pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

BUREAU OF CLEAN WATER

Continuous Instream Monitoring Report (CIMR)

Most recent revision: 2/17/2017
Revised by: Lookenbill & Wertz

STATION DESCRIPTION:

STREAM CODE: 56497
STREAM NAME: Browns Run
SITE CODE: 112375461-001
SITE NAME: Browns Run

COUNTY: Warren

LATITUDE: 41.8186 **LONGITUDE:** -79.0925

LOCATION DESCRIPTION: Upstream from Browns Run Road, Southeast of Rogertown, PA.

DRAINAGE AREA: 9.03 sq. miles

HUC: 05010001

BACKGROUND AND HISTORY: Browns Run is a freestone tributary to the Allegheny River located in Mead township, Warren County (Figure 1). The basin is dominated primarily by forested land (98%), with a minor contribution from urban land use (1%). Conventional gas wells are located throughout, at varying degrees of activity; many of which are plugged or inactive. Browns Run has a designated use of Exceptional Value.

The primary objectives of the assessment were to:

1. Characterize seasonal water temperature, specific conductance, and pH using 24-hour monitoring.
2. Characterize seasonal variation in water chemistry.
3. Characterize seasonal variation in biological communities.

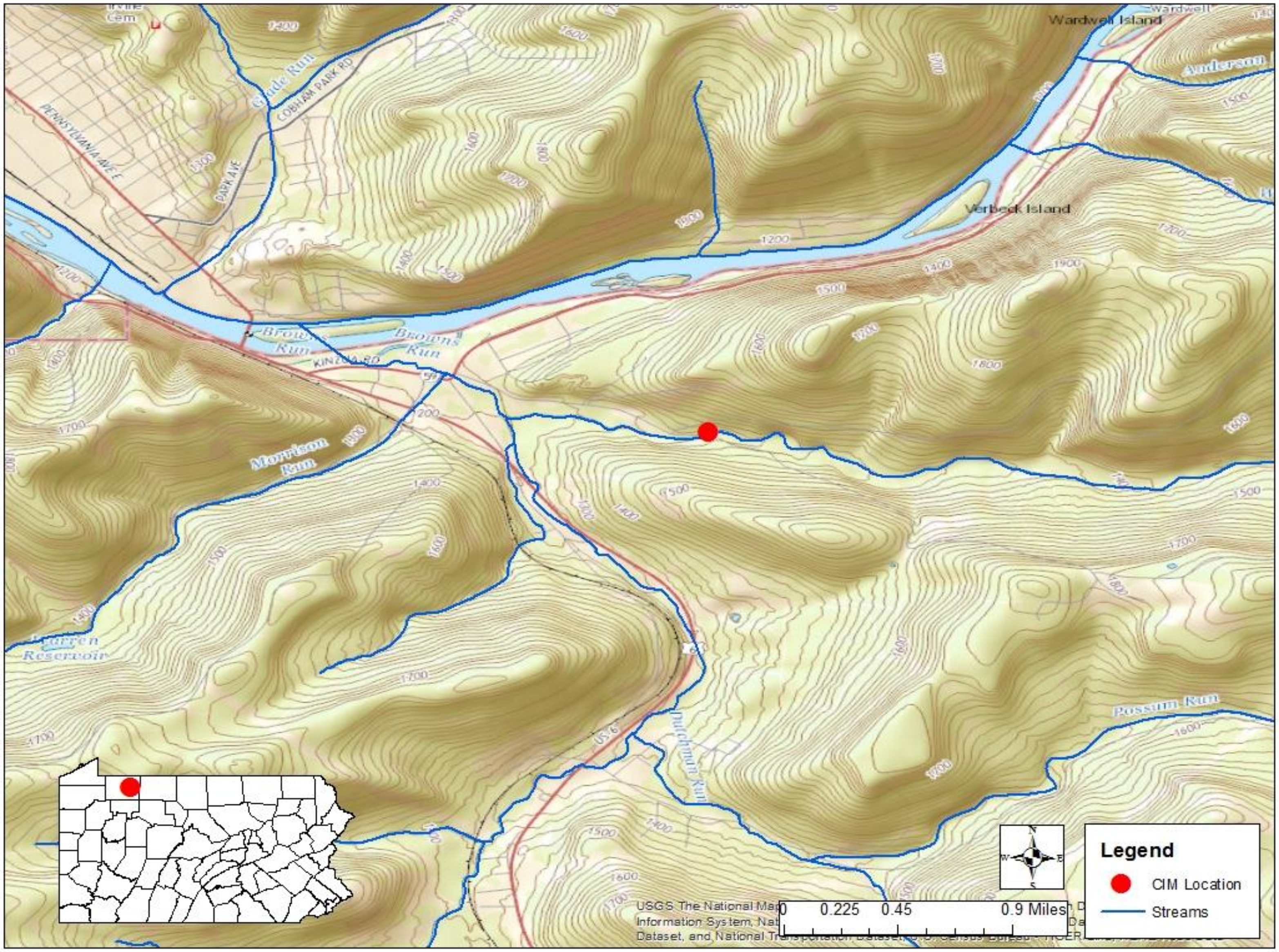

Figure 1. Browns Run continuous instream monitoring (CIM) site.

WATER QUALITY PARAMETERS:

Parameter	Units
Water Temperature	°C
Specific Conductance	μS/cm[c]
pH	standard units

EQUIPMENT:

A single Yellow Springs Instruments (YSI) 6920 water quality sonde (Serial #0018B75) was installed on July 20, 2011, and was maintained through July 25, 2012. A YSI 6920 and a YSI Pro Plus field meter were used as field meters during revisits.

The sonde was housed in a 24-inch length of 4-inch diameter schedule 80 PVC pipe with holes drilled in it to allow for flow through. One end of the pipe was capped, and a notch was cut to accommodate the metal attachment bar on the top of the sonde. The attachment bar was clipped to an eye-bolt attached to rebar driven into the stream bed. The attachment bar was also clipped to a cable attached to a second piece of rebar located just upstream of the first. The sonde recorded water quality parameters every 60 minutes.

PERIOD OF RECORD: July 20, 2011 to July 25, 2012

The station was visited eight times over the twelve-month period for the purpose of calibrating, cleaning, and servicing the sonde.

DATA:

Water chemistry grabs were collected seven times during the sampling period. Benthic macroinvertebrates were collected on November 28, 2000, April 4, 2012, and May 16, 2012. Fish were collected on June 27, 2012. Biological samples were collected following the Department's ICE protocol (PA DEP, 2013b) and Wadable Semi-Quantitative Fish Sampling Protocol (PA DEP, 2013c). Continuous data are graded based on a combination of fouling and calibration error (PA DEP, 2013a). Temperature, specific conductance, and pH data for the period April 18, 2012 through May 15, 2012 was graded unusable and deleted from the final data due to battery failure and equipment malfunction. In addition, pH data for the period November 11, 2011 through December 6, 2011; and specific conductance data for the periods August 21, 2011 through September 12, 2011, December 21, 2011 through February 3, 2012, and May 22, 2012 through June 5, 2012 were graded unusable and deleted from the final data due to sediment fouling.

Discrete Water Quality Transect Characterization: Discrete water quality transects consist of water quality measurements taken, typically at equidistant points, across the width of the targeted waterbody to determine if data collected by the sonde or data logger were representative of the surface water as a whole. CIM was initiated at Browns Run prior to routine implementation of transect monitoring and transect data was not collected as part of the Browns Run CIM.

Depth: Depth recorded by this non-vented sonde is actually the measure of water column pressure plus atmospheric pressure. Therefore, changes in atmospheric pressure appear as changes in depth. Using atmospheric pressure data from the Venango Regional Airport weather station in Franklin, PA these data were corrected by eliminating the variations in depth due to changes in atmospheric pressure.

Temperature: Min: 0.0°C; Average: 10.0°C; Max: 24.4°C

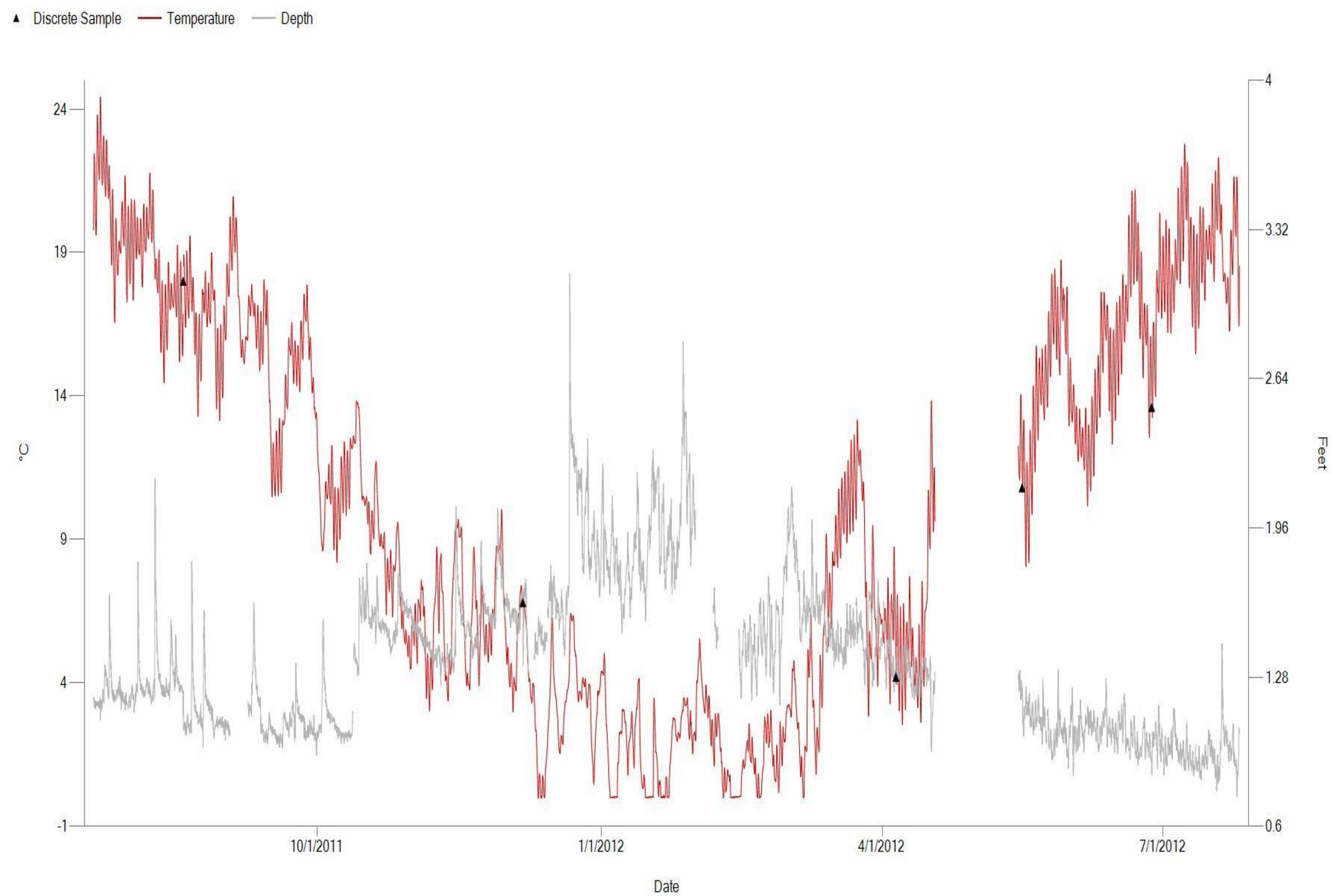

Figure 2. Continuous water temperature and depth from July 20, 2011 to July 25, 2012.

Specific Conductance: Min: 21 µS/cm; Average: 62 µS/cm; Max: 195 µS/cm

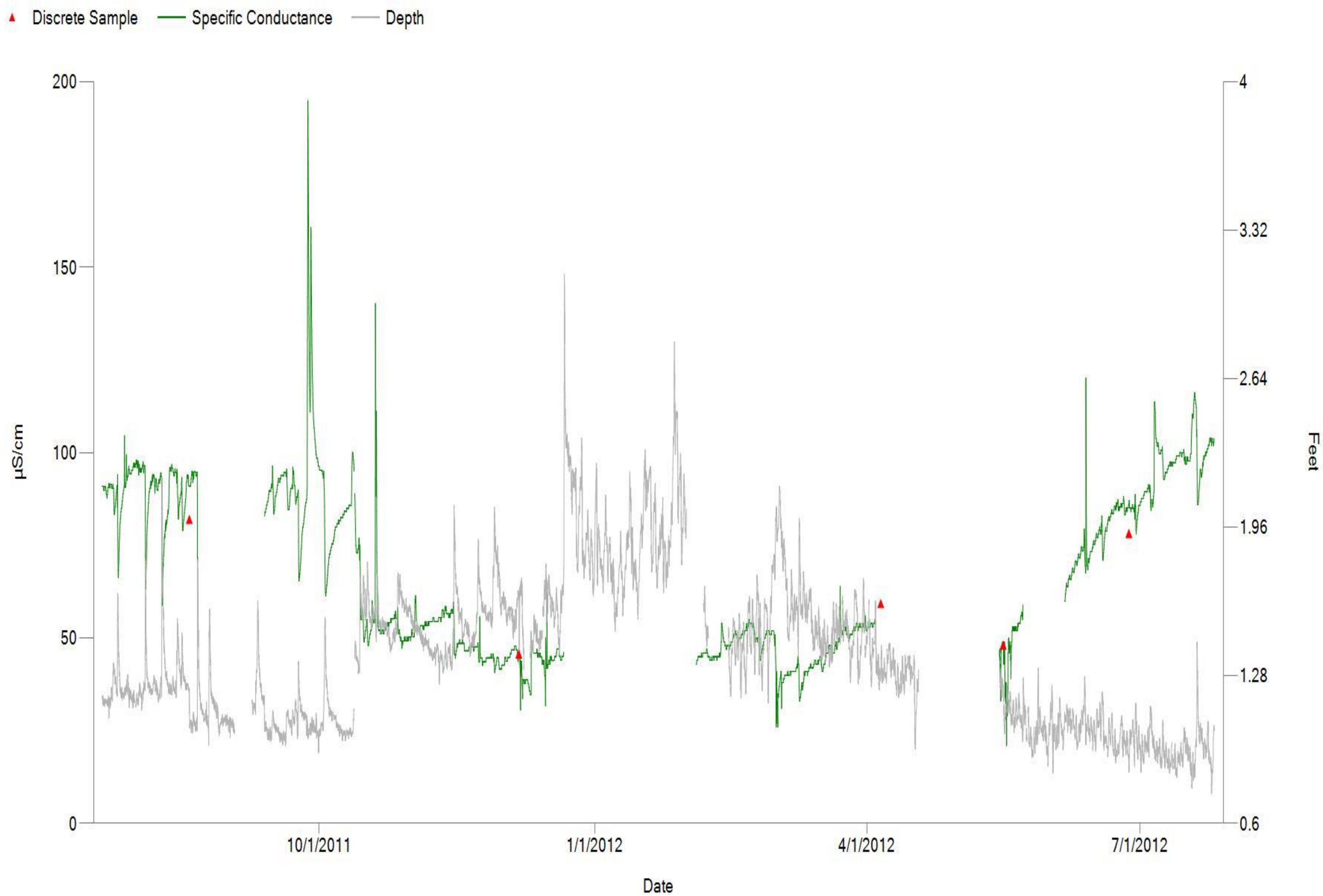

Figure 3. Continuous specific conductance and depth from July 20, 2011 to July 25, 2012.

pH: Min: 6.6 units; Average: 7.3 units; Max: 7.7 units

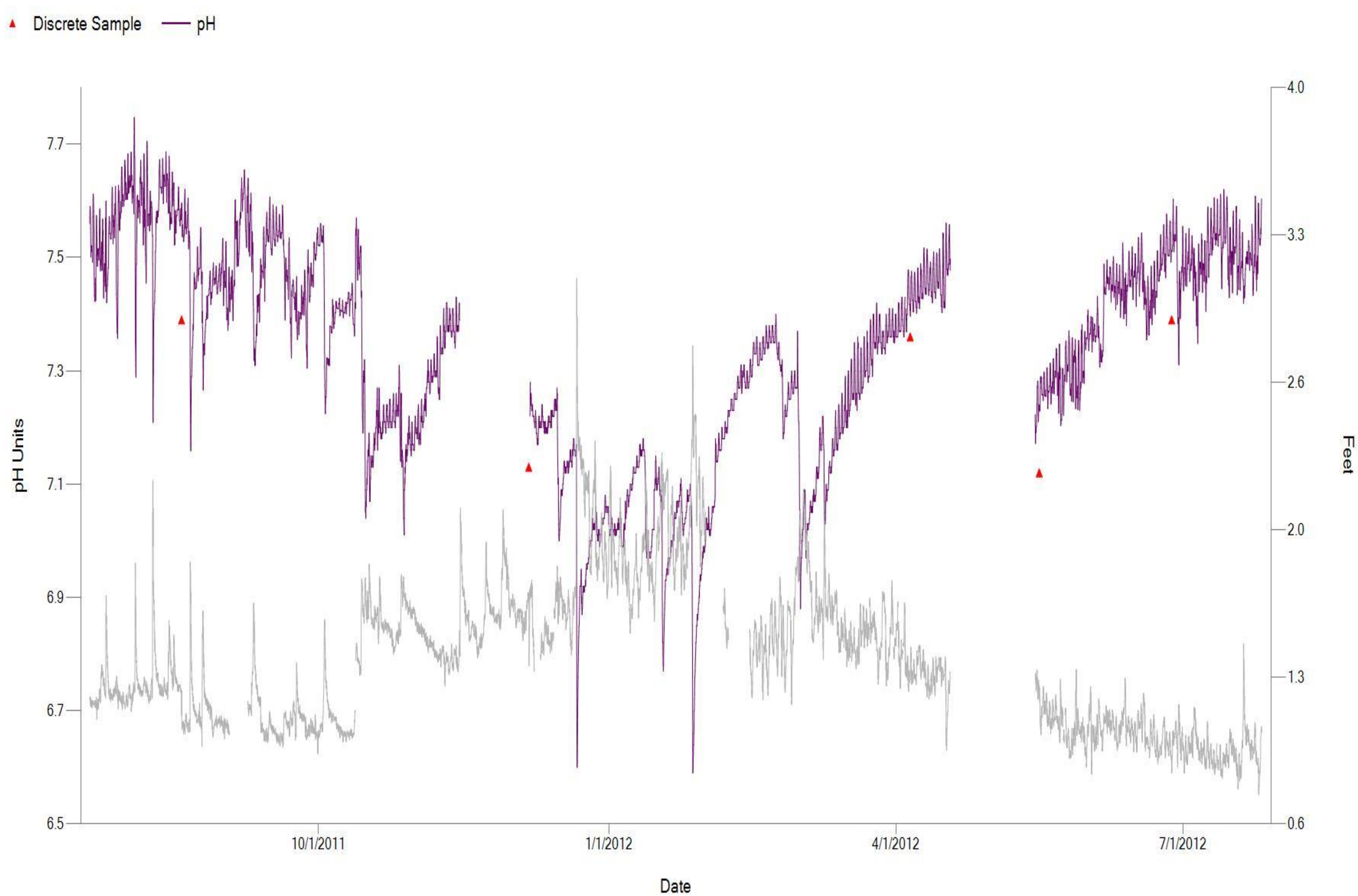

Figure 4. Continuous pH and depth from July 20, 2011 to July 25, 2012.

In-situ Water Chemistry: Samples were collected seven times using standard analysis code (SAC) 046 (Table 1). Measurements with "<" indicate concentrations below the reporting limit.

Table 1. Chemical grab sample results from Browns Run

PARAMETER	UNITS	8/18/2011	9/12/2011	10/12/2011	12/6/2011	2/29/2012	4/5/2012	5/16/2012
ALKALINITY	MG/L	26.4	23.8	26.6	7.4	9.8	13.4	10.4
ALUMINUM T	UG/L	<200	<200	<200	220	475	<200	<200
AMMONIA T	MG/L	<0.02	0.03	0.02	0.03	0.04	<0.02	<0.02
ARSENIC T	UG/L	<3	<3	<3	<3	<3	<3	<3
BARIUM T	UG/L	41	41	44	31	36	33	33
BORON T	UG/L	<200	<200	<200	<200	<200	<200	<200
CALCIUM T	MG/L	6.978	7.308	7.237	3.777	4.16	4.432	3.864
BOD	MG/L	0.3	1.3	0.5	0.6	1.9	0.55	0.7
HARDNESS T	MG/L	28	29	29	16	17	19	16
IRON T	UG/L	228	196	337	328	753	84	226
LITHIUM T	UG/L			<25	<25	<25	<25	<25
BROMIDE T	UG/L	53.01	<50	64.54	<50	<50	<50	<50
MAGNESIUM T	MG/L	2.56	2.545	2.543	1.488	1.72	1.803	1.616
MANGANESE T	UG/L	22	17	36	27	35	10	20
OSMOTIC PRESSURE	MOSM	<1	<1	<1	<1	<1	<1	<1
SELENIUM T	UG/L	<7	<7	<7	<7	<7	<7	<7
SODIUM T	MG/L	5.564	5.017	6.032	1.933	2.64	2.868	1.977
DISCHARGE	CFS	2.707	1.219	4.6		1.9566	7.44	16.294
STRONTIUM T	UG/L	44	44	45	20	24	27	23
CHLORIDE T	MG/L	6.1	4.86	6.82	2.52	3	2.58	1.89
TDS	MG/L	70	42	62	32	56	48	48
NITROGEN T	MG/L	0.14	0.09	<0.05	0.14	0.28	0.22	0.19
PHOSPHORUS T	MG/L	<0.01	<0.01	0.012	<0.01	<0.01	<0.01	<0.01
SULFATE T	MG/L	6.9	6.85	5.93	7.56	7.83	7.73	7.45
TSS	MG/L	<5	<5	<5	<5	8	<5	8
ZINC T	UG/L	<10	<10	<10	<10	11	<10	<10

Biology: The indigenous aquatic community is an excellent indicator of long-term conditions and is used as a measure of water quality. Benthic macroinvertebrates were collected at Browns Run on November 28, 2011, April 4, 2012, and May 16, 2012 (Table 2). Fish were collected on June 27, 2012 (Table 3).

Table 2. Taxa list for benthic macroinvertebrate surveys (yyyymmdd-hhmm-collector)

Genus	Total of Individuals	20111128-1530-bchalfant	20120404-1630-mebradburn	20120516-1045-jaygerber
Ameletus	2	1	1	
Acentrella	21			21
Baetis	16	2	13	1
Diphetor	5	1	3	1
Epeorus	74	35	13	26
Rhithrogena	4		4	
Stenonema	1	1		
Maccaffertium	3	3		
Cinygmula	13		9	4
Drunella	4		2	2
Ephemerella	83	4	46	33
Eurylophella	2	2		
Serratella	5	4	1	
Paraleptophlebia	41	19	11	11
Ephemera	1	1		
Lanthus	1			1
Pteronarcys	8		2	6
Taeniopteryx	6	6		
Taenionema	1	1		
Leuctra	11	1	2	8
Allocapnia	30	30		
Paracapnia	8	8		
Acroneuria	25	3	8	14
Isoperla	12	8	3	1
Alloperla	5	2	1	2
Haploperla	7		4	3
Nigronia	1			1
Dolophilodes	18	6		12
Wormaldia	1	1		
Lype	1	1		
Polycentropus	1		1	
Diplectrona	6	3	1	2
Ceratopsyche	16	8	8	
Cheumatopsyche	2	2		
Hydropsyche	5			5
Rhyacophila	6	1	4	1
Pycnopsyche	1	1		
Neophylax	1		1	
Optioservus	10		7	3
Oulimnius	62	8	25	29
Stenelmis	1	1		
Ceratopogon	1		1	
Probezzia	1		1	

Table 2 cont. Taxa list for benthic macroinvertebrate surveys (yyyymmdd-hhmm-collector)

Genus	Total of Individuals	20111128-1530-bchalfant	20120404-1630-mebradburn	20120516-1045-jaygerber
Tipula	1	1		
Dicranota	7	6		1
Hexatoma	2		2	
Erioptera	1	1		
Prosimulium	54		21	33
Chironomidae	27	8	10	9
Oligochaeta	4	3	1	
Cambaridae	1			1

Table 3. Taxa list for fish surveys (yyyymmdd-hhmm-collector)

Family	Scientific Name	Common Name	20120627-0601-mlookenbil
Cottidae	Cottus bairdii	Mottled Sculpin	45
Cyprinidae	Rhinichthys obtusus	Western Blacknose Dace	19
Cyprinidae	Rhinichthys cataractae	Longnose Dace	9
Cyprinidae	Semotilus atromaculatus	Creek Chub	1
Salmonidae	Oncorhynchus mykiss	Rainbow Trout (stocked)	6
Salmonidae	Salmo trutta	Brown Trout (stocked)	2
Salmonidae	Salmo trutta	Brown Trout (wild)	35

ASSESSMENT:

Continuous: Continuous instream monitors (CIMs) record instream parameters that have defined water quality standards (WQS) in 25 Pa Code §93.7 (temperature, pH and DO). Certain conditions must be met in order to properly assess data from CIMs. Any readings that do not comply with the applicable numeric WQS criteria are considered exceedances and are reviewed to determine if representative of the stream segment and if representative of natural quality as stated in 25 Pa Code §93.7(d). All data reviews are consistent with requirements as described in 25 Pa Code §96.3 which includes the 99 percent frequency measurement rule.

Defining Criteria Exceedance

The WQS criteria for pH and DO are expressed as either a discrete minimum, discrete maximum, or as a daily average (continuous 24-hour period, §93.1) concentration. The individual recordings exceeding the listed criteria are summed and the percent of the year (%Y) that those readings represent is calculated using the following equation:

$$\%Y = 100 * [\, n / (525{,}600 / i\,)\,]$$

Where

n = number of exceedances
i = recording interval in minutes
The constant (525,600) is the number of minutes in a year (365 days * 24 hrs/day * 60 min/hr)

If %Y > 1, then the criterion is not achieved 99% of the time as required by §96.3(c), and the waterbody is considered in violation of water quality standards. A period of one year is applied as a rolling year to avoid arbitrary divides as with a calendar year or water year. The 99 percent frequency measurement calculation is based on one continuous 365-day period.

Sampling Critical Time Periods

Temperature, pH and DO are all affected by seasonal change and can, therefore, be predicted to a certain degree. For example, CIMs may be deployed during the growing season when increases in instream production and respiration occur. The Department's CIM efforts have documented increases in pH values, increases in diel pH fluctuation, corresponding decreases in DO values, and increases in diel DO fluctuation beginning in early spring and persisting through the fall. This correlates with increased photoperiod and increased air and surface water temperatures. The effect of increased temperature and photoperiod to increased instream production and respiration are well documented (Odum 1956, Strickland et al. 1970, Neori and Holm-Hansen 1982, Raven and Geider 1988). Diel fluctuation is the difference of minimum and maximum values over a 24-hour period. This is caused by both plant photosynthetic activity and respiration throughout the day and community respiration at night (Odum 1956, White et al. 1991, Wurts 2003). An increased photoperiod with adequate nutrition will increase the standing biomass of photosynthetic organisms (Valenti et al. 2011). Phosphorus has been documented to be the limiting factor of standing biomass in freshwater systems (Stevenson 2006), however other studies indicate increased nitrogen and phosphorus can produce higher biomass than nitrogen or phosphorus alone, suggesting co-limitation (Carrick and Price 2011). During the growing season, pH is most likely to exceed maximum criteria (9.0) and DO to fall below the minimum criteria or 7-day average as described in §93.7, for each critical use. Sampling during critical periods may give sufficient information to make an assessment decision and greatly reduce the amount of resources needed to conduct the survey.

The Department must also recognize that critical or limiting conditions may not be consistent year-to-year, and a single year of data may not accurately represent conditions that water quality standards were developed to protect. Typically, this is driven by the amount and timing of precipitation for a given period or year. Elevated precipitation will result in increased surface water discharge, which moderates limiting conditions characterized by temperature, pH and DO. The Department has documented in past surveys that elevated discharge can reduce daily DO, pH, and temperature fluctuations and increase daily minimum DO values and decrease maximum pH and temperature values. It is imperative to characterize conditions that drive critical or limiting conditions, and reference those conditions as part of the protected use assessment and subsequent reassessments.

CIM, Temperature

Temperature criteria in §93.7 are applied to heated waste sources regulated under 25 Pa Code Chapters 92a and 96. Temperature limits apply to other sources when they are needed to protect designated and existing uses. An appropriate thermal evaluation includes a biological assessment based on instream flora and fauna to determine whether the biological community is affected by the thermal regime. Typically, fish community evaluations have the best resolution in characterizing a waterbody's thermal regime due to the effects to physiology and distribution patterns (Shuter et al. 1980, Ridgeway and Shuter 1991, Azevedo et al. 1998, Wehrly and Wiley 2003, Lyons et al. 2009). CIM temperature data is not typically used to assess critical uses. However, High Quality criterion in § 93.4b (a)(1)(i), "The water has long-term water quality, based on at least one year of data which exceeds levels….at least 99% of the time…" for a list of parameters including temperature may be applied to qualify as a High Quality Water.

CIM temperature data was compared to temperature criteria found in Table 3 of §93.7. For the period July 25, 2011 through July 25, 2012, Browns Run met Cold Water Fishes (CWF) criteria 69% of the year and Trout Stocking (TSF) criteria 95% of the year. The maximum temperature (24.4°C) occurred on July 22, 2011. The minimum temperature (0.0°C) occurred multiple times throughout the period in December 11, 2011 through March 6, 2011 (Figure 2).

CIM, Specific Conductance

Specific conductance measurements from Browns Run showed a relatively consistent pattern throughout the sampling period. Throughout periods of reduced or base flow discharge (July – September 2011 and July 2012) specific conductance was generally low with a mean of 88μS/cm. During more elevated discharge conditions (October 2011 through May 2012) the mean decreased to 47μS/cm. Specific conductance increased approximately 100μS/cm over a six-hour period beginning on September 26, which reached a maximum of 195μS/cm on September 27, 2011. This increase was preceded by the typical decrease in specific conductance as discharge increased, presumably due to a precipitation event. As discharge receded, specific conductance began recovering at an expected rate, but continued past baseline conditions reaching a maximum of 195μS/cm. Additional, notable increases occurred on October 19, 2011 and June 13, 2012 (Figure 3).

CIM, pH

CIM pH data collected from Browns Run was below the criteria maximum (9.0) and above the criteria minimum (6.0) found at §93.7 at least 99% of the time for the entire period. The minimum (6.6) pH occurred on January 27, 2012 as a result of a rain or snow melt event. Depressions in pH caused by rain were common, but the magnitude of decrease over time was not significant, and there were no pH values recorded less then criteria minimum (6.0). Maximum daily fluctuation (0.6) occurred on December 7, 2011 and the median for the entire period (0.1) is indicative of a fairly intact system with adequate buffering capacity and minimal instream production (Figure 4).

Biological: The benthic macroinvertebrate community suggests excellent water quality with IBI scores ranging from 88.1 to 97.7. Sensitive mayflies (Ephemeroptera) dominate all samples. Richness is highest from the November 28, 2011 sample, due to an increase in intolerant Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa (Table 4). The fish community supports a naturally reproducing population of Brown Trout indicating physiochemical properties have been favorable for reproduction throughout the year. The insectivore fishes are moderately lower than expected, but this could be attributed to the strong trout population and subsequent increased predation. Species richness remains within the expected range for small headwater streams, and the assemblage is dominated by cold-water fishes.

Table 4. Benthic macroinvertebrate metric calculations

Date	IBI	Richness	Mod EPT	HBI	% Dom	% Mod May	Beck3	Shannon Div
November 28, 2011	97.7	34	23	2.25	19.1	38.3	37	2.87
April 4, 2012	90.7	29	17	2.46	22.3	42.2	41	2.75
May 16, 2012	88.1	26	15	2.02	14.3	42.0	37	2.66

SUMMARY:

The data collected at Browns Run indicate excellent water quality within the watershed. Continuous data show that Browns Run is responding to daily, seasonal, and environmental conditions in a consistent and predictable manner. Consistency with each of the measured parameters is typical of stable land use characteristics. The majority of the watershed is currently forested, and may be the driving factor of the relatively consistent flows, chemistry and biological data. The macroinvertebrate community is excellent, as is expected in this stable watershed. The fish community appears to be relatively stable and should provide excellent recreational angling opportunities.

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