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Physical, Chemical, and Biological Characteristics of Selected Headwater Streams along the Allegheny Front, Blair County, Pennsylvania, July 2011–September 2013

Open-File Report 2015–1173

U.S. Department of the Interior
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SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Director

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft.)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
	Radioactivity	
picocurie per liter (pCi/L)	0.037	becquerel per liter (Bq/L)

Supplemental Information

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

°F = (1.8×°C)+32

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

°C = (°F-32)/1.8

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C).

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

Datum

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Elevation, as used in this report, refers to distance above the vertical datum.

Physical, Chemical, and Biological Characteristics of Selected Headwater Streams along the Allegheny Front, Blair County, Pennsylvania, July 2011–September 2013

By Dennis J. Low, Robin A. Brightbill, Heather L. Eggleston, and Jeffrey J. Chaplin

Abstract

The Altoona Water Authority (AWA) obtains all of its water supply from headwater streams that drain western Blair County, an area underlain in part by black shale of the Marcellus Formation. Development of the shale-gas reservoirs will require new access roads, stream crossing, drill-pad construction, and pipeline installation, activities that have the potential to alter existing stream channel morphology, increase runoff and sediment supply, alter streamwater chemistry, and affect aquatic habitat. The U.S. Geological Survey, in cooperation with Altoona Water Authority and Blair County Conservation District, investigated the water quality of 12 headwater streams and biotic health of 10 headwater streams.

Channel morphology was characterized at 10 of 12 stream sites using 500-foot (minimum) longitudinal profiles, four cross-sections each, and pebble counts. Channel slopes ranged from 0.008 in Poplar Run near Newry to 0.045 in Mill Run. In general, streams draining watersheds of 5 square miles or less and at higher elevation had the steepest slopes. On the basis of the median particle size, determined during pebble counts, the streambed substrate can be characterized as cobble (Mill Run, Bells Gap Run, Tipton Run, and Sink Run), a mix of gravel and cobble (South Poplar Run, Dry Gap Run, Glenwhite Run, Sugar Run, Blair Gap Run), and gravel (Poplar Run, Newry).

Daily mean values of gage height were determined, and continuous (30-minute interval) data consisting of specific conductance and water temperature were collected, at four sites; each site showed typical seasonal fluctuations and the effects of precipitation.

Streamflow affected discrete water-quality. Dissolved oxygen always increased with increased streamflow. Most cations (including barium and strontium), along with pH, specific conductance, and total dissolved solids, decreased with greater streamflow, reflecting the dilution effect of moderately acidic surface runoff and precipitation on groundwater discharge (base flow) into the stream channels. Concentrations of trace elements varied by constituent and streamflow.

On the basis of the results of water-quality analyses for the selected constituents, the water quality in 9 of the 12 streams can be considered fair or attaining with no measured constituent exceeding a U.S. Environmental Protection Agency maximum or secondary contaminant level. Abandoned mine drainage (AMD) affects Glenwhite Run, Blair Gap Run, and Sugar Run. For Sugar Run, the AMD is reflected in the elevated iron concentration (greater than 300 micrograms per liter). Manganese concentrations greater than 50 micrograms per liter were measured in Glenwhite Run, Sugar Run, and Blair Gap Run.

A mixing curve based upon chloride/bromide ratios for two end points—precipitation and deicing salts—indicate that deicing salt is migrating to the streams. A similar curve representative of late-emerging flowback water from Marcellus gas wells indicated that the surface-water samples had not been influenced by such brines.

On the basis of the concentration of major ions, the streams in the study area generally had mixed cation and anion compositions. Calcium is the dominant cation in one stream. Carbonate and bicarbonate are the dominant anions for two streams, and sulfate is dominant in three streams. The remaining six streams do not have a dominant ion.

Biotic health was characterized at 10 of 12 stream sites; the two sites excluded were established late in the study period (May 2013) for refinement of water quality in the headwaters of Poplar Run and the location of Marcellus Formation gas wells. On the basis of the Maryland Index of Biotic Integrity (MdIBI) for fish assemblages, 8 of 10 streams can be considered in fair health. Tipton Run had the highest MdIBI score (3.75) and the greatest number of native species. South Poplar Run had the lowest MdIBI score (1.75); pollution tolerant blacknose dace was dominant. On the basis of the Pennsylvania Department of Environmental Protection macroinvertebrate index of biotic integrity, 9 of 10 streams were characterized as attaining, with scores as high as 88.9 at Tipton Run. Only Sugar Run was characterized as impaired, with a score of 40.4.

Introduction

Exploration for, and development of, natural gas in the black shale of the Marcellus Formation has the potential to provide the United States with an abundant supply of natural gas (Engelder and Lash, 2008). The Marcellus Formation underlies much of Pennsylvania from the northeast to the southwest and includes the area of western Blair County that is used by the Altoona Water Authority (AWA) and Tyrone Water Authority (TWA) for water supply (fig. 1). Exploration and development activities for natural gas from the Marcellus Formation have the potential to affect source waters for the AWA and TWA.

The AWA is the largest, publicly owned, dual operating authority (water and wastewater) between Pittsburgh and Harrisburg, Pa. The AWA provides drinking water for almost 70,000 individuals in Blair County, Pa., including the city of Altoona and 12 other boroughs and townships. The present surface-water sources are captured by 12 reservoirs. The water-storage and distribution system consists of treatment plants, storage facilities, pumping stations, and distribution lines.

Major water-quality and management concerns are (1) potential degradation of surface water during the exploration and development phases of natural gas extraction, (2) documentation of the current health of the aquatic habitat and community, and (3) identification of stream degradation through comparison in the pre-natural gas development baseline assessments and future assessments via changes in water chemistry, aquatic habitat, and community. In July 2011 the U.S. Geological Survey (USGS), in cooperation with the AWA and the Blair County Conservation District (BCCD), initiated a study to document baselines for channel morphology, bed particle-size distribution, surface-water quality, fish, and benthic invertebrates in selected headwater streams, including those supplying drinking water for AWA and TWA.

Purpose and Scope

This report provides an evaluation of baseline physical, hydrologic, chemical, and biologic data for selected headwater streams in western Blair County, including those used for drinking water supply by AWA and TWA. The evaluations in this report are based on data collected between July 2011 and September 2013 by USGS and BCCD. Geomorphology data consisting of channel morphology and bed sediment particle-size distribution are presented for 10 stream reaches. Hydrologic data consisting of continuous gage height (4 sites) and instantaneous streamflow (12 sites) are presented. Results of analyses of discrete water-quality samples are presented for 12 sites and consist of standard field parameters (temperature, pH, dissolved oxygen, specific conductance), major and minor ions, trace elements, and radiochemicals. Continuous (30-minute interval) specific conductance and water temperature are presented for four sites. Biologic data (10 sites) include the abundance, size structure, and species composition of fish populations in the selected streams and the structure (for example, species composition and relative abundance) of benthic macroinvertebrate assemblages.

Description of Study Area

The 12 watersheds (fig. 1 and table 1) that comprise the study area are in the western part of Blair County and lie within the Allegheny Front Section (Sevon, 2000). The dominant lithologies within the watersheds are shale, siltstone, and sandstone with the latter typically forming resistant mountain tops and ridges. The Marcellus Formation, which is dominantly black shale, underlies the entire study area but at depths that may exceed 7,000 ft.

The watersheds vary in size from 1.3 square miles (mi^2; Dry Gap Run) to 17.3 mi^2 (Tipton Run) and typically drain eastward from the topographic highs (maximum elevation 2,950 ft) along the Allegheny Front escarpment through narrow valleys into the Little Juniata River (Bells Gap Run, Tipton Run, Sink Run) and the Frankstown Branch of the Juniata River (South Poplar Run, Blue Knob Run, Poplar Run near Puzzletown, Poplar Run near Newry, Dry Gap Run, Mill Run, Glenwhite Run, Sugar Run, Blair Gap Run).

Average monthly precipitation for the study period, as measured at the Altoona-Blair County Airport (fig. 1), was 3.19 inches. Over the study period monthly precipitation ranged from 0.47 to 10.12 inches (Pennsylvania State Climatologist, 2014).

Forest is the dominant land use. Farming is limited to minor crop, grassland, and pasture (fig. 2). Development is also limited; however, coal mining has occurred in the Glenwhite Run, Blair Gap Run, and Sugar Run watersheds, affecting the runs with abandoned mine drainage (AMD).

As of December 2013, six well pads have been approved for drilling in the Marcellus Formation in or near the studied watersheds (fig. 1). Three wells have been drilled, all of which are located in the Poplar Run near Puzzletown watershed.

Study Design and Methods

This study design provides the channel morphology, hydrologic, water-chemistry, and biologic data necessary to establish a baseline (2011–13) to document the existing quality of selected headwater streams in Blair County, including those that supply the AWA and TWA drinking-water systems. Ten monitoring stations were initially established in July 2011 (table 2, at end of report). Because permitted and drilled wells were primarily in the Poplar Run watershed (fig. 1), two additional stations at Poplar Run near Puzzletown and Blue Knob Run were established in May 2013.

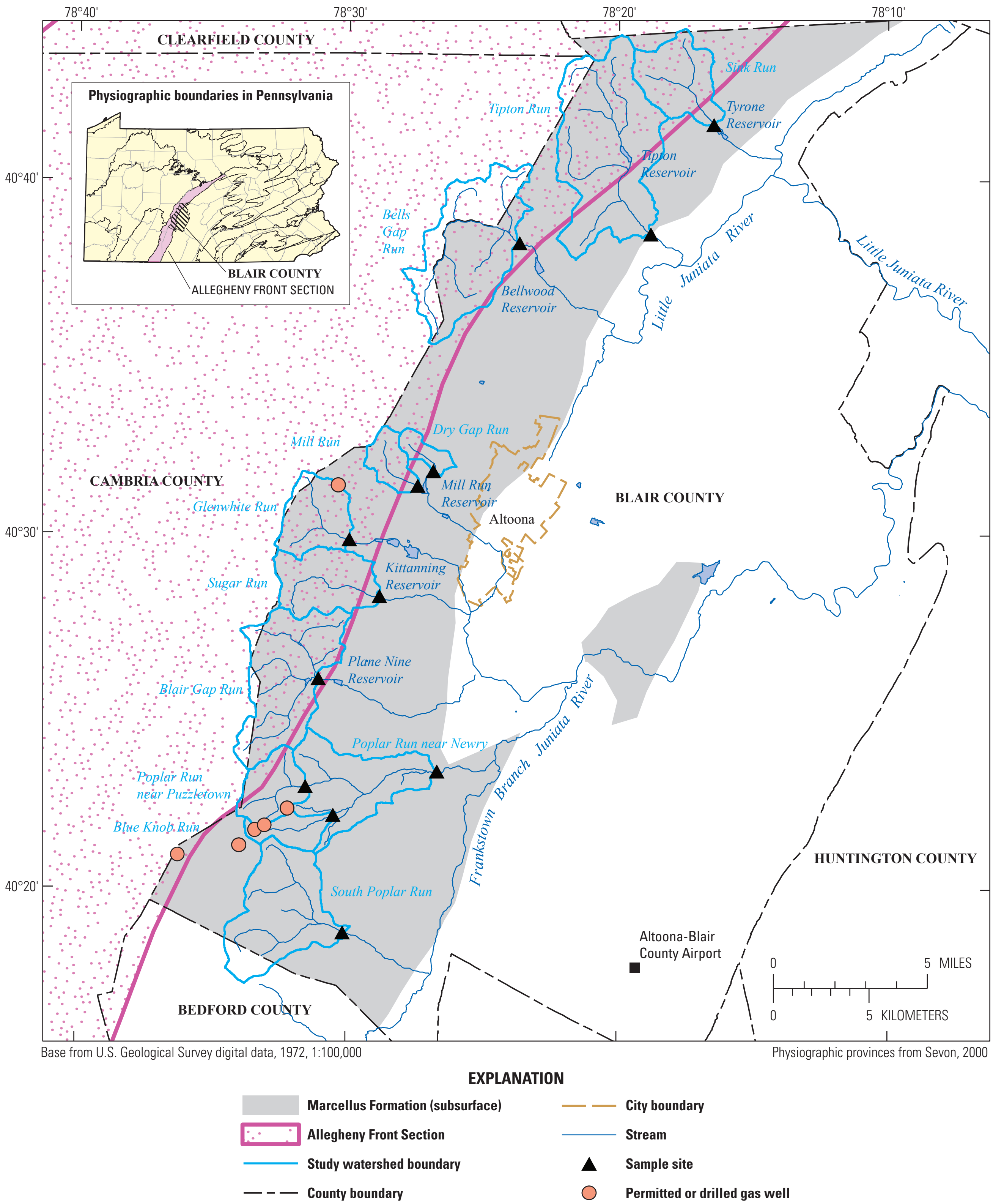


Figure 1. Location of study watersheds with surface-water sampling sites, permitted gas wells, and extent of Marcellus Formation in subsurface, Blair County, Pennsylvania.

Table 1. Description of sampling stations and numbers of samples collected, July 2011 through September 2013, Blair County, Pennsylvania.

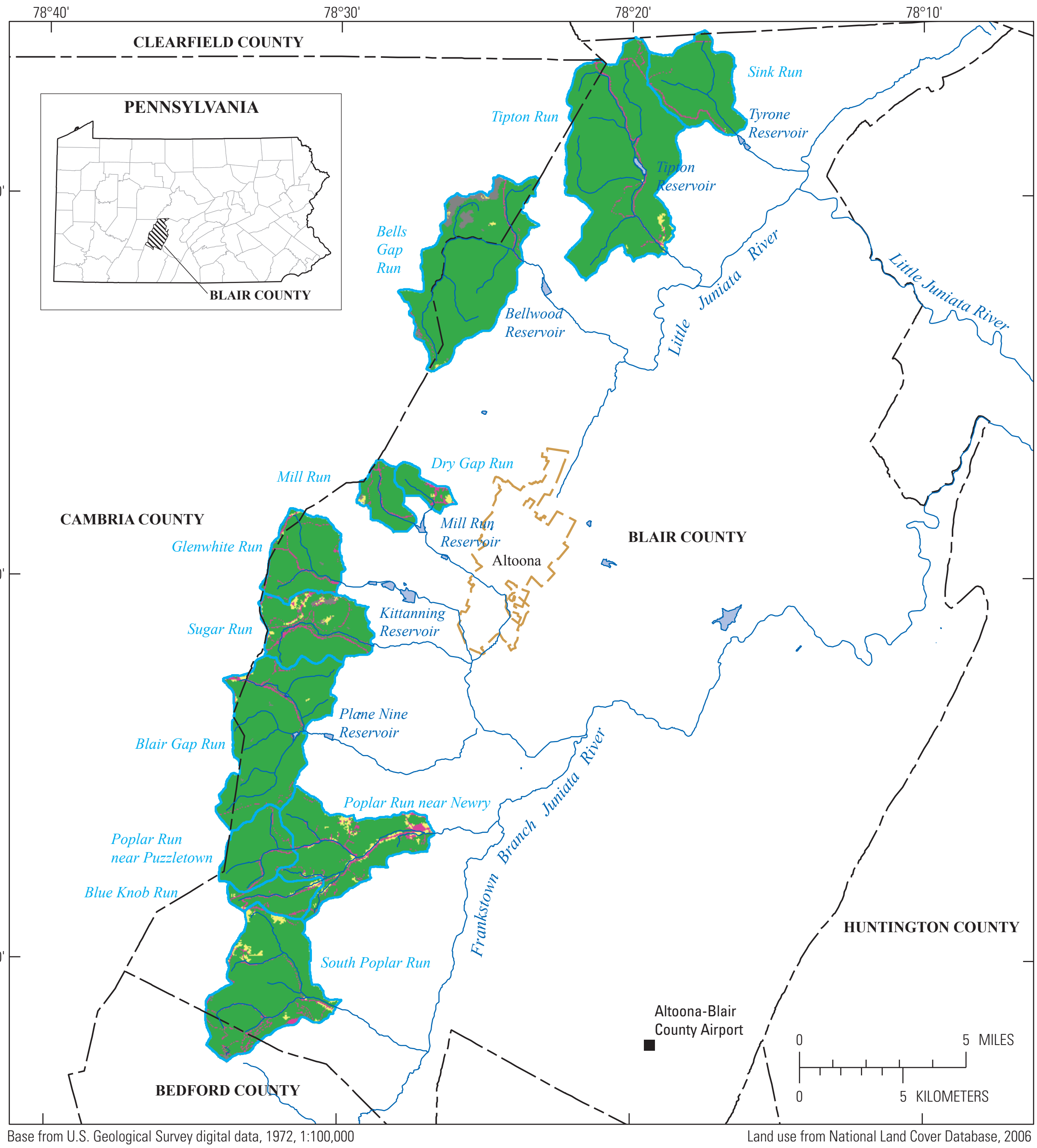
[mi^2, square miles; ft, feet; USGS, U.S. Geological Survey; AWA, Altoona Water Authority]

USGS station identification number[1]	Stream name	Tributary to	Drainage area (mi^2)	Mean elevation[2] (ft)	Number of site visits and streamflow measurements	Number of samples collected		Number of samples for uranium/gross-alpha/beta	Biologic sampling		Latitude[3]	Longitude[3]
						AWA lab schedule	USGS schedule 2364		Fish	Macro-invertebrate		
01555760	South Poplar Run	Frankstown Branch	10.4	2,264	25	21	14	14/11	1	1	401845.4	0783007.6
01555811	Poplar Run, Puzzletown	Frankstown Branch	3.9	2,201	5	0	4	4/0	0	0	402252.5	0783131.1
01555812	Blue Knob Run	Frankstown Branch	2.2	1,991	5	0	3	3/0	0	0	402204.1	0783029.6
01555813	Poplar Run, Newry	Frankstown Branch	14.5	1,798	25	21	4	4/0	1	1	402318.6	0782639.5
01555820	Dry Gap Run	Mill Run Reservoir	1.3	2,042	24	21	3	3/0	1	1	403147.2	0782650.8
01555823	Mill Run	Mill Run Reservoir	2.2	2,252	24	21	3	3/0	1	1	403122.3	0782725.1
01555829	Glenwhite Run	Kittanning Reservoir	4.9	2,200	25	21	3	3/0	1	1	402951	0782956.3
01555847	Sugar Run	Beaverdam Branch	6.0	2,163	25	21	3	3/0	1	1	402814.9	0782849.2
01555853	Blair Gap Run	Plane Nine Reservoir	11.3	2,307	25	21	14	14/11	1	1	402555.4	0783103.1
01556434	Bells Gap Run	Bellwood Reservoir	12.9	2,248	24	21	4	3/0	1	1	403814.4	0782340.8
01556460	Tipton Run	Tipton Reservoir	17.3	1,963	24	21	14	14/11	1	1	403829.7	0781849.2
01557530	Sink Run	Tyrone Reservoir	5.7	2,104	24	21	14	14/11	1	1	404135.4	0781628.6

[1]U.S. Geological Survey station identification numbers for surface-water sites are assigned on the basis of watershed position. Data are available at http://pa.waterdata.usgs.gov/nwis/.

[2]Elevation is referenced to the North American Vertical Datum 1988.

[3]Horizontal datum is referenced to the North American Datum of 1983. Latitude = ddmmss.s and longitude = dddmmss.s.



EXPLANATION

Land-use category

- Open water
- Developed space
- Barren land
- Forest
- Crop/grassland/pasture

Study watershed boundary

County boundary

City boundary

Stream

Figure 2. Land use in the study area watersheds, Blair County, Pennsylvania.

Geomorphology Methods

Stream reach surveys consisted of a longitudinal profile, four channel cross sections in pool and riffle flow regimes, and pebble counts at each cross section following the methods described by Rosgen (1996). The longitudinal profile extended for at least 500 feet (ft) at each stream and was inclusive of sampling locations where fish, macroinvertebrate, and water-quality samples were collected.

Cross sections were oriented perpendicular to the centerline of the channel at the time of each survey. Cross-sectional channel geometries were determined from surveys of the areas bounded by the fixed monuments (steel reinforcement bar or “rebar”) marking the ends of each cross section. Subsequent cross-section surveys exhibiting changes in channel geometry were derived from the surface baseline between the fixed monuments. Surface baselines were based on a measuring tape stretched between the fixed monuments placed beyond the active channel. Differences between subsequent surveys and the surface baseline between the fixed monuments could indicate changes in runoff characteristics within the watershed. Monuments were established beyond the active channel, onto the flood plain, to increase the probability that cross-section endpoints can be recovered in the future. Because cross-section surveys include parts of the flood plain, stream widths and the cross-section areas determined from the survey data are not indicative of the active channel.

Pebble counts were done to quantify the bed-particle distribution of the cross sections throughout the stream reach, following methods adapted from Wolman (1954). Bed-particle distributions are intended to characterize the bed substrate at the time of monitoring and to serve as a baseline against which future changes can be compared. Subsequent pebble counts yielding bed-particle distributions within the present size range would indicate continued transport of similar-sized sediment. Pebble counts did not extend the full distance between monuments but were conducted at established stations within each cross section. Bed-particle distributions were extracted from a cumulative frequency curve and reported in a “D#” format where # is the percentage of particles with a medium axis less than or equal to the reported value. For example, “D15” would represent the 15th percentile bed-particle size on a cumulative particle-size frequency curve.

Hydrologic Methods

Instantaneous streamflow was determined at all sites during the time of water-quality sample collection (table 2) from streamflow velocity measurements made with a vertical-axis current meter following standard methods (Rantz and others, 1982). Continuous gage height measurements were collected using an InSitu Aqua Troll 200 (Troll) at South Poplar Run, Blair Gap Run, Tipton Run, and Sink Run. Gage-height monitors were installed at these four sites by (1) determining the point of zero streamflow for the selected reach by wading to the nearest downstream riffle and locating the most shallow depth of water passing over the stream bottom along the riffle, (2) wading the gage pool and locating the deepest point within the pool (a point below the shallowest depth of the associated riffle), (3) mounting a permanent staff plate along a rock wall or solid timber within or adjacent to the deepest point of the pool, (4) installing a lag bolt adjacent to the staff plate to ensure stability of the staff plate, (5) establishing reference elevations to the lag bolt and current stream water level of the pool through leveling to the nearest 0.001 ft, and (6) adjusting the pressure transducer within the Troll to reflect the measured water-surface height (gage height) of the pool and staff plate.

Water-Quality Methods

Samples for water-chemistry analysis were collected manually as composite samples from well-mixed zones in the stream (U.S. Geological Survey, 2006) (table 2). During the initial phase of the investigation (August–November 2011), a baseline analytical schedule developed by the AWA laboratory was implemented to determine barium, bromide, chloride, total dissolved solids (TDS), strontium, and sulfate concentrations in unfiltered samples from 10 streams (table 3).

The chemical constituents barium, chloride, strontium, and TDS are typically present in high concentrations in flowback water related to hydraulic fracturing (also known as hydrofracturing or fracking), brine water from within the Marcellus Formation, and (or) drilling wastewaters of the Marcellus Formation (Hayes, 2009). Although bromide is fairly soluble in water, concentrations are not commonly elevated in undisturbed groundwater or surface water; however, bromide is found in relatively high concentrations in brines (Davis and others, 2004). Nitrate (as nitrogen [N], total) was added to the AWA parameter list in December 2011 to evaluate the effect of fertilizers in runoff to the streams.

Beginning June 2012, USGS National Water Quality Laboratory (NWQL) schedule 2364 (table 4) was used in conjunction with the AWA schedule to provide a broader suite of chemical constituents at lower reporting limits and to evaluate the effect of anthropogenic sources, such as historical coal mining, land use, and application of deicing compounds on roadways adjacent to streams, on stream water quality. Methods used to analyze the suite of major ions and trace elements that compose schedule 2364 are described in Fishman and Friedman (1989), Garbarino and others (2006), Fishman (1993), Garbarino (1999), and American Public Health Association and others (1999). Acid-neutralizing capacity (ANC) analysis was added to the AWA parameter list (table 3) in July 2012 (Greenburg and others, 1981). Eberline Services, Inc., analyzed samples for gross-alpha and gross-beta activities to evaluate baseline radioactive potential of sampled streams.

Water analyzed by NWQL for dissolved constituents was filtered through a 0.45-micrometer (µm) membrane filter using a peristaltic pump prior to acidification. Ultrex (7.5N) nitric acid was used to preserve samples analyzed for metals

Table 3. Altoona Water Authority Laboratory schedule.

[<, less than; mg/L, milligrams per liter; mL, milliliter; ANC, acid neturalizing capacity; TDS, total dissolved solids]

Analysis	Method number	Parameter code	Reporting limit	Unit	Container process preservation[1]
ANC (as calcium carbonate)	Standard Methods 2320B	P00419	1.0	mg/L	RU/chill
Barium	EPA 200.7	P01007	0.005	mg/L	RA2
Bromide	EPA 300.0	P71870	0.1	mg/L	RU/chill
Chloride	EPA 300.0	P00940	2.5	mg/L	RU/chill
Nitrate (as nitrogen)	EPA 300.0	P71850	0.1	mg/L	RA1
Residue, 180 degrees Celsius (TDS)	Standard Methods 2540C	P70300	2.0	mg/L	RU/chill
Strontium	EPA 200.7	P01082	0.005	mg/L	RA2
Sulfate	EPA 300.0	P00945	5.0	mg/L	RU/chill

[1]RU: 1,000 mL, field rinsed natural polyethylene bottle;
RA1: 500 mL, acidified pH < 2 with 1:1 sulfuric acid, field rinsed polyethylene bottle;
RA2: 250 mL, acidified pH < 2 with 7.5 normal Ultrex nitric acid, field rinsed natural polyethylene bottle.

and sulfate. Water analyzed by AWA for ANC, TDS, and nitrate (as N) was unfiltered and collected in non-acidified 250- to 500-milliliter (mL) polyethylene bottles; the nitrate was preserved with 1:1 sulfuric acid. All samples were stored at approximately 4 degrees Celsius (°C) during transport and shipping.

Field measurements of water temperature, dissolved oxygen (DO), pH, and specific conductance were made with a calibrated Hach HQ40 D multi-parameter meter. Each probe was calibrated prior to daily use according to the manufacturer's specifications.

Continuous water-quality monitoring of temperature and specific conductance was conducted at South Poplar Run, Blair Gap Run, Tipton Run, and Sink Run beginning July and August 2011 and ending September 30, 2013 (table 2). These data were collected using the same meter (InSitu Aqua Troll 200) that recorded continuous gage-height measurements. Each meter was calibrated every 6–8 weeks according to the manufacturer's specifications.

Statistical Methods

Various water-quality parameters were examined by simple statistical summaries such as minimum, maximum, median, quartiles, and standard deviation to examine the variation within and between stream sites. Scatterplots of hydrological data (including water-quality data) versus stream flow were created where five or more samples were collected; the scatterplots generally revealed log-normal distribution of the streamflow data, which is common with hydrological data (Helsel and Hirsch, 1995).

To evaluate the relation between streamflow and selected water-quality data, the streamflow data were log-transformed and plotted relative to the constituent concentrations. To evaluate whether concentrations increased or decreased with streamflow, a best-fit line and a coefficient of determination (R^2) were computed using the graphing package of Microsoft Excel.

Biological Methods

The fish communities in 10 stream reaches were sampled using the Rapid Bioassessment Protocol (RBP) 100-meter (m) reach, one pass electrofishing method (Barbour and others, 1999). The same locations selected for water-quality and geomorphology characterization coincide with the reaches selected for biologic sampling. Five stream reaches were sampled in 2011, and five were sampled in 2012 (table 2), using a SmithRoot 12-B backpack shocker to supply voltages between 300 to 600 volts. Reaches were shocked using a 3–6 person crew starting at the downstream terminus of the reach and working upstream. One or two people stayed on shore to process fish as they were captured and then placed them in a live well for their re-entry to the stream once shocking was completed. The crew consisted of personnel from USGS, AWA, John Kennedy Chapter of Trout Unlimited, and BCCD.

Fish were processed by determining their species, weight (grams) and length (millimeters). The fish were handled as little as possible to prevent harm to them. All fish were counted, and as many as 30 individuals of each species in a reach were measured and weighed. Once 30 individuals of a species were recorded, a batch weight was computed for the remainder of the fish. This was completed at all sites for all species, except trout. Each trout was measured and weighed.

The integrity of the sites for fish was measured using the Maryland Index of Biotic Integrity (MdIBI) for non-Costal Plain (Roth and others, 1997). The MdIBI was used because it was calibrated for the Susquehanna River Basin as part of the Chesapeake Bay and Watershed Program and has been used in the past to describe fish communities within the Susquehanna River Basin in Pennsylvania and New York.

Table 4. U.S. Geological Survey National Water Quality Laboratory schedule 2364—Pennsylvania Major and Trace Elements.

[µg/L, micrograms per liter; mg/L, milligrams per liter; mL, milliliters; µm, micrometer; <, less than; µS/cm, microsiemens per centimeter at 25 degrees Celsius; TDS, total dissolved solids]

Analysis	Parameter code	Reporting limit	Unit	Container process preservation[1]
Aluminum	P01106	2.2	µg/L	FA
Antimony	P01095	0.27	µg/L	FA
Arsenic	P01000	0.1	µg/L	FA
Barium	P01005	0.25	µg/L	FA
Beryllium	P01010	0.02	µg/L	FA
Boron	P01020	5	µg/L	FA
Bromide	P71870	0.03	mg/L	FU
Cadmium	P01025	0.03	µg/L	FA
Calcium	P00915	0.022	mg/L	FA
Chloride	P00940	0.02	mg/L	FU
Chromium	P01030	0.3	µg/L	FA
Cobalt	P01035	0.05	µg/L	FA
Copper	P01040	0.8	µg/L	FA
Fluoride	P00950	0.01	mg/L	FU
Iron	P01046	4	µg/L	FA
Lead	P01049	0.04	µg/L	FA
Lithium	P01130	0.1	µg/L	FA
Magnesium	P00925	0.011	µg/L	FA
Manganese	P01056	0.4	µg/L	FA
Molybdenum	P01060	0.05	µg/L	FA
Nickel	P01065	0.2	µg/L	FA
pH, laboratory	P00403	0.1	pH	RU
Potassium	P00935	0.03	mg/L	FA
Residue, 180 degrees Celsius (TDS)	P70300	20	mg/L	FU
Selenium	P01145	0.05	µg/L	FA
Silica	P00955	0.018	mg/L	FA
Silver	P01075	0.02	µg/L	FA
Sodium	P00930	0.06	mg/L	FA
Specific conductance, laboratory	P90095	5	µS/cm	RU
Strontium	P01080	0.8	µg/L	FA
Sulfate	P00945	0.02	mg/L	FA
Uranium, natural	P22703	0.014	µg/L	FA
Zinc	P01090	2	µg/L	FA

[1]FA, 250 mL, acid/filtered water (0.45 µm) rinsed clear polyethylene bottle, acidified pH < 2 with 7.5 normal Ultrex nitric acid;
FU, 250 mL, filtered water (0.45 µm) rinsed natural polyethylene bottle;
RU, 250 mL, sample rinsed natural polyethylene bottle.

The MdIBI uses eight criteria:

1. Number of native species (adjusted for watershed and stream size);
2. Number of benthic species (adjusted for watershed and stream size);
3. Percent tolerant individuals;
4. Percent abundance of dominant species;
5. Percent generalists, omnivores, and invertivores;
6. Percent insectivores;
7. Number of individuals per square meter (for the study it is based on a 100 meter reach); and
8. Percent lithophilic spawners.

A scoring system of 1, 3, and 5 points is followed and the value for each criteria is summed and divided by the number of criteria to reach an aggregated score and associated stream-health index.

- **MdIBI score 4.0–5.0 = Good—**This score means the sampled stream is comparable to reference streams considered to be minimally impacted. On average, biological metrics fall with the upper 50 percent of reference site conditions.
- **MdIBI score 3.0–3.9 = Fair—**This score means the sampled stream is comparable to reference conditions, but some aspects of biological integrity may not resemble the qualities of minimally impacted streams, indicating some degradation.
- **MdIBI score 2.0–2.9—**This means there is significant deviation from reference conditions, with many aspects of biological integrity not resembling the qualities of minimally impacted streams, indicating some degradation. On average, biological metrics fall below the 10th percentile of reference site values.
- **MdIBI score 1.0–1.9—**The sampled stream exhibits a strong deviation from reference conditions, with most aspects of biological integrity not resembling the qualities of minimally impacted streams, indicating severe degradation. On average, biological metrics fall below the 10th percentile of reference site values; most or all metrics are below this level.

The macroinvertebrate communities of the same 10 stream reaches were sampled using the Instream Comprehensive Evaluation protocols of Pennsylvania Department of Environmental Protection (PaDEP) (Shaw and Walters, 2009). The sampling effort was extended over 2 years (table 2). Five sites were sampled during low-flow conditions in July 2011, and the remaining five sites were sampled during low-flow conditions in July 2012. USGS personnel collected the samples using a 500-micron, D-frame dip net. Each sample consisted of six individual kick efforts, composited into one sample. To complete a kick, the net was placed firmly against the stream bottom and the substrate. An area approximately 1 (m) upstream from the net was disturbed for 1 minute, using only the collector's feet as means to agitate the substrate. The six kicks were collected within riffles and runs along a 100-m reach and represented various available habitats.

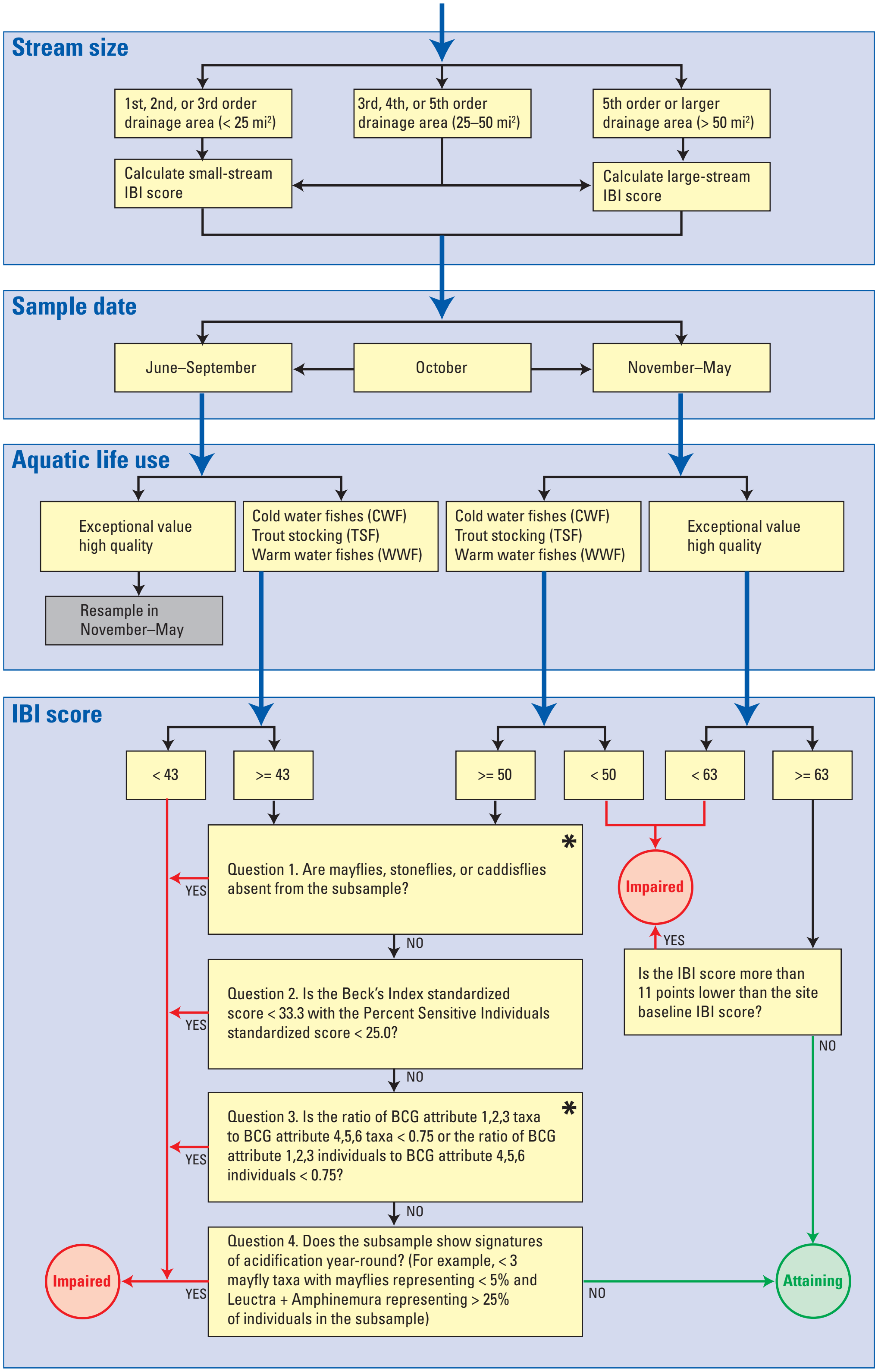
The samples were preserved in 80-percent ethanol and returned to the USGS lab for processing following the PaDEP methods (PaDEP, 2003). Each sample was subsampled in a gridded pan to randomly select a total of 200 identifiable organisms ±20 percent. The subsample was identified to genus, except for certain groups as noted in Shaw and Walters (2009), using the appropriate keys (Smith, 2001; Merritt and Cummins, 1996; Stewart and Stark, 2002; Peckarsky and others, 1990).

The integrity of the sites for macroinvertebrates was measured using the Benthic Index of Biotic Integrity for (IBI) Wadeable Freestone Riffle-Run Streams in Pennsylvania (Chalfant and others, 2009; PaDEP, 2013) (fig. 3). This IBI consists of a suite of six metrics that individually measure diverse biological attributes and exhibit various responses to different stressors (Chalfant, 2013a). The six metrics are

- Total taxa richness (the number of taxa in a sub-sample),
- Ephemeroptera + Plecoptera + Trichoptera Taxa (EPT) richness (uses the aquatic life stages of mayflies, stoneflies, and caddisflies, respectively, to evaluate many types of pollutants),
- Beck's Index (a weighted count of taxa with pollution contaminant-tolerance values of 0, 1, or 2),
- Shannon Diversity (measures taxonomic richness and evenness of individuals across taxa of a sub-sample),
- Hilsenhoff Biotic Index (a community composition and tolerance metric calculated as an average of the number of individuals in a sub-sample, weighted by pollution tolerance values), and
- Percent Sensitive Individuals (community composition and tolerance metric percentage of individuals with pollution tolerance values of 0 to 3 in a sub-sample).

All of the metrics were designed to reflect the loss of taxa and increasing dominance of a few pollution-tolerant taxa.

The IBI serves to increase sensitivity across a broad range of biological conditions; other metrics are sensitive in only part of the range (Chalfant, 2013a). The IBI uses stream size, sample date, and aquatic life to categorize a site as "impaired" or "attaining." An IBI score of less than 43 is considered "impaired." Streams with an IBI score of 43 or greater require additional screening to determine whether the stream is "impaired" or "attaining."



*Questions 1 and 3 must be applied to small-stream samples collected from November to May, but do not have to be applied to large-stream samples or samples collected from June to September.

Figure 3. A simplified framework for the aquatic life use assessment process. Although this simplified decision matrix should guide most assessment decisions for benthic macroinvertebrate samples from Pennsylvania's wadeable, freestone, riffle-run streams using the collection and processing methods discussed above, situations exist where this simplified assessment schematic will not apply exactly as outlined. Some situations are discussed in the text. (<, less than; >, greater than; >=, greater than or equal to; mi², square mile; %, percent; IBI, index of biotic integrity; BCG, Biological Condition Gradient) (Modified from Chalfant, 2013b)

Monitoring Results

Streamflow in the study area originates from precipitation, stormwater runoff, groundwater discharge, and for Glenwhite Run, Blair Gap Run, and Sugar Run, flow from abandoned mines. These sources are not mutually exclusive. Precipitation and stormwater runoff or groundwater discharge may enter the stream, infiltrate through fractures in the streambed, and drain from mine openings, seeps, or other discharge points. Water quality in the streams can be affected by bedrock geology; land use; the source of the streamflow; seasonal changes in temperature, photosynthesis and respiration; and diel cycles of light and dark.

The precipitation record from the Altoona-Blair County Airport (fig. 1) indicates hydrologic conditions during the study period varied considerably with 3 months receiving less than 1.0 in. of precipitation to 3 months receiving more than 5.0 in. of precipitation (fig. 4). Total precipitation at the Altoona-Blair County Airport was 27.72 in. from July 1 through December 31, 2011; 37.29 in. from January 1 through December 31, 2012; and 21.06 in. from January 1 through September 30 2013 (Pennsylvania State Climatologist, 2014). The maximum monthly rainfall was 10.12 in., which was the result of a long-term rain event (inclusive of Hurricane Lee) from September 4 through September 9, 2011, (6.37 in.) and another event from September 27 through September 29, 2011 (2.61 in.).

Geomorphology

Channel morphology was characterized for 10 stream reaches that were also targeted for biological and water-quality sample collection (table 2). The data presented here are intended to document baseline conditions for channel slope (through longitudinal profiles), cross-section area (through monumented cross-sectional surveys), and bed-sediment size distribution (through pebble counts). Future surveys could document any change in channel dimensions, profile, or substrate.

Channel slopes ranged from 0.008 in Poplar Run (Newry site) to 0.045 in Mill Run. Generally, the streams draining smaller watersheds (less than 5 mi^2) had the steepest slopes (fig. 5) because those streams are in more mountainous terrain and are positioned higher on the landscape. Reach slopes surveyed here are consistent with slopes determined for similar streams surveyed in the Appalachian Plateaus Province by Chaplin (2005).

The slope of a stream channel is a key factor in determining sediment transport. An increase in channel slope would cause greater stream velocity, increasing the potential for degradation of the bed, bank erosion, and transport of larger particles. In contrast, a stream with decreasing slope would have slower velocities and less sediment-transport capacity, increasing the potential for aggradation and a finer bed-particle-size distribution. Adjustments to the longitudinal profile

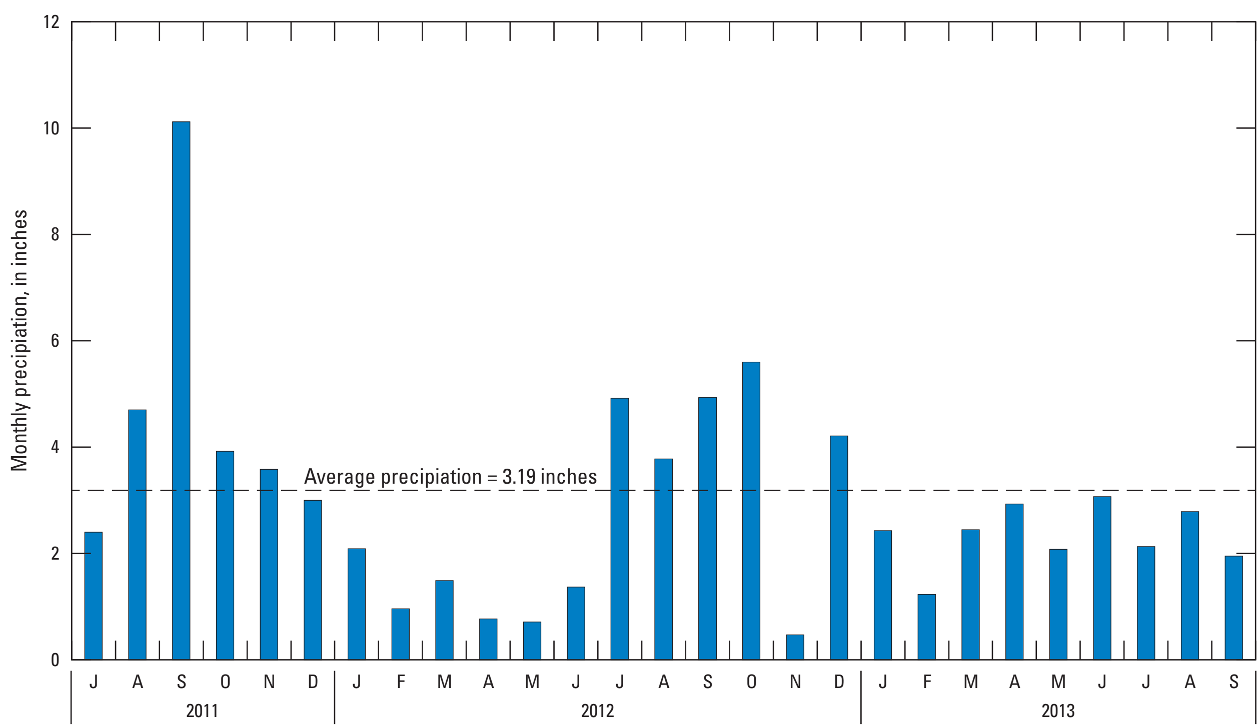


Figure 4. Monthly precipitation measured at the Altoona-Blair County Airport from July 2011 through September 2013, Blair County, Pennsylvania.

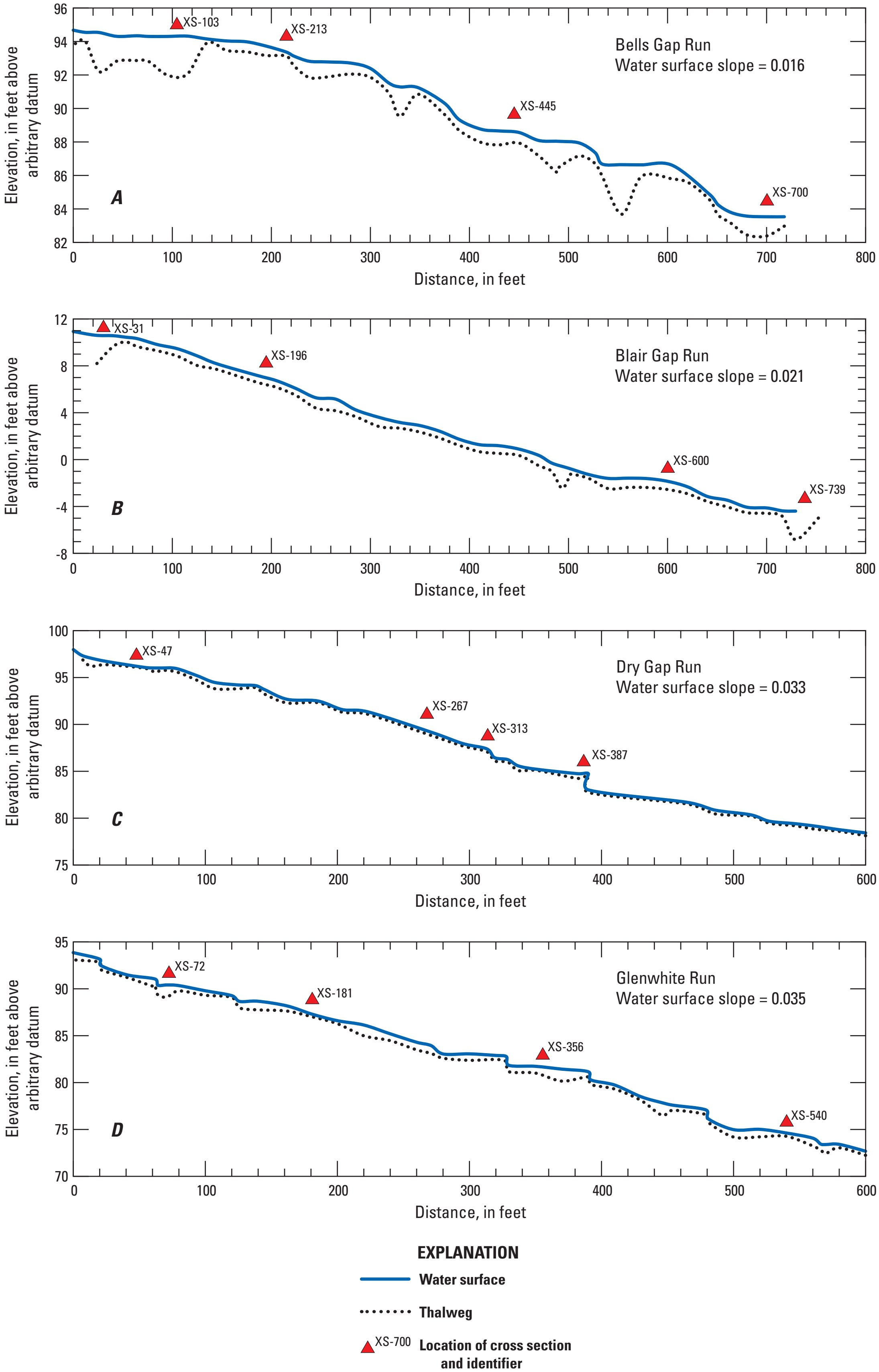


Figure 5. Longitudinal profiles of selected stream reaches, Blair County, Pennsylvania.

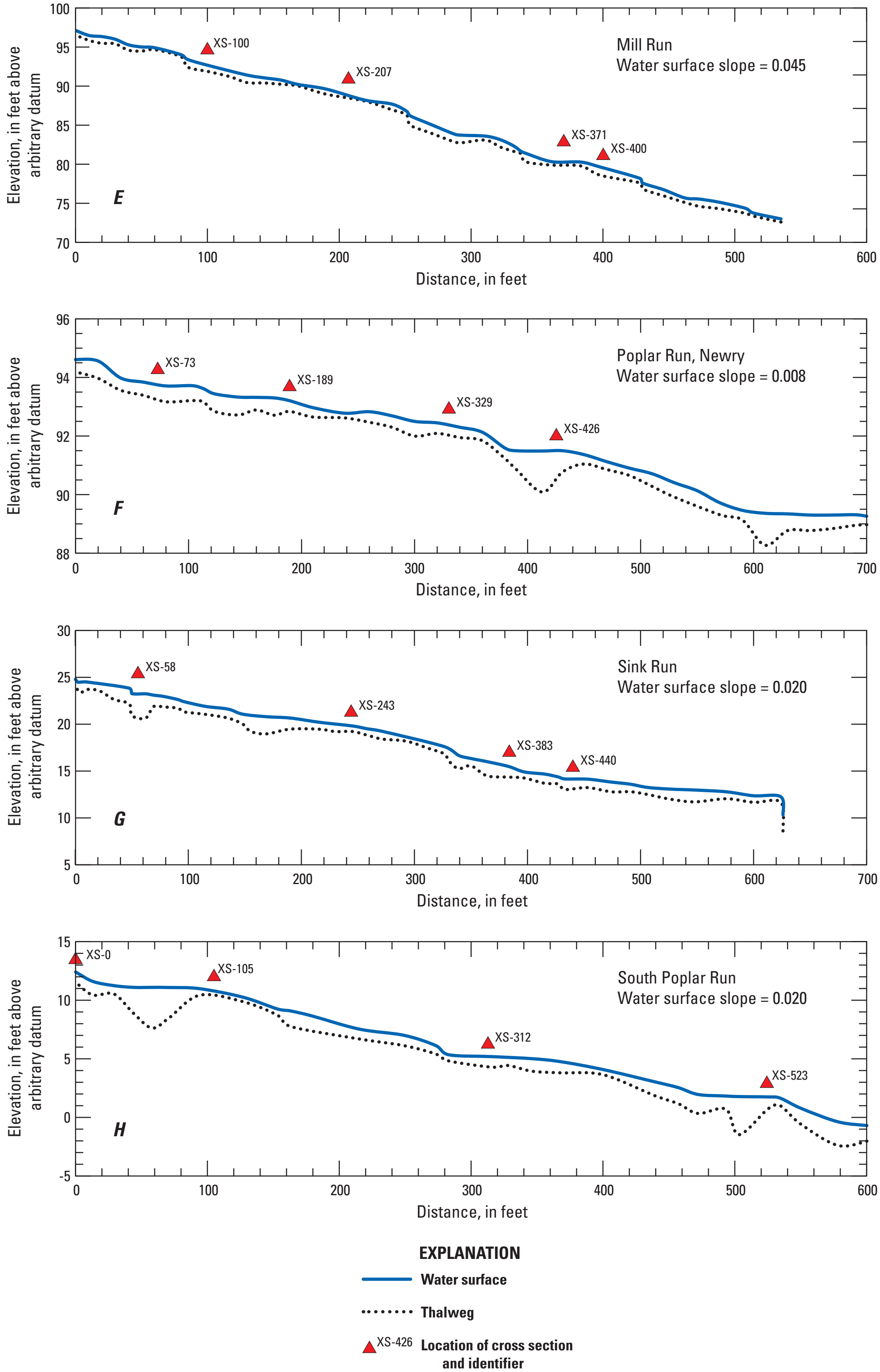


Figure 5. Longitudinal profiles of selected stream reaches, Blair County, Pennsylvania.—Continued

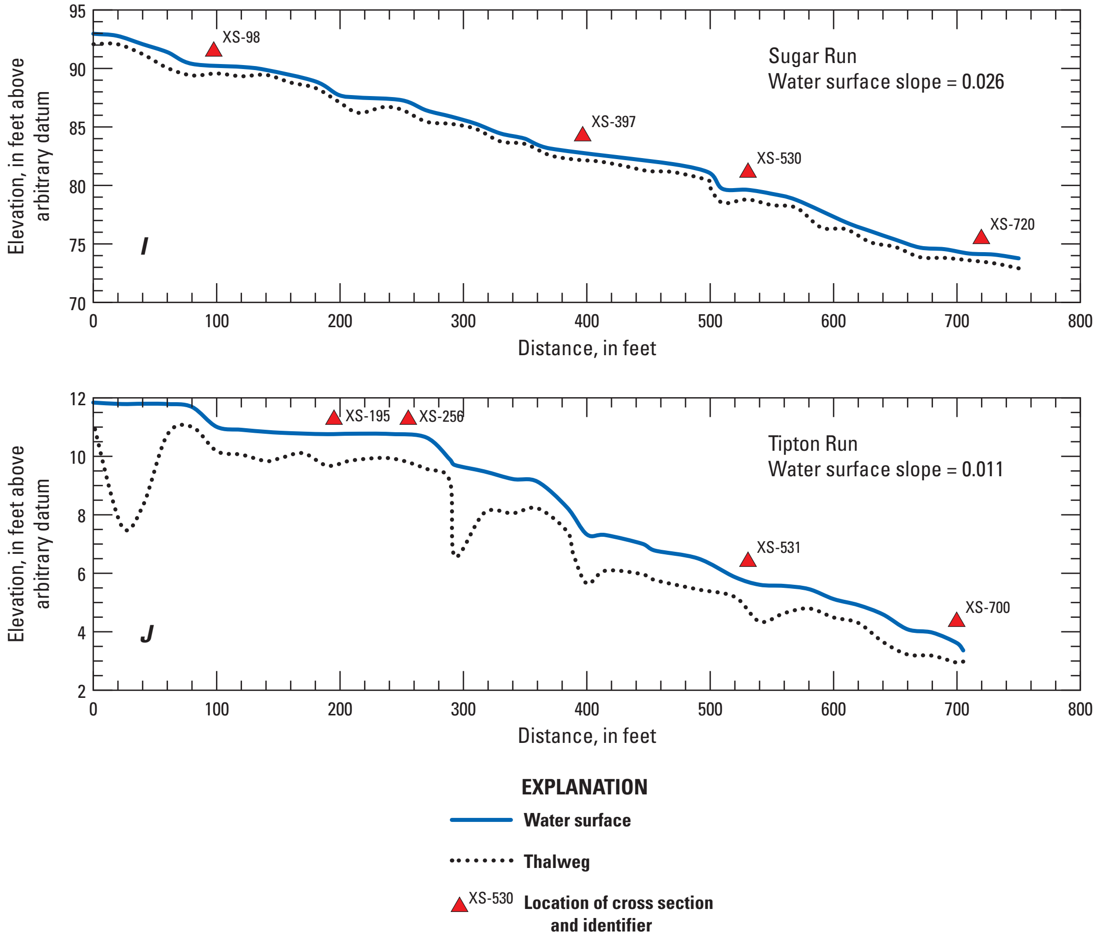


Figure 5. Longitudinal profiles of selected stream reaches, Blair County, Pennsylvania.—Continued

and substrate of a stream could be indicative of a variety of alterations in the watershed resulting in changes in runoff volume, timing, and duration, increasing sediment supply.

Changes in cross-section mean depth, maximum depth, or area over time are indications of channel adjustment. In the event of a change in hydrologic conditions or sediment supply, a stream will adjust until it reaches dynamic equilibrium, a condition that exists when the stream channel is capable of conveying the streamflow and sediment load without excessive erosion or deposition. Cross-sectional depths and areas reported in table 5 (at end of report) were computed from the surface baseline, which is a measuring tape stretched between rebar monuments placed beyond the active channel (fig. 6). This approach is intended to allow for comparison of cross-section dimensions with future surveys made using the same baseline, but it is not useful for comparing areas or depths among the surveyed streams.

The particle distribution of a streambed is indicative of the sediment load being supplied to the system and the ability of the stream to transport the load. The coarser the sediment, the more energy required to transport sediment load. On the basis of the median particle size (D50) as determined during pebble counts at each cross section, the streambed substrate at Poplar Run, Newry can be characterized as gravel. The streambeds of South Poplar Run, Dry Gap Run, Glenwhite Run, Sugar Run, and Blair Gap Run were slightly coarser and can be characterized as a mix of gravel and cobble particles. Mill Run, Bells Gap Run, Tipton Run, and Sink Run had cobble bed material (table 6).

Overall, the substrate of the steams selected for this study is relatively coarse compared to that of other Appalachian Plateau headwater streams described in a dataset used to develop regional curves for Pennsylvania and selected areas of Maryland (Chaplin, 2005). Streams in this study drain small watersheds with a median drainage area of 5.85 mi^2 and median slope of 0.020 ft/ft. To put these values in context, seven headwater streams reported in Chaplin (2005) draining watersheds less than 20 mi^2 had a median drainage area of 8.34 mi^2 and a median slope of 0.009 ft/ft. Because watersheds in this study area are smaller and steeper, streamflows are expected to have the capacity to transport larger bed particles. Bed substrate is therefore coarser [D50 of 94 millimeters (mm)] compared to bed substrate of streams in Chaplin (2005) (D50 68 mm).

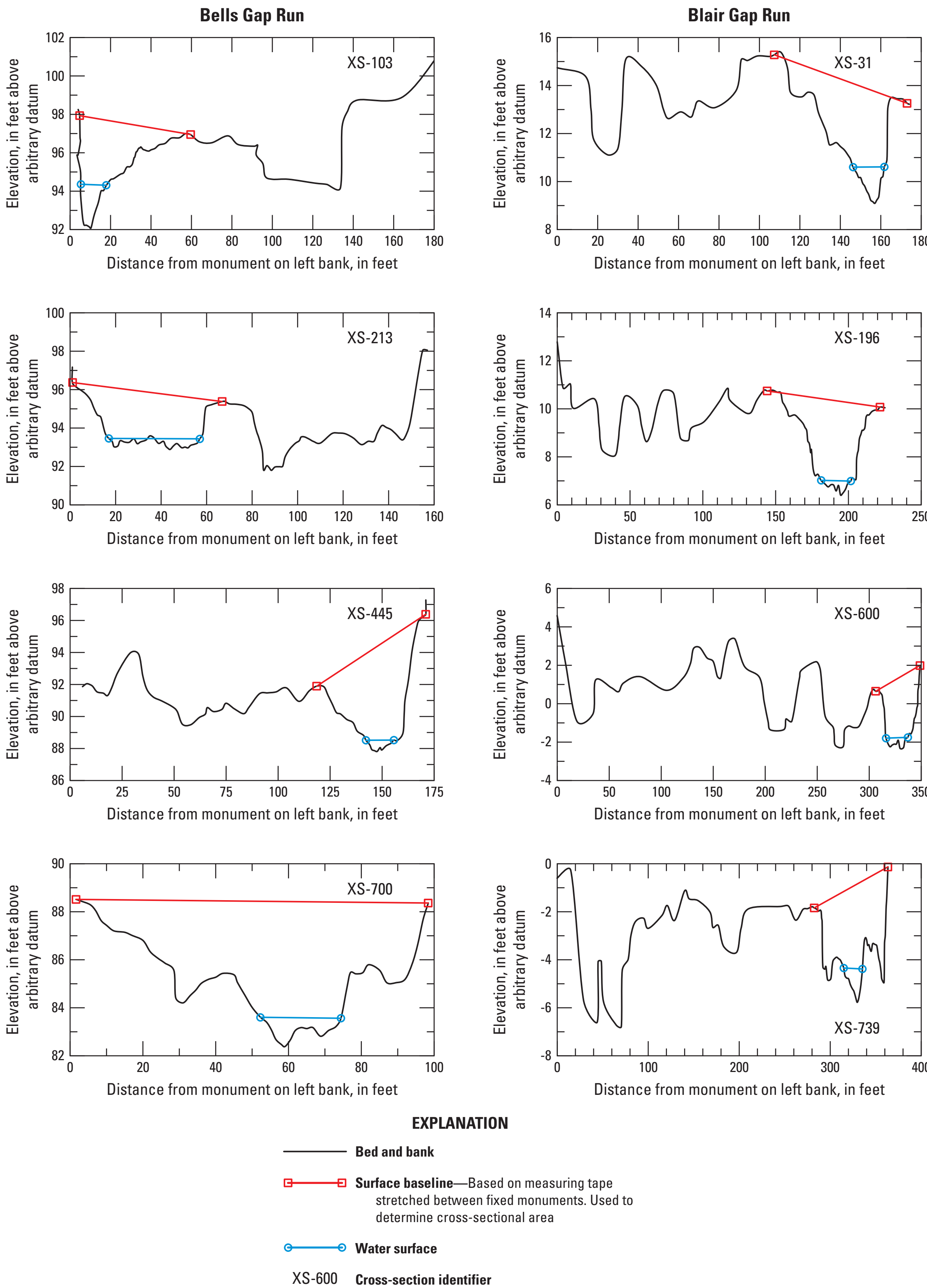


Figure 6. Cross sections of selected stream reaches, Blair County, Pennsylvania.

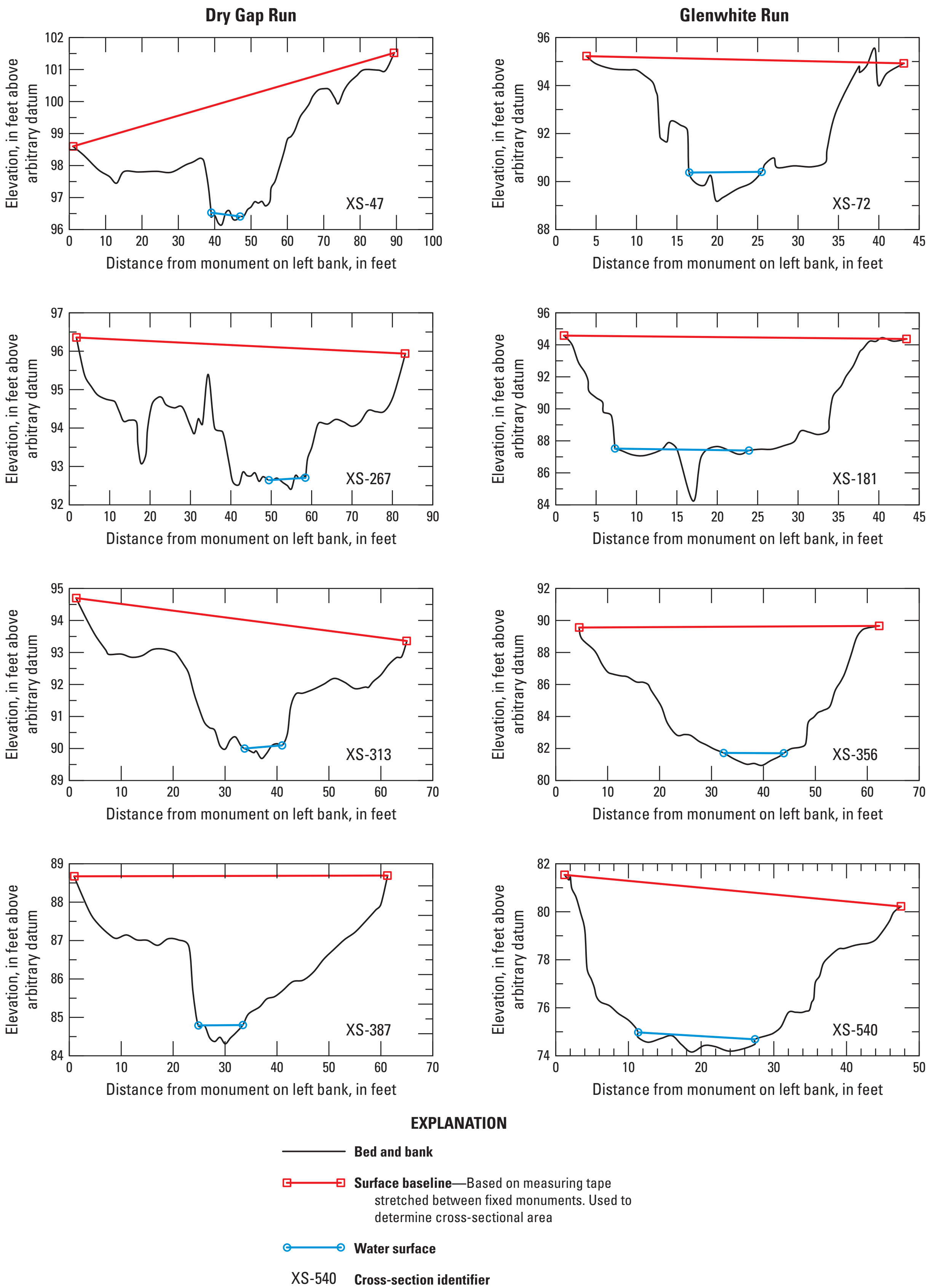


Figure 6. Cross sections of selected stream reaches, Blair County, Pennsylvania.—Continued

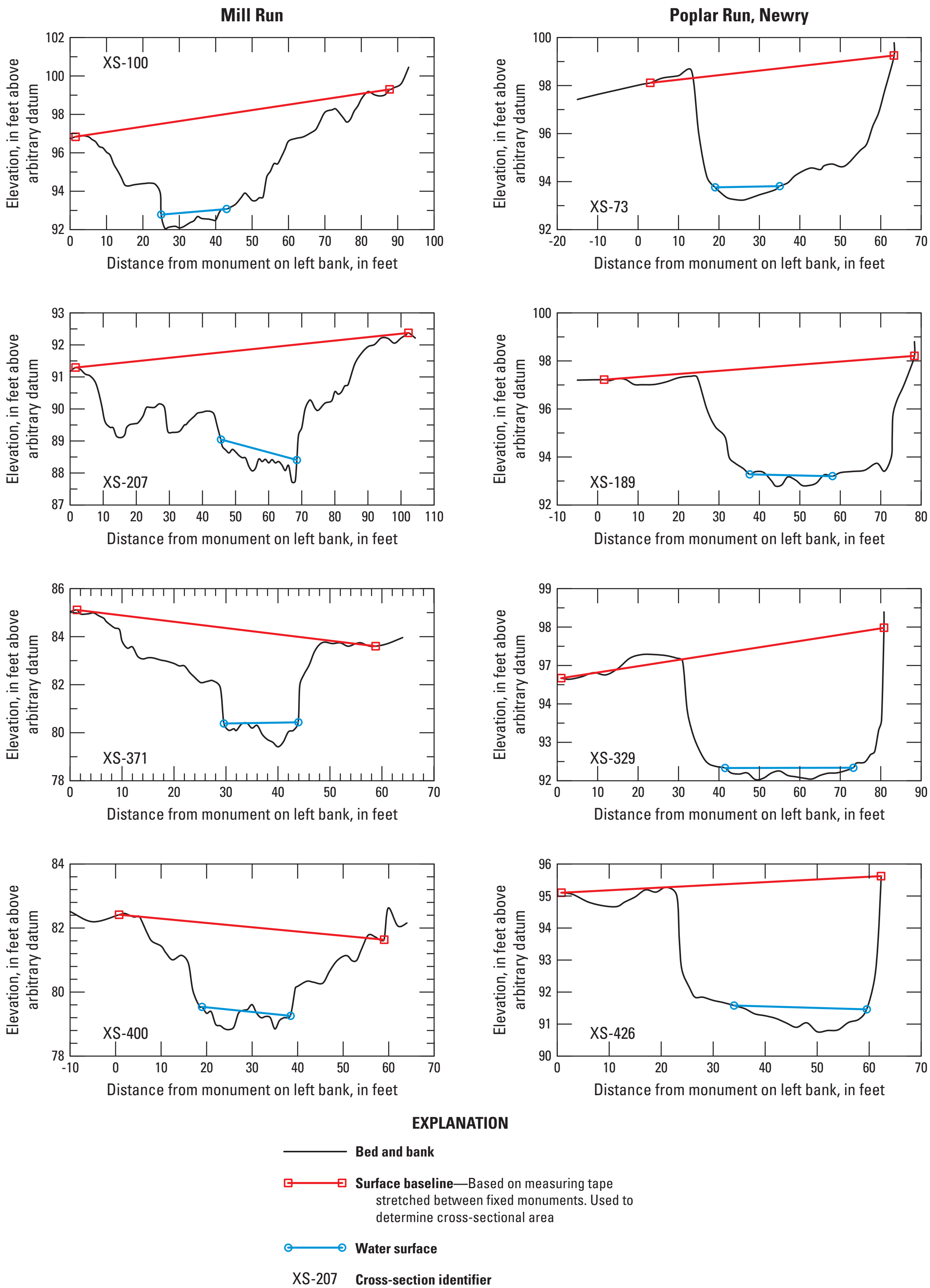


Figure 6. Cross sections of selected stream reaches, Blair County, Pennsylvania.—Continued

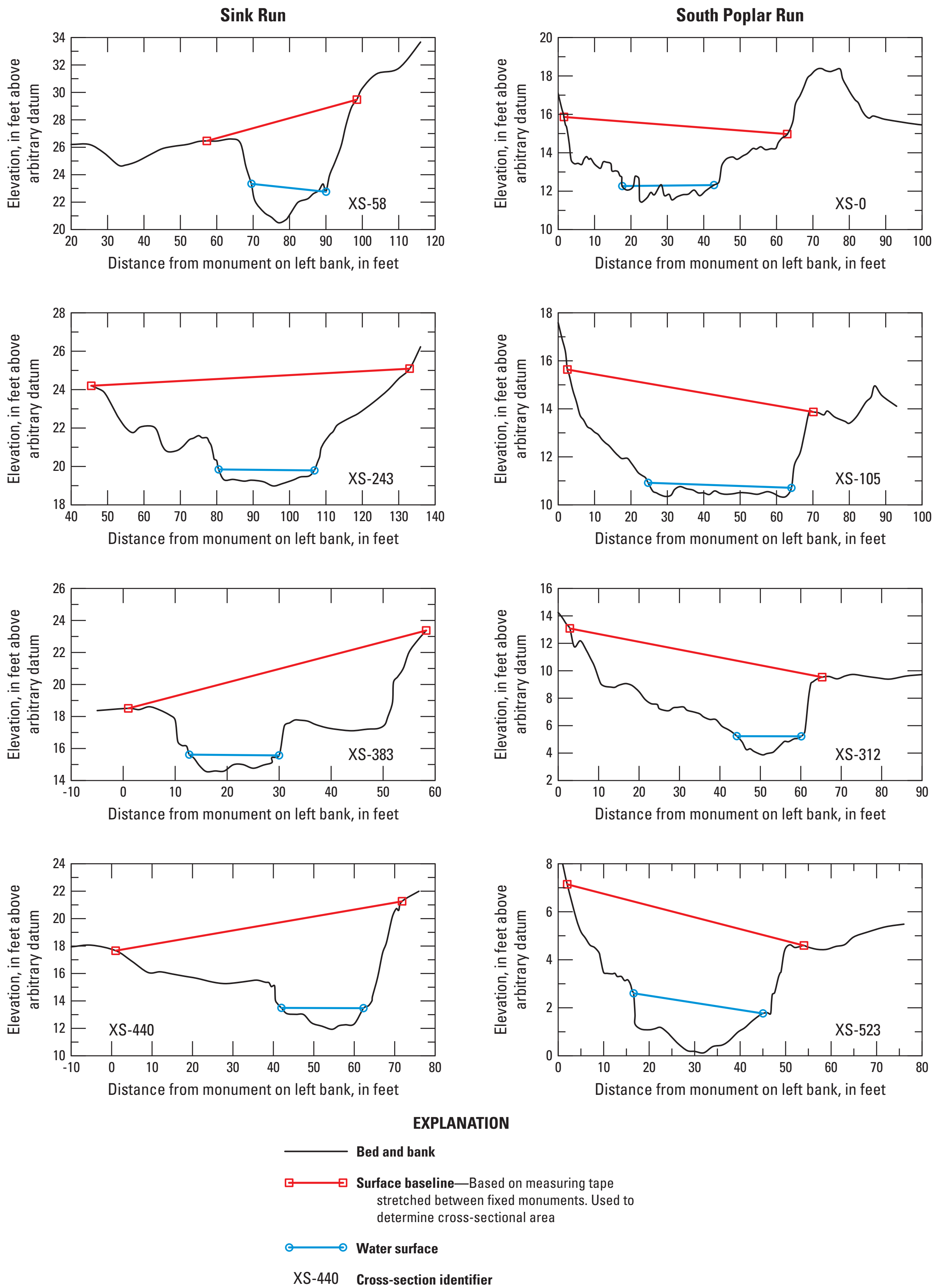


Figure 6. Cross sections of selected stream reaches, Blair County, Pennsylvania.—Continued

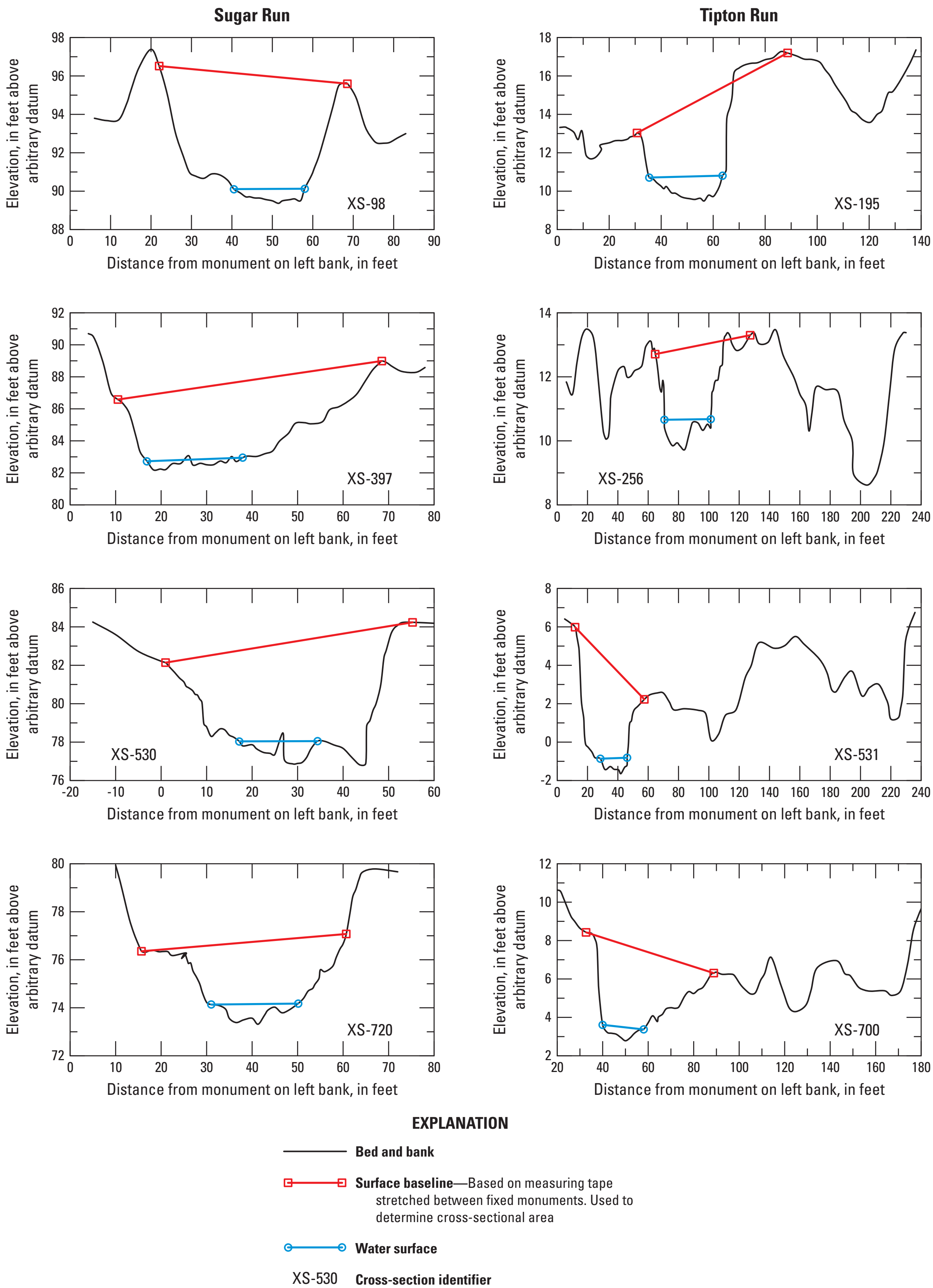


Figure 6. Cross sections of selected stream reaches, Blair County, Pennsylvania.—Continued

Table 6. Cross-section dimensions, pebble count, and bed-particle size distribution in selected streams, Blair County, Pennsylvania.

[D15, 15th percentile bed-particle size; D35, 35th percentile bed-particle size; D50, 50th percentile bed-particle size; D84, 84th percentile bed-particle size; D95, 95th percentile bed-particle size; see figures 4 and 5 for cross-section profiles]

Cross section	Flow regime	Area (square feet)	Mean depth (feet)	Maximum depth (feet)	Baseline width (feet)	Pebble size (millimeters)				
						D15	D35	D50	D84	D95
South Poplar Run										
0	Riffle	146	2.38	3.99	61.4	39	63	85	162	245
105	Riffle	225	3.33	4.42	67.6	49	100	124	202	276
312	Pool	252	4.04	7.44	62.4	13	32	62	156	246
523	Pool	214	4.11	5.75	52	28	54	69	136	228
Poplar Run, Newry										
73	Riffle	215	3.56	5.45	60.3	32	57	78	154	202
189	Pool	220	2.86	4.93	76.7	20	40	53	100	125
329	Riffle	366	4.58	4.61	79.8	35	55	69	116	163
426	Pool	160	2.66	4.60	61.5	17	30	41	78	119
Dry Gap Run										
47	Riffle	95	1.08	3.90	88.4	21	61	85	194	298
267	Riffle	174	2.14	3.73	81.4	1	14	94	191	256
313	Riffle	133	2.09	4.34	63.7	2	22	55	120	177
387	Pool	136	2.26	4.38	60.4	1	8	55	152	279
Mill Run										
100	Pool	235	2.72	5.99	86.3	19	61	111	248	354
207	Riffle	192	1.91	4.10	100.7	39	95	121	217	309
371	Riffle	103	1.78	4.95	57.5	9	34	70	169	238
400	Pool	84	1.44	3.20	58.2	33	95	138	227	319
Glenwhite Run										
72	Pool	107	2.73	5.87	39.3	14	57	82	177	370
181	Riffle	218	5.13	10.24	42.4	8	40	60	184	268
356	Pool	298	5.16	8.67	57.8	9	30	48	166	342
540	Riffle	230	4.96	6.73	46.3	31	64	89	210	376
Sugar Run										
98	Pool	219	4.69	6.69	46.6	2	51	80	191	273
397	Riffle	207	3.57	5.61	58	48	63	98	216	278
530	Pool	187	3.45	5.10	54.3	14	40	82	241	440
720	Riffle	84	1.87	3.40	45	1	24	57	166	234
Blair Gap Run										
31	Pool	139	2.11	5.18	65.7	11	38	69	151	252
196	Riffle	137	1.77	4.00	77.5	20	59	89	179	242
600	Riffle	109	2.56	3.68	42.6	20	69	97	170	247
739	Pool	244	4.96	5.80	81	0	8	49	91	158
Bells Gap Run										
103	Pool	122	2.23	5.35	54.9	48	81	102	192	2497
213	Riffle	127	1.92	4.08	65.8	49	81	105	172	228
445	Riffle	219	4.18	6.33	52.4	72	107	128	225	348
700	Pool	444	4.58	6.05	96.8	14	62	99	207	333
Tipton Run										
195	Pool	140	2.42	5.63	57.9	18	56	85	183	256
256	Riffle	93	1.49	4.39	62.5	52	98	113	207	272
531	Pool	166	3.65	5.75	45.6	51	90	112	230	361
700	Riffle	157	2.79	4.58	56.1	27	75	112	355	3088
Sink Run										
58	Pool	172	4.17	7.48	41.2	26	56	97	203	300
243	Riffle	282	3.22	5.67	87.5	53	95	120	244	368
383	Riffle	167	2.92	6.38	57.3	14	83	113	296	620
440	Pool	335	4.73	7.53	70.8	32	91	118	225	409

Quality Assurance for Water Chemistry

To evaluate differences between and within laboratories, replicate samples (separate from environmental samples) for analysis of TDS, bromide, chloride, sulfate, barium, and strontium were collected at South Poplar Run, Blair Gap Run, Tipton Run, and Sink Run. The results of these laboratory comparisons are shown in tables 5*A*–*B* and 8.

Absolute percent differences for each stream and parameter were calculated as follows:

$$(|V1 - V2| / ((V1 + V2) / 2) \times 100,$$

where

V1 represents the USGS analysis results,
V2 represents the AWA analysis results, and
|V1 – V2| is the absolute value difference.

Filtered (dissolved) and unfiltered (total or whole water) samples were collected in September 2011 for TDS, bromide, chloride, and sulfate (table 5*A*). The NWQL laboratory analyzed filtered samples, and the AWA analyzed unfiltered samples. As expected, the filtered samples contained lower concentrations of TDS, chloride, and sulfate; the absolute percent difference for bromide could not be determined as a result of different reporting limits.

Filtered samples were collected in December 2011 and January 2012. The results of the December 2011 sampling indicate that the NWQL results were, for the most part, consistently lower than the AWA results, except for TDS. The results for the January 2012 samples indicate that AWA results were generally lower than the NWQL results (table 5*A*). The absolute percent difference between laboratories varied by constituent and site. This could be the result of different methods of analyses, different detection levels, and interferences at some sites. Large absolute percent differences (greater than 20 percent) occurred most commonly with TDS (6 of 8) and chloride (5 of 8) (table 5*A*).

Additional replicate samples for barium and strontium were collected at South Poplar Run, Blair Gap Run, Tipton Run, and Sink Run from June 2011 through April 2013 (table 5*B*). These samples consisted of filtered (NWQL) and total (AWA) water. The absolute percent difference for barium ranged from 0.3 to 49.2; the median was 7.2 with 3 of 44 samples exceeding a difference of 20 percent. For strontium, the absolute percent difference ranged from 0.4 to 108; the median was 8.8 with 8 of 44 samples exceeding a difference of 20 percent.

Variation within the AWA laboratory was evaluated by collecting environmental, replicate, standard-reference, and equipment blank samples. In September 2011 for South Poplar Run, Blair Gap Run, Tipton Run, and Sink Run, replicate samples were compared for chloride, bromide, sulfate, barium, strontium, and TDS (table 7). Except for TDS (2 of 4), the absolute percent differences were less than 10 percent (table 8). For samples collected in December 2011 and January 2012, AWA analyzed filtered and unfiltered barium and strontium samples. Absolute percent differences were less than 10 percent for all samples (table 8). Table 9 presents the results of analysis by AWA of selected constituents in an equipment blank; no detectable concentrations were measured for TDS, bromide, chloride, sulfate, barium, or strontium. USGS Standard Reference Samples M200 and T207 were analyzed by the AWA laboratory for barium, strontium, chloride, TDS, sulfate, and bromide. With the exception of barium, the absolute percent difference was less than 10 percent (table 10). Table 11 presents the results for NWQL laboratory analysis of an equipment-blank sample.

Table 7. Results of analyses for selected constituents in replicate samples collected from selected streams in Blair County, Pennsylvania, and analyzed by the Altoona Water Authority Laboratory, Blair County, Pennsylvania.

[Env., Environmental sample; Rep., Replicate sample; --, not calculated; <, less than; % Diff., percent difference; µg/L, micrograms per liter; mg/L, milligrams per liter; TDS, total dissolved solids]

Parameter	South Poplar Run—9/26/11			Blair Gap Run—9/26/11			Tipton Run—9/27/11			Sink Run—9/27/11		
	Env.	Rep.	% Diff.	Env.	Rep.	% Diff.	Env.	Rep.	% Diff.	Env.	Rep.	% Diff.
Chloride (mg/L)	7.5	7.5	0.0	5.8	5.7	1.7	6.2	6.2	0.0	10.6	10.6	0.0
Bromide (mg/L)	< 0.20	< 0.20	--	< 0.20	< 0.20	--	< 0.20	< 0.20	--	< 0.20	< 0.20	--
Sulfate (mg/L)	10.5	10.4	1.0	10.3	10.3	0.0	8.7	8.7	0.0	7.2	7.1	1.4
Barium (µg/L)	103	103	0.0	81.0	83.0	2.4	89.8	88.8	1.1	90.5	89.8	0.8
Strontium (µg/L)	109	109	0.0	54.6	58.6	7.1	64.3	64.1	0.3	52.2	53.4	2.3
TDS (mg/L)	71	74	4.1	48	38	23.3	51	41	21.7	47	49	4.2

Table 8. Results of analyses of selected constituents in filtered (0.45 micrometer) and unfiltered replicate samples, collected from selected streams, Blair County, Pennsylvania, and analyzed by the Altoona Water Authority Laboratory, Blair County, Pennsylvania.

[% Diff., percent difference; µg/L, micrograms per liter; P01005, parameter number]

Station	Date	Barium in filtered water, µg/L (P01005)	Barium in unfiltered water, µg/L (P01007)	% Diff	Strontium in filtered water, µg/L (P01080)	Strontium in unfiltered water, µg/L (P01082)	% Diff
South Poplar Run	12/28/2011	37.0	38.0	2.7	25.0	25.0	0.0
South Poplar Run	1/19/2012	36.0	37.0	2.7	27.0	26.0	3.8
Blair Gap Run	12/28/2011	39.0	38.0	2.6	25.0	25.0	0.0
Blair Gap Run	1/19/2012	35.0	34.0	2.9	22.0	22.0	0.0
Tipton Run	12/28/2011	31.0	32.0	3.2	15.0	15.0	0.0
Tipton Run	1/19/2012	28.0	29.0	3.5	14.0	14.0	0.0
Sink Run	12/28/2011	31.0	32.0	3.2	14.0	14.0	0.0
Sink Run	1/19/2012	28.0	30.0	6.9	14.0	15.0	6.9

Table 9. Results of analysis for selected constituents in an equipment-blank sample analyzed December 28, 2011, by the Altoona Water Authority Laboratory, Blair County, Pennsylvania.

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

Parameter number and constituent	Final result	Units
P70300—Total dissolved solids dried at 180 degrees Celsius, water, filtered	<20	mg/L
P71870—Bromide, water, filtered	<0.20	mg/L
P00940—Chloride, water, filtered	<5.0	mg/L
P00945—Sulfate, water, filtered	<5.0	mg/L
P01007—Barium, water, unfiltered, recoverable	<5.0	µg/L
P01082—Strontium, water, unfiltered, recoverable	<5.0	µg/L

Table 10. Results of analysis for selected constituents in U.S. Geological Survey Standard Reference Samples M200 and T207 analyzed by the Altoona Water Authority Laboratory, Blair County, Pennsylvania.

[Standard Reference Sample M200 contains major ions including chloride, TDS, sulfate, and bromide; Standard Reference Sample T207 contains trace metals including barium and strontium; AWA, Altoona Water Authority; TDS, total dissolved solids, 180 degress Celsius; %, percent; µg/L, micrograms per liter; mg/L, milligrams per liter]

Constituent	Most probable value[1]	AWA laboratory value, 12/28/2012	% difference
Barium (µg/L)	42.9	49.0	13.3
Strontium (µg/L)	161	165	2.5
Chloride (mg/L)	17.9	17.7	1.1
TDS (mg/L)	91.0	87.0	4.5
Sulfate (mg/L)	11.6	12.8	9.8
Bromide (mg/L)	0.66	0.64	3.1

[1]Most probable value represents the median value obtained by over 150 laboratories participating in the inter-laboratory comparison study conducted by the U.S. Geological Survey, Branch of Quality Systems.

Table 11. Results of analysis for selected constituents in an equipment-blank sample analyzed September 27, 2011, by the U.S. Geological Survey National Water Quality Laboratory.

[RL, reporting limit; MDL, method detection limit; <, less than; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter;TDS, total dissolved solids; °C, degrees Celsius; icp, inductively coupled plasma; icp-ms, inductively coupled plasma-mass spectormetry; cicp-ms, collision/reaction cell inductively coupled plasma-mass spectrometry]

Parameter	Final result	Result units	RL	MDL
Barium, filtered, icp-ms	<0.070	µg/L	0.07	0.07
Specific conductance lab	<5	µS/cm	5	5
Residual on evaporation, dissolved at 180 °C (TDS)	<12	mg/L	12	12
Chloride, filtered, icp	<0.06	mg/L	0.06	0.06
Zinc, filtered cicp-ms	<1.40	µg/L	1.4	1.4
Sulfate, dissolved icp	<0.09	mg/L	0.09	0.09
Boron, filtered, icp-ms	<3.0	µg/L	3	3
Beryllium, filtered, icp-ms	<0.0060	µg/L	0.006	0.006
Copper, filtered, cicp-ms	<0.50	µg/L	0.5	0.5
Nickel, filtered, cicp-ms	<0.09	µg/L	0.09	0.09
Silica, filtered, icp	<0.029	mg/L	0.029	0.029
Molybdenum, filtered, icp-ms	<0.0140	µg/L	0.014	0.014
Cadmium, filtered, icp-ms	<0.016	µg/L	0.016	0.016
Silver, filtered, icp-ms	<0.0050	µg/L	0.005	0.005
Strontium, filtered, icp-ms	<0.200	µg/L	0.2	0.2
Potassium, filtered, icp	<0.0220	mg/L	0.022	0.022
Lead, filtered, icp-ms	<0.0150	µg/L	0.015	0.015
Manganese, filtered, icp	<0.16	µg/L	0.16	0.16
Cobalt, filtered, cicp-ms	<0.0200	µg/L	0.02	0.02
Fluoride, filtered	<0.040	mg/L	0.04	0.04
Calcium, filtered, icp	<0.0220	mg/L	0.022	0.022
Sodium, filtered, icp	<0.060	mg/L	0.06	0.06
pH (laboratory)	6.2	pH	0.1	0.1
Iron, filtered, icp	<3.2	µg/L	3.2	3.2
Bromide, filtered icp	<0.01	mg/L	0.01	0.01
Lithium, filtered, icp	<0.050	µg/L	0.05	0.05
Aluminum, filtered, icp-ms	<1.70	µg/L	1.7	1.7
Manganese, filtered, icp-ms	<0.130	µg/L	0.13	0.13
Antimony, filtered, icp-ms	<0.0270	µg/L	0.027	0.027
Uranium, filtered, icp-ms	<0.0040	µg/L	0.004	0.004
Magnesium, filtered, icp	<0.0080	mg/L	0.008	0.008
Arsenic, filtered, cicp-ms	<0.022	µg/L	0.022	0.022
Selenium, filtered, cicp-ms	<0.030	µg/L	0.03	0.03
Chromium, filtered, cicp-ms	<0.060	µg/L	0.06	0.06

Discrete Water-Quality Data

Summary statistics for selected water-quality data for all sites are presented in table 12 (at end of report). Results for antimony, cadmium, copper, fluoride, lead, silver, and gross-alpha and gross-beta activities are not included because most if not all of the values were at or near detection limits. Complete analytical results are presented in appendix 1.

The evaluation of instantaneous streamflow in relation to the selected water-quality parameters and constituents indicate that most cations (calcium, magnesium, potassium, sodium, lithium, barium, strontium and sulfate) decreased with increased streamflow (fig. 7); pH, specific conductance, and TDS also generally decreased with increased streamflow (fig. 8). Trace elements such as nickel, selenium, zinc, chromium, and uranium generally increased, whereas manganese, molybdenum, boron, and arsenic generally decreased with increased streamflow (fig. 9). The decreases in concentration as streamflow increases are a result of dilution of groundwater base flow by precipitation and surface runoff.

Dissolved oxygen is a critical component in maintaining the health and bio-diversity of life in a stream. It is also the oxidizing agent important for the removal of iron and other metals in streams such as Sugar Run, Blair Gap Run, and Glenwhite Run, which receive AMD. The solubility of oxygen in water is limited by, and is directly proportional to, its partial pressure in air and water temperature. DO concentrations for the 12 watersheds were near 100 percent saturated and ranged from 7.5 milligrams per liter (mg/L) (Poplar Run near Newry) to 14.3 mg/L (Tipton Run); the median DO concentration of 10.3 mg/L was well above the 5.0 mg/L minimum threshold to support a diverse fish community (Commonwealth of Pennsylvania, 2014).

The pH of water is the negative log of hydrogen ion concentrations. The pH affects the solubility of metal hydroxides and the type of biotic community in the streams. Precipitation events (rainfall, snow melt), bedrock geology, AMD, organic matter, biological activity of algae, and land use can all affect the pH of water in streams. The pH of water in the 12 watersheds ranged from 6.2 (Bells Gap Run and Tipton Run) to 8.9 (South Poplar Run) (table 12). In general, pH decreased with increased streamflow.

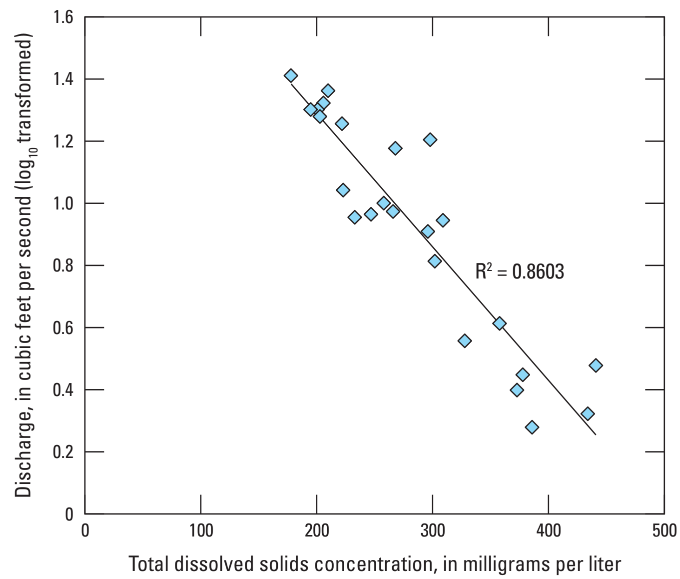


Figure 8. Total dissolved solids concentration in relation to streamflow with best-fit line and coefficient of determination (R^2) for Blair Gap Run, Blair County, Pennsylvania.

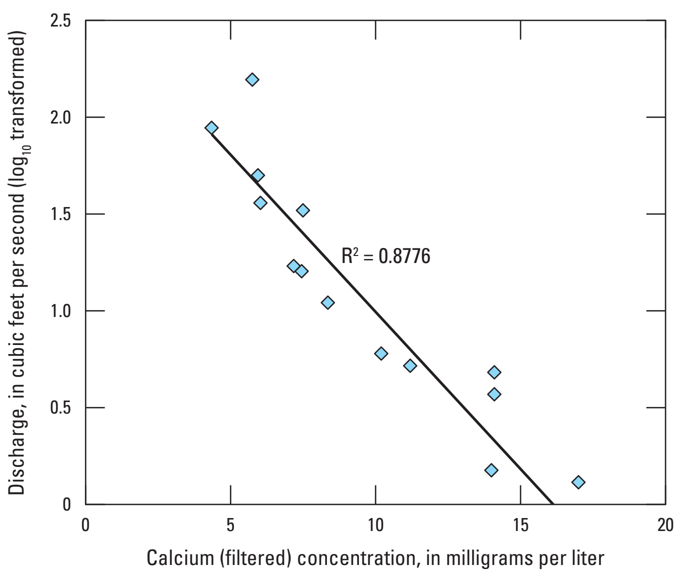


Figure 7. Calcium concentration (filtered) in relation to streamflow with best-fit line and coefficient of determination (R^2) for South Poplar Run, Blair County, Pennsylvania.

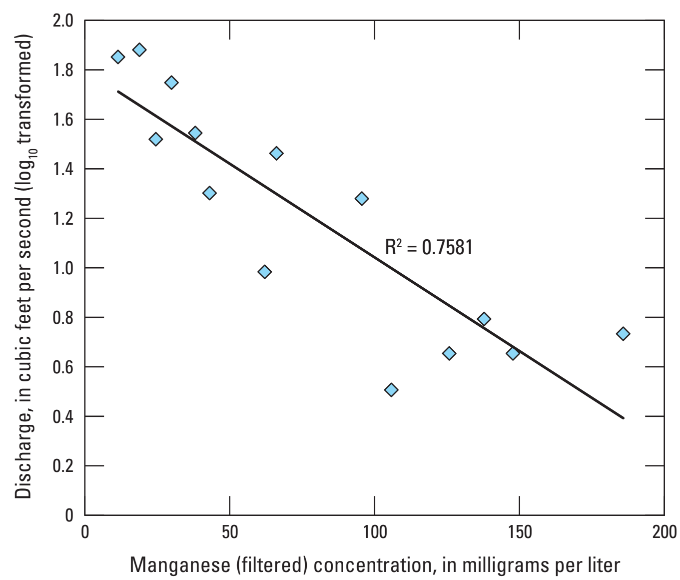


Figure 9. Manganese concentration (filtered) in relation to streamflow with best-fit line and coefficient of determination (R^2) for Sugar Run, Blair County, Pennsylvania.

Specific conductance is a measure of the capacity of dissolved ions in water to conduct an electrical current (Wilde and others, 1998). Specific conductance is positively correlated to the dissolved solids concentration. Specific conductance typically decreased with increased streamflow, indicating there is a dilution effect from stormwater runoff. Exceptions were Dry Gap Run, Tipton Run, and Sink Run. Dilution effects also were observed during major precipitation events. The specific conductance of water at the 12 watersheds ranged from 43 microsiemens per centimeter at 25 degrees Celsius (µS/cm) (Dry Gap Run) to 793 µS/cm (Sugar Run; table 12). The highest specific conductance and the highest median specific conductance were measured in Sugar Run, a stream that receives AMD.

Total dissolved solids (Residue on Evaporation) by convention are defined as all dissolved solutes and solid material that are less than 0.45 µm in size. The most common chemical constituents are calcium, phosphates, nitrates, sodium, potassium, and chloride. TDS in streamwaters primarily result from the dissolution of minerals in rocks and soils near the land surface but also can result from substances introduced by human activities, such as irrigation, mining, and oil and gas development. TDS typically decreased with increased streamflow (fig. 8). The lowest TDS was reported at Sink Run, whereas the highest was reported at Sugar Run (15 and 441 mg/L, respectively; table 12). Sugar Run also had the highest median TDS at 267 mg/L as a result of AMD contamination.

ANC is a measure of the capacity of solutes and particulate matter in water to neutralize acid. The principal source of ANC in the watersheds is bicarbonate (HCO_3^-). The dissolved carbonate is largely the result of water being in contact with calcite cement or veining from the surrounding bedrock. ANC typically decreased with increased streamflow and ranged in concentration from 2 mg/L (Glenwhite Run) to 85 mg/L (South Poplar Run; table 12).

Calcium, magnesium, potassium, sodium, lithium, barium, and strontium are all cations and typically decreased in concentration with increased streamflow. Concentrations of these cations exhibited considerable variation among streams. For calcium, magnesium, and lithium, the range in concentrations exceeded 2 orders of magnitude (table 12). The lowest median concentrations for calcium and magnesium samples were in Sink Run (4.03 and 1.18 mg/L, respectively). The lowest median potassium concentration (0.74 mg/L) occurred in Blair Gap Run, and the lowest median (unfiltered) barium concentration (32 µg/L) was in Bells Gap Run. For other cations, including sodium, lithium, and strontium, the lowest median concentrations were in Bells Gap Run (1.64 mg/L), Dry Gap Run (0.69 µg/L) and Tipton Run (17 µg/L), respectively. Bells Gap Run and Dry Gap Run, however, were sampled only three times during the study period. The highest median concentrations for calcium (47.3 mg/L), magnesium (16.6 mg/L), potassium (1.82 mg/L), sodium (16.5 mg/L), lithium (26.7 µg/L), and strontium (142 µg/L) were in Sugar Run. Blue Knob Run had the highest median barium concentration of (91.3 µg/L) (table 12).

Concentrations of silica and the anions sulfate and chloride exhibited considerable variation among streams with a maximum range of 2 orders of magnitude. Nitrate concentrations generally increased with higher streamflow (fig. 10), whereas concentrations of sulfate, silica, and chloride tended to decrease with higher streamflow (fig. 11). South Poplar Run had the highest median nitrate concentration (0.76 mg/L), but

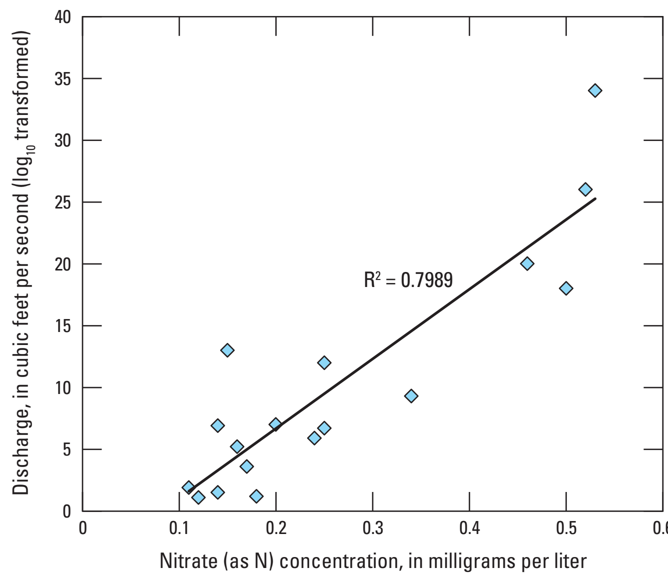


Figure 10. Nitrate (as N) concentration in relation to streamflow with best-fit line and coefficient of determination (R^2) for Glenwhite Run, Blair County, Pennsylvania.

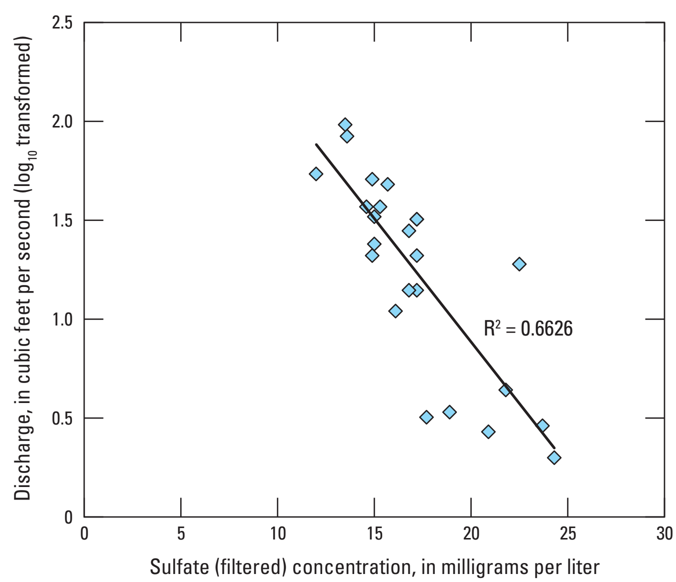


Figure 11. Sulfate concentration (filtered) in relation to streamflow with best-fit line and coefficient of determination (R^2) for Bells Gap Run, Blair County, Pennsylvania.

Sink Run had the highest maximum reported (2.35 mg/L). Median and maximum concentrations for silica (10.2 and 13.4 mg/L), sulfate (127 and 223 mg/L), and chloride (28.5 and 69.0 mg/L) were highest at Sugar Run (table 12).

Minor and trace element concentrations ranged from 2 to 3 orders of magnitude and exhibited greater variation in concentration with changes in streamflow than the cations. Aluminum, beryllium, chromium, iron, manganese, molybdenum, nickel, zinc, arsenic, boron, and uranium generally decreased in concentration as streamflow increased (fig. 9). Cobalt and selenium concentrations did not exhibit any dominant trend with changes in streamflow. Of the 13 metals analyzed, Blair Gap Run typically had the highest median and (or) greatest maximum concentrations of minor and trace elements (9 of 13). This is probably the result of the dewatering of an upstream reservoir, the subsequent incising of the stream, and the associated erosion of bottom silts and muds or AMD from various sources upstream from the main reservoir. Manganese concentrations exceeded the U.S. Environmental Protection Agency (EPA) secondary maximum contaminant levels (SMCL) of 50 µg/L in Glenwhite Run (3 of 3 samples), Blair Gap Run (8 of 15), and Sugar Run (3 of 3) (appendix 1). Sugar Run (3 samples) had the highest median and maximum manganese concentrations reported—762 and 816 µg/L, respectively. Sugar Run (3 samples) was the only watershed where iron concentrations exceeded the EPA SMCL of 300 µg/L; the median and maximum iron concentrations were 422 and 955 µg/L, respectively. These exceedances for manganese and iron are reflected in figure 12 for the watersheds where the stream health for overall water quality is shown as green to indicate fair or attaining water quality (no exceedances of a EPA MCL or SMCL) and yellow to indicate poor or impaired water quality (one or more exceedances of a EPA MCL or SMCL).

Impact of Snowmelt and Deicing

Samples collected from 10 streams in February 2013 and 8 of 10 streams in March 2013 were affected by snowmelt, as indicated by increased streamflow (determined by instantaneous streamflow) that ranged from 5 to 700 percent greater than the median streamflow. From February 4 through February 10, 2013, precipitation was minimal (less than 0.25 inches), but snow depth was 4.0–8.0 inches (National Weather Service, 2014), and average temperatures were below freezing (Pennsylvania State Climatologist, 2014). However, on February 11 the average temperature was 5.6 °C with a high of 15 °C. By February 12, snow depth was essentially zero, indicating considerable snowmelt. From March 6 through March 11, average temperatures were above freezing with daily highs reaching a maximum of 13.3 °C, total precipitation of 0.40 inches, and snow thickness that decreased from 4.0–8.0 inches to essentially zero. On March 12, 0.66 inches of rain fell, indicating snow melt with considerable surface-water runoff.

Although all 10 of the watersheds had increased streamflow from the February snowmelt, only Dry Gap Run and Mill Run exhibited notable changes in specific conductance (+420 and +180 percent), TDS (+253 and +109 percent) and chloride (+1020 and +310 percent); Mill Run also exhibited considerable increase in barium (+56 percent) and strontium (+66 percent). Watersheds that exhibited notable increases for specific conductance (68–180 percent), TDS (44–85 percent), and chloride (110–290 percent) relating to the March snowmelt were Mill Run, Blair Gap Run, and Bells Gap Run.

As seen from the water-quality results of snowmelts in February and March 2013, watersheds can be affected by deicing efforts. This has resulted in concern for subsequent water-quality degradation in the watersheds from the effects of salt and salt-related constituents. Natural sources of salts to water resources in the study area include atmospheric deposition (including the contribution from power generation), natural weathering of bedrock, surficial materials, and soil and geologic deposits containing halite or saline groundwater (brines). Anthropogenic sources of salt include deicing of roadways, fertilizer, sewage, animal waste, and brine from flowback or production fluids related to oil and gas development.

Wet deposition of chloride from the atmosphere in the study area is estimated to be greater than 0.25 to 0.5 tons per square mile (Mullaney and others, 2009; fig. 3). According to Peters (1984), the chloride yield from atmospheric deposition is related to the amount of precipitation received and may range from 28 to 62 percent of the chloride yield in undeveloped watersheds. In typical runoff attributable to wet deposition, wet deposition may contribute 0.1–2.0 mg/L of chloride to surface water (Mullaney and others, 2009). Assuming the minimum contribution, wet deposition would contribute from less than 0.5 percent (Sugar Run) to 3.0 percent (Bell Gap Run) of the median chloride concentration in the study area.

In addition to the chloride deposited by precipitation, there can be a natural input from the weathering of rocks and minerals. Chlorine is present in several minerals commonly found in rocks, but its release to waters as chloride ions is generally slow and through processes other than dissolution (Feth, 1981). According to Geyer and Wilshusen (1982), none of the formations that underlie the watersheds in the study area contain salt deposits. However, brines may be encountered at great depths.

Although all of the watersheds are dominated by forest, major roadways commonly are nearby, and the dissolution of deicing salts by road runoff is possible. According to Mullaney and others (2009), the most common form of road salt consists of sodium chloride. To identify sources of chloride (Cl), weight ratios of chloride and bromide (Br) concentrations can be used (Whittemore, 1988; Knuth and others, 1990; Davis and others, 1998; Jagucki and Darner, 2001). Chloride and bromide are useful indicators because they are (1) highly soluble, (2) minimally affected by adsorption once dissolved in water, (3) not altered by oxidation-reduction reactions, and (4) not found in high concentrations in the bedrock underlying the study areas (Hem, 1985). Differences in ratios of chloride to bromide occur because salt deposits used for deicing have high chloride to bromide ratios; bromide is even more soluble

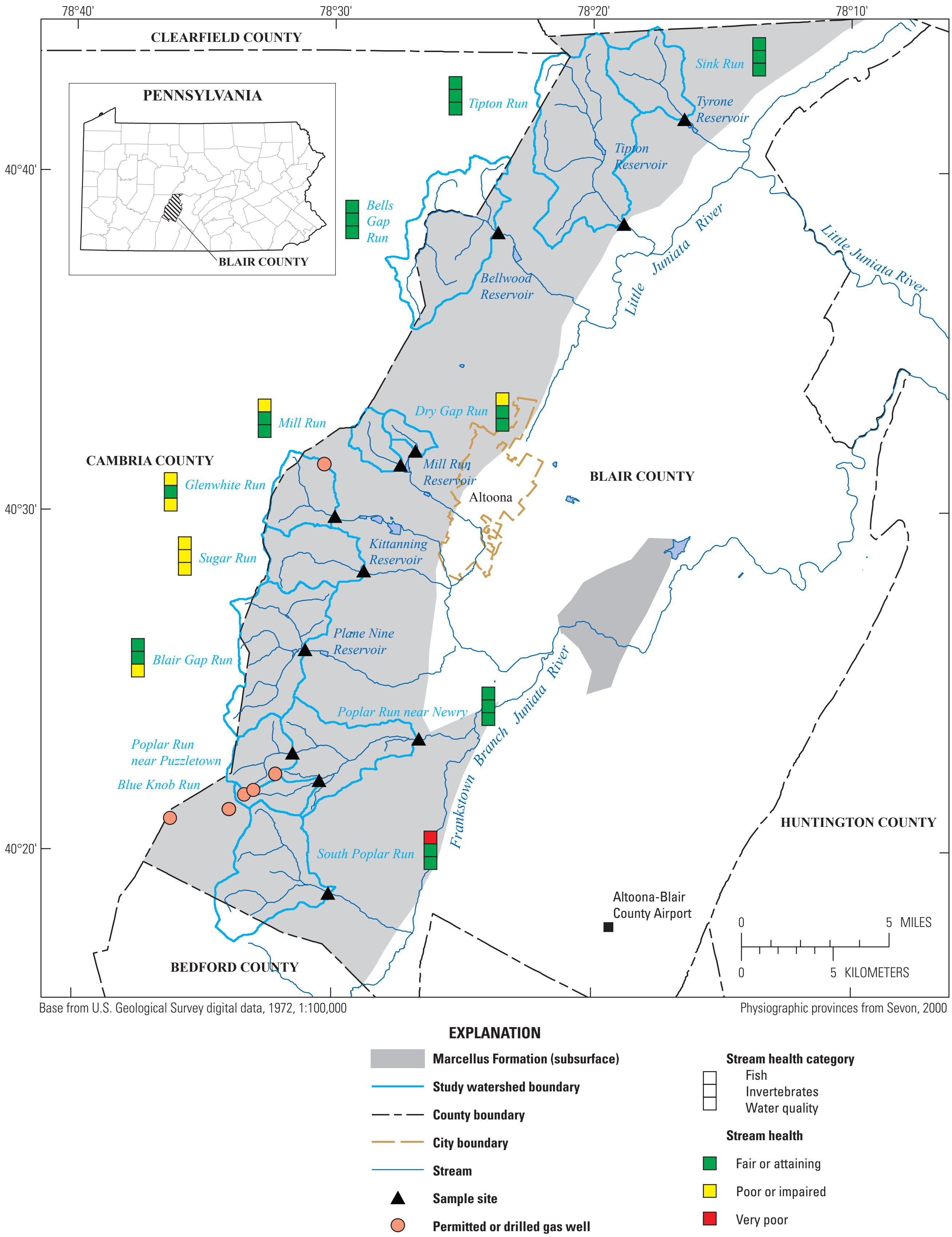


Figure 12. Selected streams with sampling sites, showing overall water quality and stream health, from July 2011 through September 2013, Blair County, Pennsylvania

in water than chloride and remains in solution after halite (NaCl) is precipitated (Davis and others, 1998, p. 339).

Two deicing mixing curves based upon Cl/Br ratios for two end points—precipitation (freshwater) and two different compositions of NaCl deicing salts—were developed. The freshwater/deicing salt mixing curve uses the deicing salt end member common value from Mullaney and others (2009) (Cl/Br ratio of 180,000/18). The Pennsylvania Department of Transportation (PennDOT) freshwater/salt mixing curve uses a deicing salt end member from a PennDOT sample collected 90 miles northeast of the study area near Trout Run, Pa. (Cl/Br ratio of 261,000/5440). Points representing the Cl/Br ratios in the study area streams were plotted along these mixing curves (fig. 13) and exhibit a fairly tight relation between the stream samples and the two mixing curves. This tight correlation of stream samples to the salt mixing curves is indicative of the effects from road salt entering the stream and groundwater system. According to Mullaney and others (2009), this pattern (1) is reflective of the natural environment where more than two sources of chloride are possible and (2) shows the mixtures are diluted with additional water and are not full-strength end members. A similar curve was developed to compare the observed Cl/Br ratios for the streams to those for oil and gas brines reported for western Pennsylvania (Dresel and Rose, 2010). According to Dresel and Rose (2010), these brines have similar composition to late-emerging flowback water from Marcellus gas wells. Comparison of these curves illustrates the considerable difference in chloride and bromide concentrations for the sources of interest (deicing salt and Marcellus flowback). The stream samples generally follow the deicing salt mixing curves and do not lie along the brine mixing curve, which indicates that brines or residue from Marcellus flowback have not affected the halogen chemistry of the sampled streams.

Water Types

The overall type of water can be described on the basis of the major-ion composition, which is a product of the bedrock lithology and land use. The major-ion composition includes those inorganic ionic constituents commonly present in concentrations exceeding 1.0 mg/L (Hem, 1985). The relative proportions of the major cations (generally calcium, magnesium, potassium, and sodium) and the major anions (generally bicarbonate plus carbonate, chloride, and sulfate) were used to describe the water type.

Piper diagrams, which illustrate the relative percentage of the major cations and anions on two trilinear plots and a diamond-shaped plot that combines the cation and anion information (Piper, 1944), indicate that major ion composition in the study area varied among sites. The trilinear plots show several water types are present in the watersheds (fig. 14). Calcium is the dominant (greater than or equal to 60 percent) cation for Glenwhite Run and Sugar Run. Magnesium composes 15 to 30 percent, whereas sodium plus potassium compose 5 to 50 percent of the total cations for the streams sampled. Chloride composes from 5 to 55 percent of the total anions for the stream sampled. Sulfate is the dominant anion for Bells Gap Run, Glenwhite Run, and Sugar Run, whereas bicarbonate is the dominant anion for Poplar Run near Puzzleton and South Poplar Run. Calcium-bicarbonate or calcium-magnesium-bicarbonate water is characteristic of groundwater from calcareous bedrock. The calcium-sulfate water type of Glenwhite Run and Sugar Run is the result of the interaction of calcareous rock with AMD; historical mining and associated AMD contributed to the elevated concentrations of sulfate and iron in these streams. The remaining streams do not have a dominant cation or anion and tend to group toward the middle of the Piper diagram.

Continuous Water-Quality Data

Continuous water-quality data for temperature and specific conductance were collected in conjunction with gage height at South Poplar Run, Blair Gap Run, Tipton Run, and Sink Run (figs. 15 and 16). Seasonal patterns are evident in temperature, specific conductance, and gage height. Daily mean water-temperature decreased from the July through August peaks of 18–20 °C to the seasonal lows of 0–4 °C of late December through February. Superimposed on the seasonal temperature patterns are periodic peaks and troughs with periods ranging from a day or two to 15–20 days.

Specific conductance unit values (30-minute intervals) also exhibit seasonal patterns. These patterns, however, are tied to seasonal changes in recharge and runoff. During the warmer months, evapotranspiration increases while streamflow decreases. During these conditions, specific conductance generally increases as streamflow becomes dominated by groundwater (base flow). In 2012 at South Poplar Run, the seasonal decrease in streamflow (as measured by gage height) began about the first of June (11.5 ft.) and continued until the end of October (10.8 ft.) (fig. 16*C*). Specific conductance, however, increased from about 80–150 µS/cm with a peak near 210 µS/cm. Similar seasonal patterns can be observed at Blair Gap Run, Sink Run, and Tipton Run (fig. 16*A*, *B*, *D*).

Super-imposed on the broader seasonal patterns of streamflow and specific conductance are large numbers of peaks and troughs. Peaks in gage height are the result of precipitation events and, in the winter, snow melt. During the warmer months when evapotranspiration from plants is active, these high-stage events are typically sharp, symmetrical, and narrow based possibly indicating runoff as a major streamflow component. However, in the fall after a heavy, killing frost (typically late October), the shape of the gage-height hydrograph following a storm generally changes to being asymmetrical with a sharp, steep rise (left side) and a much broader and trailing right side, which represents added base flow (recharge) along the recession curve of the hydrograph. The timing of peaks (maxima) in specific conductance generally matches the timing of gage-height peaks. However, specific conductance peaks are very sharp and narrow and do

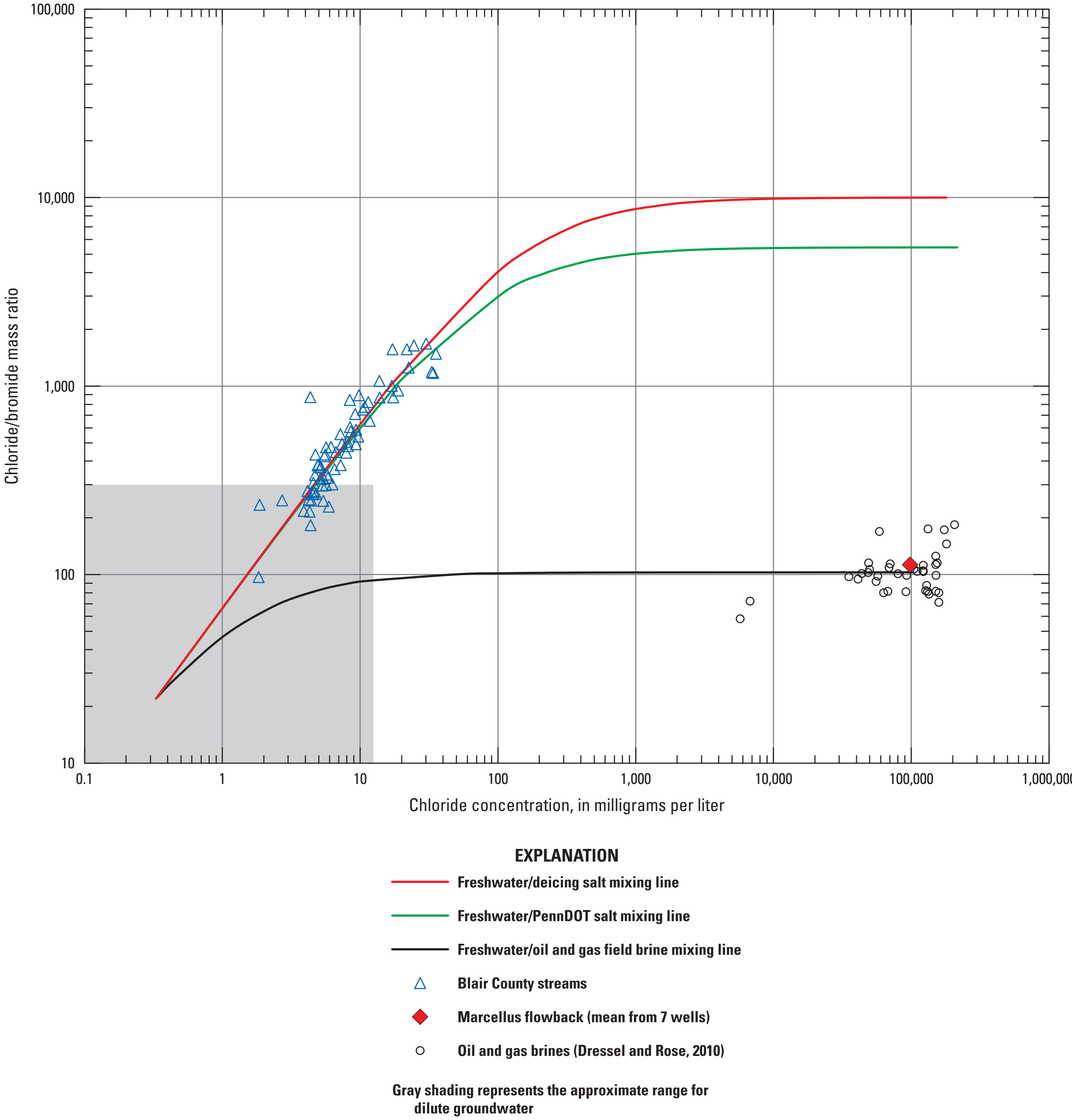


Figure 13. Binary mixing curves representing sources of chloride. Graph shows the relation of chloride concentration to chloride/bromide ratios (by mass) for stream samples from the study watersheds to the type road salt-mixing curve and the type brine mixing curve for western Pennsylvania oil and gas wells (PennDOT, Pennsylvania Department of Transportation).

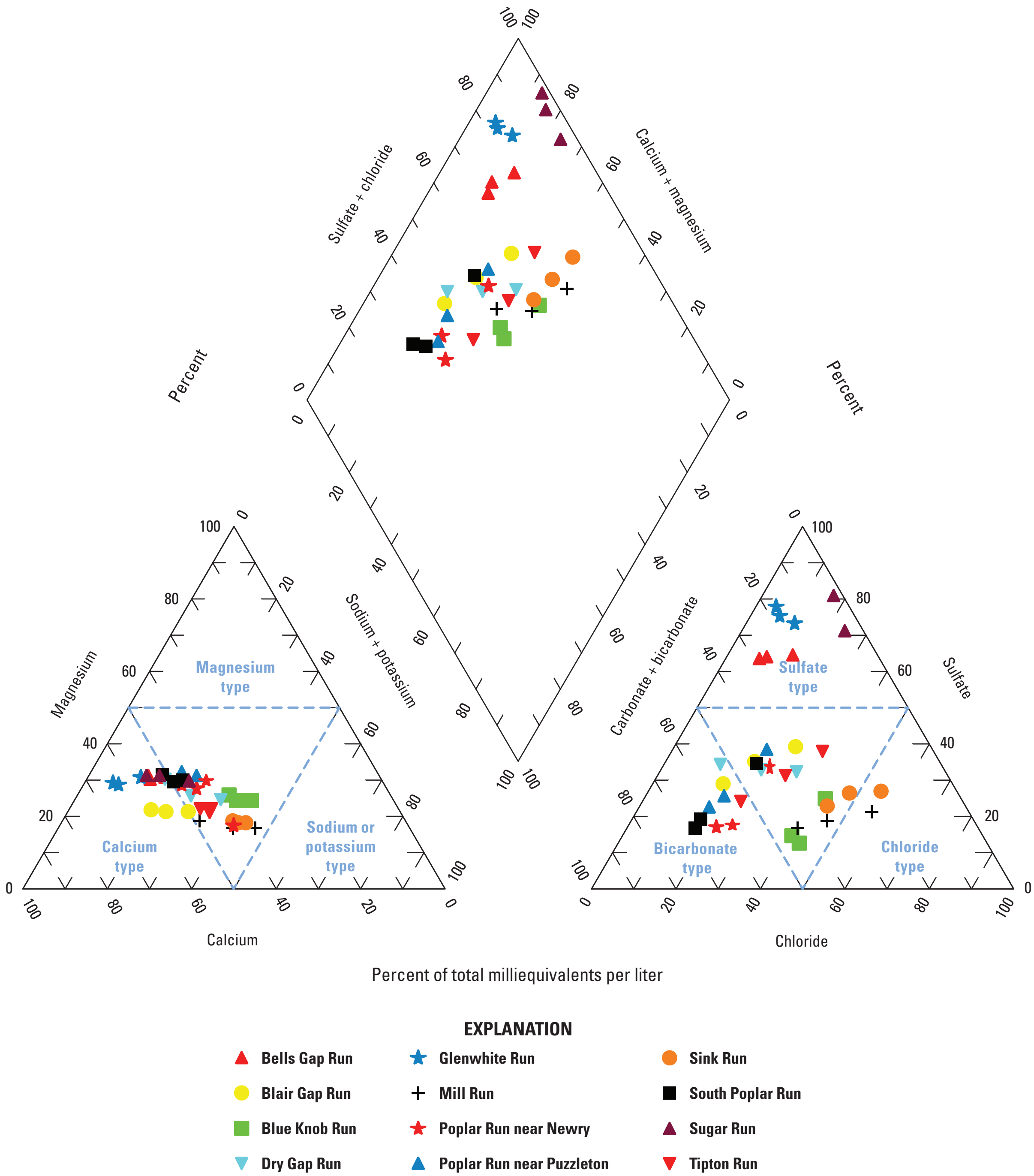


Figure 14. Different water types in the 12-watershed study area, May to September, 2013, Blair County, Pennsylvania.

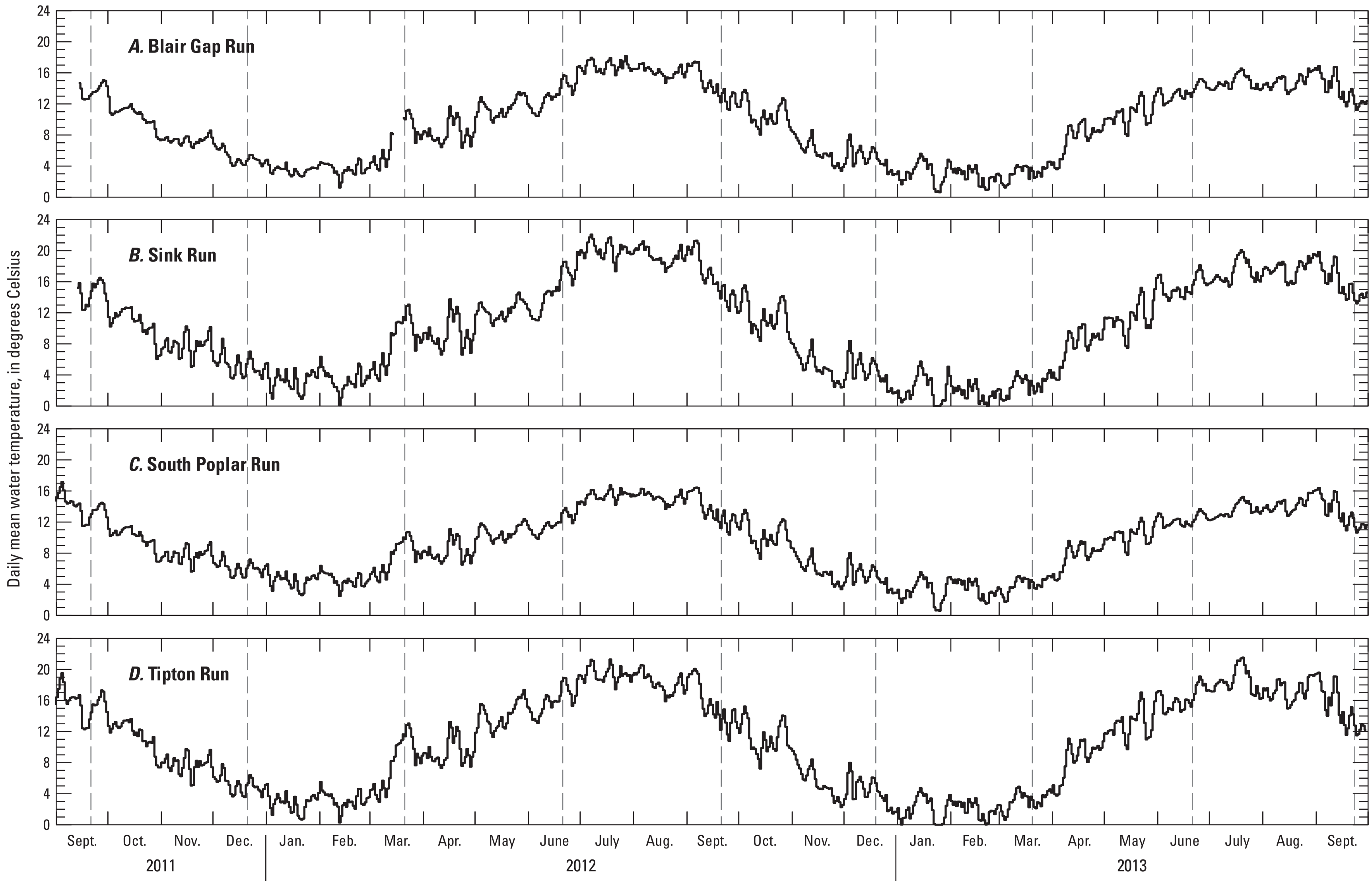


Figure 15. Daily mean water temperatures in *A*, Blair Gap Run, *B*, Sink Run, *C*, South Poplar Run, and *D*, Tipton Run, Blair County, Pennsylvania, 2011–13.

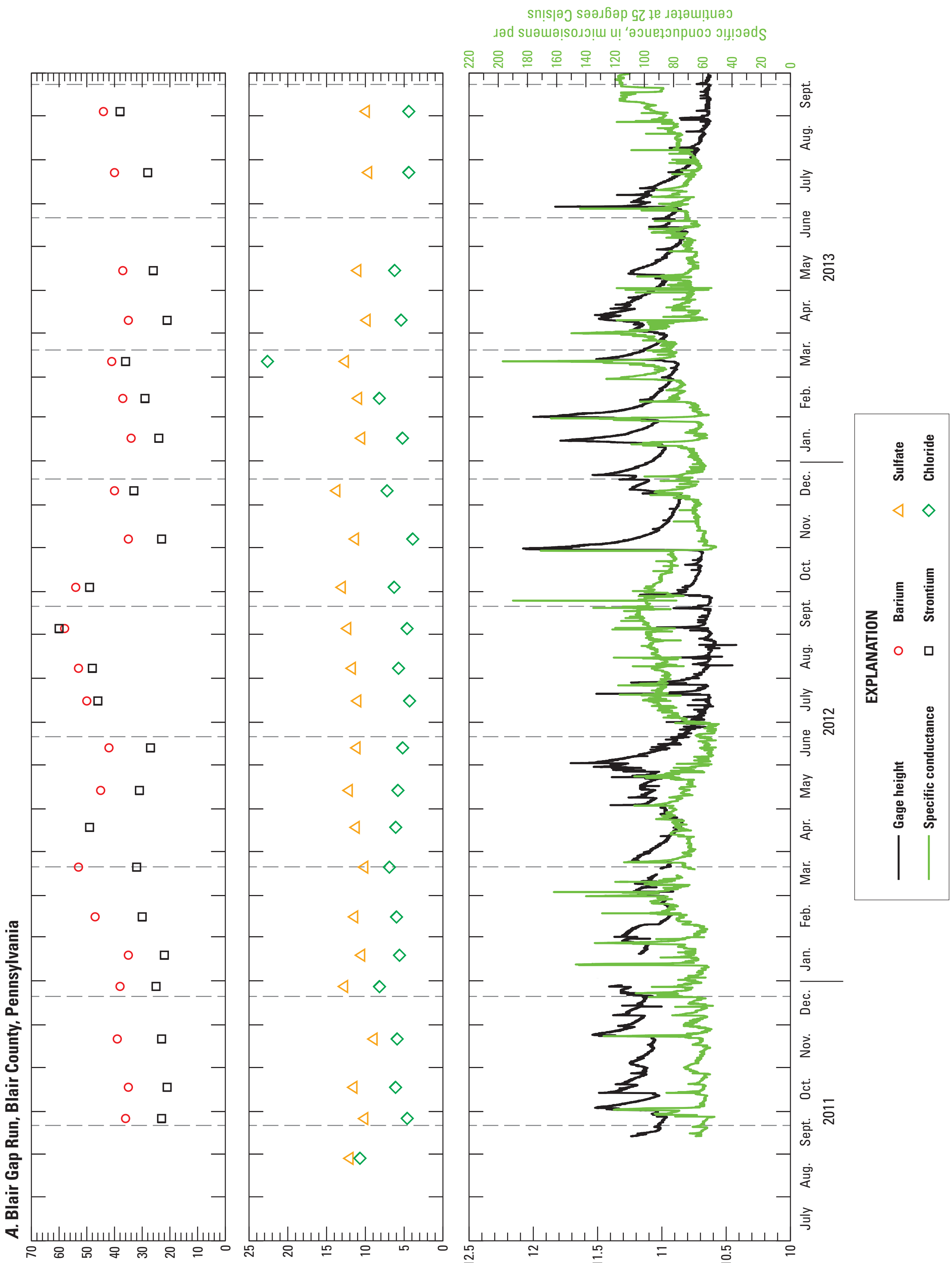
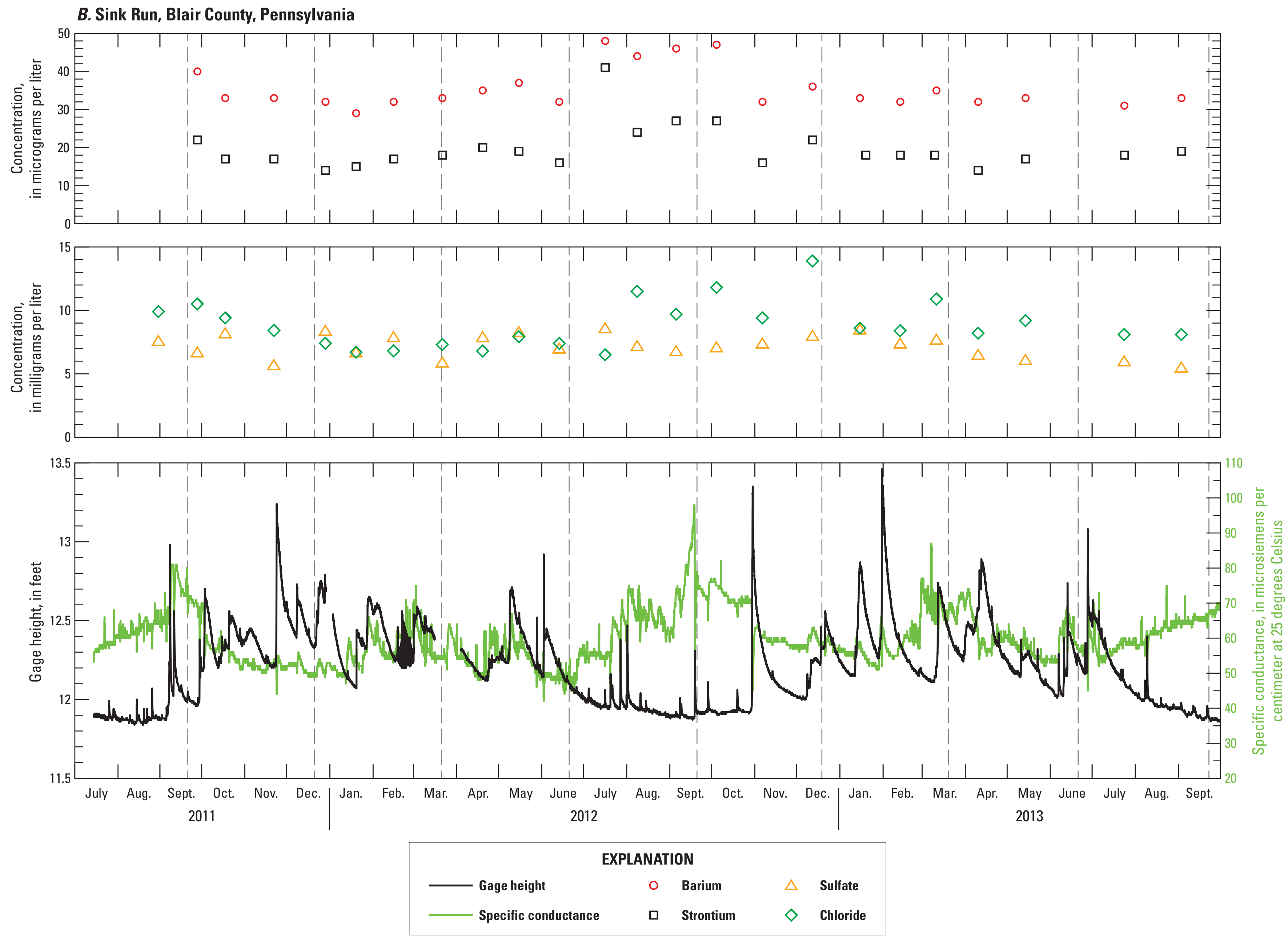


Figure 16. Relations among gage height to specific conductance measured at 30-minute intervals and concentrations of barium, strontium, sulfate, and chloride in grab samples from *A*, Blair Gap Run, *B*, Sink Run, *C*, South Poplar Run, and *D*, Tipton Run, Blair County, Pennsylvania, 2011–13.



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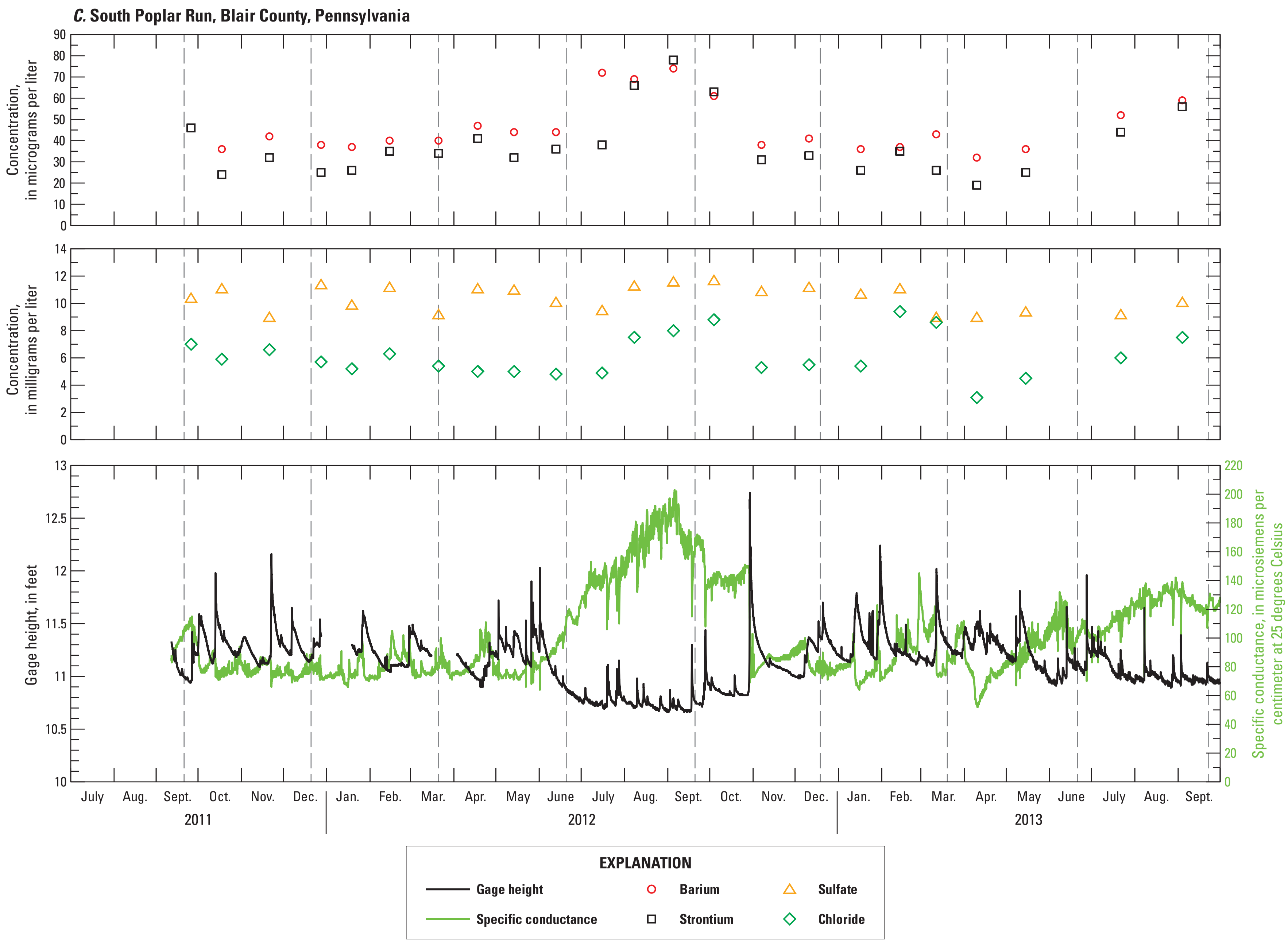

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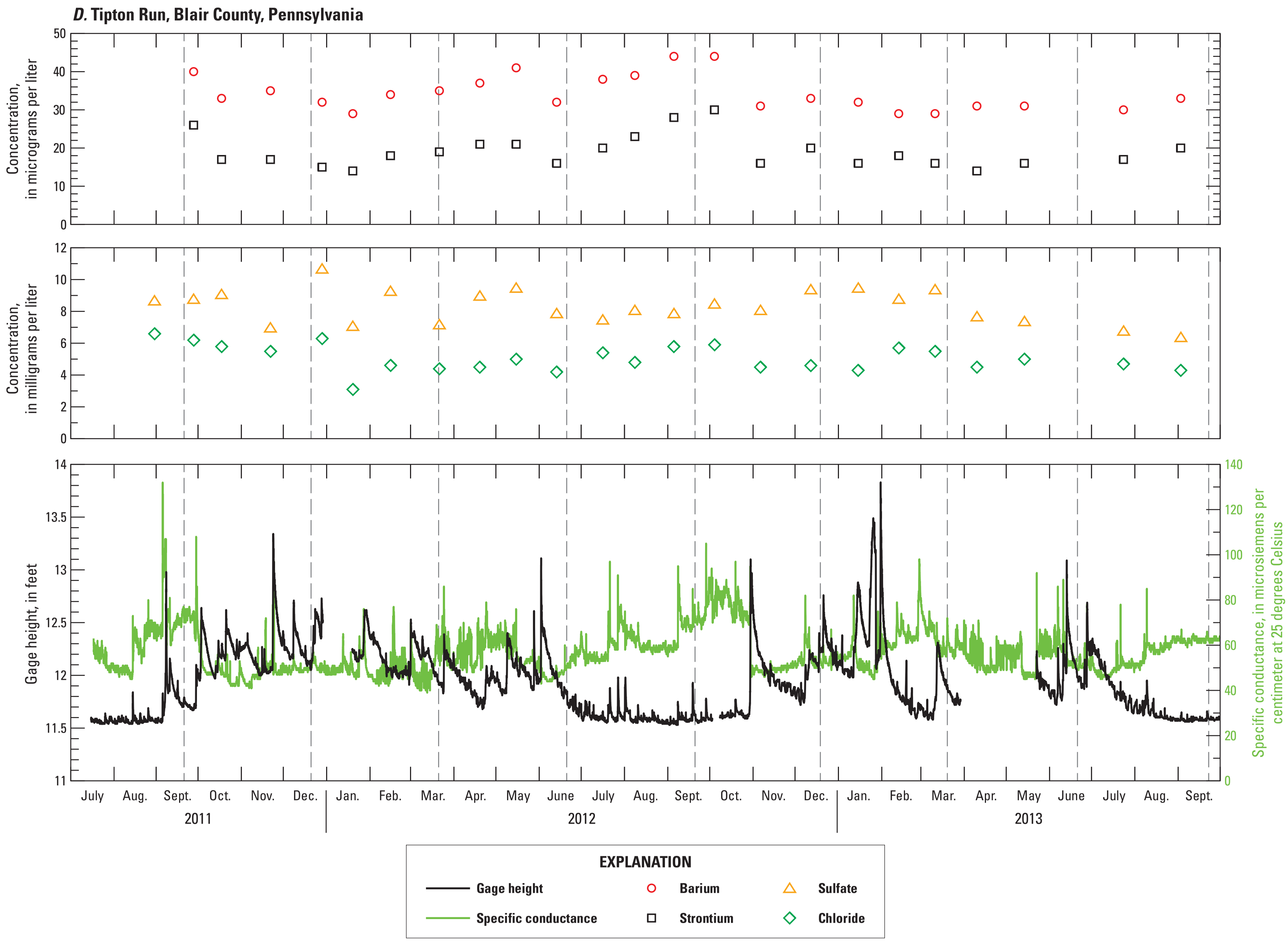

Figure 16. Relations among gage height to specific conductance measured at 30-minute intervals and concentrations of barium, strontium, sulfate, and chloride in grab samples from *A*, Blair Gap Run, *B*, Sink Run, *C*, South Poplar Run, and *D*, Tipton Run, Blair County, Pennsylvania, 2011–13.—Continued

not exhibit the broader recession curves of the gage-height peaks, indicating that storms have a short but intense effect on water chemistry. The specific conductance response to stream flow may be the result of (1) “wash off” or rapid dissolution of pyrite oxidation products (sulfate salts) in mined areas, (2) overland flow resulting in transportation of road salts into streams, and (3) increasing base flow where an initial flush of groundwater with higher dissolved solids is pushed into the streams. The best example of this is late October 2012. Gage height was at or near the seasonal low at all four monitored streams, whereas specific conductance was well above the annual median. Over a period of 2 days (October 29 and 30, 2012) 3.35 inches of precipitation fell. Gage height and specific conductance values spiked, with specific conductance initially increasing from a low of approximately 80 µS/cm to a peak near 190 µS/cm at Blair Gap Run (Blair Gap Run has AMD and road salt sources) before falling to near annual lows in all four watersheds.

Barium, strontium, sulfate, and chloride concentrations also exhibited seasonal changes to varying degrees that were strongly associated with changes in gage height (fig. 16*A–D*). With the exception of sulfate, concentrations of these constituents tended to peak during periods of low flow commonly found during the summer to early fall, indicating that they are dominant in groundwater. The highest peaks during the monitoring period occurred from June through October 2012, closely matching the increase in specific conductance as well as the seasonal lows for gage height.

Aquatic Biological Communities

A healthy aquatic community requires good water quality and suitable habitat. AMD, excessive nutrients, runoff, and other anthropogenic activities can degrade the aquatic habitat and decrease the natural diversity and abundance of fish and macroinvertebrates. Nevertheless, a few species of macroinvertebrates and fish can tolerate or even thrive in poor habitats or the presence of various contaminants. Higher percentages of tolerant species in a community generally indicate poor water-quality conditions.

Fish Assemblages

Two or more fish species were present at all sites sampled, plus trout were present at all but Poplar Run, Newry; however, the fish assemblages of the 10 Blair County sites ranged from very poor to fair. This may, in part, be related to stream size. For the five streams attaining a fair MdIBI score the average watershed size was 12.3 mi^2. For the five streams attaining a very poor or poor MdIBI score, the average watershed size was much smaller (5.0 mi^2); the exception was South Poplar Run with a drainage area of 10.4 mi^2 and a very poor MdIBI score. Although South Poplar Run (fig. 1) had water chemistry and macroinvertebrate characteristics that indicated fair or attaining water quality, this site had the lowest MdIBI of 1.75 (table 13, at end of report), which indicates the site is very poor at supporting a healthy fish community (fig. 12). Seven fish species, including a total of 13 brown trout, were captured at South Poplar Run (table 13); however, the fish sample was heavily dominated by blacknose dace, which is a pollution tolerant omnivore that composed 74 percent of the total number of individual fish captured (appendix 2). Although the catch-per-unit-effort (CPUE) was relatively high (11.43), the number of individuals per square meter was a low 0.18 (table 13). Overall, 79 percent of the fish species were pollution tolerant, and no benthic fish species, such as darter, sculpin, or madtom were captured.

In contrast, Tipton Run had the highest MdIBI of 3.75, which falls within the fair rating (fig. 12). Although Tipton Run contained a considerable percentage (17.5) of pollution tolerant fish species and general feeders, it also supported the highest number of benthic species (0.83) and large numbers of brown trout of various year classes. Tipton Run also had water quality and macroinvertebrate characteristics that indicated fair to attaining stream health (fig. 12).

At all the sites that had a fair MdIBI rating, benthic species were present. At all sites, except Poplar Run, Newry, insectivorous fish dominated instead of mostly generalized feeders.

Benthic Macroinvertebrate Communities

The macroinvertebrate assemblage at 10 Blair County sites ranged from impaired to attaining (table 14, at end of report; fig. 12; appendix 3). Although 9 of the 10 stream sites were rated as attaining, based on their macroinvertebrate IBI score, one site, Sugar Run had a low IBI score of 40.4, indicating the stream is impaired and is not conducive to sustaining a pollution sensitive community. Sugar Run lacked the required population density with only 77 individuals composing the entire sample. Typically, a sample would be subsampled to randomly identify 200 individuals. Although 12 species of macroinvertebrates were present, the two species with the highest densities were *Diplectrona* (a pollution tolerant caddisfly [tolerant value (TV) = 5]) and *Chironomidae* (a pollution tolerant family of true flies [TV = 7]) (table 14). The dominance of these two species indicates that Sugar Run is not supportive of high-quality aquatic life.

The highest scoring site was Tipton Run which achieved an attaining rating and had an IBI of 88.9 (fig. 12). This site had a diverse macroinvertebrate community composed of several pollution sensitive individuals (57.5 percent) and lower numbers of pollution tolerant individuals (table 14), which indicates that Tipton Run is supportive of high-quality aquatic life. The water quality and fish community data were consistent with this characterization.

Summary

Baseline stream geomorphology and surface-water-quality data (water chemistry and aquatic biologic communities) were collected from July 2011 through September 2013 in selected headwater streams of Blair County, Pennsylvania, including those supplying drinking water for the Altoona Water Authority and Tyrone Water Authority. The study was conducted by the U.S. Geological Survey, in cooperation with Altoona Water Authority and Blair County Conservation District.

Channel morphology was characterized at 10 streams that were also targeted for biological and water-quality sample collection. At each stream, surveys were completed for (1) a longitudinal profile extending at least 500 feet, (2) four cross-sections in varying flow regimes, and (3) pebble counts. Channel slopes ranged from 0.008 in Poplar Run, Newry, to 0.045 in Mill Run. Generally, the streams draining smaller watersheds (less than 5 square miles) have the steepest slopes because they are in more mountainous terrain and are positioned at higher elevations. Reach slopes are consistent with slopes determined for similar streams surveyed in the Appalachian Plateaus Physiographic Province. Cross-sectional depths and areas were computed from a surface baseline, which is a measuring tape stretched between rebar monuments placed beyond the active channel. This approach is intended to allow for comparison of cross-section dimensions with future surveys made using the same baseline but is not useful for comparing areas or depths among the surveyed streams. On the basis of the median particle size (D50) as determined during pebble counts at each cross section, the streambed substrate at Poplar Run can be characterized as gravel. The streambeds of South Poplar Run, Dry Gap Run, Glenwhite Run, Sugar Run, and Blair Gap Run were slightly coarser and can be characterized as a mix of gravel and cobble particles. Mill Run, Bells Gap Run, Tipton Run, and Sink Run had cobble bed material. Future surveys could document any change in channel dimensions, profile, or substrate.

Most water-quality constituents were affected by the increase or decrease in streamflow resulting from seasonal and storm events. Dissolved oxygen always increased with increased streamflow. Most cations, along with pH, specific conductance, and total dissolved solids, decreased with greater streamflow as a result of dilution of groundwater base flow. In general, increased streamflow resulted in lower concentrations of arsenic, barium, boron, lithium, manganese, molybdenum, and strontium. For the remaining trace metals, increased streamflow did not consistently relate to lower concentrations.

On the basis of the U.S. Environmental Protection Agency (EPA) contaminant levels and the results of water-quality analyses for the selected constituents, the water quality in 9 of the 12 watersheds can be considered fair or attaining with no exceedances of an EPA maximum contaminant level (MCL) or secondary maximum contaminant level (SMCL). Manganese concentrations greater than the EPA SMCL of 50 micrograms per liter (µg/L) were measured in Glenwhite Run (3 of 3 samples), Sugar Run (3 of 3 samples) and Blair Gap Run (9 of 15 samples), resulting in a poor or impaired health assessment for these waters. Sugar Run receives abandoned mine drainage and has a median iron concentration of 422 µg/L, considerably greater than the EPA SMCL of 300 µg/L. Chloride/bromide ratios for the streams compared to road deicing salts or flowback water (brine) from Marcellus Formation gas wells indicate potential contributions from road salts but no influence of brines on the streams.

Trilinear plots identified variations in the dominant water types. Calcium is the dominant cation (greater than or equal to 60 percent of total cations) in Glenwhite Run and Sugar Run. Magnesium composes 15 to 35 percent of the total cations, whereas sodium and potassium compose the remaining 5 to 55 percent of the cations at these and other sites. Carbonate and bicarbonate are the dominant anions for Poplar Run near Puzzleton and South Poplar Run, and sulfate is dominant in Bells Gap Run, Glenwhite Run, and Sugar Run. Chloride composes 5 to 55 percent of the total anions, depending on the site.

On the basis of the Maryland Index of Biotic Integrity (MdIBI) for fish assemblages, 5 of the 10 streams were rated fair (relatively healthy) with South Poplar Run receiving the lowest MdIBI score of 1.75 or very poor. The Benthic Index of Biotic Integrity (IBI) for macro-invertebrate assemblages rated 9 of 10 streams as attaining (relatively healthy). Sugar Run exhibited impaired health with a IBI score of 40.4. Tipton Run, however, was measured the healthiest with a MdIBI score of 3.75 and a IBI score of 88.9.

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Table 2. Dates of environmental data collection in selected streams, Blair County, Pennsylvania.

[Discrete water-quality samples for quality assurance/quality control are shown separately in tables 5 and 6. A, Altoona Water Authority Laboratory, E, Eberline Services, F, Fish, I, Invertebrates, N, U.S. Geological Survey National Water Quality Laboratory; C indicates period of continuous monitoring; G indicates period of data collection for pebble counts and cross-sectional channel geometry]

Stream	Collection date													
	July-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	June-12	July-12	Aug-12
Discrete water-quality sampling (letters identify the analyzing laboratory or laboratories)														
South Poplar Run		A	A,E	A,E	A,E	A,E	A,E	A,E	A,E	A	A	A,N	A,E,N	A,N
Poplar Run, Puzzletown														
Blue Knob Run														
Poplar Run, Newry		A	A	A	A	A	A	A	A	A	A	A	A	A
Dry Gap Run		A	A	A	A	A	A	A	A	A	A	A	A	A
Mill Run		A	A	A	A	A	A	A	A	A	A	A	A	A
Glenwhite Run		A	A	A	A	A	A	A	A	A	A	A	A	A
Sugar Run		A	A	A	A	A	A	A	A	A	A	A	A	A
Blair Gap Run		A	A,E	A,E	A,E	A,E	A,E	A,E	A,E	A	A	A,N	A,E,N	A,N
Bells Gap Run		A	A	A	A	A	A	A	A	A	A	A	A	A
Tipton Run		A	A,E	A,E	A,E	A,E	A,E	A,E	A,E	A	A	A,N	A,E,N	A,N
Sink Run		A	A,E	A,E	A,E	A,E	A,E	A,E	A,E	A	A	A,N	A,E,N	A,N
Continuous monitoring of stage, specific conductance, and water temperature														
South Poplar Run			C	C	C	C	C	C	C	C	C	C	C	C
Blair Gap Run			C	C	C	C	C	C	C	C	C	C	C	C
Tipton Run	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Sink Run	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Biological sampling														
South Poplar Run	I	F												
Poplar Run, Newry	I	F												
Dry Gap Run													I	F
Mill Run													I	F
Glenwhite Run	I	F												
Sugar Run	I	F												
Blair Gap Run	I	F												
Bells Gap Run													I	F
Tipton Run													I	F
Sink Run													I	F
Geomorphology														
South Poplar Run										G				
Poplar Run, Newry												G		
Dry Gap Run													G	
Mill Run											G			
Glenwhite Run														
Sugar Run														
Blair Gap Run														G
Bells Gap Run														
Tipton Run														
Sink Run														

Table 2. Dates of environmental data collection in selected streams, Blair County, Pennsylvania.—Continued

[Discrete water-quality samples for quality assurance/quality control are shown separately in tables 5 and 6. A, Altoona Water Authority Laboratory, E, Eberline Services, F, Fish, I, Invertebrates, N, U.S. Geological Survey National Water Quality Laboratory; C indicates period of continuous monitoring; G indicates period of data collection for pebble counts and cross-sectional channel geometry]

Stream	Collection date												
	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	June-13	July-13	Aug-13	Sep-13
Discrete water-quality sampling (letters identify the analyzing laboratory or laboratories)													
South Poplar Run	A,N	A,E,N	A,N	A,N	A,E,N	A,N	A,N	A,E,N	N		N		N
Poplar Run, Puzzletown									N	N	N	N	N
Blue Knob Run									N	N	N	N	N
Poplar Run, Newry	A	A	A	A	A	A	A	A	N	N	N	N	N
Dry Gap Run	A	A	A	A	A	A	A	A	N		N		N
Mill Run	A	A	A	A	A	A	A	A	N		N		N
Glenwhite Run	A	A	A	A	A	A	A	A	N		N		N
Sugar Run	A	A	A	A	A	A	A	A	N		N		N
Blair Gap Run	A,N	A,E,N	A,N	A,N	A,E,N	A,N	A,N	A,E,N	N		N		N
Bells Gap Run	A	A	A	A	A	A	A	A	N		N		N
Tipton Run	A,N	A,E,N	A,N	A,N	A,E,N	A,N	A,N	A,E,N	N		N		N
Sink Run	A,N	A,E,N	A,N	A,N	A,E,N	A,N	A,N	A,E,N	N		N		N
Continuous monitoring of stage, specific conductance, and water temperature													
South Poplar Run	C	C	C	C	C	C	C	C	C	C	C	C	C
Blair Gap Run	C	C	C	C	C	C	C	C	C	C	C	C	C
Tipton Run	C	C	C	C	C	C	C	C	C	C	C	C	C
Sink Run	C	C	C	C	C	C	C	C	C	C	C	C	C
Biological sampling													
South Poplar Run													
Poplar Run, Newry													
Dry Gap Run													
Mill Run													
Glenwhite Run													
Sugar Run													
Blair Gap Run													
Bells Gap Run													
Tipton Run													
Sink Run													
Geomorphology													
South Poplar Run													
Poplar Run, Newry													
Dry Gap Run													
Mill Run													
Glenwhite Run	G												
Sugar Run			G										
Blair Gap Run													
Bells Gap Run		G											
Tipton Run				G									
Sink Run													

Table 5. Results of water-quality analyses of replicate samples from selected streams in Blair County, Pennsylvania, September 2011 through April 2013 by the U.S. Geological Survey National Water Quality Laboratory and Altoona Water Authority Laboratory for *A*, selected constituents and *B*, barium and strontium only.

[Note that Altoona Water Authority Laboratory (AWA) results for 9/26/11 and 9/27/11 are from analysis of unfiltered samples, and USGS results are from analysis of filtered samples; filtered samples were analyzed by both labs for all other dates. NWQL, U.S. Geological Survey National Water Quality Laboratory; TDS, total dissolved solids; deg., degrees Celsius; --, not calculated; <, less than; % Diff, percent difference; µg/L, micrograms per Liter; mg/L, milligrams per liter]

A. Selected constituents

Parameter	South Poplar Run (9/26/11)			Blair Gap Run (9/26/11)			Tipton Run (9/27/11)			Sink Run (9/27/11)		
	NWQL	AWA (total)	% Diff	NWQL	AWA (total)	% Diff	NWQL	AWA (total)	% Diff	NWQL	AWA (total)	% Diff
TDS 180 deg. (mg/L)	74	74	0	34	38	11.1	39	41	5.0	31	49	45.0
Bromide (mg/L)	0.02	< 0.20	--	0.02	< 0.20	--	0.01	< 0.20	--	0.01	< 0.20	--
Chloride (mg/L)	5.86	7.5	24.6	3.35	5.7	51.9	4.07	6.2	41.5	10.4	10.6	1.9
Sulfate (mg/L)	10.1	10.4	2.9	9.81	10.3	4.8	7.68	8.7	12.5	5.99	7.1	17.0
Barium (µg/L)	--	--	--	--	--	--	--	--	--	--	--	--
Strontium (µg/L)	--	--	--	--	--	--	--	--	--	--	--	--

Parameter	South Poplar Run (12/28/11)			Blair Gap Run (12/28/11)			Tipton Run (12/28/11)			Sink Run (12/28/11)		
	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff
TDS 180 deg. (mg/L)	50.16	39	25.0	54	36	40.0	27.3	29	6.0	36.1	25.0	36.3
Bromide (mg/L)	<0.010	< 0.20	--	0.016	< 0.20	--	< 0.010	< 0.20	--	< 0.010	< 0.20	--
Chloride (mg/L)	4.35	7	46.7	7.33	9.1	21.5	4.52	6.3	32.9	6.5	8.5	26.7
Sulfate (mg/L)	10.4	12.1	15.1	12.0	13.4	11.0	23.0	10.6	73.8	7.3	9.4	25.1
Barium (µg/L)	33.3	37	10.5	34.1	39	13.4	28.2	31	9.4	28.6	31.0	8.1
Strontium (µg/L)	25.2	25	0.8	24.7	25	1.2	14.5	15	3.4	14.0	14.0	0.0

Parameter	South Poplar Run (01/19/12)			Blair Gap Run (1/19/12)			Tipton Run (1/19/12)			Sink Run (1/19/12)		
	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff
TDS 180 deg. (mg/L)	38.0	53	33.0	32.6	51	44.0	28.6	44	42.4	38.0	34	11.1
Bromide (mg/L)	0.010	< 0.20	--	< 0.010	< 0.20	--	< 0.010	< 0.20	--	< 0.010	< 0.20	--
Chloride (mg/L)	5.72	4.7	19.6	6.15	5.1	18.7	3.80	3.1	20.3	7.18	6.3	13.1
Sulfate (mg/L)	10.6	8.8	18.6	11.3	9.6	16.3	8.47	7	19.0	7.17	6	17.8
Barium (µg/L)	36.6	36	1.7	36.9	35	5.3	30.2	28	7.6	30.6	28	8.9
Strontium (µg/L)	26.8	27	0.7	24.3	22	9.9	14.9	14	6.2	15.1	14	7.6

Table 5. Results of water-quality analyses of replicate samples from selected streams in Blair County, Pennsylvania, September 2011 through April 2013 by the U.S. Geological Survey National Water Quality Laboratory and Altoona Water Authority Laboratory for *A*, selected constituents and *B*, barium and strontium only.—Continued

[Note that Altoona Water Authority Laboratory (AWA) results for 9/26/11 and 9/27/11 are from analysis of unfiltered samples, and USGS results are from analysis of filtered samples; filtered samples were analyzed by both labs for all other dates. NWQL, U.S. Geological Survey National Water Quality Laboratory; TDS, total dissolved solids; deg., degrees Celsius; --, not calculated; <, less than; % Diff, percent difference; µg/L, micrograms per Liter; mg/L, milligrams per liter]

B. Barium and strontium only

Parameter	South Poplar Run (6/13/12)			Blair Gap Run (6/13/12)			Tipton Run (6/13/12)			Sink Run (6/13/12)		
	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff
Barium (µg/L)	44.2	44	0.5	40.4	43	6.2	32.5	32	1.6	32.6	32	1.9
Strontium (µg/L)	34.4	37	7.3	26.4	28	5.9	16.2	16	1.2	16.2	16	1.2

Parameter	South Poplar Run (7/16/12)			Blair Gap Run (7/16/12)			Tipton Run (7/16/12)			Sink Run (7/16/12)		
	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff
Barium (µg/L)	60.9	83	30.7	47.1	52	9.9	35.8	39	8.6	36.3	60	49.2
Strontium (µg/L)	53.9	22	84.1	42.4	49	14.4	19.1	21	9.5	18.5	62	108

Parameter	South Poplar Run (8/8/12)			Blair Gap Run (8/8/12)			Tipton Run (8/8/12)			Sink Run (8/8/12)		
	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff
Barium (µg/L)	65.7	71	7.8	49.8	56	11.7	36.8	41	10.8	41.2	46	11.0
Strontium (µg/L)	62.3	68	8.8	45.9	50	8.6	21.7	24	10.1	22.9	25	8.8

Parameter	South Poplar Run (9/5/12)			Blair Gap Run (9/5/12)			Tipton Run (9/5/12)			Sink Run (9/5/12)		
	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff
Barium (µg/L)	70.6	76	7.4	52.6	62	16.4	41.2	47	13.2	41.7	46	9.8
Strontium (µg/L)	66.8	88	27.4	57.8	79	31.0	24.5	32	26.6	22.9	30	26.8

Parameter	South Poplar Run (10/4/12)			Blair Gap Run (10/4/12)			Tipton Run (10/4/12)			Sink Run (10/4/12)		
	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff
Barium (µg/L)	61.7	60	2.8	49.0	59	18.5	44.7	42	6.2	46.5	47	1.1
Strontium (µg/L)	60.1	66	9.4	44.6	52	15.3	27.8	30	7.6	26.0	28	7.4

Parameter	South Poplar Run (11/7/12)			Blair Gap Run (11/7/12)			Tipton Run (11/6/12)			Sink Run (11/6/12)		
	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff
Barium (µg/L)	36.6	38	3.8	33.6	36	6.9	29.8	31	3.9	30.7	32	4.2
Strontium (µg/L)	30.8	31	0.7	22.9	23	0.4	15.4	16	3.8	16.4	16	2.5

Table 5. Results of water-quality analyses of replicate samples from selected streams in Blair County, Pennsylvania, September 2011 through April 2013 by the U.S. Geological Survey National Water Quality Laboratory and Altoona Water Authority Laboratory for *A*, selected constituents and *B*, barium and strontium only.—Continued

[Note that Altoona Water Authority Laboratory (AWA) results for 9/26/11 and 9/27/11 are from analysis of unfiltered samples, and USGS results are from analysis of filtered samples; filtered samples were analyzed by both labs for all other dates. NWQL, U.S. Geological Survey National Water Quality Laboratory; TDS, total dissolved solids; deg., degrees Celsius; --, not calculated; <, less than; % Diff, percent difference; µg/L, micrograms per Liter; mg/L, milligrams per liter]

B. Barium and strontium only—Continued

Parameter	South Poplar Run (12/11/12)			Blair Gap Run (12/11/12)			Tipton Run (12/12/12)			Sink Run (12/12/12)		
	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff
Barium (µg/L)	39.3	42	6.6	36.7	43	15.8	29.8	35	16.0	33.7	37	9.3
Strontium (µg/L)	32	34	6.1	29.1	37	23.9	18.1	21	14.8	19.5	23	16.5

Parameter	South Poplar Run (1/17/13)			Blair Gap Run (1/17/13)			Tipton Run (1/15/13)			Sink Run (1/15/13)		
	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff
Barium (µg/L)	34.7	36	3.7	33.0	35	5.9	30.4	34	11.2	32.2	34	5.4
Strontium (µg/L)	24.7	26	5.1	23.5	24	2.1	15.0	17	12.5	16.2	18	10.5

Parameter	South Poplar Run (2/14/13)			Blair Gap Run (2/14/13)			Tipton Run (2/13/13)			Sink Run (2/13/13)		
	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff
Barium (µg/L)	40	38	5.1	37.1	36	3.0	29.2	29	0.7	30.8	33	6.9
Strontium (µg/L)	32.1	38	16.8	27.5	30	8.7	15.7	19	19.0	15.7	19	19.0

Parameter	South Poplar Run (3/12/13)			Blair Gap Run (3/12/13)			Tipton Run (3/11/13)			Sink Run (3/11/13)		
	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff
Barium (µg/L)	40	46	14.0	42.1	40	5.1	29.1	29	0.3	35.2	34	3.5
Strontium (µg/L)	27.3	25	8.8	38.5	34	12.4	17.0	16	6.1	19.2	18	6.5

Parameter	South Poplar Run (4/10/13)			Blair Gap Run (4/10/13)			Tipton Run (4/10/13)			Sink Run (4/10/13)		
	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff	NWQL	AWA	% Diff
Barium (µg/L)	31.1	34	8.9	30.5	39	24.5	28.8	33	13.6	29.1	33	12.6
Strontium (µg/L)	19.5	19	2.6	21.6	21	2.8	14.2	14	1.4	14.3	14	2.1

Table 12. Summary statistics for instantaneous flow and selected water-quality constituents at 12 sites, August 2011 through September 2013, Blair County, Pennsylvania.

[Locations of sites shown on figure 1; ft^3/s, cubic feet per second; mg/L, milligrams per liter; °C, degrees Celsius; µS/cm, microseimans per centimeter; ANC, acid neutralizing capacity; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; NA, insufficient data; --, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percentile; P75, 75th percentile; Stnd dev, standard deviation; %, percent]

South Poplar Run

Statistic	Flow (ft^3/s)	Oxygen, dissolved (mg/L)	Field pH (standard units)	Temperature (°C)	Specific conductance (µS/cm at 25°C)	Total dissolved solids (180°C) (mg/L)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Sodium, dissolved (mg/L)	ANC (mg/L as $CaCO_3$)
N	25	24	24	24	24	23	15	15	15	15	13
Min	0.41	8.5	6.8	2.2	68	30	4.35	1.60	0.84	1.97	6
Max	160	13.5	8.9	24.3	195	105	17.0	6.28	1.67	6.41	85
Mean	25	10.7	7.6	12.1	130	61	9.95	3.70	1.18	4.20	28
P25	4.3	9.8	7.2	5.4	108	46	6.03	2.34	0.92	3.16	11
Median	12	10.5	7.5	11.6	128	56	8.36	3.25	1.07	4.38	16
P75	34	12	8	16.9	149	78	14.1	5.25	1.42	4.98	48
Stnd dev	34.4	1.4	0.6	6.9	28.2	20.1	4.2	1.5	0.3	1.3	25.0
% censored	--	0	0	0	0	0	0	0	0	0	0

Statistic	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Silica, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Aluminum, dissolved (µg/L)	Barium, dissolved (µg/L)	Barium, unfiltered (µg/L)	Beryllium, dissolved (µg/L)	Chromium, dissolved (µg/L)	Cobalt, dissolved (µg/L)	Iron, dissolved (µg/L)	Lithium, dissolved (µg/L)
N	17	23	15	24	14	17	19	15	15	14	14	15
Min	0.010	3.14	4.69	8.85	3.2	31.1	34.0	< 0.006	< 0.07	< 0.023	< 4.0	0.73
Max	0.023	10.40	6.34	12.3	15.4	70.6	83.0	0.017	0.18	0.168	10.8	1.48
Mean	0.016	6.21	5.70	10.4	7.55	46.5	46.7	< 0.006	0.11	0.065	6.2	1.07
P25	0.013	5.00	5.60	9.30	5.35	36.0	36.0	--	< 0.07	0.044	4.0	0.80
Median	0.017	5.70	5.71	10.7	7.00	40.0	42.0	< 0.006	0.10	0.057	5.8	1.03
P75	0.02	7.45	5.99	11.1	8.55	60.0	47.0	--	0.15	0.073	8	1.36
Stnd dev	0.0	1.7	0.4	1.0	3.2	12.6	14.7	--	--	--	--	0.3
% censored	0	0	0	0	0	0	0	93	27	7	7	0

Statistic	Manganese, dissolved (µg/L)	Molybdenum, dissolved (µg/L)	Nickel, dissolved (µg/L)	Strontium, dissolved (µg/L)	Strontium, unfiltered (µg/L)	Nitrate, unfiltered (as Nitrogen) (mg/L)	Zinc, dissolved (µg/L)	Arsenic, dissolved (µg/L)	Boron, dissolved (µg/L)	Selenium, dissolved (µg/L)	Uranium, dissolved (µg/L)
N	14	15	14	17	20	17	14	15	15	15	15
Min	0.72	0.046	0.18	19.5	19	0.14	< 1.4	0.17	6	0.03	0.007
Max	3.27	0.39	0.35	66.8	110	1.62	1.8	0.71	13	0.06	0.117
Mean	1.71	0.171	0.25	39.3	40.5	0.78	< 1.4	0.38	9	0.04	0.039
P25	1.03	0.076	0.22	26.2	24.9	0.55	< 1.4	0.20	7	0.03	0.011
Median	1.60	0.118	0.24	32.1	33.0	0.76	< 1.4	0.37	9	0.04	0.022
P75	2.23	0.240	0.27	55.0	40.3	1.04	< 1.4	0.47	11	0.05	0.061
Stnd dev	0.8	0.1	0.0	15.4	23.9	0.4	--	0.2	2.1	0.0	0.0
% censored	0	0	0	0	0	0	93	0	0	0	0

Table 12. Summary statistics for instantaneous flow and selected water-quality constituents at 12 sites, August 2011 through September 2013, Blair County, Pennsylvania.—Continued

[Locations of sites shown on figure 1; ft^3/s, cubic feet per second; mg/L, milligrams per liter; °C, degrees Celsius; µS/cm, microseimans per centimeter; ANC, acid neutralizing capacity; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; NA, insufficient data; --, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percentile; P75, 75th percentile; Stnd dev, standard deviation; %, percent]

Poplar Run near Puzzleton

Statistic	Flow (ft^3/s)	Oxygen, dissolved (mg/L)	Field pH (standard units)	Temperature (°C)	Specific conductance (µS/cm at 25°C)	Total dissolved solids (180°C) (mg/L)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Sodium, dissolved (mg/L)	ANC (mg/L as $CaCO_3$)
N	5	5	5	5	5	5	5	5	5	5	3
Min	0.47	8.8	6.5	9.4	89	41	5.06	2.14	0.81	2.94	12
Max	6.8	10.7	7.2	17.7	168	84	13.3	5.50	1.39	6.35	62
Mean	5.4	9.3	6.9	15.2	114	65	8.84	3.62	1.07	4.47	34
P25	0.49	8.8	6.6	12.1	91	48	5.65	2.36	0.85	3.33	--
Median	3.1	9.0	7.0	16.4	108	66	9.01	3.47	1.11	4.47	29
P75	11.0	10.0	7.2	17.6	141	83	12.0	4.96	1.27	5.62	--
Stnd dev	6.5	0.8	0.3	3.4	32	18.0	3.3	1.4	0.2	1.3	25.6
% censored	--	0	0	0	0	0	0	0	0	0	0

Statistic	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Silica, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Aluminum, dissolved (µg/L)	Barium, dissolved (µg/L)	Barium, unfiltered (µg/L)	Beryllium, dissolved (µg/L)	Chromium, dissolved (µg/L)	Cobalt, dissolved (µg/L)	Iron, dissolved (µg/L)	Lithium, dissolved (µg/L)
N	5	5	5	5	5	5	0	5	5	5	5	5
Min	0.011	4.75	6.18	9.63	< 2.20	38.3	NA	< 0.006	< 0.07	< 0.023	< 4.0	0.84
Max	0.190	9.32	7.05	16.6	15.7	79.3	NA	< 0.006	0.36	0.241	12.0	1.70
Mean	0.015	6.30	6.63	11.6	7.75	55.9	NA	< 0.006	0.13	0.067	5.7	1.21
P25	0.012	4.84	6.22	9.77	2.30	40.8	NA	< 0.006	< 0.07	< 0.023	< 4.0	0.92
Median	0.013	5.33	6.72	10.8	2.80	52.2	NA	< 0.006	0.07	< 0.023	4.1	1.22
P75	0.019	8.26	7.04	13.7	13.2	72.9	NA	< 0.006	0.23	0.134	8.10	1.50
Stnd dev	0.0	1.9	0.4	2.9	--	16.9	NA	--	--	--	--	0.3
% censored	0	0	0	0	20	0	0	100	40	60	40	0

Statistic	Manganese, dissolved (µg/L)	Molybdenum, dissolved (µg/L)	Nickel, dissolved (µg/L)	Strontium, dissolved (µg/L)	Strontium, unfiltered (µg/L)	Nitrate, unfiltered (as Nitrogen) (mg/L)	Zinc, dissolved (µg/L)	Arsenic, dissolved (µg/L)	Boron, dissolved (µg/L)	Selenium, dissolved (µg/L)	Uranium, dissolved (µg/L)
N	5	5	5	5	0	0	5	5	5	5	5
Min	0.90	0.048	0.18	23.6	NA	NA	< 1.4	0.20	7	< 0.03	0.005
Max	5.21	0.932	0.27	70.9	NA	NA	2.0	0.42	10	0.06	0.025
Mean	2.40	0.285	0.22	43.4	NA	NA	1.5	0.34	9	0.04	0.016
P25	1.04	0.07	0.19	25.8	NA	NA	< 1.4	0.24	8	0.04	0.007
Median	1.78	0.17	0.20	44.9	NA	NA	< 1.4	0.39	9	0.04	0.016
P75	4.09	0.56	0.27	60.4	NA	NA	< 1.4	0.41	10	0.05	0.024
Stnd dev	1.8	0.4	0.0	18.9	NA	NA	0.3	0.1	1.1	--	0.0
% censored	0	0	0	0	0	0	80	0	0	20	0

Table 12. Summary statistics for instantaneous flow and selected water-quality constituents at 12 sites, August 2011 through September 2013, Blair County, Pennsylvania.—Continued

[Locations of sites shown on figure 1; ft^3/s, cubic feet per second; mg/L, milligrams per liter; °C, degrees Celsius; µS/cm, microseimans per centimeter; ANC, acid neutralizing capacity; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; NA, insufficient data; --, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percentile; P75, 75th percentile; Stnd dev, standard deviation; %, percent]

Blue Knob Run

Statistic	Flow (ft^3/s)	Oxygen, dissolved (mg/L)	Field pH (standard units)	Temperature (°C)	Specific conductance (µS/cm at 25°C)	Total dissolved solids (180°C) (mg/L)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Sodium, dissolved (mg/L)	ANC (mg/L as $CaCO_3$)
N	5	5	5	5	5	5	5	5	5	5	3
Min	0.2	8.1	7.0	12.3	167	78	7.89	5.00	0.97	11.0	< 18
Max	6.7	10.5	7.2	21.2	266	144	17.4	7.10	1.64	18.2	50
Mean	2.1	9.0	7.1	18.5	215	119	13.2	5.34	1.44	15.0	35
P25	0.2	8.4	7.0	15.6	185	100	9.95	4.16	1.22	13.0	--
Median	1.0	8.7	7.1	19.4	207	124	13.1	5.09	1.55	15.4	38
P75	4.5	9.8	7.2	21.1	249	136	16.3	6.64	1.61	16.8	--
Stnd dev	2.7	0.9	0.1	3.6	37	24.5	3.6	1.4	0.3	2.6	--
% censored	--	0	0	0	0	0	0	0	0	0	33

Statistic	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Silica, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Aluminum, dissolved (µg/L)	Barium, dissolved (µg/L)	Barium, unfiltered (µg/L)	Beryllium, dissolved (µg/L)	Chromium, dissolved (µg/L)	Cobalt, dissolved (µg/L)	Iron, dissolved (µg/L)	Lithium, dissolved (µg/L)
N	5	5	5	5	5	5	0	5	5	5	5	5
Min	0.011	4.75	6.18	9.63	< 2.20	38.3	NA	< 0.006	< 0.07	< 0.023	< 4.0	0.84
Max	0.190	9.32	7.05	16.6	15.7	79.3	NA	< 0.006	0.36	0.241	12.0	1.70
Mean	0.015	6.30	6.63	11.6	7.75	55.9	NA	< 0.006	0.13	0.067	5.7	1.21
P25	0.012	4.84	6.22	9.77	2.30	40.8	NA	< 0.006	< 0.07	< 0.023	< 4.0	0.92
Median	0.013	5.33	6.72	10.8	2.80	52.2	NA	< 0.006	0.07	< 0.023	4.1	1.22
P75	0.019	8.26	7.04	13.7	13.2	72.9	NA	< 0.006	0.23	0.134	8.10	1.50
Stnd dev	0.0	1.9	0.4	2.9	--	16.9	NA	--	--	--	--	0.3
% censored	0	0	0	0	20	0	0	100	40	60	40	0

Statistic	Manganese, dissolved (µg/L)	Molybdenum, dissolved (µg/L)	Nickel, dissolved (µg/L)	Strontium, dissolved (µg/L)	Strontium, unfiltered (µg/L)	Nitrate, unfiltered (as Nitrogen) (mg/L)	Zinc, dissolved (µg/L)	Arsenic, dissolved (µg/L)	Boron, dissolved (µg/L)	Selenium, dissolved (µg/L)	Uranium, dissolved (µg/L)
N	5	5	5	5	0	0	5	5	5	5	3
Min	2.93	0.117	0.15	40.4	NA	NA	< 1.4	0.32	12	0.05	0.012
Max	6.88	0.523	0.31	85.6	NA	NA	1.4	0.68	15	0.11	0.038
Mean	4.99	0.326	0.23	65.7	NA	NA	< 1.4	0.53	13	0.08	0.028
P25	3.35	0.171	0.18	51.8	NA	NA	< 1.4	0.36	12	0.06	--
Median	4.78	0.291	0.23	66.8	NA	NA	< 1.4	0.59	12	0.08	0.035
P75	6.75	0.500	0.28	79.1	NA	NA	< 1.4	0.68	14	0.11	--
Stnd dev	1.7	0.2	0.1	16.5	NA	NA	--	0.2	0.0	0.0	0.0
% censored	0	0	0	0	0	0	80	0	0	0	0

Table 12. Summary statistics for instantaneous flow and selected water-quality constituents at 12 sites, August 2011 through September 2013, Blair County, Pennsylvania.—Continued

[Locations of sites shown on figure 1; ft^3/s, cubic feet per second; mg/L, milligrams per liter; °C, degrees Celsius; µS/cm, microseimans per centimeter; ANC, acid neutralizing capacity; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; NA, insufficient data; --, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percentile; P75, 75th percentile; Stnd dev, standard deviation; %, percent]

Poplar Run, Newry

Statistic	Flow (ft^3/s)	Oxygen, dissolved (mg/L)	Field pH (standard units)	Temperature (°C)	Specific conductance (µS/cm at 25°C)	Total dissolved solids (180°C) (mg/L)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Sodium, dissolved (mg/L)	ANC (mg/L as $CaCO_3$)
N	25	25	26	26	26	26	5	5	5	5	12
Min	0.32	7.5	6.9	3.6	108	52	7.52	3.09	0.96	5.03	11
Max	140	13.0	8.4	24.5	298	216	20.4	7.42	1.73	10.3	82
Mean	25	10.3	7.4	13.2	183	95	13.8	5.25	1.36	7.89	33
P25	4.3	8.9	7.2	6.5	145	60	9.1	3.65	1.15	6.05	17
Median	17	10.1	7.3	13.4	169	82	12.3	4.52	1.40	7.71	21
P75	40	12.0	7.5	19.2	225	124	19.3	7.23	1.65	9.83	57
Stnd dev	30.1	1.7	0.3	6.9	51.3	42.9	5.3	1.9	0.3	2.1	24.8
% censored	--	0	0	0	0	0	0	0	0	0	0

Statistic	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Silica, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Aluminum, dissolved (µg/L)	Barium, dissolved (µg/L)	Barium, unfiltered (µg/L)	Beryllium, dissolved (µg/L)	Chromium, dissolved (µg/L)	Cobalt, dissolved (µg/L)	Iron, dissolved (µg/L)	Lithium, dissolved (µg/L)
N	5	26	5	26	5	5	19	5	5	5	5	5
Min	< 0.01	6.50	4.67	9.70	2.30	41.7	34.0	< 0.006	< 0.07	0.027	< 4.0	0.67
Max	0.050	37.3	6.65	19.8	8.80	72.8	105.0	< 0.006	0.08	0.064	9.6	1.03
Mean	0.020	11.6	5.80	14.1	4.80	57.4	53.8	< 0.006	< 0.07	0.041	6.7	0.87
P25	0.011	7.40	5.21	12.4	2.60	45.0	40.0	< 0.006	< 0.07	0.03	< 4.0	0.73
Median	0.013	9.30	5.74	13.7	3.5	54.8	45.0	< 0.006	< 0.07	0.038	6.4	0.86
P75	0.034	15.1	6.43	15.8	7.65	71.1	54.0	< 0.006	< 0.07	0.056	9.500	1.03
Stnd dev	0.017	6.5	0.7	2.5	2.8	13.4	21.0	--	--	0.0	--	0.2
% censored	40	0	0	0	0	0	0	100	80		40	0

Statistic	Manganese, dissolved (µg/L)	Molybdenum, dissolved (µg/L)	Nickel, dissolved (µg/L)	Strontium, dissolved (µg/L)	Strontium, unfiltered (µg/L)	Nitrate, unfiltered (as Nitrogen) (mg/L)	Zinc, dissolved (µg/L)	Arsenic, dissolved (µg/L)	Boron, dissolved (µg/L)	Selenium, dissolved (µg/L)	Uranium, dissolved (µg/L)
N	5	5	5	5	19	17	5	5	5	5	5
Min	1.67	0.088	0.21	36.5	27.0	0.06	< 1.4	0.30	9	0.04	0.008
Max	3.89	0.384	0.37	101	167	0.85	< 1.4	0.61	18	0.07	0.057
Mean	2.72	0.273	0.29	69.1	67.6	0.44	< 1.4	0.48	13	0.05	0.032
P25	1.84	0.147	0.22	45.5	36.0	0.30	< 1.4	0.37	10	0.05	0.017
Median	2.18	0.331	0.32	62.5	55.0	0.45	< 1.4	0.48	13	0.05	0.030
P75	3.88	0.369	0.35	96.0	65.0	0.60	< 1.4	0.59	17	0.07	0.048
Stnd dev	1.1	0.1	0.1	26.5	42.2	0.2	--	0.1	3.7	0.0	0.0
% censored	0	0	0	0	0	0	100	0	0	0	0

Table 12. Summary statistics for instantaneous flow and selected water-quality constituents at 12 sites, August 2011 through September 2013, Blair County, Pennsylvania.—Continued

[Locations of sites shown on figure 1; ft^3/s, cubic feet per second; mg/L, milligrams per liter; °C, degrees Celsius; µS/cm, microseimans per centimeter; ANC, acid neutralizing capacity; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; NA, insufficient data; --, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percentile; P75, 75th percentile; Stnd dev, standard deviation; %, percent]

Dry Gap Run											
Statistic	Flow (ft^3/s)	Oxygen, dissolved (mg/L)	Field pH (standard units)	Temperature (°C)	Specific conductance (µS/cm at 25°C)	Total dissolved solids (180°C) (mg/L)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Sodium, dissolved (mg/L)	ANC (mg/L as $CaCO_3$)
N	24	24	24	24	24	24	3	3	3	3	12
Min	0.05	8.0	6.4	0.8	43	19	3.72	1.35	0.77	1.06	6
Max	5.5	13.2	7.6	21.7	441	141	5.00	1.87	0.90	4.43	18
Mean	2.1	10.3	7.1	11.2	112	47	4.39	1.57	0.83	2.63	10
P25	0.4	8.8	6.9	6.1	71	31	--	--	--	--	8
Median	1.4	10.1	7.2	11.4	85	40	4.44	1.50	0.82	2.41	10
P75	3.0	11.5	7.4	16.6	128	53	--	--	--	--	12
Stnd dev	2.6	1.5	0.3	6.0	83.2	25.8	--	--	--	--	3.6
% censored	--	0	0	0	0	0	0	0	0		0

Statistic	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Silica, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Aluminum, dissolved (µg/L)	Barium, dissolved (µg/L)	Barium, unfiltered (µg/L)	Beryllium, dissolved (µg/L)	Chromium, dissolved (µg/L)	Cobalt, dissolved (µg/L)	Iron, dissolved (µg/L)	Lithium, dissolved (µg/L)
N	3	24	3	24	3	3	22	3	3	3	3	3
Min	< 0.010	1.83	5.17	6.48	5.5	28.5	28.5	0.009	< 0.07	< 0.023	< 4	0.66
Max	0.020	65.5	5.3	17.2	8.8	34.3	64.0	0.011	0.07	0.181	9	0.82
Mean	0.016	9.53	5.22	9.52	7.1	32.3	40.7	0.010	< 0.07	< 0.023	6	0.72
P25	--	4.20	--	8.33	--	--	34.3	--	--	--	--	--
Median	0.017	5.85	5.21	9.00	7.0	34.1	37.5	0.009	< 0.07	< 0.023	6	0.69
P75	--	8.30	--	10.4	--	--	45.5	--	--	--	--	--
Stnd dev	--	4.8	--	2.3	--	--	9.5	--	--	--	--	--
% censored	33	0	0	0	0	0	0	0	67	67	33	0

Statistic	Manganese, dissolved (µg/L)	Molybdenum, dissolved (µg/L)	Nickel, dissolved (µg/L)	Strontium, dissolved (µg/L)	Strontium, unfiltered (µg/L)	Nitrate, unfiltered (as Nitrogen) (mg/L)	Zinc, dissolved (µg/L)	Arsenic, dissolved (µg/L)	Boron, dissolved (µg/L)	Selenium, dissolved (µg/L)	Uranium, dissolved (µg/L)
N	3	3	3	3	22	16	3	3	3	3	3
Min	3.2	0.045	0.35	23.1	23.0	0.03	< 1.4	0.11	5	0.08	< 0.004
Max	17.8	0.067	0.50	29.2	96.0	0.42	3.7	0.16	7	0.10	0.006
Mean	8.5	0.055	0.44	26.2	35.5	0.25	2.2	0.14	6	0.09	0.005
P25	--	--	--	--	24.8	0.22	--	--	--	--	--
Median	4.6	0.052	0.48	26.2	27.5	0.24	1.6	0.14	6	0.09	0.005
P75	--	--	--	--	46.3	0.26	--	--	--	--	--
Stnd dev	--	--	--	--	17.4	0.1	--	--	--	--	--
% censored	0	0	0	0	0	0	33	0	0	0	33

Table 12. Summary statistics for instantaneous flow and selected water-quality constituents at 12 sites, August 2011 through September 2013, Blair County, Pennsylvania.—Continued

[Locations of sites shown on figure 1; ft^3/s, cubic feet per second; mg/L, milligrams per liter; °C, degrees Celsius; µS/cm, microseimans per centimeter; ANC, acid neutralizing capacity; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; NA, insufficient data; --, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percentile; P75, 75th percentile; Stnd dev, standard deviation; %, percent]

Mill Run

Statistic	Flow (ft^3/s)	Oxygen, dissolved (mg/L)	Field pH (standard units)	Temperature (°C)	Specific conductance (µS/cm at 25°C)	Total dissolved solids (180°C) (mg/L)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Sodium, dissolved (mg/L)	ANC (mg/L as $CaCO_3$)
N	24	24	24	24	22	22	3	3	3	3	12
Min	0.51	8.6	6.7	2.7	132	45	8.51	2.29	0.93	8.97	8
Max	13	12.6	7.5	18.1	218	116	12.1	2.82	0.95	12.1	31
Mean	4.7	10.5	7.1	10.3	165	71	10.2	2.50	0.94	10.7	18
P25	1.1	9.4	7.0	6.0	144	59	--	--	--	--	9
Median	4.0	10.3	7.2	10.7	164	67	10.1	2.39	0.95	11.0	17
P75	7.3	11.5	7.3	13.9	181	80	--	--	--	--	27
Stnd dev	3.7	1.2	0.2	4.5	24	17.7	--	--	--	--	8.5
% censored	--	0	0	0	0	0	0	0	0	0	0

Statistic	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Silica, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Aluminum, dissolved (µg/L)	Barium, dissolved (µg/L)	Barium, unfiltered (µg/L)	Beryllium, dissolved (µg/L)	Chromium, dissolved (µg/L)	Cobalt, dissolved (µg/L)	Iron, dissolved (µg/L)	Lithium, dissolved (µg/L)
N	3	22	3	24	3	3	19	3	3	3	3	3
Min	0.014	11.5	4.71	9.4	4.3	43.0	34.0	< 0.006	0.08	< 0.023	< 4	1.09
Max	0.020	24.1	5.07	14.1	11.8	49.0	64.0	0.006	0.10	0.063	5	1.58
Mean	0.018	16.1	5.25	11.1	7.0	46.0	45.1	< 0.006	0.09	0.043	< 4	1.39
P25	--	12.9	--	10.3	--	--	38.0	--	--	--	--	--
Median	0.020	16.4	5.25	11.0	4.9	45.9	41.0	< 0.006	0.09	0.042	< 4	1.49
P75	--	17.9	--	12.0	--	--	52.0	--	--	--	--	--
Stnd dev	--	3.6	--	1.1	--	--	9.7	--	--	--	--	--
% censored	0	0	0	0	0	0	0	67	0	33	67	0

Statistic	Manganese, dissolved (µg/L)	Molybdenum, dissolved (µg/L)	Nickel, dissolved (µg/L)	Strontium, dissolved (µg/L)	Strontium, unfiltered (µg/L)	Nitrate, unfiltered (as Nitrogen) (mg/L)	Zinc, dissolved (µg/L)	Arsenic, dissolved (µg/L)	Boron, dissolved (µg/L)	Selenium, dissolved (µg/L)	Uranium, dissolved (µg/L)
N	3	3	3	3	19	15	3	3	3	3	3
Min	0.5	0.043	0.32	30.2	21.0	0.29	< 1.4	0.04	5	0.14	0.004
Max	2.3	0.110	0.42	37.5	54.0	0.70	3.0	0.15	7	0.17	0.007
Mean	1.1	0.071	0.39	33.1	31.8	0.49	< 1.4	0.08	6	0.15	0.004
P25	--	--	--	--	24.0	0.39	--	--	--	--	--
Median	0.7	0.060	0.42	31.6	29.0	0.53	< 1.4	0.08	6	0.15	0.004
P75	--	--	--	--	39.0	0.58	--	--	--	--	--
Stnd dev	--	--	--	--	9.7	0.1	--	--	--	--	--
% censored	0	0	0	0	0	0	67	0	0	0	0

Table 12. Summary statistics for instantaneous flow and selected water-quality constituents at 12 sites, August 2011 through September 2013, Blair County, Pennsylvania.—Continued

[Locations of sites shown on figure 1; ft^3/s, cubic feet per second; mg/L, milligrams per liter; °C, degrees Celsius; µS/cm, microseimans per centimeter; ANC, acid neutralizing capacity; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; NA, insufficient data; --, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percentile; P75, 75th percentile; Stnd dev, standard deviation; %, percent]

Glenwhite Run

Statistic	Flow (ft^3/s)	Oxygen, dissolved (mg/L)	Field pH (standard units)	Temperature (°C)	Specific conductance (µS/cm at 25°C)	Total dissolved solids (180°C) (mg/L)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Sodium, dissolved (mg/L)	ANC (mg/L as $CaCO_3$)
N	25	23	24	24	24	24	3	3	3	3	12
Min	0.95	8.1	6.3	0.8	167	40	17.7	5.85	0.99	3.71	2
Max	26	13.1	7.5	21.0	449	282	40.5	11.1	1.61	4.02	36
Mean	8.7	10.5	7.1	10.7	279	138	29.3	8.38	1.29	3.89	15
P25	1.8	9.1	6.9	4.4	216	95	--	--	--	--	4
Median	6.0	10.2	7.0	11.2	271	115	29.7	8.18	1.26	3.93	12
P75	13	12.1	7.3	15.3	347	181	--	--	--	--	28
Stnd dev	8.6	1.6	0.3	6.2	77	64.9	--	--	--	--	11.8
% censored	--	0	0	0	0	0	0	0	0	0	0

Statistic	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Silica, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Aluminum, dissolved (µg/L)	Barium, dissolved (µg/L)	Barium, unfiltered (µg/L)	Beryllium, dissolved (µg/L)	Chromium, dissolved (µg/L)	Cobalt, dissolved (µg/L)	Iron, dissolved (µg/L)	Lithium, dissolved (µg/L)
N	3	24	3	24	3	3	19	3	3	3	3	3
Min	0.015	4.40	6.82	26.0	21.9	38.6	37.0	0.020	< 0.07	0.7	< 4	12.9
Max	0.026	12.4	7.90	141	54.4	46.2	74.0	0.085	< 0.07	5.7	15.0	21.2
Mean	0.019	6.21	7.45	72.1	38.3	42.7	46.3	0.042	< 0.07	2.7	< 4	
P25	--	4.83	--	45.2	--	--	41.0	--	--	--	--	--
Median	0.017	5.63	7.63	59.5	38.6	43.2	43.0	0.022	< 0.07	1.83	< 4	18.6
P75	--	6.66	--	96.7	--	--	46.0	--	--	--	--	--
Stnd dev	--	2.0	--	36.0	--	--	10.2	--	--	--	--	--
% censored	0	0	0	0	0	0	0		100	0	67	0

Statistic	Manganese, dissolved (µg/L)	Molybdenum, dissolved (µg/L)	Nickel, dissolved (µg/L)	Strontium, dissolved (µg/L)	Strontium, unfiltered (µg/L)	Nitrate, unfiltered (as Nitrogen) (mg/L)	Zinc, dissolved (µg/L)	Arsenic, dissolved (µg/L)	Boron, dissolved (µg/L)	Selenium, dissolved (µg/L)	Uranium, dissolved (µg/L)
N	3	3	3	3	19	14	3	3	3	3	3
Min	79.6	0.031	5.60	71.3	35.0	0.11	6.8	0.05	7	0.16	0.013
Max	303	0.050	15.0	152	283	0.53	37.1	0.07	9	0.2	0.037
Mean		0.033	7.60	114	101	0.25	17.8	0.06	8	0.18	0.026
P25	--	--	--	--	49.0	0.14	--	--	--	--	--
Median	156	0.038	9.50	118	74.0	0.18	9.4	0.07	8	0.18	0.028
P75	--	--	--	--	112	0.37	--	--	--	--	--
Stnd dev	--	--	--	--	71.0	0.2	--	--	--	--	--
% censored	0	0	0	0	0	7	0	0	0	0	0

Table 12. Summary statistics for instantaneous flow and selected water-quality constituents at 12 sites, August 2011 through September 2013, Blair County, Pennsylvania.—Continued

[Locations of sites shown on figure 1; ft³/s, cubic feet per second; mg/L, milligrams per liter; °C, degrees Celsius; µS/cm, microseimans per centimeter; ANC, acid neutralizing capacity; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; NA, insufficient data; --, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percentile; P75, 75th percentile; Stnd dev, standard deviation; %, percent]

Sink Run											
Statistic	Flow (ft³/s)	Oxygen, dissolved (mg/L)	Field pH (standard units)	Temperature (°C)	Specific conductance (µS/cm at 25°C)	Total dissolved solids (180°C) (mg/L)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Sodium, dissolved (mg/L)	ANC (mg/L as $CaCO_3$)
N	24	24	24	24	24	24	15	15	15	15	11
Min	1.1	8.5	6.3	2.7	68	15	3.24	0.90	0.81	3.86	3
Max	36	13.4	7.5	18.3	107	60	5.42	1.58	1.11	5.95	53
Mean	10	10.6	7.0	10.3	83	40	4.18	1.20	0.93	4.71	10
P25	2.9	9.4	6.9	6.0	76	33	3.66	1.06	0.83	4.30	4
Median	9.4	10.6	7.1	9.9	82	38	4.03	1.18	0.89	4.48	5
P75	13.0	11.8	7.2	14.9	92	47	4.79	1.39	1.03	5.08	10
Stnd dev	8.8	1.3	0.3	4.6	10.6	10.5	0.6	0.2	0.1	0.6	13.8
% censored	--	0	0	0	0	0	0	0	0	0	0

Statistic	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Silica, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Aluminum, dissolved (µg/L)	Barium, dissolved (µg/L)	Barium, unfiltered (µg/L)	Beryllium, dissolved (µg/L)	Chromium, dissolved (µg/L)	Cobalt, dissolved (µg/L)	Iron, dissolved (µg/L)	Lithium, dissolved (µg/L)
N	15	24	15	24	14	17	19	15	15	15	15	15
Min	< 0.010	6.50	4.08	5.44	< 2.20	27.8	29.0	< 0.006	< 0.07	0.022	< 4.0	0.83
Max	0.018	13.9	5.41	8.50	10.20	46.5	60.0	0.015	0.12	0.245	10.3	1.37
Mean	0.015	8.87	4.76	7.11	4.32	34.4	36.7	0.010	0.08	0.088	5.5	1.04
P25	0.014	7.40	4.37	6.48	3.10	30.8	32.0	0.007	0.07	0.027	< 4.0	0.88
Median	0.015	8.41	4.73	7.17	4.10	32.6	33.0	0.010	0.07	0.042	4.2	0.94
P75	0.018	9.85	5.22	7.88	4.5	38.3	37.0	0.012	0.1	0.163	6.5	1.23
Stnd dev	--	1.8	0.5	0.9	--	5.2	7.7	--	--	0.1	--	0.2
% censored	7	0	0	0	14	0	0	14	53	0	27	0

Statistic	Manganese, dissolved (µg/L)	Molybdenum, dissolved (µg/L)	Nickel, dissolved (µg/L)	Strontium, dissolved (µg/L)	Strontium, unfiltered (µg/L)	Nitrate, unfiltered (as Nitrogen) (mg/L)	Zinc, dissolved (µg/L)	Arsenic, dissolved (µg/L)	Boron, dissolved (µg/L)	Selenium, dissolved (µg/L)	Uranium, dissolved (µg/L)
N	15	15	15	17	18	13	15	15	15	15	15
Min	0.73	< 0.014	0.43	12.0	13.9	< 0.11	2.9	< 0.04	4	0.08	< 0.004
Max	3.47	0.023	0.67	26.0	62.0	2.35	5.9	0.14	7	0.14	0.004
Mean	1.55	0.017	0.51	18.1	21.3	0.3	4.0	0.08	6	0.11	< 0.004
P25	0.85	0.014	0.46	16.0	16.0	0.11	3.4	0.04	5	0.09	--
Median	1.26	0.015	0.49	17.5	18.0	0.14	4.0	0.08	5	0.10	< 0.004
P75	2.12	0.020	0.54	20.7	23.0	0.16	4.3	0.12	6	0.12	--
Stnd dev	0.9	--	0.1	3.8	10.8	--	0.8	--	0.9	0.0	--
% censored	0	47	0	0	0	8	0	20	0	0	93

Table 12. Summary statistics for instantaneous flow and selected water-quality constituents at 12 sites, August 2011 through September 2013, Blair County, Pennsylvania.—Continued

[Locations of sites shown on figure 1; ft³/s, cubic feet per second; mg/L, milligrams per liter; °C, degrees Celsius; µS/cm, microseimans per centimeter; ANC, acid neutralizing capacity; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; NA, insufficient data; --, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percentile; P75, 75th percentile; Stnd dev, standard deviation; %, percent]

Blair Gap Run

Statistic	Flow (ft^3/s)	Oxygen, dissolved (mg/L)	Field pH (standard units)	Temperature (°C)	Specific conductance (µS/cm at 25°C)	Total dissolved solids (180°C) (mg/L)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Sodium, dissolved (mg/L)	ANC (mg/L as $CaCO_3$)
N	25	23	24	24	24	24	15	15	15	15	12
Min	2.3	8.2	6.6	3.2	73	23	4.72	1.24	0.69	1.98	5
Max	76	13.0	7.8	20.2	224	75	10.1	2.19	0.96	11.20	41
Mean	25	10.4	7.3	11.3	107	49	7.44	1.77	0.80	3.79	15
P25	5.8	8.9	7.1	5.3	91	42	5.89	1.47	0.73	2.92	8
Median	19	10.3	7.3	11.5	97	47	7.36	1.69	0.74	3.14	12
P75	35	12.1	7.6	16.4	122	55	9.20	2.08	0.90	4.04	20
Stnd dev	20.9	1.6	0.3	5.7	30.7	11.7	1.7	0.3	0.1	2.2	10.1
% censored	--	0	0	0	0	0	0	0	0	0	0

Statistic	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Silica, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Aluminum, dissolved (µg/L)	Barium, dissolved (µg/L)	Barium, unfiltered (µg/L)	Beryllium, dissolved (µg/L)	Chromium, dissolved (µg/L)	Cobalt, dissolved (µg/L)	Iron, dissolved (µg/L)	Lithium, dissolved (µg/L)
N	16	24	15	24	15	17	18	15	15	15	15	15
Min	< 0.010	3.91	3.86	8.90	4.10	30.5	33.9	< 0.006	< 0.07	0.094	19.2	0.92
Max	0.024	22.60	5.27	13.7	53.6	52.6	62.0	0.022	0.16	0.746	132	1.53
Mean	0.017	6.64	4.71	11.2	16.6	40.1	44.0	0.012	0.10	0.269	47.0	1.23
P25	0.015	4.76	4.47	10.2	8.30	36.0	36.0	0.006	< 0.07	0.115	23.6	1.07
Median	0.018	5.85	4.63	11.2	13.2	37.2	41.5	0.011	0.10	0.190	35.7	1.19
P75	0.019	6.75	5.04	12.1	22.7	45.3	52.3	0.017	0.13	0.376	65.3	1.44
Stnd dev	--	3.7	0.4	1.2	13.2	6.4	8.9	--	--	0.2	33.8	0.2
% censored	6	0	0	0	0	0	0	13	33	0	0	0

Statistic	Manganese, dissolved (µg/L)	Molybdenum, dissolved (µg/L)	Nickel, dissolved (µg/L)	Strontium, dissolved (µg/L)	Strontium, unfiltered (µg/L)	Nitrate, unfiltered (as Nitrogen) (mg/L)	Zinc, dissolved (µg/L)	Arsenic, dissolved (µg/L)	Boron, dissolved (µg/L)	Selenium, dissolved (µg/L)	Uranium, dissolved (µg/L)
N	15	15	15	17	19	16	15	15	15	15	15
Min	11.7	0.020	0.52	20.0	21.0	0.34	< 1.4	< 0.04	6	0.09	< 0.004
Max	186	0.126	1.30	57.8	79.0	0.84	23.7	0.27	10	0.12	0.020
Mean	74.2	0.055	0.76	31.6	34.6	0.49	4.0	0.13	7	0.11	0.008
P25	24.7	0.025	0.61	22.8	23.0	0.41	1.6	0.06	7	0.10	0.004
Median	62.3	0.057	0.73	27.5	30.0	0.47	2.7	0.11	7	0.11	0.006
P75	126	0.081	0.86	40.5	49.0	0.57	3.6	0.19	9	0.11	0.010
Stnd dev	55.5	0.0	0.2	10.9	15.1	0.1	--	--	1.2	0.0	--
% censored	0	0	0	0	0	6	21	7	0	0	33

Table 12. Summary statistics for instantaneous flow and selected water-quality constituents at 12 sites, August 2011 through September 2013, Blair County, Pennsylvania.—Continued

[Locations of sites shown on figure 1; ft^3/s, cubic feet per second; mg/L, milligrams per liter; °C, degrees Celsius; µS/cm, microseimans per centimeter; ANC, acid neutralizing capacity; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; NA, insufficient data; --, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percentile; P75, 75th percentile; Stnd dev, standard deviation; %, percent]

Bells Gap Run

Statistic	Flow (ft^3/s)	Oxygen, dissolved (mg/L)	Field pH (standard units)	Temperature (°C)	Specific conductance (µS/cm at 25°C)	Total dissolved solids (180°C) (mg/L)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Sodium, dissolved (mg/L)	ANC (mg/L as $CaCO_3$)
N	24	23	24	24	23	24	3	3	3	3	12
Min	2.0	8.1	6.2	3.6	60	18	5.17	1.84	0.77	1.34	3
Max	96	12.2	7.7	19.2	167	73	8.02	2.63	1.04	1.94	15
Mean	28	10.3	7.1	10.9	89	42	6.46	2.19	0.89	1.64	7
P25	6.1	9.0	6.9	5.8	78	30	--	--	--	--	4
Median	23.0	10.2	7.2	11.5	83	39	6.19	2.10	0.87	1.64	5
P75	37.0	11.7	7.3	15.4	96	49	--	--	--	--	11
Stnd dev	24.8	1.4	0.4	5.0	22.9	15.6	--	--	--	--	4.4
% censored	--	0	0	0	0	0	0	0	0	0	0

Statistic	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Silica, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Aluminum, dissolved (µg/L)	Barium, dissolved (µg/L)	Barium, unfiltered (µg/L)	Beryllium, dissolved (µg/L)	Chromium, dissolved (µg/L)	Cobalt, dissolved (µg/L)	Iron, dissolved (µg/L)	Lithium, dissolved (µg/L)
N	3	22	3	24	3	3	22	3	3	3	3	3
Min	0.008	1.84	4.44	12.0	4.7	29.8	28.0	0.011	< 0.07	< 0.023	< 4	1.83
Max	0.019	10.1	5.3	24.3	8.5	34.0	45.0	0.021	< 0.07	0.163	< 4	2.07
Mean	0.013	3.90	4.94	17.2	6.6	31.3	33.7	0.015	< 0.07	0.086	< 4	1.95
P25		2.80		14.9	--	--	30.1	--	--	--	--	--
Median	0.011	3.30	5.09	16.8	6.7	30.1	32.0	0.013	< 0.07	0.071	< 4	1.96
P75	--	4.40	--	18.6	--	--	36.0	--	--	--	--	--
Stnd dev	--	2.10	--	3.3	--	--	4.8	--	--	--	--	--
% censored	0	0		0	0	0	0	0	100	33	67	0

Statistic	Manganese, dissolved (µg/L)	Molybdenum, dissolved (µg/L)	Nickel, dissolved (µg/L)	Strontium, dissolved (µg/L)	Strontium, unfiltered (µg/L)	Nitrate, unfiltered (as Nitrogen) (mg/L)	Zinc, dissolved (µg/L)	Arsenic, dissolved (µg/L)	Boron, dissolved (µg/L)	Selenium, dissolved (µg/L)	Uranium, dissolved (µg/L)
N	3	3	3	3	22	14	3	3	3	3	3
Min	2.4	< 0.014	0.85	19.9	16.0	0.09	2.1	< 0.04	6	0.11	< 0.004
Max	12.2	< 0.014	2.20	28.0	42.0	0.21	6.6	0.05	7	0.16	< 0.004
Mean	5.7	< 0.014	1.45	23.4	24.2	0.13	4.2	< 0.04	6	0.13	< 0.004
P25	--	--	--	--	18.0	0.11	--	--	--	--	--
Median	2.5	< 0.014	1.30	22.3	22.7	0.13	4.0	< 0.04	6	0.11	< 0.004
P75	--	--	--	--	27.3	0.16	--	--	--	--	--
Stnd dev	--	--	--	--	6.8	--	--	--	--	--	--
% censored	0	100	0	0	0	7	0	67	0	0	100

Table 12. Summary statistics for instantaneous flow and selected water-quality constituents at 12 sites, August 2011 through September 2013, Blair County, Pennsylvania.—Continued

[Locations of sites shown on figure 1; ft^3/s, cubic feet per second; mg/L, milligrams per liter; °C, degrees Celsius; µS/cm, microseimans per centimeter; ANC, acid neutralizing capacity; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; NA, insufficient data; --, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percentile; P75, 75th percentile; Stnd dev, standard deviation; %, percent]

Tipton Run

Statistic	Flow (ft^3/s)	Oxygen, dissolved (mg/L)	Field pH (standard units)	Temperature (°C)	Specific conductance (µS/cm at 25°C)	Total dissolved solids (180°C) (mg/L)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Sodium, dissolved (mg/L)	ANC (mg/L as $CaCO_3$)
N	24	24	24	24	24	24	15	15	15	15	13
Min	1.4	8.1	6.2	0.9	57	25	3.36	1.03	0.71	2.44	5
Max	110	14.3	7.8	20.3	93	126	6.67	2.00	1.12	4.03	38
Mean	26	10.6	7.1	11.3	74	40	4.64	1.43	0.88	3.01	11
P25	4.1	9.0	7.1	5.3	67	28	3.80	1.23	0.77	2.62	6
Median	22	10.6	7.2	11.4	72	35	4.35	1.42	0.82	2.94	7
P75	36	12.2	7.3	17.1	83	46	5.29	1.59	1.03	3.32	13
Stnd dev	25.7	1.7	0.3	6.2	10.8	20.3	1.0	0.3	0.1	0.4	9.1
% censored	--	0	0	0	0	0	0	0	0	0	0

Statistic	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Silica, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Aluminum, dissolved (µg/L)	Barium, dissolved (µg/L)	Barium, unfiltered (µg/L)	Beryllium, dissolved (µg/L)	Chromium, dissolved (µg/L)	Cobalt, dissolved (µg/L)	Iron, dissolved (µg/L)	Lithium, dissolved (µg/L)
N	15	24	15	24	15	17	19	15	15	15	15	15
Min	< 0.010	3.10	3.95	6.30	2.4	28.8	28.6	< 0.006	< 0.06	< 0.023	9.2	0.66
Max	0.022	6.60	5.52	10.6	39.2	44.7	47.0	0.013	0.11	0.336	24.7	0.98
Mean	0.015	5.02	4.73	8.23	11.1	33.0	35.0	0.007	0.08	0.093	15.7	0.80
P25	0.013	4.50	4.43	7.42	5.2	29.4	31.0	< 0.006	< 0.07	0.034	12.1	0.69
Median	0.015	4.91	4.72	8.12	7.3	30.4	34.0	0.006	< 0.07	0.043	15.5	0.74
P75	0.017	5.62	5.00	9.15	19.0	36.3	39.0	0.009	0.08	0.178	20.7	0.95
Stnd dev	--	0.8	0.4	1.0	9.8	5.0	5.0	--	--	--	4.7	0.1
% censored	7	0	0	0	0	0	0	40	60	7	0	0

Statistic	Manganese, dissolved (µg/L)	Molybdenum, dissolved (µg/L)	Nickel, dissolved (µg/L)	Strontium, dissolved (µg/L)	Strontium, unfiltered (µg/L)	Nitrate, unfiltered (as Nitrogen) (mg/L)	Zinc, dissolved (µg/L)	Arsenic, dissolved (µg/L)	Boron, dissolved (µg/L)	Selenium, dissolved (µg/L)	Uranium, dissolved (µg/L)
N	15	15	14	17	19	14	15	15	15	14	15
Min	1.72	0.015	0.18	14.2	13.6	< 0.06	< 1.4	0.07	5	0.06	< 0.004
Max	5.78	0.090	0.61	27.8	32.0	0.21	3.6	0.25	9	0.10	0.008
Mean	3.27	0.041	0.33	18.5	19.3	0.11	2.0	0.17	7	0.08	0.005
P25	2.41	0.025	0.25	15.2	16.0	0.07	< 1.4	0.10	6	0.07	< 0.004
Median	3.03	0.030	0.30	17.0	18.0	0.10	1.8	0.17	7	0.08	0.005
P75	3.71	0.055	0.40	21.0	21.0	0.14	2.3	0.21	8	0.09	0.005
Stnd dev	1.2	0.0	0.1	4.3	5.0	--	--	0.1	1.3	0.0	--
% censored	0	0	0	0	0	36	40	0	0	0	33

Table 12. Summary statistics for instantaneous flow and selected water-quality constituents at 12 sites, August 2011 through September 2013, Blair County, Pennsylvania.—Continued

[Locations of sites shown on figure 1; ft^3/s, cubic feet per second; mg/L, milligrams per liter; °C, degrees Celsius; µS/cm, microseimans per centimeter; ANC, acid neutralizing capacity; $CaCO_3$, calcium carbonate; µg/L, micrograms per liter; NA, insufficient data; --, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percentile; P75, 75th percentile; Stnd dev, standard deviation; %, percent]

Sugar Run

Statistic	Flow (ft^3/s)	Oxygen, dissolved (mg/L)	Field pH (standard units)	Temperature (°C)	Specific conductance (µS/cm at 25°C)	Total dissolved solids (180°C) (mg/L)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Sodium, dissolved (mg/L)	ANC (mg/L as $CaCO_3$)
N	25	23	24	24	24	24	3	3	3	3	12
Min	1.9	8.5	6.5	3.5	365	178	31.9	12.10	1.62	16.4	4
Max	26	12.6	7.6	20.1	793	441	61.1	20.50	2.09	18.6	12
Mean	11	10.5	7.0	10.9	571	284	46.8	16.4	1.84	17.2	8
P25	3.3	9.6	6.8	6.1	521	213	--	--	--	--	7
Median	9.2	10.3	7.0	11.8	559	267	47.3	16.6	1.82	16.5	7
P75	19	11.8	7.1	14.2	650	351	--	--	--	--	9
Stnd dev	7.5	1.3	0.2	5.1	106	78.0	14.6	4.2	0.2	1.2	2.0
% censored	--	0	0	0	0	0	0	0	0	0	0

Statistic	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Silica, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Aluminum, dissolved (µg/L)	Barium, dissolved (µg/L)	Barium, unfiltered (µg/L)	Beryllium, dissolved (µg/L)	Chromium, dissolved (µg/L)	Cobalt, dissolved (µg/L)	Iron, dissolved (µg/L)	Lithium, dissolved (µg/L)
N	3	24	3	24	3	3	19	3	3	3	3	3
Min	0.018	14.3	8.83	74.2	11.4	38.3	35.0	0.098	< 0.07	15.5	294	16.5
Max	0.028	69.0	13.4	223	14.2	44.0	59.0	0.290	< 0.07	19.6	955	38.3
Mean	0.023	31.4	10.8	138	13.0	40.3	42.5	0.169	< 0.07	17.4	557	27.2
P25	--	22.6	--	100	--	--	39.0	--	--	--	--	--
Median	0.024	28.5	10.2	127	13.4	38.5	40.0	0.119	< 0.07	17.1	422	26.7
P75	--	35.4	--	171	--	--	45.0	--	--	--	--	--
Stnd dev	0.0	12.5	2.4	42.9	1.4	3.2	6.0	0.1	--	2.1	351	10.9
% censored	0	0	0	0	0	0	0	0	100	0	0	0

Statistic	Manganese, dissolved (µg/L)	Molybdenum, dissolved (µg/L)	Nickel, dissolved (µg/L)	Strontium, dissolved (µg/L)	Strontium, unfiltered (µg/L)	Nitrate, unfiltered (as Nitrogen) (mg/L)	Zinc, dissolved (µg/L)	Arsenic, dissolved (µg/L)	Boron, dissolved (µg/L)	Selenium, dissolved (µg/L)	Uranium, dissolved (µg/L)
N	3	3	3	3	19	16	3	3	3	3	3
Min	726	0.072	37.6	102.0	61.0	0.50	49.2	0.11	13	0.43	0.008
Max	816	0.100	54.2	163	262	0.83	77.9	0.2	17	0.53	0.024
Mean	762	0.087	46.3	136	139	0.64	60.3	0.15	15.3	0.47	0.015
P25	--	--	--	--	95.0	0.54	--	--	--	--	--
Median	743	0.089	47.1	142	134	0.62	53.9	0.14	16	0.45	0.013
P75	--	--	--	--	156	0.74	--	--	--	--	--
Stnd dev	47.8	0.0	8.3	31.0	52.2	0.1	15.4	0.0	2.1	0.1	0.0
% censored	0	0	0	0	0	0	0	0	0	0	0

Table 13. Scientific fish name, common fish name, total number of individuals, and Maryland Index of Biotic Integrity (MdIBI) scores for 10 sampled sites, Blair County, Pennsylvania.

[Maryland Index of Biotic Integrity (MdIBI) score ranges: very poor = 1.0–1.9; poor = 2.0–2.9; fair = 3.0–3.9; good = 4.0–5.0]

Scientific fish name	Common fish name	Total number of individuals	Catch-per-unit-effort	MdIBI score[1]	Number of individuals per square meter[1]	Number of native species per square meter[1]	Number of benthic species per square meter[1]	Native to Chesapeake Bay drainage	Benthic species	Pollution tolerance	Trophic status	Lithophilic spawner
South Poplar Run near Frederick, Pa.; station 01555760 (Sample date: 8/23/2011)			11.43	1.75 (very poor)	0.18	0.44	0					
Cyprinidae												
Cyprinella spiloptera	Spotfin shiner	1						Yes	No	Moderate	Invertivore	Yes
Exoglossum maxillingua	Cutlips minnow	5						Yes	No	Moderate	Invertivore	Yes
Rhinichthys atratulus	Blacknose dace	351						Yes	No	Tolerant	Omnivore	No
Rhinichthys cataractae	Longnose dace	79						Yes	No	Moderate	Omnivore	No
Catostomidae												
Catostomus commersoni	White sucker	26						Yes	No	Tolerant	Omnivore	Yes
Salmonidae												
Onchorhynchus mykiss	Rainbow trout	1						No	No	Moderate	Top predator	Yes
Salmo trutta	Brown trout	13						No	No	Moderate	Top predator	Yes
Poplar Run, Newry, Pa.; station 015558813 (Sample date: 8/23/2011)			22.72	3.00 (fair)	0.33	0.65	0.85					
Cyprinidae												
Campostoma anomalum	Central stoneroller	185						Yes	No	Moderate	Algivore	Yes
Exoglossum maxillingua	Cutlips minnow	4						Yes	No	Moderate	Invertivore	Yes
Rhinichthys atratulus	Blacknose dace	477						Yes	No	Tolerant	Omnivore	No
Rhinichthys cataractae	Longnose dace	35						Yes	No	Moderate	Omnivore	No
Semotilus atromaculatus	Creek chub	53						Yes	No	Tolerant	Generalist	Yes
Catostomidae												
Catostomus commersoni	White sucker	3						Yes	No	Tolerant	Omnivore	Yes
Ictaluridae												
Noturus insignis	Margined madtom	3						Yes	Yes	Moderate	Invertivores	No
Percidae												
Etheostoma olmstedi	Tessellated darter	6						Yes	Yes	Moderant	Invertivore	No

Table 13. Scientific fish name, common fish name, total number of individuals, and Maryland Index of Biotic Integrity (MdIBI) scores for 10 sampled sites, Blair County, Pennsylvania.—Continued

[Maryland Index of Biotic Integrity (MdIBI) score ranges: very poor = 1.0–1.9; poor = 2.0–2.9; fair = 3.0–3.9; good = 4.0–5.0]

Scientific fish name	Common fish name	Total number of individuals	Catch-per-unit-effort	MdIBI score[1]	Number of individuals per square meter[1]	Number of native species per square meter[1]	Number of benthic species per square meter[1]	Native to Chesapeake Bay drainage	Benthic species	Pollution tolerance	Trophic status	Lithophilic spawner
Dry Gap Run near Altoona, Pa.; station 01555820 (Sample date: 8/21/2012)			4.95	2.00 (poor)	0.11	0.36	0					
Cyprinidae												
Rhinichthys atratulus	Blacknose dace	60						Yes	No	Tolerant	Omnivore	No
Salmonidae												
Salvelinus fontinalis	Brook trout	35						Yes	No	Intolerant	Generalist	Yes
Mill Run near Altoona, Pa.; station 01555823 (Sample date: 8/21/2012)			4.9	2.00 (poor)	0.07	0.14	0					
Salmonidae												
Salvelinus fontinalis	Brook trout	129						Yes	No	Intolerant	Generalist	Yes
Onchorhynchus mykiss	Rainbow trout	3						No	No	Moderate	Top predator	Yes
Glenwhite Run near Glenwhite, Pa.; station 01555829 (Sample date: 8/24/2011)			0.4	2.00 (poor)	0.006	0.21	0					
Cyprinidae												
Rhinichthys atratulus	Blacknose dace	1						Yes	No	Tolerant	Omnivore	No
Salmonidae												
Salvelinus fontinalis	Brook trout	7						Yes	No	Intolerant	Generalist	Yes
Sugar Run near Canan, Pa.; station 01555847 (Sample date: 8/24/2011)			0.39	2.25 (poor)	0.004	0.2	0					
Cyprinidae												
Rhinichthys atratulus	Blacknose dace	2						Yes	No	Tolerant	Omnivore	No
Semotilus atromaculatus	Creek chub	4						Yes	No	Tolerant	Generalist	Yes
Salmonidae												
Salmo trutta	Brown trout	2						No	No	Moderate	Top predator	Yes

Table 13. Scientific fish name, common fish name, total number of individuals, and Maryland Index of Biotic Integrity (MdIBI) scores for 10 sampled sites, Blair County, Pennsylvania.—Continued

[Maryland Index of Biotic Integrity (MdIBI) score ranges: very poor = 1.0–1.9; poor = 2.0–2.9; fair = 3.0–3.9; good = 4.0–5.0]

Scientific fish name	Common fish name	Total number of individuals	Catch-per-unit-effort	MdIBI score[1]	Number of individuals per square meter[1]	Number of native species per square meter[1]	Number of benthic species per square meter[1]	Native to Chesapeake Bay drainage	Benthic species	Pollution tolerance	Trophic status	Lithophilic spawner
Blair Gap Run below Holidaysburg, Pa.; station 01555853 (Sample date: 8/23/2011)			3.26	3.50 (fair)	0.06	0.34	0.45					
Cyprinidae												
Exoglossum maxillingua	Cutlips minnow	11						Yes	No	Moderate	Invertivore	Yes
Rhinichthys atratulus	Blacknose dace	11						Yes	No	Tolerant	Omnivore	No
Catostomidae												
Catostomus commersoni	White sucker	5						Yes	No	Tolerant	Omnivore	Yes
Salmonidae												
Salmo trutta	Brown trout	41						No	No	Moderate	Top predator	Yes
Cottidae												
Cottus sp	Sculpin	35						Yes	Yes	Moderate	Insectivore	No
Centrarchidae												
Ambloplites rupestris	Rock bass	6						No	No	Moderate	Generalist	Yes
Bells Gap Run above Bellwood Reservoir near Blandburg, Pa.; station 01556434 (Sample date: 8/21/2012)			3.88	3.00 (fair)	0.04	0.39	0.41					
Cyprinidae												
Rhinichthys atratulus	Blacknose dace	17						Yes	No	Tolerant	Omnivore	No
Rhinichthys cataractae	Longnose dace	1						Yes	No	Moderate	Omnivore	No
Semotilus atromaculatus	Creek chub	3						Yes	No	Tolerant	Generalist	Yes
Salmonidae												
Salmo trutta	Brown trout	16						No	No	Moderate	Top predator	Yes
Salvelinus fontinalis	Brook trout	46						Yes	No	Intolerant	Generalist	Yes
Cottidae												
Cottus sp	Sculpin	15						Yes	Yes	Moderate	Insectivore	No
Centrarchidae												

Table 13. Scientific fish name, common fish name, total number of individuals, and Maryland Index of Biotic Integrity (MdIBI) scores for 10 sampled sites, Blair County, Pennsylvania.—Continued

[Maryland Index of Biotic Integrity (MdIBI) score ranges: very poor = 1.0–1.9; poor = 2.0–2.9; fair = 3.0–3.9; good = 4.0–5.0]

Scientific fish name	Common fish name	Total number of individuals	Catch-per-unit-effort	MdIBI score[1]	Number of individuals per square meter[1]	Number of native species per square meter[1]	Number of benthic species per square meter[1]	Native to Chesapeake Bay drainage	Benthic species	Pollution tolerance	Trophic status	Lithophilic spawner
Lepomis macrochirus	Bluegill	1						No	No	Tolerant	Invertivore	No
Tipton Run near Tipton, Pa.; station 01556460 (Sample date: 8/22/2012)			5.2	3.75 (fair)	0.13	0.62	0.83					
Cyprinidae												
Exoglossum maxillingua	Cutlips minnow	24						Yes	No	Moderate	Invertivore	Yes
Nocomis micropogon	River chub	1						Yes	No	Moderate	Omnivore	Yes
Rhinichthys atratulus	Blacknose dace	40						Yes	No	Tolerant	Omnivore	No
Rhinichthys cataractae	Longnose dace	7						Yes	No	Moderate	Omnivore	No
Semotilus corporalis	Fallfish	1										
Catostomidae												
Catostomus commersoni	White sucker	12						Yes	No	Tolerant	Omnivore	Yes
Ictaluridae												
Noturus insignis	Margined madtom	1						Yes	Yes	Moderate	Invertivores	No
Salmonidae												
Salmo trutta	Brown trout	194						No	No	Moderate	Top predator	Yes
Cottidae												
Cottus sp	Sculpin	17						Yes	Yes	Moderate	Insectivore	No
Sink Run near Tyrone, Pa.; station 01557530 (Sample date: 8/22/2012)			3.83	3.50 (fair)	0.08	0.1	0.51					
Salmonidae												
Salmo trutta	Brown trout	60						No	No	Moderate	Top predator	Yes
Cottidae												
Cottus sp	Sculpin	100						Yes	Yes	Moderate	Insectivore	No

[1]Roth and others, 1997.

Table 14. Taxonomy tolerance scores for the macroinvertebrate assemblage for 10 sampled watersheds, July 2011 and July 2012, Blair County, Pennsylvania.

[Sampling date shown in parentheses below stream name]

Taxonomy	Taxonomic level	Tolerance value	Counts of individual macroinvertebrates observed, by stream									
			South Poplar Run (7/19/2011)	Poplar Run, Newry (7/19/2011)	Dry Gap Run (7/17/2012)	Mill Run (7/17/2012)	Glenwhite Run (7/20/2011)	Sugar Run (7/20/2011)	Blair Gap Run (7/19/2011)	Bells Gap (7/17/2012)	Tipton Run (7/17/2012)	Sink Run (7/17/2012)
Oligochaeta	Class	10	1	0	0	0	0	0	0	0	0	0
Lumbriculidae	Family	5	0	0	0	0	0	0	0	0	1	0
Corbicula fluminea	Species	6	0	0	0	0	0	0	0	0	2	0
Hydrachnidia	Subcorhort	8	2	1	1	0	3	0	0	0	1	0
Cambarus	Genus	6	0	0	0	0	0	0	0	1	0	0
Ephemeroptera (mayflies)	**Order**											
Habrophlebiodes	Genus	6	0	2	1	3	0	0	0	0	2	0
Paraleptophlebia	Genus	1	3	6	0	0	0	0	0	7	5	7
Ephemera	Genus	2	0	0	1	0	0	0	0	0	0	0
Caenis	Genus	6	5	3	0	0	0	0	0	0	1	0
Attenella	Genus	1	0	0	0	0	0	0	0	1	0	0
Drunella	Genus	0	0	0	3	3	0	0	0	1	0	0
Ephemerella	Genus	1	0	0	0	4	0	0	0	0	0	0
Eurylophella	Genus	2	0	0	7	0	0	0	1	0	0	0
Serratella	Genus	2	0	0	0	0	0	0	0	0	8	0
Acentrella	Genus	4	4	1	0	1	19	0	1	1	0	0
Acerpenna	Genus	5	0	0	0	8	1	0	0	0	2	0
Baetis	Genus	6	8	0	3	33	36	0	5	29	12	41
Diphetor	Genus	5	0	0	0	0	0	0	0	0	0	2
Isonychia	Genus	2	0	16	0	0	0	0	1	0	12	0
Heptageniidae	Genus	4	0	0	0	0	0	0	0	0	0	10
Epeorus	Genus	0	0	5	1	2	0	0	0	1	2	1
Leucrocuta	Genus	1	1	0	0	0	0	0	9	0	0	0
Maccaffertium	Genus	7	0	1	0	1	0	0	0	3	0	0
Stenonema	Genus	3	18	53	1	0	0	0	56	3	9	7
Lanthus	Genus	5	0	0	1	0	1	0	0	1	2	1

Table 14. Taxonomy tolerance scores for the macroinvertebrate assemblage for 10 sampled watersheds, July 2011 and July 2012, Blair County, Pennsylvania.—Continued

[Sampling date shown in parentheses below stream name]

Taxonomy	Taxonomic level	Tolerance value	Counts of individual macroinvertebrates observed, by stream									
			South Poplar Run (7/19/2011)	Poplar Run, Newry (7/19/2011)	Dry Gap Run (7/17/2012)	Mill Run (7/17/2012)	Glenwhite Run (7/20/2011)	Sugar Run (7/20/2011)	Blair Gap Run (7/19/2011)	Bells Gap (7/17/2012)	Tipton Run (7/17/2012)	Sink Run (7/17/2012)
Plecoptera (stoneflies)	**Order**											
Plecoptera	Order	1	0	0	0	0	0	0	12	0	1	1
Allocapnia	Genus	3	0	2	0	0	0	0	0	0	0	0
Leuctra	Genus	0	3	1	41	5	5	0	14	8	3	6
Amphinemura	Genus	2	0	0	0	0	0	0	0	1	0	0
Sweltsa	Genus	0	0	0	2	5	0	0	1	3	0	0
Tallaperla	Genus	3	0	0	1	4	0	0	0	1	0	2
Acroneuria	Genus	0	0	0	0	0	0	0	0	2	1	0
Agnetina	Genus	2	0	0	0	0	0	0	0	0	4	2
Beloneuria	Genus	0	0	0	0	0	0	0	0	0	8	0
Paragnetina	Genus	4	0	0	0	5	0	0	0	0	1	0
Perlesta	Genus	4	0	2	0	0	0	0	0	0	0	0
Hansonoperla	Genus	3	3	0	2	0	0	0	0	3	0	0
Perlinella	Genus	2	0	0	0	0	0	0	2	0	0	0
Isoperla	Genus	2	1	0	0	0	0	0	0	0	0	4
Pteronarcys	Genus	0	0	0	1	0	0	0	1	5	1	1
Coleoptera (aquatic beetles)	**Order**											
Ectopria	Genus	5	0	0	13	2	0	0	2	0	0	2
Psephenus	Genus	4	2	16	0	0	0	0	0	0	6	0
Dubiraphia	Genus	6	0	0	22	0	0	0	6	0	1	0
Optioservus	Genus	4	0	2	0	5	1	1	1	0	0	1
Oulimnius	Genus	4	2	0	20	36	0	0	3	4	11	26
Promoresia	Genus	2	0	0	1	0	0	0	0	0	0	20
Stenelmis	Genus	5	0	1	0	17	0	1	0	0	0	0
Megaloptera (alderflies, dobsonflies, fishflies, and hellgrammites)	**Order**											
Nigronia	Genus	4	0	0	2	0	1	2	2	0	4	0
Sialis	Genus	4	0	0	0	0	0	1	0	0	0	0

Table 14. Taxonomy tolerance scores for the macroinvertebrate assemblage for 10 sampled watersheds, July 2011 and July 2012, Blair County, Pennsylvania.—Continued

[Sampling date shown in parentheses below stream name]

Taxonomy	Taxonomic level	Tolerance value	Counts of individual macroinvertebrates observed, by stream									
			South Poplar Run (7/19/2011)	Poplar Run, Newry (7/19/2011)	Dry Gap Run (7/17/2012)	Mill Run (7/17/2012)	Glenwhite Run (7/20/2011)	Sugar Run (7/20/2011)	Blair Gap Run (7/19/2011)	Bells Gap (7/17/2012)	Tipton Run (7/17/2012)	Sink Run (7/17/2012)
Tricoptera (caddisflies)	**Order**											
Rhyacophila	Genus	1	0	0	4	1	1	0	9	14	3	7
Glossosoma	Genus	0	0	0	0	2	2	0	2	6	1	8
Chimarra	Genus	4	1	5	0	0	0	0	1	0	0	0
Dolophilodes	Genus	4	5	0	7	0	2	1	44	18	8	2
Wormaldia	Genus	2	0	0	0	1	0	0	0	0	0	0
Phylocentropus	Genus	5	1	0	0	0	0	0	0	0	0	0
Neureclipsis	Genus	7	0	0	1	0	0	0	0	0	0	0
Polycentropus	Genus	6	0	3	2	1	0	1	0	2	0	1
Cheumatopsyche	Genus	5	17	19	0	0	1	1	7	0	6	0
Diplectrona	Genus	5	0	0	4	0	6	29	0	3	0	4
Hydropsyche	Genus	4	13	26	15	14	16	0	17	21	27	11
Parapsyche	Genus	1	0	0	0	2	0	0	0	0	0	0
Micrasema	Genus	2	0	0	0	0	0	0	0	0	1	1
Lepidostoma	Genus	1	0	0	0	0	0	0	0	0	12	0
Hydatophylax	Genus	2	3	0	0	0	0	0	0	0	0	0
Apatania	Genus	1	0	0	0	3	0	0	0	0	0	0
Goera	Genus	3	0	0	0	3	0	0	0	0	0	0
Nectopsyche	Genus	3	0	0	0	1	0	0	0	0	0	0
Oecetis	Genus	5	0	0	1	0	0	0	0	0	0	0
Diptera (true flies)	**Order**											
Ceratopogonidae	Genus	6	0	0	5	0	0	0	0	1	0	1
Chironomidae	Genus	6	104	33	52	45	51	27	22	55	37	23
Dixa	Genus	1	0	0	1	0	0	0	0	0	0	0
Simulium	Genus	5	0	1	0	0	56	1	0	3	0	0
Tipula	Genus	6	0	0	1	0	0	0	0	0	0	0
Antocha	Genus	3	4	1	1	0	0	0	0	0	3	2
Dicranota	Genus	3	0	0	0	0	0	0	0	2	0	0
Hexatoma	Genus	2	0	1	2	3	2	0	3	3	2	2
Pedicia	Genus	6	0	0	3	3	0	0	0	0	0	1
Empididae	Genus	6	0	0	1	0	0	0	0	0	0	0
Chelifera	Genus	6	0	0	1	0	13	2	0	0	0	3
Clinocera	Genus	6	0	0	0	0	0	0	0	3	0	0
Hemerodromia	Genus	6	2	4	0	0	3	3	0	0	0	0
Chrysops	Genus	5	1	0	0	0	0	0	0	0	0	0

Appendixes

Appendix 1. Surface-water-quality monitoring results for 12 streams, Blair County, Pennsylvania.

Available online only at http://dx.doi.org/10.3133/ofr20151173/.

Appendix 2. Fish assemblages in 10 watersheds, Blair County, Pennsylvania.

Available online only at http://dx.doi.org/10.3133/ofr20151173/.

Appendix 3. Pennsylvania Department of Environmental Protection Index of Biotic Integrity (IBI) in wadeable freestone riffle-run streams for 10 watersheds, Blair County, Pennsylvania.

Available online only at http://dx.doi.org/10.3133/ofr20151173/.

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