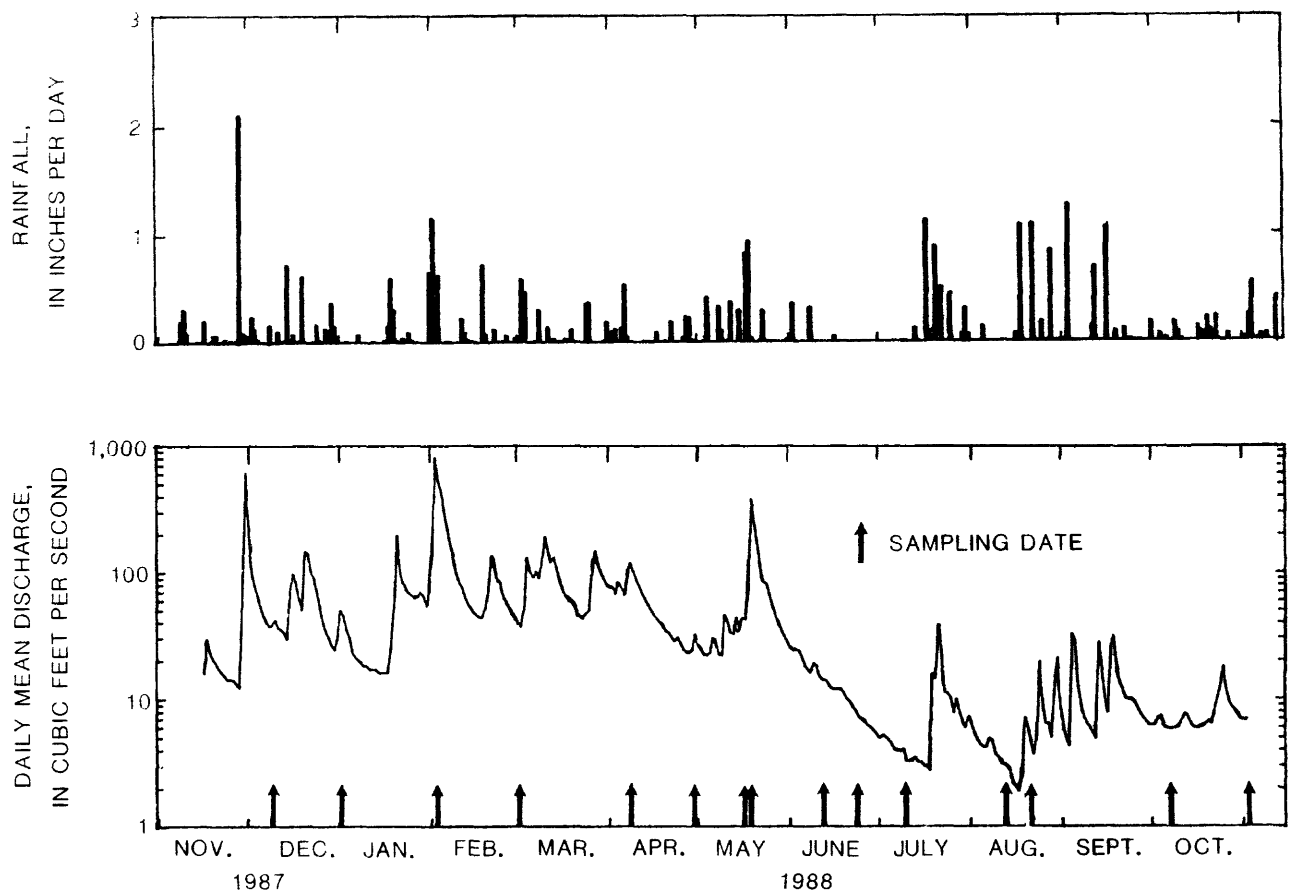

Figure 3.--Continuous stream discharge for Little Clearfield Creek at Dimeling and daily precipitation at Curwensville Lake.

WATER QUALITY

Monthly Water-Quality Samples

The chemical analyses for the monthly water-quality samples collected at Little Clearfield Creek at Dimeling, including both field and laboratory analyses, are listed in table 4. These results appear fairly consistent throughout the study period as they generally reflect base-flow conditions. Summary statistics of these results are listed in table 7.

The most noticeable exception involves the snowmelt-rainfall event on February 2, 1988. Maximum concentrations of the analyzed metals were associated with this event. Total iron increased from its median concentration of 380 μg/L (micrograms per liter), as determined from monthly water-quality samples, to about 21,000 μg/L, total aluminum increased from 90 to 12,300 μg/L, total manganese rose from 235 to 1,100 μg/L, and total zinc increased from <10 to 100 μg/L near the peak of this event.

Continuous Water-Quality Record

The Little Clearfield Creek at Dimeling station recorded pH, specific conductance, and water temperature at 1-hour intervals. Daily mean values, computed from these continuous records for the period of study, are listed in tables 8, 9, and 10. The hourly pH values were first converted to hourly hydrogen ion concentrations. The daily mean concentrations were then calculated, and these values were converted back to pH. Missing pH record during February resulted when the peak flow flushed the stream channel of all ice and subsequently damaged the pH probe. These daily mean data are plotted in figure 4. This figure illustrates the annual variation during the period of study associated with Little Clearfield Creek near its point of discharge from the CHIA basin.

Partial-Record Water Quality

Water-quality results from the four basinwide samplings are listed by event in tables 11, 12, 13, and 14. These results include both field and laboratory analyses. These water-quality samples were collected over a range of hydrologic conditions. The first sampling event reflects winter base-flow conditions. The second sampling was done during the rise of a spring storm. The third sampling event occurred during extremely low base-flow conditions, which persisted during the early and mid summer. The fourth sampling event reflects more moderate base-flow conditions present in late summer and early autumn.

Results of these basinwide samplings showed headwater streams in less disturbed areas, such as Green (P) and Stony Run (Q), possess low alkalinity and low specific conductance characteristics during periods of base flow. Conversely, tributaries in areas near active mining operations, such as Laurel Run (C) and the upper reaches of Watts Creek (R), exhibited elevated metal concentrations during base flow. These characteristics were not as pronounced in the results from the storm sampling, at which time metal concentrations were substantially higher at nearly all sample locations.

Table 7.--Summary of the monthly water-quality sampling of Little Clearfield Creek at Dimeling, from January through November, 1988

[Deg C, degrees Celsius; ft³/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 Deg C; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; N, number of samples]

Constituent	N	Median	Mean	Minimum	Maximum	Units
Water temperature	10	8.5	9.7	0	25	Deg C
Stream discharge	10	20	130	3.4	1,070	ft^3/s
Specific conductance	10	260	458	142	640	µS/cm
Dissolved oxygen	10	11.7	11.2	8.7	14	mg/L
pH	10	7.9	7.8	6.9	8.1	Standard
Alkalinity, total	10	60	57.5	12	90	mg/L
Acidity, total	10	0	0.59	0	3	mg/L
Solids, dissolved	10	335	335	186	550	mg/L
Solids, suspended	10	5	46.3	<2	415	mg/L
Nitrite, dissolved	10	<.01	<.01	<.01	<.01	mg/L
Nitrite-Nitrate	10	.67	.51	.04	1	mg/L
Phosphorus, ortho	10	<.01	.02	<.01	.08	mg/L
Calcium, dissolved	10	57	57.2	11	93	mg/L
Magnesium, dissolved	10	17.5	17.7	3.5	28	mg/L
Sodium, total	10	4.6	4.8	3.0	6.8	mg/L
Potassium, dissolved	10	2.0	2.0	1.6	2.5	mg/L
Chloride, total	10	9	9.6	7.0	13	mg/L
Sulfate, total	10	155	156	41	260	mg/L
Iron, total	10	380	2,555	270	21,000	µg/L
Iron, dissolved	10	64	121	<10	520	µg/L
Manganese, total	10	235	270	60	1,100	µg/L
Manganese, dissolved	10	190	161	31	260	µg/L
Zinc, total	10	20	28	<10	100	µg/L
Zinc, dissolved	10	20	20	<10	50	µg/L
Aluminum, total	10	90	1,344	<50	12,300	µg/L
Aluminum, dissolved	10	70	82	<50	210	µg/L
Sediment, suspended	10	10	64.5	2	552	mg/L

Table 8.--Daily mean pH of Little Clearfield Creek at Dimeling, from January 7 through November 2, 1988

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1	--	7.4	--	7.6	7.8	7.7	7.9	7.7	8.0	8.0	7.8
2	--	6.9	7.8	7.6	7.7	7.7	7.9	7.7	7.9	8.0	7.8
3	--	7.1	7.8	7.6	7.7	7.6	7.9	7.8	7.9	8.0	--
4	--	7.2	7.6	7.6	7.7	7.6	7.9	7.8	7.7	8.1	--
5	--	--	7.6	7.7	7.7	7.6	7.8	7.7	7.9	8.1	--
6	--	--	7.6	7.7	7.8	7.6	7.8	7.7	7.9	8.1	--
7	7.5	--	7.6	7.5	7.7	7.8	7.8	7.8	7.9	8.1	--
8	7.5	--	7.6	7.5	7.7	7.9	7.9	7.8	7.9	8.1	--
9	7.4	--	7.6	7.5	7.7	7.8	8.0	8.1	7.9	8.1	--
10	7.4	--	7.5	7.5	7.6	7.8	7.9	8.2	7.9	8.1	--
11	7.4	--	7.5	7.5	7.6	7.8	7.9	8.1	8.0	8.0	--
12	7.4	--	7.6	7.5	7.6	7.7	7.8	8.0	8.0	8.0	--
13	7.4	--	7.6	7.6	7.6	7.7	7.7	7.9	7.8	8.0	--
14	7.5	--	7.6	7.7	7.6	7.6	7.7	7.7	8.0	8.0	--
15	7.5	--	7.7	7.7	7.6	7.6	7.7	7.5	8.0	8.0	--
16	7.4	--	7.7	7.7	7.5	7.5	7.7	7.4	7.9	7.9	--
17	7.4	--	7.7	7.7	7.5	7.5	7.7	7.3	7.7	7.9	--
18	7.6	--	7.8	7.8	7.4	7.5	7.7	7.5	7.8	7.9	--
19	7.7	--	7.8	7.8	7.4	7.7	7.8	7.7	7.8	7.9	--
20	7.5	--	7.8	7.8	7.4	7.7	8.0	7.8	7.8	7.9	--
21	7.2	--	7.8	7.8	7.6	7.7	7.8	8.0	7.8	7.9	--
22	7.2	--	7.8	7.8	7.7	7.8	7.8	8.0	8.0	7.9	--
23	7.3	--	7.9	7.8	7.8	7.8	7.8	8.0	8.0	7.9	--
24	7.2	--	7.9	7.8	7.8	7.8	7.9	7.9	8.1	7.9	--
25	7.3	--	7.8	7.8	7.9	7.8	7.9	8.0	8.2	7.9	--
26	7.3	--	7.7	7.8	7.9	7.8	7.9	8.0	8.2	7.9	--
27	7.3	--	7.5	7.8	7.9	7.8	7.9	7.9	8.1	7.8	--
28	7.3	--	7.6	7.8	7.9	7.9	7.8	7.9	8.1	7.8	--
29	7.3	--	7.6	7.8	7.8	7.9	7.7	7.8	8.1	7.7	--
30	7.4	--	7.6	7.8	7.8	7.9	7.6	8.0	8.1	7.7	--
31	7.4	--	7.7	--	7.8	--	7.6	8.0	--	7.8	--
MEAN	--	--	7.7	7.7	7.7	7.7	7.8	7.8	8.0	8.0	--
MAX	--	--	7.9	7.8	7.9	7.9	8.0	8.2	8.2	8.1	--
MIN	--	--	7.5	7.5	7.4	7.5	7.7	7.3	7.7	7.7	--

Table 9.--Daily mean specific conductance of Little Clearfield Creek at Dimeling, from January 7 through November 2, 1988

[microsiemens per centimeter at 25 degrees Celsius]

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1	---	302	372	289	411	403	618	577	625	588	580
2	---	170	378	294	407	420	617	585	621	593	581
3	---	162	369	299	415	429	626	587	618	600	---
4	---	183	298	297	420	429	637	587	557	597	---
5	---	202	248	285	420	445	644	606	516	607	---
6	---	229	264	291	404	457	617	626	521	615	---
7	385	256	258	278	403	478	621	639	530	620	---
8	411	279	264	240	403	479	615	642	543	624	---
9	406	302	260	234	405	480	609	646	556	625	---
10	409	321	223	239	380	484	616	663	561	625	---
11	428	341	219	249	346	499	623	694	574	626	---
12	437	358	233	260	339	499	627	708	583	614	---
13	433	377	239	289	339	517	629	719	546	613	---
14	440	396	243	327	327	528	630	721	511	621	---
15	463	402	260	345	327	539	645	724	525	631	---
16	492	418	274	357	320	542	651	733	526	637	---
17	499	429	289	374	313	550	655	729	517	636	---
18	477	440	303	384	295	552	659	740	466	635	---
19	410	435	315	391	177	566	628	722	493	638	---
20	245	400	323	394	174	568	599	705	500	624	---
21	213	326	336	418	197	566	540	692	487	624	---
22	241	352	350	428	221	563	448	701	488	625	---
23	260	337	361	436	243	578	460	686	506	610	---
24	273	317	360	439	262	579	484	664	510	595	---
25	282	326	340	445	278	585	491	645	517	571	---
26	294	339	290	436	296	592	518	667	536	574	---
27	312	348	238	429	320	603	525	663	550	572	---
28	332	334	234	434	338	600	536	655	561	565	---
29	344	368	243	431	358	607	551	646	564	562	---
30	354	---	256	417	375	611	556	576	578	559	---
31	347	---	270	---	394	---	566	618	---	567	---
MEAN	---	326	287	348	332	525	588	663	540	606	---
MAX	---	440	378	445	420	611	659	740	625	638	---
MIN	---	162	219	234	174	403	448	576	466	559	---

Table 10.--Daily mean water temperature of Little Clearfield Creek at Dimeling, from January 7 through November 2, 1988

[degrees Celsius]

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1	---	.0	1.5	9.0	8.0	19.5	12.5	23.5	18.0	13.5	2.5
2	---	1.0	1.5	10.0	8.5	18.0	14.0	25.0	18.0	13.5	4.0
3	---	3.0	2.5	11.5	9.5	15.0	16.5	26.5	18.5	13.5	---
4	---	2.5	1.0	12.5	10.5	14.0	18.0	25.5	18.5	12.5	---
5	---	1.0	.5	11.5	10.5	15.0	19.5	26.0	17.0	12.5	---
6	---	.0	1.0	11.5	12.0	18.5	21.0	24.5	14.0	12.5	---
7	.0	.0	2.0	9.5	15.0	20.5	21.5	24.0	13.5	10.5	---
8	.0	.0	3.0	8.5	15.5	19.5	24.0	23.5	14.0	9.5	---
9	.0	.0	3.0	7.5	15.5	16.5	24.5	23.0	15.0	9.0	---
10	.0	.0	3.5	7.5	14.5	13.5	24.0	24.0	16.0	9.5	---
11	.0	.0	3.0	8.5	14.0	14.0	24.0	25.0	15.5	9.5	---
12	.0	.0	4.0	8.5	13.5	16.5	25.0	26.0	15.0	8.0	---
13	.0	.0	4.5	8.5	15.0	18.5	24.0	26.5	17.5	6.5	---
14	.0	.0	2.5	8.0	16.0	20.0	24.5	26.5	15.5	6.0	---
15	.0	.0	1.0	7.5	16.0	21.0	26.0	25.5	15.0	7.5	---
16	.0	.0	.5	5.0	17.5	19.0	25.5	23.5	13.5	10.0	---
17	.0	.0	1.5	6.5	17.0	19.5	25.5	23.5	14.0	12.0	---
18	.0	.0	1.5	8.0	14.5	19.5	25.5	24.0	15.5	12.5	---
19	.0	.0	2.0	7.0	12.5	19.5	24.0	20.0	18.0	9.5	---
20	.0	.0	1.5	7.0	12.0	20.5	23.5	19.5	19.5	9.0	---
21	.0	.0	.5	8.0	12.5	22.0	22.0	20.0	18.0	7.5	---
22	.0	.0	.5	8.0	14.0	21.0	22.5	18.5	16.5	7.5	---
23	.0	.0	2.5	8.5	15.0	22.0	21.0	17.0	17.0	8.0	---
24	.0	.0	5.5	8.0	16.0	19.5	21.5	18.0	15.5	8.0	---
25	.0	.0	8.0	8.5	14.0	20.0	22.0	19.0	14.5	6.5	---
26	.0	.0	8.5	10.0	12.5	19.0	21.5	20.0	14.5	5.5	---
27	.0	.0	6.0	10.5	14.0	16.5	22.5	19.5	14.5	4.5	---
28	.0	.5	5.5	9.0	16.0	15.5	23.0	22.0	14.5	5.0	---
29	.0	1.0	7.5	7.5	17.0	17.0	25.0	21.0	13.5	4.5	---
30	.0	---	8.5	7.5	18.5	15.0	24.5	19.5	12.0	4.0	---
31	.0	---	8.5	---	19.5	---	25.0	18.0	---	2.0	---
MEAN	---	.5	3.5	8.5	14.0	18.0	22.5	22.5	15.5	8.5	---
MAX	---	3.0	8.5	12.5	19.5	22.0	26.0	26.5	19.0	13.5	---
MIN	---	.0	.5	5.0	8.0	13.5	12.5	17.0	12.0	2.0	---

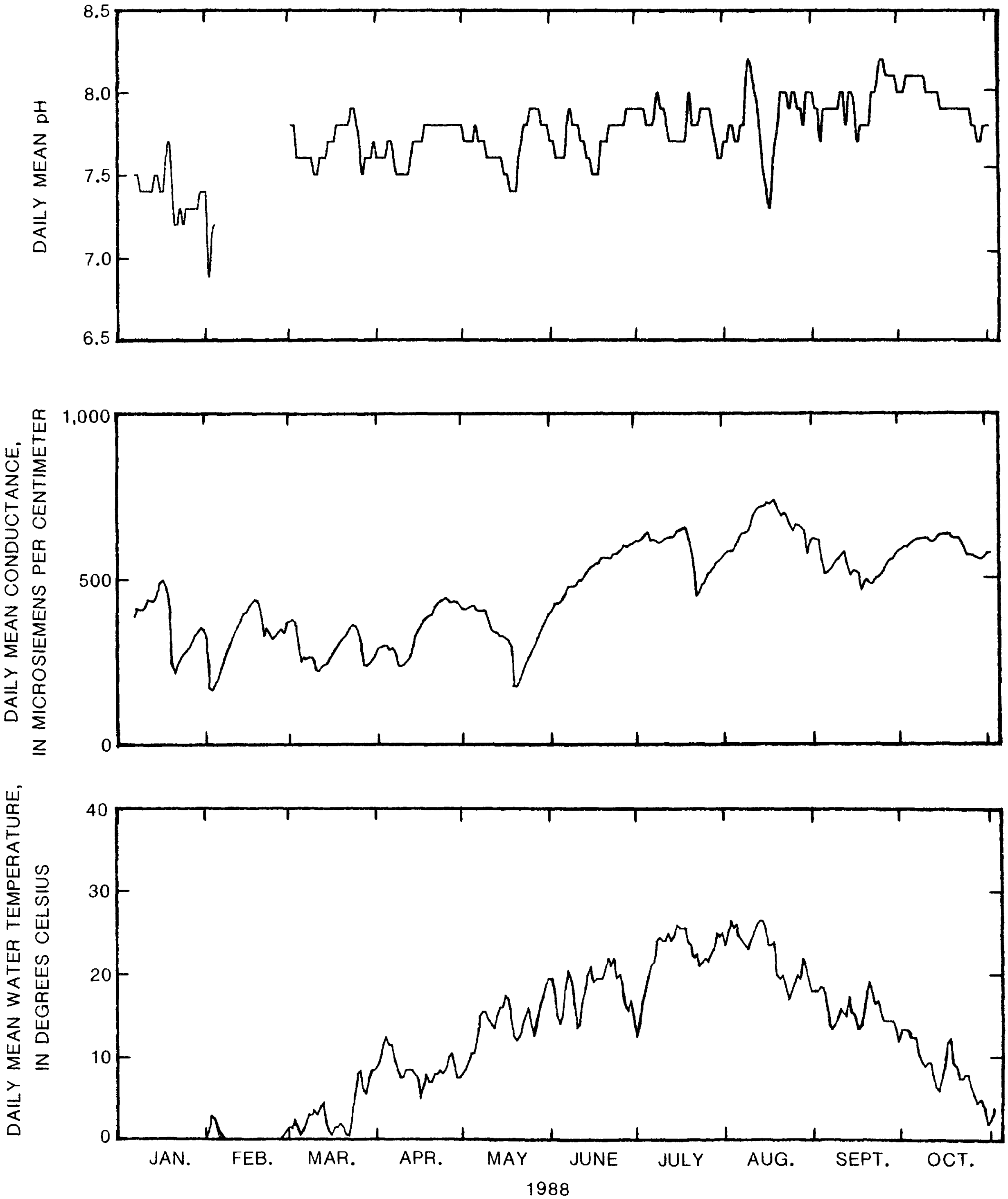

Figure 4.--Daily mean pH, specific conductance, and water temperature for Little Clearfield Creek at Dimeling.

Table 11.--Results of the winter base-flow sampling of Little Clearfield Creek basin on December 7-8, 1987

[Deg C, degrees Celsius; ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 Deg C; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than]

Station	Date	Time	Temperature, water, field (Deg C)	Streamflow, instantaneous, field (ft^3/s)	Specific conductance, field (µS/cm)	Oxygen, dissolved, field (mg/L)	pH, field (standard units)	Alkalinity, total (mg/L as $CaCO_3$)	Acidity, total (mg/L as $CsCO_3$)	Solids at 105 Deg C, dissolved (mg/L)	Solids at 105 Deg C, suspended (mg/L)	Sodium, total (mg/L as Na)	Chloride total (mg/L as Cl)	Sulfate, total (mg/L as SO_4)	Iron, total (µg/L as Fe)	Manganese, total (µg/L as Mn)	Zinc, total (µg/L as Zn)	Aluminum, total (µg/L as Al)
A	120787	1045	0.5	41	317	14.0	7.5	42	0	164	<2	3.7	8.0	110	340	200	<10	90
B	120787	1230	1.5	0.94	354	13.7	7.1	44	0	260	<2	4.4	10	120	110	75	<10	160
C	120787	1400	2.5	1.3	890	13.2	7.3	30	0	618	<2	4.3	5.0	440	1,600	3,100	<10	350
D	120787	1510	3.5	0.52	390	13.0	7.5	58	0	234	<2	15	27	90	180	100	<10	100
E	120787	1615	1.5	34	311	13.7	7.5	48	0	206	<2	3.6	8.0	100	400	120	20	140
F	120787	1715	2.0	32	319	13.6	7.5	50	0	202	<2	3.8	8.0	100	290	110	<10	<50
G	120887	0900	2.0	2.0	374	13.1	7.8	56	0	256	<2	4.5	7.0	120	140	160	<10	<50
H	120887	1030	3.5	0.70	460	12.3	7.8	78	0	334	<2	3.1	4.0	150	210	170	<10	180
I	120887	1100	2.0	24	345	13.3	7.8	56	0	234	<2	3.8	8.0	100	290	130	<10	170
J	120887	1200	3.5	1.6	464	12.8	7.8	54	0	312	<2	5.5	8.0	170	90	46	10	110
K	120787	1430	2.5	15	320	12.9	6.4	52	0	220	<2	3.1	7.0	100	260	60	<10	100
L	120787	1320	1.0	6.1	385	13.3	6.4	66	0	270	<2	2.6	7.0	130	320	280	<10	<50
M	120787	1530	2.5	2.9	363	12.8	6.7	62	0	226	<2	3.6	10	100	140	51	<10	<50
N	120887	1145	3.0	2.7	560	12.3	7.2	78	0	372	<2	3.5	7.0	210	40	54	<10	<50
O	120887	1250	4.0	6.3	189	12.0	7.3	38	0	110	<2	2.4	6.0	51	130	37	<10	<50
P	120887	0900	2.5	2.0	83	12.4	7.0	14	0	42	<2	1.7	6.0	14	180	35	90	<50
Q	120887	1015	3.0	2.5	75	12.3	6.2	16	0	38	<2	1.9	5.0	14	60	13	<10	60
R	120887	1645	2.3	1.3	283	12.5	6.5	76	0	260	<2	2.9	7.0	130	1,100	590	<10	990

Table 12.--Results of the apring storm event sampling of Little Clearfield Creek basin on May 18-19, 1988

[Deg C, degrees Celsius; ft^3/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 Deg C; mg/L, milligrams per liter; µg/L, micrograms per liter]

Station	Date	Time	Temperature, water, field (Deg C)	Streamflow, instantaneous, field (ft^3/s)	Specific conductance, field (µS/cm)	Oxygen, dissolved, field (mg/L)	pH, field (standard units)	Alkalinity (mg/L as $CaCO_3$)	Acidity (mg/L as $CaCO_3$)	Solids at 105 Deg C, dissolved (mg/L)	Solids at 105 Deg C, suspended (mg/L)	Sodium, total (mg/L as Na)	Chloride, total (mg/L as Cl)	Sulfate, total (mg/L as SO_4)	Iron, total (µg/L as Fe)	Manganese, total (µg/L as Mn)	Zinc, total (µg/L as Zn)	Aluminum, total (µg/L as Al)	Sediment, suspended (mg/L)
A	051888	1430	14.5	59	320	10.2	7.4	44	0	166	12	4.1	7.0	100	820	260	<10	200	12
A	051988	1030	13.0	554	198	10.3	7.3	26	0	156	390	3.3	8.0	47	17,000	940	250	<50	32
B	051888	1745	11.5	2.6	315	10.0	7.4	40	0	222	60	7.2	13	92	2,000	330	60	810	71
C	051888	1630	12.5	3.7	779	9.6	7.1	18	0	264	52	4.7	9.0	380	4,700	3,000	100	2,200	58
D	051988	1015	12.5	4.2	374	9.6	7.5	60	0	700	116	2.0	31	64	4,700	390	90	1,500	115
E	051988	1050	12.0	449	149	10.0	7.0	26	0	111	275	2.8	7.0	38	12,000	600	80	5,200	274
F	051988	1220	13.5	360	147	9.4	7.2	24	0	196	134	2.9	6.0	38	6,600	450	170	3,200	158
G	051988	1130	13.5	23	213	9.7	7.3	30	0	156	108	4.8	8.0	60	3,900	470	60	1,200	97
H	051888	1850	11.5	2.9	320	9.6	7.4	56	0	278	40	2.6	5.0	96	1,900	290	40	700	315
I	051888	2130	12.0	117	250	9.3	7.5	42	0	214	112	5.7	13	59	5,400	360	20	1,900	119
J	051888	2045	10.5	8.9	290	10.2	7.4	34	0	268	156	4.9	10	87	7,500	430	40	2,300	195
K	051988	0930	12.0	141	137	10.1	6.9	22	0	120	104	2.3	4.0	33	3,200	240	30	1,700	104
L	051888	2145	13.0	38	250	9.9	7.3	46	0	220	212	2.9	7.0	64	11,000	590	40	5,700	230
M	051888	2050	12.5	18	170	10.2	7.2	30	0	162	312	3.9	9.0	38	11,000	530	60	4,000	280
N	051888	1930	12.0	12	422	10.2	7.3	42	0	344	36	12	32	100	1,700	210	20	630	38
O	051888	2005	11.0	28	135	10.5	7.1	24	0	112	88	2.7	7.0	28	3,400	190	30	1,300	79
P	051888	1850	12.0	10	75	10.6	6.7	12	0	76	46	2.0	6.0	16	2,300	130	30	720	48
Q	051888	1817	12.0	11	75	10.5	6.9	16	0	70	34	2.6	5.0	16	1,800	89	<10	760	35
R	051888	1645	12.0	8.4	135	10.2	7.0	24	0	88	68	2.2	6.0	29	3,500	360	30	1,600	35

Table 13.--Results of the summer base-flow sampling of Little Clearfield Creek basin on June 21-22, 1988

[Deg C, degrees Celsius; ft^3/s, cubic feet per second; μS/cm, microsiemens per centimeter at 25 Deg C; mg/L, milligrams per liter; μg/L, micrograms per liter; <, less than]

Station	Date	Time	Temperature, water, field (Deg C)	Streamflow, instantaneous, field (ft^3/s)	Specific conductance, field (μS/cm)	Oxygen, dissolved, field (mg/L)	pH, field (standard units)	Alkalinity (mg/L as $CaCO_3$)	Acidity (mg/L as $CaCO_3$)	Solids at 105 Deg C, dissolved (mg/L)	Solids at 105 Deg C, suspended (mg/L)	Sodium, total (mg/L as Na)	Chloride, total (mg/L as Cl)	Sulfate, total (mg/L as SO_4)	Iron, total (μg/L as Fe)	Manganese, total (μg/L as Mn)	Zinc, total (μg/L as Zn)	Aluminum, total (μg/L as Al)	Sediment, suspended (mg/L)
A	062188	1130	24.5	10.3	559	7.6	8.0	80	0	464	4	4.8	9.0	205	230	100	20	130	5
B	062188	1310	21.0	0.37	625	7.6	7.6	66	0	474	14	4.4	8.0	227	490	97	15	560	21
C	062288	1530	8.5	0.59	1,420	7.8	7.7	34	0	1,430	14	3.8	3.0	880	850	5,700	40	400	13
D	062188	1400	23.0	0.11	557	7.6	7.8	94	0	394	8	15	28	140	520	80	40	270	6
E	062188	1430	25.0	7.3	565	--	7.9	92	0	428	<2	4.6	9.0	170	570	71	<10	280	7
F	062188	1521	25.0	6.8	585	7.3	8.0	106	0	436	6	3.8	11	170	310	60	<10	270	5
G	062188	1547	23.0	0.46	620	6.7	7.9	102	0	458	8	3.9	8.0	190	320	85	<10	220	10
H	062288	0820	15.5	0.27	712	6.7	7.8	134	0	544	16	2.5	5.0	230	320	150	10	310	13
I	062288	0910	20.0	4.5	607	5.8	7.8	120	0	460	8	3.9	9.0	220	510	110	10	290	10
J	062288	0930	18.0	0.42	656	6.5	7.7	82	0	526	10	3.8	7.0	250	340	85	<10	220	9
K	062288	1100	19.5	3.1	548	7.9	8.0	116	0	508	<2	3.8	9.0	260	220	58	10	150	4
L	062288	1030	20.5	1.8	554	7.6	8.1	148	0	494	6	2.9	7.0	234	500	160	16	540	14
M	062288	1130	18.0	0.43	692	7.3	8.1	146	0	542	4	3.8	6.0	210	160	30	10	160	3
N	062288	1155	18.0	1.1	840	7.6	8.0	122	0	704	2	5.4	12	340	140	51	10	190	5
O	062288	1225	19.0	1.7	424	7.8	8.1	94	0	310	10	3.9	9.0	110	160	32	20	140	4
P	062288	1300	18.5	0.15	94	7.2	7.3	24	22	66	2	1.6	5.0	22	190	14	<10	150	2
Q	062188	1325	19.0	0.14	70	7.7	7.2	22	24	50	10	1.4	4.0	13	240	20	11	240	14
R	062288	1400	19.0	0.13	543	7.8	7.7	176	0	432	10	3.0	5.0	170	590	260	20	170	15

Table 14.--Results of the base-flow sampling of Little Clearfield Creek basin on August 23-25, 1988

[Deg C, degrees Celsius; ft^3/s, cubic feet per second; μS/cm, microsiemens per centimeter at 25 Deg C; mg/L, milligrams per liter; μg/L, micrograms per liter; <, less than]

Station	Date	Time	Temperature, water, field (Deg C)	Streamflow, instantaneous, field (ft^3/s)	Specific conductance, field (μS/cm)	Oxygen, dissolved, field (mg/L)	pH, field (standard units)	Alkalinity (mg/L as $CaCO_3$)	Acidity (mg/L as $CaCO_3$)	Solids at 105 Deg C, dissolved (mg/L)	Solids at 105 Deg C, suspended (mg/L)	Sodium, total (mg/L as Na)	Chloride total (mg/L as Cl)	Sulfate, total (mg/L as SO_4)	Iron, total (μg/L as Fe)	Manganese, total (μg/L as Mn)	Zinc, total (μg/L as Zn)	Aluminum, total (μg/L as Al)
A	082388	1000	16.0	3.5	680	9.6	8.1	88	0	534	12	6.0	9.0	290	290	54	30	120
B	082388	1130	14.0	0.15	732	9.8	7.9	74	0	724	6	5.6	11	340	260	89	30	220
C	082388	1230	13.5	0.39	1,600	10.1	7.6	50	0	1,740	16	4.2	4.0	1,140	590	6,430	50	220
D	082388	1340	15.0	0.06	712	9.0	7.8	112	0	616	40	24	41	220	1,600	380	40	780
E	082388	1415	17.0	2.6	606	9.6	8.1	110	0	454	2	5.9	8.0	220	480	77	10	90
F	082388	1515	17.5	2.8	615	9.3	8.1	122	0	492	8	6.0	9.0	210	380	100	40	90
G	082388	1615	15.5	0.38	581	8.1	8.2	116	0	484	36	5.3	6.0	210	1,500	260	30	460
H	082488	0800	15.0	0.21	670	7.3	7.9	114	0	588	14	6.0	12	240	540	390	20	270
I	082488	0845	15.5	9.6	537	8.6	8.1	108	0	394	30	5.3	10	170	1,400	110	<10	1,000
J	082488	1005	16.0	0.39	630	8.6	7.9	72	0	548	20	4.5	7.0	270	730	170	20	540
K	082488	1045	15.5	4.0	548	9.0	8.1	98	0	478	34	4.2	8.0	200	1,000	81	10	730
L	082488	1130	16.5	2.6	597	9.6	8.3	142	0	474	30	4.8	9.0	180	1,600	400	20	620
M	082488	1230	16.0	0.76	568	8.8	8.1	114	0	446	4	4.3	6.0	200	290	35	<10	240
N	082488	1315	16.0	1.2	752	8.4	8.1	106	0	586	<2	3.9	6.0	360	260	62	10	160
O	082488	1400	17.0	1.4	310	9.3	8.1	68	0	242	2	3.0	6.0	95	710	54	<10	420
P	082588	1200	15.5	0.06	105	8.2	7.7	30	0	50	<2	1.7	4.0	21	750	<10	<10	150
Q	082588	1300	15.5	0.09	90	7.5	7.4	24	6.0	48	<2	0.2	4.0	23	260	24	<10	120
R	082588	1430	15.5	0.17	482	7.9	7.7	130	0	390	<2	4.3	7.0	140	680	480	10	120

SUMMARY

Little Clearfield Creek basin, located in Clearfield County, Pennsylvania, was selected for this study because future mine-permit applications for areas within this basin were anticipated. In an effort to document existing surface water conditions, a streamflow and water-quality assessment of the entire basin was done from December 1987 through November 1988.

Precipitation to this area was 18 percent below normal for the 11-month period of study. The streamflow of Little Clearfield Creek decreased substantially during the summer when precipitation was absent. Peak flow for the period of record occurred on February 2, 1988. A rainfall event that produced substantial runoff removed all ice from the stream channel at this time. A water-quality sample collected at Little Clearfield Creek at Dimeling during this peak flow contained the highest concentrations for most total and dissolved metals.

Basinwide sampling revealed several headwater streams with low alkalinity and low specific conductance. These streams may be more susceptible to degradation as a result of mining activities. Stream quality in more disturbed areas already reflects some degradation as evidenced by the elevated metal concentrations during base flow. The complexity of a basin, including its geology and the extent of all previous mining, must be considered in great detail to improve the interpretation of the available water-quality data.

REFERENCES CITED

Berg, T.M. and others, 1980, Geologic map of Pennsylvania: Pennsylvania Geological Survey, 1:250,000 scale.

Berg, T.M., McInerney, M.K., Way, J.H., and MacLachan, D.B., 1983, Stratigraphic correlation chart of Pennsylvania: Pennsylvania Geological Survey, General Geology Report 75, 1 sheet.

Brown, E., Skougstad, M.W., and Fishman, M.J., 1970, Methods for collection and analysis of water samples for dissolved minerals and gases: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 160 p.

Craig, J.D., 1983, Installation and service manual for U.S. Geological Survey manometers: U.S. Geological Survey Techniques of Water-Resources Investigations, book 8, chap. A2, 57 p.

Davidian, J., 1984, Computation of water-surface profiles in open channels: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A15, 48p.

Ficken, J.H. and Scott, C.T., 1983, Operating manual for USGS minimonitors: U.S. Geological Survey Report 6-83-02, 72 p.

ISSCO Inc., 1984, Telagraf user's manual: Integrated Software Sytems Corporation, San Diego, Calif., 700 p.

Kennedy, E.J., 1983, Computation of continuous records of streamflow: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A13, 53 p.

P-STAT, Inc., 1986, P-Stat user's manual: Duxbury Press, Boston, 852 p.

Rantz, S.E. and others, 1982, Measurement and computation of streamflow, Volume 1 and 2: U.S. Geological Survey Water-Supply Paper 2175, 631 p.

SAS INC., 1982, SAS user's guide - basics: SAS Institute Inc., Raleigh, N.C., 921 p.

Shaw, L.C., 1984, Pennsylvania gazetteer of streams, Part II: Commonwealth of Pennsylvania, Department of Environmental Resources, Water Resources Bulletin no. 16, 418 p.

Shaw, L.C. and Busch, W.F., 1970, Pennsylvania gazetteer of streams, Part I: Commonwealth of Pennsylvania, Department of Forests and Waters, Water Resources Bulletin no. 6, 280 p.

Skougstad, M.W. and others, 1979, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 626 p.

U.S. Department of Commerce, 1970-88, Climatological data, Pennsylvania: National Oceanic and Atmospheric Administration, Environmental Data Service.

U.S. Department of the Interior, 1976, Preparation of water-resources data reports: U.S. Geological Survey, Water Resources Division, Data Reports Unit, 100 p.