Coldwater Heritage Partnership –

Implementation Grant for Miller Run in Huntingdon County, PA

The implementation grant for Miller Run consisted of several phases, all of which were outlined as recommended projects in the Coldwater Conservation Plan for Miller Run. The first phase was a construction project to improve trout habitat in the stream. A road culvert was preventing trout migration within the stream and was replaced with a culvert based on natural stream design. The second phase included a macroinvertebate study along the entire length of the stream. This data provided a valuable update since previous surveys were done prior to construction of several AMD treatment systems that dramatically improved the water quality in the lower stretches of the stream. The third phase included a fish survey to continue documentation of the trout population and to track their migration into lower portions of the stream that were previously uninhabited. The three project phases are reported in detail below.

Project Deliverables, Partners, and Timetables List

1. **Habitat Improvement**

- ✓ Secure permission for construction – Pennsylvania Game Commission
- ✓ Secure designs for culvert replacement – PACD engineering staff
- ✓ Secure additional funding – Shoup's Run Watershed Association (SRWA), Foundation for PA Watersheds
- ✓ Obtain permit from PA DEP for stream work – Huntingdon County Conservation District (HCCD)
- ✓ Construction and installation of culvert structure – HCCD and SRWA

2. **Macroinvertebrate Study**

- ✓ Collect and identify macroinvertebrate samples from the Miller Run watershed – HCCD and Trout Unlimited
- ✓ Compile results of aquatic surveys and provide to the Coldwater Heritage Partnership – HCCD

3. **Fish Survey**

- ✓ Complete follow up fish survey – HCCD and Juniata College
- ✓ Compile results of aquatic surveys and provide to the Coldwater Heritage Partnership – HCCD

1. Habitat improvement

Habitat improvement is cited in the Coldwater Conservation Plan for Miller Run as one of the most important recommendations for future projects in the watershed (p. 29). Conserving the existing brook trout population is the ultimate goal for SRWA and their partners, and habitat improvements would be a way to even enhance this existing population. The most important habitat concern was located at the confluence of Miller Run and its only named tributary, Kennedy Run (p. 31). A road culvert in very poor condition created a one-way street where fish could not migrate upstream into Kennedy Run, where some of the best trout habitat is located (Figure 1). The project called for removal of the old culvert, installation of concrete footers, and installation of a bottomless culvert in its place. HCCD worked with the PACD engineering staff to obtain the design of the project, secured the necessary permits for construction (including resolution of several issues), coordinated with the contractor and the PA Game Commission, and oversaw the construction of the project. The final product was a road crossing that had a natural stream design and should not inhibit fish passage (Figure 2).

Partial funding for the project had already been secured by SWRA from the Foundation for Pennsylvania Watersheds prior to the proposal for this implementation grant. The total cost of the construction project was $11,190, with $7280 as cash matching funds. The PA Game Commission, as landowner of the property, will maintain the structure as needed, as with the rest of the roadway along Miller Run. Future work on this project included a follow up fish survey to document any changes in the stream.

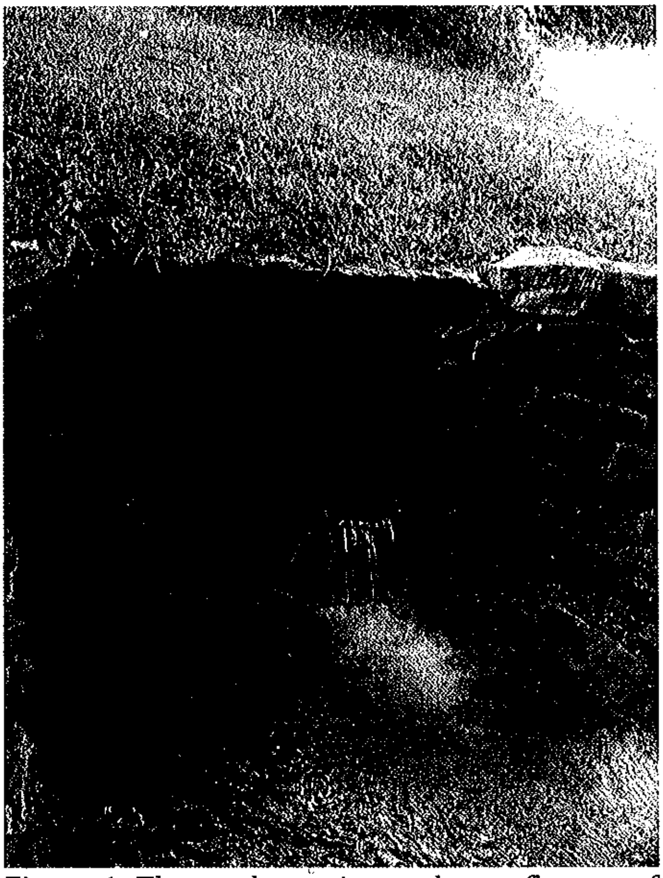

Figure 1: The road crossing at the confluence of Miller and Kennedy Run prior to the habitat improvement project created a barrier to fish migration.

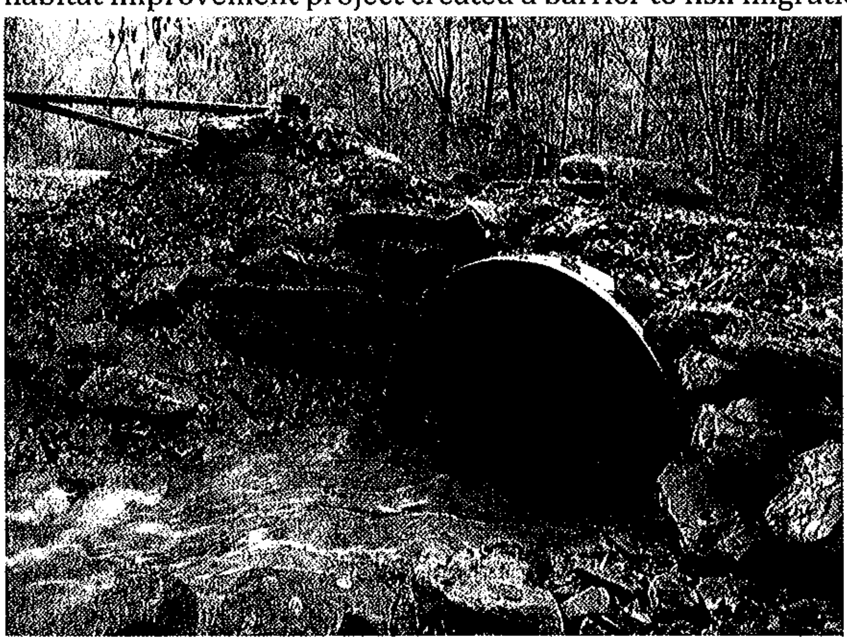

Figure 2: The new crossing, with natural stream design, should no longer inhibit fish passage to the breeding grounds in Kennedy Run.

2. Macroinvertebrate study

Previous macroinvertebate studies on Miller Run were completed in 2004 in partnership with the PA Department of Environmental Protection. Since then, the Shoup's Run Watershed Association (SRWA) and the Huntingdon County Conservation District (HCCD) have constructed three AMD treatment systems, and a fourth system was majorly upgraded. In the Coldwater Conservation Plan for Miller Run, these projects can be referenced as Miller Run AMD Passive Treatment systems #1 and #2 (p. 12), Minersville Road Passive Alkalinity Addition Project (p. 13), and Minersville AMD Abatement Project (p. 10-11). The construction of these systems improved water quality in Miller Run to levels that would be habitable by brook trout living in the unpolluted headwaters of the stream. However, fish surveys completed in 2010 revealed very few fish in the lower portions of the stream, despite excellent water quality conditions. This fish survey prompted interest in a new macroinvertebrate study to determine what factors may be keeping the trout from utilizing the entire stream corridor. Conducting an updated macroinvertebrate study was cited in the recommendations from the Coldwater Conservation Plan for Miller Run and was suggested as a means for directing future habitat improvement projects (p. 35).

The updated macroinvertebrate study was conducted in partnership with Trout Unlimited's Eastern Abandoned Mine Program. The program offers a free AMD Technical Assistance Program to support remediation of areas impacted by AMD. The program covered field sampling as well as laboratory analysis of the samples collected. Sampling was completed on April 5, 2012 with assistance from HCCD and volunteers from Huntingdon Area High School, including two science teachers and four students (Figure 3). Sample sites were selected based on the existing features in the watershed, such as AMD treatment system and previously sampled sites. A total of six sites were sampled using PA DEP's Instream Comprehensive Evaluation (ICE) protocol. A full workup of the samples and recommendations based on the results will be provided to HCCD by TU in December 2012. The results of this study will likely direct future work on Miller Run, including the possibility of conducting a storm event sampling project to determine if drastic water quality changes are occurring during high flow events.

Figure 3: Shawn Rummel, from Trout Unlimited, and Kathleen Quinn, from Huntingdon Area High School, use a kick net to sample macroinvertebrates in Miller Run while students observe and later assist with sampling.

3. Fish Survey

Approximately one year after constructing the habitat improvement project, a fish survey was completed to determine if fish migration was improved. Previous fish surveys, cited in the Coldwater Conservation Plan for Miller Run, found the highest number of fish in the headwaters of Miller Run and Kennedy Run, and fewer fish downstream of the AMD treatment systems (p. 24). Since water quality had improved more than enough to support brook trout populations, macroinvertebrates and habitat were investigated as possible causes for the fish not migrating downstream. A Juniata College field methods class with 10 students partnered with HCCD to conduct the fish survey on September 28, 2012 (Figure 4). A full analysis of the data collected is being done by the field methods class and will be included in a future report.

This sampling trip yielded the highest number of trout in the lower reaches of the stream, where previously very few fish were ever caught (Table 1). The treatment systems are located upstream of this sampling location, and finding so many fish in this location showed that the fish do utilize the downstream habitat and confirms that the treatment systems are working well. Each sampling location contained trout of different ages, showing a health population (Figure 5). Also, the trout that were sampled demonstrated a very healthy appearance, as judged by their size and color. Previous sampling trips have yielded higher numbers of trout in upstream portions of the stream, compared to this sampling trip. Equipment malfunction likely resulted in lower numbers upstream, as it was discovered that the unit was not delivering enough voltage to sample the fish. This sampling excursion has opened up a partnership with the professor of this course to repeat sampling work, potentially on an annual basis. Further, several faculty at Juniata College are collaborating with HCCD staff to develop a senior capstone project for 2013 that will revolve around exploring habitat and macroinvertebrate issues in Miller Run.

Figure 4: Juniata College students assist with sampling brook trout populations in Miller Run.

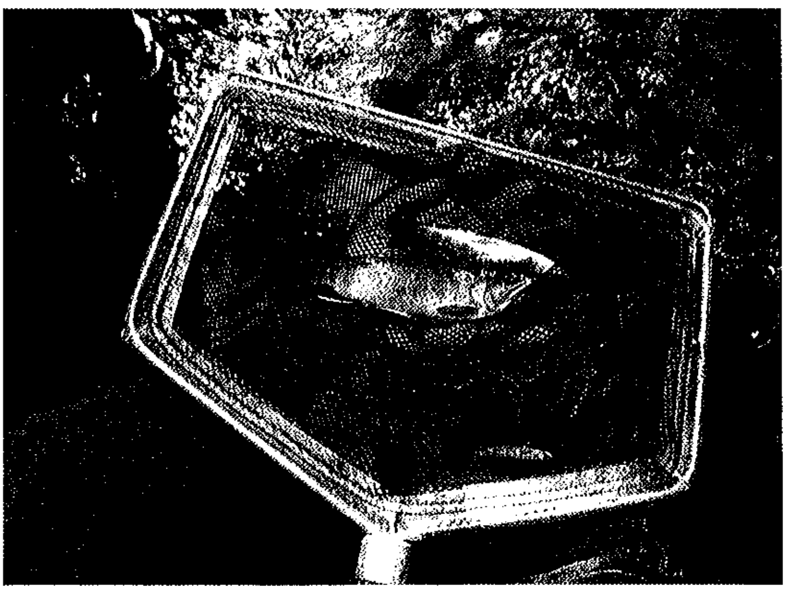

Figure 5: Brook Trout sampled included adults, subadults, and young of the year, all pictured here.

Table 1: Brook Trout Sampling Data for Miller Run

Site	Date	Temp (C)	pH	DO (mg/L)	% Saturation	Total Brook Trout	Young of the Year	Sub-adults	Adults
MR1A	9/28/12	14.9	8.2	9.4	93	24	17	3	4
MR1C	9/28/12	14.6	7.8	9.19	90.3	7	5	1	1
KR1	9/28/12	14.4	7.2	9.15	89.4	7	4	0	3

BUDGET NARRATIVE

LINE ITEM	DESCRIPTIONS/DETAILS/ EXPLANATIONS	CHP GRANT FUNDS	LOCAL CONTRIBUTIONS (CASH AND/OR IN-KIND)
SALARY AND BENEFITS (PLEASE BE SPECIFIC)	WATERSHED SPECIALIST – AQUATIC SURVEYS (87 HOURS @ $20.85/HOUR)	$1825	
	DISTRICT MANAGER – CONSTRUCTION INSPECTIONS AND OVERSIGHT (61 HOURS @ $28.87/HOUR)	$1775	
TRAVEL (PLEASE BE SPECIFIC)	CONSTRUCTION INSPECTIONS (6 TRIPS @ 70 MILES/TRIP)	$210	
	AQUATIC SURVEYS (3 TRIPS @ 70 MILES/TRIP)	$105	
EQUIPMENT & SUPPLIES (PLEASE LIST EACH ITEM. ATTACH A SEPARATE SHEET IF NECESSARY.)	CULVERT STRUCTURE	0	$4990 (CASH)
CONTRACTUAL (PLEASE BE SPECIFIC)	MACROINVERTEBRATE IDENTIFICATION	0	$500 (IN KIND)
	CULVERT DESIGN AND INSTALLATION PLAN (30 HOURS @ $80/HR)	0	$2400 (IN KIND)
ADMINISTRATIVE (POSTAGE, MAILINGS, PHONE)	SOUTHERN ALLEGHENIES CONSERVANCY GRANT ADMINISTRATION	$150	
CONSTRUCTION (PLEASE BE SPECIFIC)	CULVERT INSTALLATION	$3910	$2290 (CASH)
OTHER (ITEMIZE)			
TOTALS		$7975	$10,180

Benthic Macroinvertebrate and Habitat Survey of Miller Run, Huntingdon County, Pennsylvania

Technical Report Provided Through the Trout Unlimited AMD Technical Assistance Program

December 2012

<u>Background and Methods</u>

Shoup's Run Watershed Association and Huntingdon County Conservation District requested technical assistance from Trout Unlimited's AMD Technical Assistance Program for a benthic macroinvertebrate survey and visual habitat assessment on Miller Run. Miller Run is a tributary to Shoup's Run, which flows into the Raystown Branch of the Juniata River at Saxton, PA. The Miller Run watershed is comprised of approximately 4,540 acres and is located almost entirely on State Game Land #67, near the villages of Barnettstown and Dudley.

The watershed is located in an area that was extensively mined for coal from the mid 1800s to the late 1900s. Miller Run has been the focus of many projects for abandoned mine drainage (AMD) restoration because of a native brook trout population that survives in the headwaters. The Shoup's Run Watershed Association has implemented eight passive treatment systems and numerous stream bank stabilization projects throughout the watershed. Marked improvements in water quality at the mouth of Miller Run have been noted since the completion of these projects (Miller Run Coldwater Conservation Plan, 2010). Benthic macroinvertebrates have not been sampled in the watershed since 2004.

Trout Unlimited staff, in cooperation with Huntingdon County Conservation District staff, identified six sampling locations to characterize the benthic macroinvertebrate community and habitat of Miller Run (Table 1; Figure 1).

Table 1: Sampling locations for the Miller Run watershed. Each site was surveyed for benthic macroinvertebrates and habitat quality.

Site #	Latitude (N)	Longitude (W)	Site Description
1	40.215942	-78.187721	Miller Run Mouth
2	40.222645	-78.18587	Miller Run DWS Treatment System 1
3	40.229007	-78.177882	Miller Run DWS Treatment System 2
4	40.233986	-78.168261	Miller Run DWS Kennedy Run
5	40.234994	-78.162736	Miller Run UPS Kennedy Run
6	40.234919	-78.164832	Kennedy Run Mouth

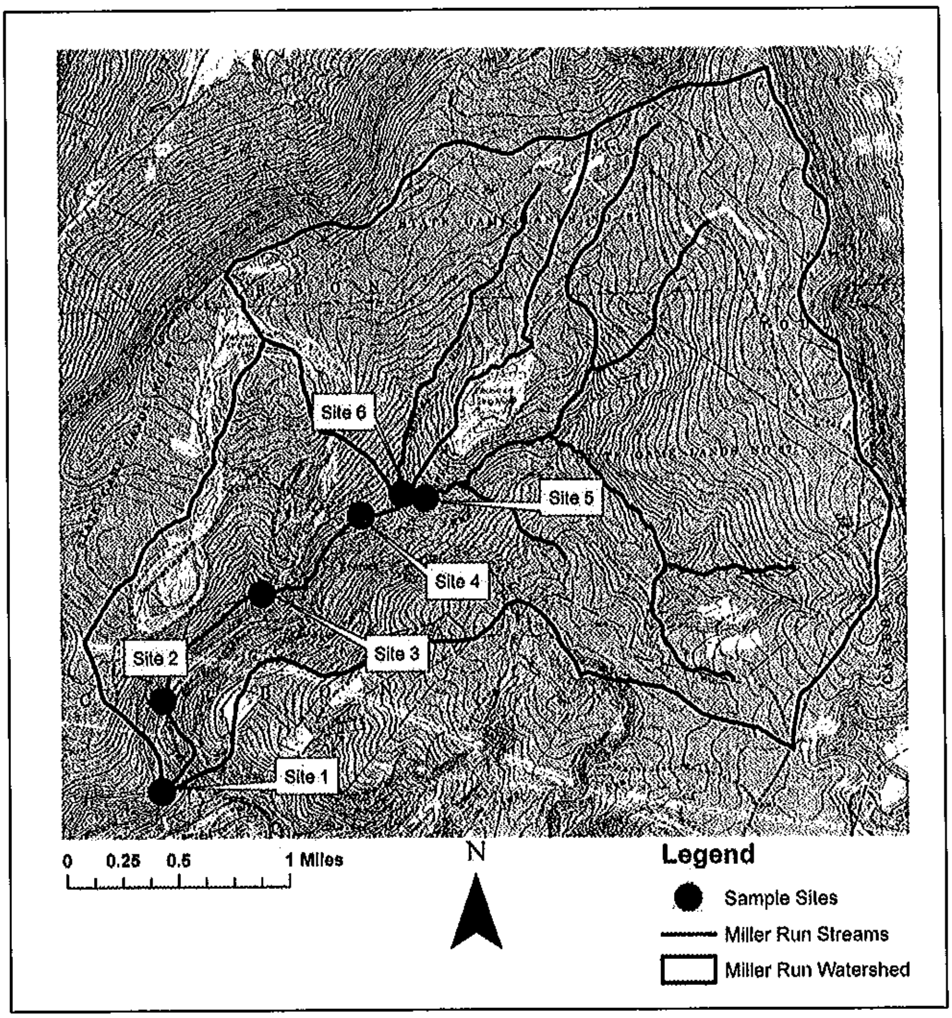

Figure 1: Sampling locations within the Miller Run watershed. Each site was surveyed for habitat and benthic macroinvertebrates.

Aquatic Habitat Assessment

Habitat was evaluated for 100 meters at each sample site using DEP's *Water Quality Network Habitat Assessment* form, which considers the following twelve parameters: instream cover, epifaunal substrate, embeddedness, velocity/depth regimes, channel alteration, sediment deposition, frequency of riffles, channel flow status, condition of banks, bank vegetative protection, grazing or other disruptive pressure, and riparian vegetation zone width. These parameters are explained in Appendix A. Each parameter is given a score (from 0 – 20) based on a visual survey of the sample site. The scores from each parameter are summed to obtain an overall habitat score. The habitat scoring system is as follows: the "optimal" category scores from 240 to 192, "suboptimal" from 180-132, "marginal" from 120 – 72, and "poor" is a site with a combined score less than 60. The gaps between these categories are left to the discretion of the investigator's best professional judgment.

Benthic Macroinvertebrate Sampling and Evaluation

Benthic macroinvertebrates were collected according to Pennsylvania Department of Environmental Protection's (DEP) Instream Comprehensive Evaluation (ICE) protocol (specifically section C.1.b. Antidegradation Surveys). A benthic macroinvertebrate sample consisted of a combination of six D-frame efforts in a 100-meter stream section. Sampling effort was distributed to select the best riffle habitat areas with varying depths. Each effort sampled an area of 1 m^2 and a minimum depth of 10.2 cm as the substrate allowed. Sample efforts used a 500 micron mesh, 12 inch diameter D-frame kick net. The six individual samples were composited and preserved in ethanol for processing in the laboratory.

Benthic macroinvertebrates were processed according to semi-qualitative protocols. These protocols require that the sample be deposited into a 3.5 inch deep rectangular pan (14" x 8") marked in 2" x 2" grids. Four grids are randomly selected and their contents placed into another pan. Organisms from the second pan are sorted from randomly selected 2" x 2" grids until a 200 organism subsample is achieved. If less than 160 identifiable organisms are obtained, additional randomly selected grids from the first pan are added to the subsample until the target of 200 organisms is reached. If more than 240 identifiable organisms are subsampled from the original four grids, one randomly selected grid will be removed until the target number of 200 organisms is obtained.

Benthic macroinvertebrates were identified to the lowest possible taxonomic level. In most cases, organisms were identified to genus. Samples were evaluated according to the six metrics comprising the DEP's Index of Biological Integrity (Total Taxa Richness, EPT Taxa Richness, Beck's Index V.3, Shannon Diversity, Hillsenhoff Biotic Index, and Percent Sensitive Individuals). Appendix B contains a description of each of these six metrics. These metrics were standardized and used to determine if the stream met the Aquatic Life Use (ALU) threshold for coldwater fishes, warmwater fishes, and trout stocked fishes (Figure 2). Biological metrics are provided for sites containing less than 160 individuals however, an IBI score was not calculated for these sites because sites with less than 160 individuals do not qualify according to DEP.

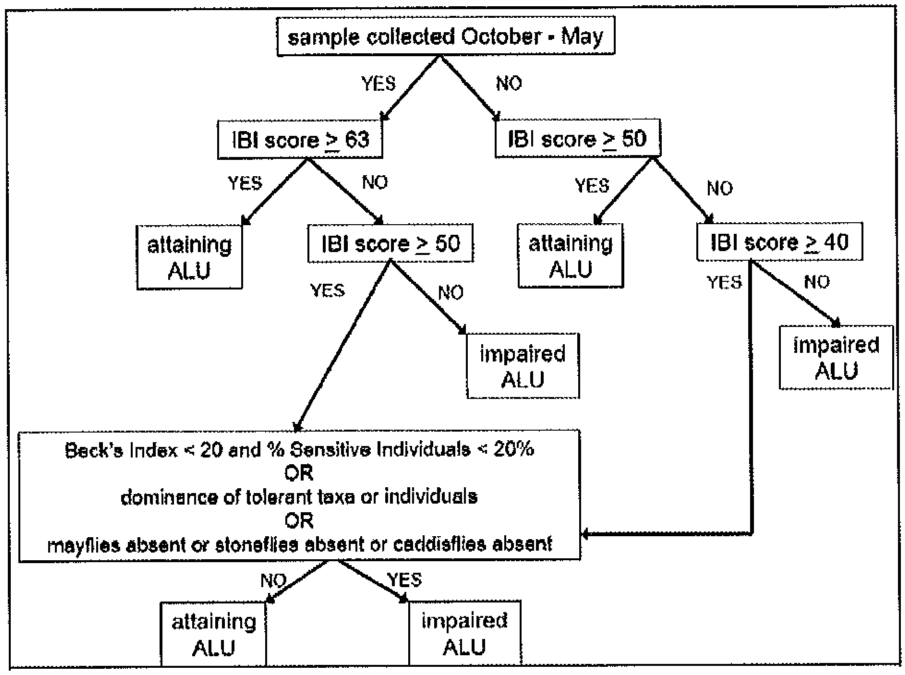

Figure 2: ALU Attainment and Impairment Thresholds for Coldwater Fishes (CWF), Warmwater Fishes (WWF), and Trout Stocked Fishes (TSF) Protected Uses (Department of Environmental Protection, 2009).

Results

Aquatic Habitat Assessment

Total habitat scores were generally in the "optimal" to "suboptimal" range (Table 2). These results were consistent with previous habitat assessments throughout the watershed, which scored most sites in the "optimal" range.

Table 2: Habitat scores for each of the six sample sites in the Miller Run watershed. Score categories are color-coded.

Site Number	1	2	3	4	5	6
Instream Cover (Fish)	18	19	16	17	17	14
Epifaunal Substrate	19	20	18	18	18	19
Embeddedness	16	17	16	15	15	18
Velocity/Depth Regimes	20	20	18	13	13	17
Channel Alteration	15	20	14	15	15	18
Sediment Deposition	20	20	18	17	17	19
Frequency of Riffles	19	19	19	19	19	20
Channel Flow Status	16	18	18	18	18	18
Condition of Banks	18	17	11	13	10	15
Bank Vegetative Protection	16	20	12	14	18	20
Grazing or Other Disruptive Pressure	20	20	15	13	18	20
Riparian Vegetative Zone Width	20	20	15	14	20	20
Total Habitat Score	219	230	190	**186**	198	218

OPTIMAL
SUBOPTIMAL
MARGINAL
POOR

Benthic Macroinvertebrates

Benthic macroinvertebrates were collected at each of the six sample sites on 5 April 2012 as outlined in the methods. A full list of the taxa collected, their abundance, and the pollution tolerance value (PTV) (based on DEP data) for each site is provided in Table 3. Pollution tolerance of the taxa increases as the PTV increases. For example, a taxa with a PTV of 6 is more tolerant to anthropogenic pollution than a taxa with a PTV of 2.

Overall, the most abundant families of benthic macroinvertebrates within the watershed were the Chironomidae (Order Diptera), Leuctridae (Order Plecoptera), and Nemouridae (Order Plecoptera) (see Table 3). Although the PTV for the families Leuctridae and Nemouridae are low (PTV 0 and 3, respectively), these families are known to be tolerant to acidic conditions and are often present in streams impacted by AMD. The biological metrics calculated for each site are provided in Table 4. Detailed descriptions of the biological metrics calculated are given in Appendix B. IBI scores are shown in Table 4 for sample sites 1, 3, and 4, however, due to the low number of individuals that were present in these samples, the stream at these locations would not meet the benchmark for aquatic life use attainment.

Table 3: List of taxa collected at each of the six sample sites within the Miller Run watershed.

				Site Number						
Order	**Family**	**PA Taxon**	**PTV (PA DEP)**	**1**	**2**	**3**	**4**	**5**	**6**	**TOTAL**
		Oligochaeta	1	1	2	1		3	2	9
		Hydracarina	7					1		1
Decapoda	Cambaridae	Cambaridae	6				1		1	2
Coleoptera	Elmidae	Oulimnius	5					7		7
		Promoresia	2					2		2
Diptera	Ceratopogonidae	Ceratopogonidae	6			1		1	1	3
	Chironomidae	Chironomidae	6	15	169	5	8	139	119	455
	Simuliidae	Prosimulium	2						10	10
	Tipulidae	Dicranota	3					1		1
		Hexatoma	2			2		5	2	9
		Molophilus	4			1				1
		Pseudolimnophila	2		1					1
Ephemeroptera	Baetidae	Baetis	6				1			1
	Heptageniidae	Heptageniidae	3		1					1
	Leptophlebiidae	Paraleptophlebia	1		1					1
Plecoptera	Chloroperlidae	Alloperla	0	1						1
		Haploperla	0	1	1			4	3	9
		Sweltsa	0		2	2	1	2	10	17
	Leuctridae	Leuctra	0	1	1	4	2	10	15	33
	Nemouridae	Amphinemura	3	1	7	4	2	24	53	91
		Ostrocerca	2					1	1	2
	Peltoperlidae	Peltoperla	2						2	2
		Peltoperlidae	2				1			1
Trichoptera	Hydropsychidae	Diplectrona	0					6	1	7
		Hydropsyche	5		1					1
	Lepidostomatidae	Lepidostoma	1		3		2		1	6
	Limnephilidae	Pycnopsyche	4				1			1
	Philopotamidae	Dolophilodes	0					1		1
		Wormaldia	0		2			2	2	6
	Polycentropodidae	Nyctiophylax	1					1		1
		Polycentropus	6	1	4	2		2	3	12
	Rhyacophilidae	Rhyacophila	1					6	2	8
	Uenoidae	Neophylax	3					1	1	2
			TOTAL	21	195	22	19	219	229	705

Table 4: Calculated biometrics based on the results presented in Table 3. * indicates that less than the required 200 ± 40 individuals were collected in the sample. Therefore, IBI scores should be interpreted cautiously for these sites.

	Site Number					
Metric	**1**	**2**	**3**	**4**	**5**	**6**
Total Taxa Richness	7	13	9	9	20	18
EPT Taxa Richness (PTV 0-4)	4	8	3	6	10	11
Beck's Index, V.3	9	17	7	9	23	23
Hilsenhoff Biotic Index	5.19	5.61	3.55	3.89	4.7	4.19
Shannon Diversity	1.11	0.69	2.03	1.85	1.54	1.59
Percent Sensitive Individuals (PTV 0-3)	19	9.7	54.5	42.1	29.7	45
IBI Score	31.1*	36	46.1*	45.4*	54.7	58.9

As expected, the two sites upstream of the mining influence (sites 5 and 6), had the highest abundance of benthic macroinvertebrates and the highest IBI scores. Benthic macroinvertebrates were last surveyed in the watershed by PA DEP in 2004. These surveys included four of the six sample sites used in the current project (Sites 1, 3, 5, and 6). Compared with the 2004 data, sites 3, 5, and 6 have shown an increase in the total abundance, the total number of taxa collected, and EPT taxa (Table 5). Site 1 has remained relatively constant in each of those parameters (Table 5). None of the sample sites would have met the benchmark for attaining life use in 2004 based on the low number of individuals (total abundance) collected at each site.

Table 5: Comparison of metrics from 2004 data collection (PA DEP) and 2012 data collection (TU) for sites 1, 3, 5, and 6.

Metric	**Site 1**		**Site 3**		**Site 5**		**Site 6**	
	2004	**2012**	**2004**	**2012**	**2004**	**2012**	**2004**	**2012**
Total Abundance	24-36	21	2	22	17	219	60	229
Total # Taxa	8	7	2	9	7	20	5	18
EPT Taxa	5	4	1	3	5	10	2	11

APPENDIX A: Description of habitat parameters.

Instream Fish Cover
Evaluates the percent makeup of the substrate (boulders, cobble, other rock material) and submerged objects (logs, undercut banks) that provide refuge for fish.

Epifaunal Substrate
Evaluates riffle quality, i.e., areal extent relative to stream width and dominant substrate materials that are present. (In the absence of well-defined riffles, this parameter evaluates whatever substrate is available for aquatic invertebrate colonization.)

Embeddedness
Estimates the percent (vertical depth) of the substrate interstitial spaces filled wifine sediments. (Pool substrate characterization: evaluates the dominant type of substrate materials, i.e., gravel, mud, root mats, etc. that are more commonly found in glide/pool habitats.)

Velocity/Depth Regime
Evaluates the presence/absence of four velocity/depth regimes - fast-deep, fastshallow, slow-deep and slow-shallow. (Generally, shallow is <0.5m and slow is <0.3m/sec. (*Pool variability:* describes the presence and dominance of several pool depth regimes.)

The next four parameters evaluate a larger area surrounding the sampled riffle. As a rule of thumb, this expanded area is the stream length defined by how far upstream and downstream the investigator can see from the sample point.

Channel Alteration
Primarily evaluates the extent of channelization or dredging but can include any other forms of channel disruptions that would be detrimental to the habitat.

Sediment Deposition
Estimates the extent of sediment effects in the formation of islands, point bars and pool deposition.

Riffle Frequency (pool/riffle or run/bend ratio)
Estimates the frequency of riffle occurrence based on stream width. *(Channel sinuosity:* the degree of sinuosity to total length of the study segment.)

Channel Flow Status
Estimates the areal extent of exposed substrates due to water level or flow conditions. The next four parameters evaluate an even greater area. This area is usually defined as the length of stream that was electroshocked for fish (or an approximate 100-meter stream reach when no fish were sampled). It can also take into consideration upstream land-use activities in the watershed.

Condition of Banks
Evaluates the extent of bank failure or signs of erosion.

Bank Vegetative Protection
Estimates the extent of stream bank that is covered by plant growth providing stability through well-developed root systems.

Grazing or Other Disruptive Pressures
Evaluates disruptions to surrounding land vegetation due to common human activities, such as crop harvesting, lawn care, excavations, fill, construction projects and other intrusive activities.

Riparian Vegetative Zone Width
Estimates the width of protective buffer strips or riparian zones. This is a rating of the buffer strip with the least width.

APPENDIX B: Description of biological metrics that were used in this project.

Total Abundance

The total abundance is the total number of organisms collected in a sample or sub-sample.

Dominant Taxa Abundance

This metric is the total number of individual organisms collected in a sample or sub-subsample that belong to the taxa containing the greatest numbers of individuals.

Taxa Richness

This is a count of the total number of taxa in a sample or sub-sample. This metric is expected to decrease with increasing anthropogenic stress to a stream ecosystem, reflecting loss of taxa and increasing dominance of a few pollution-tolerant taxa.

% EPT Taxa

This metric is the percentage of the sample that is comprised of the number of taxa belonging to the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT). Common names for these orders are mayflies, stoneflies, and caddisflies, respectively. The aquatic life stages of these three insect orders are generally considered sensitive to, or intolerant of, pollution (Lenat and Penrose 1996). This metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of taxa from these largely pollution-sensitive orders.

Shannon Diversity Index

The Shannon Diversity Index is a community composition metric that takes into account both taxonomic richness and evenness of individuals across taxa of a sample or sub-sample. In general, this metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting loss of pollution-sensitive taxa and increasing dominance of a few pollution-tolerant taxa.

Hilsenhoff Biotic Index

This community composition and tolerance metric is calculated as an average of the number of individuals in a sample or sub-sample, weighted by pollution tolerance values. The Hilsenhoff Biotic Index was developed by William Hilsenhoff (Hilsenhoff 1977, 1987; Klemm et al. 1990) and generally increases with increasing ecosystem stress, reflecting dominance of pollution-tolerant organisms. Pollution tolerance values used to calculate this metric are largely based on organic nutrient pollution. Therefore, care should be given when interpreting this metric for stream ecosystems that are largely impacted by acidic pollution from abandoned mine drainage or acid deposition.

Beck's Biotic Index

This metric combines taxonomic richness and pollution tolerance. It is a weighted count of taxa with PTVs of 0, 1, or 2. It is based on the work of William H. Beck in 1955. The metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of pollution-sensitive taxa.

Percent (%) Sensitive Individuals

This community composition and tolerance metric is the percentage of individuals with PTVs of 0 to 3 in a sample or sub-sample and is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of pollution-sensitive organisms

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Before:

After: