pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

BUREAU OF POINT & NON-POINT SOURCE MANAGEMENT

Continuous Instream Monitoring Report (CIMR)

Most recent revision: 11/5/2015
Revised by: Bendick

STATION DESCRIPTION:
STREAM CODE: 12366
STREAM NAME: Jacks Creek
SITE CODE: 66204809-001
SITE NAME: Back Maitland Rd.

COUNTY: Mifflin

LATITUDE: 40.612941 **LONGITUDE:** -77.531736

LOCATION DESCRIPTION: The 2013 deployment site was approximately 50 meters downstream of Back Maitland Rd. Bridge. The 2014 deployment site was moved downstream of the 2013 site as a result of damming.

HUC: 02050304

DRAINAGE AREA: 57.07 sq. miles

BACKGROUND AND HISTORY: Jacks Creek is a limestone-influenced tributary to the Juniata River within Derry Township, Mifflin County (Figure 1). The basin is characterized by ridge and valley topography and is located on the North-western side of Shade Mountain. Land use consists of forested land (65%), urban land use (1%), and agricultural uses (34%). The purpose of this survey was to collect baseline data on a Trout Stocking, Migratory Fishes (TS, MF) stream to determine water quality and biological conditions.

The primary objectives of the assessment were to:

1. Characterize baseline water temperature, specific conductance, pH, and dissolved oxygen using 24-hour monitoring.
2. Characterize water chemistry.
3. Characterize biological communities.

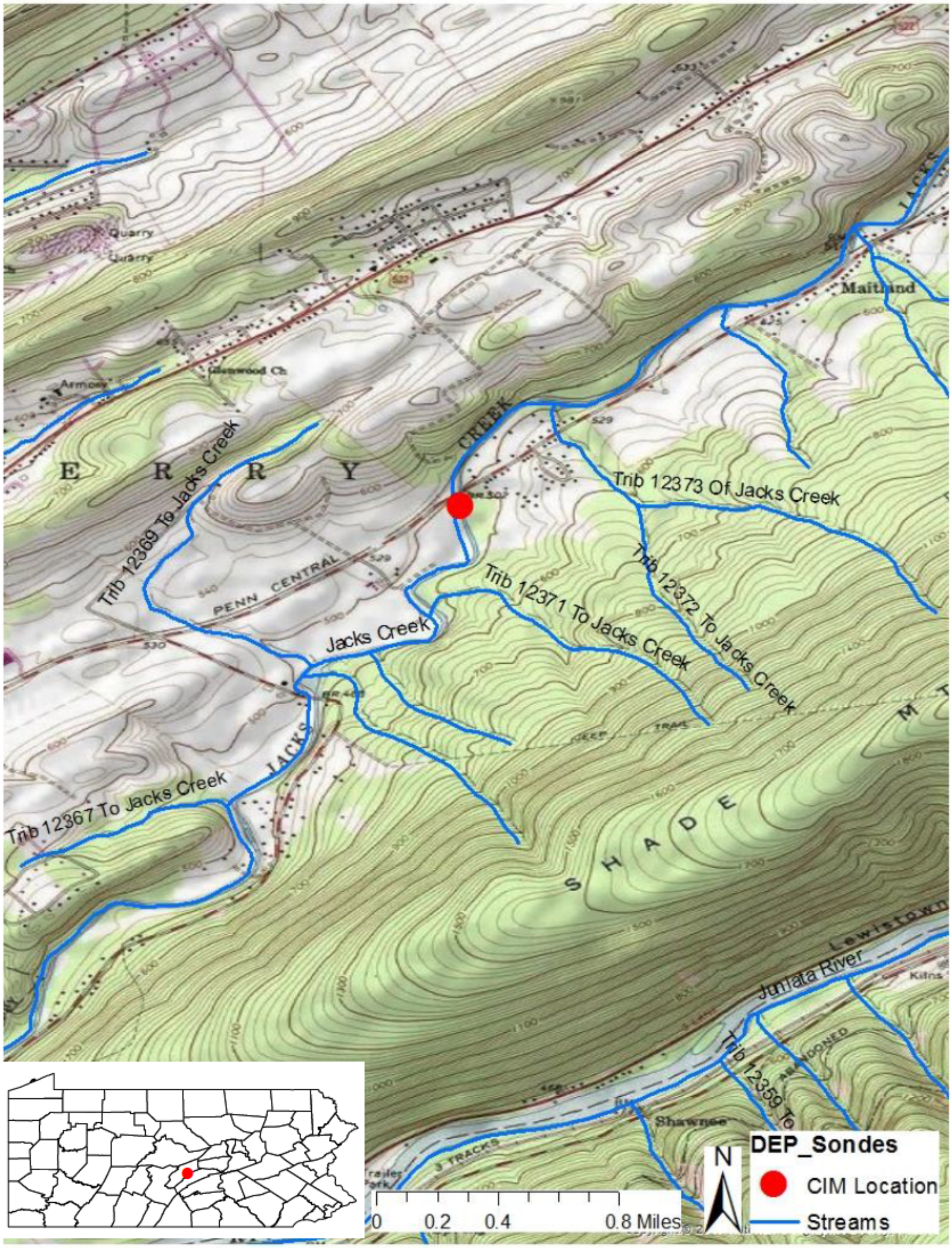


Figure 1. Map of the Jacks Creek continuous instream monitoring (CIM) site.


Figure 2. Jacks Creek sampling location.

WATER QUALITY PARAMETERS:

Parameter	Units
Water Temperature	°C
Specific Conductance (@25°C)	μS/cm[c]
pH	standard units
Dissolved Oxygen	mg/L

EQUIPMENT:

A single Yellow Springs Instruments (YSI) YSI 6600 (Serial #SRBC001849) was used from April 19, 2013 to November 7, 2013. A Measurement Specialties Eureka2 water-quality sonde (Serial #MT04131240) was deployed in the following year from February 28, 2014 to September 25, 2014. A Yellow Springs Instruments (YSI) 6920 V2 was used as a field meter 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 30 minutes.

PERIOD OF RECORD: April 19, 2013 to November 7, 2013 AND February 28, 2014 to September 25, 2014

In 2013, the station was revisited seven times over seven months for the purpose of downloading data, checking calibration, and cleaning. In 2014, the station was revisited eight times over seven months for the purpose of downloading data, checking calibration, and cleaning.

DATA:

Water chemistry grabs were collected nine times during the 2013 sampling period and ten times during the 2014 sampling period. Benthic macroinvertebrates were collected on January 15, 2013, August 27, 2013, and November 7, 2013; no macroinvertebrate samples were collected in 2014. Fishes were collected on July, 12, 2013 and July 7, 2014, and periphyton samples were collected one time in 2013 using the Department's ICE protocol (PA DEP, 2013). Continuous data were graded based on a combination of fouling and calibration error according to the Department's Continuous Instream Monitoring Protocol (PA DEP, 2013). No 2013 data were graded unusable. In 2014, one period for specific conductance and two periods for pH were graded unusable and deleted from the final report.

Discrete Water Quality Transect Characterization: A transect across the width of the stream was established to characterize water quality. The purpose of the transect was to determine if data collected by the sonde was representative of the surface water as a whole. Discrete water quality measurements were taken at equidistant points across the transect starting at the right ascending bank. Transects were conducted one time during the 2013 sampling period and four times throughout the 2014 sampling period. Temperature, specific conductance, pH, and dissolved oxygen measurements indicated a homogenous system (Figures 3 and 4).

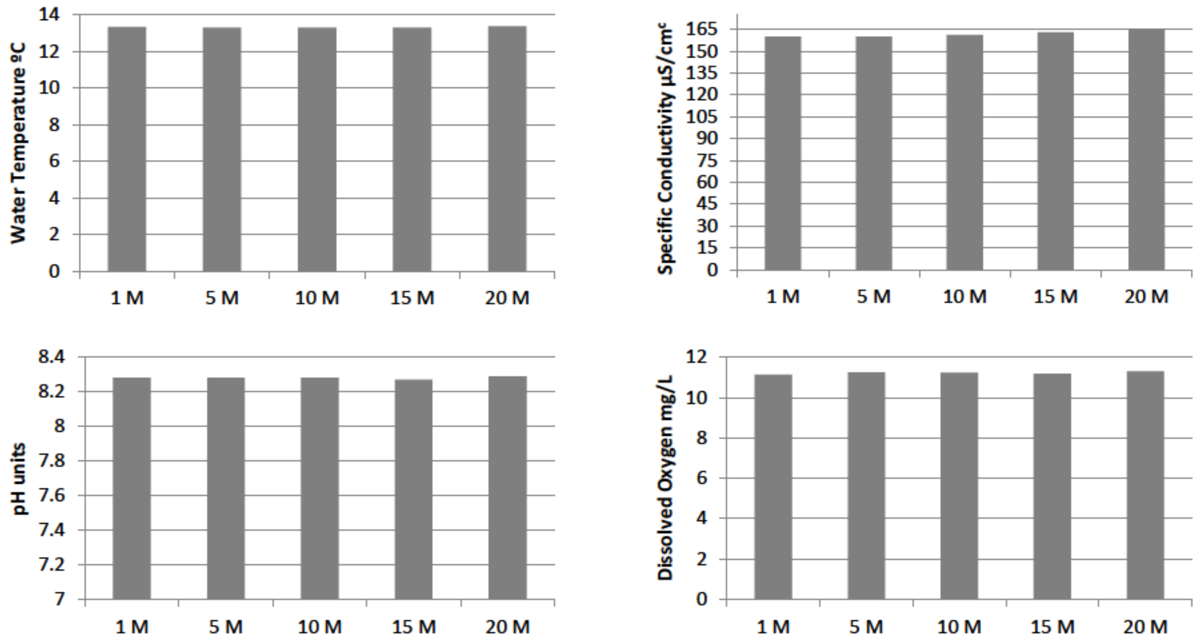


Figure 3. Initial discrete water quality data collected on April 19, 2013.

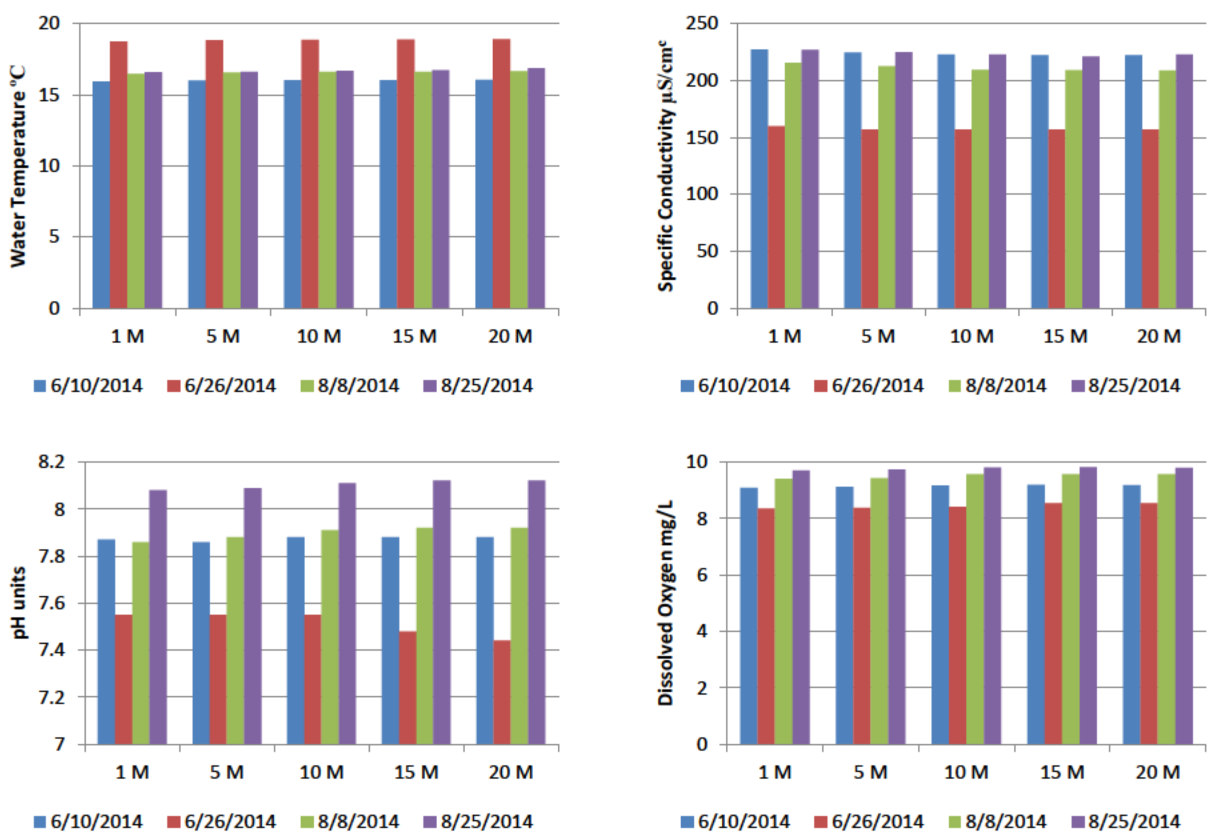


Figure 4. 2014 discrete water quality data collected at equidistant intervals from the right ascending bank to the left ascending bank.

Depth: Depth measured by the non-vented YSI 6600 (2013) and by the Measurement Specialties Eureka2 (2014) is actually the measure of water column pressure plus atmospheric pressure. Changes in atmospheric pressure while the sonde was deployed appear as changes in depth. Data were corrected for barometric pressure using Quality Controlled Local Climatological Data (QCLCD) data from the State College, University Park NOAA station. These data are used only as qualitative interpretation for changes in other parameters due to a lack of verification.

Comparatively, higher flows were observed in 2014. Storm events proved to have a stronger effect on flow status in 2014 than 2013 (Figure 5).

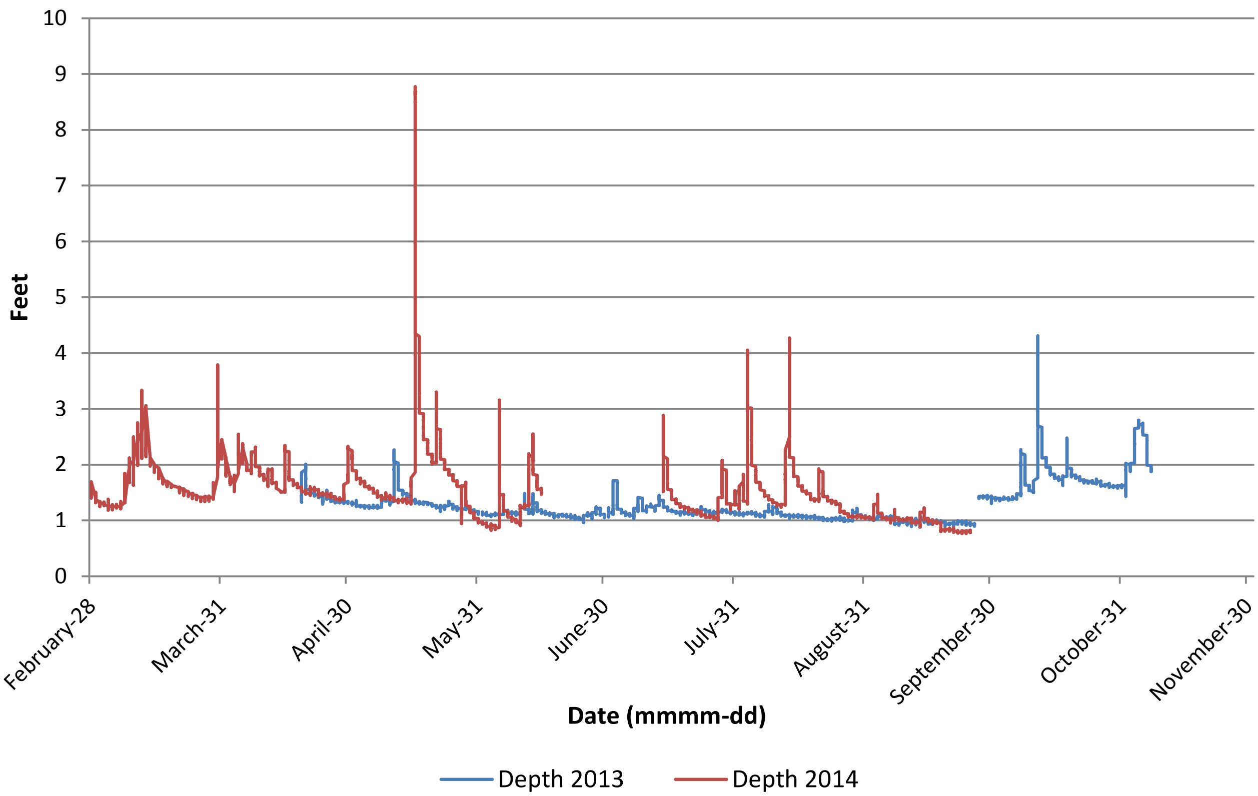


Figure 5: Continuous depth data compared.

Water Temperature:
2013 Statistics - Average: 16.3 °C; Maximum: 24.4 °C; Minimum: 6.5 °C.

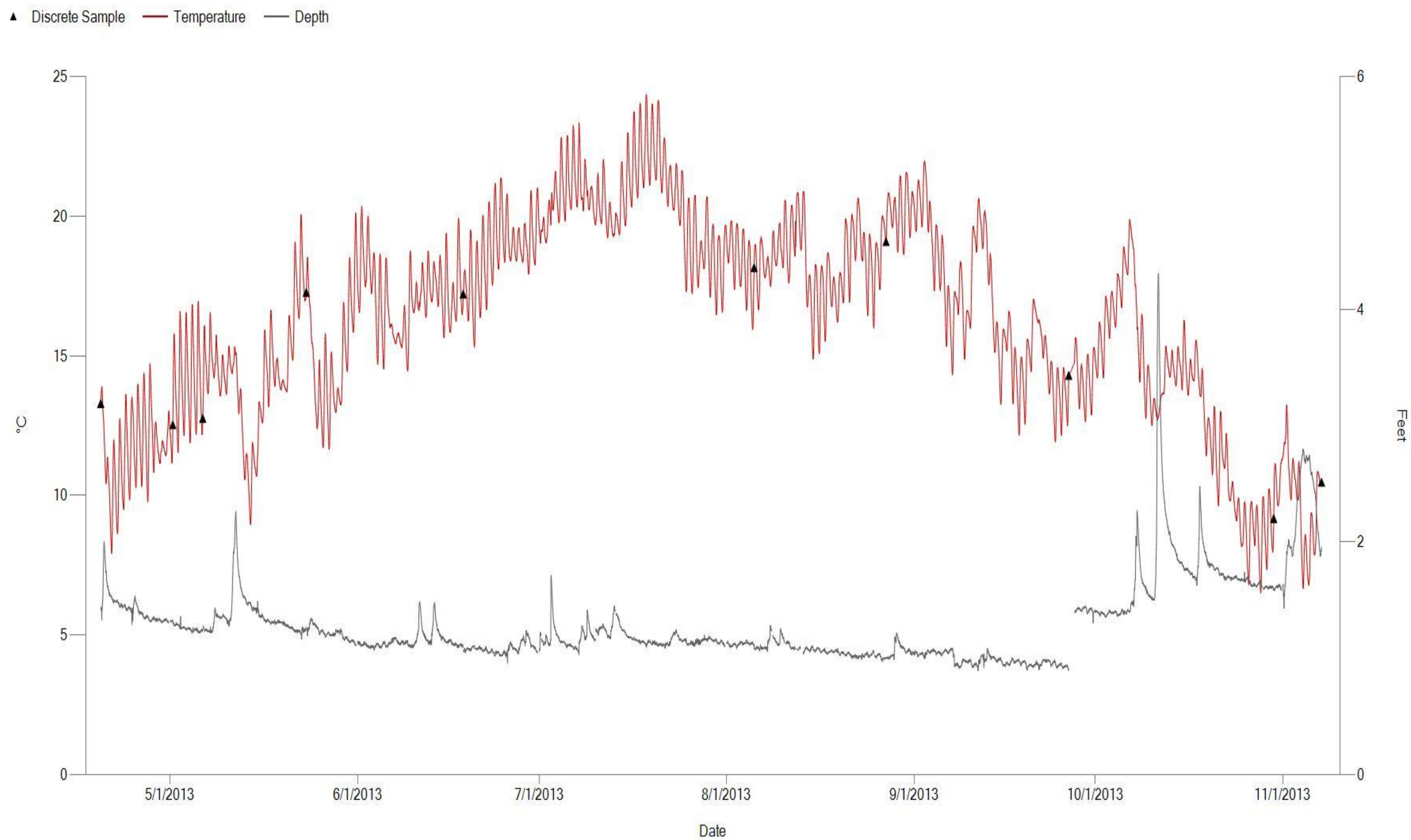


Figure 6. Continuous water temperature, continuous depth, and discrete samples from April 19, 2013 to November 7, 2013.

2014 Statistics - Average: 15.6 °C; Maximum: 21.5 °C; Minimum: 6.5 °C.

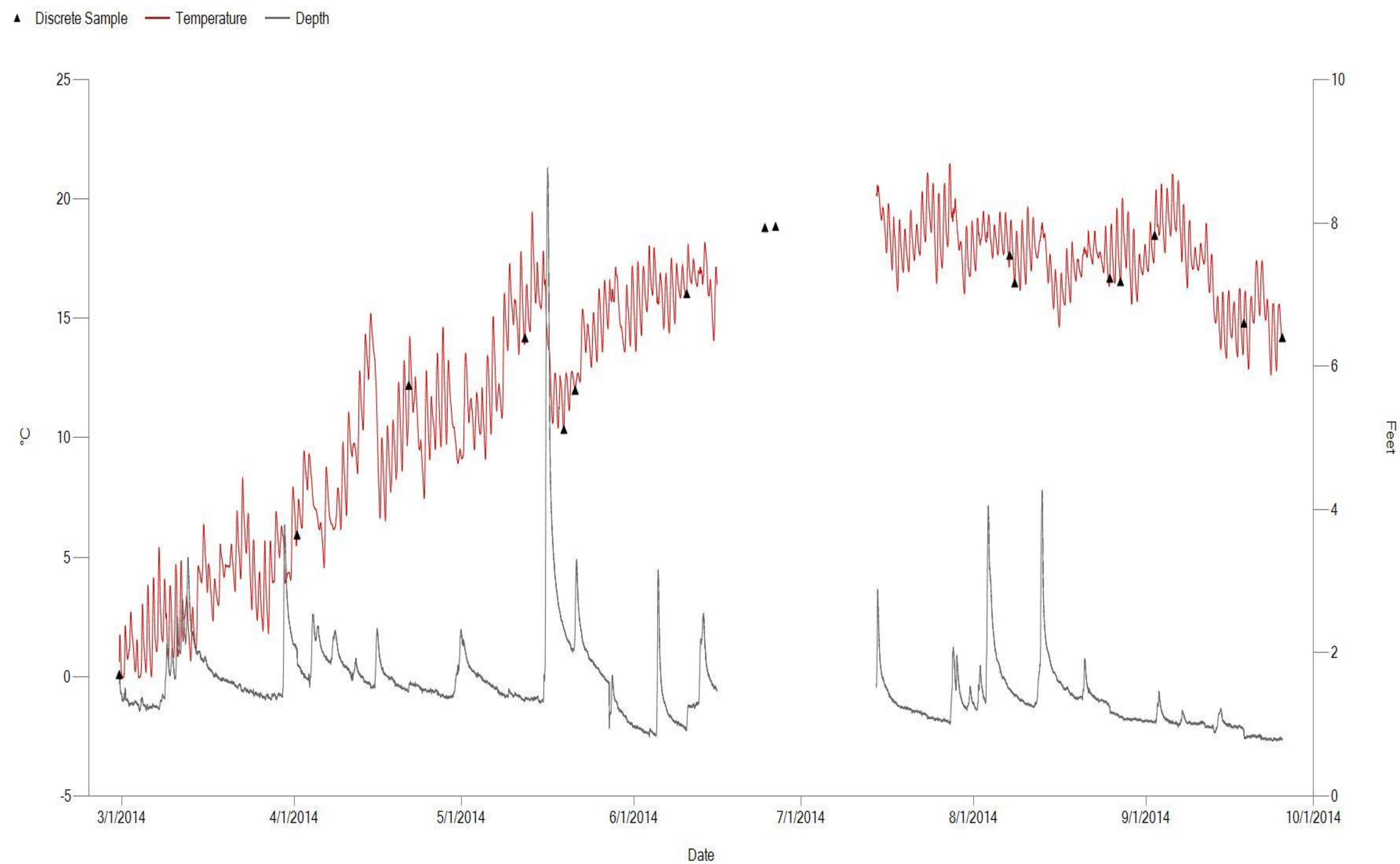


Figure 7. Continuous water temperature, continuous depth, and discrete samples from February 28, 2014 to September 25, 2014. The data gap was due to equipment failure; no data was recorded.

Specific Conductance:
2013 Statistics - Average: 256 µS/cm[c]; Maximum: 333 µS/cm[c]; Minimum: 141 µS/cm[c].

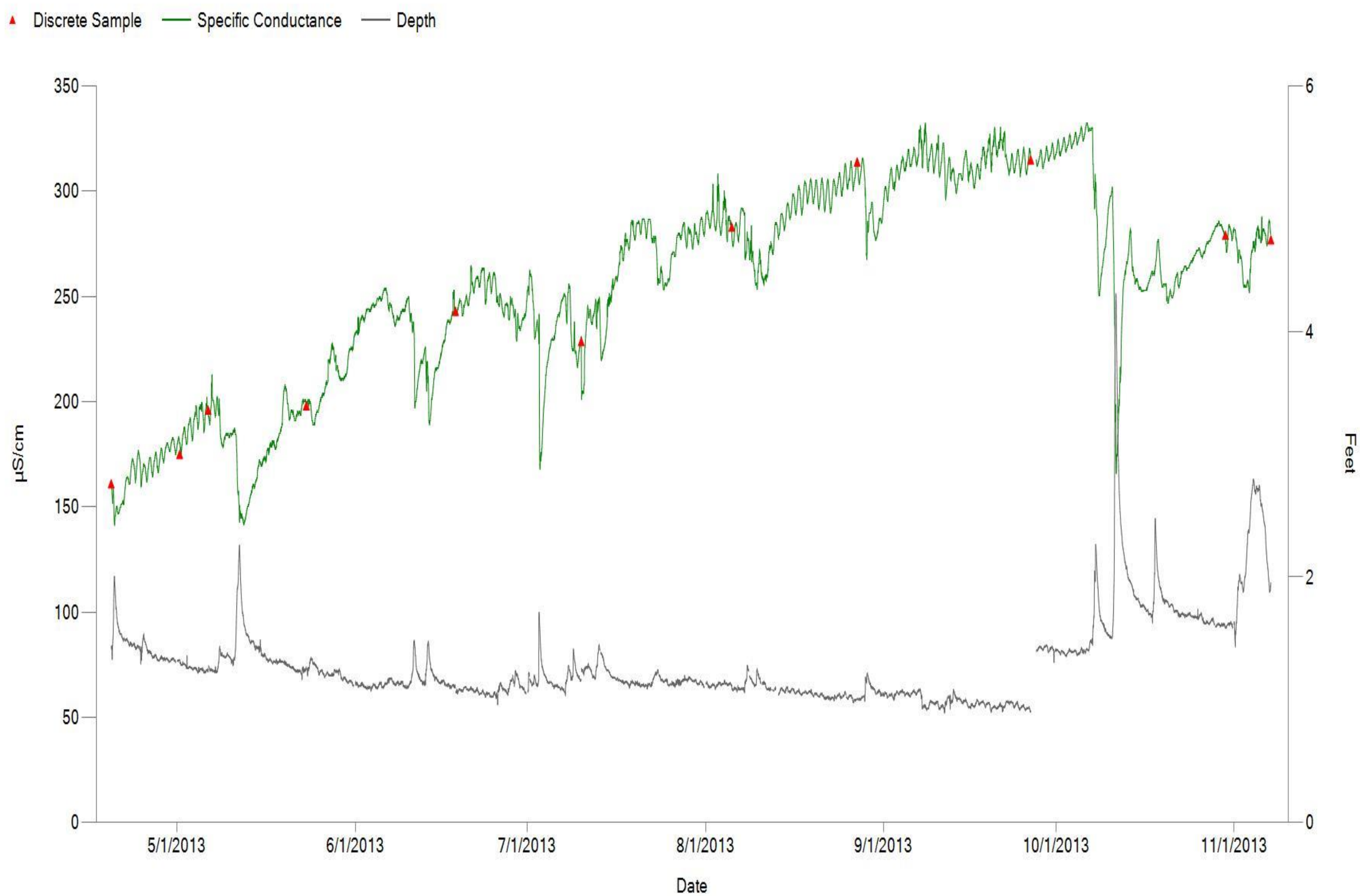


Figure 8. Continuous specific conductance, continuous depth, and discrete samples from April 19, 2013 to November 7, 2013.

2014 Statistics - Average: 203 µS/cm[c]; Maximum: 288 µS/cm[c]; Minimum: 95 µS/cm[c].

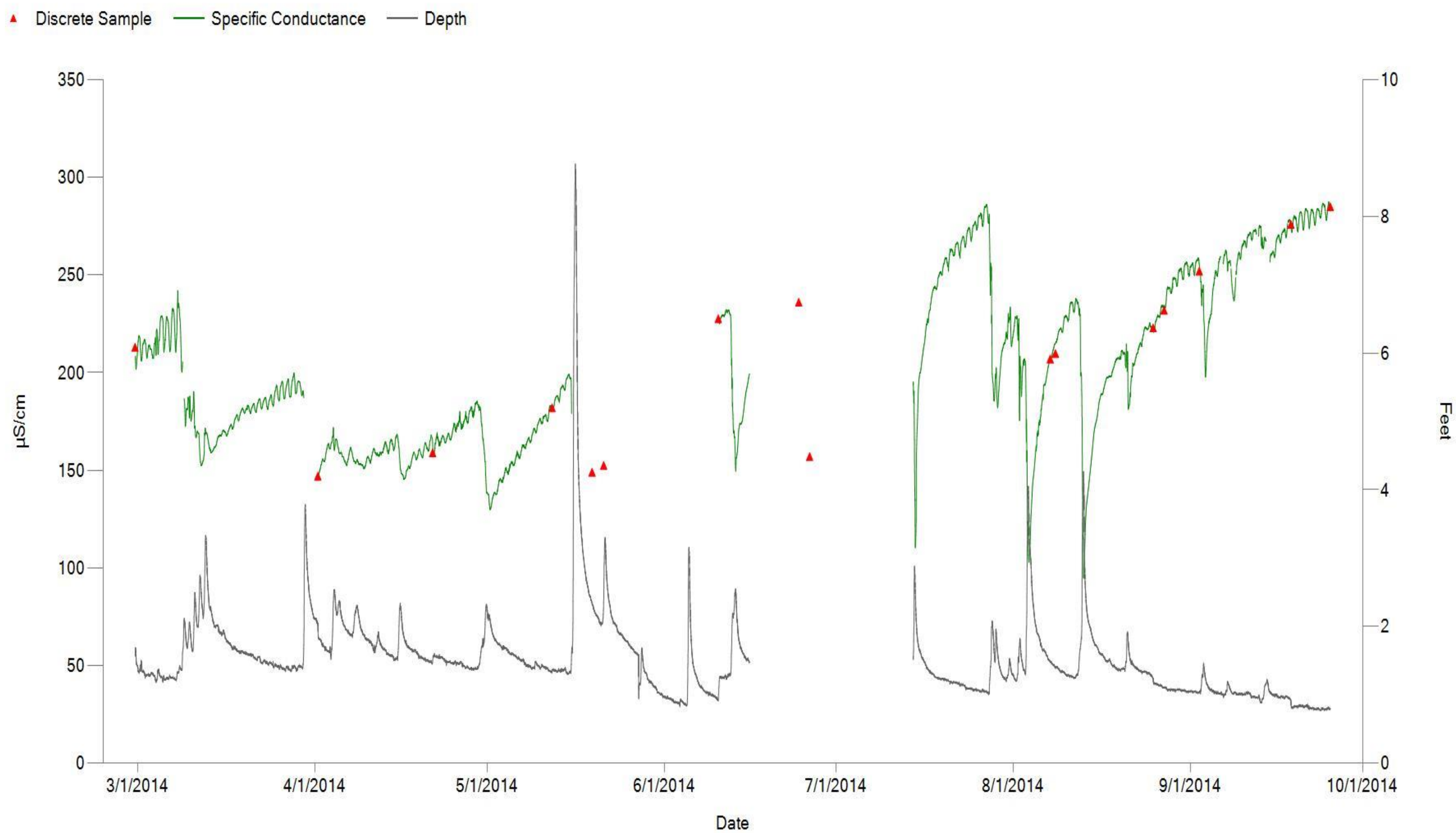


Figure 9. Continuous specific conductance, continuous depth, and discrete samples from February 28, 2014 to September 25, 2014. The first data gap was due to data being graded unusable for a large fouling error. The second data gap was due to equipment failure; no data was recorded.

pH:

2013 Statistics - Average: 7.9 units; Maximum: 9.1 units; Minimum: 7.3 units.

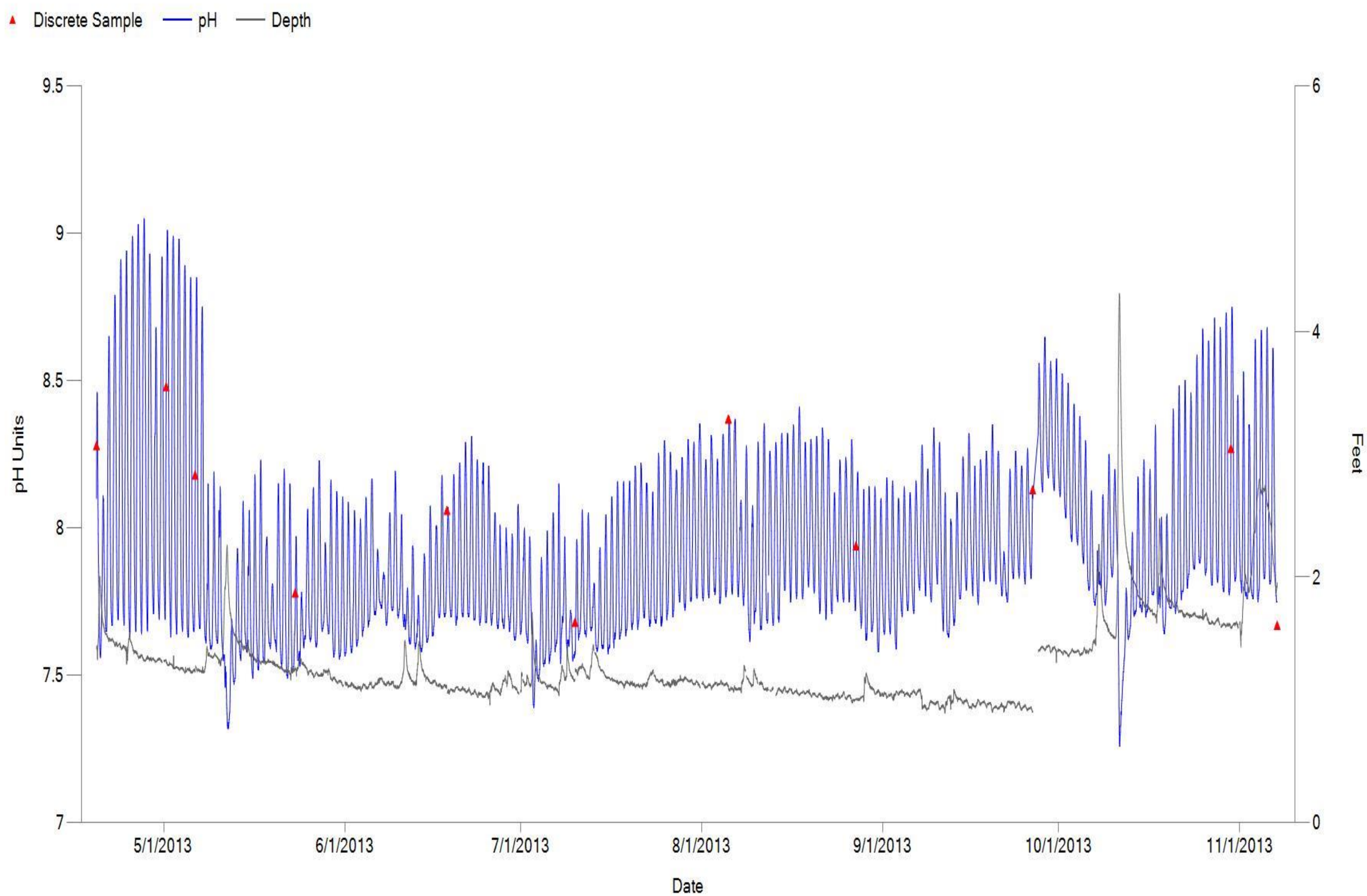


Figure 10. Continuous pH, continuous depth, and discrete samples from April 19, 2013 to November 7, 2013.

2014 Statistics - Average: 7.8 units; Maximum: 9.5 units; Minimum: 7.0 units.

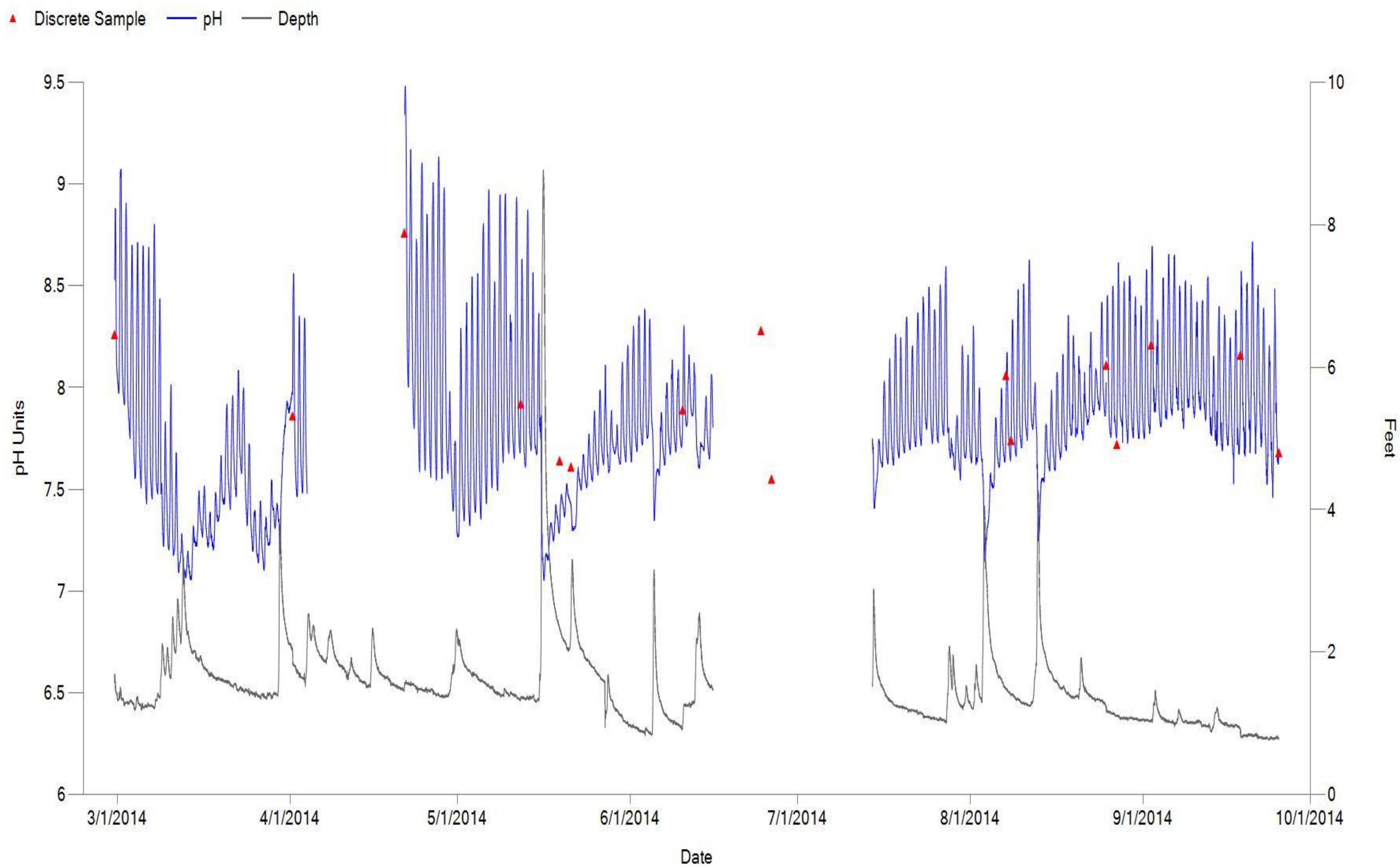


Figure 11. Continuous pH, continuous depth, and discrete samples from February 28, 2014 to September 25, 2014. The first data gap was due to being graded unusable for undocumented fouling. The second data gap was due to equipment failure as a result; no data was recorded.

Dissolved Oxygen:
2013 Statistics - Average: 9.3 mg/L; Maximum: 14.0 mg/L; Minimum: 6.0 mg/L.

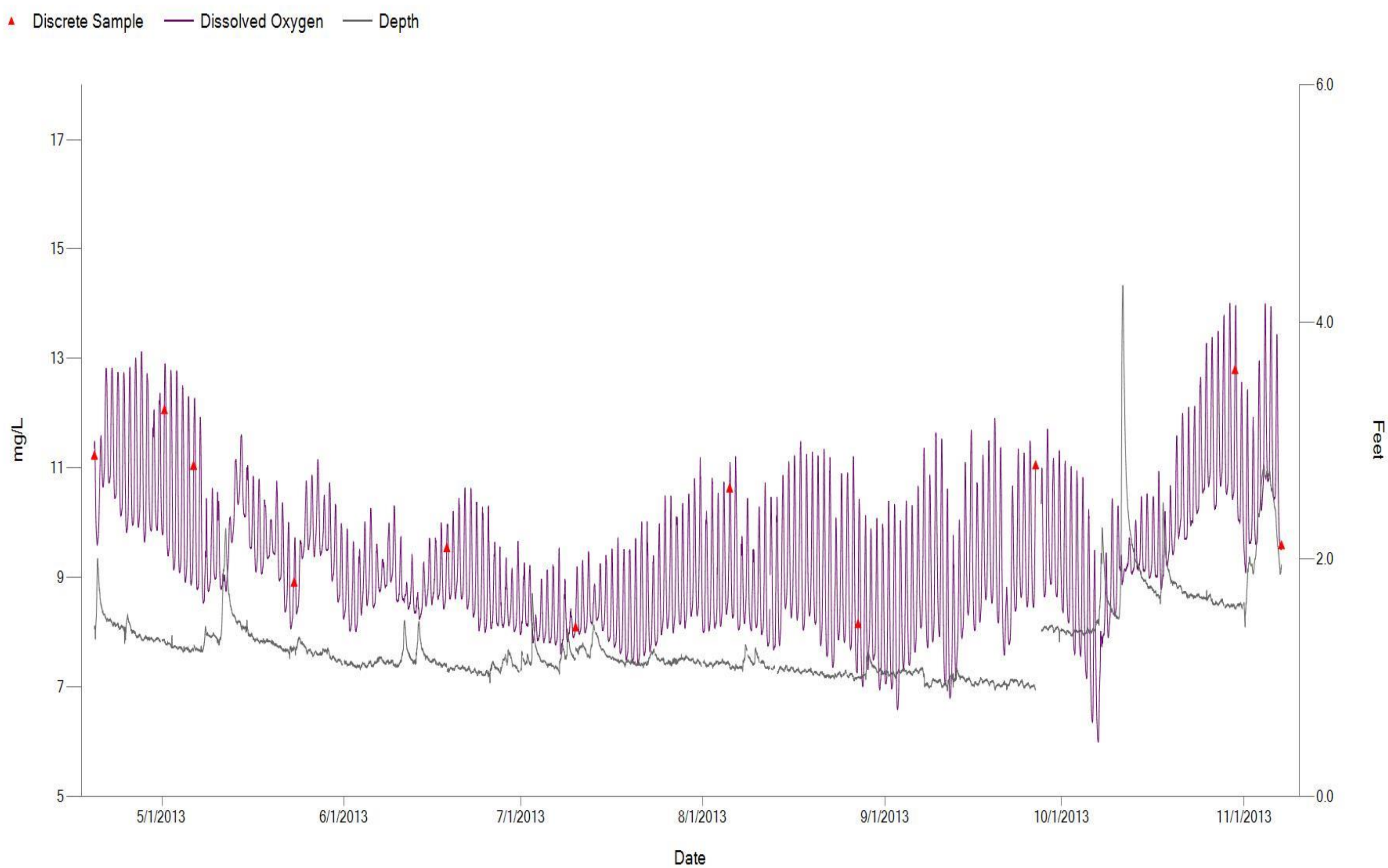


Figure 12. Continuous dissolved oxygen concentrations, continuous depth, and discrete samples from April 19, 2013 to November 7, 2013.

2014 Statistics - Average: 10.2 mg/L; Maximum: 18.6 mg/L; Minimum: 7.8 mg/L.

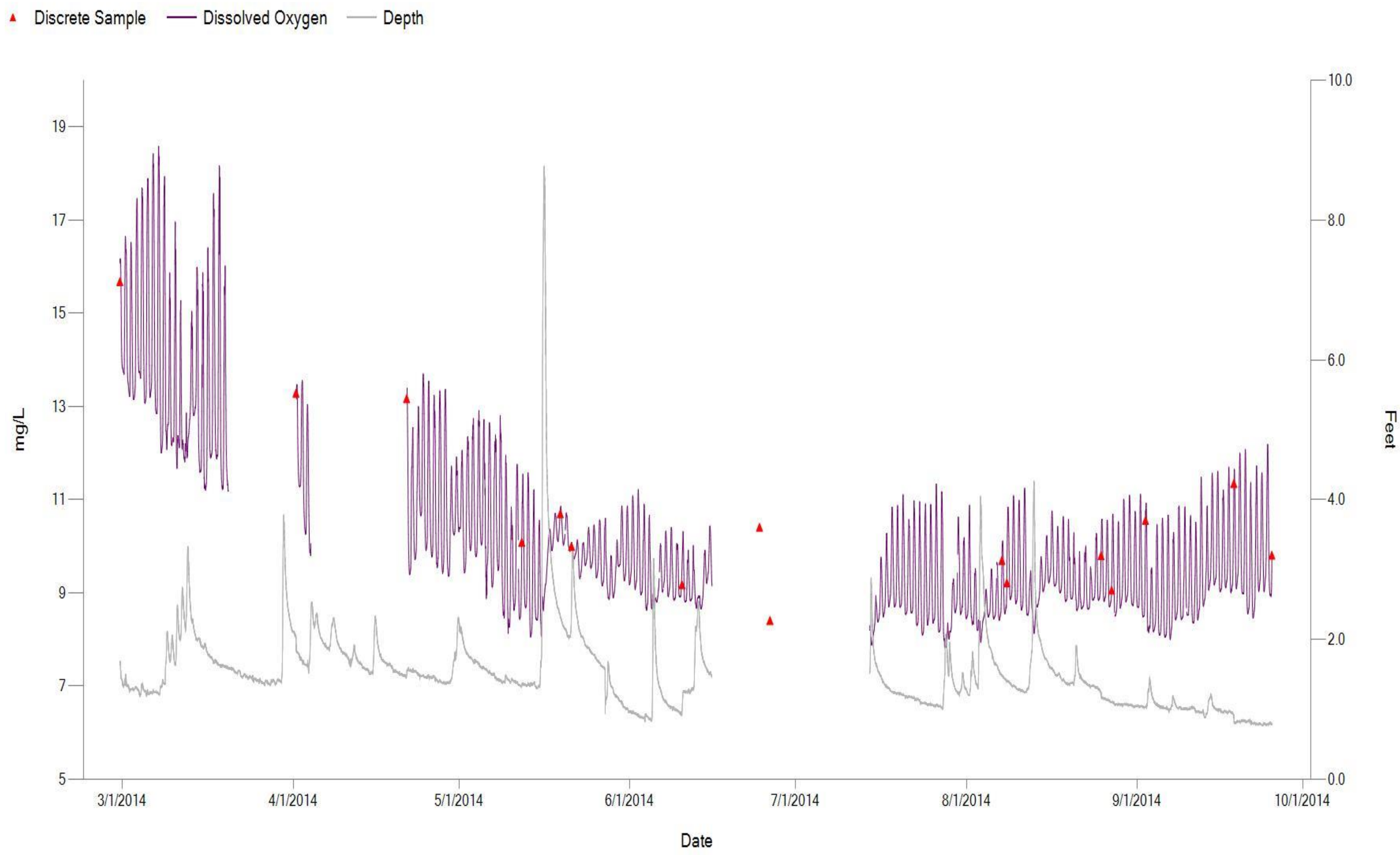


Figure 13. Continuous dissolved oxygen concentrations, continuous depth, and discrete samples from February 28, 2014 to September 25, 2014. All data gaps were due to either false recording as a result of fouling, or equipment failure where no data was collected.

In-situ Water Chemistry: Samples were collected nine times in 2013 and ten times in 2014 using standard analysis code 612. Measurements with "<" indicate concentrations below the reporting limit.

Table 1. 2013 Chemical grab sample results.

Parameters	Units	05/01/2013	05/06/2013	05/23/2013	06/18/2013	08/05/2013	09/26/2013	10/30/2013
		10:00	9:30	13:00	11:00	13:04	15:30	11:17
Stream Flow	CFS	53.195	34.968	41.535	18.762	10.125	--	11.086
ALUMINUM T	UG/L	89.000	71.000	144.000	222.000	53.000	60.000	50.000
BARIUM T	UG/L	44.000	46.000	52.000	61.000	64.000	72.000	60.000
BORON T	UG/L	30.00	40.00	20.00	30.00	20.00	20.00	20.00
BROMIDE	UG/L	<7.03284	<7.03284	9.3210	<7.03284	7.6740	10.4110	10.9020
CALCIUM T	MG/L	21.800	23.800	23.900	31.000	39.900	44.300	36.100
COPPER T	UG/L	0.706	0.597	0.791	1.780	0.708	0.745	0.793
CHLORIDE T	MG/L	5.2680	4.7110	5.1220	7.3710	5.5230	5.2190	9.8850
IRON, T	UG/L	198.000	158.000	236.000	348.000	98.000	74.000	92.000
LEAD T	UG/L	0.202	0.211	0.327	0.457	0.167	0.154	0.095
MAGNESIUM T	MG/L	4.715	5.069	4.982	6.344	7.682	8.740	8.386
MANGANESE T	UG/L	14.000	15.000	21.000	21.000	11.000	10.000	5.000
NICKEL T	UG/L	<13.7856	<13.7856	<13.7856	<13.7856	<13.7856	<13.7856	<13.7856
SELENIUM T	UG/L	<0.32605	<0.32605	<0.32605	<0.32605	<0.32605	<0.32605	<0.32605
SODIUM T	MG/L	3.731	3.296	3.336	4.398	4.186	4.174	5.561
STRONTIUM T	UG/L	251.000	291.000	309.000	406.000	502.000	718.000	530.000
SULFATE T	MG/L	13.7020	14.7610	14.4980	17.0550	19.0900	23.3820	22.9690
ZINC T	UG/L	28.000	7.000	68.000	51.000	<5.1325	<5.1325	<5.1325
ALKALINITY @ pH 4.5	MG/L	67.4	76.8	77.0	93.6	113.4	125.6	102.4
HARDNESS T	MG/L	74	80	80	104	131	147	125
OSMOTIC PRESSURE	MOSM	4	5	6	5	6	5	5
pH	pH units	8.2	8.3	8.2	8.2	8.3	8.2	8.3
SPECIFIC COND @ 25 C	umhos/cm	175.80	195.00	191.90	237.00	275.00	312.00	271.00
TDS @ 180C	MG/L	112	130	116	150	180	168	162
TOC	MG/L	1.7140	1.5840	1.6280	1.7970	1.2610	1.3540	1.4000

Table 1 (continued). 2013 Chemical grab sample results.

Parameters	Units	05/01/2013	05/06/2013	05/23/2013	06/18/2013	08/05/2013	09/26/2013	10/30/2013
		10:00	9:30	13:00	11:00	13:04	15:30	11:17
TSS	MG/L	<5	<5	<5	6	<5	<5	<5
AMMONIA D	MG/L	<0.00672	<0.00672	0.029	0.021	0.010	0.011	<0.00672
AMMONIA T	MG/L	0.142	<0.00672	0.034	0.020	0.009	0.012	<0.00672
NITRATE & NITRITE D	MG/L	0.689	0.642	0.750	1.164	0.817	0.700	1.344
NITRATE & NITRITE T	MG/L	0.689	0.643	0.758	1.177	0.815	0.710	1.338
NITROGEN D	MG/L	0.800	0.737	0.892	1.149	0.968	0.797	1.460
NITROGEN T	MG/L	0.786	0.781	0.921	1.176	0.987	0.770	1.442
PHOSPHORUS D	MG/L	0.009	0.007	0.016	0.018	0.013	0.012	0.008
PHOSPHORUS T	MG/L	0.014	0.013	0.028	0.030	0.016	0.016	0.009
ORTHO PHOSPHORUS T	MG/L	0.006	0.004	0.013	0.025	0.012	0.008	0.006
ORTHO PHOSPHORUS D	MG/L	0.006	0.002	0.009	0.024	0.011	0.007	0.008

Table 2. 2014 Chemical grab sample results.

Parameter	Units	04/01/2014	04/21/2014	05/19/2014	05/21/2014	06/10/2014	06/24/2014	08/07/2014	09/02/2014
		10:41	12:06	8:45	9:23	10:10	11:31	10:16	11:10
Stream Flow	CFS	134.657	90.80	204.820	--	39.132	--	--	18.005
ALUMINUM D	UG/L	--	--	--	--	<200.0	<200.0	<200.0	<200.0
ALUMINUM T	UG/L	217.000	75.000	448.000	298.000	154.000	111.000	119.000	57.000
BARIUM T	UG/L	45.000	40.000	52.000	33.000	65.000	53.000	57.000	56.000
BORON T	UG/L	30.00	<19.1058	<19.1058	20.00	20.00	30.00	30.00	<19.1058
BROMIDE	UG/L	11.2980	9.0090	<6.677	<6.677	6.9690	14.8280	13.2000	15.1640
CALCIUM T	MG/L	18.550	20.100	18.100	17.150	28.200	33.820	26.600	34.100
COPPER D	UG/L	--	--	--	--	<4	<4	<4	<4
COPPER T	UG/L	1.290	0.966	1.400	0.656	1.140	1.070	3.840	0.714
CHLORIDE T	MG/L	9.3970	6.6380	5.6300	3.2610	7.9300	7.4100	8.0150	5.1210
GLYPHOSATE	UG/L	--	--	--	--	nd*	nd*	nd*	--
IRON D	UG/L	--	--	--	--	40.000	34.000	59.000	<20
IRON T	UG/L	369.000	154.000	561.000	350.000	265.000	182.000	291.000	120.000
LEAD D	UG/L	--	--	--	--	<1.0	<1.0	<1.0	<1.0
LEAD T	UG/L	0.445	0.151	0.457	0.289	0.378	0.360	0.640	0.152
MAGNESIUM T	MG/L	3.535	4.095	3.733	3.918	6.197	6.035	5.032	6.304
MANGANESE D	UG/L	--	--	--	--	<10	<10	<10	<10
MANGANESE T	UG/L	17.000	15.000	24.000	17.000	14.000	12.000	12.000	8.000
NICKEL T	UG/L	<13.7856	<13.7856	<13.7856	<13.7856	<13.7856	<13.7856	<13.7856	<13.7856
SELENIUM T	UG/L	0.851	0.725	0.500	1.210	<0.32605	0.624	<0.32605	0.398
SODIUM T	MG/L	5.194	3.929	3.790	2.542	5.107	4.355	5.095	4.060
STRONTIUM T	UG/L	152.000	220.000	161.000	176.000	345.000	360.000	256.000	404.000
Sulfate-Ion T	MG/L	12.0990	12.9590	12.0160	9.9590	15.4900	17.1080	13.4320	17.3600
ZINC D	UG/L	--	--	--	--	<10.0	10.000	<10.0	<10.0
ZINC T	UG/L	<5.1325	8.000	11.000	12.000	<5.1325	12.000	6.000	<5.1325
ALKALINITY @ pH 4.5	MG/L	39.6	53.2	44.8	42.6	78.4	88.2	69.4	94.6

*nd = Not detected

Table 2 (continued). 2014 Chemical grab sample results.

Parameter	Units	04/01/2014	04/21/2014	05/19/2014	05/21/2014	06/10/2014	06/24/2014	08/07/2014	09/02/2014
		10:41	12:06	8:45	9:23	10:10	11:31	10:16	11:10
HARDNESS T	MG/L	61	67	61	59	96	109	87	111
OSMOTIC PRESSURE	MOSM	--	1	<1	<1	5	6	5	3
pH	pH units	7.2	8.3	7.6	7.6	7.9	8.3	8.1	8.2
SPECIFIC COND @25.0 C	umhos/cm	145.80	159.50	145.80	127.90	224.00	234.00	204.00	252.00
TDS @ 180C	MG/L	108	108	100	98	152	162	140	156
TOC	MG/L	2.6290	1.7460	2.3540	1.8720	1.7800	1.5060	2.6130	1.3380
TSS	MG/L	8	<5	12	8	10	<5	6	<5
AMMONIA D	MG/L	0.01200	0.01300	<0.008	0.02900	0.02300	0.01300	0.01700	0.01800
AMMONIA T	MG/L	0.012	0.014	<0.008	0.016	0.012	0.008	0.014	0.009
NITRATE & NITRITE D	MG/L	1.896	0.882	1.666	1.447	1.746	1.227	1.997	1.090
NITRATE & NITRITE T	MG/L	1.918	0.850	1.666	1.438	1.738	1.215	1.978	1.085
NITROGEN D	MG/L	2.148	1.095	1.940	1.459	2.118	1.298	2.401	1.210
NITROGEN T	MG/L	2.172	1.052	1.816	1.471	2.002	1.320	2.229	1.157
PHOSPHORUS D	MG/L	0.013	0.009	0.022	0.015	0.028	0.008	0.018	0.011
PHOSPHORUS T	MG/L	0.026	0.014	0.037	0.025	0.009	0.015	0.025	0.017
ORTHO PHOSPHORUS D	MG/L	0.008	0.007	0.015	0.010	0.016	0.008	0.016	0.010
ORTHO PHOSPHORUS T	MG/L	0.013	0.009	0.021	0.012	0.017	0.011	0.020	0.011

Ammonia Toxicity: The toxicity of ammonia in an aquatic environment varies with respect to the temperature and pH of the water. The ammonia concentrations measured from grab samples were compared to acute and chronic criteria derived from continuous temperature and pH data and formulas in Table 3 of §93.7(a). Measured values were well below these calculated toxicity values (Table 3 and Figures 14 and 15).

Table 3: Grab sample ammonia concentrations and calculated toxicity values in mg/L.

Date	Time	Total Ammonia Concentration	Calculated Acute Toxicity	Calculated Chronic Toxicity
2013 Samples				
05/01/2013	10:00	0.142	3.07	0.721
05/06/2013	09:30	<0.00672	2.45	0.562
05/23/2013	13:00	0.034	2.13	0.500
06/18/2013	11:00	0.02	2.19	0.513
08/05/2013	13:04	0.009	1.71	0.390
09/26/2013	15:30	0.012	--	--
10/30/2013	11:17	<0.00672	3.05	0.698
2014 Samples				
04/01/2014	10:41	0.012	17.51	3.62
04/21/2014	12:06	0.014	2.59	0.592
05/19/2014	08:45	<0.008	10.47	2.79
05/21/2014	09:23	0.016	9.22	2.45
06/10/2014	10:10	0.012	4.17	1.08
06/24/2014	11:31	0.008	1.61	0.369
08/07/2014	10:16	0.014	2.57	0.619
09/02/2014	11:10	0.009	2.00	0.469

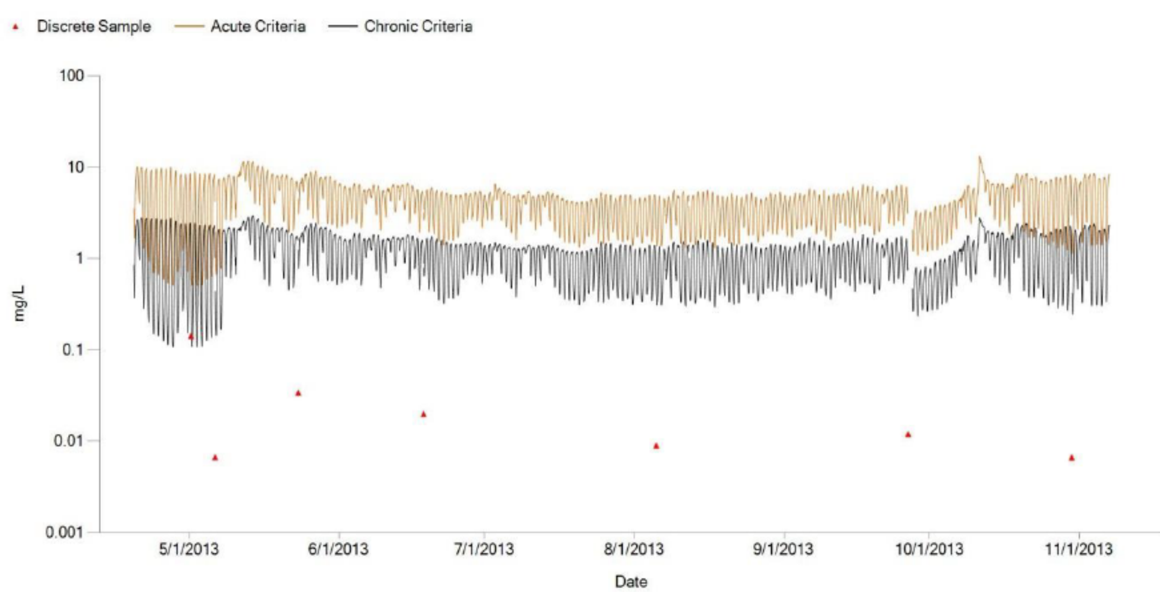


Figure 14. Calculated acute ammonia toxicity, calculated chronic ammonia toxicity, and measured ammonia concentrations from April 19, 2013 to November 7, 2013.

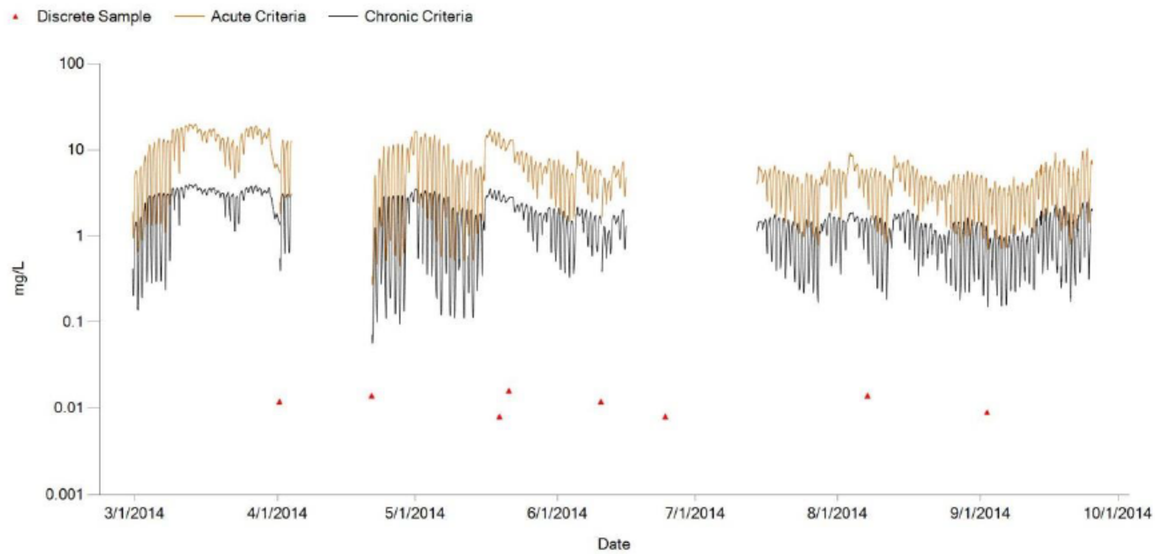


Figure 15. Calculated acute ammonia toxicity, calculated chronic ammonia toxicity, and measured ammonia concentrations from February 28, 2014 to September 25, 2014.

Biology: The indigenous aquatic community is an excellent indicator of long-term conditions and is used as a measure of water quality. Benthic macroinvertebrates (Table 4) were collected on January 15, 2013, August 27, 2013, and November 7, 2013. Fishes were collected on July 12, 2013 (Table 5) and periphyton was sampled on May 6, 2013 (Table 6).

Table 4. Taxa list for benthic macroinvertebrate survey.

Family	Genus	20130115-1100-censor	20130827-0950-mbrickner	20131107-0945-dushull
Baetidae	*Acentrella*		1	
Baetidae	*Baetis*	1	10	
Isonychiidae	*Isonychia*	2	21	4
Heptageniidae	*Epeorus*		2	
Heptageniidae	*Leucrocuta*	2	4	2
Heptageniidae	*Maccaffertium*	5	11	10
Ephemerellidae	*Ephemerella*	57	4	30
Ephemerellidae	*Serratella*	2		1
Caenidae	*Caenis*	1	13	
Leptophlebiidae	*Leptophlebia*	1		
Leptophlebiidae	*Paraleptophlebia*	1	1	3
Ephemeridae	*Ephemera*			1
Gomphidae	*Lanthus*			1
Perlidae	*Agnetina*		5	
Perlidae	*Neoperla*		1	
Taeniopterygidae	*Taeniopteryx*	5		5
Taeniopterygidae	*Taenionema*			2
Taeniopterygidae	*Strophopteryx*	1		

Table 4 (continued). Taxa list for benthic macroinvertebrate survey.

Family	Genus	20130115-1100-censor	20130827-0950-mbrickner	20131107-0945-dushull
Capniidae	*Allocapnia*	24		
Perlidae	*Acroneuria*	3	11	2
Sialidae	*Sialis*	1		2
Corydalidae	*Corydalus*	2	5	
Philopotamidae	*Chimarra*	6	1	3
Hydropsychidae	*Ceratopsyche*	9	3	9
Hydropsychidae	*Cheumatopsyche*	15	5	19
Rhyacophilidae	*Rhyacophila*	1	2	2
Glossosomatidae	*Glossosoma*			1
Apataniidae	*Apatania*			9
Goeridae	*Goera*			1
Brachycentridae	*Brachycentrus*		2	
Limnephilidae	*Pycnopsyche*	2		
Uenoidae	*Neophylax*	7		1
Psephenidae	*Psephenus*	8	22	5
Elmidae	*Optioservus*	32	33	45
Elmidae	*Stenelmis*	7	27	8
Athericidae	*Atherix*	2	3	
Empididae	*Hemerodromia*	1		
Limoniidae	*Antocha*	3	3	9
Pediciidae	*Dicranota*			1
Simuliidae	*Prosimulium*	2		
Chironomidae		25	20	14
Oligochaeta		2	4	2
Gammaridae	*Gammarus*	2		
Cambaridae	*Orconectes*		1	

Table 5: Taxa list for fish survey.

Family	Species Name	Common Name	20130712-1300-twertz	20140701-1100-twertz
Catostomidae	*Catostomus commersonii*	White Sucker	15	8
Centrarchidae	*Ambloplites rupestris*	Rock Bass	10	1
Cottidae	*Corrus cognatus*	Slimy Sculpin	1	
Cyprinidae	*Luxilus cornutus*	Common Shiner	4	15
Cyprinidae	*Pimephales notatus*	Bluntnose Minnow		2
Cyprinidae	*Rhinichthys atratulus*	Blacknose Dace		23
Cyprinidae	*Rhinichthys cataractae*	Longnose Dace	100	14

Table 5 (continued): Taxa list for fish survey.

Family	Species Name	Common Name	20130712-1300-twertz	20140701-1100-twertz
Cyprinidae	*Exoglossum maxillingua*	Cutlip Minnow	16	63
Cyprinidae	*Semotilus atromaculatus*	Creek Chub	3	
Percidae	*Etheostoma blennioides*	Greenside Darter	2	2
Percidae	*Etheostoma olmstedi*	Tessellated Darter	2	3
Percidae	*Percina peltata*	Shield Darter		3
Salmonidae	*Salmo trutta*	Brown Trout	97	61

Table 6: Periphyton analysis data, 2013

	Chlorophyll-a	Pheophytin-a
May 6, 2013	277 mg/m^3	33 mg/m^3

ASSESSMENT:

Continuous: Overall, parameters collected by the instream monitor indicated good water quality conditions in 2013. Specific conductance measurements steadily increased throughout the sampling period and were consistent with expected seasonal and diel fluctuations. Dilution effects were observed during high flow events. Continuous measurements of pH were elevated at the beginning of the sampling period, with readings close to or slightly exceeding 9.0 on a few days. Otherwise, pH measurements were consistent. Dissolved oxygen measurements were consistent with seasonal and diel swings.

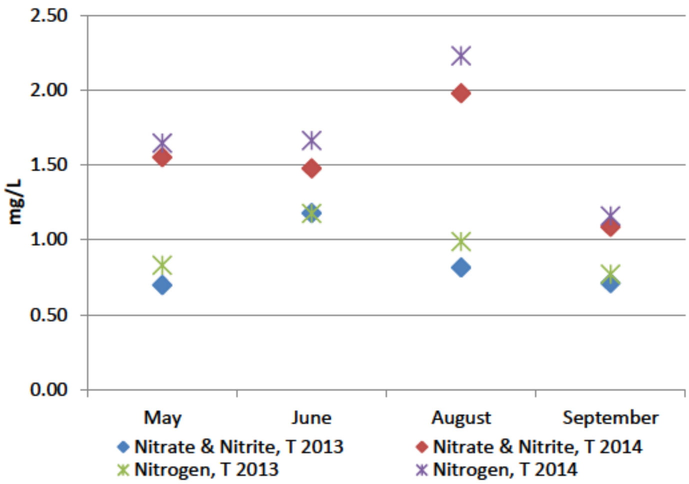
Continuous instream monitoring in 2014 indicated a more enriched water quality condition than 2013. Overall, specific conductance, pH, and dissolved oxygen measurements were consistent with diel and seasonal fluctuations, with a strong dilution effect occurring during high flow events. Specific conductance was slightly elevated for a brief amount of time in the beginning of the sampling period. An early high flow event diluted the system and specific conductance steadily increased as was expected. Measurements of pH were elevated for the first few monitoring months with multiple daily exceedances of 9.0 to as high as 9.5. In addition, above normal dissolved oxygen diel swings, a difference of approximately 7 mg/L, were observed during the first few months of the sampling period. These observations demonstrate anthropogenic influences on the water quality conditions of the watershed.

Chemistry: In both years grab samples were collected in May, June, August, and September. Means were calculated from those four months and were used as a basis for highlighting chemistry parameters showing the most change between 2013 and 2014 (Table 7). Nutrient concentrations, in particular the nitrogen containing compounds, resulted in a noticeable change between years. Nitrate and nitrite, nitrogen, aluminum, and iron concentrations were greater in 2014 (Figure 16). All other analytes were similar in both the 2013 and 2014 sampling periods.

Table 7. Analytes grouped with means and standard deviations calculated as described above. Parameters in red text were further compared.

Nutrients	Year	Mean (mg/L)	SD (mg/L)	Metals	Year	Mean (µg/L)	SD (µg/L)
AMMONIA T	2013	0.088	0.044	ALUMINUM T	2013	101.333	50.667
	2014	0.013	0.008		2014	252.750	175.881
NITRATE & NITRITE T	2013	0.697	0.348	BARIUM T	2013	47.333	23.667
	2014	1.514	0.875		2014	50.750	30.065
NITROGEN T	2013	0.829	0.415	BORON T	2013	30.000	15.000
	2014	1.652	0.954		2014	22.500	13.150
ORTHO PHOSPHORUS T	2013	0.016	0.012	COPPER T	2013	0.698	0.349
	2014	0.015	0.009		2014	1.067	0.617
PHOSPHORUS T	2013	0.024	0.015	IRON T	2013	197.333	98.667
	2014	0.022	0.015		2014	339.500	217.694
				LEAD T	2013	0.247	0.123
Salts		Mean (mg/L)	SD (mg/L)		2014	0.371	0.214
CALCIUM T	2013	23.167	11.583	BROMIDE	2013	9.321	4.661
	2014	24.318	15.066		2014	10.899	6.292
SODIUM T	2013	3.454	1.727	MAGNESIUM T*	2013	4.922	2.461
	2014	3.949	2.368		2014	4.971	3.018
CHLORIDE T	2013	5.034	2.517	MANGANESE T	2013	16.667	8.333
	2014	6.058	3.737		2014	16.750	10.144
SULFATE T	2013	14.320	7.160	NICKEL T	2013	--	--
	2014	13.643	8.170		2014	--	--
TDS @ 180 C	2013	134.667	78.751	SELENIUM T	2013	--	--
	2014	128.000	77.602		2014	0.740	0.437
TOC	2013	1.720	0.995	STRONTIUM T	2013	283.667	141.833
	2014	1.878	1.101		2014	260.500	168.115
TSS	2013	--	--	ZINC T	2013	--	--
	2014	10.000	5.774		2014	--	--

*magnesium reported in mg/L



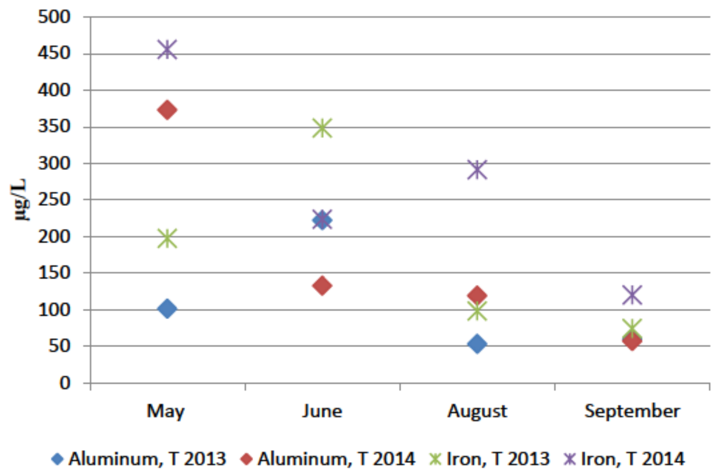


Figure 16. A visual comparison of nutrient and metal concentrations resulting in noticeable change between sampling years.

With 2014 being a higher flow year, the elevated chemistry concentrations observed may be related to an increase in surface runoff in 2014. Furthermore, discrete discharges measured at time of sample collection (refer to Tables 1 and 2), particularly in May 2014, could contribute to differences in aluminum and iron concentrations between 2013 and 2014.

Biological: Overall, the macroinvertebrate surveys conducted in 2013 indicated good water quality. Samples scored consistently and total richness was similar amongst samples (Table 8). The most dominant taxa were *Ephemerella,* a mayfly intolerant to pollution, and *Optioservus*. The fish collected are typical of a small, cold-water stream. The most abundant fish were the brown trout and longnose dace in 2013, and the cutlip minnow and brown trout in 2014.

Table 8. Benthic macroinvertebrate metric calculations.

Date	IBI	Richness	Mod EPT	HBI	% Dom	% Mod May	Beck3	Shannon Div
January 15, 2013	87.6	31	19	3.39	24.6	30.2	15	2.65
August 27, 2013	79.5	26	17	4.10	15.3	20.5	18	2.77
November 7, 2013	88.0	27	18	3.60	23.4	26.6	20	2.64

SUMMARY: Continuous instream monitor, water chemistry, and biological data suggest overall good water quality. Elevated pH measurements in the beginning of both sampling years and deviations from normal dissolved oxygen diel swings in 2014 suggest an impacted watershed. In addition, elevated concentrations of nitrogen containing compounds, aluminum, and iron suggest an increase in anthropogenic inputs to the watershed in 2014. The biological surveys yielded similar community compositions in each of the seasons sampled, signifying aquatic life attainment for the watershed. Since the watershed is made up of mostly forested land (65%), impacts observed in water quality are most likely contributed to agricultural land use (34%).

LITERATURE CITED

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