Big Run
Coldwater Conservation Plan

Prepared by:

Western Pennsylvania Conservancy

water, land, life.

Watershed Conservation Program

Assistance Provided by:

Allegheny Mountain Chapter of Trout Unlimited

The Borough of Big Run and the Citizens of the Big Run Watershed

Coldwater Heritage Partnership

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Acknowledgements

A special thank you goes out to the citizens of the Big Run Watershed. They stopped many times to offer assistance when they saw a WPC staff standing along the road, thinking that they were lost or having car trouble. When they learned about what the staff were actually doing, they were helpful with a story and sharing their knowledge of the area. If they didn't know, they knew someone that did. The information gleaned from these quick roadside conversations added value to the content of this plan.

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Lastly, the COVID-19 pandemic erupted during prime data collection time for this project. As were all things everywhere, the timeline, data gathering, travel, public interaction and communication about this project were all initially paused and then modified as information about the virus developed. Getting the work done while trying to keep everyone as safe as possible was a challenge that created a need for flexibility and adaptation. Much appreciation goes out to those that were flexible and amiable to the necessary adjustments.

INTRODUCTION AND BACKGROUND

The Coldwater Conservation Plan, developed by the Western Pennsylvania Conservancy for the Big Run Watershed in Jefferson County, contains stream health analysis based upon water quality data collected through sampling and visual inspection, as well as recommendations for potential restoration and protection strategies supported by these analyses. The objective of this document is to generate support and participation from local landowners and municipal entities and to encourage community awareness, so that recommendations can be advanced into the implementation phase, yielding watershed improvements.

The initial work of the Big Run Cold Water Conservation Plan began in 2019 with the gathering of data from previous studies and plans, along with Geographic Information Systems (GIS) mapping and the coordination of a public meeting in the borough of Big Run. The meeting brought together conservation district staff, municipal officials and planners, local conservation organizations, and private landowners. The focus of the meeting was to inform attendees of the planning process and how they could be involved, encourage information sharing, develop landowner cooperation, and discuss anticipated outcomes. The meeting resulted in information sharing and a willingness of all parties to assist with the development of the plan.

DESCRIPTION of the WATERSHED

The Big Run watershed is located in the southeastern corner of Jefferson county, and covers a 19.4 square-mile area. It is a southern sloped drainage and contributes to the upper portion of Mahoning Creek watershed and is part of the Ohio River watershed. There are no public lands within the Big Run watershed. Several large private parcels are owned and managed by a timber company. There is also a large Amish community within the watershed. There are four townships (Henderson, McCalmont, Bell, and Winslow) and the borough of Big Run that make up the municipalities of the area. There are a mix of low volume paved and dirt and gravel roads (DGR) that crisscross the watershed connecting the communities of Big Run, Desire, and Paradise. Some of these are posted as 'no winter maintenance'. The Big Run Watershed: Land Use map (Figure 1) provides a visual display of how the forest land parallels the stream and how the open land is mostly on the outskirts of the watershed.

Land Cover

The land use of Big Run is a patchwork of forested, agriculture, disturbed lands (abandoned mine land and rail lines, etc.), private residences and commercial lands. Table 1: Land Use Breakdown of Big Run Watershed shows the acres of land uses in the watershed as well as the percent of the land use. Approximately 60% of the Big Run Watershed is under natural cover, meaning that there are abundant natural areas within the watershed to benefit water quality and wildlife habitat. See Appendix 3 document called 2013/2014 Mapped 1-meter Resolution Land Use Classes for land use descriptions.

Table 1: Land Use Breakdown of Big Run Watershed

Land Use	Acres	Percent
Impervious Roads	104	0.8
Impervious, Non-Roads	97	0.8
Tree Canopy over Impervious Surfaces	65	0.5
Water	47	0.4
Floodplain Wetlands	18	0.1
Other Wetlands	2	0.0
Forest	7284	58.7
Tree Canopy over Turf	97	0.8
Mixed Open	567	4.6
Fractional Impervious	1	0.0
Turf Grass	1086	8.8
Agriculture	3035	24.5
Total	**12402**	**100**

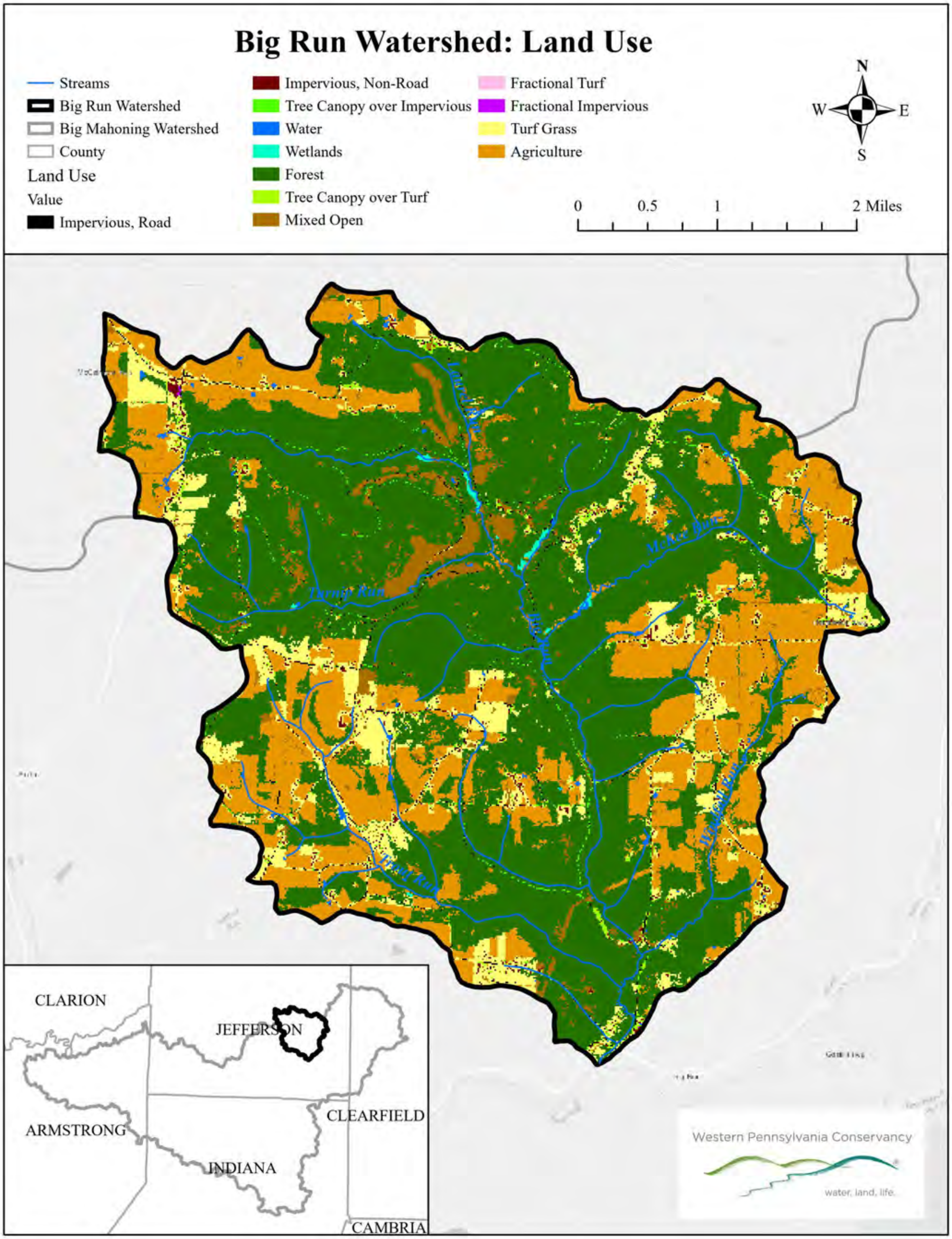

Figure 1: Land Use Map of the Big Run Watershed

Forest land comprises approximately 58% of the watershed. Most of the forested areas are in the norther portion of the watershed. Fortunately, the forest land also parallels the mainstem of Big Run leaving a relatively robust riparian area along a majority of the larger segments of the stream.

Agriculture, primarily row crops and hayland along with limited pasture land, comprise just over 24% of the watershed. There is a mix of beef, dairy and white-tailed deer farms scattered about the watershed. A majority of the agriculture activity spreads over the Trout Run and Windfall Run sub-watersheds.

BIG RUN

The main stem of Big Run landowners are a mix of private individuals and timber companies, but all seem to value the recreational benefits of a forested watershed through management of the properties for hunting and fishing. This has led to areas of Big Run being listed for 'walk-in only' fishing and other portions posted private access exclusive to 'members only' hunting groups. The choices of these landowners to limit access and use the land for game recreation has kept the percentage of land available for development low, which has a positive effect on water quality, but also poses a challenge to adding additional best management practices (BMPs), such as adding forested riparian buffers to the open stream areas. The challenge comes in the form of resistance from the non-forest landowners not wanting to install BMPs that would 'tie-up' what open land is available. Overcoming this challenge will involve landowner outreach and promotion of BMPs that mesh well with the desires of the community.

Most of the residences within the watershed are scattered along the perimeter of Big Run and their water drains into the named and un-named tributaries of the system. The majority of these residences are a type of agriculture operation, including hayland, livestock and row crops. Runoff from annual cropping activities as well as over-grazed pastures is known to lead to excess sedimentation in the watershed, which can be detrimental to stream ecology without the implementation of BMPs to mitigate the sedimentation. An additional source of sediment are dirt and gravel roads, as there are 13.1 miles of these roads within the watershed. There is also a small amount of abandoned mine drainage (AMD) within the watershed, and sediment from seeps and discharges add to the sediment load. Fine sediment appears throughout the watershed and can be contributed to these land uses.

Photo 1: Land use within the Big Run watershed includes active crop land including hay production.

Sediment threatens the food supply and habitat for the wild brown trout as well as the other fish communities that reside within the watershed. The silt and sediment are filling in niche spaces, leaving limited macroinvertebrate habitat. Trout populations are dependent on a diverse macroinvertebrate population and this diversity is dependent on proper habitat, which includes a mix of gravel, cobble, boulders, fine woody debris and leaves. Without this habitat, both the fish and their food source will be limited in their abilities to survive. Because of the forested nature of portions of the watershed, there are patches of great habitat, but the stream tributaries are not as well forested and also have a higher gradient. These factors are allowing sediment from agriculture land and DGRs to move faster over long distances through the system and cover the very suitable habitat within the mainstem. Even with the noted sediment throughout the watershed, there are reproducing trout populations; however, these populations are limited by food supply and when there are not enough macroinvertebrates for consumption, these fish may feed on their own young. This feeding habit is not ideal and will not allow a population of fish to grow as it would when diets include macroinvertebrates. It is possible that the existing trout population may become threatened due to the limited food supply and increased sediment loading.

Big Run is currently designated as a Coldwater Fishery (CWF). Portions of the stream are listed as natural reproduction with some even listed as class A natural reproduction. The Big Run Watershed: Trout Streams map (Figure 2) shows where the trout stocked area, natural reproduction, and class A areas are located on the streams of Big Run. There are also portions of the stream that are trout stocked, with 300 fish annually. This information shows that the water quality is suitable for trout and that the trout want to be in this watershed, but without active protection of this resource, the existing population could fail.

Photo 2: The bridge on TR 506 crossing Big Run just above the start of the Class A section of the stream.

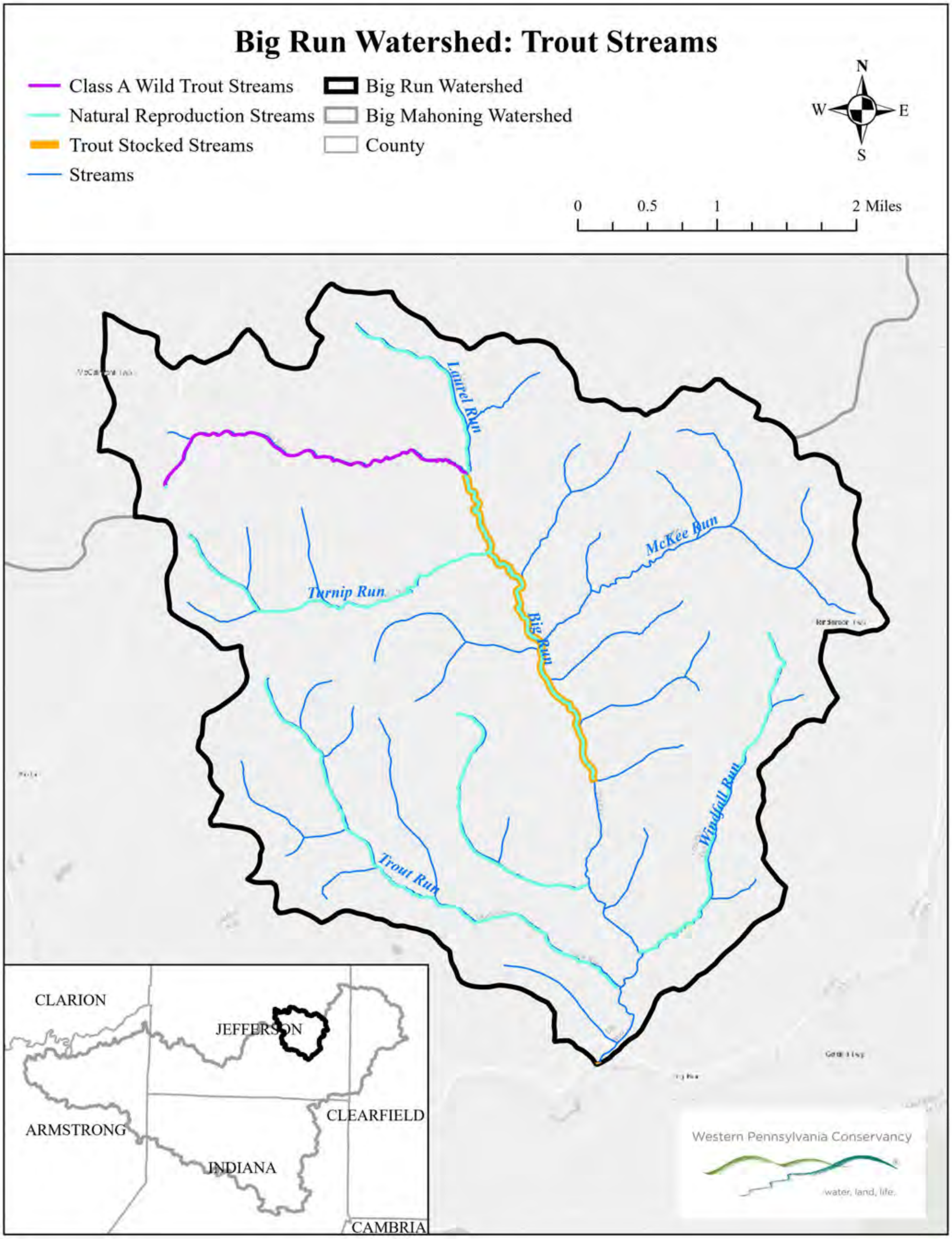

Figure 2: Big Run Watershed: Trout Streams

PREVIOUS and CURRENT STUDIES/ANALYSIS of the WATERSHED

Previous studies that have taken place within the Big Run Watershed include Pennsylvania Natural Heritage Program (PNHP) inventories and Pennsylvania Fish and Boat Commission (PFBC) unassessed waters surveys, both of which focused on the biodiversity of the area. Interested parties can reach out to these partners for any information on these studies. There was also an analysis completed on riparian landowners within the watershed through a partnership project led by the Pennsylvania Department of Conservation and Natural Resources (DCNR) partnership project known as Prime Prospects. Additionally, the Pennsylvania Department of Protection (DEP) has data on mining activity and abandoned mine land features for Big Run.

Information from these studies helped direct landowner networking and data collection for the Big Run CHP. This included sending out an informational postcard mailer to the landowners on the Prime Prospect list as well as planning for the locations of the water quality surveys. Descriptions of the field data collection parameters are listed in an Overview subsection and the results of the work will be summarized following the overview. Components of the results will also be discussed throughout this document.

ASSESSMENT AND MONITORING

VISUAL ASSESSMENT OVERVIEW

In order to record current habitat conditions, a modified visual habitat assessment was conducted throughout the watershed. This was done by walking along the stream as much as possible. In an effort to create comparable data, the stream was broken into reaches based on confluence points. For example the point where Big Run joins with Mahoning Creek to the point where the first un-named tributary joins with Big Run mainstem is a segment. The data collected for each segment was based off of a modified version of the US Environmental Protection Agency's (USEPA's) Rapid Bioassessment Protocol for Streams and Wadeable Rivers. The EPA protocol assigns a numeric value to ten different stream characteristics, or "assessment elements," equating to overall stream quality. The assigned assessment scores range from zero to twenty, with twenty being the highest in quality, and are based on specific conditions associated with each assessment element. An example of the assessment sheets used in the field can be found in the appendices (appendix 1 and 2). The ten individual assessment scores for each segment were totaled and averaged to yield an overall habitat assessment score. This average score was then broken into four categories: optimal, with an average score ranging between 16-20, suboptimal, with an average score ranging between 11-15, marginal, with an average score ranging between 6-10, and poor, with an average score ranging between 0-5. To help identify on which side of the stream pollution sources are located, a designation of "river right" or "river left" is used, which is the standard practice used by the American Canoe Association when describing locations on a stream. These directions are given in relationship to the observer always facing downstream. In this way, the repetition of north, south, east, and west directions are minimized as streams are constantly shifting the direction in which they flow.

Habitat Assessment Ranking	
Optimal	*average score ranges between 16-20*
Suboptimal	*average score ranges between 11-15*
Marginal	*average score ranges between 6-10*
Poor	*average score ranges between 0-5*

VISUAL ASSESSMENT EFFORTS AND RESULTS

With these four categories as a reference, the Big Run Watershed Visual Assessment map (Figure 3) was developed on the overall average score.

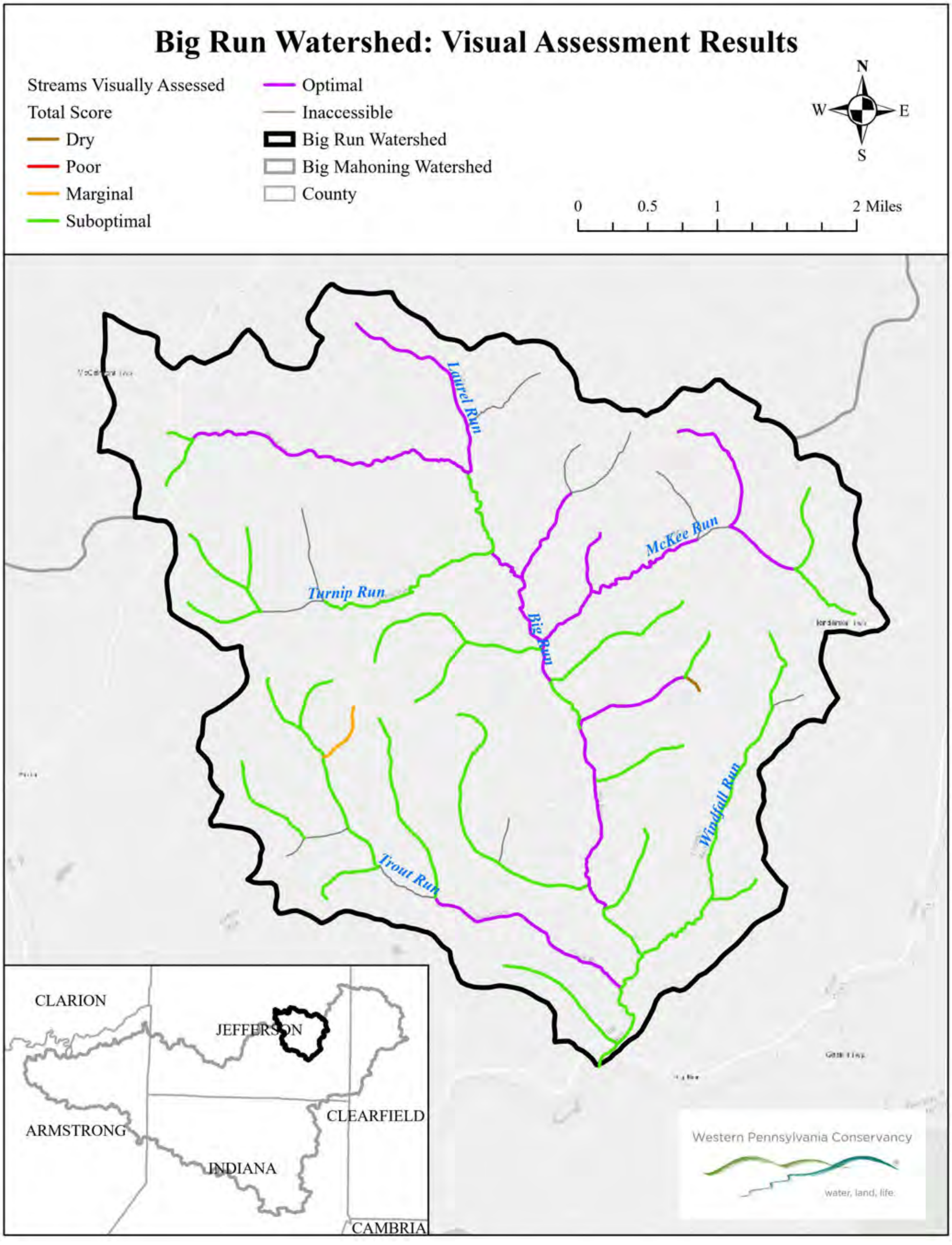

Figure 3: Big Run Watershed Visual Assessment Results

There are about 44 miles (43.29 listed in 305b or 43.29 listed in Chap 93) of stream in the Big Run Watershed, which break down into 69 different reaches based on the habitat assessment protocol. During the course of this project, WPC staff walked as many of these reaches as possible. When access was limited, best professional judgement was used to evaluate the entire reach. None the less, there were a few reaches that were not accessible. In these cases, a projected score was give based on information from nearby reaches. A total of 56 reaches were evaluated and scored (Figure 4).

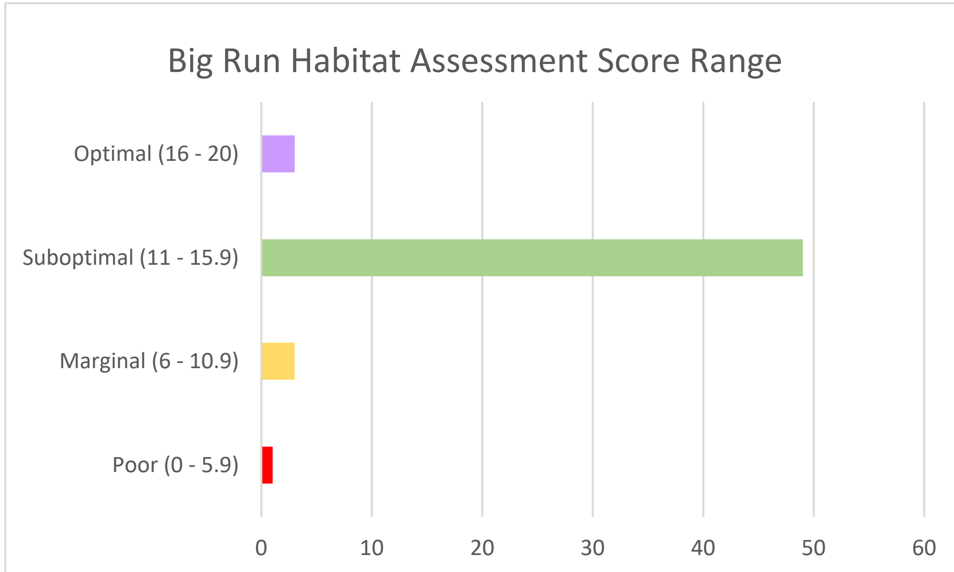

Figure 4: Average Visual Assessment Scores for Big Run

In general, there were very few reaches that fell in the Optimal (3 reaches) or Poor (1 reach) range, which is not unexpected because the variability among the individual parameters balanced out over all the parameters as a whole. Meaning a reach that might have dirt and gravel road impacts and was scored low for the embeddedness parameter also had an excellent riparian buffer that scored high. The high and low scores evened the average out and led to the overall score staying in the sub-optimal range, but the individual embeddedness score would be low as compared to the riparian score. Because of this the overall scores were used as a guide, but the major evaluation points were pulled from the individual scores. A breakdown of the average score can be seen in Figure 5.

From these scores it can be seen that four parameters averaged scores equal to or higher than the total overall average. The Channel Flow Status parameter is connected to the condition of how the water travels through the channel regardless of the quality of the water, and a higher score indicates that the water table supplying the streams are fairly stable, even with seasonal variability of rainfall and snow melt. Having a stable channel flow is beneficial for the stream's aquatic life. Also good for the aquatic life are the Epifaunal Substrate/Available Cover, Frequency of Riffle and Bends, and Velocity/Depth Regimes parameters. These three also scored higher than the overall average and are indicative of well-spaced and necessary habitat for aquatic communities to thrive.


Photo 3: The central portion of Big Run Mainstem has an optimal riparian buffer and well protected banks; however, sediment buildup can be seen in the channel.

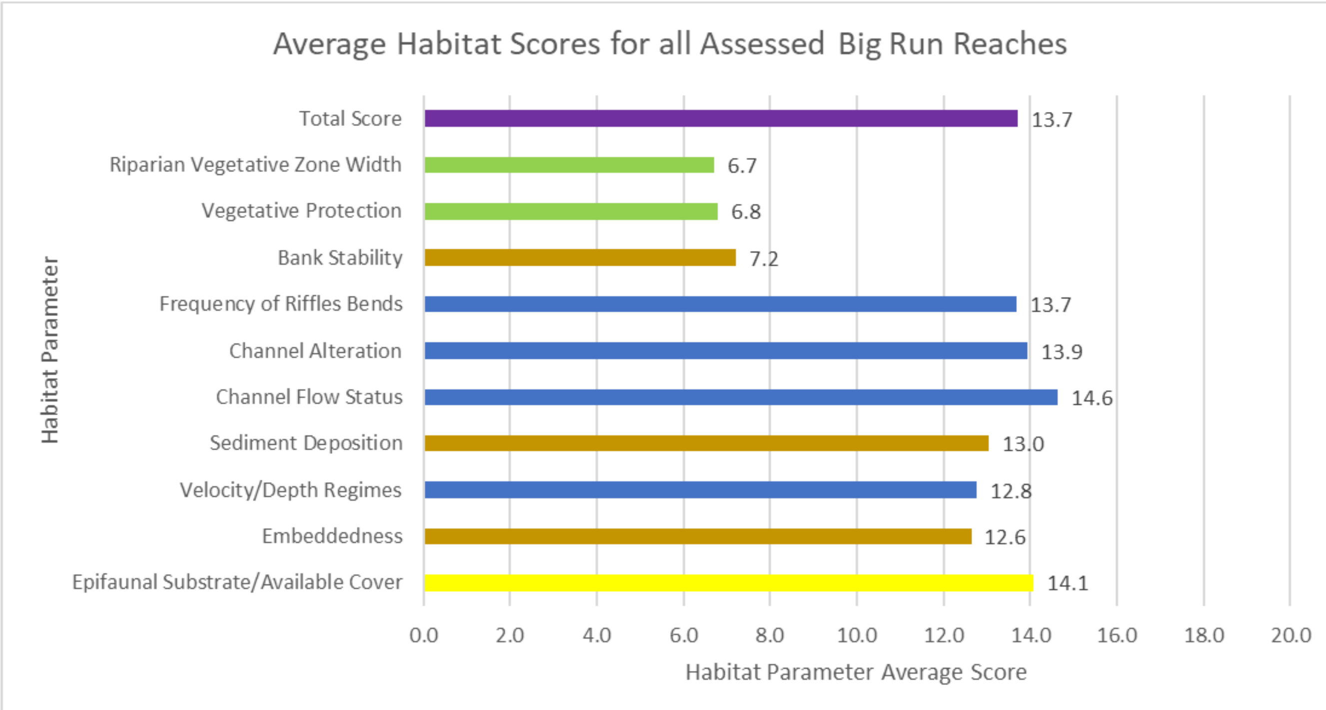

Figure 5: Average Individual Habitat Scores for Big Run

There are two related parameters that scored in the low end of the marginal category, Vegetative Protection and Riparian Vegetative Zone Width. A low vegetative protection score can lead to a low bank stability score as well, because without adequate bank protection by native vegetation the banks are prone to eroding. This erosion will contribute sediment to the stream. Key to controlling sediment is the riparian zone, especially those associated with headwater streams, which provides important ecological functions that influence the overall health of a river system. This zone serves to trap and retain upland pollutants, nutrients, and sediments from entering the aquatic environment. Healthy, native riparian vegetation provides shading, which helps maintain the typically cold temperatures of headwater streams. Native vegetation also stabilizes the streambank and reduces erosion. Riparian plant litter and woody debris supply nutrients to the aquatic food chain and contribute to instream habitat and structure. Alterations to the riparian zone may result in degraded water and habitat quality of a river system. Having a low average riparian score implies that there would be a low score for epifaunal habitat, but this is not the case for Big Run. In reviewing the Land Use Map (Figure 1), it can be seen that a forested riparian buffer is either present and wide on the stream or not present at all. The averaged marginal score of 6.8 masks both the extreme low scores and the exceptional scores of the riparian habitat, both of which occurred. Because the average is on the low range of marginal, it can be projected that there are more riparian areas in need of restoration, and that the established mature riparian areas could use protection to maintain their prime condition. Both restoration and protection of the riparian areas will not only benefit water quality by reducing sediment and controlling nutrients, but will also improve and expand aquatic habitat.

In summary, the visual habitat inspection of the streams within Big Run watershed provided data to be used as a guide for improvement and protection suggestions for water quality, but can also be used as a bench mark to gauge the results of improvement efforts. A notable additional benefit of the visual assessment data collection was the resulting human hours spent out on the landscape of the watershed. The locals noticed the assessment activities and stopped to have conversations with the investigators. They provided local insight into the watershed as well as anecdotal accounts of activities that guided investigators to look more in-depth at particular locations, and generally added to the information provided in this document.

Water Quality and Macroinvertebrates Overview

Knowing about the existing water quality conditions and macroinvertebrate populations throughout various sites in the watershed will help with the overall evaluation of Big Run. Having data points at different locations, high and low in the watershed, will also help direct where problems may be coming from or reconfirm that a section is staying in good condition. There are expected differences in data between spring and fall collection seasons, but having information from both time periods is valuable for future evaluation and conservation efforts.

Water Quality: The following information provides descriptions about the water quality parameters that were analyzed for the project.

Flow and Turbidity

- **Stream Flow** is the measurement, reported in gallons per minute, of the amount of water traveling through the stream channel at any one specific moment. Flow measurements taken at the time of water sample collections are used to support water quality monitoring efforts. Multiple readings over time will allow for the seasonal flow levels to be tracked. The information also allows for loading rates to be calculated for some of the parameters. Natural seasonal variations are expected when monitoring flow. Other factors such as storms, snowmelt, ice, and aquatic plants can affect rates during each season makings reading vary from the expected norm.
- **Turbidity** is the measure of the relative clarity of water. Turbidity increases as a result of suspended solids in the water that reduce the transmission of light. Soil erosion, waste discharge, urban runoff, or algal growth may cause high turbidity. Water becomes warmer as suspended particles absorb heat from sunlight, resulting in depleted oxygen levels and an environment that is difficult for some species to survive.

Temperature and Dissolved Oxygen

- **Temperature** influences dissolved oxygen levels, rate of photosynthesis by aquatic plants, metabolic rates of aquatic organisms, and sensitivity of organisms to toxins, parasites, and diseases. Temperature can be controlled by the amount of vegetative cover along stream banks, sediment levels, and waste distribution into a stream.
- **Dissolved oxygen** concentration in a stream is the mass of the oxygen gas present, in milligrams per liter of water. A healthy stream is considered to be 90-100 % saturated with oxygen.

pH and Alkalinity

- **pH** is a measurement of how acidic or basic water is. Acidic water (less than 7.0) or basic water (greater than 7.0) has the ability to impair aquatic life. Most aquatic organisms are able to tolerate small fluctuations in this parameter but as a general rule of thumb, a pH of less than 6.0 or greater than 8.0 will affect aquatic communities.
- ***Alkalinity*** measures the buffering capacity of a stream, referring to how well it can neutralize acidic pollution or resists abrupt changes in pH.

Conductivity and Total Dissolved Solids

- **Conductivity** is a measure of the ability of water to pass an electrical current. Conductivity in streams and rivers is affected primarily by the geology of the area through which the water flows.

- **Total dissolved solids** in stream water consist of calcium, chlorides, nitrate, phosphorus, iron, sulfur, and other particles. If a stream has too many dissolved solids it will negatively impact stream communities (high values for this parameter depend on a variety of factors but will typically be over 500 ppm).

Phosphates and Nitrates

- **Phosphate** is the form of phosphorous that is typically present in natural waters. Organic phosphate is present in living organisms, their waste products, and their remains. Excess phosphate produces algal blooms, which can often lead to eutrophication. Phosphorous may come from human, animal, and industrial waste as well as human disturbance of the land and its vegetation.
- **Nitrates** are a natural nitrogen compound needed by all living plants and animals to build proteins, but in excess they can cause significant water quality problems. Sewage is the main source of nitrates added by humans to streams; however, fertilizers and agricultural runoff are also significant sources of nitrate pollution. Excess nitrates can cause low levels of dissolved oxygen, and concentrations as high as 10 mg/L can become toxic to warm blooded animals.

Macroinvertebrates

One of the most effective ways to judge long-term water quality is through the macroinvertebrate community – the insects, crustaceans, worms, etc. They form the base of the in-stream animal food chain so a diversity of macroinvertebrates is essential for a diversity of higher life forms such as fish. Some macroinvertebrates are very sensitive to different types of pollution, and they have different needs for food and shelter.

Aquatic macroinvertebrate collections were done following the DEP In-stream Comprehensive Evaluation (ICE) protocol (DEP 2013). Sites selected were wadable, riffle-run sections of the stream. Sampling consisted of six, one-minute kicks from riffle areas throughout a 100-meter reach, using a 500-micron mesh D-frame net, and with each kick disturbing approximately one square meter directly upstream of net. Samples were stored in alcohol in the field and transported back to the lab for processing. Sub-sampling and the identification were done according to ICE protocol. Organisms were identified to the family level. Results are stored in an excel database.

Evaluation of the macroinvertebrate communities were done for each site. A variety of indices were used to examine the data, and allow for a general assessment of the health of a stream based on the results of the evaluation.

Pollution Tolerance Index (PTI)
The Pollution Tolerance Index assesses water quality based on the pollution tolerance values of all the macroinvertebrates found in a sample. In this indexing tool, a score of 23 or greater is characterized as Excellent water quality.

EPT:D Ratio% Chironomids
Ephemeroptera, Plecoptera, and Tricoptera (EPT) are commonly known as mayflies, stoneflies and caddisflies, respectively. EPT larvae are aquatic and sensitive to disturbance and pollution in streams. Diptera (D), specifically Chironomids are commonly known as midge flies and their aquatic larvae are able to withstand varying levels of pollution. The relative amounts of these two groups of insects in a sample can help determine the health of the stream.

Hilsenhoff Biotic Index (B)

The Hilsenhoff Index measures the likelihood of organic pollution by assigning a pollution tolerance value to a particular organism or group of organisms. Tolerance values range from one to ten, with one indicating a low pollution tolerance. Depending on the abundance of tolerant verses intolerant organisms in a sample, (B) will either be driven up or down. Scores can be seen in the adjacent chart.

HBI Value	Water Quality	Degree or Organic Pollution
0.00-3.50	Excellent	No apparent organic pollution
3.51-4.50	Very Good	Slight organic pollution
4.51-5.50	Good	Some organic pollution
5.51-6.50	Fair	Fairly significant organic pollution
6.51-7.50	Fairly Poor	Significant organic pollution
7.51-8.50	Poor	Very significant organic pollution
8.51-10.00	Very Poor	Severe organic pollution

From Hilsenhoff, 1987

Water Quality and Macroinvertebrates Effort and Results

Photo 4: WPC staff run in-field water quality tests on Big Run.

In-field water quality sampling and macroinvertebrate monitoring were done twice over the course of this project; once in the fall 2019 and once in the spring 2020. Five sites were chosen based on location within the watershed in an effort to provide the best overall view of the macroinvertebrate populations within the watershed. Three sites were on mainstem Big Run, a lower (BR-1), middle (BR-2), and upper site (BR-3), as well as sites on two named tributaries; McKee Run and Turnip Run. The map titled: Big Run Watershed Monitoring Points (Figure 6) shows that the sites were spread across the watershed to document current conditions on the mainstem of Big Run as well as two major tributaries.

The data for all the monitoring sites were reviewed and summarized. Table 2: Big Run Water Quality Monitoring Results lists the data information that was collected on water quality. Much of the information showed expected trends and water quality fluctuations, but there were some areas where results varied. Some of these variations can be explained through weather events and other knowns about the surrounding area; however, there are some areas where without further monitoring, an explanation about the results cannot be done with any amount of certainty. Future efforts should include continued analysis of the current data while expanding the dataset through more monitoring.

Table 2: Big Run Water Quality Data

	Site Location	40.96968	-78.88716	41.01141	-78.89755	41.0296	-78.90902	41.01215	-78.89728	41.01933	-78.9139
	Site ID	BR-1	BR-1	BR-2	BR-2	BR-3	BR-3	McR-1	McR-1	TurR-1	TurR-1
	Date	10/17/2019	4/10/2020	10/17/2019	4/10/2020	10/17/2019	4/10/2020	1/10/1900	4/10/2020	10/17/2019	4/10/2020
	Collection Time	9:00 AM	5:25 PM	10:00 AM	3:20 PM	12:30 PM	4:45 PM	10:35 AM	2:45 PM	11:45 AM	4:15 PM
SU	pH Field	8.14	8.41	7.95	8.27	8.3	8.6	7.2	8.6	7.67	8
ppm	TDS	178	130	179	129	221	174	128	95.7	52.7	52.6
µS/cm	Conductivity	255	226	259	54.4	311	260	181	138.4	74.1	78.5
FAU	Turbidity	4	0	13	0	0	0	13	0	10	0
mg/L	Phosphates	0.08	0.15	0.48	0.35	0	0.22	0.04	0	0.03	0.1
mg/L	Nitrates	1.1	4.4	3.2	2.6	1.6	1.1	8.3	2.7	2	1.4
mg/L	DO	11.1	N/A	10.95	12.69	11.82	N/A	10.98	12.75	11.14	N/A
˚C	Temperature	8.7	6.1	8.1	5.9	8.5	7	8.4	5.2	7.7	4.9
mg/L	Alkalinity	76	N/A	78	N/A	108	N/A	58	N/A	24	N/A
ft	Stream width	16.5	26	24	24	8.5	11	15.5	12	5.5	6
GPM	Flow	3781.6	17287.7	2353.5	6167.5	1078.2	2528.5	769	1294.3	32.3	403.5

Generally, the EPT taxa (Mayflies or *Ephemeroptera*, Stoneflies or *Plecoptera*, and Caddisflies or *Trichoptera*) require clean water with low levels of pollution, while the *Diptera* (Flies) can tolerate higher levels of organic pollution and sedimentation and are often associated with lower quality streams

Photo 5: WPC staff and AmeriCorps service member collect macroinvertebrates on Big Run. Photo taken prior to Covid.

The areas with the highest EPT:D ratios are also areas that support natural trout reproduction. Turnip Run and McKee Run are tributaries feeding into Big Run mainstem between the upper (BR-3) and middle (BR-2) sample locations. The land feeding Turnip Run is a reclaimed strip mine with poor soils and limited forest cover. Although McKee Run is primarily surrounded by forest, it features a low-gradient wetland complex in its middle section – a habitat that doesn't support high volumes of EPT species. The quality of the water from these two tributaries may be suppressing the populations of sensitive macroinvertebrates in the middle section of Big Run.

The seasonal differences in EPT:D seen in lower (BR-1) and upper (BR-3) sites may have to do with lower water levels concentrating macroinvertebrates in fewer favorable habitat areas (making them more likely to be sampled). The high levels of EPT found in the fall demonstrate that EPT reproduction is successful (the water quality and habitat requirements are present).

Pollution Tolerance Indices (PTI): All five sites we sampled in the Big Run watershed scored Good or Excellent during both sampling events (Table 3). These observations indicate that water quality has not changed dramatically in the watershed over the course of this study. The current water quality trends are consistent enough to support sensitive aquatic life such as a number of different mayfly, stonefly, and caddisfly families as well as wild reproducing brown trout in significant numbers in the headwaters of Big Run.

In an effort to track changes in water quality within the Big Run watershed a monitoring program should be continued and expanded upon based on the efforts that took place during the data collection of this project. At a minimum, at least two more years of water quality data collection should be performed at the sites listed on Figure 6, as well as possibly adding a site on Windfall Run to establish baseline criteria for that stream.

Table 3: Macroinvertebrate PTI Results

	BR-1	BR-2	BR-3	McR-1	TurR-1
Fall 2019	28	26	23	22	22
	Excellent	Excellent	Excellent	Good	Good
Spring 2020	21	24	26	26	21
	Good	Excellent	Excellent	Excellent	Good

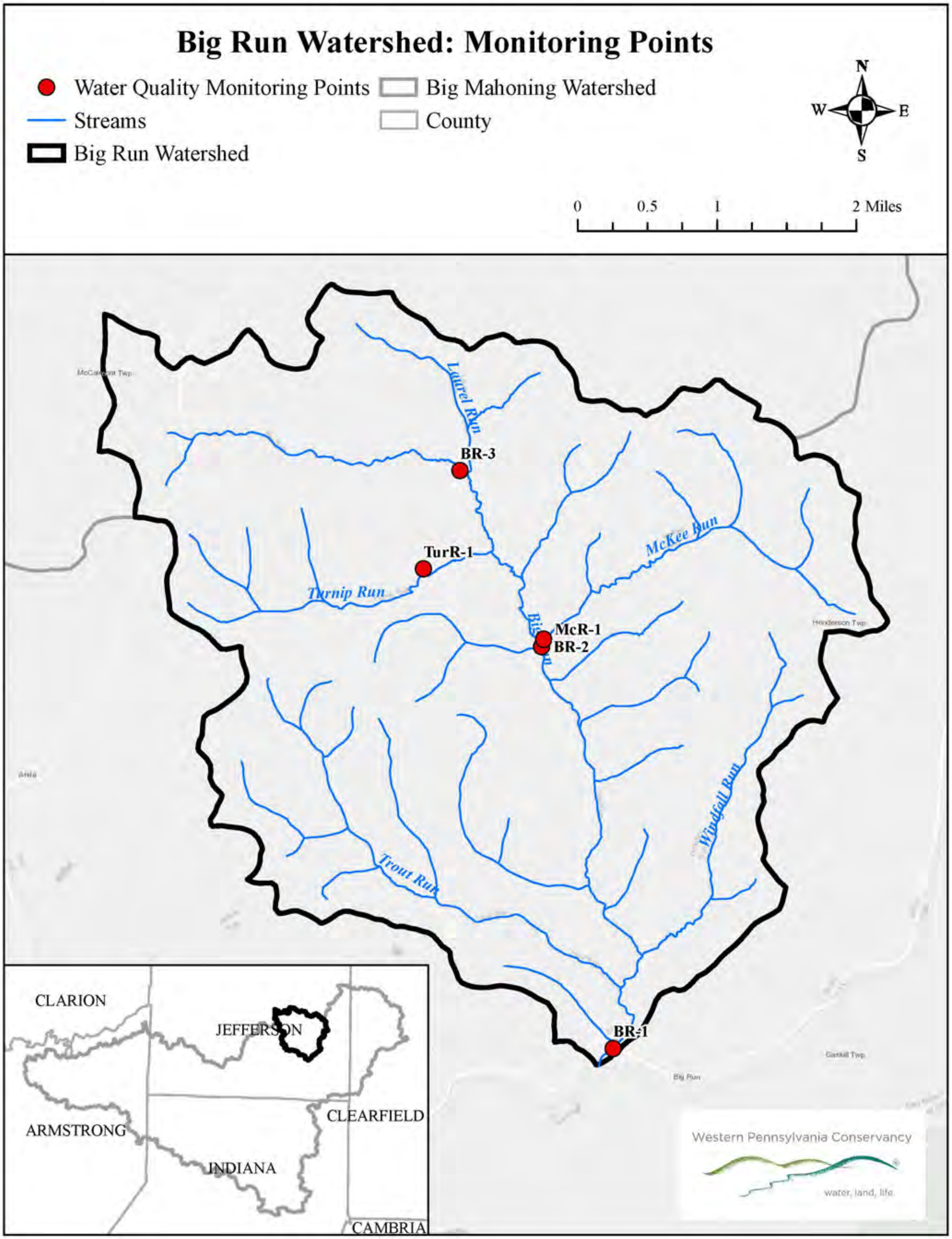

Figure 6: Big Run Watershed: Monitoring Points Map

Fish Survey Overview

Fish electro-surveys were done through the Pennsylvania Fish and Boat Commissions unassessed waters program. The surveys were done in 2015, 2016 and 2018. The surveys showed that there is the typical variety of native non-game cold water species within the watershed as well as a few warm water species (bluegill and sunfish) present, in addition to wild trout. The documented species found during the unassessed waters surveys are listed in Table 4.

Table 4: Fish Species found within the Big Run Watershed

Species Occurance in Named Streams within the Big Run Watershed*					
Big Run	**Laurel Run**	**Turnip Run**	**Mckee Run**	**Trout Run**	**Windfall Run**
Brown Trout	Brown Trout	Brown Trout	Creek Chub	Blacknose Dace	Blacknose Dace
Creek Chub	Creek Chub	Creek Chub	Green Sunfish	Brown Trout	Bluegill
Mottled Sculpin	Mottled Sculpin	Bluntnose Minnow	Johnny Darter	Fantail Darter	Brown Trout
Blacknose Dace	Blacknose Dace	Johnny Darter	Mottled Sculpin	Mottled Sculpin	Creek Chub
White Sucker	White Sucker	Mottled Sclupin	Redside Dace	Pumpkin Seed	Mottled Sculpin
Brown Bullhead		Redside Dace	Western Blacknose Dace		White Sucker
Redside Dace		Blacknose Dace	White Sucker		
Northern Hog Sucker		White Sucker			
Greenside Darter					
Bluegill					
Johnny Darter					
Central Stoneroller					
Pumpkin Seed					
Golden Shiner					
Brook Trout			*Stocked trout excluded from counts		

Note: Brook trout are on this list, but the record was from 1982 and listed one 9-inch fish. It is theorized that there may not have been as much emphasis to differentiate between stocked and native trout at that time.

Fish Survey Effort and Results

The mix and variety of species indicates that water quality conditions have been generally stable and good for the survival of fish. Tracking changes in the population of the trout is encouraged and could be done on more reaches within the watershed.

Aquatic Organism Passage (AOP) Overview

Stream connectivity is important for all aquatic species, but especially important for salmonid species in a number of ways including access to thermal refuge, access to important spawning habitat, and for eliminating genetic isolation of populations. However, poor design of culverts and bridges (road-stream intersections) can negatively affect stream connectivity. Culverts can act as barriers to fish passage in a number of ways. A culvert can be perched above the stream bed, causing fish to have to jump large heights. Aquatic organisms have varying levels of mobility and passable culverts are essential for a connected ecosystem. High current velocities in culverts can make it impossible for organisms to move through them. Water depth within the culvert can be too shallow, or may not provide resting areas for organisms that are migrating upstream. In fact, properly designed and installed culverts also benefit other aquatic species that are less mobile than trout including mussels, hellbenders, other amphibians, reptiles and macroinvertebrates. Poorly designed and/or installed culverts also pose problems for stormwater runoff, infrastructure maintenance and public safety in the event of flooding. Often, an undersized culvert creates a blowout effect downstream, increasing water velocities and streambank erosion. A plugged culvert that cannot pass debris also acts as a dam during high water events, exacerbating flooding and becoming a public safety hazard.

Photo 6: WPC Staff pause for a photo during an AOP evaluation of a culvert in the Big Run watershed.

The North Atlantic Aquatic Connectivity Collaborative (NAACC) is a collaboration of individuals from universities, conservation organizations, and state and federal natural resource and transportation departments focused on improving aquatic connectivity across a thirteen-state region, from Maine to West Virginia. NAACC has developed standardized protocols and training for assessing road-stream crossings (culverts and bridges) and developed a regional database for this field data. The information collected can be used to identify high priority bridges and culverts for upgrade and replacement. All field survey data was collected using the NAACC Stream Crossing Survey Data Form Instruction Guide (NAACC 2016). Data was collected on a Getac 600 tablet and uploaded into the NAACC online database. All data was checked for quality assurance by WPC's L1 Coordinator. Upon entry into the database, all crossings are automatically scored using two scoring systems.

AQUATIC ORGANISM PASSAGE (AOP) EFFORT AND RESULTS

A total of 40 road-stream intersections were examined as part of the Big Run CHP. Structures were scored using the NAACC protocol as referenced in the AOP Overview section. Only crossings that were located on public roadways were scored during the 2019 and 2020 surveys. Structure types assessed included single culverts, box culverts, multiple pipe culverts, and bridges. Examples of these structure types can be found in the NAACC Stream Crossing Survey Data Form Instruction Guide available on-line (NAACC 2016). Numerous crossings that were assessed failed to provide adequate fish passage, which resulted in reduced or no-AOP rankings for 58% of all crossings surveyed (Figure 7 and Figure 8). Many of the crossings that had a ranking of full AOP were large bridge structures often associated with main roads. We examined 24 culverts, only two of which didn't pose as barriers to aquatic organisms. Of all crossings that were surveyed, a structure found on Turnip Run at the intersection where T506 crosses the stream appears to have the most conservation benefit if this structure were to be replaced. An additional four miles of reconnected habitat will be available to this important population of wild brown trout. Replacing undersized road-stream crossings is of high conservation value not only to trout populations but other aquatic organisms as well.

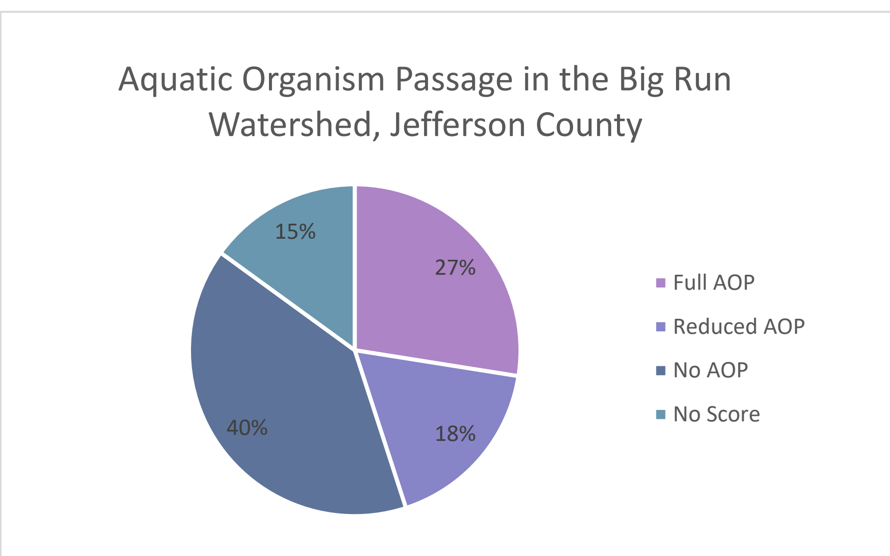

Figure 7: Ranking of the ability of passage for aquatic organisms.

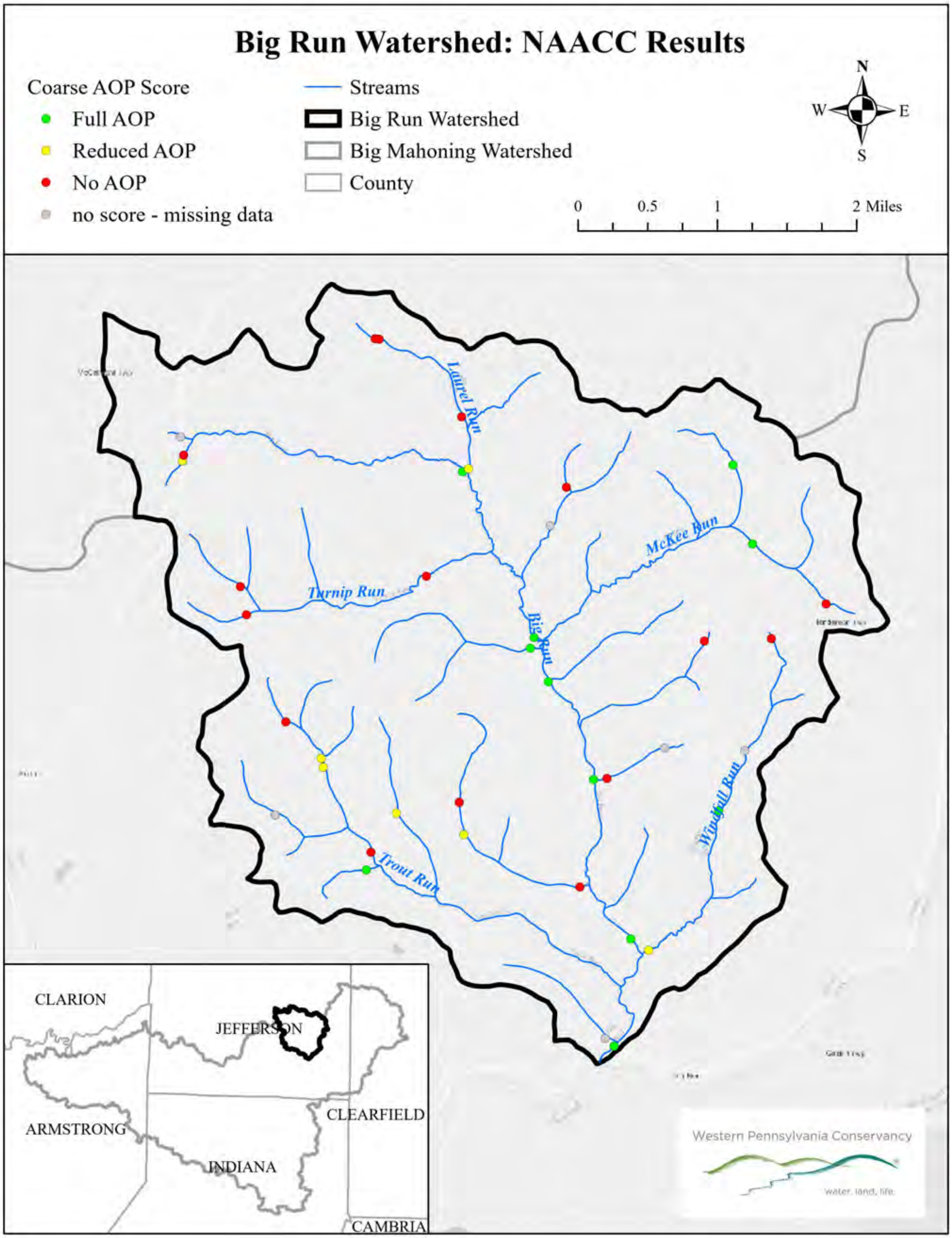

Figure 8: NAACC AOP Sites

PRIME PROSPECTS OVERVIEW

The Mahoning Creek watershed, which includes the Big Run watershed, is one of the HUC 10 watersheds with the unique feature of lying across one of the seven counties of Pennsylvania that drain to both the Ohio and the Susquehanna Rivers. Because of this feature, watershed information geared towards nutrient reduction of waters that flow into the Chesapeake Bay have been developed for roughly two-thirds of the Mahoning Creek watershed, even though it drains into the Allegheny River and ultimately the Ohio River watershed. One of the data sets that resulted from this unique feature is the generation of a list of riparian landowners ranked according to the likelihood of them planting open riparian areas with trees. This data is part of a Department of Conservation and Natural Resources (DCNR) partnership project known as Prime Prospects. The "Prime Prospects" landowners were found through the combination of data mining public consumer reports and mapping tracts of land with open riparian areas. The results of the data mining and mapping were compared to conservation efforts of individuals who have already installed riparian buffer plantings with similar data mining results. These comparisons lead to a list of landowners that can be ranked from highest to lowest likelihood of installing a riparian planting on their property.

PRIME PROSPECTS EFFORTS AND RESULTS

Western Pennsylvania Conservancy consulted with DCNR on the Prime Prospect data for Big Run, and generated a list of riparian landowners within the watershed. There is a total of 38 Prime Prospect parcel owners. The Prime Prospects map (Figure 9) displays the ranking of potential landowners within the Big Run watershed to install riparian buffer on their property. All ranked landowners were sent an informative postcard about riparian buffers. This postcard encouraged the landowners to contact WPC to discuss a potential project on their property. A landowner with property on Windfall Run, a sub-watershed of Big Run, responded to the mailing. With conversation and a site inspection it was found that this parcel does have potential for a riparian restoration project. There is about 1,000 feet of stream that lacks an adequate riparian buffer, and there is opportunity to plant at least one acre, if not more, depending on the desire of the landowner.

Post card mailed to Prime Prospect landowners within the Big Run Watershed.

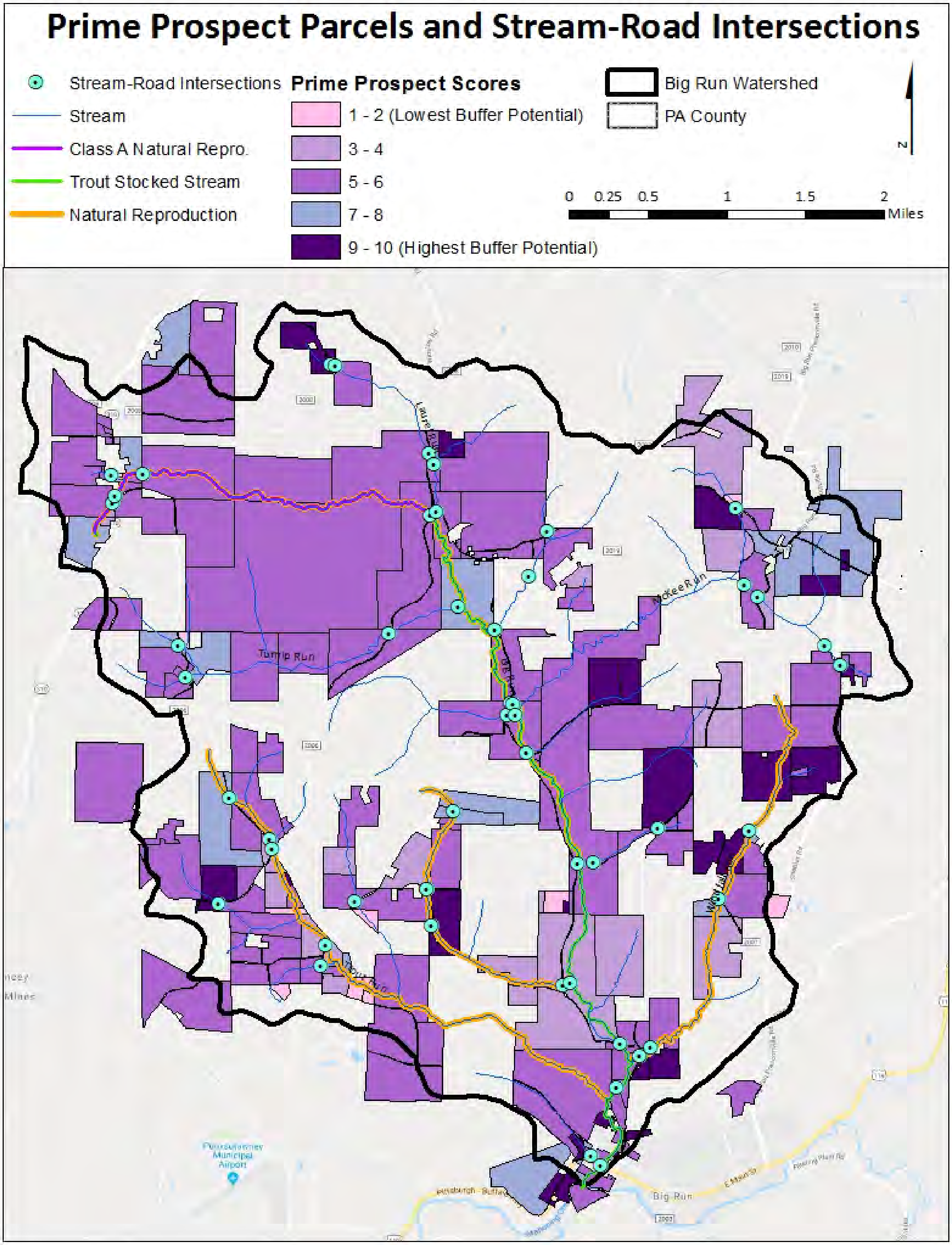

Figure 9: Prime Prospect Map for riparian landowners within the Big Run Watershed

Dirt and Gravel Roads Overview

Roads and trails surfaced with dirt and/or gravel can provide an economic alternative to impervious surfacing materials like concrete or asphalt. They provide several environmental benefits as well: allowing stormwater to more readily infiltrate into the ground, slowing the flow of runoff, and, where limestone is used, they can help buffer the effects of acid precipitation. However, if improperly constructed or maintained, they can negatively impact the watersheds they traverse. Sediment that washes off DGRs quickly finds its way into streams, filling the interstitial spaces between cobble and gravel that provide habitat for fish and aquatic macroinvertebrates. These interstitial spaces are essential locations for spawning activities for fish, particularly trout, and are often used as colonization areas by a number of important macroinvertebrate taxa.

Dirt and Gravel Roads Efforts and Results

During in-field assessments, dirt and gravel roads were noted when observed within each segment, as well as any obvious issues that may have been associated with them. These issues may have included stream fords, drainage ditches discharging high amounts of sediment to the stream, heavily eroded tire tracks leading to the stream, and changes in streambed substrate composition near the road-stream interaction zone. It can be seen on Figure 10 Dirt and Gravel Roads of Big Run that the majority of the DGRs are in the center of the watershed and often parallel the main stem of Big Run. Having a naturally well buffered stream will do nothing to protect against un-natural sedimentation issues, such as those caused by poor DGR practices, and without the cooperation of the local municipalities to improve issues, sedimentation may continue to plague the watershed.

Photo 7: Runoff from dirt and gravel roads carry sediment and pollutants and when not maintained properly can negatively impact water quality and aquatic habitats.

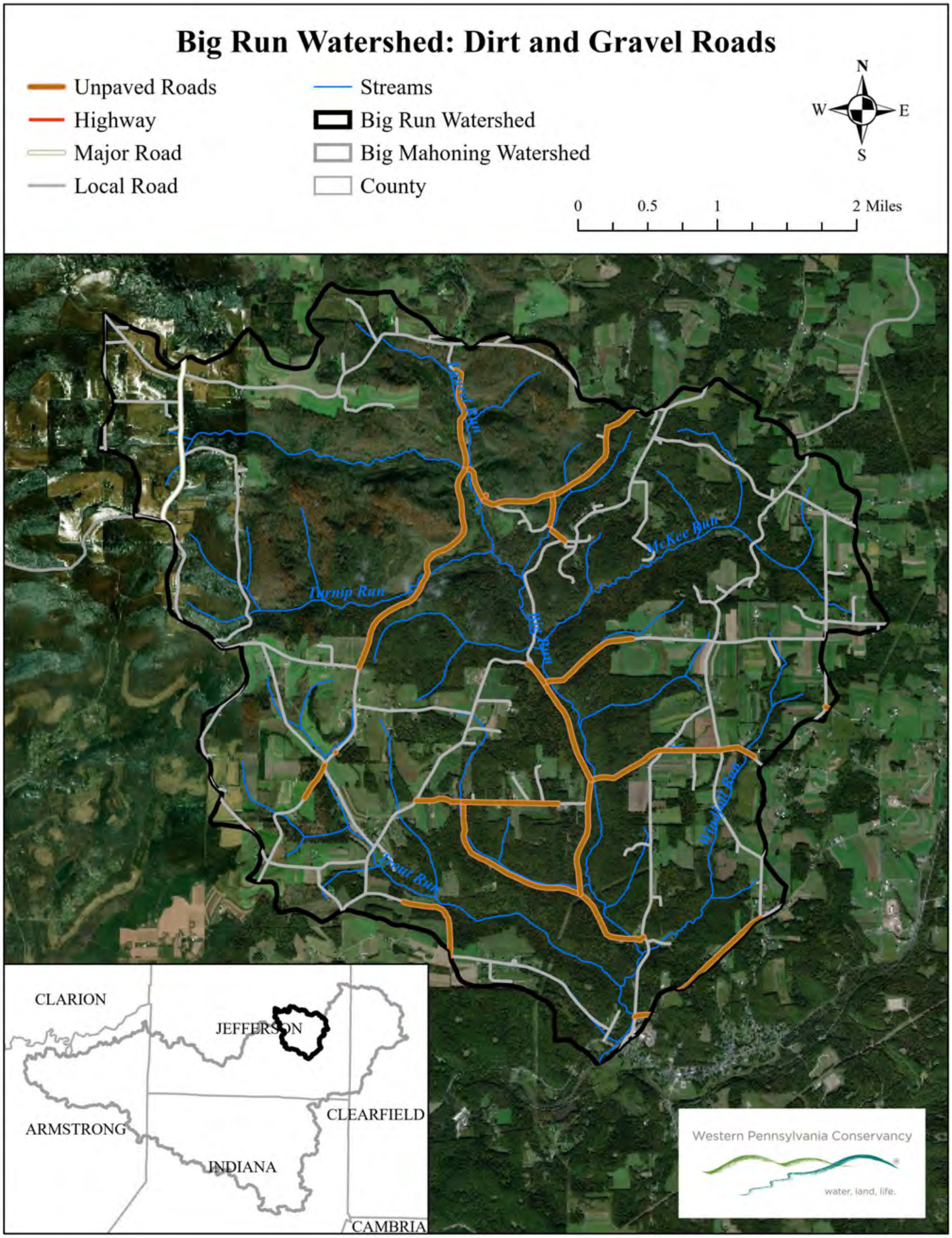

Figure 10: Dirt and Gravel Roads Map

UNIQUE and OUTSTANDING VALUES in the WATERSHED/STREAM

The Big Run watershed has the unique feature of being a water haven in the trout desert of the larger Mahoning Creek watershed, which has very few populations of wild trout as found by WPC staff during their unassessed waters data collection throughout the Mahoning Creek watershed. Big Run has five natural wild trout reproduction streams scattered from headwater areas down to the lower portion of the watershed. Having a natural population present as well as wide spread throughout the watershed showcases another valuable asset of the area and that is the presence of a wide, mature, well-treed riparian buffer. Another valuable feature of the watershed is that despite having historical coal mining activities occur within the watershed, the land and the water quality is relatively unscathed. There is some evidence of AMD, but the impacts of the discharges are minimal. The watershed is also home to a thriving population of beavers. These animals have built dams throughout the watershed, which have minimal impact on the overall water quality, but do cause localized natural changes in the stream around their impoundments. There is historic evidence of trout evolving with beavers and their presence raises little concern for water quality and may in fact also benefit the aquatic habitat by providing areas of slow, deep pools in the relatively shallow waters of Big Run.


Photo 8: Beaver activity on Big Run is a common and natural occurrence.

AREAS OF CONCERN and POTENTIAL CONFLICTS

Current and historic threats to water quality are present throughout the Big Run watershed. Historic threats include coal mining and shallow gas extraction. Current threats include poor agriculture practices and poor dirt and gravel road drainage management. Other issues that may affect water quality include faulty septic systems, invasive species, illegal garbage dumping, and potential unconventional gas development.

Photo 9: Antiquated aquatic habitat/stream stabilization structures on Big Run.

An area of concern within the watershed is a well-intentioned but antiquated aquatic habitat/stream stabilization structures on the mainstem of Big Run. Records indicate these structures were installed in the late 1970's to early 1980's, making them well over 40 years in age and beyond the functional life expectancy of the structures. In addition to the documented age of the structures, visual inspection shows that the integrity of the structures is failing and causing negative effects on the stream bank and stream channel itself.

A less drastic, but still notable area of concern are the residential and commercial areas scattered throughout the watershed. Small clusters of houses and businesses are commonly located adjacent to mainstem Big Run as well as all of its tributaries. These buildings often have large tracts of impervious surfaces and/or mowed ground directly up to the streambank. The lack of riparian vegetation increases the impacts through concentrated flows and unstable streambanks.

There are many agricultural operations farming the productive soils of the Big Run watershed, including a large population of Amish-run farms as well as the traditional, modern styled operations. The traditional life style of the Amish adds to the challenge of communicating new technologies about conservation agriculture and BMPs.

Much of the tillage styles of the operations appear to be of a deep plow style and are prone to erosion and silt loss. This silt originates within the headwater tributaries flowing downstream and impacting the entire watershed. Livestock activities with unrestricted access to streams and riparian areas also contribute to the sediment issues.

Active clearing of trees within riparian areas is a common activity done by landowners, farming and non-farming alike. The clearing may be done for aesthetic reasons or to make more open space for farming or grazing, nonetheless the removal of the natural riparian vegetation can negatively impact water quality. It is concerning to see continued riparian removal occuring as landowners expand the open areas in the watershed.

The construction and maintenance of the DGRs are the responsibility of the local municipalities. These municipalities may not be trained in the most effective dirt and gravel road best management practices or they may not have the equipment or funding to implement the best practices. This has led to portions of the DGRs to drain sediment as well as pollutants, such as winter ice reducing chemicals or elements, directly into the stream. There are also private drives and fords that contribute to sediment issues, and these property owners may not even be aware that there are BMPs for unpaved roads.

Photo 10: Private dirt roads and stream crossing can contribute sediment to the streams, as seen in this photo taken on a tributary to Big Run.

RECCOMMENDATIONS and NEXT STEPS

The sedimentation and riparian habitat degradation issues throughout the Big Run watershed need to be addressed if the health of the stream's water quality and aquatic habitat is going to improve and its wild trout population level is to be maintained and potentially thrive and grow.

Fortunately, many simple precautions can be taken to reduce these impacts. Best management practices that help reduce the impact of sedimentation include no-till and low tillage farming, cover crops, stream bank fencing, forested riparian plantings, riparian pollinator plantings, and dirt and gravel road crowning improvements. Community engagement and youth education can also help with the implementation of these BMPs. There are also steps that can be taken to keep the high scoring habitat areas of Big Run protected, including the promotion of conservation easements. Table 5 lists the recommendations for improving and protecting the water quality of the Big Run watershed.

Table 5: Recommendations for Improving Water Quality

Recommendations
Community and Landowner Outreach
Youth Education
No-Till and Low Tillage Workshops
Implement a Cover Crops Program
Dirt & Gravel Road Environmentally Sensitive Maintenance
(Training and BMP Implementation)
Riparian Restoration
(Tree and Pollinator Habitat Plantings)
Promote Conservation Easements

The next steps for improving the Big Run watershed should include increasing the support to conservation partners for promoting and assisting with outreach and education programs, as well as implementing some conservation BMPs. Potential projects can include the development of a public community education program focused on water quality best management practices run by a youth group (i.e. 4-H, scouts, or school club), as well as the introduction of a no-till and cover crops program that could include the rental use of no-till equipment and providing cover crops seed to agricultural operators willing to add cover crops into their program. Potential implementation of these practices could include the improvement of the noted antiquated fish structures and the implementation of a riparian planting project on Windfall Run. Both potential projects have been discussed with the landowners of the sites, and at the time of the completion of this plan had support from the landowners. These projects would lead to more community engagement and hopefully more projects. There is also the potential to improve the culvert on Turnip Run to meet aquatic organism passage standards, but communication would need to take place with the local township prior to any planning. Table 6 lists these potential projects, as well as their location and possible partners to assist with the implementation. This list should be used as a guide, and if other potential projects that improve the watershed are identified, it is encouraged that all efforts be made for them to be implemented as well.

Table 6: Potential Watershed Improvement Projects and Activities

Potential Improvement Projects and Activities	Location	Potential Partners*
Culvert replacement for aquatic organism passage	41.01853, -78.91353	McCalmont Township, JCCD, WPC
Habitat structure improvement	41.00688, -78.89623	Landowner, WPC, JCCD, TU
Riparian restoration planting	40.98079, -78.88092	Landowner, WPC, JCCD, TU, Volunteers
Cover crop funding assistance for new implementors	TBD throughout watershed	JCCD, TBD Landowners, USDA
		**list not comprehensive*

The following subsections below describe the recommendations that could be implemented throughout the watershed.

Community and Landowner Outreach and Youth Education Programs

General Outreach and targeted landowner education can be an effective tool in addressing watershed-related problems. Landowners are often willing to alter past practices when they are informed on how conservation practices benefit their property as well as water quality. It is encouraged that local partners promote water quality BMPs and that trainings and public presentation be done within the communities of Big Run. This may include, but not be limited to delivery of programs at schools (the Punxsutawney Area School District is the primary school district for the area) as well as at public meetings. Agricultural field days are also a good way to outreach to the farming communities.

Agricultural best management practices (BMPs)

Conservation practices for active crop land such as conservation tillage, contour strip cropping, no-till planting, cover crops, and grassed waterways, can affect the amount of, and the way in which, water and nutrients run off, and soil is eroded from, the land. Slowing the flow of water and allowing it to evenly disperse over vegetated land permits the water to naturally percolate through the soil before reaching the receiving stream. Vegetation slows the water and holds the soil and nutrients, so they are not washed away. Utilizing conservation practices for active pastures, such as streambank fencing, stabilized stream crossings, rotational grazing, and roof gutters on livestock buildings are also essential agricultural BMPs. Streambank fencing is effective in reducing sediment and nutrient concentrations. Through the construction of fencing, the streambank becomes stabilized by new plant growth. This buffer zone slows nutrient runoff and allows stormwater to percolate through the soil, rather than become surface runoff that directly enters the stream. By limiting livestock activity in the riparian area, nutrient concentrations are also reduced in the stream. Additionally, macroinvertebrate and fish populations benefit significantly within the fenced area and beyond. Along with reducing nutrients and erosion, the stream is shaded by plant regeneration, which offers colder water for its inhabitants.

Dirt and gravel road environmentally sensitive maintenance

Dirt and gravel roads are recommended to be managed to have a minimum impact on aquatic resources and be removed, decommissioned, or at the very least vegetated when they are no longer needed. Proper Best Management Practices (BMPs) should be installed whenever possible, including but not limited to: re-surfacing with Driving Surface Aggregate, grade breaks, and cross drains. While sediment contributions from dirt and gravel roads were noted as minimal throughout the majority of these watersheds, staff noted high amounts of sand and fine material on many of the segments assessed. They were not noted as DGR sediment contributions as this connection could not positively be established. Some of the material noted was natural to the area, yet it was also hypothesized that tributaries and road ditches in ephemeral headwaters were acting as conduits for fine, sandy sediment to the streams. Additionally, not all Dirt and Gravel Roads were available through GIS mapping, and segments on that map may have improvements recommended for “unmapped” private access roads. Stakeholders seeking to reduce road maintenance and sediment contributions to those stream segments should work with the appropriate township or borough, Jefferson County Conservation District, and the landowner(s) for solutions that benefit all. If possible, while working on DGR improvements, AOP barriers should also be removed/replaced/decommissioned within the same project.

Riparian restoration and establishment of streambank vegetation

Planting streamside trees and shrubs as well as allowing native vegetation to establish along streambanks not only helps to stabilize the bank and reduce erosion, but also shades the stream, cooling the water and increasing the dissolved oxygen levels. Increased habitat for wildlife is also established, which can make for enjoyable nature viewing. Simple practices, such as not mowing the stream edge can dramatically improve stream conditions for both terrestrial and aquatic life. A more involved and strongly recommended practice includes riparian tree plantings as well as planting areas that cannot be vegetated with trees because of utility right of ways with native pollinator habitat.

Conservation Easements

A voluntary conservation easement is a legal agreement between a landowner and a land trust or government agency that permanently limits uses of the land in order to protect its conservation values. It allows a landowner to continue to own and use their land, as well as sell it or pass it on to heirs. Conservation Easements are flexible. For example, an easement on property containing rare wildlife habitat might prohibit any development, while one on a farm might allow continued farming and the building of additional agricultural structures. An easement may apply to just a portion of the property, and need not require public access.

As next steps move forward, a need to expand upon the recommendations may be necessary. It is expected that as outreach and education efforts begin, that suggestions and unrealized projects may develop and a new recommendation may be suggested. If this document is updated, adding these recommendations to the list may help with future funding opportunities.

CONSERVATION PARTNERS AND POSSIBLE FUNDING SOURCES

The following list contains the names of possible conservation partners and/or potential funding sources *(list is not comprehensive and other public and private partners and sources may be applicable)* for the variety of improvement recommendations in this plan:

- Department of Conservation and Natural Resources (DCNR)
- Department of Environmental Protection (DEP)
- Environmental Protection Agency (EPA)
- Farm Service Agency (FSA)
- Jefferson County Conservation District (JCCD)
- National Fish and Wildlife Foundation (NFWF)
- Natural Resources Conservation Services (NRCS)
- PennState Extension
- PennState Center for Dirt and Gravel Road Studies
- Pennsylvania Game Commission (PGC)
- Pennsylvanian Fish and Boat Commission (PFBC)
- Trout Unlimited (TU)
- United Stated Department of Agriculture (USDA)
- Western Pennsylvania Conservancy (WPC)

These conservation partners may be national, state, non-government organization (NGO) or private in nature, but all are dedicated to protecting and improving the environment. There may be funding for a wide variety of environmentally beneficial activities for communities, municipalities, and landowners, including farmers. For instance, installing dirt and gravel road best management practices (culverts, DSA, etc.) may make a road improvement project eligible for grant funding from the Coldwater Heritage Partnership, the DEP Growing Greener Program, and others, since it will also have benefits to the aquatic ecosystem. Coordinating with a variety of partners is likely to increase the chances of a particular project getting funded, as the initiating party can rely on a wide field of expertise. The Western Pennsylvania Conservancy is happy to partner with willing parties to assist in grant application and management. Those interested should contact the Watershed Conservation Program.

SUMMARY/CONCLUSIONS

In summary, the Big Run watershed is holding its own in terms of water quality and habitat, but this condition balances on a tipping point of current conditions not changing. Overall, it offers acceptable water quality and suitable habitat for patchy populations of valued macroinvertebrate families and naturally reproducing wild brown trout. The ability of these populations to continue to exist means that land condition within the watershed must remain at its current condition at a minimum, as the amount of prime habitat to support these populations is on the lowest end of productive. Presently, sedimentation and riparian habitat degradation throughout the Big Run watershed are the largest impacts to the stream's health. Protection of existing riparian habitat and improvement of dirt and gravel road conditions would ease the impacts and could even aid in improving the populations.

Fortunately, there are a few basic best management practices and simple precautions that can be taken to reduce these impacts, thus improving the quality of the Big Run watershed. Raising community awareness of the wild trout populations within the watershed as well as informing landowners about sediment reducing BMPs should open the doors for implementing water quality conservation practices. The relationships developed by installing successful projects will serve as a model to continue implementing the recommendations of this plan, and lead to improved coldwater resources.

Literature Cited

Barbour, M.T., J. Gerritsen, B. D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Pennsylvania Department of Environmental Protection. 2013. A Benthic Macroinvertebrate Index of Biotic Integrity for Wadeable Freestone Riffle-Run Streams in Pennsylvania.

Pennsylvania Fish and Boat Commission. 2016. Pennsylvania Wild Trout Waters (Natural Reproduction) – March 2021. http://fishandboat.com/trout_repro.pdf Accessed 3.18.2021.

List of Resources for BMPs relating to Watershed Conservation

North Atlantic Aquatic Connectivity Collaborative
https://streamcontinuity.org/

Pennsylvania Center for Dirt and Gravel Roads
http://www.dirtandgravel.psu.edu/

PA Department of Environmental Protection
http://www.dep.pa.gov/Business/Water/Waterways/Pages/default.aspx

PA Fish and Boat Commission
http://www.fishandboat.com/Pages/default.aspx

Penn State Extension Service
http://extension.psu.edu/natural-resources/water

US Department of Agriculture: Natural Resource Conservation Service Field Office Technical Guide (FOTG)
https://efotg.sc.egov.usda.gov/

APPENDIX 1: GENERAL VISUAL ASSESSMENT FIELD DATA AND SCORE SHEETS

Big Run Watershed; Jefferson County General Visual Assessment
PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
(FRONT)

STREAM NAME:	GIS ID:
Start: LAT LONG	WATERSHED:
End: LAT LONG	AGENCY: Western Pennsylvania Conservancy
INVESTIGATORS:	REASON for SURVEY: *Big Run Visual Assessment Data Collection*
FORM COMPLETED by:	DATE: ____________ TIME:________ AM PM

WEATHER CONDITIONS

Now
- ☐ clear/sunny
- ☐ storm (heavy rain)
- ☐ rain (steady rain)
- ☐ showers (intermittent)
- ☐ % cloud cover (circle %) 25% - 50 % - 75% - 100%

Past 24 hours
- ☐ clear/sunny
- ☐ storm (heavy rain)
- ☐ rain (steady rain)
- ☐ showers (intermittent)
- ☐ % cloud cover (circle %) 25% - 50 % - 75% - 100%

Has there been a heavy rain in the last 7 days? ☐ Yes ☐ No

Other____________________

STREAM CHARACTERIZATION

Stream Subsystem ☐ Perennial ☐ Intermittent

Stream Type (*This can be looked up via GIS*) ☐ Coldwater ☐ Warmwater

Stream Gradient ☐ High (riffle/run prevalent) ☐ Low (glide/pool prevalent)

Segment Type ☐ Main Stem ☐ Named Tributary ☐ Unnamed Tributary ☐ Other____________

IMPROVEMENT OPPORTUNITIES and FEATURES of NOTE

Describe significant features and/or impacts seen in section. Include GPS points when applicable.

☐ Check box if stream is dry

☐ Check box if native/wild trout were observed in segment

Stream Segment Flows through the following Land Type (*Check One*): ☐ Public ☐ Private ☐ Both

POINT TYPE

☐ Reference Photo(s)

	Ref Photo	Latitude (North)	Longitude (West)	Notes
1				
2				

Possible BMP's- None (N) Agriculture (Ag) Abandonded Mine Drainage (AMD) Bank Stablization (BS) Culvert Replacement (CR) Dam Removal (DR) Dirt & Gravel Road (DGR) Habitat Improvement (HI) Mine Belt Deflector (MBD) Riparian Planting (RP) Stormwater (SW) Other (O)

☐ BMP(s) *Describe improvement needs and improvement recommendations:*

	BMP	Latitude (North)	Longitude (West)	Notes
1				
2				
3				
4				
5				

☐ Feature(s) of Note (FoN)

	FoN	Latitude (North)	Longitude (West)	Notes
1				
2				
3				
4				

Segment Accessibility for Implementing Possible BMP's: ☐ Excellent ☐ Good ☐ Poor ☐ In-Accessible

Describe:____________________

Segment was Assessed: ☐ Entirely ☐ Partially

Describe:____________________

This sheet was printed on 3/31/2021

WATERSHED FEATURES (within ~100 ft. (~30 m) buffer)	**Predominant Surrounding Land-Use** (Must = 100%) ☐ Forest ______% ☐ Field/Pasture ______% ☐ Agricultural ______% ☐ Open space (i.e., parks/golf courses) ______% ☐ Commercial/Industrial ______% ☐ Residential ______% ☐ Paved Roads ____% ☐ Dirt and Gravel Roads ______% (TWP, Gas & Logging) ☐ Rail Line ______% ☐ Wetland ______% ☐ Other ________________ ______%	**Stormwater Inputs** ☐ None ☐ Tile Drain ☐ Road Ditch ☐ Urban Stormwater Pipe ☐ Field Ditch ☐ Overland Flow **D&GR Sediment Contribution (Runoff)**: ☐ None ☐ Minimal ☐ Moderate ☐ Heavy **Bank revetments:** ☐ None ☐ Rip-rap ☐ Gabion ☐ Concrete ☐ Other _______
VEGETATION INFORMATION NOTE: Bank side determined when facing DOWN Stream	**Riparian Zone Width** **Riparian Zone Encroachment** ☐ Yes ☐ No Right Bank: ☐ 0 – 15 feet ☐ 16 – 50 feet ☐ 51 – 150 feet ☐ 150 – 300 feet ☐ Greater than 300 feet Left Bank: ☐ 0 – 15 feet ☐ 16 – 50 feet ☐ 51 – 150 feet ☐ 150 – 300 feet ☐ Greater than 300 feet **Indicate dominant vegetation type within riparian zone (~18 meter buffer),and record dominant species present:** ☐ Trees ☐ Shrubs ☐ Grasses ☐ Herbaceous ☐ Invasive – Dominant species present: ____________ **Bank Canopy Vegetation:** Right Bank ☐ 100% (Shaded) ☐ 75% ☐ 50% ☐ 25% ☐ 0% (No Cover) Left Bank ☐ 100% (Shaded) ☐ 75% ☐ 50% ☐ 25% ☐ 0% (No Cover) **Presence of Large Woody Debris (LWD):** ☐ Significant ☐ Moderate ☐ Minimal ☐ None **Presence of aquatic vegetation:** ☐ None ☐ Normal ☐ Excessive - Describe: ____________	**Channel Canopy:** ☐ Open ☐ Closed
INSTREAM FEATURES Average Number of Riffles in section: ____________	**Average Stream Width** ________ ft **Active Streambank Erosion for Segment** ☐ None ☐ Minimal ☐ Moderate ☐ Heavy **Surface Velocity:** ☐ Slow ☐ Moderate ☐ Fast **Flow Status:** ☐ Low ☐ Moderate ☐ High **Springs/Seeps:** ☐ Abundant ☐ Minimal ☐ None **Adjacent Wetlands:** ☐ Abundant ☐ Minimal ☐ None **Proportion of Stream Morphology Types** ☐ Riffle______% ☐ Run______% ☐ Pool______%	**Channelization** ☐ No ☐ Yes: Length of Straightening ____ft. **Dam Present (Beaver or Human)** ☐ Yes ☐ No **Constrictions Present :** ☐ None ☐ Culvert ☐ Bridge ☐ Old Abutment ☐ Bedrock Outcrop ☐ Other ________ **Stream Ford or Animal Crossing Present** ☐ Yes ☐ No **Debris Jam Present** ☐ Yes ☐ No **Connectivity to Flood Plain** (Zero percent equals not connected to flood plain) Right Bank: ☐ 100% ☐ 75% ☐ 50% ☐ 25% ☐ 0% Left Bank: ☐ 100% ☐ 75% ☐ 50% ☐ 25% ☐ 0%
WATER QUALITY (During visual assessment use pH and conductivity meters to take reading.)	*ToR = top of reach / BoR = bottom of reach* **pH** ToR________/________BoR **H2O Temp** ToR________/________BoR (°F or °C) **Conductivity** ToR________/________BoR (µs) **Turbidity (If not measured)** ☐ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other_____ **Water Odors** ☐ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other________	**Water Surface Oils** ☐ None ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☐ Other____________ **Overall Water Quality** ☐ Excellent ☐ Good ☐ Fair ☐ Poor **Primary source(s) of water quality impact** ☐ None ☐ Agriculture ☐ Active Pasture ☐ Sedimentation ☐ Gas Wells ☐ Development ☐ Sewage ☐ Bank Erosion ☐ Pipeline Crossing ☐ AMD ☐ Timber ☐ Other________

INORGANIC SUBSTRATE COMPONENTS (Should add up to 100%)			**Invasive Species Observations (note any invasive species in reach and list details if possible)**	
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	Flora	Fauna
Bedrock			☐ None	☐ None
Boulder	> 256 mm (10")		☐ Barberry	☐ Asiatic clam (Corbicula)
Cobble	64-256 mm (2.5"-10")		☐ Knotweed	☐ Emerald ash borer
Gravel	2-64 mm (0.1"-2.5")		☐ Multiflora rose	☐ Round goby
Sand	0.06-2mm (gritty)		☐ Mile-a-minute weed	☐ Wooly adelgid
Silt	0.004-0.06 mm		☐ Purple loosestrife	☐ Zebra mussel
Clay	< 0.004 mm (slick)		☐ ________ ☐ Other(s) ________ ________	☐ Other(s) ________ ________

This sheet was printed on 3/31/2021

Big Run Watershed; Jefferson County

General HABITAT ASSESSMENT FIELD DATA SHEET

High or Low Gradient Streams

This sheet can be used for high or low gradient streams, please specify which was scored on score sheet page.

	Condition Category			
Habitat Parameter	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/Available Cover (high and low gradient)	Greater than 70% (50% for low gradient streams) of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	40-70% (30-50% for low gradient streams) mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% (10-30% for low gradient streams) mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% (10% for low gradient streams) stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Score A or B only, not both. **2a. Embeddedness** (high gradient)	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2b. Pool Substrate Characterization (low gradient)	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or submerged vegetation.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Score A or B only, not both. **3a. Velocity/Depth Regimes** (high gradient)	All 4 velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (slow is <0.3 m/s, deep is >0.5 m).	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3b. Pool Variability (low gradient)	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition (high and low gradient)	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status (high and low gradient)	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration (high and low gradient)	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Score A or B only, not both. 7a. Frequency of Riffles (or bends) (high gradient)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7b. Channel Sinuosity (low gradient)	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream (high and low gradient)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream (high and low gradient)	More than 90% of the streambank surfaces and immediate riparian zones covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone) (high and low gradient)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Big Run Watershed; Jefferson County
General HABITAT ASSESSMENT SCORE SHEET
High or Low Gradient Streams

STREAM NAME:	GIS ID:
Start: LAT LONG	WATERSHED:
End: LAT LONG	AGENCY: Western Pennsylvania Conservancy
INVESTIGATORS:	REASON for SURVEY: *General Visual Assessment Data Collection*
FORM COMPLETED by:	DATE: ____________ TIME: ________ AM PM

Stream Gradient (Select one) ☐ High (riffle/run prevalent) or ☐ Low (glide/pool prevalent)

**Note: If a parameter has an "a" or "b" only score for one or the other, not both.*

Habitat Parameter	Score	Explanation of Score Given *(Please provide details, especially for lower ratings!)*	
1. Epifaunal Substrate /Available Cover			
*2a. Embeddedness (High) or 2b. Pool Substrate Characterization (Low)			
*3a. Velocity/Depth Regimes (High) or 3b. Pool Variability (Low)			
4. Sediment Deposition			
5. Channel Flow Status			
6. Channel Alteration			
*7a. Frequency of Riffles (or bends) (High) or 7b. Channel Sinuosity (Low)			
8. Bank Stability (score each bank) *Note: determine left or right side by facing downstream*	LB & RB Total	(RB)	
		(LB)	
9. Vegetative Protection (score each bank) *Note: determine left or right side by facing downstream*	LB & RB Total	(RB)	
		(LB)	
10. Riparian Vegetative Zone Width (score each bank riparian zone)	LB & RB Total	(RB)	
		(LB)	
Total Score		**Add all scores and divide by the number of scores given.**	

Please include additional notes of back of this sheet.

☐ Check box when data entered

Date entered: ____________

Western Pennsylvania Conservancy
Field Data Sheet
Big Run; Jefferson County

Site ID: ______________________ Date: _______________ Time: _________________

Site Location: (North) __________________________ (West) __________________________

Collector(s) Name(s): ____

Weather Notes (i.e. temp., cloud cover): ____

Stream Flow Status (circle): Normal High Low Dry Other: __________

Field Notes: ____

____

	Parameter	Data	Units	Notes
Multi-Parameter	pH		SU	
	Total Dissolved Solids		ppm	
	Conductivity		µS/cm	
Colorimeter	Turbidity		FAU	
	Phosphates (PO_4)		mg/L	
	Nitrates (NO_3)		mg/L	
Dissolved Oxygen Meter	Dissolved Oxygen		mg/L	
	Temperature		°C	
Titration Kit	Alkalinity		mg/L	

Were water samples collected from this site and taken to a lab? Yes No

Were macroinvertebrate samples collected from this site? Yes No

Date data was entered into database: ____________, data enter by: _________________.

Stream Gaging Data

Site:	Date:
Sampling Team:	Current Weather:
Gaging Station ID:	Weather of past 72 hours:

Chosen number of verticals: **12**
Please note if different number is chosen and modify calculations accordingly.

Distance from Point (ft) Tape measure reading		Vertical Width (ft) Same number for all points	Water Depth (ft) Rod reading	Area (ft^2)	Velocity (ft/sec) Flowmeter reading	Discharge		Notes
						CFS	GPM	
1.	(SP)							
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
11.								
12.								
13.								
14.								
15.								
16.								
17.								
18.								
19.								
20.								
					Totals:			

Start Point (SP): (reading of tape on water's edge in feet)	End Point (EP): (reading of tape on water's edge in feet)

Field formulas:

- Stream Width(ft) = (EP-SP)
- Vertical Width (Ft) = Stream Width/**12***
  (*or other chosen number of verticals)
- Start Point(SP) = Vertical Width(ft)/2

Columns in grey are manual calculations.
All other data is gathered in the field
Manual formulas:

- Area(ft^2) = Width(ft) x Depth(ft)
- Discharge CFS = Area(ft^2) x Velocity(ft/sec)
- Discharge GPM = CFS x 448.8

Field Notes and Comments:

APPENDIX 3: LAND CLASS USE CLASS DESCRIPTIONS

2013/2014 Mapped 1-meter Resolution Land Use Classes

This document describes the 1m classification scheme applied to the 1m land use data mapped for the Chesapeake Bay watershed and intersecting counties using 2013 (DE, NY, PA, and MD) and 2014 (WV and VA) aerial imagery. These data have also been aggregated to 10m resolution with a condensed classification scheme. The 10m land use data include a more complete representation of streams and differentiate between cropland and pasture throughout the watershed- these distinctions are largely absent in the 1m data. The aggregated 10m data currently inform the Chesapeake Bay Program's Phase 6 watershed model, the Bay Total Maximum Daily Load (TMDL), and Phase III Watershed Implementation Plans. The 10m land use data consist of thirteen separate 10m-resolution raster datasets which can be viewed and downloaded from: http://chesapeake.usgs.gov/phase6/map/.

High-resolution Land Use Classification

Impervious Roads (IR) = paved and unpaved roads, bridges, and some driveways.

Impervious Non-Roads (INR) = buildings, driveways, sidewalks, parking lots, runways, and some private roads. Note that portions of some quarries and other extractive lands may be mistakenly included in this class.

Tree Canopy over Impervious Surfaces (TCI) = trees over roads and non-road impervious surfaces.

Water (WAT) = wide streams and canals, large ponds and swimming pools, wet detention basins, reservoirs, etc. mapped from the high-resolution imagery, National Wetlands Inventory (NWI) ponds and lakes, and large waterbodies identified in the 1:24,000-scale National Hydrography Dataset. Note that small-to-medium width (< 20-30m) streams and other waterbodies and heavily eutrophic ponds could not be consistently detected from NAIP imagery and are therefore mostly absent from this class.

Tidal Wetlands (WLT) = wetlands classified as marine and estuarine wetland systems (E2EM, E5FO, W2SS) according to the NWI Wetlands and Deepwater Habitats Classification chart (https://www.fws.gov/wetlands/Documents/Wetlands-and-Deepwater-Habitats-Classificationchart.pdf), NWI palustrine wetlands (PEM, PFO, PSS) with water regime modifiers associated with tidal hydrological conditions (e.g., saltwater tidal or freshwater tidal), and all wetlands mapped from imagery that could be influenced by tidal characteristics/processes by having an elevation less than or equal to 2 meters above sea level according to the 10m-resolution NED (downloaded July 2015). Note that Tidal Wetlands are excluded from the watershed model but are being mapped for input to the hydrodynamic water quality model.

Floodplain Wetlands (WLF) = National Wetlands Inventory (NWI) non-pond, non-lake wetlands, emergent wetlands mapped from high-resolution imagery outside Virginia, state designated wetlands, and state identified potential non-tidal wetlands located within the FEMA designated 100-year floodplain or on frequently flooded soils (SSURGO).

Other Wetlands (WLO) = National Wetlands Inventory (NWI) non-pond, non-lake wetlands, emergent wetlands mapped from high-resolution imagery outside Virginia, state designated wetlands, and state identified potential non-tidal, non-floodplain wetlands. These are typically headwater or isolated wetlands.

Forest (FOR) = all standing trees and areas of tree harvest farther than 30' to 80' from non-road impervious surfaces and forming contiguous patches >=1-acre in extent. The variable range of distances result from the application of multiple filtering algorithms (e.g., focal moving windows) to identify areas covered by tree canopy with an undisturbed/unmanaged understory.[1]

Tree Canopy over Turf Grass (TCT) = trees within 30' to 80' of non-road impervious surfaces where the understory is assumed to be turf grass or otherwise altered through compaction, removal of surface organic material, and/or fertilization.

Mixed Open (MO) = Small patches of trees (< 1 acre) outside developed areas, and all scrub-shrub, herbaceous, and barren lands that have been minimally disturbed (e.g., periodically bush hogged, meadows, etc.), reclaimed, or that have internal and/or regulated drainage (e.g., served by combined sewer systems). Mixed Open areas include active, abandoned and reclaimed mines, landfills, unconventional oil and gas pads, beaches, waterbody margins, natural grasslands, and utility rights-of-way.

Fractional Turf (small) = "Small" contiguous patches of herbaceous and barren land <= 10 acres that fall within local land use polygons designated as mixed open, institutional, universities, colleges, monuments, or within non-agricultural protected/public lands (e.g., PADUS) and federal facilities. Also included are herbaceous and barren lands within medium-to-large developed parcels (> 10 acres with >= 10% impervious cover). When aggregated to 10m resolution, these areas were designated as 70% Turf Grass and 30% Mixed Open.

Fractional Turf (med) = "Medium" contiguous patches of herbaceous and barren land > 10 acres and <= 1000 acres that fall within local land use polygons designated as mixed open, institutional, universities, colleges, monuments, or within non-agricultural protected/public lands (e.g., PADUS) and federal facilities. When aggregated to 10m resolution, these areas were designated as 50% Turf Grass and 50% Mixed Open.

Fractional Turf (large) = "Large" contiguous patches of herbaceous and barren land > 1000 acres that fall within local land use polygons designated as mixed open, institutional, universities, colleges, monuments, or within non-agricultural protected/public lands (e.g., PADUS) and federal facilities. When aggregated to 10m resolution, these areas were designated as 60% Mixed Open, 30% Turf Grass, 5% Cropland, and 5% Pasture.

Fractional Impervious = Herbaceous and barren lands designated by local land use data as junk yards, warehouses/storage, industrial, railyards, and transitional, or vehicle related. When aggregated to 10m resolution, these areas were designated as 30% Impervious Non-Road and 70% Mixed Open. This class excludes rail rights-of-way because the spatial accuracy of the rail data is insufficient to align with the

[1] Developed areas are mapped using a series of four circular focal filters corresponding to 10-acre, 1-acre, ¾-acre, and ½-acre areas with respective radii of 113m, 37m, 27m, and 18m. These represent different concentrations of non-road impervious surfaces and serve to create variable width buffers around developed areas. The largest filter, 10-acres, is only applied to Census Urbanized Areas and Clusters and helps to fill gaps created by the smaller filters. The smaller filters help define the interface between densely developed and rural areas. Large filters over-generalize and therefore have high commission errors, e.g., classifying forests as tree canopy over turf or cropland as turf grass. Small filters under-generalize and may not fully cover areas maintained as turf grass or trees over turf grass. Therefore, all four filters are needed. Many different filter sizes, combinations of filters, and filter density thresholds were evaluated. Through trial and error, observing the effect of each set of filters and decision rules on resultant forest vs non-forest classifications in Prince George's county, we settled on the above set of four. The exact filter sizes are not as important as having a set that captures a range of relevant scales.

1m-resolution land cover data informing the land use classification.

Turf Grass (TG) = Herbaceous and barren lands that have been altered through compaction, removal of organic material, and/or fertilization. These include all herbaceous and barren lands within road rights-of-way, residential, commercial, recreational, other turf-dominated land uses (e.g., cemeteries, shopping centers, golf courses, airports, hospitals, amusement parks, etc.), and small developed parcels (<= 10 acres with >= 93 m^2 of total impervious cover). The 93 m^2 (1000 ft^2) threshold is meant to represent the average size of a single-wide mobile home.

Cropland (CRP) = This class was only mapped at 1-meter resolution in Virginia. The Virginia Department of Conservation and Recreation has a spatial dataset of points and polygons to differentiate between cropland and pasture. These data were overlaid on the land cover to classify herbaceous lands as either cropland or pasture at 1-meter resolution. Outside of Virginia, all herbaceous and barren lands that are not classed as turf grass or mixed open are simply classed as "agriculture". This explains why there are 17 classes in the Virginia portion of the dataset compared to outside Virginia, where there are only 16 classes.

Note that cropland is mapped everywhere as part of the aggregated 10m land use dataset. In Virginia, the 1m cropland and 1m pasture cells are simply aggregated to each overlaying 10m cell. Outside Virginia, the portion of a 10m cell that is classed as "agriculture" at 1m is reclassed as part cropland and part pasture using eight years of the annual, 30m-resolution NASS Cropland Data Layer (CDL 2008 through 2015). The frequency at which each 30m CDL cell was classified as crops over the eight-year period determines the proportion of crops in each of the nine underlying 10m cells. For example, if a 10m cell (100 m^2) includes 80 1-m "agriculture" cells (i.e., it's 80% agriculture) and the overlaying 30m CDL cell was classed as some form of crop in 2 out of 8 years, 25% of the portion of the 10m cell that is agriculture would be considered to be cropland and the remaining 75% of the portion that is agriculture would be considered to be pasture. Therefore, this cell would have 20m^2 (25% of 80m^2) of crop, 60m^2 of pasture, and 20m^2 of some other land use.

Pasture/Hay (PAS) = This class was only mapped at 1-meter resolution in Virginia. Outside of Virginia, all herbaceous and barren lands that are not classed as turf grass or mixed open are simply classed as "agriculture". Pasture is mapped everywhere as part of the aggregated 10m land use dataset (see the more detailed description of the "Cropland" class). Note that hay is grouped with pasture because they are difficult to differentiate through image interpretation.