Aultmans Run Watershed AMD Assessment & Implementation Plan Update

A Public-Private Partnership Effort

AWARE & Stream Restoration Inc.

Funded by PA DEP, AMD Set-Aside Program

Prepared by BioMost, Inc.

Indiana County, Pennsylvania

June 2021

Aultmans Run Watershed AMD Assessment & Implementation Plan – Update

Table of Contents Page Number

Front Page Photo: Coal Run is still heavily impacted by mine discharges and is stained red, especially during the low-flow time of year.

Appendices

Tables

1.0 INTRODUCTION

This report is an expansion of the "Aultmans Run Watershed AMD Assessment & Implementation Plan" (2016 Report) completed in March 2016 to better assess the current conditions within the watershed and develop a Qualified Hydrologic Unit Plan (QHUP). The 2016 Report primarily contained historic data from previous monitoring conducted by local mining companies and the Pennsylvania Department of Environmental Protection (PA DEP). Funding was received through the AML Set-Aside program to conduct a year of sampling of the major streams and most polluted abandoned mine discharges. A total of 21 discharges were monitored and 17 stream sites. Since the 2016 Report, additional treatment components were added to the Neal Run Restoration Area, a limestone-only automatic-flushing vertical flow pond and settling pond. No other changes were identified in the watershed that would affect water quality since the previous monitoring. A major discharge not included in previous assessment efforts was identified with the help of the PA DEP and PA Game Commission (PGC). This discharge is likely from an abandoned underground mine and has contributed to the degraded ponds located along Aultmans Run Road in the area locally referred to as "Coon Hollow". As part of the assessment, two students from the Indiana University of Pennsylvania collected macroinvertebrates and fish samples at a dozen locations in the watershed. These samples were identified to the family level and species level, respectively.

2.0 WATER MONITORING

Through a partnership with Aultman Watershed Association for Restoring the Environment (AWARE), Stream Restoration Incorporated (SRI), Kiski-Conemaugh Stream Team, and BioMost, Inc. (BioMost), water samples were collected on a quarterly and monthly basis dependent on location. Chris Garbark, director of the Stream Team, was in the process of restarting sampling within the Aultmans Run Watershed after a prolonged period of no sampling. SRI coordinated with the Stream Team and AWARE to avoid duplicate sampling. The names and naming conventions used in the previous report were used to identify the sample points. Many of the sample points have been given multiple names throughout the years. Alternative names are included in the description of the sample points found in Appendix D. The last four months of sampling became a challenge due to the onset of the COVID-19 pandemic. Due to the PA DEP lab shutting down, the Stream Team was unable to sample the scheduled April 2020 sampling. BioMost agreed to monitor in their place. Several samples were also lost by the PA DEP lab for the January 2020 sampling.

2.1 Streams

A total of 17 instream monitoring points were established on the main stem of Aultmans Run and its major tributaries, Reeds Run, Neal Run, and Coal Run. Biological data was also collected at 12 of these monitoring points. Please see Appendix D and F for all of the water quality data and biological report, respectively.

2.1.1 Water Quality

Monitoring consisted of water sample collection for laboratory analysis of typical mine drainage parameters along with field measurements of pH, DO, temperature, alkalinity, and flow rate. Samples were taken quarterly for a year to determine the current conditions of the watershed. Flows were taken during one monitoring event in May 2020 using a USGS Pygmy Current Meter.

These results were compared with the TMDL endpoints established for the entire Kiski-Conemaugh River Basin for AMD affected streams. A TMDL establishes the amount of a pollutant that a waterbody can assimilate without exceeding its water quality standard for that pollutant. The TMDL endpoints included in the TMDL are shown in Table 1.

Table 1: TMDL Endpoint

Parameter	Endpoint
Aluminum	712.5 µg/L
Total Iron	1,425.0 µg/L
Dissolved Iron	285.0 µg/L
Manganese	950.0 µg/L

In addition to the TMDL endpoints, the in-stream water quality criteria of pH has been set between 6.0 and 9.0 in Pennsylvania.

Aultmans Run: Water quality has improved to the point that all in stream monitoring points meet the limits included in the TMDL except for dissolved iron. In comparison the historical data provided in the 2016 Report, all of the monitoring points have improved. Above the SR286 PTS, A2M-MP13 indicates no influence due to mining with a very low sulfate concentration of 16 mg/L. The highest metal concentrations were found at A2M-MP14, which is below the SR286 Passive Treatment System. This system treats a high-flow, alkaline, iron discharge. Alkalinity within Aultmans Run rises as it flows downstream to John-1 but lowers below Reeds Run and Coal Run. Sulfate concentrations rise as you move downstream as well. Dissolved iron increases again at K56-2, which is located downstream of Reeds Run and is still impacted with abandoned mined drainage.

Table 2: Aultmans Run Water Monitoring Data (average values)

	Sample Point	**pH** (s.u.)	**Alk** (mg/l)	**Acidity** (mg/l)	**Fe** (mg/l)	**D. Fe** (mg/L)	**Mn** (mg/L)	**Al** (mg/L)	**SO_4** (mg/L)
←Downstream	A2M – MP13	7.5	52.7	-44.1	0.4	0.2	0.1	0.2	16
	A2M – MP14	7.2	55.1	-46.3	1.4	0.8	0.2	0.1	41
	John – 1	7.8	73.6	-62.3	0.5	0.2	0.2	0.1	120
	K56 – 2	7.6	52.5	-47.3	0.4	0.4	0.4	0.2	133
	AUL03	7.5	53.7	-43.9	0.4	0.2	0.3	0.3	155
	K55 – SM14	7.3	46.5	-37.3	0.5	0.2	0.4	0.3	154

Highlighted fields indicate that the sampling point does not meet the applicable water quality criteria listed in Table 1. Total metal values. (Refer to attached monitoring data in Appendix D.)

Reeds Run: A total of five sample points were located on Reeds Run, while three were located on Neal Run and one on RUNT04B, which are tributaries to Reeds Run. Water quality results indicate that Reeds Run has improved from the headwaters near the Reeds Run Restoration Area all the way to the mouth. Sampling within this watershed, however, is affected by the daily flushing from the Neal Run passive treatment system that is located on a tributary of Reeds Run. During monitoring the system was scheduled to flush at 10 AM Eastern Standard Time for 90 minutes. During and after the flushing events, the downstream reaches of Neal Run and Reeds Run are likely influenced by the slug of partially treated water. Downstream of the treatment system, water samples were primarily collected in the afternoon post-flushing. A conductivity data logger was installed by the Stream Team near the mouth of Neal Run. This logger has documented slight variations in the conductivity within Neal Run during flushing events; however, by the time the flush water reaches the data logger, the average upward swing in conductivity is only 15 µS/cm (See Appendix E - Data Logger Data and Graph). Dissolved iron concentrations were above the water quality criterion below the Reeds Run Restoration Area, below the RD0-D3 discharge at REE03, and below Neal Run, which is still impacted by the D2 discharge. The pH below the D2 discharge is also below the water quality criteria.

Table 3: Reeds Run Water Monitoring Data (average values)

	Sample Point	pH (s.u.)	Alk (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/L)	Mn (mg/L)	Al (mg/L)	SO_4 (mg/L)
←Downstream	K53 - SW32	7.4	37	-28	0.6	<0.1	0.4	0.1	33
	K53 - SW33	7.0	32	-18	1.1	1.1	0.5	0.5	50
	REE03	7.5	52	-44	0.4	0.4	0.6	0.2	203
	Jack - MP27	7.5	41	-34	0.8	0.3	0.6	0.3	148
	REE01A	7.3	38	-27	0.6	0.3	0.9	0.5	254

Highlighted fields indicate that the sampling point does not meet the applicable water quality criteria listed in Table 1: TMDL Endpoint. K53-SW33 sample dated 9/19/19 had a total iron value of 15.7 mg/L and was excluded from the average due to being anomalous. (Refer also to attached monitoring data in Appendix D.)

Table 4: Neal Run Water Monitoring Data (average values)

	Sample Point	pH (s.u.)	Alk (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/L)	Mn (mg/L)	Al (mg/L)	SO_4 (mg/L)
↓ Downstream	NL0-MP2	7.2	84	-68	0.3	0.2	0.2	0.1	133
	NL0-MP3	5.2	25	82	12.4	9.4	1.2	13.5	319
	NEAL01	7.3	34	-26	1.2	0.3	0.6	0.6	138

Highlighted fields indicate the sampling point does not meet the applicable water quality criteria listed in Table 1: TMDL Endpoint. (Refer also to attached monitoring data in Appendix D.)

Table 5: RUNT04B Water Monitoring Data (average values)

Sample Point	pH (s.u.)	Alk (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/L)	Mn (mg/L)	Al (mg/L)	SO_4 (mg/L)
RUNT04B	7.4	59	-47	0.7	0.1	5.2	1.5	411

Highlighted fields indicate the sampling point does not meet the applicable water quality criteria listed in Table 1: TMDL Endpoint. Total metal values except for dissolved iron. (Refer also to attached monitoring data in Appendix D.)

Coal Run: Monitoring on Coal Run was not conducted as frequently as Reeds Run due to the size of the watershed and the planned upcoming reclamation. Two sample points were established on the stream, one above Saltsburg Road, COAL02, and the other at the mouth of the watershed. Previous monitoring has shown that the unnamed tributary to Coal Run, CUT01, has not been impacted by mining, and as a result, was not sampled. AWARE and BioMost. conducted a stream walk to determine the location of the majority of impacts on the mainstem of Coal Run. The mouth of Coal Run exceeded the water quality criteria for total iron and dissolved iron.

Table 6: Coal Run Water Monitoring Data (average values)

↓ Downstream	**Sample Point**	**pH** (s.u.)	**Alk** (mg/l)	**Acidity** (mg/l)	**Fe** (mg/l)	**D. Fe** (mg/L)	**Mn** (mg/L)	**Al** (mg/L)	**SO_4** (mg/L)
	COA02	7.5	93	-84	0.2	0.1	0.2	0.0	165
	COA01	6.7	36	-27	1.5	1.2	0.5	0.3	134

Highlighted fields indicate the sampling point does not meet the applicable water quality criteria listed in Table 1. Total metal values except for dissolved iron. (Refer also to attached monitoring data in Appendix D.)

2.1.2 Flow and Loading

During the May 2020 monitoring event, flows were measured at the stream locations with a USGS Pygmy Current Meter. These measurements can be seen in Table 7: Stream Flow Measurements and Loading Calculations.

Table 7: Stream Flow Measurements and Loading Calculations from 5/20/20

Stream	**Location**	**Flow (gpm)**	**Loading (lb/day)**		
			Fe	**Mn**	**Al**
Aultmans Run	A2M-MP13	1145	5.0	1.2	2.6
	A2M-MP14	1781	10.7	3.2	3.4
	John-1	1989	11.0	5.3	2.9
	K56-2	5155	24.2	24.8	13.0
	AUL03	5028	22.4	15.7	27.2
	K55-SM14	6633	31.9	27.9	36.7
Reeds Run	SW32	186	0.4	0.0	0.3
	SW33	261	3.2	1.3	0.8
	RUNT04B	233	2.0	10.5	6.7
	REE03	666	2.2	6.7	0.8
	Jack-MP27	1465	24.8	11.1	6.3
	REE01	2035	11.7	19.1	13.0
Neal Run	NL0-MP2	335	0.5	0.5	0.4
	NL0-MP3	432	1.5	1.6	0.6
	NEAL01	602	1.5	2.8	0.7
Coal Run	COA2	119	0.3	0.3	0.0
	COA1	932	14.0	5.8	4.9

Note: Please also see Appendix A for sample point locations.

Flow and metal loadings increase significantly after Reeds Run flows into Aultmans Run. Loadings increase also after the confluence with Coal Run, especially aluminum.

2.1.3 Biological

Students from Indiana University of Pennsylvania under the direction of Dr. David Janetski, Professor of Biology, completed a stream bioassessment at 12 locations throughout the watershed. The goals of the study were to determine areas of the watershed that need improvement due to non-point source impacts and also document the recovery of some sections of stream due to the construction of the three existing passive treatment systems. Benthic macroinvertebrates were collected using 1-m^2 kick net within a 1-m^2 area for one minute in two separate areas within the stream reach. These macroinvertebrates were taken back to the laboratory for identification. Fish were collected using a backpack electrofishing unit and then identified and counted in the field.

Prior to the coal refuse removal and construction of the passive treatment systems at the Reeds Run and Neal Run Restoration Areas, IUP students documented no aquatic life in the streams downstream of the discharges. The current monitoring has identified macroinvertebrates at every sample location except A2M-MP14 (85-13) and fish were found at every sample point, although some areas were very limited. A narrative summarizing the results along with the raw data can be found within Appendix F: IUP Biological Study. Macroinvertebrates were collected at eleven sites while fish were collected at eight sites. The preservative for REE01 was bad and the collected macroinvertebrates became unidentifiable. Fish were sampled above and below the treatment systems, at the mouth of Coal Run, and at the furthest downstream sample point, K55-SM14.

Table 8: Macroinvertebrate and Fish Summary

Site Name	Macroinvertebrates		Fish	
	Taxonomic Richness	**Abundance**	**Taxonomic Richness**	**Abundance**
NLO-MP2	10	178	2	63
NLO-MP3	1	1	1	1
NEAL01	4	16	--	--
K53-SW32	12	173	2	112
K53-SW33	9	44	4	63
REE01	--	--	--	--
85-14	10	511	14	236
85-13	0	0	17	194
John-1	5	38	--	--
K56-2	6	101	--	--
AUL03	9	249	--	--
K55-SM14	--	--	17	106
COA1	--	--	--	--
Total	**19**	**1311**	**22**	**775**

An evaluation of habitat was conducted using the Environmental Protection Agency's Rapid Bioassessment Protocol For Use in Streams and Wadeable Rivers. Habitat scores ranged from 4.9 to 9.5, with the lowest score below the Neal Run Restoration Area at NL0-MP3. This segment of stream has been affected for years by precipitating metals from mine drainage causing high embeddedness and lowering the frequency of riffles and available cover. Sites with the highest ratings were over 0.5 miles from the discharge sites. The highest rated site was Aultmans Run below Reeds Run at K56-2 with a score of 9.5. The individual rankings are included in Table 9. Raw data can be found within Appendix F: IUP Biological Study.

Table 9: Stream Habitat Scores

Site Name	Overall Score
NLO-MP2	7.0
NLO-MP3	4.9
NEAL01	8.0
K53-SW32	7.8
K53-SW33	6.2
REE01	6.7
85-14	8.3
85-13	6.1
John-1	6.8
K56-2	9.5
AUL03	7.1
K55-SM14	8.3

2.2 Abandoned Mine Drainage (AMD)

A total of 21 discharges were monitored during the study period. Water monitoring was conducted on the discharges at the sites with the largest metal loadings in the watershed. Discharges that have been fully treated with an existing passive system were monitored quarterly. In addition, several discharges were discovered during the assessment including CL0-D13 and CL0-D14. The discharges found within the "Foot Run" subwatershed were only sampled during one monitoring event as water quality is likely to improve with the adjacent coal refuse removal project to be completed in the near future.

Table 10: Average Water Monitoring Data of Abandoned Mine Discharges (2019-2020)

Sample Point	**Flow** (gpm)	**pH** (su)	**SC** (µS/cm)	**Alk** (mg/l)	**Acidity** (mg/l)	**Fe** (mg/l)	**D. Fe** (mg/l)	**Mn** (mg/l)	**D. Mn** (mg/l)	**Al** (mg/l)	**D. Al** (mg/l)	**SO_4** (mg/l)
AM0-D13	33.1	3.3	1307	0.0	73.0	1.7	1.5	3.4	3.0	4.5	4.0	636
AM11-D1	63.8	4.0	982	1.8	164.0	0.6	--	6.9	--	12.6	--	597
CL0-D13	199.5	3.7	1267	0.0	61.2	7.0	6.1	1.5	1.4	5.2	4.9	596
CL0-D14	4.6	6.2	610	30.5	-8.2	15.6	14.5	1.5	1.4	0.0	0.0	253
CL0-D2	2.6	4.5	662	5.7	13.5	2.2	1.9	2.1	2.0	0.1	0.1	296
CL0-D8	6.1	3.0	1656	0.0	216.6	10.3	9.4	3.2	3.0	17.0	16.1	851
D2	15.2	2.8	6038	0.0	5029.6	943.6	933.4	15.7	13.8	430.0	395.4	6203
D3	4.8	3.2	1287	0.0	501.5	55.0	32.0	6.7	4.7	39.7	9.2	1012
GPR3	6.2	6.2	1833	63.6	23.3	42.3	38.7	3.5	3.2	0.1	0.0	944
Jack-MP1	1.7	3.6	1538	0.0	63.9	0.4	0.3	4.0	3.8	6.0	5.7	866
Jack-MP2	1.1	3.6	1584	0.0	74.7	1.5	1.4	3.9	3.7	7.0	6.6	871
Jack-MP4	41.3	3.7	1718	0.2	67.7	9.2	8.1	3.8	3.5	4.2	3.8	903
Jack-MP4A	9.7	3.4	1829	0.0	78.6	1.3	0.5	2.0	1.9	5.4	5.2	1021
K53-MS29	36.2	7.5	240	86.8	-76.3	3.9	2.0	0.9	0.5	3.1	1.8	29
RD0-D3	28.1	6.1	554	54.1	-37.1	11.5	10.2	4.4	4.1	0.1	0.0	233
SR286 Discharge	92.6	6.5	457	90.3	-54.7	15.2	11.5	0.6	0.5	0.1	0.0	132

AM11-D1 averages from 2002 sampling conducted by AWARE.

Table 11: Individual Mine Discharges in the Aultmans Run Watershed Ranked by Total Metals Loadings (2019-2020)

Rank	Sample Point	Loading (lb/day)					Contribution (%)				
		Acidity	Fe	Mn	Al	Total Metals	Acidity	Fe	Mn	Al	Total Metals
1	D2	847.3	194.0	2.5	85.7	282.2	76.9	81.1	12.2	77.9	76.3
2	CL0-D13	162.8	13.6	3.7	14.2	31.6	14.8	5.7	17.9	12.9	8.5
3	SR286	-64.6	15.6	0.7	0.2	16.4	-5.9	6.5	3.2	0.2	4.4
4	AM11-D1*	100.9	0.2	8.4	3.6	12.2	9.2	0.1	40.6	3.3	3.3
5	Jack-MP4	23.9	3.2	1.4	1.4	6.0	2.2	1.3	6.9	1.3	1.6
6	RD0-D3	-13.6	3.6	1.4	0.0	5.0	-1.2	1.5	6.7	0.0	1.4
7	K53-MS29*	-8.6	2.4	0.3	1.3	4.0	-0.8	1.0	1.4	1.2	1.1
8	GPR3	1.6	3.0	0.2	0.0	3.3	0.1	1.3	1.2	0.0	0.9
9	AM0-D13	22.6	0.5	1.2	1.5	3.2	2.0	0.2	5.9	1.3	0.9
10	CL0-D8	16.4	0.8	0.2	1.3	2.4	1.5	0.4	1.2	1.2	0.7
11	D3	8.1	1.4	0.2	0.3	2.0	0.7	0.6	1.1	0.3	0.5
12	CL0-D14	-0.4	0.8	0.1	0.0	0.9	0.0	0.4	0.4	0.0	0.2
13	Jack-MP4A	3.2	0.1	0.1	0.2	0.4	0.3	0.0	0.4	0.2	0.1
14	Jack-MP1	1.3	0.0	0.1	0.1	0.2	0.1	0.0	0.4	0.1	0.1
15	Jack-MP2	0.9	0.0	0.1	0.1	0.2	0.1	0.0	0.3	0.1	0.0
16	CL0-D2	0.4	0.1	0.1	0.0	0.1	0.0	0.0	0.3	0.0	0.0

AM11-D1 loadings from 2002 sampling conducted by AWARE. RD0-D3 only sampled between 1/2020 and 6/2020 (n=5) and would likely rank lower if sampled for the entire year. K53-SW29 only had one flow measurement on 5/20/21 at the effluent of the wetland and assumed to the same for the influent.

(peach)	= Abandoned mine discharge partially treated with passive system.
(green)	= Abandoned mine discharge treated with passive system.

2.2.1 Aultmans Run Discharges

Three discharges flow directly into Aultmans Run, the SR286 Discharge, AM11-D1, and AM0-D13. The SR286 Discharge was the largest of these discharges and is treated with an aerobic wetland (see Section 3.1 for more information). AM11-D1 is also known as "Foot Run" and is located in the "Coon Hollow" portion of the watershed. Five separate discharges were identified that flow into "Foot Run", AM11-D1A, AM11-D1A-2, AM11-D1B, AM11-D1C, and AM11-D1D. AM0-D13 is also found within the "Coon Hollow" area and is known as "Mule Run". This discharge emanates from a break in spoil piles of a surface mine pit located at the top of the hill. Older watershed members, including Carl Trout and Harry Charles, who monitored the discharge in the early 2000's provided the nickname for the site, as they said they needed a mule to climb the hill to the discharge.

2.2.2 Reeds Run Discharges

Reeds Run has historically been the most impacted stream of the watershed. Two projects, the Reeds Run AMD Remediation Project and the Neal Run Restoration Project, have improved water quality drastically, but some smaller discharges remain. The RD0-D3 discharge is an alkaline, iron-laden discharge that appears downgradient of the Challenger Speedway, which was built on a former surface mine. This discharge was collected subsurface and conveyed to the edge of the road, where it flows beneath Willow Road into a ditch and Reeds Run. "Golden Pheasant Run" is another small tributary made up of almost entirely mine drainage named after a nearby bar that has since closed. Five discharges, Jack-MP1, Jack-MP2, Jack-MP4, Jack-MP4A, and GPR3, make up the headwaters of "Golden Pheasant Run". This stream flows into Reeds Run near its mouth with Aultmans Run.

Neal Run has the distinction of having the worst discharge in the entire watershed and one of the worst in the entire state. The D2 discharge emanates from a large coal refuse pile outside of the town of McIntyre, PA. A passive treatment system has been constructed to partially treat this discharge, which will be expanded with new components in 2022 (See Section 3.3). Several smaller discharges are located in the floodplain to Neal Run upstream of the passive treatment system that flows into Neal Run.

2.2.3 Coal Run Discharges

Two known discharges, CL0-D2 and CL0-D8, flow directly into Coal Run and were sampled monthly for a year. CL0-D2 was sampled at the outlet of an impaired wetland as no specific source could be found. CL0-D8 emerges from the bottom of a dangerous highwall near the mouth of Coal Run. Several other discharges were found within the watershed, including CL0-D13 and CL0-D14. CL0-D13 is a large discharge that was not previously documented in permit applications or assessments. This discharge was found by Jeff Painter of the PA Game Commission and Dean Baker of the PA DEP, during a site investigation. CL0-D13 appears to emanate from an underground mine exposed within an abandoned surface mining pit, which creates large ponds found on both sides of Aultmans Run Road and eventually into Aultmans Run. These ponds are classified as a Health and Safety Hazard with a Priority 2 designation by the PA DEP due to the proximity to Aultmans Run Road. CL0-D14 is an alkaline, iron-laden discharge that upwells within the stream near the mouth of Coal Run.

3.0 PREVIOUS PROJECTS

To date, three mine drainage projects have been constructed within the Aultmans Run Watershed through a public-private partnership effort of AWARE and Stream Restoration Inc. The following sections contain summaries for each of these projects. For additional information, including project reports, water quality data, and schematics, please go to www.datashed.org. Water samples were taken quarterly for the existing treatment systems by BioMost and the Stream Team.

3.1 SR286 Passive Treatment System

The SR286 Passive Treatment System was the first construction project of AWARE in 2003. The system consists of a ½ acre aerobic wetland. No major maintenance has occurred at the site. Water quality from the first few samples and observation of unused portions of the wetland indicated that the mine discharge was short circuiting the treatment system. AWARE contacted SRI through their O&M Technical Assistance Program to evaluate the issue. Two directional floating baffle curtains were installed in January 2020 to break up the channelized flow. Iron sludge from the channel wetland was also removed. Water quality results from May 2020 show improved iron removal of close to 75% (See Appendix D: Water Quality). Ideally, the treatment system should have been size larger but was limited due to permitting constraints. As this system is nearing 20 years in age, the site should be considered for potential cleanout and reevaluated for expansion.

Table 12: Average Water Quality of SR286 PTS

Sample Point	Time Frame	Flow (gpm)	pH (su)	SC (µS/cm)	Alk. (mg/L)	Acidity (mg/L)	Fe (mg/L)	Mn (mg/L)	Al (mg/L)	SO_4 (mg/L)
SR286 Discharge	1999-2010	229.4	6.3	486	87	-26	17.5	0.7	0.3	146
	2019-2020	92.6	6.5	457	90	-55	15.2	0.6	0.1	132
85-16	2002-2010	120.8	6.8	458	71	-41	5.7	0.6	0.3	142
	2019-2020	92.6	6.7	433	79	-61	5.9	0.7	0.2	125

Total metal concentrations.

3.2 Reeds Run AMD Remediation

This project involved the removal of coal refuse and the construction of an aerobic wetland in 2011 to treat any remaining discharges on site. The largest discharge, RD0-D1, which emanated within Reeds Run, was eliminated with the removal of the coal refuse pile along the stream. The small amount of coal refuse that remains along the stream bank is likely causing a small seep within the wetland area. K53-MS29, a smaller discharge monitored and previously treated by Rochester and Pittsburgh Coal Company, appears to have improved with the removal of some of the coal refuse onsite. This discharge is now net alkaline with lower concentrations of manganese. Iron concentrations have remained basically the same while aluminum concentrations have increased. By the time this discharge leaves the aerobic wetland and settling pond, the iron and aluminum concentrations are less than 1 mg/L.

Table 13: Average Water Quality of Reeds Run

Sample Point	Time Frame	Flow (gpm)	pH (su)	SC (µS/cm)	Alk. (mg/L)	Acidity (mg/L)	Fe (mg/L)	Mn (mg/L)	Al (mg/L)	SO_4 (mg/L)
WL Influent (K53-SW29)	1988-2001	16.7	5.4	634	49	76	4.0	21.2	1.9	346
	2019-2020	36.2	7.5	320	87	-76	3.9	0.9	3.1	29
WL Effluent (WTLD)	2011-2012	20.0	6.9	NA	39	-20	4.0	1.1	0.5	104
	2019-2020	36.2	7.2	325	52	-42	1.1	0.8	0.4	99

Total metal concentrations. NA-not available. Flows post-construction of the aerobic wetland normally not taken due lack of elevation drop needed for measuring with a bucket and stopwatch. Only one flow measured with a flow meter taken on 5/20/20 at the effluent and assumed the same for the influent.

3.3 Neal Run Restoration Project

The Neal Run Restoration Project has undergone several phases. Phase I involved the removal of 37,608 tons of coal refuse and installation of over 2500' feet of Oxidation

Precipitation Channels (OPCs), also known as Terraced Iron Formations (TIFs). This project was completed in 2012 and resulted in low-pH iron removal. Water quality on www.datashed.org and Table 14 reveals a 60% reduction in iron between D2 and D7, which is approximately 1300' downstream from the beginning of the OPC. Some of this reduction is due to the "dilution" of D2 with D3, but even when accounting for this dilution, iron is being removed within the OPC. On 5/9/2018, D3 was not flowing and 25% of the iron was removed within the OPC.

Table 14: Average Water Quality of Neal Run (2011-2018)

Sample Point	Flow (gpm)	pH (su)	SC (µS/cm)	Alk. (mg/L)	Acidity (mg/L)	Fe (mg/L)	Mn (mg/L)	Al (mg/L)	SO_4 (mg/L)
D2	6.7	3.1	8063	0	4389	1310.4	19.7	270.3	5871
D3	3.7	3.2	540	0	409	74.0	12.1	27.5	931
D7	8.0	2.9	5978	0	3473	484.1	17.2	295.3	4546

Total metal concentrations.

During the summer of 2018, an Auto-Flushing, Vertical Flow Pond (AFVFP) containing 715-tons of crushed limestone to generate alkalinity for metal removal and a ¼-acre settling pond for the retention of metal precipitates was constructed. A check dam was constructed within OPC1 approximately 1130' from beginning of the channel and the mine drainage was diverted into the AFVFP. A pipe was installed at the influent of the AFVFP for flow measurements. The effluent of the AFVFP flows across the OPC1 in a pipe and into the settling pond. The effluent to the settling pond empties back into OPC1. A Smart Drain valve opens for 90 minutes every day at 10AM Eastern Time to flush the AFVFP. This flushing makes sampling the downstream components complicated. Sampling occurred monthly by AWARE volunteers and BioMost staff and the Kiski-Conemaugh Stream Team. In general, sampling occurred 2-4 hours after flushing had completed. In addition, to better account for all of the sources of flow to this site, two weirs, RAW and OPC1-MID, were constructed in February 2020.

Table 15: Average Water Quality of Neal Run (2019-2020)

Sample Point	Flow (gpm)	pH (su)	SC (µS/cm)	Alk. (mg/L)	Acidity (mg/L)	Fe (mg/L)	Mn (mg/L)	Al (mg/L)	SO_4 (mg/L)
D2	10.9	2.8	6038	0	5030	943.6	15.7	430.0	6203
D3	4.8	3.2	1287	0	502	55.0	6.7	40.0	1012
RAW	23.4	3.0	5560	0	4397	958.4	14.6	449.3	4803
D7A	15.5	2.7	5149	0	4080	575	22.5	347.9	4955
OPC1-MID	17.2	7.4	468	70	-57	5.1	0.1	3.2	150
SP	14.5	2.8	6151	0	2425	295.8	10.3	235.7	3209
OPC1 Effluent	20.6	2.8	3116	0	1883	157.9	7.8	177.8	2560

Total metal concentrations. RAW and OPC1-MID only sampled between February and June 2020 (n=5). Other points sampled monthly for a year (n=12).

As can be seen in Table 15, iron has been reduced within the treatment system an astounding 83% and acidity has been reduced 63%. **The AVFP alone is eliminating**

41% of the acidity! At this rate, 261 pounds of acidity are removed every day! There are no other water inputs into the AFVFP and Settling Pond other than a small flow that is normally dry from an old diversion ditch (see sample point DD in Appendix D). Overall, between the RAW and OPC1 Effluent sample points, an average of 831 lb/day of acidity is being removed. Using this average, an estimated 872,550 lb, or 436 tons, of acidity have been removed after the last 35 months. To treat this amount of acidity actively would cost about $87,200 for chemical alone!

4.0 PROPOSED PROJECTS

Water quality has continued to improve within Aultmans Run; however, additional projects are necessary to remove Aultmans Run and its tributaries from the impaired waters list. Individual site recommendations have been compiled for the top five discharges and are summarized below. Appendix B contains conceptual designs for these priority sites. Passive treatment systems are proposed to treat the priority discharges. Although these systems may not remove 100% of the pollutant load all of the time due to fluctuating flow rates and water quality, passive treatment is the best option due to the lower operation and maintenance costs and remoteness of some of the sites.

A preliminary pollutant load reduction estimate is provided for each proposed passive system based only on existing pollutant loading of the discharge. Although passive systems have been online in the Aultmans Run Watershed that have operated for more than a decade and have met or exceeded the design effluent criteria, typically passive systems are not expected to remove 100% of all pollutant loadings 100% of the time. Table 16 briefly describes the functions of the components included in the passive treatment systems proposed for the Aultmans Run Watershed:

Table 16: Passive Treatment System Components – General Function and Description

Component	Function & Description
Anoxic Limestone Drain **(ALD)**	Buried limestone aggregate; generate alkalinity; require settling pond for metal precipitation.
Oxidation & Precipitation Channel **(OPC)**	Promote removal and recovery of iron minerals at low pH; substrate limestone aggregate with geotextile. Also known as a Terraced Iron Formation (TIF).
Holding Pond **(HP)**	Used to hold water for batch treatment with an AFVFP.
Forebay **(FB)**	Ponds used for collecting, intercepting, combining, and/or conveying water, settling of debris such as sticks and leaves, and allowing oxidation, precipitation, and accumulation of metals solids.
Auto-Flushing Vertical Flow Pond **(AFVFP)**	Generate alkalinity; limestone aggregate; metal solids flushed automatically or manually
Jennings-Type Vertical Flow Pond (**JVFP)**	Generate alkalinity; organic material with limestone aggregate; metal sulfides formed/retained; iron reduced (Fe^{+3} to Fe^{+2})
Settling Pond **(SP)**	Oxidize, precipitate, settle, retain metal solids
Aerobic Wetland **(WL)**	Oxidize, precipitate, settle, retain metal solids; provide wildlife habitat

4.1 Neal Run Restoration Area – Phase III

Neal Run Restoration Area – Phase III was recently funded through the PA DEP Growing Greener Program in December 2020. This grant will allow for the construction of a Jennings-type Vertical Flow Pond (JVFP) containing 1,800 cubic yards of treatment media consisting of a mixture of compost, crushed limestone, and woodchips and a 9,000 SF settling pond/wetland complex. Permitting and design have been completed and construction is planned for Spring 2022. A check dam within OPC1 will help direct flow into the JVFP. The effluent of the JVFP will flow into the settling pond/wetland complex, which will primarily be constructed within the existing OPC1.

Proposed Passive Treatment System Components

Neal Run Restoration Area – Phase III

OPC (existing) → **AFVFP**(existing) → **SP**(existing) → **OPC** (existing) → **JVFP** (new) → **SP/WL** (new)

Treatment Media: AFVFP-715 tons limestone; JVFP-1200 tons limestone,
300 CY compost, 600 CY wood chips

Projected Decrease in Pollutant Loadings: 182,500 lb/yr acidity; 54,750 lb/yr metals

Grant Amount: $210,956

4.2 Coon Hollow Restoration

"Coon Hollow" is the name given by locals to the southern portion of the Aultmans Run Watershed on land formerly owned by Rochester and Pittsburgh Coal Company. In the 2016 report, this area was previously split into the Aultmans Run South Restoration Area and Coal Run Restoration Area. The land of "Coon Hollow" was extensively underground and surface mined and now belongs to the PA Game Commission as part of State Game Land #332. The PA DEP abandoned mine land inventory designates the Coon Hollow area as Problem Areas #3821 and #4406, named BM 1029 and Coal Run South, respectively. These areas are impaired with abandoned surface mine pits, spoil piles, impacted water, and mine entries. Several discharges are located within the watershed from abandoned and active mining operations. The Lewisville Recovery Plant is an old coal refuse disposal facility that is still an active permit. Two active treatment systems are used to manage mine drainage associated with this site. Robindale Energy Services (RES) has received a permit from the PA DEP to remove this coal refuse and place alkaline ash from the circulating-fluidized bed coal power plant, which should improve the water quality of multiple discharges in this area. The approximate RES coal refuse removal area is shown in Appendix A: Aultmans Run Watershed Map. Upon removal of the coal refuse and reclamation of the site, additional water monitoring will need to be conducted to evaluate if additional treatment is needed.

4.2.1 AM11-D1 – "Foot Run"

Only one sampling event was conducted in the "Foot Run" area as most of the discharges will likely to be affected by the coal refuse removal project located upgradient. AM11-D1 is located near the mouth of "Foot Run" and has historic flows ranging from 3 to 314 gallons per minute (gpm). Sampling in 2002 was conducted for an entire year, which was used to calculate the averages and loadings in Tables 17 and 18. The 8/20/19 sampling event occurred during a typically low flow period. In comparison to the August 2002 sampling (Table 18), the flows of AM11-D1 are the same; however, the quality of the water has improved.

Table 17: Water Quality of AM11-D1 and Discharges on 8/20/2019

Sample Point	Flow (gpm)	pH (su)	SC (µS/cm)	Alk. (mg/L)	Acidity (mg/L)	Fe (mg/L)	Mn (mg/L)	Al (mg/L)	SO_4 (mg/L)
AM11-D1	5.0	3.6	894	0	72	1.6	6.9	9.5	522
AM11-D1A	0.7	3.0	1580	0	286	1.7	11.2	10.7	852
AM11-D1A-2	1.7	3.1	1517	0	298	3.2	10.1	36.8	786
AM11-D1B	0.3	6.9	1429	32	-24	<0.1	<0.1	<0.1	935
AM11-D1C	1.2	4.8	698	2	13	5.8	2.8	0.7	385
AM11-D1D	1.0	4.5	408	0	13	1.0	7.0	10.0	188

Table 18: Comparison of Water Quality of AM11-D1 on 8/2/2002 and 8/20/2019

Date	Flow (gpm)	pH (su)	SC (µS/cm)	Alk. (mg/L)	Acidity (mg/L)	Fe (mg/L)	Mn (mg/L)	Al (mg/L)	SO_4 (mg/L)
2002	5.0	3.4	1209	0	233	2.1	15.6	26.7	894
2019	5.0	3.6	894	0	72	1.6	6.9	9.5	522
Difference	**0**	**+0.2**	**-315**	**0**	**-161**	**-0.5**	**-8.7**	**-17.2**	**-372**

No new conceptual designs were developed for these discharges due to the expected water quality improvements with the proposed coal refuse removal upgradient of the valley. The "Foot Run" Passive Treatment System Conceptual Design plan has been updated to show the coal refuse removal area (see Appendix B). Additional sampling should be conducted after the removal of the coal refuse to determine if changes are necessary to the design. Three separate systems are proposed to treat the "Foot Run" discharges and are outlined below.

<u>Proposed Passive Treatment System Components</u>

<u>Foot Run – AM11-D1</u>

FB (9,000 SF)→ JVFPA→ WL (17,000 SF)

AFVFP→ SP/FP (6,000 SF)→ JVFPB → WL (5,900 SF)

ALD

<u>Treatment Media</u>: JVFPA-800 tons limestone, 300 CY compost, 300 CY wood chips
JVFPB-400 tons limestone, 150 CY compost, 150 CY wood chips
ALD-200 tons limestone

<u>Projected Decrease in Pollutant Loadings</u>: 36,500 lb/yr acidity; 4,450 lb/yr metals

<u>Preliminary Cost Estimate</u>: ~$350,000

4.2.2 AM0-D13 – "Mule Run"

Also known as "Mule Run", AM0-D13 is ranked the 9th discharge in the watershed for metal loadings and 5th for acidity loadings. This discharge is located on SGL 332. Water quality of this discharge has improved compared to the data available from 2002; however, the flow rate has more than doubled. Flow measurements in 2002 were made with a v-notch weir; however, the 2019-2020 flow measurements were made with a bucket and stopwatch. The highest flows were recorded in March 2020 at 92.3 gpm. This discharge flows directly into Aultmans Run.

Table 19: Average Water Quality Comparison of AM0-D13

Sample Point	Time Frame	Flow (gpm)	pH (su)	SC (μS/cm)	Alk. (mg/L)	Acidity (mg/L)	Fe (mg/L)	Mn (mg/L)	Al (mg/L)	SO_4 (mg/L)
AM0-D13	2002	14.1	3.2	1724	2	216	3.4	8.8	14.3	1111
	2019-2020	33.1	3.3	1307	0	73	1.7	3.4	4.5	636

Total metal concentrations.

<u>Proposed Passive Treatment System Components</u>

<u>Mule Run – AM0-D13</u>

AFVFP→ SP (1500 CY) → WL (5,500 SF)

<u>Treatment Media</u>: AFVFP-1200 tons limestone

<u>Projected Decrease in Pollutant Loadings</u>: 8,232 lb/yr acidity; 1,155 lb/yr metals

<u>Preliminary Cost Estimate</u>: $202,176

4.2.3 Coal Run

As stated in Section 2.2.3, four discharges, CL0-D2, CL0-D8, CL0-D13, and CL0-D14, were sampled within this subwatershed during the monitoring period. All four discharges are located within SGL 332. The largest of these discharges, CL0-D13, flows directly out of a large underground mine from a crack in surface mine highwall. Recent monitoring indicates it is currently ranked the 2nd worst discharge in the watershed, contributing iron, aluminum, manganese, and acidity to Aultmans Run. Three ponds have formed downstream of the discharge in former surface mine pits that contain little to no life. An unnamed tributary to Aultmans Run flows into the final pond, which precipitates aluminum creating a "blue lagoon" visible from aerial photos. A public-private partnership effort is underway to treat this discharge along with reclaiming dangerous highwalls and spoil piles using the Abandoned Mine Land Economic Revitalization (AMLER) grant program.

Proposed Passive Treatment System Components

Coon Hollow – CL0-D13

HP (9,000 CY) → AFVFP1 → SP (5,000 CY) → AFVFP2 → SP (2,600 CY)

Treatment Media: AFVFP1-4,000 tons limestone; AFVFP2-2,000 tons limestone

Projected Decrease in Pollutant Loadings: 59,409 lb/yr acidity; 11,527 lb/yr metals

Preliminary Cost Estimate: $902,525

CL0-D8 is currently ranked the 10th highest discharge in the watershed in terms of total metal load. CL0-D8 originates from a crack in the highwall and is likely fed by an underground mine. Mine land reclamation is also proposed around this discharge using AMLER funding, which is an opportune time for treatment. Water quality in comparison to the 2002 time period has improved with the acidity, manganese, and aluminum roughly reducing in half and iron reducing by two-thirds.

Table 20: Average Water Quality Comparison of CL0-D8

Sample Point	Time Frame	Flow (gpm)	pH (su)	SC (µS/cm)	Alk. (mg/L)	Acidity (mg/L)	Fe (mg/L)	Mn (mg/L)	Al (mg/L)	SO_4 (mg/L)
CL0-D8	2002	8.3	3.2	1740	0.0	401	32.4	7.4	33.2	1451
	2019-2020	6.1	3.0	1656	0.0	217	10.3	3.2	17.0	851

Total metal concentrations.

Proposed Passive Treatment System Components

Coon Hollow – CL0-D8

JVFP→ WL (10,000 SF)

Treatment Media: JVFP-500 tons limestone, 130 CY compost, 260 CY wood chips

Projected Decrease in Pollutant Loadings: 5,975 lb/yr acidity; 879 lb/yr metals)

Preliminary Cost Estimate: $198,744

CL0-D14 emanates from the right bank of Coal Run, which consists of a large spoil pile, approximately 200 feet upstream from the mouth. Coal Run has been mined through and rerouted in this area of the watershed. CL0-D14 was not previously monitored. The likely source of this discharge is the spoil pile, which is planned for reclamation with the other Coon Hollow restoration efforts. Upon completion of the land reclamation, additional sampling should occur to determine if this discharge remains.
The CL0-D2 is located approximately ¾ of a mile upstream from the mouth of Coal Run. This discharge has improved significantly in comparison to the data gathered with the 2016 Report. The metal loadings from CL0-D2 have decreased to only 0.1 lb/day and the acid loading has been reduced to 0.4 lb/day from 13.2 lb/day in the 2016 Report. As a result, no treatment is proposed for the CL0-D2 discharge. The reason behind the changes to the water quality are not known, although sulfide minerals responsible for the AMD may have been exhausted. The existing wetland that CL0-D2 flows out of should not be disturbed to allow for settling of the remaining iron in the water.

Table 21: Average Water Quality Comparison of CL0-D2

Sample Point	**Time Frame**	**Flow** (gpm)	**pH** (su)	**SC** (µS/cm)	**Alk.** (mg/L)	**Acidity** (mg/L)	**Fe** (mg/L)	**Mn** (mg/L)	**Al** (mg/L)	**SO_4** (mg/L)
CL0-D2	2000-2002	5.9	3.6	1405	4	139	14.6	5.4	0.5	607
	2019-2020	2.6	4.5	662	6	14	2.2	2.1	0.1	296

Total metal concentrations. Fe concentration on 4/5/00 considered anomalous and not included in calculation of average.

4.2.4 Golden Pheasant Run

"Golden Pheasant Run" is located near the mouth of Reeds Run. The source of the unnamed tributary to Reeds Run is essentially composed of entirely abandoned mine drainage. According to the PA DEP, a large pre-SMCRA strip mine is located upgradient of the valley, which was backfilled with coal refuse. Amerikohl Mining reprocessed a portion of this coal refuse in the early 2000's; however, some coal refuse likely remains as several discharges persist. Five discharges, Jack-MP1, Jack-MP2, Jack-MP4, Jack-MP4A, and GPR3, were found in the headwaters of "Golden Pheasant Run" and monitored for a year. The mouth of "Golden Pheasant Run", RD5-D1, was monitored in 2000 and 2001 but the headwater discharges were not sampled. No flows were measured at RD5-D1.

Table 22: Average Water Quality of RD5-D1 from 2000-2001

Sample Point	Time Frame	Flow (gpm)	pH (su)	SC (µS/cm)	Alk. (mg/L)	Acidity (mg/L)	Fe (mg/L)	Mn (mg/L)	Al (mg/L)	SO_4 (mg/L)
RD5-D1	2000-2001	--	3.3	--	0	244	26.8	10.3	20.9	928

Total metal concentrations. Fe concentration on 4/5/00 considered anomalous and not included in calculation of average.

Table 23: Average Water Quality of "Golden Pheasant Run" Discharges from 2019-2020

Sample Point	Flow (gpm)	pH (su)	SC (µS/cm)	Alk. (mg/L)	Acidity (mg/L)	Fe (mg/L)	Mn (mg/L)	Al (mg/L)	SO_4 (mg/L)
GPR3	6.2	6.2	1833	64	23	42.3	3.5	0.4	944
Jack-MP1	1.7	3.6	1538	0	64	0.4	4	6	866
Jack-MP2	1.1	3.6	1584	0	75	1.5	3.9	7	871
Jack-MP4	41.3	3.7	1718	0	68	9.2	3.8	4.2	903
Jack-MP4A	9.7	3.4	1829	0	79	1.3	2	5.4	1021

Total metal concentrations. Fe concentration on 4/5/00 considered anomalous and not included in calculation of average. Jack-MP4A monitored from 4/2020 to 6/2020.

Jack-MP1, Jack-MP2, Jack-MP4, and Jack-MP4A were all acidic with low to moderate concentrations of iron, manganese, and aluminum. Flows were very small at Jack-MP1 and Jack-MP2; however, flow increases downstream at Jack-MP4 indicating degraded baseflow. Jack-MP4 was previously monitored during the remining operation as a Sub-Chapter F point. Prior to remining, the acidity and iron of Jack-MP4 was 487 mg/L and 79 mg/L, respectively (See 2016 Report). Nearly 15 years later, the acidity has decreased 86% to 68 mg/L and iron has decreased 88% to only 9.2 mg/L. This reduction makes the treatment of the discharge with a passive system less challenging.

GPR3 was alkaline and contained 42.3 mg/L of iron and little to no aluminum. Due to the varying water quality, several different treatment components are proposed. The GPR3 discharge is still net acidic and would be treated with an anoxic limestone drain.

Proposed Passive Treatment System Components

Golden Pheasant Run

FB (800 CY) → JVFP →
ALD →
→SP/WL (25,400 SF)

Treatment Media: JVFP-1,990 tons limestone; 491 CY compost, 982 CY wood chips; ALD-200 tons limestone

Projected Decrease in Pollutant Loadings: 11,288 lb/yr acidity; 3,553 lb/yr metals

Preliminary Cost Estimate: $534,550

4.3 Other Discharges

In addition to the priority discharges where passive treatment systems have been proposed, several other discharges have been identified within this report and other smaller discharges not included in this report remain untreated in the watershed. These discharges, although degraded, do not have a severe affect upon the main stem of Aultmans Run. If all of the major discharges are treated, these smaller discharges may not need to be addressed in order for Aultmans Run to meet the water quality criteria. Additional sampling is recommended prior to designing and constructing any additional treatment systems.

4.3.1 RD0-D3

The RD0-D3 discharge is an alkaline, iron-laden discharge that appeared downgradient of the Challenger Speedway, which was built on a former strip mine. This discharge was collected subsurface and conveyed to the edge of the road, where it flows beneath Willow Road into a ditch that empties into Reeds Run. RD0-D3 was previously ranked #11 in the 2016 Report and was not sampled for the entire year as it was not a priority discharge. As the discharge is located along a public road, an increase in flow was noticed and subsequently sampled for water quality. Flows had tripled from the highest flows observed in 2002. The final sample in June 2020 shows the flow had decreased and were expected to remain low during the summer. RD0-D3 was ranked #6 during this assessment; however, the rank would likely had been lower if samples were collected during the entire year. A conceptual design has not been developed for this site; however, the landowner, Jack Lentz, has shown a willingness to allow a treatment system to be constructed on his property. An aerobic wetland is the appropriate type of passive system necessary to treat this discharge. Adequate room is available for construction but not much hydraulic gradient is available. Upon the completion of Neal Run Restoration Area – Phase III, Reeds Run should be evaluated again to determine if this discharge should be treated.

4.3.2 RD2-D1 – "Willow Run Discharge"

RD2-D1 is a small discharge located near the headwaters of tributary RUNT04, also known as Willow Run. This discharge was monitored during the 2002 assessment; however, no additional samples have been taken. In the 2016 Report, this discharge was acidic with elevated concentrations of manganese and aluminum and was the 10th worst discharge in the watershed. The water quality at the mouth of Willow Run is impacted with manganese and aluminum; however, Reeds Run downstream of Willow Run is only impacted with dissolved iron, which is likely from the RD0-D3 discharge. The flow of the RD2-D1 discharge averages 9.4 gpm while Willow Run at RUNT04B was flowing 233 gpm in May 2020. It is unlikely that RD2-D1 is the only source of impacts for this stream. The stream is located on the eastern side of the large coal refuse pile outside of McIntyre, PA, which likely contributes to the base flow of the stream. A more thorough investigation into Willow Run should occur to determine all the sources of flow and whether a treatment system is required.

4.4 AML Reclamation

Additional abandoned mine reclamation is needed throughout the Aultmans Run Watershed. As documented in the 2016 Report, nearly 3,400 acres have been permitted for surface mining in the watershed, which is almost 20% of the entire watershed!Many of these mines were permitted prior to the Surface Mining Control and Reclamation Act (SMCRA) in 1977. The 2021 DEP AML Problem Area database includes 57 abandoned mine land features that need reclamation within the watershed, including subsidence prone areas, spoil piles, coal refuse piles, impacted water sources, mine openings, and AMD ground saturation. Other sites not found within this database also exist and are continuously updated by the DEP.

4.4.1 Forest Reclamation Approach

Hundreds of acres of mine lands within the watershed were reclaimed using techniques encouraged under SMCRA to improve safety, stability, and water quality at mine sites. These practices involved excessively compacting soils and planting aggressive ground covers to prevent erosion, which has slowed succession and created large areas of low diversity grasslands. In 2005, the Office of Surface Mining began their Appalachian Regional Reforestation Initiative to promote the restoration of high-quality forests on reclaimed coal mines. Using this approach, highly productive post-mining forests and cost-effective regulatory compliance can be achieved. The five steps to FRA are the following:

1. Create a suitable rooting medium for good tree growth that is no less than 4 feet deep and comprised of topsoil, weathered sandstone and/or the best available material.
2. Loosely grade the topsoil or topsoil substitute established in step one to create a non-compacted growth medium.
3. Use ground covers that are compatible with growing trees.
4. Plant two types of trees, early successional species for wildlife and soil stability and commercially valuable crop trees.
5. Use proper tree planting techniques.

Some coal operators have begun using the FRA on active mining permits. Pennsylvania Environmental Council has taken the lead in Pennsylvania in implementing the FRA on abandoned mine sites on public and private property. The FRA should be considered a priority for implementation within the watershed on any future AML reclamation projects.

5.0 ALTERNATIVES ANALYSIS

Active treatment is an alternative to the passive treatment systems proposed in Section 4 that are planned for construction. Due to the relatively low flow / loading characteristics of the discharges associated with the Mule Run site (AMO-D13) and Golden Pheasant Run site (Jack-MP4, Jack-MP4A, GPR3) – the practical implementation of active treatment systems at these site locations is not recommended. Due to budgetary considerations, individual installations of small active treatment facilities are not the most cost-effective or labor efficient means of treating these discharges. In addition, many of the sites do not have ready access to electricity, which makes the costs to install the active systems even higher. Costs have been developed for both active treatment and passive treatment alternatives for site-specific cost estimates and projections (See Appendix C). The cost to bring electricity to the sites was not included.

As an illustration, the base cost of installing a lime slurry chemical delivery style treatment system for sites that need to deliver less than 100 Tons of acid neutralizing potential per year (>100 Tons of acid neutralization per year would have been evaluated as a hydrated lime style system) with (2) treatment ponds with electric-powered pH controls and (2) sludge ponds set the base construction cost of the systems at close to $300K per site. Adding in the site-specific access; E&S Controls; Mobilization / Demobilization; Engineering / Design / Permitting the capital costs for construction is in the range of $380,000 - $390,000. The annual costs (Operation, Maintenance, Labor, & Chemical) projected over 20 years are what noticeably separate the cost differences between the passive and active treatment systems. The active systems average nearly $1.25 million dollars to construct and operate over the 20-year evaluation period, without adjusting the annual costs for inflation. Conversely, passive treatment systems applied to these same sites would bring the average cost of constructing and operating these sites over the 20-year evaluation period to approximately $420,000.

6.0 UPDATED PRIORITIZATION, SCHEDULING, AND LOAD REDUCTIONS

The restoration of Aultmans Run to a viable fishery will involve a combination of implementing new treatment systems and AML projects along with maintaining the existing sites.

6.1 New Treatment

The project sites have been prioritized based on metal load reductions and potential improvement to the streams. Sites located higher in the watershed were given preference. Table 24 summarizes the ranking, cost estimates, and load reductions of each site. Nearly $2.2 million are needed to permit, design, and construct all of the priority sites. Potential sources of funding can be found in Section 7.0 of the 2016 Report.

Table 24: Cost Estimates and Load Reductions for Proposed Passive Treatment Systems

Priority	Project Name	Risk Matrix	Capital Cost	Stream Miles Improved	Load Reduction (lb/day)				
					Acidity	Fe	Mn	Al	Total Metals
1	Coon Hollow Pond Discharge (CL0-D13)	Medium	$902,525	2.5	162.8	13.6	3.7	14.2	31.6
2	"Foot Run" PTS (AM11-D1)	Medium	$350,000	1.5	49.0	0.22	1.9	7.7	9.8
3	Golden Pheasant Run PTS (Jack-MP1,2,& 4, GPR3)	Medium	$534,550	1.5	30.6	6.1	1.8	1.8	9.7
4	"Mule Run" PTS (AM0-D13)	Medium	$202,176	1.0	20.8	0.4	1.1	1.4	2.9
5	Coal Run PTS (CL0-D8)	Medium	$198,744	1.0	16.4	0.8	0.3	1.3	2.4
	Totals		**$2,187,995**	**5.0**	**331.5**	**21.1**	**16.3**	**21.2**	**58.7**

Note: As some improved stream miles overlap, stream segments are only considered once in the calculation of total stream miles improved. "Foot Run" PTS loadings based on 2002 data and will need resampled to determine if any changes to the water quality occurred after removal of the coal refuse.

Table 25 provides a proposed schedule for implementing the restoration plan. Previously constructed treatment systems have not been included. Priorities may be rearranged based upon further evaluation of the discharges and watershed in order to restore Aultmans Run in the most efficient and economical manner possible. The priority list and proposed schedule are to serve as guides to developing and implementing projects and may be revised as needed. Load reductions, water quality criteria, and landowner access are to be used to prioritize future projects.

Upon completion of the RES coal refuse removal project on SGL332, sampling should be conducting on Coal Run, Mule Run, and Foots Run to determine if additional treatment is necessary.

Table 25: Proposed Schedule for Implementing Restoration Plan

Passive System	Obtain Funding		Design & Construct	
	Start	End	Start	End
Neal Run - Phase III	Awarded		4/2022	8/2022
Coon Hollow	1/2021	12/2021	1/2022	12/2025
Golden Pheasant Run	6/2021	12/2022	12/2022	12/2023
"Foot Run"	6/2022	6/2023	6/2023	6/2024
"Mule Run"	6/2023	6/2024	6/2024	6/2025

6.2 Operation and Maintenance

Any passive treatment system requires maintenance to operate at its fullest potential. Maintenance includes but is not limited to water sampling, cleaning pipes and channels from excessive metal accumulation and vegetation, stirring/cleaning the treatment media to improve hydraulic conductivity, erosion control, and vandalism repairs. At the end of the design life, metals will need removed from the ponds and wetlands and treatment media will need replenished.

Maintenance on the existing treatment systems will vary based on the quality of the discharge and type of treatment components. The Reeds Run Restoration Area has the one of the lowest maintenance components, an aerobic wetland. The amount of metal accumulation has been low and will take many years before needing to be cleaned out. Only minor maintenance of the system has been needed to date, which involved the rebuilding of the eroding inlet spillway from the existing wetland to the constructed aerobic wetland due to ATV traffic through the site. Attempts should be made to minimize access to this site. The SR286 PTS, on the other hand, has had much more iron accumulate within the wetland. Fortunately, there is adequate capacity within the wetland to continue to accumulate iron for years to come. Neal Run Restoration Area will have the highest maintenance costs due to the extraordinarily high metal and acidity concentrations. To date, the AFVFP has been stirred once in February 2020 and is scheduled to be stirred again in 2021. In addition, maintenance of the smart drain occurred in 2020 and 2021.

Table 26: O&M Cost Estimates for the Existing & Proposed Passive Treatment Systems

Project Name	Annual Cost
Neal Run Restoration Area	$7,745
Coon Hollow Pond Discharge (CL0-D13)	$7,100
CL0-D8 PTS	$1,350
Golden Pheasant Run PTS (Jack-MP1,2,4,4A, GPR3)	$2,095
“Foot Run” PTS	$2,685
“Mule Run” PTS	$2,960
SR286 PTS	$1,100

7.0 Cost-Benefit Analysis

As stated in the 2016 Report, the goal of the implementation plan is to improve the water quality of Aultmans Run and its tributaries and return the streams to a viable fishery. More specifically, this plan intends to improve the water quality of Aultmans Run to a point that it can be stocked with trout. Aultmans Run is listed in Title 25, Chapter 93 of the Pennsylvania Code as a trout stocked fishery that, according to PA Fish and Boat Commission records, has never been stocked. Every tributary in the watershed is not expected to become a trout fishery. Aultmans Run is adequately sized and has the habitat necessary to become a good trout fishery; however, smaller tributaries, such as Reeds Run, are smaller and may not be suitable for stocking. According to the PA Fish and Boat Commission’s Recreational Use Loss Estimates for Pennsylvania Streams Degraded by AMD, when adjusted to 2021 dollars, Aultmans Run is losing nearly $900,000 annually in potential economic value due to lost recreational fishing opportunities in the watershed.

Table 27: Recreational Use Loss Estimate for Aultmans Run

Stream Name	Projected Use	Miles	Use Rate (Trips/Year)	Valuation 1989 Dollars ($/Trip)	Valuation 2021 Dollars ($/trip)	Lost Value
Aultmans Run	TSF	8	1100	$46.83	$101.71	$895,048

Aultmans Run has a high potential to return to a trout stocked fishery. The IUP bioassessment has found 17 species of fish at the most downstream sample point of Aultmans Run, K55-SM14, including many species of darter, which are more sensitive to pollution. At AUL03, the furthest downstream sample on Aultmans Run with macroinvertebrate data, 9 species of macroinvertebrates and the second highest abundance with 249 individuals were counted. The treatment systems must be maintained or improved to continue the successful restoration of Aultmans Run. Upon completion of the Neal Run Restoration Area – Phase III project, AWARE will request the PA Fish and Boat Commission to determine if portions of the creek can support a trout fishery. The stocking of trout was one of the original goals of AWARE when they began the organization over 20 years ago.

8.0 REFERENCES CITED

AWARE and Stream Restoration Inc. 6/2005. SR286 Passive Treatment System Final Report: A Public Private Partnership Effort. Aultmans Run Watershed, Center Township, Indiana County, PA. PA DEP Environmental Stewardship and Watershed Protection Grant (Growing Greener).

AWARE and Stream Restoration Inc. 6/2007. Reeds Run AMD Remediation Design Technical Report: A Public Private Partnership Effort. Aultmans Run Watershed, Armstrong Township, Indiana County, PA. PA DEP Environmental Stewardship and Watershed Protection Grant (Growing Greener).

AWARE and Stream Restoration Inc. 7/2012. Neal Run Abandoned Coal Refuse Removal Project Summary: A Public Private Partnership Effort. Aultmans Run Watershed, Center Township, Indiana County, PA. PA DEP Environmental Stewardship and Watershed Protection Grant (Growing Greener).

BioMost, Inc. and Stream Restoration Inc. 2011. Reeds Run AMD Remediation Construction Project Summary. Aultmans Run Watershed, Armstrong Township, Indiana County, PA. PA DEP Environmental Stewardship and Watershed Protection Grant (Growing Greener).

Institute for Mine Mapping, Archival Procedures, and Safety, Indiana University of Pennsylvania. 2/2013. Underground Mine Mapping in the Aultmans Run Watershed (shapefile format).

PA Code. Title 25. Environmental Protection, Chapter 93: Water quality Standards; Chapter 96: Water Quality Standards Implementation. [portions electronically retrieved 6/2014].

PA Department of Environmental Protection. 10/1998. Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania.

Skelly and Loy, Inc. Water Quality and Riparian Health Watershed Assessment for the Aultman Watershed. PA DEP Environmental Stewardship and Watershed Protection Grant (Growing Greener).

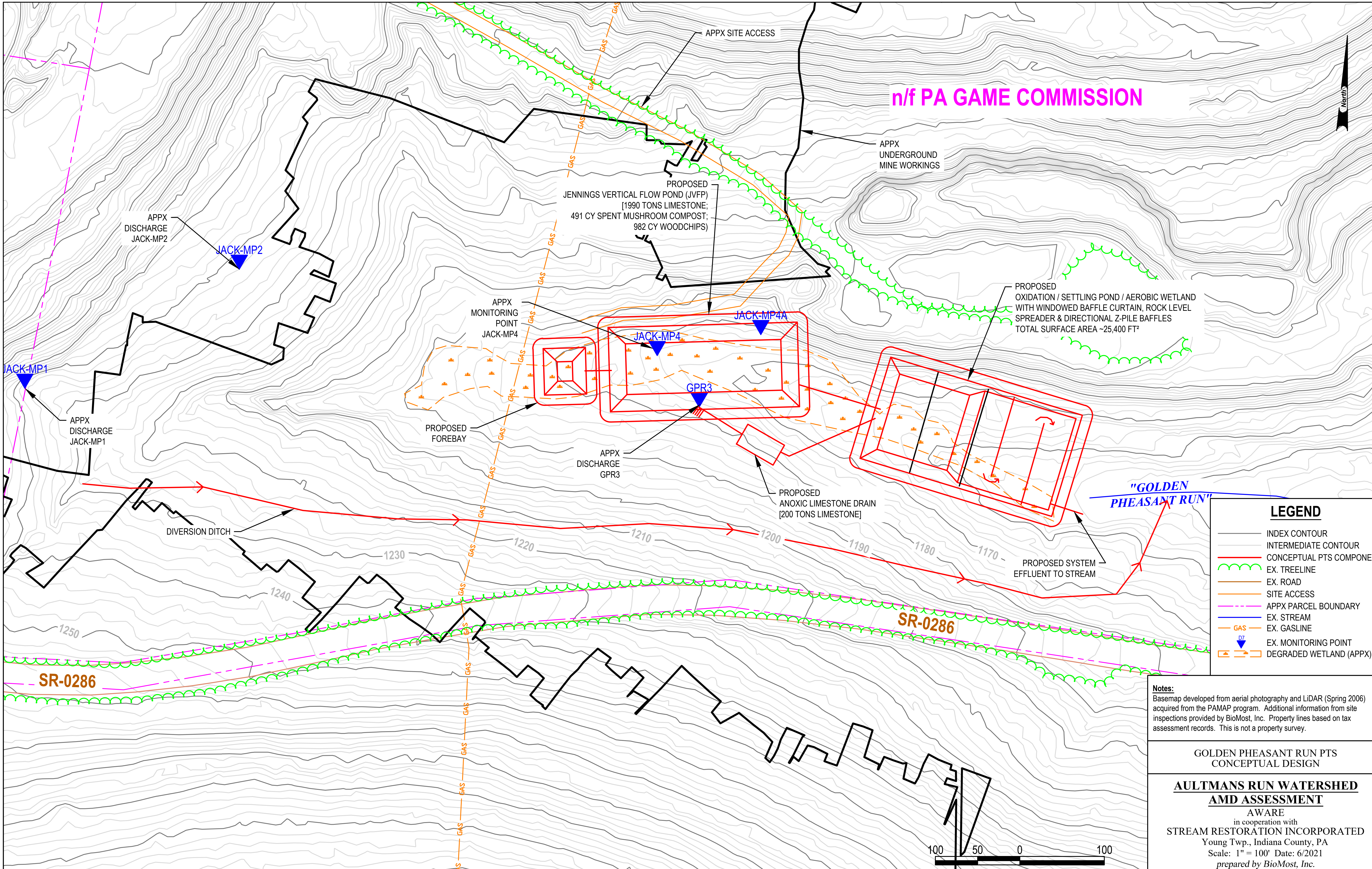
Tetra Tech, Inc. 1/29/2010. TMDLs for Streams Impaired by Acid Mine Drainage in the Kiskiminetas-Conemaugh River Watershed, Pennsylvania (Contract EP-C-08-004, Task Order #8). Prepared for US Environmental Protection Agency, Region 3.

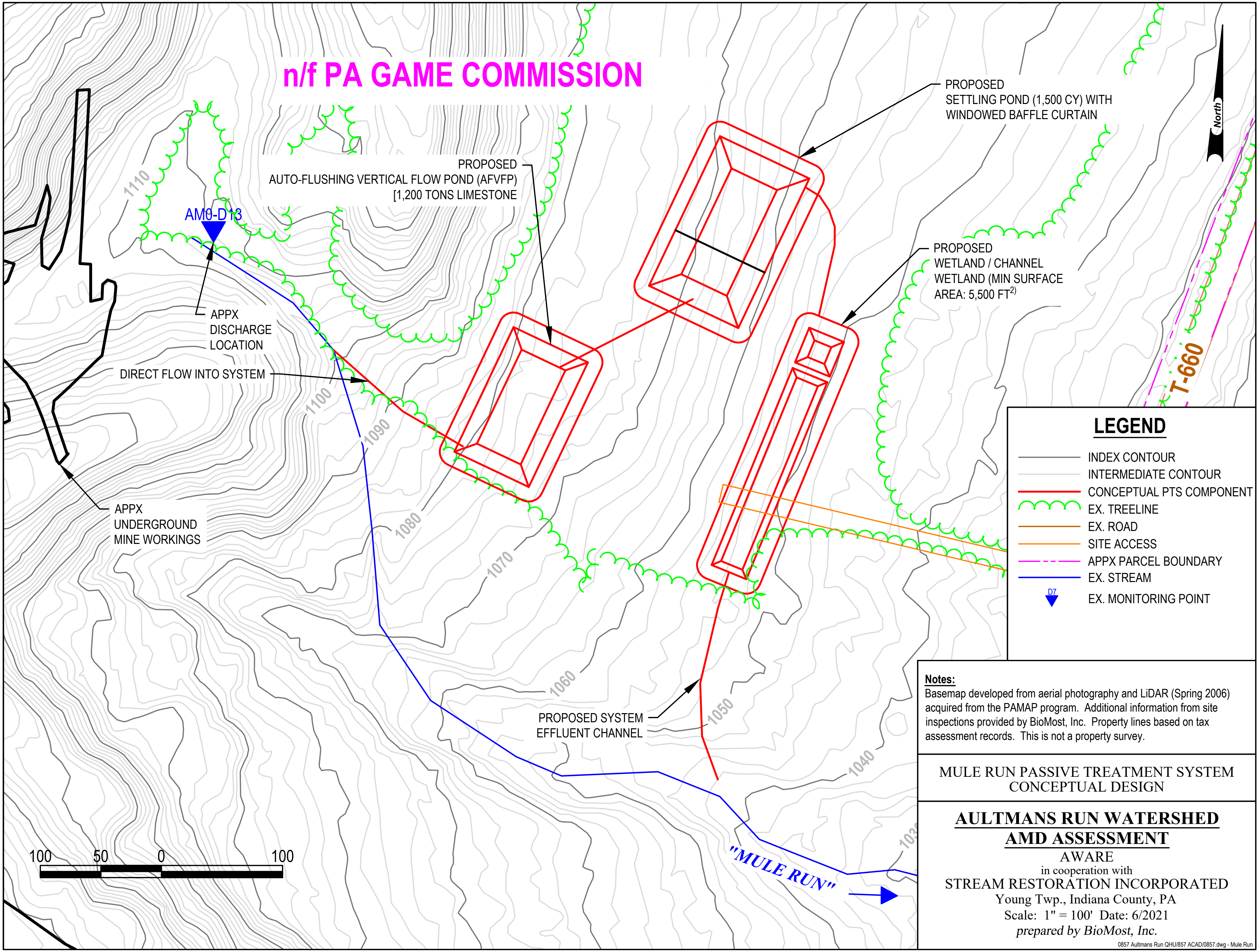
Appendix A
Aultmans Run Watershed Map

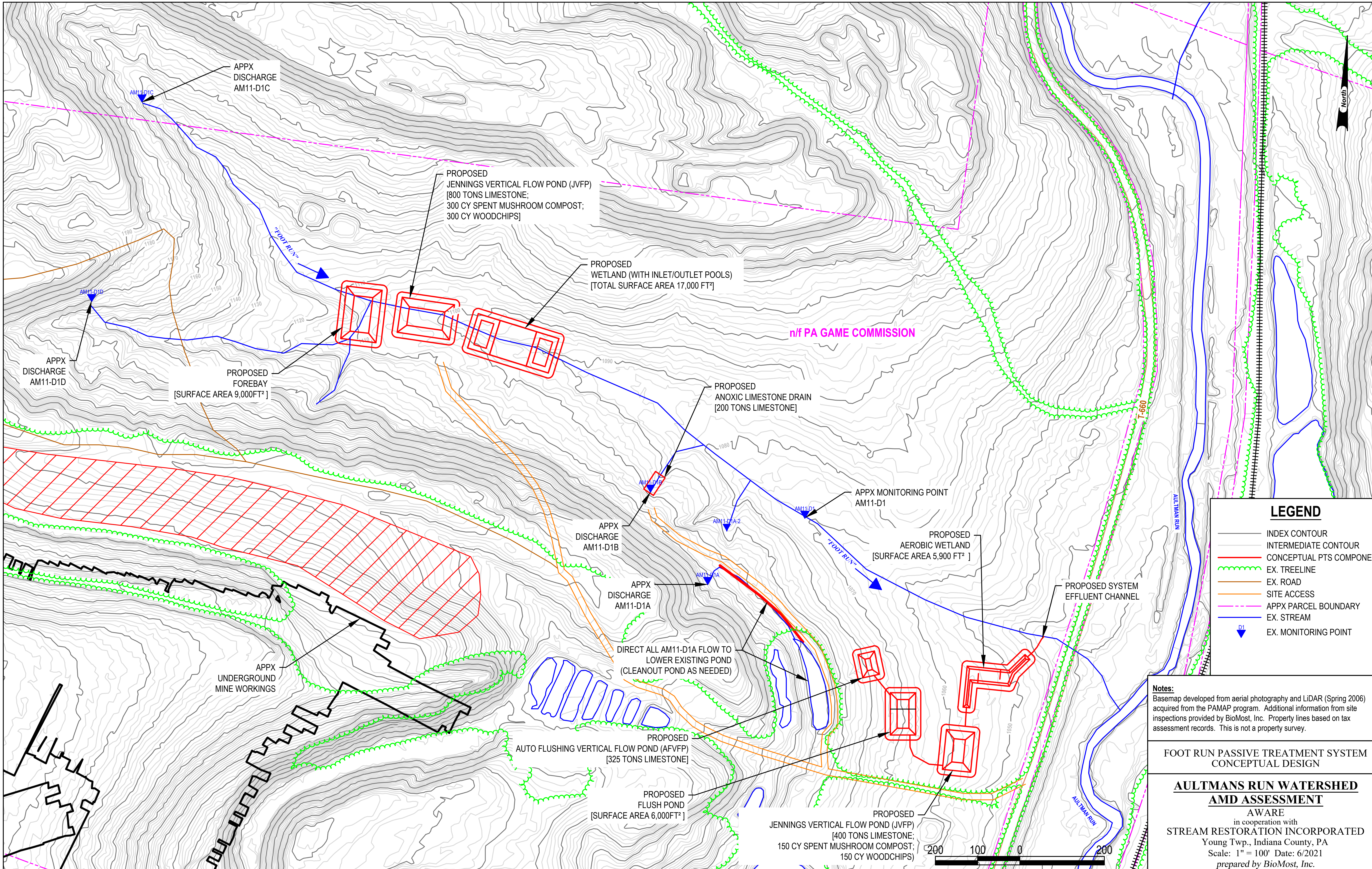
Neal Run Restoration Project
Reeds Run AMD Remediation Project
SR286 Passive Treatment System
ARMSTRONG
CENTER
YOUNG
BLACKLICK
CONEMAUGH
DERRY
McIntyre
Coal Run
Aultman
Jacksonville
Lewisville
Fillmore
Reeds Run AMD Remediation Project
Neal Run Restoration Project
Coal Refuse Pile
SR286 Passive Treatment System
JOHN GEORGE
MARUCA
PARK
WILLOW
LOCUST
RIGLEY
ALLISON
YOUNG
SIMEONE
REAM
MCINTYRE
COAL RUN
MCGEE
ZAGURSKIE
SWAN
ENTRY
BETHEL CHURCH
GRAHAM
STUCHELL
NEAL
KLIMKOS
HANCOCK
GEMMELL
HUNTER SCHOOL
PHIPPS
MARYAI
SALTSBURG
AULTMANS RUN
CUNKELMAN
OLD STRIPE
CRAMER
NEWPORT
BROWN
STAHL
LEWISVILLE
MARSHALL
MARTIN
McCONNELL
WAINWRIGHT
BARKLEY
ARCHIBALD
CLARKSBURG
GRANGE
286
217
Neal Run
Reeds Run
Coal Run
Miller Run
Aultmans Run
Conemaugh River
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Small watershed boundary datasets created by Environmental Resources Research Institute.
National Hydrography Dataset (stream) created by USGS. Minor modifications by BioMost, Inc. to conform to aerial photography.
County, municipality, and road datasets created by PA Department of Transportation.
Funding for this project was provided by the PA DEP AMD Set-Aside Program. Original mapping developed under funding provided by the Foundation for Pennsylvania Watersheds.
ARMSTRONG
KISKI-CONEMAUGH RIVER BASIN
INDIANA
Aultmans Run Watershed
WESTMORELAND
CAMBRIA
SOMERSET
6 3 0 6 Miles
Legend
Community
Existing Project
Proposed Project
Boat Launch
Stream
Lake/Pond
RES Coal Refuse Removal
Underground Mine
Army COE Property
SGL 332
Aultmans Run Watershed
Sample Point
Discharge
PTS
Stream
RBA Point
Roads
State Road
Township Road
Non-Attaining Stream Designations
AMD - Metals
AMD- Metals ; Crop Related Agric - Siltation
Agriculture - Siltation
Crop Related Agric - Siltation
0.25 0.125 0 0.25 0.5 Miles
AULTMANS RUN SAMPLE POINT MAP
AULTMANS RUN QHU PLAN
AWARE
&
STREAM RESTORATION INCORPORATED
Blacklick, Center, Conemaugh, and Young Townships
Indiana County, Pennsylvania
Scale: 1" = 1/4 Mile June 2021
BioMost, Inc. Mining and Reclamation Services
Mars, PA www.biomost.com
857

Appendix B
Conceptual Designs


North
2,000 CY HOLDING POND
CONVEYANCE PIPE
4,000 TON AUTO-FLUSHING
VERTICAL FLOW POND
APPX
CL0-D13
DISCHARGE
LOCATION
CL0-D13
COLLECTION SYSTEM
5,000 CY SETTLING POND
n/f PA GAME COMMISSION
COLLECTION SYSTEM
COAL RUN
500 TON JENNINGS-STYLE
VERTICAL FLOW POND
CONVEYANCE PIPE
CL0-D14
10,000 SF AEROBIC
WETLAND
2,000 TON AUTO-FLUSHING
VERTICAL FLOW POND
EXTENT OF UNDERGROUND
MINE WORKINGS
2,600 CY SETTLING POND
ABANDONED RAILROAD
GRADE AND SITE ACCESS
EXISTING PIT POND
STAHL ROAD
AULTMANS RUN
UNNAMED TRIBUTARY
AULTMANS RUN ROAD
n/f PA GAME COMMISSION
CRAMER ROAD
TRASH DUMPING
UNNAMED TRIBUTARY
AULTMANS RUN ROAD
AULTMANS RUN
100 50 0 100
LEGEND
INDEX CONTOUR
INTERMEDIATE CONTOUR
CONCEPTUAL PTS COMPONENT
EX. ROAD
SITE ACCESS
ABANDONED RAILROAD GRADE
APPX PARCEL BOUNDARY
EX. STREAM
UNDERGROUND MINE EXTENT
EX. MONITORING POINT
Notes:
Basemap developed from aerial photography and LiDAR (Spring 2006) acquired from the PAMAP program. Additional information from site inspections provided by BioMost, Inc. Property lines based on tax assessment records. This is not a property survey. Underground mine extents provided by the Institute of Mine Mapping, Indiana University of Pennsylvania.
CL0-D13 & CL0-D8
CONCEPTUAL DESIGNS
AULTMANS RUN WATERSHED
AMD ASSESSMENT
AWARE
in cooperation with
STREAM RESTORATION INCORPORATED
Young Twp., Indiana County, PA
Scale: 1" = 100' Date: 6/2021
prepared by BioMost, Inc.
857.dwg/Coon Hollow


n/f PA GAME COMMISSION
North
APPX SITE ACCESS
APPX UNDERGROUND MINE WORKINGS
PROPOSED JENNINGS VERTICAL FLOW POND (JVFP) [1990 TONS LIMESTONE; 491 CY SPENT MUSHROOM COMPOST; 982 CY WOODCHIPS)
APPX DISCHARGE JACK-MP2
JACK-MP2
APPX MONITORING POINT JACK-MP4
JACK-MP4
JACK-MP4A
GPR3
PROPOSED OXIDATION / SETTLING POND / AEROBIC WETLAND WITH WINDOWED BAFFLE CURTAIN, ROCK LEVEL SPREADER & DIRECTIONAL Z-PILE BAFFLES TOTAL SURFACE AREA ~25,400 FT²
JACK-MP1
APPX DISCHARGE JACK-MP1
PROPOSED FOREBAY
APPX DISCHARGE GPR3
PROPOSED ANOXIC LIMESTONE DRAIN [200 TONS LIMESTONE]
"GOLDEN PHEASANT RUN"
DIVERSION DITCH
PROPOSED SYSTEM EFFLUENT TO STREAM
1250
1240
1230
1220
1210
1200
1190
1180
1170
SR-0286
SR-0286
GAS
LEGEND
INDEX CONTOUR
INTERMEDIATE CONTOUR
CONCEPTUAL PTS COMPONENT
EX. TREELINE
EX. ROAD
SITE ACCESS
APPX PARCEL BOUNDARY
EX. STREAM
EX. GASLINE
EX. MONITORING POINT
DEGRADED WETLAND (APPX)
Notes:
Basemap developed from aerial photography and LiDAR (Spring 2006) acquired from the PAMAP program. Additional information from site inspections provided by BioMost, Inc. Property lines based on tax assessment records. This is not a property survey.
GOLDEN PHEASANT RUN PTS CONCEPTUAL DESIGN
AULTMANS RUN WATERSHED AMD ASSESSMENT
AWARE
in cooperation with
STREAM RESTORATION INCORPORATED
Young Twp., Indiana County, PA
Scale: 1" = 100' Date: 6/2021
prepared by BioMost, Inc.
100 50 0 100


n/f PA GAME COMMISSION
PROPOSED
SETTLING POND (1,500 CY) WITH
WINDOWED BAFFLE CURTAIN
PROPOSED
AUTO-FLUSHING VERTICAL FLOW POND (AFVFP)
[1,200 TONS LIMESTONE
AM0-D13
APPX
DISCHARGE
LOCATION
DIRECT FLOW INTO SYSTEM
PROPOSED
WETLAND / CHANNEL
WETLAND (MIN SURFACE
AREA: 5,500 FT2)
APPX
UNDERGROUND
MINE WORKINGS
PROPOSED SYSTEM
EFFLUENT CHANNEL
"MULE RUN"
T-660
North
1110
1100
1090
1080
1070
1060
1050
1040
100
50
0
100
LEGEND
INDEX CONTOUR
INTERMEDIATE CONTOUR
CONCEPTUAL PTS COMPONENT
EX. TREELINE
EX. ROAD
SITE ACCESS
APPX PARCEL BOUNDARY
EX. STREAM
D7
EX. MONITORING POINT
Notes:
Basemap developed from aerial photography and LiDAR (Spring 2006) acquired from the PAMAP program. Additional information from site inspections provided by BioMost, Inc. Property lines based on tax assessment records. This is not a property survey.
MULE RUN PASSIVE TREATMENT SYSTEM
CONCEPTUAL DESIGN
AULTMANS RUN WATERSHED
AMD ASSESSMENT
AWARE
in cooperation with
STREAM RESTORATION INCORPORATED
Young Twp., Indiana County, PA
Scale: 1" = 100' Date: 6/2021
prepared by BioMost, Inc.
0857 Aultmans Run QHU/857 ACAD/0857.dwg - Mule Run



APPX DISCHARGE AM11-D1C
AM11-D1C
PROPOSED JENNINGS VERTICAL FLOW POND (JVFP) [800 TONS LIMESTONE; 300 CY SPENT MUSHROOM COMPOST; 300 CY WOODCHIPS]
PROPOSED WETLAND (WITH INLET/OUTLET POOLS) [TOTAL SURFACE AREA 17,000 FT²]
"FOOT RUN"
AM11-D1D
APPX DISCHARGE AM11-D1D
PROPOSED FOREBAY [SURFACE AREA 9,000FT²]
n/f PA GAME COMMISSION
PROPOSED ANOXIC LIMESTONE DRAIN [200 TONS LIMESTONE]
T-660
AM11-D1B
APPX DISCHARGE AM11-D1B
APPX MONITORING POINT AM11-D1
AM11-D1
AM11-D1A-2
PROPOSED AEROBIC WETLAND [SURFACE AREA 5,900 FT²]
"FOOT RUN"
AULTMAN RUN
AM11-D1A
APPX DISCHARGE AM11-D1A
PROPOSED SYSTEM EFFLUENT CHANNEL
APPX UNDERGROUND MINE WORKINGS
DIRECT ALL AM11-D1A FLOW TO LOWER EXISTING POND (CLEANOUT POND AS NEEDED)
PROPOSED AUTO FLUSHING VERTICAL FLOW POND (AFVFP) [325 TONS LIMESTONE]
PROPOSED FLUSH POND [SURFACE AREA 6,000FT²]
PROPOSED JENNINGS VERTICAL FLOW POND (JVFP) [400 TONS LIMESTONE; 150 CY SPENT MUSHROOM COMPOST; 150 CY WOODCHIPS]
AULTMAN RUN
North
200 100 0 200
LEGEND
INDEX CONTOUR
INTERMEDIATE CONTOUR
CONCEPTUAL PTS COMPONENT
EX. TREELINE
EX. ROAD
SITE ACCESS
APPX PARCEL BOUNDARY
EX. STREAM
D1
EX. MONITORING POINT
Notes:
Basemap developed from aerial photography and LiDAR (Spring 2006) acquired from the PAMAP program. Additional information from site inspections provided by BioMost, Inc. Property lines based on tax assessment records. This is not a property survey.
FOOT RUN PASSIVE TREATMENT SYSTEM CONCEPTUAL DESIGN
AULTMANS RUN WATERSHED AMD ASSESSMENT
AWARE
in cooperation with
STREAM RESTORATION INCORPORATED
Young Twp., Indiana County, PA
Scale: 1" = 100' Date: 6/2021
prepared by BioMost, Inc.
0854-2.dwg/Foot Run Conceptual

Appendix C
Treatment Alternatives

MULE RUN - PASSIVE TREATMENT ALTERNATIVE

ITEM	QTY	UNIT	UNIT Cost	PRICE
Auto-Flushing Vertical Flow Pond (1,200 Tons) installed cost per ton of Treatment Stone	1200	Tons	70.00	84,000.00
Settling Pond	1500	CY	15.00	22,500.00
Baffle Curtain	80	LF	25.00	2,000.00
Conveyance channels	1	JOB	20,000.00	20,000.00
Aerobic Wetland / Channel wetland	800	CY	15.00	12,000.00
Road / Access Costs	550	LF	30.00	16,500.00
E&S Controls	1	JOB	5,000.00	5,000.00
Mobilization / Demobilization (% of Construction)			4%	6,480.00
CONSTRUCTION- SUBTOTAL				**168,480.00**
Engineering / Design / Permitting (% of Construction subtotal)			20%	33,696.00
ENGINEERING / PERMITTING - SUBTOTAL				**33,696.00**
CAPITAL COST TOTAL				**202,176.00**

ITEM	QTY	UNIT	UNIT Cost	PRICE
Stirring of Auto-Flushing Vertical Flow Pond Media - **Annual**	1200	Tons	1.00	1,200.00
Operation and Maintenance - ***Annual***	32	HR	55.00	1,760.00
OPERATION AND MAINTENANCE COST TOTAL				**2,960.00**

20-YEAR COST ANALYSIS

	Cost	YEARS
Capital Costs	202,176.00	
Annual Costs	2,960.00	20
20-YEAR COMPARISON COST (EXCLUDING INFLATION)	**261,376.00**	

GOLDEN PHEASANT RUN - PASSIVE TREATMENT ALTERNATIVE

ITEM	QTY	UNIT	UNIT Cost	PRICE
Jennings Vertical Flow Pond (1,990 Tons) Installed Cost per Ton of Treatment Stone	1990	Tons	130.00	258,700.00
ALD - Installed Cost per Ton of Treatment Stone	200	Tons	50.00	10,000.00
Settling Pond / Aerobic Wetland	6000	CY	15.00	90,000.00
Forebay	800	CY	15.00	12,000.00
Water Conveyance (pipe/channel)	400	LF	30.00	12,000.00
Baffle Curtains	125	LF	25.00	3,125.00
Levelspreader & Directional z-pile Barriers	1	JOB	6,000.00	6,000.00
Road / Access Costs	1050	LF	30.00	31,500.00
E&S Controls	1	JOB	5,000.00	5,000.00
Mobilization / Demobilization (% of Construction)			4%	17,133.00
CONSTRUCTION- SUBTOTAL				**445,458.00**
Engineering / Design / Permitting (% of Construction subtotal)			20%	89,091.60
ENGINEERING / PERMITTING - SUBTOTAL				**89,091.60**
CAPITAL COST TOTAL				**534,549.60**

ITEM	QTY	UNIT	UNIT Cost	PRICE
Stirring of Jennings Vertical Flow Pond Media - **Annual**	1990	Tons	0.50	995.00
Operation and Maintenance (Labor)- ***Annual***	20	HR	55.00	1,100.00
OPERATION AND MAINTENANCE COST TOTAL				**2,095.00**

20-YEAR COST ANALYSIS

	Cost	YEARS
Capital Costs	534,549.60	
Annual Costs	2,095.00	20
20-YEAR COMPARISON COST (EXCLUDING INFLATION)	**576,449.60**	

COON HOLLOW (CLO-D13) - PASSIVE TREATMENT ALTERNATIVE

ITEM	QTY	UNIT	UNIT Cost	PRICE
Inlet Collection System & Flow Measurement (Flume)	1	JOB	17,500.00	17,500.00
Holding Pond Earthwork	2000	CY	15.00	30,000.00
Holding Pond Outlet Channel / Conveyance	1	JOB	5,000.00	5,000.00
Automatic Flushing Vertical Flow Pond #1 (4,000 Tons) Installed Cost per Ton of Treatment Stone	4000	Tons	70.00	280,000.00
Settling Pond #1 - Earthwork	5000	CY	15.00	75,000.00
Settling Pond #1 Outlet Channel / Conveyance	1	JOB	5,000.00	5,000.00
Baffle Curtains (SP #1)	200	LF	25.00	5,000.00
Auto-Flushing Vertical Flow Pond #2 (2,000 Tons) Installed Cost per Ton of Treatment Stone	2000	Tons	70.00	140,000.00
Settling Pond #2 - Earthwork	2600	CY	15.00	39,000.00
Settling Pond #2 Outlet Channel / Conveyance	1	JOB	15,000.00	15,000.00
Baffle Curtains (SP #2)	150	LF	25.00	3,750.00
Road / Access Costs	2300	LF	30.00	69,000.00
E&S Controls	1	JOB	10,000.00	10,000.00
Mobilization / Demobilization (% of Construction)			4%	27,770.00
CONSTRUCTION- SUBTOTAL				**722,020.00**
Engineering / Design / Permitting (% of Construction subtotal)			25%	180,505.00
ENGINEERING / PERMITTING - SUBTOTAL				**180,505.00**
CAPITAL COST TOTAL				**902,525.00**

ITEM	QTY	UNIT	UNIT Cost	PRICE
Stirring of Auto-Flushing Vertical Flow Pond Media - **Annual**	6000	Tons	1.00	6,000.00
Operation and Maintenance (Labor)- ***Annual***	20	HR	55.00	1,100.00
OPERATION AND MAINTENANCE COST TOTAL				**7,100.00**

20-YEAR COST ANALYSIS

	Cost	YEARS
Capital Costs	902,525.00	
Annual Costs	7,100.00	20
20-YEAR COMPARISON COST (EXCLUDING INFLATION)	**1,044,525.00**	

COON HOLLOW (CLO-D8) - PASSIVE TREATMENT ALTERNATIVE

ITEM	QTY	UNIT	UNIT Cost	PRICE
Inlet Collection System & Flow Measurement (Flume)	1	JOB	17,500.00	17,500.00
Jennings Vertical Flow Pond (500 Tons) Installed Cost per Ton of Treatment Stone	500	Tons	130.00	65,000.00
Settling Pond / Aerobic Wetland	2500	CY	15.00	37,500.00
Settling Pond / Aerobic Wetland Outlet Water Conveyance Channel	1	JOB	5,000.00	5,000.00
Baffle Curtains / Level Spreader (2)	200	LF	25.00	5,000.00
Road / Access Costs	400	LF	30.00	12,000.00
E&S Controls	1	JOB	5,000.00	5,000.00
Mobilization / Demobilization (% of Construction)			4%	5,880.00
CONSTRUCTION- SUBTOTAL				**152,880.00**
Engineering / Design / Permitting (% of Construction subtotal)			30%	45,864.00
ENGINEERING / PERMITTING - SUBTOTAL				**45,864.00**
CAPITAL COST TOTAL				**198,744.00**

ITEM	QTY	UNIT	UNIT Cost	PRICE
Stirring of Jennings Vertical Flow Pond Media - **Annual**	500	Tons	0.50	250.00
Operation and Maintenance (Labor)- ***Annual***	20	HR	55.00	1,100.00
OPERATION AND MAINTENANCE COST TOTAL				**1,350.00**

20-YEAR COST ANALYSIS

	Cost	YEARS
Capital Costs	198,744.00	
Annual Costs	1,350.00	20
20-YEAR COMPARISON COST (EXCLUDING INFLATION)	**225,744.00**	

MULE RUN - ACTIVE TREATMENT ALTERNATIVE

ITEM	QTY	UNIT	UNIT Cost	PRICE	
Active Treatment Components for Chemical Addition - **Lime Slurry System**	1	JOB	200,000.00	200,000.00	
pH Control System	1	JOB	15,000.00	15,000.00	
Treatment Ponds (24 hr)	2	EA	10,000.00	20,000.00	*(AMD TREAT)*
Sludge Ponds (24 hr)	2	EA	10,000.00	20,000.00	*(AMD TREAT)*
Permanent sludge line	500	LF	30.00	15,000.00	
Baffle Curtains	250	LF	25.00	6,250.00	
Road / Access Costs	550	LF	30.00	16,500.00	
E&S Controls	1	JOB	5,000.00	5,000.00	
Mobilization / Demobilization (% of Construction)			4%	11,910.00	
CONSTRUCTION- SUBTOTAL				**309,660.00**	
Engineering / Design / Permitting (% of Construction subtotal)			25%	77,415.00	
ENGINEERING / PERMITTING - SUBTOTAL				**77,415.00**	
CAPITAL COST TOTAL				**387,075.00**	

ITEM	QTY	UNIT	UNIT Cost	PRICE	
Chemical Cost (Lime Slurry) - ***Annual***	3.8	Tons	600.00	2,280.00	*(AMD TREAT)*
Operation and Maintenance - ***Annual***	1	JOB	40,000.00	40,000.00	
OPERATION AND MAINTENANCE COST TOTAL				**42,280.00**	

20-YEAR COST ANALYSIS

	Cost	YEARS
Capital Costs	387,075.00	
Annual Costs	42,280.00	20
20-YEAR COMPARISON COST (EXCLUDING INFLATION)	**1,232,675.00**	

FOOT RUN - ACTIVE TREATMENT ALTERNATIVE

ITEM	QTY	UNIT	UNIT Cost	PRICE	
Active Treatment Components for Chemical Addition - **Lime Slurry System**	1	JOB	200,000.00	200,000.00	
pH Control System	1	JOB	15,000.00	15,000.00	
Treatment Ponds (24 hr)	2	EA	10,000.00	20,000.00	*(AMD TREAT)*
Sludge Ponds (24 hr)	2	EA	10,000.00	20,000.00	*(AMD TREAT)*
Permanent sludge line	400	LF	30.00	12,000.00	
Baffle Curtains	100	LF	25.00	2,500.00	
Road / Access Costs	700	LF	30.00	21,000.00	
E&S Controls	1	JOB	5,000.00	5,000.00	
Mobilization / Demobilization (% of Construction)			4%	11,820.00	
CONSTRUCTION- SUBTOTAL				**307,320.00**	
Engineering / Design / Permitting (% of Construction subtotal)			25%	76,830.00	
ENGINEERING / PERMITTING - SUBTOTAL				**76,830.00**	
CAPITAL COST TOTAL				**384,150.00**	

ITEM	QTY	UNIT	UNIT Cost	PRICE	
Chemical Cost (Lime Slurry) - ***Annual***	0.8	Tons	600.00	480.00	*(AMD TREAT)*
Operation and Maintenance - ***Annual***	1	JOB	40,000.00	40,000.00	
OPERATION AND MAINTENANCE COST TOTAL				**40,480.00**	

20-YEAR COST ANALYSIS

	Cost	YEARS
Capital Costs	384,150.00	
Annual Costs	40,480.00	20
20-YEAR COMPARISON COST (EXCLUDING INFLATION)	**1,193,750.00**	

GOLDEN PHEASANT RUN - ACTIVE TREATMENT ALTERNATIVE

ITEM	QTY	UNIT	UNIT Cost	PRICE	
Active Treatment Components for Chemical Addition - **Lime Slurry System**	1	JOB	200,000.00	200,000.00	
pH Control System	1	JOB	15,000.00	15,000.00	
Treatment Ponds (24 hr)	2	EA	10,000.00	20,000.00	*(AMD TREAT)*
Sludge Ponds (24 hr)	2	EA	10,000.00	20,000.00	*(AMD TREAT)*
Permanent sludge line	400	LF	30.00	12,000.00	
Baffle Curtains	250	LF	25.00	6,250.00	
Road / Access Costs	1050	LF	30.00	31,500.00	
E&S Controls	1	JOB	5,000.00	5,000.00	
Mobilization / Demobilization (% of Construction)			4%	12,390.00	
CONSTRUCTION- SUBTOTAL				**322,140.00**	
Engineering / Design / Permitting (% of Construction subtotal)			20%	64,428.00	
ENGINEERING / PERMITTING - SUBTOTAL				**64,428.00**	
CAPITAL COST TOTAL				**386,568.00**	

ITEM	QTY	UNIT	UNIT Cost	PRICE	
Chemical Cost (Lime Slurry) - ***Annual***	7.4	Tons	600.00	4,440.00	*(AMD TREAT)*
Operation and Maintenance - ***Annual***	1	JOB	40,000.00	40,000.00	
OPERATION AND MAINTENANCE COST TOTAL				**44,440.00**	

20-YEAR COST ANALYSIS

	Cost	YEARS
Capital Costs	386,568.00	
Annual Costs	44,440.00	20
20-YEAR COMPARISON COST (EXCLUDING INFLATION)	**1,275,368.00**	

COON HOLLOW (CLO-D13) - ACTIVE TREATMENT ALTERNATIVE

ITEM	QTY	UNIT	UNIT Cost	PRICE	
Active Treatment Components for Chemical Addition - **Lime Slurry System**	1	JOB	200,000.00	200,000.00	
pH Control System	1	JOB	15,000.00	15,000.00	
Treatment Ponds (24 hr)	2	EA	18,000.00	36,000.00	*(AMD TREAT)*
Sludge Ponds (24 hr)	2	EA	18,000.00	36,000.00	*(AMD TREAT)*
Permanent sludge line	400	LF	30.00	12,000.00	
Baffle Curtains	250	LF	25.00	6,250.00	
Road / Access Costs	2300	LF	30.00	69,000.00	
E&S Controls	1	JOB	10,000.00	10,000.00	
Mobilization / Demobilization (% of Construction)			4%	15,370.00	
CONSTRUCTION- SUBTOTAL				**399,620.00**	
Engineering / Design / Permitting (% of Construction subtotal)			25%	99,905.00	
ENGINEERING / PERMITTING - SUBTOTAL				**99,905.00**	
CAPITAL COST TOTAL				**499,525.00**	

ITEM	QTY	UNIT	UNIT Cost	PRICE	
Chemical Cost (Lime Slurry) - ***Annual***	29.7	Tons	600.00	17,820.00	*(AMD TREAT)*
Operation and Maintenance - ***Annual***	1	JOB	40,000.00	40,000.00	
OPERATION AND MAINTENANCE COST TOTAL				**57,820.00**	

20-YEAR COST ANALYSIS

	Cost	YEARS
Capital Costs	499,525.00	
Annual Costs	57,820.00	20
20-YEAR COMPARISON COST (EXCLUDING INFLATION)	**1,655,925.00**	

COON HOLLOW (CLO-D8) - ACTIVE TREATMENT ALTERNATIVE

ITEM	QTY	UNIT	UNIT Cost	PRICE	
Active Treatment Components for Chemical Addition - **Lime Slurry System**	1	JOB	200,000.00	200,000.00	
pH Control System	1	JOB	15,000.00	15,000.00	
Treatment Ponds (24 hr)	2	EA	10,000.00	20,000.00	*(AMD TREAT)*
Sludge Ponds (24 hr)	2	EA	10,000.00	20,000.00	*(AMD TREAT)*
Permanent sludge line	400	l-FT	30.00	12,000.00	
Baffle Curtains	75	L-FT	25.00	1,875.00	
Road / Access Costs	400	L-FT	30.00	12,000.00	
E&S Controls	1	JOB	5,000.00	5,000.00	
Mobilization / Demobilization (% of Construction)			4%	11,435.00	
CONSTRUCTION- SUBTOTAL				**297,310.00**	
Engineering / Design / Permitting (% of Construction subtotal)			30%	89,193.00	
ENGINEERING / PERMITTING - SUBTOTAL				**89,193.00**	
CAPITAL COST TOTAL				**386,503.00**	

ITEM	QTY	UNIT	UNIT Cost	PRICE	
Chemical Cost (Lime Slurry) - ***Annual***	3	Tons	600.00	1,800.00	*(AMD TREAT)*
Operation and Maintenance - ***Annual***	1	JOB	40,000.00	40,000.00	
OPERATION AND MAINTENANCE COST TOTAL				**41,800.00**	

20-YEAR COST ANALYSIS

	Cost	YEARS
Capital Costs	386,503.00	
Annual Costs	41,800.00	20
20-YEAR COMPARISON COST (EXCLUDING INFLATION)	**1,222,503.00**	

Appendix D
Water Quality Data

Sample Point	Latitude	Longitude	Point Type	Frequency	BMI Freq. #	RBA	KCST	Location
85-16	40.555556	-79.259444	PTS	Monthly	1		Existing	Effluent of SR286 PTS prior to entering Aultmans Run. Also known as KCOATS by the Kiski-Conemaugh Stream Team and OUT286 by the PADEP.
A2M-MP13	40.555515	-79.25927	Stream	Quarterly	4	Yes		Aultman Run upstream of SR286 Discharge. Also known as 85-14.
A2M-MP14	40.555368	-79.259879	Stream	Quarterly	4	Yes		Aultman Run downstream of SR286 Discharge. Also known as 85-13.
AM0-D13	40.524633	-79.29004	Discharge	Monthly	12			Discharge flowing from abandoned strip pit. Labeled as AM0-D5 in the field on the weir. Forms large sloped wetland.
AM11-D1	40.529457	-79.285591	Discharge	Bi-Annual	2			"Foot Run" formed from a collection of discharges. Also known as UNT06 by the PADEP.
AM11-D1A	40.529632	-79.287954	Discharge	Bi-Annual	2			Seep flowing into "Foot Run". Same as Lewis-58.
AM11-D1B	40.530225	-79.288456	Discharge	Bi-Annual	2			Seep flowing into "Foot Run". Same as Lewis-57.
AM11-D1C	40.532701	-79.292845	Discharge	Bi-Annual	2			Seep in the headwaters of "Foot Run".
AM11-D1D	40.531372	-79.293247	Discharge	Bi-Annual	2			Seep in the headwaters of "Foot Run".
AUL03	40.516667	-79.285278	Stream	Quarterly	4			Kent Strip No 55 (32860106) - Aultmans Run upstream of Coal Run
CL0-D13	40.515672	-79.294775	Discharge	Monthly	12			Discharge flowing from abandoned highwall. Lots of iron accumulation in valley. Water flows into Priority 2 pond near Aultmans Run Road. Found by Dean Baker.
CL0-D14	40.514631	-79.288468	Discharge	Bi-Annual	4			New discharge found upstream of COA01. Bubbles up within stream channel on the right bank.
CL0-D2	40.518636	-79.294313	Discharge	Annual	1			Discharge flowing into Coal Run upstream of CL0-D8. Also known by SRI as 851-6.
CL0-D2A			Discharge	Monthly	12			
CL0-D8	40.514654	-79.290408	Discharge	Monthly	12			Discharge near the mouth of Coal Run. Also known by SRI as 851-7.
COA01	40.514444	-79.288611	Stream	Quarterly	4	Yes		Lewisville Rec (32803712) - Coal Run at mouth. Also known as MP 3.
COA02	40.534167	-79.304722	Stream	Bi-Annual	2	Yes		Jacksonville Surface Mine (32980108) - Coal Run, downstream, 2400' SW of site. Same as MP16 on Lewisville Rec mine (32803712) and MP26 on Jacksonville Surface Mine.
D2	40.567528	-79.29326	Discharge	Monthly	8		Existing	French drain outlet at beginning of PTS. Emanates from large refuse pile in Mcintyre, PA.
D3	40.567413	-79.292722	Discharge	Monthly	8		Existing	Seep upgradient of access road at toe of coal refuse pile. Flows taken at culvert.
D7A	40.56655	-79.294948	PTS	Monthly	8		Moved	Influent to AFVFP. D7 sample previously taken within OPC above confluence with diversion ditch. Prior to any reclamation activities, D7 was the discharge emanating from the ground. After coal refuse was removed, the discharge was found to be flowing higher in elevation at D2.
GPR3	40.54111	-79.294587	Discharge	Monthly	12			Iron seep flowing into "Golden Pheasant Run" below Jack-MP4.
Jack - MP1	40.541389	-79.298056	Discharge	Monthly	12			Jacksonville Surface Mine (32980108) - Discharge in headwaters of "Golden Pheasant Run".
Jack - MP2	40.541944	-79.296389	Discharge	Monthly	12			Jacksonville Surface Mine (32980108) - Discharge in headwaters of "Golden Pheasant Run".
Jack - MP27	40.547979	-79.289786	Stream	Quarterly	4			Jacksonville Surface Mine (32980108) - Reeds Run upstream of Jacksonville Permit, 2100' northeast of site.
Jack - MP4	40.541389	-79.295	Discharge	Monthly	12			Jacksonville Surface Mine (32980108) - Weir on "Golden Pheasant Run", also known as Unnamed Trib B in Jacksonville Mining Permit or RUNT01 in PADEP BMR Stream Assessment.
Jack - MP4A	40.541419	-79.294391	Discharge	Irregular	4			Small discharge near Jack-MP4 that only flows suring high-flow time of year. Originates upgradient from low-pH iron hillside.
John - 1	40.543333	-79.277222	Stream	Quarterly	4	Yes		Johnston Mine (32020107) - Aultmans Run upstream of UNT08.
K53 - SW29	40.579444	-79.276944	Discharge	Quarterly	1		Existing	Kent No 53 (32803037) - Discharge that flowed into Kent-2A bog area. Also known as MS29. Also known by KCST as MS28.
K53 - SW32	40.579722	-79.275556	Stream	Quarterly	1	Yes	Existing	Kent No 53 (32803037) - Reeds Run above Kent 2-A taken at township road. Also known as RD0-MP1 by AWARE.
K53 - SW33	40.575556	-79.275556	Stream	Quarterly	1	Yes	Existing	Kent No 53 (32803037) - Reeds Run below Kent 2-A taken below beaver dam. Also known as 851-5 by SRI and R05 by PADEP.
K55 - SM14	40.51	-79.291111	Stream	Quarterly	4	Yes		Kent Strip No 55 (32860106) - Aultmans Run Downstream
K56 - 2	40.536389	-79.283333	Stream	Quarterly	4			Kent No 56 (32803010) - AULTMAN RUN ABOVE
NEAL01	40.555278	-79.291389	Stream	Quarterly	1		Naming?	Lentz Mine (32020102) - Mouth of Neal Run. Previously called REE03 by the DEP.
NL0-MP2	40.567998	-79.297617	Stream	Quarterly	1	Yes	Existing	Neal Run upstream of Neal Run Restoration Area. Also known as MP2 by the Kiski-Conemaugh Stream Team.
NL0-MP3	40.565585	-79.29744	Stream	Quarterly	1	Yes	Existing	Neal Run downstream of Neal Run Restoration Area. Also known as MP3 by the Kiski-Conemaugh Stream Team.
OPC1 Effluent	40.566163	-79.297173	PTS	Monthly	8		Moved	Effluent of OPC1 prior to entering Neal Run.
OPC1-MID	40.566385	-79.295068	PTS	Monthly	6			Weir installed to measure flow of OPC2 and diversion ditch.
RAW	40.567487	-79.293424	Discharge	Monthly	6			Weir installed downstream of D2 and D3 discharges.
REE01	40.538821	-79.280812	Stream	Quarterly	1	Yes	Moved	Mouth of Reeds Run. Same as Johnston Mine MP12.
REE03	40.555278	-79.291111	Stream	Quarterly	1	Yes	Naming?	Lentz Mine (32020102) - Reeds Run upstream of Neal Run. Possibly also known as RUNT04A by the DEP and KCST.
RUNT04B	40.565266	-79.287468	Stream	Quarterly	1		Existing	Unnamed tributary to Reeds Run upstream of Neal Run and to the east of the large coal refuse pile in McIntyre, PA. Also known as "Willow Run".
SP	40.566357	-79.295668	PTS	Monthly	8		New	Outlet of settling pond on Neal Run PTS.
SR286 Discharge	40.556649	-79.25881	Discharge	Monthly	1		Existing	Large alkaline, iron discharge that flows directly into Aultmans Run. PTS has been constructed. Also known as KCOAB8 by the Kiski-Conemaugh Stream Team, AM0-D1 by AWARE, and RAW286 by the PADEP.
WETLD	40.576407	-79.275881	PTS	Monthly	1		Existing	Effluent of wetland at Reeds Run. Also known by KCST as MS29.
WL			PTS	Quarterly	0		Existing	Effluent of SR286 Wetland prior to entering channel wetland. Also known as WET/DITCH by the Kiski-Conemaugh Stream Team.

Discharge	**21**	**213**	**KCST Sites 17**	
PTS	**7**		**RBA 12**	**RBA=Rapid Bioassessment**
Stream	**17**			

= Lab lost sample.
= Results appear anomalous and not included in calculation of average.

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
D2	01/15/19	RMM			0.00			2.79	6632	ND	5576.98	422.38		12.17		329.12		4079.6	<5												
D2	07/16/19	SLB	9.80	2.89	0.00	0.72	23.80	2.85	6430	ND	5108.63	1231.69	1197.01	11.68	10.99	463.71	280.27	6118.1	<5					601.78	145.09	1.38	54.62	219648.31	52957.18	502.19	19937.46
D2	08/20/19	SLB/CS	2.90	2.78	0.00	2.90	23.70	2.75	7105	ND	5800.74	1112.82	1086.23	14.79	14.70	533.83	525.00	7215.4	<5					202.20	38.79	0.52	18.61	73803.80	14158.60	188.18	6792.01
D2	09/23/19	CG	4.45	2.87	0.00			2.70	>4000	ND	6297.80	>300		20.52		>500		8800.0	82					336.86		1.10		122955.00	0.00	400.60	0.00
D2	10/28/19	CG						2.80		ND	6365.40	>300		20.67		>500		8241.0	136					0.00		0.00		0.00	0.00	0.00	0.00
D2	11/13/19	SLB	7.80	2.69	0.00	0.88	20.60	2.83	7650	ND	6465.67	1249.76	1094.29	23.53	20.19	576.36	495.75	7511.4	19					606.20	117.17	2.21	54.04	221261.31	42767.96	805.22	19723.58
D2	12/19/19	KMM	20.60	3.26	0.00		18.00	3.10	4998	ND	3278.46	915.71	770.16	8.95	7.96	310.48	223.11	4917.2	<5					811.79	226.74	2.22	76.88	296301.90	82760.39	808.89	28060.68
D2	1/22/2020	CG	26.00					2.69	>4000	ND	5614.00	>300		19.66		>500		7792.0	52					1,754.49		6.14		640387.86	0.00	2242.61	0.00
D2	02/06/20	RMM	13.00	2.99	0.00		19.10	2.81	6780	ND	4895.83	1190.14	1089.47	21.33	20.05	484.13	448.15	6309.5	8	427	403	177	166	765.02	185.97	3.33	75.65	279233.17	67879.52	1216.55	27612.31
D2	02/25/20	CC		3.06	0.00		4.50	3.05	1743	ND	383.11	80.57	78.73	10.58	10.29	35.82	32.33	1108.0	28	245	241	36	35								
D2	03/24/20	CC	24.80	2.67	0.00	0.69	18.10	2.87	6213	ND	4974.52	1053.33	995.23	13.06	12.19	431.41	413.87	5915.7	<5	481	455	154	144	1,482.88	313.99	3.89	128.60	541252.85	114607.61	1420.99	46939.58
D2	04/20/20	SLB	31.32	2.81	0.00	0.41	20.30	2.81	6541	ND	5096.32	1028.37	999.26	12.56	12.24	509.87	503.62	6453.8	<5	467	463	157	155	1,918.59	387.15	4.73	191.95	700286.53	141308.56	1725.87	70061.36
D2	05/20/20	SLB	15.65	2.72	0.00	1.24	20.30	2.85	6161	ND	5275.97	976.10	929.41	14.64	14.41	569.37	548.94	5485.2	6	497	471	161	154	992.48	183.62	2.75	107.11	362254.67	67020.24	1005.20	39093.65
D2	6/22/2020	CC,CH,KM	10.95	2.84	0.00	2.19	24.20	2.85	6165	ND	5281.05	1118.37	1093.81	16.08	15.28	486.24	483.14	6898.2	13	516	514	184	183	695.09	147.20	2.12	64.00	253706.58	53727.54	772.50	23359.42
MIN			2.90	2.67	0.00	0.41	4.50	2.69	1743.00	0.00	383.11	80.57	78.73	8.95	7.96	35.82	32.33	1108.00	6.00	244.83	241.04	35.61	34.65	0.00	38.79	0.00	18.61	0.00	0.00	0.00	0.00
MAX			31.32	3.26	0.00	2.90	24.20	3.10	7650.00	0.00	6465.67	1249.76	1197.01	23.53	20.19	576.36	548.94	8800.00	136.00	516.01	514.04	183.62	182.53	1918.59	387.15	6.14	191.95	700286.53	141308.56	2242.61	70061.36
AVG			15.21	2.87	0.00	1.29	19.26	2.84	6038.00	#DIV/0!	5029.61	943.57	933.36	15.73	13.83	430.03	395.42	6203.22	43.00	438.75	424.41	144.74	139.38	847.28	193.97	2.53	85.72	309257.67	53098.97	924.07	23465.00

=water sample appears spurious and was not used in the loading calculation.

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
D3	03/17/15	SLB						3.78	540	ND	76.60	20.61	12.65	2.76	2.59	6.35	4.06	214.1	17												
D3	07/16/19	SLB	dry																												
D3	08/20/19	SLB/CS	dry																												
D3	09/23/19	CG	dry																												
D3	10/28/19	CG						2.7		ND	2506.4	>300		11.44		250.84		3261.0	42												
D3	11/13/19	SLB	0.80	2.64		2.62		3.03	1905	ND	456.07	22.26	20.33	3.87	3.59	7.22	6.53	1046.2	6					4.39	0.21	0.04	0.07	1600.73	78.13	13.58	25.34
D3	12/19/19	KMM	trickle	3.44			1.70	3.38	881	ND	152.11	50.60	29.64	2.66	1.85	4.47	2.24	374.1	18												
D3	1/22/2020	CG		3.12			1.20	3.10	1960	0.00	459.60	136.29		11.61		24.94		1174.0	8					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D3	02/06/20	RMM	12.00	3.61			5.20	3.46	772	ND	88.84	15.60	15.13	3.26	3.16	4.58	3.77	377.7	50	96.10	94.05	13.16	12.53	12.81	2.25	0.47	0.66	4677.21	821.30	171.63	241.13
D3	02/25/20	CC	Not Taken	2.85			4.20	3.09	1937	ND	365.02	115.22	73.10	14.56	12.65	43.60	33.62	1529.4	<5	327.40	280.90	46.44	39.42								
D3	03/24/20	CC	7.10	3.52		9.64	7.30	3.37	947	ND	137.89	29.59	27.07	4.27	3.87	6.34	5.61	466.0	<5	121.50	118.54	12.64	10.95	11.77	2.53	0.36	0.54	4295.25	921.72	133.01	197.49
D3	4/20/2020	SLB	3.58	2.34		8.55	11.8	3.17	1357	ND	271.27	49.51	45.73	5.7	5.19	8.68	8.24	667.4	<5	177.36	166.32	16.53	15.54	11.67	2.13	0.25	0.37	4260.71	777.63	89.53	136.33
D3	5/20/2020	SLB	0.58	2.73		8.38	16.1	2.94	2494	ND	725.73	13.22	12.67	17.03	16.73	26.81	24.67	1513.0	<5	375.45	364.83	47.61	45.13	5.06	0.09	0.12	0.19	1846.72	33.64	43.34	68.22
D3	6/22/2020	KMM	dry																												
MIN			0.58	2.34	0.00	2.62	1.20	2.70	540.00	0.00	76.60	15.60	12.65	2.66	1.85	4.47	2.24	214.10	6.00	96.10	94.05	12.64	10.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAX			12.00	3.61	0.00	9.64	11.80	3.78	1960.00	0.00	2506.40	136.29	73.10	14.56	12.65	250.84	33.62	3261.00	50.00	327.40	280.90	46.44	39.42	12.81	2.53	0.47	0.66	4677.21	921.72	171.63	241.13
AVG			4.81	3.03	#DIV/0!	7.30	5.23	3.23	1287.38	0.00	501.53	54.96	31.95	6.68	4.70	39.67	9.15	1012.21	23.50	180.59	164.95	22.19	19.61	8.13	1.42	0.22	0.33	2966.78	519.76	81.55	120.06

=no flow taken on this day and as a result could not be used in the loading calculation.

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
RAW	02/06/20	RMM	26.00	3.10			12.90	3.36	1898	ND	920.18	115.73	112.30	4.23	4.20	51.17	50.44	1286.7	20	125.80	122.51	27.71	26.29	287.57	36.17	1.32	15.99	104964.75	13201.30	482.52	5836.95
RAW	02/25/20	CC	23.20	2.78	0.00		13.40	2.98	4877	ND	3568.74	889.66	858.78	17.30	16.45	443.15	440.16	4200.6	5	382.15	362.94	125.53	123.47	995.19	248.09	4.82	123.58	363245.49	90554.36	1760.89	45106.18
RAW	03/24/20	CC	29.10	2.93	0.00		14.30	3.05	4484	ND	3279.47	783.98	731.14	10.96	10.93	412.36	379.65	3437.8	<5	359.17	338.75	107.94	99.39	1,147.10	274.22	3.83	144.24	418691.35	100091.06	1399.27	52646.18
RAW	04/20/20	SLB	34.90	2.80	0.00	0.20	21.90	2.84	6504	ND	5073.99	981.34	860.93	12.89	12.04	437.78	395.58	6324.2	8	436.88	398.34	90.57	84.76	2,128.53	411.67	5.41	183.65	776912.96	150259.61	1973.68	67031.46
RAW	05/20/20	SLB	16.23	2.75	0.00	4.74	21.60	2.92	5941	ND	5034.40	1011.78	988.29	15.81	15.32	505.91	495.48	2972.5	6	463.37	462.41	147.27	146.22	982.13	197.38	3.08	98.70	358478.88	72044.68	1125.76	36023.77
RAW	06/22/20	CC,CH,KM	10.95	2.47	0.00		28.50	2.88	5996	ND	5030.34	1125.16	1112.03	16.15	15.54	447.48	435.36	7079.2	30	495.89	483.37	174.57	170.20	662.09	148.09	2.13	58.90	241662.24	54053.74	775.86	21497.36
MIN			10.95	2.47	0.00	0.20	12.90	2.84	1898.00	0.00	920.18	115.73	112.30	4.23	4.20	51.17	50.44	1286.70	5.00	125.80	122.51	27.71	26.29	287.57	36.17	1.32	15.99	104964.75	13201.30	482.52	5836.95
MAX			34.90	3.10	0.00	4.74	28.50	3.36	6504.00	0.00	5073.99	1125.16	1112.03	17.30	16.45	505.91	495.48	7079.20	30.00	495.89	483.37	174.57	170.20	2128.53	411.67	5.41	183.65	776912.96	150259.61	1973.68	67031.46
AVG			22.88	2.75	0.00	2.47	19.94	2.93	5560.40	#DIV/0!	4397.39	958.38	910.23	14.62	14.06	449.34	429.25	4802.86	12.25	427.49	409.16	129.18	124.81	1183.01	255.89	3.86	121.81	431798.18	93400.69	1407.09	44460.99

=water sample appears spurious and was not used in the loading calculation.

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
D7A	07/16/19	SLB	9.80	2.51		4.55	32.4	2.45	6671	ND	5142.68	386.40	375.70	14.55	14.22	326.70	293.75	6534.7	6					605.79	45.52	1.71	38.48	221112.30	16613.48	625.59	14046.64
D7A	08/20/19	SLB/CS	2.90	2.26		4.34	33.1	2.25	7795	ND	6745.17	397.72	384.26	17.74	16.81	322.78	297.25	7627.5	<5					235.12	13.86	0.62	11.25	85819.94	5060.26	225.71	4106.78
D7A	09/23/19	KCST	4.45	2.55				2.40	4000+	ND	6229.20	>300		22.84		>500		7836.0	82					333.19		1.22		121615.69	0.00	445.84	
D7A	10/28/19	KCST						2.70		0.00	4292.20	>300		16.99		397.76		5659.0	48					0.00							
D7A	11/13/19	SLB	8.60	2.7		11.5	6.3	2.82	4249	ND	2929.13	470.33	466.92	13.85	13.78	262.69	262.41	4061.2	13					302.79	48.62	1.43	27.15	110518.36	17745.92	522.57	9911.50
D7A	12/19/19	KMM	20.60	3.2			3.2	2.86	3188	ND	1895.57	407.54	405.73	5.69	5.49	172.38	145.80	2920.3	9					469.37	100.91	1.41	42.68	171318.55	36832.80	514.25	15579.43
D7A	1/22/2020	CG	26.00	2.97			1	2.9	3999+	0	3586.8	>300		16.266		374.8		4791	38					1,120.95		5.08	117.13	409145.56	0.00	1855.46	42753.36
D7A	02/06/20	RMM	35.00	3.0			8.0	2.91	2964	ND	1596.74	288.81	285.10	9.50	9.41	157.45	156.67	2450.0	26	249	245.71	69.98	69.14	671.75	121.50	4.00	66.24	245188.21	44348.36	1458.78	24177.31
D7A	02/25/20	CC	18.20	2.78			9.5	2.79	4937	ND	3988.95	710.04	692.03	116.30	16.01	419.28	410.29	4081.1	24	371.75	363.63	120.83	118.46	872.64	155.33	25.44	91.72	318513.11	56695.88	9286.42	33479.03
D7A	03/24/20	CC	31.90	2.8			12.8	2.91	4003	ND	2579.12	538.78	530.66	10.17	9.38	330.17	324.52	1879.1	<5	347	339.88	92.66	90.61	988.93	206.59	3.90	126.60	360960.40	75404.88	1423.34	46208.90
D7A	04/20/20	KM	22.81	2.7			20.4	2.68	5620	ND	3986.92	763.41	672.70	13.29	11.72	401.37	357.35	5157.8	6	461	406.60	90.91	81.71	1,093.12	209.31	3.64	110.05	398988.28	76397.73	1329.99	40166.83
D7A	05/20/20	SLB	13.70	2.5		6.1	19.8	2.69	5858	ND	4867.94	900.38	874.65	17.47	17.45	545.53	529.44	4069.6	6	534	512.28	166.41	160.17	801.62	148.27	2.88	89.83	292592.45	54118.25	1050.05	32789.63
D7A	6/22/2020	CC,CH,KM	8.26	2.44			27.5	2.44	6208	ND	5202.89	887	881.76	17.66	17.1	464.38	462.14	7350.9	6	534.19	533.07	187.12	186.68	516.57	88.07	1.75	46.11	188548.04	32144.08	639.98	16828.71
MIN			2.90	2.26	0.00	4.34	1.00	2.25	2964.00	0.00	1596.74	288.81	285.10	5.69	5.49	157.45	145.80	1879.10	6.00	248.89	245.71	69.98	69.14	0.00	13.86	0.62	11.25	85819.94	0.00	225.71	4106.78
MAX			35.00	3.15	0.00	11.51	33.10	2.91	7795.00	0.00	6745.17	900.38	881.76	116.30	17.45	545.53	529.44	7836.00	82.00	534.19	533.07	187.12	186.68	1120.95	209.31	25.44	126.60	409145.56	76397.73	9286.42	46208.90
AVG			16.85	2.69	#DIV/0!	6.63	15.81	2.68	5149.30	0.00	4080.25	575.04	556.95	22.49	13.14	347.94	323.96	4955.25	24.00	416.07	400.20	121.32	117.80	616.30	113.80	4.42	69.75	243693.41	34613.47	1614.83	25458.92

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)
OPC1-MID	02/06/20	RMM	39.30	7.00	72.00		5.70	7.41	376	66.06	-55.68	2.95	2.71	<0.05	<0.05
OPC1-MID	02/25/20	CC	10.10	7.0			6.6	7.32	504	59.53	-45.63	20.72	18.97	0.24	0.23
OPC1-MID	03/24/20	KM	26.00	6.18		5.80	9.40	7.44	365	67.08	-57.29	1.09	1.07	0.06	<0.05
OPC1-MID	04/20/20	KM	8.64	6.76			15.80	7.47	451	69.94	-59.49	0.32	0.17	<0.05	<0.05
OPC1-MID	05/20/20	SLB	1.97	6.42		9.79	17.60	7.28	647	85.13	-68.16	0.18	0.18	0.09	0.08
OPC1-MID	06/22/20	KM	dry												
MIN			1.97	6.18	72.00	5.80	5.70	7.28	365.00	59.53	-68.16	0.18	0.17	0.06	0.08
MAX			39.30	7.01	72.00	9.79	17.60	7.47	647.00	85.13	-45.63	20.72	18.97	0.24	0.23
AVG			17.20	6.67	72.00	7.80	11.02	7.38	468.60	69.55	-57.25	5.05	4.62	0.13	0.16

Sample ID	Sample Date	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
OPC1-MID	02/06/20	3.35	3.34	108.5	<5	60.89	58.47	11.57	10.80	-26.30	1.39		1.58	-9600.40	508.64		577.61
OPC1-MID	02/25/20	9.15	8.38	166.0	<5	175.06	87.54	30.30	17.42	-5.54	2.52	0.03	1.11	-2021.94	918.14	10.63	405.45
OPC1-MID	03/24/20	0.17	0.13	98.1	<5	59.16	56.16	8.92	8.20	-17.90	0.34	0.02	0.05	-6535.06	124.34	6.84	19.39
OPC1-MID	04/20/20	0.10	<0.10	147.7	<5	69.87	66.05	9.42	8.91	-6.18	0.03		0.01	-2255.04	12.13		3.79
OPC1-MID	05/20/20	<0.10	<0.10	231.6	<5	126.41	125.06	14.22	13.54	-1.61	0.00	0.00		-589.11	1.56	0.78	0.00
OPC1-MID	06/22/20																
MIN		0.10	0.13	98.10	0.00	59.16	56.16	8.92	8.20	-26.30	0.00	0.00	0.01	-9600.40	1.56	0.78	0.00
MAX		9.15	8.38	231.60	0.00	175.06	125.06	30.30	17.42	-1.61	2.52	0.03	1.58	-589.11	918.14	10.63	577.61
AVG		3.19	3.95	150.38	#DIV/0!	98.28	78.66	14.89	11.77	-11.51	0.86	0.02	0.69	-4200.31	312.96	6.09	201.25

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
DD	02/06/20	RMM	9.00	6.18	39.00		5.80	7.16	130	37.80	-26.73	0.92	0.74	<0.05	<0.05	3.31	2.78	24.0	<5	18.69	17.67	3.53	3.51	-2.89	0.10	0.00	0.36	-1055.45	36.33	0.00	130.70
DD	02/25/20	CC	1.10	6.9			5.0	6.45	124	8.01	1.01	3.74	3.35	0.28	0.24	5.49	3.52	39.7	<5	16.58	13.82	6.07	5.82	0.01	0.05	0.00	0.07	4.87	18.05	1.35	26.49
DD	03/24/20	KM	6.10	6.40		10.93	8.10	7.21	127	35.01	-27.34	0.78	0.61	0.09	0.09	0.43	0.18	8.0	<5	19.42	18.23	2.76	2.51	-2.00	0.06	0.01	0.03	-731.69	20.87	2.41	11.51
DD	04/20/20	SLB	2.38	6.81			13.30	7.16	126	25.60	-13.40	0.45	0.30	0.11	0.09	0.31	0.18	25.0	<5	18.32	16.73	2.57	2.33	-0.38	0.01	0.00	0.01	-139.92	4.70	1.15	3.24
DD	05/20/20	SLB	0.11	5.55		6.64	16.00	7.15	147	28.64	-18.52	0.71	0.50	1.13	0.91	0.44	0.30	39.4	20	20.82	16.03	3.39	2.69	-0.02	0.00	0.00	0.00	-8.94	0.34	0.55	0.21
DD	06/22/20	KM	dry																												
MIN			0.11	5.55	39.00	6.64	5.00	6.45	124.00	8.01	-27.34	0.45	0.30	0.09	0.09	0.31	0.18	8.00	20.00	16.58	13.82	2.57	2.33	-2.89	0.00	0.00	0.00	-1055.45	0.34	0.00	0.21
MAX			9.00	6.90	39.00	10.93	16.00	7.21	147.00	37.80	1.01	3.74	3.35	1.13	0.91	5.49	3.52	39.70	20.00	20.82	18.23	6.07	5.82	0.01	0.10	0.01	0.36	4.87	36.33	2.41	130.70
AVG			3.74	6.37	39.00	8.79	9.64	7.03	130.80	27.01	-17.00	1.32	1.10	0.40	0.33	2.00	1.39	27.22	20.00	18.77	16.50	3.66	3.37	-1.06	0.04	0.00	0.09	-386.22	16.06	1.09	34.43

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
SP	07/16/19	SLB	9.80			3.90		2.55	5019	ND	3492.53	415.12	303.92	12.04	11.92	241.54	239.33	4815.9	13					411.41	48.90	1.42	28.45	150163.21	17848.31	517.67	10385.14
SP	08/20/19	SLB/CS	2.90			6.66		2.42	6151	ND	4893.65	375.79	353.66	16.03	15.05	376.57	346.89	6397.1	<5					170.58	13.10	0.56	13.13	62262.74	4781.24	203.95	4791.16
SP	09/23/19	CG																													
SP	10/28/19	CG						2.70		ND	2787.00	>300		12.58		263.71		3549.0	32												
SP	11/13/19	SLB	8.60	2.66		4.15	0.70	2.79	3421	ND	1975.62	260.20	226.70	10.86	9.57	198.74	177.20	3416.2	18					204.22	26.90	1.12	20.54	74541.68	9817.55	409.76	7498.62
SP	12/19/19	KM	17.70	3.41			2.30	2.86	2177	ND	802.75	111.80	73.81	3.46	2.29	59.47	48.18	1759.1	28					170.79	23.79	0.74	12.65	62337.72	8681.85	268.69	4618.16
SP	1/22/2020	CG	27.00	2.95			3.60	2.80	2696	ND	1602.40	234.09		9.27		178.76		2142.0	48					520.04	75.97	3.01	58.02	189815.66	27729.39	1098.33	21175.87
SP	02/06/20	RMM	23.00	3.07			6.30	2.84	2501	ND	1199.17	176.92	167.96	7.51	7.36	126.38	124.18	1740.3	88	215	210.57	56.02	54.66	331.52	48.91	2.08	34.94	121005.73	17852.63	757.82	12752.74
SP	02/25/20	CC	18.80	2.81			7.70	2.91	3144	ND	1596.60	252.91	248.73	9.80	9.74	197.87	195.27	2034.5	74	330	328.21	73.86	73.64	360.79	57.15	2.21	44.71	131689.55	20860.33	808.32	16320.56
SP	03/24/20	CC	40.30	3.00		0.48	11.10	2.95	3013	ND	1493.07	265.17	230.13	6.61	6.40	212.42	200.36	2133.3	71	314	304.58	59.31	58.33	723.25	128.45	3.20	102.90	263987.00	46884.23	1168.70	37557.60
SP	04/20/20	KM	24.92	2.89			13.90	2.93	3474	ND	2346.68	307.02	269.81	7.81	7.01	217.42	195.95	2799.0	73	325	294.78	53.80	49.34	702.92	91.96	2.34	65.13	256566.08	33566.96	853.88	23770.86
SP	05/20/20	SLB	13.70	2.68		3.57	18.30	2.79	4090	ND	2847.08	422.21	379.78	12.01	11.87	346.34	337.44	1519.6	39	428	411.11	110.50	105.64	468.84	69.53	1.98	57.03	171126.62	25377.36	721.87	20817.12
SP	6/22/2020	CC,CH,KM	1.20	2.53			27.8	2.52	5248	ND	4069.14	432.51	414.41	16.22	15.71	409.2	400.61	6203.9	23	516.39	507.66	166.47	163.28	58.69	6.24	0.23	5.90	21423.05	2277.06	85.39	2154.34
MIN			1.20	2.53		0.48	0.70	2.42	2177.00	0.00	802.75	111.80	73.81	3.46	2.29	59.47	48.18	1519.60	13.00	215.05	210.57	53.80	49.34	58.69	6.24	0.23	5.90	21423.05	2277.06	85.39	2154.34
MAX			40.30	3.41		6.66	27.80	2.95	6151.00	0.00	4893.65	432.51	414.41	16.22	15.71	409.20	400.61	6397.10	88.00	516.39	507.66	166.47	163.28	723.25	128.45	3.20	102.90	263987.00	46884.23	1168.70	37557.60
AVG			17.08	2.89		3.75	10.19	2.76	3721.27	#DIV/0!	2425.47	295.79	266.89	10.35	9.69	235.70	226.54	3209.16	46.09	354.70	342.82	86.66	84.15	374.82	53.72	1.72	40.31	136810.82	19606.99	626.76	14712.92

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
NL0-D3	09/23/19	CG		2.61				2.4	4000+	0	3673.6	>300		16.357		392.29		5147	52					0.00		0.00	0.00	0.00	0.00	0.00	0.00
NL0-D3	10/28/19	CG						2.70		0.00	2700.20	>300		12.44		272.31		3524.0	36					0.00		0.00	0.00	0.00	0.00	0.00	0.00
NL0-D3	01/22/20	CG	8.60	3.1			2.2	2.90	2110	0.00	1085.20	151.82		6.30		119.82		1698.0	78					112.18	15.69	0.65	12.39	40945.44	5728.25	237.74	4520.79
MIN			8.60	2.61	0.00	0.00	2.20	2.40	2110.00	0.00	1085.20	151.82	0.00	6.30	0.00	119.82	0.00	1698.00	36.00	0.00	0.00	0.00	0.00	0.00	15.69	0.00	0.00	0.00	0.00	0.00	0.00
MAX			8.60	3.12	0.00	0.00	2.20	2.90	2110.00	0.00	3673.60	151.82	0.00	16.36	0.00	392.29	0.00	5147.00	78.00	0.00	0.00	0.00	0.00	112.18	15.69	0.65	12.39	40945.44	5728.25	237.74	4520.79
AVG			8.60	2.87	#DIV/0!	#DIV/0!	2.20	2.67	2110.00	0.00	2486.33	151.82	#DIV/0!	11.70	#DIV/0!	261.47	#DIV/0!	3456.33	55.33	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	56.09	15.69	0.33	6.19	20472.72	2864.12	118.87	2260.39

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
OPC1	03/17/15	SLB						3.08	2131	ND	898.4	104	101.09	4.67	4.47	98	93	1802.1	29	567903				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OPC1	07/16/19	SLB	9.80	2.58		6.07	24.10	2.48	5194	ND	4270.55	263.65	258.75	12.15	11.60	245.94	236.75	4402.5	<5					503.05	31.06	1.43	28.97	183614.60	11335.77	522.40	10574.32
OPC1	08/20/19	SLB/CS	2.90	2.3		6.5	37.5	2.18	7449	ND	4802.84	259.78	258.74	15.54	15.14	330.15	321.42	7215.4	<5					167.42	9.06	0.54	11.51	61107.35	3305.23	197.72	4200.55
OPC1	09/23/19	CG	4.50	2.61				2.40	4000+	ND	3674.00	>300		16.36		392.29		5147.0	52					198.73		0.88	21.22	72535.23		322.93	7744.92
OPC1	10/28/19	CG	dry																												
OPC1	11/13/19	SLB	8.60			12.64	0.90	2.83	2744	ND	1255.23	85.87	85.20	4.47	4.37	95.05	94.56	1685.0	36					129.76	8.88	0.46	9.83	47360.81	3239.94	168.66	3586.31
OPC1	12/19/19	KM	17.70	3.17			0.3	2.94	1745	ND	490.86	93.98	57.86	2.29	2.18	50.78	41.31	1139.0	56					104.43	19.99	0.49	10.80	38117.84	7298.04	177.83	3943.33
OPC1	01/22/20	CG	27.00	3.06			0.1	2.90	2195	0	1064.40	136.96		6.37		120.77		2110.0	48					345.44	44.45	2.07	39.19	126085.74	16224.24	753.98	14305.83
OPC1	02/06/20	RMM	62.30	3.35			7	3.08	1315	ND	357.58	43.41	28.26	2.57	2.49	44.00	42.71	654.0	89	118.62	115.55	25.55	25.04	267.77	32.51	1.92	32.95	97736.91	11865.20	702.45	12026.47
OPC1	02/25/20	CC	28.90	2.79			8.5	2.88	2542	ND	1142.69	157.15	131.38	7.39	7.15	148.69	144.79	1658.9	65	283.43	276.74	59.36	57.68	396.95	54.59	2.57	51.65	144885.06	19925.52	937.00	18852.85
OPC1	03/24/20	CC	66.30	3.16		9.93	12.3	3.03	2000	ND	688.02	123.32	99.45	3.93	3.83	125.25	111.56	1013.4	90	230.87	207.17	39.38	34.56	548.30	98.28	3.13	99.81	200129.87	35871.07	1143.15	36432.47
OPC1	04/20/20	KM	33.56					2.89	2875	ND	1384.91	194.17	187.34	5.98	5.53	168.52	157.86	2008.6	36	279.40	264.11	43.90	40.07	558.66	78.33	2.41	67.98	203911.08	28589.16	880.48	24812.51
OPC1	05/20/20	SLB	13.70	2.46		7.79	21.6	2.66	4086	ND	2572.01	274.19	270.76	11.27	10.47	313.99	308.64	1878.2	11	412.45	404.47	101.11	99.31	423.54	45.15	1.86	51.71	154593.26	16480.47	677.39	18872.69
OPC1	06/22/20	KM	dry																												
MIN			2.90	2.25	0.00	6.07	0.10	2.18	1315.00	0.00	357.58	43.41	28.26	2.29	2.18	44.00	41.31	654.00	11.00	118.62	115.55	25.55	25.04	104.43	8.88	0.46	9.83	38117.84	3239.94	168.66	3586.31
MAX			66.30	3.35	0.00	12.64	37.50	3.08	7449.00	0.00	4802.84	274.19	270.76	16.36	15.14	392.29	321.42	7215.40	90.00	########	404.47	101.11	99.31	558.66	98.28	3.13	99.81	203911.08	35871.07	1143.15	36432.47
AVG			25.02	2.83	#DIV/0!	8.58	12.48	2.78	3116.00	0.00	1883.46	157.86	147.88	7.75	6.72	177.79	155.26	2559.51	51.20	94871.30	253.61	53.86	51.33	331.28	42.23	1.61	38.69	120916.16	15413.46	589.45	14122.93

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
GPR3	03/17/15	SLB						5.91	2082	59.04	52.40	70.16	56.27	5.26	4.89	0.05	<0.10	1293.3	10												
GPR3	07/19/19	SLB	3.80	6.65	78	0.67	12.40	6.00	1776	59.13	16.52	39.73	38.31	3.37	3.31	0.05	<0.10	1019.7	12					0.75	1.81	0.15	0.00	275.42	662.37	56.18	0.83
GPR3	08/17/19	SLB	5.60	7.0	77	0.31	12.5	5.97	1847	52.47	15.32	35.17	33.39	2.80	2.65	0.05	<0.10	893.0	19					1.03	2.37	0.19	0.00	376.40	864.09	68.79	1.23
GPR3	09/20/19	SLB	5.70	6.64	71	0.94	11.00	6.17	1844	87.16	18.18	50.24	46.67	4.10	3.82	0.41	<0.10	1086.6	6					1.25	3.44	0.28	0.03	454.64	1256.38	102.53	10.25
GPR3	10/18/19	SLB	5.50	6.97	82	1.29	11.60	6.33	1784	70.87	21.21	37.15	37.12	3.13	3.09	0.05	<0.10	838.8	25					1.40	2.46	0.21	0.00	511.80	896.44	75.53	1.21
GPR3	11/20/19	SLB	3.80	6.59	85		10.90	6.37	1829	66.9	14.73	27.80	27.49	2.43	2.37	0.05	<0.10	804.5	<5					0.67	1.27	0.11	0.00	245.57	463.47	40.51	0.83
GPR3	12/23/19	SLB	6.8	6.56	81	7.28	8.3	6.26	1828	78.83	13.33	31.64	28.41	2.60	2.38	0.05	<0.10	1213.1	13					1.09	2.59	0.21	0.00	397.68	943.94	77.57	1.49
GPR3	01/16/20	SLB	7.2	7.06	71	4.99	9.1	6.17	1811	62.24	15.08	41.95	41.39	3.57	3.54	0.05	<0.10	857.5	5					1.31	3.63	0.31	0.00	476.36	1325.14	112.77	1.58
GPR3	02/20/20	SLB	7.9	6.93	84	4.24	9.7	6.34	1802	62.51	17.29	42.92	41.84	3.48	3.47	0.05	<0.10	793.9	22					1.64	4.08	0.33	0.00	599.27	1487.59	120.62	1.73
GPR3	03/24/20	SLB	5.5	7.29	85	1.30	9.5	6.34	1855	63.01	21.71	42.17	41.69	3.55	3.47	0.05	<0.10	986.7	<5					1.44	2.79	0.23	0.00	523.87	1017.57	85.66	1.21
GPR3	04/20/20	SLB	9.6	6.99	75	2.79	11.2	6.31	1873	67.41	22.26	39.31	38.55	3.28	3.18	0.05	<0.10	887.7	<5					2.57	4.54	0.38	0.01	937.55	1655.66	138.15	2.11
GPR3	05/19/20	SLB	7.5	7.34	71	0.24	11.9	6.25	1722	46.26	21.08	46.07	30.57	3.55	2.53	0.05	<0.10	701.7	45					1.90	4.15	0.32	0.00	693.63	1515.92	116.81	1.65
GPR3	06/22/20	SLB	5.90	6.34	60	1.88	12.40	5.96	1772	51.12	54.18	45.58	41.30	3.75	3.40	0.05	<0.10	889.6	19					3.84	3.23	0.27	0.00	1402.45	1179.84	97.07	1.29
MIN			3.80	6.34	60.00	0.24	8.30	5.91	1722.00	46.26	13.33	27.80	27.49	2.43	2.37	0.05	0.00	701.70	5.00	0.00	0.00	0.00	0.00	0.67	1.27	0.11	0.00	245.57	463.47	40.51	0.83
MAX			9.60	7.34	85.00	7.28	12.50	6.37	2082.00	87.16	54.18	70.16	56.27	5.26	4.89	0.41	0.00	1293.30	45.00	0.00	0.00	0.00	0.00	3.84	4.54	0.38	0.03	1402.45	1655.66	138.15	10.25
AVG			6.23	6.86	76.67	2.36	10.88	6.18	1832.69	63.61	23.33	42.30	38.69	3.45	3.24	0.08	#DIV/0!	943.55	17.60	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	1.57	3.03	0.25	0.01	574.55	1105.70	91.02	2.12

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
JACK-MP1	03/17/15	SLB						3.55	2081	ND	89.20	0.32	0.19	4.73	4.34	13.34	12.44	1378.1	17												
JACK-MP1	07/19/19	SLB	1.30	3.66		6.66	12.10	3.54	1515	ND	62.09	0.42	0.26	3.93	2.47	5.46	3.82	616.6	5					0.97	0.01	0.06	0.09	354.13	2.40	22.41	31.14
JACK-MP1	08/17/19	SLB	0.80	3.6		6.8	19.2	3.47	1658	ND	60.30	0.63	0.50	3.62	3.35	5.91	5.61	1005.3	<5					0.58	0.01	0.03	0.06	211.64	2.21	12.71	20.74
JACK MP1	09/20/19	SLB	0.80	3.62		8.20	13.60	3.61	1666	ND	73.73	0.63	0.54	4.78	4.54	6.86	6.71	1063.7	<5					0.71	0.01	0.05	0.07	258.78	2.21	16.78	24.08
JACK-MP1	10/18/19	SLB	0.70	3.64		7.93	12.30	3.75	1609	ND	60.60	0.92	0.63	3.69	3.56	5.70	5.51	856.5	16					0.51	0.01	0.03	0.05	186.11	2.83	11.33	17.51
JACK-MP1	11/20/19	SLB	0.60	3.82			7.00	3.78	1670	ND	61.09	0.31	0.22	2.88	2.86	4.97	4.92	878.2	<5					0.44	0.00	0.02	0.04	160.81	0.82	7.58	13.08
JACK-MP1	12/23/19	SLB	1.5	4.2		10.22	5.3	3.76	1405	ND	53.33	0.21	0.17	2.86	2.79	3.50	3.45	1034.0	<5					0.96	0.00	0.05	0.06	350.96	1.38	18.82	23.03
JACK-MP1	01/16/20	SLB	1.6	3.65		10.79	6.1	3.47	1468	ND	59.90	0.37	0.35	4.35	4.28	5.14	5.07	588..7	<5					1.15	0.01	0.08	0.10	420.48	2.60	30.54	36.08
JACK-MP1	02/20/20	SLB	2.3	3.59		10.9	4.3	3.73	1400	ND	61.71	0.27	0.27	4.26	4.24	6.24	6.21	747.1	5					1.71	0.01	0.12	0.17	622.70	2.72	42.99	62.97
JACK-MP1	03/24/20	SLB	3.9	3.94		10.26	6.4	3.73	1255	ND	55.68	0.38	0.3	4.32	4.00	6.04	5.48	722.1	<5					2.61	0.02	0.20	0.28	952.71	6.50	73.93	103.35
JACK-MP1	04/20/20	SLB	3.8	3.75		9.96	10.9	3.73	1301	ND	58.90	0.30	0.26	4.12	3.96	4.62	4.3	809.9	<5					2.69	0.01	0.19	0.21	981.97	5.00	68.69	77.02
JACK-MP1	05/19/20	SLB	2.3	3.61		8.92	14.1	3.62	1421	ND	69.74	0.38	0.32	4.48	4.44	5.94	5.77	537.3	<5					1.93	0.01	0.12	0.16	703.73	3.83	45.21	59.94
JACK-MP1	06/22/20	SLB	1.1	3.59		7.63	14.70	3.58	1548	ND	63.83	0.44	0.43	4.39	4.25	4.29	4.16	740.7	6					0.82	0.01	0.06	0.06	299.64	2.07	20.61	20.14
MIN			0.60	3.59		6.66	4.30	3.47	1255.00	0.00	53.33	0.21	0.17	2.86	2.47	3.50	3.45	537.30	5.00	0.00	0.00	0.00	0.00	0.44	0.00	0.02	0.04	160.81	0.82	7.58	13.08
MAX			3.90	4.20		10.90	19.20	3.78	2081.00	0.00	89.20	0.92	0.63	4.78	4.54	13.34	12.44	1378.10	17.00	0.00	0.00	0.00	0.00	2.69	0.02	0.20	0.28	981.97	6.50	73.93	103.35
AVG			1.72	3.72		8.93	10.50	3.64	1538.23	#DIV/0!	63.85	0.43	0.34	4.03	3.78	6.00	5.65	865.79	9.80	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	1.26	0.01	0.08	0.11	458.64	2.88	30.97	40.76

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
JACK-MP2	03/17/15	SLB						3.52	2067	ND	111.40	0.55	0.54	6.19	6.09	18.16	17.53	1547.7	6												
JACK-MP2	07/19/19	SLB	dry																												
JACK-MP2	08/17/19	SLB	0.15	3.5		3.3	20.4	3.30	1667	ND	72.04	2.00	1.83	3.38	3.09	5.33	5.01	930.5	<5					0.13	0.00	0.01	0.01	47.41	1.32	2.22	3.51
JACK-MP2	09/20/19	SLB	0.46	3.43		7.56	14.50	3.39	1751	ND	84.23	7.05	6.47	2.42	2.18	4.99	4.45	1035.2	<5					0.47	0.04	0.01	0.03	169.99	14.23	4.88	10.07
JACK-MP2	10/18/19	SLB	0.44	3.50		8.37	13.20	3.58	1605	ND	76.96	1.70	1.68	3.79	3.76	6.22	6.12	933.2	7					0.41	0.01	0.02	0.03	148.56	3.28	7.32	12.01
JACK-MP2	11/20/19	SLB	0.46	3.65			6.90	3.68	1632	ND	78.41	0.87	0.86	3.00	2.94	6.11	5.97	866.8	<5					0.43	0.00	0.02	0.03	158.24	1.76	6.05	12.33
JACK-MP2	12/23/19	SLB	0.93	4.25		10.84	3.8	3.76	1511	ND	68.07	0.69	0.58	2.88	2.81	5.11	4.81	891.9	<5					0.76	0.01	0.03	0.06	277.74	2.82	11.75	20.85
JACK-MP2	01/16/20	SLB	1	3.75		10.89	6.2	3.50	1557	ND	70.95	0.84	0.84	4.23	4.15	6.73	6.58	699.0	<5					0.85	0.01	0.05	0.08	311.28	3.69	18.56	29.53
JACK-MP2	02/20/20	SLB	2.1	3.64		12.44	3.3	3.76	1468	ND	69.95	0.67	0.65	4.05	3.99	7.73	7.57	707.0	5					1.77	0.02	0.10	0.20	644.47	6.17	37.31	71.22
JACK-MP2	03/24/20	SLB	2.3	4.01		10.94	6.4	3.78	1349	ND	61.31	0.66	0.58	4.01	3.85	6.81	6.28	783.6	<5					1.69	0.02	0.11	0.19	618.67	6.66	40.46	68.72
JACK-MP2	04/20/20	SLB	2.1	3.89		9.98	11	3.73	1395	ND	61.86	0.67	0.56	3.84	3.68	5.15	4.82	907.1	<5					1.56	0.02	0.10	0.13	569.94	6.17	35.38	47.45
JACK-MP2	05/19/20	SLB	1.55	3.63		7.74	16.1	3.68	1433	ND	66.59	0.88	0.71	4.41	3.85	6.79	5.63	360.8	8					1.24	0.02	0.08	0.13	452.83	5.98	29.99	46.17
JACK-MP2	06/22/20	SLB	0.92	3.49		6.34	17.7	3.45	1570	ND	74.86	1.53	1.49	4.06	3.97	4.39	4.26	791.4	<5					0.83	0.02	0.04	0.05	302.16	6.18	16.39	17.72
MIN			0.15	3.43		3.31	3.30	3.30	1349.00	0.00	61.31	0.55	0.54	2.42	2.18	4.39	4.26	360.80	5.00	0.00	0.00	0.00	0.00	0.13	0.00	0.01	0.01	47.41	1.32	2.22	3.51
MAX			2.30	4.25		12.44	20.40	3.78	2067.00	0.00	111.40	7.05	6.47	6.19	6.09	18.16	17.53	1547.70	8.00	0.00	0.00	0.00	0.00	1.77	0.04	0.11	0.20	644.47	14.23	40.46	71.22
AVG			1.13	3.70		8.84	10.86	3.59	1583.75	#DIV/0!	74.72	1.51	1.40	3.86	3.70	6.96	6.59	871.18	6.50	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.92	0.01	0.05	0.08	336.48	5.30	19.12	30.87

Sample ID	Sample Date	Taken By	Flow (gpm)	Flow (gpm)-GPR3	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
JACK-MP4	03/17/15	SLB							3.56	1817	ND	68.60	2.13	1.91	5.15	4.95	9.09	8.63	943.5	8												
JACK-MP4	07/19/19	SLB	34.50	30.70	3.68		1.10		3.34	1767	ND	70.84	10.76	1.40	4.12	1.51	3.82	0.61	944.5	9					26.14	3.97	1.52	1.41	9541.45	1449.27	554.92	514.52
JACK-MP4	08/17/19	SLB	28.20	22.60	3.5		7.7	18.5	3.20	2016	ND	83.18	15.52	14.85	4.41	3.93	4.51	4.02	1305.3	8					22.60	4.22	1.20	1.23	8247.54	1538.85	437.26	447.18
JACK-MP4	09/20/19	SLB	21.40	15.70	3.98		7.00	13.4	3.68	1994	ND	114.53	27.09	25.48	6.08	5.88	5.92	5.90	1372.0	5					21.61	5.11	1.15	1.12	7888.90	1865.98	418.79	407.77
JACK-MP4	10/18/19	SLB	20.10	14.60	3.93		6.18	13.2	3.69	1938	ND	90.09	15.72	15.58	4.22	4.10	4.75	4.69	1033.4	7					15.81	2.76	0.74	0.83	5770.68	1006.94	270.31	304.26
JACK-MP4	11/20/19	SLB	19.50	15.70	3.96			7.1	3.71	1985	ND	78.61	7.08	6.71	3.12	3.01	4.47	4.40	1093.5	<5					14.83	1.34	0.59	0.84	5414.70	487.67	214.91	307.90
JACK-MP4	12/23/19	SLB	27.8	21.00	4.83		8.28	2.7	4.06	1731	ND	57.37	7.62	7.41	3.23	3.01	3.04	2.84	972.2	<5					14.48	1.92	0.82	0.77	5285.69	702.06	297.59	280.09
JACK-MP4	01/16/20	SLB	30.1	22.90	3.8		9.62	6.7	3.60	1704	ND	56.28	6.74	6.63	3.95	3.87	3.78	3.50	843.7	<5					15.49	1.86	1.09	1.04	5654.40	677.16	396.85	379.77
JACK-MP4	02/20/20	SLB	53.9	46.00	4.71		10.87	2.8	3.88	1482	ND	47.84	5.83	5.63	3.31	3.31	3.58	3.43	700.3	8					26.45	3.22	1.83	1.98	9654.87	1176.59	668.01	722.50
JACK-MP4	03/24/20	SLB	90.9	85.40	5.65		10.15	6.7	4.54	1193	0.17	28.74	4.48	4.30	2.62	2.55	2.20	2.11	562.0	<5					29.50	4.60	2.69	2.26	10768.17	1678.55	981.65	824.29
JACK-MP4	04/20/20	SLB	69.8	60.20	4.05		9.44	11.0	4.06	1320	ND	44.92	4.77	4.76	2.64	2.52	2.13	1.97	660.9	<5					32.50	3.45	1.91	1.54	11864.07	1259.83	697.26	562.57
JACK-MP4	05/19/20	SLB	61.9	54.40	3.8		7.96	17.5	3.59	1556	ND	56.54	5.07	4.19	3.26	2.89	3.80	3.36	342.5	7.0					36.97	3.32	2.13	2.48	13494.35	1210.05	778.06	906.94
JACK-MP4	06/22/20	SLB	36.9	31.00	3.52		7.00	16.6	3.42	1827	ND	82.74	6.48	5.92	3.71	3.37	3.82	3.48	963.2	9.0					30.83	2.41	1.38	1.42	11253.16	881.32	504.58	519.54
MIN			19.50	14.60	3.52		1.10	2.70	3.20	1193.00	0.17	28.74	2.13	1.40	2.62	1.51	2.13	0.61	342.50	5.00	0.00	0.00	0.00	0.00	14.48	1.34	0.59	0.77	5285.69	487.67	214.91	280.09
MAX			90.90	85.40	5.65		10.87	18.50	4.54	2016.00	0.17	114.53	27.09	25.48	6.08	5.88	9.09	8.63	1372.00	9.00	0.00	0.00	0.00	0.00	36.97	5.11	2.69	2.48	13494.35	1865.98	981.65	906.94
AVG			41.25	35.02	4.12		7.75	10.56	3.72	1717.69	0.17	67.71	9.18	8.06	3.83	3.45	4.22	3.76	902.85	7.63	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	23.94	3.18	1.42	1.41	8736.50	1161.19	518.35	514.78

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
JACK-MP4A	4/20/2020	SLB	15.0	3.47	0	10.21	11.6	3.47	1885	ND	81.76	0.48	0.47	2.01	1.97	5.44	5.25	1211.7	<5					3.41	0.02	0.08	0.23	1244.71	7.31	30.60	82.82
JACK-MP4A	5/19/2020	SLB	7.1	3.46	0	7.52	15.7	3.32	1760	ND	73.48	2.87	0.45	1.96	1.88	6.13	6	817.3	6					3.06	0.12	0.08	0.25	1115.43	43.57	29.75	93.05
JACK-MP4A	6/22/2020	SLB	7.0	3.35	0	61	13.6	3.35	1842	ND	80.57	0.53	0.53	2.16	1.89	4.74	4.22	1032.7	5					3.24	0.02	0.09	0.19	1184.17	7.79	31.75	69.67
MIN			6.99	3.35	0.00	7.52	11.60	3.32	1760.00	0.00	73.48	0.48	0.45	1.96	1.88	4.74	4.22	817.30	5.00	0.00	0.00	0.00	0.00	3.06	0.02	0.08	0.19	1115.43	7.31	29.75	69.67
MAX			15.00	3.47	0.00	61.00	15.70	3.47	1885.00	0.00	81.76	2.87	0.53	2.16	1.97	6.13	6.00	1211.70	6.00	0.00	0.00	0.00	0.00	3.41	0.12	0.09	0.25	1244.71	43.57	31.75	93.05
AVG			9.70	3.43	0.00	26.24	13.63	3.38	1829.00	#DIV/0!	78.60	1.29	0.48	2.04	1.91	5.44	5.16	1020.57	5.50	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	3.24	0.05	0.08	0.22	1181.44	19.55	30.70	81.85

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
AM0-D13	03/24/15	SLB						3.45	1381	ND	65.60	0.87	0.74	4.24	4.19	7.52	7.06	758.4	<5												
AM0-D13	07/19/19	SLB	16.00	3.4		6.1	16.4	3.07	1443	ND	85.37	2.02	1.04	3.88	2.09	4.57	2.68	777.9	<5					16.42	0.39	0.75	0.88	5992.70	141.80	272.36	320.80
AM0-D13	08/17/19	SLB	10.60	3.05		6.72	15.90	3.08	1547	ND	87.56	5.65	5.27	2.76	2.36	3.55	3.50	775.6	<5					11.16	0.72	0.35	0.45	4072.01	262.76	128.35	165.09
AM0-D13	09/20/19	SLB	8.20	3.22		6.51	14.10	3.09	1588	ND	95.34	2.93	2.91	4.40	4.25	6.60	6.22	854.5	<5					9.40	0.29	0.43	0.65	3429.94	105.41	158.29	237.44
AM0-D13	10/13/19	SLB	9.80	3.19		8.19	10.50	3.27	1544	ND	95.14	2.34	2.32	3.82	3.77	5.47	5.33	693.2	<5					11.21	0.28	0.45	0.64	4090.60	100.61	164.24	235.19
AM0-D13	11/20/19	SLB	7.00	3.37			8.50	3.23	1625	ND	99.10	1.28	1.26	3.19	3.16	5.09	5.07	781.8	<5					8.34	0.11	0.27	0.43	3043.47	39.31	97.97	156.32
AM0-D13	12/23/19	SLB	18.00	4.36		9.06	6.60	3.55	1001	ND	50.50	0.55	0.48	2.02	1.96	2.50	2.33	537.1	<5					10.93	0.12	0.44	0.54	3988.06	43.43	159.52	197.43
AM0-D13	01/16/20	SLB	19.10	3.31		10.36	6.60	3.09	1344	ND	69.55	1.00	0.84	3.80	3.28	4.77	4.23	512.9	<5					15.97	0.23	0.87	1.10	5828.11	83.80	318.43	399.71
AM0-D13	02/20/20	SLB	59.10	3.21		11.23	6.80	3.33	1241	ND	69.14	0.96	0.90	3.30	3.11	4.67	4.49	573.3	<5					49.12	0.68	2.34	3.32	17927.27	248.92	855.66	1210.88
AM0-D13	03/24/20	SLB	92.30	3.56		12.03	9.20	3.70	851	ND	36.98	0.90	0.67	3.37	2.20	4.22	2.76	399.6	<5					41.03	1.00	3.74	4.68	14974.97	364.45	1364.67	1708.88
AM0-D13	04/20/20	SLB	86.30	3.94		14.07	13.9	3.81	726	ND	28.57	0.45	0.4	1.70	1.55	1.58	1.5	381.0	<5					29.64	0.47	1.76	1.64	10817.29	170.38	643.66	598.23
AM0-D13	05/19/20	SLB	53.3	3.3		10.75	14.6	3.26	1267	ND	76.83	1.30	1.14	3.66	3.38	4.27	3.87	561.7	<5					49.22	0.83	2.34	2.74	17966.16	304.00	855.87	998.51
AMO-D13	06/22/20	SLB	16.9	3.17		6.31	15.5	3.11	1434	ND	89.83	2.47	1.93	4.02	3.73	3.59	3.26	667.3	16					18.25	0.50	0.82	0.73	6660.48	183.14	298.06	266.18
MIN			7.00	3.05		6.11	6.60	3.07	726.00	0.00	28.57	0.45	0.40	1.70	1.55	1.58	1.50	381.00	16.00	0.00	0.00	0.00	0.00	8.34	0.11	0.27	0.43	3043.47	39.31	97.97	156.32
MAX			92.30	4.36		14.07	16.40	3.81	1625.00	0.00	99.10	5.65	5.27	4.40	4.25	7.52	7.06	854.50	16.00	0.00	0.00	0.00	0.00	49.22	1.00	3.74	4.68	17966.16	364.45	1364.67	1708.88
AVG			33.05	3.42		9.21	11.55	3.31	1307.08	#DIV/0!	73.04	1.75	1.53	3.40	3.00	4.49	4.02	636.48	16.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	22.56	0.47	1.21	1.48	8232.59	170.67	443.09	541.22

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
CL0-D2	07/19/19	SLB	1.00	5.85	21.00	5.40	28.50	5.95	350	11.36	-1.39	9.55	7.92	0.79	0.67	<0.10	<0.10	146.1	29					-0.02	0.11	0.01		-6.10	41.90	3.47	0.00
CL0-D2	08/17/19	SLB	0.71	5.4	0.0	1.1	24.1	3.39	957	ND	23.08	0.18	0.17	2.66	2.39	0.15	<0.10	434.2	<5					0.20	0.00	0.02	0.00	71.89	0.56	8.29	0.47
CL0-D2	09/20/19	SLB	0.58	4.15	0.00	7.30	18.00	3.96	829	ND	19.19	2.21	2.16	3.46	3.31	<0.10	<0.10	411.8	<5					0.13	0.02	0.02		48.83	5.62	8.80	0.00
CL0-D2	10/13/19	SLB	2.00	5.89	1.00	9.34	10.40	5.91	677	5.26	9.29	3.05	3.05	1.99	1.84	<0.10	<0.10	304.3	<5					0.22	0.07	0.05		81.52	26.76	17.46	0.00
CL0-D2	11/20/19	SLB	1.94	4.54	0.00		6.90	4.40	774	ND	8.96	1.18	1.15	2.00	1.83	0.10	0.10	381.9	<5					0.21	0.03	0.05	0.00	76.26	10.04	17.02	0.85
CL0-D2	12/23/19	SLB	1.04	5.21	1.00	10.63	2.50	5.06	676	0.42	16.56	2.56	2.34	1.87	1.76	<0.10	<0.10	336.5	<5					0.21	0.03	0.02		75.56	11.68	8.53	0.00
CL0-D2	01/16/20	SLB	3.29	6.10	1.00	8.98	4.50	4.41	634	ND	11.46	2.10	1.89	2.27	2.21	<0.10	<0.10	243.2	<5					0.45	0.08	0.09		165.42	30.31	32.77	0.00
CL0-D2	02/20/20	SLB	4.80	4.83	0.00	12.53	3.30	4.47	623	ND	15.08	1.84	1.32	2.08	1.59	<0.10	<0.10	271.0	8					0.87	0.11	0.12		317.57	38.75	43.80	0.00
CL0-D2	03/24/20	SLB	6.59	5.10	0.00	10.81	7.80	4.45	531	ND	11.26	1.45	1.33	1.69	1.62	0.17	<0.10	247.0	<5					0.89	0.11	0.13	0.01	325.55	41.92	48.86	4.92
CL0-D2	04/20/20	SLB	5.22	4.41	0.00	7.76	18.00	4.43	501	ND	13.98	0.58	0.52	1.49	1.41	<0.10	<0.10	212.5	<5					0.88	0.04	0.09		320.17	13.28	34.12	0.00
CL0-D2	05/19/20	SLB	1.42	4.57	0.00	6.71	22.6	3.99	687	ND	15.17	0.43	0.42	2.58	2.52	<0.10	<0.10	271.8	<5					0.26	0.01	0.04		94.51	2.68	16.07	0.00
CLO-D2	06/22/20	SLB	2.85	3.86	0.00	6.92	23.2	3.79	700	ND	19.90	1.24	1.1	2.85	2.77	<0.10	<0.10	285.8	6					0.68	0.04	0.10		248.83	15.50	35.64	0.00
MIN			0.58	3.86	0.00	1.14	2.50	3.39	350.00	0.42	-1.39	0.18	0.17	0.79	0.67	0.10	0.10	146.10	6.00	0.00	0.00	0.00	0.00	-0.02	0.00	0.01	0.00	-6.10	0.56	3.47	0.00
MAX			6.59	6.10	21.00	12.53	28.50	5.95	957.00	11.36	23.08	9.55	7.92	3.46	3.31	0.17	0.10	434.20	29.00	0.00	0.00	0.00	0.00	0.89	0.11	0.13	0.01	325.55	41.92	48.86	4.92
AVG			2.62	4.99	2.00	7.96	14.15	4.52	661.58	5.68	13.55	2.20	1.95	2.14	1.99	0.14	0.10	295.51	14.33	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.42	0.05	0.06	0.01	151.67	19.92	22.90	0.52

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
CL0-D8	07/18/19	SLB	1.56	3.01	0	6.53	12.60	2.96	1625.00	ND	203.98	11.51	10.18	3.10	2.74	17.2	16.9	1,030.40	<5					3.82	0.22	0.06	0.32	1396.08	78.78	21.22	117.99
CL0-D8	08/17/19	SLB	0.32	2.9	0	7.77	13.9	2.94	1709.00	ND	199.80	6.17	2.85	2.39	2.27	16.5	16.0	909.20	<5					0.77	0.02	0.01	0.06	280.51	8.66	3.36	23.15
CLO-D8	09/20/19	SLB	1.35	3.10	0	5.27	14.00	3.04	1644.00	ND	210.28	7.63	6.99	3.66	3.19	19.6	17.7	1,018.10	<5					3.41	0.12	0.06	0.32	1245.46	45.19	21.68	116.27
CLO-D8	10/13/19	SLB	0.77	3.10	0	5.83	11.00	3.13	1647.00	ND	195.94	7.37	6.86	2.81	2.62	16.0	15.1	803.70	<5					1.81	0.07	0.03	0.15	661.93	24.90	9.49	53.95
CLO-D8	11/20/19	SLB	Dry		0																										
CL0-D8	12/23/19	SLB	0.91	3.62	0	8.51	10.90	3.07	1689.00	ND	225.63	11.50	9.69	2.47	2.09	12.9	11.0	780.70	<5					2.47	0.13	0.03	0.14	900.81	45.91	9.86	51.66
CLO-D8	01/16/20	SLB	3.61	3.05	0	8.22	10.50	2.79	1737.00	ND	232.36	15.45	14.90	3.45	3.34	17.3	17.0	712.80	<5					10.08	0.67	0.15	0.75	3680.15	244.70	54.64	274.32
CLO-D8	02/20/20	SLB	14.30	3.03	0	7.89	10.20	3.11	1662.00	ND	234.57	13.79	12.89	3.44	3.22	20.2	18.9	787.20	<5					40.32	2.37	0.59	3.46	14716.54	865.16	215.82	1264.18
CL0-D8	03/24/20	SLB	17.20	3.20	0	7.82	11.10	3.17	1641	ND	220.70	12.70	12.14	3.42	3.28	19.51	18.2	851.3	<5					45.63	2.63	0.71	4.03	16654.37	958.36	258.08	1472.26
CL0-D8	04/20/20	SLB	14.00	3.05	0	6.94	11.90	3.14	1644	ND	230.49	9.90	9.41	3.23	3.08	15.12	14.0	997.8	<5					38.79	1.67	0.54	2.54	14157.20	608.08	198.39	928.70
CLO-D8	05/19/20	SLB	8.5	2.79	0	8.53	12.2	3.11	1606	ND	212.96	9.75	9.26	3.61	3.48	20.03	19.2	701.7	<5					21.76	1.00	0.37	2.05	7941.71	363.60	134.62	746.96
CLO-D8	06/22/20	SLB	4.31	2.99	0	7.60	12.7	3.00	1609	ND	216.31	7.79	7.76	3.29	3.27	12.88	12.8	772.6	6					11.21	0.40	0.17	0.67	4090.26	147.30	62.21	243.55
MIN			0.32	2.79			10.20	2.79	1606.00	0.00	195.94	6.17	2.85	2.39	2.09	12.88	10.98	701.74	6.00	0.00	0.00	0.00	0.00	0.77	0.02	0.01	0.06	280.51	8.66	3.36	23.15
MAX			17.20	3.62			14.00	3.17	1737.00	0.00	234.57	15.45	14.90	3.66	3.48	20.15	19.22	1030.40	6.00	0.00	0.00	0.00	0.00	45.63	2.63	0.71	4.03	16654.37	958.36	258.08	1472.26
AVG			6.08	3.07			11.91	3.04	1655.73	#DIV/0!	216.64	10.32	9.36	3.17	2.96	17.03	16.07	851.41	6.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	16.37	0.84	0.25	1.32	5975.00	308.24	89.94	481.18

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
CLO-D13	07/16/19	SLB	108.00	4.67	4.00	1.76	12.10	3.83	1154	ND	39.20	6.59	6.04	1.30	1.24	3.52	3.31	557.7	12					50.89	8.55	1.69	4.57	18574.07	3122.53	615.98	1667.88
CLO-D13	08/17/19	SLB	107.00	4.51	0.00	2.40	14.20	3.69	1210	ND	42.59	7.31	3.60	1.39	1.18	3.64	3.47	556.4	17					54.78	9.40	1.79	4.68	19993.50	3431.61	652.52	1708.77
CLO-D13	09/20/19	SLB	103.90	4.73	1.00	1.96	12.50	3.66	1208	ND	42.42	9.70	9.67	1.55	1.52	4.08	3.42	612.3	20					52.98	12.11	1.94	5.10	19336.75	4421.65	706.55	1859.83
CLO-D13	10/13/19	SLB	92.30	4.77	0.00	2.64	11.80	3.79	1238	ND	44.64	10.97	10.80	1.31	1.29	3.60	3.48	650.3	18					49.53	12.17	1.45	3.99	18076.87	4442.28	530.48	1457.81
CLO-D13	11/20/19	SLB	108.60	4.93	0.00		11.90	3.98	1248	ND	55.52	10.61	10.61	1.18	1.16	3.71	3.58	668.5	15					72.47	13.85	1.54	4.84	26453.10	5055.25	562.22	1767.67
CL0-D13	12/23/19	SLB	192.00	5.16	0.00	3.76	11.70	4.34	1235	ND	64.03	10.05	7.78	1.41	1.15	4.59	3.64	663.4	9					147.77	23.19	3.25	10.59	53936.41	8465.73	1187.73	3866.44
CLO-D13	01/16/20	SLB	152.00	4.00	0.00	1.96	11.50	3.42	1322	ND	70.75	8.29	6.97	1.71	1.54	6.11	5.61	554.3	8					129.26	15.15	3.12	11.16	47181.02	5528.35	1140.35	4074.57
CLO-D13	02/20/20	SLB	339.00	3.64	0.00	1.73	10.70	3.62	1306	ND	71.76	4.18	3.12	1.60	1.54	7.44	7.19	613.4	12					292.41	17.03	6.52	30.32	106728.27	6216.89	2379.67	11065.47
CL0-D13	03/24/20	SLB	404.00	3.78	0.00	3.34	11.70	3.64	1303	ND	72.76	3.66	3.21	1.58	1.54	7.31	6.91	629.8	<5					353.33	17.77	7.67	35.50	128964.86	6487.24	2800.50	12956.75
CL0-D13	04/20/20	SLB	381.00	3.54	0.00	1.59	12.10	3.63	1324	ND	80.57	2.83	2.27	1.56	1.51	6.00	5.95	576.6	<5					368.98	12.96	7.14	27.48	134677.69	4730.52	2607.64	10029.37
CL0-D13	05/19/02	SLB	269.00	3.42	0.00	1.55	12.30	3.57	1303	ND	84.51	3.09	2.37	1.73	1.71	7.97	7.84	476.5	5					273.25	9.99	5.59	25.77	99737.32	3646.77	2041.72	9406.06
CLO-D13	06/22/20	SLB	137.20	3.95	0.00	1.78	12.20	3.61	1358	ND	65.21	6.99	6.56	1.63	1.60	4.16	4.13	594.5	19					107.54	11.53	2.69	6.86	39252.35	4207.54	981.16	2504.06
MIN			92.30	3.42			10.70	3.42	1154.00	0.00	39.20	2.83	2.27	1.18	1.15	3.52	3.31	476.50	5.00	0.00	0.00	0.00	0.00	49.53	8.55	1.45	3.99	18076.87	3122.53	530.48	1457.81
MAX			404.00	5.16			14.20	4.34	1358.00	0.00	84.51	10.97	10.80	1.73	1.71	7.97	7.84	668.50	20.00	0.00	0.00	0.00	0.00	368.98	23.19	7.67	35.50	134677.69	8465.73	2800.50	12956.75
AVG			199.50	4.26			12.06	3.73	1267.42	#DIV/0!	61.16	7.02	6.08	1.50	1.42	5.18	4.88	596.14	13.50	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	162.77	13.64	3.70	14.24	59409.35	4979.70	1350.54	5197.06

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
CL0-D14	7/19/2019	SLB	3.0	6.43	30.00	2.15	10.70	6.27	618	34.88	-10.75	15.75	14.28	1.65	1.39	<0.10	<0.10	306.00	11.0					-0.39	0.57	0.06		-141.49	207.30	21.72	
CL0-D14	10/13/2019	SLB	1.0	7.23	77.00	0.17	10.00	5.90	670	15.80	-10.10	16.73	15.49	1.69	1.57	<0.10	<0.10	273.60	32.0					-0.12	0.20	0.02		-44.31	73.40	7.41	
CL0-D14	1/16/2020	SLB	5.0	6.29	40.00	0.24	10.20	6.24	588	37.27	-1.65	15.05	13.91	1.42	1.31	<0.10	<0.10	218.40	5.0					-0.10	0.90	0.09		-36.20	330.14	31.15	
CL0-D14	5/19/2020	SLB	9.5	6.05	44.00	0.23	9.70	6.34	565	34.03	-10.44	14.87	14.28	1.36	1.35	<0.10	<0.10	213.30	5.0					-1.19	1.69	0.15		-433.30	617.16	56.45	
MIN			1.00	6.05			9.70	5.90	565.00	15.80	-10.75	14.87	13.91	1.36	1.31	0.00	0.00	213.30	5.00	0.00	0.00	0.00	0.00	-1.19	0.20	0.02	0.00	-433.30	73.40	7.41	0.00
MAX			9.46	7.23			10.70	6.34	670.00	37.27	-1.65	16.73	15.49	1.69	1.57	0.00	0.00	306.00	32.00	0.00	0.00	0.00	0.00	-0.10	1.69	0.15	0.00	-36.20	617.16	56.45	0.00
AVG			4.62	6.50			10.15	6.19	610.25	30.50	-8.24	15.60	14.49	1.53	1.41	#DIV/0!	#DIV/0!	252.83	13.25	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-0.45	0.84	0.08	#DIV/0!	-163.82	307.00	29.18	#DIV/0!

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
COA01	7/19/2019	SLB		6.90	32.00	7.63	18.30	6.80	485	39.68	-31.04	0.98	0.57	0.56	0.52	0.29	<0.10	163.10	5.0												
COA01	10/13/2019	SLB		8.76	40.00	8.65	9.00	7.07	447	43.59	-31.71	1.88	1.88	0.50	0.46	<0.10	<0.10	141.10	<5												
COA01	1/16/2020	SLB		6.56	25.00	10.37	6.60	6.64	362	31.04	-23.20	1.80	1.37	0.43	0.40	0.18	<0.10	105.00	<5												
COA01	5/19/2020	SLB	932.2	6.01	38.00	8.30	16.30	6.35	397	29.29	-21.28	1.25	0.85	0.52	0.52	0.44	<0.10	124.80	7.0					-238.44	14.01	5.83	4.93	-87030.88	5112.25	2126.69	1799.51
MIN			932.19	6.01	25.00	7.63	6.60	6.35	362.00	29.29	-31.71	0.98	0.57	0.43	0.40	0.18	0.00	105.00	5.00	0.00	0.00	0.00	0.00	-238.44	14.01	5.83	4.93	-87030.88	5112.25	2126.69	1799.51
MAX			932.19	8.76	40.00	10.37	18.30	7.07	485.00	43.59	-21.28	1.88	1.88	0.56	0.52	0.44	0.00	163.10	7.00	0.00	0.00	0.00	0.00	-238.44	14.01	5.83	4.93	-87030.88	5112.25	2126.69	1799.51
AVG			932.19	7.06	33.75	8.74	12.55	6.72	422.75	35.90	-26.81	1.48	1.17	0.50	0.48	0.30	#DIV/0!	133.50	6.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-238.44	14.01	5.83	4.93	-87030.88	5112.25	2126.69	1799.51

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
RD0-D3	1/24/2020	SLB	20.7	6.14	75	4.2	9.9	6.21	513	55.29	-48.24	10.55	9.17	3.96	3.75	<0.10	<0.10	278	16					-12.00	2.62	0.98		-4378.83	957.64	359.46	0.00
RD0-D3	3/24/2020	SLB	52.3	6.02		4	11.1	6.17	488	56.5	-43.01	9.61	8.86	3.98	3.61	<0.10	<0.10	176.4	<5					-27.04	6.04	2.50		-9868.89	2205.07	913.23	0.00
RD0-D3	4/20/2020	SLB	46.20	5.83	57	2.82	12.00	6.23	516	64.67	-38.61	10.96	10.61	3.98	3.94	<0.10	<0.10	199.6	<5					-21.44	6.09	2.21		-7825.99	2221.52	806.72	0.00
RD0-D3	5/21/2020	SLB	15.30	4.97	49	4.28	14.60	6.12	575	43.62	-31.32	11.38	<0.10	4.74	<0.05	0.11	<0.10	241.7	12					-5.76	2.09	0.87	0.02	-2102.38	763.89	318.18	7.38
RD0-D3	6/22/2020	SLB	6.10	5.93	61	5.82	13.60	5.99	677	50.64	-24.23	15.07	12.32	5.50	5.01	<0.10	<0.10	270.2	17					-1.78	1.10	0.40		-648.46	403.31	147.19	0.00
MIN			6.10	4.97	49.00	2.82	9.90	5.99	488.00	43.62	-48.24	9.61	8.86	3.96	3.61	0.11	0.00	176.40	12.00	0.00	0.00	0.00	0.00	-27.04	1.10	0.40	0.02	-9868.89	403.31	147.19	0.00
MAX			52.30	6.14	75.00	5.82	14.60	6.23	677.00	64.67	-24.23	15.07	12.32	5.50	5.01	0.11	0.00	278.00	17.00	0.00	0.00	0.00	0.00	-1.78	6.09	2.50	0.02	-648.46	2221.52	913.23	7.38
AVG			28.12	5.78	60.50	4.22	12.24	6.14	553.80	54.14	-37.08	11.51	10.24	4.43	4.08	0.11	#DIV/0!	233.18	15.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-13.60	3.59	1.39	0.02	-4964.91	1310.29	508.96	1.48

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Fe +2 (mg/L)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
SR286 Discharge	07/16/19	SLB	80.9	6.51	84.00	0.10	12.40	6.51	437	77.26	-67.26	11.49	11.40		0.53	0.52	0.15	<0.10	124.4	19					-65.40	11.17	0.52	0.15	-23872.76	4078.18	188.11	53.24
SR286 Discharge	09/23/19	CG	28.1	6.96			12.10	6.40	485	103.40	-46.00	18.10		15.41	0.67		<0.5		142.8	<5					-15.54	6.11	0.22		-5671.02	2231.67	82.11	0.00
SR286 Discharge	10/28/19	CG	86.0	5.60			12.90	6.40	471	103.20	-42.40	19.25		18.74	0.65		<0.5		154.4	5					-43.83	19.90	0.67		-15997.85	7264.31	246.00	0.00
SR286 Discharge	01/22/20	CG		6.29			11.80		447																							
SR286 Discharge	05/20/20	SLB	163.40	7.58	93.00	2.38	12.20	6.51	444	77.47	-63.04	11.93	11.64		0.58	0.57	0.13	<0.10	107.4	5					-123.81	23.43	1.14	0.26	-45192.42	8552.44	415.79	93.20
MIN			28.10	5.60	84.00	0.10	11.80	6.40	437.00	77.26	-67.26	11.49	11.40	15.41	0.53	0.52	0.13	0.00	107.40	5.00	0.00	0.00	0.00	0.00	-123.81	6.11	0.22	0.15	-45192.42	2231.67	82.11	0.00
MAX			163.40	7.58	93.00	2.38	12.90	6.51	485.00	103.40	-42.40	19.25	11.64	18.74	0.67	0.57	0.15	0.00	154.40	19.00	0.00	0.00	0.00	0.00	-15.54	23.43	1.14	0.26	-5671.02	8552.44	415.79	93.20
AVG			89.60	6.59	88.50	1.24	12.28	6.46	456.80	90.33	-54.68	15.19	11.52	17.07	0.61	0.55	0.14	#DIV/0!	132.25	9.67	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-62.15	15.16	0.64	0.20	-22683.51	5531.65	233.00	36.61

=sample lost by lab

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Fe +2 (mg/L)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
WL	9/23/2019	CG	28.1	6.96			16.10	6.40	465	79.20	-64.20	9.44		0.96		<0.5		138.40	6.0						-21.68	3.19	0.00	0.00	-7914.78	1163.18	0.00	0.00
WL	10/28/2019	CG	86.0	6.00			12.60	6.50	441	83.40	-51.80	7.22		0.59		<0.5		142.60	8.0						-53.55	7.46	0.00	0.00	-19544.54	2724.54	0.00	0.00
WL	1/22/2020	CG		6.88			7.50		432																0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
																									0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MIN			28.10	6.00			7.50	6.40	432.00	79.20	-64.20	7.22	0.00	0.59	0.00	0.00	0.00	138.40	6.00	0.00	0.00	0.00	0.00	0.00	-53.55	0.00	0.00	0.00	-19544.54	0.00	0.00	
MAX			86.00	6.96			16.10	6.50	465.00	83.40	-51.80	9.44	0.00	0.96	0.00	0.00	0.00	142.60	8.00	0.00	0.00	0.00	0.00	0.00	0.00	7.46	0.00	0.00	0.00	2724.54	0.00	
AVG			57.05	6.61			12.07	6.45	446.00	81.30	-58.00	8.33	#DIV/0!	0.77	#DIV/0!	#DIV/0!	#DIV/0!	140.50	7.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-18.81	2.66	0.00	0.00	-6864.83	971.93	0.00	

=sample lost by lab

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Fe +2 (mg/L)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
85-16	7/16/2019	SLB	80.9	7.26	74.00	7.24	16.40	6.91	425	74.98	-65.07	8.88	7.92		0.58	0.58	<0.10	<0.10	98.3	17					-63.28	8.64	0.56	#VALUE!	-23095.46	3151.80	205.86	#VALUE!
85-16	9/23/2019	CG	28.1	7.01			16.00	6.60	455	79.40	-65.20	5.82		0.23	0.91		<0.5		142.9	6					-22.02	1.96	0.31	#VALUE!	-8038.06	717.14	112.06	#VALUE!
85-16	10/28/2019	CG	86.0	6.22			13.30	6.60	434	77.80	-40.60	6.09		5.14	0.59		<0.5		135.6	24					-41.97	6.30	0.61	#VALUE!	-15318.70	2297.80	222.99	#VALUE!
85-16	1/22/2020	CG		7.12			7.20		431																							
85-16	5/20/2020	SLB	163.4	5.80	89.00	8.12	13.30	6.85	420	82.36	-72.10	2.86	1.71		0.58	0.56	<0.10	<0.10	123.3	<5					-141.61	5.62	1.14	#VALUE!	-51687.40	2050.29	415.79	#VALUE!
MIN			28.10	5.80			7.20	6.60	420.00	74.98	-72.10	2.86	1.71	0.23	0.58	0.56	0.00	0.00	98.30	6.00	0.00	0.00	0.00	0.00	-141.61	1.96	0.31	#VALUE!	-51687.40	717.14	112.06	#VALUE!
MAX			163.40	7.26			16.40	6.91	455.00	82.36	-40.60	8.88	7.92	5.14	0.91	0.58	0.00	0.00	142.90	24.00	0.00	0.00	0.00	0.00	-22.02	8.64	1.14	#VALUE!	-8038.06	3151.80	415.79	#VALUE!
AVG			89.60	6.68			13.24	6.74	433.00	78.64	-60.74	5.91	4.82	2.69	0.67	0.57	#DIV/0!	#DIV/0!	125.03	15.67	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-67.22	5.63	0.66	#VALUE!	-24534.90	2054.26	239.18	#VALUE!

=sample lost by lab

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
K53-SW29	7/16/2019	SLB		7.38	75.00	6.81	24.50	7.80	248	95.88	-80.79	1.93	0.42	0.39	0.36	0.84	<0.10	14.70	18.0												
K53-SW29	9/19/2019	CG		7.65			13.50	7.60	320	146.20	-132.00	5.75		2.18		2.23		<20	302.0												
K53-SW29	10/28/2019	CG		5.96			12.20	7.60	225	80.00	-74.00	0.69		0.72		<0.5		36.70	14.0												
K53-SW29	1/22/2020	CG		7.53			0.20	7.20	191	46.00	-35.40	0.33		0.00		<0.5		33.20	6.0												
K53-SW29	5/20/2020	SLB	36.2	8.36			12.70	7.46	216	65.99	-59.10	11.01	3.60	1.17	0.65	6.08	1.80	30.20	23.0					-25.72	4.79	0.51	2.65	-9388.87	1749.09	185.87	965.89
MIN			36.21	5.96			0.20	7.20	191.00	46.00	-132.00	0.33	0.42	0.00	0.36	0.84	1.80	14.70	6.00	0.00	0.00	0.00	0.00	-25.72	4.79	0.51	2.65	-9388.87	1749.09	185.87	965.89
MAX			36.21	8.36			24.50	7.80	320.00	146.20	-35.40	11.01	3.60	2.18	0.65	6.08	1.80	36.70	302.00	0.00	0.00	0.00	0.00	-25.72	4.79	0.51	2.65	-9388.87	1749.09	185.87	965.89
AVG			36.21	7.38	75.00	6.81	12.62	7.53	240.00	86.81	-76.26	3.94	2.01	0.89	0.51	3.05	1.80	28.70	72.60	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-25.72	4.79	0.51	2.65	-9388.87	1749.09	185.87	965.89

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
WETLD	7/16/2019	SLB		6.93	38.00	7.86	30.00	7.21	302	58.97	-52.93	0.81	<0.10	0.42	0.40	<0.10	<0.10	64.60	<5												
WETLD	9/19/2019	CG		7.70			21.00	7.50	324	68.80	-56.80	0.63		0.21		<0.5		90.30	<5												
WETLD	10/28/2019	CG		6.25			13.00	7.30	392	61.40	-54.00	0.49		0.48		<0.5		144.50	5.0												
WETLD	1/22/2020	CG		7.20			1.30	6.80	259	38.80	-24.80	1.77		1.15		<0.5		68.90	<5												
WETLD	5/20/2020	SLB	36.2	7.26			17.10	7.14	350	33.84	-21.67	1.55	0.14	1.50	1.47	0.39	<0.10	126.20	<5					-9.43	0.67	0.65	0.17	-3442.59	246.24	238.30	61.96
MIN			36.21	6.25			1.30	6.80	259.00	33.84	-56.80	0.49	0.14	0.21	0.40	0.39	0.00	64.60	5.00	0.00	0.00	0.00	0.00	-9.43	0.67	0.65	0.17	-3442.59	246.24	238.30	61.96
MAX			36.21	7.70			30.00	7.50	392.00	68.80	-21.67	1.77	0.14	1.50	1.47	0.39	0.00	144.50	5.00	0.00	0.00	0.00	0.00	-9.43	0.67	0.65	0.17	-3442.59	246.24	238.30	61.96
AVG			36.21	7.07			16.48	7.19	325.40	52.36	-42.04	1.05	0.14	0.75	0.94	0.39	#DIV/0!	98.90	5.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-9.43	0.67	0.65	0.17	-3442.59	246.24	238.30	61.96

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
A2M-MP13	7/16/2019	SLB		7.92	64.00	8.95	21.80	7.58	224	67.82	-59.10	0.30	<0.10	0.17	0.16	<0.10	<0.10	18.6	11					0.00	0.00	0.00	#VALUE!				
A2M-MP13	10/13/2019	SLB		6.49	48	11.78	10	7.56	206	53.52	-46.06	0.61	0.34	0.15	0.1	0.11	<0.10	22.1	5					0.00	0.00	0.00	0.00				
A2M-MP13	5/20/2020	SLB	1145.4	6.81	64	11.13	12.7	7.24	148	36.63	-27.19	0.36	0.14	0.09	0.08	0.19	<0.10	7.7	5					-374.35	4.96	1.24	2.62				
MIN			1145.43	6.49			10.00	7.24	148.00	36.63	-59.10	0.30	0.14	0.09	0.08	0.11	0.00	7.70	5.00	0.00	0.00	0.00	0.00	-374.35	0.00	0.00	#VALUE!	0.00	0.00	0.00	0.00
MAX			1145.43	7.92			21.80	7.58	224.00	67.82	-27.19	0.61	0.34	0.17	0.16	0.19	0.00	22.10	11.00	0.00	0.00	0.00	0.00	0.00	4.96	1.24	#VALUE!	0.00	0.00	0.00	0.00
AVG			1145.43	7.07			14.83	7.46	192.67	52.66	-44.12	0.42	0.24	0.14	0.11	0.15	#DIV/0!	16.13	7.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-124.78	1.65	0.41	#VALUE!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

e: Also known as 85-14.

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
A2M-MP14	7/16/2019	SLB		7.91	60.00	8.66	18.90	7.27	292	66.28	-57.91	2.74	1.64	0.30	0.28	0.10	<0.10	49.7	7					0.00	0.00	0.00	0.00				
A2M-MP14	10/13/2019	SLB		6.28	55	11.36	10	7.36	243	60.92	-53.73	1.07	0.58	0.18	0.13	0.11	<0.10	37.5	<5					0.00	0.00	0.00	0.00				
A2M-MP14	5/20/2020	SLB	1781.1	6.5	54	9.79	12.1	6.98	187	38.08	-27.38	0.5	0.26	0.15	0.15	0.16	<0.10	35.2	<5					-586.17	10.70	3.21	3.43	-213953.34	3907.11	1172.13	1250.28
MIN			1781.10	6.28			10.00	6.98	187.00	38.08	-57.91	0.50	0.26	0.15	0.13	0.10	0.00	35.20	7.00	0.00	0.00	0.00	0.00	-586.17	0.00	0.00	0.00	-213953.34	3907.11	1172.13	1250.28
MAX			1781.10	7.91			18.90	7.36	292.00	66.28	-27.38	2.74	1.64	0.30	0.28	0.16	0.00	49.70	7.00	0.00	0.00	0.00	0.00	0.00	10.70	3.21	3.43	-213953.34	3907.11	1172.13	1250.28
AVG			1781.10	6.90			13.67	7.20	240.67	55.09	-46.34	1.44	0.83	0.21	0.19	0.12	#DIV/0!	40.80	7.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-195.39	3.57	1.07	1.14	-213953.34	3907.11	1172.13	1250.28

e: Also known as 85-13.

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
JOHN-1	7/19/2019	SLB		6.99	68	8.61	22.2	7.67	550	101.27	-89.35	0.45	<0.10	0.21	0.19	<0.10	<0.10	153.4	<5												
JOHN-1	10/21/2019	SLB		7.03	84	9.72	12.2	7.94	476	86.48	-78.58	0.73	0.33	0.18	0.17	<0.10	<0.10	137.1	8												
JOHN-1	1/24/2020	SLB		7.57	40	11.61	3.3	7.66	296	44.16	-37.39	0.31	0.18	0.15	0.14	<0.10	<0.10	77.1	6												
JOHN-1	5/20/2020	SLB	1988.6	6.5	59	10.3	13.5	7.71	398	62.39	-43.93	0.46	0.13	0.22	0.22	0.12	<0.10	112.6	<5					-1,050.07	11.00	5.26	2.87	-383276.79	4013.37	1919.44	1046.97
MIN			1988.63	6.50			3.30	7.66	296.00	44.16	-89.35	0.31	0.13	0.15	0.14	0.12	0.00	77.10	6.00	0.00	0.00	0.00	0.00	-1050.07	11.00	5.26	2.87	-383276.79	4013.37	1919.44	1046.97
MAX			1988.63	7.57			22.20	7.94	550.00	101.27	-37.39	0.73	0.33	0.22	0.22	0.12	0.00	153.40	8.00	0.00	0.00	0.00	0.00	-1050.07	11.00	5.26	2.87	-383276.79	4013.37	1919.44	1046.97
AVG			1988.63	7.02			12.80	7.75	430.00	73.58	-62.31	0.49	0.21	0.19	0.18	0.12	#DIV/0!	120.05	7.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-1050.07	11.00	5.26	2.87	-383276.79	4013.37	1919.44	1046.97

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
K56-2	7/19/2019	SLB		6.75	48	7.6	24.1	7.48	564	53.3	-55.32	0.34	<0.10	0.46	0.39	0.28	<0.10	174.9	<5												
K56-2	10/18/2019	SLB		7.11	55	10.56	13.1	7.9	556	67.25	-59.39	0.57	0.71	0.42	0.41	0.13	<0.10	184.3	7												
K56-2	1/24/2020	SLB		6.62	35	11.57	3.2	7.55	336	41.28	-34.77	0.4	0.23	0.37	0.32	0.21	<0.10	96.9	8												
K56-2	5/19/2020	SLB	5154.8	7.3	37	9.25	18	7.63	438	48.29	-39.6	0.39	0.19	0.4	0.38	0.21	<0.10	133	<5					-2,453.62	24.16	24.78	13.01	-895572.95	8820.04	9046.19	4749.25
MIN			5154.76	6.62			3.20	7.48	336.00	41.28	-59.39	0.34	0.19	0.37	0.32	0.13	0.00	96.90	7.00	0.00	0.00	0.00	0.00	-2453.62	24.16	24.78	13.01	-895572.95	8820.04	9046.19	4749.25
MAX			5154.76	7.30			24.10	7.90	564.00	67.25	-34.77	0.57	0.71	0.46	0.41	0.28	0.00	184.30	8.00	0.00	0.00	0.00	0.00	-2453.62	24.16	24.78	13.01	-895572.95	8820.04	9046.19	4749.25
AVG			5154.76	6.95			14.60	7.64	473.50	52.53	-47.27	0.43	0.38	0.41	0.38	0.21	#DIV/0!	147.28	7.50	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-2453.62	24.16	24.78	13.01	-895572.95	8820.04	9046.19	4749.25

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
AUL03	7/19/2019	SLB		7.18	41.00	8.88	23.80	7.25	589	55.51	-48.56	0.30	<0.10	0.31	0.24	0.22	<0.10	199.60	<5												
AUL03	10/18/2019	SLB		7.20	62.00	11.65	13.20	7.90	551	69.72	-56.96	0.54	0.41	0.27	0.26	0.17	<0.10	172.50	10.0												
AUL03	1/16/2020	SLB		6.12	44.00	12.94	5.50	7.38	384	44.86	-35.18	0.40	0.15	0.40	0.37	0.22	<0.10	98.30	<5												
AUL03	5/19/2020	SLB	5028.2	6.77	47.00	9.89	18.50	7.64	437	44.79	-35.07	0.37	0.13	0.26	0.26	0.45	0.34	147.60	5.0					-2,119.59	22.36	15.71	27.20	-773650.44	8162.27	5735.65	9927.08
MIN			5028.19	6.12			5.50	7.25	384.00	44.79	-56.96	0.30	0.13	0.26	0.24	0.17	0.34	98.30	5.00	0.00	0.00	0.00	0.00	-2119.59	22.36	15.71	27.20	-773650.44	8162.27	5735.65	9927.08
MAX			5028.19	7.20			23.80	7.90	589.00	69.72	-35.07	0.54	0.41	0.40	0.37	0.45	0.34	199.60	10.00	0.00	0.00	0.00	0.00	-2119.59	22.36	15.71	27.20	-773650.44	8162.27	5735.65	9927.08
AVG			5028.19	6.82			15.25	7.54	490.25	53.72	-43.94	0.40	0.23	0.31	0.28	0.27	0.34	154.50	7.50	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-2119.59	22.36	15.71	27.20	-773650.44	8162.27	5735.65	9927.08

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
K55-SM14	7/19/2019	SLB		6.68	40	8.69	21.2	7.34	620	54.36	-45.97	0.29	<0.10	0.42	0.39	0.18	<0.10	214.7	<5												
K55-SM14	10/18/2019	SLB		6.41	45	11.97	10	7.55	481	48.34	-39.19	0.61	0.36	0.46	0.45	0.13	<0.10	153.6	8												
K55-SM14	1/16/2020	SLB		6.02	51	12.86	5.9	7.17	409	39.52	-31.36	0.5	0.23	0.45	0.42	0.27	<0.10	110.8	5												
K55-SM14	5/19/2020	SLB	6633.3	6.21	27	9.74	18.8	6.96	457	43.59	-32.7	0.4	0.13	0.35	0.34	0.46	0.2	135.4	<5					-2,607.25	31.89	27.91	36.68	-951644.46	11640.91	10185.80	13387.05
MIN			6633.30	6.02			5.90	6.96	409.00	39.52	-45.97	0.29	0.13	0.35	0.34	0.13	0.20	110.80	5.00	0.00	0.00	0.00	0.00	-2607.25	31.89	27.91	36.68	-951644.46	11640.91	10185.80	13387.05
MAX			6633.30	6.68			21.20	7.55	620.00	54.36	-31.36	0.61	0.36	0.46	0.45	0.46	0.20	214.70	8.00	0.00	0.00	0.00	0.00	-2607.25	31.89	27.91	36.68	-951644.46	11640.91	10185.80	13387.05
AVG			6633.30	6.33			13.98	7.26	491.75	46.45	-37.31	0.45	0.24	0.42	0.40	0.26	0.20	153.63	6.50	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-2607.25	31.89	27.91	36.68	-951644.46	11640.91	10185.80	13387.05

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
NL0-MP2	7/16/2019	SLB		6.37	56	7.7	20.1	7.09	421	53.89	-39	0.32	0.15	0.17	0.17	<0.10	<0.10	92.8	10												
NL0-MP2	9/23/2019	CG		7.1			17.1	7	637	129.6	-100.8	0.42		0.24		<0.5		227	<5												
NL0-MP2	10/28/2019	CG		6.07			13.4	7.4	462	100.4	-87.4	0.367		0.183		<0.5		137.8	<5												
NL0-MP2	1/22/2020	CG		7.01			2.6		300																						
NL0-MP2	5/21/2020	SLB	334.7	6.52	46	9.56	14.4	7.22	330	49.9	-44.13	0.12	<0.10	0.12	<0.05	0.11	<0.10	75.9	<5					-177.52	0.48	0.48	0.44	-64795.98	176.20	176.20	161.51
MIN			334.67	6.07			2.60	7.00	300.00	49.90	-100.80	0.12	0.15	0.12	0.17	0.11	0.00	75.90	10.00	0.00	0.00	0.00	0.00	-177.52	0.48	0.48	0.44	-64795.98	176.20	176.20	161.51
MAX			334.67	7.10			20.10	7.40	637.00	129.60	-39.00	0.42	0.15	0.24	0.17	0.11	0.00	227.00	10.00	0.00	0.00	0.00	0.00	-177.52	0.48	0.48	0.44	-64795.98	176.20	176.20	161.51
AVG			334.67	6.61			13.52	7.18	430.00	83.45	-67.83	0.31	0.15	0.18	0.17	0.11	#DIV/0!	133.38	10.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-177.52	0.48	0.48	0.44	-64795.98	176.20	176.20	161.51

=sample lost by lab

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
NL0-MP3	7/16/2019	SLB		3.35		7.95	22.3	3.06	1313	ND	328.15	38.12	18.73	1.95	1.84	37.01	35.64	545.8	78												
NL0-MP3	9/23/2019	CG		4.65			18.4	5.7	777	22.4	4.8	3.055		1.595		6.083		385.8	24												
NL0-MP3	10/28/2019	CG		4.62			13	4.9	533	10	25.6	8.183		0.966		10.766		246.4	44												
NL0-MP3	1/22/2020	CG		5.34			1.3		356																						
NL0-MP3	5/21/2020	SLB	432.1	8.66	43	9.85	14.7	7.14	371	42.7	-32.5	0.28	0.05	0.31	<0.05	0.11	0	97.1	7					-168.81	1.45	1.61	0.57	-61616.23	530.85	587.72	208.55
MIN			432.13	3.35			1.30	3.06	356.00	10.00	-32.50	0.28	0.05	0.31	1.84	0.11	0.00	97.10	7.00	0.00	0.00	0.00	0.00	-168.81	1.45	1.61	0.57	-61616.23	530.85	587.72	208.55
MAX			432.13	8.66			22.30	7.14	1313.00	42.70	328.15	38.12	18.73	1.95	1.84	37.01	35.64	545.80	78.00	0.00	0.00	0.00	0.00	-168.81	1.45	1.61	0.57	-61616.23	530.85	587.72	208.55
AVG			432.13	5.32			13.94	5.20	670.00	25.03	81.51	12.41	9.39	1.21	1.84	13.49	17.82	318.78	38.25	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-168.81	1.45	1.61	0.57	-61616.23	530.85	587.72	208.55

=sample lost by lab

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
NEAL01	7/19/2019	SLB		7.38	2	8.29	23.2	6.95	484	21.04	-13.93	1.76	0.28	0.96	0.83	0.88	<0.10	193.2	7												
NEAL01	10/18/2019	SLB		6.81	38	10.01	12.8	7.59	478	45.75	-36.97	1.89	0.34	0.82	0.44	0.82	<0.10	170.1	14												
NEAL01	1/24/2020	SLB		7.28	38	11.71	3.2	7.46	287	38.14	-31.16	0.98	0.52	0.24	0.24	0.6	<0.10	80	11												
NEAL01	5/21/2020	SLB	601.8	6.7	35	9.07	17.7	7.35	358	31.69	-22.06	0.21	0.05	0.38	<0.05	0.1	<0.10	108	<5					-159.57	1.52	2.75	0.72	-58243.55	554.45	1003.29	264.02
MIN			601.79	6.70			3.20	6.95	287.00	21.04	-36.97	0.21	0.05	0.24	0.24	0.10	0.00	80.00	7.00	0.00	0.00	0.00	0.00	-159.57	1.52	2.75	0.72	-58243.55	554.45	1003.29	264.02
MAX			601.79	7.38			23.20	7.59	484.00	45.75	-13.93	1.89	0.52	0.96	0.83	0.88	0.00	193.20	14.00	0.00	0.00	0.00	0.00	-159.57	1.52	2.75	0.72	-58243.55	554.45	1003.29	264.02
AVG			601.79	7.04			14.23	7.34	401.75	34.16	-26.03	1.21	0.30	0.60	0.50	0.60	#DIV/0!	137.83	10.67	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-159.57	1.52	2.75	0.72	-58243.55	554.45	1003.29	264.02

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
K53 - SW32	7/16/2019	SLB		7.38	39	8.28	21.4	7.65	152	35.6	-30.65	0.012	<0.10	0.7	0.06	<0.10	<0.10	20.1	<5												
K53 - SW32	9/19/2019	CG		7.77			14.2	7.4	182	58.8	-48.2	0.434		0.221		<0.5		30	16												
K53 - SW32	10/28/2019	CG		6.6			12.8	7.2	136	40	-30.8	1.731		0.293		<0.5		71	5												
K53 - SW32	1/22/2020	CG		7.8			0.1	7	118	22.4	-13.8	<0.3		<.05		<0.5		21	<5												
K53 - SW32	5/20/2020	SLB	185.8	7.46			11.9	7.51	129	26.41	-16.75	0.18	<0.10	<0.05	<0.05	0.13	<0.10	21.4	<5					-37.41	0.40	#VALUE!	0.29	-13653.94	146.73	#VALUE!	105.97
MIN			185.80	6.60			0.10	7.00	118.00	22.40	-48.20	0.01	0.00	0.22	0.06	0.13	0.00	20.10	5.00	0.00	0.00	0.00	0.00	-37.41	0.40	#VALUE!	0.29	-13653.94	146.73	#VALUE!	105.97
MAX			185.80	7.80			21.40	7.65	182.00	58.80	-13.80	1.73	0.00	0.70	0.06	0.13	0.00	71.00	16.00	0.00	0.00	0.00	0.00	-37.41	0.40	#VALUE!	0.29	-13653.94	146.73	#VALUE!	105.97
AVG			185.80	7.40			12.08	7.35	143.40	36.64	-28.04	0.59	#DIV/0!	0.40	0.06	0.13	#DIV/0!	32.70	10.50	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-37.41	0.40	#VALUE!	0.29	-13653.94	146.73	#VALUE!	105.97

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
K53 - SW33	7/16/2019	SLB		6.4	42	7.61	23.6	7.1	204	35.22	-28.66	2.4	1.52	0.39	0.38	0.2	<0.10	42.7	10												
K53 - SW33	9/19/2019	CG		7.1			21	6.4	355	34.2	-0.4	15.721		1.538		0.902		125.7	36												
K53 - SW33	10/28/2019	CG		6.57			13	7.4	233	37.6	-28.2	0.3		0.05		<0.5		25.3	5												
K53 - SW33	1/22/2020	CG		7.43			0.3	6.8	149	23.4	-10.8	0.849		0.293		<0.5		34.4	<5												
K53 - SW33	5/20/2020	SLB	260.6	7.57			13.5	7.3	191	28.29	-19.7	1.03	0.69	0.41	0.39	0.26	<0.10	21.8	<5					-61.71	3.23	1.28	0.81	-22522.74	1177.59	468.75	297.25
MIN			260.59	6.40			0.30	6.40	149.00	23.40	-28.66	0.30	0.69	0.05	0.38	0.20	0.00	21.80	5.00	0.00	0.00	0.00	0.00	-61.71	3.23	1.28	0.81	-22522.74	1177.59	468.75	297.25
MAX			260.59	7.57			23.60	7.40	355.00	37.60	-0.40	15.72	1.52	1.54	0.39	0.90	0.00	125.70	36.00	0.00	0.00	0.00	0.00	-61.71	3.23	1.28	0.81	-22522.74	1177.59	468.75	297.25
AVG			260.59	7.01			14.28	7.00	226.40	31.74	-17.55	4.06	1.11	0.54	0.39	0.45	#DIV/0!	49.98	17.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-61.71	3.23	1.28	0.81	-22522.74	1177.59	468.75	297.25

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
RUNT04B	7/19/2019	SLB		7.22		8.03	22.8	7.37	1068	56.68	-43.58	0.77	<0.10	6.15	5.21	1.43	<0.10	508.9	9												
RUNT04B	10/28/2019	CG		5.78			13.5	7.5	845	67.6	-58	0.504		5.665		0.584		400.9	<5												
RUNT04B	1/22/2020	CG		7.47			0.2		621																						
RUNT04B	5/20/2020	SLB	233.2	8.01			13	7.38	765	51.67	-39.2	0.7	0.18	3.75	3.62	2.38	<0.10	322.9	23					-109.89	1.96	10.51	6.67	-40111.40	716.27	3837.19	2435.33
MIN			233.23	5.78			0.20	7.37	621.00	51.67	-58.00	0.50	0.18	3.75	3.62	0.58	0.00	322.90	9.00	0.00	0.00	0.00	0.00	-109.89	1.96	10.51	6.67	-40111.40	716.27	3837.19	2435.33
MAX			233.23	8.01			22.80	7.50	1068.00	67.60	-39.20	0.77	0.18	6.15	5.21	2.38	0.00	508.90	23.00	0.00	0.00	0.00	0.00	-109.89	1.96	10.51	6.67	-40111.40	716.27	3837.19	2435.33
AVG			233.23	7.12			12.38	7.42	824.75	58.65	-46.93	0.66	0.18	5.19	4.42	1.46	#DIV/0!	410.90	16.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-109.89	1.96	10.51	6.67	-40111.40	716.27	3837.19	2435.33

=sample lost by lab

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
REE03	7/19/2019	SLB		7.33	35	8.49	23.9	7.47	543	59.28	-50.94	0.19	<0.10	0.53	0.5	<0.10	<0.10	195.3	<5												
REE03	9/23/2019	CG		6.76			18.7	7.2	867	62.4	-48.6	<0.3		0.47		<0.5		414.3	<5												
REE03	10/18/2019	SLB		6.51	59	9.6	13.1	7.55	536	49.68	-42.02	0.58	0.38	0.58	0.56	<0.10	<0.10	204.3	<5												
REE03	10/28/2019	CG		5.53			13	7.6	379	53.8	-47.8	0.368		0.379		<0.5		149.2	<5												
REE03	1/22/2020	CG		7.73			0.5		316																						
REE03	1/24/2020	SLB		7.49	38	12.15	1.5	7.48	330	38.33	-31.76	0.48	0.29	0.84	0.8	0.26	<0.10	121.3	7												
REE03	5/21/2020	SLB	666.2	6.53	55	9.79	17.3	7.45	447	50.91	-43.14	0.28	<0.10	0.84	<0.05	0.1	<0.10	130.7	<5					-345.44	2.24	6.73	0.80	-126086.64	818.36	2455.09	292.27
MIN			666.18	5.53			0.50	7.20	316.00	38.33	-50.94	0.19	0.29	0.38	0.50	0.10	0.00	121.30	7.00	0.00	0.00	0.00	0.00	-345.44	2.24	6.73	0.80	-126086.64	818.36	2455.09	292.27
MAX			666.18	7.73			23.90	7.60	867.00	62.40	-31.76	0.58	0.38	0.84	0.80	0.26	0.00	414.30	7.00	0.00	0.00	0.00	0.00	-345.44	2.24	6.73	0.80	-126086.64	818.36	2455.09	292.27
AVG			666.18	6.84			12.57	7.46	488.29	52.40	-44.04	0.38	0.34	0.61	0.62	0.18	#DIV/0!	202.52	7.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-345.44	2.24	6.73	0.80	-126086.64	818.36	2455.09	292.27

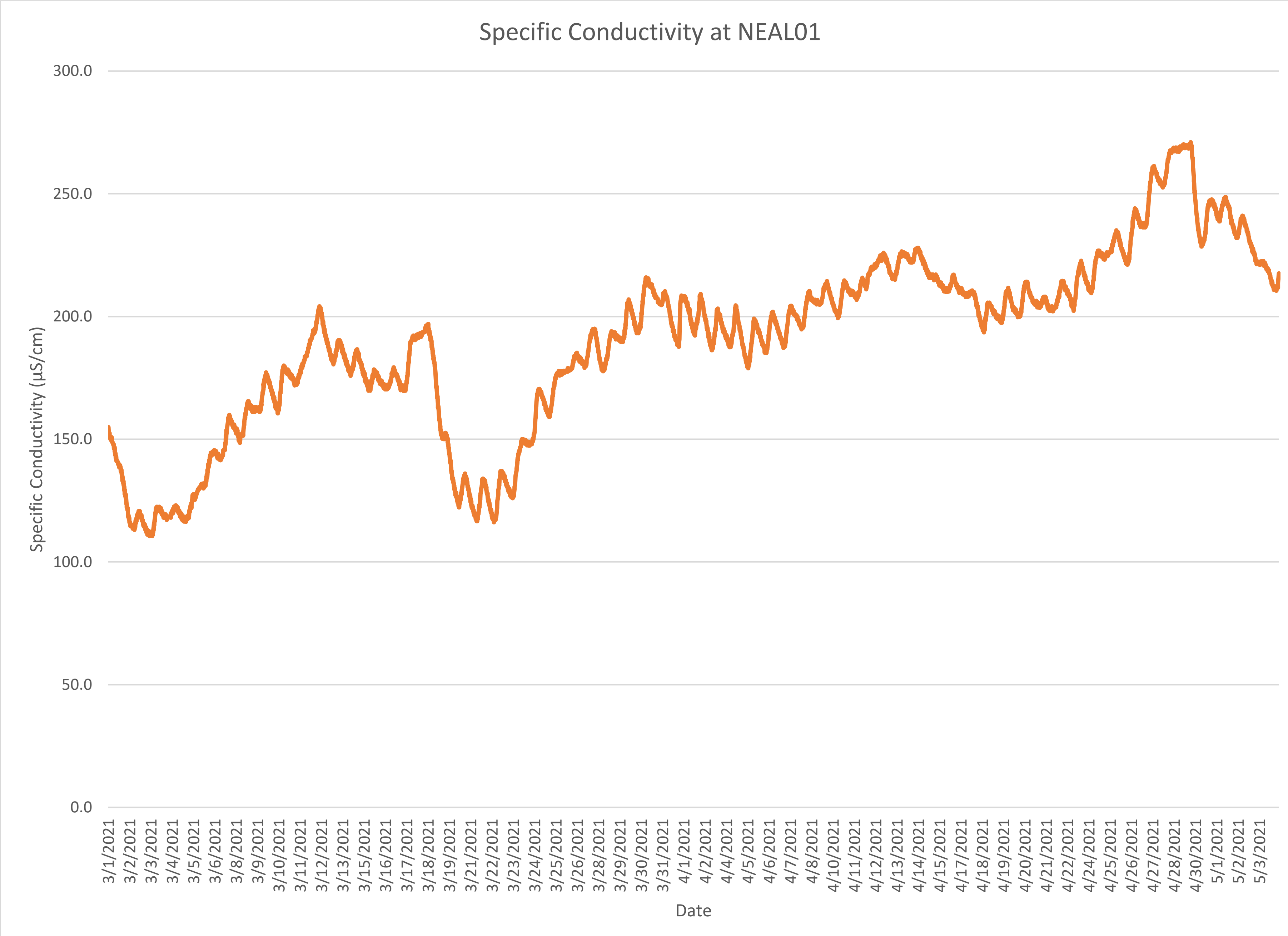
=sample lost by lab

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
JACK-MP27	7/19/2019	SLB		7.34		8.32	22.70	7.12	511	40.02	-32.84	0.38	<0.10	0.68	0.55	0.45	<0.10	163.10	5.0												
JACK-MP27	10/18/2019	SLB		6.34	51.00	9.59		7.65	487	50.84	-41.81	0.71	0.41	0.66	0.65	0.12	<0.10	177.20	11.0												
JACK-MP27	1/24/2020	SLB		7.08	35.00	11.52	3.00	7.49	310	38.83	-31.36	0.64	0.37	0.54	0.53	0.34	<0.10	106.60	10.0												
JACK-MP27	5/20/2020	SLB	1464.9	6.83		10.24	14.70	7.54	395	35.71	-29.35	1.41	0.18	0.63	0.62	0.36	<0.10	143.30	5.0					-516.80	24.83	11.09	6.34	-188633.73	9062.13	4049.04	2313.74
MIN			1464.92	6.34	35.00	8.32	3.00	7.12	310.00	35.71	-41.81	0.38	0.18	0.54	0.53	0.12	0.00	106.60	5.00	0.00	0.00	0.00	0.00	-516.80	24.83	11.09	6.34	-188633.73	9062.13	4049.04	2313.74
MAX			1464.92	7.34	51.00	11.52	22.70	7.65	511.00	50.84	-29.35	1.41	0.41	0.68	0.65	0.45	0.00	177.20	11.00	0.00	0.00	0.00	0.00	-516.80	24.83	11.09	6.34	-188633.73	9062.13	4049.04	2313.74
AVG			1464.92	6.90	43.00	9.92	13.47	7.45	425.75	41.35	-33.84	0.79	0.32	0.63	0.59	0.32	#DIV/0!	147.55	7.75	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-516.80	24.83	11.09	6.34	-188633.73	9062.13	4049.04	2313.74

Sample ID	Sample Date	Taken By	Flow (gpm)	Field pH (su)	Field Alkalinity	Field DO (mg/L)	Temp (C)	Lab pH (su)	Cond. (umhos)	Alkalinity (mg/l)	Acidity (mg/l)	Fe (mg/l)	D. Fe (mg/l)	Mn (mg/l)	D. Mn (mg/l)	Al (mg/l)	D. Al (mg/l)	Sulfate (mg/l)	TSS (mg/l)	Ca (mg/l)	D. Ca (mg/l)	Mg (mg/l)	D. Mg (mg/l)	Acid Load (lb/day)	Fe Load (lb/day)	Mn Load (lb/day)	Al Load (lb/day)	Acid Load (lb/yr)	Fe Load (lb/yr)	Mn Load (lb/yr)	Al Load (lb/yr)
REE01A	7/19/2019	SLB		6.95	16	8.35	22.6	6.91	674	38.5	-30.85	0.36	<0.10	0.98	0.8	0.74	<0.10	274.9	8												
REE01A	9/23/2019	CG		6.81			16.3	6.8	1032	30.6	-10.8	<0.3		1.05		<0.5		419.6	<5												
REE01A	10/18/2019	SLB		6.22	52	10.25	12.4	7.65	645	44.22	-33.53	0.55	0.32	1	0.99	0.38	<0.10	270.4	8												
REE01A	10/28/2019	CG		6.62			12.2	7.4	504	45.4	-38.4	0.695		0.742		<0.5		192.8	<5												
REE01A	1/22/2020	CG		8.05			0.4		356																						
REE01A	1/24/2020	SLB		7.31	36	12.17	1.8	7.55	386	34.76	-28.74	0.67	0.44	0.66	0.52	0.48	0.14	130	11												
REE01A	5/19/2020	SLB	2035.2	7.23	19	9.25	16.8	7.43	520	32.04	-21.87	0.48	0.13	0.78	0.75	0.53	<0.10	235.3	<5					-535.01	11.74	19.08	12.97	-195278.91	4285.96	6964.68	4732.41
MIN			2035.21	6.22			0.40	6.80	356.00	30.60	-38.40	0.36	0.13	0.66	0.52	0.38	0.14	130.00	8.00	0.00	0.00	0.00	0.00	-535.01	11.74	19.08	12.97	-195278.91	4285.96	6964.68	4732.41
MAX			2035.21	8.05			22.60	7.65	1032.00	45.40	-10.80	0.70	0.44	1.05	0.99	0.74	0.14	419.60	11.00	0.00	0.00	0.00	0.00	-535.01	11.74	19.08	12.97	-195278.91	4285.96	6964.68	4732.41
AVG			2035.21	7.03			11.79	7.29	588.14	37.59	-27.37	0.55	0.30	0.87	0.77	0.53	0.14	253.83	9.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	-535.01	11.74	19.08	12.97	-195278.91	4285.96	6964.68	4732.41

=sample lost by lab

Appendix E
Data Logger Data and Graphs


Specific Conductivity at NEAL01
Specific Conductivity (µS/cm)
300.0
250.0
200.0
150.0
100.0
50.0
0.0
3/1/2021
3/2/2021
3/3/2021
3/4/2021
3/5/2021
3/6/2021
3/8/2021
3/9/2021
3/10/2021
3/11/2021
3/12/2021
3/13/2021
3/15/2021
3/16/2021
3/17/2021
3/18/2021
3/19/2021
3/21/2021
3/22/2021
3/23/2021
3/24/2021
3/25/2021
3/26/2021
3/28/2021
3/29/2021
3/30/2021
3/31/2021
4/1/2021
4/2/2021
4/4/2021
4/5/2021
4/6/2021
4/7/2021
4/8/2021
4/10/2021
4/11/2021
4/12/2021
4/13/2021
4/14/2021
4/15/2021
4/17/2021
4/18/2021
4/19/2021
4/20/2021
4/21/2021
4/22/2021
4/24/2021
4/25/2021
4/26/2021
4/27/2021
4/28/2021
4/30/2021
5/1/2021
5/2/2021
5/3/2021
Date

Appendix F
IUP Biological Study

Aultman Run Watershed: Assessment of Acid Mine Drainage Impacts on Stream Condition

Ryan Neese and David Janetski

Department of Biology, Indiana University of Pennsylvania

June 8, 2021

Abstract

The appropriate implementation of acid mine drainage (AMD) treatment systems can enhance stream quality and generate substantial biological recovery. Thorough monitoring of biotic conditions in streams with passive control systems is often lacking, despite being essential for making decisions about further treatment action and funding. To meet this need, we measured physicochemical conditions and macroinvertebrate and fish diversity upstream, downstream, and not close to (~1/2 mile downstream) three passive treatment systems in the Aultman Run watershed, Indiana County, PA. Diminished water quality was recorded directly downstream of treatments, with 43% receiving an EPA quality rating of poor or fair. In contrast, reaches upstream or not close to treatments made up 100% of the good/excellent quality ratings. Macroinvertebrate results showed impairment of stream reaches immediately downstream of treatment systems, with two of three sites essentially devoid of macroinvertebrates. Fish species richness varied by stream identity, with low richness in Reeds Run and Neal Run (1 to 4 species) and high richness in Aultman Run headwaters (14 to 17 species). Fish abundance was higher upstream of treatment systems than downstream, with one site (Neal Run) nearly devoid of fish below the

treatment system (one creek chub). The variation in biological recovery we observed among sites highlights the importance of routine monitoring to identify fouled or failing treatment systems and prioritize them for repair and/or expansion to properly treat the AMD discharge.

Introduction

Pennsylvania has had a long history of coal mining that has led to economic prosperity for generations, although with deep shaft mining and coal refuse practices, there is a price to be paid. Our grandfathers and great-grandfathers of generations past have left residents of Appalachia with the ill-effects of past reward in many forms. Acid mine drainage (AMD) resulting from abandoned coal mines and refuse is one of countless negative outcomes. AMD degrades more than 12,000 km of streams in the Appalachian Region of the Northeastern, USA, with 80% of the impacted stream miles located in western Pennsylvania and West Virginia (DiNicola and Stapleton 2002). AMD wreaks havoc on biotic communities and abiotic factors in impacted streams, as sludge deposits, called yellow-boy, suffocate the water and leach into the stream substrate.

The U.S. Environmental Protection Agency (U.S. EPA) has identified that AMD from abandoned coal mines is and will continue to be the greatest water-quality problem in Appalachia (US EPA 1994). In the Eastern U.S., over 7,000 km of streams are impaired by abandoned coal mines or coal mine related activities (Kim et al. 1982). In addition to low pH and high acidity, acid mine drainage often contains dissolved heavy metals in toxic concentrations. The processes that produce AMD are natural, but they are accelerated by mining and can produce large volumes of contaminates (Ferguson and Erickson 1988).

Many investigations have examined the effects of AMD on benthic macroinvertebrates and fish; it has been found that AMD leads to reduced diversity and/or species shifts from intolerant to tolerant taxa. Less research has examined AMD water column and sediment toxicity impacts (Soucek et al. 2000). Biotic indicators, such as benthic macroinvertebrates, can be impaired by some precipitated forms of AMD metals. This precipitate may be more detrimental to benthic communities than dissolved metals because the precipitate can bury substrate and organisms. Moreover, the rate of recovery of streams following restoration of mine drainage is influenced by the amount of residual insoluble, metal precipitate on the substrate (DiNicola and Stapleton 2002). It is of utmost concern that as ecologically conscious citizens, we are not only aware of AMD and its painful side effects, but we also strive to eliminate and remedy this point source pollutant to preserve the natural resource, for ourselves and for generations to come.

The Aultman Run watershed is no exception to western Pennsylvania's deep mine history, thus necessitating the need for AMD passive treatment controls to be implemented. Passive treatment systems divert AMD discharges through limestone beds to neutralize acid and increase alkalinity. The discharge then flows into an oxidation/retention pond or wetland where dissolved metals precipitate out, leaving treated water to enter the stream. Correctly designed passive treatment systems have been shown to be extremely effective in improving water quality (DiNicola and Stapleton 2002).

In the early 2000's Stream Restoration Incorporated entered the fold to restore the Aultman Run watershed. Since then, Aultman Run Watershed has seen the implementation of three AMD passive treatment control systems. Thus, strict water quality monitoring has been necessitated to understand, improve upon, and maximize value at an impact versus cost perspective. To effect meaningful change, scientists and public alike should be aware of the severity of impact that each stream ecosystem is dealing with.

Because there has been no comprehensive study conducted since the implementation of such passive treatment AMD controls, it is of utmost importance that Aultman Run and its tributary streams are resurveyed to detect any stream quality improvement and to guide future implementation of AMD passive treatment control systems. Acid mine drainage can be influenced by a wide variation in mineralogy and particle size among sites. Changes in these variables appear to influence drainage water quality (Doepker 1993). Generally, we seek to gain better understanding of the process that an AMD impaired watershed must go through in western Pennsylvania to restore it to its pre-impairment state.

Gaining a better understanding of the benthic macroinvertebrate and fish community present in Aultman Run watershed is vital in gaining a multi-dimensional understanding of how the stream is recovering. Benthic macroinvertebrates can be indicators of stream health, as some are more tolerant to poor water quality, poor substrate, and embeddedness than others. This variable tolerance allows for the ability to gauge overall stream health through indices; based on the amount of high and low quality indicating macroinvertebrates caught through kick-netting by running their quality score and abundance. The same can be said for fish captured through electrofishing practices on Aultman Run Watershed reaches. Fish are indicative of the stream health given a top-down view as they are often the top-level consumers, or close to it, in the stream. A top-down approach can be very important when understanding the immediate impacts in AMD remediation recovery, as fish are a great indicator of the immediate impact and effectiveness of implemented AMD passive treatment sites.

While biotic factors are certainly important, an impacted stream may be lacking such indicators, and therefore abiotic assessments must also take place in order to gauge the impairment and ability for an impacted stream to recover. Among other metrics, it is important use EPA stream quality scores, which factor in metrics such as riparian zone quality, stream bank erosion, substrate impairment, and stream flow characteristics, with benthic macroinvertebrate data and habitat assessments.

As data is gathered and analyzed using EPA stream score standards for benthic macroinvertebrates and stream habitat, we learn more about these impaired streams and thus better understand where AMD control systems can be improved and where emphasis should be placed within the Aultman Run watershed. Additionally, we can pinpoint areas in most dire need of controls either before they become too severely impaired to quickly remedy, and/or the sources that are most negatively impacting the watershed. These integrative rapid bioassessments using several different types of assessment tools are critical for obtaining a broad, overall picture of the environmental impacts of pollutants. This is especially true when many biotic factors are lacking due to impairment (Cherry et al. 2001).

In completing this study, our goal is to gather new data to better guide and develop the ongoing restoration project in the Aultman Run watershed through USDA stream quality data, benthic macroinvertebrate data, fish data, physicochemical conditions, and stream flow. The information provided will help direct efforts in new passive treatment sites and updates/modifications of existing sites if data indicates that such work is necessary. My expectation was that sampling sites directly downstream of AMD passive treatment controls would have lower average EPA stream scores, as well as lower abundance and taxonomic richness of benthic macroinvertebrates and fish due to yellow-boy fouling the passive treatment limestone beds over time since they were implemented. Additionally, I expected that sites above passive treatment controls would have higher stream scores and diversity among macroinvertebrate communities, but not necessarily fish communities because many reaches above passive treatment sites are first order.

Methods

Aultman Run and its tributaries in southern Indiana County have found no relief from AMD related effects, quite obviously showing the disastrous effects of AMD along select stream miles. The Aultman Run Watershed basin, with headwaters in Crete, Pennsylvania, drains 29 square miles of Armstrong, Blacklick, Center, Conemaugh, and Young Townships in Indiana County, Pennsylvania (Figure 1). Aultman Run empties into the Conemaugh River and is a part of the larger Ohio River watershed. There are three treatment projects throughout the watershed; one each on Aultman Run, Neal Run, and Reeds Run. Despite many efforts, the Aultman Run watershed is still classified as impaired by the Pennsylvania Department of Environmental Protection (DEP) due to farmland and AMD/coal refuse.

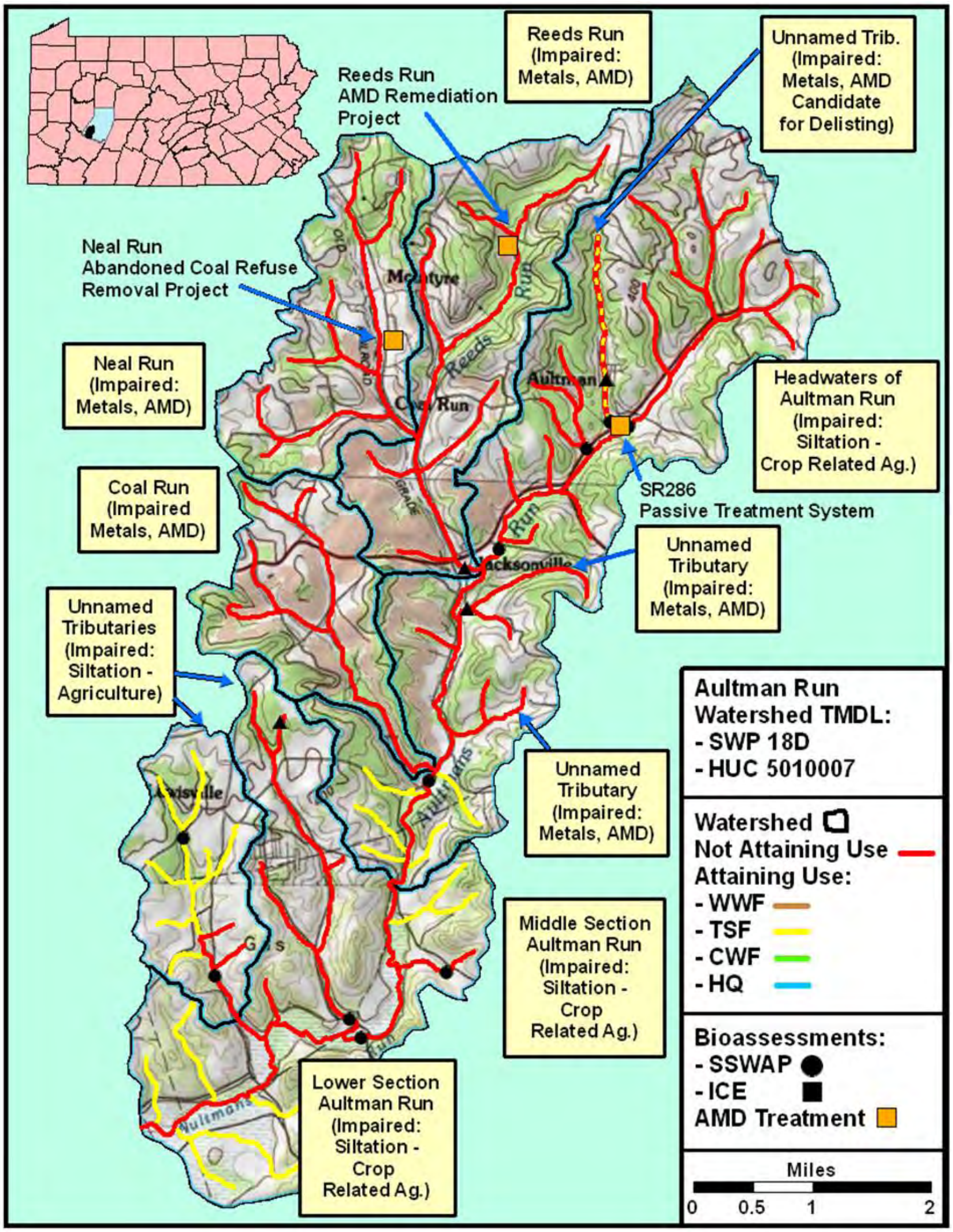


Figure 1. Map of the Aultman Run Watershed and the passive treatment systems implemented therein with a description of each identified point of impairment.

We sampled 12 sites throughout the Aultman Run watershed (Figure 1). Streams reaches were categorized as directly above a treatment (3 sites), directly below a treatment (3 sites), or not close to a treatment (3-6 sites, depending on the variable measured). Streams not close to a treatment, at least ½ mile away, made up 50% of the streams sampled and were all downstream of treatment controls. Streams reaches classified as directly above a treatment did not incur the point of AMD pollution, but were within 50 meters of the treatment outlet. These reaches had the potential to have been contaminated by pollutants further upstream but not by the waters being outlet by the treatment systems in place. Reaches directly below treatments received the treated AMD water no more than 50 meters upstream of sampling.

The EPA Rapid Bioassessment Protocols for Streams, Forum 2, was used to rate habitat conditions all 12 locations. The following process was repeated to generate information for each category on the USDA Rapid Bioassessment, including riparian zone, substrate, epifaunal, and water quality datasets. Once at a sample point, indicated by an orange marker with the site name, an exact coordinate was taken. To minimize disruption, the stream was always entered downstream of the sampling point. Once in place, the recorder remained facing upstream at all points to generate consistent data regarding the left and right banks. The recorder then checked their score with the observer to avoid false readings.

After completing the Rapid Bioassessment Protocol, metadata were gathered for each site, and stream flow calculations were made with a flow gauge. To make stream calculations, a tape measure was pulled across the span to be measured, fixed to both banks, and read. The width of the stream was recorded, and the stream was assigned an interval (0.2m, 0.5m, or 1m) at which velocity measurements should be taken. Each stream had a minimum of 9 intervals to take measurements from.

Benthic macroinvertebrate data was gathered last, and always upstream of where other testing had occurred to ensure that there were no accidental dislodgements of macroinvertebrates. A 1-m^2 kick net was used to collect dislodged macroinvertebrates while a 1-m^2 area was disturbed to dislodge as many macroinvertebrates as possible in 1 minute time. Collected items were washed into a bucket, then the process was repeated in a different area of the same reach. Each reach had two kick net samples taken. Once both trials were collected in a bucket, leaves and other debris were manually sorted from the sample. Each leaf or piece of debris was inspected for macroinvertebrates before being removed. A sieve was used to sort fine sediment and water away from the remaining coarse sediment and macroinvertebrates. This mixture was funneled into a whirl pack, filled with ethanol, and stored for sorting. Macroinvertebrates were sorted from debris into collection vials, and then a microscope was used to determine their identification to the family level.

Fish were shocked using a backpack electrofishing unit that pulsed DC current through the water at variable voltages to temporarily stun fish in the 100m transect taken. After being stunned, fish were netted and carried in a bucket to be observed at the end of each 100m transect. After being identified by their common name, a count was taken for each species present in the bucket and the abundance at which each species appeared in the bucket.

Data was collected between November 15, 2019 and March 23, 2021, generally in the fall, winter, and early spring. The riparian zone can be more readily seen without foliage, the stream tends to be less opaque for substrate evaluation, and a more accurate year-round biotic representation is present in the fall and winter months. Sampling was not done when streams were frozen over this time period in order to better observe the systems, as there is already a level of subjectivity with the protocol.

Data was analyzed in Program R using a one-way ANOVA test after checking for statistical outliers with a normality plot and by running a Shapiro-Wilk test on the data. Assumptions of the ANOVA test were met thus the data did not require a transformation. Macroinvertebrate data and fish data were compiled in tables to analyze, but without running a statistical analysis because of the amount of null data points present in each macroinvertebrate and fish datasets. We feel as though running a statistical analysis for such data would make for misleading and inaccurate assumptions of what the data gathered means.

Results

Habitat conditions in stream reaches above and not close to passive treatment controls scored higher than streams below passive treatment systems. The averages of stream reaches above and not close to passive treatment systems were nearly identical. Reaches directly below passive treatment systems scored lower on average than both reaches above and not close to passive treatment systems. The most common rating was fair, which happened 50% of the time. Streams below treatments scored in the poor to fair category 3 times which makes up 43% of the total streams scoring as such (Table 1). The only stream to score poor was also below a treatment

(Figure 2). Sites above treatments either scored as good, one time, or fair, two times, and made up 20% of the good and excellent categories. Reaches not close to a treatment made up 80% of the good and excellent categories (Table 1). The only stream reach to score excellent was not close to a treatment (Figure 2).

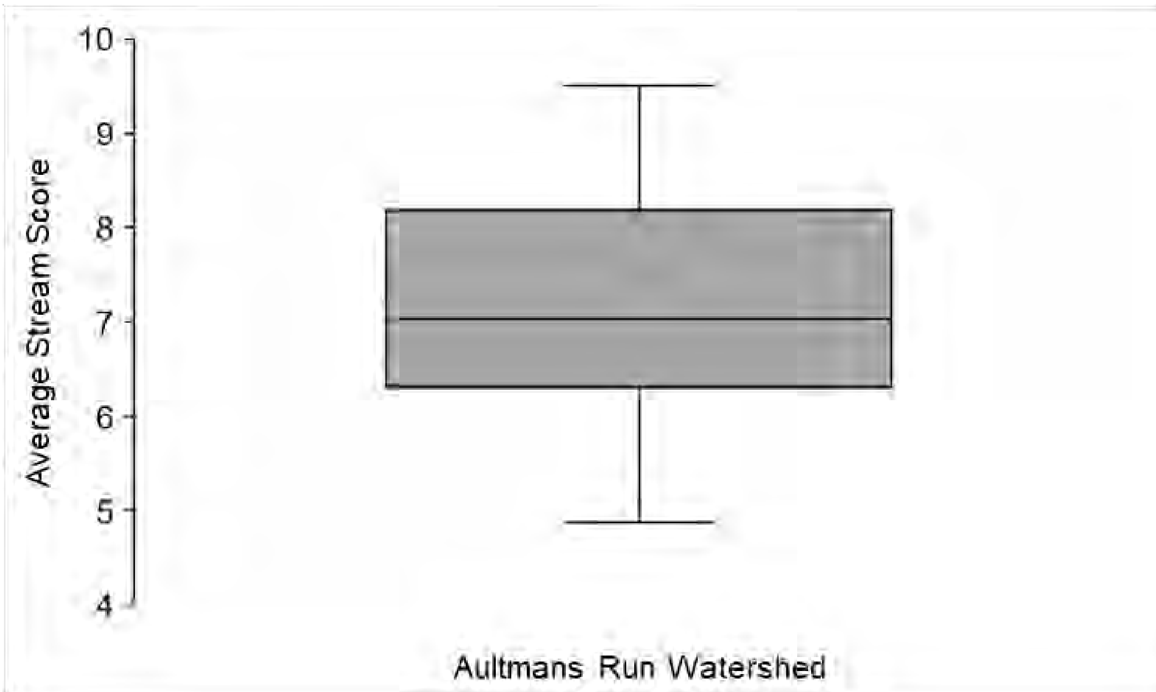


Figure 2. Shows the range of scores seen in Aultmans Run Watershed while depicting the absolute extreama (stie K56-2) and absolute minima (site NLO-MP3)

Table 1. A representation of abiotic stream quality for each treatment category.

	Poor (<6.0)	Fair (6.1-7.4)	Good (7.5-8.9)	Excellent (>9.0)
Above Treatment	0	2	1	0
Below Treatment	1	2	0	0
Not Close to Treatment	0	2	3	1

Stream scores varied for each of the stream reaches sampled. Average scores in reaches above passive treatment systems and in reaches not close to passive treatment systems place them in the good category of the EPA protocol. Reaches directly below passive treatment systems return an overall score that categorizes them as poor quality (Figure 3). Reaches that were not close to treatments and reaches that were above treatments showed a difference in average score of just over 0.03 quality

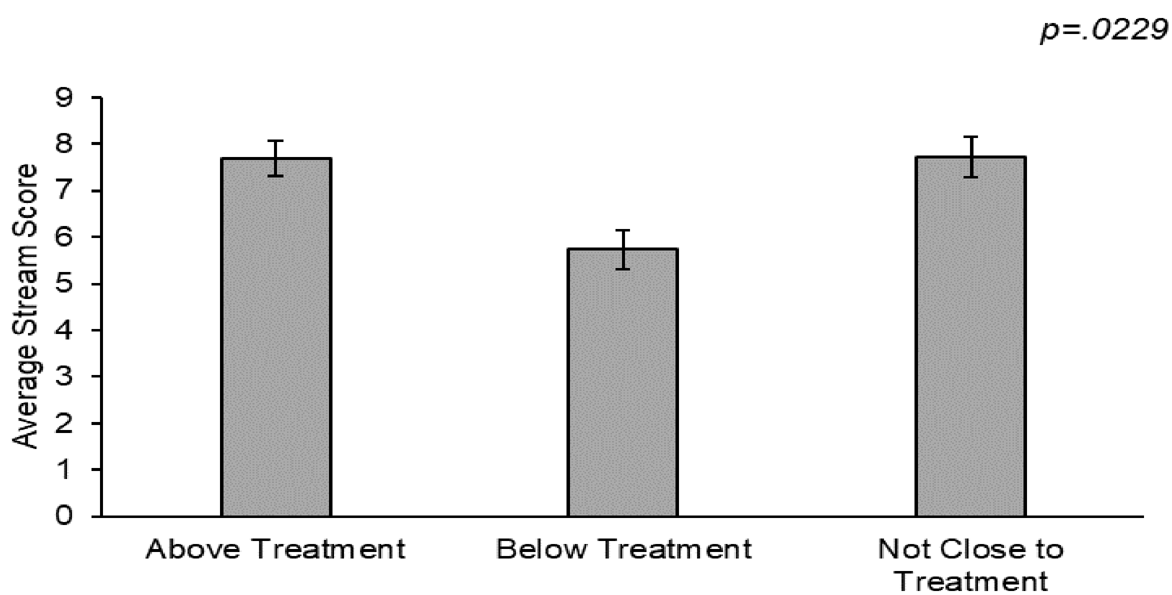


Figure 3. Average EPA Visual-Based Habitat Assessment for each of the treatments considered with respective standard error values

points (Figure 3). Reaches directly below treatments scored 1.96 quality points lower, on average, than reaches above treatments (Figure 3). The null hypothesis is rejected because stream reaches above and not close to passive treatment systems have higher habitat scores than stream reaches directly below passive treatment systems (ANOVA, df=11, f=5.918, p=0.0229) (Tukey HSD, p=0.0073).

Reaches directly below passive treatments had noticably higher levels of embeddeness and sediment depostion, lower quality of depth rigime (missing one or more of: fast and shallow, slow and shallow, fast and deep, slow and deep), and lacked quality riperian zones, when compared to their couterpart stream reaches directly upstream of passive treatment sites. These factors alone did not account for the entire discrepency in score, but do explain a large part of it.

Macroinvertebrate abundance and taxonomic richness were substantially lower at sampling sites below treatment systems (Table 2a). Two of the three sites below treatment systems were completely devoid of macroinvertebrates (zero and one total individuals). The most common taxa overall were Hydropsychidae (Trichoptera) and Chironomidae (Diptera). The contrast among site types was particularly evident in the stoneflies (Plecoptera), a macroinvertebrate taxon particularly sensitive to AMD impairment (Table 2b). Stoneflies were 14 times more abundance at upstream sites than at downstream sties or those not close to treatment systems.

Table 2a. Average macroinvertebrate abundance and taxonomic richness above, below, and not close to treatment systems in the Aultman Run watershed.

Site location relative to treatment system	Abundance	Taxonomic Richness
Below	15.0	3.3
Above	287.3	10.7
Not Close	101.0	6.0

Table 2b. Abundance of Plectoptera (stoneflies), a taxa that is particularly sensitive to AMD, observed in each of three areas with respect to passive treatment systems on Reeds Run, Neal Run, and Aultman Run in the Aultman Run Watershed.

	Above Treatment	Below Treatment	Not Close to Treatment
Plecoptera Capniidae	57	5	4
Plecoptera Perlodidae	15	0	0
Plecoptera Taeniopterygidae	0	0	1
Total Plecoptera Abundance	**72**	**5**	**5**

Fish abundance and species richness appeared more closely related to stream identity than proximity to treatment systems. Sampling sites in Reeds Run and Neal Run had only 1 to 4 fish species, while sites above and below the treatment system in the Aultman Run headwaters had 14 and 17 species, respectively. Sites above treatment systems had higher abundance than sites downstream of treatments (Table 3). The most commonly observed species above and below treatments were creek chub and white sucker, while the most common species at sites not close to treatments were white sucker and northern hogsucker.

Table 3. Relative abundance of fish species from each site type with respect to passive treatment systems in the Aultmans Run Watershed.

	Above Treatment	Below Treatment	Not Close to Treatment
Creek Chub	187	93	8
Smallmouth Bass	2	3	1
Yellow Bullhead	0	1	2
Blunt Nose Minnow	25	8	13
Rainbow Darter	1	1	7
Central Stoneroller	3	0	11
Pumpkinseed	7	4	1
White Sucker	105	50	19
Largemouth Bass	8	3	0
Longnose Dace	0	0	9
Redside Dace	3	7	0
Rosyface Shiner	0	0	2
Log Perch	0	1	1
Northern Hogsucker	0	4	14
Blacknose Dace	24	20	2
Greenside Darter	0	0	2
Silverjaw Minnow	0	2	0
Green Sunfish	3	19	0
Fantail Darter	7	6	10
Bluegill	24	5	0
Sculpin	0	0	1
Johnny Darter	12	33	3
Species Richness	**14**	**17**	**17**
Total Site Abundance	**411**	**260**	**106**

Discussion

The null hypothesis was rejected because the stream reaches directly above and not close to passive treatment site showed significant positive difference in their mean quality in both stream score and macoinvertebrate quality when compared to sites directly below passive treatments. Fish were found in varing levels of abundance and quality as one may expect, and the data may have been influenced by watershed position (i.e., stream order) of the sampling sites. Nevertheless, consistent patterns of reduced biological and environmental condition downstream of treatment systems strongly suggest continued impairment of these stream reaches in the Aultman Run watershed.

Some limitations of our study may have had an influence on the data in general. For example, all streams were not sampled on the same day or at the same time, and thus weather and seasonal differences may have had some influence on stream conditions. We accounted for stochastic events like cloud cover, precipitation, and temperature swings to the best of our ablities by sampling in the late fall and winter months, or on days without rain and/or snow.

If a passive treatment system becomes fouled with iron pyrite, then it will be less effective, and therefore allow untreated or undertreated AMD to flow into the stream. Armoring of limestone is a common cause of failure in limestone-based treatment systems. It has been shown that they can become armored with reddish-colored ore within 48 hours of contact in such limestone systems (Hammarstrom et al. 2003). In limestone based systems this is a ligitimate concern since acidic water will precipitate iron pyrite onto limestone beds once pH levels raise. Limestone fouled by iron pyrite, yellow boy, is not effective in raising the pH of acidic water, and therfore, the system loses effectiveness in treating AMD. The Neal Run AMD Restoration Project is heavily impared by this effect and is reflected by the site directly downstream of it, NLO-MP3, reciving the lowest overall quality score of all watershed stream reaches. We are likely seeing this effect at the Reeds Run AMD Restoration Project and the SR286 Passive Treatment System to a lesser degree.

Settling swamps face a similar concern, as they do not need to raise pH, but rather provide an area where water heavy with iron can settle. Since deposits can be very heavy, an overfilled settling swamp can channelize. A channelized settling swamp is useless in treating AMD because water will flow through the passive treatment system at such a rate that does not allow iron pyrite to percipitate. Work should be done at the Neal Run AMD Restoration Project to mitigate and reduce the risk of this compounding the existing limestone fouling problems.

Our results show that impairment immediately below treatment systems is to some degree aliviated with distance downstream. Reaches directly below passive treatment controls experience point-source pollution, the effects of AMD are more profusely evident. Despite this, reaches not close to passive treatment systems, all of which are downstream of passive treatment systems, show stream quality ratings compareable to reaches above systems. This suggests that the effects of AMD are not reaching the entirety of the Aultman Run watershed. Instead, the effects of AMD are staying confined to an area around the treatment systems. This may be indicative of a system that is overloaded and on its way to becoming fouled. Future studies should examine how to further reduce the impact of AMD on reaches of stream directly below a passive treatment system, how to prolong a passive treatment systems effective life, and how to increase their effective capasity, as it seems that the areas of most concern have already been identified. Areas not close to and above treatments are of significantly better quality and will only become better as more work is done at the established controls.

Conclusion

The Aultman Run watershed shows varying degrees of impairment and recovery thanks to the work that Stream Restoration Incorperated has done in implemening AMD passive treatment systems. Treatment systems can be improved upon, but money and resources are limiting factors, as with any project or experiment. Focus should be put into existing controls by reinvesting and rejuvinating their funcitonality. This is the most logical approach forward because the data suggests that the areas directly below treatments still have the worst quality, meaning that they could still benefit the most from passive treatment controls. Other reaches of the stream measure nearly identical in quality, meaning that the most likely barrier to a biotic resurgence and connectivity in the Aultmans Run watershed is directly below the treatment sites.

It is important to stress that this difference is likely not caused by a faulty system, but rather a system that is probably overcapacity for the waters traveling through it. Work and monitoring should continue in the Aultman Run watershed, especially in the areas already identified to be major AMD pollution sites. A raised awareness and direct action have the potential to make the Aultmans Run watershed an amazing resource for the surrounding community for many generations to come, just as it has been in the past.

Literature Cited

Cherry D.S., Currie R.J., Soucek D.J., Latimer H.A., Trent G.C. 2001. An integrative assessment of a watershed impacted by abandoned mined land discharges. Environmental Pollution. 111: 3: 377-388.

DeNicola D.M., Stapleton M.G. 2002. Impact of acid mine drainage on benthic communities in streams: the relative roles of substratum vs. aqueous effects. Environmental Pollution. 119: 3: 303-315.

Doepker, Richard D., 1993. Laboratory Determination of Parameters Influencing Metal Dissolution From Sulfidic Waste Rock. Preprint from American Society of Surface Mining and Reclamation

Ferguson, K.D. and P.M. Erickson, 1988. Pre-Mine Prediction of Acid Mine Drainage. In: Dredged Material and Mine Tailings. Edited by Dr. Willem Salomons and Professor Dr. Ulrich Forstner.

Hammarstrom J.M., Sibrell, P.L., Belkin, H.E., 2003. Characterization of limestone reacted with acid-mine drainage in a pulsed limestone bed treatment system at the Friendship Hill National Historical Site, Pennsylvania, USA. Applied Geochemistry. 18: 11: 1705-1721

Kim, A.G., Heisey B., Kleinmann R., Duel M., 1982. Acid Mine Drainage: Control and Abatement Research. U.S. DOI, Bureau of Mines IC 8905, p.22

Soucek D.J., Cherry D.S, Currie R.J., Latimer H.A., Trent G.C. 2000. Laboratory to field validation in an integrative assessment of an acid mine drainage–impacted watershed. Environmental Toxicology and Chemistry. 19: 4: 1046-1043.

U.S. EPA. 1994. Acid Mine Drainage Prediction. U.S. Environmental Protection Agency. December: 1-52.

Aultman Run Watershed Macroinvertebrate Data
Fall 2019- Winter 2020
Investigators: Ryan Neese, Cody Rester, Dave Janetski

Abundance by taxon:

Site Name	Loc w/ regard to treatment	Collection Date	Trichoptera Hydropsychidae	Diptera Chironomidae	Annelids Oligochaete	Diptera Tipulidae	Ephemeroptera Ephemeridae	Trichoptera Philopototamidae	Ephemeroptera Leptophlebiidae	Trichoptera Hydropsyche	Diptera Simuliidae	Odonnata Aeshnidae	Pelecoptera Capniidae	Ephemeroptera Heptageniidae	Megaloptera Corydalidae	Pelechotera Perloidae	Coleoptera Psephemidae	Diptera Limoniidae	Ephemeroptera Baetidae	Trichoptera Limnephilidae	Pelecoptera Tacniopterygidae	Abundance	Taxonomic Richness
NLO-MP2	Upstream	11/26/2019	34	80	0	3	9	27	3	0	0	0	10	9	1	2	0	0	0	0	0	178	10
NLO-MP3	Downstream	11/26/2019	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1
Neal-01	Not Close	11/26/2019	5	2	0	8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	16	4
K53-SW33	Downstream	2/8/2020	0	6	0	2	1	0	2	0	25	1	5	1	1	0	0	0	0	0	0	44	9
K53-SW32	Upstream	2/8/2020	21	24	0	4	0	0	0	0	31	0	45	24	1	13	1	4	3	2	0	173	12
REE01	Not Close	11/18/2019	*Bad preservative- Samples Unidentifiable																			N/A	N/A
85-13	Downstream	11/13/2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85-14	Upstream	10/25/2019	212	143	0	23	1	95	10	0	0	0	2	0	3	0	0	21	1	0	0	511	10
AUL03	Not Close	2/8/2020	179	43	0	2	9	0	6	0	0	0	4	0	1	0	0	0	4	0	1	249	9
K56-2	Not Close	11/15/2019	90	2	0	3	0	0	4	0	0	0	0	1	1	0	0	0	0	0	0	101	6
John-1	Not Close	11/13/2019	2	30	1	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	5
Total			543	330	1	46	24	123	25	1	56	1	66	35	8	15	1	25	8	2	1	**1311**	**19**

	Above Treatment	Below Treatment	Not Close to Treatment
Plecoptera Capniidae	57	5	4
Plecoptera Perlodidae	15	0	0
Plecoptera Taeniopterygidae	0	0	1
Total Plecoptera Abundance	72	5	5

Location relative to treatment	Abundance	Taxonomic Richness
Downstream	15.0	3.3
Upstream	287.3	10.7
Not Close	101.0	6.0

Aultman Run Watershed Fish Data
Fall 2020- Spring 2021
Investigators: Ryan Neese, Dave Janetski

Abundance by taxon:

Site Name	K55-SM14 & COA01	84-14	84-13	NLO-MP3	NLO-MP2	K53-SW33	K53-SW32
Loc. w/ regard to treatment	Not Close	Above	Below	Below	Above	Below	Above
Species							
Creek Chub	8	32	64	1	55	26	100
Smallmouth Bass	1	2	3	0	0	0	0
Yellow Bullhead	2	0	1	0	0	0	0
Blunt Nose Minnow	13	25	8	0	0	0	0
Rainbow Darter	7	1	1	0	0	0	0
Central Stoneroller	11	3	0	0	0	0	0
Pumpkinseed	1	7	4	0	0	0	0
White Sucker	19	97	44	0	8	6	0
Largemouth Bass	0	8	3	0	0	0	0
Longnose Dace	9	0	0	0	0	0	0
Redside Dace	0	3	7	0	0	0	0
Rosyface Shiner	2	0	0	0	0	0	0
Log Perch	1	0	1	0	0	0	0
Northern Hogsucker	14	0	4	0	0	0	0
Blacknose Dace	2	12	20	0	0	0	12
Greenside Darter	2	0	0	0	0	0	0
Silverjaw Minnow	0	0	2	0	0	0	0
Green Sunfish	0	3	1	0	0	18	0
Fantail Darter	10	7	6	0	0	0	0
Bluegill	0	24	5	0	0	0	0
Sculpin	1	0	0	0	0	0	0
Johnny Darter	3	12	20	0	0	13	0
# of Spe	17	14	17	1	2	4	2
Total Individuals	106	236	194	1	63	63	112

	Above Treatment	Below Treatment	Not Close to Treatment
Creek Chub	187	93	8
Smallmouth Bass	2	3	1
Yellow Bullhead	0	1	2
Blunt Nose Minnow	25	8	13
Rainbow Darter	1	1	7
Central Stoneroller	3	0	11
Pumpkinseed	7	4	1
White Sucker	105	50	19
Largemouth Bass	8	3	0
Longnose Dace	0	0	9
Redside Dace	3	7	0
Rosyface Shiner	0	0	2
Log Perch	0	1	1
Northern Hogsucker	0	4	14
Blacknose Dace	24	20	2
Greenside Darter	0	0	2
Silverjaw Minnow	0	2	0
Green Sunfish	3	19	0
Fantail Darter	7	6	10
Bluegill	24	5	0
Sculpin	0	0	1
Johnny Darter	12	33	3
Species Richness	**14**	**17**	**17**
Total Site Abundance	**411**	**260**	**106**

Aultman Run Watershed EPA Visual Assessment Data
Fall 2019- Winter 2020
Investigators: Ryan Neese, Cody Rester, Dave Janetski

EPA Habitat Assessment by Site:

Site Name	Loc. w/ regard to treatment	Avalable Cover	Embeddedness	Depth Regime	Sediment Deposition	Channel Flow	Channel Alteration	Frequency of Riffles	Bank Stability	Vegitative Protection	Riparian Zone Width	**Total Score**	**Number Scored**	**Overall Score**
K56-2	Not Close	18	14	17	18	13	12	14	12	14	20	152	16	9.5
John-1	Not Close	13	12	11	8	12	14	3	9	15	12	109	16	6.8125
85-14	Above	12	18	15	14	10	14	8	11	15	16	133	16	8.3125
85-13	Below	13	7	10	13	8	7	14	8	10	8	98	16	6.125
AUL03	Not Close	11	8	6	15	12	12	2	14	15	18	113	16	7.0625
K55-SM14	Not Close	18	9	7	13	15	19	6	9	18	18	132	16	8.25
REE01	Not Close	7	12	18	8	9	13	18	14	3	5	107	16	6.6875
K53-SW33	Below	7	2	14	7	12	17	7	8	12	13	99	16	6.1875
K53-SW32	Above	13	4	8	6	16	12	15	12	18	20	124	16	7.75
Neal-01	Not Close	10	20	15	19	7	15	14	12	12	4	128	16	8
NLO-MP2	Above	12	13	14	14	14	0	7	15	13	10	112	16	7
NLO-MP3	Below	1	2	6	15	13	16	2	7	9	7	78	16	4.875

Stream flow calculation template

Stream name: Aultmans Run Total width (m): 2.0 m
Date: 25 October 2019
Investigator(s): Ryan Neese, Cody Rester

Width (m)	Depth (m)	Velocity (m/s)	Discharge (m3/s)
0.2	0	0	0.00005
0.2	0.05	0.02	0.00065
0.2	0.08	0.08	0.00162
0.2	0.1	0.1	0.00207
0.2	0.08	0.13	0.00184
0.2	0.08	0.1	0.00221
0.2	0.05	0.24	0.0017
0.2	0.05	0.1	0.000525
0.2	0.02	0.05	0.000075
0.2	0.01	0	0
0.2	0	0	0

	m^3/s	gpm
TOTAL DISCHARGE	0.01074	170.2325

Stream flow calculation template

Stream name: Aultmans Run   Total width (m): 2.70 m
Date: 13 November 2019
Investigator(s): Ryan Neese, Cody Rester

Width (m)	Depth (m)	Velocity (m/s)	Discharge (m3/s)
0.2	0	0	0.0007
0.2	0.07	0.2	0.00423
0.2	0.11	0.27	0.00736
0.2	0.12	0.37	0.00847
0.2	0.1	0.4	0.01025
0.2	0.15	0.42	0.0092
0.2	0.08	0.38	0.00592
0.2	0.08	0.36	0.00584
0.2	0.08	0.37	0.005175
0.2	0.07	0.32	0.00351
0.2	0.06	0.22	0.00185
0.2	0.04	0.15	0.00069
0.2	0.02	0.08	0.00008
0.2	0	0	0
0.2	0	0	0
0.2	0	0	0

	m^3/s	gpm
TOTAL DISCHARGE	0.063275	1002.929

Stream flow calculation template

Stream name: Aultmans Run   Total width (m): 5.3 m
Date: 13 November 2019
Investigator(s): Ryan Neese, Cody Rester

Width (m)	Depth (m)	Velocity (m/s)	Discharge (m3/s)
0.5	0	0	0.000375
0.5	0.1	0.03	0.002925
0.5	0.16	0.06	0.0068
0.5	0.18	0.1	0.025
0.5	0.22	0.4	0.0625
0.5	0.28	0.6	0.0468
0.5	0.2	0.18	0.0116375
0.5	0.29	0.01	0.00285
0.5	0.28	0.03	0.0022
0.5	0.16	0.01	0.0006
0.5	0.08	0.01	0.0001
0.3	0	0	0

	m^3/s	gpm
TOTAL DISCHARGE	0.1617875	2564.384

Stream flow calculation template

Stream name: Reeds Run Total width (m): 2.10 m
Date: 8 February 2020
Investigator(s): Ryan Neese, Cody Rester

Width (m)	Depth (m)	Velocity (m/s)	Discharge (m3/s)
0.2	0	0	0.00399
0.2	0.14	0.57	0.01526
0.2	0.14	0.52	0.01164
0.2	0.1	0.45	0.00632
0.2	0.06	0.34	0.0052
0.2	0.07	0.46	0.0052
0.2	0.06	0.34	0.00308
0.2	0.02	0.43	0.0012
0.2	0.02	0.17	0.0004
0.2	0.02	0.03	0.000045
0.2	0.01	0	0
0.1	0	0	0

	m^3/s	gpm
TOTAL DISCHARGE	0.052335	829.5267

Stream flow calculation template

Stream name: Reeds Run Total width (m): 1.70 m
Date: 8 February 2020
Investigator(s): Ryan Neese, Cody Rester

Width (m)	Depth (m)	Velocity (m/s)	Discharge (m3/s)
0.2	0	0	0.000055
0.2	0.11	0.01	0.008415
0.2	0.22	0.5	0.02185
0.2	0.24	0.45	0.02046
0.2	0.2	0.48	0.01674
0.2	0.16	0.45	0.0119
0.2	0.18	0.25	0.00697
0.2	0.16	0.16	0.00136
0.2	0.01	0	0
0.1	0	0	0

	m^3/s	gpm
TOTAL DISCHARGE	0.08775	1390.866

Stream flow calculation template

Stream name: Reeds Run Total width (m): 5.20 m
Date: 18 November 2019
Investigator(s): Ryan Neese, Cody Rester

Width (m)	Depth (m)	Velocity (m/s)	Discharge (m3/s)
0.5	0	0	0.0003
0.5	0.04	0.06	0.0042625
0.5	0.07	0.25	0.0076
0.5	0.12	0.07	0.0074
0.5	0.04	0.3	0.0033
0.5	0.02	0.14	0.0014
0.5	0.05	0.02	0.0076375
0.5	0.08	0.45	0.023925
0.5	0.14	0.42	0.022
0.5	0.08	0.38	0.004275
0.5	0.01	0	0
0.2	0	0	0

	m^3/s	gpm
TOTAL DISCHARGE	0.0821	1301.312

Stream flow calculation template

Stream name: Aultmans Run Total width (m): 6.50 m
Date: 15 November 2019
Investigator(s): Ryan Neese, Cody Rester

Width (m)	Depth (m)	Velocity (m/s)	Discharge (m3/s)
0.5	0	0	0.0039
0.5	0.13	0.24	0.016675
0.5	0.16	0.22	0.0161
0.5	0.12	0.24	0.0151125
0.5	0.19	0.15	0.01815
0.5	0.14	0.29	0.0203
0.5	0.14	0.29	0.01995
0.5	0.14	0.28	0.0146875
0.5	0.11	0.19	0.0026125
0.5	0	0	0.003375
0.5	0.1	0.27	0.011
0.5	0.1	0.17	0.0038
0.5	0.06	0.02	0.00015
0.5	0	0	0

	m^3/s	gpm
TOTAL DISCHARGE	**0.1458125**	2311.175243

Stream flow calculation template

Stream name: Aultmans Run   Total width (m): 7.50 m
Date: 20 November 2019
Investigator(s): Cody Rester

Width (m)	Depth (m)	Velocity (m/s)	Discharge (m3/s)
0.5	0	0	0.0004
0.5	0.02	0.16	0.0027
0.5	0.06	0.11	0.0086
0.5	0.1	0.32	0.008575
0.5	0.04	0.17	0.0035
0.5	0.06	0.11	0.0030375
0.5	0.03	0.16	0.0030625
0.5	0.04	0.19	0.005125
0.5	0.06	0.22	0.00615
0.5	0.06	0.19	0.0050875
0.5	0.05	0.18	0.0037125
0.5	0.04	0.15	0.0011875
0.5	0.01	0.04	0.00015
0.5	0.02	0	0
0.5	0	0	0
0.5	0	0	0

	m^3/s	gpm
TOTAL DISCHARGE	0.0512875	812.9234

Stream flow calculation template

Stream name: Neal Run   Total width (m): 2.50 m
Date: 26 November 2019
Investigator(s): Ryan Neese

Width (m)	Depth (m)	Velocity (m/s)	Discharge (m3/s)
0.2	0	0	0.000015
0.2	0.03	0.01	0.00247
0.2	0.1	0.37	0.00621
0.2	0.08	0.32	0.00324
0.2	0.1	0.04	0.0034
0.2	0.07	0.36	0.005775
0.2	0.08	0.41	0.00609
0.2	0.06	0.46	0.00451
0.2	0.05	0.36	0.00162
0.2	0.04	0	0.00055
0.2	0.06	0.11	0.00308
0.2	0.08	0.33	0.00378
0.2	0.04	0.3	0.0006
0.1	0	0	0

	m^3/s	gpm
TOTAL DISCHARGE	0.04134	655.2524

Stream flow calculation template

Stream name: Neal Run   Total width (m): 2.70 m
Date: 26 November 2019
Investigator(s): Ryan Neese

Width (m)	Depth (m)	Velocity (m/s)	Discharge (m3/s)
0.2	0	0	0.00015
0.2	0.02	0.15	0.00144
0.2	0.04	0.33	0.00133
0.2	0.03	0.05	0.00132
0.2	0.05	0.28	0.00084
0.2	0.01	0	0.0007
0.2	0.06	0.2	0.00245
0.2	0.08	0.15	0.00312
0.2	0.08	0.24	0.00108
0.2	0.01	0	0.00025
0.2	0.04	0.1	0.0005
0.2	0.06	0	0
0.2	0.04	0	0
0.2	0.01	0	0
0.1	0	0	0

	m^3/s	gpm
TOTAL DISCHARGE	0.01318	208.9073

Stream flow calculation template

Stream name: Neal Run Total width (m): 1.55 m
Date: 26 November 2019
Investigator(s): Ryan Neese

Width (m)	Depth (m)	Velocity (m/s)	Discharge (m3/s)
0.2	0	0	0.00032
0.2	0.04	0.16	0.00176
0.2	0.04	0.28	0.00488
0.2	0.12	0.33	0.005175
0.2	0.11	0.12	0.003675
0.2	0.1	0.23	0.00294
0.2	0.11	0.05	0.000575
0.2	0.12	0	0
0.15	0	0	0

	m^3/s	gpm
TOTAL DISCHARGE	0.019325	306.3075

Stream flow calculation template

Stream name: Aultmans Run Total width (m): 11.65 m
Date: 8 February 2020
Investigator(s): Ryan Neese, Cody Rester

Width (m)	Depth (m)	Velocity (m/s)	Discharge (m3/s)
1	0	0	0.0068
1	0.34	0.08	0.0522
1	0.38	0.21	0.0608
1	0.38	0.11	0.1029
1	0.46	0.38	0.207
1	0.46	0.52	0.20925
1	0.44	0.41	0.2499
1	0.54	0.61	0.2875
1	0.46	0.54	0.1833
1	0.32	0.4	0.1053
1	0.22	0.38	0.05025
1	0.08	0.29	0.0058
0.65	0	0	0

	m^3/s	gpm
TOTAL DISCHARGE	1.521	24108.34

Biological Recovery after Acid Mine Remediation in the Aultmans Run Watershed

Ryan Neese, David Janetski, Shaun Busler, and Cody Rester

Department of Biology, Indiana University of Pennsylvania, Indiana, PA

Introduction

- Acid mine drainage (AMD) is a natural process that has been accelerated by coal mining and refuse piles by allowing the following reaction to take place at a rate exponentially higher than normal.

$4\ FeS_2 + 15\ O_2 + 14\ H_2O \rightarrow 4\ Fe(OH)_3 + 8\ H_2SO_4$

OR

Pyrite+Oxygen+Water -> "Yellow-boy"+Sulfuric Acid

- AMD degrades more than 12,000 km of streams in the NE Appalachian Region; 80% of the impacted stream miles are located in western Pennsylvania and West Virginia
- In the early 2000's Stream Restoration Inc. began restoration work on the Aultmans Run Watershed (Figure 1.) via implementation of three AMD passive treatment control systems and land reclamation.

Generally, we seek to gain better understanding of the process that an AMD impaired watershed must go through in western Pennsylvania to restore it to its pre-impairment state. Our objective was to quantify levels of biotic recovery while visually assessing the habitat quality of select stream reaches that have been identified and designated as important for monitoring.

Study Area

This study took place in the Aultmans Run Watershed, located in southwest Indiana County, Pennsylvania. Monitoring is undertaken in cooperation with SRI. Samples were taken at 12 points, capturing a snapshot of conditions above, below, and away from implemented treatment systems (Figure 1).

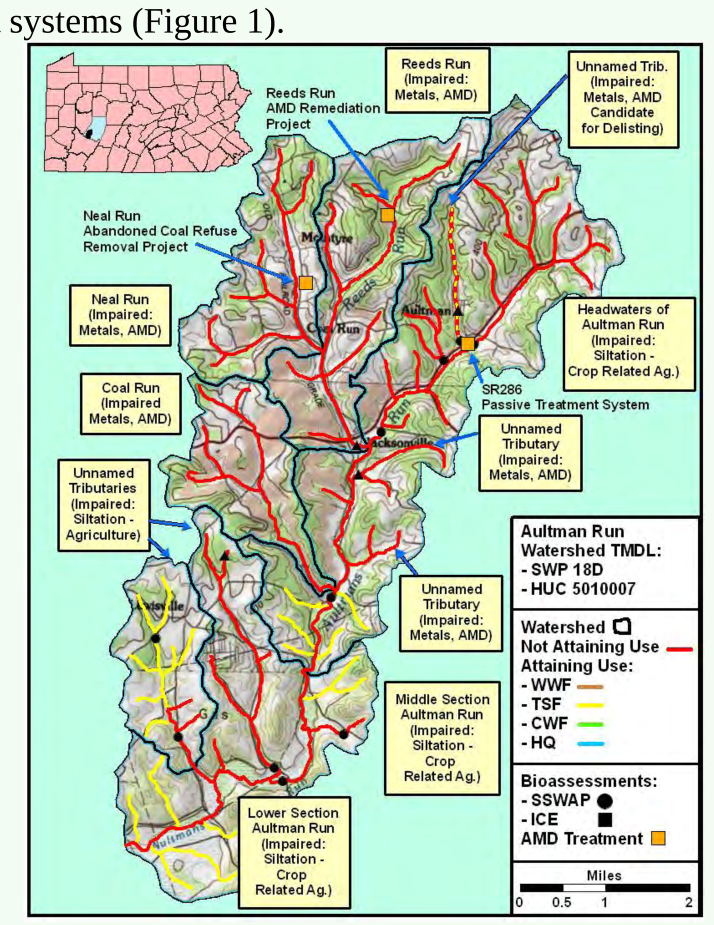


Figure 1. *Map of the Aultmans Run Watershed and the passive treatment systems implemented therein with a description of each identified point of impairment.*

Methods

Biotic Assessments

- Macroinvertebrate and Electrofishing Sampling Protocol – EPA Rapid Bioassessment Protocols for use in Streams and Wadeable Rivers (1999).
- Macroinvertebrate samples collected under section 7.1.1 (Field Sampling Protocol for Single Habitat).
- Samples were caught using a 1 square meter kick-net (Figure 2.) with ~500 micron opening mesh and processed through a sieve with ~500 micron opening mesh.
- Specimens were preserved in 95% ethanol in a site-specific manner the identified to the family level under microscope (Figure 3.).
- Abundance of pollution intolerant taxa can be used to help in understanding impairment levels among benthic communities impacted by AMD sedimentation and embeddedness.

- Fish samples collected under the protocol entitled Fish Collection Procedures: Electrofishing.
- 100 meter transects were waded in an upstream orientation at select sites.
- Dip-nets and a backpack electrofishing unit were used to stun and capture fish for identification.
- Species tolerance designation indices designated for use in the Northeastern United States by the EPA corresponds with Halliwell et al. 1999

Abiotic Assessments

- Physicochemical Characteristics (Temperature, Conductivity, Alkalinity, and pH), a Visual-Based Habitat Assessment (EPA RBAs 5.2) and flow rates (Figure 4.) were taken for each of 12 designated sites
- Physicochemical characteristics were taken electrometrically or colormetrically.
- The EPA Visual-Based Habitat Assessment provides a good overview/idea of site health and is considered on a 100 meter transect.

Figure 2. A standard kick-net used in macroinvertebrate collection.

Figure 3. A Trichoptera Philopotamidae under 20x magnification.

Figure 4. An example of measuring stream discharge rates.

Results

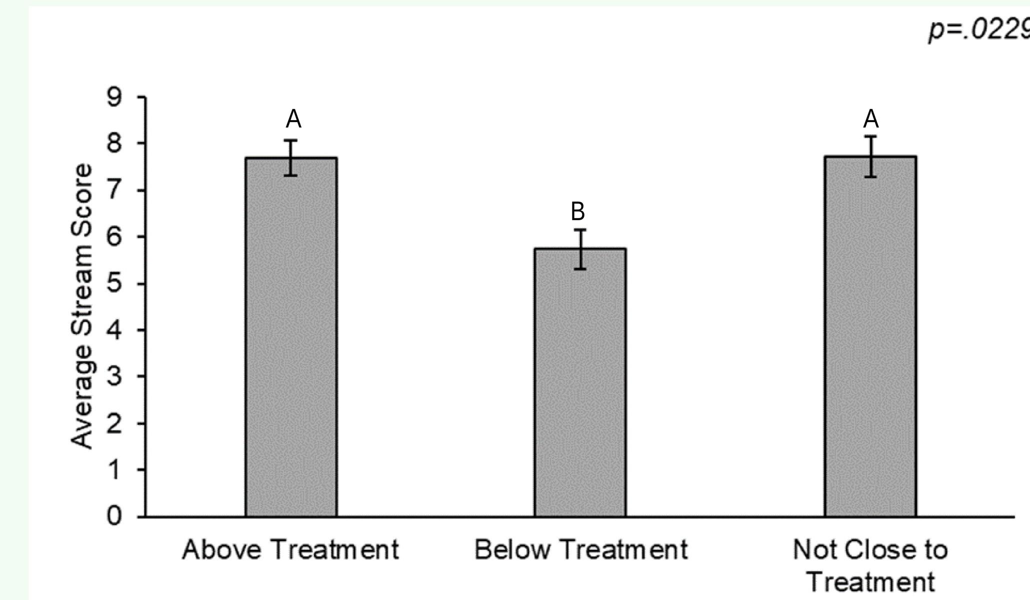


Figure 5. Average EPA Visual-Based Habitat Assessment score for each of three possible site positions relative to passive treatment systems, considered with respective standard error values (ANOVA, df=11, f=5.918, p=0.0229) (Tukey HSD, p=0.0073).

- Reaches directly below passive treatments returned an overall score that categorizes them as poor per the EPA Visual-Based Habitat Assessment.
- These reaches had noticeably higher levels of embeddedness, lacked quality riparian zones, and had lower quality depth regimes.

Table 1. Abundance of Stonefly order insects, a taxa that is particularly sensitive to AMD, observed in each of three areas with respect to passive treatment systems on Reeds Run, Neal Run, and Aultman Run in the Aultman Run Watershed.

	Above Treatment	Below Treatment	Not Close to Treatment
Plecoptera Capniidae	57	5	4
Plecoptera Perlodidae	15	0	0
Plecoptera Taeniopterygidae	0	0	1
Total Plecoptera Abundance	**72**	**5**	**5**

Table 2. Species Richness and abundance of fish observed by species in each of three areas with respect to passive treatment systems in the Aultmans Run Watershed.

	Above Treatment	Below Treatment	Not Close to Treatment
Creek Chub	87	65	8
Smallmouth Bass	2	3	1
Yellow Bullhead	0	1	2
Blunt Nose Minnow	25	8	13
Rainbow Darter	1	1	7
Central Stoneroller	3	0	11
Pumpkinseed	7	4	1
White Sucker	105	44	19
Largemouth Bass	8	3	0
Longnose Dace	0	0	9
Redside Dace	3	7	0
Rosey Face Shiner	0	0	2
Log Perch	0	1	1
Northren Hogsucker	0	4	14
Blacknose Dace	12	20	2
Greenside Darter	0	0	2
Silverjaw Minnow	0	2	0
Green Sunfish	3	1	0
Fantail Darter	7	6	10
Bluegill	24	5	0
Sculpin	0	0	1
Johnny Darter	12	20	3
Species Richness	**14**	**17**	**17**
Total Site Abundance	**299**	**195**	**106**

- There is a trend suggesting that sites above passive treatments show higher biotic abundance in both fish and macroinvertebrate species.
- Fish abundance, though still impacted, is much higher at all site types than that of sensitive stoneflies .

Conclusions

- Figure (5) highlights the need for continued routine visual monitoring to identify fouled or failing passive treatment systems, but also the need for biotic assessment inclusion.
- Table (1) and (2) emphasize the differential impairment of impacted AMD sites, highlighting the strain that sedimentation and embeddedness can put on benthic communities, especially pollution sensitive ones, making them a quality indicator of stream recovery.

Limitations:

- Range of dates/seasons used to sample resulting in high variability in physicochemical conditions and potential degradation of passive treatment sites.
- Variability was found in much of the data suggesting that AMD recovery may be controlled by reach-scale factors that cannot adequately be captured by a snapshot study.

Future Study:

- Continue monitoring of the watershed to direct efforts, especially directly below passive treatment sites.
- Explore the potential of rejuvenating existing sites via re-working fouled limestone and/or adding more settlement area.
- Compare downstream reaches before and after treatment.

References

Cherry D.S., Currie R.J., Soucek D.J., Latimer H.A., Trent G.C. 2001. An integrative assessment of a watershed impacted by abandoned mined land discharges. Environmental Pollution. 111: 3: 377-388.

DeNicola D.M., Stapleton M.G. 2002. Impact of acid mine drainage on benthic communities in streams: the relative roles of substratum vs. aqueous effects. Environmental Pollution. 119: 3: 303-315.

Doepker, Richard D., 1993. Laboratory Determination of Parameters Influencing Metal Dissolution From Sulfidic Waste Rock. Preprint from American Society of Surface Mining and Reclamation

Ferguson, K.D. and P.M. Erickson, 1988. Pre-Mine Prediction of Acid Mine Drainage. In: Dredged Material and Mine Tailings. Edited by Dr. Willem Salomons and Professor Dr. Ulrich Forstner.

Hammarstrom J.M., Sibrell, P.L., Belkin, H.E., 2003. Characterization of limestone reacted with acid-mine drainage in a pulsed limestone bed treatment system at the Friendship Hill National Historical Site, Pennsylvania, USA. Applied Geochemistry. 18: 11: 1705-1721

Kim, A.G., Heisey B., Kleinmann R., Duel M., 1982. Acid Mine Drainage: Control and Abatement Research. U.S. DOI, Bureau of Mines IC 8905, p.22

Soucek D.J., Cherry D.S, Currie R.J., Latimer H.A., Trent G.C. 2000. Laboratory to field validation in an integrative assessment of an acid mine drainage–impacted watershed. Environmental Toxicology and Chemistry. 19: 4: 1046-1043.

U.S. EPA. 1994. Acid Mine Drainage Prediction. U.S. Environmental Protection Agency. December: 1-52.

Acknowledgements

Indiana University of Pennsylvania Biology Department, Dr. David Janetski, and Shaun Busler for their guidance, support and patience through the COVID-19 pandemic.

Sierra Farrington, Elijah Clevenger, Angela Malak, and any other residents of the Aultmans Run Watershed for their assistance in the field and graciousness in allowing easy and quick access to sampling locations.

Appendix G
Photographs

85-14 (7-16-19)

85-13 (5-19-20)

John-1 (5-20-20)

K56-2 (7-18-19)

AUL03 (5-19-20)

K55-SW14 (1-16-20)

NL0-MP2 (5-21-20)

NL0-MP3 (5-21-20)

NEAL01 (5-21-20)

K53-SW32 (5-21-20)

K53-SW33 (5-21-20)

REE03 (5-21-20)

Jack-MP27 (5-21-20)

REE01A (5-19-20)

COA02 (5-21-20)

COA01 (7-18-19)

SR286 Discharge (5-19-20)

WL (5-20-20)

85-16 (5-19-20)

D2 (3-24-20)

D3 (3-24-20)

D2, D3, and RAW (5-20-20)

D7A (5-20-20)

SP (5-20-20)

OPC1 Effluent (5-20-20)

D6 (3-24-20)

OPC1-MID (3-24-20)

DD (3-24-20)

RDO-D3 (3-24-20)

GPR3 (4-20-20)

Jack-MP1 (8-17-19)

Jack-MP2 (8-17-19)

Jack-MP4 (8-17-19)

Jack-MP4A (4-20-20)

AM0-D13 (5-19-20)

CL0-D8 (4-20-20)

CL0-D2 (3-24-20)

CL0-D13 (2-20-20)

CL0-D14 (1-16-20)

K53-SW29 (5-21-20)

WTLD (5-21-20)

"Blue Lagoon" pond below CL0-D13 (7-18-19)

AWARE members helping with sampling at the Neal Run Restoration Area (11-13-19)