Coldwater Conservation Plan for the Moshannon Creek Watershed in Central Pennsylvania

Prepared by the Moshannon Creek Watershed Association
September 30, 2021

Moshannon Creek at Peale, PA. Photo Courtesy of Grassflat Grown.

Acknowledgements

This project was financed in part by a grant from the Coldwater Heritage Partnership on behalf of the PA Department of Conservation and Natural Resources (Environmental Stewardship Fund), the PA Fish and Boat Commission, the Foundation for Pennsylvania Watersheds, and the PA Council of Trout Unlimited

In addition, the organizations and groups listed in alphabetical order below provided labor and equipment and much additional support for this project.

Dr. Bill Burgos and the Penn State Spring 2021 Students of CE 475 Water Quality Chemistry
Centre County Conservation District
Clearfield County Conservation District
Coldwater Heritage Partnership
Native Fish Coalition - Pennsylvania Chapter
Office of Surface Mining Reclamation and Enforcement
Pennsylvania Council - Trout Unlimited
Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation
Pennsylvania Department of Environmental Protection, Moshannon District Mining Office
Penn State University
Susquehanna River Basin Commission

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Executive Summary

Moshannon Creek has a 275 square mile watershed in Central Pennsylvania. This includes one square mile of stream water diverted into the Sevenmile Run watershed from outside of the natural watershed by a mine drainage treatment system. For most of its length, the main stem of Moshannon Creek is the county line between Centre and Clearfield Counties. All of the tributaries and the upper portion of the main stem of Moshannon Creek are classified as coldwater fisheries. This document is the Coldwater Conservation Plan for the Moshannon Creek watershed.

The watershed has a mix of clean streams, many with trout, and streams impacted by abandoned mine drainage (AMD) from long abandoned coal and clay mines. This mixed legacy has created the situation where the Moshannon Creek watershed is a popular place for fishing and other recreational activities even with significant AMD impacts to many of the streams. To better understand current conditions and plan for improvements, the Moshannon Creek Watershed Association (MCWA), in partnership with other organizations, looked for a way to obtain current data.

MCWA, in partnership with the Clearfield County Conservation District, sought a Planning Grant from the Coldwater Heritage Partnership early in 2020 for producing this Coldwater Conservation Plan. After the grant was awarded, the Susquehanna River Basin Commission (SRBC) stepped forward and provided substantial assistance in planning and labor for the first round of water sampling, which was conducted during the week of July 20 thru July 24, 2020. A second round of water sampling was performed on September 25,2020, and a third round was conducted in April 2021. The Pennsylvania Department of Environmental Protection (PA DEP), the Clearfield County Conservation District, the Native Fish Coalition - Pennsylvania Chapter Penn State University, and the Coldwater Heritage Partnership all provided labor and equipment for this sampling effort, which included benthic macroinvertebrate sampling performed by the Native Fish Coalition in two sections of the watershed.

In planning the sampling efforts performed, historical studies and obvious data gaps were both investigated to plan the new efforts. The results of the first round of water sampling were used to plan for the second and third rounds of water sampling. The results of all of this effort were used to assemble a set of prescriptions for the watershed, which if done in sequence, would allow substantial improvement over time in the Moshannon Creek watershed. These prescriptions are explained in detail in this coldwater conservation plan. Those steps are called restoration focus areas and are listed in order and reference a map below the list.

A. Safeguard the clean water sections of the headwaters by addressing a few isolated AMD impacts and a coal refuse pile. This does not have to be in sequence with the rest of the list.
B. Treat the AMD flowing into Moshannon Creek and the end of Roup Run near where Roup Run joins Moshannon Creek. This is the first place where a lasting, rather than a local, impact from AMD is found. Moshannon Creek is impaired for the rest of its length. Start improvements here.
C. Evaluate the series of AMD discharges MC10 through MC15, located downstream of Hale Road, to gauge their relative importance and select the best choices for treatment. The next discharge past this series, MC16, is impactful enough alone that it will require treatment in order to improve this part of the Moshannon.
D. Identify and treat the AMD that severely impacts two of the eastern tributaries of Bear Run.
E. Target for particular evaluation the segment of Moshannon Creek between the Junior Coal Leslie Tipple and Big Run. A series of deep mine discharges, including MC140L, a very large discharge associated with the Banner No. 1 deep mine, emerge in this stream section. Sampling for this report found flows and metals concentrations of a magnitude from MC140L and the others that an active treatment system is most likely warranted in this area. Because of its proximity and poor quality, Big Run should also be considered for inclusion in such a system.
F. Focus on restoring Trout Run once steps B through E are completed. Improvements to Moshannon Creek above Trout Run will turn attention to just how detrimental the impact is from this tributary. Sampling indicates that the largest impacts to Trout Run occur on a northern tributary and in the lowest section of the main stem. Addressing steps B through E, then Trout Run, would turn Moshannon Creek into fish habitat from its headwaters to downstream of Philipsburg.
G. Periodically reevaluate the section of Moshannon Creek downstream of Trout Run and upstream of Hawk Run as improvements are made upstream in the Moshannon Creek watershed. Perform these reevaluations in order to better judge the significance of the comparatively small untreated discharges in this section. This section has already seen enough improvement over time that hardy fish species have returned. The treated discharge from the Rushton Mine, and improvements to Shimel Run, Laurel Run, and Emigh Run have all contributed to this improvement.
H. Bring attention to and raise support for the need to construct a large active treatment facility to address the numerous and voluminous AMD discharges concentrated in the area downstream of Philipsburg. Design, build and operate this facility in order to make huge

improvements in the water quality in the northern half of the main stem of Moshannon Creek and the West Branch of the Susquehanna River.

Over a straight line distance of about four miles, significant amounts of AMD enter Moshannon Creek from the Hawk Run discharge, Munson Run, and Sulphur Run on the Clearfield County side, and from Cold Stream Project 70, and a series of small, severely impaired streams and direct seeps between One Mile Run and Barlow Hollow on the Centre County side. The quantity of AMD emerging across this area makes the logical solution the construction and operation of a large active treatment plant, perhaps similar in design to that currently operating in Hollywood, in the northwest corner of Clearfield County.

I. Evaluate the pollutional impacts that AMD laden streams such as Browns Run, Grassflat Run, and Moravian Run have on the improving Moshannon Creek as steps B through H are addressed. The need to fix these streams to sustain gains in water quality will become more apparent over time as improvements are made upstream. For the same reasons, impaired tributaries to Black Moshannon Creek and the impact of Sevenmile Run will also need to be addressed. The map on the next page shows the areas of focus discussed in items A through I above.

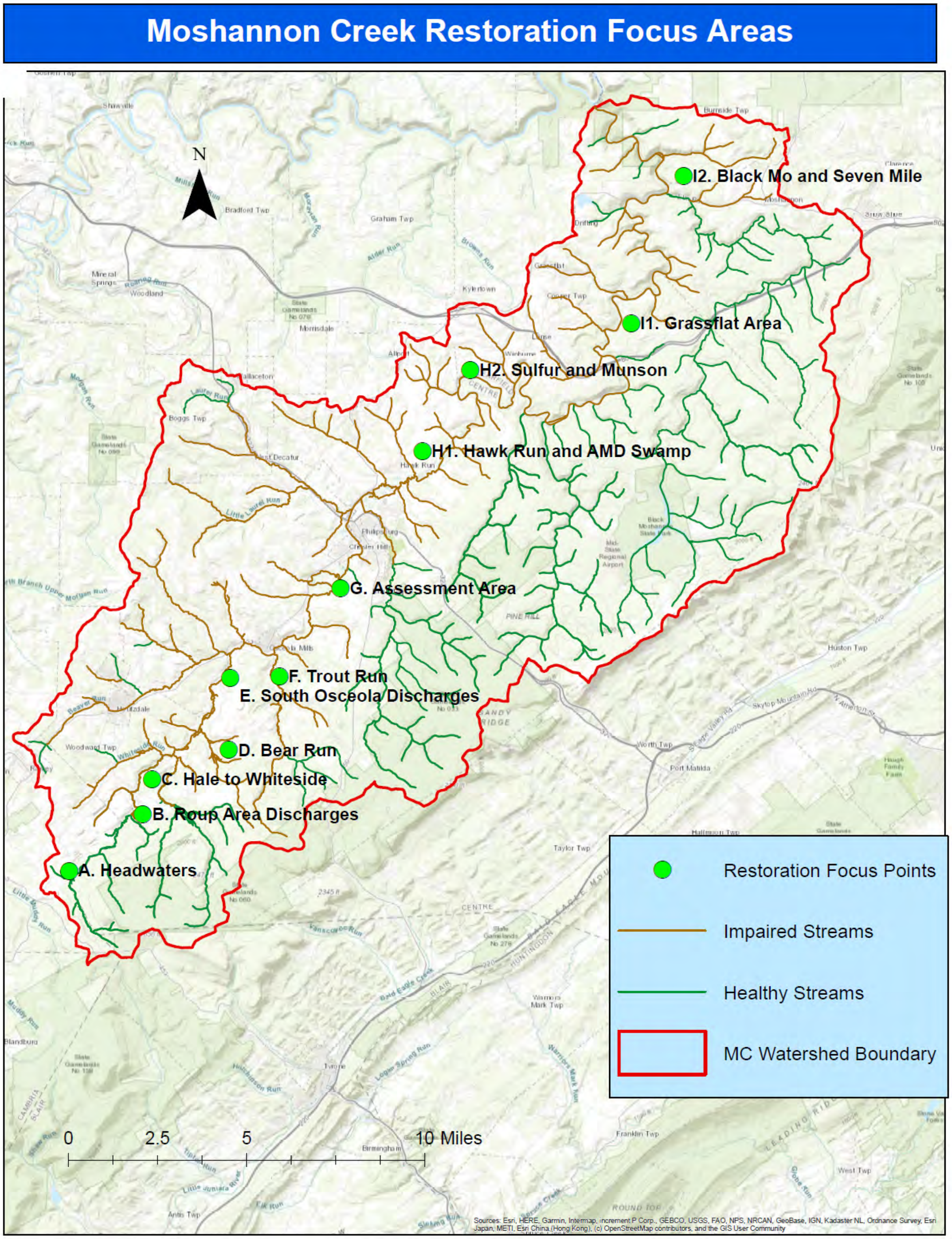

Figure 1. Moshannon Creek Restoration Focus Areas

The steps outlined above for the “big fix” of the Moshannon Creek watershed would not solve every problem, but they would create continuous, interconnected fish habitat from the headwaters to the mouth and greatly reduce the impact Moshannon Creek has on the West Branch of the Susquehanna. The watershed should be reevaluated after major improvements are made in order to bring to light problems that were masked by the larger ones that have been corrected. Subsequent projects on impaired smaller streams could add many more miles of fish habitat to the Moshannon Creek watershed.

After discussing the prescriptions for the watershed, this report then discusses each tributary stream and main stem sample point, in geographic order as the stream flows from south to north. Water sampling data from this project for those locations is provided in those discussions. The appendix also has a link to a collection of this data on the Moshannon Creek Watershed Association website. Round 1 sampling data has been posted on the SRBC website as will be the data from the subsequent rounds.

“Thanks to everyone for your efforts to collect this data. Your blood, sweat, tears, broken fingers, bruised feet, and hospital stays allowed us to create this path forward.” - Tom Clark, SRBC.

Figure 2. Beaver Dams in Moshannon Creek Near Roup Run. April 1, 2021.

Summary of Recommended Stream Evaluations

Below are lists of streams to evaluate for the presence of trout, streams to evaluate for attaining unimpaired status, and a couple of streams to evaluate for losing unimpaired status.

Streams to Evaluate for Natural Trout Populations

Stream name	Sample Point	COMID	Note
Black Moshannon Creek	13	61829563	Lower section of stream
Crawford Run	14	61829743	Fish farm in northern trib
Laurel Run (Centre)	24	61830463	
Potter Run	25	61830691	
Tark Hill Run	27	61830813	
Saw Dust Hollow	28	61831009	
Hawk Run	40	61831343	Headwaters above Pardee
Shimel Run	49	61832389	
Bear Run Upstream BRM4	BRM4	61833903	
Bear Run West Tributary	BRT2	61833697	Seen by project team
Beaver Run	54	61832801	Below Goss Run
Unnamed Tributary	8	61829417	
Unnamed Tributary	48	61832265	Near Shimel Run
Unnamed Tributary	51	61832781	Near Edendale
Ames Run	10	61829531	
Unnamed Tributary	46	61832063	Near Philipsburg
Unnamed Tributary	9	61829315	
Trout Run	TR102	61833329	Upstream of AMD

Naturally Reproducing Trout Streams and Special Protection Status

Almost all the known trout streams on the Centre County side of Moshannon Creek also carry special protection status as High-Quality Coldwater Fishery (HQ-CWF) or Exceptional Value (EV) waters according to PA Code Title 25 Chapter 93 (see Figure 9). Having one of these designations affords the stream greater protection against water quality degradation from many activities such as development, industry, construction, agriculture, etc. Roup Run and several tributaries to Mountain Branch in Centre County, as well as Beaver Run and most of Laurel Run in Clearfield County, are still only designated as Coldwater Fisheries (CWF). Because these streams are known to support wild trout, and in some cases are a Class A wild trout fishery, these watersheds should be studied more thoroughly, and efforts made to change their Chapter 93 Designated Use status from CWF to HQ-CWF so they can be better protected.

Streams to Evaluate for Attaining Unimpaired Status

Stream name	Sample Point	COMID	Note
Unnamed Tributary	56	61833445	
Bear Run	BRM4	61833903	Upstream of AMD
Unnamed Trib Bear Run	BRT2	618336987	Good chemistry and fish
Trout Run	TR102	61833329	Upstream of AMD
Shimel Run	49	61832389	Good chemistry
Unnamed Tributary	46	61832063	

Streams to Evaluate for Losing Unimpaired Status

Stream name	Sample Point	COMID	Note
Unnamed Tributary	64	61834781	MC-FORE discharge impact
Unnamed Tributary	11	61829523	Bad chemistry

Summary of Potential Project Partners

The majority of projects needed to connect trout habitat in the Moshannon Creek watershed involve AMD projects to complete treatment systems to improve stream water chemistry. The list of potential partners for the Moshannon Creek Watershed Association for those projects looks very similar to the list of partners in the Acknowledgements for this Coldwater Conservation Plan.

The Moshannon Creek Watershed Association has recently partnered with the Susquehanna River Basin Commission to seek a Growing Greener Plus grant for a site evaluation and conceptual treatment design for mine discharges MC7, MC8 and MC8.5.

Some coal refuse piles can be used as fuel in power plants designed to use that fuel, if the amount of carbon in the piles is sufficient. RESFuels is planning to evaluate the estimated 350,000 ton refuse pile in the headwaters area that is mentioned in this report.

List of Potential Partners

Centre County Conservation District
Clearfield County Conservation District
Coldwater Heritage Partnership
Native Fish Coalition - Pennsylvania Chapter - water sampling and stream evaluation
Office of Surface Mining Reclamation and Enforcement
Pennsylvania Council - Trout Unlimited
Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation
Pennsylvania Department of Environmental Protection, Moshannon District Mining Office
Penn State University
Susquehanna River Basin Commission
US Department of Environmental Protection
Private Foundations, especially for headwaters area projects
Landowners
Mining and Mine Reclamation Companies

Summary of Potential Projects

The list below shows potential projects in geographic order from south to north. MCWA anticipates seeking funding for some or many of the passive treatment systems, likely often in partnership with other organizations. MCWA anticipates having an ongoing maintenance role for some or many of the passive treatment systems on the list below after they are built. MCWA anticipates its role for the larger active systems to be that of an advocate, with the construction and operation of those plants occurring under the auspices of the Pennsylvania Department of Environmental Protection, the federal Office of Surface Mining, Reclamation and Enforcement, and the United States Department of Environmental Protection. All treatment systems in the list of potential projects are anticipated to be passive systems unless it is mentioned as active treatment in the list. Detailed site evaluation and treatment design will be an important step with most or all of the treatment projects listed below.

List of Potential Projects to Improve the Moshannon Creek Watershed

Treatment of MC-FORE discharge
Removal of headwaters coal refuse pile
Treatment of MC3 discharge (after refuse pile removal)
Treatment of MC7, MC8 and MC8.5 discharges with one or more treatment systems.
Treatment of some or all of MC10 thru MC16 discharges with one or more treatment systems.
Treatment of AMD in two eastern tributaries of Bear Run
Reclamation and revegetation of abandoned mine land and/or removal of refuse along the Moshannon, Mountain Branch, Whiteside Run, and Bear Run in both Clearfield and Centre Counties
Construction of an Active Treatment Plant to treat large discharges near Osceola Mills
Treatment of AMD in Trout Run watershed
Removal of coal refuse piles in Trout Run watershed
Full rehabilitation of the Cold Stream passive treatment systems currently under MCWA management
Treatment of AMD in the Emigh Run watershed to continue the work of the Emigh Run Lakeside Watershed Association

Construction of Active Treatment to treat AMD in the Moshannon Creek watershed from Hawk Run to Winburne at a central location.

Reclamation and revegetation of abandoned mine land and/or removal of refuse along the Moshannon in the Loch Lomond Road/Coaldale Road area of Centre County

Treatment of AMD in Browns Run

Treatment of AMD in Grassflat Run Watershed

Treatment of AMD in Moravian Run Watershed

Treatment of AMD in Sevenmile Run and impaired tributaries of Black Moshannon Creek

Introduction

A coldwater conservation plan examines conditions within a watershed that is capable of supporting trout and other coldwater fish and makes recommendations for that watershed. The Coldwater Heritage Partnership elaborates further that a coldwater conservation plan is a conservation plan that identifies the threats to the health of local coldwater ecosystems that have naturally reproducing trout as well as the opportunities for habitat restoration and conservation within those watersheds. The Moshannon Creek Watershed Association, in partnership with Kelly Williams, Watershed Specialist of the Clearfield County Conservation District, sought and obtained funding through the Coldwater Heritage Partnership to produce a coldwater conservation plan for the Moshannon Creek watershed while performing an update of the water quality and aquatic life conditions in the watershed.

Moshannon Creek has a 275 square mile watershed. For most of its length, the stream is the county line between Centre and Clearfield Counties in central Pennsylvania. From its headwaters area in the northernmost extremes of Blair and Cambria Counties, Moshannon Creek meanders generally northward, meeting the West Branch of the Susquehanna River a few miles upstream of the town of Karthaus, PA. The headwaters of Moshannon Creek, and many of its tributaries, are clean water streams that are known to have trout. In contrast, many miles of the main stem of Moshannon Creek, and many of its tributaries, are severely impacted by mine drainage from abandoned coal and clay mines. Much of the data about stream conditions for the watershed is more than ten years old. In examining the existing data it was also found that existing knowledge of the watershed was very unevenly distributed. Because restoration plans were created for much of the southern third of the watershed, historical knowledge of that portion was better developed than in other sections. Additionally, much can change in a decade. The first step for developing a new conservation plan was determining current water quality conditions in order to validate the continued usefulness of historical data and fill knowledge gaps in that data.

As detailed in the methods section of this plan, the initial water sampling was performed as a near simultaneous sampling of the major tributaries of Moshannon Creek near where they joined the main stem. The results of those samples were compared to each other to identify which tributaries and main stem sections provided the most contaminants and which parts provided clean water. This information was used to select tributaries and main stem sections for two subsequent rounds of water sampling. This follow up sampling included mine discharges as well as in stream sampling of tributary streams. Additionally, benthic macroinvertebrate sampling was performed in two sections of the Moshannon Creek watershed to better understand the health of the life in the stream in those areas.

While water chemistry was an important part of the investigation that led to this plan, water temperature sampling was part of the field sampling performed with most water samples. This data, especially from the July samples, enabled identification of watershed sections to explore further to evaluate threats to cold water stream conditions. The first round of sampling was performed in moderate drought conditions in late July 2020, so the combination of summertime temperatures and low flow made visible several stream sections where stream water temperature was higher than desired for cold water fish species.

The 2020 drought in central Pennsylvania provided unplanned insight into the resiliency of different portions of the watershed. The second round of water sampling was conducted in late September, 2020, while all of the Moshannon Creek watershed was classified as being in moderate to severe drought. Drought conditions persisted well into the fall (Figure 3).

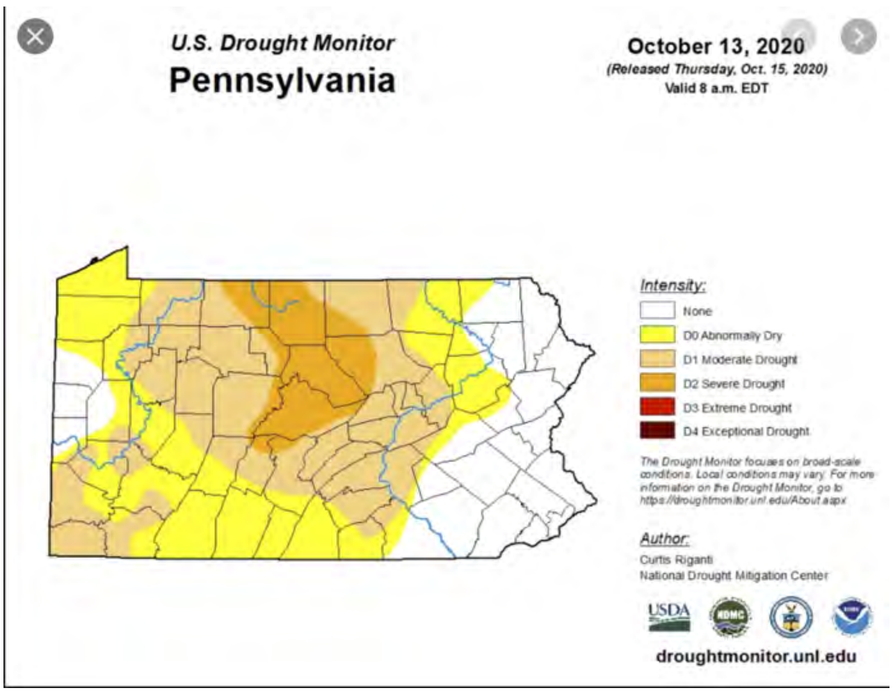

Figure 3. The 2020 US Drought Monitoring Data for Pennsylvania.

More normal levels of precipitation returned during the winter and spring. A final round of water sampling was conducted in higher water flow conditions in April 2021.

The results of the sampling, and other investigations performed in the watershed, were used to produce the prescriptions for sections of the watershed. Because Moshannon Creek has severe mine drainage problems, the watershed level prescriptions, and many of the discussions of individual tributaries, focus on mine drainage impacts and ways to improve upon them. Mine drainage is the dominant problem affecting the cold water fishery in the Moshannon Creek watershed, but it is not the only problem present. When individual tributary sections are discussed, those other problems are mentioned where appropriate.

The mine drainage problems in the Moshannon Creek watershed, while severe, are not impossible to solve.The findings detailed in this plan indicate that well placed treatment systems can greatly improve the water discharged into the West Branch of the Susquehanna from Moshannon Creek, and better connect sections of trout habitat known to exist in the watershed. Some improvement in the fishery has already happened. During this study, Justin Wian, a Philipsburg resident, decided to fish in the main stem of Moshannon Creek near Philipsburg, a section where he had always been told fish did not and could not live. He found fish living in a section of the watershed long believed to lack them (Figure 4).

Figure 4. Pumpkinseed Sunfish caught in Moshannon Creek in Philipsburg (Justin Wian).

This report is structured so that the results of three rounds of water sampling are presented visually with maps and narrative. Then, watershed level prescriptions are also discussed and then presented visually with maps. After those sections, each tributary watershed is discussed in greater detail, and the water sample results for that tributary are presented in tables.

The Moshannon Creek Watershed

Geographical Description

Moshannon Creek is located in Central Pennsylvania and has a 275 square mile watershed (Figure 5). The stream forms in the area where Blair, Cambria, Clearfield and Centre Counties converge. The stream meanders greatly but the general trend is for downstream flow to the northeast. Moshannon Creek serves as the county line between Clearfield and Centre Counties for most of its length. It discharges into the West Branch of the Susquehanna River a few miles upstream of Karthaus, PA.

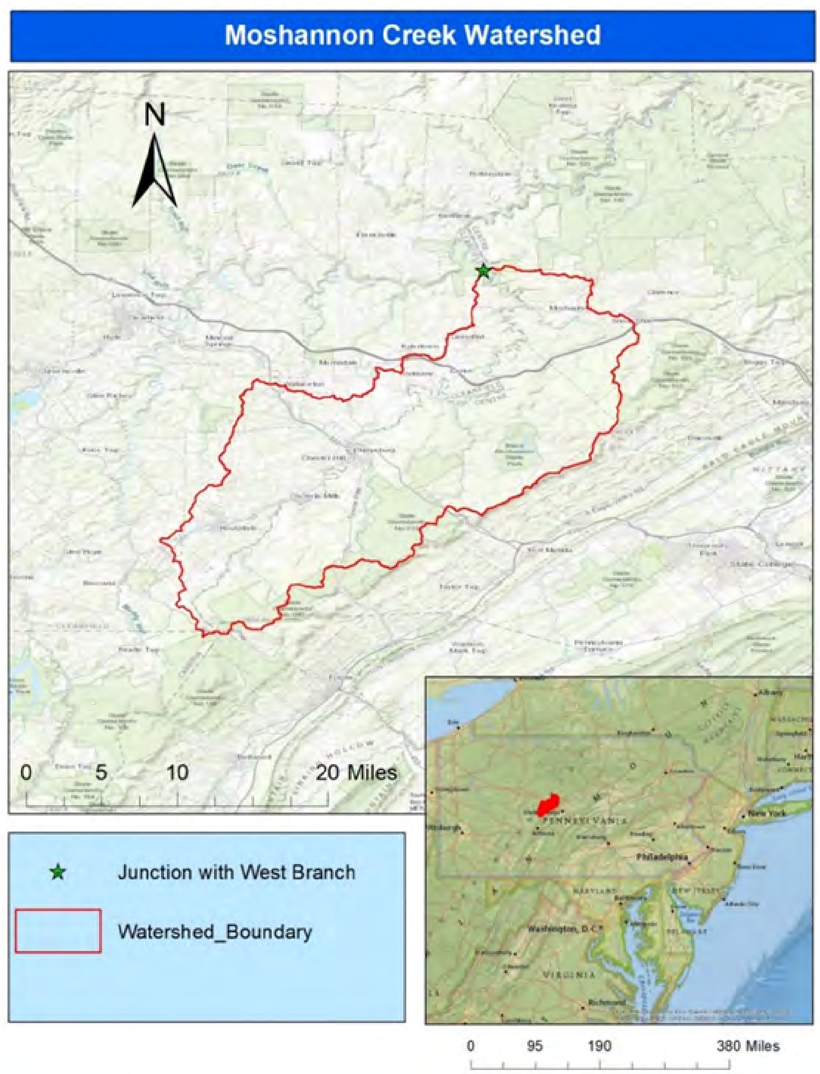

Figure 5. Watershed boundary of Moshannon Creek.

The watershed is mostly rural, with several moderately sized towns within it. The largest metropolitan area is the combination of Philipsburg and Chester Hill, which straddles the main stem of Moshannon Creek in the central part of the watershed. Other towns include Osceola Mills, Houtzdale, Hawk Run, Grassflat, parts of Snowshoe and Moshannon, and several smaller villages. A prison facility near Houtzdale is an additional population center. A prison facility in the watershed west of Philipsburg closed during the period of this study. All of the urban centers in the watershed have sewage treatment plants that appear to be effective.

Large parts of Philipsburg, Chester Hill, and Osceola Mills are within the floodplain of Moshannon Creek and have periodically flooded. Because of flash flooding that occurred in 2019, members of MCWA had multiple occasions during this study where citizens expressed their concerns about flooding. While flood vulnerability is not the primary focus of this study, there is one area where water quality improvements and reduction of flood risk converge. Reforestation of reclaimed surface mines, and proper reclamation of mines that were not well reclaimed, may add capacity within the landscape of the watershed to slow runoff. This will reduce the flood risk exposure of these communities while improving water quality in the streams that receive that runoff.

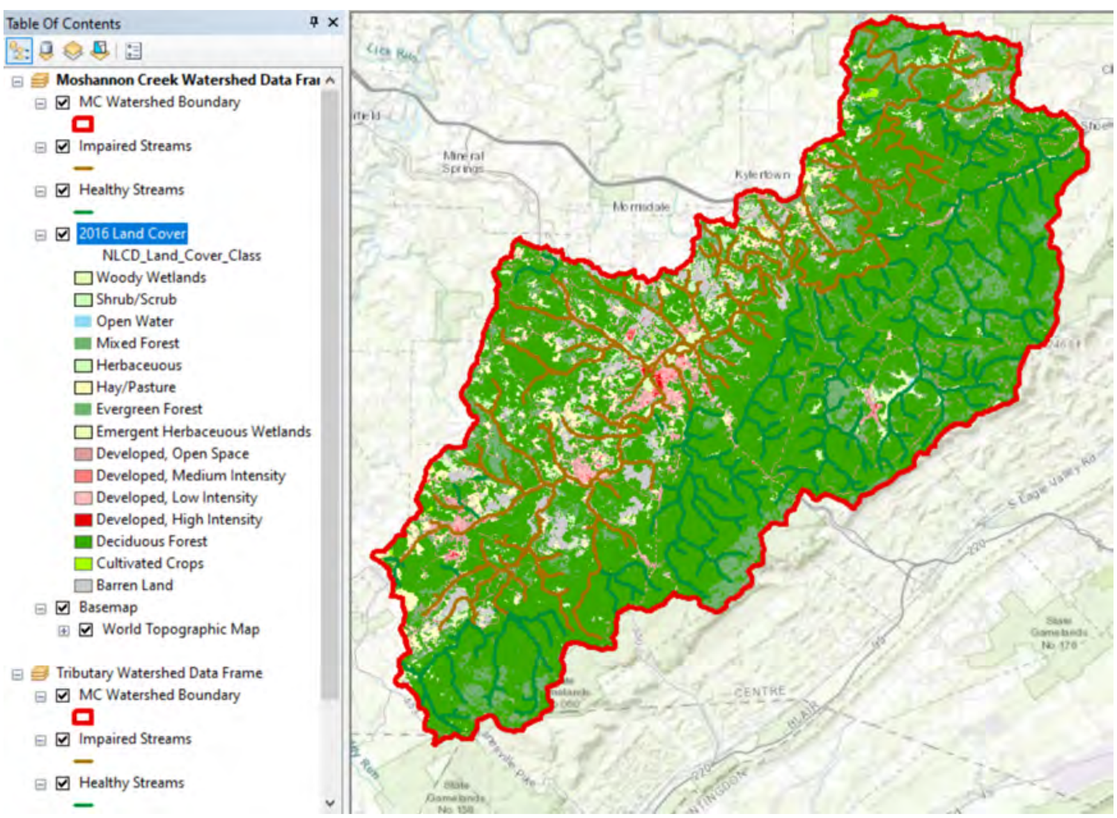

Figure 6. National Land Classification Database 2016 Map of the Moshannon Creek Watershed

As can be seen from the map above, much of the Moshannon Creek watershed is forest. Significant additional land, some classifying as barren and some classifying as hay/pasture, is old surface mines with varying quality of mine reclamation. Agriculture is scattered in the watershed, with the greatest concentration of agricultural activity in Clearfield County near and north of I-80. While urban and agricultural impacts to stream conditions are not unknown, the greatest impacts, by far, come from abandoned mine drainage from pre-1977 surface and underground coal and clay mines. A later section of this report will discuss the history of mining and its impacts upon the watershed in more detail. The map below shows the streams within the watershed that are classified as 'attaining' or 'non-attaining' the Pennsylvania Department of Environmental Protections standards for supporting aquatic life (Figure 7). By far the most common reasons that streams are 'non-attaining' is acidity, metals and/or sediment from mining. Even with large impacts from mining, about half of the streams in the watershed have clean water, and many of those have reproducing populations of trout and other fish. Some streams manage to have both trout populations and mining impacts.

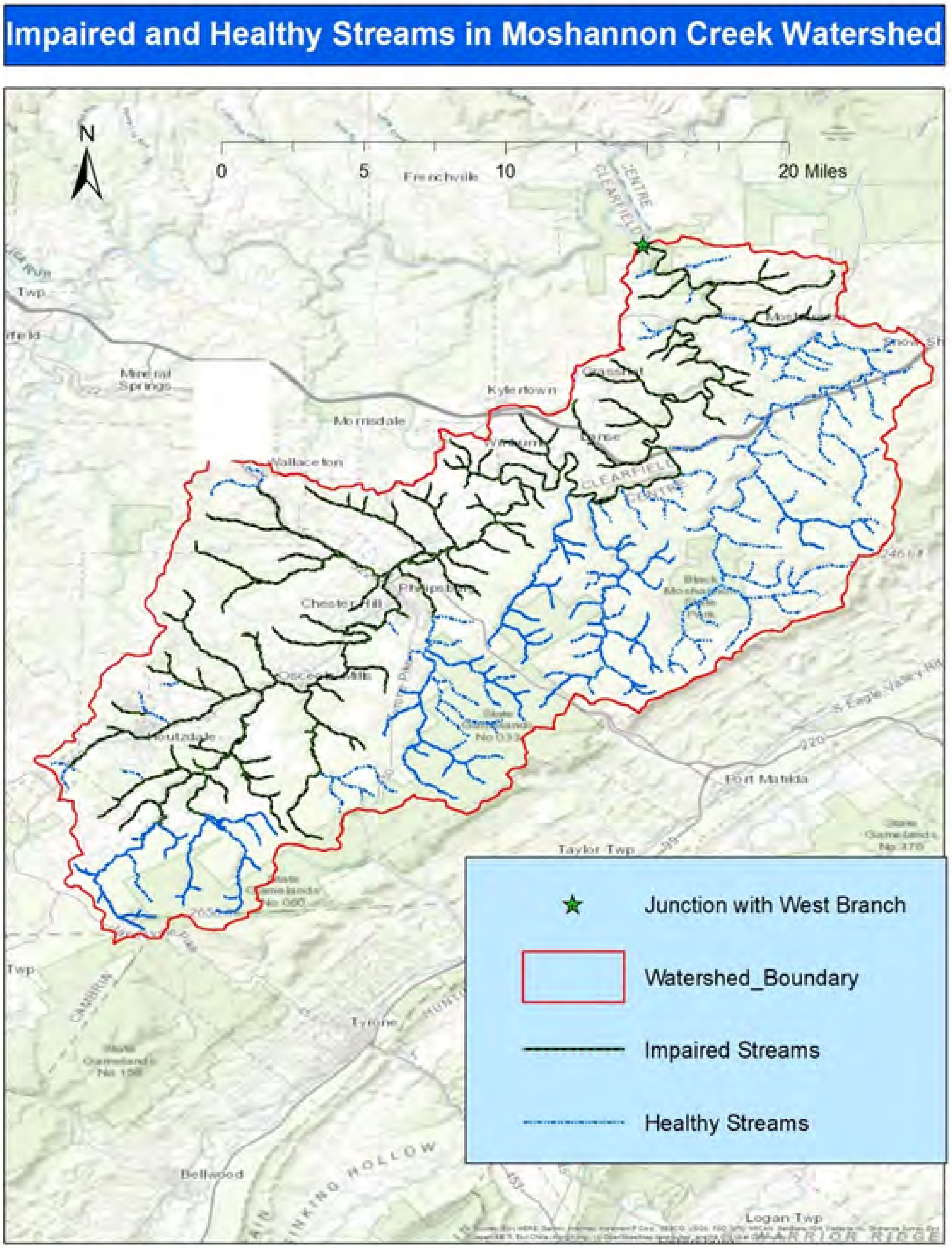

Figure 7. Map of impaired streams within the Moshannon Creek Watershed.

Trout Fishery

In the face of future uncertainty from climate change, restoration and protection of wild trout streams is vital to conserve Pennsylvania's only stream dwelling native salmonid, the eastern brook trout. In watersheds impaired by AMD, the acidity and metals concentrations are often the limiting factor preventing fish and macroinvertebrates from surviving in a particular waterway. Not only is restoration of AMD in Moshannon Creek and other AMD impaired waters important for the local economy and immediate biological restoration of the stream, but also for the long-term survival of native and wild trout in Pennsylvania.

Though no fishery surveys were conducted as a part of this project, there have been surveys completed by other agencies in the past. These surveys have led to numerous stream sections being classified as supporting natural trout reproduction by the PA Fish and Boat Commission. This section summarizes the known wild trout resources in Moshannon Creek and identifies potential tributaries where new populations of wild trout may be found.

<u>Existing Naturally Reproducing Trout Waters</u>

Despite the extent of AMD impairment in Moshannon Creek, there are over 237 miles of stream listed as supporting naturally reproducing trout in the watershed, according to the PA Fish and Boat Commission (see Figure 5). These include:

- The very headwaters of Moshannon Creek downstream to Roup Run
- Roup Run (Centre Co)
- Mountain Branch (Centre Co)
- Beaver Run, headwaters downstream to and including Goss Run (Clearfield Co)
- Headwaters of Trout Run (Centre Co)
- Laurel Run (Clearfield Co)
- Cold Stream, headwaters to Cold Stream Dam (Centre Co)
- Black Bear Run (Centre Co)
- Sixmile Run (Centre Co)
- Black Moshannon Creek, headwaters downstream to Gorton Road (Centre Co)

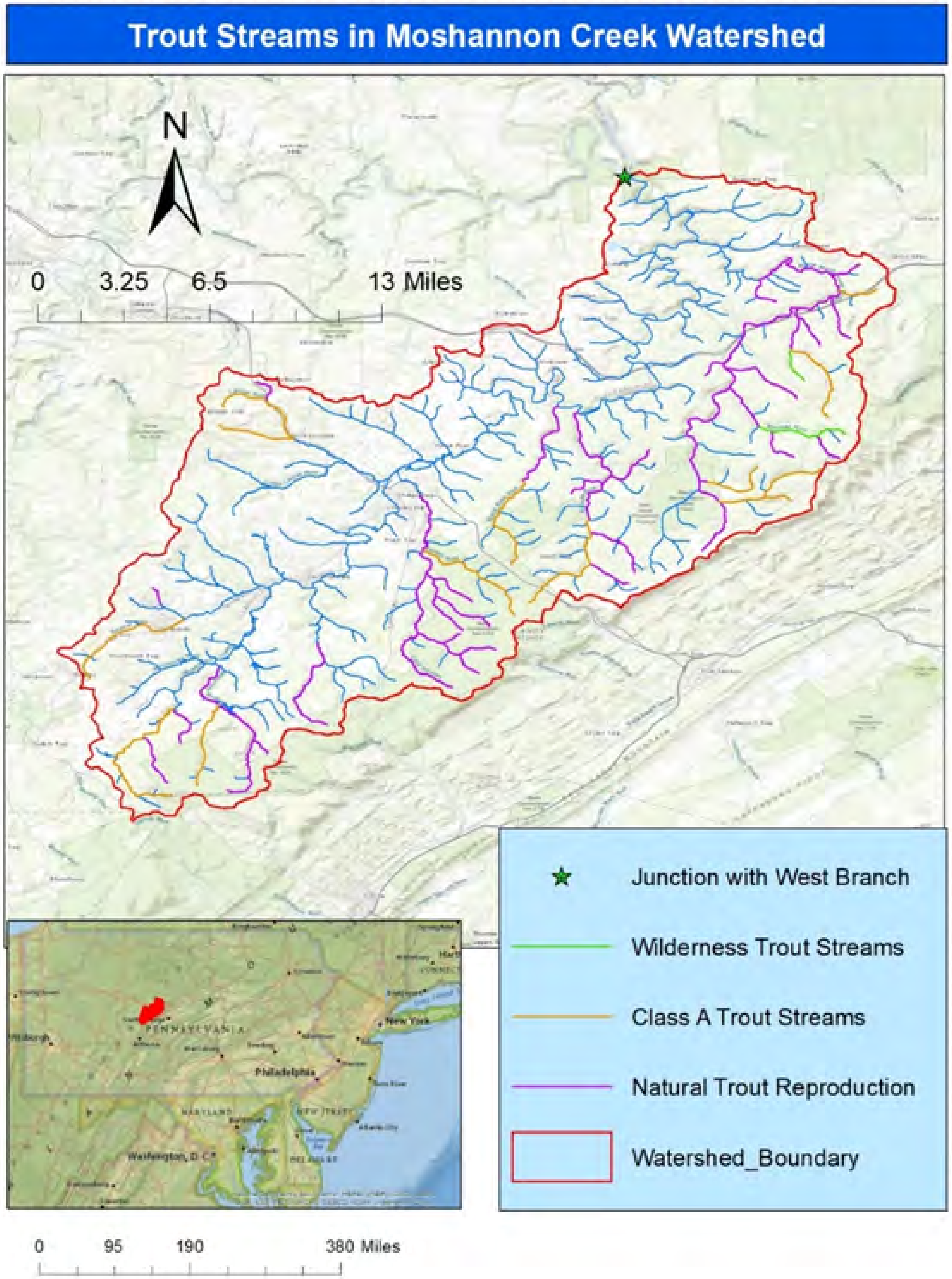

Figure 8. Map of naturally reproducing trout streams within the Moshannon Watershed.

Additionally, there are 48 miles of Class A trout streams in the watershed (see Figure 8). Class A wild brook trout streams are:

- The very headwaters of Moshannon Creek downstream to Roup Run
- Trim Root Run in the Mountain Branch tributary (Centre Co)
- The headwaters of Laurel Run (Clearfield Co)
- Simeling Run in the Laurel Run tributary (Clearfield Co)
- Black Bear Run downstream to the Black Bear Reservoir (Centre Co)
- Several tributaries to Black Moshannon Creek including parts of North Run, Smays Run, Benner Run, Rock Run, and Hicklen Run

Class A trout streams supporting a mix of wild brook and brown trout are:

- Tomtit Run in the Coldstream tributary (Centre Co)
- A section of Sixmile Run (Centre Co)

And lastly, the headwaters of Beaver Run in Clearfield County is classified as a Class A brown trout fishery.

Naturally Reproducing Trout Streams and Special Protection Status

Almost all the known trout streams on the Centre County side of Moshannon Creek also carry special protection status as High-Quality Coldwater Fishery (HQ-CWF) or Exceptional Value (EV) waters according to PA Code Title 25 Chapter 93 (see Figure 9). Having one of these designations affords the stream greater protection against water quality degradation from many activities such as development, industry, construction, agriculture, etc. Roup Run and several tributaries to Mountain Branch in Centre County, as well as Beaver Run and most of Laurel Run in Clearfield County, are still only designated as Coldwater Fisheries (CWF). Because these streams are known to support wild trout, and in some cases are a Class A wild trout fishery, these watersheds should be studied more thoroughly, and efforts made to change their Chapter 93 Designated Use status from CWF to HQ-CWF so they can be better protected.

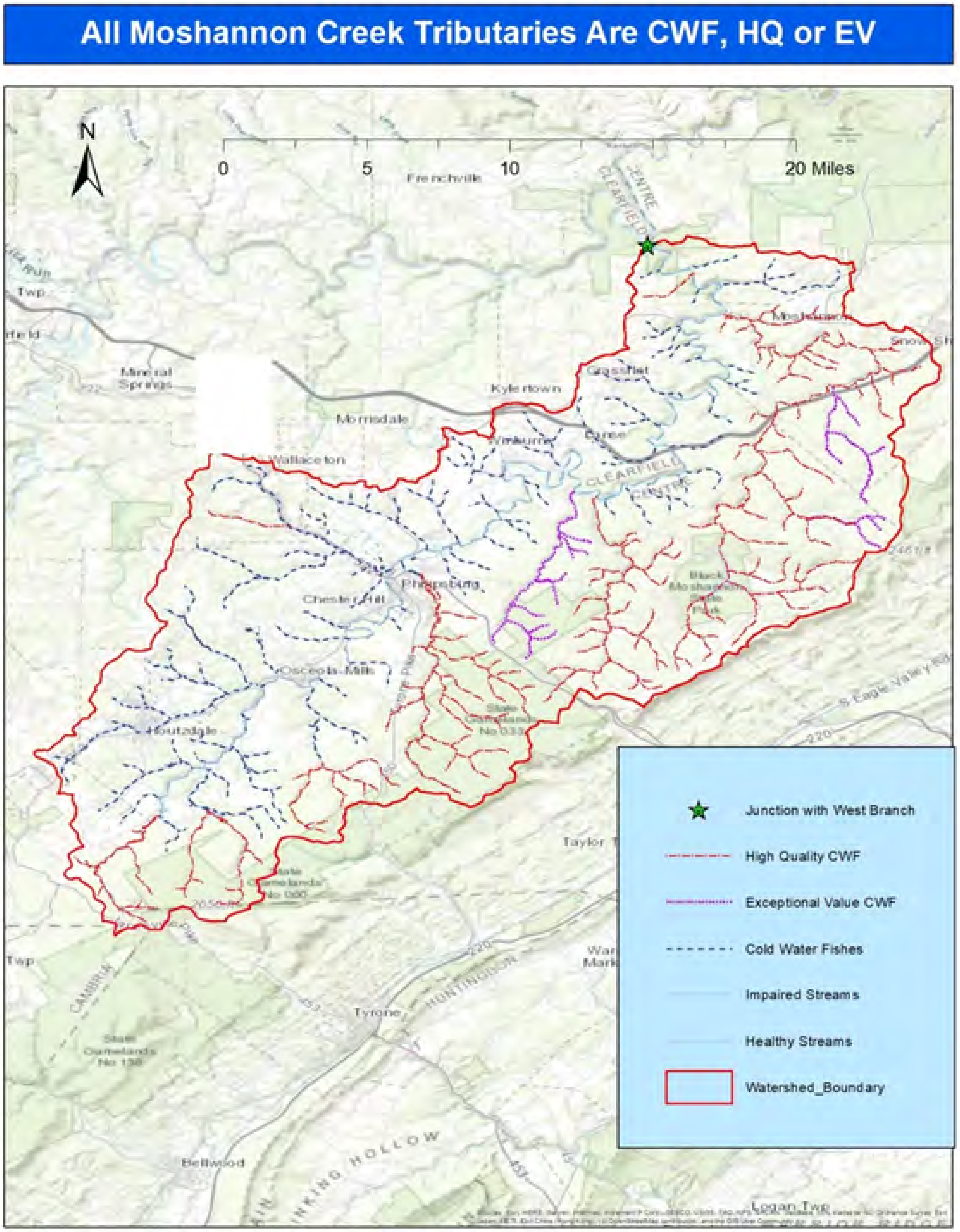

Figure 9. Map of the High Quality and Exceptional Value streams in the Moshannon Watershed.

Potential Streams Supporting Natural Trout Reproduction

Based on water quality and field observations during this assessment, there are several stream sections that could contain trout. The sections listed below warrant biological surveys and should be studied more closely:

- Lower Black Moshannon Creek from the UNT at RM 3.27 to the mouth (COMID 61829563, Sample ID 13)
  - Also fairly easy to access from SR53
- Crawford Run (COMID 61829743, Sample ID 14)
  - Zett's Fish Farm is located on the headwaters of the northern tributary of Crawford Run, so further study could indicate whether the fish farm is having an impact on the biology of the stream.
- Laurel Run (Centre County) that enters Moshannon just north of I-80 (COMID 61830463, Sample ID 24)
  - Good water quality despite the proximity to I-80, access could be difficult.
- Potter Run (COMID 61830691, Sample ID 25)
- Tark Hill Run (COMID 61830813, Sample ID 27)
- Saw Dust Hollow (COMID 61831009, Sample ID 28)
  - Potter Run, Tark Hill Run, and Saw Dust Hollow are harder to get to but could be surveyed all at the same time given their proximity to one another.
- Hawk Run upstream of the Hawk Run discharge (COMID 61831343, Sample ID 40)
  - Trout could survive here based on the water quality found in July 2020, but the population would be very isolated. Based on surveys completed elsewhere in AMD impaired streams in Clearfield County, it's possible a remnant population could exist. Water sampling performed in April 2021 indicated much higher iron. There may be seasonal AMD flows higher in the watershed. Fish more likely upstream of the community of Pardee.
- Shimel Run (COMID 61832389, Sample ID 49)
  - Should be fairly easy to access from SR53.
- Bear Run upstream of AMD discharges (COMID 61833903) as well as an UNT to Bear Run (COMID 61833697)
  - Trout were observed in the unnamed tributary by the Native Fish Coalition - Pennsylvania Chapter while doing a water chemistry and benthic macroinvertebrate study of the Bear Run watershed. Water chemistry and

benthic sampling in the section of Bear Run upstream of the AMD discharges indicate potential for fish habitat.

- Lower End of Beaver Run (COMID 61832801, Sample ID 54)
    - This stream is only listed as fish habitat to Goss Run even though Goss Run has good water quality. It seems very likely trout could survive much closer to the mouth of Beaver Run than what is currently listed.

There are also a few smaller tributaries in the watershed with water quality that could potentially support wild trout. Some are much smaller streams that may not even flow year-round, so resources available vs. likelihood of the presence of trout should be weighed carefully when considering doing biological surveys in these tributaries. These include:

- UNT near the Mouth (COMID 61829417, Sample ID 8)
    - Due to geography this would be pretty hard to get to.
- Ames Run (COMID 61829531, Sample ID 10)
    - Ames Run is listed as HQ-CWF but also listed in the 2020 Integrated Report as impaired by siltation from AMD. According to the water quality, the pH of the stream is low but so are the metal concentrations, so further study is warranted if the resources are available. Ames Run could be surveyed at the same time as the UNT (COMID 61829417)
- UNT just north of Shimel Run (COMID 61832265, Sample ID 48)
    - This stream could be accessed from SR53.
- UNT that flows through Edendale just outside Osceola Mills (COMID 61832781, Sample ID 51)
    - There are roads near the mouth so access may not be very difficult.

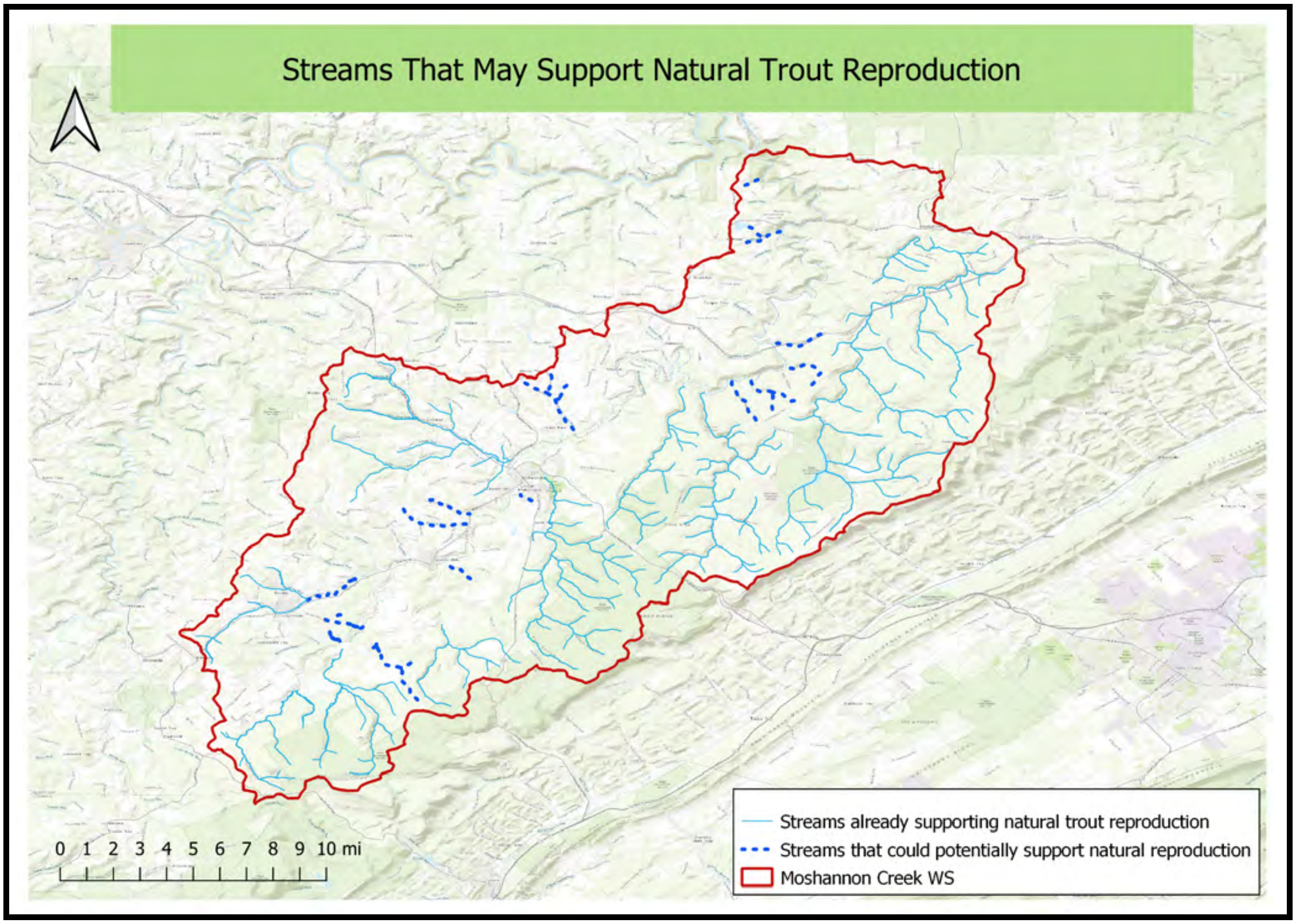

Figure 10. Streams to Investigate for Trout Populations.

History of Mining and Its Impacts

Mining for coal began within the Moshannon Creek watershed in the early 1800’s and continues today. Deep mining was the first method of coal mining used in the watershed, starting in the 1840's and 50's with small operations but expanding rapidly at the time of the Civil War as coal, with a higher BTU content, replaced wood for use in kilns, iron furnaces, and home heating systems.

Most towns within the watershed were established and grew in response to the success of deep mining, which continued expanding into the 1940's. Railroads and highways were built to service the mining areas and for the demand of transporting coal to markets. The Moshannon Valley experienced a large population growth in the latter 19th century from the high demand for the coal located there.

Targeted Seams

The bituminous coal mined within the Moshannon Creek watershed is geologically of the Allegheny Formation or Group, and is located in the physiographic province known as the Allegheny Plateau. The formation contains six major coal zones. The zones, from oldest to youngest are the Clarion (aka Brookville), Lower Kittanning, Middle Kittanning, Upper Kittanning, Lower Freeport and Upper Freeport.

Generally referred to using an alphabetical system within a group, the earliest mines in the area were on the Clarion-Brookville "A", Lower Kittanning "B" and Lower Freeport or Moshannon "D" seams due to their relatively good quality and thickness.

Over time, the "A" and "B" coals have been the most extensively mined and productive coal seams in the area, though all seams in the group, including the Upper and Middle Kittanning "C" seams, have been important producers. The Lower Freeport coal has almost been mined out in the area, mostly by small old deep mines and outcrop strip mines.

Most mine drainage problems in the watershed are emanating from strata and workings associated with the coals of the Lower Kittanning "B" and Clarion "A"seams.

Deep Mining Methods

Deep mining required miners to tunnel underground to reach coal seams, either directly into hillsides following a seam as a drift mine, or by sinking vertical shafts to reach underground seams. Older deep mining complexes often combine access features of both types of deep mines. Once into a seam, coal was removed from a grid of tunnels also known as rooms, leaving walls, or pillars, of coal to hold up the roof. These pillars would later be a target of strip mining. Both shaft and drift mines also have additional openings to the surface to provide air flow.

Few coal seams are perfectly level. There is usually a slope to the coal seam. Most old deep mines were driven into the coal seams updip to facilitate gravity mine water drainage into surface waterways. All water encountered in the workings drained downdip toward the synclinal axis which roughly underlies Moshannon Creek. Moshannon Creek and its tributaries currently receive the majority of their acid loads from year-round discharges from downdip drifts, blowouts, air shafts, and stripped out deep mine workings.

Large interconnected deep mine complexes developed in several areas on the "A" and "B" seams. A large "B" seam complex developed on the northwest flank of the Houtzdale Syncline, between Hawk Run, Alder Run, Weber Run, and Moshannon Creek. Similar though somewhat smaller complexes are found throughout the Moshannon Creek Watershed.

Strip Mining

A shift in mining methods began in the early 1940’s as surface strip mining began to replace deep mining, and this mining method eventually became prevalent across the watershed. Strip miners initially concentrated on coal outcrops adjacent to deep mine workings, which negated the need for any coal exploration. Often strip miners would “remine” an area to recover the coal pillars left by deep mining, a practice which continues today. Strip mines use large draglines or other heavy equipment to remove cover or overburden to reach, expose, and remove coal seams that are deep underground. Since the 1950's, improvements in equipment and methods have allowed miners to remove more and more overburden to uncover thinner coals and still be able to realize a profit.

As strip mines began to flourish and deep mines began to decline in importance, many deep miners lost their jobs and the small towns which had prospered with the deep mines slowly declined in population and wealth. This declining trend has continued for many years, and today most of the Appalachian bituminous coal mining belt is still recovering from this severe economic impact. In the Moshannon Creek watershed, the last of the deep mines, operated by the Rushton Coal Company, ceased operations in 1991.

Despite a nationwide trend downward in coal use and coal mining, strip mining remains a major industry within the watershed, with a number of coal operations currently underway. Additionally, at least one large open hardrock mine (a quarry) is active in the watershed.

Conditions Left by Past Practice

Inconceivable as it is now, the standard practice through the first 130 years of mining in the Moshannon watershed, as elsewhere, was to simply abandon coal workings when a mine was played out, creating what is now referred to as Abandoned Mine Land, or AML.

Most deep mines were left abandoned after economically accessible coal was removed. Often this meant leaving mine portals and air shafts open. Fortunately, most open features have been covered or have collapsed on their own, but some do remain, and even when collapsed continue to discharge mine water. Deep mines also left behind large amounts of coal refuse material at many entry points, which was created by the removal of rock from the coal. Further, the extensive underground voids created by deep mining led to the continuing problem of mine subsidence.

Like the deep mines, earlier era strip mines were also left unreclaimed and abandoned after coal was removed. These mines have a more extensive surface impact due to the nature of the method. Unreclaimed areas that were strip mined and abandoned now appear as barren and scarred landscapes, with sparse vegetation, rocky or black surfaces, refuse and spoil piles, exposed highwalls, and abandoned pits, which can often hold water. Water infiltrating through pit floors is a constant source of mine drainage.

Results of Abandonment

AML within the watershed borders the main stem and many tributaries of Moshannon Creek creating a perpetual source of Acid Mine Drainage (AMD) and posing a public safety hazard.

Acid Mine Drainage is a type of non-point pollution that occurs due to past mining practices and conditions described above. It is formed when water and oxygen react with iron pyrite that is found in coal, refuse, or the overburden of a coal operation. This reaction results in water with high acidity and dissolved metals. These metals will remain in solution until the pH rises to a level that causes them to precipitate as a solid. The most common metals found are iron, aluminum and manganese. As a solid, iron will be red in color; aluminum will be white and manganese, black. Iron and aluminum are the most lethal metals to aquatic life. While in solution, these metals can make streams with a low pH even more lethal. As solids, the metals can coat gills of fish, bury substrate used for spawning and macroinvertebrate habitat, and increase turbidity that can interrupt feeding.

Acidic discharges exist throughout the watershed where AML is found. Downstream of Wilson Run, nearly all of the tributaries on the Clearfield County side of Moshannon Creek are affected by acid mine drainage. On the Centre County side, upper and mid Moshannon tributaries are most often impacted, as the geology of the area has spared many of the tributaries entering from the more eastern Ridge and Valley formation from mining related impacts. These clean tributaries and headwaters can serve as a source of wild fish populations to repopulate recovered segments of stream. As it stands today however, the entire length of Moshannon Creek, except for the extreme headwaters, is polluted to some degree by acid mine drainage. Figure 11 shows the correlation between AML and impaired streams in the Moshannon Creek watershed. Note the clear distinction between impacted streams flowing primarily from the Allegheny Plateau to the west, and from the Ridge and Valley province to the east.

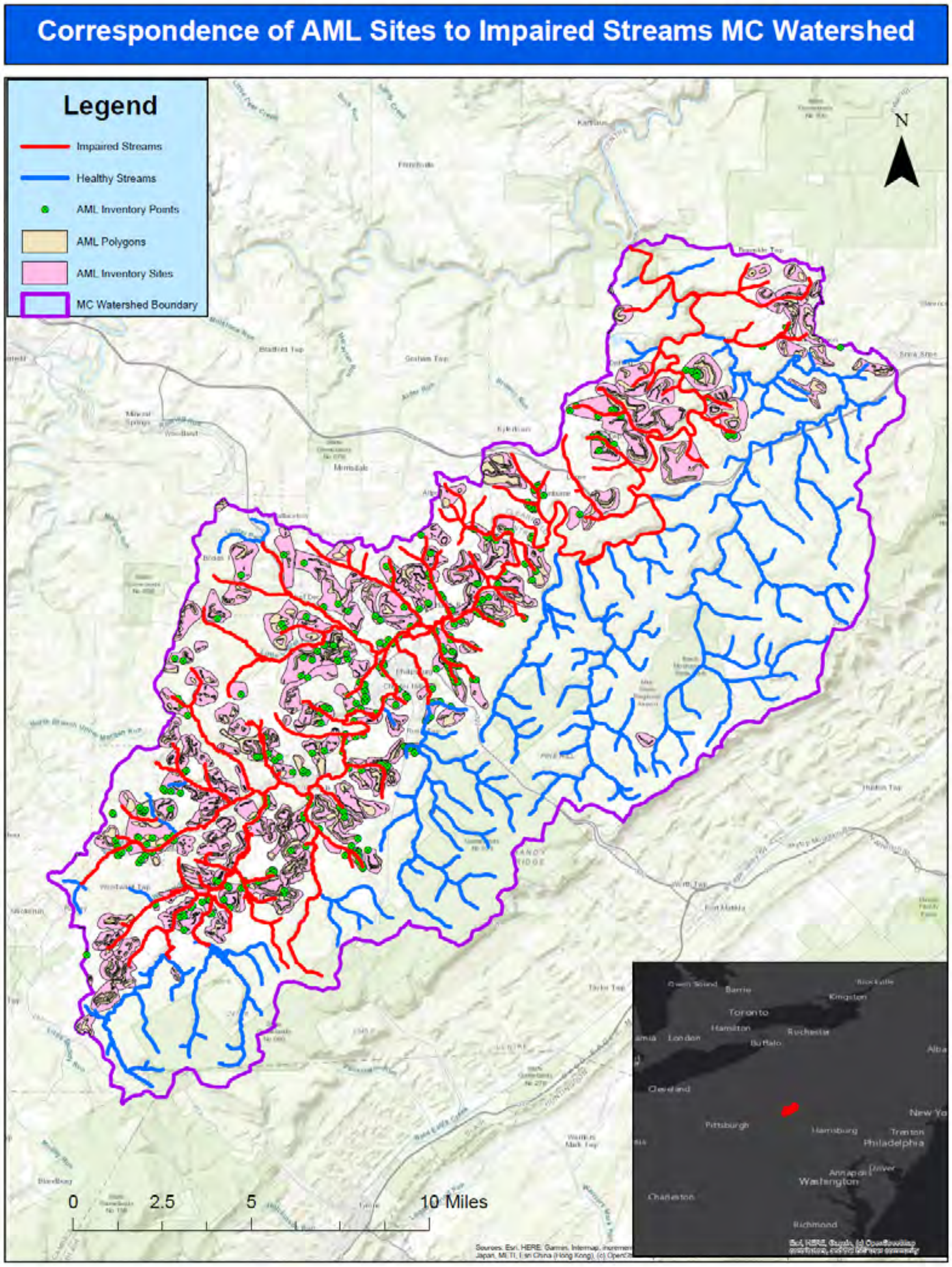

Figure 11. Map of the Abandoned Mined Lands and Streams in the MC Watershed

At 275 square miles with a main stem stream length of over 50 miles, the Moshannon Creek watershed is the fifth largest tributary of the West Branch of the Susquehanna River. Great strides have been made in improving the water quality of the West Branch over the past few decades, but until the water contributed by Moshannon Creek is also improved, recovery efforts on the West Branch can only get so far.

In a 2008 report, Rose, Fang and Undercofler describe the detrimental impact of two tributaries of the West Branch, Clearfield Creek and Moshannon Creek, to the water quality in the West Branch. Moshannon Creek was the worst of the two. The significant sulfuric acid loading that Moshannon Creek provides is shown in Figure 12.

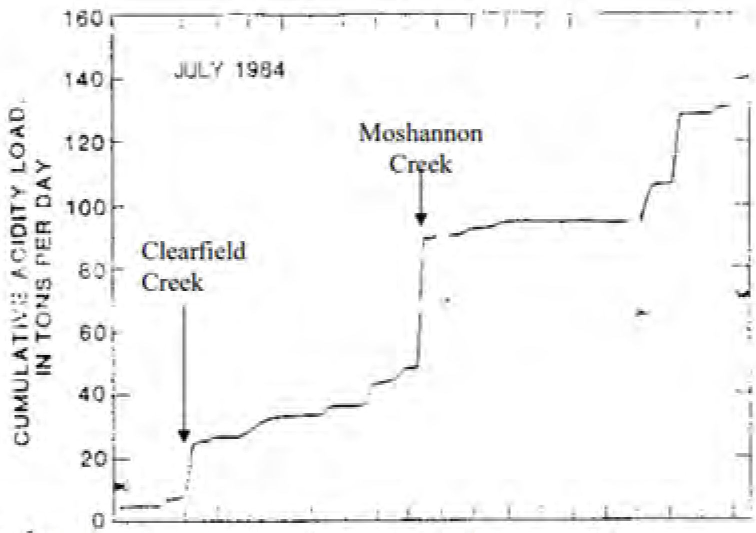

Figure 1. Calculated cumulative acidity load of the West Branch from Curwensville to Renovo in July 1984 (after Hainly and Barker, 1993).

Figure 12. Cumulative acidity loading on the West Branch Susquehanna River in 1984. Note the impact of Moshannon Creek.

Present Practices

Until the past few decades, beginning with State regulatory improvements in the 1960's and Federal regulatory improvements in the 1970's, reclamation laws that did exist were inadequate and sometimes not strictly enforced. As a result, most of the older strip cuts in the study area are unreclaimed or very poorly reclaimed. Today strip mine reclamation requirements are very effective and are stringently enforced.

Recent mining within the watershed consists entirely of surface strip mining. Several current mining operations are remining operations that include the reclamation of abandoned mine lands. This includes the elimination of abandoned underground deep mines by removing the coal left in place by the room and pillar method, and by working through and backfilling abandoned highwalls. These reclamation practices along with alkaline addition placed within the spoil of the mine site should help improve the water quality within the watershed.

Other Concerns Besides Mining Impacts

While abandoned mine drainage is the dominant problem impairing streams in the Moshannon Creek watershed, other threats to water quality and fish habitat do exist. Some of these problems are listed below. They are not ranked in importance. Most require vigilance to prevent small problems from developing into larger ones. Any or all of these could increase in importance with the passage of time.

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1. Dirt roads, both public and private, are numerous throughout the watershed and pose a risk of sediment flow to nearby streams.
2. Informal trails from ATV/UTV use are common in the watershed and pose a sediment risk to nearby streams similar to the sediment risk from dirt roads.
3. Two tributaries of Moshannon Creek, Browns Run and Laurel Run (Centre County), run parallel to Interstate 80 for long distances, receiving drainage from that multi-lane highway. Snow removal activities on I-80 are likely to contribute road salt to these streams. Browns Run is currently badly impaired from mine drainage in the stretches also impacted by I-80, but Laurel Run (Centre County) is a clean water stream. Other streams have exposure to road salt to a lesser degree than these two.
4. Logging activity varies with the price of timber, which was quite valuable during the period of this study. Logging’s impact to water quality and temperature varies with the precautions taken, the amount of timber removed and the size of stream buffers left by the logging operation.
5. Philipsburg is increasingly becoming a bedroom community for State College. As State College continues to grow, development pressure in other parts of the watershed is likely to occur.
6. OIl and gas drilling is occurring near the watershed and has the potential to become a major activity, especially in the northern portion of the watershed. A few wells have been drilled.
7. Much of the land in the eastern portion of the watershed is public land. Many other large parcels in the watershed are privately owned, often due to past or current mining activity. Substantial changes in land use can occur with ownership changes of these large parcels.

8. A few streams were found to have warmer water and/or lower flow than expected. Whiteside Run, in particular, was found to have warmer water than expected, and much of its watershed dried up during 2020's drought.
9. There are a number of wastewater treatment facilities treating the sewage from the communities and institutions in the watershed. The largest of these are for Woodward Township, Osceola Mills Borough, Houtzdale Borough, and Philipsburg Borough. At present these facilities are adequate for the task, but population growth requires similar growth of treatment capacity. Additionally, wet weather events can cause incidents where poorly treated wastewater enters the environment. Fortunately such events take place when streams are high, with diluting and flushing preventing long term impacts.
10. Agriculture is dispersed in the watershed and most concentrated in the watershed in the vicinity of I-80 in Clearfield County. Some of the streams most exposed to agriculture are currently severely impaired by AMD.

Previous Studies of the Moshannon Creek Watershed

The first comprehensive assessment of the state of the watershed was for the Scarlift Report. This was the first extensive effort to catalog the impact of mining on Pennsylvania and led to the first round of extensive efforts at reclaiming abandoned mine lands.

Several studies of some or all of the watershed were conducted ten or more years ago. These include a TMDL for the entire Moshannon Creek watershed and a TMDL for the Laurel Run (Clearfield County) watershed. A coldwater conservation plan for the headwaters of Moshannon Creek was prepared by the Clearfield County Conservation District in 2005. Environmental contractor New Miles of Blue Stream prepared five restoration plans for the upper third of the watershed. These plans are listed below.

- PA Scarlift Report 101.7 Clearfield and Moshannon Creeks. (initiated 1972)
- Moshannon Creek Watershed TMDL. (PA DEP, 2009)
- Final Laurel Run Watershed TMDL, Clearfield County, For Acid Mine Drainage Affected Segments. (PA DEP, 2007)

- Moshannon Creek Headwaters Mine Drainage Assessment and Restoration Plan (NMBS, 2009)
- Moshannon Creek Headwaters Coldwater Conservation Plan (CCCD, 2005)
- Moshannon Creek Phase II Mine Drainage Assessment and Restoration Plan (NMBS, 2010)
- Emigh Run Watershed Mine Drainage Assessment and Restoration Plan (NMBS, 2004)
- Shimel Run Mine Drainage Assessment and Restoration Plan (NMBS, 2008)
- Trout Run Watershed Mine Drainage Assessment and Restoration Plan (NMBS, 2006)

Because of the extensive water sampling that was done for the restoration plans and other reports listed above, historical water sampling data for the Moshannon Creek watershed is heavily concentrated in the southern third of the watershed and is concentrated on stream segments that were impaired, as can be seen in the map below. Most of this data resides on the Susquehanna River Basin Commission website at https://www.srbc.net/minedrainageportal/ . Additional data, mostly from the US Geological Survey, resides on the National Water Quality Monitoring Council's website at https://www.waterqualitydata.us/ . Much of the water chemistry sampling that was done in the past included multiple samples from mine water discharges (Figure 13).

The methods used to evaluate the watershed and produce this Coldwater Conservation Plan were chosen to confirm whether existing data was still applicable to conditions in the watershed and also to expand knowledge of watershed sections that were not as well examined in past investigations.

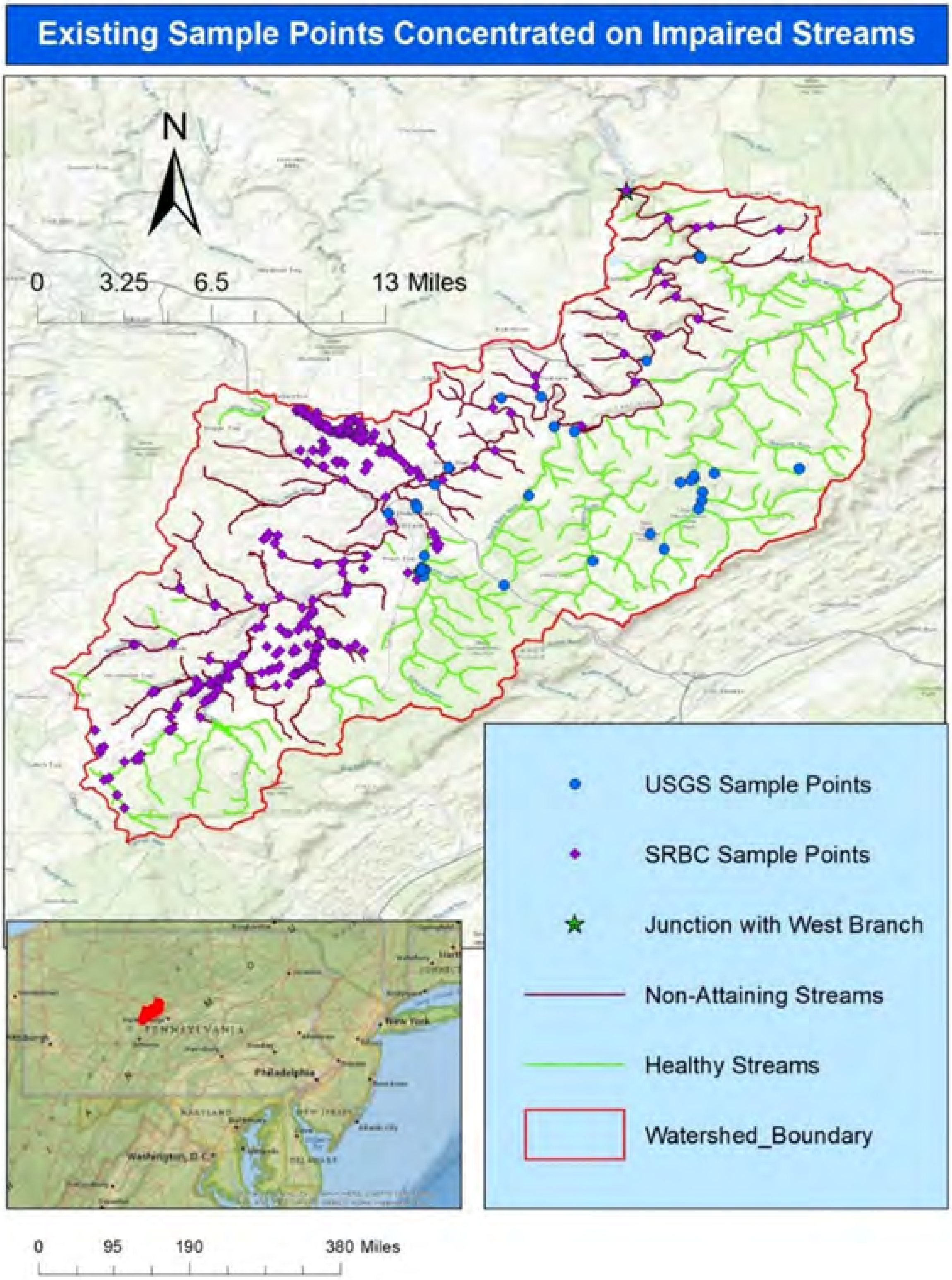

Figure 13. Historical water quality sampling stations within the Moshannon Watershed.

Project Water Chemistry Sampling Methodology

Tom Clark, Mine Drainage Program Coordinator for the Susquehanna River Basin Commission (SRBC) is one of this project's external partners. He has successfully used a method to take a snapshot of a watershed to identify the main sources of mine drainage that he refers to as "follow the sulfate" (Tom Clark, personal communication). When pyrites dissolve and produce sulfuric acid in mine drainage, the sulfate ions often stay in solution even when clean water inflows raise the pH and remove the hydrogen ions and other contaminants such as dissolved metals. The amount of sulfate in a tributary in a watershed provides a strong indication of the amount of mine drainage contributed by that tributary. The total amount of sulfates in the tributaries is summed and then subtracted from the sulfates found in the main stem of the watershed downstream of those tributaries, and the remainder is the amount of sulfate that enters the main stem from discharges directly into it, or other sources like small tributaries that were not measured. This method is most accurate when all the sampling is done nearly simultaneously in a static weather condition. This technique was recently used by the SRBC to evaluate the Tioga River, where 30 locations were sampled by 3 crews of two people over 36 hours (Tom Clark, personal communication).

Tom Clark, along with SRBC Environmental Scientist Andrew King, developed the "follow the sulfate" sampling plan that was used for the first round of water chemistry sampling of Moshannon Creek that is shown below as figure 15 and table 1. It was used in a multi-day sampling event for the first round of water sampling in the Moshannon Creek watershed. 65 sample points were planned, although some were found to be dry. Two person sampling teams were used with each team sampling 6 or 7 sample points. Some of the more remote sample points were sampled earlier in the week. Most sample points were sampled on Friday July 24, 2020 by nine teams with volunteers paired with environmental professionals from SRBC, the PA DEP, the Clearfield County Conservation District, and Trout Unlimited. Several sample points that were still deep water even in drought conditions were sampled by SRBC employees using special flow measuring equipment.

When the sampling plan for this event was originally developed, the lowest two sections of the watershed, Peale to Highway 53, and Highway 53 to the West Branch of the Susquehanna, were planned to be sampled with teams using kayaks, due to the remoteness of the sample points in these sections. 2020's drought conditions resulted in very low flow, and these two sections were sampled by teams walking the stream bed of Moshannon Creek to gain access to the sample points (Figure 14).

Figure 14. Moshannon Creek low flow condition on July 11, 2020 at Hwy 53 Bridge.

The teams visited and sampled their designated points. They took field measurements of pH, temperature, flow, and conductivity, and, when equipment allowed, dissolved oxygen. They filled sample bottles with stream water from their sample points that were evaluated by Mahaffey Laboratory for pH, alkalinity, acidity, sulfates, iron, aluminum, manganese and total dissolved and suspended solids. A map with a table of the sample points used in the first round of water sampling is shown below (Figure 15). The sample points were color coded based upon whether they were main stem sample points (blue), tributary sample points previously sampled (green) or tributary sample points that were not previously sampled (red).

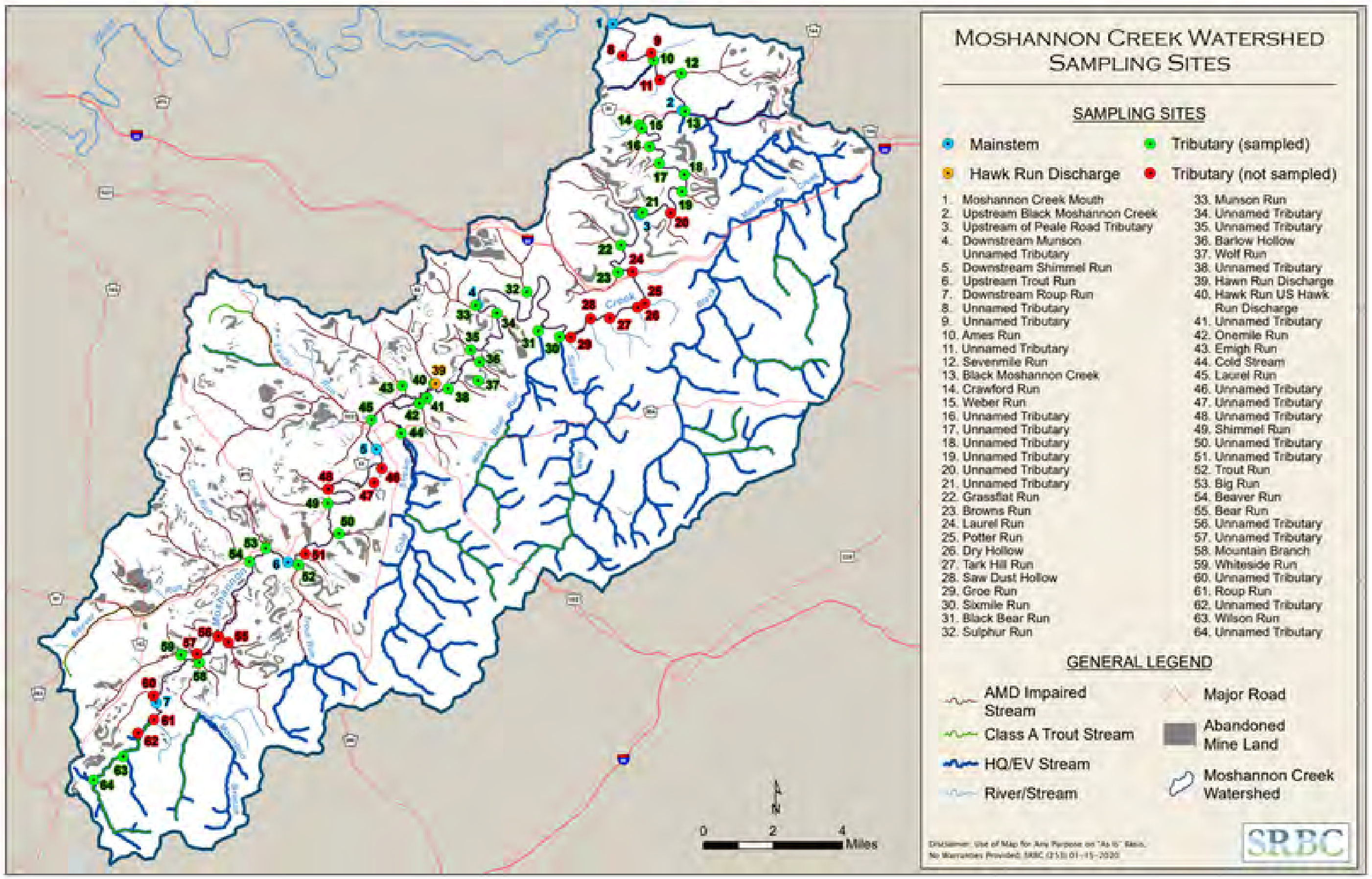

Figure 15. Sample Points and Location for Phase 1 Sampling. From Clark and King, SRBC.

Table 1. Sample stations collected during the July 2020 watershed snapshot.

MAPID	SITENAME	LAT	LONG	COLOR
1	Moshannon Creek	41.0723	-78.0972	Blue
2	MC Upstream Black	41.0367	-78.0584	Blue
3	MC Upstream of Peale Rd Tributary	40.9932	-78.0809	Blue
4	MC Downstream Munson Run	40.955	-78.1694	Blue
5	MC Downstream Shimmel Run	40.8945	-78.224	Blue
6	MC Upstream Trout Run	40.8472	-78.2715	Blue
7	MC Downstream Roup Run	40.7881	-78.3426	Blue
8	Unnamed Trib	41.0592	-78.0915	Red
9	Unnamed Trib	41.0605	-78.0759	Red
10	Ames Run	41.0574	-78.0743	Green
11	Unnamed Trib	41.0493	-78.0708	Red
12	Sevenmile Run	41.0521	-78.059	Green
13	Black Moshannon Creek	41.0362	-78.0566	Green
14	Crawford Run	41.0305	-78.0816	Green
15	Weber Run	41.0292	-78.0804	Green
16	Unnamed Trib	41.0217	-78.0761	Green
17	Unnamed Trib	41.0148	-78.0705	Green
18	Unnamed Trib	41.0102	-78.0568	Green
19	Unnamed Trib	41.0031	-78.0579	Green
20	Unnamed Trib	40.9942	-78.0638	Red
21	Unnamed Trib	40.9943	-78.0795	Green
22	Grassflat Run	40.9805	-78.0912	Green
23	Browns Run	40.9694	-78.0926	Green
24	Laurel Run	40.9696	-78.0844	Red
25	Potter Run	40.9566	-78.0776	Red
26	Dry Hollow	40.9548	-78.0814	Red
27	Tark Hill Run	40.9503	-78.0967	Red
28	Saw Dust Hollow	40.9499	-78.1073	Red
29	Panther Hollow	40.9421	-78.118	Red
30	Sixmile Run	40.9423	-78.1242	Green
31	Black Bear Run	40.9446	-78.1359	Green
32	Sulphur Run	40.9606	-78.1425	Green
33	Munson Run	40.9548	-78.1705	Green
34	Unnamed Trib	40.9517	-78.1587	Green
35	Unnamed Trib	40.9364	-78.1729	Green
36	Barlow Hollow	40.9313	-78.168	Green
37	Wolf Run	40.9235	-78.1685	Green
38	Unnamed Trib	40.92	-78.1848	Green
39	Hawn Run Discharge	40.9222	-78.192	Orange
40	Hawk Run US Hawk Run Discharge	40.9222	-78.1929	Green
41	Unnamed Trib	40.9161	-78.1965	Green
42	Onemile Run	40.9137	-78.2006	Green
43	Emigh Run	40.9212	-78.2101	Green
44	Cold Stream	40.9013	-78.2104	Green
45	Laurel Run	40.9069	-78.2269	Green
46	Unnamed Trib	40.8867	-78.2207	Red
47	Unnamed Trib	40.8806	-78.2249	Red
48	Unnamed Trib	40.8776	-78.2502	Red
49	Shimmel Run	40.8719	-78.2501	Green
50	Unnamed Trib	40.8593	-78.2439	Green
51	Unnamed Trib	40.8508	-78.2621	Red
52	Trout Run	40.8462	-78.2657	Green
53	Big Run	40.8527	-78.2838	Green
54	Beaver Run	40.8472	-78.2927	Green
55	Bear Run	40.8134	-78.3035	Red
56	Unnamed Trib	40.8159	-78.3092	Red
57	Unnamed Trib	40.8087	-78.3205	Red
58	Mountain Branch	40.8051	-78.3193	Green
59	Whiteside Run	40.808	-78.3294	Green
60	Unnamed Trib	40.7909	-78.3441	Red
61	Roup Run	40.7812	-78.3437	Red
62	Unnamed Trib	40.7752	-78.3522	Red
63	Wilson Run	40.7656	-78.3601	Green
64	Unnamed Trib	40.7555	-78.3761	Green
65	MC Headwaters	40.7552	-78.3755	

An additional sample point at the bottom of this list, sample point 65, was added in the headwaters of Moshannon Creek after the map was produced.

In order to attain the Pennsylvania Department of Environmental Protection’s standards for stream water chemistry, streams with suspected mining impacts must fall within the following ranges: pH between 6 and 9, manganese < 1.0 mg/l, iron < 1.5 mg/l, aluminum < 0.75 mg/l, sulfates < 250 mg/l, and alkalinity greater than acidity (PA DEP, 2018). Sample results outside of those ranges indicate probable mine drainage water quality problems in that stream drainage. The results of round 1 water sampling were compared to these standards to indicate which drainages had the the most impact on Moshannon Creek and/or the largest changes from historical data.

Subsequent sampling, detailed below, was done in two phases, September 2020 and April 2021. Data was reviewed and additional sampling points were scouted for the subsequent rounds during August 2020. After considerable internal debate, sample points for a round of sampling done in late September 2020 were selected. Those are shown below in Table 2. In round 1, Sulfur Run was found to be an extremely important contributor to AMD in the Moshannon Creek watershed, and the SRBC began ongoing water sampling and characterization of that basin. This sampling, and sampling of other major discharges in the vicinity of Sulfur Run, continues.

The water sampling that was done in July 2020 was done during moderate drought conditions. By the time of the 2nd round of water sampling in late September 2020, drought conditions had become severe. The severe drought conditions provided insights into several watersheds, particularly Munson Run and Whiteside Run, that wouldn’t necessarily have occurred during more normal flow. The sample points that were selected and sampled for round 2 are shown below. Round 2 sampling done on Munson Run and Sulfur Run was very exploratory because of minimal historical data for those watersheds. Because of drought conditions, beaver activity, and historical mine discharges proving to no longer flow, not every selected point was sampled during round 2. Attempts to sample all points listed in Table 2 were made.

Table 2. Sampling stations of the Round 2 Sampling Event.

ID	Station Name	Lat	Long	ID	Station Name	Lat	Long
32	Sulphur Run Mouth (R2)	40.9606	-78.1425	6	MC7 at Osceola (R2)	40.8472	-78.2715
150	UNT 1 South UNT	40.96672	-78.14945	53	Big Run Mouth (R2)	40.8527	-78.2838
156	MD3 House Discharge	40.96594	-78.1476	85	Big Run Discharge Near Highway	40.855619	-78.283703
155	UNT 2 North Discharge	40.97261	-78.14529	84	Big Run Disch at Bucket Line	40.869577	-78.29248
152	MD1 Brown 1 Discharge	40.97658	-78.14997	83	Big Run at Scotch H Road	40.871309	-78.294189
153	MD 2 Brown 2 Discharge	40.98005	-78.15414	82	Coal Run Beaver Lane	40.8528	-78.3011
151	SR 2035 Up	40.970063	-78.145374	81	Coal Run higher	40.8611	-78.3062
33	Munson Run Mouth (R2)	40.954734	-78.170169	80	MC Scrapyard (R2)	40.8232	-78.3008
120	MR UNT-1	40.956335	-78.180361	59	Whiteside Run near Mouth (R2)	40.808	-78.3294
121	MR UNT-2	40.956449	-78.183924	77	Whiteside Disch	40.8064	-78.3279
122	MR UNT-3	40.959994	-78.185844	78	MC-16 Disch (R2)	40.8044	-78.3279
123	MR UNT-4 (R2)	40.960723	-78.188099	79	QMC6 - Upstream Whiteside + MC16 (R2)	40.8043	-78.328
124	MR Upstream	40.959684	-78.18915	7	MC – Hale (R2)	40.7881	-78.3426
331	Munson (2' down from) Pipe 1 DN	40.953983	-78.173653	68	MC-8 Disch (R2)	40.78179	-78.34248
332	Munson Pipe 1	40.953983	-78.173653	66	MC-7 Disch (R2)	40.78138	-78.34348
333	Munson Pipe 2	40.954129	-78.173902	61	Roup Run (R2)	40.7812	-78.3437
334	Munson Big Pool	40.953981	-78.174478	67	MC above Roup	40.7814	-78.3444
335	Munson Mossy Seep	40.954161	-78.17514				

In the first two weeks of April, 2021, a third round of water chemistry sampling was done in the watershed. Important tributaries and main stem sections with discharges identified in previous sampling rounds were sampled in this round. Additionally, benthic macroinvertebrate sampling was done in parts of the watershed as detailed in the next report section.

1. A Penn State team, under the direction of Dr. Bill Burgos, used their own equipment and laboratory to resample Munson Run and its tributaries. Munson Run had a lot of dry tributaries during drought conditions in September 2020, necessitating this revisit.
2. Discharges upstream of the Hale Road bridge across Moshannon Creek were resampled. Two of these were not flowing significantly during September 2020 sampling in drought conditions. The Clearfield County side of the stream was scouted and the historic discharges on that side were confirmed to no longer be flowing even in high flow conditions in April.
3. The Browns Run watershed was sampled in multiple locations.
4. The Pennsylvania Chapter of the Native Fish Coalition sampled the Bear Run watershed. They made multiple water chemistry samples in parts of the watershed and also performed benthic macroinvertebrate sampling.
5. The Moravian Run watershed and associated AMD discharges were sampled.
6. Seven Mile Run and the impaired tributaries of Black Moshannon Creek were sampled.
7. A string of AMD discharges on the Centre County side of Moshannon Creek across from the Leslie Tipple was sampled. Round 2 of the water sampling found that significant deterioration in water quality happened in this stretch of Moshannon Creek that did not appear to come from tributary streams.
8. The tributary streams associated with the MC-FORE discharge in the headwaters were sampled above and below the discharge, and the discharge itself was sampled.
9. The Pennsylvania Chapter of the Native Fish Coalition sampled benthic macroinvertebrates in Moshannon Creek upstream and downstream of the MC-FORE discharge. This sampling was done to confirm whether or not the impact of MC-FORE is significant in Moshannon Creek.
10. A string of discharges flowing into Moshannon Creek downstream of the Hale Road bridge were sampled. A larger discharge, MC-16, located just upstream of Whiteside Run, was also sampled.
11. Seven sample points within the Trout Run watershed were sampled.
12. Grassflat Run, an impaired watershed in the lower section of the Moshannon Creek watershed, is scheduled to be sampled by Penn State students in the Spring of 2022. Planning for this activity is underway.

Table 3. Round Three Sample Points

ID	Station Name	Lat	Long
BLU01	BLUNT01 – mouth BM UNT01	41.03412	-78.04023
BLU02	BLUNT02 – Black Mo UNT02	41.03544	-78.01685
BLU03	BLUNT03 – Black Mo UNT03	41.03524	-78.01666
BLU04	BLUNT – Black Mo UNT above UNT01	41.03374	-78.04063
SVN04	SEVN04 – Main stem above Y trib	41.05199	-78.03709
SVN05	SEVN05 – Rght side Y above SEVN02	41.05469	-78.03665
SVN06	SEVN06 – left side Y above SEVN02	41.05555	-78.03734
SVN03	SEVN03 – at road	41.05101	-78.01414
SVN06	SEVN06 – at road	41.0649	-78.03097
21	Moravian Run (R3)	40.9943	-78.0795
MR8	MR8 – trib Peale Road	40.998522	-78.082996
MR7	MR7 – north trib	41.00826	-78.1029
MR6	MR6 – south trib	41.0036	-78.1017
MR5	MR5 – south trib Dorbytown Rd	41.00347	-78.1117
MRD2	MRD2 – 2 pipes south trib	41.00615	-78.118
MR2	MR2- south trib headwaters	41.006686	-78.12225
23	Browns Run (R3)	40.9694	-78.0926
BR4	BR4 - BR at I-80	40.96157	-78.10812
BR5	BR5 - Trib to BR	40.9611	-78.10914
BR3	BR3 - Viaduct Road	40.9622	-78.11118
BR2.5	BR2.5 - Pale Moon Dr	40.97091	-78.12154
BR2	BR2 - Knox Run Road	40.98349	-78.12912
BR1	BR1 - Headwaters	40.99467	-78.13037
33	Munson Run mouth (R3) (PSU MR-1)	40.954734	-78.170169
120	MR UNT-1 (PSU)	40.956335	-78.180361
121	MR UNT-2 (MCWA)	40.956449	-78.183924
122	MR UNT-3 (PSU)	40.959994	-78.185844
123 (#2)	MR UNT-4 (R3)(PSU)	40.960723	-78.188099
124	MR Upstream Trolly (PSU TR-1)	40.96259	-78.201249
124A	Munson Run Hardscrabble (PSU MR-2)	40.95615	-78.17964
52	TR104 – Trout Run Mouth (R3)	40.84519	-78.26649
TR48	TR48 - Impaired TR trib	40.83198	-78.26238
TR1	TR1 - Vicinity combined discharges	40.82702	-78.26908
TR66	TR66 - Impaired trib	40.81595	-78.26615

ID	Station Name	Lat	Long
TR102	TR102 - Trout Run Good Water	40.81667	-78.26504
TR29	TR29 - Low pH Upper Trib	40.82454	-78.26471
TR48A	TR48A	40.83154	-78.26254
6	MC Osceola Upstream Fr Trout Run (R3)	40.8472	-78.2715
55	Bear Run 1 (R3) (BRM1)	40.813146	-78.303206
BRT1L	BRT1(1) L - northernmost trib to east	40.812539	-78.294508
BRTD	BRTD BR-2 Discharge to main stem at road	40.80886	-78.300106
BRT2	BRT2-Trib from west	40.806866	-78.300516
BRT5	BRT5 - 2nd long trib from east	40.804276	-78.29836
BRM4	BRM4 – Bear Run Main Stem 4th sample point	40.804102	-78.298459
BRT1U	BRT1 (2) U	40.8132	-78.2897
BRM2	BRM2 Mainstem	40.809	-78.3009
BRM3	BRM3	40.8069	-78.3006
MC60L	MC60L (R3)	40.8462	-78.2909
MC70L	MC70L (R3)	40.8458	-78.2907
MC75L	MC75L (R3)	40.84556	-78.29094
MC100W	MC100 @ Weir (R3)	40.8437	-78.2897
MC110L	MC110L (R3)	40.8425	-78.2905
MC130L	MC130L (R3)	40.8379	-78.2944
MC140L	MC140L (R3)	40.8366	-78.2961
80	MC - Scrapyard Sample Point (R3)	40.82308	-78.30075
78	MC-16 Disch (R3)	40.80439	-78.32788
79	QMC6 - Upstream Whiteside + MC16 (R3)	40.8043	-78.328
MC15	MC15	40.8029	-78.3297
MC14	MC14	40.801	-78.3318
MC13	MC13	40.8004	-78.3337
MC12	MC12	40.7996	-78.3362
MC11	MC11	40.7949	-78.3391
MC10	MC10	40.7931	-78.3397
7	MC Hale (R3)	40.7881	-78.3426
66	MC-7 Discharge (R3)	40.78138	-78.34348
68	MC-8 Discharge (R3)	40.78179	-78.34248
MC8.5	MC-8.5 Discharge	40.785	-78.34167
64U	MC FORE Above	40.7556	-78.3783
MC-FORE	MC FORE	40.7537	-78.3793
64	MC FORE complex outlet	40.75543	-78.3755
60	UNT1	40.7909	-78.3441

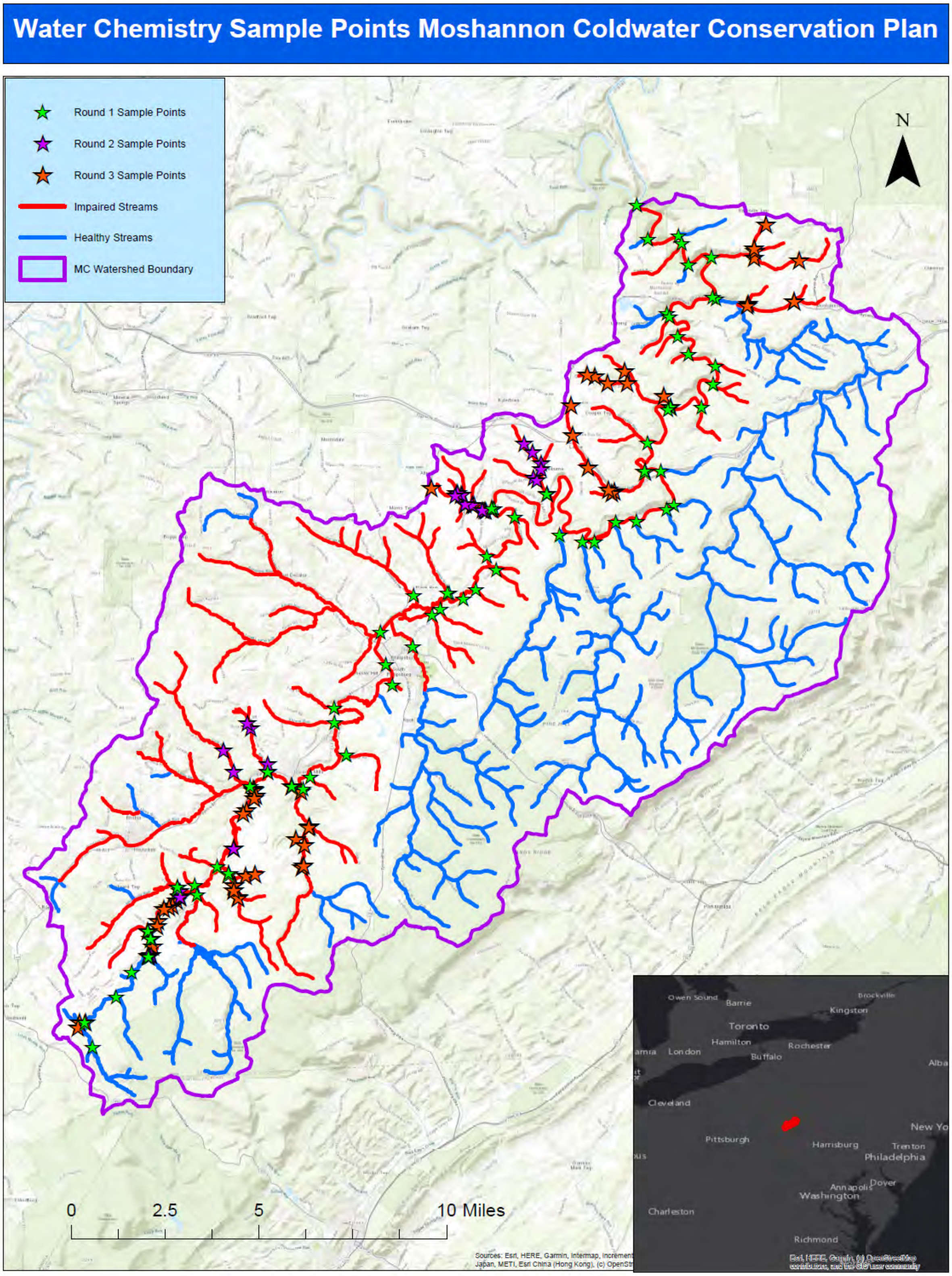

Figure 16. Water Chemistry Sample Points From Three Rounds of Water Sampling Throughout Length of Moshannon Creek Watershed.

BENTHIC MACROINVERTEBRATE SAMPLING METHODS

Site Selection: The design method chosen for site selection is based on the Cause and Effect Monitoring model. A cause and effect sampling design is employed to investigate possible relationships between point or nonpoint sources of conventional pollutants and known or suspected instream water quality problems through the collection and analysis of biological, physical, and chemical data.

On the day of sampling, the team conducted multiple field tests to sample water quality parameters using an Apera water quality testing kit that was calibrated the night before sample collection. The team sampled sites throughout the mainstem of Bear Run and two sites on Moshannon Creek's mainstem to identify input tributaries or point source pollution with a low pH and/or high Conductivity to determine the best sites on the stream to represent the impact of point source pollution on the macroinvertebrate community.

Bear Run Site #1 (40.804102, -78.298459) was located directly upstream of a water quality sample site at an input tributary with a low pH and high Conductivity (field observed 3.89 pH & 149.6 Conductivity).

Bear Run Site #2 (40.804276, -78.29836) was located directly downstream of the impaired input tributary with low pH & high Conductivity.

Habitat observed at both sample sites were comprised of Silt/sand/gravel substrate.This habitat includes sandy, silty, or muddy stream bottoms; rocks along the stream bottom; and/or wetted gravel bars. This habitat may also contain algae covered rocks (sometimes called Aufwuchs).

Moshannon Creek Site #1 (-78.375708,40.751238) was located upstream of known legacy mining activity and known water quality degradation. The substrate at sample site #1 was a silt/sand/gravel substrate with good size distribution of cobble, and three riffle-run stations were selected in a 100 meter reach where no human or animal (beaver) impact was evident.

Moshannon Creek Site #2 (-78.370650,40.758047) was located downstream of Site #1 below a known impaired input tributary that enters Moshannon Creek from the West. This site is in an area of obvious historical beaver activity. Three survey stations at site #2 were selected based on available 100 meter reaches that contained riffle-run habitat.

Sample Collection: The team employed the USEPA's Rapid Bioassessment Protocol for use in Wadeable Streams and Rivers (Barbour et al.1999) single, most productive habitat (Riffle-Run) approach. Two benthic macroinvertebrate sample collection sites were identified by delineating two 100-meter reaches along the stream where the best available representation of riffle-run habitat existed for the stream segment of interest. Within each reach, three, three-foot by three-foot kick stations were established. Each station sampled was kicked for 1 minute directly upstream of a non-truncated D-framed net with 500 μm mesh.

Stations were "kicked" starting with the downstream station first so as not to disturb the other two stations upstream.

One member of the team held the D-frame net in a constant location for 1 minute at station #1, while the other team member dislodged macroinvertebrates from large rocks in the 3 foot by 3 foot sample area, and then thoroughly dislodged macroinvertebrates from the smaller cobble in the sample area by "kicking" the streambed with their feet.

Following capture of specimens from the first of three sample stations in site #1, the contents of the D-frame net were emptied into a clean 5 gallon bucket with a small amount of clean stream water. Water was poured over the outside of the net to dislodge all specimens from the net. Additionally, individual specimens were manually picked from the net to ensure no specimens were lost.

Upon collecting the specimens from the first sample station, the above process was repeated for the final two sample stations at site #1. Specimens from all three sample stations were collected in the same 5 gallon bucket to create a composite score for the sample site based on the three sample stations within the 100 meter reach of the first station.

Upon completion of the collection process for site #1, the contents of the 5 gallon bucket were emptied into a large shallow white pan. Using tweezers, eye droppers, and a small spatula, individual macroinvertebrates were picked from the shallow pan and sorted into divided white sorting trays. Specimens were sorted by order in each compartment of the sorting trays.

Assessment: The Wadeable Freestone Single, Most Productive Habitat (Riffle-Run) Stream Macroinvertebrate Assessment Method was used to assess the macroinvertebrate community at both survey sites on Bear Run and Moshannon Creek.

This assessment method is designed to make ALU (Aquatic Life Use) assessment determinations using benthic macroinvertebrate communities in Pennsylvania's wadeable, freestone, riffle-run streams. Through direct quantification of biological attributes along a gradient of conditions, the index of biotic integrity (IBI) provided in this assessment method measures the extent to which anthropogenic activities compromise a stream's ability to support healthy aquatic communities (Davis and Simon 1995).

Six metrics are included in this assessment protocol:

Total Taxa Richness:

This taxonomic richness metric is a count of the total number of taxa in a subsample. Generally, 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. Other benefits of including this metric include its common use in many biological monitoring and assessment programs in other parts of the world as well as its ease of explanation and calculation.

Ephemeroptera + Plecoptera + Trichoptera Taxa Richness

(Pollution Tolerance Values 0-4 only)

This taxonomic richness metric is a count of the number of taxa belonging to the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) in a subsample. 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, many types of pollution (Lenat and Penrose 1996), although sensitivity to different types of pollution varies among taxa in these insect orders. The version of this metric used here only counts EPT taxa with PTVs of 0 to 4, excluding a few of the most tolerant mayfly and caddisfly taxa. 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. This metric has a history of use across the world and is relatively easy to use, explain, and calculate (Lenat and Penrose 1996).

Beck's Index (version 3)

This taxonomic richness and tolerance metric is a weighted count of taxa with pollution tolerance values of 0, 1, or 2. The name and conceptual basis of this metric are derived from the water quality work of William H. Beck in Florida (Beck 1955). This metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of pollution sensitive taxa.

Shannon Diversity

This community composition metric measures taxonomic richness and evenness of individuals across taxa of a sub-sample. 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. The name and conceptual basis for this metric are derived from the information theory work of Claude Elwood Shannon (Shannon 1948).

Hilsenhoff Biotic Index

This community composition and tolerance metric is calculated as an average of the number of individuals in a sub-sample, weighted by pollution tolerance values. Developed by William Hilsenhoff, the Hilsenhoff Biotic Index (Hilsenhoff 1977, 1987, 1988; Klemm et al. 1990) generally increases with increasing ecosystem stress, reflecting increasing dominance of pollution-tolerant organisms. Percent Sensitive Individuals (Pollution Tolerance Values 0-3 only) This community composition and tolerance metric is the percentage of individuals with pollution tolerance values of 0 to 3 in a sub-sample and is expected to decrease in value with increasing anthropogenic stress

Percent Sensitive Individuals (Pollution Tolerance Values 0-3 only)

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

Values from the six metrics are then standardized based on stream size and averaged to obtain a final IBI Calculation Score. Both macroinvertebrate sample sites in this report were standardized using the “small stream” standardization values (i.e. Hilsenhoff Biotic Index Standardized score = (observed value)/(standardization value) * 100).

Standardization value table (Pennsylvania DEP Bureau of Clean Water An Index of Biotic Integrity for Benthic Macroinvertebrate Communities in Pennsylvania's wadeable, freestone, riffle-run streams 2015):

Metric	Metric Standardization Values	
	smaller streams most 1st to 3rd order < 25 square miles	**larger streams** most 5th order and larger > 50 square miles
Total Taxa Richness	33	31
EPT Taxa Richness (PTV 0-4 only)	19	16
Beck's Index (version 3)	38	22
Hilsenhoff Biotic Index	1.89	3.05
Shannon Diversity	2.86	2.86
Percent Sensitive Individuals (PTV 0-3 only)	84.5	66.7

The resulting IBI value is evaluated using the flowchart below to determine whether the stream is impaired.

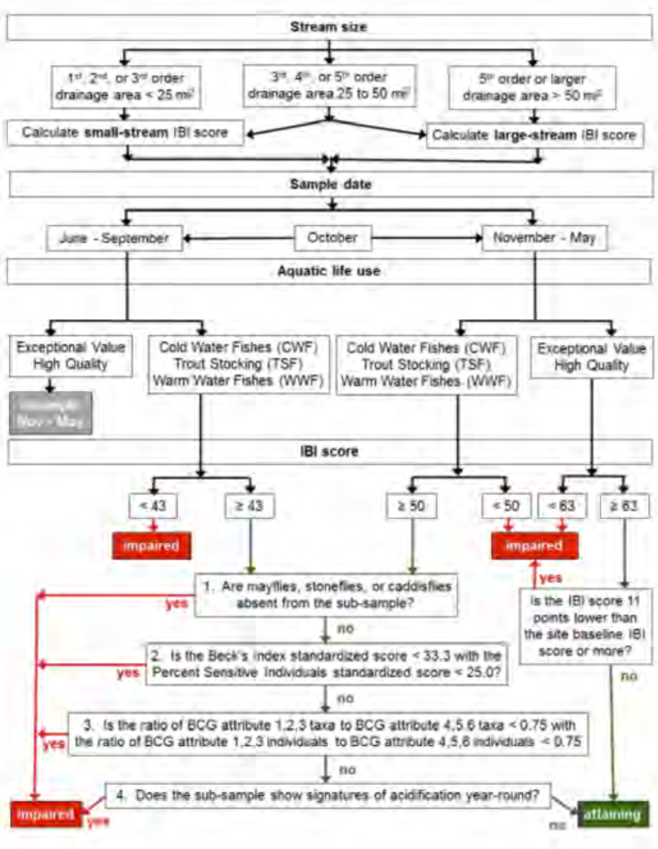

Figure 17. Flowchart for Impairment Determination. From PA DEP.

Project Results

The results discussion below is divided into three sections to reflect our three rounds of water sampling. The results for the watershed are displayed in multiple maps. The three tables of sample points in the **'Methods'** section of this plan may be useful when reviewing the maps. Later in this plan, each tributary stream to the main stem of Moshannon Creek, and each sampled section of the main stem is discussed. Tabular water sample data is presented then and a link to a spreadsheet version of this data is provided in several places in this document and the appendix.

Much of the analysis of the data from the first round was performed by Tom Clark, Mine Drainage Program Coordinator with the Susquehanna River Basin Commission. The results from the first round were used by the Restoration Committee of the Moshannon Creek Watershed Association to select the sample points for the second round of water sampling. The results of the first and second rounds were examined by the Restoration Committee to select sample points for the third round. In addition to water chemistry sampling, the third round included benthic macroinvertebrate sampling at several locations in the Bear Run watershed and above and below the impact of the MC-FORE AMD discharge in the main stem of Moshannon Creek.

Results from the first round of water sampling performed in late July 2020

(Adapted from analysis performed by Tom Clark of the SRBC).

Good Streams That Need A Second Look

Discussions about the Moshannon Creek watershed often focus on the bad news. While still impaired, the watershed, for the most part, is highly improved in many areas, including on most of the mainstem stations. In addition, there are several tributaries that deserve a second look to determine what they have in them in terms of fish populations (wild brook trout) that could allow those streams to be listed for additional protection. Working downstream to upstream, the first is the lower section of **Black Moshannon Creek**. The lower section of Black Moshannon, from the unnamed trib at RM 3.27 to its confluence with Moshannon, is not listed as Wild Trout. This section should be investigated to determine whether there are wild trout in this section in order to get it properly listed if they are present. **Crawford Run** is improved since last sampled, containing a pH of 6 with low metal concentrations. Crawford Run is also not listed as Wild Trout, but could contain a population. **Laurel Run (I-80), Potter Run, and Tark Hill Run** are other streams that haven't been sampled in the past that came back with good quality through this most recent water sampling. These streams are not listed as Wild Trout, but could have such populations. **Beaver Run** has much of its headwaters listed as Class A. That listing ends at Goss Run, even though Goss Run is relatively good in quality. The lower sections of Beaver Run should be investigated further for populations of wild trout, The July 2020 water chemistry sampling of the lower section of Beaver Run indicated a high pH and just a touch of iron.

Where The Loading Is Located

The most important data to use when attempting to restore a watershed is where the acidity and metal loadings are located. While the late July sampling was scheduled intentionally to be in a period of low flow, a small amount of rain that happened did impact the mainstem sampling in a small way, likely inflating the numbers in the "Watershed Area 2-1 Not Sampled" (this is the watershed area between Station 1 (mouth of Moshannon Creek at the West Branch) and 2 (Moshannon Creek just upstream of Black Moshannon Creek) that is not drained by a tributary. It is suspected that this section is too highly represented in the loading analysis due to this rainfall increasing flows along the mainstem. When looking at loadings, there are some tributaries that are represented, but aren't as impactful as they appear. For example, except for impaired tributaries in the last mile before its junction with Moshannon Creek, Black Moshannon is clean, but it has such a high flow (it is 20% of the whole watershed) that it is overly represented in the loading numbers. Laurel Run in Phillipsburg has high Manganese and Sulfate loading, but is high in pH, low in other more toxic metals, and has a fish population.

The Round 1 sample results worksheet that is available through the following link is set up so that it highlights sections that seem to be the primary contributors driving the issues on Moshannon Creek (they are highlighted in red).

https://moshannoncreek.org/reports

In terms of acidity loading, almost 70% is originating in only three areas; **Sulphur Run, the Watershed Area Between 7 (the Hale Road crossing of Moshannon Creek) and 6 (Moshannon Creek at Osceola Mills upstream of Trout Run), and the Watershed Area Between 5 (Moshannon Creek near the Presqueisle Rd Bridge in Philipsburg) and 4 (Moshannon Creek downstream of Munson Run and the Casanova Road Bridge)**. **Munson Run, the Hawk Run Discharge and Trout Run** are also major players in terms of acidity loading.

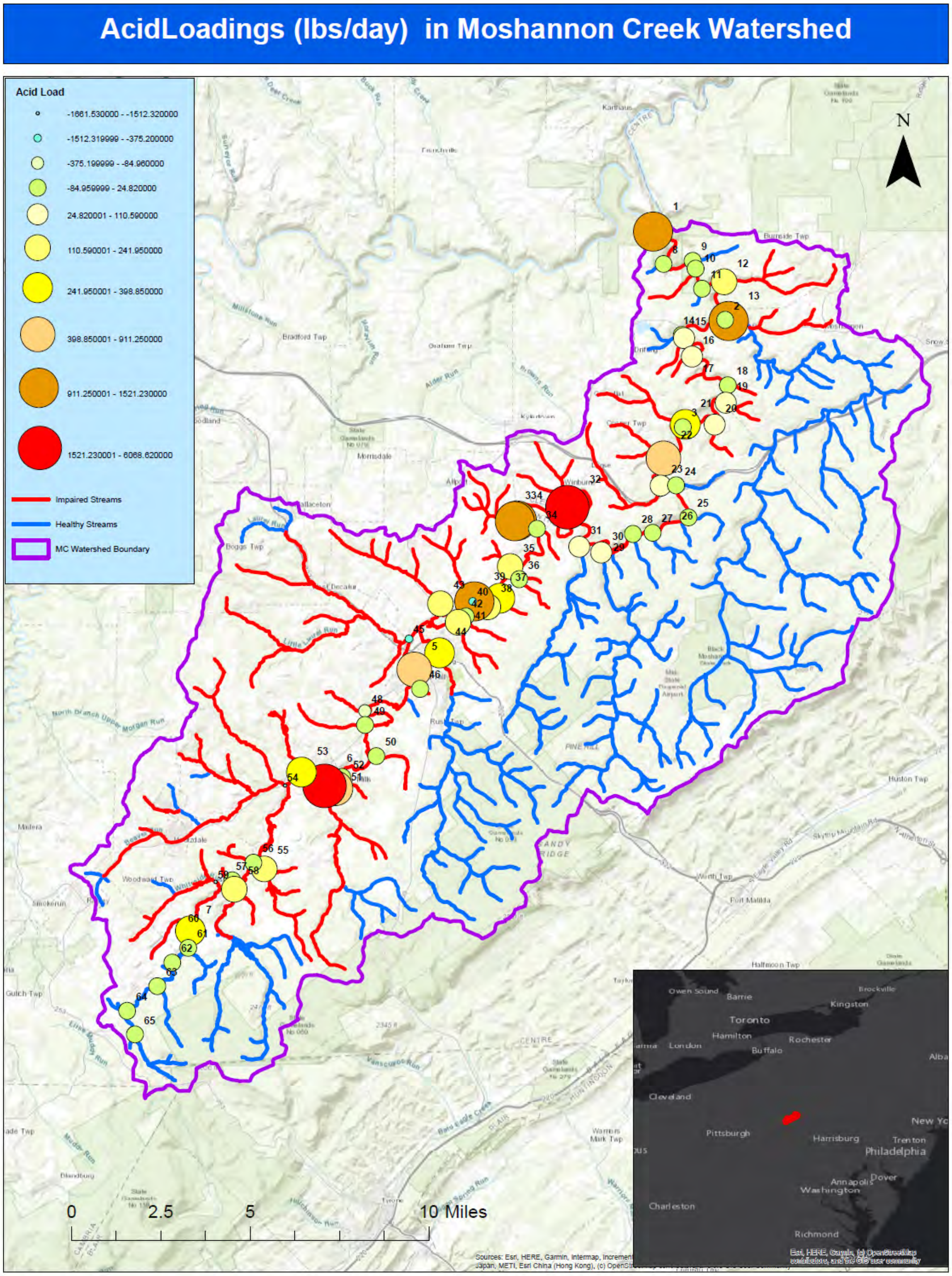

Figure 18. Acid Loadings Measured in the Moshannon Creek Watershed - July 2020

As expected, the **Hawk Run Discharge** is where the most iron loading is originating (24%). Adding in **7-to-6, Sulphur Run, and Munson Run**, and 72% of the iron loading is only coming from four sources. As each contaminant is discussed, a pattern is emerging.

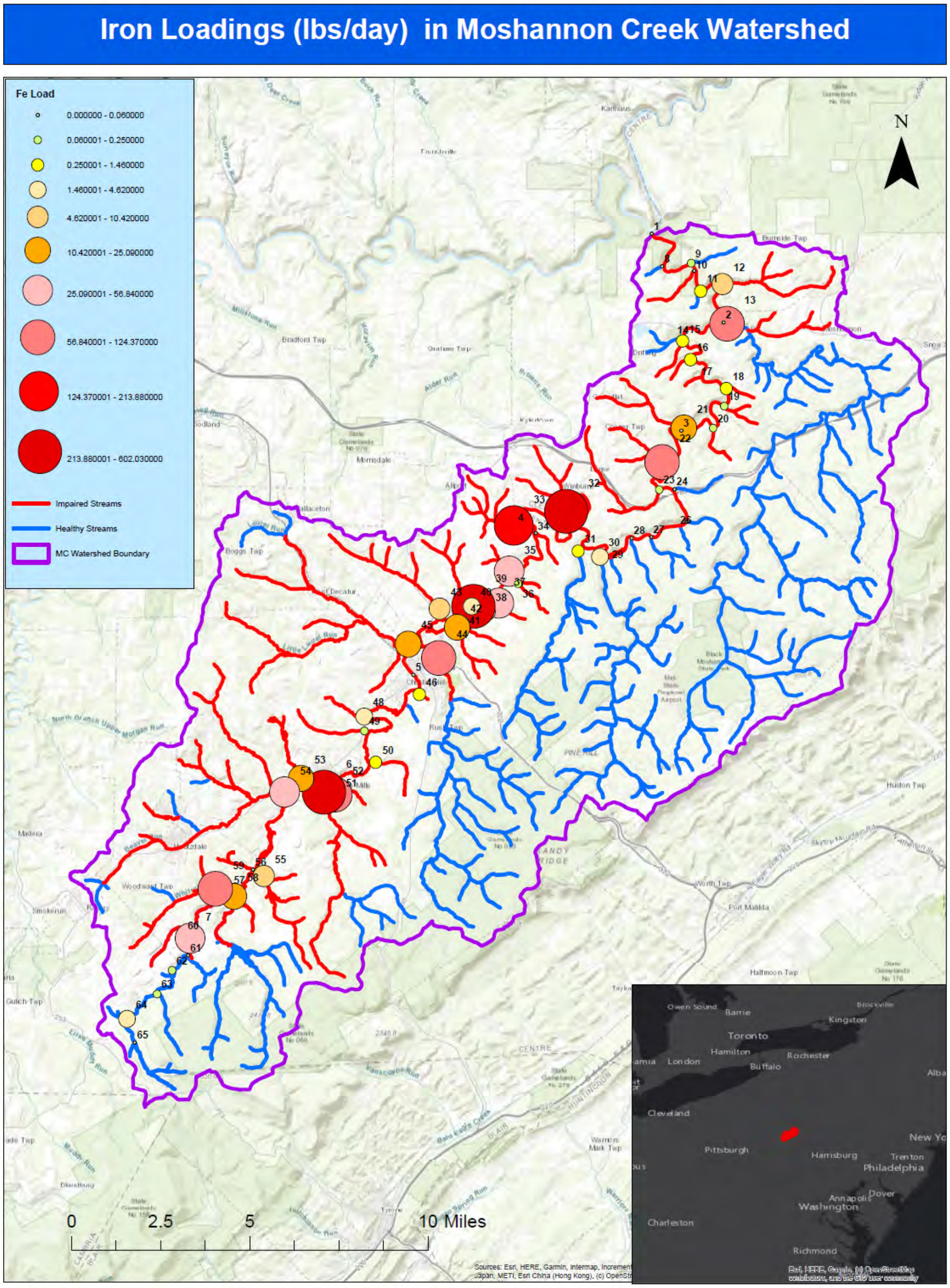

Figure 19. Iron Loadings Measured in the Moshannon Creek Watershed July 2020

Manganese is more significant for drinking water than for aquatic life, unless concentrations are very high, but **7-to-6** is once again a major player.

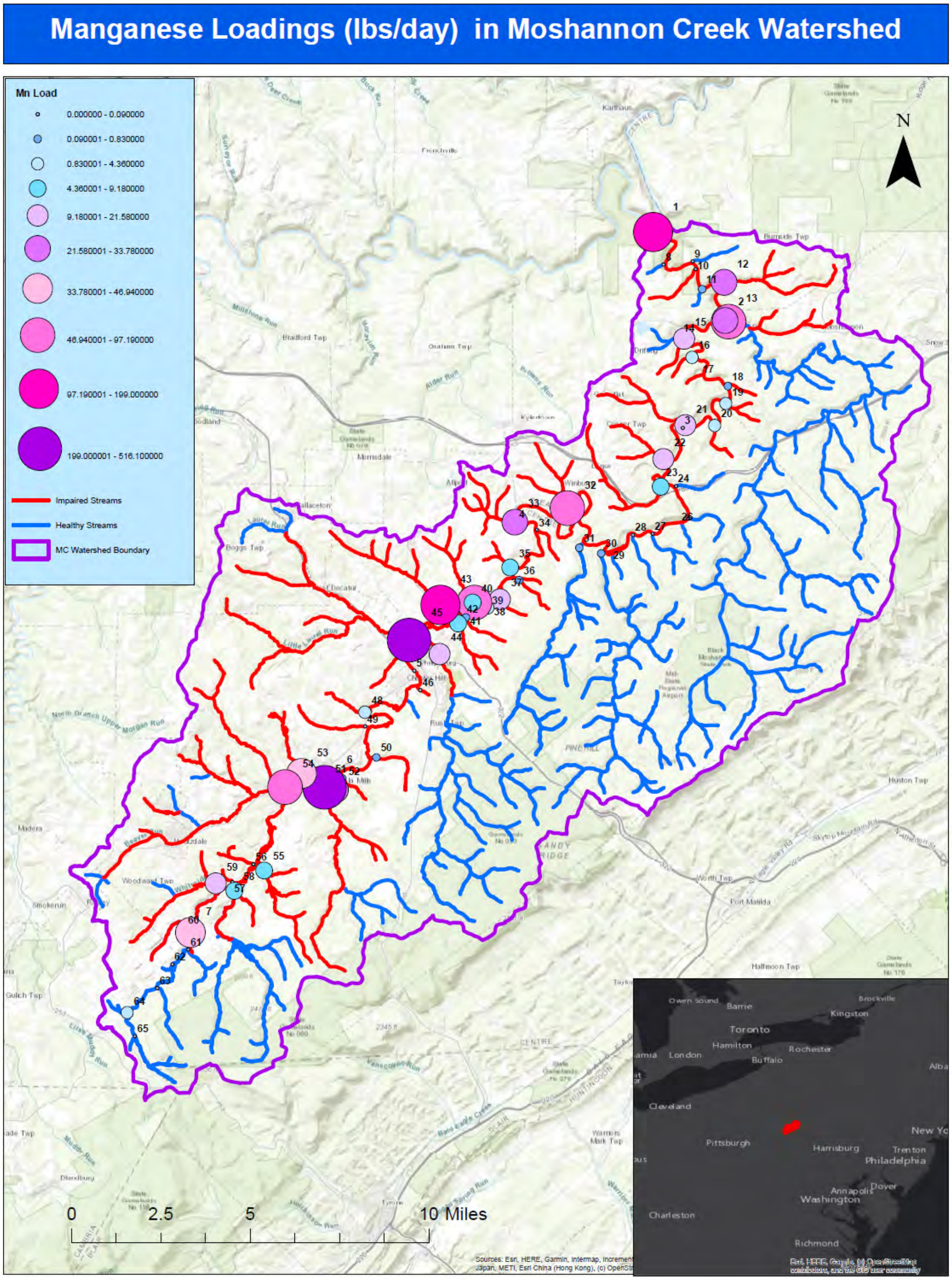

Figure 20. Manganese Loadings Measured in the Moshannon Creek Watershed July 2020

In terms of aluminum loading, and disregarding the too highly represented 2-to-1 section, 36 percent comes from one source, **Sulphur Run**, which is by far the worst tributary in the watershed. Adding in **7-to-6, Munson Run, and Trout Run**, 70 percent of the aluminum loading is coming from four sources.

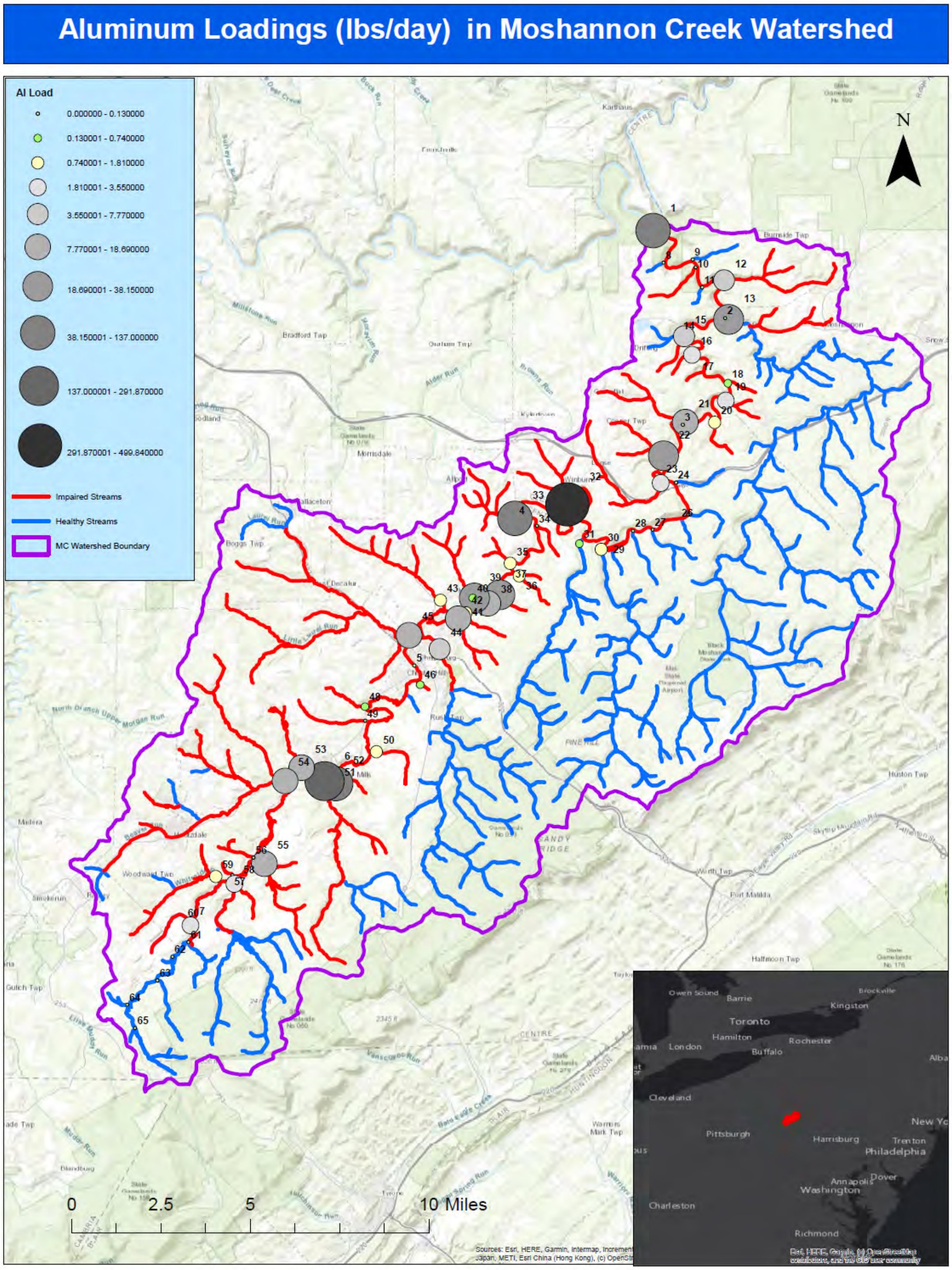

Figure 21. Aluminum Loadings Measured in the Moshannon Creek Watershed in July 2020

Sulfate, much like Manganese, isn’t a significant biology killer unless at extremely high concentrations, but allows for tracking as sulfate doesn’t precipitate very easily. Once again disregarding 2-to-1 and Laurel Run, 50% of the Sulfate loading is coming from **7-to-6, Sulphur Run, 6-to-5, and the Hawk Run Discharge**. When you accumulate the rankings of the different contaminants, **7-to-6 and Sulphur Run are #1 and #2, followed by the Hawk Run Discharge, Munson Run, Trout Run, 5-to-4, 6-to-5, and Grassflat Run**.

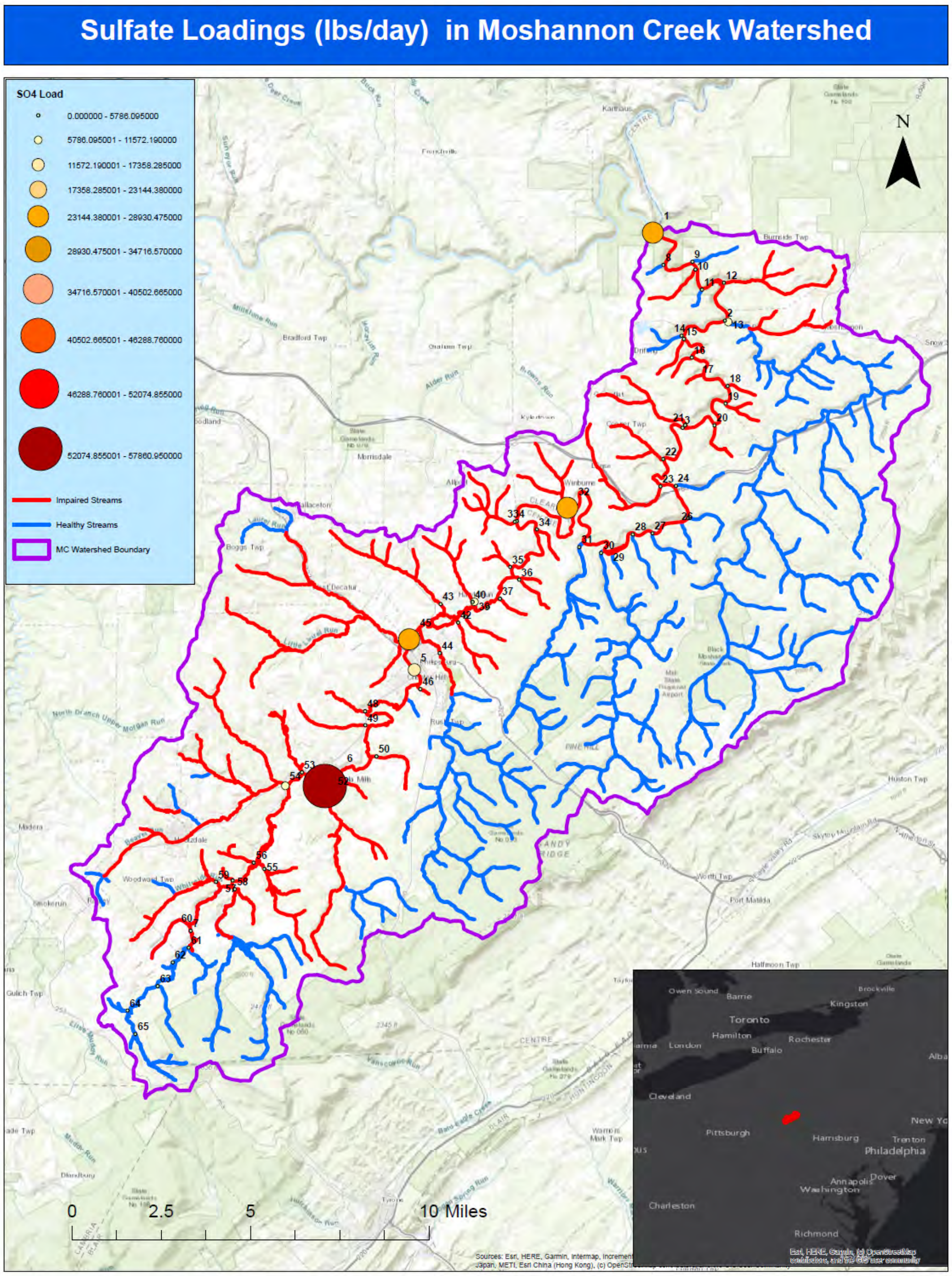

Figure 22. Sulfate Loadings Measured in Moshannon Creek Watershed July 2020

Streams That May Have Gotten Worse Or Just Need Additional Investigation

Round 1 sampling had some bad news stories as well. In particular, there are sections that need more investigation because they either do not have enough data or seem to have gotten worse in the last decade or two. First and foremost are the tributaries and discharges along Loch Lomond Rd and Coaldale Rd. These include **Onemile Run, Unnamed Trib 41, Wolf Run, and Barlow Hollow**. Those tributaries haven't been investigated enough, they are of awful quality, and seem to have gotten worse. **Trout Run** is not only a heavy load stream, but also a stream that may have gotten worse. One other station where this is a problem is the mainstem station at Hale Rd **(#7**). That station also seems to have gotten worse and may have something to do with the three **discharges near the mouth of Roup Run** that need further investigation as well.

Another way of examining the data from the first round of water sampling is to normalize loadings by area. Below, the numbers are all in lbs per day/square mile of watershed area. The Hawk Run discharge is not included in the comparisons below, because it is not certain where all it pulls water from. Here are the top 5 from each important parameter. A pattern continues.

<u>Acidity</u>

Sulphur Run	1754
7-6	622 (Hale Road to Osceola Mills)
5-4	527 (Presqueisle Road to Downstream of Munson Run)
Munson Run	448
UNT 38	420 (Unnamed tributary near Wolf Run)

<u>Fe</u>

Sulphur Run	135
7-6	77
Munson Run	70
UNT 35	43 (Unnamed tributary across Moshannon Creek from Barlow Hollow)
Wolf Run	37

<u>Al</u>

Sulphur Run	144
UNT 38	44
7-6	40
Wolf Run	35
Munson Run	34

<u>SO4</u>

7-6	7826
Sulphur Run	6897
6-5	2113
Munson Run	1579
UNT 35	1438

Discussions of the findings of the first round of sampling led to the formation of a more formal Restoration Committee. The Committee then selected the sampling focus for Round 2 and created an initial plan for what would be sampled in Round 3. This led to a period of scouting discharges and watershed sample points within tributary watersheds. Additional main stem sample points between round 1 points were also scouted and selected within important parts of the main stem.

Round 2 Water Sampling Sites and Results

The importance of the discharges MC7 and MC8 that emerge on the Centre County side of Moshannon Creek upstream of Hale Road was recognized by New Miles of Blue Stream in the restoration plan for the headwaters of Moshannon Creek. While scouting sample spots for these discharges with the landowner on September 3, 2021, the landowner informed MCWA volunteers of a third discharge that was subsequently labeled MC8.5. A search of aerial imagery seemed to indicate the past existence of similar discharges on the Clearfield County side of the stream in this same area. MC7, MC8 and MC8.5 were all flowing when the sample points were scouted on 9/3/2021. When sampled on 9/25/2021, MC8.5 was not flowing and MC8 was barely flowing, so the sample results from 9/25/2021 mostly show the impact of MC7. The Moshannon Creek sample taken on 7/24/2021 at Hale Road, downstream of their impact, was notably worse than the sample taken at the same spot on 9/25/2021. This indicates that the combined effect of the three discharges when all three are flowing is much worse than MC7 by itself. One of the possible sample points on the Clearfield County side of Moshannon Creek in this area was found to be dry and the others were not easily accessed by crossing the main stem due to wetlands. Because of the drought conditions and this site’s importance, the discharges at this site were resampled in the third round of sampling in April 2021.

Round 1 sampling showed that the AMD added to Moshannon Creek between Hale Road (sample point 7) and Osceola Mills upstream of Trout Run (sample point 6) made this stretch of the watershed one of the most important sections to investigate further. This stretch was divided by adding two more sample points, one upstream of the junction with Whiteside Run and another sample point near a scrapyard for mining machinery near Osceola Mills. When the sample points were scouted, an obvious mine discharge, MC16, was found to be near the sample point upstream of Whiteside Run and it was added to the sampling plan. When these points were sampled in Round 2, the results indicated that water quality in Moshannon Creek continues to deteriorate in the stretch downstream of Hale Road and upstream of Whiteside Run. This stretch has multiple small mine discharges. Sampling these discharges was added to the plan for round three. It was also found that Moshannon Creek lost a lot of water in the stretch upstream of Whiteside Run. This loss of flow magnifies the impact of mine discharge MC16, which is just downstream of the sample point.

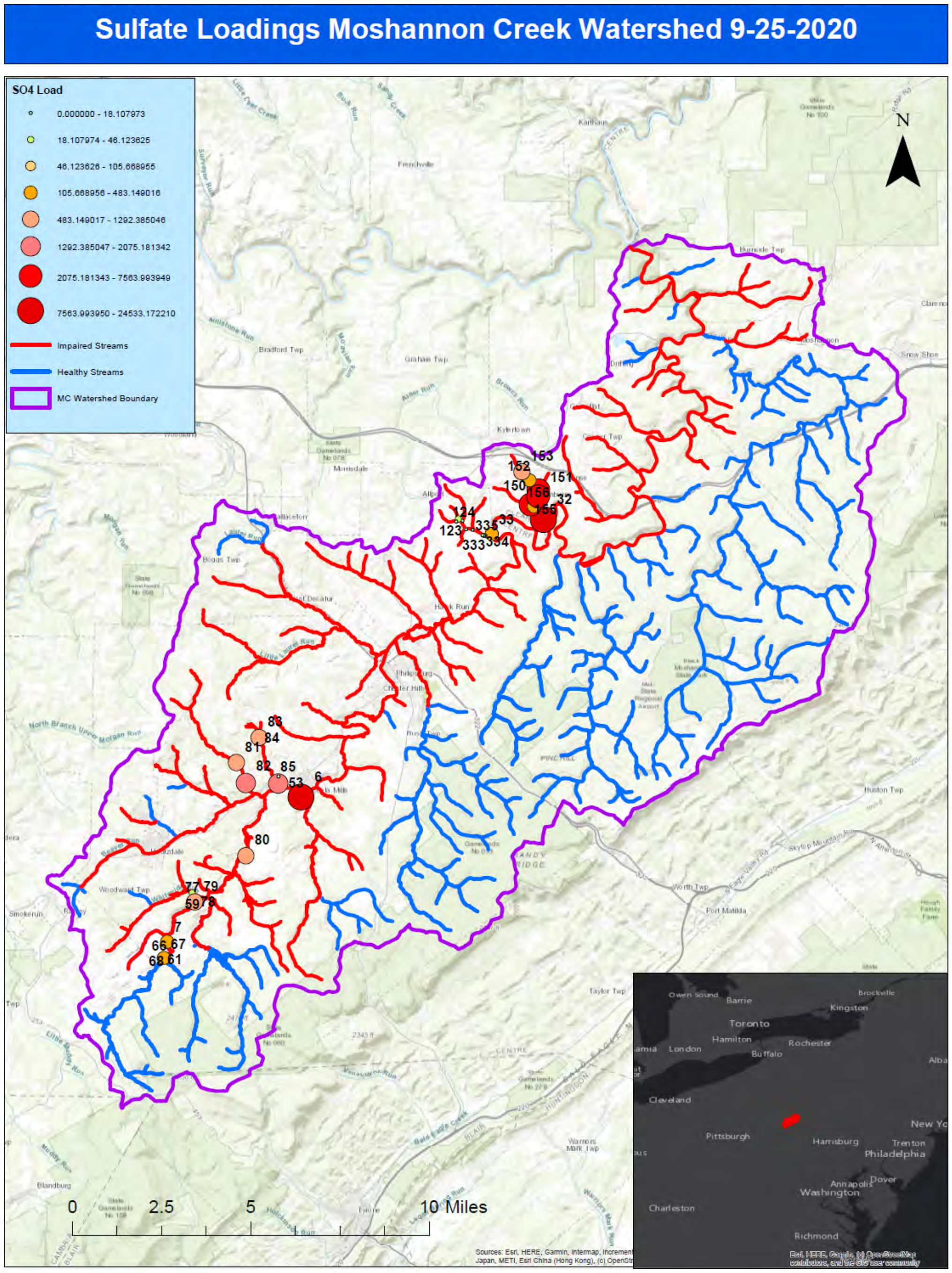

Figure 23. Sulfate Loadings for Sampled Areas of Moshannon Creek Watershed Round 2

The stretch of Moshannon Creek between upstream of Whiteside Run and the Scrapyard sample point was found to have considerably more water after Mountain Branch and Bear Run discharged into it. The increase in loadings found at the Scrapyard sample site could largely be accounted for by loadings from discharge MC16, Mountain Branch and Bear Run. Mountain Branch has known AMD discharges within its watershed, but its water quality is high enough that it improves Moshannon Creek when it enters it, and it is fish habitat. Bear Run was identified as a watershed for additional sampling in Round 3.

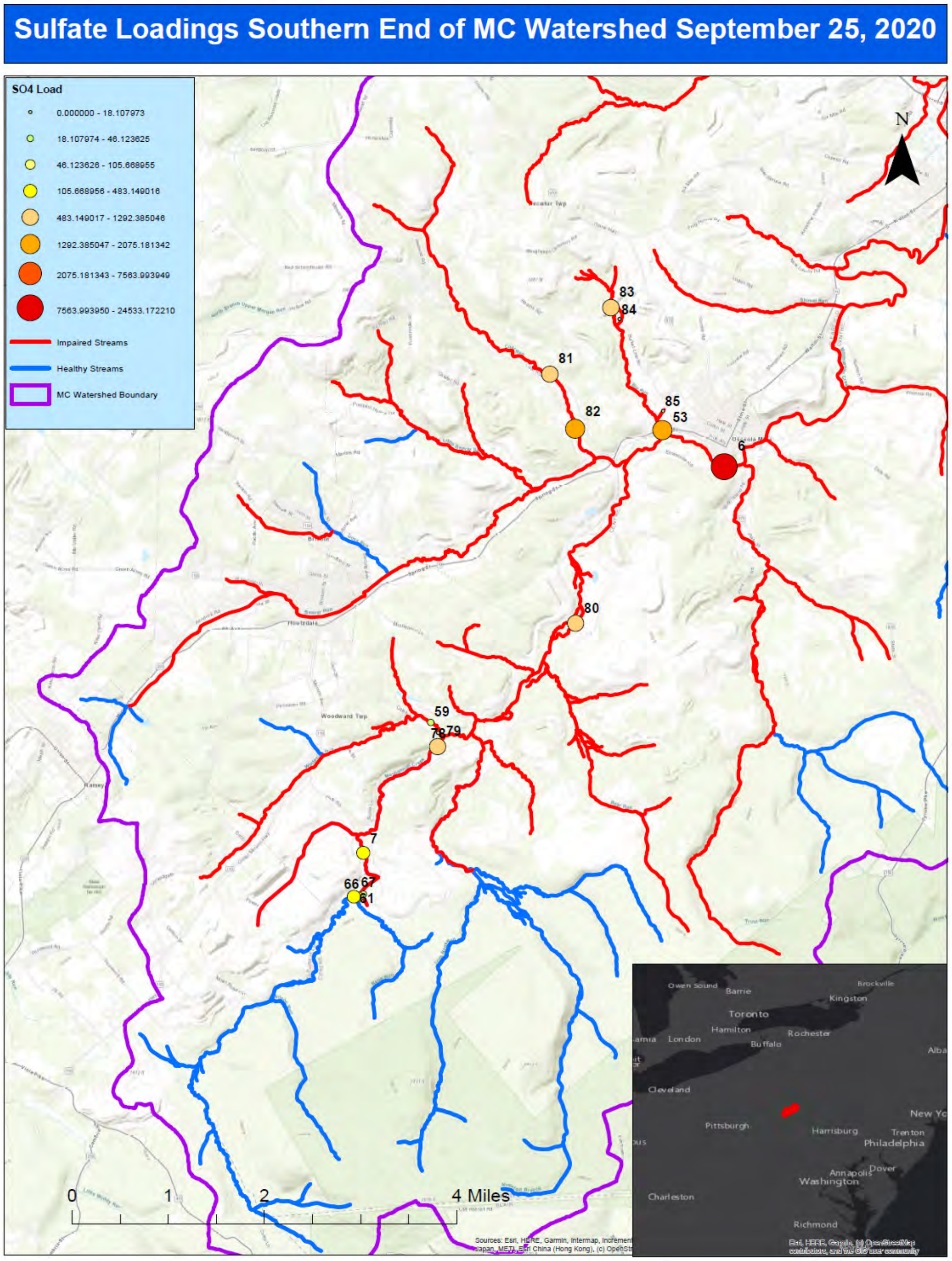

Figure 24. Sulfate Loadings in Southern End of Watershed Round 2 Sampling

The stretch of Moshannon Creek between the Scrapyard sample point and Osceola Mills had substantial increases in AMD that could not be accounted for by the loadings from Beaver Run and Big Run. Previous studies had identified significant old deep mine discharges on the Centre County side of the stream across from the coal loading tipple near Osceola Mills. Resampling those discharges to quantify their current impact was planned for Round 3.

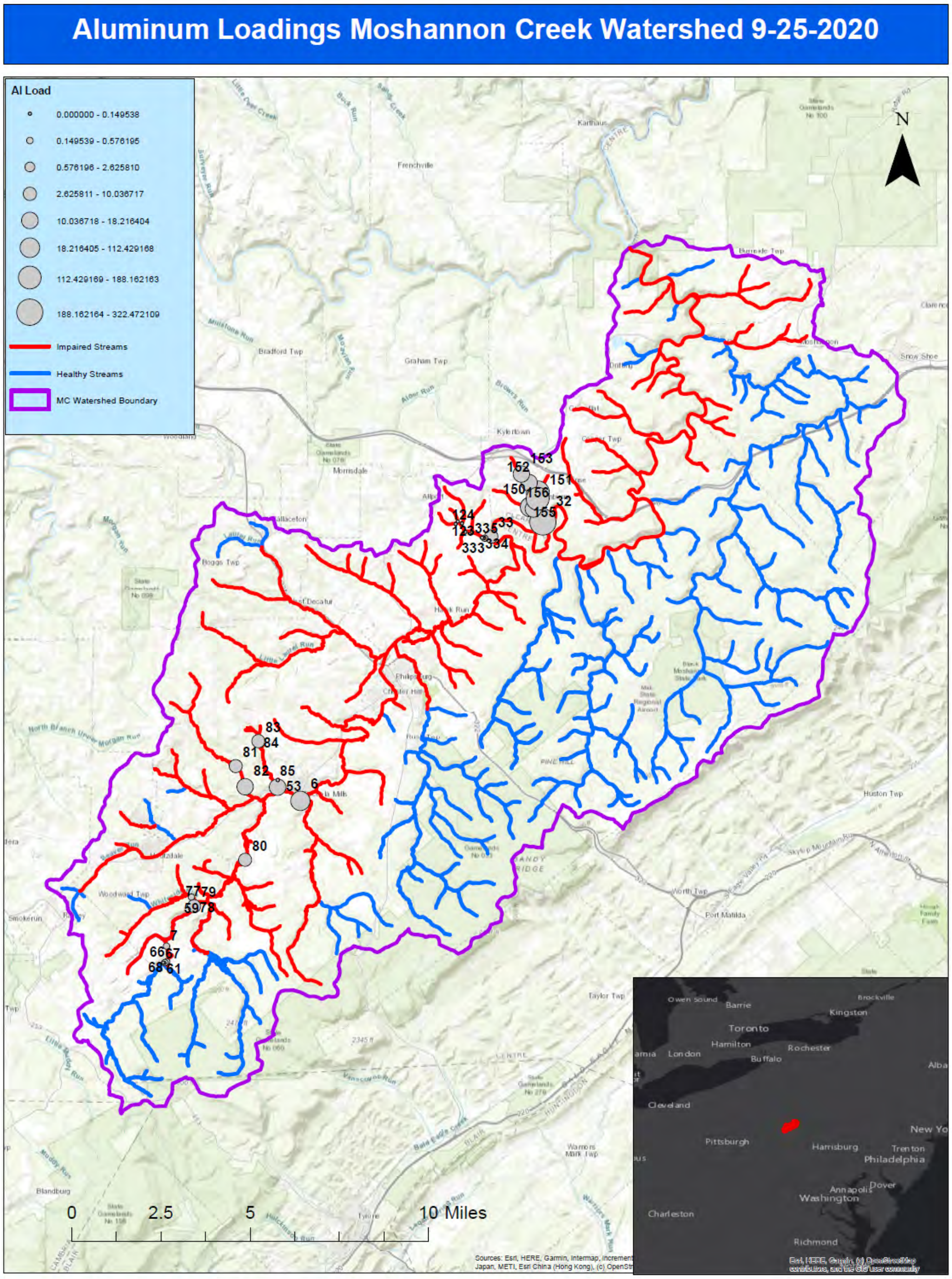

Figure 25. Aluminum Loading at Points Sampled in Round 2 Water Sampling

One stream, Whiteside Run, was evaluated in the second round of water sampling with the hope that the improved water chemistry found at its mouth in round 1 indicated that the stream was recovering and may have parts of the watershed that were no longer impaired. Those hopes increased when small fish were found at one of the sample points that was selected when MCWA volunteers were scouting sample points in late August. Unfortunately, it was discovered that Whiteside Run lacks resiliency in drought conditions. Both of the sample points that were selected upstream in the watershed were found to be dry on September 25, 2021, including the location that had fish a few weeks earlier.

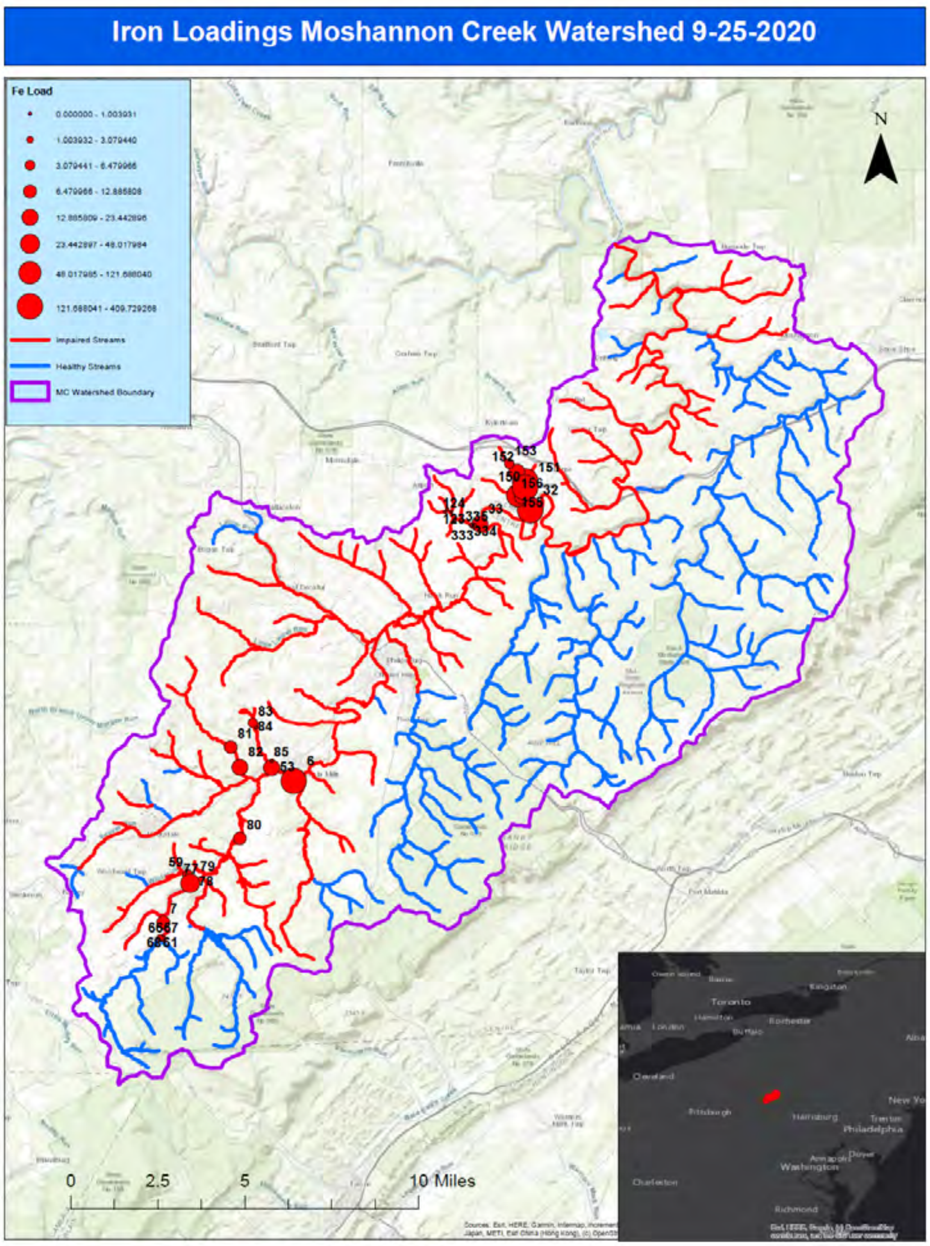

Figure 26. Iron Loading at Points Sampled in Round 2 Water Sampling.

Another watershed that was found to be supplying much improved water to Moshannon Creek in round 1 sampling was Beaver Run. This had occurred even though some of the tributaries had historically been considered to be very impaired, especially Coal Run. The restoration committee decided to sample in the Coal Run watershed to determine its current status. Unfortunately, it was found that Coal Run is still very impaired. The volume of cleaner water in Beaver Run is limiting the impact of Coal Run farther downstream, but Coal Run still needs help.

Round 1 sampling at the mouth of Big Run indicated that this stream is still impaired. Big Run is not very big. Historical sampling on Big Run had the highest measured flow at approximately 1000 gpm, and most flows measured were well below that number. The above being said, Big Run has water quality similar to many mine discharges. In round 2, both the upper and lower portions of Big Run were sampled as well as two branches that appear in aerial imagery to flow from mine discharges. None of the samples made in the Big Run watershed indicated good water. The samples pulled from the suspected discharges had chemistry that indicated they were mine water. Big Run will need attention, especially as upstream improvements magnify its potential to degrade Moshannon Creek.

Round 1 water sampling indicated the importance of Munson Run. During round 2 sampling, a team sampled this watershed on September 25, 2021. The team discovered that Munson Run's watershed was dry in many places during 2020's drought conditions. The team sampled AMD discharges that had been piped away from residences. They also made the important discovery that, at least during drought conditions, most of the AMD in Munson Run is emerging directly into the stream bed of the main stem over the last half mile before it flows into Moshannon Creek. A need for data from Munson Run during periods of higher flow was recognized. It was revisited during the third round of water sampling.

Round 1 water sampling of Sulfur Run clearly indicated the importance of this stream to recovery efforts in the Moshannon Creek and West Branch of the Susquehanna River watersheds. The measured flow in the stream did not seem to correspond to the drought in progress and the water quality was terrible. The Susquehanna River Basin Commission began exploring this watershed and performing regular water sampling upon it. The SRBC discovered that more than 90% of the flow in the stream originates in deep mine discharges from the Winburne #45 and Winburne #46 Collieries. Much of the remaining flow in the main stem originates from smaller mine discharges. Sulfur Run is well named. The SRBC has established a program of regular water sampling in this watershed that is ongoing. The results used in this Coldwater Conservation Plan are from the first month of the SRBC's regular sampling within this watershed.

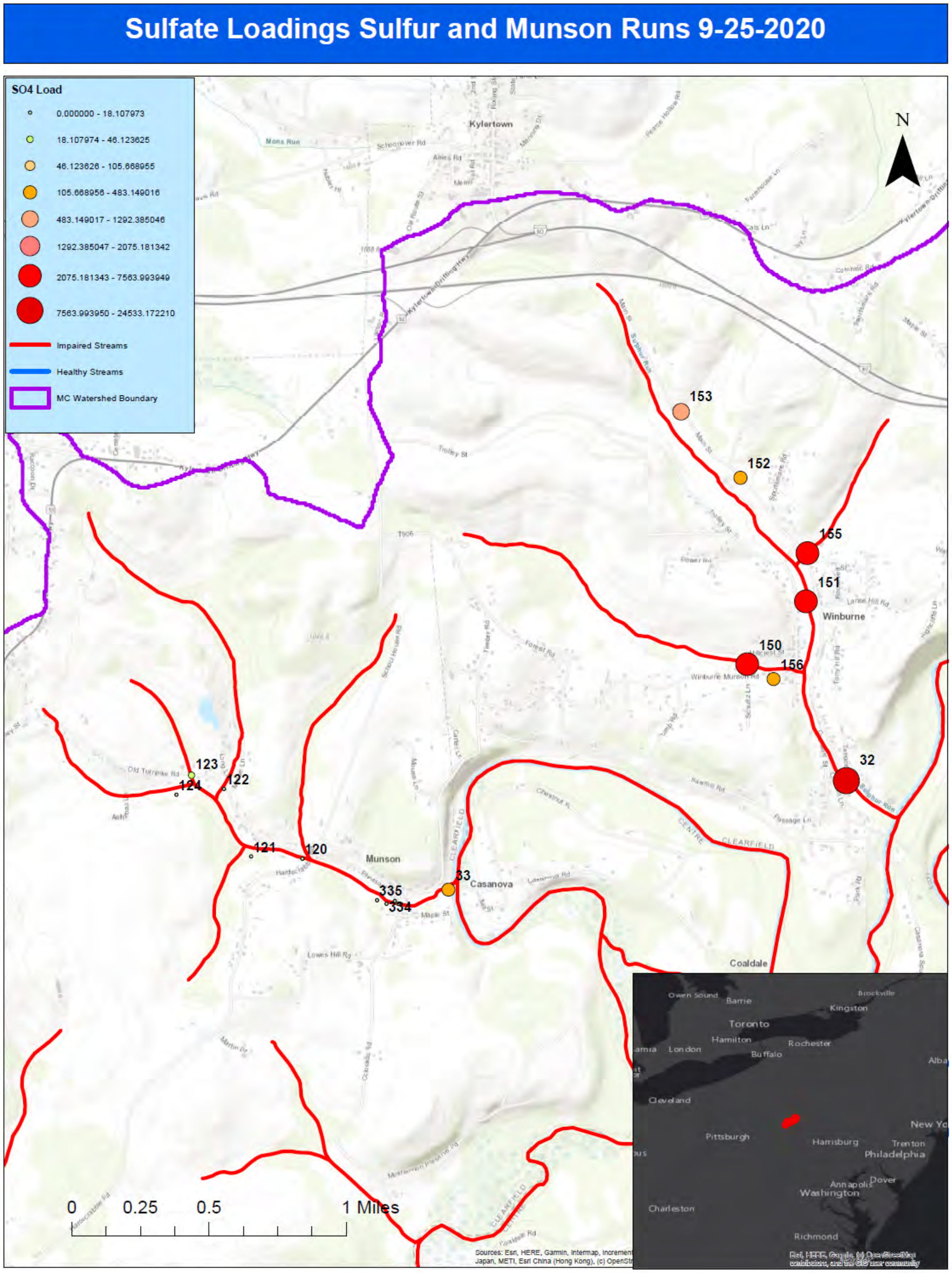

Figure 27. Sulfate Loadings in Tributary Sampling Sulfur Run and Munson Run 9/25/2020

Round 2 water sampling data is available in tables later in this report and also available in a spreadsheet found at the following link: https://moshannoncreek.org/reports .

Round 3 Water Sampling

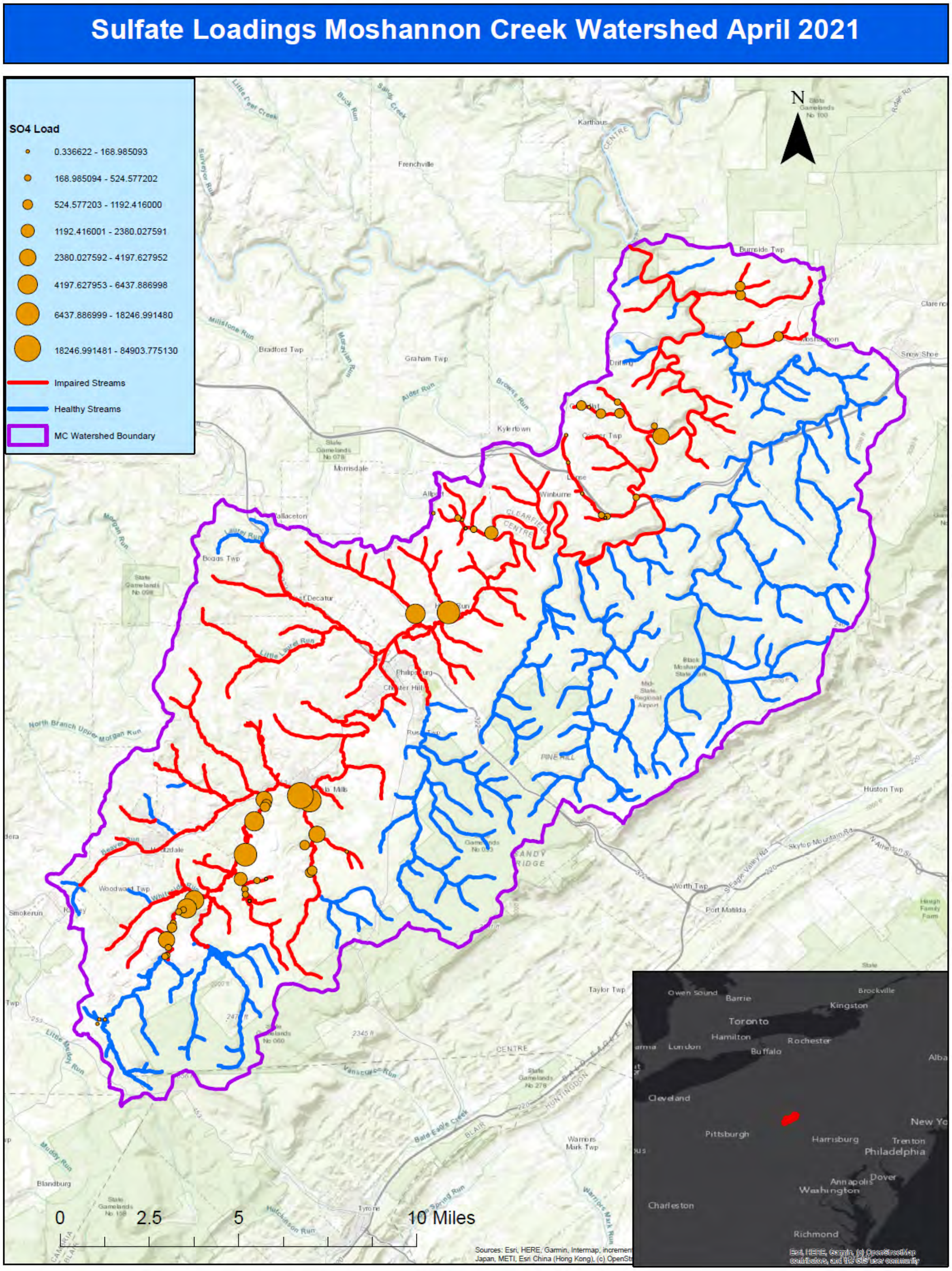

Figure 28. Sulfate Loadings Found in Sections of the Watershed Sampled in April 2021.

The Restoration Committee entered into the Spring of 2021 with the knowledge that important parts of the Moshannon Creek watershed remained to be sampled and funds for water sampling that remained from the Coldwater Heritage Partnership Planning Grant for this project were limited. Late in the Fall of 2020, the drought ended, with higher precipitation levels returning for Winter and early Spring 2021. Important watershed sections that had results obscured by the drought during previous sampling and additional sections that needed evaluations not yet made were both selected for the third round of water sampling.

The importance of areas clustered in the northern and southern sections of the watershed was becoming increasingly apparent. Important watershed areas were sampled in both sections of the watershed, and those in the northern watershed are discussed first.

At an opportune time during planning for the third round of water sampling, Dr. Bill Burgos, from Penn State, reached out to MCWA seeking a watershed to evaluate as a classroom and field exercise for his students. Because Munson Run was both shown to be important, and results from Round 2 were greatly impacted by the drought conditions then present, it was selected for the Penn State team to sample. They resampled the Munson Run watershed as part of round 3 of this project, and they are planning to sample the Grassflat Run watershed during the Spring semester of 2022.

The Penn State team sampled the Munson Run watershed on April 5, 2021, and MCWA volunteers obtained one more sample on a tributary of Munson Run on April 11, 2021. These samples taken in much higher flow conditions confirmed that most of the AMD in Munson Run enters it in the last section downstream of its crossing of Hardscrabble Road. Sampling in round 2 found that most AMD in this section was entering into the stream bed. Sampling during higher flows confirmed that this is still the case and much of the Munson Run watershed has relatively good water quality. The AMD added in the lower section near its junction with Moshannon Creek make Munson Run a significant source of iron, aluminum and acidity in the Moshannon Creek watershed.

In the following week, a team from MCWA sampled Browns Run multiple times along its length and one small tributary was also sampled. While a few mining impacts are found north of the first crossing of Browns Run and I-80, the water chemistry in this stretch is relatively good. The stretch north of I-80 has other problems that hinder its ability to host coldwater fish including lack of stream buffers and lack of shade. Browns Run was found to have relatively good water chemistry at its sample point at Pale Moon Drive. It lost a lot of water during the section upstream of this point. The next 0.9 miles (straight line distance) contain one or more mine drainage impacts that need investigation in order to plan recovery of this stream. The water quality in the stream deteriorates drastically in this section. The water quality gradually improves along its remaining length but the stream remains impaired by AMD. Browns Run is discussed in more detail later in this report where each tributary of Moshannon Creek is discussed, mapped, and the sampling data for that tributary watershed is presented in tabular form. Browns Run sample points are labeled ‘BR’ in the sulfate map below.

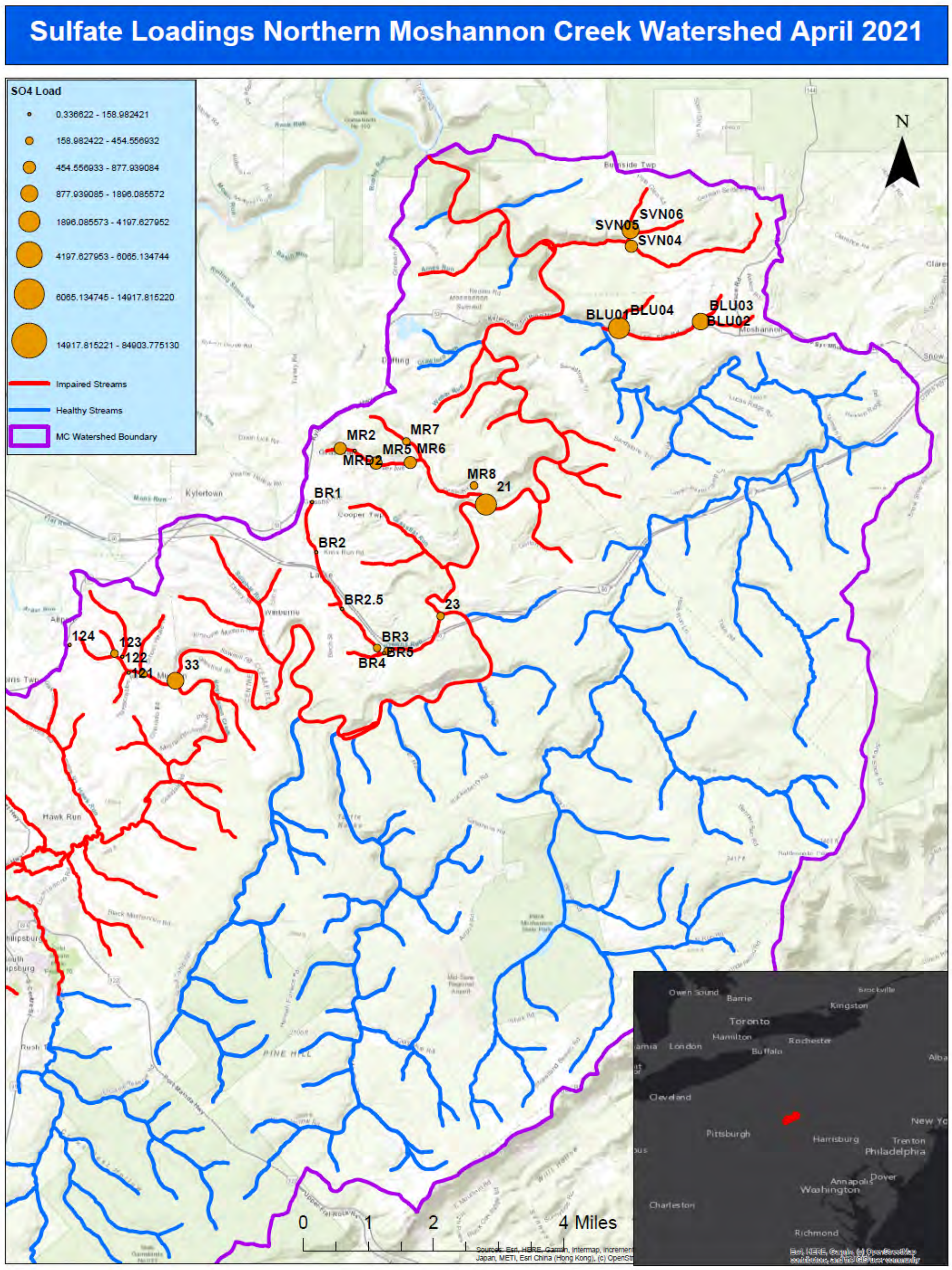

Figure 29. Sulfate loadings found at sample points in the northern watershed in April 2021.

In March, the Moravian Run watershed was scouted for sample points, and the best of those were sampled on April 9th. This watershed will need to be addressed as improvements are made in the main stem of Moshannon Creek. Today it provides bad water to an already impaired main stem. All of the points sampled in the Moravian Run watershed showed significant water chemistry impacts from AMD. One of the challenges for planning to address the problems in this watershed is that the southern tributary of Moravian Run flows through the community of Grassflat and has multiple deep mine discharges emerging from pipes in the town and flowing along the roadsides. Finding space for treating this water will be challenging. The discharges that are labeled beginning with 'MR' in the map above are in the Moravian Run watershed.

Black Moshannon Creek is the largest tributary to Moshannon Creek. It provides water that improves the main stem where they meet. Even so, it has impaired tributaries that impact its last mile or two. Those were sampled and their impairment was confirmed. While the Scarlift report did not indicate that there were deep mine discharges in this part of the watershed, flow in these tributaries was found to be much higher than should be present in watersheds of their size. A significant deep mine discharge bringing water in from outside the watershed is suspected. The impaired tributary sample points in the Black Moshannon Creek watershed are unnamed. Those sample points that were sampled in April 2021 are all labeled beginning with 'BLU' on the sulfate loadings map above.

The Sevenmile Run watershed is one that had disappointing results in round 1 sampling. It is the last large tributary to Moshannon Creek as it flows downstream to meet the West Branch of the Susquehanna. Existing mine drainage treatment in this watershed was expected to show better results at the mouth of Sevenmile Run than were found in round 1. As will be detailed in greater detail in the individual watershed discussions, two of the three branches sampled were found to still be impaired in the water sampling performed in April. Sevenmile Run sample points are all labeled with numbers that begin with 'SVN' in the sulfate loadings map above.

The remainder of the results discussion of the round 3 water sampling will discuss results for stream sections sampled that were at or south of Osceola Mills in the southern third of the Moshannon Creek Watershed.

The three deep mine discharges impacting Moshannon Creek between Roup Run and Hale Road were resampled in higher flow conditions. In addition, the potential for AMD discharges on the Clearfield County side of Moshannon Creek in this area was more deeply investigated. The mine map for the Hale Coal Company's Ladysmith Mine showed drainage drifts for this mine flowing directly into Moshannon Creek from the Clearfield County side of the stream. With landowner permission and insight, this area was scouted on foot in April 2021 and those former discharges were found to not be flowing, although their channels were clearly visible. The Scarlift Report briefly mentions the possibility of plugging these drift entrances, and this may very well have taken place, because they were found to not be flowing in both high and low flow conditions in this project.

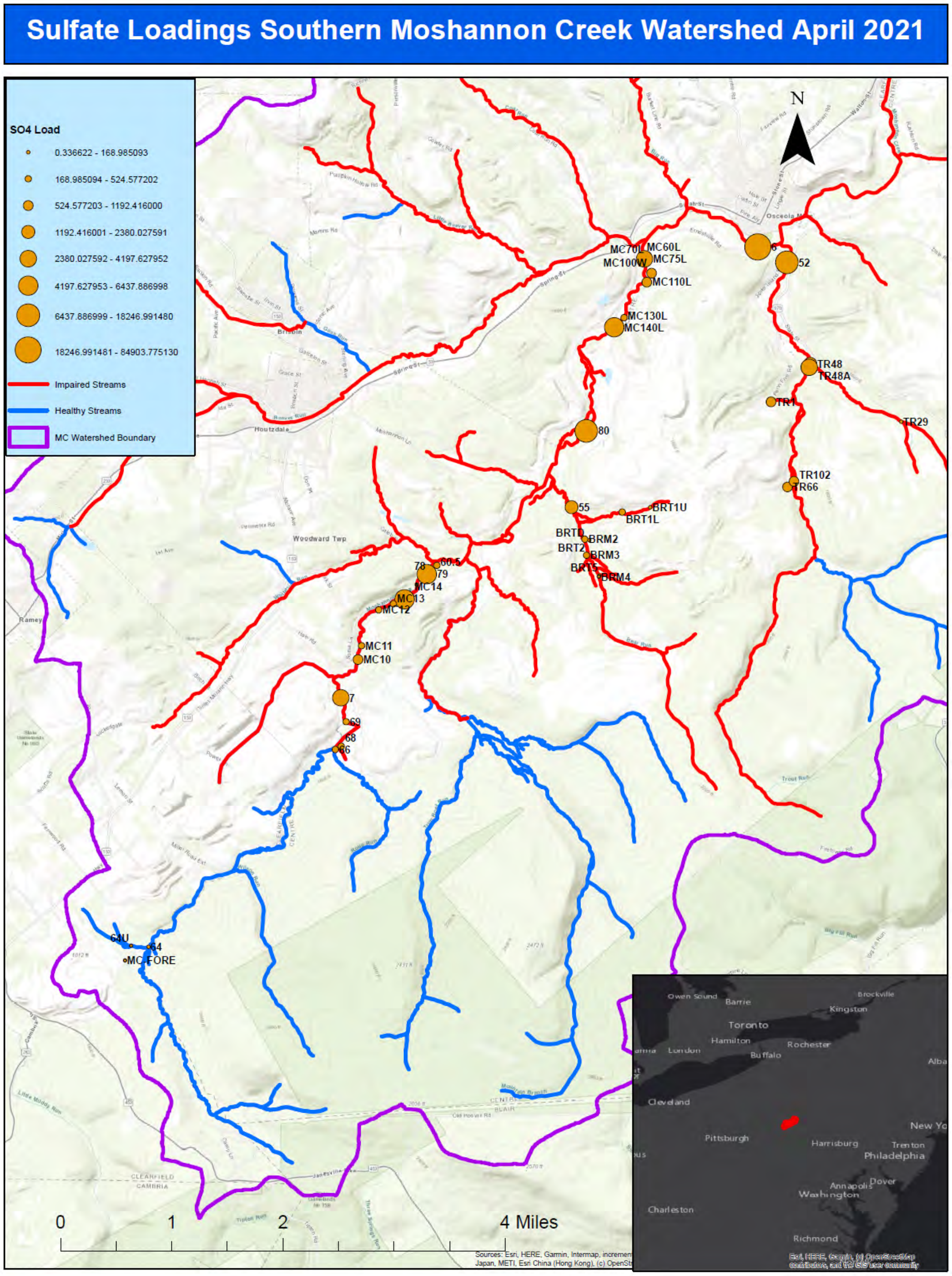

Figure 30. Sulfate loadings found at sample points in the southern watershed in April 2021.

On the Centre County side, the water chemistry found in this round of sampling confirmed the impact of mine discharges MC7, MC8 and MC8.5 to Moshannon Creek. These three discharges largely explain the rapid deterioration of Moshannon Creek between just upstream of Roup Run and the Hale Road bridge sampling location.

Potential threats to the Moshannon Creek headwaters were evaluated in the third round of water sampling. During round 1 water sampling, the small headwaters tributary of Moshannon Creek that was sampled as sample point 64 was found to have a very concerning iron concentration of 13.09 mg/l in the water, although the pH was relatively good. This stream is impacted by the MC-FORE mine discharge, the first known discharge to impact Moshannon Creek as it flows downstream. On April 11, 2021, this small watershed was resampled, with the MC-FORE discharge sampled and the stream it impacts sampled above and below the MC-FORE discharge. While this small stream clearly originated in areas impacted by mining activity in the past, it was found to have good metals and a moderately good pH of 5.85 in the water chemistry above the MC-FORE discharge. The MC-FORE discharge has historically been found to have a low flow with a very high iron concentration. In round 3, this discharge was flowing at a rate of 10 gpm, with a pH of 3.58 and an iron concentration of 125 mg/l. At the higher flow rates present in April, the stream below MC-FORE had an iron measurement of 0.871 mg/l, complying with the standard of being below 1.5 mg/l. This tributary stream has shown the potential of feeding the main stem with higher concentrations of iron in low flow conditions.

To gage the impact this stream has actually had on Moshannon Creek, the Native Fish Coalition, Pennsylvania Chapter, did macroinvertebrate sampling above and below the tributary at sample point 64. The report from this sampling is contained in the appendix of this coldwater conservation plan. The IBI score in the mainstem of Moshannon Creek was found to be 50.62 upstream of the tributary with MC-FORE impacts and 46.38 downstream of the junction with the impacted tributary. Because the IBI declined below 50, the score downstream of the MC-FORE discharge impact does indicate some impairment of benthic macroinvertebrates in the main stem of Moshannon Creek from this discharge.

Another threat to the headwaters that was observed during scouting of sample points for water chemistry and benthic macroinvertebrate sampling was a coal refuse pile of several acres in size. This pile is in direct contact with Moshannon Creek and the pile forms the bank for the creek on the Clearfield County side. While this study did not gauge the impact of this pile to the water quality in Moshannon Creek, these piles are a known source of negative impacts to water quality. Possibilities for removal of this pile are currently being explored.

Round 2 water sampling indicated a decline in water quality between Hale Road and the Moshannon Creek sample point upstream of Whiteside Run. This stretch of Moshannon Creek is primarily impacted by a string of small discharges that flow directly into Moshannon Creek. These discharges are labeled MC10 thru MC15 on the SRBC Mine Drainage Portal. An additional, very important discharge, MC16, flows directly into Moshannon Creek just downstream of the sample point for this section of the creek. All of these discharges were sampled, and MC12, MC13 and MC14 were found to have the most significant impact to the section of Moshannon Creek between Hale Road and the sample point. These discharges had higher flows than typically found in the historical data and are extremely rich in metals. MC13 was found to have an iron concentration of 188 mg/l.

Discharge MC16, just downstream of the mainstem sample point, was found to have a flow of highly contaminated water that was approximately 8.0% of the water found in Moshannon Creek upstream of it when it was sampled in drought conditions in round 2. It's flow rate was very similar in both round 2 and round 3 sampling. MC16 appears to be a stream killer in low flow conditions. MC16 discharges into Moshannon Creek just after a stretch of the creek that loses considerable water during dry conditions, and this increases its impact. The water it provides has high acidity (190.8 mg/l) and extremely high iron (71.7 mg/l) and high aluminum (8.46 mg/l). Discharge MC16 would be the 'killer of Moshannon Creek' if the discharges near Roup Run had not already had their impact.

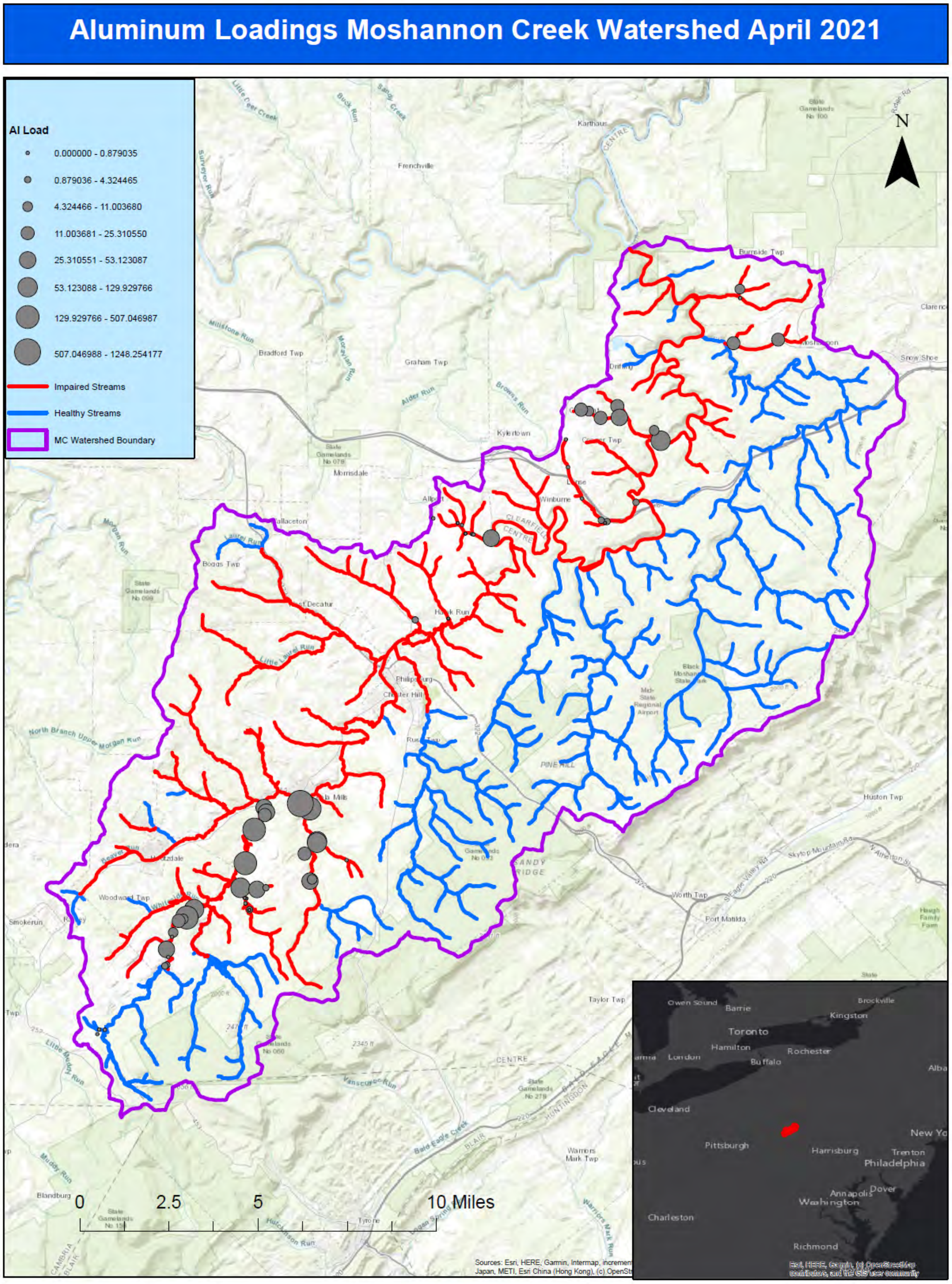

Figure 31. Aluminum loadings found in parts of the Moshannon Creek watershed in April 2021

The stretch of Moshannon Creek between the sample point upstream of Whiteside Run and discharge MC16 and the Scrapyard sample point is a stretch that has considerable potential for improvement. Much of the water that enters this stretch from tributary streams and other sources is better than the water within Moshannon Creek. There are two notable exceptions, discharge MC16 near the beginning of this stretch and Bear Run, near the end.

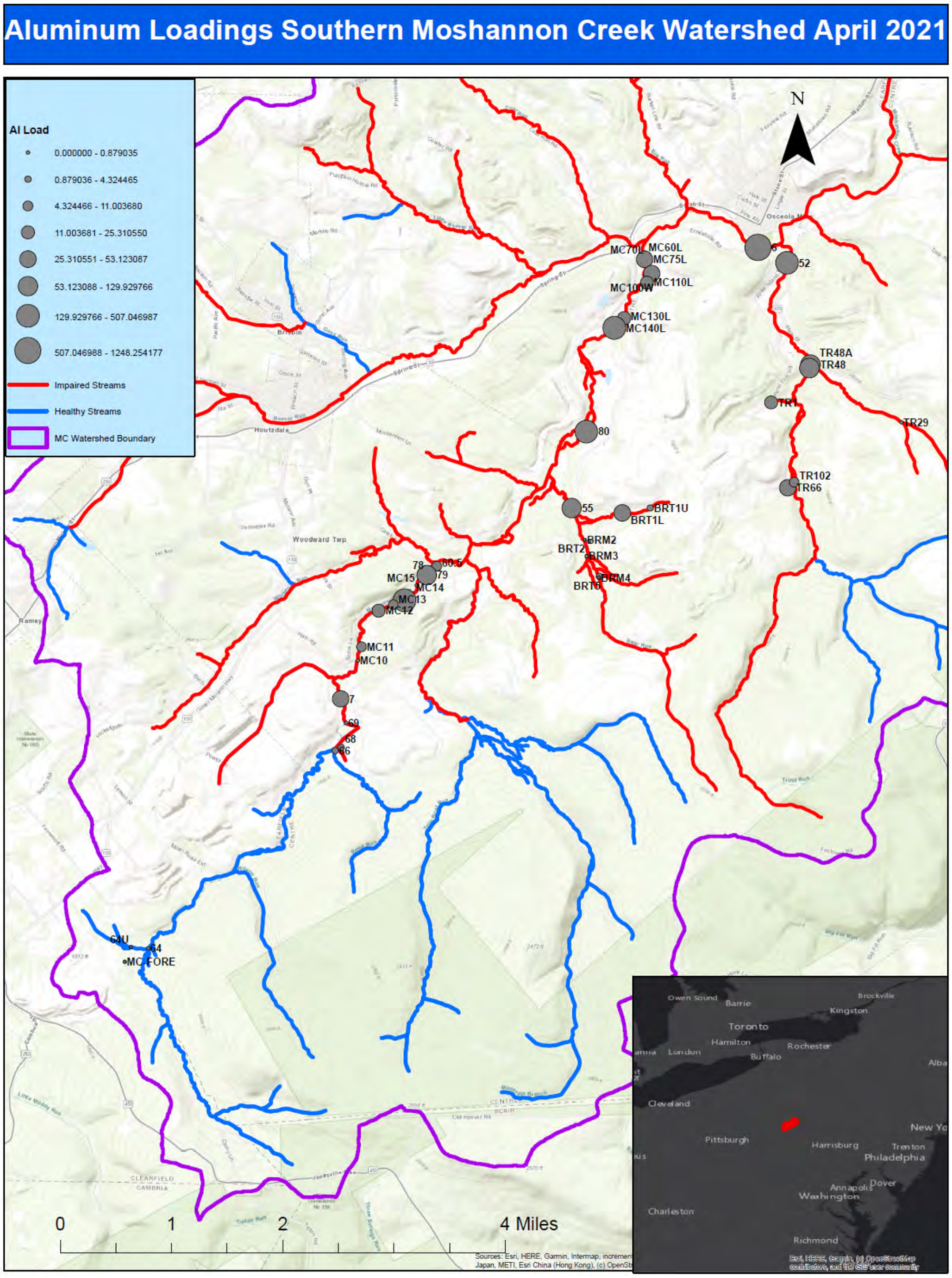

Figure 32. Aluminum Loadings in Sampled Sections of Southern Watershed. April 2021

Downstream of MC16, conditions gradually improve until Moshannon Creek encounters its next major impact, Bear Run. Bear Run is a major source of acidity, iron and aluminum and joins Moshannon Creek with a pH hovering around 4.0. Recognizing the importance of Bear Run, MCWA partnered with the Native Fish Coalition - Pennsylvania Chapter, who performed the water chemistry sampling and benthic macroinvertebrate sampling in the Bear Run watershed, while keeping an eye out for trout. Currently, all of the Bear Run watershed is classified as impaired without a lot of historical water sampling history for the upper portions of the Bear Run watershed.

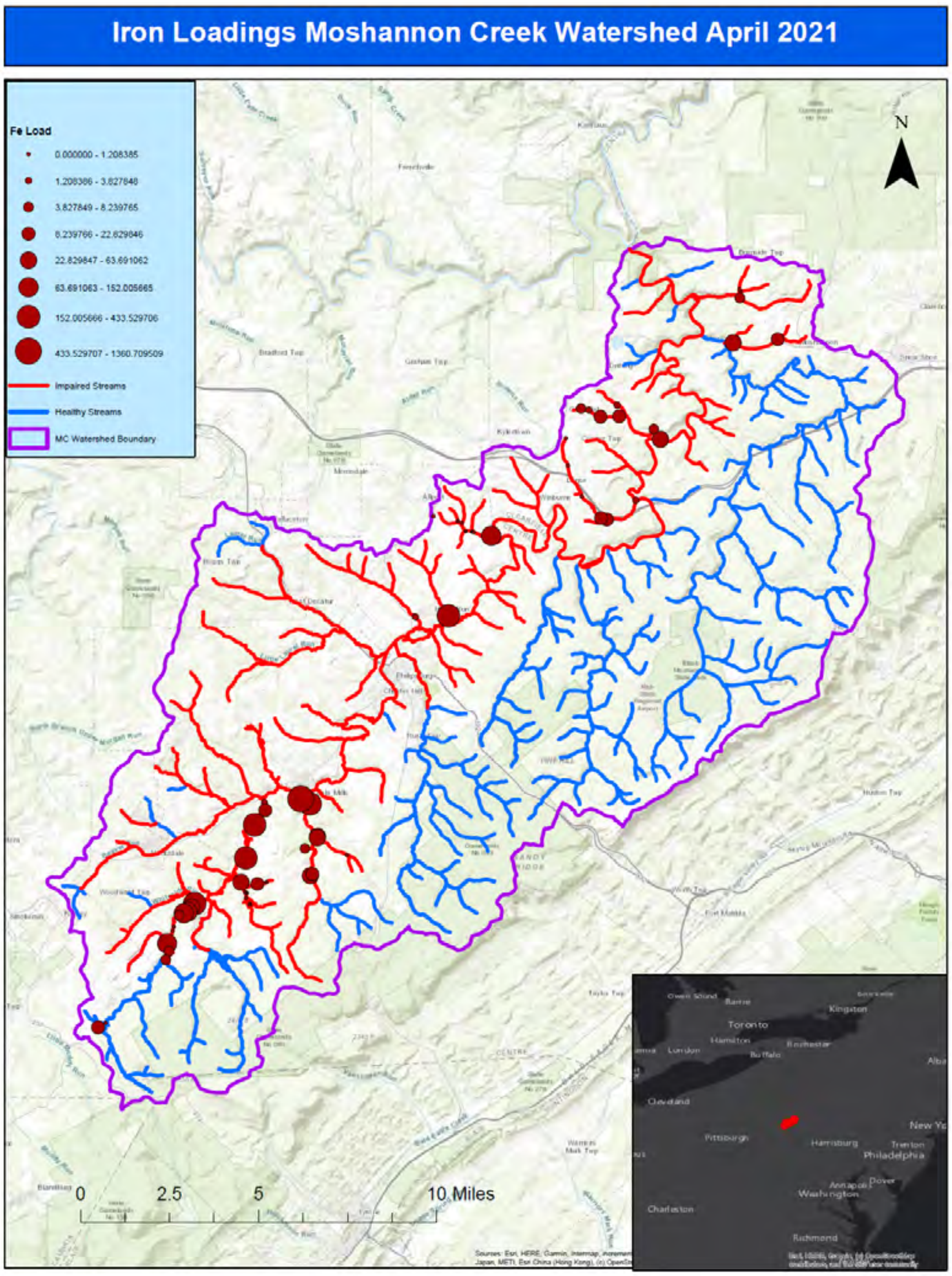

Figure 33. Iron Loadings in Sampled Sections of Moshannon watershed. April 2021

The NFC-PA volunteers found trout in a western tributary of Bear Run. Bear Run was found to have two eastern tributaries that supplied very AMD impaired water to Bear Run. Above the uppermost impaired eastern tributary, Bear Run was found to have an IBI score of 46, near the threshold value of 50 for an unimpaired stream, and the water chemistry sampling at this location indicated good metals and a pH of 6.6. Much of the Bear Run watershed is upstream of this sample point and appears to be unimpaired.

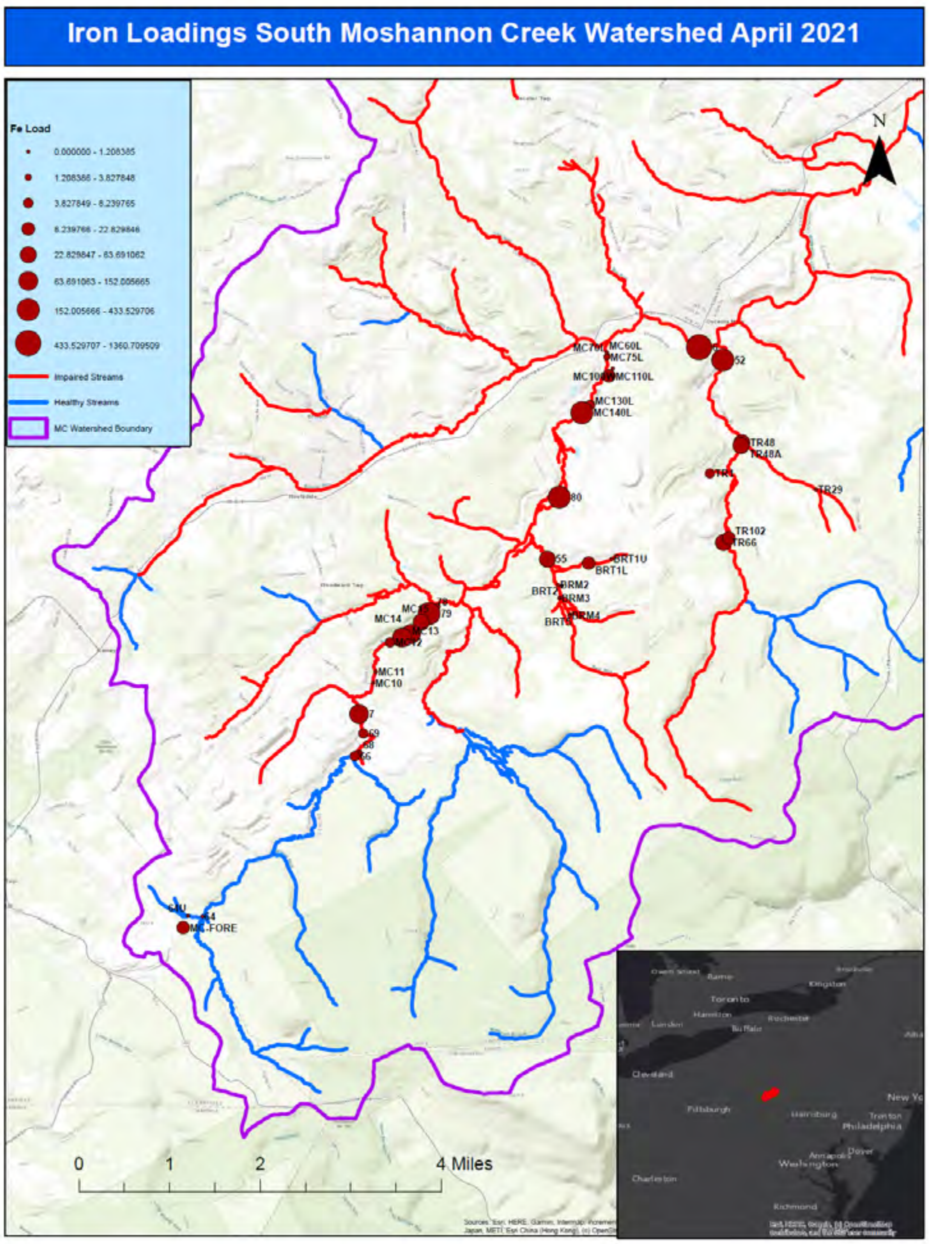

Figure 34. Iron Loadings Found in Southern Moshannon Watershed April 2021.

The stretch of Moshannon Creek between the scrapyard and Osceola Mills has a battle between relatively good water flowing in from the Beaver Run watershed and very, very bad water flowing in from Big Run and a string of mine discharges. When those discharges were sampled on April 10, 2021, they were found to collectively discharge more than 1700 gallons per minute of very concentrated mine drainage. Over 1100 gallons per minute of that mine drainage emerges at the MC140L discharge, a legacy discharge of the long abandoned Banner No. 1 deep mine. Combined with 300 to 400 gpm (sometimes more) of very bad water flowing in from Big Run, there is more than 2000 gpm of untreated mine drainage with low pH and high metals content flowing into this stretch of Moshannon Creek. Addressing this stretch will be critical for the health of the southern half of the watershed and will be discussed later in this report.

The Trout Run watershed was sampled enough to confirm the loadings found were similar to the loadings already found in the very extensive Trout Run Watershed Mine Drainage Assessment and Restoration Plan prepared by New Miles of Blue Stream in 2006. Trout Run is an important watershed for AMD impairment that also has a healthy upper watershed. As will be discussed later in this report, the tributary at sample point TR48 is the first large substantially impaired tributary that Trout Run encounters as it flows downstream. Restoration efforts for Trout Run should start on that tributary. The sampling for this Coldwater Conservation Plan confirmed the continuing substantial impact of the lower portions of the Trout Run watershed to the water quality in Moshannon Creek. Additional analysis and planning activities for improvements in the Trout Run watershed will be needed as restoration efforts work downstream to Osceola Mills. Several coal refuse areas remain in the Trout Run watershed including some directly in contact to tributary streams of Trout Run.

Round 3 water sampling data is available in tables later in this report when the individual tributaries are discussed, and also available in a spreadsheet found at the following link:

https://moshannoncreek.org/reports

A few open questions remain to be explored further in the Moshannon Creek watershed.

Regular sampling of the Sulfur Run watershed by the SRBC continues. This sampling is anticipated to expand to include regular sampling of the multiple AMD sources along Coaldale Road on the Centre County side of Moshannon Creek in the same area.

One more tributary watershed with an important AMD contribution to Moshannon Creek remains to be evaluated in the northern portion of the watershed. Grassflat Run is planned to be evaluated by Penn State students under the direction of Dr. Bill Burgos in the Spring of 2022.

A water feature that episodically provides a flow of AMD to Moshannon Creek was discovered near Casanova, PA in an area difficult to access. This feature is planned to be sampled when conditions allow meaningful results.

Watershed Level Recommendations

The non-AMD concerns listed earlier in this report all matter but they are dwarfed in their impact to the coldwater fishery in the Moshannon Creek watershed by the impact of abandoned mine drainage. AMD affects about half of the stream miles in the watershed. Evaluating each of the major sources of AMD and their impacts led to the development of a plan for an orderly recovery process for the watershed with a manageable number of improvements. Those improvements are spelled out below from south to north. Additional commentary about conditions and other problems in specific streams are contained in the next section, entitled 'Individual Watershed Sections With Prescriptions'.

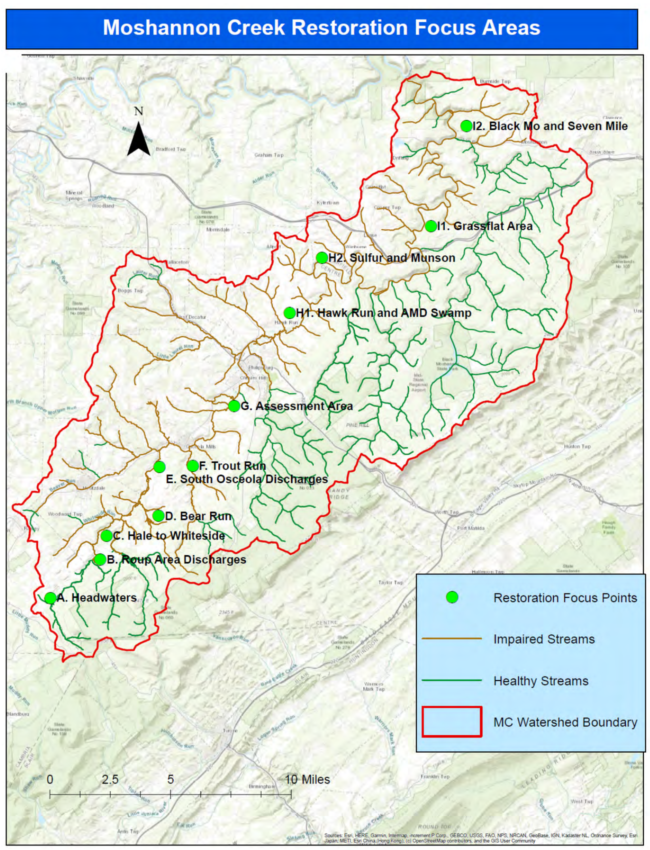

Figure 35. Restoration Focus Areas in the Moshannon Creek Watershed.

The prescriptions for area A, the headwaters, can be pursued independently from the others, because this is mainly safeguarding a currently healthy watershed section. Because area G is currently improving due to watershed changes already made, the prescription for this area is assessment and monitoring. Assessment of this area after upstream improvements are completed may highlight some problems that are currently masked by larger problems upstream. For the remainder of prescription areas, B thru I, completing improvements sequentially would allow the most effective expansion and connection of fish habitat as improvements are made. The scale of the problems present in E and H is much larger than the others, and planning for those improvements is already underway for H.

Each of the restoration focus areas will be described below in turn. More specific information for each tributary stream and main stem section of the Moshannon Creek watershed are contained in the Individual Watershed Tributaries and Sections portion of this report. Details such as water quality sampling data and discharge locations are included there.

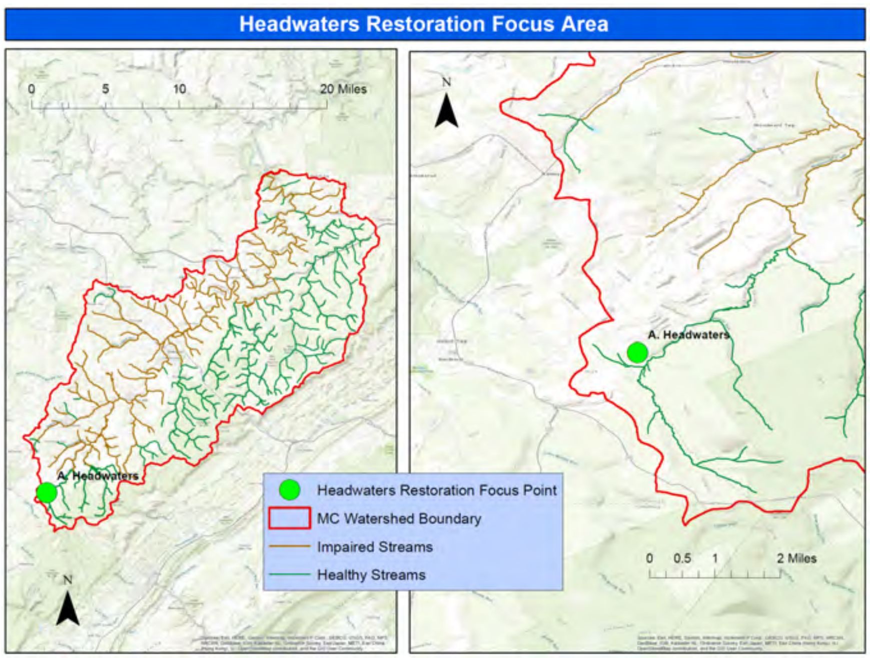

Figure 36. Headwaters Restoration Focus Area.

A. Upstream of Roup Run, the Moshannon Creek watershed has several trout streams, and Moshannon Creek is a Class A trout stream. Even this section of the watershed has mining impacts, but the loadings from the mine discharges and coal refuse pile are small enough that they do not currently significantly impair Moshannon Creek away from their immediate vicinity. A major landowner in the headwaters has made extensive use of land application of alkaline paper mill waste to counteract acidity and create topsoil on strip mined land, and this may have helped keep Moshannon Creek net alkaline in this section. Treating the MC-FORE discharge and removing a large coal refuse pile that partially sits in Moshannon Creek near Wilson Run would be the two primary actions to increase the resiliency to AMD already present in the headwaters section.

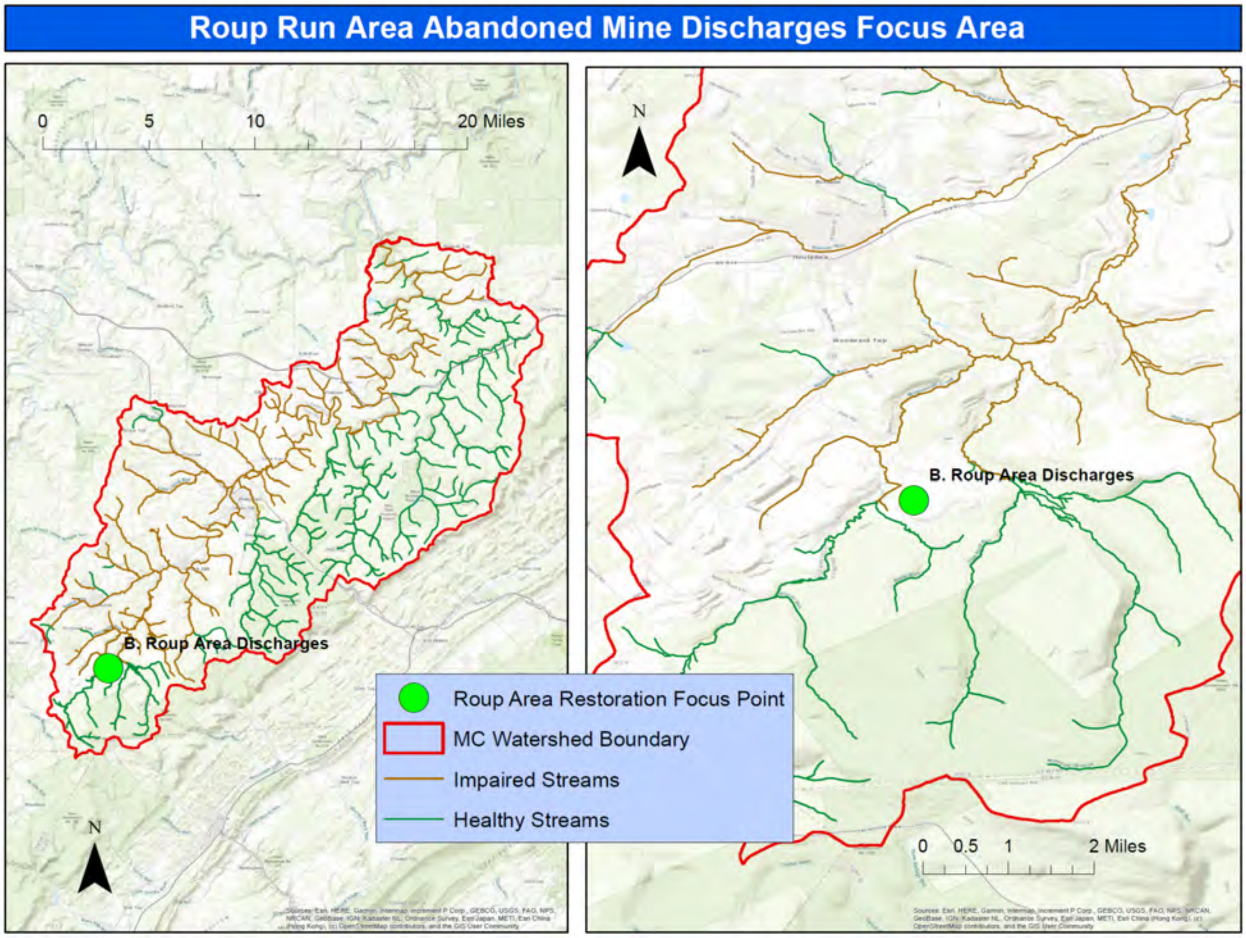

Figure 37. Roup Run Restoration Focus Area.

B. Once Moshannon Creek joins with Roup Run, it is impacted by AMD for its remaining length. Three abandoned mine discharges, MC-7, MC-8 and MC-8.5, impact the last few feet of Roup Run and Moshannon Creek downstream from Roup Run. These three discharges serve as the 'killers of Moshannon Creek'. No section of Moshannon Creek downstream of Roup Run ever fully recovers from the mine drainage impacts that begin here. Recovery efforts for the Moshannon Creek watershed that are intended to add fish habitat and connect existing fish habitat should begin here. A Growing Greener grant application for a detailed site evaluation and conceptual design for treating MC-7, MC-8 and MC-8.5 was submitted by MCWA in partnership with the SRBC in June of 2021.

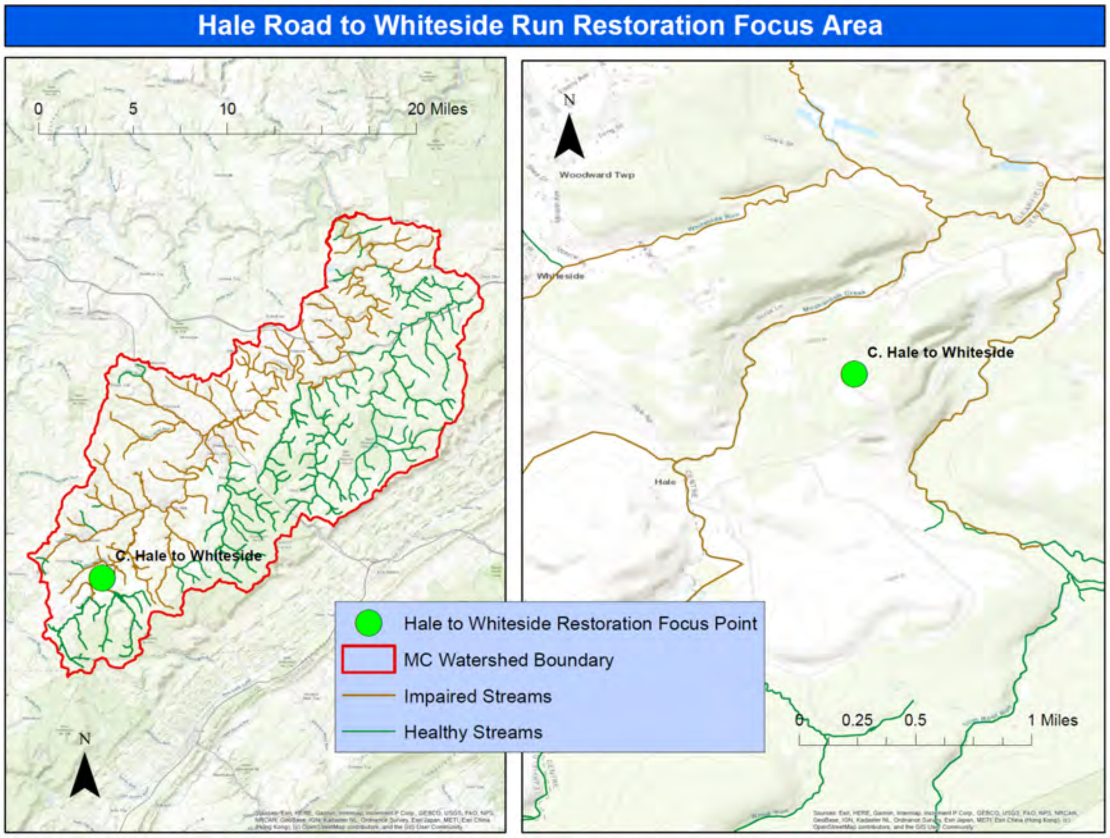

Figure 38. Hale to Whiteside Restoration Focus Area.

C. The stretch of Moshannon Creek downstream of Hale Road to its junction with Whiteside Run should be the next section of the watershed upstream of Philipsburg where improvements should be sought. Downstream of Hale Road a string of small AMD discharges, numbered MC10 thru MC15, are encountered. A discharge to Moshannon Creek just upstream of Whiteside Run, MC16, is substantially larger than the others during low flow conditions. If discharges MC7, MC8 and MC8.5 are effectively addressed, MC16 would be the next discharge that by itself would be a 'killer' of Moshannon Creek. The impact of MC16 is magnified by the fact that Moshannon Creek at least seasonally loses flow in this segment of stream. The reasons for this flow loss should be investigated and considered as part of a site evaluation and conceptual design for this stretch of Moshannon Creek. The anticipated result of an evaluation would be a selection of some of the small discharges for treatment, as well as a treatment plan for discharge MC16. Some of the smaller discharges have very concentrated AMD and collectively they have an impact beyond the impact of typical small mine discharges. The measured flow for MC14 in April was much higher than historically found, and this discharge may be a growing problem. Addressing the impact of these discharges, after the Roup Run area improvements are implemented, would allow Moshannon Creek to be fish habitat from its headwaters until at least its junction with Bear Run.

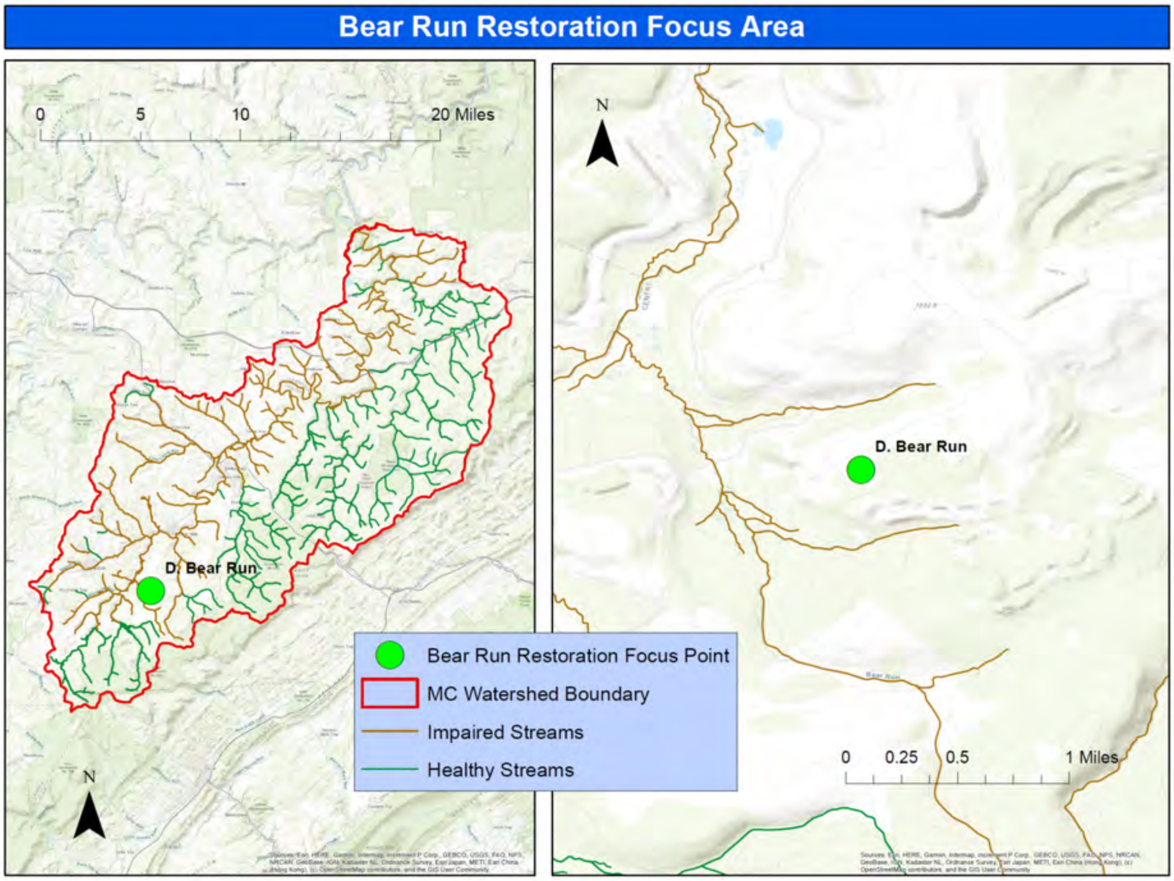

Figure 39. Bear Run Restoration Focus Area.

D. Once the primary AMD problems in Moshannon Creek upstream of Whiteside Run are addressed, the next section that will need improvement will be the section of Moshannon Creek from Whiteside Run to the Scrapyard near Osceola Mills. Water sampling found that the increase in the loadings in acidity and metals in Moshannon Creek in this stream segment can be attributed to the loadings that the creek receives from Mountain Branch and Bear Run. Because the water discharged by Mountain Branch into Moshannon Creek improves the creek in spite of the loadings, and Mountain Branch is fish habitat even with several AMD discharges, initial improvement efforts in this stretch should focus on improving Bear Run. Bear Run is severely impaired, but the impairment is concentrated in two eastern tributaries. In fact, trout were found living in a section of the Bear Run watershed. Improving the two impaired tributaries of Bear Run should be the next step in improving the Moshannon Creek watershed after improvements are made upstream of Whiteside Run. The ongoing impact of Mountain Branch on Moshannon Creek should be reevaluated after the other listed improvements are completed.

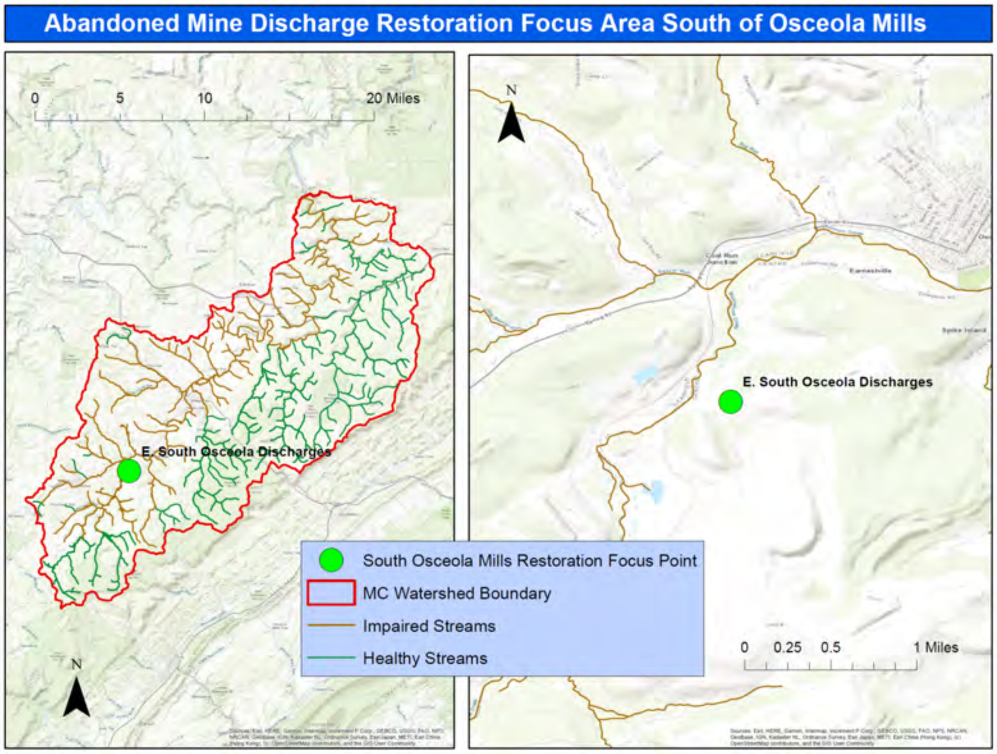

Figure 40. South Osceola Restoration Focus Area.

E. Once the steps already outlined for improving Moshannon Creek upstream of the Scrapyard sample site are completed, Moshannon Creek would be fish habitat until encountering a series of mine discharges from abandoned deep mines that flow directly into Moshannon Creek on the Centre County side of the stream opposite the Leslie Tipple near Osceola Mills. One of these discharges, MC140L, seasonally has a very high flow, measured at 1,113 gpm in April 2021 and historically as high as 1,800 gpm. Because of the volume of flow out of MC140L, combined with the wetlands near many of the others, the most likely scenario for treating these discharges is to gather the water together and pipe it to an active treatment plant. MC140L is the largest untreated discharge in the southern half of the Moshannon Creek watershed and has very poor water quality. Big Run, a small stream entering Moshannon Creek from Clearfield County across from the tipple discharges, has very poor water quality and flow often measured in the 300 gpm range. The water in Big Run should be treated either by piping it to the active plant or building several passive systems in its watershed. Once upstream improvements are made, addressing the discharges south of Osceola Mills, along with

Big Run, would result in Moshannon Creek having fish habitat until it encounters Trout Run in Osceola Mills.

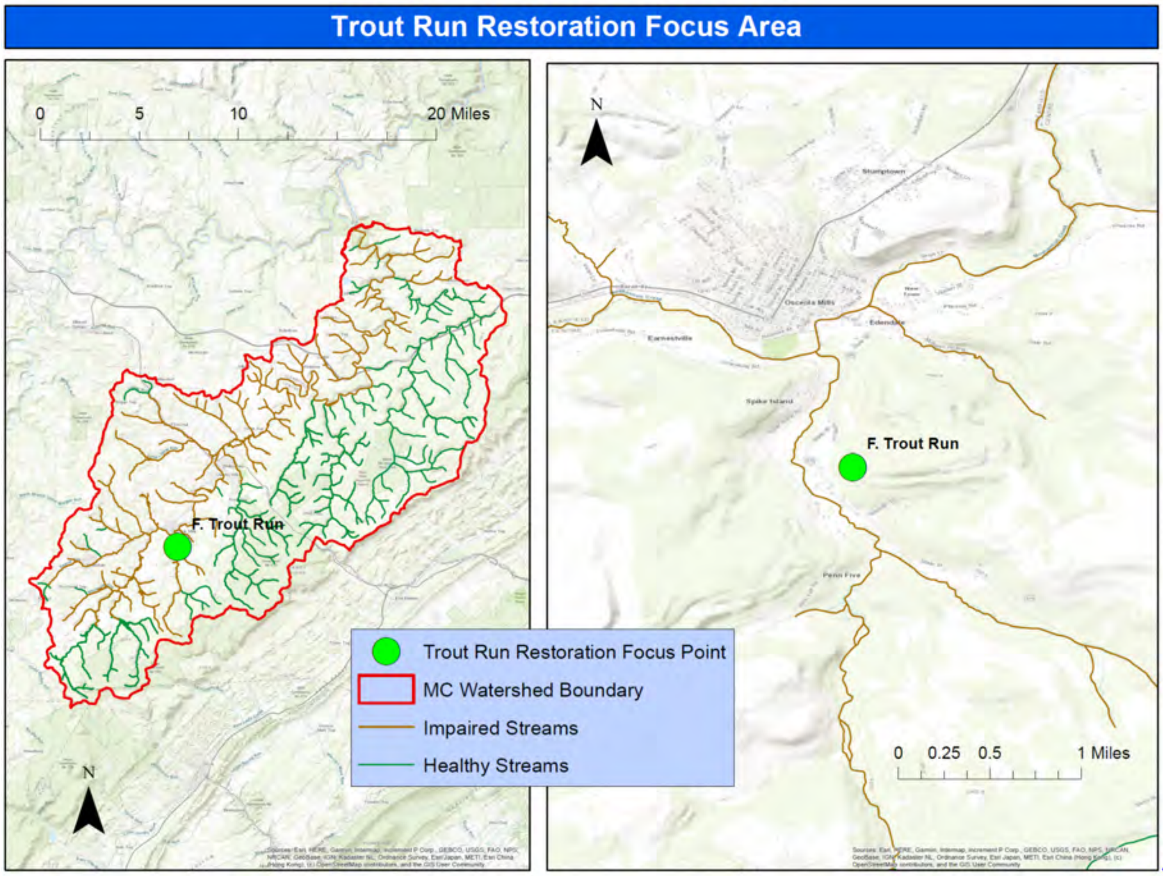

Figure 41. Trout Run Restoration Focus Area

F. In 2006, New Miles of Blue Stream prepared the extensive 'Trout Run Watershed Mine Drainage Assessment and Restoration Plan'. Water sampling in 2020 and 2021 confirmed the continued detrimental impact of Trout Run to the health of the Moshannon Creek watershed and addressing its most significant discharges will be necessary. Sampling indicates that Trout Run's northern tributary that flows in from the east is where the largest impacts to water quality in the Trout Run watershed begin. Because considerable mining activity and mine reclamation activity has occurred since 2005, further reassessment of the Trout Run watershed should be done to update the 2006 restoration plan specifically to confirm which discharges most need to be addressed. Trout Run is one of the largest tributaries of Moshannon Creek, and its name indicates that it has historically been a coldwater fish habitat. There are trout in the headwaters of Trout Run today. Making the previously described improvements in B thru E, and improving Trout Run, will provide connected fish habitat from the Moshannon Creek headwaters to the area downstream of Philipsburg described in 'H' below.

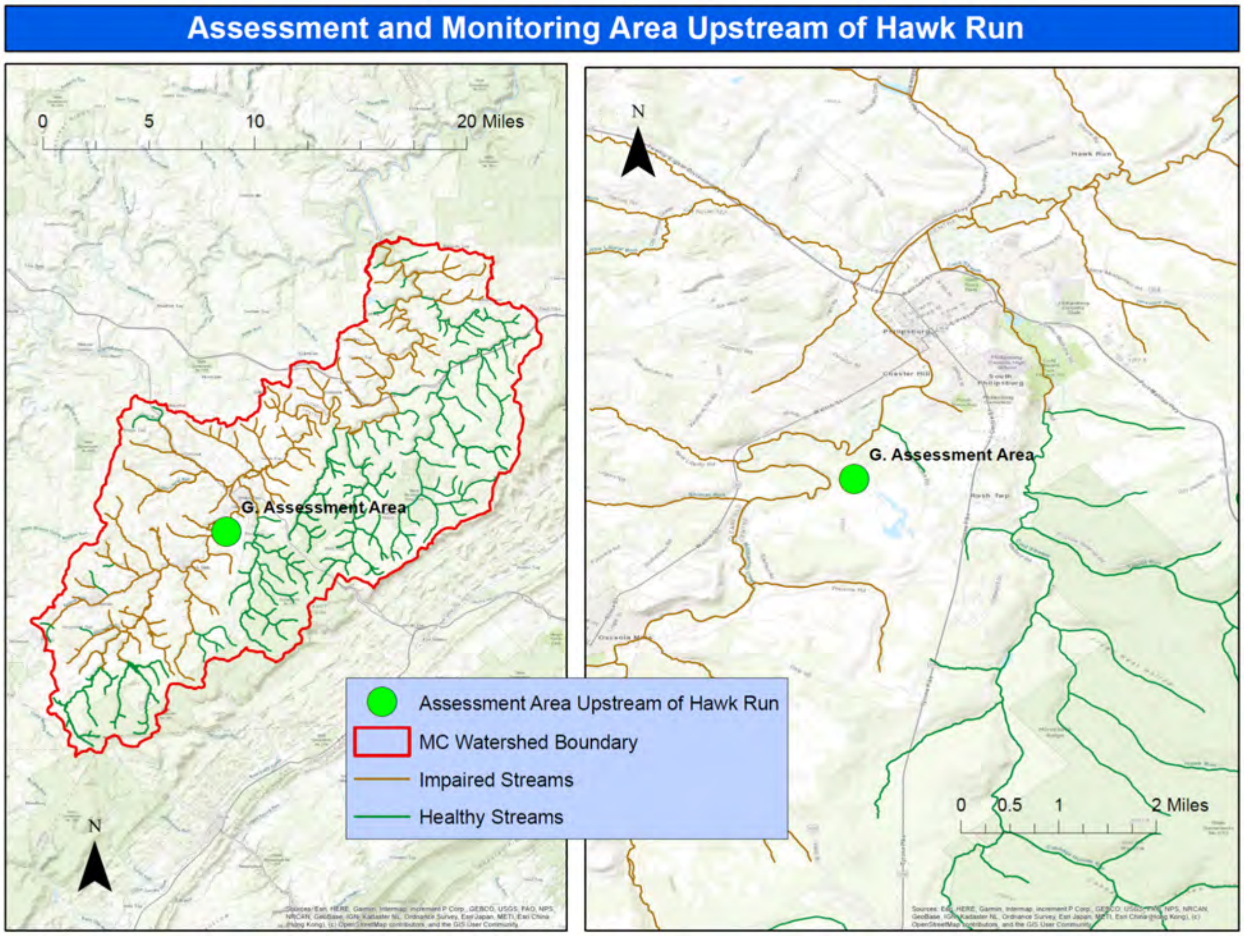

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Figure 42. Assessment Area Downstream of Trout Run and Upstream of Hawk Run.

G. The section of the watershed downstream of Trout Run until after Moshannon Creek's junction with Emigh Run is a section that has improved enough to host populations of sunfish and pickerel downstream of the Rushton Mine discharge. The treated discharge from the Rushton Mine, improvements in the Laurel Run watershed, and improvements in the Emigh Run watershed have all had a positive impact on the water quality in this stretch of Moshannon Creek. This stretch of Moshannon Creek is still impaired but has improved enough that hardy species of fish can live there. This section should be reassessed after the improvements in B thru F are made. There are some small impaired tributaries and untreated discharges whose effects may be masked by the problems upstream.

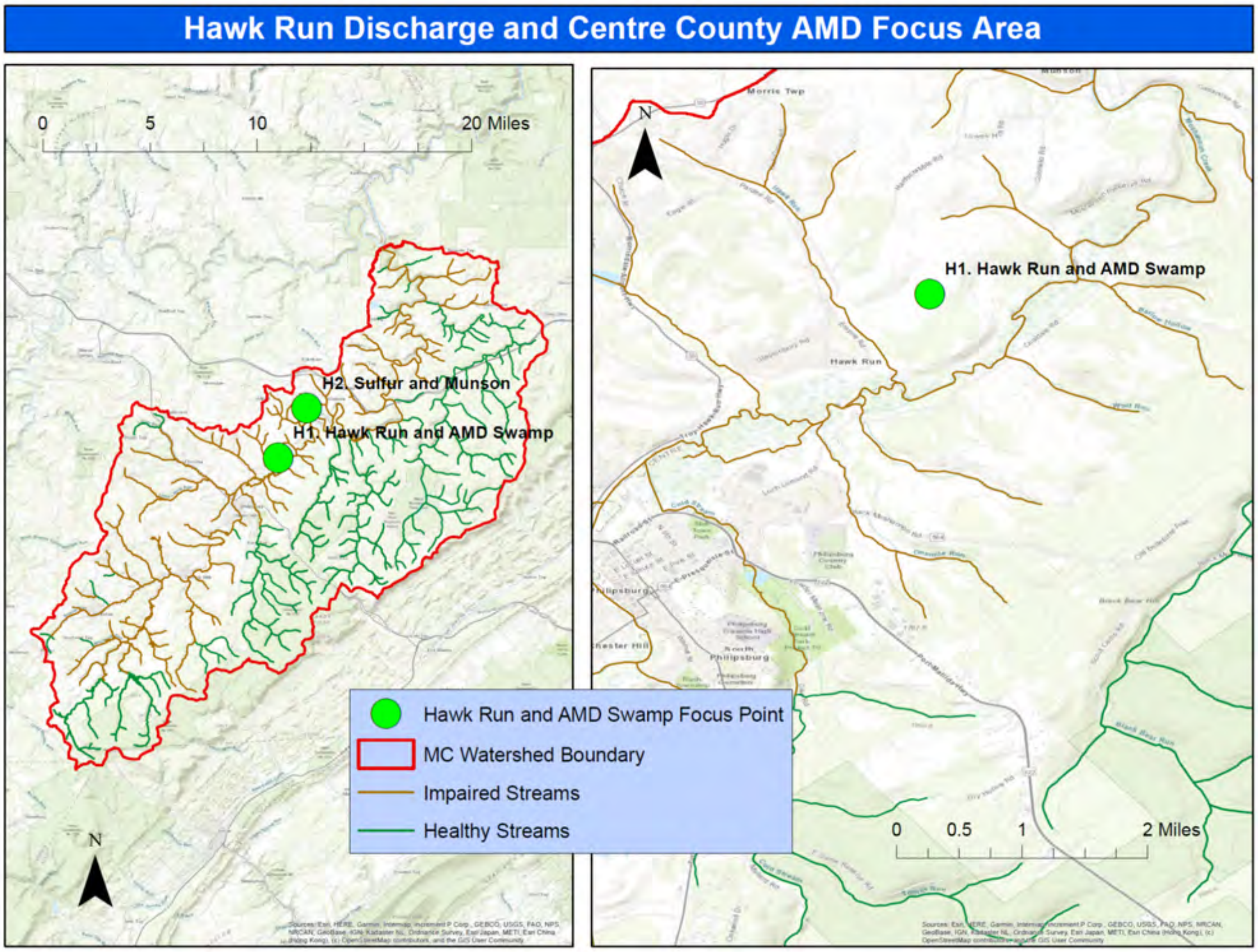


Figure 43. Hawk Run Discharge and Centre County Restoration Across From It.

H. From the perspective of the impact of Moshannon Creek on the West Branch of the Susquehanna and points downstream, the stretch of Moshannon Creek from downstream of Emigh Run to downstream of Sulfur Run is the most important stretch in the Moshannon Creek watershed. Sulfur Run, in a watershed with many other impairments, provides a third of the acidity found in the water flowing from Moshannon Creek into the West Branch. The Hawk Run discharge and Munson Run are also major suppliers of AMD from the Clearfield County side of Moshannon Creek. In the same area on the Centre County side, AMD discharges to the lower end of Cold Stream, Onemile Run, Wolf Run, Barlow Hollow, and several unnamed tributaries, along with multiple AMD discharges between those streams that flow to mine water swamps along Coaldale Road, all provide substantial quantities of AMD to Moshannon Creek. There is also a water feature near Casanova that episodically provides substantial AMD flows to Moshannon Creek.

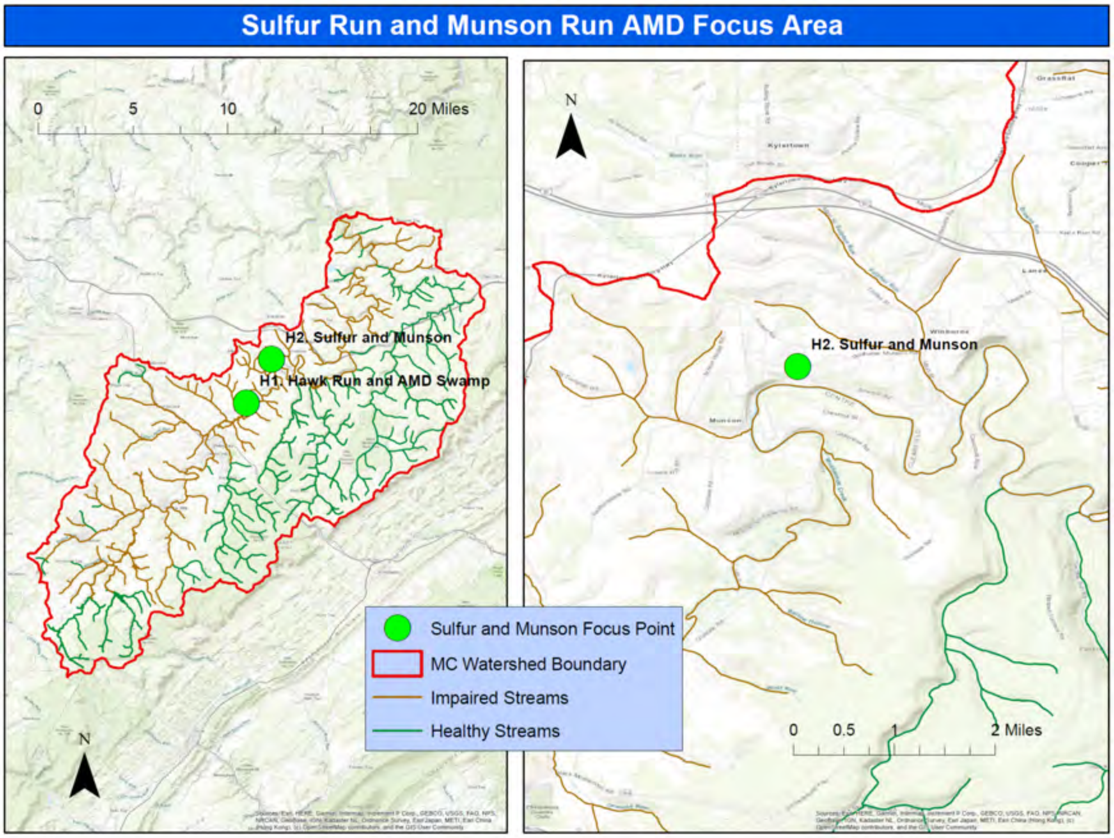


Figure 44. Sulfur Run and Munson Run AMD Focus Areas.

As a result of the sampling done for this Coldwater Conservation Plan, the Susquehanna River Basin Commission has become aware of the importance of the AMD discharges in this stretch of Moshannon Creek to its detrimental impact to the West Branch of the Susquehanna. The SRBC is now engaged in regular water sampling of Sulfur Run and its discharges, and they are beginning similar detailed investigations of other major AMD sources in this stretch of Moshannon Creek. It is clear that the volume of AMD involved in these impairments is large enough that at least one large active treatment plant and an associated gathering of impaired waters for treatment will be necessary to improve fish habitat in Moshannon Creek and reduce its detrimental impact to fish habitat in the West Branch of the Susquehanna.

Once Moshannon Creek rounds the bend with Barlow Hollow and an impaired unnamed tributary on the Centre County side and Sulfur Run on the Clearfield County side, there is a sudden improvement of the water quality flowing in from the tributary streams. Several streams in a row flow in from the Moshannon State Forest with very good water. Some of the streams in the State Forest already host trout, and others are suspected to do so. It will be no small task to address the AMD problem areas in maps H1 and H2, but completing those improvements will provide connected trout habitat in cooler times of year between streams already hosting trout. Improving the problems explained above, and displayed in maps H1 and H2, after the improvements in B thru G already mentioned, will provide good fish habitat in Moshannon Creek from its headwaters to the vicinity of I-80.

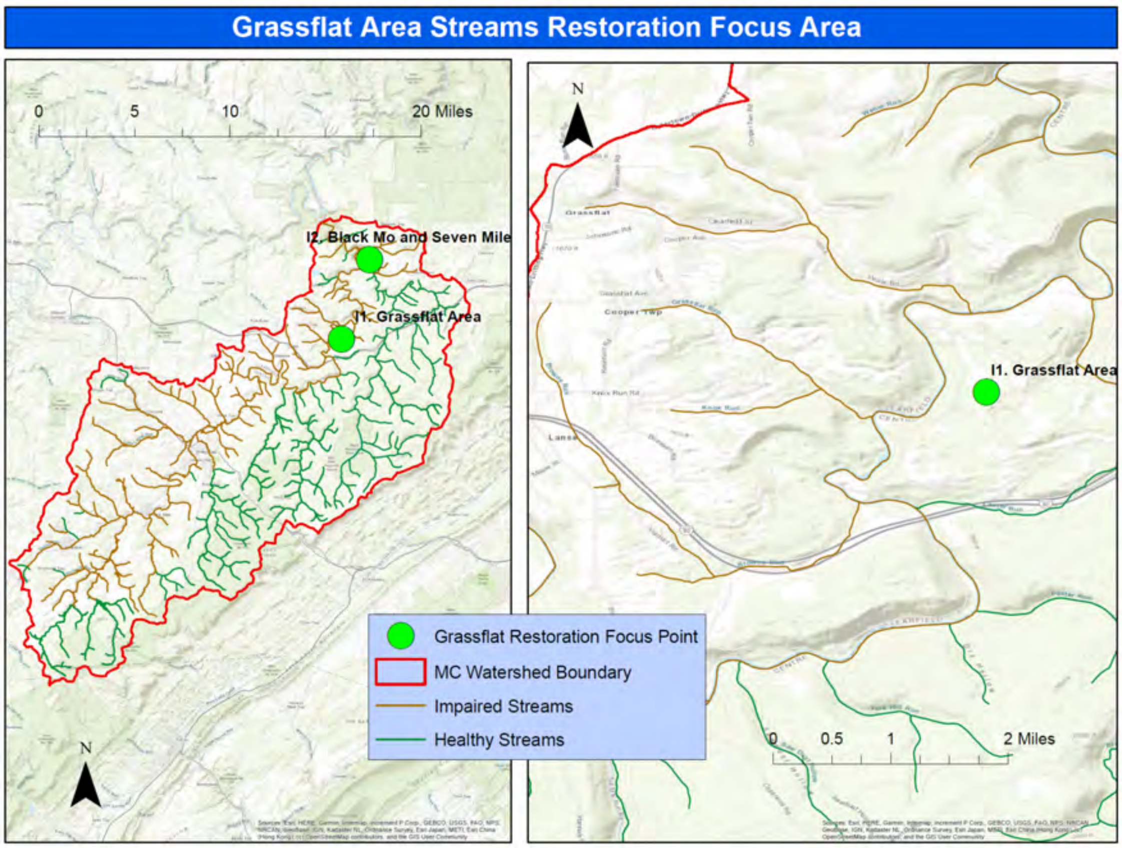


Figure 45. Browns Run, Grassflat Run and Moravian Run Restoration Focus Area.

I. After the major improvements upstream have been completed, the AMD discharges that impair Browns Run, Grassflat Run, Moravian Run, the lower tributaries of Black Moshannon Creek, and Seven Mile Run would rise in importance. Today, these tributaries provide bad water to an already severely impaired stream. When the main stem of Moshannon Creek has improved upstream of these tributaries, their impact to it will be much more detrimental. Improving these streams, after the listed improvements upstream of them, will allow Moshannon Creek to be fish habitat from its headwaters to its junction with the West Branch of the Susquehanna.

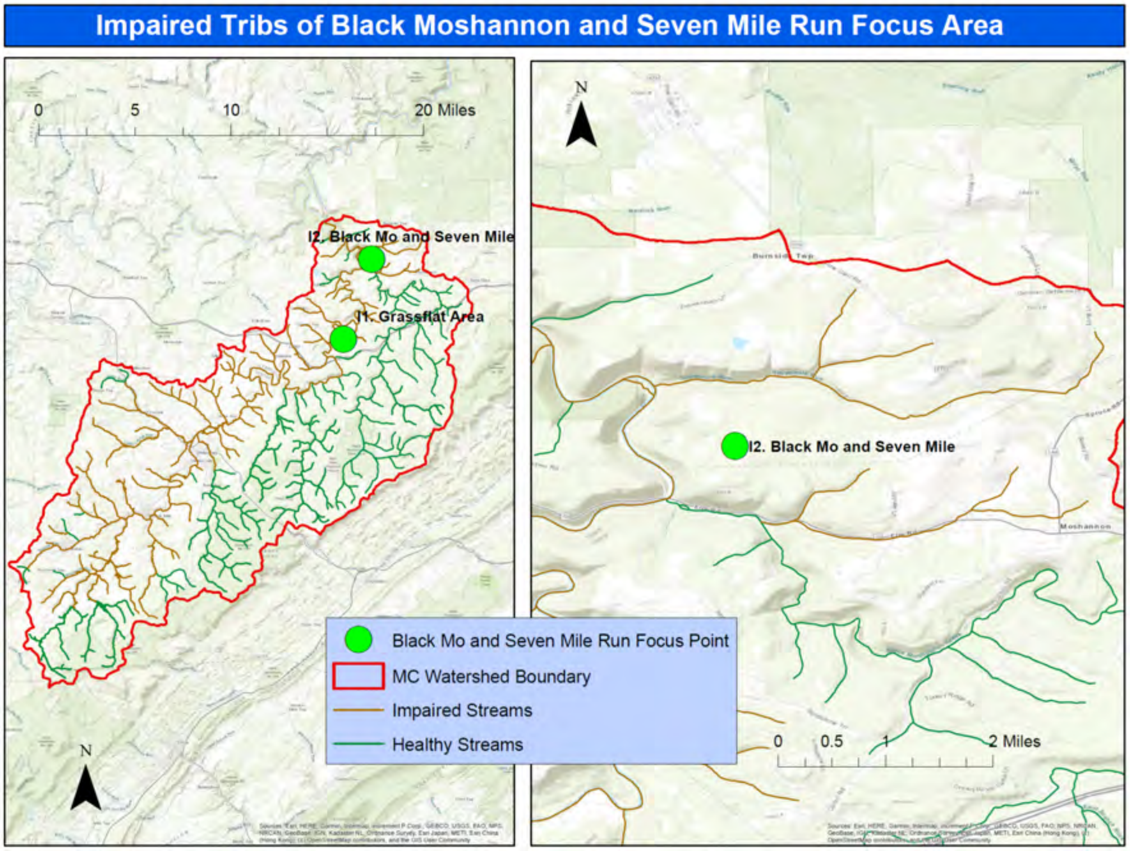


Figure 46. Black Moshannon Creek and Seven Mile Run Restoration Focus

While the "big fix" will hugely improve the water flowing into the West Branch of the Susquehanna and make fish habitat out of the main stem, it will leave plenty of impaired streams that would be considered significant if they were in almost any other watershed in Pennsylvania. Additional efforts to address these could and should be pursued after the "big fix" to add many miles of additional streams supporting aquatic life including trout. Periodic reevaluations of the watershed should be conducted while improvements are underway in order to better reveal the remaining impacts from these many smaller problems that are masked by the big ones that are getting fixed.

The next section of this report discusses each tributary in the Moshannon Creek watershed and multiple sections of the main stem of Moshannon Creek. In those discussions, water sampling data, bug count results (in two locations), and field observations from three rounds of sampling are discussed. Sampling in the 2nd and 3rd round included significant mine discharges as well as in stream sampling of tributaries of the main tributaries that enter

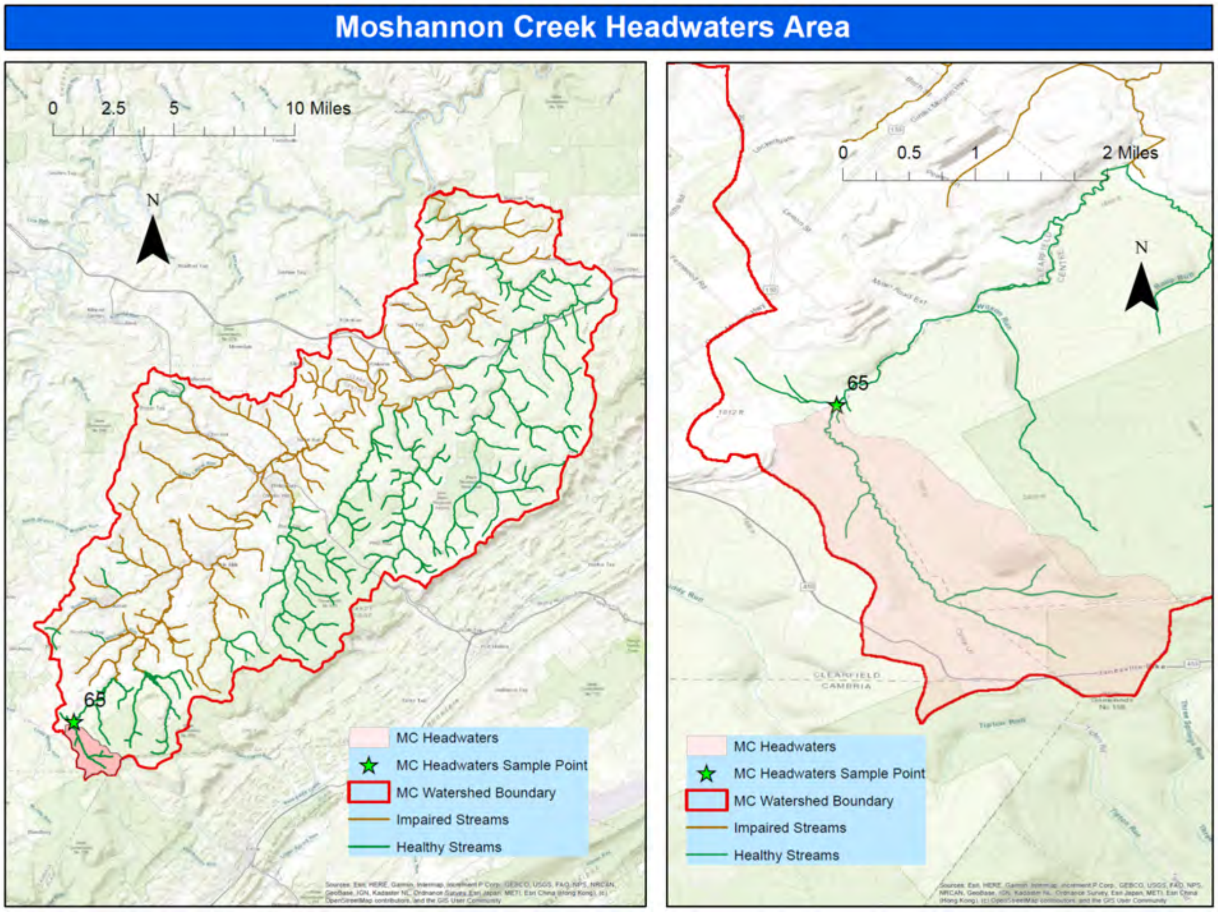
Moshannon Creek. Restoration questions that are touched upon in the discussion just finished are explored in more detail for each piece of the watershed discussed.

Individual Watershed Tributaries and Sections

This section of the Coldwater Conservation Plan lists from south to north watershed sections and the tributaries that flow into those sections. The streams are mentioned by both HUC number and the name as the authors understand it. In cases where a widely used name for a stream was discovered for a stream shown by the USGS as an unnamed stream (such as Moravian Run in Grassflat), this plan uses the commonly used name and the HUC number so that someone reading this twenty years from now can find the stream being discussed. Discussions of these sections can vary from a few sentences for a small stream that is dry most of the time, to an extensive discussion of streams like Sulfur Run and Bear Run. Each tributary watershed and each section of the main stem of Moshannon Creek has a map. There are many, many mine discharges in the Moshannon Creek watershed. The ones shown on the maps below and discussed in the narrative are ones that were sampled.

Flow Measurement in Trout Run, April 2021.

Moshannon Creek Headwaters Area. HUC 02050201000563 and points upstream.



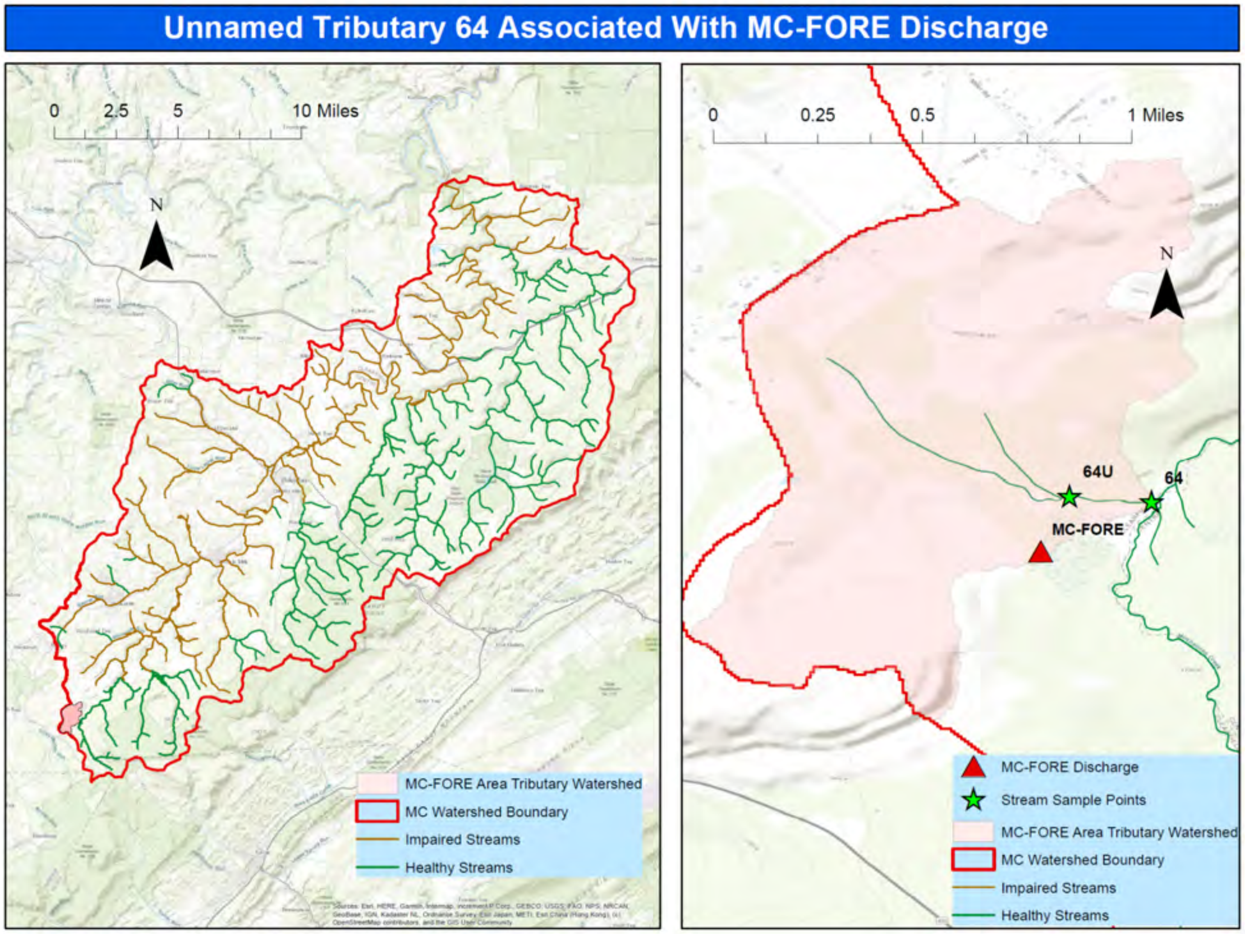
This clean water stream that is known to host trout originates in State Game Lands 60 and flows through private land that is partially used as a hunting preserve. Parts of this watershed appear to have been logged in the recent past according to satellite imagery. The sediment load in this water appears to be minimal. Current threats to this stream are minimal, although the measured water temperature during the heat of the day in late July during low flow in drought conditions is not ideal for trout. This stream can be used as a reference stream for clean water conditions in smaller streams in the Moshannon Creek watershed.

ID	Unit	65
Station Name		Headwaters
Flow	CFS	0.105
Lat		40.7460
Long		-78.3718
Area	Mi^2	2.34
Area	%	0.85
Field Temp	°C	24.58
Field DO	mg/l	
Field Cond	uS/cm	95.00
Field pH	SU	6.38
Field Turb	NTU	
Lab pH	SU	6.4
Lab Cond	uS/cm	92

ID	Unit	65
Alk	mg/l	10
Acid	mg/l	4
Acid Load	lbs/day	2
Fe	mg/l	0.06
Fe Load	lbs/day	0
Mn	mg/l	0.02
Mn Load	lbs/day	0
Al	mg/l	0.05
Al Load	lbs/day	0
SO_4	mg/l	5
SO_4 Load	lbs/day	3
TSS	mg/l	4
TDS	mg/l	60

Moshannon Creek at Hale Road Bridge. June 2019.

Unnamed Tributary Upstream of Sample Point 64. HUC 02050201002257 and points upstream.



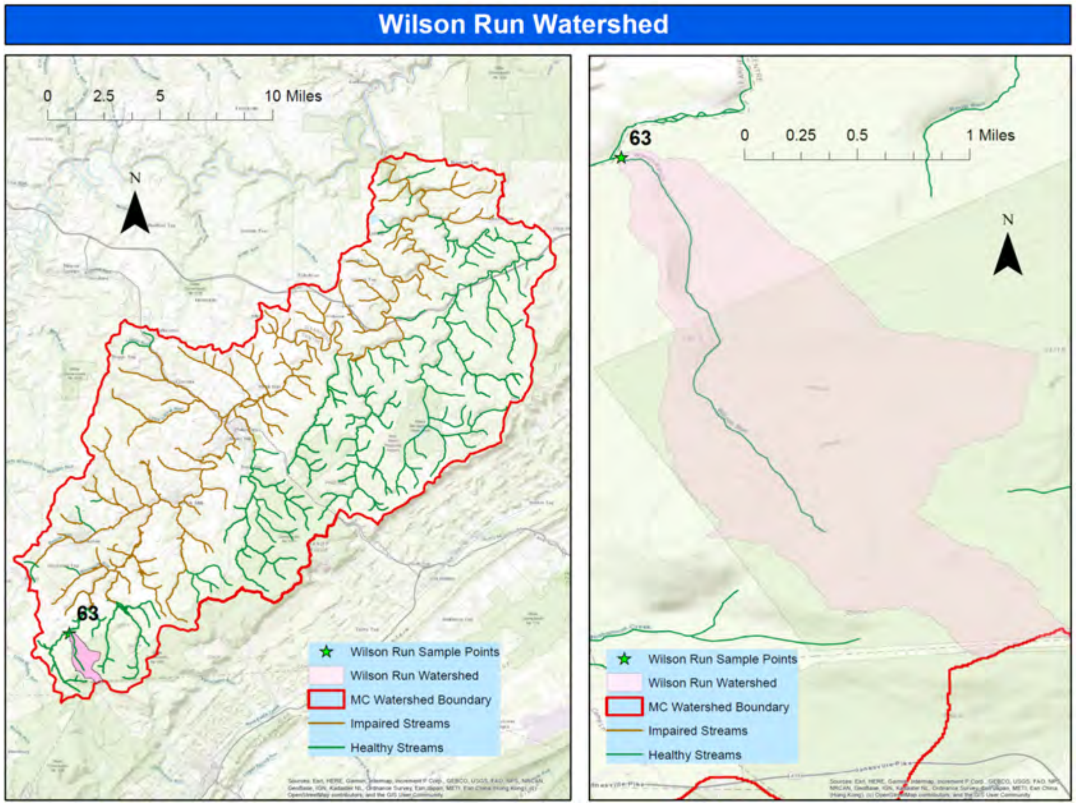
This stream has a 0.71 square mile watershed that is 0.26% of the Moshannon Creek watershed. It is impacted by discharge MC-FORE and other discharges on the hillside above its mouth. It was resampled in April due to the high metals concentration that was found when it was sampled in July. The MC-FORE discharge has low flow but very high concentrations of metals. At low stream flow, the unnamed tributary associated with sample point 64 was sending an elevated concentration of iron and manganese to Moshannon Creek. At higher stream flow, the metals were dropping out of the water but the associated chemistry of this process resulted in a lower than desirable lab pH of 4.78 in the water discharged to Moshannon Creek.

The Native Fish Coalition Pennsylvania Chapter volunteers performed benthic macroinvertebrate sampling in Moshannon Creek above and below this stream entering the main stem. The IBI score dropped from 51 to 46. This tributary does have a negative impact but Moshannon Creek currently manages to remain a Class A trout stream past this point.

The MC-FORE discharge should be viewed as a threat to the clean water section of Moshannon Creek. The unnamed tributary associated with sample point 64 is not classed as impaired. It probably should be. While there are much larger AMD problems downstream in the Moshannon Creek watershed, they are impacting a larger stream. It would be a shame to lose a stretch of Class A trout stream in the upper watershed while improvements are being made elsewhere. The MC-FORE discharge should be treated to reduce this threat.

ID	unit	64	64	64U	MC-FORE
Station Name		Unnamed Trib	Unnamed Trib	MC FORE Above	MC FORE
Date		7/24/2020	4/10/2021	4/10/2021	4/10/2021
Flow	CFS	0.045	0.252	0.178	0.022
Lat		40.7555	40.7555	40.75563	40.7537
Long		-78.3761	-78.3761	-78.3783	-78.3793
Area	Mi^2	0.71	0.71		
Area	%	0.26	0.26		
Field Temp	°C	26.60	18.80	14.66	10.30
Field DO	mg/l	7.81			
Field Cond	uS/cm	51.80	215.0	158.0	1485.0
Field pH	SU	7.29	4.32	5.96	5.45
Field Turb	NTU				
Lab pH	SU	6.2	4.78	5.85	3.58
Lab Cond	uS/cm	505	206.0	140.0	1580.0
Alk	mg/l	17	<20	<20	<20
Acid	mg/l	15	12.91	14.88	237.50
Acid Load	lbs/day	4	18	14	28
Fe	mg/l	13.09	0.87	0.42	125.00
Fe Load	lbs/day	3	1	0	15
Mn	mg/l	10.16	0.64	2.69	39.20
Mn Load	lbs/day	2	1	3	5
Al	mg/l	0.09	<.1	0.10	0.30
Al Load	lbs/day	0	0	0	0
SO_4	mg/l	210	53.1	41.6	894.0
SO_4 Load	lbs/day	51	72	40	107
TSS	mg/l	25	2.0	6.8	20.0
TDS	mg/l	365	122	90	1100

Wilson Run. HUC 02050201000171 and points upstream.

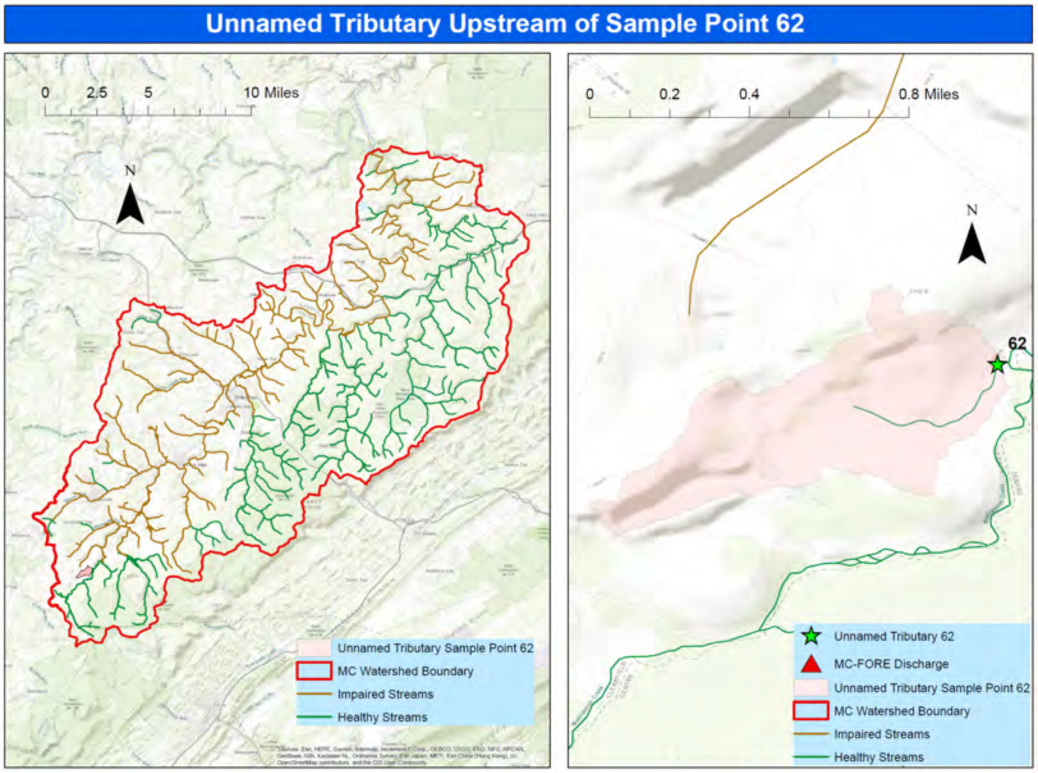


This clean water stream that is known to host trout originates in State Game Lands 60 and flows through private land that is used as a hunting preserve. Current threats to this stream are minimal. This stream can be used as a reference stream for clean water conditions in smaller streams in the Moshannon Creek watershed.

ID	Unit	63
Station Name		Wilson Run
Flow	CFS	0.416
Lat		40.7656
Long		-78.3601
Area	Mi^2	1.46
Area	%	0.53
Field Temp	°C	21.81
Field DO	mg/l	
Field Cond	uS/cm	17.00
Field pH	SU	6.55
Field Turb	NTU	
Lab pH	SU	6.2
Lab Cond	uS/cm	24

ID	Unit	63
Alk	mg/l	3
Acid	mg/l	10
Acid Load	lbs/day	22
Fe	mg/l	0.08
Fe Load	lbs/day	0
Mn	mg/l	0.02
Mn Load	lbs/day	0
Al	mg/l	0.06
Al Load	lbs/day	0
SO_4	mg/l	5
SO_4 Load	lbs/day	11
TSS	mg/l	10
TDS	mg/l	18

Unnamed Tributary Upstream of Sample Point 62. HUC 02050201002226 and points upstream.

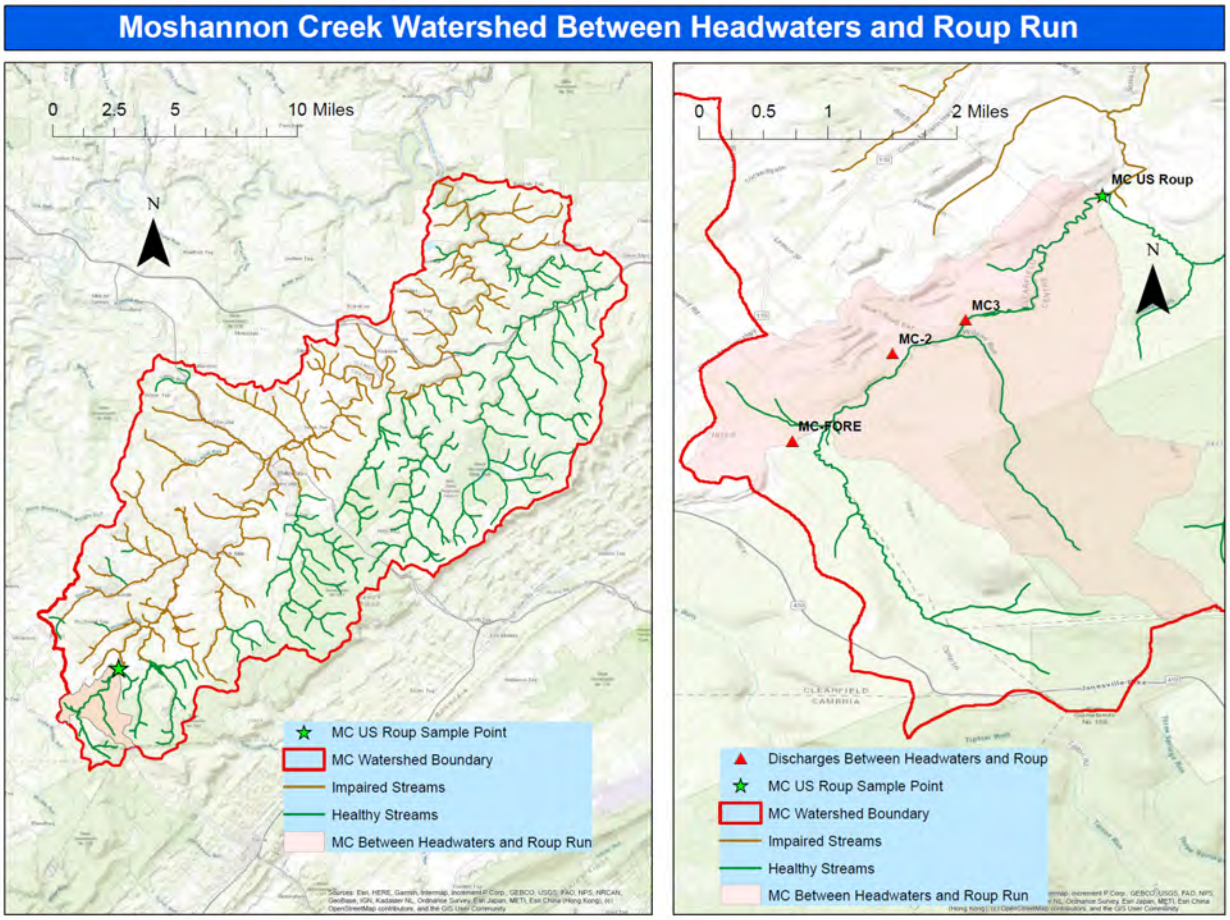


This small stream drains several strip mine cuts and water sampling in July 2020 showed a concerning, but not lethal, pH of 5.24 and elevated iron at 1.98 mg/l. This stream should be monitored to ensure its impact on Moshannon Creek does not worsen. It was providing cool water to Moshannon Creek during low flow conditions in the heat of summer. At higher flows, fish may visit this stream.

ID	Unit	62
Station Name		Unnamed Trib
Flow	CFS	0.017
Lat		40.7752
Long		-78.3522
Area	Mi^2	0.23
Area	%	0.08
Field Temp	°C	19.30
Field DO	mg/l	
Field Cond	uS/cm	87.00
Field pH	SU	5.24
Field Turb	NTU	
Lab pH	SU	5.4
Lab Cond	uS/cm	78

ID	Unit	62
Alk	mg/l	2
Acid	mg/l	14
Acid Load	lbs/day	1
Fe	mg/l	1.98
Fe Load	lbs/day	0
Mn	mg/l	0.94
Mn Load	lbs/day	0
Al	mg/l	0.18
Al Load	lbs/day	0
SO_4	mg/l	25
SO_4 Load	lbs/day	2
TSS	mg/l	2
TDS	mg/l	63

Moshannon Creek upstream of Roup Run and downstream of sample point 65. HUC 02050201000170 and points upstream..



This section of Moshannon Creek is classified as a Class A trout stream and water sampling in September of 2020 confirmed it is a clean water stream. It is not free of mining impacts but it recovers from those exposures. These include mine discharges MC-FORE, MC2 and MC3, and an estimated 350,000 ton coal refuse pile that forms the western bank of the stream near mine discharge MC3. Removal of the coal refuse pile is being evaluated, and the condition of this section of stream should be monitored to ensure it is continuing to handle its known threats.

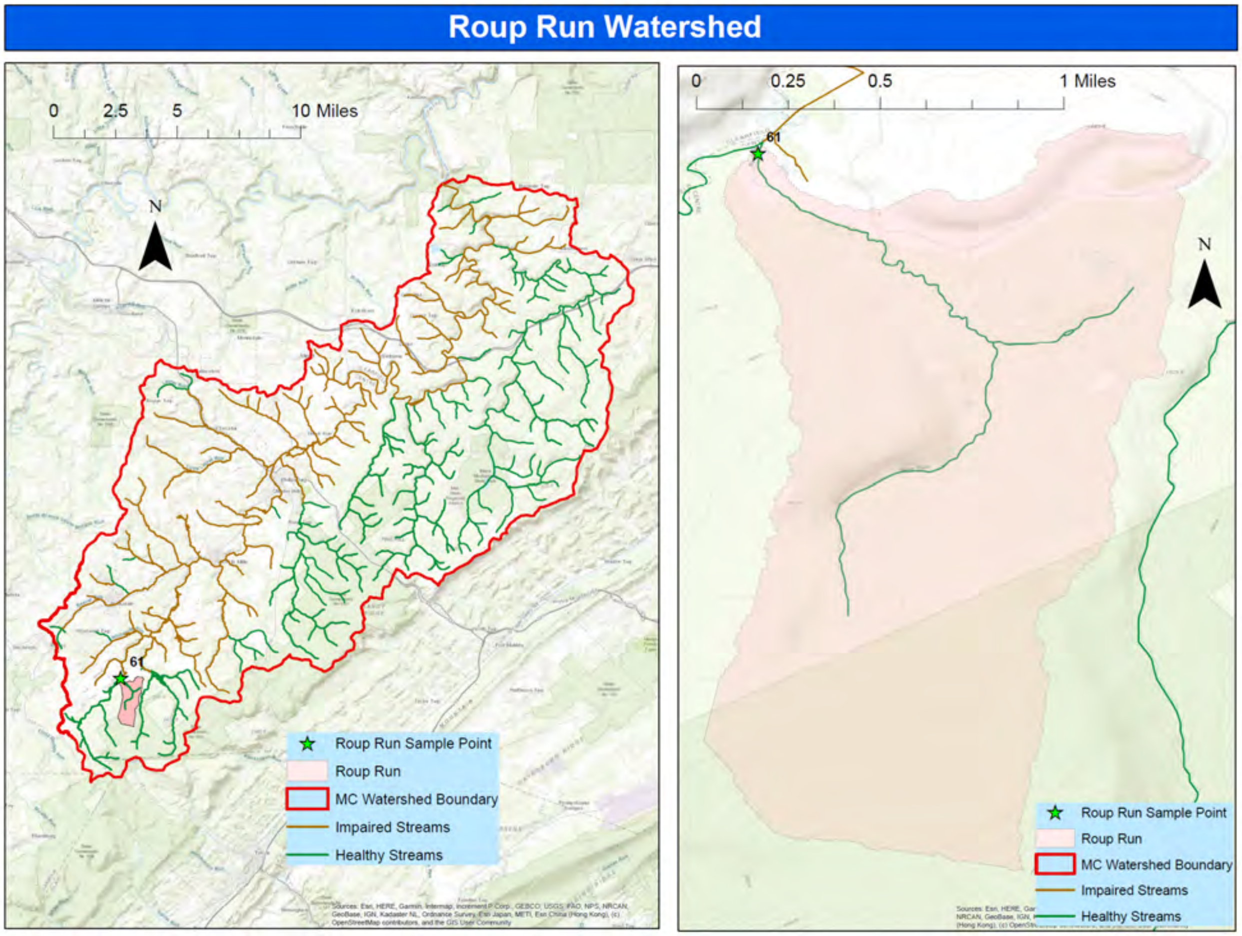
MC3 Discharge and Coal Refuse Pile. From the SRBC Website.

Coal Refuse Pile Serving as West Bank of Moshannon Creek near Wilson Run. 8/31/2021.

ID	Unit	67
Station Name		MC above Roup
Flow	CFS	2.020
Lat		40.7814
Long		-78.3444
Area	Mi^2	
Area	%	
Field Temp	°C	14.80
Field DO	mg/l	
Field Cond	uS/cm	121.0
Field pH	SU	7.80
Field Turb	NTU	
Lab pH	SU	6.70
Lab Cond	uS/cm	106.0

ID	Unit	67
Alk	mg/l	8.0
Acid	mg/l	5.00
Acid Load	lbs/day	54
Fe	mg/l	0.24
Fe Load	lbs/day	3
Mn	mg/l	0.08
Mn Load	lbs/day	1
Al	mg/l	<0.05
Al Load	lbs/day	0
SO_4	mg/l	25.0
SO_4 Load	lbs/day	272
TSS	mg/l	7.0
TDS	mg/l	55

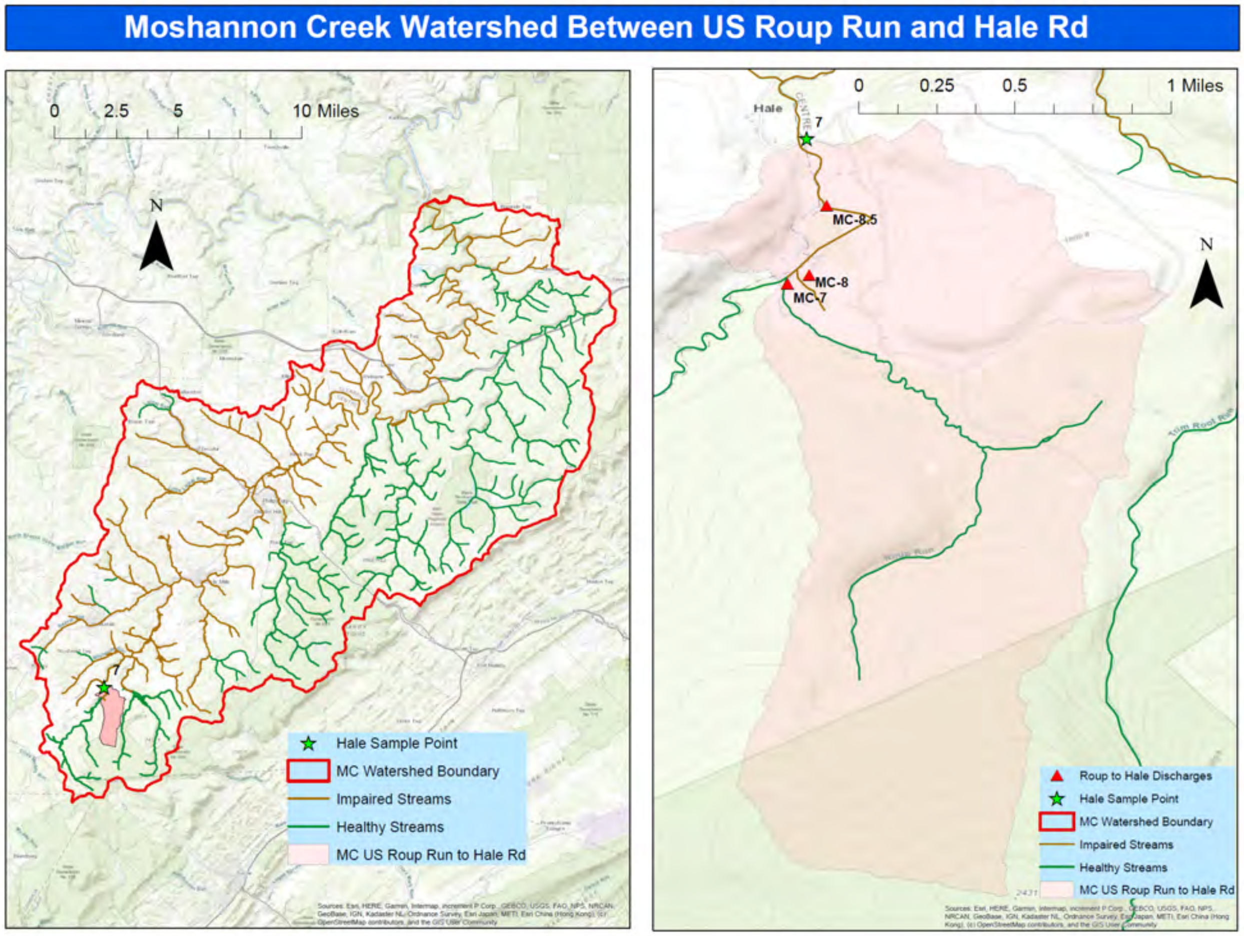
Roup Run. HUC 02050201000564 and points upstream.



Roup Run is a healthy stream with minimal threats until it encounters AMD seeps near mine discharge MC7, and then soon encounters the main flow of the MC7 discharge a short distance upstream of its junction with Moshannon Creek. Roup Run upstream of MC7 should be monitored to verify that it remains healthy. MC7 will be discussed further in the next section. The water sample results are from samples taken upstream of the point where discharge MC7 enters Roup Run.

ID	unit	61	61
Station Name		Roup Run	Roup Run
Date		7/24/2020	9/25/2020
Flow	CFS	0.017	0.022
Lat		40.7812	40.7812
Long		-78.3437	-78.3437
Area	Mi^2	1.31	1.31
Area	%	0.48	0.48
Field Temp	°C	19.53	14.80
Field DO	mg/l		
Field Cond	uS/cm	40.00	52.0
Field pH	SU	7.63	6.10
Field Turb	NTU		
Lab pH	SU	6.6	6.40
Lab Cond	uS/cm	45	91.0
Alk	mg/l	9	10.0
Acid	mg/l	4	3.00
Acid Load	lbs/day	0	0
Fe	mg/l	0.36	0.27
Fe Load	lbs/day	0	0
Mn	mg/l	0.10	0.08
Mn Load	lbs/day	0	0
Al	mg/l	0.08	0.06
Al Load	lbs/day	0	0
SO_4	mg/l	7	6.0
SO_4 Load	lbs/day	1	1
TSS	mg/l	6	<2.0
TDS	mg/l	24	35

Moshannon Creek from upstream of Roup Run to the Hale Road bridge. HUC 02050201000168 and points upstream to upstream of Roup Run.



This section of the watershed is the first section that encounters AMD discharges that consistently have much more than a local impact. Discharges MC7 and MC8 were located in previous investigations and their importance was confirmed in water sampling done in September, 2020 and April, 2021. A third discharge, which was given the designation MC8.5, was found to be flowing from a round hole, possibly an air shaft, in a dug channel leading to Moshannon Creek. MC7, MC8 and MC8.5 are all associated with the Hale Coal Company's Brookwood 2 mine and/or Harchak and Lucas Coal Company H&L #6. The Brookwood 2 mine was mining the Lower Kittanning coal seam until shutting down in the late 1930's. H&L #6's history is less well understood but it was known to mine the Brookville coal seam in the 1950's. Treating these three discharges will be necessary to mitigate their impact to Moshannon Creek. The Headwaters Restoration Plan calls MC7 a 'stream killer', a distinction that is appropriate and should be given to MC8 and MC8.5 as well. MC7 has a deep flooded area that may include one or more mine openings, and MC8.5 has an open, flooded, round vertical shaft. These hazards should be investigated and safeguarded as appropriate as part of any strategy for these discharges.

The water chemistry found in the discharges and the Moshannon Creek sample point 7 at Hale Road bridge is shown in the table below.

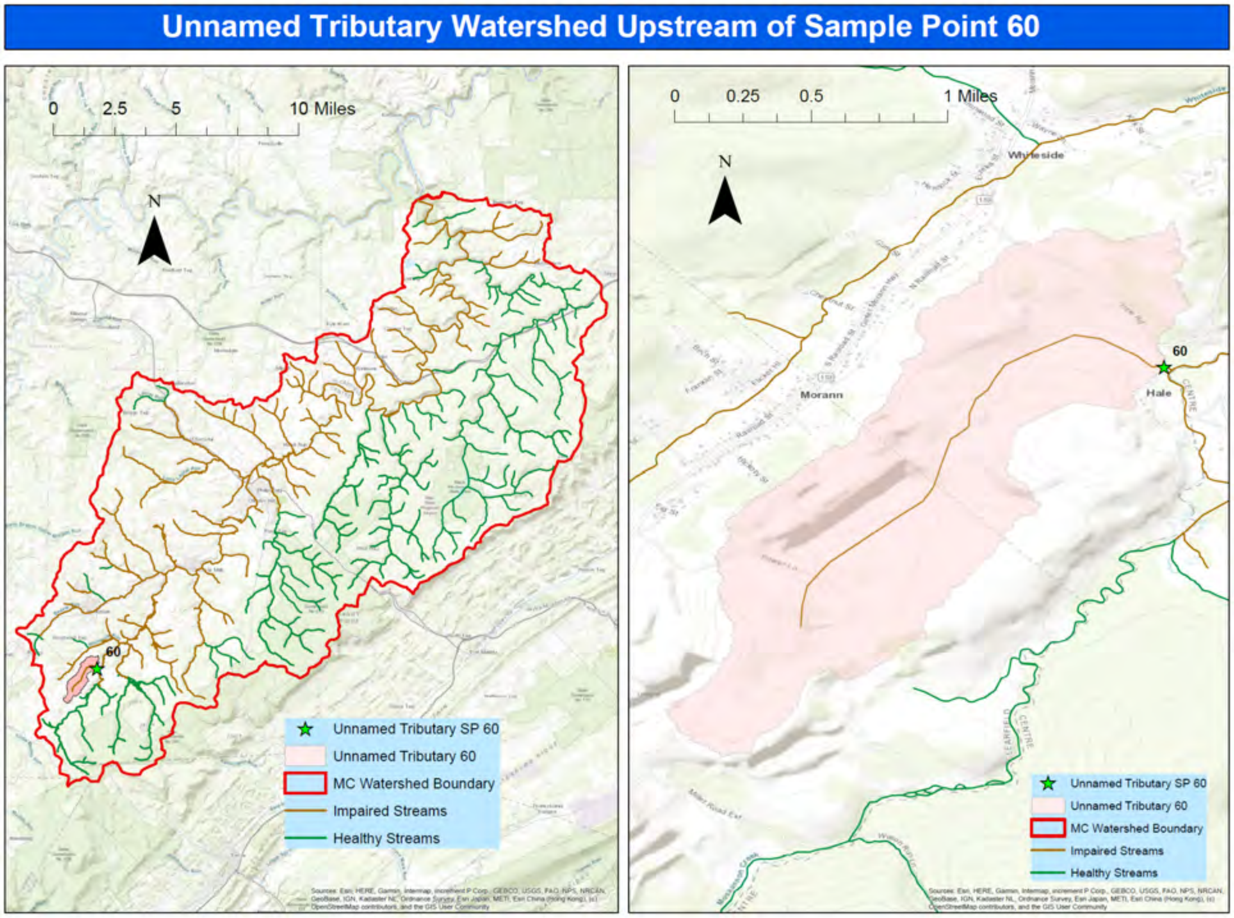
ID	unit	7	7	7	66	66	68	68	69	69
Station Name		MC Hale	Hale Rd Bridge	MC Hale (R3)	MC-7	MC-7	MC-8	MC-8	MC-8.5	MC-8.5
Date		7/24/2020	9/25/2020	4/19/2021	11/22/2020	4/19/2021	9/25/2020	4/19/2021	9/25/2020	4/19/2021
Flow	CFS	3.480	0.971	18.922	0.028	0.078	0.002	0.036	0.000	0.022
Lat		40.7881	40.7881	40.7881	40.8714	40.7814	40.7818	40.7818	40.7850	40.7850
Long		-78.3426	-78.3426	-78.3426	-78.3435	-78.3435	-78.3425	-78.3425	-78.3417	-78.3417
Area	Mi^2	9.14	9.14	9.14						
Area	%		3.34	3.34						
Field Temp	°C	22.40	14.60	8.80	7.16	14.80	17.50	13.50		15.20
Field DO	mg/l									
Field Cond	uS/cm	261.50	178.0	93.0	1248.0	1202.0	3250.0	2610.0		2420.0
Field pH	SU	4.63	5.80	6.18	3.09	3.06	1.79	3.26		3.02
Field Turb	NTU	0.03								
Lab pH	SU	4.5	6.10	7.58	3.20	3.25	3.30	3.38		3.27
Lab Cond	uS/cm	278	206.0	105.0	1170.0	1510.0	3680.0	2770.0		2610.0
Alk	mg/l	0	4.0	<20	0.0	<20	0.0	<20		<20
Acid	mg/l	19	15.00	10.32	109.00	152.50	402.00	274.80		310.40
Acid Load	lbs/day	357	79	1053	16	64	4	53	0	37
Fe	mg/l	3.22	2.46	0.78	14.64	17.90	93.05	11.10		58.80
Fe Load	lbs/day	60	13	79	2	8	1	2	0	7
Mn	mg/l	2.64	1.15	0.82	15.81	24.90	67.84	<0.02		54.30
Mn Load	lbs/day	50	6	84	2	10	1	0	0	7
Al	mg/l	0.20	0.11	0.29	3.34	5.56	19.05	22.50		7.34
Al Load	lbs/day	4	1	29	1	2	0	4	0	1
SO_4	mg/l	115	66.0	32.4	543.0	766.0	2365.0	1970.0		1850.0
SO_4 Load	lbs/day	2159	346	3307	81	322	26	378	0	222
TSS	mg/l	6	4.0	<1.6	<2.0	<1.6	10.0	4.8		3.2
TDS	mg/l	166	117	78	755	1010	3540	2470		2320

New Miles of Blue Stream called discharge MC7 the 'killer of Moshannon Creek' in their 'Moshannon Creek Headwaters Mine Drainage Assessment and Restoration Plan'. The sampling done for this plan indicates that the combined impact of discharges MC7, MC8 and MC8.5 is much worse than MC7 alone. The severity of these three discharges is very clear. Moshannon Creek never fully recovers downstream from the deterioration seen at the Hale Road bridge sample point. Inflows of cleaner water farther downstream are almost always offset by inflows from impaired tributary streams or mine discharges that flow directly to Moshannon Creek. The impact is worst during low flow periods in Moshannon Creek when all three discharges are flowing.

When MCWA volunteers were scouting sample points on 9/3/2020, all three of the discharges were observed to be flowing. During the 2nd round of sampling on 9/25/2020, MC8 was barely flowing and MC8.5 was not flowing. Even though flow in Moshannon Creek was lower in September than in July, the water quality measured in Moshannon Creek at the Hale Road Bridge sample point downstream from these discharges was better in September than in July because MC8 and MC8.5 were not impacting the stream.Treating these three discharges should allow Moshannon Creek to improve gradually to a Class A trout stream from its junction with Roup Run at Latitude 40.7814, Longitude -78.3444 downstream to its junction with mine discharge MC12 (discussed later in this report) at Latitude 40.7996, Longitude -78.3362. Moshannon Creek would remain fish habitat downstream from discharge MC12 to mine discharge MC16 (discussed later in this report) where discharge MC16, if not improved, would become the new ‘killer of Moshannon Creek’.

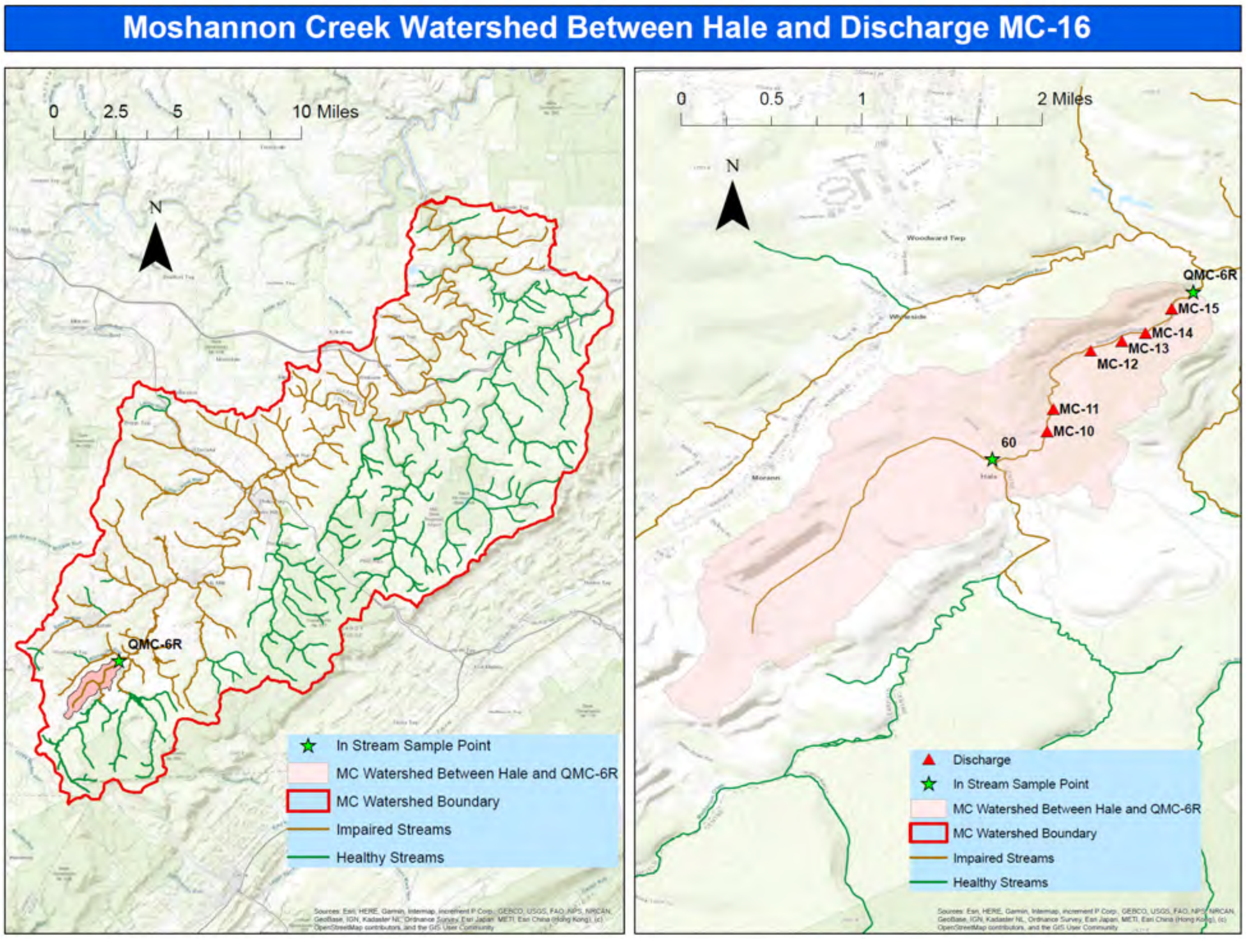
Mine Discharge MC8.5 Photographed on 9/3/2020.

Unnamed Tributary Sample Point 60 in Round 1 Sampling. HUC 02050201009781.



This stream was dry during the sampling performed in July, 2020. This location was passed frequently during this project because it crosses Hale Road, an important access point. Despite the size of this watershed (1.25 square miles, 0.45% of the Moshannon Creek watershed) this stream was found to be dry many times except for immediately after a rain event, when it had a small flow. This stream’s watershed is mostly reclaimed and unreclaimed surface mines, and it may have lost its connection to groundwater during the mining. It appears to have limited potential as a viable stream.

Moshannon Creek from the Hale Road Bridge to Just Upstream of Discharge MC-16. HUC 02050201000168 and points upstream to Hale Road Bridge. Sample point 79, QMC-6R



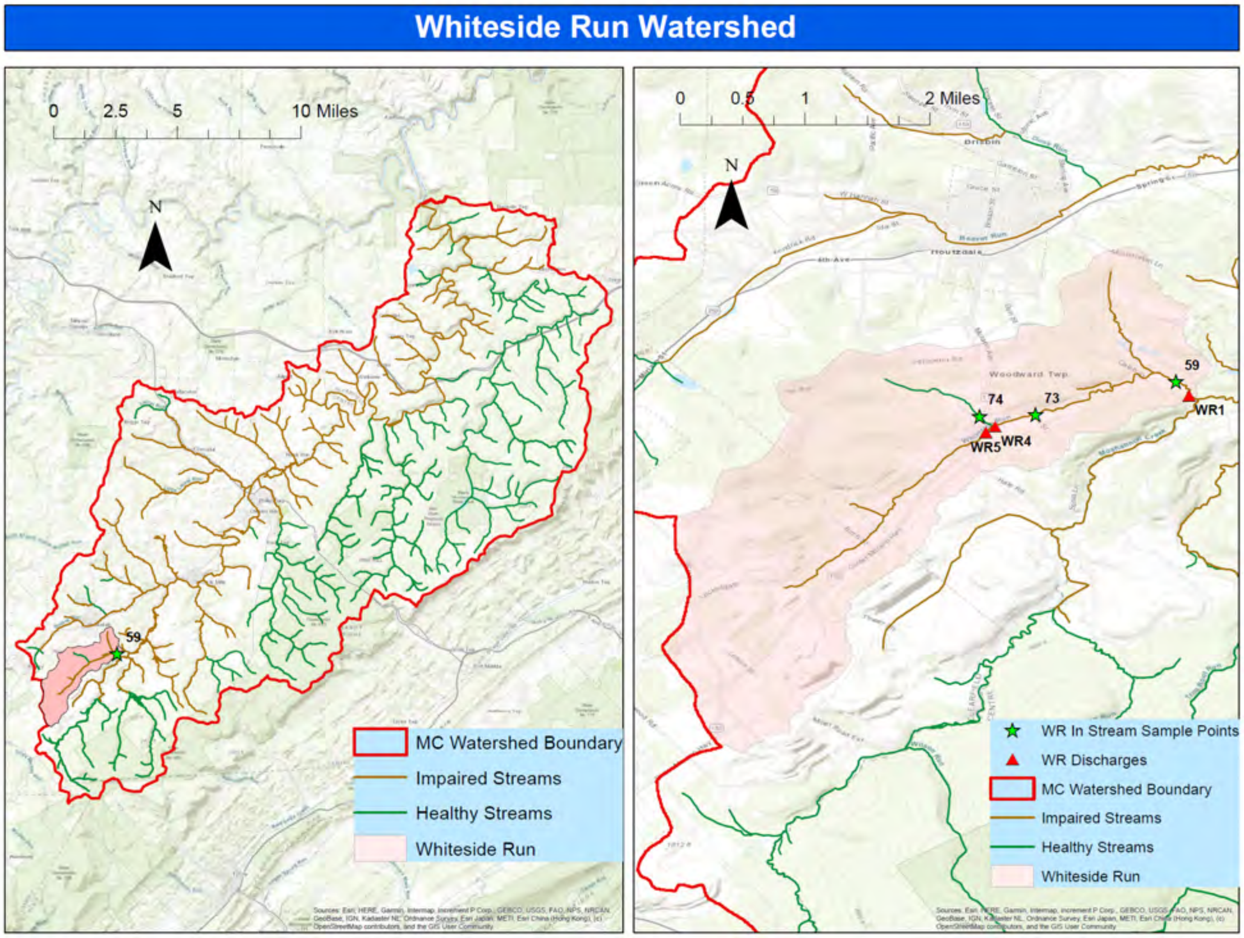
Other than the insignificant tributary upstream of sample point 60, this section of Moshannon Creek does not have any major tributaries. However, it does contain a series of AMD discharges that flow directly into Moshannon Creek. Some of these discharges tend to have very high metals concentrations. A carefully chosen selection of these discharges will need to be treated to prevent the steady deterioration of water quality in this stretch of Moshannon Creek. In September, 2020 there appeared to be flow loss in this section of the main stem. The sample results for the six discharges, labeled MC10 thru MC15, that were sampled in this study, as well as the in stream sample points, are shown in the table below. The increase in flow found at discharge MC14 from historical numbers that are less than ten percent of this value should be investigated further. While the winter of 2021 was quite wet, something significant may have changed.

Downstream of this section lies the important discharge, MC16, that will be discussed later in this report.

ID	unit	79	79	MC10	MC11	MC12	MC13	MC14	MC15	60
Station Name		QMC6 R	QMC6 R	MC10	MC11	MC12	MC13	MC14	MC15	UNT
Date		9/25/2020	4/9/2021	4/9/2021	4/9/2021	4/9/2021	4/9/2021	4/9/2021	4/9/2021	7/24/2020
Flow	CFS	0.772	20.020	1.250	0.063	0.072	0.079	0.829	0.088	0.000
Lat		40.8043	40.8043	40.7931	40.7949	40.7996	40.8004	40.801	40.8029	40.7909
Long		-78.328	-78.328	-78.3397	-78.3391	-78.3362	-78.3337	-78.3318	-78.3297	-78.3441
Area	Mi^2									
Area	%									
Field Temp	°C	20.00								
Field DO	mg/l									
Field Cond	uS/cm	579.0								
Field pH	SU	3.48	4.30	5.10	3.30	2.80	3.70	3.20	3.30	
Field Turb	NTU									
Lab pH	SU	3.30	4.61	5.90	3.45	3.01	3.39	3.24	3.08	
Lab Cond	uS/cm	591.0	174.0	321.0	604.0	1430.0	1690.0	2190.0	1020.0	
Alk	mg/l	0.0	0	0	0	0	0	0	0	
Acid	mg/l	59.00	24.56	13.26	84.06	321.80	395.20	455.30	199.60	
Acid Load	lbs/day	246	2652	89	29	125	168	2036	94	
Fe	mg/l	11.53	2.36	0.00	1.28	12.00	188.00	34.00	84.70	
Fe Load	lbs/day	48	255	0	0	5	80	152	40	
Mn	mg/l	3.26	1.37	0.18	8.03	8.33	13.20	30.70	6.98	
Mn Load	lbs/day	14	148	1	3	3	6	137	3	
Al	mg/l	2.41	0.97	0.00	6.06	33.60	14.70	57.50	0.78	
Al Load	lbs/day	10	105	0	2	13	6	257	0	
SO_4	mg/l	186.0	59.4	125.0	234.0	705.0	1030.0	1440.0	358.0	
SO_4 Load	lbs/day	775	6415	843	80	274	438	6438	169	
TSS	mg/l	6.0	<1.6	9.2	0.8	2.0	7.2	9.6	3.2	
TDS	mg/l	293	94	178	272	746	1410	314	642	

Flow Measurement in Moshannon Creek at Sample Point 79, aka QMC6-R. 9/25/2020.

Whiteside Run. HUC 02050201000559 and points upstream.

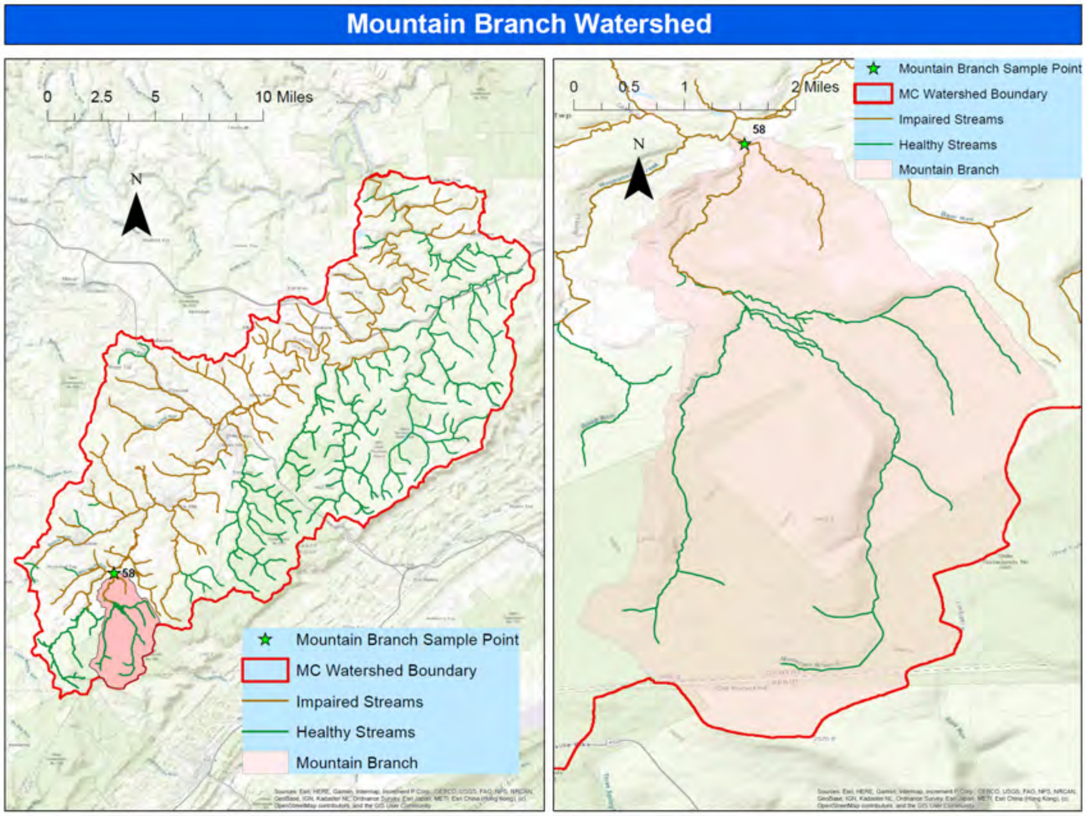


When sampled in July 2020 during developing drought conditions, Whiteside Run was found to have a near neutral pH, elevated iron, and an alarmingly warm water temperature of 26.5C. This combination of findings led to further investigation of this watershed. Mine discharges that were historically considered important were selected for resampling in an attempt to locate the sources of the iron. It was also suspected that parts of the watershed might not be impaired. In late August, the watershed was scouted, and sample points were selected, including one where small fish were observed. When sampling this stream on September 25, 2020, the sample point that had fish was dried up, as were other segments of the watershed. Some of the historic mine drainage discharges were found to be submerged in beaver ponds and could not be sampled. Unfortunately, this watershed is not very resilient in drought conditions, possibly hindering its value as a refuge for coldwater fish. The warm temperature found in the water on a hot day in July is suspected to be due to wetlands, both created by terrain in this watershed and fairly extensive beaver activity. There may be cold water sections of this watershed, or coldwater refuges in this watershed, that would be present in more normal flow conditions.

Another significant factor to consider when examining Whiteside Run is the presence of the Woodward Township Wastewater Treatment Plant, which services the Houtzdale Correctional Facility and parts of the township. The plant may introduce up to 300,000 gallons per day of treated wastewater into the Run year round, which would make up a significant portion of the total stream flow in dry weather conditions. No other wastewater treatment plant in the Moshannon watershed has such a proportional impact to its receiving stream.

ID	Units	59	59	77	73	74	75	76
Station Name		Whiteside Run	Whiteside Run near Mouth (R2)	Whiteside Disch	WS at Kirk Street	WS UT near ball fields	WR5 Disch	WR4 Disch
Date		7/24/2020	9/25/2021	9/25/2021	9/25/2021	9/25/2021	9/25/2021	9/25/2021
Flow	CFS	3.461	0.475	0.008	0.000	0.000	?	?
Lat		40.8080	40.8080	40.8064	40.80418	40.804	40.8021	40.8028
Long		-78.3294	-78.3294	-78.3279	-78.34566	-78.3522	-78.3515	-78.3504
Area	Mi^2	5.05	5.05				Discharge	Discharge
Area	%	1.84	1.84				In	In
Field Temp	C°	26.50	15.90	12.60			Flooded	Flooded
Field DO	mg/l						Beaver	Beaver
Field Cond	uS/cm	334.20	393.0	405.0			Pond	Pond
Field pH	SU	7.19	7.14	6.57			?	?
Field Turb	NTU	10.14						
Lab pH	SU	7.3	7.10	6.60			?	?
Lab Cond	uS/cm	346	393.0	356.0				
Alk	mg/l	97	82.0	39.0			?	?
Acid	mg/l	-81	-61.00	-21.00			?	?
Acid Load	lbs/day	-1512	-156	-2	0	0	?	?
Fe	mg/l	4.17	1.78	23.12			?	?
Fe Load	lbs/day	78	5	1	0	0	?	?
Mn	mg/l	1.05	0.33	0.90			?	?
Mn Load	lbs/day	20	1	0	0	0	?	?
Al	mg/l	0.08	0.08	0.05			?	?
Al Load	lbs/day	1	0	0	0	0	?	?
SO_4	mg/l	7	18.0	93.0			?	?
SO4 Load	lbs/day	131	46	4	0	0	?	?
TSS	mg/l	8	5.0	33.0			?	?
TDS	mg/l	194	204	205			?	?

Mountain Branch and Tributaries. HUC 02050201000385 and points upstream.

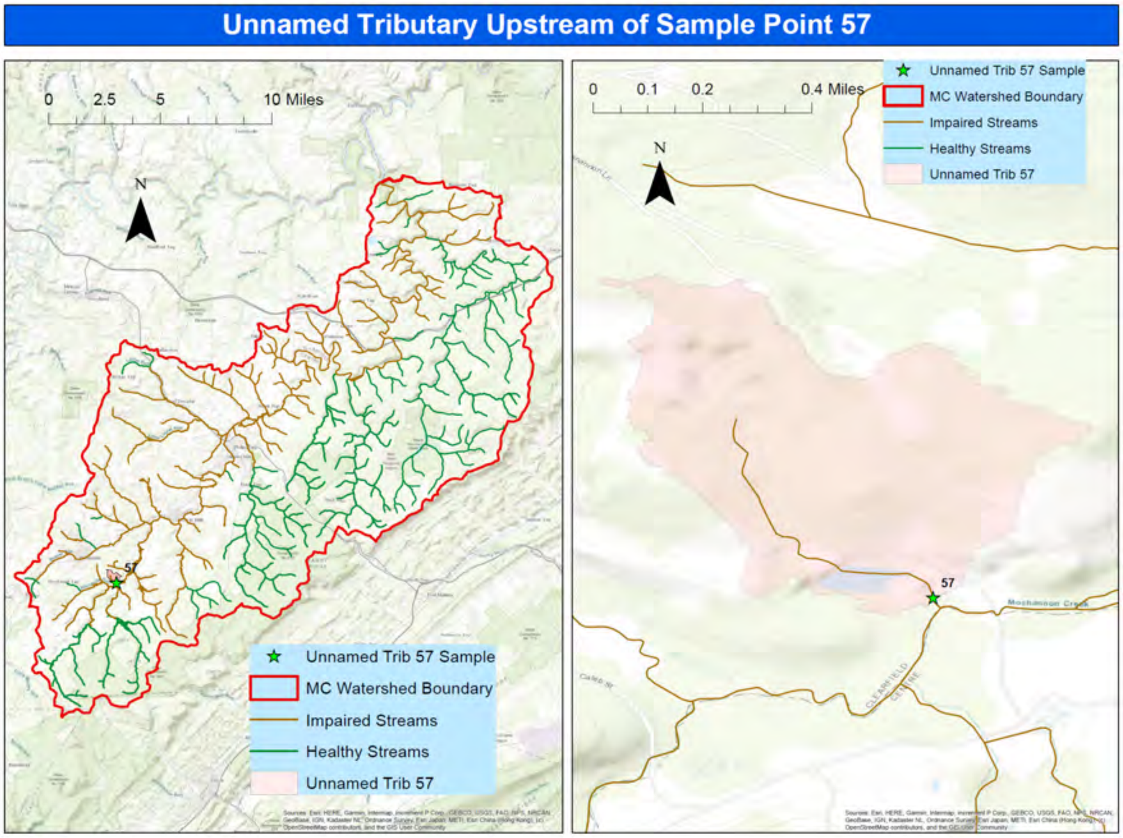


Mountain Branch has AMD impairments, but is also known as a trout fishery. Treatment of some of the mine discharges on Mountain Branch has created the situation where it currently improves conditions in Moshannon Creek when it joins it. As improvements are made in this section of the Moshannon Creek watershed, Mountain Branch should be reevaluated in order to determine what else, if anything, is needed. The below sampling data is from the July 24, 2020 first round of water chemistry sampling.

ID	Unit	58
Station Name		Mountain Branch
Flow	CFS	2.435
Lat		40.8051
Long		-78.3193
Area	Mi^2	10.90
Area	%	3.98
Field Temp	°C	21.90
Field DO	mg/l	
Field Cond	uS/cm	74.90
Field pH	SU	5.46
Field Turb	NTU	0.87
Lab pH	SU	5.8
Lab Cond	uS/cm	84

ID	Unit	58
Alk	mg/l	2
Acid	mg/l	12
Acid Load	lbs/day	158
Fe	mg/l	1.11
Fe Load	lbs/day	15
Mn	mg/l	0.46
Mn Load	lbs/day	6
Al	mg/l	0.17
Al Load	lbs/day	2
SO_4	mg/l	28
SO_4 Load	lbs/day	368
TSS	mg/l	4
TDS	mg/l	49

Unnamed Tributary Upstream of Sample Point 57. HUC 02050201002115 and points upstream.

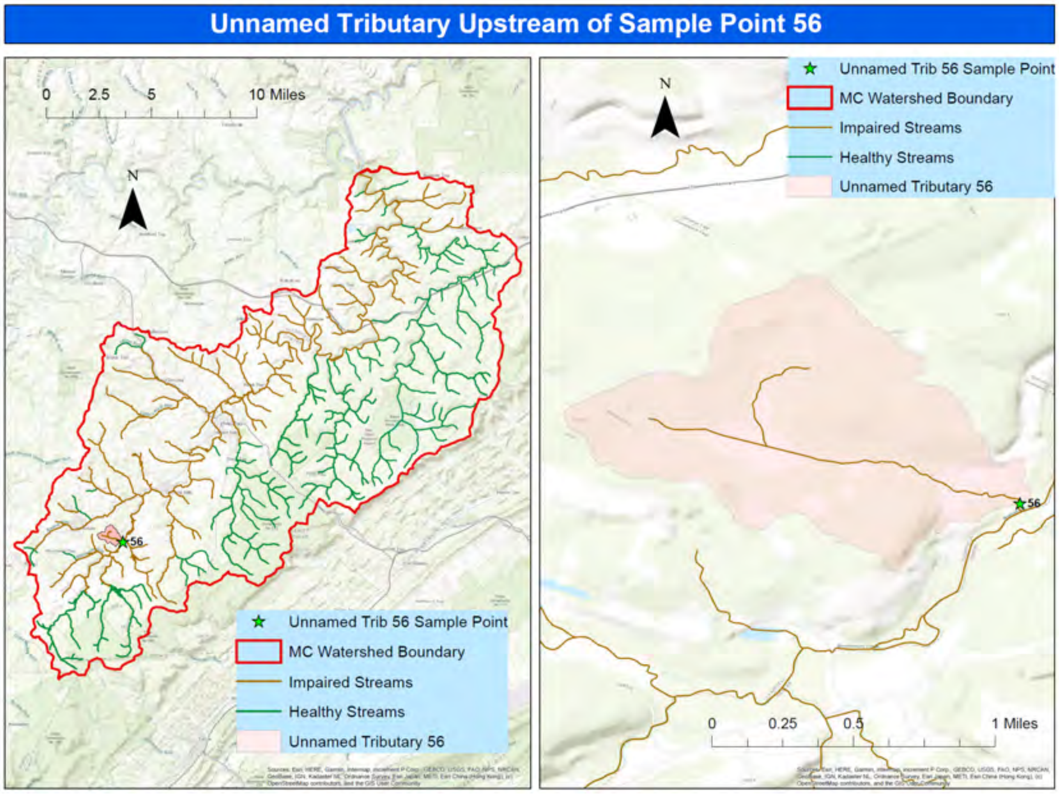


When sampled during very low flow in drought conditions in July of 2020, this stream was found to have moderately elevated iron. As improvement efforts move into this section of the watershed, this stream should be evaluated further. It may be too small to support many fish, but it does have larger pools of water, at least partially manmade, in its lower section.

ID	Unit	57
Station Name		Unnamed Trib
Flow	CFS	0.004
Lat		40.8087
Long		-78.3205
Area	Mi^2	0.24
Area	%	0.09
Field Temp	°C	22.10
Field DO	mg/l	
Field Cond	uS/cm	114.90
Field pH	SU	6.63
Field Turb	NTU	143.00
Lab pH	SU	6.7
Lab Cond	uS/cm	126

ID	Unit	57
Alk	mg/l	37
Acid	mg/l	-22
Acid Load	lbs/day	0
Fe	mg/l	1.87
Fe Load	lbs/day	0
Mn	mg/l	0.98
Mn Load	lbs/day	0
Al	mg/l	0.38
Al Load	lbs/day	0
SO_4	mg/l	17
SO_4 Load	lbs/day	0
TSS	mg/l	21
TDS	mg/l	60

Unnamed Tributary Upstream of Sample Point 56. HUC 02050201002088 and points upstream.

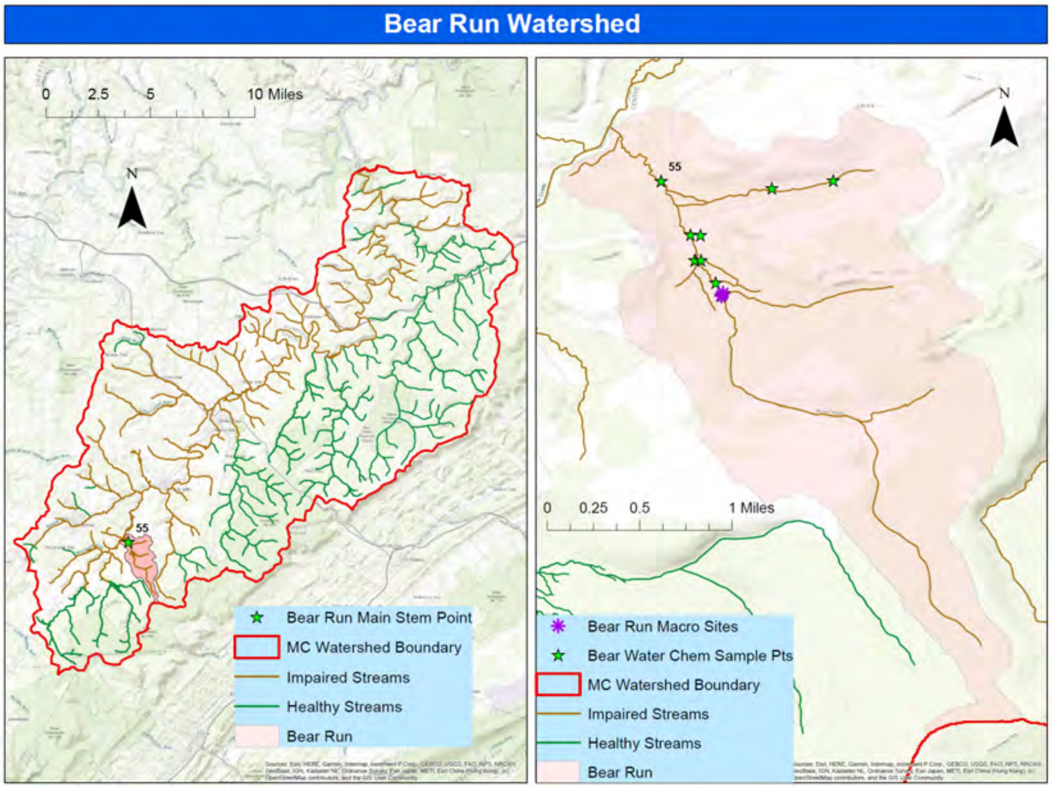


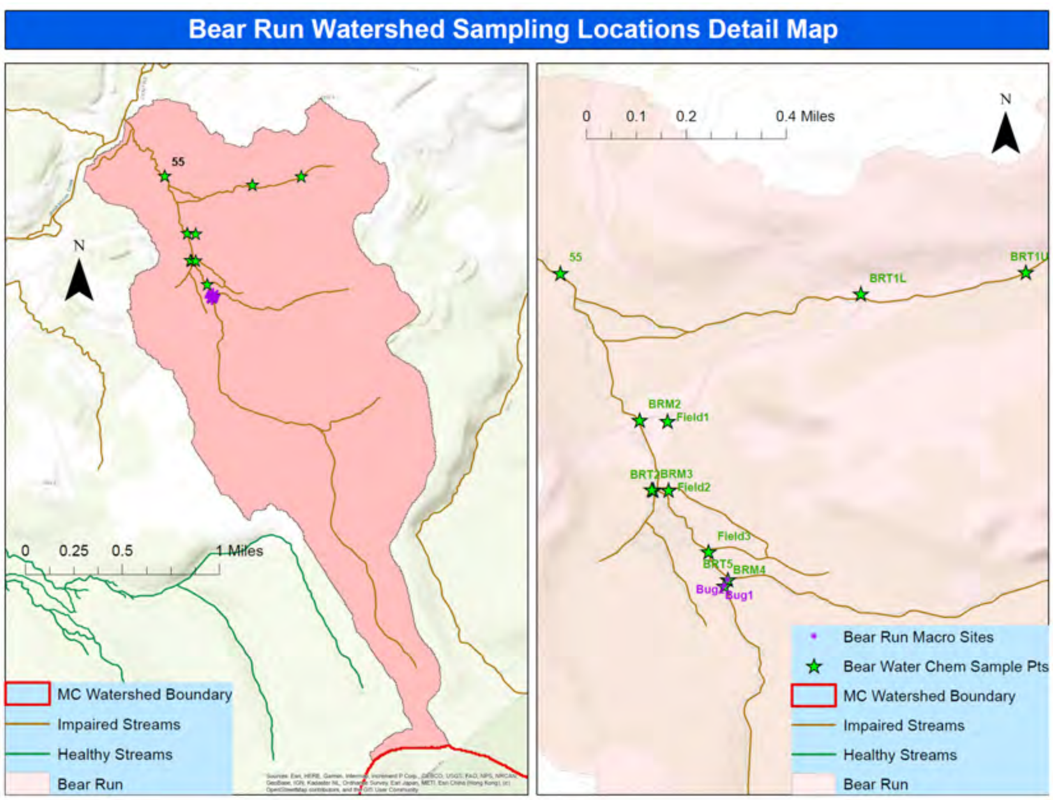
When sampled during very low flow in drought conditions in July of 2020, this stream was found to have acceptable water chemistry. This stream should be evaluated to determine whether it is still accurate to classify this stream as impaired. It may be too small of a stream to host many fish. The water chemistry data below was from the first round of water sampling performed on 7/24/2020.

ID	Unit	56
Station Name		Unnamed Trib
Flow	CFS	0.013
Lat		40.8159
Long		-78.3092
Area	Mi^2	0.63
Area	%	0.23
Field Temp	°C	25.40
Field DO	mg/l	6.49
Field Cond	uS/cm	145.90
Field pH	SU	6.49
Field Turb	NTU	7.32
Lab pH	SU	6.6
Lab Cond	uS/cm	164

ID	Unit	56
Alk	mg/l	23
Acid	mg/l	-7
Acid Load	lbs/day	0
Fe	mg/l	0.87
Fe Load	lbs/day	0
Mn	mg/l	0.46
Mn Load	lbs/day	0
Al	mg/l	0.08
Al Load	lbs/day	0
SO_4	mg/l	47
SO_4 Load	lbs/day	3
TSS	mg/l	9
TDS	mg/l	98

Bear Run. HUC02050201000571 and points upstream including tributaries.





The water chemistry sampling performed for this plan confirmed that Bear Run is an important source of contaminants discharging into Moshannon Creek. Historical data for the Bear Run watershed has a noticeable lack of sample points in the upper watershed, even though all of the watershed is classified as impaired. Geographically, Bear Run sits between two watersheds, Trout Run and Mountain Branch, that have AMD impacted lower sections and upper watershed sections that have clean water streams with native trout populations. For all of these reasons, MCWA partnered with the Native Fish Coalition - Pennsylvania Chapter to perform watershed exploration, water chemistry sampling, and benthic macroinvertebrate sampling. They also brought a fly rod.

The water chemistry results are posted in the table below. The results indicate that two tributaries, BRT1 and BRT5, are severely impaired tributaries that flow into the watershed from the east. BRT5 was found to impact the benthic macroinvertebrates in Bear Run severely, with the IBI score declining from 46 to 21 when it enters the main stem of Bear Run. The water chemistry in Bear Run upstream of BRT5 was below the threshold limits used by Fairway Labs for metal contaminants and had a good pH. The IBI score of 46 was an indicator of minor impairment and is similar to the score found downstream of the MC-FORE discharge in the Moshannon Creek headwaters, in an area that is a Class A trout stream. The Bear Run watershed upstream of this point should be investigated further for the presence of fish, good water chemistry, and proper classification for its impairment status.

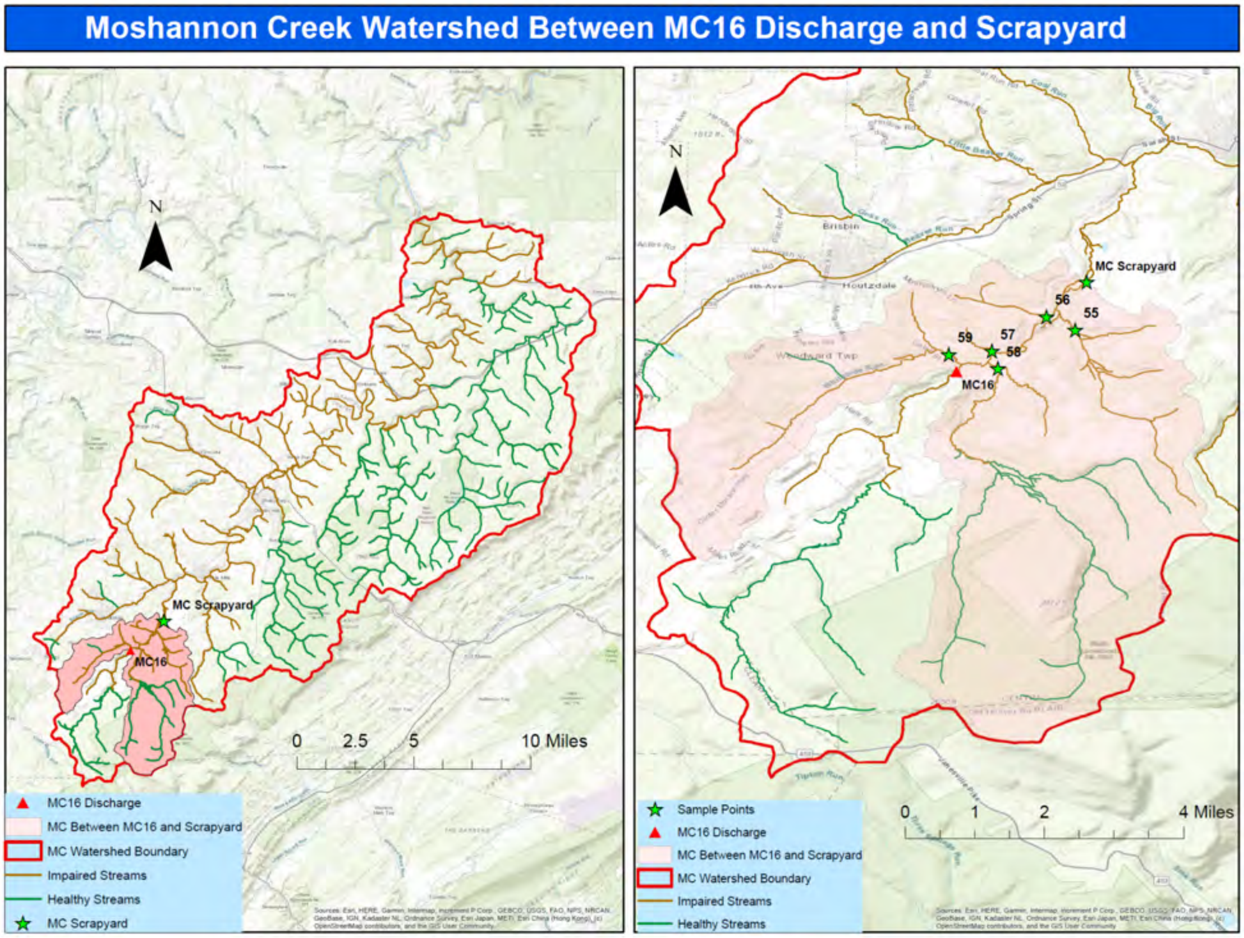
Two sample points, BRT1U and BRT2, were found to have a labeling error on the metals bottles for the water chemistry samples for those two points. This resulted in the metals values for those points being reversed in the initial data. This was recognized because the metals reported at one sample location were dramatically more than the total dissolved solids for that sample point, and the other sample point had an extremely high reported field conductivity and total dissolved solids but almost no metals reported. The corrected data is shown in the table below. A couple of trout were hooked in BRT2, so that is another confirmation that this tributary is a clean water stream, rather than a stream with a toxic level of aluminum.

BRT2 should be investigated further for confirmation of its fish population. The two eastern tributaries, BRT1 and BRT5, appear to both need treatment in order to improve the Bear Run watershed. BRT1 has a spot where field sampling during sample point scouting indicated that the water flowing directly out of a collapsed mine entrance was of better quality than the water already in the stream.

ID	Units	55	55	BRT1L	BRT1U	BRM2	BRT2	BRM3	BRT5	BRM4
Station Name		Bear Run	Bear Run	BR Trib1 Low	BR Trib1 Up	Bear Run2	BR Trib2	Bear Run3	BR Trib5	Bear Run4
Sample Date		7/24/2020	4/9/2021	4/9/2021	4/9/2021	4/9/2021	4/9/2021	4/9/2021	4/9/2021	4/9/2021
Note*					Corrected Metals		Corrected Metals			
Flow	GPM	206.00	2258.97	116.25	5.83	1615.79	1068.22	2342.90	80.79	744.16
Flow	CFS	0.459	5.033	0.259	0.013	3.600	2.380	5.220	0.180	1.658
Lat		40.8134	40.8134	40.8124	40.8132	40.8090	40.8134	40.8069	40.8043	40.8041
Long		-78.3035	-78.3035	-78.2945	-78.2897	-78.3009	-78.3035	-78.3006	-78.2984	-78.2946
Area	Mi^2	3.00	3.00							
Area	%	1.09	1.09							
Field Temp	°C	21.20	12.00	11.50	10.50	12.11	11.67	11.28	10.78	11.28
Field DO	mg/l	8.28								
Field Cond	uS/cm	427.30	199.70	1094.00	553.00	48.10	34.20	53.50	149.60	29.00
Field pH	SU	3.14	3.79	2.97	3.61	5.43	6.63	5.22	3.89	6.52
Field Turb	NTU	0.00	0.00							
Lab pH	SU	3.4	4.0	3.0	3.6	6.4	6.3	5.4	4.0	6.6
Lab Cond	uS/cm	466	188	1000	708	44.6	37	50	124	28.4
Alk	mg/l	0	0	0	0	0	0	0	0	0
Acid	mg/l	74	40.58	249.2	218.8	16.34	8.01	14.97	27.86	6.68
Acid Load	lbs/day	183	1102	348	15	317	103	422	27	60
Fe	mg/l	4.21	1.26	13.40	1.39	0.00	0.00	0.00	0.00	0.00
Fe Load	lbs/day	10	34	19	0	0	0	0	0	0
Mn	mg/l	2.75	1.12	7.51	10.60	0.19	0.04	0.24	0.61	0.00
Mn Load	lbs/day	7	30	10	1	4	1	7	1	0
Al	mg/l	6.40	3.18	26.40	38.60	0.00	0.00	0.00	1.71	0.00
Al Load	lbs/day	16	86	37	3	0	0	0	2	0
SO_4	mg/l	156	51.2	369	340	16	8.9	18.5	38	5.5
SO_4 Load	lbs/day	386	1390	516	24	311	114	521	37	49
TSS	mg/l	4	1.8	4	0	2.8	2.4	4	0	4
TDS	mg/l	270	86	270	290	22	<20	270	38	270

Water Flowing From a Collapsed Mine Entrance in the Bear Run Watershed.

Moshannon Creek Between Discharge MC-16 and Sample Point Near the Scrapyard. HUC 02050201000165 and points upstream.



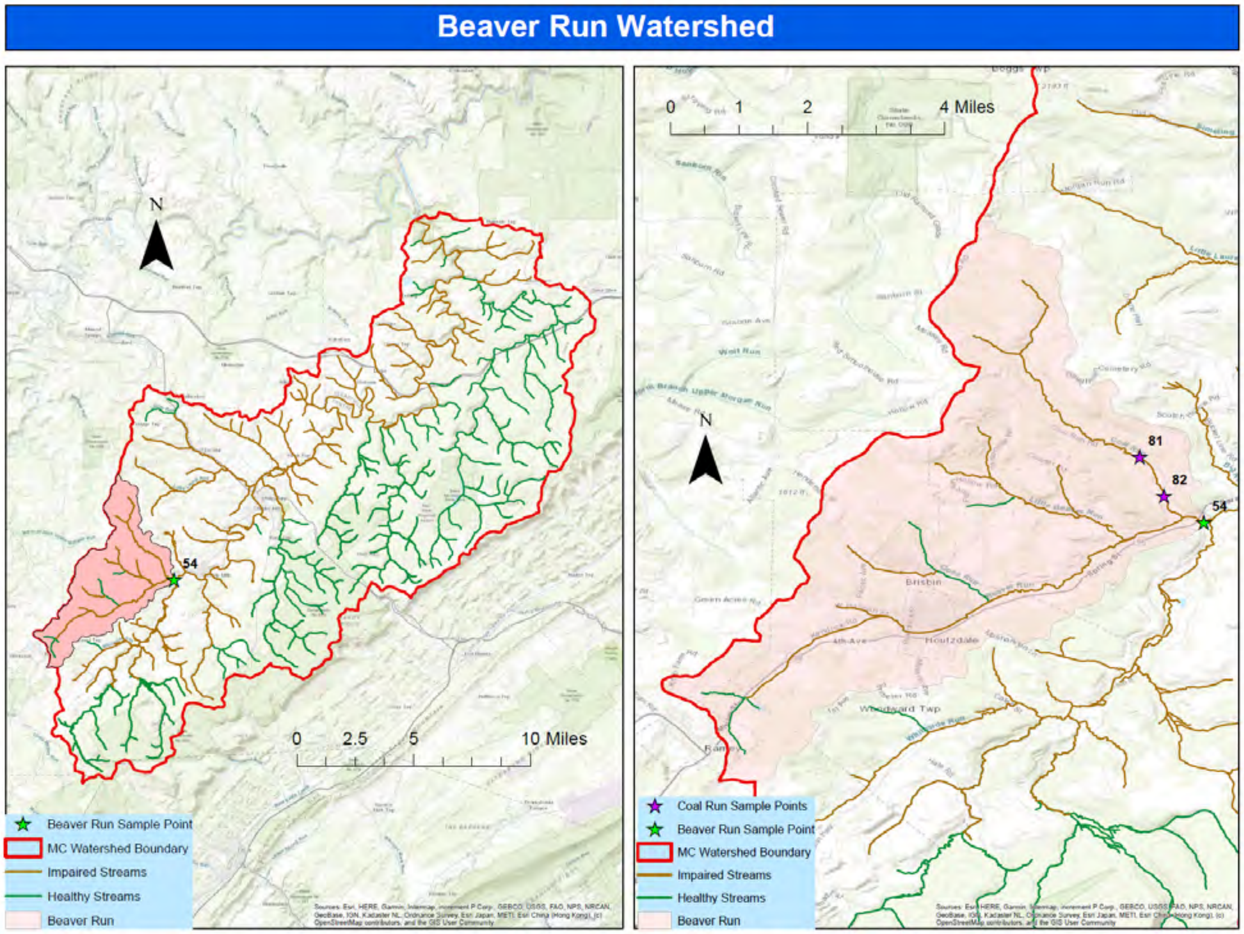
This section of the Moshannon Creek watershed has two primary sources of consistently bad water, the MC-16 discharge and Bear Run. Other tributaries in this segment provide water that incrementally improves conditions in Moshannon Creek, although briefly. The table below shows conditions in September 2020 and April 2021 at the Scrapyard sample point and the MC-16 discharge. For reference purposes, also shown is data from the 2020 snapshot for the tributaries in this section. The contrast of Bear Run with the other streams in this watershed section is easy to see. During drought conditions in September of 2020, the lab pH at the Scrapyard sample site was 3.9, which is life threatening for most fish. The MC-16 discharge at the beginning of this section discharges very poor quality water with a pH near 3 and high metals content. To improve this section of the Moshannon Creek watershed, treating the MC-16 discharge and improving Bear Run will both be necessary.

Mine Discharge MC16 Flows Directly to Moshannon Creek Upstream of Whiteside Run

ID	Unit	MC-SY	MC-SY	MC-16	MC-16
Station Name		Scrapyard	Scrapyard	MC-16	MC-16
Sample Date		9/25/2020	4/9/2021	9/25/2020	4/9/2021
Type		Stream	Stream	Discharge	Discharge
Flow	CFS	1.550	54.3	0.059	0.056
Flow	GPM	695.7	24370	26.5	25
Lat		40.82308	40.82308	40.8044	40.8044
Long		-78.30075	-78.30075	-78.3279	-78.3279
Field Temp	°C	15.9	13.1	17.6	
Field Cond	uS/cm				
Field pH	SU	3.6	4.9	3.39	3.3
Field Turb	NTU				
Lab pH	SU	3.9	4.76	3	3.06
Lab Cond	uS/cm	418	130	961	910
Alk	mg/l	0	<20	0	<20
Acid	mg/l	28	23.21	166	190.8
Fe	mg/l	1.27	1.48	51.13	71.7
Mn	mg/l	2.52	0.873	3.22	3.34
Al	mg/l	0.98	1.06	8.25	8.46
SO_4	mg/l	150	48.5	332	335
TSS	mg/l	2	4.2	42	11
TDS	mg/l	232	74	523	416

ID	Unit	55	56	57	58	59
Station Name		Bear Run	Unnamed Trib	Unnamed Trib	Mountain Branch	Whiteside Run
Sample Date		7/24/2020	7/24/2020	7/24/2020	7/24/2020	7/24/2020
Type		Stream	Stream	Stream	Stream	Stream
Flow	CFS	0.459	0.013	0.004	2.435	3.461
Flow	GPM	206	5.83	1.8	1093	1553
Lat		40.8134	40.8159	40.8087	40.8051	40.8080
Long		-78.3035	-78.3092	-78.3205	-78.3193	-78.3294
Field Temp	°C	21.20	25.40	22.10	21.90	26.50
Field Cond	uS/cm	427.30	145.90	114.90	74.90	334.20
Field pH	SU	3.14	6.49	6.63	5.46	7.19
Field Turb	NTU	0.00	7.32	143.00	0.87	10.14
Lab pH	SU	3.4	6.6	6.7	5.8	7.3
Lab Cond	uS/cm	466	164	126	84	346
Alk	mg/l	0	23	37	2	97
Acid	mg/l	74	-7	-22	12	-81
Fe	mg/l	4.21	0.87	1.87	1.11	4.17
Mn	mg/l	2.75	0.46	0.98	0.46	1.05
Al	mg/l	6.40	0.08	0.38	0.17	0.08
SO_4	mg/l	156	47	17	28	7
TSS	mg/l	4	9	21	4	8
TDS	mg/l	270	98	60	49	194

Beaver Run. HUC 02050201000217 and points upstream including tributaries.

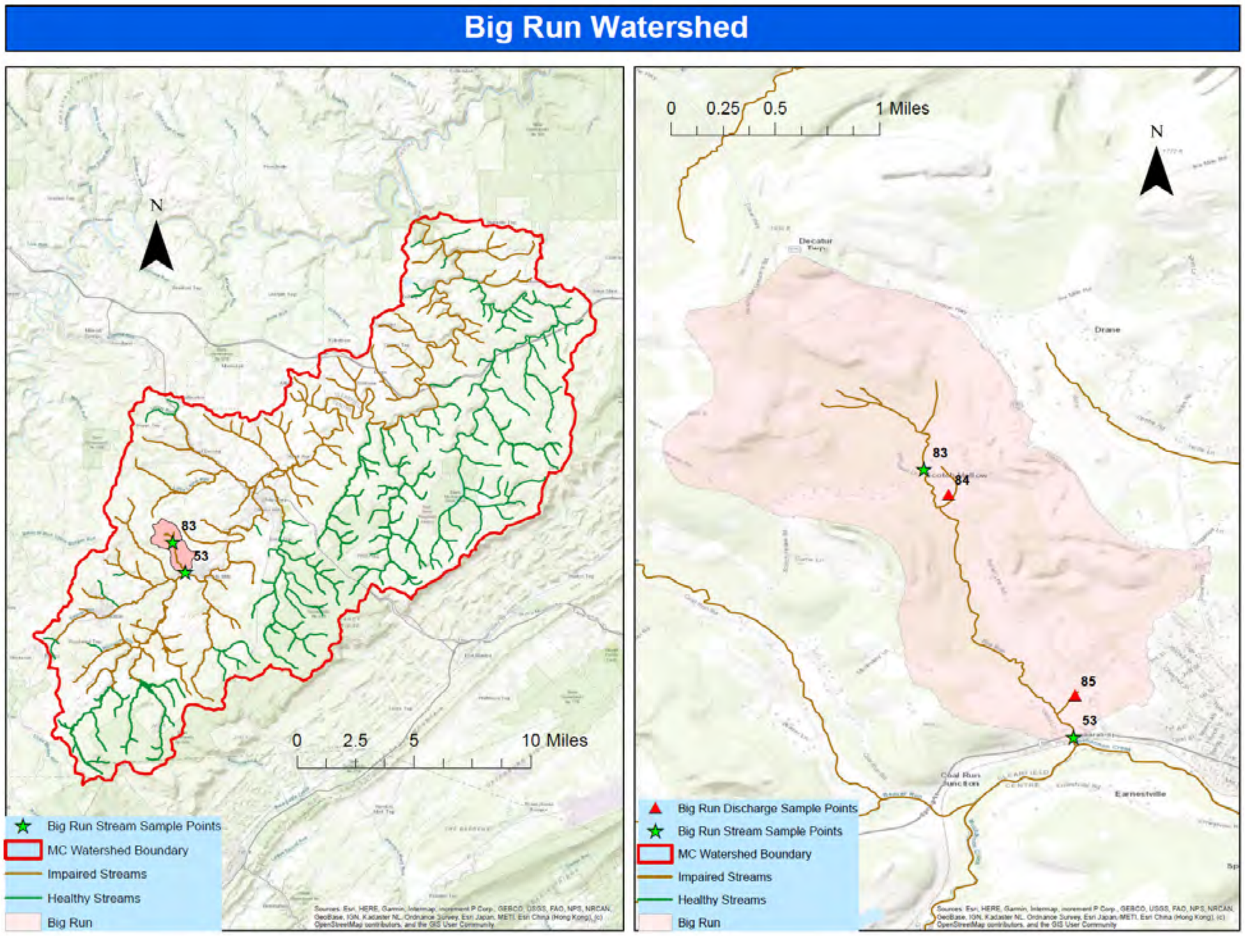


Beaver Run is a watershed that has seen gradually improving water quality in the main stem and some of the tributaries. This stream currently improves Moshannon Creek after they meet. Parts of the Beaver Run watershed have improved enough that they support fish. Some sections, particularly Coal Run, and to a lesser extent Little Beaver Run, remain impaired. Beaver Run has much of its headwaters listed as Class A trout habitat. That listing ends at Goss Run, even though Goss Run is relatively good in quality. The lower sections of Beaver Run should be investigated further for populations of wild trout. The July 2020 water chemistry sampling of the lower section of Beaver Run indicated a near neutral pH and just a touch of iron.

One tributary of Beaver Run, Coal Run, has historically been very impaired by mine drainage. To determine its current contribution to Beaver Run and points downstream, two sample points in the Coal Run watershed were selected and those were sampled in September 2020. The sample results clearly indicate that Coal Run remains impaired. The loading calculations below indicate that it is a major contributor to the loadings in Beaver Run.

ID		54	81	82
Station Name		Beaver Run	Coal Run Upper	Coal Run Lower
Sample Date		7/24/2020	9/25/2020	9/25/2020
Flow	GPM	2765	238.4	370.1
Flow	CFS	6.160	0.53119	0.82464
Lat		40.8472	40.8611	40.8528
Long		-78.2927	-78.3062	-78.3011
Area	Mi^2	18.90		
Area	%	6.90		
Field Temp	°C	20.30	15.7	14.9
Field DO	mg/l	7.33		
Field Cond	uS/cm	785.00	1213	1106
Field pH	SU	7.05	3.21	3.3
Field Turb	NTU	8.00		
Lab pH	SU	7.0	3.3	3.4
Lab Cond	uS/cm	833	1110	1070
Alk	mg/l	68	0	0
Acid	mg/l	-50	76	66
Acid Load	lbs/day	-1662	218	294
Fe	mg/l	1.35	4.18	5.27
Fe Load	lbs/day	45	12	23
Mn	mg/l	2.08	7.58	8.37
Mn Load	lbs/day	69	22	37
Al	mg/l	0.39	2.06	2.42
Al Load	lbs/day	13	6	11
SO_4	mg/l	321	451	425
SO_4 Load	lbs/day	10667	1292	1891
TSS	mg/l	10	<2	3
TDS	mg/l	582	671	670

Big Run. HUC 02050201001398 and points upstream.



The first round of water sampling displayed the impairment of Big Run. It was selected for round 2 water sampling in order to better understand the sources of the mine drainage impacting Big Run. An intermediate sample point, 83, was selected to separate the headwaters tributaries from the main stem lower in the watershed. Two mine discharges, 84 and 85, were selected to sample. 84 had been previously sampled by New Miles of Blue Stream, but 85 had not. The data indicated that Big Run has AMD impairment in both its upper and lower watersheds. The two discharges sampled for this plan were not providing most of the contaminants found in the main stem samples, at least during drought conditions in September of 2020.

A table of data from the water sampling performed on Big Run is shown below. New Miles of Blue Stream found in their survey, Moshannon Creek Phase II Mine Drainage Assessment and Restoration Plan (NMBS, 2010), that Big Run is impacted by multiple mine discharges along its length. A screenshot below the data table of the upper two thirds of the Big Run watershed from the SRBC Mine Drainage Map shows a string of those discharges. It is unfortunate that AMD sources are so widely distributed in the Bear Run watershed. It would be a good source of cold water if it was not impaired.

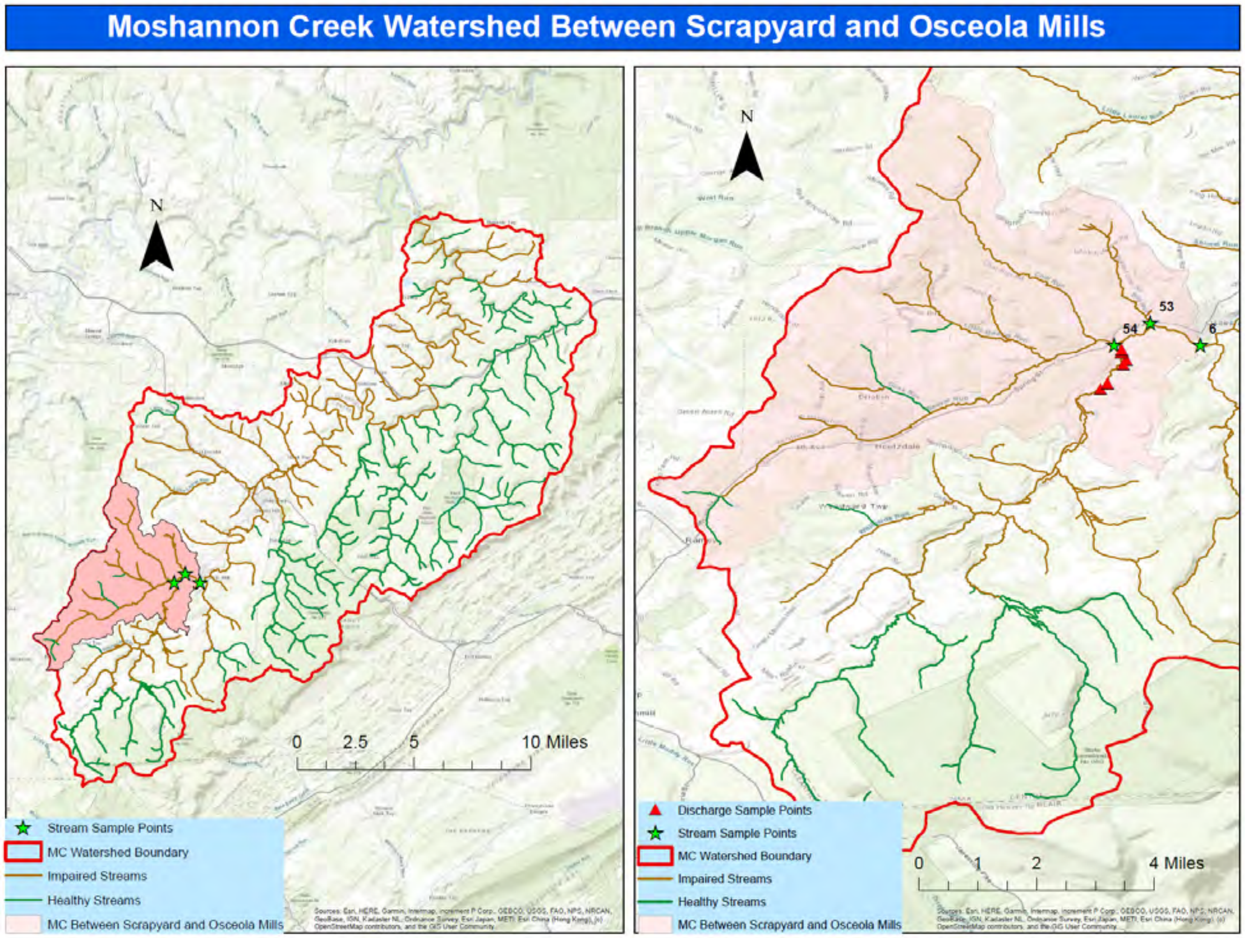
Big Run Should be monitored closely over the next few years as there is an active mining operation in the watershed that is working with the PA Department of Environmental Protection to address water quality concerns on their site. Addressing those may lead to limited improvement in water quality in Big Run.

Big Run is geographically located just downstream from the large mine discharges that will be discussed in the next section of this report. Big Run should be improved at the same time that those discharges are addressed.

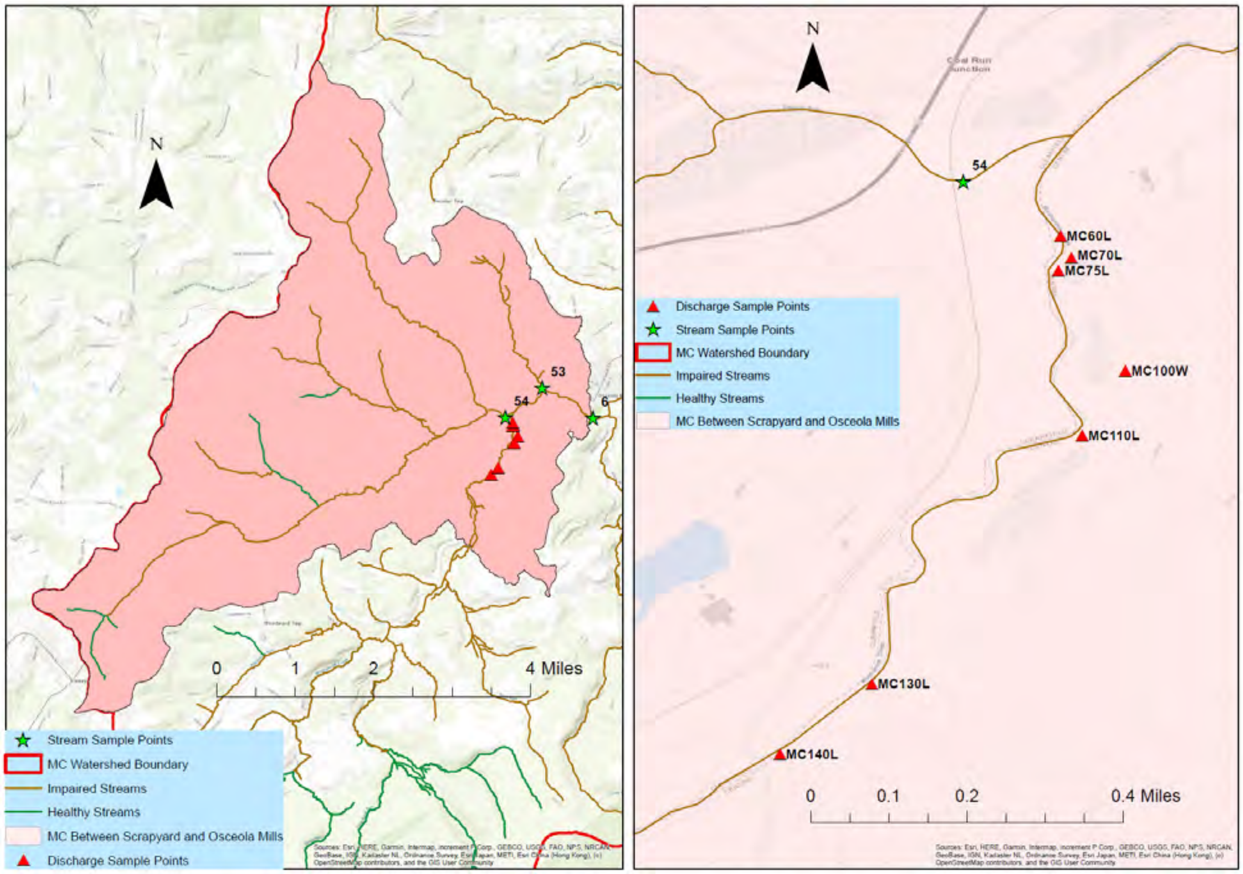
ID	UNIT	53	53	83	84	85
Station Name		Big Run	Big Run	Big Run Up	BL Road Disch	Hwy Disch
Sample Date		7/24/2020	9/25/2020	9/25/2020	9/25/2020	9/25/2020
Sample Type		Stream	Stream	Stream	Discharge	Discharge
Flow	GPM	403.9	260.4	117.5	1.21	1.21
Flow	CFS	0.900	0.58	0.262	0.003	0.003
Lat		40.8527	40.8527	40.871309	40.869577	40.855619
Long		-78.2838	-78.2838	-78.294189	-78.29248	-78.283703
Area	Mi^2	2.22	2.22			
Area	%	0.81	0.81			
Field Temp	°C	20.72	12.40	11.40	11.90	14.10
Field DO	mg/l	7.82				
Field Cond	uS/cm	1184.00	1497.00	1676.00	1289.00	1086.00
Field pH	SU	3.39	3.48	4.12	3.22	3.84
Field Turb	NTU	1.70				
Lab pH	SU	3.5	3.5	3.8	3.2	3.9
Lab Cond	uS/cm	1250	1480	1700	1280	1040
Alk	mg/l	0	0	0	0	0
Acid	mg/l	61	67	66	102	48
Acid Load	lbs/day	296	210	93	1	1
Fe	mg/l	2.67	4.92	3.44	21.50	0.66
Fe Load	lbs/day	13	15	5	0	0
Mn	mg/l	8.50	9.54	9.52	11.57	7.04
Mn Load	lbs/day	41	30	13	0	0
Al	mg/l	3.35	3.56	6.16	6.07	3.96
Al Load	lbs/day	16	11	9	0	0
SO_4	mg/l	622	663	830	480	445
SO_4 Load	lbs/day	3020	2074	1172	7	6
TSS	mg/l	2	6	5	68	38

AMD Discharges in the Northern Portion of the Big Run Watershed.

Moshannon Creek Between the Scrapyard and Osceola Mills Upstream from Trout Run. HUC 02050201000162 and points upstream to the scrapyard sample site.



Abandoned Mine Discharges Flowing to Moshannon Creek Near Osceola Mills



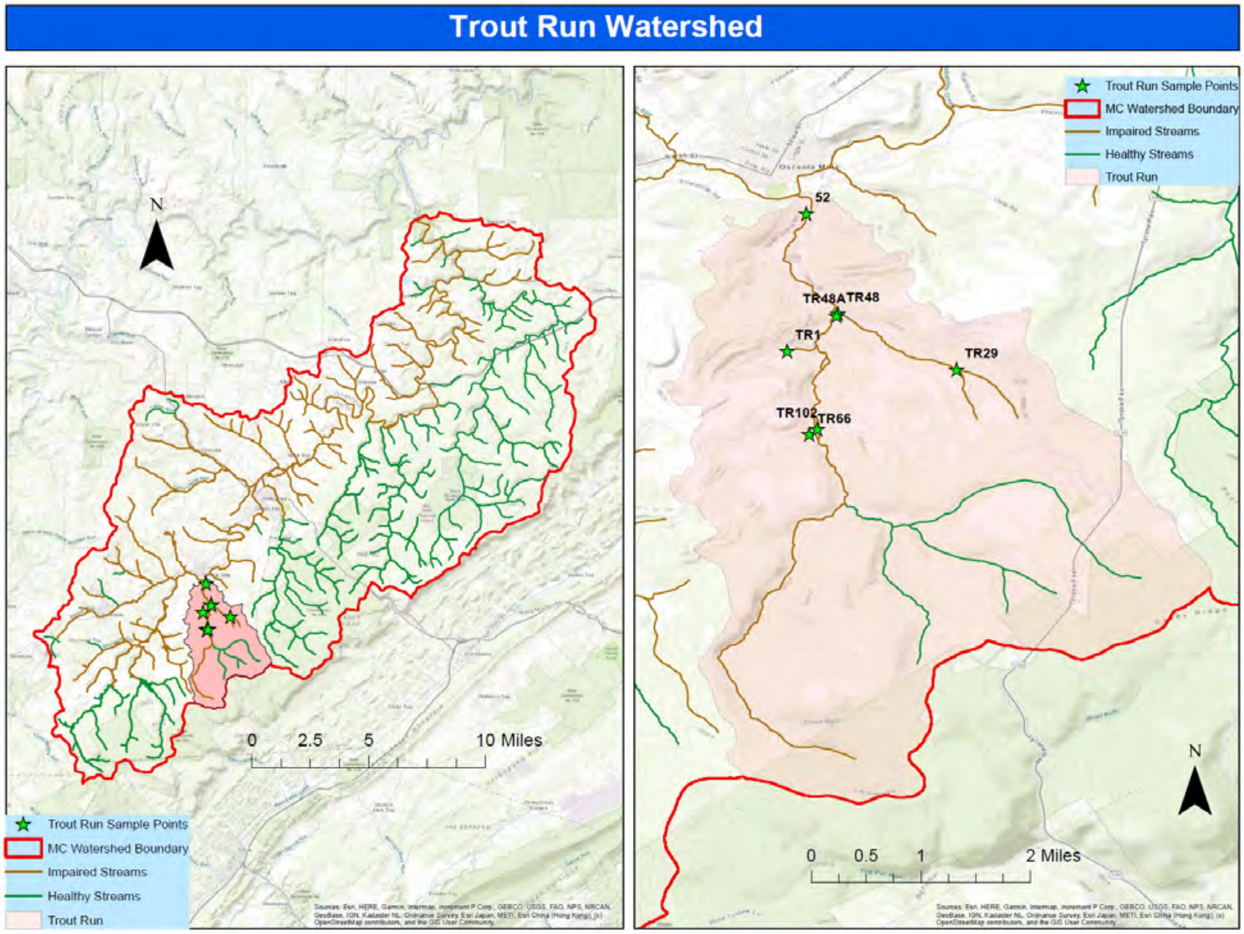
The section of the Moshannon Creek watershed between the Scrapyard sample point and Osceola Mills (upstream from Trout Run) is a section that has negative water quality impacts from two sources. The first problem is abandoned mine discharges flowing directly to Moshannon Creek. There is a series of abandoned mine discharges across Moshannon Creek from the Leslie Tipple south of Osceola Mills. Some of these discharges are known to be associated with the Banner No. 1 deep mine that was a large operation in Centre County. The largest discharge by far, MC140L, is known to be from that mine. MC140L has much seasonal variation in its flow, with the highest flows found in the winter and early spring. In historical data from New Miles of Blue Streams, a flow of 1,871 gpm was measured on February 13, 2009. Sampling on April 9, 2021 had a measured flow of 1,113 gpm. The water quality from this mine discharge is terrible and is shown in the table below. The other discharges from historical data were also resampled, and a 202 gpm flow of AMD that did not seem associated with historical discharges, MC75L, was added to the list of problems in this area.The second problem in this section of the watershed is the previously discussed Big Run.

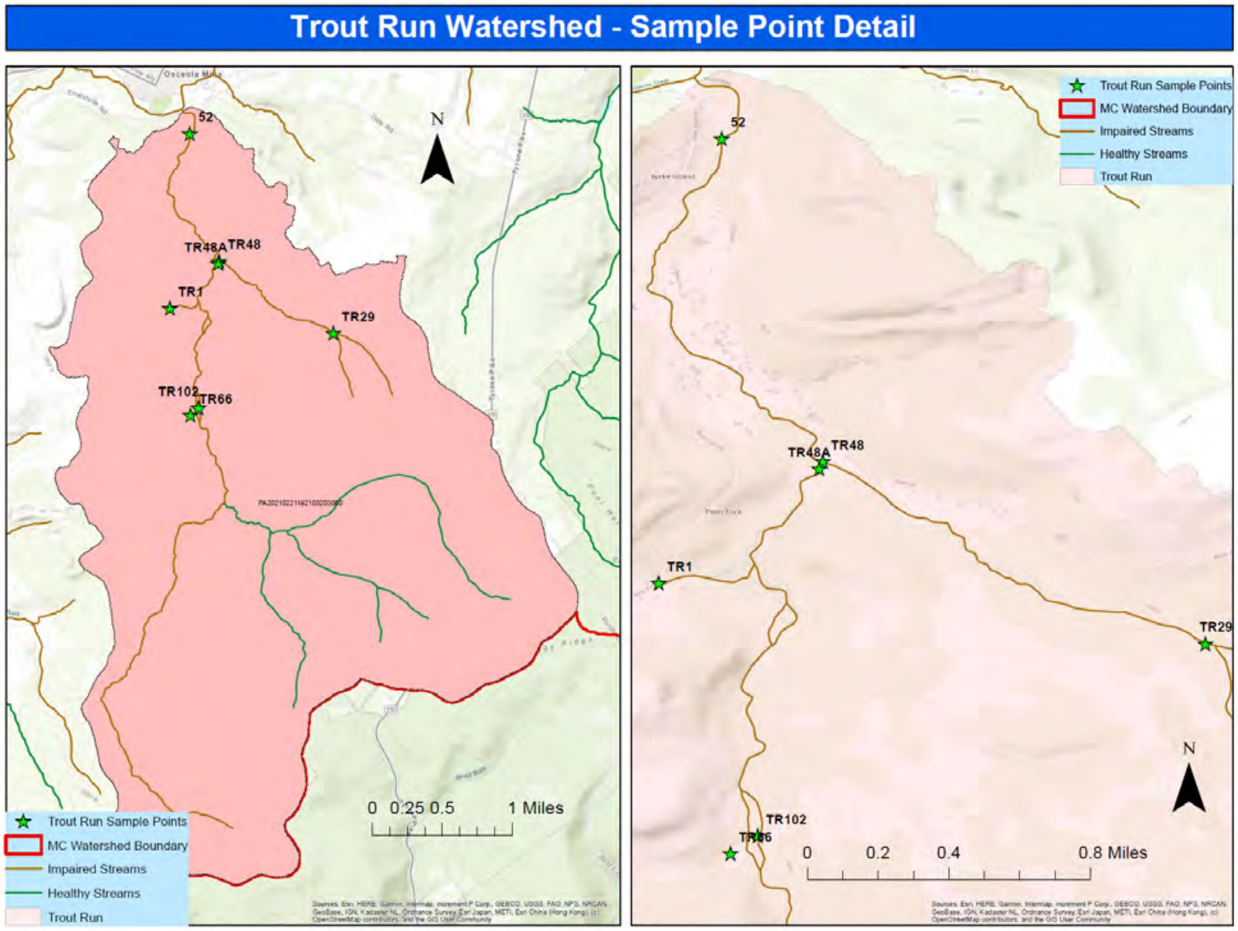
Given the combined flows and water chemistry of the Centre County discharges, along with the fact that much of the land near them is wetlands, an active plant with the flows gathered and sent to a central location for treatment is likely to be necessary. Including impaired water from the Big Run watershed and possibly some from nearby mine discharges in the Beaver Run watershed would keep an active treatment plant busy even in the driest seasons of the driest years and make an enormous difference in water quality in the Moshannon Creek watershed. MC140L is the biggest known untreated source of mine drainage in the Moshannon Creek watershed south of Philipsburg.

The MC140L mine discharge flows directly out of a hillside from the long abandoned Banner No. 1 Mine and enters into Moshannon Creek a short distance later.

ID	6	53	54	MC100W	MC110L	MC70L	MC75L	MC60L	MC140L	MC130L
Station Name	MC Osceola Upstream Trout Run	Big Run - July 2020	Beaver Run - July 2020	MC100 @ Weir	MC110L	MC70L	MC75L	MC60L	MC140L	MC130L
Flow	104.23	0.90	6.16	0.40	0.36	0.00	0.45	0.03	2.48	0.07
Lat	40.8472	40.8527	40.8472	40.84369	40.84252	40.84582	40.84556	40.84624	40.83661	40.83787
Long	-78.2715	-78.2838	-78.2927	-78.28968	-78.2905	-78.2907	-78.29094	-78.2909	-78.2961	-78.2944
Field Temp	13.5	20.72	20.3	9.7	14.6	12.3	11.7	13.1	12.1	12.1
Field Cond	322	1184	785	618	937	693	609	768	1814	1500
Field pH	5.88	3.39	7.05	3.24	3.16	3.21	3.25	3.11	2.61	2.89
Lab pH	6.18	3.5	7	3.49	3.5	3.51	3.6	3.37	3.04	3.23
Lab Cond	410	1250	833	738	1130	831	738	925	2080	1820
Alk	0	0	68	0	0	0	0	0	0	0
Acid	14.16	61	-50	150.5	113.7	174.5	155	203.2	356.7	326.2
Acid Load	7961.84	296.16	-1661.53	327.41	218.65	4.19	376.31	34.20	4772.13	117.55
Fe	2.42	2.67	1.35	0.00	7.25	11.70	1.50	2.82	14.80	17.70
Fe Load	1360.71	12.96	44.86	0.00	13.94	0.28	3.64	0.47	198.00	6.38
Mn	1.79	8.50	2.08	3.41	4.70	4.16	3.37	3.98	10.10	9.64
Mn Load	1006.48	41.27	69.12	7.42	9.04	0.10	8.18	0.67	135.12	3.47
Al	2.22	3.35	0.39	19.30	8.08	20.30	17.00	23.20	37.90	36.80
Al Load	1248.25	16.26	12.96	41.99	15.54	0.49	41.27	3.90	507.05	13.26
SO4	151.00	622.00	321.00	335.00	540.00	354.00	1350.00	384.00	366.00	1090.00
SO4 Load	84903.78	3019.88	10667.02	728.78	1038.45	8.51	3277.57	64.63	4896.55	392.79
TSS	10.80	2.00	10.00	1.00	<0.8	24.00	<1.60	<1.6	1.80	3.80
TDS	248.00	925.00	582.00	982.00	726.00	562.00	454.00	560.00	1560.00	1400.00

Trout Run. HUC 02050201000434 and points upstream including tributaries.





The continued importance of Trout Run to the current conditions in the Moshannon Creek watershed was confirmed by the water sampling data gathered for this Coldwater Conservation Plan. Trout Run is a coldwater stream with a large flow. The measured flow of 1849 gal/min of cold water near the mouth of Trout Run was measured during a drought on a hot day in July. This stream could be trout habitat for its entire watershed. It already has trout in its headwaters streams.

Looking at the results from the April sampling, and looking at historical data, Trout Run shows to have good water chemistry in its main stem upstream of sample point TR102. Quite a bit of the watershed is classed as impaired above that point. This should be reevaluated. Downstream of TR102 until sample point TR48A, Trout Run is probably fish habitat today. It has slightly elevated aluminum and a pH above 5, conditions similar to ones fish tolerate in parts of the Mountain Branch watershed. Downstream of TR48A is where conditions markedly deteriorate. The eastern tributary upstream of sample point TR48 should be the place to begin making improvements in the Trout Run watershed. That tributary, plus impacts lower in the main stem, are the sources of much of the impairment in the watershed.

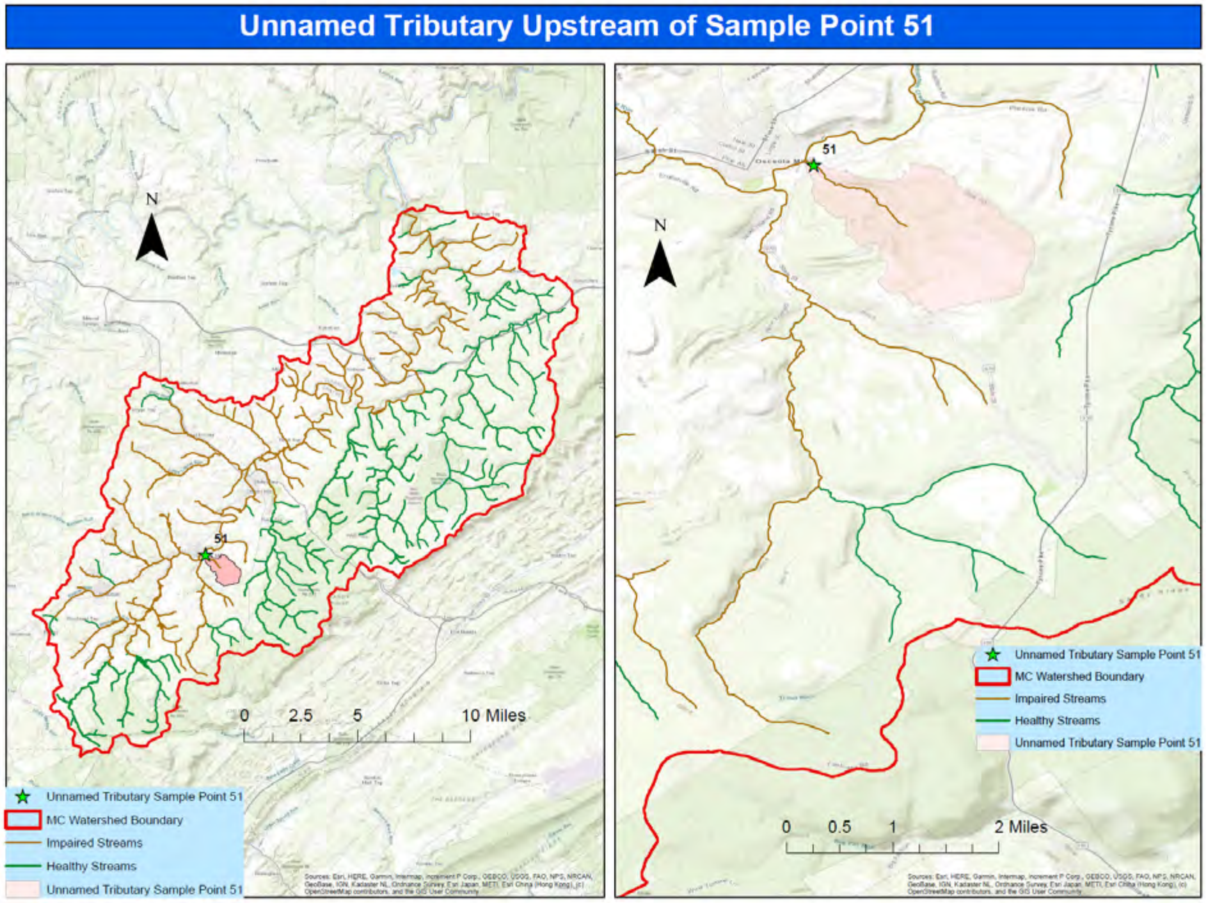
Above TR48, Trout Run is absorbing impacts from tributary TR66 and from the two discharges that form TR1. These are not as detrimental as TR48 and should be evaluated for possible improvements after changes are made to improve TR48 and the lower watershed.

Trout Run is an important watershed both for its impact to Moshannon Creek and for its own current and future hosting of aquatic life. New Miles of Blue Stream's study of Trout Run, completed in 2006, was very extensive. A lot of mining and mine reclamation has occurred since the data for that study was gathered by MCWC volunteers in 2004 and 2005. Analysis for this Coldwater Conservation Plan confirmed that the main stem and tributary sampling is still broadly relevant, but specifics down to the mine discharge level will need to be updated.

The name of this stream is a clear indication that the whole watershed was once a coldwater habitat. It could be again.

ID	Unit	52	52	TR48	TR48A	TR1	TR66	TR102	TR29
Date		7/24/2020	4/14/2021	4/14/2021	4/14/2021	4/14/2021	4/14/2021	4/14/2021	4/14/2021
Station Name		Trout Run	TR104 Trout Run Mouth	TR48 Impaired trib	Trout Run Above TR48 Trib	TR1 Vicinity combined discharges	TR66 Impaired trib	TR102 Trout Run Good Water	TR29 Low pH Upper Trib
Flow	CFS	4.120	31.640	2.961	27.780	0.331	0.813	21.442	0.506
Lat		40.8462	40.84519	40.83198	40.8317	40.82702	40.81595	40.81667	40.82454
Long		-78.2657	-78.26649	-78.26238	-78.2625	-78.26908	-78.26615	-78.26504	-78.24671
Field Temp	°C	18.15	8.78	9.17	9.55	11.50	12.05	11.00	10.05
Field Cond	uS/cm	407.00	257.00	519.00	94.80	995	602.00	54.80	268.00
Field pH	SU	3.53	3.79	3.45	5.90	3.13	3.28	7.30	4.99
Lab pH	SU	3.8	4.4	3.6	5.4	3.4	3.3	6.8	5.2
Lab Cond	uS/cm	448	223	455	90.7	877	542	67.3	33.6
Alk	mg/l	0	0	0	0	0	0	0	0
Acid	mg/l	41	25.99	62.6	14.26	114.7	106.3	20.8	9.87
Acid Load	lbs/day	911	4436	1000	2137	205	466	2406	27
Fe	mg/l	2.77	1.12	2.25	0.43	2.53	6.75	0.10	0.10
Fe Load	lbs/day	62	191	36	64	5	30	12	0
Mn	mg/l	1.52	0.70	1.39	0.40	5.71	2.09	0.01	0.08
Mn Load	lbs/day	34	119	22	59	10	9	1	0
Al	mg/l	3.25	2.18	4.85	0.87	11.70	7.65	0.05	0.15
Al Load	lbs/day	72	372	77	130	21	34	6	0
SO_4	mg/l	180	87.4	149	23.7	394	168	7.59	8.64
SO_4 Load	lbs/day	4001	14918	2380	3552	703	737	878	24
TSS	mg/l	6	4.4	<1.6	5.6	4.4	<1.6	67.6	<1.6
TDS	mg/l	283	64	166	76	362	206	<20	<20

Unnamed Tributary Upstream of Sample Point 51. HUC 02050201000579.



This small stream was flowing at 60 gallons per minute with a water temperature of 19.65 C during a hot day in July during a drought. Water chemistry sampling done in July 2020 had good results for both pH and metals. This stream shows too much sulfate but is otherwise approaching unimpaired status. It may also already be fish habitat or be capable of hosting dispersing fish that find this stream.

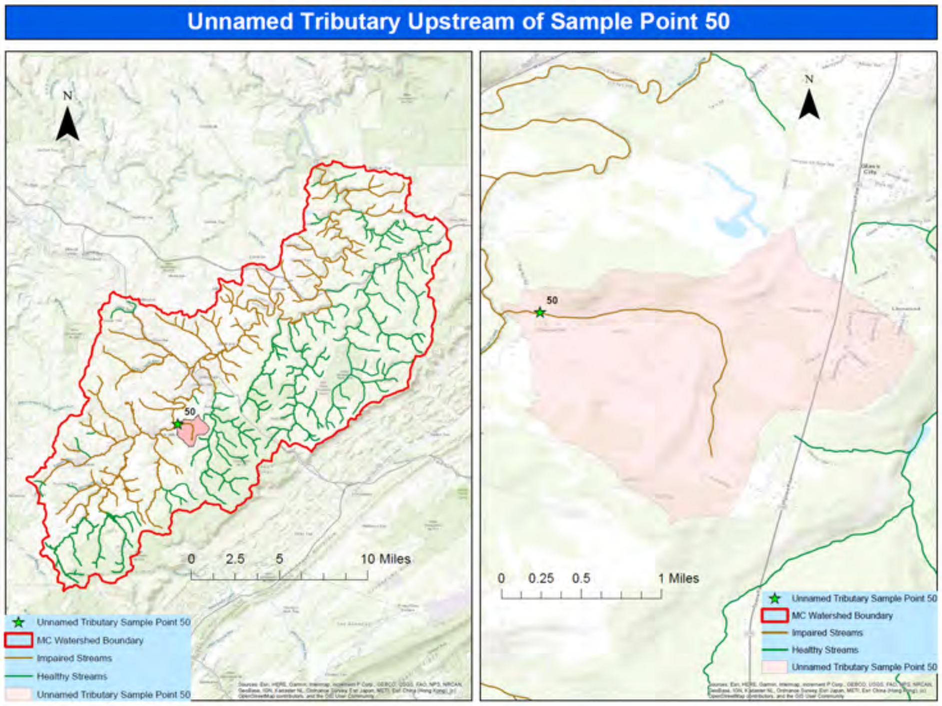
ID	unit	51
Station Name		Unnamed Trib
Flow	CFS	0.134
Lat		40.8508
Long		-78.2621
Area	Mi^2	1.25
Area	%	0.46
Field Temp	°C	19.65
Field DO	mg/l	8.42
Field Cond	uS/cm	981.00
Field pH	SU	6.55
Field Turb	NTU	0.00
Lab pH	SU	6.4
Lab Cond	uS/cm	1010

ID	unit	51
Alk	mg/l	12
Acid	mg/l	5
Acid Load	lbs/day	4
Fe	mg/l	0.16
Fe Load	lbs/day	0
Mn	mg/l	0.72
Mn Load	lbs/day	1
Al	mg/l	0.05
Al Load	lbs/day	0
SO_4	mg/l	535
SO_4 Load	lbs/day	387
TSS	mg/l	2
TDS	mg/l	810

It is very encouraging that this stream has improved. Older aerial imagery showed it surrounded by active mining activity. Newer imagery from Google Maps shows reclaimed mines on both sides with one active mine on its southwest side.

Google Maps image of watershed for unnamed tributary upstream of sample point 51.

Unnamed Tributary Upstream of Sample Point 50. Referred to as UNT10 in Historical Data on SRBC Website. HUC 02050201000580.



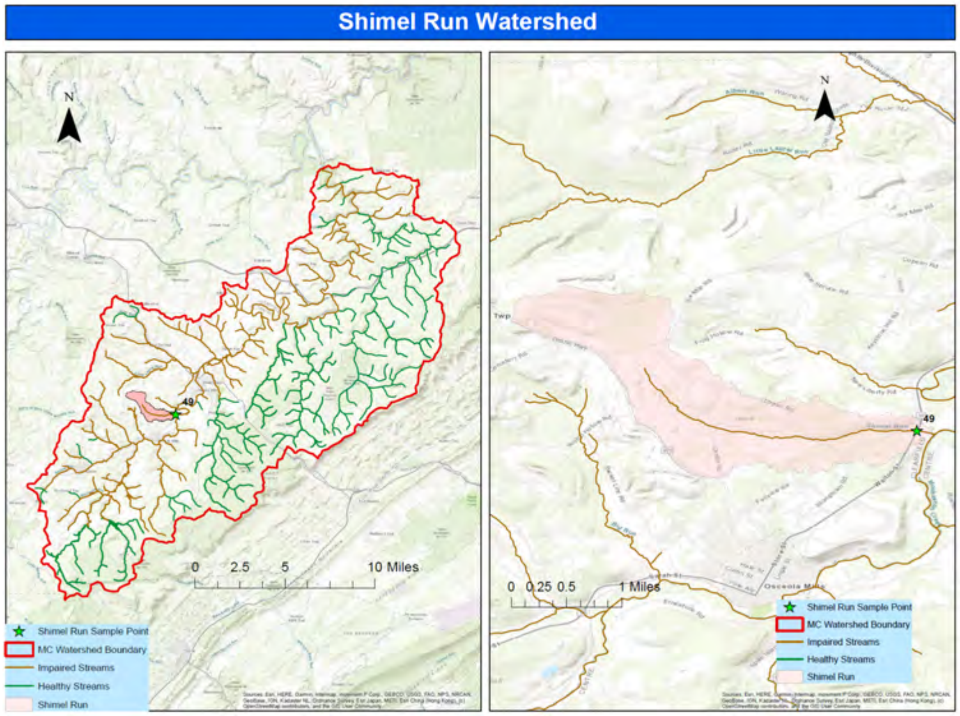
This small stream is severely impaired. As the "big fixes" in the watershed are underway, this stream should be revisited to determine if larger problems in the watershed are masking its impact. It would be a nice little coldwater stream without the AMD impacts. It should be resampled in higher flows.

The sample data below is from July 2020 during drought conditions.

ID	Unit	50
Station Name		Unnamed Trib
Flow	CFS	0.100
Lat		40.8593
Long		-78.2439
Area	Mi^2	1.52
Area	%	0.55
Field Temp	°C	19.36
Field DO	mg/l	8.40
Field Cond	uS/cm	431.00
Field pH	SU	3.11
Field Turb	NTU	1.30
Lab pH	SU	3.6
Lab Cond	uS/cm	432

ID	Unit	50
Alk	mg/l	0
Acid	mg/l	46
Acid Load	lbs/day	25
Fe	mg/l	1.53
Fe Load	lbs/day	1
Mn	mg/l	1.54
Mn Load	lbs/day	1
Al	mg/l	2.77
Al Load	lbs/day	1
SO_4	mg/l	132
SO_4 Load	lbs/day	71
TSS	mg/l	2
TDS	mg/l	200

Shimel Run. HUC 02050201000550.

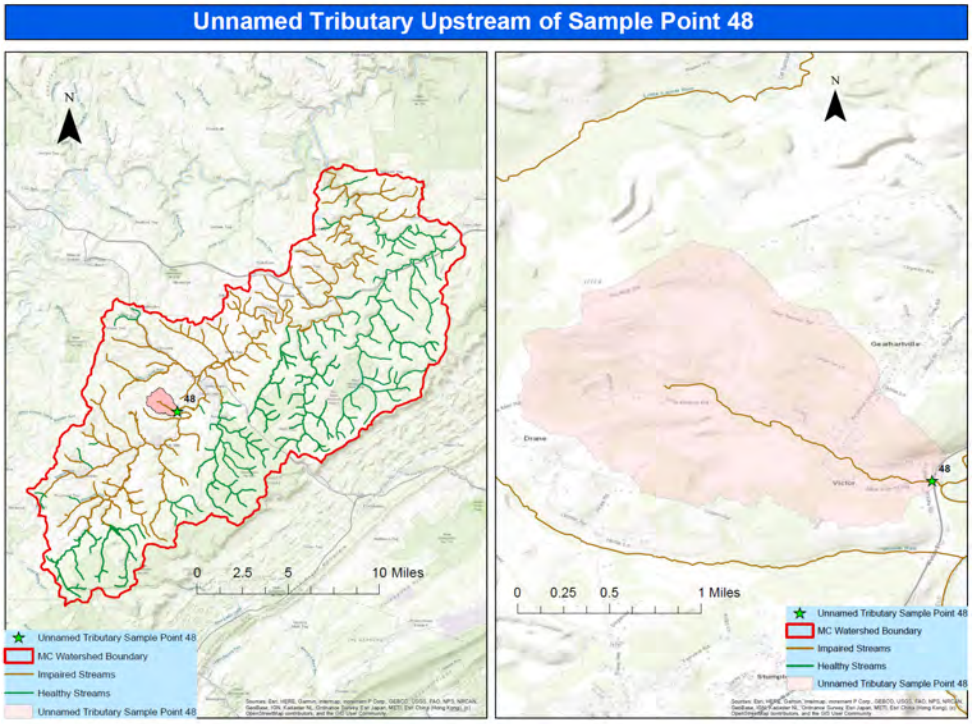


Data from the water chemistry sample taken on 7/24/2020 is shown below. The measured flow in drought conditions was only 15.7 gpm. Shimel Run has been found to lose flow in sections in past evaluations, so further studies of this watershed should select their sampling locations carefully. In normal conditions, this watershed is believed to host a trout population. The presence or absence of trout should be confirmed. This stream should be resampled at a higher flow rate to determine whether the water chemistry continues to be high quality. If it does, it should be evaluated to determine whether this stream should still be classified as impaired.

ID	unit	49
Station Name		Shimel Run
Flow	CFS	0.035
Lat		40.8719
Long		-78.2501
Area	Mi^2	1.87
Area	%	0.68
Field Temp	°C	20.19
Field DO	mg/l	7.91
Field Cond	uS/cm	413.00
Field pH	SU	7.13
Field Turb	NTU	17.30
Lab pH	SU	7.0
Lab Cond	uS/cm	447

ID	unit	49
Alk	mg/l	38
Acid	mg/l	-23
Acid Load	lbs/day	-4
Fe	mg/l	0.57
Fe Load	lbs/day	0
Mn	mg/l	0.06
Mn Load	lbs/day	0
Al	mg/l	0.26
Al Load	lbs/day	0
SO_4	mg/l	154
SO_4 Load	lbs/day	29
TSS	mg/l	8
TDS	mg/l	276

Unnamed Tributary Upstream of Sample Point 48. HUC 02050201000549.

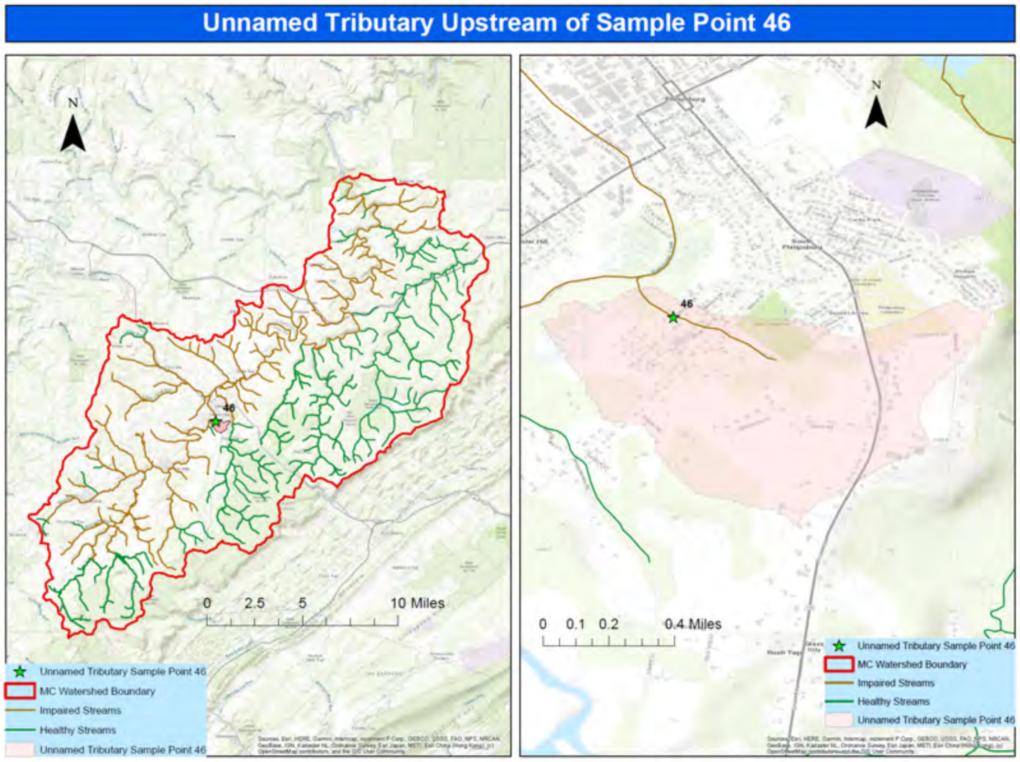


This stream is shown to be classified as impaired due to AMD. Water chemistry sampling in July of 2020 found this stream to have a pH of 7, acceptable levels of metals, and a sulfate reading of 678 mg/l. It also had a measured flow of 282 gpm during a drought. This stream intersects with a section of Moshannon Creek that has had fish return to it after the positive impact of the treated Rushton Mine discharge. This stream should be evaluated as to whether fish have also returned here. It had a measured temperature of 21.8 C when sampled. The lower portion of this stream appears to lack shade. The sampling data below is from July 24, 2020.

ID	unit	48
Station Name		Unnamed Trib
Flow	CFS	0.630
Lat		40.8776
Long		-78.2502
Area	Mi^2	1.70
Area	%	0.62
Field Temp	°C	21.79
Field DO	mg/l	7.90
Field Cond	uS/cm	1313.00
Field pH	SU	7.35
Field Turb	NTU	8.00
Lab pH	SU	7.0
Lab Cond	uS/cm	1280

ID	unit	48
Alk	mg/l	43
Acid	mg/l	-25
Acid Load	lbs/day	-85
Fe	mg/l	0.79
Fe Load	lbs/day	3
Mn	mg/l	0.49
Mn Load	lbs/day	2
Al	mg/l	0.13
Al Load	lbs/day	0
SO_4	mg/l	678
SO_4 Load	lbs/day	2304
TSS	mg/l	7
TDS	mg/l	1047

Unnamed Tributary Upstream of Sample Point 46. HUC 02050201001918

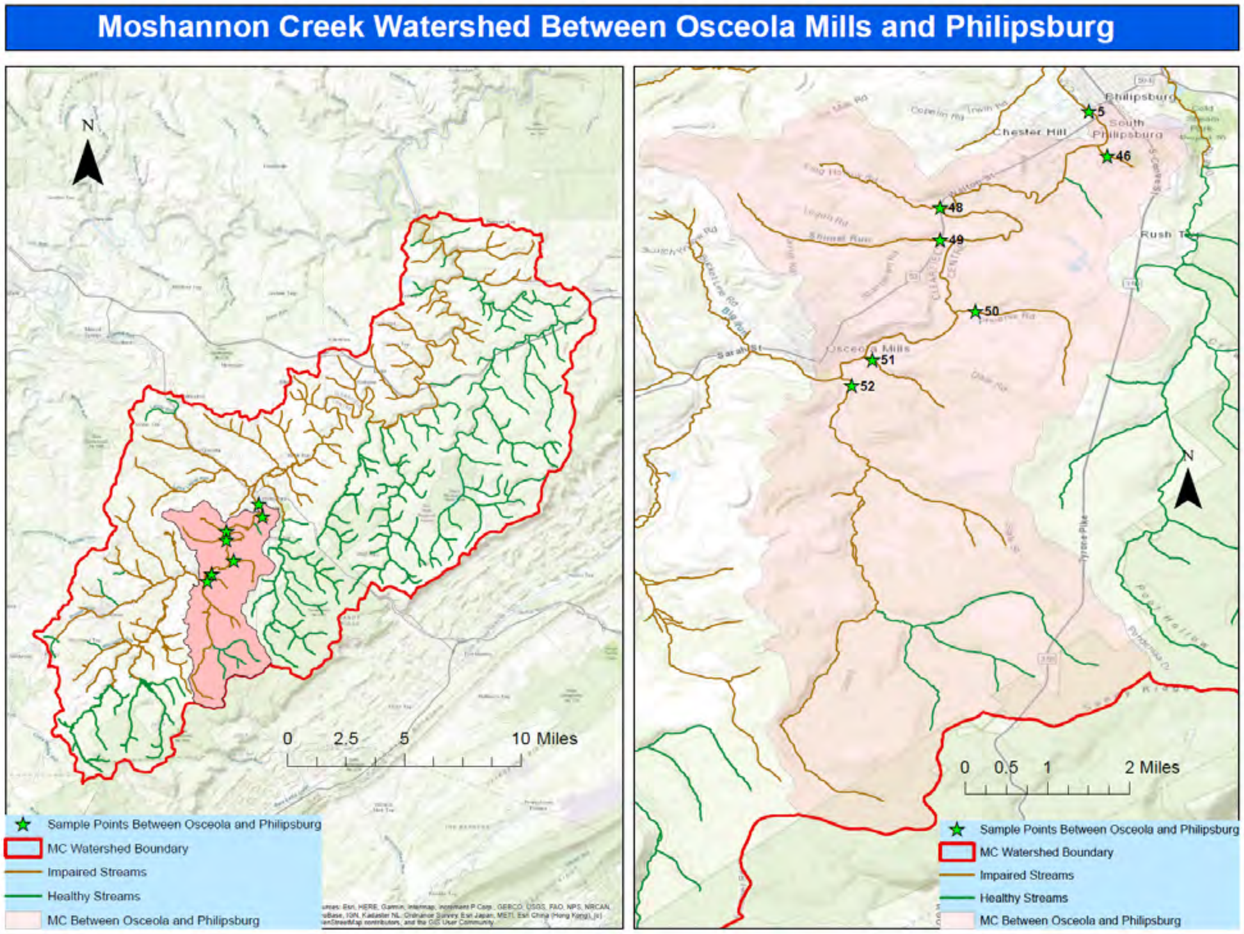


This small stream is classified as impaired on PA DEP's eMapPA for residential area related siltation. It was found to have clean water when sampled in July 2020. The water was flowing at 157 gpm at a temperature of 17.6 C on a hot day in July during a drought. This stream may already be fish habitat and should be investigated further. The water chemistry found on 7/24/2020 is shown below.

ID	unit	46
Station Name		Unnamed Trib
Flow	CFS	0.350
Lat		40.8867
Long		-78.2207
Area	Mi^2	0.26
Area	%	0.09
Field Temp	°C	17.90
Field DO	mg/l	8.89
Field Cond	uS/cm	169.20
Field pH	SU	8.04
Field Turb	NTU	8.60
Lab pH	SU	6.9
Lab Cond	uS/cm	190

ID	unit	46
Alk	mg/l	26
Acid	mg/l	-13
Acid Load	lbs/day	-25
Fe	mg/l	0.33
Fe Load	lbs/day	1
Mn	mg/l	0.03
Mn Load	lbs/day	0
Al	mg/l	0.15
Al Load	lbs/day	0
SO_4	mg/l	20
SO_4 Load	lbs/day	38
TSS	mg/l	18
TDS	mg/l	84

Moshannon Creek Between Osceola Mills Upstream of Trout Run and Presqueisle Bridge in Philipsburg. HUC 02050201000157 and points upstream to Osceola Mills upstream of Trout Run.



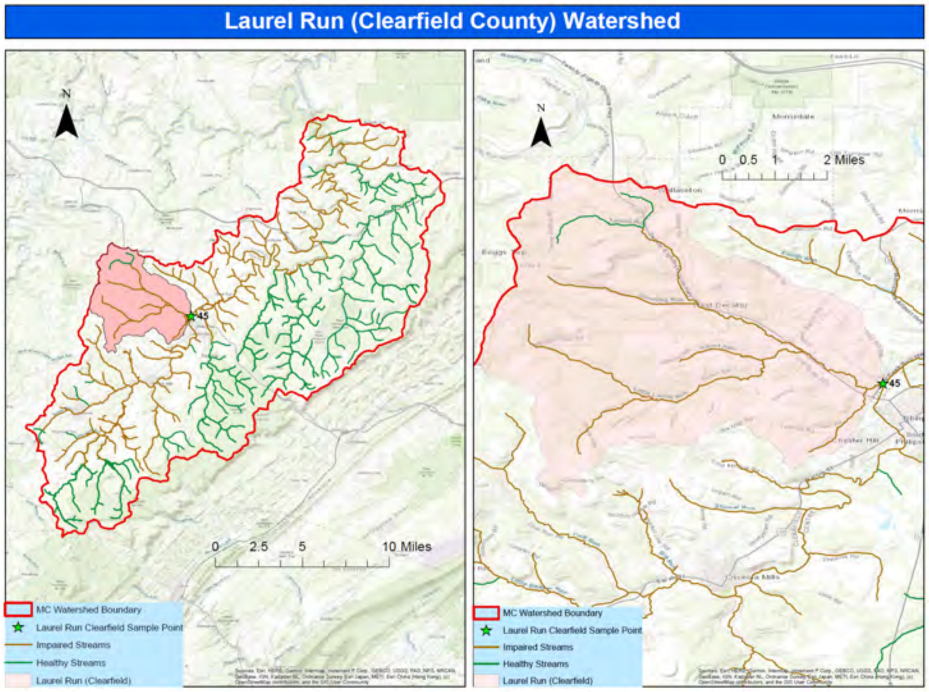
This section of Moshannon Creek has the negative impacts of Trout Run and the positive impact of the treated discharge from the Rushton Mine. While this section is still impaired and is visually unattractive in places because of metals precipitating out of the water, the water has improved enough that it now has fish, at least between the Rushton treated discharge and north of Philipsburg (in the next section) past Emigh Run. This stream segment is subject to periodic incidents of sediment mobilization during high flow events. After high pH water from the Rushton Treatment Plant joins Moshannon Creek subsequent chemical reactions cause some of the metal in the creek water to precipitate out on the stream bed. As Philipsburg residents will attest, after particularly heavy rainfalls much of this sediment will scour off the bed, creating an orange slug of material moving through the borough over the course of a few hours. Making improvements upstream of this section, and to Trout Run, would reduce this effect and would create fish habitat from the headwaters of Moshannon Creek to downstream of Philipsburg.

The water sampling data below is all from July 2020.

ID	Unit	46	5	46	48	49	50	51	52
Station Name		Unnamed Trib	MC Pburg	Unnamed Trib	Unnamed Trib	Shimel Run	Unnamed Trib	Unnamed Trib	Trout Run
Flow	CFS	0.35	41.16	0.35	0.63	0.035	0.1	0.134	4.12
Lat		40.8867	40.8945	40.8867	40.8776	40.8719	40.8593	40.8508	40.8462
Long		-78.2207	-78.224	-78.2207	-78.2502	-78.2501	-78.2439	-78.2621	-78.2657
Area	Mi^2	0.26	80.9	0.26	1.7	1.87	1.52	1.25	8
Area	%	0.09		0.09	0.62	0.68	0.55	0.46	2.92
Field Temp	ºC	17.9	22.33	17.9	21.79	20.19	19.36	19.65	18.15
Field DO	mg/l	8.89	8.39	8.89	7.9	7.91	8.4	8.42	8.84
Field Cond	uS/cm	169.2	882	169.2	1313	413	431	981	407
Field pH	SU	8.04	4.83	8.04	7.35	7.13	3.11	6.55	3.53
Field Turb	NTU	8.6	1.11	8.6	8	17.3	1.3	0	0.3
Lab pH	SU	6.9	5.2	6.9	7	7	3.6	6.4	3.8
Lab Cond	uS/cm	190	888	190	1280	447	432	1010	448
Alk	mg/l	26	2	26	43	38	0	12	0
Acid	mg/l	-13	17	-13	-25	-23	46	5	41
Acid Load	lbs/day	-25	3775	-25	-85	-4	25	4	911
Fe	mg/l	0.33	0.13	0.33	0.79	0.57	1.53	0.16	2.77
Fe Load	lbs/day	1	29	1	3	0	1	0	62
Mn	mg/l	0.03	2.69	0.03	0.49	0.06	1.54	0.72	1.52
Mn Load	lbs/day	0	597	0	2	0	1	1	34
Al	mg/l	0.15	0.49	0.15	0.13	0.26	2.77	0.05	3.25
Al Load	lbs/day	0	109	0	0	0	1	0	72
SO_4	mg/l	20	440	20	678	154	132	535	180
SO_4 Load	lbs/day	38	97698	38	2304	29	71	387	4001
TSS	mg/l	18	2	18	7	8	2	2	6
TDS	mg/l	84	644	84	1047	276	200	810	283

Pickerel From Main Stem of Moshannon Creek Near Philipsburg, Summer 2020. Photo Courtesy of Justin Wian.

Laurel Run (Clearfield County). HUC 02050201000309 and points upstream.



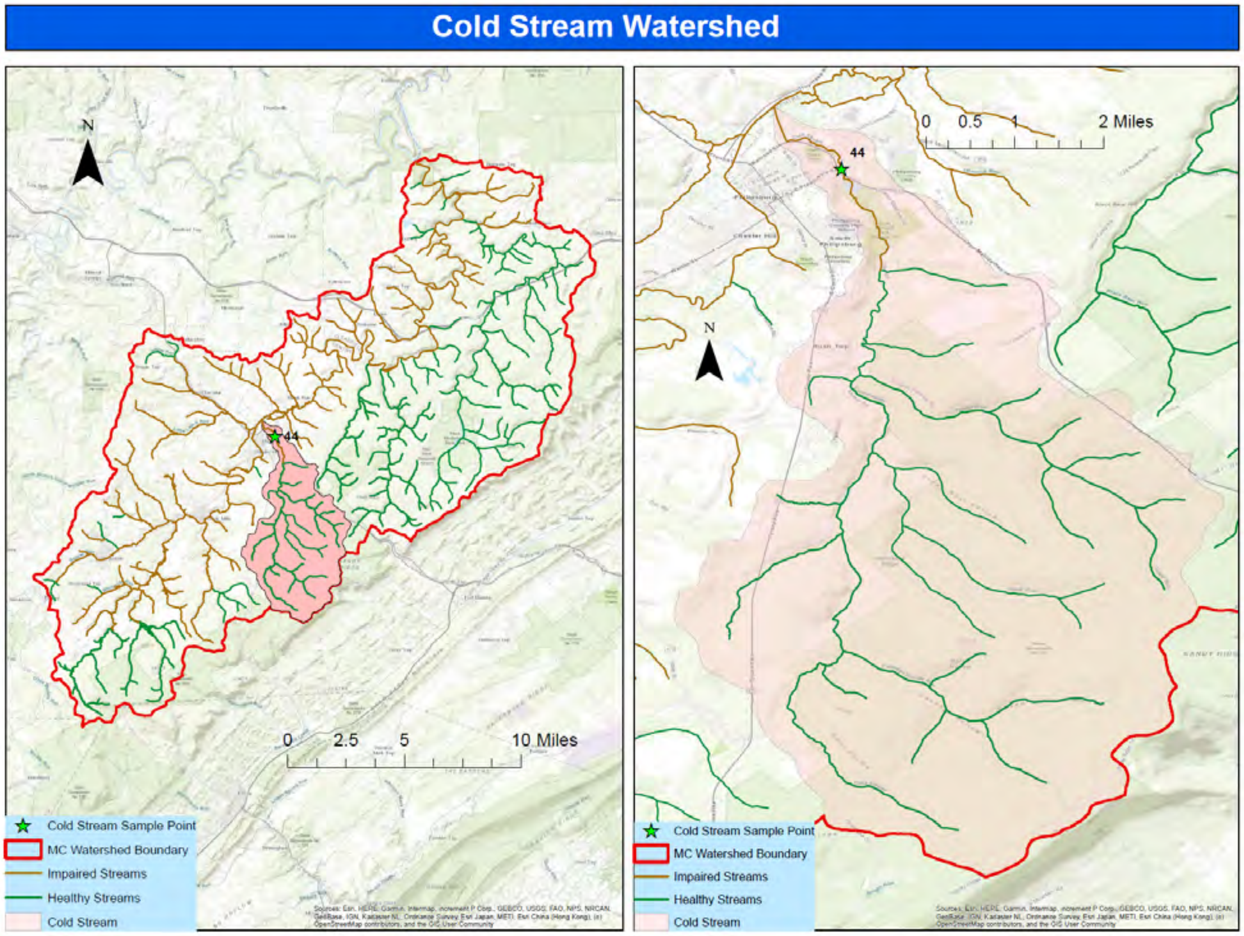
The water that this stream discharges to Moshannon Creek has improved substantially over the last several decades. It is a major stream in the watershed. It was discharging 4250 gpm to Moshannon Creek during a drought in July 2020. The discharged water was warmer than desirable at 22 C. However, the lower section of this watershed is a very slow moving wetlands with much exposure to warm air and sun. This watershed should be investigated further for stream sections that have improved enough that they should no longer be classed as impaired. Other than the manganese and sulfate numbers, the water chemistry for this stream is good.

The water sampling data below is from July 24, 2020.

ID	Unit	45
Station Name		Laurel Run
Flow	CFS	9.492
Lat		40.9069
Long		-78.2269
Area	Mi^2	22.00
Area	%	8.03
Field Temp	°C	22.08
Field DO	mg/l	7.99
Field Cond	uS/cm	983.00
Field pH	SU	6.45
Field Turb	NTU	1.42
Lab pH	SU	6.6
Lab Cond	uS/cm	984

ID	Unit	45
Alk	mg/l	27
Acid	mg/l	-9
Acid Load	lbs/day	-461
Fe	mg/l	0.49
Fe Load	lbs/day	25
Mn	mg/l	6.60
Mn Load	lbs/day	338
Al	mg/l	0.23
Al Load	lbs/day	12
SO_4	mg/l	467
SO_4 Load	lbs/day	23913
TSS	mg/l	5
TDS	mg/l	732

Cold Stream. HUC 02050201000262 and points upstream including tributaries and a lake.



Much of the Cold Stream watershed is healthy and known to host trout. The lower section is increasingly exposed to mining impacts as it flows downstream. During Operation Scarlift, the Project 70 ditch routed mine drainage seeping from multiple points to the downstream outlet of the Cold Stream Lake dam. Beginning about the year 2000, six passive treatment systems were built that treat some of the AMD that enters the Project 70 ditch. MCWA assumed operation, monitoring and maintenance responsibility for those systems in June of 2020 and has been improving their performance. More treatment will be needed on AMD flows that are currently untreated.

The sample point for Cold Stream used in this report is downstream of the blending of AMD impaired water from the Project 70 ditch and much cleaner water flowing over the Cold Stream dam. A large AMD discharge exists downstream of the sample point on the edge of a wetlands that Cold Stream flows through in a constructed channel.

The sample results that were taken in July 2020 showed considerable improvement in the water quality in Cold Stream. Several of the AMD discharges that supply the water in the Project

70 ditch were known to not be flowing at all, or flowing in a very limited way during the 2020 drought. Some of those AMD seeps are not flowing during the Summer in 2021 as well, so seasonal variation occurs with higher rainfall amounts as well.

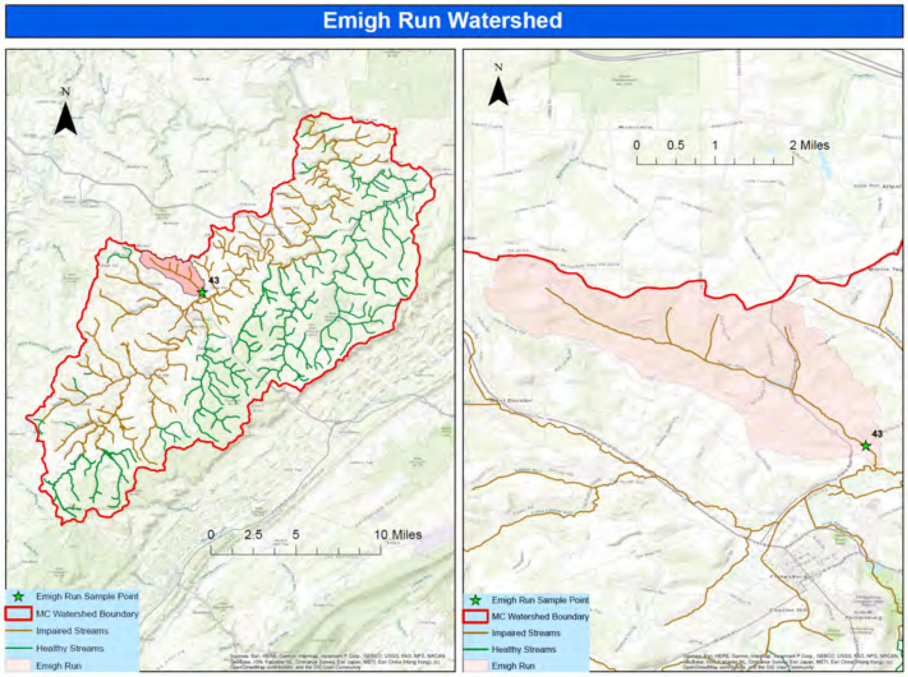
As improvement projects take place farther upstream in the Moshannon Creek watershed, Cold Stream should be resampled to better understand the seasonality in the water quality in the lower watershed and quantify the impacts of the untreated discharges. Water quality in the discharges from the adopted treatment systems and the Project 70 ditch should be monitored as improvements are made to those systems.

ID	Unit	44
Station Name		Cold Stream
Flow	CFS	6.260
Lat		40.9013
Long		-78.2104
Area	Mi^2	22.00
Area	%	8.03
Field Temp	°C	26.10
Field DO	mg/l	
Field Cond	uS/cm	73.30
Field pH	SU	6.39
Field Turb	NTU	0.72
Lab pH	SU	6.4
Lab Cond	uS/cm	106

ID	Unit	44
Alk	mg/l	6
Acid	mg/l	8
Acid Load	lbs/day	270
Fe	mg/l	1.83
Fe Load	lbs/day	62
Mn	mg/l	0.38
Mn Load	lbs/day	13
Al	mg/l	0.23
Al Load	lbs/day	8
SO_4	mg/l	23
SO_4 Load	lbs/day	777
TSS	mg/l	10
TDS	mg/l	52

Maintenance Activities on the Fossil Rock Treatment System in the Cold Stream Watershed.

Emigh Run. HUC 02050201000539 and points upstream.



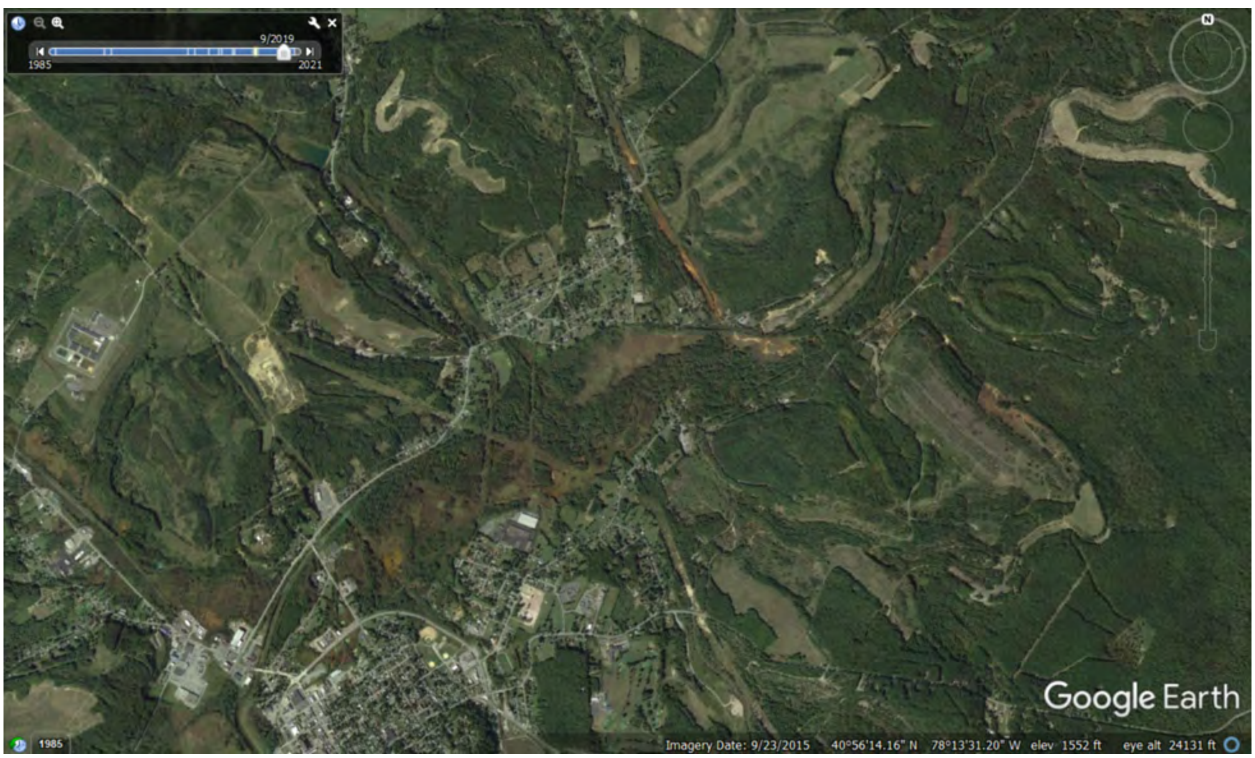
Water quality in Emigh Run has improved gradually over the last several decades. Considerable attention was focused on this watershed through the efforts of the Emigh Run/Lakeside Watershed Association (ERLWA). Mine reclamation activity has also been widespread in this watershed. Treatment systems have been constructed. The sample taken in July 2020 had a high level of manganese and somewhat elevated sulfate. The temperature observed, 23C, was higher than desirable for coldwater fish. The sample was taken downstream of a large lake that likely allows warming of the water. A water sample taken on April 5, 2021 with higher flow showed lower manganese and sulfate than the July 2020 sample. Portions of this watershed may have clean enough water to host fish. The lake and associated small dam on this stream may hinder fish passage.

ID	Unit	43	43
Station Name		Emigh Run	Emigh Run
Date		7/24/2020	4/5/2021
Flow	CFS	2.239	4.512
Lat		40.9212	40.9216
Long		-78.2101	-78.2106
Area	Mi^2	4.16	
Area	%	1.52	
Field Temp	°C	23.10	14.80
Field DO	mg/l		9.20
Field Cond	uS/cm	971.00	373.0
Field pH	SU	5.89	7.26
Field Turb	NTU		
Lab pH	SU	6.2	
Lab Cond	uS/cm	915	
Alk	mg/l	9	4.9
Acid	mg/l	19	5.73
Acid Load	lbs/day	229	139
Fe	mg/l	0.61	0.08
Fe Load	lbs/day	7	2
Mn	mg/l	11.81	2.61
Mn Load	lbs/day	143	64
Al	mg/l	0.15	0.14
Al Load	lbs/day	2	3
SO_4	mg/l	434	225.0
SO_4 Load	lbs/day	5242	5476
TSS	mg/l	5	
TDS	mg/l	674	96*

*The TDS value from the April 5, 2021 water sampling was calculated.

Centre County AMD Swamp Area

The next several streams mentioned on the Centre County side of Moshannon Creek will all tell similar stories. All of these small streams flow into Moshannon Creek from an expansive mining impacted area, and all have very poor water quality. Between those streams there are numerous AMD seeps that flow through culverts across Coaldale Road into wetlands areas between Coaldale Road and Moshannon Creek. The wetlands areas are obviously loaded with metal precipitates. BAMR has reclaimed some of the abandoned mine lands in this area, but much remains. Continuing mine reclamation and a gathering of the large amounts of impaired water in this area for treatment at an active plant appear very necessary for addressing the problems in this stretch. Sampling that will quantify the amount of AMD flowing through the wetlands between the streams in this section will be necessary to correctly size treatment for this area. Each impaired stream on the Centre County side will be briefly mentioned as they are encountered on the downstream trip through the watershed. The image below from 9/2019 shows the impacted wetlands diagonally across the screen from bottom left to upper right. .

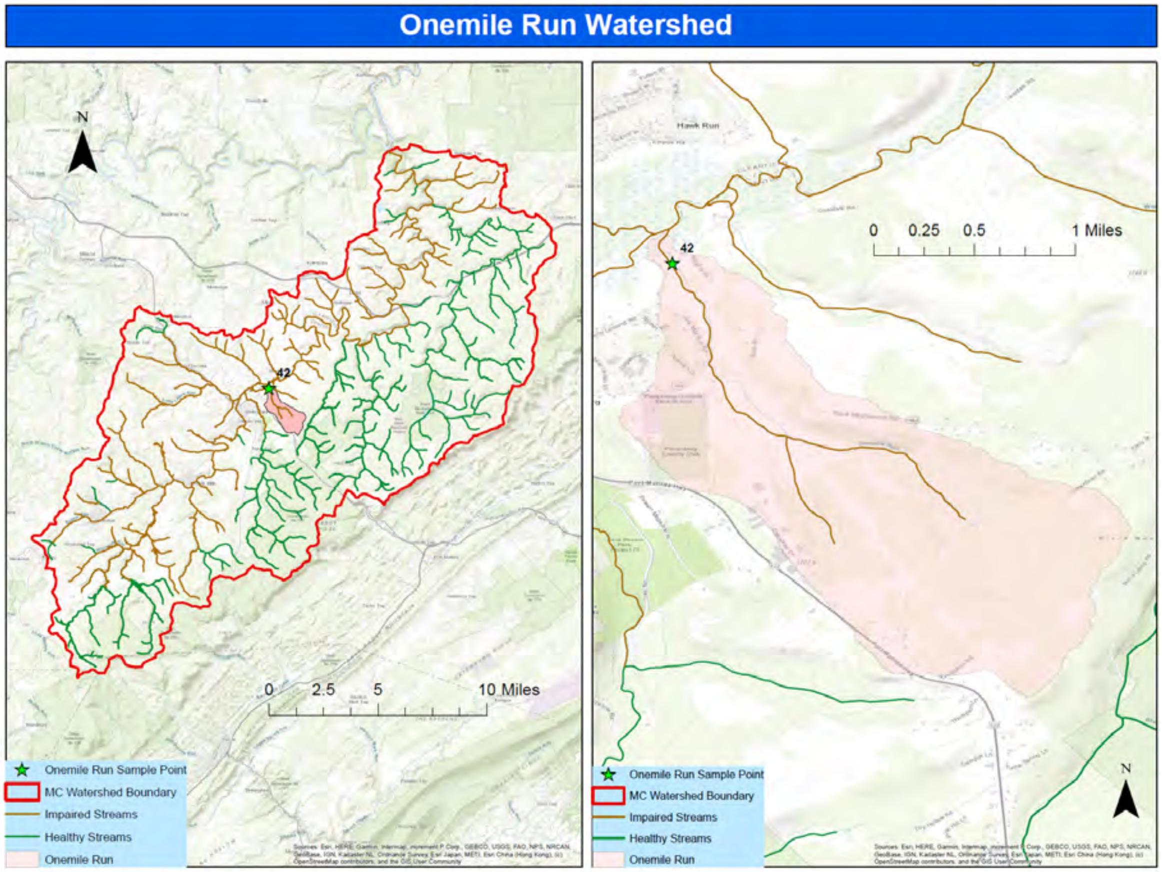


Google Earth Image Showing the Wetlands Along Moshannon Creek.

One of Many AMD Seeps Along Coaldale Road in Centre County, PA.

AMD Impacted Wetlands Along Coaldale Road in Centre County, PA.

Onemile Run. HUC 02050201000594 and points upstream.

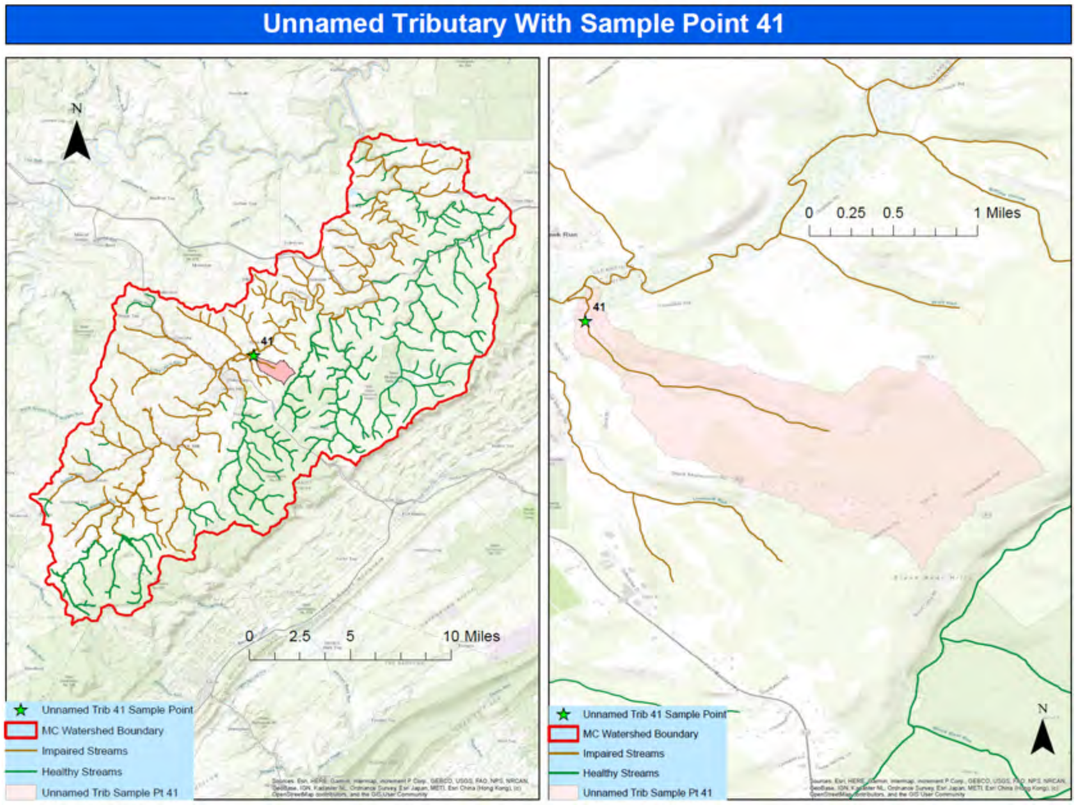


Onemile Run is the first of a string of severely AMD impaired streams on the Centre County side of Moshannon Creek north of Philipsburg. Part of the watershed is a golf course.

ID	Unit	42
Station Name		Onemile Run
Flow	CFS	0.207
Lat		40.9137
Long		-78.2006
Area	Mi^2	1.87
Area	%	0.68
Field Temp	°C	17.10
Field DO	mg/l	
Field Cond	uS/cm	879.00
Field pH	SU	2.85
Field Turb	NTU	0.10
Lab pH	SU	3.1
Lab Cond	uS/cm	991

ID	Unit	42
Alk	mg/l	0
Acid	mg/l	133
Acid Load	lbs/day	149
Fe	mg/l	11.53
Fe Load	lbs/day	13
Mn	mg/l	5.20
Mn Load	lbs/day	6
Al	mg/l	10.30
Al Load	lbs/day	12
SO_4	mg/l	356
SO_4 Load	lbs/day	398
TSS	mg/l	7
TDS	mg/l	622

Unnamed Tributary With Sample Point 41. Referred to as UNT09 on SRBC Website. HUC 02050201001862 and points upstream.

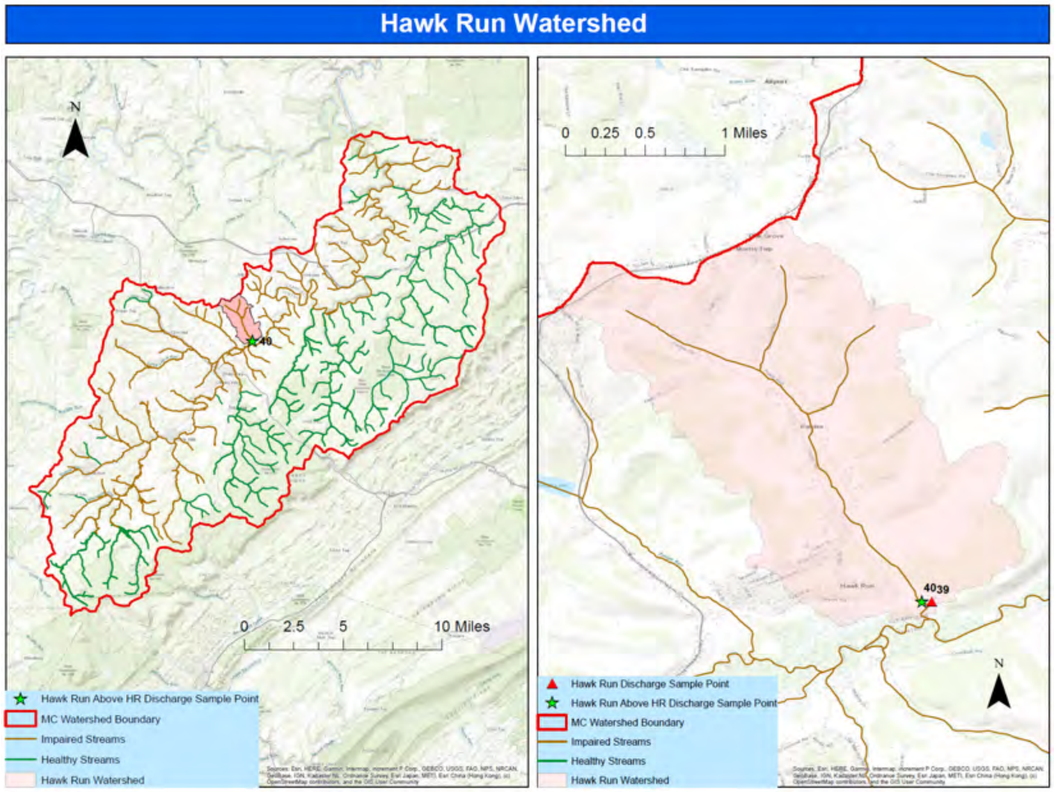


This unnamed tributary is another severely impaired stream on the Centre County side of Moshannon Creek. Historic data and the measurements made in July 2020 show that low flow rates are typical for this stream.

ID	Unit	41
Station Name		Unnamed Trib
Flow	CFS	0.014
Lat		40.9161
Long		-78.1965
Area	Mi^2	1.34
Area	%	0.49
Field Temp	°C	21.40
Field DO	mg/l	
Field Cond	uS/cm	1172.00
Field pH	SU	3.19
Field Turb	NTU	
Lab pH	SU	3.2
Lab Cond	uS/cm	1090

ID	Unit	41
Alk	mg/l	0
Acid	mg/l	126
Acid Load	lbs/day	10
Fe	mg/l	2.22
Fe Load	lbs/day	0
Mn	mg/l	5.53
Mn Load	lbs/day	0
Al	mg/l	11.89
Al Load	lbs/day	1
SO_4	mg/l	473
SO_4 Load	lbs/day	36
TSS	mg/l	8
TDS	mg/l	799

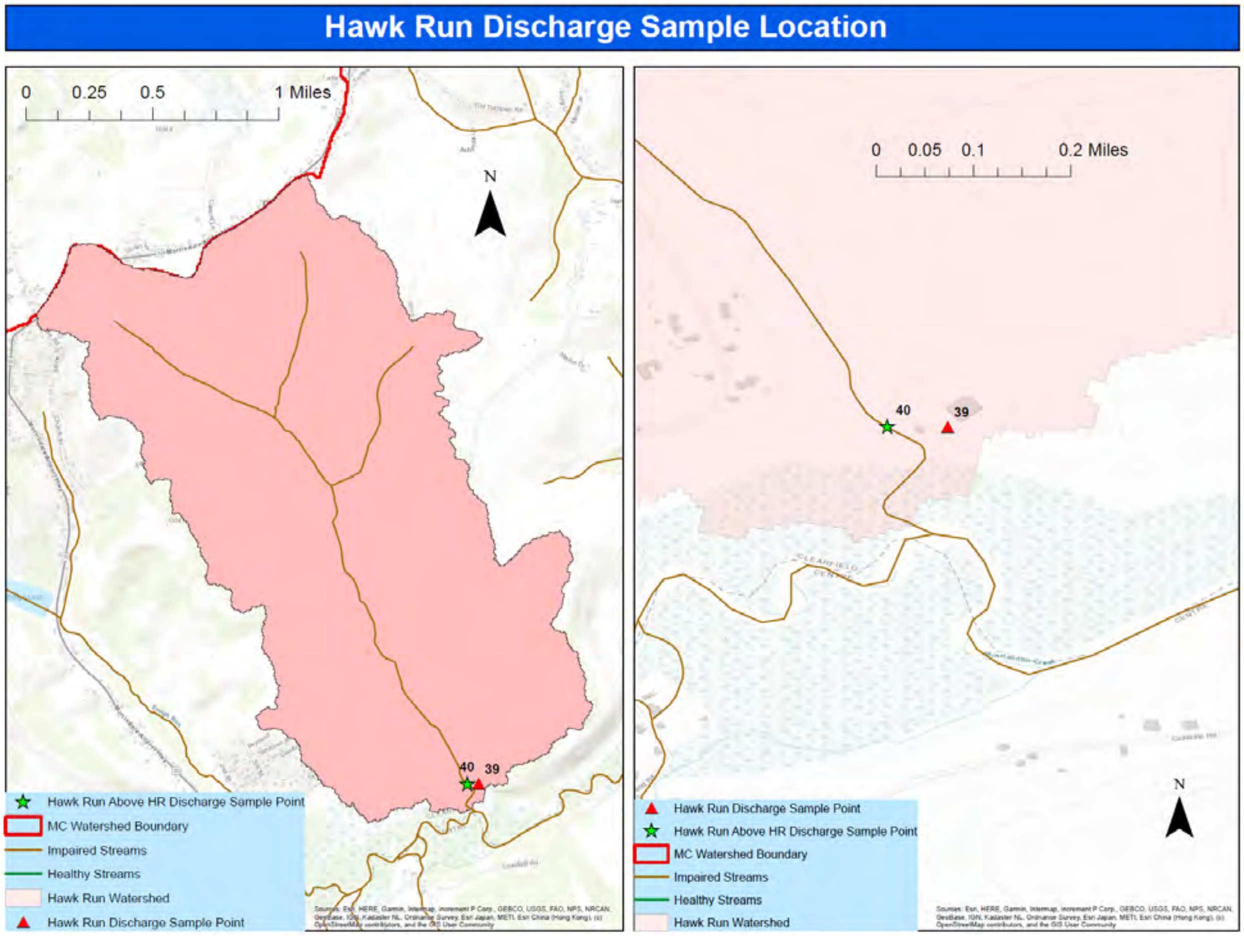
Hawk Run. Sampled Upstream of Hawk Run Discharge. HUC 02050201000538 and points upstream.



There is considerable iron in the stream bed of this stream which sometimes samples cleaner than expected from visual indications. Flow in this stream is often dwarfed by the flow in the discharge that joins it just below the sample point. The headwaters of Hawk Run are reported to have a very isolated trout population. There is AMD in the Hawk Run watershed upstream of the large discharge near the mouth. The AMD farther upstream is highly variable. The two samples shown below reflect that variability.

ID	Unit	40	40
Station Name		Hawk Run US Hawk Run Discharge	Hawk Run US Hawk Run Discharge
Date		7/24/2020	4/5/2021
Flow	CFS	0.756	8.190
Lat		40.9222	40.9222
Long		-78.1929	-78.1929
Area	Mi^2	2.66	
Area	%	0.97	
Field Temp	°C	22.30	18.30
Field DO	mg/l	8.13	9.02
Field Cond	uS/cm	992.00	687.0
Field pH	SU	7.50	6.52
Field Turb	NTU	7.00	
Lab pH	SU	7.4	
Lab Cond	uS/cm	1000	
Alk	mg/l	114	42.1
Acid	mg/l	-92	17.44
Acid Load	lbs/day	-375	771
Fe	mg/l	0.86	5.02
Fe Load	lbs/day	4	222
Mn	mg/l	2.25	2.19
Mn Load	lbs/day	9	97
Al	mg/l	0.08	<
Al Load	lbs/day	0	0
SO_4	mg/l	390	413.0
SO_4 Load	lbs/day	1591	18247
TSS	mg/l	6	
TDS	mg/l	715	188*

Hawk Run Discharge. Long -78.1921, Lat 40.9223.



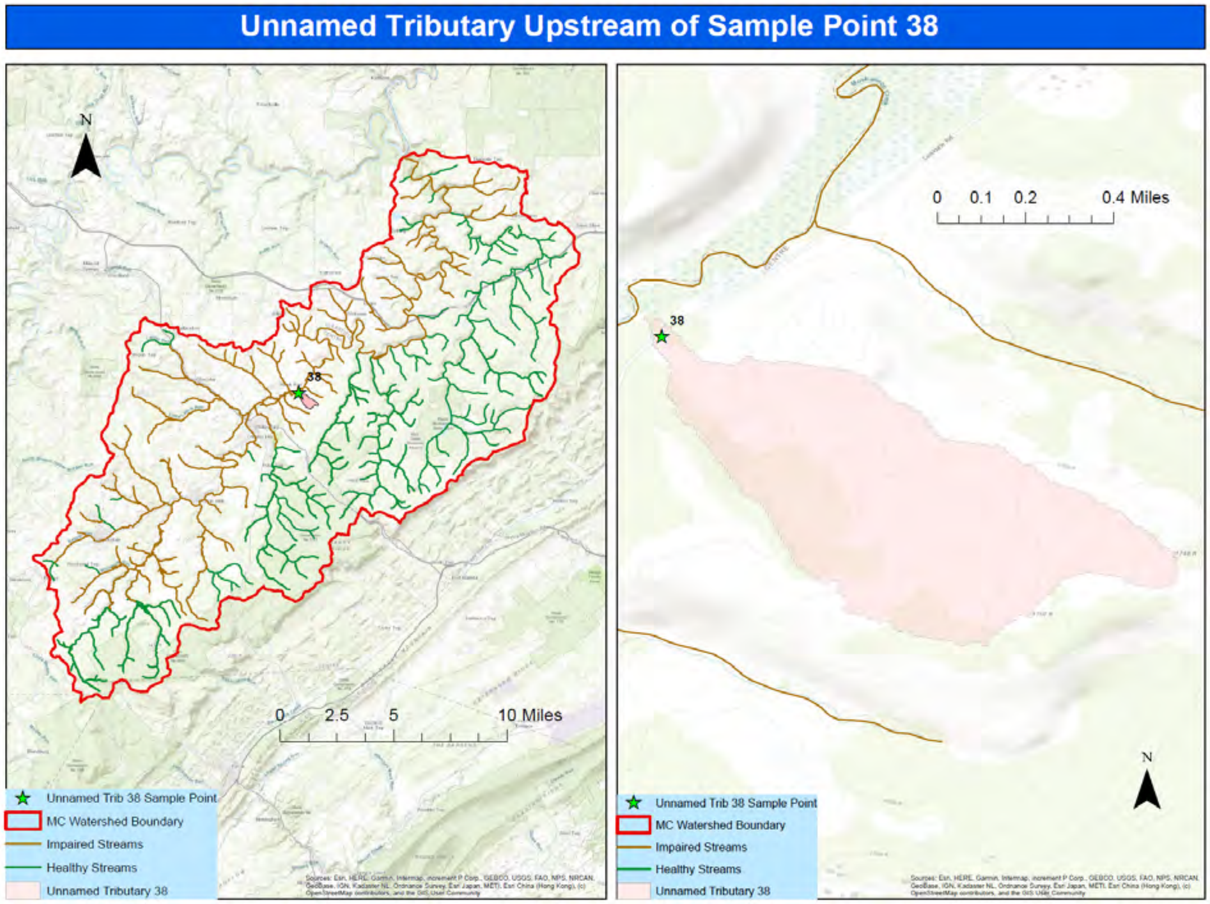
The Hawk Run discharge is a notorious source of deep mine drainage. It is one of the biggest problems in the Moshannon Creek watershed, in a stretch of the watershed with an abundance of big problems. This discharge contributes approximately two tons of iron per week to the water in Moshannon Creek. The Hawk Run discharge is associated with an entrance shaft to the Morrisdale Coal Company's mine complex. The pH of this discharge has been gradually increasing over time, making the chemistry of removal of the metals potentially easier to manage. The flow from this discharge is likely to be included in the flow to be treated in one or more active treatment plants for the mine drainage in this section of the Moshannon Creek watershed. For a short period in the early 1970's, the Hawk Run discharge was captured and treated by an experimental plant utilizing an ion exchange process designated as the "Modified Desal Process" to remove mineral acidity. The facility ran well but was prohibitively expensive to operate, shutting down permanently in under two years.

ID	Unit	39
Station Name		Hawk Run Discharge
Flow	CFS	3.750
Lat		40.9222
Long		-78.1920
Area	Mi^2	NA
Area	%	NA
Field Temp	°C	10.40
Field DO	mg/l	1.37
Field Cond	uS/cm	1094.00
Field pH	SU	5.83
Field Turb	NTU	0.90
Lab pH	SU	5.9
Lab Cond	uS/cm	1100

ID	Unit	39
Alk	mg/l	27
Acid	mg/l	51
Acid Load	lbs/day	1032
Fe	mg/l	29.76
Fe Load	lbs/day	602
Mn	mg/l	3.31
Mn Load	lbs/day	67
Al	mg/l	1.63
Al Load	lbs/day	33
SO_4	mg/l	552
SO_4 Load	lbs/day	11167
TSS	mg/l	6
TDS	mg/l	861

Hawk Run Discharge.

Unnamed Tributary at Sample Point 38. Referred to as UNT9.5 on SRBC Website.

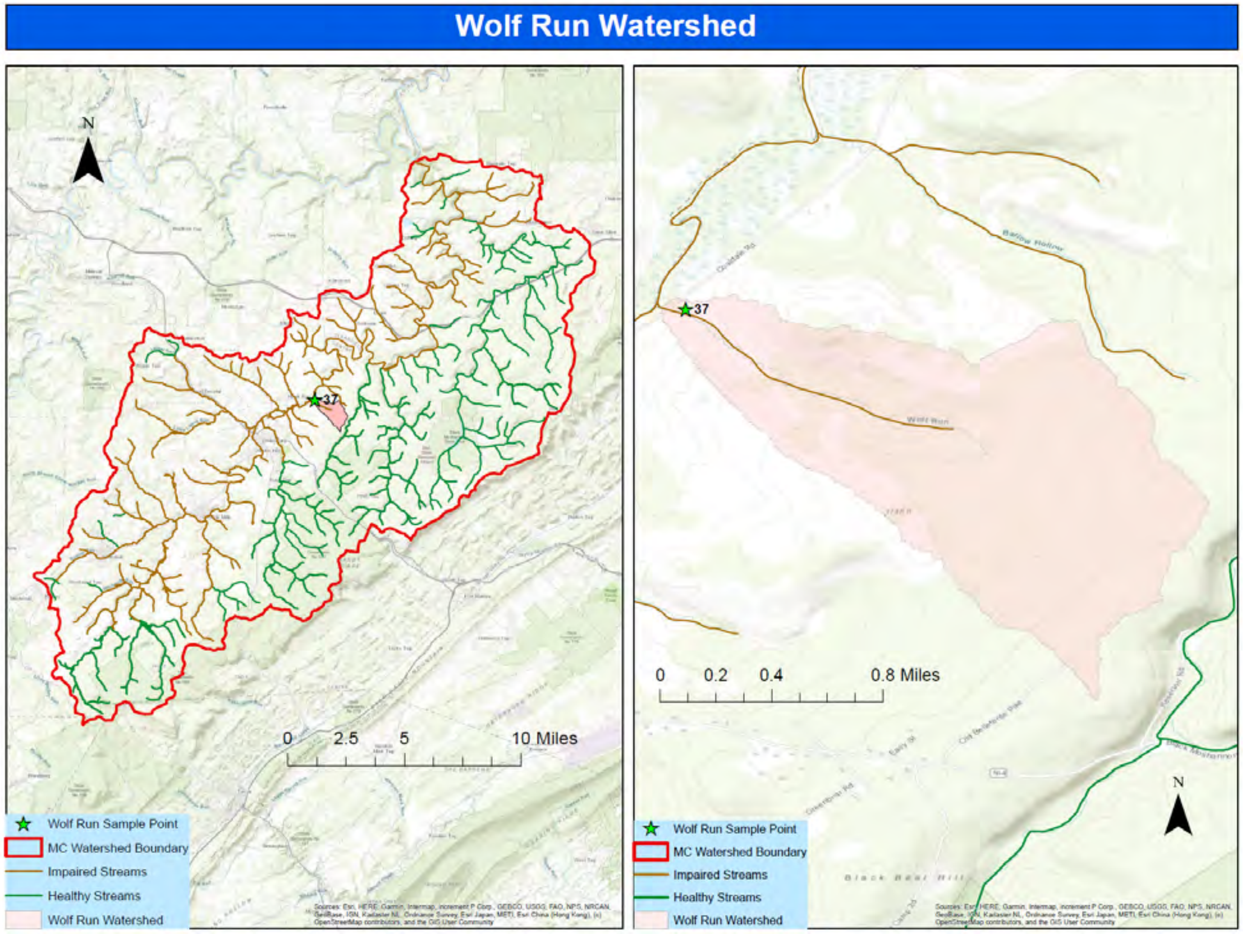


This is a small, extremely acidic impaired tributary to Moshannon Creek with very high aluminum. It is yet another stream in the row of impaired streams on the Centre County side of Moshannon Creek in this section of the watershed.

ID	Unit	38
Station Name		Unnamed Trib
Flow	CFS	0.073
Lat		40.9200
Long		-78.1848
Area	Mi^2	0.34
Area	%	0.12
Field Temp	°C	20.80
Field DO	mg/l	
Field Cond	uS/cm	2340.00
Field pH	SU	2.76
Field Turb	NTU	
Lab pH	SU	2.8
Lab Cond	uS/cm	2260

ID	Unit	38
Alk	mg/l	0
Acid	mg/l	363
Acid Load	lbs/day	143
Fe	mg/l	11.74
Fe Load	lbs/day	5
Mn	mg/l	11.08
Mn Load	lbs/day	4
Al	mg/l	37.58
Al Load	lbs/day	15
SO_4	mg/l	1064
SO_4 Load	lbs/day	419
TSS	mg/l	2
TDS	mg/l	1736

Wolf Run. HUC 02050201001844.

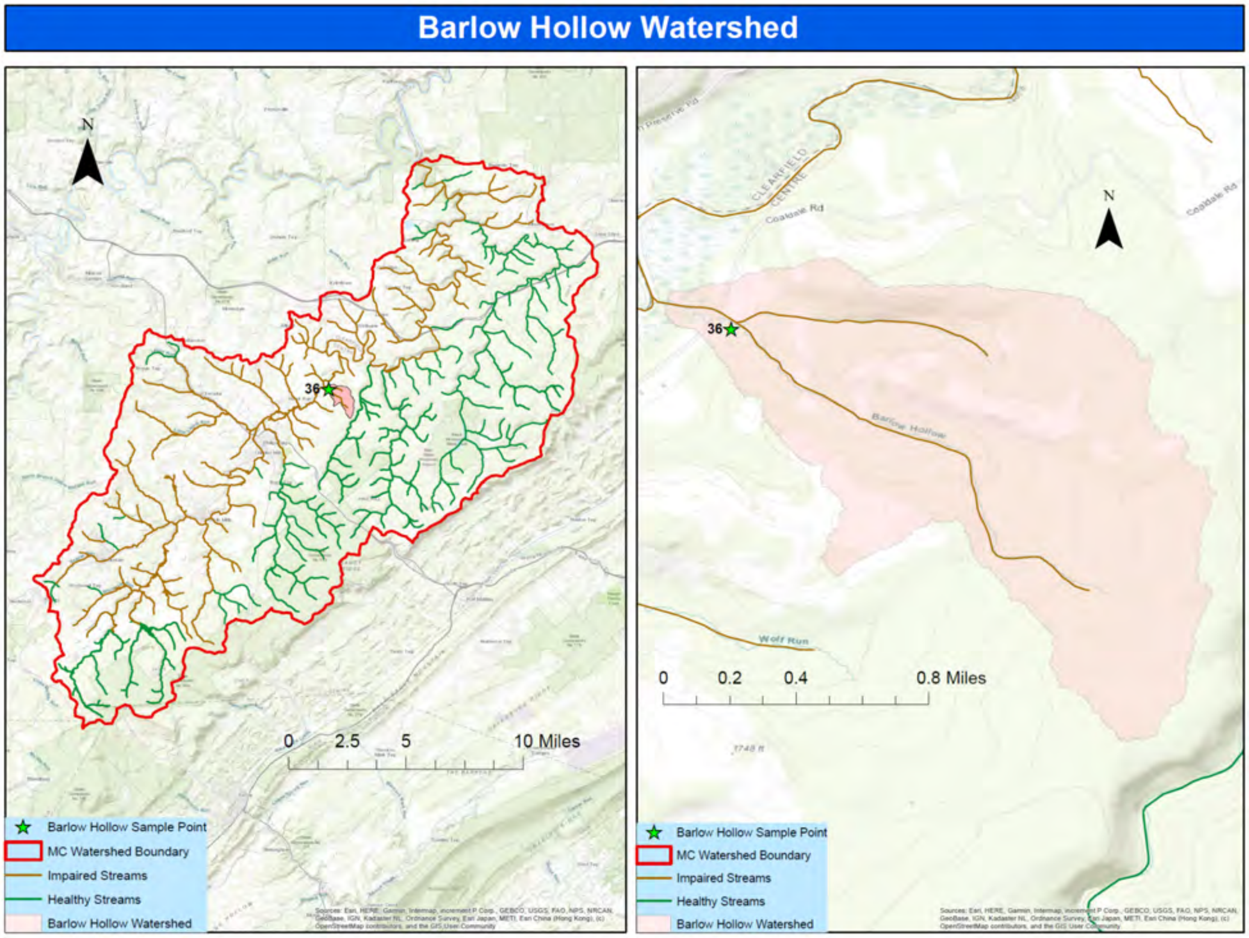


Wolf Run is a small, extremely acidic impaired tributary with very high metals content. It is one of several impaired streams on the Centre County side of Moshannon Creek in this section.

ID	Unit	37
Station Name		Wolf Run
Flow	CFS	0.155
Lat		40.9235
Long		-78.1783
Area	Mi^2	1.09
Area	%	0.40
Field Temp	°C	20.30
Field DO	mg/l	
Field Cond	uS/cm	2400.00
Field pH	SU	2.80
Field Turb	NTU	
Lab pH	SU	2.8
Lab Cond	uS/cm	2360

ID	Unit	37
Alk	mg/l	0
Acid	mg/l	477
Acid Load	lbs/day	399
Fe	mg/l	48.55
Fe Load	lbs/day	41
Mn	mg/l	15.55
Mn Load	lbs/day	13
Al	mg/l	45.62
Al Load	lbs/day	38
SO_4	mg/l	1283
SO_4 Load	lbs/day	1073
TSS	mg/l	4
TDS	mg/l	2048

Barlow Hollow. HUC 02050201000595 and points upstream.

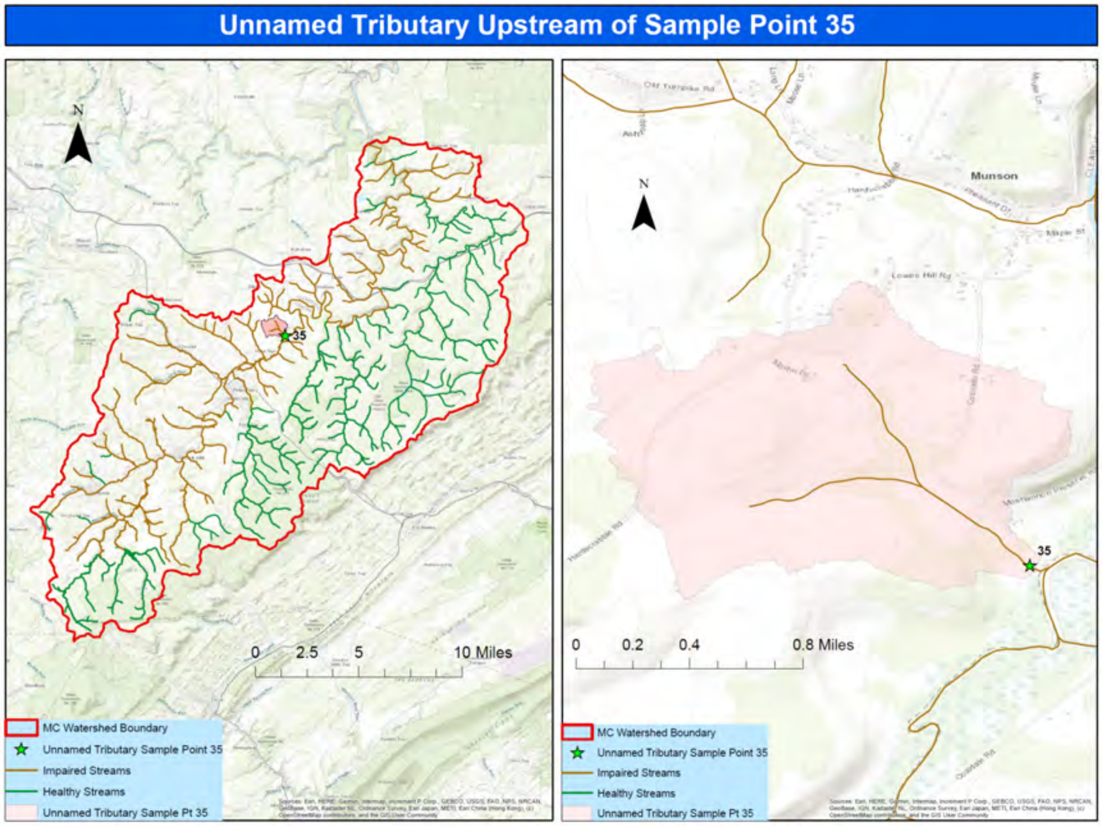


Barlow Hollow is another impaired stream on the Centre County side of Moshannon Creek in this area. It is not as acidic as several of the tributaries upstream of it, but it would be notably bad in most other neighborhoods.

ID	Unit	36
Station Name		Barlow Hollow
Flow	CFS	0.013
Lat		40.9313
Long		-78.1680
Area	Mi^2	0.85
Area	%	0.31
Field Temp	°C	14.50
Field DO	mg/l	
Field Cond	uS/cm	733.00
Field pH	SU	3.52
Field Turb	NTU	
Lab pH	SU	3.4
Lab Cond	uS/cm	702

ID	Unit	36
Alk	mg/l	0
Acid	mg/l	109
Acid Load	lbs/day	8
Fe	mg/l	2.02
Fe Load	lbs/day	0
Mn	mg/l	5.05
Mn Load	lbs/day	0
Al	mg/l	12.64
Al Load	lbs/day	1
SO_4	mg/l	290
SO_4 Load	lbs/day	20
TSS	mg/l	25
TDS	mg/l	489

Unnamed Tributary Upstream of Sample Point 35. HUC 02050201001797 and points upstream.

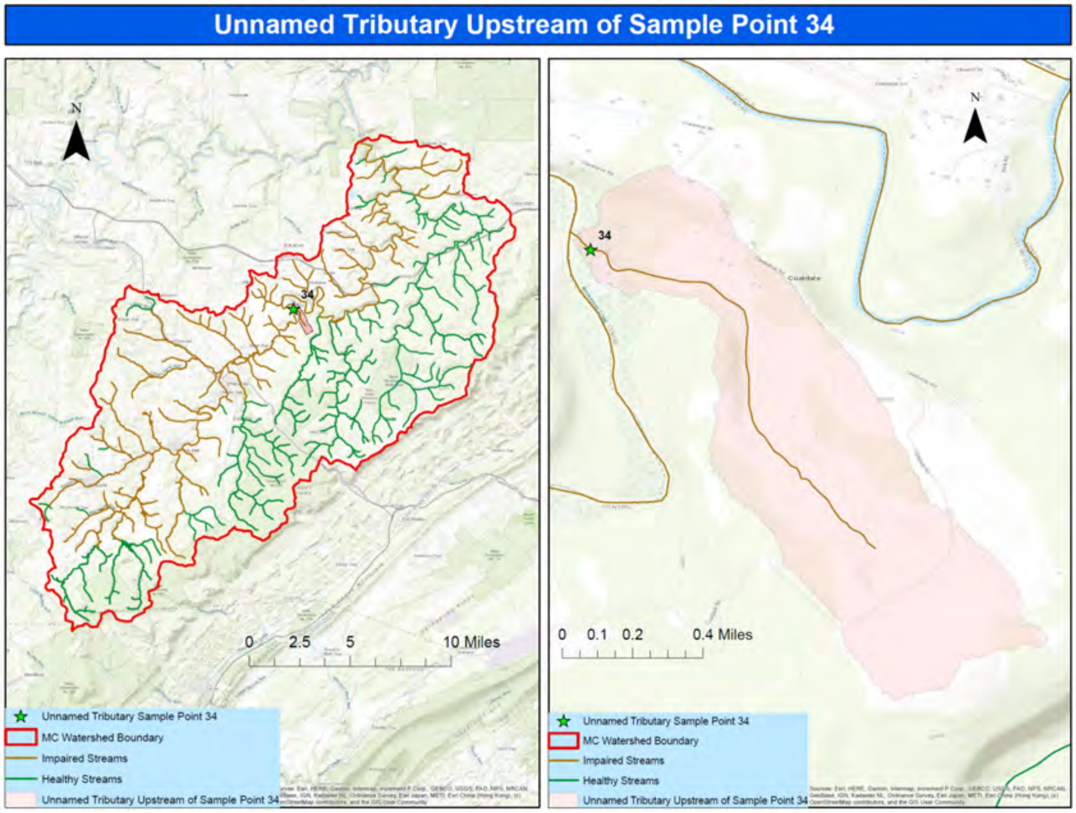


This tributary is an extremely acidic impaired stream with very high iron on the Clearfield County side of Moshannon Creek. The flow was measured at 152 gpm in a small watershed in a drought when sampled in July 2020. This stream may be worth scouting for mine discharges that may explain the flow. The same deep mine (Ghem Mine) that appears to supply AMD to Munson Run underlies part of this watershed as well.

ID	Unit	35
Station Name		Unnamed Trib
Flow	CFS	0.345
Lat		40.9364
Long		-78.1729
Area	Mi^2	0.84
Area	%	0.31
Field Temp	°C	18.60
Field DO	mg/l	6.67
Field Cond	uS/cm	1500.00
Field pH	SU	2.92
Field Turb	NTU	9.40
Lab pH	SU	3.0
Lab Cond	uS/cm	1530

ID	Unit	35
Alk	mg/l	0
Acid	mg/l	130
Acid Load	lbs/day	242
Fe	mg/l	19.41
Fe Load	lbs/day	36
Mn	mg/l	4.02
Mn Load	lbs/day	7
Al	mg/l	0.50
Al Load	lbs/day	1
SO_4	mg/l	649
SO_4 Load	lbs/day	1208
TSS	mg/l	5
TDS	mg/l	913

Unnamed Tributary Upstream of Sample Point 34. Referred to as UNT08 on SRBC website. HUC 02050201001784 and points upstream.

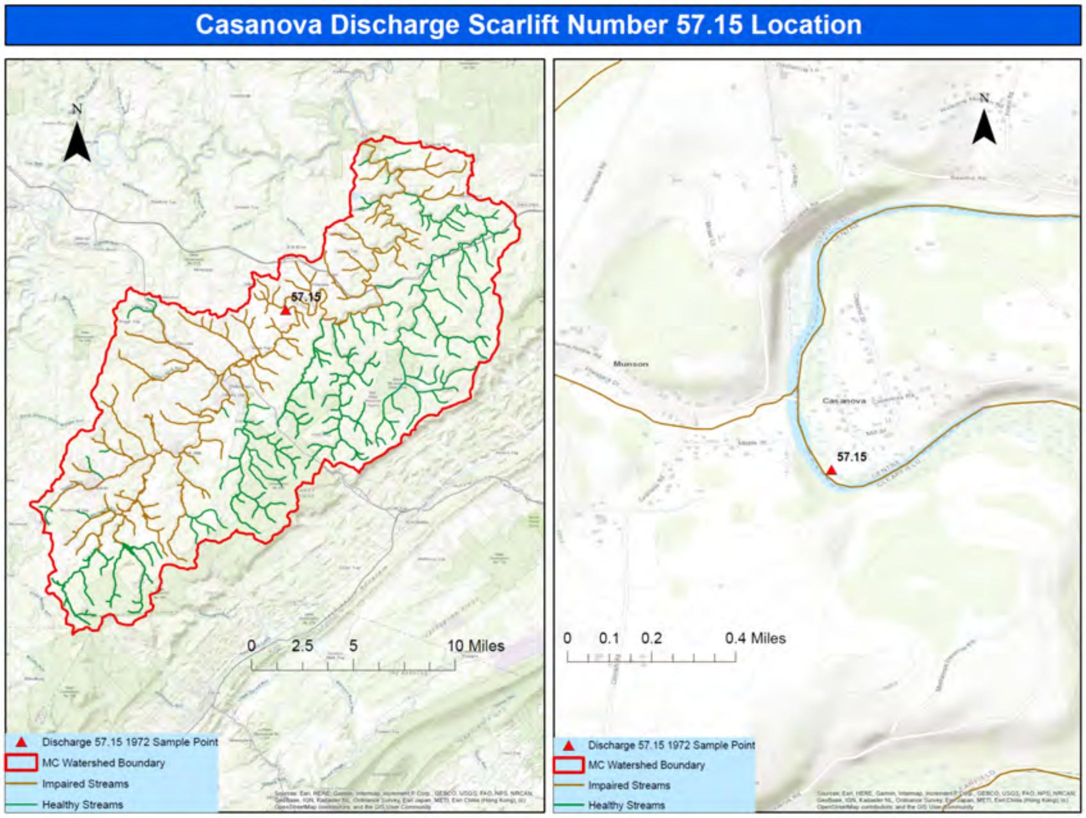


This stream was found to have pools of impaired water with a dry channel between the pools when it was sampled during a drought in July 2020. The sample results were very acidic and very high in iron. This stream needs to be resampled during more typical flow to better determine its importance to conditions in Moshannon Creek. This is the last of the row of impaired streams on the Centre County side of Moshannon in this area.

ID	Unit	34
Station Name		Unnamed Trib
Flow	CFS	0.000
Lat		40.9517
Long		-78.1587
Area	Mi^2	0.48
Area	%	0.18
Field Temp	°C	18.40
Field DO	mg/l	2.58
Field Cond	uS/cm	526.00
Field pH	SU	2.58
Field Turb	NTU	
Lab pH	SU	3.0
Lab Cond	uS/cm	714

ID	Unit	34
Alk	mg/l	0
Acid	mg/l	115
Acid Load	lbs/day	0
Fe	mg/l	28.71
Fe Load	lbs/day	0
Mn	mg/l	5.89
Mn Load	lbs/day	0
Al	mg/l	4.24
Al Load	lbs/day	0
SO_4	mg/l	205
SO_4 Load	lbs/day	0
TSS	mg/l	34
TDS	mg/l	317

Casanova Discharge Scarlift Report Number 57.15. -78.1684, 40.9525.



South of Casanova on the Centre County side of Moshannon Creek, there is a pond-like water body with an approximately six foot wide channel connecting it to Moshannon Creek. Aerial imagery indicates that the central portion of this water feature is deeper than the sides. Historic imagery on PASDA indicates that this structure was built between 1938 and 1957. The drainage channel was dry in July 2020 when it was first observed during the drought. The drainage channel was also observed to be dry in much of the Summer of 2021, a much wetter year. Had this feature only been observed in the Summer, it probably would not be mentioned in this report.

In the Winter, the outlet of this feature was observed to be discharging a robust flow of water. In the early Spring it was observed to still be flowing but with smaller volume. This discharge was sampled by Skelly and Loy on 8/24/1972 during a very wet year because of hurricane Agnes. The sample results for this discharge from 1972 showed it to be a large source of acidity and iron. Aluminum and Manganese were not measured in the Scarlift sampling.

An adjacent landowner who was a small child when this feature was dug in the 1950's believes that this feature was dug to provide material for road construction when the roads in Casanova were paved. Whether that was the only function this feature was created for is yet to be determined. Given the sample results from 1972, it must have a connection to mine water, either planned or accidental. This feature is planned to be sampled when it is observed producing significant stable flow, probably in the Winter of 2022. If it has results at all similar to the ones from 1972, planning for addressing the water seasonally flowing from this hole will need to be made.

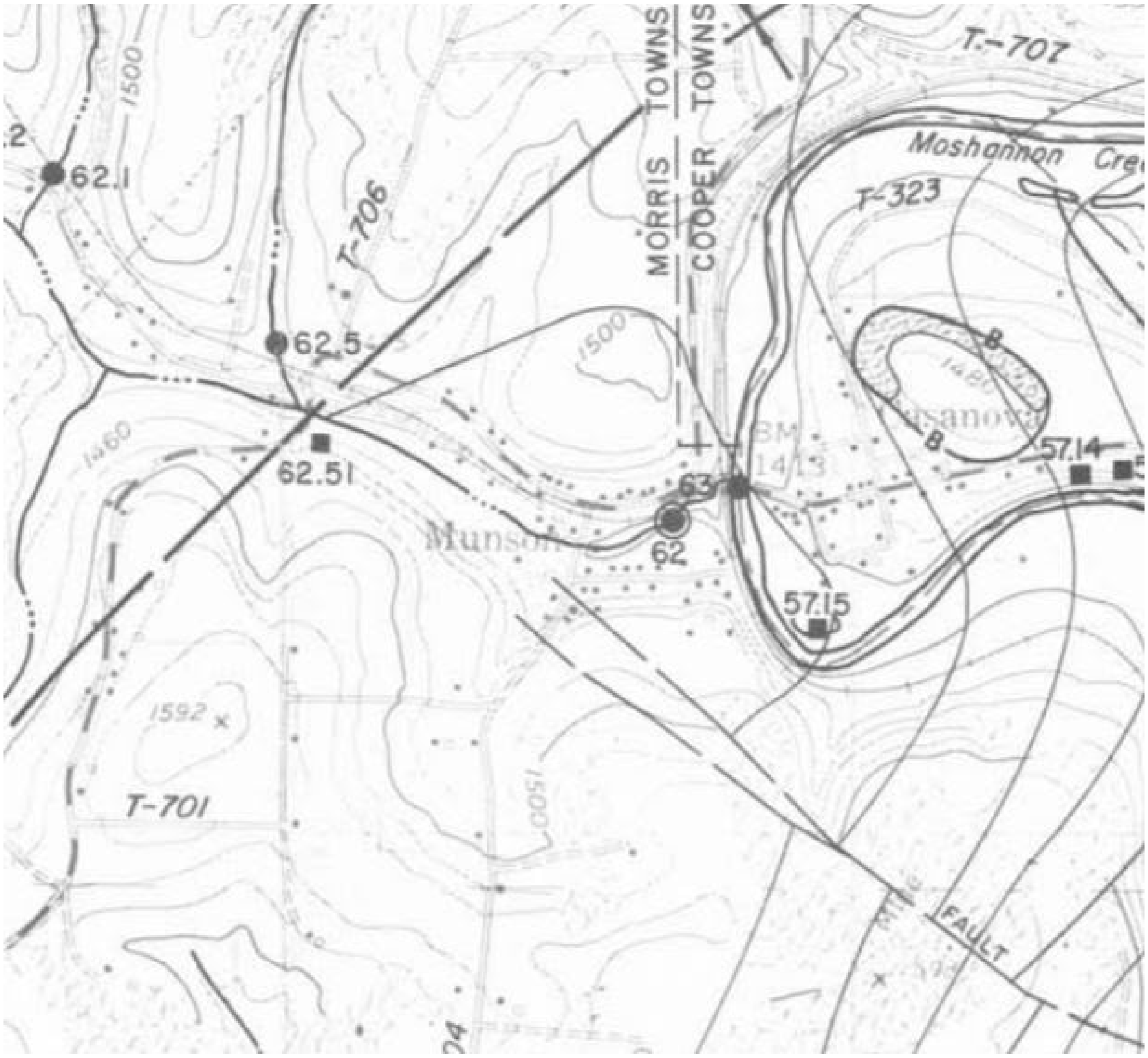
2015 Image from Google Earth of Casanova Discharge 57.15.

ID	Unit	57.15
Station Name		Casanova Discharge
Date		8/24/1972
Flow	CFS	0.230
Lat		40.9525
Long		-78.1684
Field pH	SU	2.50
Lab pH	SU	3.5
Alk	mg/l	0
Acid	mg/l	1264
Acid Load	lbs/day	1568
Fe	mg/l	99.00
Fe Load	lbs/day	123
SO_4	mg/l	1060
SO_4 Load	lbs/day	1315

Loading Table Produced Using 1972 Sample Data of Casanova Discharge

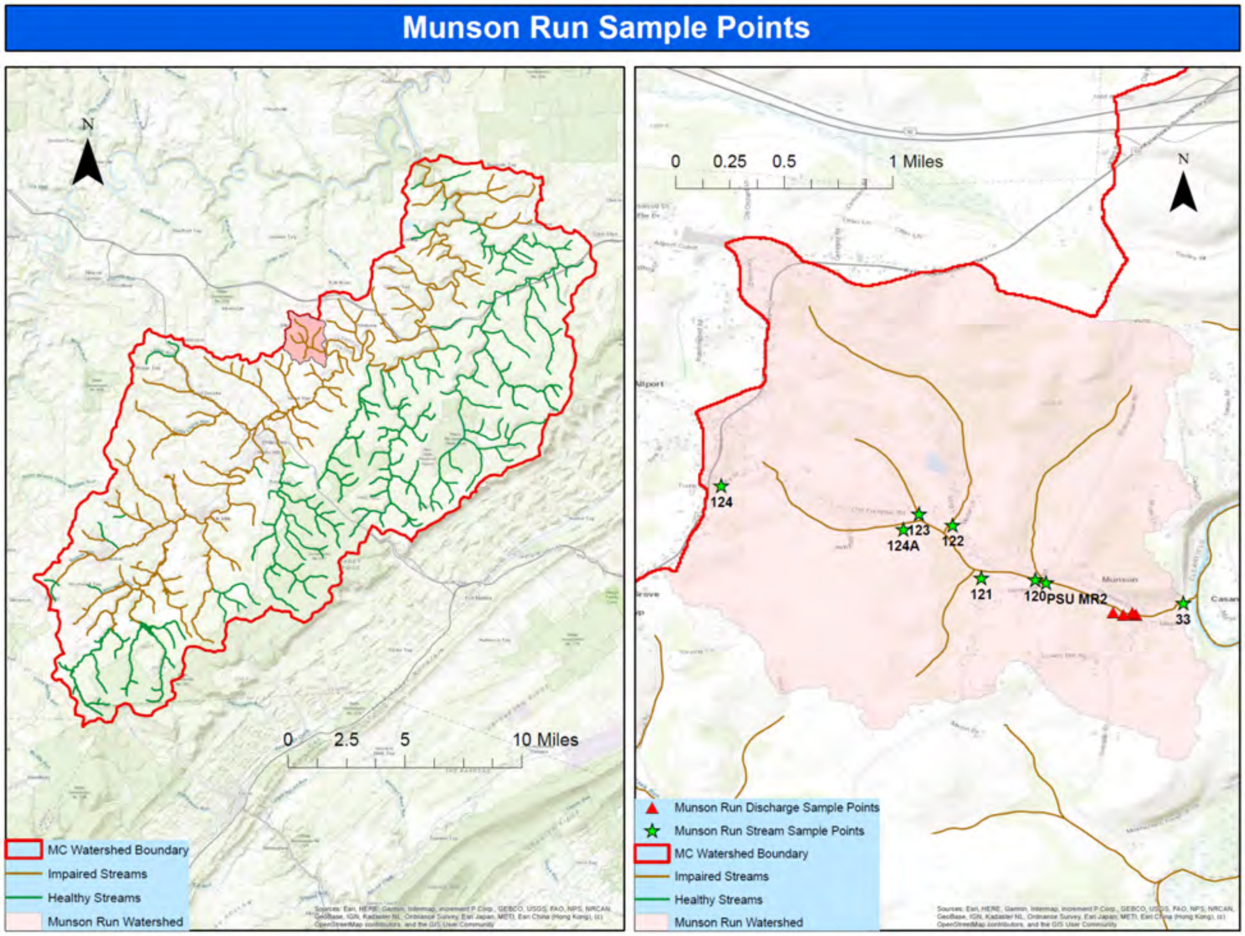
1938 Imagery of Location of Casanova Discharge 57.15

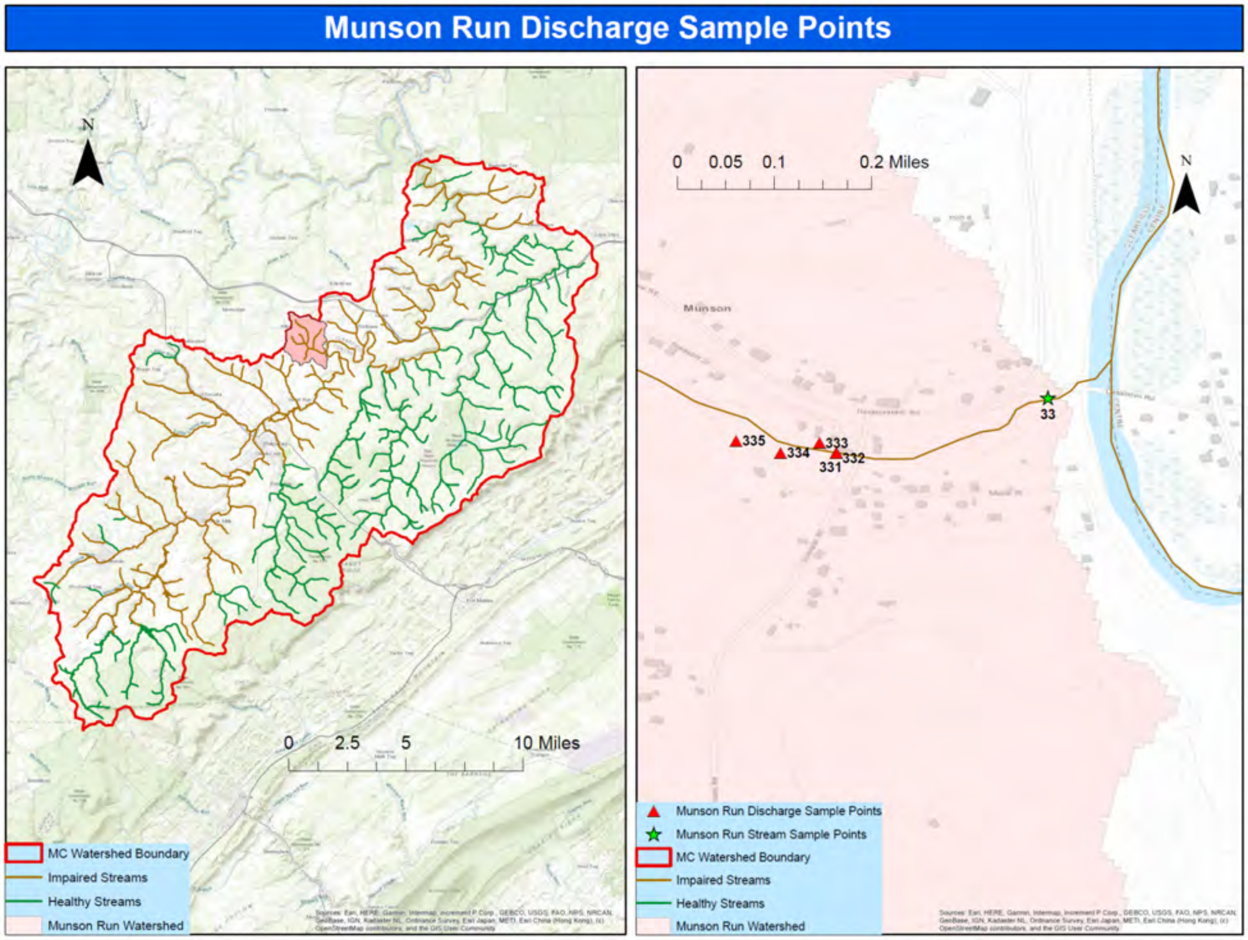
1957 Imagery of Casanova Discharge 57.15. Both images were Centre County Aerial imagery from PASDA downloaded as KMZ files.



Map detail from the 1972 Scarlift Report showing the location of discharge 57.15.

Munson Run. HUC 02050201000535 and points upstream including tributaries.





Munson Run joins Moshannon Creek just upstream of the Casanova Road bridge over Moshannon Creek. The first round of water sampling showed the importance of Munson Run to AMD conditions in the main stem of Moshannon Creek. Because of this, the Munson Run watershed was sampled in the second round of water sampling performed on 9/25/2020. Drought conditions did not provide meaningful results for most of the tributaries, because they were dry. What the drought conditions did expose were multiple mine discharges emerging in or near the stream bed in the last half mile of the main stem of Munson Run.

Munson Run also has AMD piped to it from the rear of residences in the town of Munson, where AMD emerging in people's basements was piped away from the houses. A selection of those discharges were sampled in round 2. Round 3 water sampling of Munson Run was performed in April 2021. This sampling was performed by Penn State University students working under the direction of Dr. Bill Burgos. The third round of water sampling, performed in much higher Spring flows, demonstrated that most of the tributaries of Munson Run, and the main stem of Munson Run upstream of Hardscrabble Road, have fairly good water in them. In non-drought years, much of the Munson Run watershed probably could support fish, if they avoided exposure to the lower end of the watershed. Sampling during higher flows in April 2021 again demonstrated that most of the AMD in Munson Run enters it in the last half mile. Munson Run is a very important source of AMD flowing to Moshannon Creek. It will be essential to treat this water. The challenge will be finding a way to intercept and treat the AMD that enters Munson Run in or very near the stream bed as it flows through a residential area in the lower portion of the watershed.

Date	7/24/2020	9/25/2020	4/5/2021
Flow	2.360	0.1645	1.515
Lat	40.9548	40.954734	40.954734
Long	-78.1705	-78.170169	-78.170169
SM Area	3.04	3.04	3.04
% Area	1.11	1.11	1.11
Field Temp	16.60	11.27	11.70
Field DO	7.83		9.94
Field Cond	934.00		489.00
Field pH	3.06	3.89	3.60
Field Turb			
Lab pH	3.2	3.1	
Lab Cond	1000	1130	
Alk	0	0	0
Acid	107	124	74.71
Acid Load	1362	110	611
Fe	16.80	20.22	8.83
Fe Load	214	18	72
Mn	2.48	2.81	1.32
Mn Load	32	2	11
Al	8.15	9.59	6.50
Al Load	104	9	53
SO_4	377	407	232
SO_4 Load	4800	361	1896
TSS	14	15	
TDS	616	648	113*

Samples of Mouth of Munson Run. *TDS value calculated in April 2021 Sample.

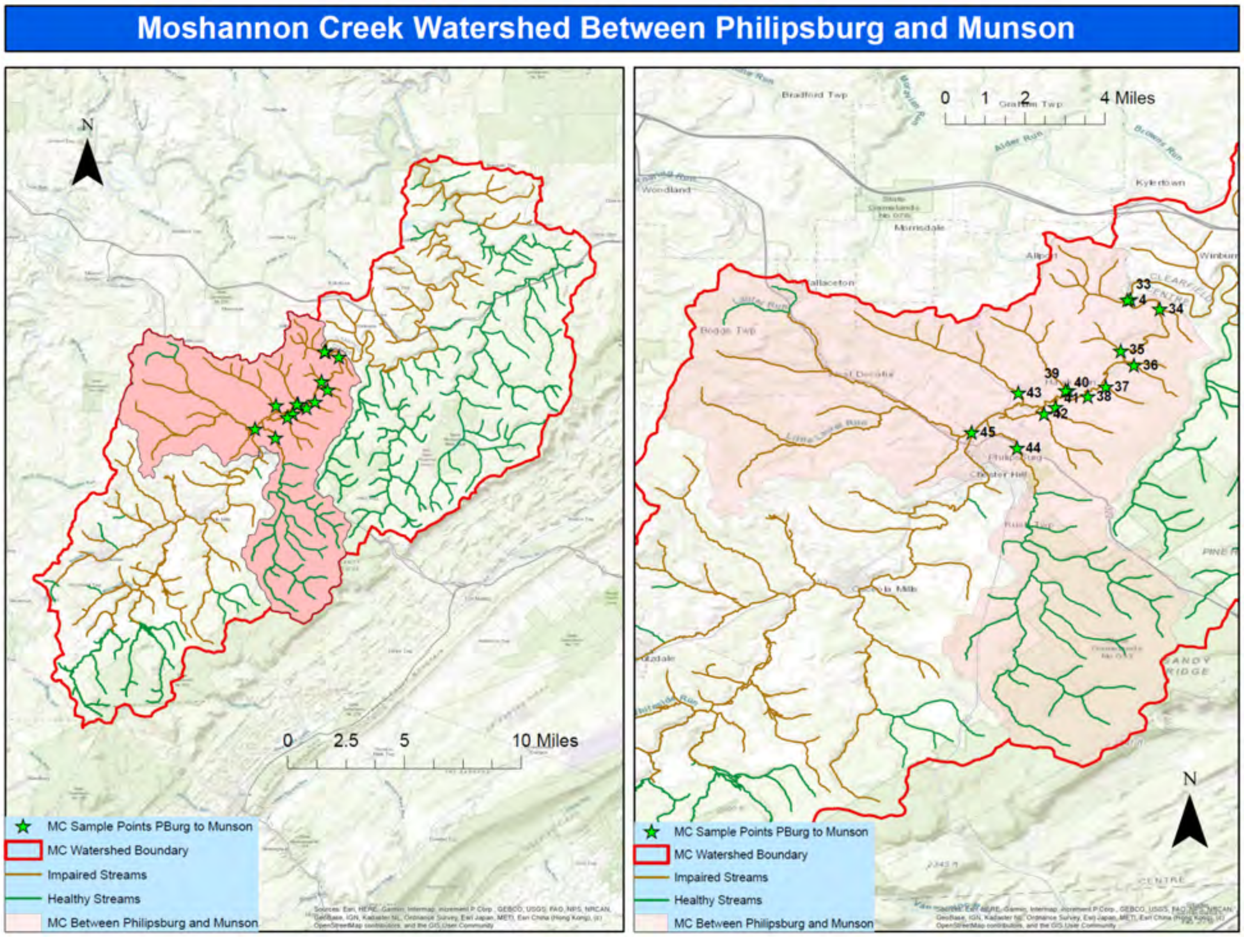
ID	120	121	122	123	124 (#1)	120	121	122	123 (#2)	124A
Station Name	MR UNT-1	MR UNT-2	MR UNT-3	MR UNT-4	MR Upstream	MR UNT-1 (PSU)	MR UNT-2 (MCWA)	MR UNT-3 (PSU)	MR UNT-4 (PSU)	MR Upstream Trolly (PSU TR-1)
Date	9/25/2020	9/25/2020	9/25/2020	9/25/2020	9/25/2020	4/5/2021	4/14/2021	4/5/2021	4/5/2021	4/5/2021
Flow	0.000	0.000	0.000	0.0337	0.000	0.0102	0.0401	0.0102	0.2651	0.0024
Lat	40.956335	40.956449	40.959994	40.960723	40.959684	40.956335	40.956449	40.959994	40.960723	40.96259
Long	-78.180361	-78.183924	-78.185844	-78.188099	-78.18915	-78.180361	-78.183924	-78.185844	-78.188099	-78.201249
SM Area										
% Area										
Field Temp				11.67		9.9	8.77	15.9	15.3	12.2
Field DO						9.89		9.76	9.64	10.51
Field Cond						166	206	328	371	716
Field pH				7.1		6.8	6.05	5.89	6.38	7.02
Field Turb										
Lab pH				6.8			6.58			
Lab Cond				714			190			
Alk				35		42.8	<20	7.2	22.3	117.2
Acid				-16		0.29	17.3	10.74	0.52	0
Acid Load	0	0	0	-3	0	0	4	1	1	0
Fe				0.05		0.06	<0.2	0.74	<.3	<.3
Fe Load	0	0	0	0	0	0	0	0	0	0
Mn				0.08		0.06	<0.02	2.56	0.28	<1
Mn Load	0	0	0	0	0	0	0	0	0	0
Al				0.05		<.75	<0.1	0.73	<.75	<.75
Al Load	0	0	0	0	0	0	0	0	0	0
SO_4				226		36	5	163	157	26
SO_4 Load	0	0	0	41	0	2	1	9	225	0
TSS				<2			0.8			
TDS				409		45*	128	85*	95*	183*

Munson Run tributary sampling.

ID	331	332	333	334	335
Station Name	Munson (2' down from) Pipe 1 DN	Munson Pipe 1	Munson Pipe 2	Munson Big Pool	Munson Mossy Seep
Flow	0.0028	0.0067	0.0011	0.0022	0.0011
Lat	40.95398	40.95398	40.95413	40.95398	40.95416
Long	-78.1737	-78.1737	-78.1739	-78.1745	-78.1751
SM Area					
% Area					
Field Temp	17.05	15.11	16.67	15.55	15.72
Field DO					
Field Cond					
Field pH	3.51	3.77	3.51	3.27	3.35
Field Turb					
Lab pH	3.3	3.3	3.3	3.2	3.3
Lab Cond	1020	1190	1110	1030	1030
Alk	0	0	0	0	0
Acid	136	200	196	106	115
Acid Load	2	7	1	1	1
Fe	28.39	85.2	59.85	5.76	1.4
Fe Load	0	3	0	0	0
Mn	2.3	3.23	3.55	2.83	2.71
Mn Load	0	0	0	0	0
Al	9.9	9.4	9.72	8.29	12.69
Al Load	0	0	0	0	0
SO_4	372	501	479	348	385
SO_4 Load	6	18	3	4	2
TSS	<2	3	<2	<2	<2
TDS	613	795	779	561	623

Munson Run Discharge Sampling From 9/25/2020.

Moshannon Creek Between Presqueisle Bridge and Downstream of Casanova Road Bridge. HUC 02050201000151 and points upstream to the Presqueisle Bridge.

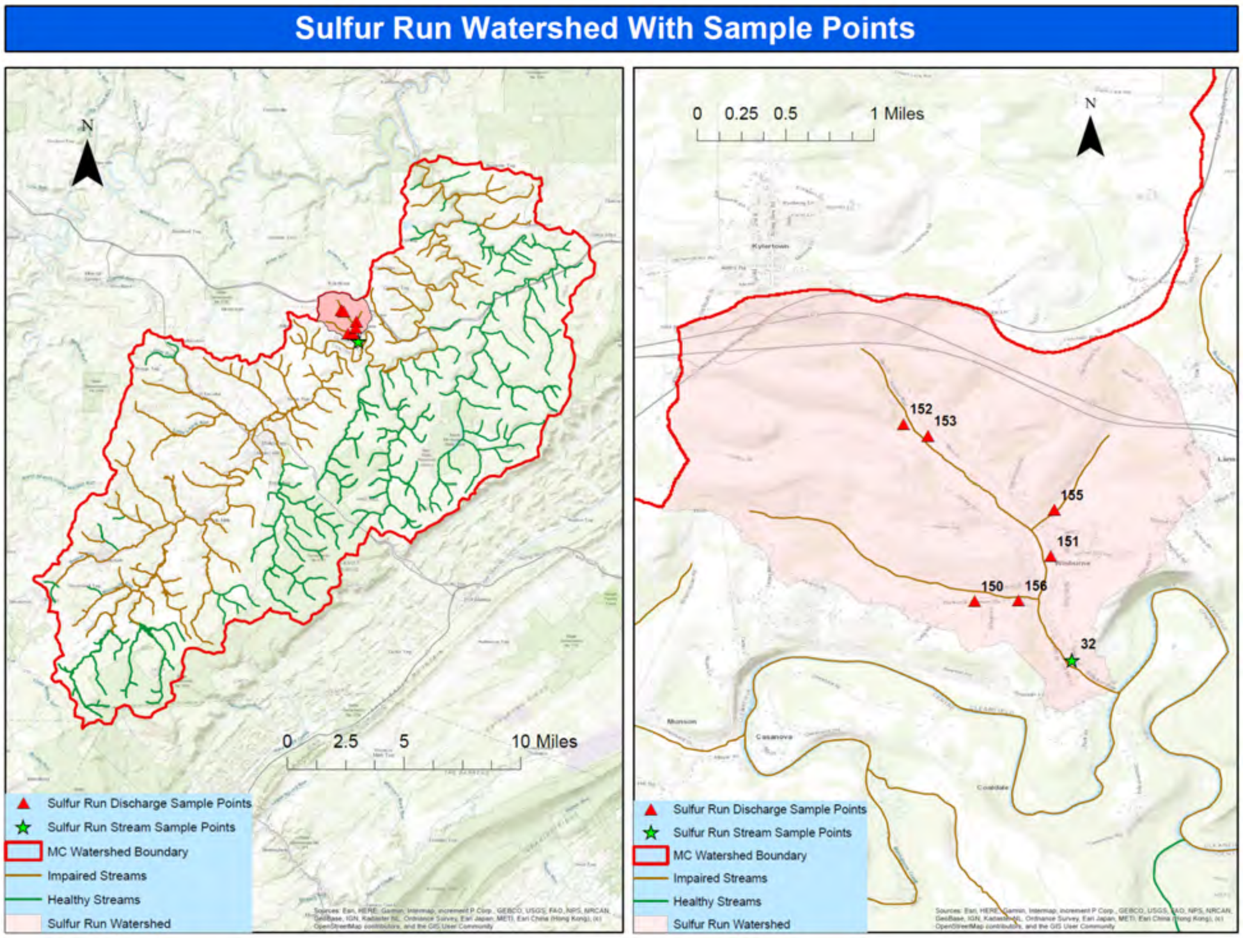


As water flows downstream from Philipsburg, it flows into the most mine drainage impacted stretch of the Moshannon Creek watershed. Starting just north of Cold Stream on the Centre County side of Moshannon Creek, and starting at Hawk Run on the Clearfield County side of Moshannon Creek, and extending downstream past this section to include Sulfur Run, this stretch of Moshannon Creek will require a large active plant to treat the substantial quantity of AMD that enters Moshannon Creek in this stretch. The AMD that enters into this stretch, plus the AMD in the Sulfur Run watershed just downstream, make up a substantial part of the contaminants that escape the Moshannon Creek watershed into the West Branch of the Susquehanna. There is great potential for recovery in Moshannon Creek and in the West Branch downstream of Moshannon Creek by treating the worst of the discharges in this stretch along with treating the nearby and critically important Sulfur Run.

ID	4	33	34	35	36	37	38
Station Name	Downstream Munson Run	Munson Run	Unnamed Trib	Unnamed Trib	Barlow Hollow	Wolf Run	Unnamed Trib
Flow	69.960	2.360	0.000	0.345	0.013	0.155	0.073
Lat	40.9550	40.9548	40.9517	40.9364	40.9313	40.9235	40.9200
Long	-78.1694	-78.1705	-78.1587	-78.1729	-78.1680	-78.1783	-78.1848
Area	144.00	3.04	0.48	0.84	0.85	1.09	0.34
Area		1.11	0.18	0.31	0.31	0.40	0.12
Field Temp	21.90	16.60	18.40	18.60	14.50	20.30	20.80
Field DO	7.27	7.83	2.58	6.67			
Field Cond	835.00	934.00	526.00	1500.00	733.00	2400.00	2340.00
Field pH	4.01	3.06	2.58	2.92	3.52	2.80	2.76
Field Turb				9.40			
Lab pH	4.6	3.2	3.0	3.0	3.4	2.8	2.8
Lab Cond	842	1000	714	1530	702	2360	2260
Alk	0	0	0	0	0	0	0
Acid	22	107	115	130	109	477	363
Acid Load	8303	1362	0	242	8	399	143
Fe	1.46	16.80	28.71	19.41	2.02	48.55	11.74
Fe Load	551	214	0	36	0	41	5
Mn	2.70	2.48	5.89	4.02	5.05	15.55	11.08
Mn Load	1019	32	0	7	0	13	4
Al	0.49	8.15	4.24	0.50	12.64	45.62	37.58
Al Load	185	104	0	1	1	38	15
SO_4	397	377	205	649	290	1283	1064
SO_4 Load	149830	4800	0	1208	20	1073	419
TSS	4	14	34	5	25	4	2
TDS	610	616	317	913	489	2048	1736

ID	39	40	41	42	43	44	45
Station Name	Hawk Run Discharge	Hawk Run US Hawk Run Discharge	Unnamed Trib	Onemile Run	Emigh Run	Cold Stream	Laurel Run
Flow	3.750	0.756	0.014	0.207	2.239	6.260	9.492
Lat	40.9222	40.9222	40.9161	40.9137	40.9212	40.9013	40.9069
Long	-78.1920	-78.1929	-78.1965	-78.2006	-78.2101	-78.2104	-78.2269
Area	NA	2.66	1.34	1.87	4.16	22.00	22.00
Area	NA	0.97	0.49	0.68	1.52	8.03	8.03
Field Temp	10.40	22.30	21.40	17.10	23.10	26.10	22.08
Field DO	1.37	8.13					7.99
Field Cond	1094.00	992.00	1172.00	879.00	971.00	73.30	983.00
Field pH	5.83	7.50	3.19	2.85	5.89	6.39	6.45
Field Turb	0.90	7.00		0.10		0.72	1.42
Lab pH	5.9	7.4	3.2	3.1	6.2	6.4	6.6
Lab Cond	1100	1000	1090	991	915	106	984
Alk	27	114	0	0	9	6	27
Acid	51	-92	126	133	19	8	-9
Acid Load	1032	-375	10	149	229	270	-461
Fe	29.76	0.86	2.22	11.53	0.61	1.83	0.49
Fe Load	602	4	0	13	7	62	25
Mn	3.31	2.25	5.53	5.20	11.81	0.38	6.60
Mn Load	67	9	0	6	143	13	338
Al	1.63	0.08	11.89	10.30	0.15	0.23	0.23
Al Load	33	0	1	12	2	8	12
SO_4	552	390	473	356	434	23	467
SO_4 Load	11167	1591	36	398	5242	777	23913
TSS	6	6	8	7	5	10	5
TDS	861	715	799	622	674	52	732

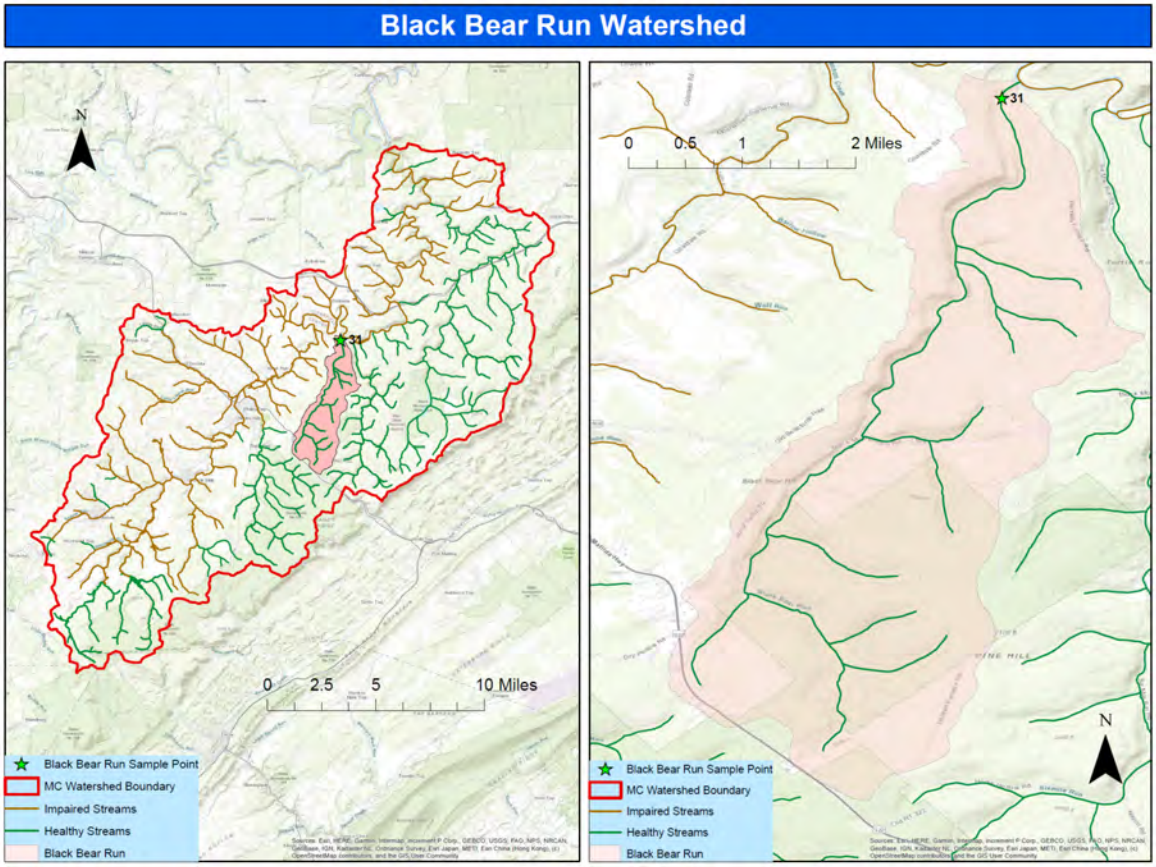
Sulfur Run. HUC 02050201000532 and points upstream including tributaries.



On an 1866 map of Clearfield County, this stream was named Big Run. This stream was apparently renamed after the impacts of mine drainage became apparent. It is very well named. Sulfur Run is the largest source of acidity in the Moshannon Creek watershed. When its importance became apparent after the July 2020 sampling, this watershed was chosen for additional sampling by the SRBC that began in September 2020. The first month of that data is presented here. The SRBC has continued monthly water sampling of the Sulfur Run watershed because of its obvious importance. An active plant will be needed to treat the volume of AMD that is found in this watershed and the areas around it. Almost all of the water flowing in this stream is mine drainage. Flow was measured at 3411 gpm in July 2020 and 1753 gpm in September 2020 during moderate to severe drought conditions.

ID	Unit	32	32	150	156	155	152	153	151
Station Name		Sulphur Run	Sulphur Run Mouth (R2)	46 Mine	Olson Drift	45 Mine	Flume Discharge	45B Entry	45C House Discharge
Date		7/24/2020	9/25/2020	9/25/2020	9/25/2020	9/25/2020	9/25/2020	9/25/2020	9/25/2020
Flow	CFS	7.601	3.907	0.743	0.253	2.700	0.067	0.140	2.897
Lat		40.961317	40.961317	40.966198	40.966231	40.973667	40.980627	40.979649	40.969853
Long		-78.14275	-78.14275	-78.150741	-78.147156	-78.1442	-78.156566	-78.154571	-78.144513
Area	Mi^2	3.46	3.46						
Area	%	1.26	1.26						
Field Temp	°C	12.30	11.80	13.00	16.60	16.00	16.20	13.90	13.80
Field DO	mg/l	10.47							
Field Cond	uS/cm	1313.00	1330.0	1480.0	925.0	1105.0	1698.0	2075.0	1183.0
Field pH	SU	3.01							
Field Turb	NTU								
Lab pH	SU	3.2	3.10	3.00	3.20	3.10	2.90	3.10	3.10
Lab Cond	uS/cm	1310	1600.0	2450.0	1040.0	1350.0	2130.0	2470.0	1410.0
Alk	mg/l	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Acid	mg/l	148	162.00	268.00	106.00	146.00	313.00	210.00	149.00
Acid Load	lbs/day	6069	3414	1074	145	2127	113	159	2329
Fe	mg/l	11.37	19.44	30.36	6.37	16.43	47.85	8.58	16.78
Fe Load	lbs/day	466	410	122	9	239	17	6	262
Mn	mg/l	2.30	2.72	3.44	2.10	2.29	4.34	3.50	2.50
Mn Load	lbs/day	94	57	14	3	33	2	3	39
Al	mg/l	12.19	15.30	28.05	8.70	12.52	33.07	24.12	12.04
Al Load	lbs/day	500	322	112	12	182	12	18	188
SO_4	mg/l	582	1164.0	1166.0	354.0	458.0	835.0	1186.0	484.0
SO_4 Load	lbs/day	23864	24533	4674	483	6671	302	896	7564
TSS	mg/l	7	2.0	4.0	<2.0	2.0	6.0	<2.0	3.0
TDS	mg/l	915	972	1828	572	725	1272	1796	772

Black Bear Run. HUC 02050201000244.

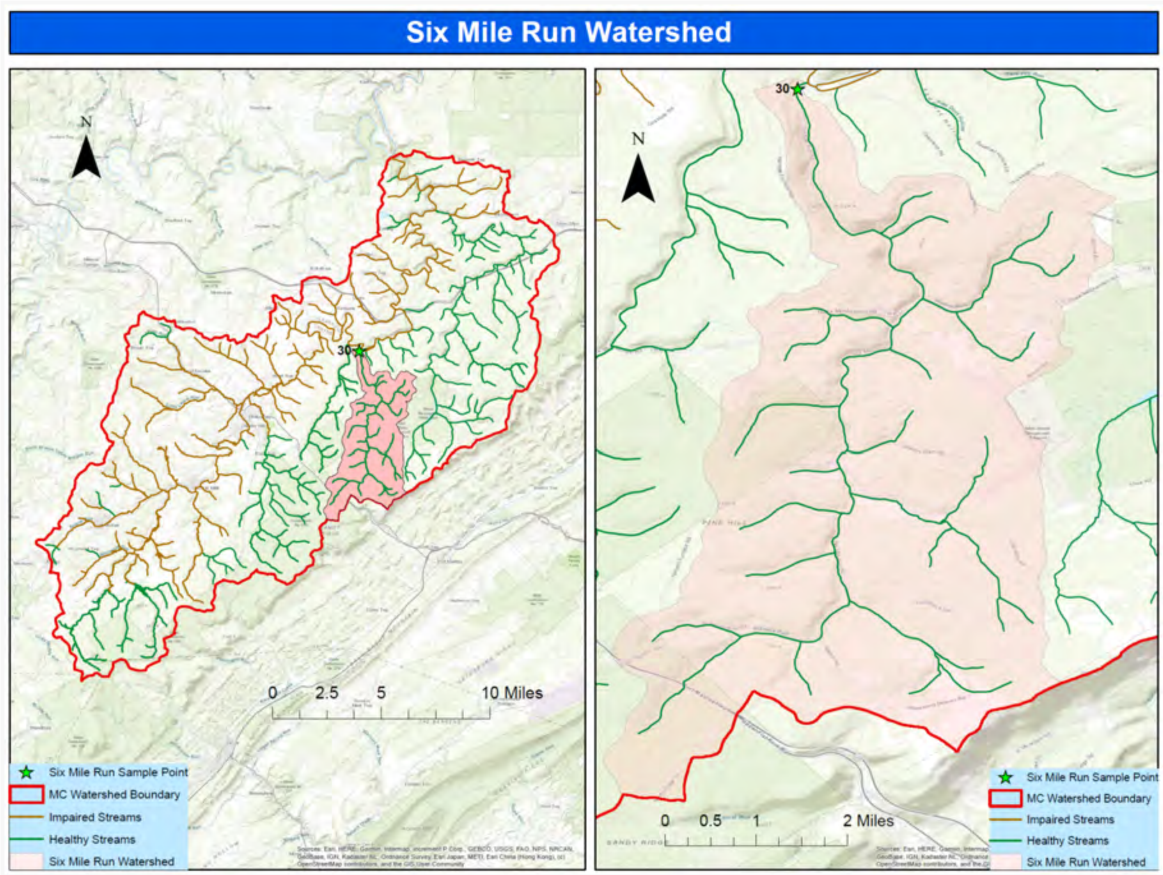


This stream is the first of several clean water streams flowing into Moshannon Creek from Centre County and the Moshannon State Forest and adjacent State Game Lands. Water sampling in July 2020 showed excellent water chemistry and a water temperature of 18.4 C during the hottest part of summer. This stream should be monitored for threats and used as a reference clean water stream for this section of the watershed.

ID	Unit	31
Station Name		Black Bear Run
Flow	CFS	2.754
Lat		40.9446
Long		-78.1359
Area	Mi^2	8.74
Area	%	3.19
Field Temp	°C	18.40
Field DO	mg/l	8.83
Field Cond	uS/cm	51.10
Field pH	SU	6.39
Field Turb	NTU	0.60
Lab pH	SU	6.3
Lab Cond	uS/cm	55

ID	Unit	31
Alk	mg/l	6
Acid	mg/l	5
Acid Load	lbs/day	74
Fe	mg/l	0.07
Fe Load	lbs/day	1
Mn	mg/l	0.02
Mn Load	lbs/day	0
Al	mg/l	0.05
Al Load	lbs/day	1
SO_4	mg/l	6
SO_4 Load	lbs/day	89
TSS	mg/l	3
TDS	mg/l	37

Sixmile Run. HUC 02050201000479.

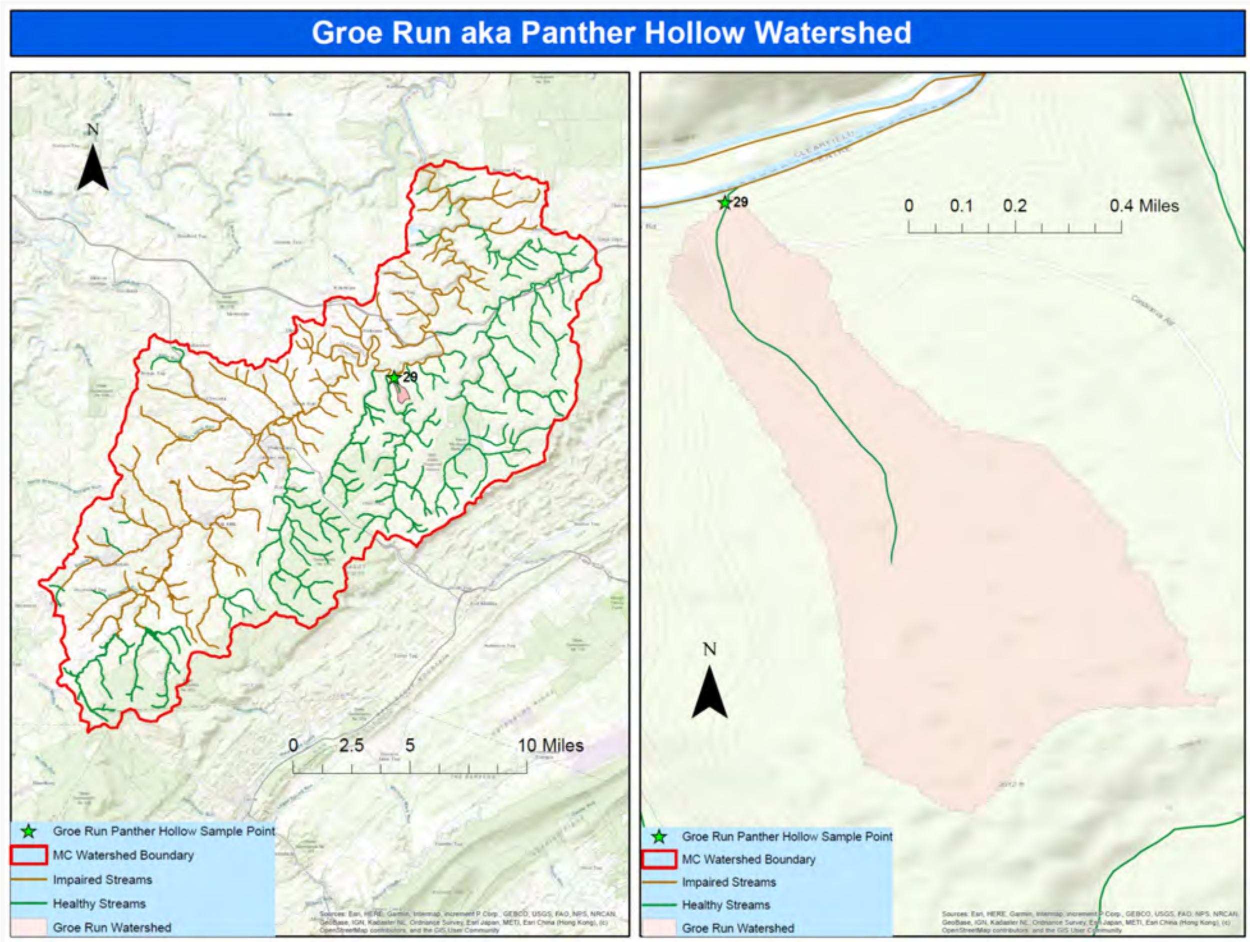


Sixmile Run is another clean water stream flowing into Moshannon Creek from the Moshannon State Forest and adjacent State Game Lands. This stream has excellent water chemistry and had a water temperature of 18.9 C when sampled in July 2020. This stream should be monitored and used as a reference stream.

ID	Unit	30
Station Name		Sixmile Run
Flow	CFS	6.675
Lat		40.9423
Long		-78.1242
Area	Mi^2	17.50
Area	%	6.39
Field Temp	°C	18.90
Field DO	mg/l	8.86
Field Cond	uS/cm	
Field pH	SU	6.49
Field Turb	NTU	1.87
Lab pH	SU	6.5
Lab Cond	uS/cm	63

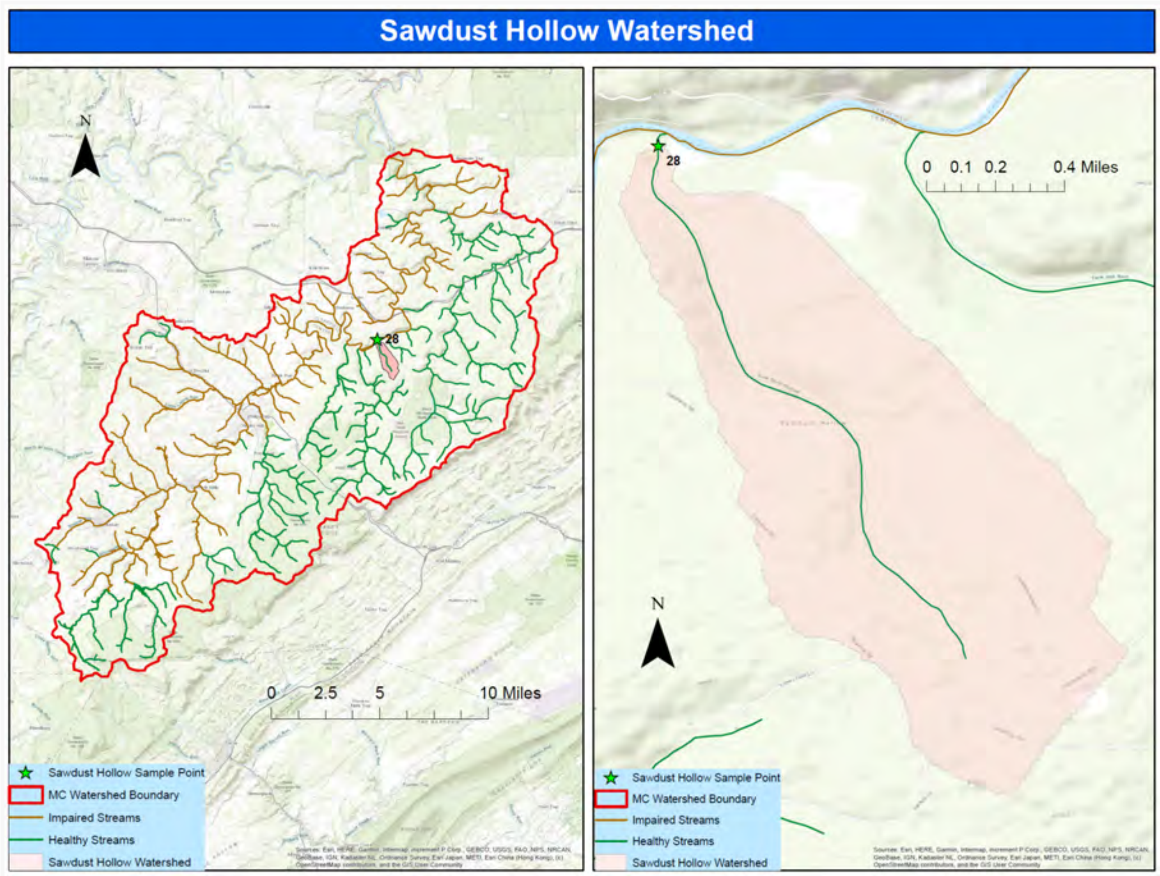
ID	Unit	30
Alk	mg/l	13
Acid	mg/l	2
Acid Load	lbs/day	72
Fe	mg/l	0.11
Fe Load	lbs/day	4
Mn	mg/l	0.02
Mn Load	lbs/day	1
Al	mg/l	0.05
Al Load	lbs/day	2
SO_4	mg/l	6
SO_4 Load	lbs/day	216
TSS	mg/l	3
TDS	mg/l	34

Groe Run, also referred to as Panther Hollow. HUC 02050201001788.



This historically clean water stream was dry during drought conditions in July 2020. It should be sampled when the opportunity arises.

Saw Dust Hollow. HUC 02050201000607.

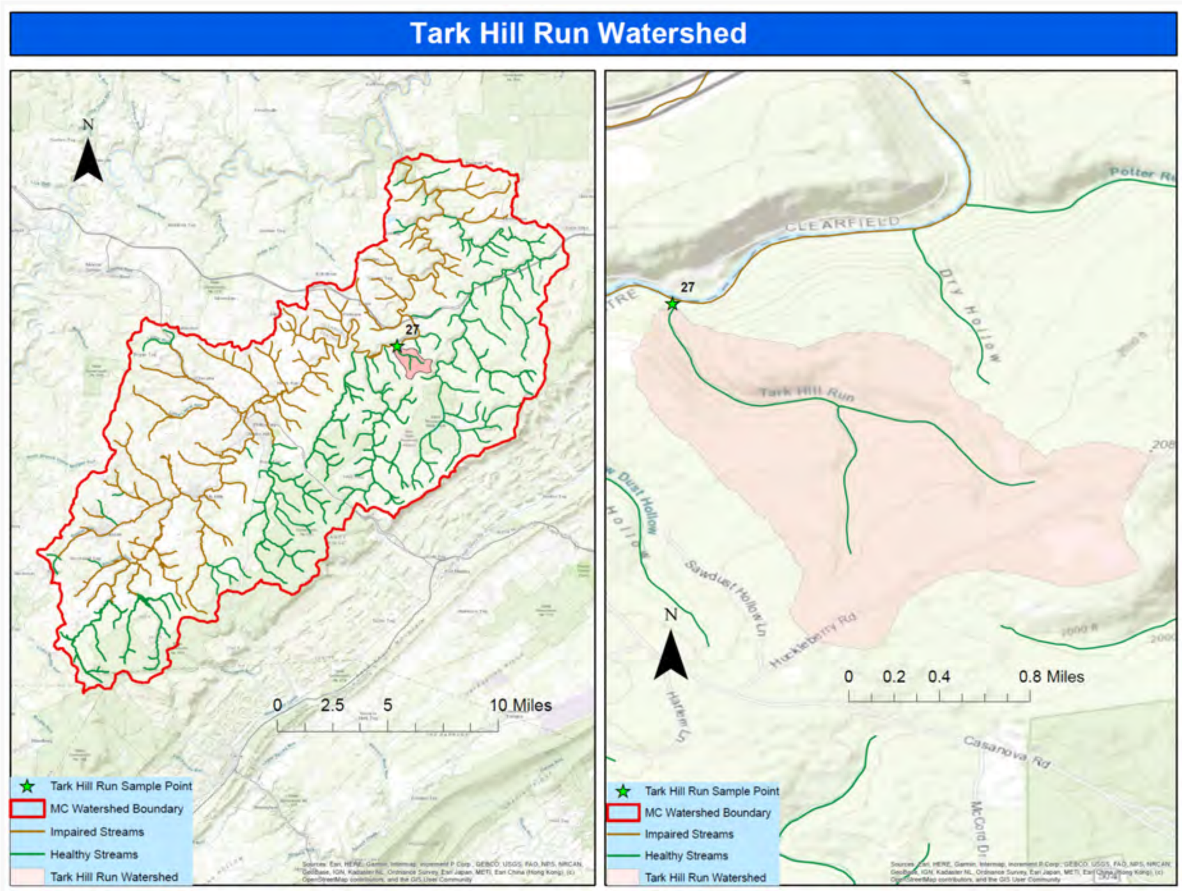


This stream flows from Moshannon State Forest, and it had good water chemistry but low flow during drought conditions in July 2020. It's Temperature was 17.2 C when the flow was only 18 gpm. This stream historically has had a pH measured in the 5's and measured 5.7 at the most recent sampling. It appears to be naturally moderately acidic. It may host fish during periods with higher flow.

ID	Unit	28
Station Name		Sawdust Hollow
Flow	CFS	0.045
Lat		40.9499
Long		-78.1073
Area	Mi^2	0.89
Area	%	0.32
Field Temp	°C	17.20
Field DO	mg/l	8.90
Field Cond	uS/cm	
Field pH	SU	5.74
Field Turb	NTU	0.92
Lab pH	SU	5.7
Lab Cond	uS/cm	37

ID	Unit	28
Alk	mg/l	2
Acid	mg/l	11
Acid Load	lbs/day	3
Fe	mg/l	0.05
Fe Load	lbs/day	0
Mn	mg/l	0.02
Mn Load	lbs/day	0
Al	mg/l	0.05
Al Load	lbs/day	0
SO_4	mg/l	7
SO_4 Load	lbs/day	2
TSS	mg/l	2
TDS	mg/l	26

Tark Hill Run. HUC 02050201001788. COMID 61830813.

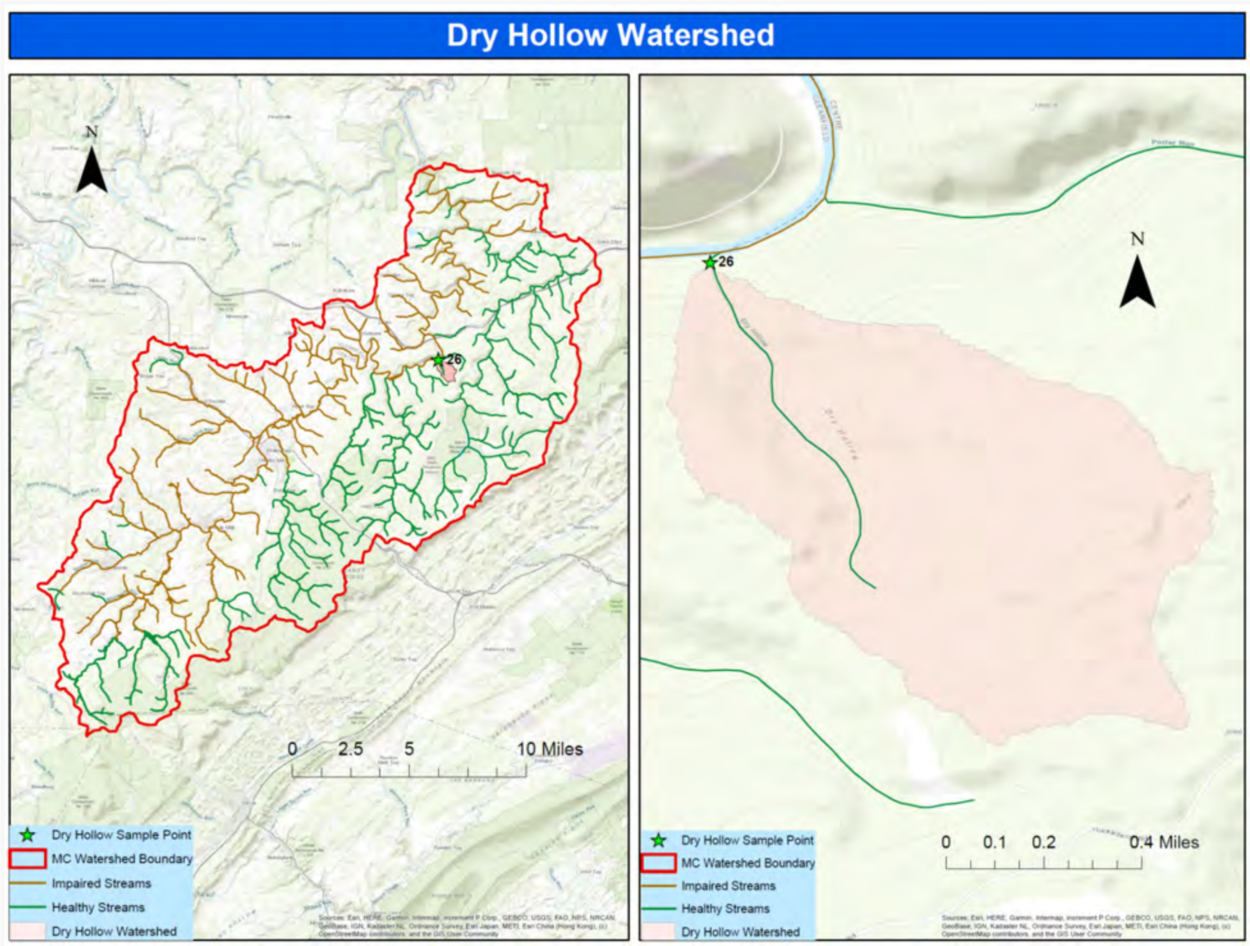


Tark Hill Run is a clean water stream with a pH of 5.9. Stream flow was measured at 54 gpm in drought conditions in July 2020. The stream was found to have a desirable coldwater temperature of 16.1 C in hot weather. This stream should be investigated to determine whether it hosts a wild trout population.

ID	Unit	27
Station Name		Tark Hill Run
Flow	CFS	0.123
Lat		40.9503
Long		-78.0967
Area	Mi^2	1.40
Area	%	0.51
Field Temp	°C	16.10
Field DO	mg/l	9.24
Field Cond	uS/cm	
Field pH	SU	5.15
Field Turb	NTU	0.70
Lab pH	SU	5.9
Lab Cond	uS/cm	30

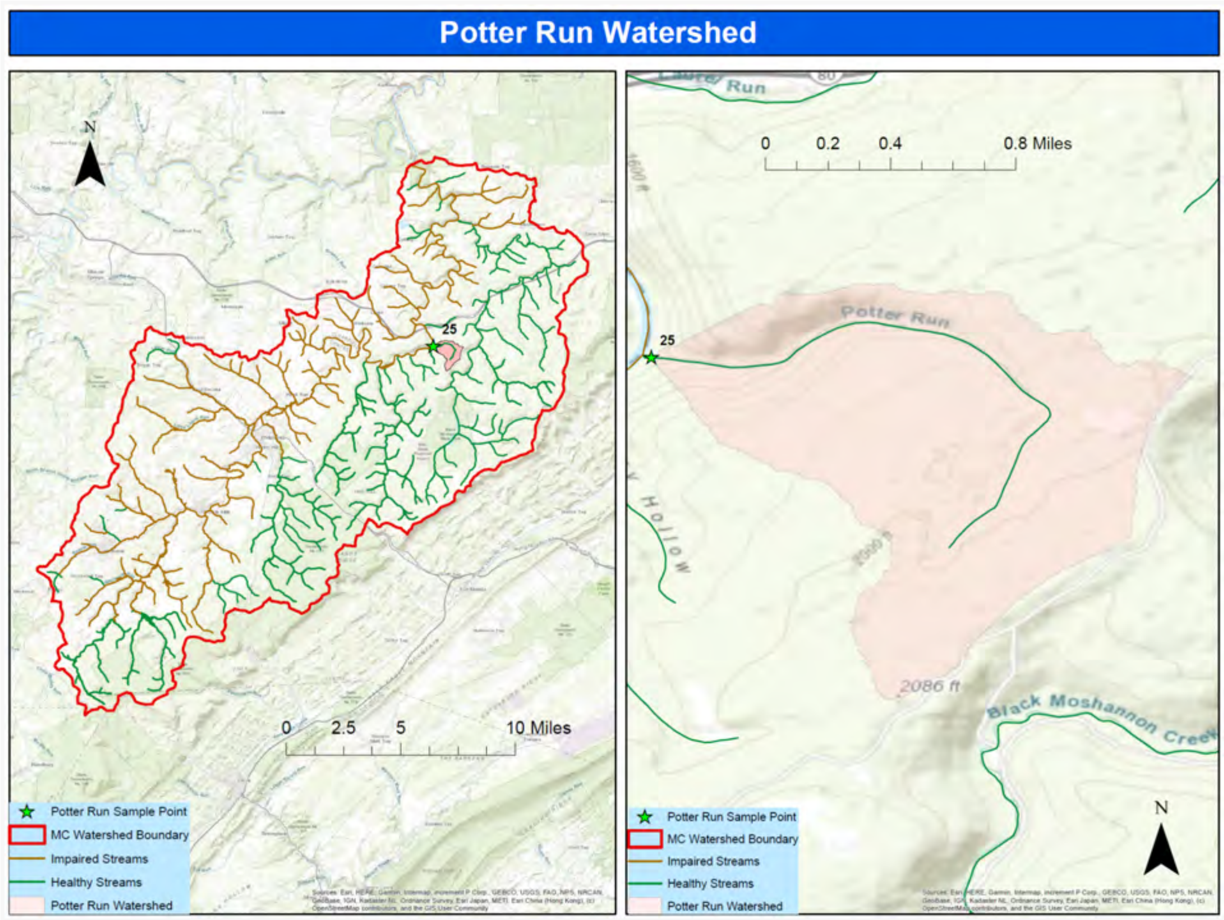
ID	Unit	27
Alk	mg/l	2
Acid	mg/l	8
Acid Load	lbs/day	5
Fe	mg/l	0.05
Fe Load	lbs/day	0
Mn	mg/l	0.02
Mn Load	lbs/day	0
Al	mg/l	0.05
Al Load	lbs/day	0
SO_4	mg/l	7
SO_4 Load	lbs/day	5
TSS	mg/l	2
TDS	mg/l	24

Dry Hollow. HUC REACHCODE 02050201001757.



During water sampling in July 2020, this stream was found to be dry. Given that the name of this small watershed is Dry Hollow, it is likely that it is frequently dry.

Potter Run. HUC 02050201000609. COMID 61830691.

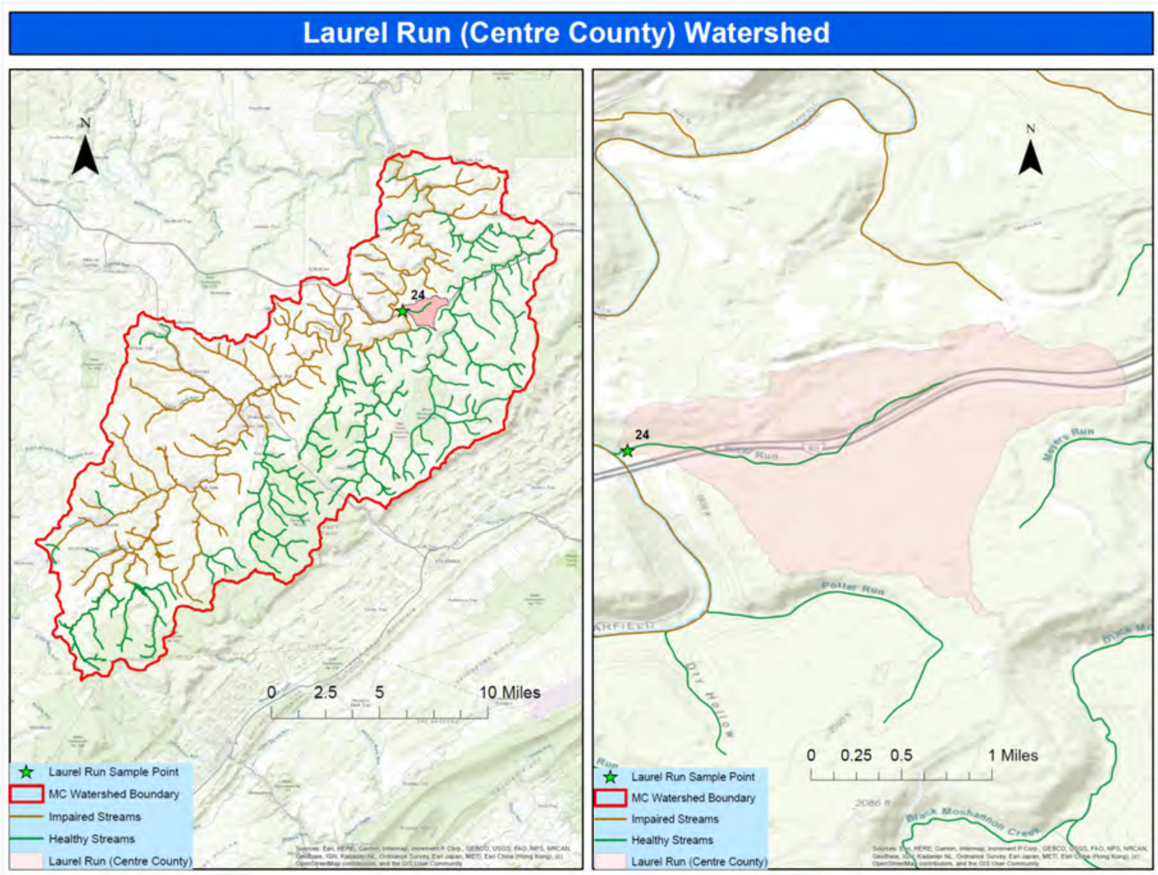


Potter Run is a clean water stream with an apparently naturally low pH of 5.5. Stream water flow was measured at 80 gpm, and the water temperature was a very trout friendly 16.4 C during drought conditions in July 2020. This stream should be investigated to see whether it has a resident wild trout population.

ID	Unit	25
Station Name		Potter Run
Flow	CFS	0.178
Lat		40.9566
Long		-78.0776
Area	Mi^2	0.87
Area	%	0.32
Field Temp	°C	16.36
Field DO	mg/l	9.20
Field Cond	uS/cm	
Field pH	SU	4.30
Field Turb	NTU	0.40
Lab pH	SU	5.5
Lab Cond	uS/cm	33

ID	Unit	25
Alk	mg/l	2
Acid	mg/l	11
Acid Load	lbs/day	11
Fe	mg/l	0.05
Fe Load	lbs/day	0
Mn	mg/l	0.03
Mn Load	lbs/day	0
Al	mg/l	0.09
Al Load	lbs/day	0
SO_4	mg/l	8
SO_4 Load	lbs/day	8
TSS	mg/l	2
TDS	mg/l	22

Laurel Run (Centre County). HUC 02050201000610.

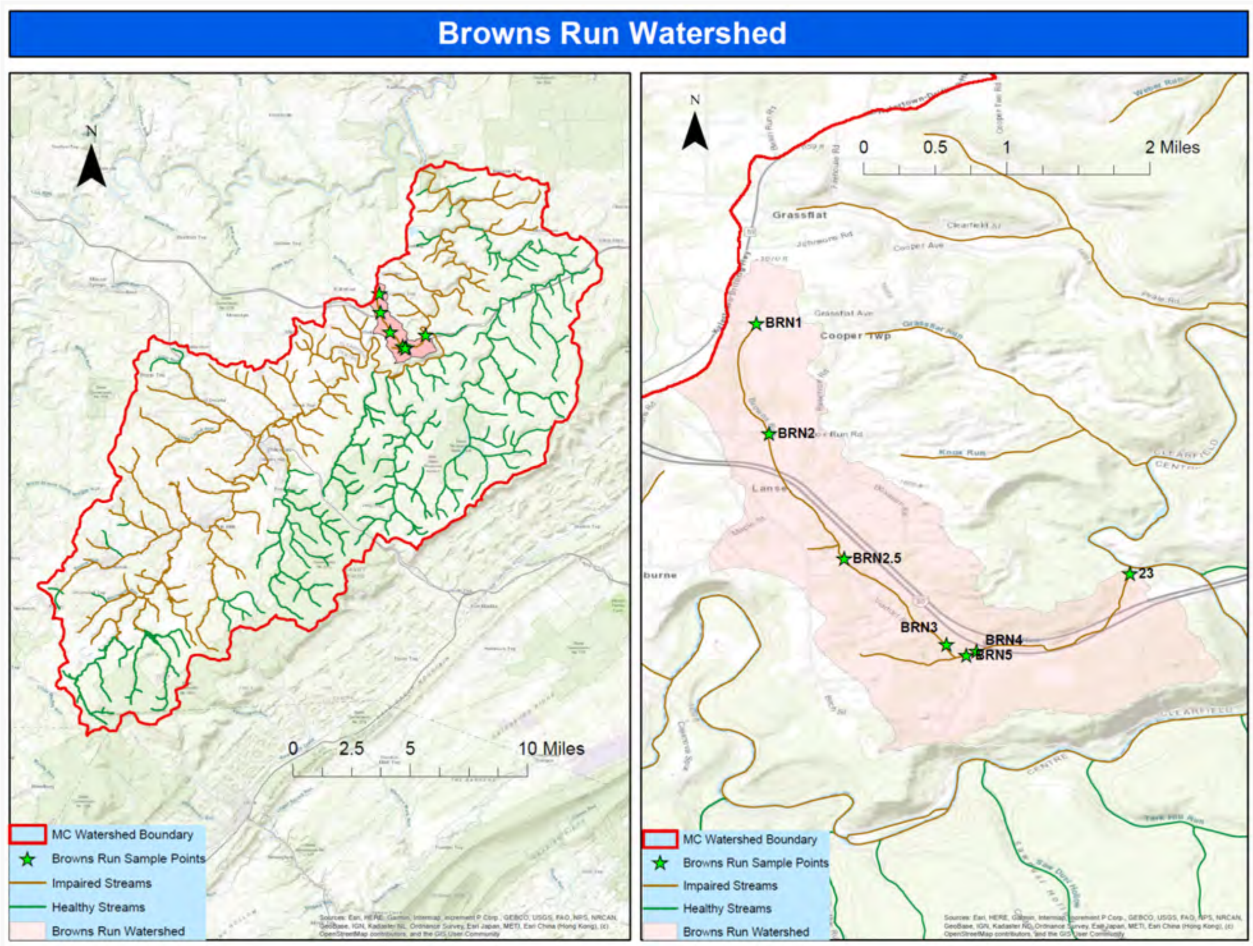


The watershed's second tributary named Laurel Run has a good pH and low metals. It flows along and crosses Interstate 80. Even with this flow path with a lack of tree cover it had a measured water temperature of 19.3 C on a hot day in July. This stream may be vulnerable to road salt contamination during snow removal periods on I-80. This stream should be investigated to determine whether it hosts a wild trout population.

ID	Unit	24
Station Name		Laurel Run
Flow	CFS	0.223
Lat		40.9696
Long		-78.0844
Area	Mi^2	1.73
Area	%	0.63
Field Temp	°C	19.30
Field DO	mg/l	8.51
Field Cond	uS/cm	
Field pH	SU	7.36
Field Turb	NTU	0.40
Lab pH	SU	6.5
Lab Cond	uS/cm	319

ID	Unit	24
Alk	mg/l	14
Acid	mg/l	1
Acid Load	lbs/day	1
Fe	mg/l	0.05
Fe Load	lbs/day	0
Mn	mg/l	0.02
Mn Load	lbs/day	0
Al	mg/l	0.05
Al Load	lbs/day	0
SO_4	mg/l	30
SO_4 Load	lbs/day	36
TSS	mg/l	2
TDS	mg/l	164

Browns Run. HUC 02050201000531.

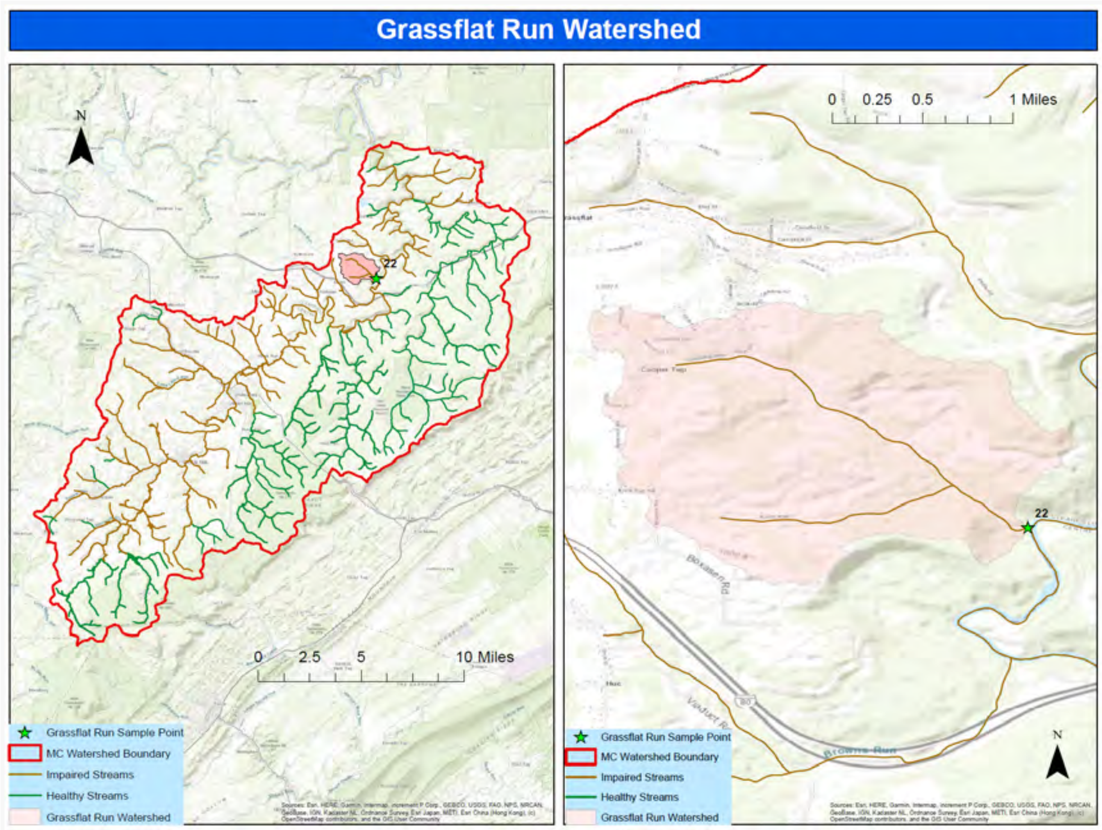


According to landowners, this stream has some fish in its headwaters area, at least within stocked ponds along its flow path. The headwaters area is mainly threatened by the lack of a stream buffer and shade in places north of I-80. It does have some mining impacts earlier, but deteriorates markedly in the stretch between Buck Road (aka Pale Moon Drive) and the first crossing of Viaduct Road. In this 0.9 mile stretch, the lab pH drops from 7.3 to 3.8. Each measurement point after this deterioration shows a gradual improvement of the stream. Browns Run could be fish habitat if the source of the AMD impairments that start downstream of Buck Road is identified and treated. This stream has a long association with I-80 and may have impacts from road salt when snow removal activity is frequent. A southern tributary of Browns Run remains to be sampled so that its impact to Browns Run is better understood.

ID	Unit	23	23	BR1	BR2	BR2.5	BR3	BR5	BR4
Station Name		Browns Run	Browns Run	BR Headwaters	BR at Knox Run Road	BR at Pale Moon Dr	BR at Viaduct Rd	BR Trib	BR at I-80
Date		7/24/2020	4/7/2021	4/7/2021	4/7/2021	4/7/2021	4/7/2021	4/7/2021	4/7/2021
Flow	CFS	0.370	0.370	0.037	0.209	0.058	0.212	0.085	0.771
Lat		40.9694	40.9694	40.99467	40.98349	40.97091	40.9622	40.9611	40.96157
Long		-78.0926	-78.0926	-78.13037	-78.12912	-78.12154	-78.11118	-78.10914	-78.10812
Area	Mi^2	3.18	3.18						
Area	%	1.16	1.16						
Field Temp	°C	17.30	11.39	10.20	13.56	10.78	12.67	10.28	11.89
Field DO	mg/l	8.10							
Field Cond	uS/cm	606.00	309.00	119.40	363.00	401.00	994.00	42.30	409.00
Field pH	SU	4.05	4.32	6.43	6.05	6.72	3.28	6.15	3.82
Field Turb	NTU								
Lab pH	SU	4.4	4.9	7.2	6.7	7.3	3.8	6.4	4.2
Lab Cond	uS/cm	636	282	99.8	332	369	939	31.7	384
Alk	mg/l	0	<20	<20	<20	<20	<20	<20	<20
Acid	mg/l	23	25.67	-0.92	12.25	14.88	77.3	10.79	28.78
Acid Load	lbs/day	46	51	0	14	5	88	5	120
Fe	mg/l	0.06	0.39	<0.20	<0.20	<0.20	20.00	<0.2	3.95
Fe Load	lbs/day	0	1	0	0	0	23	0	16
Mn	mg/l	2.92	0.80	0.05	1.91	<0.02	4.94	0.03	1.65
Mn Load	lbs/day	6	2	0	2	0	6	0	7
Al	mg/l	1.26	0.47	<20	0.40	<0.1	2.35	0.10	1.04
Al Load	lbs/day	3	1	0	0	0	3	0	4
SO_4	mg/l	185	58.7	24.2	115	93.8	323	9.1	101
SO_4 Load	lbs/day	369	117	5	130	29	369	4	420
TSS	mg/l	2	2.4	<1.6	3.6	<1.6	3.6	<1.6	2.4
TDS	mg/l	364	98	<20	248	236	500	<20.0	174

Browns Run Passes Under an Abandoned Railroad Grade Near Moshannon Creek

Grassflat Run. HUC 02050201000530 and points upstream.

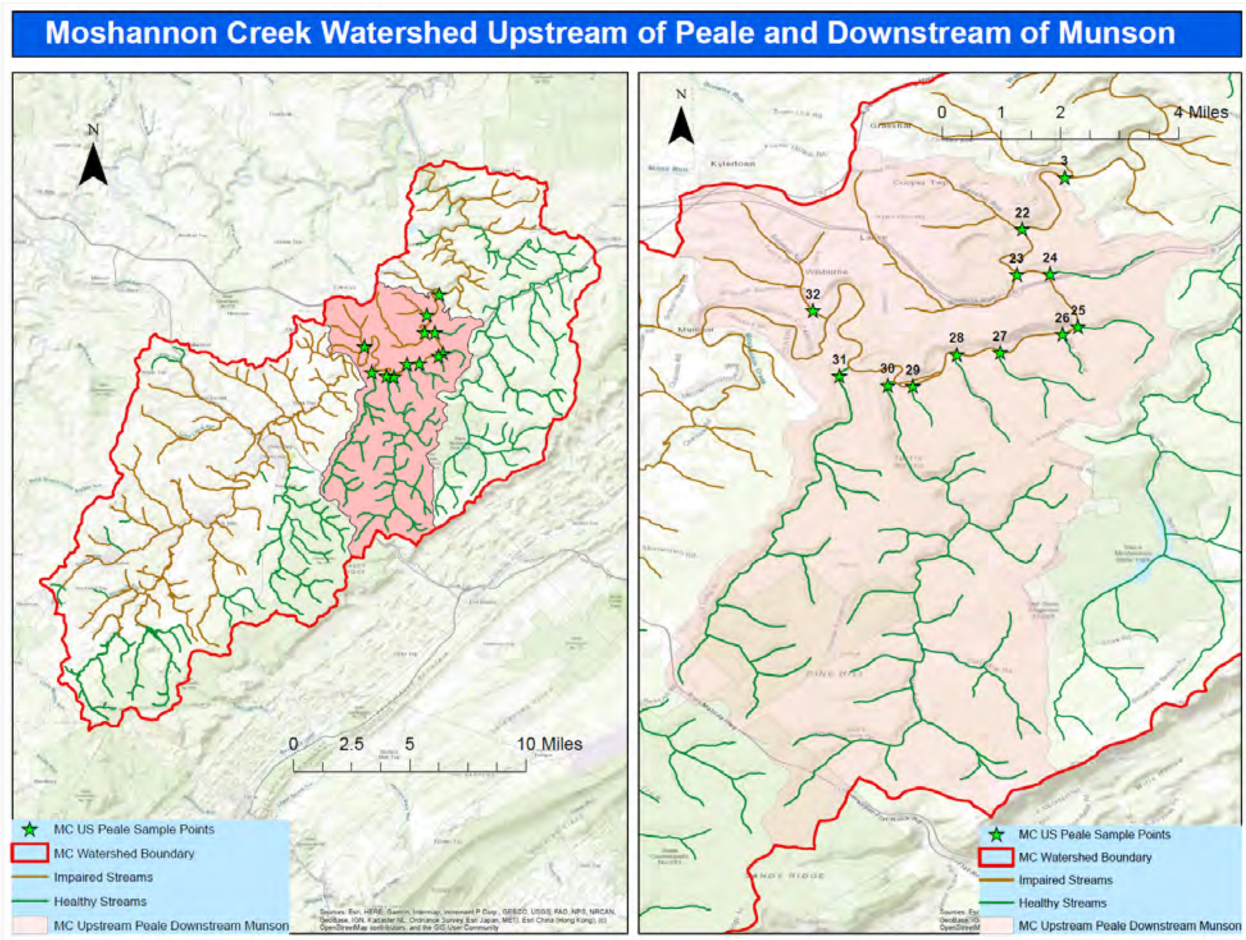


This stream, and its main tributary, Knox Run, have historically been found to be severely impaired by AMD. That this is still true was confirmed by the July 2020 water sampling. Interestingly, its flow was measured at a higher value than the flows measured in historic data. This watershed needs deeper investigation. It is planned to be studied by Penn State students working under Dr. Bill Burgos in the Spring of 2022. Grassflat Run should be one of the first streams to be tackled for improvement after the large discharges north of Philipsburg.

ID	Unit	22
Station Name		Grassflat Run
Flow	CFS	1.008
Lat		40.9805
Long		-78.0912
Area	Mi^2	2.12
Area	%	0.77
Field Temp	°C	17.90
Field DO	mg/l	8.88
Field Cond	uS/cm	945.00
Field pH	SU	2.87
Field Turb	NTU	0.00
Lab pH	SU	3.1
Lab Cond	uS/cm	1020

ID	Unit	22
Alk	mg/l	0
Acid	mg/l	103
Acid Load	lbs/day	560
Fe	mg/l	11.55
Fe Load	lbs/day	63
Mn	mg/l	3.52
Mn Load	lbs/day	19
Al	mg/l	5.03
Al Load	lbs/day	27
SO_4	mg/l	390
SO_4 Load	lbs/day	2121
TSS	mg/l	2
TDS	mg/l	602

Moshannon Creek upstream of Moravian Run at Peale and Downstream of Casanova Road at Munson. HUC 02050201000141 and points upstream to Casanova Road.

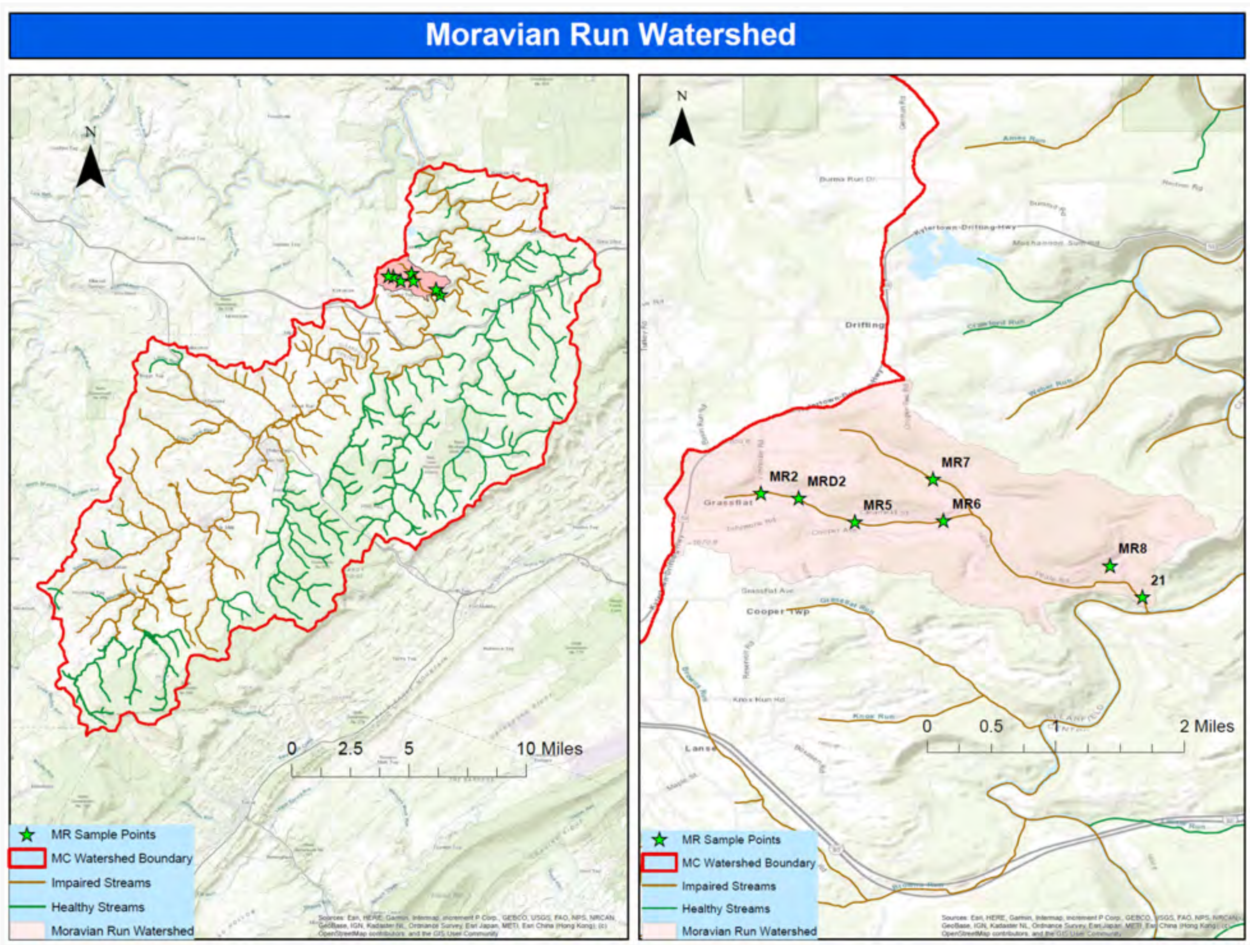


This stretch of Moshannon Creek contains the worst AMD impaired stream in the Moshannon Creek watershed (and among the worst in the Commonwealth of Pennsylvania), Sulfur Run. It also has multiple tributaries that are clean coldwater streams known to have natural trout populations, and others suspected of having them. Looking at the comparison between streams in this section in the data below, the significance of Sulfur Run is obvious.

ID	Unit	3	22	23	24	25	26
Station Name		Upstream of Moravian Run	Grassflat Run	Browns Run	Laurel Run	Potter Run	Dry Hollow
Flow	**CFS**	65.650	1.008	0.370	0.223	0.178	0.000
Lat		40.9932	40.9805	40.9694	40.9696	40.9566	40.9548
Long		-78.0809	-78.0912	-78.0926	-78.0844	-78.0776	-78.0814
Area	**Mi^2**	195.00	2.12	3.18	1.73	0.87	0.51
Area	**%**		0.77	1.16	0.63	0.32	0.19
Field Temp	**°C**	23.30	17.90	17.30	19.30	16.36	
Field DO	**mg/l**		8.88	8.10	8.51	9.20	
Field Cond	**uS/cm**	744.00	945.00	606.00			
Field pH	**SU**	3.70	2.87	4.05	7.36	4.30	
Field Turb	**NTU**	0.00	0.00		0.40	0.40	
Lab pH	**SU**	4.0	3.1	4.4	6.5	5.5	
Lab Cond	**uS/cm**	781	1020	636	319	33	
Alk	**mg/l**	0	0	0	14	2	
Acid	**mg/l**	34	103	23	1	11	
Acid Load	**lbs/day**	12041	560	46	1	11	
Fe	**mg/l**	0.74	11.55	0.06	0.05	0.05	
Fe Load	**lbs/day**	262	63	0	0	0	
Mn	**mg/l**	2.24	3.52	2.92	0.02	0.03	
Mn Load	**lbs/day**	793	19	6	0	0	
Al	**mg/l**	1.87	5.03	1.26	0.05	0.09	
Al Load	**lbs/day**	662	27	3	0	0	
SO_4	**mg/l**	364	390	185	30	8	
SO_4 Load	**lbs/day**	128912	2121	369	36	8	
TSS	**mg/l**	2	2	2	2	2	
TDS	**mg/l**	531	602	364	164	22	

ID	Unit	27	28	29	30	31	32
Station Name		Tark Hill Run	Saw Dust Hollow	Panther Hollow	Sixmile Run	Black Bear Run	Sulphur Run
Flow	CFS	0.123	0.045	0.000	6.675	2.754	7.601
Lat		40.9503	40.9499	40.9421	40.9423	40.9446	40.9606
Long		-78.0967	-78.1073	-78.1180	-78.1242	-78.1359	-78.1425
Area	Mi^2	1.40	0.89	0.35	17.50	8.74	3.46
Area	%	0.51	0.32	0.13	6.39	3.19	1.26
Field Temp	°C	16.10	17.20		18.90	18.40	12.30
Field DO	mg/l	9.24	8.90		8.86	8.83	10.47
Field Cond	uS/cm					51.10	1313.00
Field pH	SU	5.15	5.74		6.49	6.39	3.01
Field Turb	NTU	0.70	0.92		1.87	0.60	
Lab pH	SU	5.9	5.7		6.5	6.3	3.2
Lab Cond	uS/cm	30	37		63	55	1310
Alk	mg/l	2	2		13	6	0
Acid	mg/l	8	11		2	5	148
Acid Load	lbs/day	5	3		72	74	6069
Fe	mg/l	0.05	0.05		0.11	0.07	11.37
Fe Load	lbs/day	0	0		4	1	466
Mn	mg/l	0.02	0.02		0.02	0.02	2.30
Mn Load	lbs/day	0	0		1	0	94
Al	mg/l	0.05	0.05		0.05	0.05	12.19
Al Load	lbs/day	0	0		2	1	500
SO_4	mg/l	7	7		6	6	582
SO_4 Load	lbs/day	5	2		216	89	23864
TSS	mg/l	2	2		3	3	7
TDS	mg/l	24	26		34	37	915

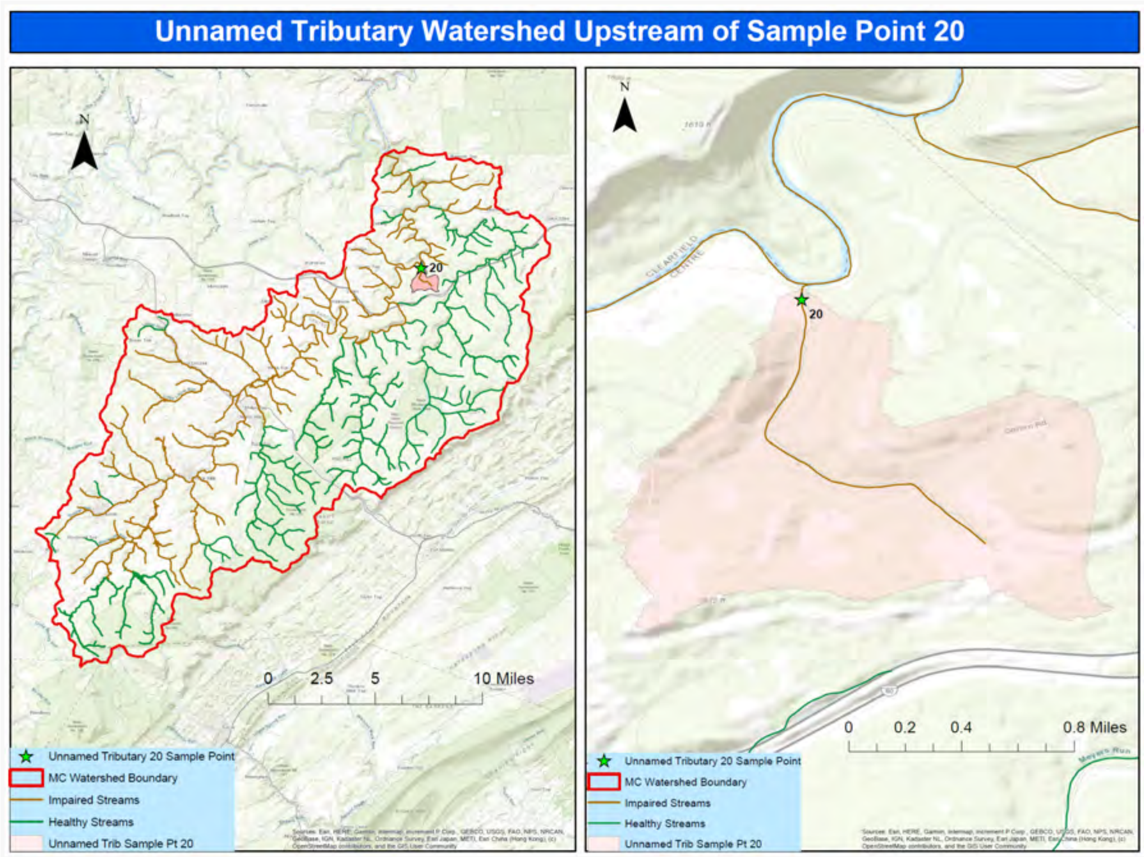
Moravian Run and tributaries. HUC 02050201000527 and points upstream.



As improvements are made moving north through the Moshannon Creek watershed, the combined impact of Browns Run, Grassflat Run, and Moravian Run will rise in importance. These three streams would significantly impact an unimpaired or improving stream, which Moshannon Creek will be, particularly after the large discharges between Philipsburg and Winburne are addressed. An interesting challenge to improving the Moravian Run watershed is that when it flows through the community of Grassflat, there are multiple piped AMD discharges that empty into the stream in a semi-rural residential area. The largest of these discharges was sampled as part of this project, and it clearly is mine drainage.

ID	Unit	21	21	MR8	MR7	MR6	MR5	MRD2	MR2
Station Name		Moravian Run	Moravian Run	Small Trib	Northern Trib	South Trib at Clearfield	South Trib at Dobrytown Rd	Double Pipe Discharges	South Trib Headwaters
Sample Date		7/23/2020	4/9/2021	4/9/2021	4/9/2021	4/9/2021	4/9/2021	4/9/2021	4/9/2021
Flow	**CFS**	1.031	2.970	0.467	*0.29566*	0.891	0.913	0.184	0.576
Lat		40.9943	40.9943	40.998522	41.00826	41.0036	41.00347	41.00615	41.006686
Long		-78.0795	-78.0795	-78.082996	-78.1029	-78.1017	-78.1117	-78.118	-78.12225
Area	**Mi^2**	3.25	3.25						
Area	**%**	1.19	1.19						
Field Temp	**°C**	18.80	11.20	11.70	11.30	11.30	11.50	11.10	12.20
Field DO	**mg/l**								
Field Cond	**uS/cm**	670.00	720.00	550.00	932.00	667.00	596.00	811.00	784.00
Field pH	**SU**	3.25	3.80	3.51	3.22	3.47	3.59	3.05	3.31
Field Turb	**NTU**								
Lab pH	**SU**	3.4	3.6	3.5	3.3	3.6	3.7	3.2	3.4
Lab Cond	**uS/cm**	725	594	456	775	539	504	645	630
Alk	**mg/l**	0	<20	<20	<20	<20	<20	<20	<20
Acid	**mg/l**	59	79.61	61.42	109.5	73.31	60.87	109.6	90.5
Acid Load	**lbs/day**	328	1275	155	175	352	300	109	281
Fe	**mg/l**	2.49	2.97	1.79	2.40	2.69	2.40	2.16	2.65
Fe Load	**lbs/day**	14	48	5	4	13	12	2	8
Mn	**mg/l**	3.88	3.00	2.07	3.72	1.52	0.79	0.45	0.68
Mn Load	**lbs/day**	22	48	5	6	7	4	0	2
Al	**mg/l**	3.36	5.58	4.37	10.60	6.00	5.14	6.98	5.97
Al Load	**lbs/day**	19	89	11	17	29	25	7	19
SO_4	**mg/l**	285	262	134	285	148	125	160	198
SO_4 Load	**lbs/day**	1585	4198	337	455	711	616	159	616
TSS	**mg/l**	2	<1.6	2	1.2	<0.8	<0.8	<0.8	1.6
TDS	**mg/l**	438	300	182	336	246	250	230	228

Unnamed tributary upstream of sample point 20. HUC 02050201001714.

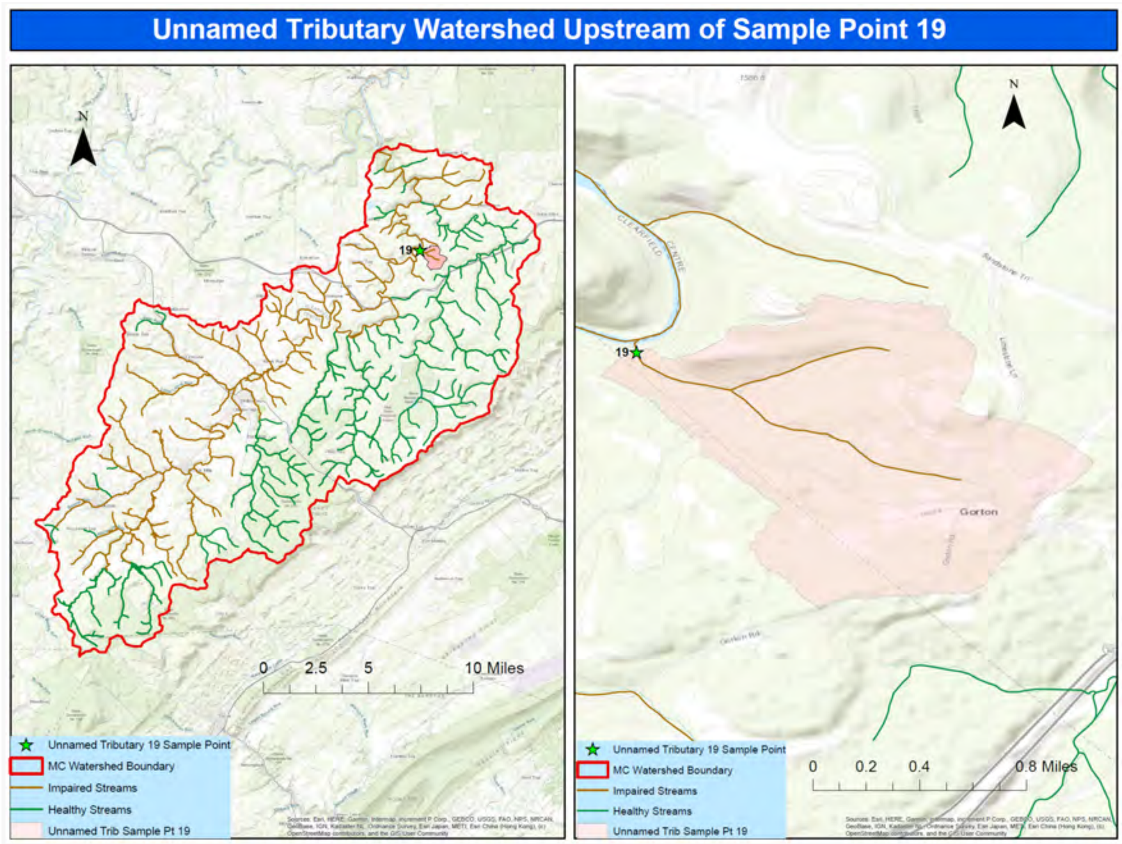


This small stream was found to have a flow above 100 gpm with a temperature of 17.6 C during drought conditions in July 2020. It has a pH around 4.0 and elevated aluminum. When improvements upstream are made and this stream is no longer isolated, it has potential to become coldwater fish habitat with the right attention.

ID	Unit	20
Station Name		Unnamed Trib
Flow	CFS	0.250
Lat		40.9942
Long		-78.0638
Area	Mi^2	1.00
Area	%	0.36
Field Temp	°C	17.60
Field DO	mg/l	8.84
Field Cond	uS/cm	204.50
Field pH	SU	3.72
Field Turb	NTU	0.00
Lab pH	SU	4.0
Lab Cond	uS/cm	227

ID	Unit	20
Alk	mg/l	0
Acid	mg/l	24
Acid Load	lbs/day	32
Fe	mg/l	0.12
Fe Load	lbs/day	0
Mn	mg/l	1.35
Mn Load	lbs/day	2
Al	mg/l	1.21
Al Load	lbs/day	2
SO_4	mg/l	76
SO_4 Load	lbs/day	102
TSS	mg/l	2
TDS	mg/l	134

Unnamed tributary with sample point 19 referred to as UNT04 on SRBC Website. HUC 02050201000611 and points upstream.

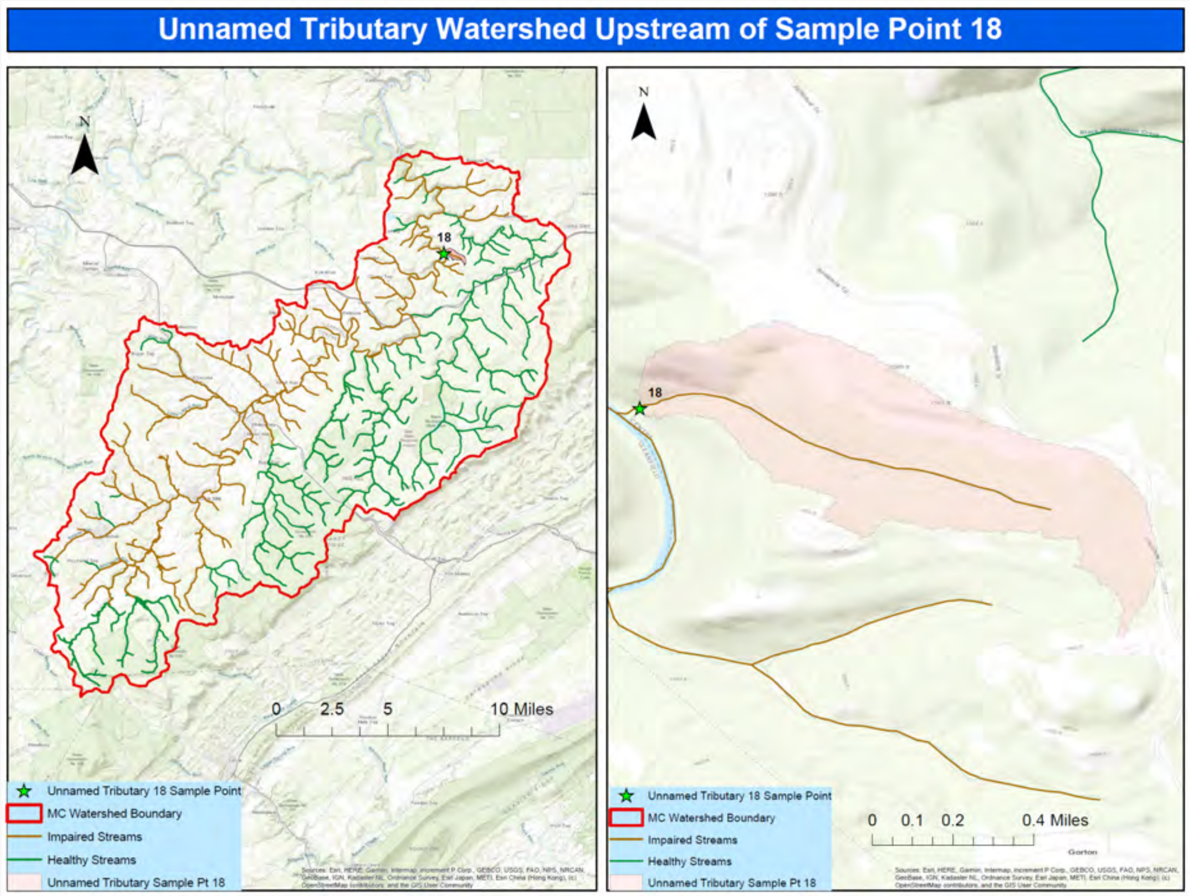


This small stream was found to have a flow of 67 gpm and a temperature of 19.0 C. Historic sampling does not have measured flows much higher, and it was found to be dry at times in 2005 and 2006. This stream has a pH below 4 and elevated aluminum. With cleaner water it could be fish habitat during periods of higher flow.

ID	Unit	19
Station Name		Unnamed Trib
Flow	CFS	0.200
Lat		41.0031
Long		-78.0579
Area	Mi^2	0.94
Area	%	0.34
Field Temp	°C	19.00
Field DO	mg/l	8.19
Field Cond	uS/cm	281.00
Field pH	SU	3.64
Field Turb	NTU	0.00
Lab pH	SU	3.9
Lab Cond	uS/cm	314

ID	Unit	19
Alk	mg/l	0
Acid	mg/l	33
Acid Load	lbs/day	36
Fe	mg/l	0.23
Fe Load	lbs/day	0
Mn	mg/l	2.43
Mn Load	lbs/day	3
Al	mg/l	2.46
Al Load	lbs/day	3
SO_4	mg/l	112
SO_4 Load	lbs/day	121
TSS	mg/l	6
TDS	mg/l	174

Unnamed tributary with sample point 18 referred to as UNT03 on SRBC Website. HUC 02050201001671.

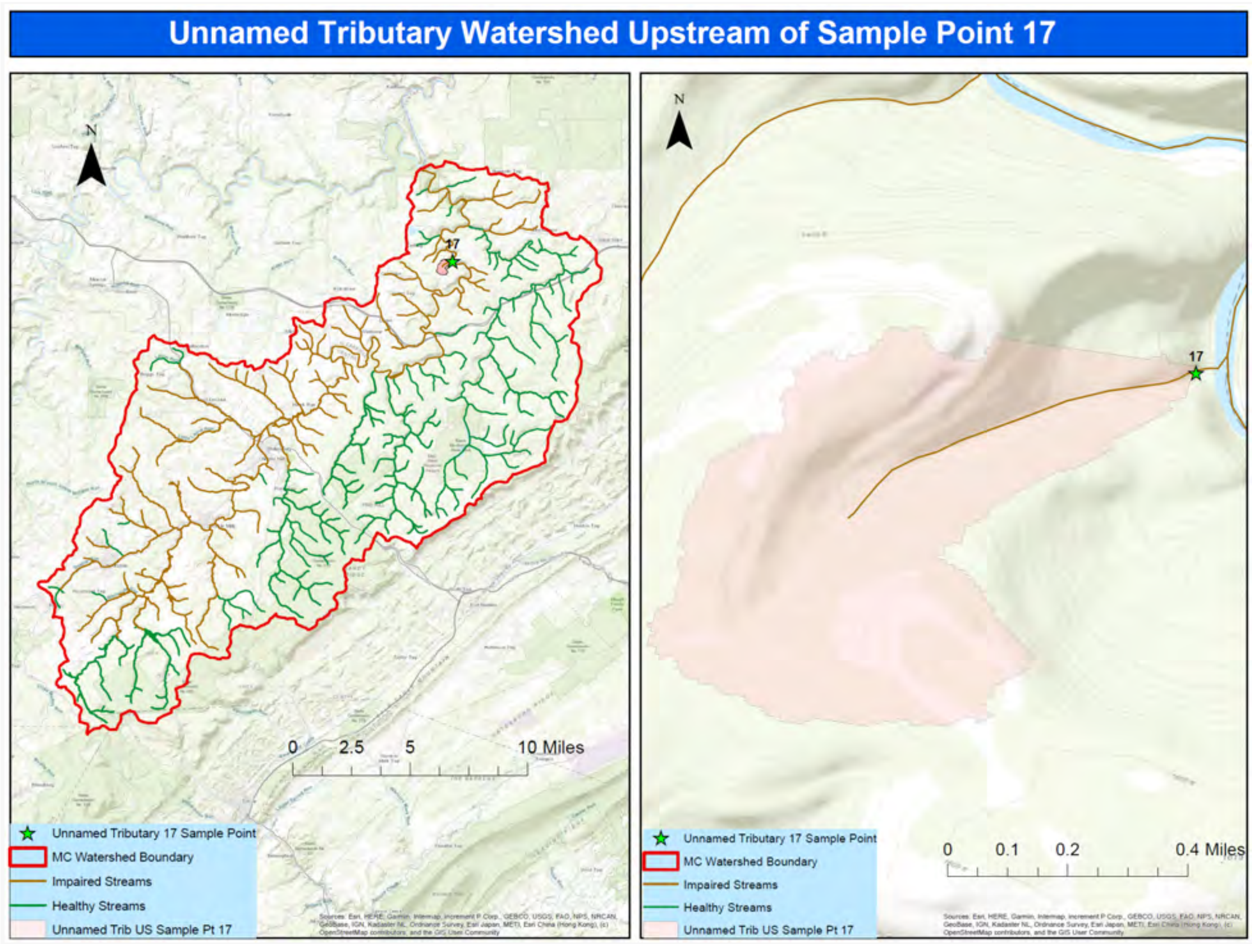


This is a small stream with low flow, low pH and elevated metals. The laboratory and field sampling data resemble a mine discharge more than a stream.

ID	Unit	18
Station Name		Unnamed Trib
Flow	CFS	0.020
Lat		41.0102
Long		-78.0568
Area	Mi^2	0.29
Area	%	0.11
Field Temp	°C	18.40
Field DO	mg/l	
Field Cond	uS/cm	903.00
Field pH	SU	2.97
Field Turb	NTU	0.00
Lab pH	SU	3.2
Lab Cond	uS/cm	953

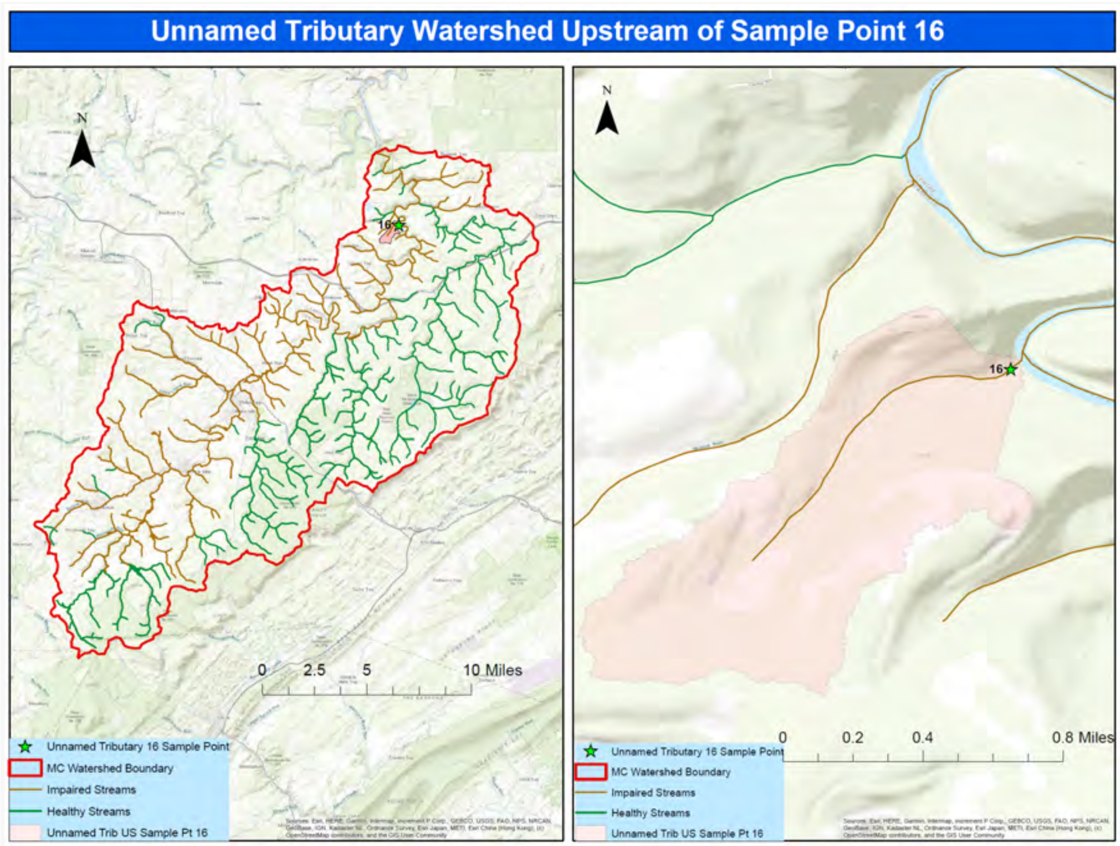
ID	Unit	18
Alk	mg/l	0
Acid	mg/l	74
Acid Load	lbs/day	8
Fe	mg/l	4.94
Fe Load	lbs/day	1
Mn	mg/l	7.34
Mn Load	lbs/day	1
Al	mg/l	2.00
Al Load	lbs/day	0
SO_4	mg/l	364
SO_4 Load	lbs/day	39
TSS	mg/l	2
TDS	mg/l	539

Unnamed tributary with sample point 17 referred to as UNT02 on SRBC Website. HUC 02050201001672.



This ephemeral stream was found to be dry during sampling done during July 2020. Historic sampling done in 2005 and 2006 had another occasion when it was dry. According to the historic data, when it had flow it had a pH around 4.5 and elevated aluminum.

Unnamed tributary with sample point 16 referred to as UNT01 on SRBC Website. HUC 02050201001669.

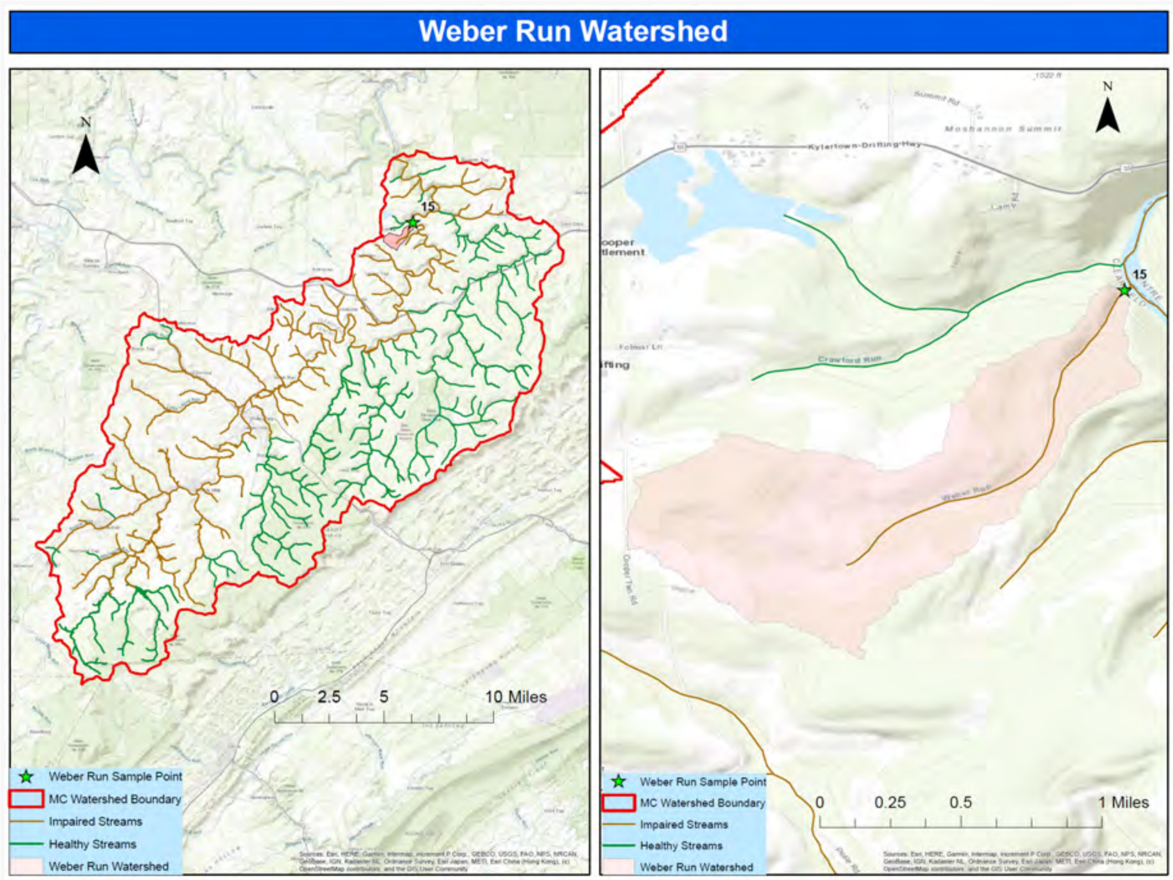


This stream was found to have a flow of 67 gpm, a pH of 3.4 and elevated manganese and aluminum. This flow measured in drought conditions in July 2020 matched the highest flow measured in historical flow measurements for this stream. This is another of the string of small impaired streams in this stretch of the Moshannon Creek watershed.

ID	Unit	16
Station Name		Unnamed Trib
Flow	CFS	0.150
Lat		41.0217
Long		-78.0761
Area	Mi^2	0.48
Area	%	0.18
Field Temp	°C	18.30
Field DO	mg/l	9.07
Field Cond	uS/cm	621.00
Field pH	SU	3.13
Field Turb	NTU	0.00
Lab pH	SU	3.4
Lab Cond	uS/cm	682

ID	Unit	16
Alk	mg/l	0
Acid	mg/l	60
Acid Load	lbs/day	49
Fe	mg/l	0.68
Fe Load	lbs/day	1
Mn	mg/l	3.45
Mn Load	lbs/day	3
Al	mg/l	3.99
Al Load	lbs/day	3
SO_4	mg/l	274
SO_4 Load	lbs/day	222
TSS	mg/l	2
TDS	mg/l	407

Weber Run. HUC 02050201000526.

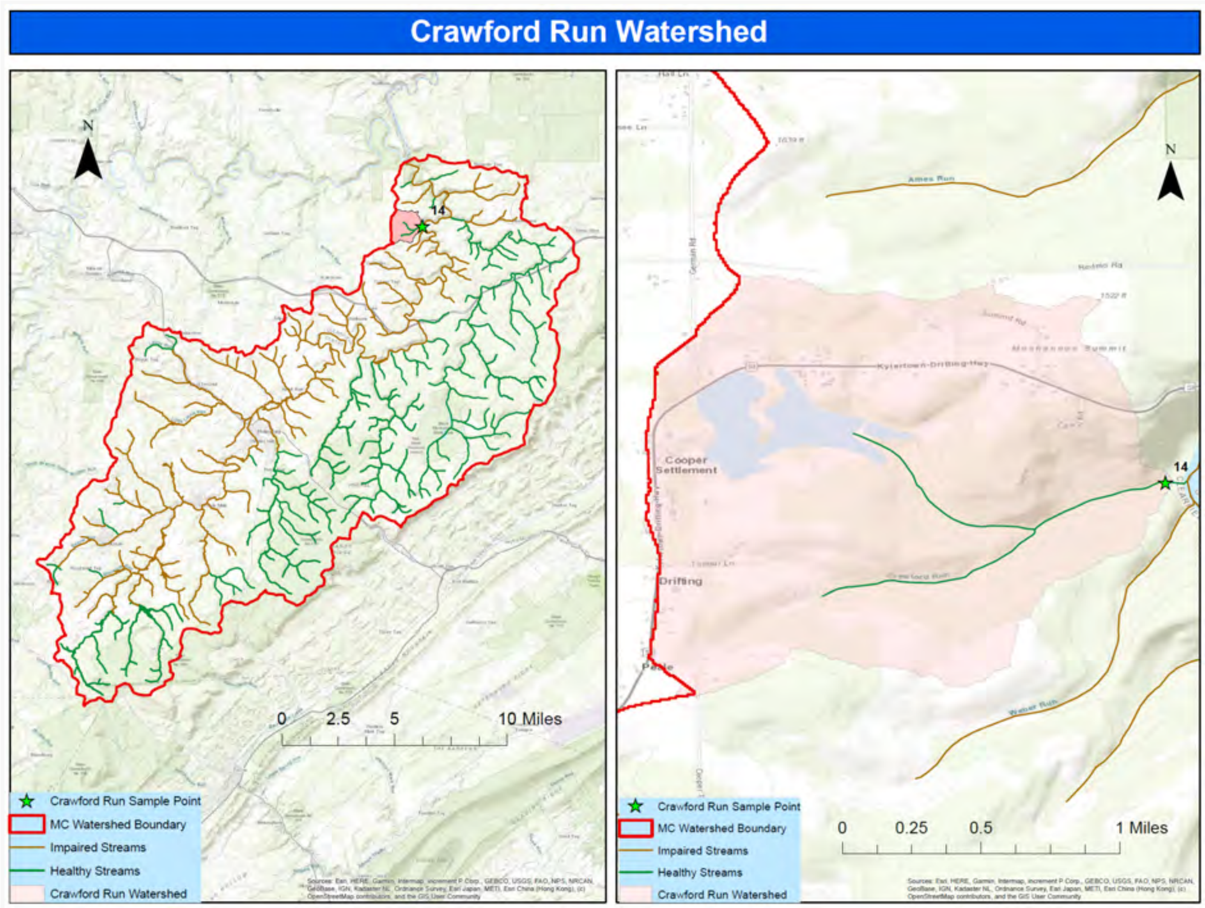


The flow measured in July 2020 of 112 gpm was higher than any flow measurement in historical data for this stream. This is yet another small stream with a low pH and high metals in this section of the Moshannon Creek watershed. The water quality is similar to a mine discharge.

ID	Unit	15
Station Name		Weber Run
Flow	CFS	0.250
Lat		41.0292
Long		-78.0804
Area	Mi^2	0.66
Area	%	0.24
Field Temp	°C	19.60
Field DO	mg/l	
Field Cond	uS/cm	1078.00
Field pH	SU	3.02
Field Turb	NTU	0.00
Lab pH	SU	3.3
Lab Cond	uS/cm	1100

ID	Unit	15
Alk	mg/l	0
Acid	mg/l	82
Acid Load	lbs/day	111
Fe	mg/l	1.08
Fe Load	lbs/day	1
Mn	mg/l	12.03
Mn Load	lbs/day	16
Al	mg/l	4.10
Al Load	lbs/day	6
SO_4	mg/l	509
SO_4 Load	lbs/day	686
TSS	mg/l	4
TDS	mg/l	777

Crawford Run. HUC 02050201000523.

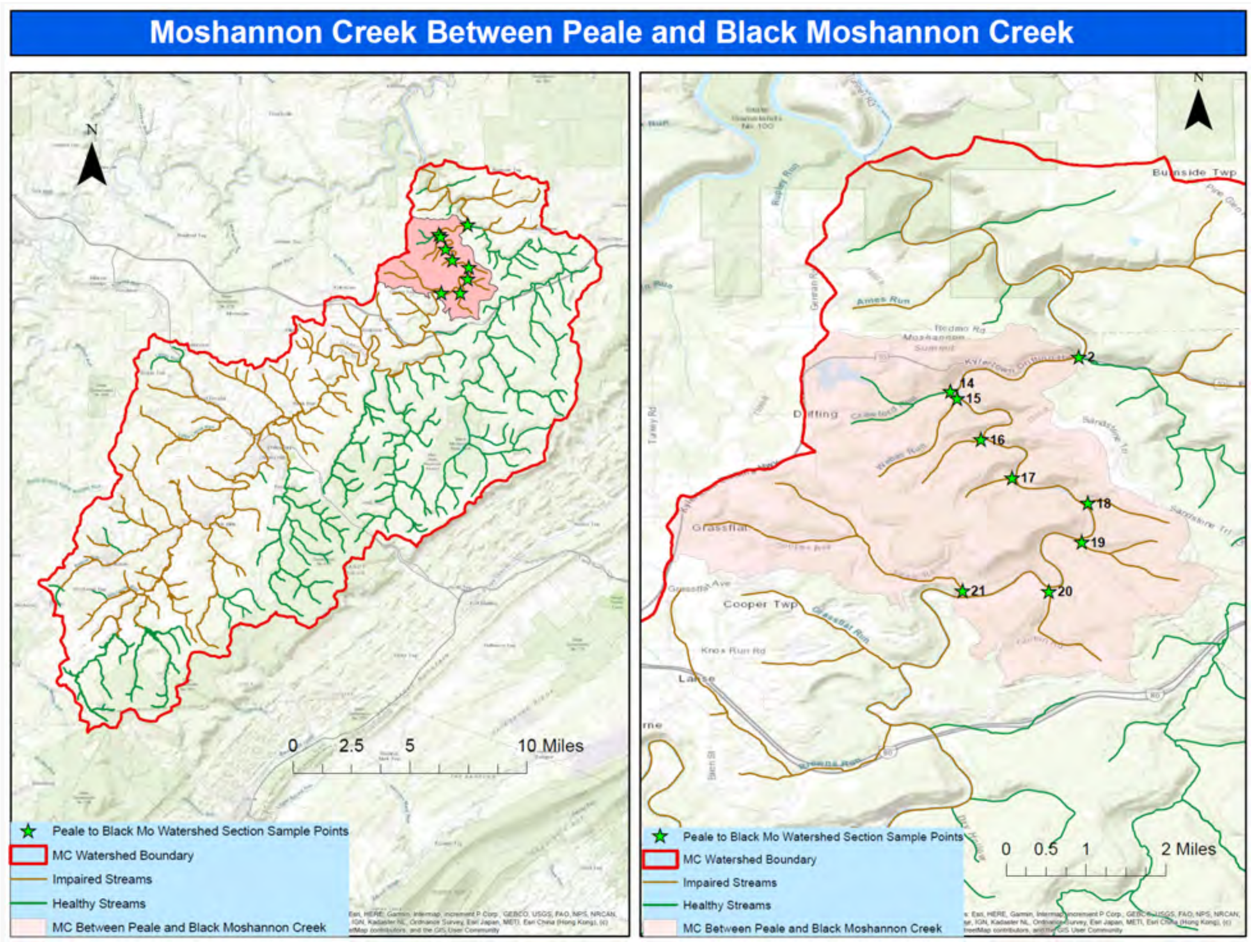


Crawford Run is a clean stream after a string of small streams impaired by mining impacts. It was measured to have a flow of 90 gpm and water temperature of 19 C in July 2020 in drought conditions. This stream should be examined to see if it hosts a wild population of fish. The northern tributary of Crawford Run contains a private fish hatchery in its headwaters area.

ID	Unit	14
Station Name		Crawford Run
Flow	CFS	0.200
Lat		41.0305
Long		-78.0816
Area	Mi^2	1.67
Area	%	0.61
Field Temp	°C	19.00
Field DO	mg/l	
Field Cond	uS/cm	158.40
Field pH	SU	6.00
Field Turb	NTU	0.00
Lab pH	SU	6.1
Lab Cond	uS/cm	182

ID	Unit	14
Alk	mg/l	3
Acid	mg/l	13
Acid Load	lbs/day	14
Fe	mg/l	0.05
Fe Load	lbs/day	0
Mn	mg/l	0.02
Mn Load	lbs/day	0
Al	mg/l	0.05
Al Load	lbs/day	0
SO_4	mg/l	48
SO_4 Load	lbs/day	52
TSS	mg/l	3
TDS	mg/l	94

Moshannon Creek Upstream of Black Moshannon Creek and Downstream of Peale. HUC 02050201000137 and points upstream to the bridge at Peale.

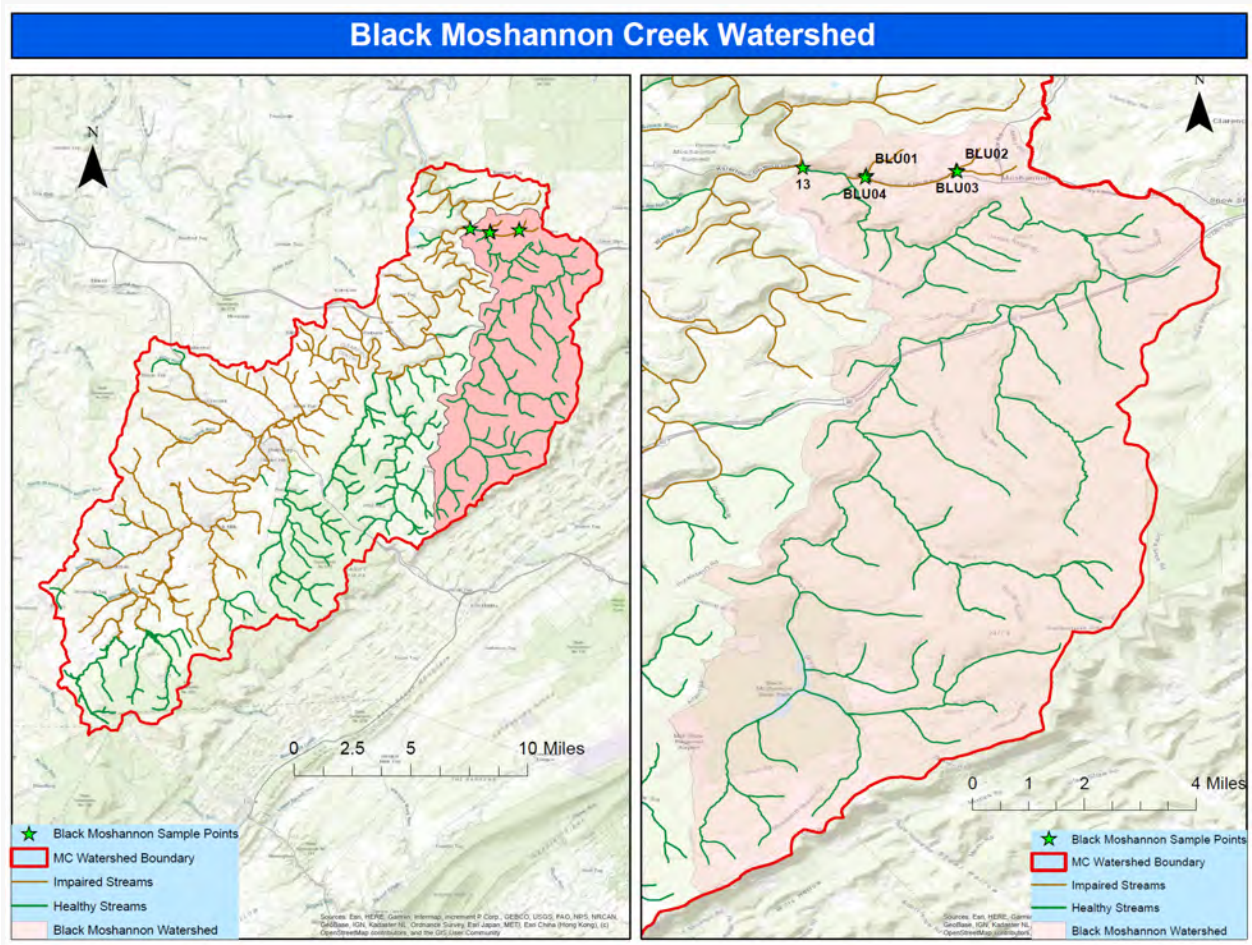


This stretch of Moshannon Creek flows through a canyon and is known for its rapids. It is the location for the Red Moshannon Downriver Race, a canoe and kayak race held annually on the last Saturday in March. The largest tributary that feeds into this section is Moravian Run. The others are much smaller. Almost all of the tributaries are impaired. Strip mine reclamation, some currently in progress, may improve the water quality of the tributaries in this section. Treating Moravian Run will be necessary to ensure recovery of this section of the main stem as watershed improvements work their way north. The smaller tributaries north of Moravian Run would make good trout streams if they had clean water, something most of them currently do not have. The temperature measured in this section in the hottest part of summer during low flow in July 2020, 23.3 C, is hotter than desired for cold water fish. Moshannon Creek is much wider in the lower sections of the watershed and it has much sun exposure.

ID	Unit	2	14	15	16	17	18	19	20	21
Station Name		Upstream Black	Crawford Run	Weber Run	Unnamed Trib	Unnamed Trib	Unnamed Trib	Unnamed Trib	Unnamed Trib	Moravian Run
Flow	CFS	65.858	0.200	0.250	0.150	0.000	0.020	0.200	0.250	1.031
Lat		41.0367	41.0305	41.0292	41.0217	41.0148	41.0102	41.0031	40.9942	40.9943
Long		-78.0584	-78.0816	-78.0804	-78.0761	-78.0705	-78.0568	-78.0579	-78.0638	-78.0795
Area	Mi^2	208.00	1.67	0.66	0.48	0.24	0.29	0.94	1.00	3.25
Area	%		0.61	0.24	0.18	0.09	0.11	0.34	0.36	1.19
Field Temp	°C	23.30	19.00	19.60	18.30		18.40	19.00	17.60	18.80
Field DO	mg/l	8.25			9.07			8.19	8.84	
Field Cond	uS/cm	737.00	158.40	1078.00	621.00		903.00	281.00	204.50	670.00
Field pH	SU	3.74	6.00	3.02	3.13		2.97	3.64	3.72	3.25
Field Turb	NTU	0.02	0.00	0.00	0.00		0.00	0.00	0.00	
Lab pH	SU	4.0	6.1	3.3	3.4		3.2	3.9	4.0	3.4
Lab Cond	uS/cm	778	182	1100	682		953	314	227	725
Alk	mg/l	0	3	0	0		0	0	0	0
Acid	mg/l	33	13	82	60		74	33	24	59
Acid Load	lbs/day	11724	14	111	49		8	36	32	328
Fe	mg/l	0.51	0.05	1.08	0.68		4.94	0.23	0.12	2.49
Fe Load	lbs/day	181	0	1	1		1	0	0	14
Mn	mg/l	2.44	0.02	12.03	3.45		7.34	2.43	1.35	3.88
Mn Load	lbs/day	867	0	16	3		1	3	2	22
Al	mg/l	1.84	0.05	4.10	3.99		2.00	2.46	1.21	3.36
Al Load	lbs/day	654	0	6	3		0	3	2	19
SO_4	mg/l	355	48	509	274		364	112	76	285
SO_4 Load	lbs/day	126123	52	686	222		39	121	102	1585
TSS	mg/l	2	3	4	2		2	6	2	2
TDS	mg/l	518	94	777	407		539	174	134	438

Photo from the 2021 Red Moshannon Downriver Race

Black Moshannon Creek. HUC 02050201000137 and points upstream.



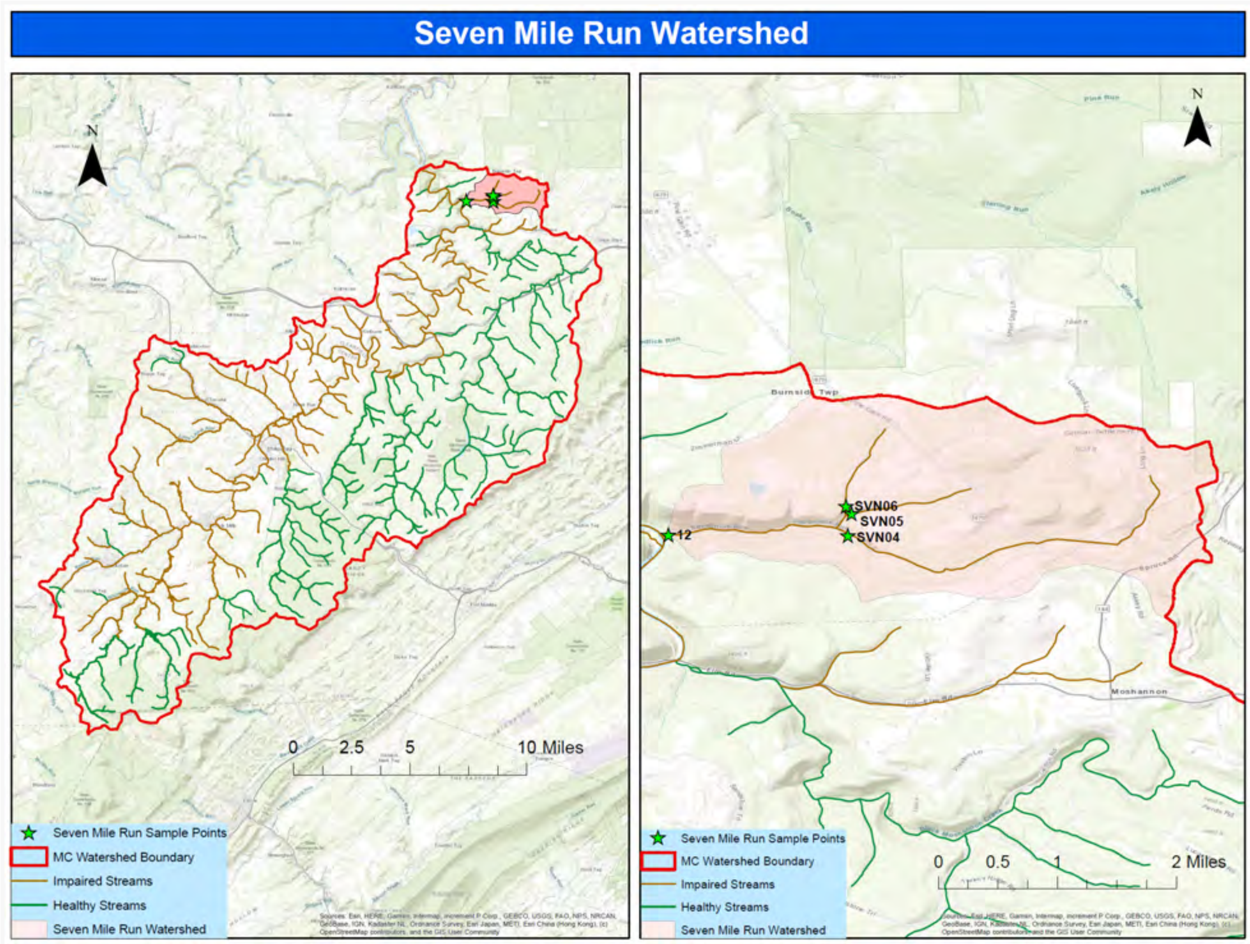
Black Moshannon Creek is the largest tributary of Moshannon Creek. It has mining impacts in impaired tributaries near its junction with Moshannon Creek. These tributaries were sampled in Round 3 water sampling. The results are shown in the table below. Today, Black Moshannon significantly improves the water in Moshannon Creek when they join. As improvements are made in Moshannon Creek upstream of Black Moshannon, the loadings from Black Moshannon will rise in importance, and treatment of the impaired tributaries near the mouth will rise in importance. The Scarlift Report did not find that there was historical underground mining in this section of the watershed. The flow rate found at sample point BLU04 seems exceptionally high for a watershed that is less than 2 square miles. There may be a feature (such as a deep mine discharge) transferring water into this tributary from outside of the watershed.

Except for those few problems in the tributaries near the mouth, this watershed has trout and clean water. After its junction with Moshannon Creek, water from Black Moshannon Creek typically makes up about 20% of the combined stream flow. This important source of clean water, fish habitat, and class III whitewater should be protected and enjoyed.

The lower section of the main stem of Black Moshannon, from the unnamed trib at RM 3.27 to its confluence with Moshannon, is not listed as Wild Trout. This section should be investigated to determine whether there are wild trout in this section in order to get it properly listed if they are present.

ID	Unit	13	BLU01	BLU02	BLU03	BLU04
Station Name		Black Moshannon Creek	BLUNT01 – mouth BM UNT01	BLUNT02 – Black Mo UNT02	BLUNT03 – Black Mo UNT03	BLUNT – Black Mo UNT above UNT01
Date		7/24/2020	4/9/2021	4/9/2021	4/9/2021	4/9/2021
Flow	CFS	15.268	0.395	0.114	1.575	2.117
Lat		41.0362	41.03412	41.03544	41.03524	41.03374
Long		-78.0566	-78.04023	-78.01685	-78.01666	-78.04063
Area	Mi^2	55.70	0.77	0.64	0.45	1.97
Area	%	20.33				
Field Temp	°C	21.10	9.90	10.70	9.50	9.60
Field DO	mg/l					
Field Cond	uS/cm	205.10	330.0	1615.0	432.0	566.0
Field pH	SU	6.38	3.99	3.12	4.92	4.65
Field Turb	NTU	0.56				
Lab pH	SU	6.0	4.46	3.52	4.79	4.55
Lab Cond	uS/cm	227	330.0	1590.0	434.0	581.0
Alk	mg/l	3	<20	<20	<20	<20
Acid	mg/l	13	20.52	102.00	18.21	23.33
Acid Load	lbs/day	1071	44	63	155	266
Fe	mg/l	1.51	0.00	8.98	1.58	3.41
Fe Load	lbs/day	124	0	6	13	39
Mn	mg/l	1.18	3.39	21.70	3.18	4.73
Mn Load	lbs/day	97	7	13	27	54
Al	mg/l	0.33	0.83	6.09	1.59	1.37
Al Load	lbs/day	27	2	4	14	16
SO_4	mg/l	78	112.0	856.0	130.0	270.0
SO_4 Load	lbs/day	6424	238	525	1105	3083
TSS	mg/l	7	0.8	1.8	1.2	4.4
TDS	mg/l	128	20	1080	280	302

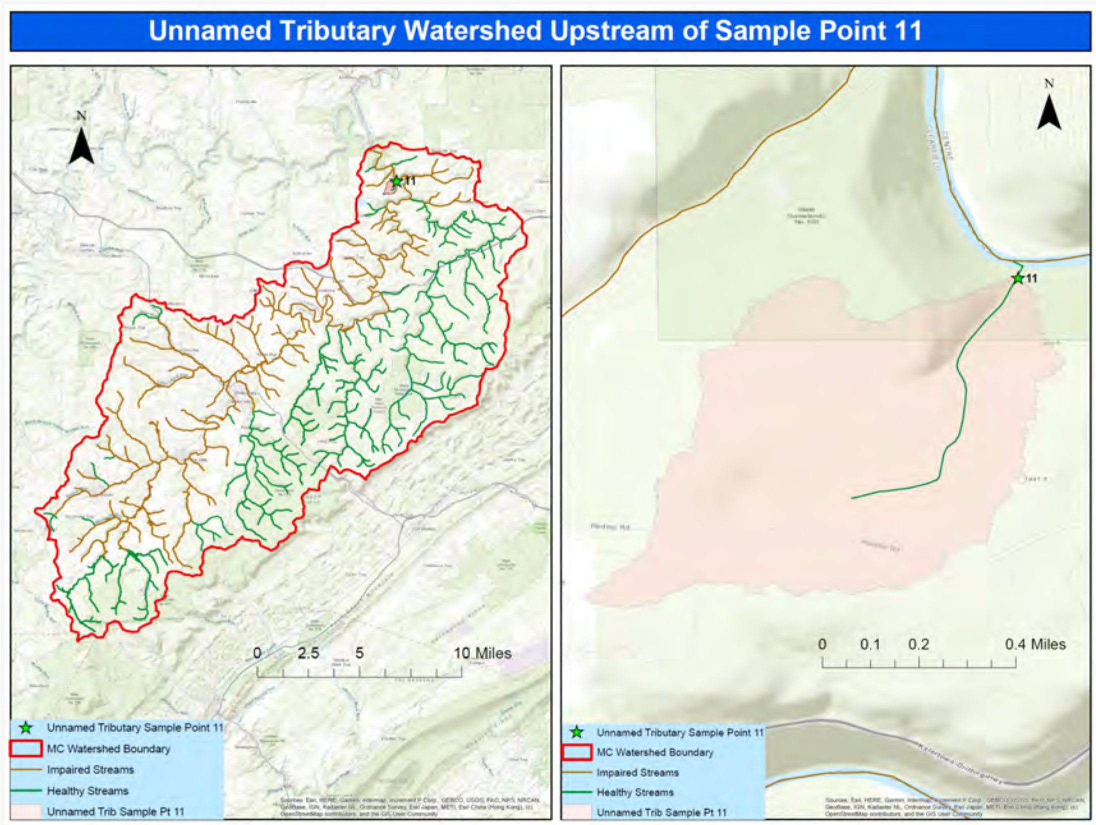
Sevenmile Run. HUC 02050201000632 and points upstream.



Because of treatment systems constructed on mine discharges in this watershed, better results were anticipated for Sevenmile Run during the July 2020 sampling than actually came to pass. This was rather disappointing, but it does demonstrate that there are more problems on Sevenmile Run than a 300 gallon per minute treatment facility can correct. In fact, Sevenmile must have been contributing much worse water to Moshannon before treatment was activated in 2016. April 2021 sampling farther upstream in this watershed showed that the unnamed tributary upstream of sample point SVN05 may be unimpaired, but the tributary to the north and the main stem upstream of this area are both impaired by mine drainage. Sevenmile Run will need to be attended to when improvements upstream make its impact to Moshannon Creek more apparent. The unimpaired tributary in the middle of this watershed, combined with the cool water temperature of 17.3C found at the mouth of the main stem on a very hot day in July 2020, shows that this watershed could host trout if it had cleaner water.

ID	Unit	12	SVN04	SVN05	SVN06
Station Name		Sevenmile Run	SEVN04 – Main stem above Y trib	SEVN05 – Right side Y above SEVN02	SEVN06 – left side Y above SEVN02
Date		7/24/2020	4/9/2021	4/9/2021	4/9/2021
Flow	CFS	0.723	0.724	0.270	0.593
Lat		41.0521	41.05199	41.05469	41.05555
Long		-78.0590	-78.03709	-78.03665	-78.03734
Area	Mi^2	4.37			
Area	%	1.59			
Field Temp	°C	17.30	10.00	9.50	11.00
Field DO	mg/l	7.70			
Field Cond	uS/cm	748.00	464.0	151.0	693.0
Field pH	SU	3.36	3.93	6.58	4.90
Field Turb	NTU				
Lab pH	SU	3.5	4.30	7.10	5.00
Lab Cond	uS/cm	896	420.0	157.0	700.0
Alk	mg/l	0	<20	<20	<20
Acid	mg/l	49	20.49	10.36	25.68
Acid Load	lbs/day	191	80	15	82
Fe	mg/l	2.05	1.69	0.00	0.00
Fe Load	lbs/day	8	7	0	0
Mn	mg/l	7.45	4.30	0.00	7.37
Mn Load	lbs/day	29	17	0	24
Al	mg/l	1.63	0.00	0.00	2.49
Al Load	lbs/day	6	0	0	8
SO_4	mg/l	398	170.0	35.5	373.0
SO_4 Load	lbs/day	1552	664	52	1192
TSS	mg/l	3	2.0	2.8	<0.8
TDS	mg/l	586	210	68	414

Unnamed Tributary Upstream of Sample Point 11. HUC 02050201001630.

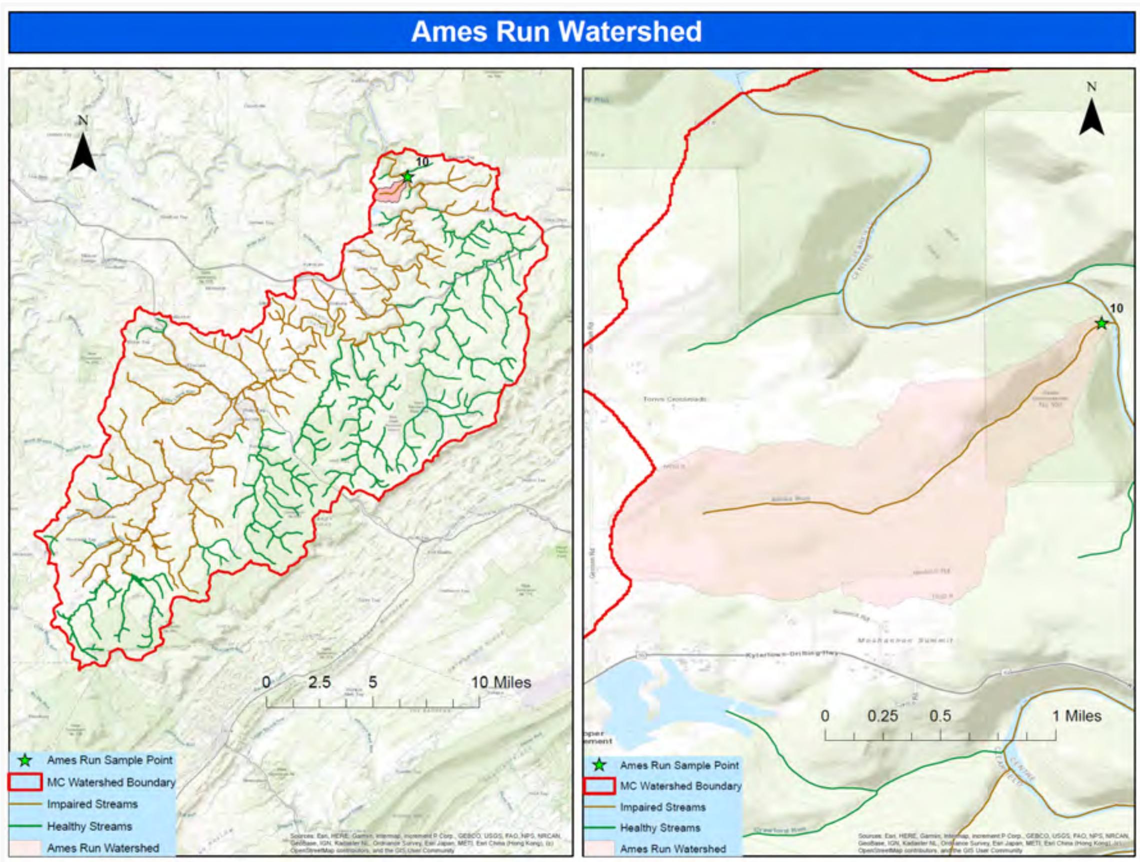


This small stream has been classified as being unimpaired. When sampled it was found to have a pH below six and iron of 4.42 mg/l. There is visible iron staining on the rocks it cascades down when reaching Moshannon Creek. This stream should be investigated further in more normal flow conditions in order to determine whether it should be classified as impaired.

ID	Unit	11
Station Name		Unnamed Trib
Flow	CFS	0.036
Lat		41.0493
Long		-78.0708
Area	Mi^2	0.28
Area	%	0.10
Field Temp	°C	19.40
Field DO	mg/l	8.20
Field Cond	uS/cm	234.80
Field pH	SU	5.03
Field Turb	NTU	
Lab pH	SU	5.8
Lab Cond	uS/cm	229

ID	Unit	11
Alk	mg/l	2
Acid	mg/l	20
Acid Load	lbs/day	4
Fe	mg/l	4.42
Fe Load	lbs/day	1
Mn	mg/l	1.48
Mn Load	lbs/day	0
Al	mg/l	0.05
Al Load	lbs/day	0
SO_4	mg/l	97
SO_4 Load	lbs/day	19
TSS	mg/l	3
TDS	mg/l	147

Ames Run. HUC 02050201000522.

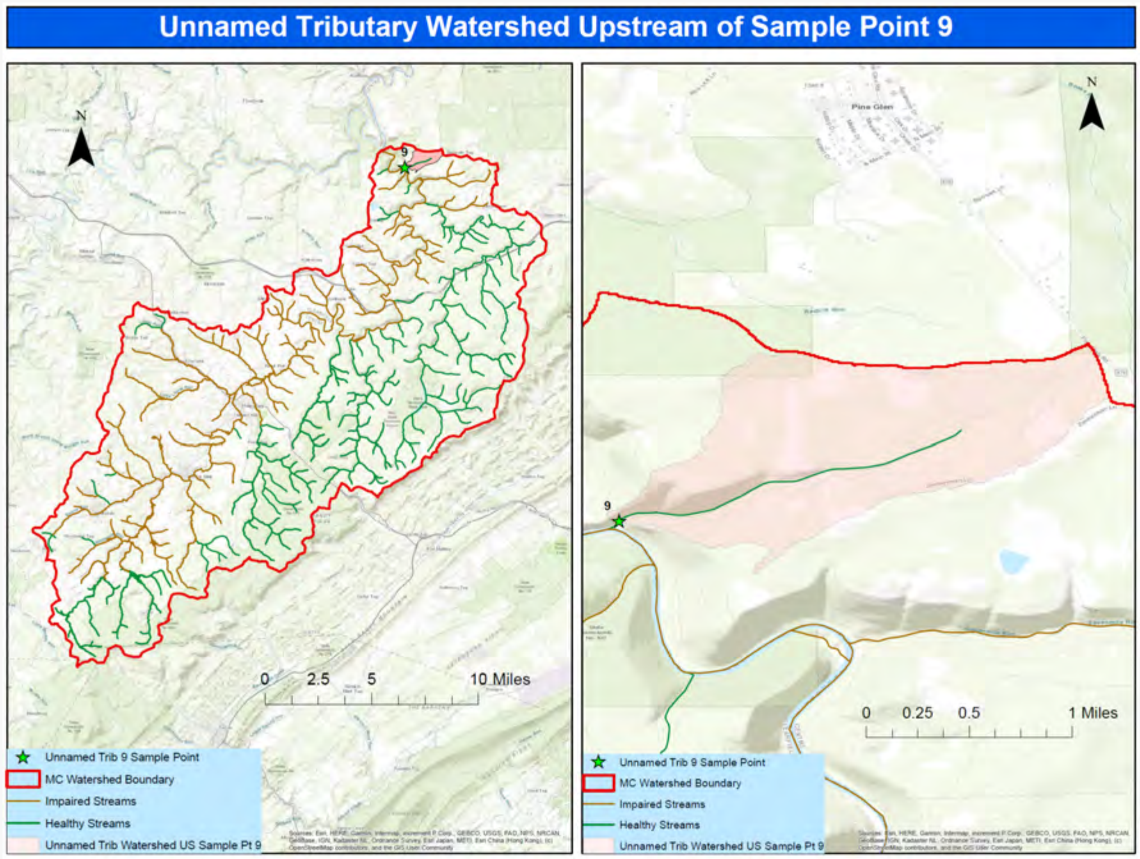


This stream was sampled in drought conditions in July 2020. It was found to have a flow of 9 gpm and a pH of 4.5. Iron was only measured at 0.05 mg/l but there was visible red staining on the rock face it cascades down. This stream may benefit from added alkalinity. It may have limited potential for fish habitat because of its cascade near its junction with Moshannon Creek, but the presence of fish should be investigated.

ID	Unit	10
Station Name		Ames Run
Flow	CFS	0.002
Lat		41.0574
Long		-78.0743
Area	Mi^2	1.02
Area	%	0.37
Field Temp	°C	17.60
Field DO	mg/l	7.30
Field Cond	uS/cm	165.80
Field pH	SU	4.19
Field Turb	NTU	
Lab pH	SU	4.5
Lab Cond	uS/cm	194

ID	Unit	10
Alk	mg/l	0
Acid	mg/l	19
Acid Load	lbs/day	0
Fe	mg/l	0.05
Fe Load	lbs/day	0
Mn	mg/l	0.64
Mn Load	lbs/day	0
Al	mg/l	0.89
Al Load	lbs/day	0
SO_4	mg/l	75
SO_4 Load	lbs/day	1
TSS	mg/l	3
TDS	mg/l	114

Unnamed Tributary Upstream of Sample Point 9. HUC 02050201000635.

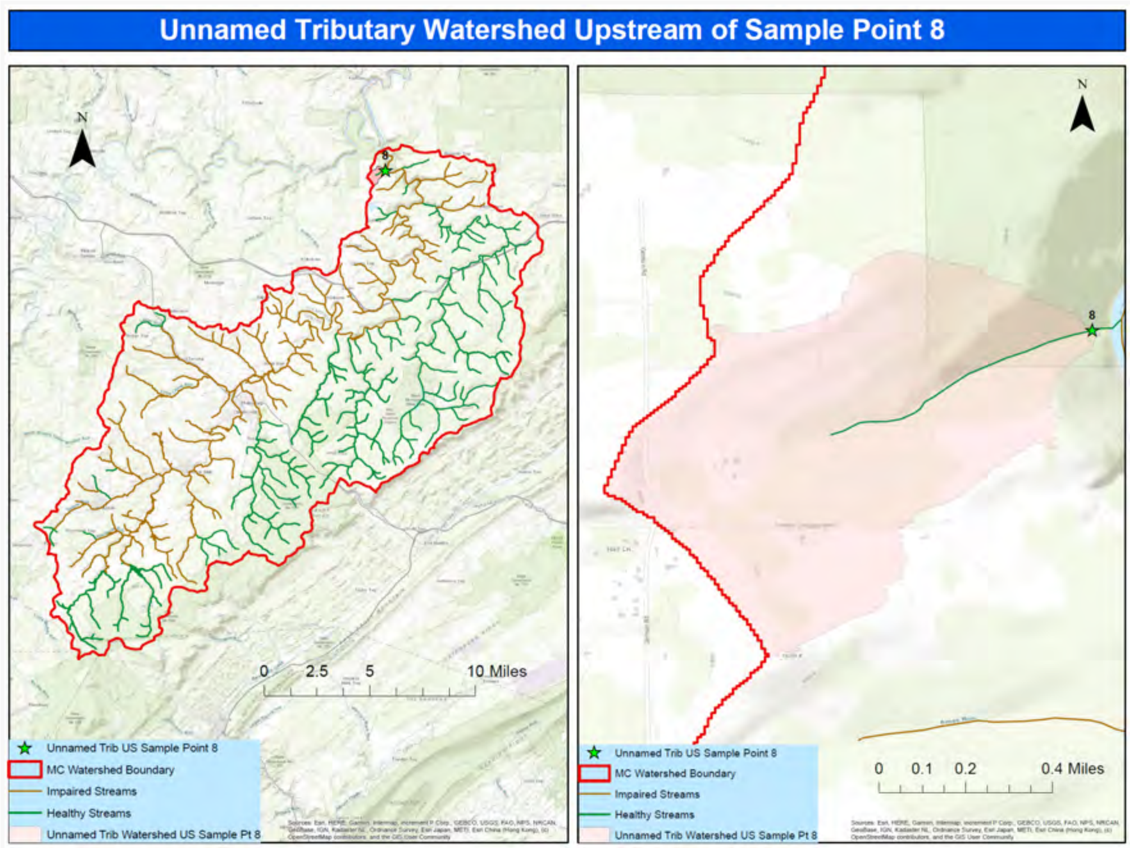


This stream was found to have a 49 gpm flow of water with a pH of 6.00 and low metals. The measured temperature of 17.3C during a hot day during a drought in July 2020 indicates that this stream has potential to become, or it may already be, a trout stream if the terrain does not hinder use of this watershed by coldwater fish.

ID	Unit	9
Station Name		Unnamed Trib
Flow	CFS	0.114
Lat		41.0605
Long		-78.0759
Area	Mi^2	0.98
Area	%	0.36
Field Temp	°C	17.30
Field DO	mg/l	8.00
Field Cond	uS/cm	32.20
Field pH	SU	5.05
Field Turb	NTU	
Lab pH	SU	6.0
Lab Cond	uS/cm	43

ID	Unit	9
Alk	mg/l	2
Acid	mg/l	10
Acid Load	lbs/day	6
Fe	mg/l	0.16
Fe Load	lbs/day	0
Mn	mg/l	0.03
Mn Load	lbs/day	0
Al	mg/l	0.05
Al Load	lbs/day	0
SO_4	mg/l	10
SO_4 Load	lbs/day	6
TSS	mg/l	2
TDS	mg/l	24

Unnamed Tributary Upstream of Sample Point 8. HUC 02050201001620.

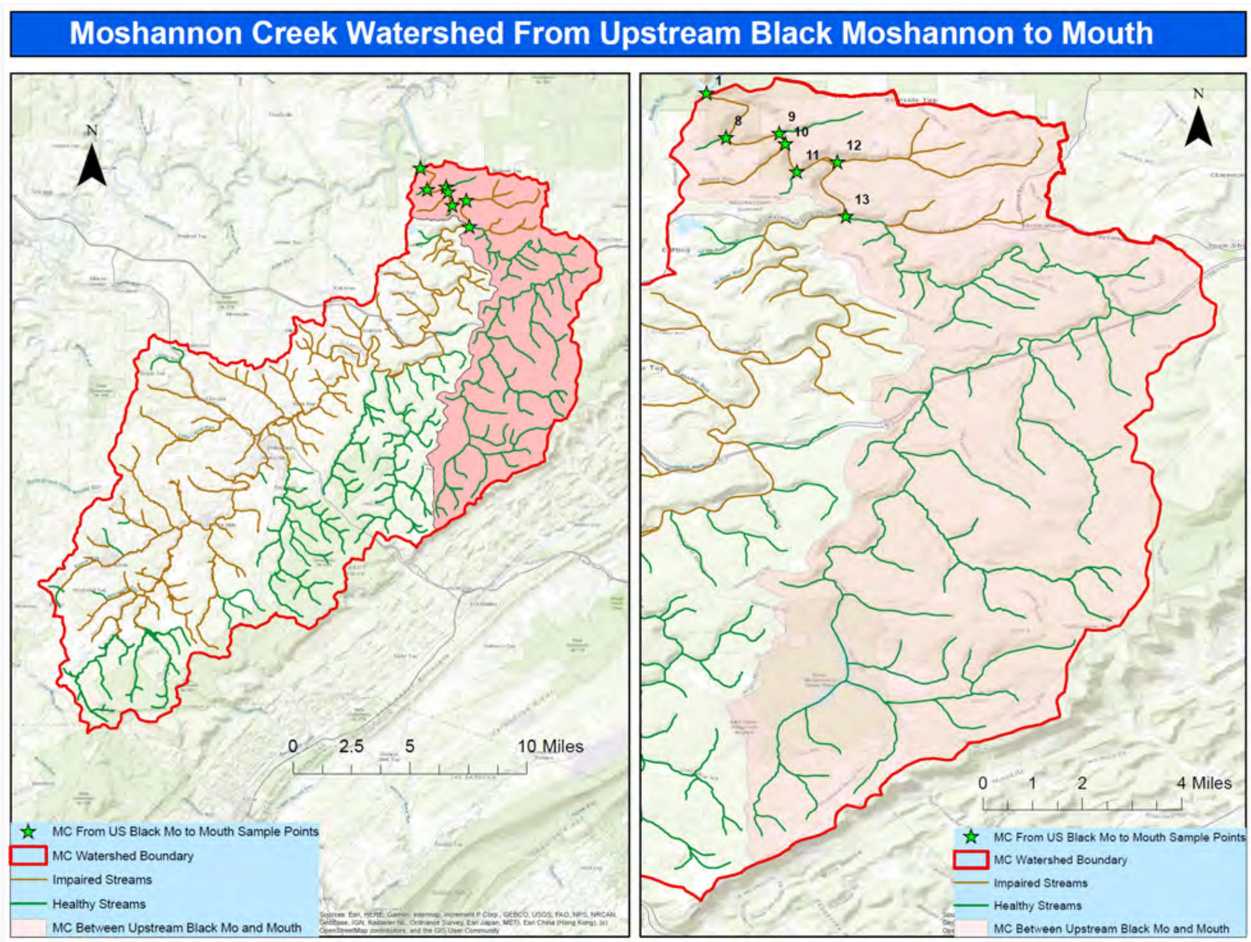


This small stream was found to have only 9 gpm flow but clean water with a pH of 6.00 when sampled during drought conditions in July 2020. During periods of higher flow this stream may be able to host a few coldwater fish if the terrain allows access.

ID	Unit	8
Station Name		Unnamed Trib
Flow	CFS	0.002
Lat		41.0592
Long		-78.0915
Area	Mi^2	0.42
Area	%	0.15
Field Temp	°C	18.80
Field DO	mg/l	6.61
Field Cond	uS/cm	171.70
Field pH	SU	5.53
Field Turb	NTU	
Lab pH	SU	6.0
Lab Cond	uS/cm	248

ID	Unit	8
Alk	mg/l	2
Acid	mg/l	11
Acid Load	lbs/day	0
Fe	mg/l	0.30
Fe Load	lbs/day	0
Mn	mg/l	0.04
Mn Load	lbs/day	0
Al	mg/l	0.10
Al Load	lbs/day	0
SO_4	mg/l	103
SO_4 Load	lbs/day	1
TSS	mg/l	9
TDS	mg/l	147

Moshannon Creek from Above its Junction With Black Moshannon Creek to Its Mouth at the West Branch of the Susquehanna. HUC 02050201000133 and upstream past the junction with Black Moshannon Creek.



This final section of Moshannon Creek is remote and wild. This roadless section of the watershed flows through deep canyons. It is joined by a mix of impaired and clean tributaries that flow down into the canyon. This section begins just above the junction with Black Moshannon Creek, the watershed's largest tributary. Sevenmile Run is another important tributary. The other tributaries are much smaller. Some of the tributaries flow over substantial drops into the Moshannon Creek canyon, which may hinder their potential as fish habitat. Black Moshannon Creek has some mining impacts near the mouth but most of the watershed is high quality coldwater fish habitat. Sevenmile Run is severely impaired, except for one tributary. The other, smaller, streams are a mix of impaired and clean water streams. This section of Moshannon Creek is popular with kayakers who finish their paddle on the West Branch of the Susquehanna.

ID	Unit	1	8	9	10	11	12	13
Station Name		Moshannon Creek Mouth	Unnamed Trib	Unnamed Trib	Ames Run	Unnamed Trib	Sevenmile Run	Black Moshannon Creek
Flow	CFS	92.061	0.002	0.114	0.002	0.036	0.723	15.268
Lat		41.0723	41.0592	41.0605	41.0574	41.0493	41.0521	41.0362
Long		-78.0972	-78.0915	-78.0759	-78.0743	-78.0708	-78.0590	-78.0566
Area	Mi^2	274.00	0.42	0.98	1.02	0.28	4.37	55.70
Area	%		0.15	0.36	0.37	0.10	1.59	20.33
Field Temp	°C	27.90	18.80	17.30	17.60	19.40	17.30	21.10
Field DO	mg/l	6.36	6.61	8.00	7.30	8.20	7.70	
Field Cond	uS/cm	718.00	171.70	32.20	165.80	234.80	748.00	205.10
Field pH	SU	3.92	5.53	5.05	4.19	5.03	3.36	6.38
Field Turb	NTU							0.56
Lab pH	SU	4.1	6.0	6.0	4.5	5.8	3.5	6.0
Lab Cond	uS/cm	708	248	43	194	229	896	227
Alk	mg/l	0	2	2	0	2	0	3
Acid	mg/l	29	11	10	19	20	49	13
Acid Load	lbs/day	14402	0	6	0	4	191	1071
Fe	mg/l	0.35	0.30	0.16	0.05	4.42	2.05	1.51
Fe Load	lbs/day	174	0	0	0	1	8	124
Mn	mg/l	2.40	0.04	0.03	0.64	1.48	7.45	1.18
Mn Load	lbs/day	1192	0	0	0	0	29	97
Al	mg/l	1.66	0.10	0.05	0.89	0.05	1.63	0.33
Al Load	lbs/day	824	0	0	0	0	6	27
SO_4	mg/l	313	103	10	75	97	398	78
SO_4 Load	lbs/day	155445	1	6	1	19	1552	6424
TSS	mg/l	2	9	2	3	3	3	7
TDS	mg/l	458	147	24	114	147	586	128

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Appendix. Water Sampling Data Links and Benthic Macroinvertebrate Sampling Reports.

A spreadsheet with all of the water sampling data from the three rounds of water sampling performed to complete this plan is located at the following link:

https://moshannoncreek.org/reports

Water sampling data from the first round of water sampling has been posted on the Susquehanna River Basin Commission’s Mine Drainage Portal. Data from rounds 2 and 3 will be posted there. This data is available from the following link:l

https://www.srbc.net/minedrainageportal/

Copies of the Headwaters Benthic Macroinvertebrate Sampling Report and the Bear Run Benthic Macroinvertebrate Sampling Report begin on the next page.

9 April 2021

Prepared by Philip Light – Chair Pennsylvania chapter of Native Fish Coalition
With Andrew Mickey – Vice Chair PA NFC, Christopher Mickey – Secretary PA NFC, &
Eammon Powers – Board member PA NFC

For

The Moshannon Creek Watershed Association

MCWA
www.moshannoncreek.org

FOREWORD

Native Fish Coalition (NFC) is a nonpartisan, grassroots, donor-funded, all volunteer, 501(c)(3) national non-profit organization dedicated to the conservation, preservation, and restoration of wild native fish. We currently have state chapters in Alabama, Connecticut, Maine, Massachusetts, New Hampshire, Pennsylvania, Vermont, and West Virginia representing thousands of members, partners, volunteers, supporters and followers.

ACKNOWLEDGEMENTS

Survey work on Moshannon Creek was made possible through the donation of equipment from the Susquehanna River Watershed Basin Commission, the Department of Environmental Protection and the Potter County Conservation District with landowner permission from Warriors Mark Wingshooting.

INTRODUCTION

Moshannon Creek is a major tributary of the West Branch of the Susquehanna River in west central Pennsylvania. The stream meanders considerably but generally flows from Southwest to Northeast. Moshannon Creek forms the border between Clearfield County and Centre County over most of its length. The watershed is approximately 274 square miles, and it measures 30.4 miles in length in the flow direction and is 14.4 miles wide at its widest point. All of the above measurements were made using ArcGIS and the watershed boundary calculated by the USGS StreamStats database on July 7, 2019 (USGS,2019). The watershed includes land in Clearfield County, Centre County, and small parts of Cambria and Blair County in its headwaters area.

This report documents the sampling methods and summarizes the IBI (Index of Biotic Integrity) observed on April 9th 2021.

METHODS

Site Selection: The design method chosen for site selection is based on the Cause and Effect Monitoring model. A cause and effect sampling design is employed to investigate possible relationships between point or nonpoint sources of conventional pollutants and known or suspected instream water quality problems through the collection and analysis of biological, physical, and chemical data.

On the day of sampling, the team conducted multiple field tests to sample water quality parameters using an Apera water quality testing kit that was calibrated the night before sample collection. We sampled sites throughout the mainstem to identify input tributaries with a low pH and/or high Conductivity to determine the best sites on the stream to represent the impact of point source pollution on the macroinvertebrate community.

Site #1 (-78.375708,40.751238) was located upstream of known legacy mining activity and known water quality degradation. The substrate at sample site #1 was silt/sand/gravel substrate with good size distribution of cobble, and three riffle-run stations were selected in a 100 meter reach where no human or animal (beaver) impact was evident.

Site #2 (-78.370650,40.758047) was located downstream of Site #1 below a known impaired input tributary that enters Moshannon Creek from the West. This site is in an area of obvious historical beaver activity. Three survey stations at site #2 were selected based on available 100 meter reaches that contained riffle-run habitat.

Habitat observed at both sample sites were comprised of Silt/sand/gravel substrate.
This habitat includes sandy, silty, or muddy stream bottoms; rocks along the stream bottom; and/or wetted gravel bars. This habitat may also contain algae covered rocks (sometimes called Aufwuchs).

Moshannon Creek Macro Sample Site Locations

Moshannon Creek Macro Site #1

Sample Collection: We employed the USEPA's Rapid Bioassessment Protocol for use in Wadeable Streams and Rivers (Barbour et al.1999) single, most productive habitat (riffle-Run) approach. Two benthic macroinvertebrate sample collection sites were identified by delineating two 100-meter reaches along the stream where the best available representation of riffle-run habitat existed for the stream segment of interest. Within each reach, three, three-foot by three-foot kick stations were established. Each station sampled was kicked for 1 minute directly upstream of a non-truncated D-framed net with 500 µm mesh.

Stations were "kicked" starting with the downstream station first as not to disturb the other two stations upstream.

One member of the team held the D-frame net in a constant location for 1 minute at station #1, while the other team member dislodged macroinvertebrates from large rocks in the 3 foot by 3 foot sample area, and then thoroughly dislodged macroinvertebrates from the smaller cobble in the sample area by "kicking" the streambed with their feet.

Following capture of specimens from the first of three sample stations in site #1, the contents of the D-frame net were emptied into a clean 5 gallon bucket with a small amount of clean stream water. Water was poured over the outside of the net to dislodge all specimens from the net. Additionally, individual specimens were manually picked from the net to ensure no specimens were lost.

Upon collecting the specimens from the first sample station, the above process was repeated for the final two sample stations at site #1. Specimens from all three sample stations were collected in the same 5 gallon bucket to create a composite score for the sample site based on the three sample stations within the 100 meter reach of the first station.

Upon completion of the collection process for site #1, the contents of the 5 gallon bucket were emptied into a large shallow white pan. Using tweezers, eye droppers, and a small spatula, individual macroinvertebrates were picked from the shallow pan and sorted into divided white sorting trays. Specimens were sorted by order in each compartment of the sorting trays.

Specimen Sorting Tray

Assessment: The Wadeable Freestone Single, Most Productive Habitat (Riffle-Run) Stream Macroinvertebrate Assessment Method was used to assess the macroinvertebrate community at both survey sites on Moshannon Creek.

This assessment method is designed to make ALU assessment determinations using benthic macroinvertebrate communities in Pennsylvania's wadeable, freestone, riffle-run streams. Through direct quantification of biological attributes along a gradient of conditions, the index of biotic integrity (IBI) provided in this assessment method measures the extent to which anthropogenic activities compromise a stream's ability to support healthy aquatic communities (Davis and Simon 1995).

Six metrics are included in this assessment protocol:

Total Taxa Richness:
This taxonomic richness metric is a count of the total number of taxa in a subsample. Generally, 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. Other benefits of including this metric include its common use in many biological monitoring and assessment programs in other parts of the world as well as its ease of explanation and calculation.

Ephemeroptera + Plecoptera + Trichoptera Taxa Richness (Pollution Tolerance Values 0-4 only)
This taxonomic richness metric is a count of the number of taxa belonging to the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) in a sub-sample – 2-5 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, many types of pollution (Lenat and Penrose 1996), although sensitivity to different types of pollution varies among taxa in these insect orders. The version of this metric used here only counts EPT taxa with PTVs of 0 to 4, excluding a few of the most tolerant mayfly and caddisfly taxa. 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. This metric has a history of use across the world and is relatively easy to use, explain, and calculate (Lenat and Penrose 1996).

Beck's Index (version 3)
This taxonomic richness and tolerance metric is a weighted count of taxa with pollution tolerance values of 0, 1, or 2. The name and conceptual basis of this metric are derived from the water quality work of William H. Beck in Florida (Beck 1955). This metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of pollution sensitive taxa.

Shannon Diversity

This community composition metric measures taxonomic richness and evenness of individuals across taxa of a sub-sample. 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. The name and conceptual basis for this metric are derived from the information theory work of Claude Elwood Shannon (Shannon 1948).

Hilsenhoff Biotic Index

This community composition and tolerance metric is calculated as an average of the number of individuals in a sub-sample, weighted by pollution tolerance values. Developed by William Hilsenhoff, the Hilsenhoff Biotic Index (Hilsenhoff 1977, 1987, 1988; Klemm et al. 1990) generally increases with increasing ecosystem stress, reflecting increasing dominance of pollution-tolerant organisms. Percent Sensitive Individuals (Pollution Tolerance Values 0-3 only) This community composition and tolerance metric is the percentage of individuals with pollution tolerance values of 0 to 3 in a sub-sample and is expected to decrease in value with increasing anthropogenic stress

Percent Sensitive Individuals (Pollution Tolerance Values 0-3 only)

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

Findings

Moshannon Creek Sample Site #1

Taxa Name	Number of Individuals	Pollution Tolerance Value
Hydropsychidae	4	5
Capniidae	8	2
Culicidae	50	8
Rhyacophilidae	1	1
Peltoperlidae	1	0
Decapoda	1	8
Heptageniidae	9	4
Ephemerellidae	125	1
Corduliidae	3	2
Tipulidae	1	3
Perlidae	6	2

Total Taxa Richness: 11

EPT Taxa Richness (PTV 0-4 only)

3 Ephemeroptera taxa (Ephemerellidae, Heptageniidae, Heptageniidae)
3 Plecoptera taxa (Peltoperlidae, Capniidae, Perlidae)
2 Trichoptera taxa (Hydropsychidae, Rhyacophilidae)

EPT Taxa Richness = 3 + 3 + 2
EPT Taxa Richness = 8

Beck's Index (Version 3):

$= 3 * (n_{taxaPTV0}) + 2 * (n_{taxaPTV1}) + 1 * (n_{taxaPTV2})$

Where ntaxaPTV0 is the number of taxa with a PTV attribute of 0, ntaxaPTV1 is the number of taxa with a PTV attribute of 1, and ntaxaPTV2 is the number of taxa with a PTV attribute of 2.

Beck's Index (version 3) = 3(1) + 2(2) + 1(3)
Beck's Index (version 3) = 3 + 4 + 3
Beck's Index (version 3) = 10

Hilsenhoff Biotic Index

$$= \sum_{i=0}^{10} [(i * n_{indvPTVi})] / N$$

where nindvPTVi = the number of individuals in a sub-sample with PTV of i and N = the total number of individuals in a sub-sample.
There are 1 individuals with a PTV = 0
There are 126 individuals with a PTV = 1
There are 17 individuals with a PTV = 2
There are 1 individuals with a PTV = 3
There are 9 individuals with a PTV = 4
There are 4 individuals with a PTV = 5
There are 0 individuals with a PTV = 6
There are 0 individuals with a PTV = 7
There are 51 individuals with a PTV = 8
There are 0 individuals with a PTV = 9
There are 0 individuals with a PTV = 10

There are a total of 209 individuals in this sample.

Hilsenhoff Biotic Index = [(0*1) + (1*126) + (2*17) + (3*1) + (4*9) + (5*4) + (6*0) + (7*0) + (8*51) + (9*0) + (10*0)]/209

Hilsenhoff Biotic Index = 2.56

Shannon Diversity Index

$$= -1\left(\sum_{i=1}^{Rich} [(n_i/N) \ln(n_i/N)]\right)$$

where ni = the number of individuals in each taxon (relative abundance); N = the total number of individuals in a sub-sample; and Rich = the total number of taxa in a subsample (total taxa richness).

There are 11 taxa in this sample. The number of each taxon are shown in the table above.
There are a total of 209 individuals in this sample.

Shannon Diversity Index = -1 [(4/209) ln (4/209) + (8/209) ln (8/209) + (50/209) ln (50/209) + (1/209) ln (1/209) + (1/209) ln (1/209) + (1/209) ln (1/209) + (9/209) ln (9/209) + (125/209) ln (125/209) + (3/209) ln (3/209) + (1/209) ln (1/209) + (6/209) ln (6/209)]

Shannon Diversity Index = 1.06

Percent Sensitive Individuals (PTV 0-3 only)

$$= \left(\sum_{i=0}^{3} n_{indvPTVi} \Big/ N \right) *100$$

where nindvPTVi = the number of individuals in a sub-sample with PTV of i and N = the total number of individuals in a sub-sample.

There are 1 individuals with a PTV = 0
There are 126 individuals with a PTV = 1
There are 17 individuals with a PTV = 2
There are 1 individuals with a PTV = 3

There are a total of 209 individuals in this sub-sample.

Percent Sensitive Individuals (PTV 0-3 only) = (1+126+17+1)/209*100
Percent Sensitive Individuals (PTV 0-3 only) = 145/209*100
Percent Sensitive Individuals (PTV 0-3 only) = 69.38%

Moshannon Creek Macro Sample Site #1

IBI Calculation			
Metric	**Standardization Equation** (Using small-stream standardization values)	**Observed Metric Value**	**Standardized Metric Score**
Total Taxa Richness	(observed value / 33)*100	11	33.33
EPT Taxa Richness	(observed value / 19)*100	8	42.11
Beck's Index	(observed value/38)*100	10	26.32
Hilsenhoff Biotic Index	[(10-observed value)/(10-1.89)]*100	3.54	79.65
Shannon Diversity	(observed value/2.86)*100	1.15	40.21
Percent Sensitive Individuals	Observed value/84.5)*100	69.38	82.11
Average of standardized core metric scores (IBI Score) =			50.62

Moshannon Creek Sample Site #2

Taxa Name	Number of Individuals	Pollution Tolerance Value
Hydropsychidae	2	5
Capniidae	2	2
Heptageniidae	6	4
Ephemerellidae	14	1
Haplotaxida	1	5
Perlidae	4	2

Total Taxa Richness: 6

EPT Taxa Richness (PTV 0-4 only)

2 Ephemeroptera taxa (Ephemerellidae, Heptageniidae)
1 Plecoptera taxa (Perlidae)
1 Trichoptera taxa (Hydropsychidae)
EPT Taxa Richness = 4

Beck's Index (Version 3):

$= 3 * (n_{taxaPTV0}) + 2 * (n_{taxaPTV1}) + 1 * (n_{taxaPTV2})$

Where ntaxaPTV0 is the number of taxa with a PTV attribute of 0, ntaxaPTV1 is the number of taxa with a PTV attribute of 1, and ntaxaPTV2 is the number of taxa with a PTV attribute of 2.

Beck's Index (version 3) = 3*(0) + 2*(1) + 1*(2)
Beck's Index (version 3) = 4

Hilsenhoff Biotic Index

$$= \sum_{i=0}^{10} [(i * n_{indvPTVi})] / N$$

where nindvPTVi = the number of individuals in a sub-sample with PTV of i and N = the total number of individuals in a sub-sample.
There are 0 individuals with a PTV = 0
There are 14 individuals with a PTV = 1
There are 6 individuals with a PTV = 2
There are 0 individuals with a PTV = 3
There are 6 individuals with a PTV = 4
There are 2 individuals with a PTV = 5
There are 0 individuals with a PTV = 6
There are 0 individuals with a PTV = 7
There are 0 individuals with a PTV = 8
There are 0 individuals with a PTV = 9
There are 0 individuals with a PTV = 10

There are a total of 4 individuals in this sample.

Hilsenhoff Biotic Index = [(0*0) + (1*14) + (2*6) + (3*0) + (4*6) + (5*2) + (6*0) + (7*0) + (8*0) + (9*0) + (10*0)]/29

Hilsenhoff Biotic Index = 2.17

Shannon Diversity Index

$$= -1 \left(\sum_{i=1}^{Rich} [(n_i/N) \ln(n_i/N)] \right)$$

where ni = the number of individuals in each taxon (relative abundance); N = the total number of individuals in a sub-sample; and Rich = the total number of taxa in a subsample (total taxa richness).

There are 6 taxa in this sample. The number of each taxon are shown in the table above. There are a total of 29 individuals in this sample.

Shannon Diversity Index = -1 [(2/29) ln (2/29) + (2/29) ln (2/29) + (6/29) ln (6/29) + (14/29) ln (14/29) + (1/29) ln (1/29) + (4/29) ln (4/29)]

Shannon Diversity Index = 1.44

Percent Sensitive Individuals (PTV 0-3 only)

$$= \left(\sum_{i=0}^{3} n_{indvPTVi} / N \right) *100$$

where nindvPTVi = the number of individuals in a sub-sample with PTV of i and N = the total number of individuals in a sub-sample.

There are a total of 29 individuals in this sub-sample.

There are 0 individuals with a PTV = 0
There are 14 individuals with a PTV = 1
There are 6 individuals with a PTV = 2
There are 0 individuals with a PTV = 3

There are a total of 29 individuals in this sub-sample.

Percent Sensitive Individuals (PTV 0-3 only) = (0+14+6+0)/29*100
Percent Sensitive Individuals (PTV 0-3 only) = 20/29*100
Percent Sensitive Individuals (PTV 0-3 only) = 68.97%

IBI Calculation			
Metric	**Standardization Equation** (Using small-stream standardization values)	**Observed Metric Value**	**Standardized Metric Score**
Total Taxa Richness	(observed value / 33)*100	6	18.18
EPT Taxa Richness	(observed value / 19)*100	4	21.05
Beck's Index	(observed value/38)*100	4	10.53
Hilsenhoff Biotic Index	[(10-observed value)/(10-1.89)]*100	2.17	96.55
Shannon Diversity	(observed value/2.86)*100	1.44	50.35
Percent Sensitive Individuals	Observed value/84.5)*100	68.97	81.62
Average of standardized core metric scores (IBI Score) =			46.38

Conclusion

The difference in macro community diversity between Moshannon Creek Macro Site #1 and Macro Site #2 indicate that the downstream site (#2) is impaired due to toxic pollution or severe habitat alteration. The stream in the vicinity of site #2 exhibits traits that are characteristic of historic beaver dam activity. Some reduction in the diversity of macroinvertebrates in this section could also be attributed to the heavy sedimentation and channelization of the stream in that area.

Macroinvertebrate diversity at site #1 is good, and the stream habitat in the vicinity of site #1 is indicative of many Class A brook trout streams in Pennsylvania. In addition to the habitat observations and macroinvertebrate survey, we also observed numerous brook trout throughout both site #1 and #2 on the day of the survey.

9 April 2021

Prepared by Philip Light – Chair Pennsylvania chapter of Native Fish Coalition
With Andrew Mickey – Vice Chair PA NFC, Christopher Mickey – Secretary PA NFC, &
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For

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ACKNOWLEDGEMENTS

Survey work on Bear Run was made possible through the donation of equipment from the Susquehanna River Watershed Basin Commission, the Department of Environmental Protection and the Potter County Conservation District.

INTRODUCTION

Bear Run is a tributary to Moshannon Creek in central Pennsylvania. Moshannon Creek is a major tributary of the West Branch of the Susquehanna River in west central Pennsylvania. The stream meanders considerably but generally flows from Southwest to Northeast. Moshannon Creek forms the border between Clearfield County and Centre County over most of its length. The watershed is approximately 274 square miles, and it measures 30.4 miles in length in the flow direction and is 14.4 miles wide at its widest point. All of the above measurements were made using ArcGIS and the watershed boundary calculated by the USGS StreamStats database on July 7, 2019 (USGS,2019). The watershed includes land in Clearfield County, Centre County, and small parts of Cambria and Blair County in its headwaters area.

Bear Run originates on the West slope of Sandy Ridge in Center County and flows Northwest for approximately 3.4 miles to meet Moshannon Creek on the Clearfield/Center County line. Bear Run has three small tributaries and a number of smaller inputs along it's course. The mid section of Bear Run is braided with a small tributary on the West and a larger tributary on the East.

This report documents the sampling methods and summarizes the IBI (Index of Biotic Integrity) observed on April 9th 2021.

METHODS

Site Selection: The design method chosen for site selection is based on the Cause and Effect Monitoring model. A cause and effect sampling design is employed to investigate possible relationships between point or nonpoint sources of conventional pollutants and known or suspected instream water quality problems through the collection and analysis of biological, physical, and chemical data.

On the day of sampling, the team conducted multiple field tests to sample water quality parameters using an Apera water quality testing kit that was calibrated the night before sample collection. We sampled sites throughout the mainstem of Bear Run to identify input tributaries with a low pH and/or high Conductivity to determine the best sites on the stream to represent the impact of point source pollution on the macroinvertebrate community.

Site #1 (40.804102, -78.298459) was located directly upstream of a water quality sample site at an input tributary with a low pH and high Conductivity (field observed 3.89 pH & 149.6 Conductivity).

Site #2 (40.804276, -78.29836) was located directly downstream of the impaired input tributary with low pH & Conductivity.

Habitat observed at both sample sites were comprised of Silt/sand/gravel substrate.
This habitat includes sandy, silty, or muddy stream bottoms; rocks along the stream bottom; and/or wetted gravel bars. This habitat may also contain algae covered
rocks (sometimes called Aufwuchs).

Bear Run Macro Sample Site Locations

Bear Run Macro Site #1

Sample Collection: We employed the USEPA's Rapid Bioassessment Protocol for use in Wadeable Streams and Rivers (Barbour et al.1999) single, most productive habitat (riffle-Run) approach. Two benthic macroinvertebrate sample collection sites were identified by delineating two 100-meter reaches along the stream where the best available representation of riffle-run habitat existed for the stream segment of interest. Within each reach, three, three-foot by three-foot kick stations were established. Each station sampled was kicked for 1 minute directly upstream of a non-truncated D-framed net with 500 µm mesh.

Stations were "kicked" starting with the downstream station first as not to disturb the other two stations upstream.

One member of the team held the D-frame net in a constant location for 1 minute at station #1, while the other team member dislodged macroinvertebrates from large rocks in the 3 foot by 3 foot sample area, and then thoroughly dislodged macroinvertebrates from the smaller cobble in the sample area by "kicking" the streambed with their feet.

Following capture of specimens from the first of three sample stations in site #1, the contents of the D-frame net were emptied into a clean 5 gallon bucket with a small amount of clean stream water. Water was poured over the outside of the net to dislodge all specimens from the net. Additionally, individual specimens were manually picked from the net to ensure no specimens were lost.

Upon collecting the specimens from the first sample station, the above process was repeated for the final two sample stations at site #1. Specimens from all three sample stations were collected in the same 5 gallon bucket to create a composite score for the sample site based on the three sample stations within the 100 meter reach of the first station.

Upon completion of the collection process for site #1, the contents of the 5 gallon bucket were emptied into a large shallow white pan. Using tweezers, eye droppers, and a small spatula, individual macroinvertebrates were picked from the shallow pan and sorted into divided white sorting trays. Specimens were sorted by order in each compartment of the sorting trays.

Specimen Sorting Tray

Assessment: The Wadeable Freestone Single, Most Productive Habitat (Riffle-Run) Stream Macroinvertebrate Assessment Method was used to assess the macroinvertebrate community at both survey sites on Bear Run.

This assessment method is designed to make ALU assessment determinations using benthic macroinvertebrate communities in Pennsylvania's wadeable, freestone, riffle-run streams. Through direct quantification of biological attributes along a gradient of conditions, the index of biotic integrity (IBI) provided in this assessment method measures the extent to which anthropogenic activities compromise a stream's ability to support healthy aquatic communities (Davis and Simon 1995).

Six metrics are included in this assessment protocol:

Total Taxa Richness:

This taxonomic richness metric is a count of the total number of taxa in a subsample. Generally, 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. Other benefits of including this metric include its common use in many biological monitoring and assessment programs in other parts of the world as well as its ease of explanation and calculation.

Ephemeroptera + Plecoptera + Trichoptera Taxa Richness (Pollution Tolerance Values 0-4 only)

This taxonomic richness metric is a count of the number of taxa belonging to the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) in a sub-sample – 2-5 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, many types of pollution (Lenat and Penrose 1996), although sensitivity to different types of pollution varies among taxa in these insect orders. The version of this metric used here only counts EPT taxa with PTVs of 0 to 4, excluding a few of the most tolerant mayfly and caddisfly taxa. 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. This metric has a history of use across the world and is relatively easy to use, explain, and calculate (Lenat and Penrose 1996).

Beck's Index (version 3)

This taxonomic richness and tolerance metric is a weighted count of taxa with pollution tolerance values of 0, 1, or 2. The name and conceptual basis of this metric are derived from the water quality work of William H. Beck in Florida (Beck 1955). This metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of pollution sensitive taxa.

Shannon Diversity

This community composition metric measures taxonomic richness and evenness of individuals across taxa of a sub-sample. 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. The name and conceptual basis for this metric are derived from the information theory work of Claude Elwood Shannon (Shannon 1948).

Hilsenhoff Biotic Index

This community composition and tolerance metric is calculated as an average of the number of individuals in a sub-sample, weighted by pollution tolerance values. Developed by William Hilsenhoff, the Hilsenhoff Biotic Index (Hilsenhoff 1977, 1987, 1988; Klemm et al. 1990) generally increases with increasing ecosystem stress, reflecting increasing dominance of pollution-tolerant organisms. Percent Sensitive Individuals (Pollution Tolerance Values 0-3 only) This community composition and tolerance metric is the percentage of individuals with pollution tolerance values of 0 to 3 in a sub-sample and is expected to decrease in value with increasing anthropogenic stress

Percent Sensitive Individuals (Pollution Tolerance Values 0-3 only)

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Findings

Bear Run Sample Site #1

Taxa Name	Number of Individuals	Pollution Tolerance Value
Ephemerellidae	8	1
Hydropsychidae	1	5
Heptageniidae	2	4
Perlidae	1	2
Decapoda	1	8
Heptageniidae	1	3

Total Taxa Richness: 6

EPT Taxa Richness (PTV 0-4 only)

3 Ephemeroptera taxa (Ephemerellidae, Heptageniidae, Heptageniidae)
1 Plecoptera taxa (Perlidae)
1 Trichoptera taxa (Hydropsychidae)

EPT Taxa Richness = 3 + 1 + 1
EPT Taxa Richness = 5

Beck's Index (Version 3):

$= 3 * (n_{taxaPTV0}) + 2 * (n_{taxaPTV1}) + 1 * (n_{taxaPTV2})$

Where ntaxaPTV0 is the number of taxa with a PTV attribute of 0, ntaxaPTV1 is the number of taxa with a PTV attribute of 1, and ntaxaPTV2 is the number of taxa with a PTV attribute of 2.

Beck's Index (version 3) = 3(0) + 2(1) + 1(1)
Beck's Index (version 3) = 0 + 2 + 1
Beck's Index (version 3) = 3

Hilsenhoff Biotic Index

$$= \sum_{i=0}^{10} [(i * n_{indvPTVi})] / N$$

where nindvPTVi = the number of individuals in a sub-sample with PTV of i and N = the total number of individuals in a sub-sample.
There are 0 individuals with a PTV = 0
There are 8 individuals with a PTV = 1
There are 1 individuals with a PTV = 2
There are 1 individuals with a PTV = 3
There are 2 individuals with a PTV = 4
There are 1 individuals with a PTV = 5
There are 0 individuals with a PTV = 6
There are 0 individuals with a PTV = 7
There are 1 individuals with a PTV = 8
There are 0 individuals with a PTV = 9
There are 0 individuals with a PTV = 10

There are a total of 14 individuals in this sample.

Hilsenhoff Biotic Index = [(0*0) + (1*8) + (2*1) + (3*1) + (4*2) + (5*1) + (6*0) + (7*0) + (8*1) + (9*0) + (10*0)]/14

Hilsenhoff Biotic Index = 2.43

Shannon Diversity Index

$$= -1 \left(\sum_{i=1}^{Rich} [(n_i/N) \ln(n_i/N)] \right)$$

where ni = the number of individuals in each taxon (relative abundance); N = the total number of individuals in a sub-sample; and Rich = the total number of taxa in a subsample (total taxa richness).

There are 6 taxa in this sample. The number of each taxon are shown in the table above. There are a total of 14 individuals in this sample.

Shannon Diversity Index = -1 [(8/14) ln (8/14) + (1/14) ln (1/14) + (2/14) ln (2/14) + (1/14) ln (1/14) + (1/14) ln (1/14) + (1/14) ln (1/14)

Shannon Diversity Index = 1.35

Percent Sensitive Individuals (PTV 0-3 only)

$$= \left(\sum_{i=0}^{3} n_{indvPTVi} \Big/ N \right) *100$$

where nindvPTVi = the number of individuals in a sub-sample with PTV of i and N = the total number of individuals in a sub-sample.

There are 0 individuals with a PTV = 0
There are 8 individuals with a PTV = 1
There are 1 individuals with a PTV = 2
There are 1 individuals with a PTV = 3

There are a total of 14 individuals in this sub-sample.

Percent Sensitive Individuals (PTV 0-3 only) = (0+8+1+1)/14*100
Percent Sensitive Individuals (PTV 0-3 only) = 10/14*100
Percent Sensitive Individuals (PTV 0-3 only) = 71.43%

IBI Calculation			
Metric	**Standardization Equation** (Using small-stream standardization values)	**Observed Metric Value**	**Standardized Metric Score**
Total Taxa Richness	(observed value / 33)*100	6	18.18
EPT Taxa Richness	(observed value / 19)*100	5	26.32
Beck's Index	(observed value/38)*100	3	7.89
Hilsenhoff Biotic Index	[(10-observed value)/(10-1.89)]*100	2.43	93.34
Shannon Diversity	(observed value/2.86)*100	1.35	47.20
Percent Sensitive Individuals	Observed value/84.5)*100	71.43	84.53
Average of standardized core metric scores (IBI Score) =			46.24

Bear Run Sample Site #2

Taxa Name	Number of Individuals	Pollution Tolerance Value
Hydropsychidae	4	5

Total Taxa Richness: 1

EPT Taxa Richness (PTV 0-4 only)

1 Trichoptera taxa (Hydropsychidae)

EPT Taxa Richness = 1

Beck's Index (Version 3):

$= 3 * (n_{taxaPTV0}) + 2 * (n_{taxaPTV1}) + 1 * (n_{taxaPTV2})$

Where ntaxaPTV0 is the number of taxa with a PTV attribute of 0, ntaxaPTV1 is the number of taxa with a PTV attribute of 1, and ntaxaPTV2 is the number of taxa with a PTV attribute of 2.

Beck's Index (version 3) = 0

Hilsenhoff Biotic Index

$$= \sum_{i=0}^{10} [(i * n_{indvPTVi})] / N$$

where nindvPTVi = the number of individuals in a sub-sample with PTV of i and N = the total number of individuals in a sub-sample.
There are 0 individuals with a PTV = 0
There are 0 individuals with a PTV = 1
There are 0 individuals with a PTV = 2
There are 0 individuals with a PTV = 3
There are 0 individuals with a PTV = 4
There are 1 individuals with a PTV = 5
There are 0 individuals with a PTV = 6
There are 0 individuals with a PTV = 7
There are 0 individuals with a PTV = 8
There are 0 individuals with a PTV = 9
There are 0 individuals with a PTV = 10

There are a total of 4 individuals in this sample.

Hilsenhoff Biotic Index = [(0*0) + (1*0) + (2*0) + (3*0) + (4*0) + (5*1) + (6*0) + (7*0) + (8*0) + (9*0) + (10*0)]/14

Hilsenhoff Biotic Index = .35

Shannon Diversity Index

$$= -1\left(\sum_{i=1}^{Rich}[(n_i/N)\ \ln(n_i/N)]\right)$$

where ni = the number of individuals in each taxon (relative abundance); N = the total number of individuals in a sub-sample; and Rich = the total number of taxa in a subsample (total taxa richness).

There are 6 taxa in this sample. The number of each taxon are shown in the table above. There are a total of 14 individuals in this sample.

Shannon Diversity Index = -1 [(1/4) ln (1/4)]

Shannon Diversity Index = 0

Percent Sensitive Individuals (PTV 0-3 only)

$$= \left(\sum_{i=0}^{3} n_{indvPTVi} / N\right) * 100$$

where nindvPTVi = the number of individuals in a sub-sample with PTV of i and N = the total number of individuals in a sub-sample.

There are 0 individuals with a PTV = 0
There are 0 individuals with a PTV = 1
There are 0 individuals with a PTV = 2
There are 0 individuals with a PTV = 3

There are a total of 4 individuals in this sub-sample.

Percent Sensitive Individuals (PTV 0-3 only) = 0
Percent Sensitive Individuals (PTV 0-3 only) = 0
Percent Sensitive Individuals (PTV 0-3 only) = 0%

IBI Calculation			
Metric	**Standardization Equation** (Using small-stream standardization values)	**Observed Metric Value**	**Standardized Metric Score**
Total Taxa Richness	(observed value / 33)*100	1	3.03
EPT Taxa Richness	(observed value / 19)*100	1	5.26
Beck's Index	(observed value/38)*100	0	0.00
Hilsenhoff Biotic Index	[(10-observed value)/(10-1.89)]*100	0.35	118.99
Shannon Diversity	(observed value/2.86)*100	0	0.00
Percent Sensitive Individuals	Observed value/84.5)*100	0	0.00
Average of standardized core metric scores (IBI Score) =			21.21

Conclusion

Upstream of Macro Site #1, Bear Run exhibits a limited community of macroinvertebrates. The tributary that enters Bear Run from the east just below Site #1 degrades water quality and the limited macroinvertebrate life found below the tributary illustrates the impact of pollution on the macroinvertebrate community within the mainstem of Bear Run.

Note that the low overall individual collection rate at both sites indicates impaired habitat due to toxic pollution, or severe habitat alteration. Typical sample size should be greater than 160 total organisms per composite site.