2020 Water Quality Study

Monroe County Pennsylvania

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Materials and Methods

Field Chemistry Sampling

Field chemistry sampling was conducted using a hand-held YSI Professional Digital Sampling System (ProDSS) multiparameter water quality meter. The following parameters were collected and recorded on standard data forms at each sampling location:

- Potential of Hydrogen (pH)
- Temperature (°C)
- Dissolved Oxygen (D.O.) Concentration (mg/L)
- D.O. (%)
- Conductivity (µS/cm)

Laboratory Chemistry Sampling

Chemical sampling was conducted using sampling bottles and directives by Microbac Laboratories. The samples were transported on ice to their facilities via courier at the end of each sampling day. The following table shows the parameters that were collected and analyzed for each sampling location:

Table 1: Chemical testing parameters by Microbac Laboratories

Test	Units	Method	Reporting Limit (RL)
Nitrate Calculated	mg/L	EPA 353.2, Rv. 2 (1993)	0.0500
Biochemical Oxygen Demand (BOD5)	mg/L	SM 5210 B-2011	3.00
Hardness (as $CaCO_3$)	mg/L	Calculation by ICP	0.999
Aluminum	mg/L	EPA 200.7, Rv. 4.4 (1994)	0.160
Calcium	mg/L	EPA 200.7, Rv. 4.4 (1994)	0.400
Iron	mg/L	EPA 200.7, Rv. 4.4 (1994)	0.0800
Magnesium	mg/L	EPA 200.7, Rv. 4.4 (1994)	0.400
Chloride	mg/L	EPA 300.0, Rv. 2.1 (1993)	0.50
Alkalinity, Total to $CaCO_3$ to pH 4.5	mg $CaCO_3$/L	SM 2310 B-2011	6.0
Total Dissolved Solids (TDS)	mg/L	SM 2540 C-2011	10.0
pH	N/A	SM 4500-H+ B-2011	1.0
Ammonia as N	mg/L	SM 4500-NH3 F-2011	0.30
Total Kjeldahl Nitrogen (TKN)	mg/L	SM 4500-NH3 F-2011	1.25
Phosphorus, Total as P	mg/L	SM 4500-P E-2011	0.020
Total Organic Carbon (TOC)	mg/L	SM 5310 C-2011	0.50

Macroinvertebrate Sampling

The collection of macroinvertebrates began with delineating a 100-meter reach of each sampling location that best represented the habitat of the stream. Collection would be distributed throughout the 100-meter reach and would represent the variety of habitats shown in the bullet points below. In each case, macroinvertebrates were collected using a 12" 500-micron D-frame net that was held downstream from the substrate disturbance. The collection would be moved upstream along the 100-meter reach to limit disturbance of the study area. Six one-minute kicks were used in each of the riffle/run habitats and ten jabs or kicks were used in the multi-habitat locations (Shull & Lookenbill, 2018).

Riffle/Run Habitat – Six Samples

- Fast/Shallow
- Fast/Deep
- Slow/Shallow
- Slow/Deep

Multi-Habitat Collection – Ten Samples

- Cobble/Gravel
- Snag
- Coarse Particulate Organic Matter (CPOM)
- Submerged Aquatic Vegetation (SAV)
- Sand/Fine Sediment

Each sample was placed in a round wide-mouth plastic jar containing 95% ethanol and delivered to Aquatic Resource Consulting for macroinvertebrate identification and analysis.

Habitat Analysis

Each sampling location was assessed as riffle/run or low gradient streams depending on the habitat. Each parameter was rated on a score from 1-20; 20 being the highest score possible (Shull & Lookenbill, 2018).

Riffle/Run Streams
Instream Cover
Epifaunal Substrate
Embeddedness
Velocity/Depth Regimes
Channel Alteration
Sediment Deposition
Riffle Frequency
Channel Flow Status
Condition of Banks
Bank Vegetative Protection
Grazing or Other Disruptive Pressure
Riparian Vegetative Zone

Low Gradient Streams
Epifaunal Substrate/Available Cover
Pool Substrate Characterization
Pool Variability
Sediment Deposition
Channel Flow Status
Channel Alteration
Condition of Banks
Bank Vegetative Protection
Riparian Vegetative Zone

Appendix A – Surface Water Parameters

Field Measurements

Potential of Hydrogen (pH)

pH is an expression of the hydrogen ion concentration in water. The pH scale is used to determine the acidity or basicity of a solution on a scale of 0 to 14, with pH 7 being neutral. When the pH of a solution is below 7, the solution is acidic. If the pH of a solution is above 7, the solution is basic. pH impacts most chemical and biological processes in water and different species flourish within different ranges of pH. Most aquatic organisms have an optimal pH range between 6.5 - 8. Slight changes in pH can shift community composition in streams. This is because pH alters the chemical state of many pollutants, changing their solubility, transport, and bioavailability. This can increase the exposure to and toxicity of metals and nutrients to aquatic organisms (EPA, 2018).

Temperature

Water temperature is influenced by many atmospheric and hydrologic processes and plays a fundamental role in shaping the structure and function of aquatic systems. Even a slight temperature change can affect aquatic organism survival, growth, reproduction, and development. The temperature of the stream is also used as the basis for classifying streams. (EPA, 2018)

Dissolved Oxygen (DO)

Dissolved oxygen refers to the concentration of oxygen gas incorporated in water. It enters the water through direct absorption from the atmosphere and is enhanced by turbulence. Sufficient DO is essential to the growth and reproduction of aerobic aquatic life. Sources from non-point or point source runoff, impoundments, treatment outfalls, and removal of riparian vegetation can impact the DO of a water body (EPA, 2018). In 25 Pa Code Chapter 93.7, the current DO criteria for flowing waters is: CWF; For flowing waters, 7-day average 6.0 mg/L; minimum 5.0 mg/L. WWF; 7-day average 5.5 mg/L; minimum 5.0 mg/L. TSF; For the period February 15 to July 31 of any year, 7-day average 6.0 mg/L; minimum 5.0 mg/L. For the remainder of the year, 7-day average 5.5 mg/L; minimum 5.0 mg/L.

Specific Conductance

Conductivity is a measure of water's ability to pass an electrical current and is used as a general measure of water quality. Dissolved salts and other inorganic compounds conduct electrical currents so as salinity in a water body increases, conductivity increases. Significant changes in the conductivity could be an indicator of a discharge or other source of pollution that is influencing the aquatic system (EPA, 2016). The conductivity in the United States can range from 50 to 1500 µS/cm, but inland freshwater streams supporting mixed fisheries generally range from 150 to 500 µS/cm (EPA, 2012).

Field Measurement Data Form

2020 Monroe County Water Quality Study Field Data Form

Site Information

Stream ID		Date	
		Time	
Stream Name		Air Temp	
Latitude DMS		Weather	
Longitude DMS		Studied by	

Location Description:

Field Chemistry

Make sure there is complete mixing (similary readings across the stream)	pH	Dissolved Oxygen		Conductance		Temp (°C)
		%DO	mg/L DO	(µS/cm)	TDS (mg/L)	
Right Bank						
Thalweg						
Left Bank						

Macroinvertebrates Sampling

(12" diameter D-Frame net)

Multihabitat (10 samples)			Riffle/Run (6 Samples)		
Choose 10 sites based on in stream abundance	Target	Talley	At least 1 of each flow regimes	Talley	**Comments:**
Cobble/Gravel			slow/shallow		
Snag			fast/shallow		
CPOM			slow/deep		
Submerged Aquatic Veg			fast/deep		
Sand/Fine Sediment			**Total**	**6**	

Comments:

Water Chemistry Laboratory Analysis

Nitrogen

Nitrogen can be found in several types of species throughout the natural environment. Through nitrification and denitrification, bacteria can convert nitrogen which can increase or decrease the availability of this essential limiting nutrient in a system. Nitrification is when bacteria transform ammonia (NH_3) into nitrite (NO_2^-) and then to nitrate (NO_3^-), and denitrification is when bacteria convert nitrate to nitrite and then nitrogen gas. Additionally, ammonia can be transformed from ammonium in low oxygen environments. Excessive nutrients in surface water promotes eutrophication which is when algae and bacterial blooms are stimulated and causes a decrease in oxygen to other aquatic organisms. Sources such as fertilizer, effluent from treatment plants, urban stormwater runoff, and livestock waste can all contribute to an influx of nitrogen into a system (EPA, 2006). Early laboratory studies demonstrated that the lethal concentrations for a variety of fish range between 0.2 to 2.0 mg/L NH_3 with trout being the most sensitive species (EPA, 1976).

Biological Oxygen Demand (BOD)

BOD measures how much oxygen is consumed while microorganisms decompose organic matter. This directly affects the amount of dissolved oxygen available. The higher the BOD, the more rapidly oxygen is consumed. Sources of BOD can include leafy debris, dead organisms, effluent from wastewater treatment plants, urban stormwater runoff, and feedlots. Generally, unpolluted natural waters have <5 mg/L BOD levels (EPA, 2006).

Total Hardness

Water hardness is caused by metallic ions, primarily calcium and magnesium, dissolving in water. Other metals such as iron, strontium, and manganese can also contribute to the hardness. Natural contributors to water hardness include dissolved limestone however, inorganic chemical industries and abandoned mines can also contribute to increased water hardness (EPA, 1986). According to the USGS Water Science School (n.d.), the general classification of waters are:

Soft Water	0 - 60 mg/L
Moderately Hard Water	60 - 120 mg/L
Hard Water	120 - 180 mg/L
Very Hard Water	180 mg/L and up

Aluminum

Aluminum is a natural element found in rocks and soils that can enter the water through natural processes. It can also be released by activities like mining and industrial processes that use aluminum. Elevated levels of aluminum in surface water can affect aquatic organism's ability to regulate ions and inhibit respiratory function. According to 25 Pa Code Chapter 93.8c, the water quality criteria for toxic substances maximum concentration is 750 µg/L. According to the *Final Aquatic Life Ambient Water Quality Criteria for Aluminum*, the concentration varied as a function of the site's pH, DOC, and total hardness but ranged between 1-4,800 µg/L (EPA, 2018).

Calcium

Calcium is a naturally occurring element in water bodies due to its abundance in the earth's crust. It enters waterways through the erosion process of sedimentary rocks such as limestone. It is a contributor to water hardness and can influence pH because of its buffering quality. Rivers generally contain 1-2 mg/L calcium. In limestone areas, rivers may contain calcium concentrations as high as 100 mg/L (Lenntech, 2020).

Total Kjeldahl Nitrogen

T.K.N is the sum of free-ammonia and organic nitrogen compounds. Samples in the field are preserved by the addition of Sulfuric Acid (H_2SO_4) (EPA, 1993).

Iron

Iron is the fourth most commonly found element in the earth's crust which enters waterbodies in varying quantities depending on the surrounding geological formations and hydrological processes. In the aquatic environment, there are two types of iron of most concern ferrous (Fe^{2+}) and ferric (Fe^{3+}), although other forms can be found. Ferrous iron can originate from mining operations and inorganic wastewater and can persist in anaerobic conditions. Ferric iron is highly insoluble and can originate from industrial wastes or mine drainage (EPA, 1976).

Magnesium

Magnesium is the eighth-most abundant element found in the earth's crust and is frequently used in manufacturing, fertilizer, and animal feed. Along with calcium, it contributes to the hardness and salinity of water bodies (USGS, 2001).

Chloride

Chlorides are salts resulting from the combination of the gas chlorine with a metal. The major anthropogenic sources of chloride are deicing salts, urban and agricultural runoff, and effluent from wastewater plants (EPA, 1988). The EPA's maximum criteria for chloride is 250 mg/L (25 Pa. Code § 93.7).

Total Organic Carbon (TOC)

TOC is the measure of the total amount of carbon in organic compounds in a water sample (Whitehead, 2020). This measurement is important to characterize the amount of oxygen being used by microorganisms thereby depleting the oxygen availability of other aquatic organisms. The samples collected in the field were preserved by the addition of 1 mL of sulfuric acid (H_2SO_4).

Total Alkalinity

Alkalinity is the measure of the capacity of water to neutralize acids. Alkaline compounds do this by combining with hydrogen ions to increase the pH of the solution. Alkalinity is influenced by geologic formations, salts, plant activity, and wastewater effluent. The ability for water to resist drastic pH change is crucial to the survival of aquatic life (EPA, 2006). The minimum criteria from EPA for alkalinity is a minimum of 20 mg/L as $CaCO_3$, except where natural conditions are less. If so, the discharge to the waterway should not further reduce the alkalinity of the receiving waters (25 Pa. Code § 93.7).

Total Dissolved Solids (TDS)

Total Solids refers to the suspended or dissolved matter that is left over after the sample of water is evaporated. Total Dissolved Solids are determined after the matter is filtered through a 2 µm or smaller pore size filter which retains the suspended particles. Regular monitoring can assist in determining increased erosion or sedimentation influx into the waterway (EPA, 2006). The criteria for TDS is 500 mg/L as a monthly average or a maximum value of 750 mg/L (25 Pa. Code § 93.7).

Total Phosphorus

Total phosphorus refers to the dissolved and particulate forms of phosphorus in a water sample. Phosphorus is an essential nutrient that can enter water bodies in numerous ways. Fertilizers, waste treatment effluent, and agricultural/urban runoff are a few examples of how phosphorus can enter a system. Phosphorus tends to attach to soil particles making them easily transported during high runoff events. Excessive nutrients in surface water promotes eutrophication which is when algae and bacterial blooms are stimulated and causes a decrease in oxygen to other aquatic organisms (EPA, 2006).

Appendix B – Benthic Macroinvertebrates

The organisms collected during the water quality study are called benthic macroinvertebrates. Benthic defines the zone in which they occupy which is on, in, or near the stream bottom. Macroinvertebrates are animals without a backbone and large enough to see with the naked eye. Macroinvertebrates are an important link in the food web between producers and higher consumers such as fish. They are commonly used to study water quality for several reasons. They are fairly easy to sample and identify, they are sensitive to pollution and changes in their habitats, they are common in most streams and rivers, and they offer an indicator of water quality over time due to their relatively long life cycle (Stroud Water Research, 2020).

Macroinvertebrates can be divided into several groups based on pollution tolerance. Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) and many others can be an indicator of the best water quality because they are intolerant of pollution in their habitats. Macroinvertebrates such as aquatic worms and blood midge larvae can tolerate a significant amount of pollution but can also live in a broader range of quality conditions. The ongoing collection of macroinvertebrate populations can indicate a drastic change in conditions, offer a clearer picture of water quality, and provide overall environmental oversight in a stream (Penn State Extension, 2020).

Figure 1: Stonefly collected from Brodhead Creek.

Chalfant (2012) defines how PADEP assigns numeric pollution tolerance values (PTV) to most macroinvertebrates found in Pennsylvania in *A benthic index of biotic integrity for wadeable freestone*

streams in Pennsylvania. The values range from zero to ten, with ten representing a relative tolerance to pollution. Most of the values reflect the response to pollution-related to organic enrichment and sedimentation, and not necessarily reflective of other types of pollution such as low pH related to stream acidification. Chalfant lists the pollution tolerance values in Appendix D and includes other attributes pertaining to macroinvertebrate tolerance to pollution.

Macroinvertebrate Analysis

The PA Department of Environmental Protection (PADEP) has designed several assessment methods for Aquatic Life Use determinations based on the type of biological attributes and gradient conditions of a stream. For the Monroe County study sampling locations, the wadeable freestone riffle-run stream macroinvertebrate assessment method and the wadeable multihabitat stream macroinvertebrate assessment method were applied and described below. The published protocols and equations are designed to ultimately find the index of biotic integrity (IBI) which enables the ability to quantify the evaluation of the stream and assist in the management of the natural resource (Shull & Pulket, 2018).

Wadeable Freestone Riffle-Run Stream

The metrics used to evaluate the macroinvertebrate population in freestone riffle-run streams exhibited a strong ability to distinguish between pristine and heavily impacted conditions while measuring different aspects of the benthic macroinvertebrate communities.

Freestone riffle/run stream macroinvertebrate collection is conducted with a D-framed net with 500 µm mesh. A 100-meter reach is chosen which best represents the ideal habitats describes in the methods section. Each of the six kicks disturbs 1 m^2 immediately upstream of the net to an approximate depth of 10 cm. The kicks are completed from downstream to upstream to avoid disturbance (Shull & Lookenbill, 2018). Once the sampling is complete, each sample is composited into one container preserved with 95% ethanol in the field and transported to the contracted entomologist for enumeration and identification.

The following metrics and analyses are from Shull and Pulket (2018) wadeable freestone riffle-run stream macroinvertebrate assessment method in PA DEPs *Assessment Methodology for Rivers and Streams*:

Total Taxa Richness

This metric is the count of the total number of taxa in a sub-sample. As anthropogenic stress increases on a stream ecosystem, it is expected that the total taxa will decrease while generally increasing the dominance of a few pollutant tolerant taxa.

EPT Taxa Richness

EPT taxa richness metric is the count of the number of taxa belonging to the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) in a sub-sample. The common name for these insect orders are mayflies, stoneflies, and caddisflies. The reason these are important metrics is that these insect orders are generally considered intolerant of many types of pollution. It is important to note that this metric excludes some of the more tolerant mayfly and caddisfly, and only counts the EPT taxa with pollution tolerant values (PTV) of 0 to 4. This metric reflects the loss of taxa with low pollution tolerance and is expected to decrease with increasing anthropogenic stress.

Modified Beck's Index *(Version 3)*

Modified Beck's index is a weighted count of taxa with a pollution tolerance value of 0, 1, or 2. The metric is expected to decrease as anthropogenic stress is increased.

Shannon Diversity

Shannon diversity is a community composition metric. It measures taxonomic richness and evenness of individuals across taxa of a sub-sample. When the loss of pollution intolerant taxa occurs and there is an increasing dominance of a few pollution tolerant taxa, it indicates an increase of stress to the ecosystem and the metric will decrease.

Hilsenhoff Biotic Index

The Hilsenhoff Biotic Index weighs the values by pollution tolerance and is a community composition and tolerance metric that is the average of the number of individuals in a sub-sample. The index increases with ecosystem stress and reflects the increasing dominance of pollution tolerant organisms.

Percent Sensitive Individuals

This metric accounts for the percent of individuals with pollution tolerance values from 0 to 3. The value is expected to decrease in value with increasing stress to an ecosystem reflecting the loss of pollution-sensitive organisms (Shull & Pulket, 2018).

Aquatic Resource Consulting provides the metrics calculated for both small and large stream sizes which are used to account for natural changes in benthic biota with stream size. Generally, the small stream values are used for first, second, and third-order streams draining less than 25 to 50 mi^2, while larger stream values are appropriate for fifth and larger streams draining more than 50 mi^2. PADEP does not set a single cutoff for drainage area or stream order and offers other screening considerations when making an assessment decision (Shull & Pulket, 2018). Careful consideration is made in this study for how the stream is assessed however, both values are included in the macroinvertebrate results below. Table 2 provides the standardization values used for each calculation.

Table 2: Metric standardization values for small and large streams (Shull & Pulket, 2018).

Metric	Metric Standardization Values	
	Smaller Streams	Larger Streams
Total Taxa Richness	33	31
EPT Taxa Richness	19	16
Beck's Index	38	22
Hilsenhoff Biotic Index	1.89	3.05
Shannon Diversity	2.86	2.86
Percent Sensitive Individuals	84.5	66.7

Table 3 shows the process for index calculations to ultimately obtain an IBI for each sampling site. The averaged sum of these specific metric equations constructs an IBI, which then can be related to reflect the ecology and impacts on the aquatic community being studied.

Table 3: Index calculation process for freestone riffle/run streams (Shull & Pulket, 2018).

Metric	**Standardization Equation** (using small-stream standardization values)	**Observed Metric Value**	**Standardized Metrics Score**	**Adjusted Standardized Metric Score** Maximum = 100
Total Taxa Richness	(Observed value / 33)*100			
EPT Taxa Richness	(Observed value / 19)*100			
Beck's Index	(Observed value / 38) *100			
Hilsenhoff Biotic Index	[(10-observed value) / (10-1.89)] *100			
Shannon Diversity	(Observed / 2.86)*100			
Percent Sensitive Individuals	(Observed value / 84.5)*100			
Average of adjusted standardized metric scores = **IBI Score** =				

Aquatic Life Use Attainment Benchmarks

PADEP implemented a multi-tiered benchmark decision flowchart (Figure 2) for the decision process of assessing if a wadeable, freestone, riffle-run stream has achieved its attainment. The simplified matrix should guide most decisions however, situations exist where the simplified matrix will not apply exactly as outlined. For further clarification on the Aquatic Life Uses, 25 Pa. Code § 93.3 offers the water quality criteria defined by the Pennsylvania Water Quality Standards.

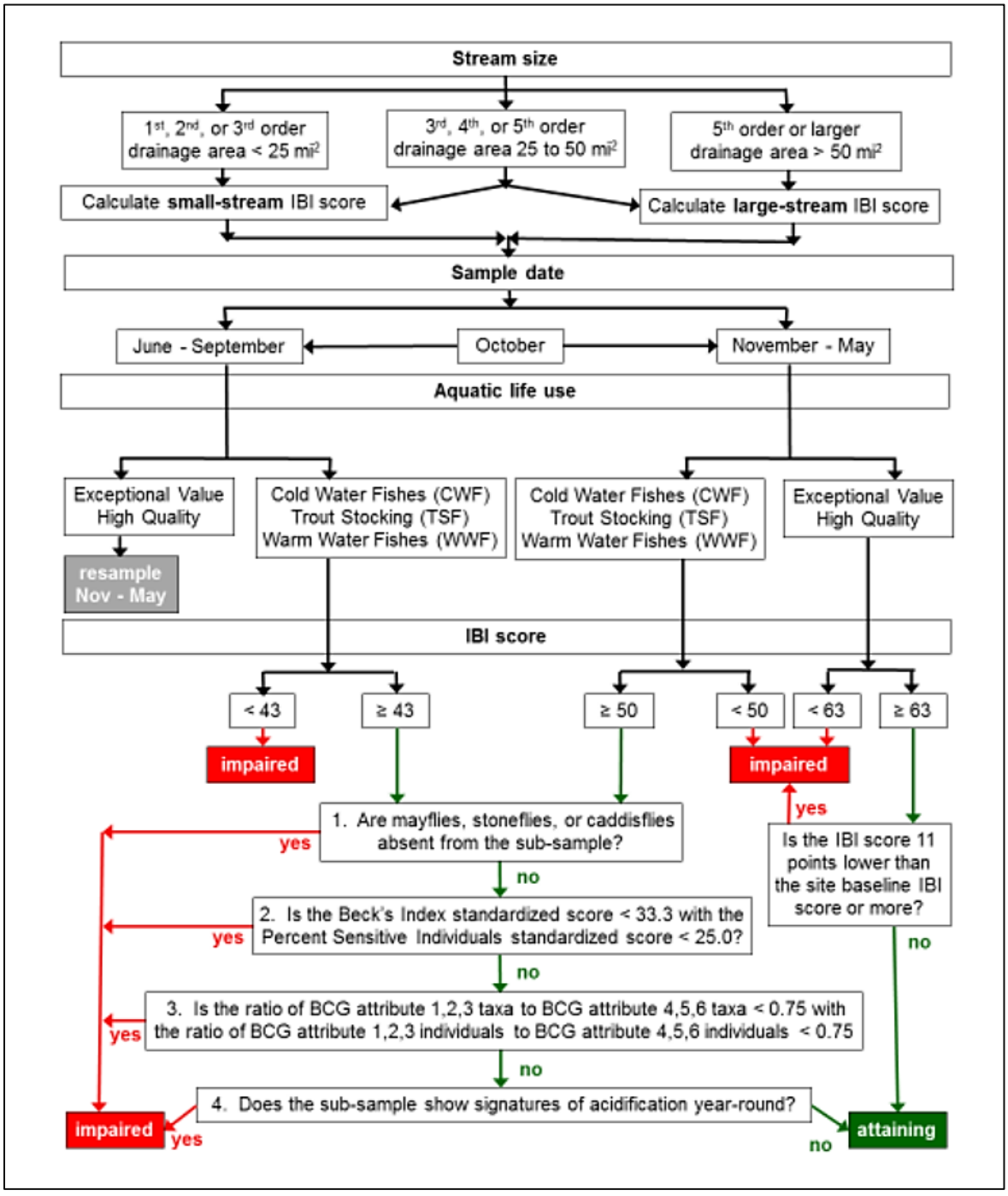

Figure 2: Aquatic Life Use Simplified Assessment Schematic (Shull & Pulket, 2018).

Considerations for the stream must be made before analyzing the IBI score and is shown in Figure 2.

- **Stream Size:** This is based on considerations given by DEP in the *Assessment Methodology for Rivers and Streams* (2018) and discussed above.
- **Sample Date:** The Monroe County water quality study is conducted annually between April and May.
- **Aquatic Life Use:** The stream designated use is defined in 25 Pa. Code § 93.9 and the existing use is defined in PADEP's *Existing Use Classification* (2020). These are noted before approaching this benchmark.

For samples collected in Exceptional Value (EV) or High Quality (HQ) streams, a score of ≥ 63 results in ALU attainment if the IBI score is not lower than the baseline when available. A score of < 63 means that the stream was potentially not attaining its Aquatic Life Uses when it was sampled. For streams designated Cold Water Fishery (CWF), Trout Stocked Fishery (TSF), or Warm Water Fishery (WWF), an IBI score < 50 means that the stream was potentially not attaining it's Aquatic Life Use when it was sampled. An IBI score of ≥ 50 requires the following additional evaluation to determine attainment (Shull & Pulket, 2018).

1. **Are mayflies, stoneflies, or caddisflies absent from the sub-sample?** These organisms are typically found in most healthy streams therefore if any or all of these orders are absent, it could indicate some sort of impact to the stream. Note that this question does not have to be applied to samples from larger streams and samples collected between June and September, but must be applied to small stream samples collected between November and May.

2. **Is the standardized metric score for Beck's Index metric < 33.3 with the standardization metric score for the Percent Sensitive Individuals metric < 25.0?** This serves as a double-check that the sample has substantial richness and abundance of the most sensitive organism.

3. **Is the ratio of Biological Condition Gradient (BCG) attribute 1, 2, 3 taxa to BCG attribute 4, 5, 6 taxa < 0.75 with the ratio of BCG attribute 1, 2, 3 individuals to BCG attribute 4, 5, 6 individuals < 0.75?** This evaluates the balance of pollution tolerant organisms with sensitive organisms in terms of taxonomic richness and organismal abundance. This question must be applied to small-stream samples collected between November and May but does not have to be applied to samples from larger streams and samples collected between June and September.

4. **Does the sub-sample show signatures of acidification year-round?** The primary acidification signatures in a sub-sample include low mayfly abundance and low mayfly diversity (i.e., scarce mayfly individuals and few mayfly taxa), especially when combined with a high abundance of Amphinemura and/or Leuctra stoneflies, occasionally combined with a high abundance of Simuliidae and/or Chironomidae individuals. This information can be difficult to determine if low pH conditions are natural, so sampling water chemistry and/or fish communities can inform the

assessment. With this protocol, PADEP will only list impaired sites that show persistent acidification signatures year-round (Shull & Pulket, 2018).

Wadeable Multihabitat Stream

The metrics used to evaluate the macroinvertebrate population in multihabitat streams exhibited a strong ability to distinguish between pristine and heavily impacted conditions of various low gradient habitats while measuring different aspects of the benthic macroinvertebrate communities.

Multihabitat stream macroinvertebrate collection is conducted with a D-framed net with 500 µm mesh. A 100-meter reach is chosen which best represents the five habitat types described in the Methods section and Table 4 (Shull & Lookenbill, 2018). Once the ten samples are obtained, each sample is composited into one container preserved with 95% ethanol in the field and transported to the contracted entomologist for enumeration and identification (Shull & Lookenbill, 2018).

Table 4: Habitat Types and Field Sampling Techniques (Shull & Lookenbill, 2018).

Habitat Type	Description	Sample Technique
Cobble/Gravel Substrate	Stream bottom areas consisting of mixed gravel and larger substrate particles.	Place the net on the substrate near the downstream end of an area of gravel or larger substrate particles and simultaneously pushing down on the net while pulling it in an upstream direction with adequate force to dislodge organisms.
Snag	Submerged sticks, branches, and other woody debris that appears to have been submerged long enough to be adequately colonized.	The net is placed immediately downstream of the snag in an area where water is flowing; The snag is then kicked in a manner such attached organisms are dislodged.
CPOM	A mix of plant parts (leaves, bark, twigs, seeds, etc.) that have accumulated on the stream bottom in "depositional" areas of the stream channel.	Pass the net along a 30in path through the accumulated organic material to collect the material and its associated aquatic macroinvertebrates.
SAV	Rooted aquatic macrophytes.	Draw the net in an upstream direction along a 30in path through the vegetation; Efforts should be made to avoid collecting stream bottom sediments.
Sand/Fine Sediment	Stream bottom areas that are composed primarily of sand, silt, and/or clay.	Bump and tap the net along the substrate along a 30in path.

The following metrics and analyses are from Shull and Pulket (2018) wadeable multihabitat stream macroinvertebrate assessment method in PADEP's *Assessment Methodology for Rivers and Streams*:

Total Taxa Richness

Total taxa richness is similar to the freestone riffle/run metric. This metric is the count of the total number of taxa in a sub-sample.

EPT Taxa Richness

Similar to the freestone riffle/run metric, this metric is the count of the number of taxa belonging to the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) in a sub-sample.

Beck4

Beck4 is a weighted taxon richness measure. It is based on Hilsenhoff Biotic Index Scores which measures the pollution tolerance of an organism on a scale of zero to ten, where the organisms' tolerance level decreases with the score. This is chosen because it better represents low-gradient streams. For Beck4, taxa with an HBI score of 0 or 1 are given 2 points and HBI scores of 2, 3, or 4 are given 1 point.

Shannon Diversity

Similar to the freestone riffle/run metric, it measures taxonomic richness and evenness of individuals across taxa of a sub-sample. When there is increased stress on a stream ecosystem, this metric will decrease.

Number of Caddisfly Taxa

The metric is the sum of the Caddisfly taxa present in the subsample.

Number of Mayfly Taxa

The metric is the sum of the Mayfly taxa present in the subsample (Shull & Pulket, 2018).

Table 5 shows the process for index calculations to ultimately obtain an IBI for each sampling site. The sum of these specific metric equations constructs an IBI, which then can be related to reflect the ecology and impacts on the aquatic community being studied.

Table 5: Index calculation process for multihabitat streams (Shull & Pulket, 2018).

Metric	**Equation**	**Observed Metric Value**	**Normalized Metric Score**	**Adjusted Metric Score** Maximum = 100
Total Taxa Richness	(Observed / 31)*100			
EPT Taxa Richness	(Observed / 17)*100			
Beck4	(Observed / 22)*100			
Shannon Diversity	(Observed / 2.43)*100			
# of Caddisfly Taxa	(Observed / 11)*100			
# of Mayfly Taxa	(Observed / 6)*100			
Average of adjusted standardized metric scores = **IBI Score** =				

Aquatic Life Use Attainment Benchmarks

Aquatic Life Use for multihabitat low gradient has a benchmark of 55 therefore if the score is ≥ 55 the stream has reached attainment, and if the score is < 55 the sample reach has not achieved attainment.

Precision Quantification

Two sampling locations were replicated to verify accuracy and minimize variability. One replicate site was conducted for freestone riffle/run habitat and the other was conducted on a mulithabitat stream. This also complies with the PADEP's quality assurance manual to verify identification work performed on macroinvertebrates.

Quality Assurance

Water samples were stored in coolers with ice packs for stabilization and then transported to EPA certified Microbac Laboratories. The specifics of the chemical parameters are discussed in Appendix A of this report. Data quality requirements were maintained in the field throughout the collections. The calibration of field equipment was performed daily.

Macroinvertebrate Collection Data

2020 Monroe County Water Quality Study

TAXON	Poll.Tol.	NUMBER COLLECTED AT SAMPLING STATION											
ORDER *GENERA/SPECIES*		01	02	03	04	05	06	07	08	09	10	11	12
AMPHIPODA (shrimp)		App	Aq	BC22	BC27	BC27r	BC30	BC31	BW1	BH1	BK7	BZ1	CH1
Gammarus spp.	4							31					2
BIVALVIA (clams)													
Pisidium spp.	8												
COLEOPTERA (beetles)													
Stenelmis spp.	5			7		3	10	5	2	7			10
Promoresia spp.	2								1	1			1
Dubiraphia spp.	6												
Optioservus spp.	4		2				5						4
Ectopria spp.	5												
Psephenus herricki	4	4		19	9	2	7	11	1		1	19	16
Microcylloepus spp.	2												
Hydrochus spp.	5												
Leutrochus spp.	6												
Ancyronyx spp.				1									
Oulimnius spp.	5												
DIPTERA (true flies)													
Chironomidae	6	42	34	39	52	35	25	18	25	14	39	49	23
Limnophora spp.	6	1		4	8	5	1	8					
Blepharicera spp.	0	1			4	1							
Tipula spp.	4		6			1							
Hexatoma spp.	2				1	1				1		1	
Pericoma spp.	4												
Hemerodromia spp.	6					8		3					
Tabanus spp.	5												
Atherix spp.	2			1									
Antocha spp.	3	3		4	1	1	4	2			1		3
Simulium spp.	6	1	11	1	1	3		3		1		1	
Dicranota spp.	3	1											
Empididae spp.	6												
Prosimulium	2		2		1							1	
Bezzia spp.	6												
Chrysops spp.	7												
EPHEMEROPTERA (mayflies)													
Epeorus spp.	0	5		4	37	17	1		4	45		9	7
Mccaffertium spp.	3	5	9	10	5	9	16	5	3	1	13	7	9
Stenacron spp.	4			1									
Ephemerella spp.	1	32	15	41	31	57	40	25	68	14	15	29	79
Eurylophella spp.	4	1	1	2			4	2	2	1			
Drunella spp.	1	34		17	2	2	24	5	3	2	4	6	4
Danella spp.	2												
Attenuatella spp	2												
Seratella spp.	2	3		2	9	1		2			1	1	7
Leucrocuta spp.	1												
Paraleptophlebia spp.	1				9	15	1			3	5	2	
Leptophlebia spp.	4												
Heterocloen spp.	2												
Cinygmula spp.	1					1				76			
Nixe spp.	2												
Rithrogena spp.	0					4				2			
Leucrocuta spp.	1										10		1
Siphlonurus spp.	7							2					
Heptageniidae	3												
Ameletus spp.	0									1		4	
Isonychia spp.	3	6	2	3	2	2	1		6		1		2
Baetidae	6									10			
Diphetor spp.	6					3							
Baetis spp.	6	4			5		2		4				
Acerpenna spp.	6												
Plauditus spp.	4												
Acentrella spp.	4	28			7	5		8	1			17	
GASTROPODA (snails)													
Physinae	8												
Fossaria	7							1					
HEMIPTERA (true bugs)													
Microvelia spp.	9												
HIRUDINEA (leeches)	8												
Myzobdella spp.													
ISOPODA (sowbugs)													
Caecidotea spp.	6							1					
LEPIDOPTERA (moths)													
Petrophila spp.	5												
MEGALOPTERA (hellgramites)													
Sialis spp.	6			1									
Corydalus spp.	4												
Nigronia spp.	2	1		1	1								2
NEMERTEA	6												
NEMATOPHORA (horsehair worm)	9												
ODONATA (dragon flies)													
Libellula spp.	8												
Calopteryx spp.	6												
Hagenius spp.	3												
Gomphidae spp	4			2								2	
Boyeria spp.	2		2	1							1		
Ophiogomphus spp.	1			2				1					
Progomphus spp.	5												
Gomphus spp.	5										2		
Lanthus spp.	5												
Stylogomphus spp.	4			1	2		1						
calopteryx spp.	6		1										
Cordulegaster spp.	3												
Tachopteryx spp.	5												
OLIGOCHAETA (worms)	10	2	1		3	2		14	10		2	1	3
PLECOPTERA (stoneflies)													
Leuctra spp.	0	2	2	1	6		2					11	
Taeniopteryx spp.	2												
Amphinemura spp.	3	1	15		1				5	3		3	
Haploperla spp.	0									4			
Pteronarcys spp.	0									1			
Acroneuria spp.	0	3	3	3	2	1	2	1	3		3	7	3
Paragnetina spp.	1	2	4	2			1						
Agnetina spp.	1				1				1		1		
Perlesta spp.	4							2					
Suwallia/Sweltsa spp.	0	2	1			3			2	8		36	
Shipsa spp.	2												
Alloperla spp.	0									7			
Tallaperla spp.	0		1							2			
Diploperla spp.	2												
Clioperla spp.	2									1			
Alocapnia spp.	3								1				

Diura spp.	2			1									
Yugus spp.	2									2			
Cultus spp.	2				1								
Isoperla spp.	2		6		2	2				3	8		
TURBELLARIA (flatworms)													
Macrostemum spp.	8												
TRICHOPTERA (caddisflies)													
Chimarra spp.	4		2	1			2		7				3
Wormaldia spp.	0												
Dolophilodes spp.	0	6	1	1	6	3			4				
Neophylax spp.	3	2			2	2			2			1	
Hydropsyche spp.	5		4					2	1				
Diplectrona spp.	0		2							2		1	
macrostemum spp.	3												
Ceratopsyche spp.	5	1	7	7	6	3	3	9	4			1	7
Cheumatopsyche spp.	6	3	14	15	2	7	15	17	18		6		12
Parapsyche spp.	0												
Diplectrona spp.	0	2							2				
Rhyacophila spp.	1	8	1	5	13	6	3		4	9			10
Lepidostoma spp.	1						2	2					
Psilotreta spp.	0			3							5		
Glossossoma spp.	0												
Agapetus spp.	0								3				
Protoptila spp.	1												2
Psychomyia spp.	2												
Brachycentrus spp.	1			1									
Lype spp.	2												
Micrasema spp.	2												
Goera spp.	0			2									
Ceraclea spp.	3							4					
Helicopsyche spp.	3												
Leucotrichia spp.	6												
Pycnopsyche spp.	4		7			1		1			1		1
Oxyethira spp.	3												
Hydatophylax spp.	2												
Polycentropus spp.	6					6	1		1		5		5
Nectopsyche spp.	3												
Neureclipsis spp.	7										1		
TOTAL		206	156	206	232	212	173	185	188	221	125	209	216
METRICS													
Total Taxa Richness		29	27	34	31	32	24	27	28	26	21	22	24
Shannon Diversity Index		2.57	2.76	2.74	2.71	2.69	2.50	2.79	2.46	2.31	2.43	2.39	2.43
EPT Taxa Richness		17	16	18	17	17	13	11	18	20	12	14	12
Hilsenhoff Biotic Index		2.92	2.99	3.24	2.84	2.92	3.12	4.23	3.17	1.45	3.56	2.62	2.86
Percent Intolerant Individuals		57.8	42.3	51.5	59.1	60.4	56.1	23.8	59.6	85.1	54.4	57.9	60.2
Modified Beck's Index		31	27	36	32	31	21	11	27	42	19	27	19
IBI SMALL STREAM		**84.1**	**78.3**	**88.3**	**86.8**	**86.8**	**72.5**	**60.9**	**81.9**	**93.3**	**67.6**	**75.7**	72
IBI LARGE STREAM		**95.0**	**91.2**	**95.0**	**97.2**	**97.4**	**87.4**	**70.4**	**94.0**	**94.1**	**81.4**	**88.1**	85.7

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TAXON ORDER *GENERA/SPECIES*	Pollution Tolerance	NUMBER COLLECTED AT SAMPLING STATION												
		13	14	15	16	17	18	19	20	21	22	23	24	25
AMPHIPODA (shrimp)		CH6	CH6r	FH20	IR3	JO1	KPR2	MR11	MR18	MR19	MC10	MC22	MC37	MD4
Gammarus spp.	4								4		3		5	
BIVALVIA (clams)														
Pisidium spp.	8	1										1		
COLEOPTERA (beetles)														
Lutrochus spp.	6											2		1
Microcylloepus spp.	2													
Stenelmis spp.	5										3			
Dubiraphia spp.	6		1											
Promoresia spp.	2						1				1	6		1
Stenelmis spp.	5								3					
Ectopria spp.	5													
Optioservus spp.	4	3	6		4	6	2		3		1	4	1	
Agabus spp.	5													
Micronychus spp.	2													
Lutrochus spp.	6													
Oulimnius spp.	5													5
Psephenus herricki	4			4				11	39	5	14	2	7	4
DECAPODA														
Cambarus spp.	6						2							
DIPTERA (true flies)														
Chironomidae	6	28	15	40	81	59	48	55	11	9	36	15	2	16
Probezzia spp.	6				1									
Bezzia spp.	6													
Hemerodromia spp.	6							1			2			
Blepharicera spp.	0													
Limnophora spp.	6				2							1		
Chrysogaster spp.	10						1							
Muscidae	6													
Tipula spp.	4	1	1	1	1								1	1
Hexatoma spp.	2				12	6						2		
Atherix spp.	2													
Antocha spp.	3	2	1		4	5			1		5	2	1	
Tabanus spp.	5													
Empedidae spp.	6													
Dicranota spp.	3											5		
Prosimulium spp.	0													
Pseudolimnophila spp.	2			1										
Ptychoptera spp.	8													
Clinocera spp.	6												1	
Chrysops spp.	7													
Simulium spp.	6	1	1		3	1	133	6		2	2	3	3	1
EPHEMEROPTERA (mayflies)														
Epeorus spp.	0				26	17			1		3	5		24
Mccaffertium spp.	3	11	6	5		1		6	6	1	3	5	22	11
Stenacron spp.	4					2								
Ephemerella spp.	1	60	106	12	21	19		48	57	119	38	48	41	38
Eurylophella spp.	4		1					1		11			1	1
Serratella spp.	2	8	2					1	10		4	9	4	
Leucrocuta spp.	1							3						1
Dannella spp.	2													
Drunella spp.	1			26				6	4		4	2	1	1
Heterocloen spp.	2													
Paraleptophlebia spp.	1				1	19		6		2		9		4
Isonychia spp.	3	2							5			2	1	1
Ameletus spp.	0													
Caenis spp.	7													
Baetis spp.	6		1	9	7	6		11	3			5		18
Acerpenna spp.	6								5	3				
Nixe spp.	2					2								
Ameletus spp.	0													1
Acentrella spp.	4			33				5			18	7	3	
Rhithrogena spp.	0													9
Ephemera spp.	2													
Plauditus spp.	4													
Diphetor spp.	6			3	3	6				2				1
Cinygmula spp.	1					10								
GASTROPODA (snails)														
Gyraulus spp.	6													
Fossaria spp.									2					
Valvata spp.	2													
HEMIPTERA (true bugs)														
HIRUDINEA (leeches)														
ISOPODA (Sowbugs)														
Caecidotea spp.	6													
MEGALOPTERA (hellgramites)														
Sialis spp.	6													
Nigronia spp.	2						3		2	1	1	3		1
Corydalus spp.	4										1			
ODONATA (dragon/damsel flies)														
Gomphidae	5											1		
Lanthus spp.	4			1						5				
Progomphus spp.	5													
Cordulegaster spp.	3						1							
Stylogomphus spp.	4					1		1						
Bayeria spp.	2						1							
Gomphidae	4						17							
Calopteryx spp.	6		1											
Ophiogomphus spp.	1													
OLIGOCHAETA (worms)	10	5	5						22			3	30	
PLECOPTERA (stoneflies)														
Paraleuctra spp.	0													
Leuctra spp.	0	2			2	2	1	2	2			4		1
Amphinemura spp.	3	7	11					2	3			4		
Pteronarcys spp.	0				7			1			1		1	
Acroneuria spp.	0		1	1			1	10	3	1	5	6	4	2
Paragnetina spp.	1								1		1	5		
Agnetina spp.	2	1		1	1									
Suwallia/Sweltsa spp.	0	1			4	5	1					2		3
Perlesta spp.	4	1	3								1			
Tallaperla spp.	0				1	6								
Diploperla spp.	2													
Alloperla spp	0			40										
Cultus spp.	2				2							3		
Isoperla spp.	2	2	4		4	2	1	2		7		6		4

Isogenoides spp.	0													
Haploperla spp.	0			6										
Diura spp.	2				5									
Clioperla spp.	2					3								
Remenus spp.	2													
TURBELLARIA (flatworms)	9											1		
TRICHOPTERA (caddisflies)														
Chimarra spp.	4	9	1	1					3		4			
Dolophilodes spp.	0	2	1								4	3		5
Hydropsyche spp.	5	10	1						3				1	
Cheumatopsyche spp.	6	19	3		4			2	11	1	29	2	41	12
Wormaldia spp.	0									1				
Parapsyche spp.	0					1								
Ceratopsyche spp.	5	10	7		11			2	3		15	8	12	7
Diplectrona spp.	0			1	1	20		8	1	21				14
Psilotreta spp.	0								1					
Rhyacophila spp.	1	1	1		14	2		3	8		6	13	7	12
Glossosoma spp.	0													
Neureclipsis spp.	7													
Psychomyia spp.	2													
Nyctiophylax spp.	6													
Parapsyche spp.	0													
Lepidostoma spp.	1				2						2		4	
Leucotrichia spp.	6													
Protoptila spp.	1												1	
Micrasema spp.	2							1		4				
Neophylax spp.	3	1		2	1				1	2		2	1	1
Pycnopsyche spp.	4				1									
Brachycentrus spp.	1													
Agapetus spp.	0								1					1
Psychomyia spp.	2													
Macrostemum spp.	3													
Nectopsyche spp.	3													
Mystacides spp.	4													
Polycentropus spp.	6			1	2	2		2	1					1
Pycnopsyche spp.	4	6	7	1					1	1	1			
TOTAL		194	187	189	228	203	213	196	221	198	208	201	196	203
METRICS														
Total Taxa Richness		25	23	20	29	24	14	25	32	19	28	36	25	32
Shannon Diversity Index		3.54	1.83	2.21	2.47	2.53	1.18	2.40	2.67	1.64	2.64	3.08	2.40	2.83
EPT Taxa Richness		15	12	12	16	15	4	16	17	11	15	18	13	19
Hilsenhoff Biotic Index		3.49	2.50	2.88	3.50	2.82	5.63	3.28	3.65	1.74	3.67	1.75	4.37	2.42
Percent Intolerant Individuals		51.5	71.5	50.3	47.4	59.1	4.7	50.5	48.4	71.7	37.5	72.6	44.9	62.1
Modified Beck's Index		16	12	18	28	30	14	22	28	16	25	29	17	40
IBI SMALL STREAM		73	**67.6**	**66.0**	**78.1**	**79.6**	**33.5**	**74.1**	**81.5**	**66.6**	**74.1**	**92.8**	**65.9**	**93.8**
IBI LARGE STREAM		86.3	**78.0**	**79.0**	**90.8**	**91.4**	**47.0**	**89.5**	**92.9**	**76.7**	**87.3**	**100**	**78.6**	**98.7**

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TAXON	Pollution Tolerance	NUMBER COLLECTED AT SAMPLING STATION														
ORDER *GENERA/SPECIES*		26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
AMPHIPODA (shrimp)		ML3	PA8	PA9	PO1	PO9	PO14	PH1	PH29	SA2	SA20	SS1	SS2	SW10	TO14	TN3
Gammarus spp.	4									14						
BIVALVIA (clams)																
COLEOPTERA (beetles)																
Microcylloepus spp.	2															
Macronychus spp.	2															
Stenelmis spp.	5								8				8		10	2
Promoresia spp.	2								1		1			2		2
Stenelmis spp.	5		29				5			8		13				
Optioservus spp.	4	6						6					2			
Ancyronyxs pp.	2															
Psephenus herricki	4		1	2		1	18			8						1
Ectopria spp.	5	3						1								
Oulimnius spp.	5													21		
DECAPODA																
Cambarus spp.	6								1							1
DIPTERA (true flies)																
Chironomidae	6	41	28	119	7	35	51	50	46	130	14	27	27	6	23	26
Limnophora spp.			2				4							3		1
Blepharicera spp.	0	2			10	4						2	2	1		
Hemerodromia spp.	6					4										
Empididae	6															
Muscidae	6															
Chrysogaster spp.	10						1									
Tipula spp.	4	1				1										1
Hexatoma spp.	2	5		1	8	2		4						6		
Atherix spp.	2															
Antocha spp.	3				1		5	2	1	3				1	2	3
Prosimulium spp.	2	2	2	3	1								57		1	
Simulium spp.	6				6		2	2	1			71	18	3	2	1
Dicranota spp.	3							2						3		
Probezzia spp.	6															
Bezzia spp.	6															
Tabanus spp.	5															
Chrysops spp.	7															
Dolichocephala spp.	5			1												
EPHEMEROPTERA (mayflies)																
Epeorus spp.	0	64	5	3	86	8		1	3			5		12	3	
Mccaffertium spp.	3	1	2	3	5	13	11	6	32	3	1				15	19
Stenacron spp.	4														2	16
Cinygmula spp.	1	1			15	1								11		
Ephemerella spp.	1	18	23	3	14	40	11	49	37		2			25	9	
Eurylophella spp.	4	2		1						6					12	2
Caenis spp.	7															
Drunella spp.	1		59		1	10				1	1			1	24	
Serratella spp.	2		1					1	1							
Drunella spp.	1						25	1								
Paraleptophlebia spp.	1	3			1	1		9				1		3	1	
Leptophlebia spp.	4															
Habrophlebiodes spp.	6															
Isonychia spp.	3		3				4		12						23	
Ameletus spp.	0	1						1								
Baetis spp.	6		1	2	23	9		2			4	4		14	2	
Rhythrogena spp.	0								2							
Diphetor spp.	6	11	1					2						3		
Acerpenna spp.	6															3
Acentrella spp.	4		8	22		2	10			7	2					
GASTROPODA (snails)																
HEMIPTERA (true bugs)																
Microvelia spp.	9															
HIRUDINEA (leeches)																
ISOPODA (sowbugs)																
MEGALOPTERA (hellgramites)																
Sialis spp.	6															
Nigronia spp.	2		1						2						6	2
Corydalus spp.	4															
ODONATA (dragon/damsel flies)																
Boyeria spp.	2										2				1	3
Cordulegaster spp.	3															
Gomphidae	4	1							1	2	3			1		1
Ophiogomphus spp.	1															
Gomphus spp.	5														1	
Hagenius spp.	3															
Argia spp.	6															
Progomphus spp.	5															
Lanthus spp.	5			1												
Stylogomphus spp.	4							4		3						
OLIGOCHAETA (worms)	10		1			3				7		18		14	1	
PLECOPTERA (stoneflies)																
Leuctra spp.	0	2	4	2	2			3		3	5	1	3	3		
Amphinemura spp.	3							5			6	7				
Pteronarcys spp.	0	1												1		2
Perlidae	3															
Acroneuria spp.	0	2	2	1		1	4	2	5	8	3	1	3		3	3
Paragnetina spp.	1		1		1	3									5	
Agnetina spp.	1	1	2	1	1		1							2		
Suwallia/Sweltsa spp.	0	28	7	6	3	6						5	2	14		
Paranemoura spp.	2															
Tallaperla spp.	0	1						2								
Diploperla spp.	2															
Clhloroperlidae	0								1							
Clioperla spp.	2															
Diura spp.	2															
Cultus spp.	2				3											
Isoginoides app.	3					1										

Taeniopteryx spp.	2															
Beloneuria spp.	3					2										
Perlesta spp.	4															
Isoperla spp.	2		1	1		6		15	1					8		1
TURBELLARIA (flatworms)																
TRICHOPTERA (caddisflies)																
Chimarra spp.	4		1				3		2	2		22				
Brachycentrus spp.	1													4		
Dolophilodes spp.	0	1	4	5		2	6		1			1		1		
Hydropsyche spp.	5			1						2		4				
Cheumatopsyche spp.	6		3	1			18	1	8	5	6	8		6	12	4
Agarodes spp.	2															3
Lype spp.	2							2	2							2
Ceratopsyche spp.	5	3	4	11	19	16	6	1	8			3		13	9	9
Diplectrona spp.	0	5				1	1	20	4			4	1	2		
Glossossoma spp.	0			1												
Wormaldia spp.	0															
Rhyacophila spp.	1	4	2		4	11	5	1	7			3		12	1	1
Neureclipsis spp.	7														12	
Parapsyche spp.	0															
Agapetus spp.	0													1		
Ceraclea spp.	3										1					
Lepidostoma spp.	1	2				1	1	4		13						
Macrostemum spp.	3														3	
Cyrnellus spp.	8			1												
Neophylax spp.	3		1	1		2			1		2	1			1	
Psilotreta spp.	0		1			2								1		
Mystacides spp.	4							2								
Apatania spp.	3															
Micrasema spp.	2									1		1				
Diphetor spp.	6															
Nyctiophylax spp.	7	1						1							1	
Limnephilidae	4															
Phylocentropus spp.	5															
Polycentropus spp.	6		1		3	3	2	2	3	2						
Pycnopsyche spp.	4			2		2		6	1							3
Goera spp.																
TOTAL		213	201	195	214	193	194	210	192	228	53	202	123	198	185	112
METRICS																
Total Taxa Richness		28	30	25	21	30	22	32	27	20	15	12	11	31	27	25
Shannon Diversity Index		2.35	2.45	1.68	2.20	2.74	2.54	2.58	2.45	1.85	2.38	2.01	1.27	3.00	2.80	2.59
EPT Taxa Richness		18	17	14	12	20	12	19	16	9	9	7	4	19	13	10
Hilsenhoff Biotic Index		2.01	2.72	4.91	1.90	2.99	3.89	2.82	3.34	4.79	3.83	3.58	3.51	3.22	3.67	3.60
Percent Intolerant Individuals		67.6	60.2	14.4	72.9	60.6	38.1	61.9	58.9	14.0	49.1	28.1	55.3	54.5	49.7	36.6
Modified Beck's Index		46	32	24	26	37	20	32	27	11	12	14	16	44	19	13
IBI SMALL STREAM		**90.0**	**85.2**	**58.5**	**76.4**	**90.4**	**65.3**	**88.9**	**79.1**	**47.1**	**57.0**	**48.8**	**47.7**	**90.3**	**72.5**	**62.6**
IBI LARGE STREAM		**95.4**	**95.4**	**70.3**	**86.6**	**97.2**	**78.5**	**97.2**	**92.8**	**55.2**	**67.5**	**58.5**	**59.0**	**96.5**	**86.4**	**73.3**

An amendment to the macroinvertebrate results was made on October 22, 2020, to include the multihabitat low-gradient scores for three sites.

Aquashicola Creek 19				
Metric	**Equation**	**Observed Metric Value**	**Normalized Metric Score**	**Adjusted Metric Score** Maximum = 100
Total Taxa Richness	(Observed / 31)*100	27	87.1	87.1
EPT Taxa Richness	(Observed / 17)*100	19	111.8	100
Beck4	(Observed / 22)*100	27	122.7	100
Shannon Diversity	(Observed / 2.43)*100	2.76	113.6	100
# of Caddisfly Taxa	(Observed / 11)*100	8	72.7	72.7
# of Mayfly Taxa	(Observed / 6)*100	4	66.7	66.7
Average of adjusted standardized metric scores = **IBI Score** =				87.8

Cherry Creek 06				
Metric	**Equation**	**Observed Metric Value**	**Normalized Metric Score**	**Adjusted Metric Score** Maximum = 100
Total Taxa Richness	(Observed / 31)*100	25	80.6	80.6
EPT Taxa Richness	(Observed / 17)*100	18	105.9	100
Beck4	(Observed / 22)*100	26	118.2	100
Shannon Diversity	(Observed / 2.43)*100	3.53	145.3	100
# of Caddisfly Taxa	(Observed / 11)*100	8	72.7	72.7
# of Mayfly Taxa	(Observed / 6)*100	3	50	50
Average of adjusted standardized metric scores = **IBI Score** =				83.9

Cherry Creek 06R				
Metric	**Equation**	**Observed Metric Value**	**Normalized Metric Score**	**Adjusted Metric Score** Maximum = 100
Total Taxa Richness	(Observed / 31)*100	23	74.2	74.2
EPT Taxa Richness	(Observed / 17)*100	16	94.1	94.1
Beck4	(Observed / 22)*100	12	54.5	54.5
Shannon Diversity	(Observed / 2.43)*100	1.83	75.3	75.3
# of Caddisfly Taxa	(Observed / 11)*100	7	63.6	63.6
# of Mayfly Taxa	(Observed / 6)*100	5	83.3	83.3
Average of adjusted standardized metric scores = **IBI Score** =				74.2

Note - The primary difference between the Cherry Creek 06 and 06R was the lower score for Shannon Diversity at 06R. This was caused mostly by a greater number of the mayflies Ephemerella in 06R. Since Ephemerella mayflies are intolerant, this difference does not necessarily reflect a difference in organic pollution between samples.

Appendix C – Habitat Assessment

The habitat assessment is a modification of the habitat evaluation methods from the USEPA *Rapid Bioassessment Protocols*. It is used to evaluate key physical characteristics of the available habitat and conditions to aquatic biota which impacts the community structure and composition. The parameters are scored on a scale of 1 – 20, where 20 represents the most optimal conditions for that category. The following parameters are directly based on the Shull and Lookenbill (2018) *Water Quality Monitoring Protocols for Streams and Rivers* and are followed by examples of the datasheets from the protocols:

Riffle/Run Parameters

1. Instream Fish Cover – The percent makeup of the substrate that provides refuge for a variety of fish.

2. Epifaunal Substrate – Evaluates the riffle quality relative to stream width and the abundance of dominant substrate materials.

3. Embeddedness – This evaluates the extent to which gravel/cobble/or boulders are covered by smaller particle substrate.

4. Velocity Depth Regimes – Evaluates the presence of all four depth regimes in riffle/run habitat.

5. Channel Alteration – Evaluates the extent of channelization, dredging, or any other large-scale changes to the shape of the stream channel that has occurred that are detrimental to the habitat.

6. Sediment Deposition – This parameter looks at islands, point bars, or deposition in pools to estimate the extent of sediment deposits.

7. Riffle Frequency – Estimates the frequency of riffle occurrence based on stream width.

8. Channel Flow Status – Evaluates the flow conditions relative to bank height and width and the exposed channel substrate.

9. Condition of Banks – This parameter looks for signs of erosion or the potential for erosion on the stream bank using a bank full delineation.

10. Bank Vegetative Protection – Assesses the extent of stream bank covered by vegetation which provides stabilization through root coverage.

11. Grazing or Other Disruptive Pressures – This parameter evaluates the impact on the surrounding area by human activities.

12. Riparian Vegetative Zones – Estimates the width of the riparian zone from the edge of the stream bank out through the riparian zone. Assesses the presence of roads, parking lots, lawns, etc., that decreases the riparian zone length.

Riffle/Run Habitat Evaluation Form

Physical Habitat Evaluation Form for Riffle/Run Prevalence				
Waterbody Name:	GIS Key (YYYYMMDD-hhmm-User):			
Location:				
Investigators:	Completed By:			
Parameter	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
1. Instream Cover (Fish)	Greater than 50% mix of boulder, cobble, submerged logs, undercut banks, or other stable habitat.	30-50% mix of boulder, cobble, or other stable habitat; adequate habitat.	10-30% mix of boulder, cobble, or other stable habitat; habitat availability less than desirable.	Less than 10% mix of boulder, cobble, or other stable habitat; lack of habitat is obvious.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Well-developed riffle and run; riffle is as wide as stream and length extends two times the width of stream; abundance of cobble.	Riffle is as wide as stream but length is less than two times width; abundance of cobble; boulders and gravel common.	Run area may be lacking; riffle not as wide as stream and its length is less than 2 times the stream width; gravel or large boulders and bedrock prevalent; some cobble present.	Riffles or run virtually nonexistent; large boulders and bedrock prevalent; cobble lacking.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
3. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment.	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.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
4. Velocity/Depth Regimes	All four velocity/depth regimes present (slow-deep, slow shallow, fast-deep, fast shallow)	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 lower than if missing other regimes).	Dominated by 1 velocity/depth regime (usually slow-deep).
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Channel Alteration	No channelization or dredging present.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e. dredging (greater than 20 yr.) may be present, but recent channelization is not present.	New embankments 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.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar information, mostly from coarse gravel; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel coarse sand on old and new bars; 30-50% of the bottom affected; sediment deposits at obstruction, construction and bends, moderate depositions of pools prevalent.	Heavy deposits of fine material increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Parameter	Optimal	Suboptimal	Marginal	Poor
7. Riffle Frequency	Occurrence of riffles relatively frequent;; distance between riffles divided by the width of the stream equals 5 to 7; variety of habitat.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream equals 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 >25.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Channel Flow Status	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.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach have areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; on side slopes, 60-100% of bank has erosional scars.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the stream bank surfaces covered by vegetation.	70-90% of the stream bank surfaces covered by vegetation.	50-70% of the stream bank surfaces covered by vegetation.	Less than 50% of the stream bank surfaces covered by vegetation.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetative disruption through grazing or mowing is minimal or not evident; almost all plants allowed to grow naturally.	Disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation is very high; vegetation has been removed to 2 inches or less in average stubble height.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone	Width or 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.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

TOTAL _____

Low Gradient Parameters

1. Epifaunal Substrate/Available Cover – Evaluates the riffle quality relative to stream width and the abundance of dominant substrate materials.

2. Pool Substrate Characterization – Evaluates the type and condition of the bottom substrate found in the pools.

3. Pool Variability – Assesses the overall mixture of pool types according to size and depth.

4. Sediment Deposition – This parameter looks at islands, point bars, or deposition in pools to estimate the extent of sediment deposits.

5. Channel Flow Status – Evaluates the flow conditions relative to bank height and width and the exposed channel substrate.

6. Channel Alteration – Evaluates the extent of channelization, dredging, or any other large-scale changes to the shape of the stream channel that has occurred that are detrimental to the habitat.

7. Condition of Banks – This parameter looks for signs of erosion or the potential for erosion on the stream bank using a bank full delineation.

8. Bank Vegetative Protection – Assesses the extent of stream bank covered by vegetation which provides stabilization through root coverage.

9. Riparian Vegetative Zone – Estimates the width of the riparian zone from the edge of the stream bank out through the riparian zone. Assesses the presence of roads, parking lots, lawns, etc., that decreases the riparian zone length.

Multihabitat, Low Gradient Evaluation Form

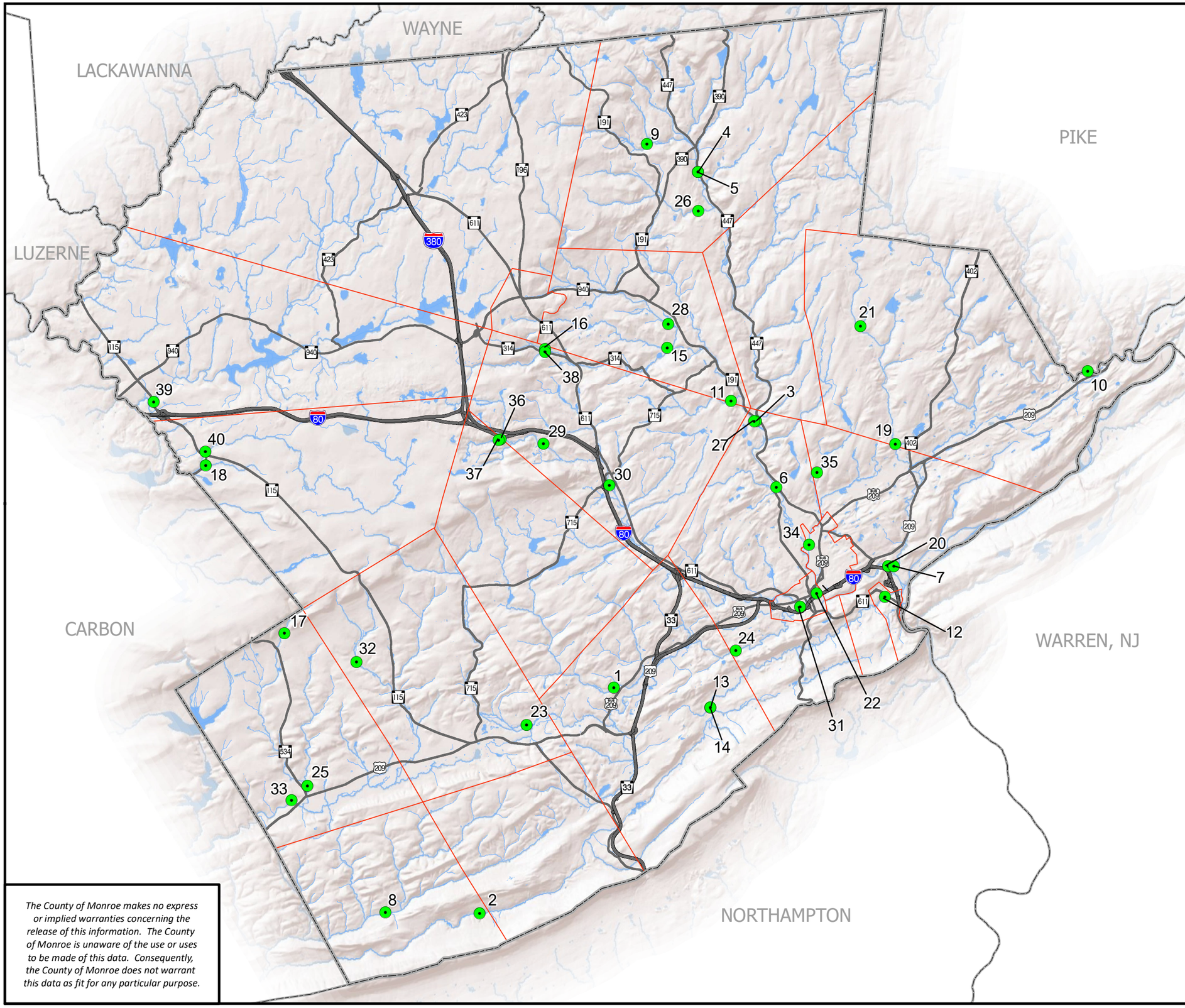
Physical Habitat Evaluation Form for Low Gradient (Pool/Glide) Streams

Waterbody Name:	GIS Key (YYYYMMDD-hhmm-User):
Location:	
Investigators:	Completed By:

Parameter	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale)	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	20 19 18 17 16	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1**
2. Pool Substrate Characterization	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 vegetation.
	20 19 18 17 16	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1**
3. Pool Variability	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.
	20 19 18 17 16	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1**
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 20% of the bottom affected by sediment deposition	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% 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 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
	20 19 18 17 16	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1**
5. Channel Flow Status	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.
	20 19 18 17 16	**15 14 13 12 11**	**10 9 8 7 6**	**5 4 3 2 1**

Parameter	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	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
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Condition of Banks	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 sealed 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.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Bank Vegetative Protection	More than 90% of the streambank surfaces and immediate riparian zone 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 stubble height.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
9. Riparian Vegetative Zone	Width or 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.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Appendix D – Site Map



Site Number	Stream Name
1	Appenzel Creek 02
2	Aquashicola Creek 19
3	Brodhead Creek 22
4	Brodhead Creek 27
5	Brodhead Creek 27R
6	Brodhead Creek 30
7	Brodhead Creek 31
8	Buckwha Creek 01
9	Buck Hill Creek 07
10	Bushkill Creek 07
11	Butz Run 01
12	Cherry Creek 01
13	Cherry Creek 06
14	Cherry Creek 06R
15	Forest Hills Run 20
16	Indian Run 03
17	Jonas Creek 01
18	Keiper Run 02
19	Marshalls Creek 11
20	Marshalls Creek 18
21	Marshalls Creek 19
22	McMichael Creek 10
23	McMichael Creek 22
24	McMichael Creek 37
25	Middle Creek 04
26	Mill Creek 03
27	Paradise Creek 08
28	Paradise Creek 09
29	Pocono Creek 01
30	Pocono Creek 09
31	Pocono Creek 14
32	Pohopoco Creek 01
33	Pohopoco Creek 29
34	Sambo Creek 02
35	Sambo Creek 20
36	Sand Spring 01
37	Sand Spring 02
38	Swiftwater Creek 10
39	Tobyhanna Creek 14
40	Tunkhannock Creek 03

2020 WATER QUALITY STUDY SITES

MONROE COUNTY
PENNSYLVANIA

- Sample Location
- County Boundaries
- Municipal Boundaries
- Streams
- Lakes & Ponds

0 2 4
Miles

1:190,000

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MONROE 2030

www.monroecountypa.gov

PREPARED BY

Monroe County
Planning Commission

1 Quaker Plaza, Room 106
Stroudsburg, PA 18360
(570) 517-3100
mcpc@monroecountypa.gov

October 2020

The County of Monroe makes no express or implied warranties concerning the release of this information. The County of Monroe is unaware of the use or uses to be made of this data. Consequently, the County of Monroe does not warrant this data as fit for any particular purpose.

Site #	Site ID	Stream Name	Location
1	APPECR02	Appenzel Creek	Near residential housing, 160m west of the Foundry St. bridge.
2	AQUACR19	Aquashicola Creek	315 meters east from intersection of Upper Smith Gap Rd and Camp Hill Rd
3	BRODCR22	Brodhead Creek	Sugar Cane Ln. access off of Rt. 191 Bridge upstream of confluence of PARACR08.
4	BRODCR27	Brodhead Creek	170 meters northeast of Pasold Farm Dr. parking area.
5	BRODCR27R	Brodhead Creek	170 meters northeast of Pasold Farm Dr. parking area.
6	BRODCR30	Brodhead Creek	120 meters southeast of Rt. 191 bridge near intersection of Rt.191 and Rt. 447
7	BRODCR31	Brodhead Creek	55 meters east of Paper Mill Rd near entrance of paper mill
8	BUCKCR01	Buckwha Creek	200 meters east of Chestnut Ridge Rd bridge
9	BUHICR07	Buck Hill Creek	165 meters upstream of Buck Hill Golf Club off of Cresco Rd.
10	BUSHCR07	Bushkill Creek	340 meters north of Route 209 through ROW.
11	BUTZRN01	Butz Run	1.14 miles down Sylvan Cascades Rd from intersection of Rt. 191
12	CHERCR01	Cherry Creek	Located near Edge of the Woods Outfitters 100m from the intersection of 611 and Broad St.
13	CHERCR06	Cherry Creek	25 meters south of bridge on Kemmertown Rd.
14	CHERCR06R	Cherry Creek	25 meters south of bridge on Kemmertown Rd.
15	FOHICR20	Forest Hills Run	40 meters west (upstream) of Lower Swiftwater Rd. bridge
16	INDIRN03	Indian Run	150 meters north of Manor Dr. Bridge upstrem of confluence with Swiftwater Creek.
17	JONACR01	Jonas Creek	150m north of the Laurel Ln cul-de-sac
18	KEIPRN02	Keiper Run	70 meters east of Rt. 903 bridge, upstream of bridge
19	MARSCR11	Marshalls Creek	385 meters north of intersection of Marshalls Creek Rd. and Golfcart Rd.
20	MARSCR18	Marshalls Creek	Next to Minisink Hotel parking lot off of Post Office Rd.
21	MARSCR19	Marshalls Creek	40 meters north of one land bridge on Tallyrand Dr.
22	MCMICR10	McMichael Creek	360 meters downstream of Broad Street bridge.
23	MCMICR22	McMichael Creek	115m south of intersection of Mcilhaney Rd. and Kennel Rd.
24	MCMICR37	McMichael Creek	Hickory Valley State Park 60m southeast from parking area.
25	MIDDCR04	Middle Creek	Downstream of observation deck on Cliff Woodring Trail.
26	MILLCR03	Mill Creek	560m west of instersection of Sand Spring Rd. and Mill Creek Rd.
27	PARACR08	Paradise Creek	Sugar Cane Ln. access off of Rt. 191 Bridge upstream of confluence of Brodhead Creek.
28	PARACR09	Paradise Creek	160m north of intersection of Summit Dr. and Hemlock Rd.
29	POCOCR01	Pocono Creek	300m south on Camelback Rd from intersection of Camelback Rd. and Wilke Rd.
30	POCOCR09	Pocono Creek	65m north of Old Mill Rd. bridge.
31	POCOCR14	Pocono Creek	70m south from S. 10th St and Ann St.
32	POHOCR01	Pohopoco Creek	330m southeast from intersection of Merwinsburg Rd. and Burger Hollow Rd.
33	POHOCR29	Pohopoco Creek	700 meters west on Whitey B Ln. from intersection of Whitey B Ln. and Rt. 209.
34	SAMBCR02	Sambo Creek	45m east of Levee Loop Trail, north of John Konawalick Field
35	SAMBCR20	Sambo Creek	220m south of Brushy Mtn. Rd. Downstream of Sambo Creek Lower Reservoir
36	SASPR01	Sand Spring	600m west of Wilke Rd. dead end.
37	SASPR02	Sand Spring	700m west of Wilke Rd. dead end.
38	SWIFCR10	Swiftwater Creek	25m north of Manor Dr. bridge.
39	TOBYCR14	Tobyhanna Creek	50m east of Rt. 115 bridge near Austin T. Blakeslee Natural Area.
40	TUNKCR03	Tunkhannock Creek	160m north of Tunhannok Fishing Association Parking area.

Data Pages

APPECR02

Location	Near residential housing, 160m west of the Foundry St. bridge.		
Site #	2020-1	Date	4/28/2020
Stream Name	Appenzel Creek	Time	12:50:00 PM
Township	Hamilton	Latitude	40.946838
Habitat Asmt.	210	Longitude	-75.310513

Field Measurements	
Temp C	10.6
pH	7.62
Press inHg	
DO Percent	103.1
DO mg/L	11.46
Cond (uS/cm)	100

Macroinvertebrate Metrics	
Total Taxa	29
Shannon Diversity Index	2.57
EPT Taxa Richness	17
Hilsenhoff Biotic Index	2.92
Intolerant individuals (%)	57.8
Modified Becks Index	31
Index of Biotic Integrity	**84.1**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.72
Aluminum mg/L	<0.160
Calcium mg/L	6.85
Iron mg/L	0.105
Magnesium mg/L	2.05
Hardness CaCO3	25.6
Chloride mg/L	14.8
pH	7.4
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.422
Alkalinity to pH 4.5 mg CaCO3/L	14.7
Total Dissolved Solids mg/L	77
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

AQUACR19

Location	315 meters east from intersection of Upper Smith Gap Rd and Camp Hill Rd		
Site #	2020-2	Date	4/28/2020
Stream Name	Aquashicola Creek	Time	10:52:00 AM
Township	Eldred	Latitude	40.845611
Habitat Asmt.	152	Longitude	-75.394982

Field Measurements	
Temp C	9.2
pH	7.78
Press inHg	
DO Percent	102
DO mg/L	11.72
Cond (uS/cm)	144

Macroinvertebrate Metrics	
Total Taxa	27
Shannon Diversity Index	2.76
EPT Taxa Richness	16
Hilsenhoff Biotic Index	2.99
Intolerant individuals (%)	42.3
Modified Becks Index	27
Index of Biotic Integrity	**78.3**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.58
Aluminum mg/L	<0.160
Calcium mg/L	17.1
Iron mg/L	0.127
Magnesium mg/L	4.01
Hardness CaCO3	59.2
Chloride mg/L	9.33
pH	7.8
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.445
Alkalinity to pH 4.5 mg CaCO3/L	46.2
Total Dissolved Solids mg/L	143
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

BRODCR22

Location	Sugar Cane Ln. access off of Rt. 191 Bridge upstream of confluence of PARACR08.		
Site #	2020-3	Date	4/30/2020
Stream Name	Brodhead Creek	Time	11:35:00 AM
Township	Stroud	Latitude	41.066523
Habitat Asmt.	205	Longitude	-75.220216

Field Measurements	
Temp C	9.1
pH	7.19
Press inHg	
DO Percent	98.2
DO mg/L	11.31
Cond (uS/cm)	61

Macroinvertebrate Metrics	
Total Taxa	34
Shannon Diversity Index	2.74
EPT Taxa Richness	18
Hilsenhoff Biotic Index	3.24
Intolerant individuals (%)	51.5
Modified Becks Index	36
Index of Biotic Integrity	**95**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.84
Aluminum mg/L	<0.160
Calcium mg/L	4.01
Iron mg/L	<0.0800
Magnesium mg/L	1.07
Hardness CaCO3	14.4
Chloride mg/L	8.47
pH	6.7
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.134
Alkalinity to pH 4.5 mg CaCO3/L	12.6
Total Dissolved Solids mg/L	40
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

BRODCR27

Location	170 meters northeast of Pasold Farm Dr. parking area.		
Site #	2020-4	Date	4/29/2020
Stream Name	Brodhead Creek	Time	9:13:00 AM
Township	Barrett	Latitude	41.180941
Habitat Asmt.	208	Longitude	-75.25091

Field Measurements	
Temp C	7.9
pH	7.05
Press inHg	
DO Percent	100.1
DO mg/L	11.88
Cond (uS/cm)	58

Macroinvertebrate Metrics	
Total Taxa	31
Shannon Diversity Index	2.71
EPT Taxa Richness	17
Hilsenhoff Biotic Index	2.84
Intolerant individuals (%)	59.1
Modified Becks Index	32
Index of Biotic Integrity	**97.2**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.38
Aluminum mg/L	<0.160
Calcium mg/L	3.71
Iron mg/L	<0.0800
Magnesium mg/L	1
Hardness CaCO3	13.4
Chloride mg/L	8.59
pH	6.5
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.14
Alkalinity to pH 4.5 mg CaCO3/L	8.4
Total Dissolved Solids mg/L	102
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

BRODCR27R

Location	170 meters northeast of Pasold Farm Dr. parking area.		
Site #	2020-5	Date	4/29/2020
Stream Name	Brodhead Creek	Time	9:13:00 AM
Township	Barrett	Latitude	41.180941
Habitat Asmt.	208	Longitude	-75.25091

Field Measurements	
Temp C	7.9
pH	7.05
Press inHg	
DO Percent	100.1
DO mg/L	11.88
Cond (uS/cm)	58

Macroinvertebrate Metrics	
Total Taxa	32
Shannon Diversity Index	2.69
EPT Taxa Richness	17
Hilsenhoff Biotic Index	2.92
Intolerant individuals (%)	60.4
Modified Becks Index	31
Index of Biotic Integrity	**97.4**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.44
Aluminum mg/L	<0.160
Calcium mg/L	3.72
Iron mg/L	0.0938
Magnesium mg/L	0.983
Hardness CaCO3	13.3
Chloride mg/L	8.53
pH	6.6
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.138
Alkalinity to pH 4.5 mg CaCO3/L	6.3
Total Dissolved Solids mg/L	96
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

BRODCR30

Location	120 meters southeast of Rt. 191 bridge near intersection of Rt.191 and Rt. 447		
Site #	2020-6	Date	4/21/2020
Stream Name	Brodhead Creek	Time	9:11:00 AM
Township	Stroud	Latitude	41.036093
Habitat Asmt.	185	Longitude	-75.209176

Field Measurements	
Temp C	6.65
pH	7.3
Press inHg	
DO Percent	98.75
DO mg/L	12.09
Cond (uS/cm)	102

Macroinvertebrate Metrics	
Total Taxa	24
Shannon Diversity Index	2.5
EPT Taxa Richness	13
Hilsenhoff Biotic Index	3.12
Intolerant individuals (%)	56.1
Modified Becks Index	21
Index of Biotic Integrity	**87.4**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.68
Aluminum mg/L	<0.160
Calcium mg/L	5.89
Iron mg/L	<0.0800
Magnesium mg/L	1.53
Hardness CaCO3	21
Chloride mg/L	18
pH	7.3
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.238
Alkalinity to pH 4.5 mg CaCO3/L	12.9
Total Dissolved Solids mg/L	55
Phosphorus as P mg/L	0.02
Biochemical Oxygen Demand mg/L	<3.00

BRODCR31

Location	55 meters east of Paper Mill Rd near entrance of paper mill		
Site #	2020-7	Date	5/5/2020
Stream Name	Brodhead Creek	Time	9:23:00 AM
Township	Smithfield	Latitude	40.998746
Habitat Asmt.	167	Longitude	-75.143353

Field Measurements	
Temp C	10.05
pH	7.54
Press inHg	
DO Percent	101.95
DO mg/L	11.48
Cond (uS/cm)	137

Macroinvertebrate Metrics	
Total Taxa	27
Shannon Diversity Index	2.79
EPT Taxa Richness	11
Hilsenhoff Biotic Index	4.23
Intolerant individuals (%)	23.8
Modified Becks Index	11
Index of Biotic Integrity	**70.4**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.88
Aluminum mg/L	<0.160
Calcium mg/L	9.78
Iron mg/L	0.0907
Magnesium mg/L	1.82
Hardness CaCO3	31.9
Chloride mg/L	20.8
pH	6.7
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.317
Alkalinity to pH 4.5 mg CaCO3/L	21.1
Total Dissolved Solids mg/L	91
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

BUCKCR01

Location	200 meters east of Chestnut Ridge Rd bridge		
Site #	2020-8	Date	4/28/2020
Stream Name	Buckwha Creek	Time	10:20:00 AM
Township	Eldred	Latitude	40.847275
Habitat Asmt.	180	Longitude	-75.451532

Field Measurements	
Temp C	7.8
pH	7.36
Press inHg	
DO Percent	102.9
DO mg/L	12.24
Cond (uS/cm)	95

Macroinvertebrate Metrics	
Total Taxa	28
Shannon Diversity Index	2.46
EPT Taxa Richness	18
Hilsenhoff Biotic Index	3.17
Intolerant individuals (%)	59.6
Modified Becks Index	27
Index of Biotic Integrity	**81.9**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.16
Aluminum mg/L	<0.160
Calcium mg/L	7.9
Iron mg/L	0.0955
Magnesium mg/L	2.37
Hardness CaCO3	29.5
Chloride mg/L	9.38
pH	7.2
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	1.63
Alkalinity to pH 4.5 mg CaCO3/L	14.7
Total Dissolved Solids mg/L	55
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

BUHICR07

Location	165 meters upstream of Buck Hill Golf Club off of Cresco Rd.		
Site #	2020-9	Date	4/29/2020
Stream Name	Buck Hill Creek	Time	8:32:00 AM
Township	Barrett	Latitude	41.194403
Habitat Asmt.	226	Longitude	-75.281357

Field Measurements	
Temp C	6.4
pH	6.66
Press inHg	
DO Percent	98.73
DO mg/L	12.15
Cond (uS/cm)	38

Macroinvertebrate Metrics	
Total Taxa	26
Shannon Diversity Index	2.31
EPT Taxa Richness	20
Hilsenhoff Biotic Index	1.45
Intolerant individuals (%)	85.1
Modified Becks Index	42
Index of Biotic Integrity	**93.3**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.11
Aluminum mg/L	<0.160
Calcium mg/L	2.61
Iron mg/L	<0.0800
Magnesium mg/L	0.672
Hardness CaCO3	9.28
Chloride mg/L	5.09
pH	6.5
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.0885
Alkalinity to pH 4.5 mg CaCO3/L	6.3
Total Dissolved Solids mg/L	65
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

BUSHCR07

Location	340 meters north of Route 209 through ROW.		
Site #	2020-10	Date	4/30/2020
Stream Name	Bushkill Creek	Time	8:25:00 AM
Township	Middle Smithfield	Latitude	41.084861
Habitat Asmt.	211	Longitude	-75.019417

Field Measurements	
Temp C	9.7
pH	6.85
Press inHg	
DO Percent	97.6
DO mg/L	11.09
Cond (uS/cm)	49

Macroinvertebrate Metrics	
Total Taxa	21
Shannon Diversity Index	2.43
EPT Taxa Richness	12
Hilsenhoff Biotic Index	3.56
Intolerant individuals (%)	54.4
Modified Becks Index	19
Index of Biotic Integrity	**81.4**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	3.7
Aluminum mg/L	<0.160
Calcium mg/L	3.45
Iron mg/L	0.107
Magnesium mg/L	0.956
Hardness CaCO3	12.5
Chloride mg/L	5.83
pH	6.3
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	<0.0500
Alkalinity to pH 4.5 mg CaCO3/L	8.4
Total Dissolved Solids mg/L	61
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

BUTZRN01

Location	1.14 miles down Sylvan Cascades Rd from intersection of Rt. 191		
Site #	2020-11	Date	4/29/2020
Stream Name	Butz Run	Time	10:43:00 AM
Township	Paradise	Latitude	41.076071
Habitat Asmt.	219	Longitude	-75.235002

Field Measurements	
Temp C	9.2
pH	7.4
Press inHg	
DO Percent	100.5
DO mg/L	11.57
Cond (uS/cm)	94

Macroinvertebrate Metrics	
Total Taxa	22
Shannon Diversity Index	2.39
EPT Taxa Richness	14
Hilsenhoff Biotic Index	2.62
Intolerant individuals (%)	57.9
Modified Becks Index	27
Index of Biotic Integrity	**75.7**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.6
Aluminum mg/L	<0.160
Calcium mg/L	7.16
Iron mg/L	0.1
Magnesium mg/L	1.46
Hardness CaCO3	23.9
Chloride mg/L	12.1
pH	6.9
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.197
Alkalinity to pH 4.5 mg CaCO3/L	16.8
Total Dissolved Solids mg/L	87
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

CHERCR01

Location	Located near Edge of the Woods Outfitters 100m from the intersection of 611 and Broad St.		
Site #	2020-12	Date	4/21/2020
Stream Name	Cherry Creek	Time	10:20:00 AM
Township	Delaware Water Gap	Latitude	40.984712
Habitat Asmt.	167	Longitude	-75.145848

Field Measurements	
Temp C	7.9
pH	8
Press inHg	
DO Percent	96.2
DO mg/L	11.4
Cond (uS/cm)	281

Macroinvertebrate Metrics	
Total Taxa	24
Shannon Diversity Index	2.43
EPT Taxa Richness	12
Hilsenhoff Biotic Index	2.86
Intolerant individuals (%)	60.2
Modified Becks Index	19
Index of Biotic Integrity	**72**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.28
Aluminum mg/L	<0.160
Calcium mg/L	26.7
Iron mg/L	0.161
Magnesium mg/L	5.53
Hardness CaCO3	89.5
Chloride mg/L	8.2
pH	7.8
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.273
Alkalinity to pH 4.5 mg CaCO3/L	68.6
Total Dissolved Solids mg/L	161
Phosphorus as P mg/L	0.029
Biochemical Oxygen Demand mg/L	<3.00

CHERCR06

Location	25 meters south of bridge on Kemmertown Rd.		
Site #	2020-13	Date	4/29/2020
Stream Name	Cherry Creek	Time	11:40:00 AM
Township	Hamilton	Latitude	40.93657
Habitat Asmt.	153	Longitude	-75.252769

Field Measurements	
Temp C	11
pH	8.54
Press inHg	
DO Percent	112.9
DO mg/L	12.43
Cond (uS/cm)	150

Macroinvertebrate Metrics	
Total Taxa	25
Shannon Diversity Index	3.54
EPT Taxa Richness	15
Hilsenhoff Biotic Index	3.49
Intolerant individuals (%)	51.5
Modified Becks Index	16
Index of Biotic Integrity	**73**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.46
Aluminum mg/L	<0.160
Calcium mg/L	21.5
Iron mg/L	0.126
Magnesium mg/L	4.4
Hardness CaCO3	71.7
Chloride mg/L	4.48
pH	8.4
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.228
Alkalinity to pH 4.5 mg CaCO3/L	54.6
Total Dissolved Solids mg/L	157
Phosphorus as P mg/L	0.021
Biochemical Oxygen Demand mg/L	<3.00

CHERCR06R

Location	25 meters south of bridge on Kemmertown Rd.		
Site #	2020-14	Date	4/29/2020
Stream Name	Cherry Creek	Time	11:40:00 AM
Township	Hamilton	Latitude	40.93657
Habitat Asmt.	153	Longitude	-75.252769

Field Measurements	
Temp C	11
pH	8.54
Press inHg	
DO Percent	112.9
DO mg/L	12.43
Cond (uS/cm)	150

Macroinvertebrate Metrics	
Total Taxa	23
Shannon Diversity Index	1.83
EPT Taxa Richness	12
Hilsenhoff Biotic Index	2.5
Intolerant individuals (%)	71.5
Modified Becks Index	12
Index of Biotic Integrity	**67.6**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.27
Aluminum mg/L	<0.160
Calcium mg/L	21.2
Iron mg/L	0.193
Magnesium mg/L	4.35
Hardness CaCO3	70.9
Chloride mg/L	4.54
pH	8.2
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.229
Alkalinity to pH 4.5 mg CaCO3/L	54.6
Total Dissolved Solids mg/L	272
Phosphorus as P mg/L	0.026
Biochemical Oxygen Demand mg/L	<3.00

INDIRN03

Location	150 meters north of Manor Dr. Bridge upstrem of confluence with Swiftwater Creek.		
Site #	2020-16	Date	4/22/2020
Stream Name	Indian Run	Time	11:00:00 AM
Township	Pocono	Latitude	41.10221
Habitat Asmt.	217	Longitude	-75.346358

Field Measurements	
Temp C	6.5
pH	7.79
Press inHg	
DO Percent	98.4
DO mg/L	12.11
Cond (uS/cm)	199

Macroinvertebrate Metrics	
Total Taxa	29
Shannon Diversity Index	2.47
EPT Taxa Richness	16
Hilsenhoff Biotic Index	3.5
Intolerant individuals (%)	47.4
Modified Becks Index	28
Index of Biotic Integrity	**78.1**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	0.62
Aluminum mg/L	<0.160
Calcium mg/L	9.41
Iron mg/L	<0.0800
Magnesium mg/L	2.7
Hardness CaCO3	34.6
Chloride mg/L	46.3
pH	7.1
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.548
Alkalinity to pH 4.5 mg CaCO3/L	12.9
Total Dissolved Solids mg/L	108
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

JONACR01

Location	150m north of the Laurel Ln cul-de-sac		
Site #	2020-17	Date	4/20/2020
Stream Name	Jonas Creek	Time	11:40:00 AM
Township	Polk	Latitude	40.97567
Habitat Asmt.	221	Longitude	-75.507843

Field Measurements	
Temp C	7.9
pH	6.96
Press inHg	
DO Percent	95.7
DO mg/L	11.36
Cond (uS/cm)	92

Macroinvertebrate Metrics	
Total Taxa	24
Shannon Diversity Index	2.53
EPT Taxa Richness	15
Hilsenhoff Biotic Index	2.82
Intolerant individuals (%)	59.1
Modified Becks Index	30
Index of Biotic Integrity	**79.6**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	0.57
Aluminum mg/L	<0.160
Calcium mg/L	3.61
Iron mg/L	<0.0800
Magnesium mg/L	1.47
Hardness CaCO3	15.1
Chloride mg/L	19.8
pH	6.5
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.678
Alkalinity to pH 4.5 mg CaCO3/L	6.4
Total Dissolved Solids mg/L	51
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

KEIPRN02

Location	70 meters east of Rt. 903 bridge, upstream of bridge		
Site #	2020-18	Date	4/20/2020
Stream Name	Keiper Run	Time	11:40:00 AM
Township	Tunkhannock	Latitude	41.053224
Habitat Asmt.	179	Longitude	-75.552658

Field Measurements	
Temp C	6.2
pH	6.71
Press inHg	
DO Percent	91.4
DO mg/L	11.31
Cond (uS/cm)	99

Macroinvertebrate Metrics	
Total Taxa	14
Shannon Diversity Index	1.18
EPT Taxa Richness	4
Hilsenhoff Biotic Index	5.63
Intolerant individuals (%)	4.7
Modified Becks Index	14
Index of Biotic Integrity	**33.5**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.05
Aluminum mg/L	<0.160
Calcium mg/L	3.59
Iron mg/L	0.126
Magnesium mg/L	1.08
Hardness CaCO3	13.4
Chloride mg/L	22.2
pH	6.7
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.302
Alkalinity to pH 4.5 mg CaCO3/L	6.4
Total Dissolved Solids mg/L	149
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

FOHIRN20

Location	40 meters west (upstream) of Lower Swiftwater Rd. bridge		
Site #	2020-15	Date	5/4/2020
Stream Name	Forest Hills Run	Time	9:45:00 AM
Township	Paradise	Latitude	41.101108
Habitat Asmt.	212	Longitude	-75.272583

Field Measurements	
Temp C	11.3
pH	7.59
Press inHg	
DO Percent	98.4
DO mg/L	10.77
Cond (uS/cm)	222

Macroinvertebrate Metrics	
Total Taxa	20
Shannon Diversity Index	2.21
EPT Taxa Richness	12
Hilsenhoff Biotic Index	2.88
Intolerant individuals (%)	50.3
Modified Becks Index	18
Index of Biotic Integrity	**66**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.8
Aluminum mg/L	<0.160
Calcium mg/L	11.3
Iron mg/L	<0.0800
Magnesium mg/L	2.99
Hardness CaCO3	40.4
Chloride mg/L	48.5
pH	6.8
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.367
Alkalinity to pH 4.5 mg CaCO3/L	23.2
Total Dissolved Solids mg/L	96
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

MARSCR11

Location	385 meters north of intersection of Marshalls Creek Rd. and Golfcart Rd.		
Site #	2020-19	Date	4/30/2020
Stream Name	Marshalls Creek	Time	10:15:00 AM
Township	Middle Smithfield	Latitude	41.054246
Habitat Asmt.	211	Longitude	-75.13672

Field Measurements	
Temp C	9.1
pH	7.21
Press inHg	
DO Percent	98.4
DO mg/L	11.34
Cond (uS/cm)	78

Macroinvertebrate Metrics	
Total Taxa	25
Shannon Diversity Index	2.4
EPT Taxa Richness	16
Hilsenhoff Biotic Index	3.28
Intolerant individuals (%)	50.5
Modified Becks Index	22
Index of Biotic Integrity	**74.1**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.91
Aluminum mg/L	<0.160
Calcium mg/L	6.39
Iron mg/L	<0.0800
Magnesium mg/L	1.41
Hardness CaCO3	21.8
Chloride mg/L	8.87
pH	6.8
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.229
Alkalinity to pH 4.5 mg CaCO3/L	8.4
Total Dissolved Solids mg/L	69
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

MARSCR18

Location	Next to Minisink Hotel parking lot off of Post Office Rd.		
Site #	2020-20	Date	4/21/2020
Stream Name	Marshalls Creek	Time	10:44:00 AM
Township	Smithfield	Latitude	40.998555
Habitat Asmt.	189	Longitude	-75.139952

Field Measurements	
Temp C	8.06
pH	7.74
Press inHg	
DO Percent	98.1
DO mg/L	11.6
Cond (uS/cm)	167

Macroinvertebrate Metrics	
Total Taxa	32
Shannon Diversity Index	2.67
EPT Taxa Richness	17
Hilsenhoff Biotic Index	3.65
Intolerant individuals (%)	48.4
Modified Becks Index	28
Index of Biotic Integrity	**92.9**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.04
Aluminum mg/L	<0.160
Calcium mg/L	17.5
Iron mg/L	0.121
Magnesium mg/L	2.25
Hardness CaCO3	52.9
Chloride mg/L	19.2
pH	7.5
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.202
Alkalinity to pH 4.5 mg CaCO3/L	34.3
Total Dissolved Solids mg/L	84
Phosphorus as P mg/L	0.025
Biochemical Oxygen Demand mg/L	<3.00

MARSCR19

Location	40 meters north of one land bridge on Tallyrand Dr.		
Site #	2020-21	Date	4/30/2020
Stream Name	Marshalls Creek	Time	9:30:00 AM
Township	Middle Smithfield	Latitude	41.108419
Habitat Asmt.	207	Longitude	-75.155693

Field Measurements	
Temp C	8.7
pH	7.19
Press inHg	
DO Percent	93.2
DO mg/L	10.85
Cond (uS/cm)	45

Macroinvertebrate Metrics	
Total Taxa	19
Shannon Diversity Index	1.64
EPT Taxa Richness	11
Hilsenhoff Biotic Index	1.74
Intolerant individuals (%)	71.7
Modified Becks Index	16
Index of Biotic Integrity	**66.6**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.65
Aluminum mg/L	<0.160
Calcium mg/L	4.13
Iron mg/L	0.0915
Magnesium mg/L	0.821
Hardness CaCO3	13.7
Chloride mg/L	3.3
pH	6.5
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	<0.0500
Alkalinity to pH 4.5 mg CaCO3/L	8.4
Total Dissolved Solids mg/L	66
Phosphorus as P mg/L	0.022
Biochemical Oxygen Demand mg/L	<3.00

MCMICR10

Location	360 meters downstream of Broad Street bridge.		
Site #	2020-22	Date	5/5/2020
Stream Name	McMichael Creek	Time	9:56:00 AM
Township	Stroudsburg	Latitude	40.98724
Habitat Asmt.	166	Longitude	-75.186808

Field Measurements	
Temp C	10.4
pH	7.63
Press inHg	
DO Percent	103.6
DO mg/L	11.57
Cond (uS/cm)	159

Macroinvertebrate Metrics	
Total Taxa	28
Shannon Diversity Index	2.64
EPT Taxa Richness	15
Hilsenhoff Biotic Index	3.67
Intolerant individuals (%)	37.5
Modified Becks Index	25
Index of Biotic Integrity	**87.3**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2
Aluminum mg/L	<0.160
Calcium mg/L	11.8
Iron mg/L	0.128
Magnesium mg/L	2.24
Hardness CaCO3	38.7
Chloride mg/L	24
pH	6.8
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.394
Alkalinity to pH 4.5 mg CaCO3/L	23.2
Total Dissolved Solids mg/L	139
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

MCMICR22

Location	115m south of intersection of Mcilhaney Rd. and Kennel Rd.		
Site #	2020-23	Date	4/28/2020
Stream Name	McMichael Creek	Time	11:30:00 AM
Township	Chestnuthill	Latitude	40.930902
Habitat Asmt.	215	Longitude	-75.363567

Field Measurements	
Temp C	10.1
pH	7.42
Press inHg	
DO Percent	105.23
DO mg/L	11.84
Cond (uS/cm)	69

Macroinvertebrate Metrics	
Total Taxa	36
Shannon Diversity Index	3.08
EPT Taxa Richness	18
Hilsenhoff Biotic Index	1.75
Intolerant individuals (%)	72.6
Modified Becks Index	29
Index of Biotic Integrity	**92.8**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.22
Aluminum mg/L	<0.160
Calcium mg/L	4.63
Iron mg/L	<0.0800
Magnesium mg/L	1.61
Hardness CaCO3	18.2
Chloride mg/L	10.6
pH	7.1
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.434
Alkalinity to pH 4.5 mg CaCO3/L	10.5
Total Dissolved Solids mg/L	83
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

MCMICR37

Location	Hickory Valley State Park 60m southeast from parking area.		
Site #	2020-24	Date	4/21/2020
Stream Name	McMichael Creek	Time	11:00:00 AM
Township	Stroud	Latitude	40.962041
Habitat Asmt.	184	Longitude	-75.236508

Field Measurements	
Temp C	7.4
pH	7.68
Press inHg	
DO Percent	98.03
DO mg/L	11.78
Cond (uS/cm)	128

Macroinvertebrate Metrics	
Total Taxa	25
Shannon Diversity Index	2.4
EPT Taxa Richness	13
Hilsenhoff Biotic Index	4.37
Intolerant individuals (%)	44.9
Modified Becks Index	17
Index of Biotic Integrity	**78.6**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.32
Aluminum mg/L	<0.160
Calcium mg/L	11.1
Iron mg/L	0.0829
Magnesium mg/L	2.16
Hardness CaCO3	36.6
Chloride mg/L	15.5
pH	7.5
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.527
Alkalinity to pH 4.5 mg CaCO3/L	25.7
Total Dissolved Solids mg/L	84
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

MIDDCR04

Location	Downstream of observation deck on Cliff Woodring Trail.		
Site #	2020-25	Date	4/28/2020
Stream Name	Middle Creek	Time	9:04:00 AM
Township	Polk	Latitude	40.905822
Habitat Asmt.	211	Longitude	-75.496614

Field Measurements	
Temp C	6.5
pH	7.33
Press inHg	
DO Percent	100.3
DO mg/L	12.19
Cond (uS/cm)	75

Macroinvertebrate Metrics	
Total Taxa	32
Shannon Diversity Index	2.83
EPT Taxa Richness	19
Hilsenhoff Biotic Index	2.42
Intolerant individuals (%)	62.1
Modified Becks Index	40
Index of Biotic Integrity	**93.8**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.2
Aluminum mg/L	<0.160
Calcium mg/L	4.43
Iron mg/L	<0.0800
Magnesium mg/L	1.89
Hardness CaCO3	18.8
Chloride mg/L	11.4
pH	7.1
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.906
Alkalinity to pH 4.5 mg CaCO3/L	8.4
Total Dissolved Solids mg/L	38
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

MILLCR03

Location	560m west of instersection of Sand Spring Rd. and Mill Creek Rd.		
Site #	2020-26	Date	4/29/2020
Stream Name	Mill Creek	Time	9:50:00 AM
Township	Barrett	Latitude	41.163201
Habitat Asmt.	211	Longitude	-75.251528

Field Measurements	
Temp C	7.4
pH	7.21
Press inHg	
DO Percent	99.9
DO mg/L	12.01
Cond (uS/cm)	75

Macroinvertebrate Metrics	
Total Taxa	28
Shannon Diversity Index	2.35
EPT Taxa Richness	18
Hilsenhoff Biotic Index	2.01
Intolerant individuals (%)	67.6
Modified Becks Index	46
Index of Biotic Integrity	**90**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.21
Aluminum mg/L	<0.160
Calcium mg/L	4.17
Iron mg/L	<0.0800
Magnesium mg/L	1.02
Hardness CaCO3	14.6
Chloride mg/L	12.4
pH	6.9
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.173
Alkalinity to pH 4.5 mg CaCO3/L	10.5
Total Dissolved Solids mg/L	69
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

PARACR08

Location	Sugar Cane Ln. access off of Rt. 191 Bridge upstream of confluence of Brodhead Creek.		
Site #	2020-27	Date	4/30/2020
Stream Name	Paradise Creek	Time	11:15:00 AM
Township	Stroud	Latitude	41.066498
Habitat Asmt.	214	Longitude	-75.221395

Field Measurements	
Temp C	9.26
pH	7.41
Press inHg	
DO Percent	99.6
DO mg/L	11.43
Cond (uS/cm)	152

Macroinvertebrate Metrics	
Total Taxa	30
Shannon Diversity Index	2.45
EPT Taxa Richness	17
Hilsenhoff Biotic Index	2.72
Intolerant individuals (%)	60.2
Modified Becks Index	32
Index of Biotic Integrity	**95.4**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.44
Aluminum mg/L	<0.160
Calcium mg/L	7.45
Iron mg/L	<0.0800
Magnesium mg/L	1.92
Hardness CaCO3	26.5
Chloride mg/L	30.6
pH	6.8
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.358
Alkalinity to pH 4.5 mg CaCO3/L	14.7
Total Dissolved Solids mg/L	103
Phosphorus as P mg/L	0.02
Biochemical Oxygen Demand mg/L	<3.00

PARACR09

Location	160m north of intersection of Summit Dr. and Hemlock Rd.		
Site #	2020-28	Date	5/4/2020
Stream Name	Paradise Creek	Time	9:09:00 AM
Township	Paradise	Latitude	41.111957
Habitat Asmt.	206	Longitude	-75.271678

Field Measurements	
Temp C	10.3
pH	7.22
Press inHg	
DO Percent	97.6
DO mg/L	10.93
Cond (uS/cm)	123

Macroinvertebrate Metrics	
Total Taxa	25
Shannon Diversity Index	1.68
EPT Taxa Richness	14
Hilsenhoff Biotic Index	4.91
Intolerant individuals (%)	14.4
Modified Becks Index	24
Index of Biotic Integrity	**58.5**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.61
Aluminum mg/L	<0.160
Calcium mg/L	6.12
Iron mg/L	<0.0800
Magnesium mg/L	1.54
Hardness CaCO3	21.6
Chloride mg/L	24.5
pH	6.6
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.446
Alkalinity to pH 4.5 mg CaCO3/L	10.6
Total Dissolved Solids mg/L	69
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

POCOCR01

Location	300m south on Camelback Rd from intersection of Camelback Rd. and Wilke Rd.		
Site #	2020-29	Date	4/22/2020
Stream Name	Pocono Creek	Time	12:00:00 PM
Township	Pocono	Latitude	41.058983
Habitat Asmt.	220	Longitude	-75.34886

Field Measurements	
Temp C	6.5
pH	7.47
Press inHg	
DO Percent	98.5
DO mg/L	12.11
Cond (uS/cm)	100

Macroinvertebrate Metrics	
Total Taxa	21
Shannon Diversity Index	2.2
EPT Taxa Richness	12
Hilsenhoff Biotic Index	1.9
Intolerant individuals (%)	72.9
Modified Becks Index	26
Index of Biotic Integrity	**76.4**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.9
Aluminum mg/L	<0.160
Calcium mg/L	3.96
Iron mg/L	0.0872
Magnesium mg/L	0.977
Hardness CaCO3	13.9
Chloride mg/L	21.1
pH	6.9
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.125
Alkalinity to pH 4.5 mg CaCO3/L	8.6
Total Dissolved Solids mg/L	97
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

POCOCR09

Location	65m north of Old Mill Rd. bridge.		
Site #	2020-30	Date	4/22/2020
Stream Name	Pocono Creek	Time	12:44:00 PM
Township	Pocono	Latitude	41.039252
Habitat Asmt.	210	Longitude	-75.309729

Field Measurements	
Temp C	7.8
pH	7.43
Press inHg	
DO Percent	99
DO mg/L	11.77
Cond (uS/cm)	168

Macroinvertebrate Metrics	
Total Taxa	30
Shannon Diversity Index	2.74
EPT Taxa Richness	20
Hilsenhoff Biotic Index	2.99
Intolerant individuals (%)	60.6
Modified Becks Index	37
Index of Biotic Integrity	**90.4**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.45
Aluminum mg/L	<0.160
Calcium mg/L	7.87
Iron mg/L	<0.0800
Magnesium mg/L	1.97
Hardness CaCO3	27.8
Chloride mg/L	30.6
pH	6.9
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.262
Alkalinity to pH 4.5 mg CaCO3/L	8.6
Total Dissolved Solids mg/L	124
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

POCOCR14

Location	70m south from S. 10th St and Ann St.		
Site #	2020-31	Date	4/29/2020
Stream Name	Pocono Creek	Time	12:59:00 PM
Township	Stroudsburg	Latitude	40.981165
Habitat Asmt.	217	Longitude	-75.197009

Field Measurements	
Temp C	10.6
pH	7.89
Press inHg	
DO Percent	106.8
DO mg/L	118.73
Cond (uS/cm)	193

Macroinvertebrate Metrics	
Total Taxa	22
Shannon Diversity Index	2.54
EPT Taxa Richness	12
Hilsenhoff Biotic Index	3.89
Intolerant individuals (%)	38.1
Modified Becks Index	20
Index of Biotic Integrity	**78.5**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.29
Aluminum mg/L	<0.160
Calcium mg/L	11
Iron mg/L	0.0937
Magnesium mg/L	2.41
Hardness CaCO3	37.4
Chloride mg/L	36.5
pH	7.6
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.301
Alkalinity to pH 4.5 mg CaCO3/L	21
Total Dissolved Solids mg/L	125
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

POHOCR01

Location	330m southeast from intersection of Merwinsburg Rd. and Burger Hollow Rd.		
Site #	2020-32	Date	4/28/2020
Stream Name	Pohopoco Creek	Time	8:21:00 AM
Township	Chestnuthill	Latitude	40.961684
Habitat Asmt.	225	Longitude	-75.465

Field Measurements	
Temp C	7
pH	7.03
Press inHg	
DO Percent	98.1
DO mg/L	11.9
Cond (uS/cm)	123

Macroinvertebrate Metrics	
Total Taxa	32
Shannon Diversity Index	2.58
EPT Taxa Richness	19
Hilsenhoff Biotic Index	2.82
Intolerant individuals (%)	61.9
Modified Becks Index	32
Index of Biotic Integrity	**88.9**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	0.77
Aluminum mg/L	<0.160
Calcium mg/L	5.61
Iron mg/L	<0.0800
Magnesium mg/L	2.57
Hardness CaCO3	24.6
Chloride mg/L	26
pH	7
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	1
Alkalinity to pH 4.5 mg CaCO3/L	10.5
Total Dissolved Solids mg/L	74
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

POHOCR29

Location	700 meters west on Whitey B Ln. from intersection of Whitey B Ln. and Rt. 209.		
Site #	2020-33	Date	4/28/2020
Stream Name	Pohopoco Creek	Time	9:34:00 AM
Township	Polk	Latitude	40.89951
Habitat Asmt.	225	Longitude	-75.506215

Field Measurements	
Temp C	7.53
pH	7.17
Press inHg	
DO Percent	99.07
DO mg/L	11.87
Cond (uS/cm)	114

Macroinvertebrate Metrics	
Total Taxa	27
Shannon Diversity Index	2.45
EPT Taxa Richness	16
Hilsenhoff Biotic Index	3.34
Intolerant individuals (%)	58.9
Modified Becks Index	27
Index of Biotic Integrity	**92.8**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.24
Aluminum mg/L	<0.160
Calcium mg/L	6.85
Iron mg/L	0.0925
Magnesium mg/L	2.53
Hardness CaCO3	27.5
Chloride mg/L	18.4
pH	6.9
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	1.3
Alkalinity to pH 4.5 mg CaCO3/L	12.6
Total Dissolved Solids mg/L	94
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

SAMBCR02

Location	45m east of Levee Loop Trail, north of John Konawalick Field		
Site #	2020-34	Date	4/21/2020
Stream Name	Sambo Creek	Time	8:15:00 AM
Township	East Stroudsburg	Latitude	41.009419
Habitat Asmt.	167	Longitude	-75.190549

Field Measurements	
Temp C	7.3
pH	7.36
Press inHg	
DO Percent	94.9
DO mg/L	11.42
Cond (uS/cm)	207

Macroinvertebrate Metrics	
Total Taxa	20
Shannon Diversity Index	1.85
EPT Taxa Richness	9
Hilsenhoff Biotic Index	4.79
Intolerant individuals (%)	14
Modified Becks Index	11
Index of Biotic Integrity	**47.1**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.38
Aluminum mg/L	<0.160
Calcium mg/L	18.9
Iron mg/L	0.12
Magnesium mg/L	2.33
Hardness CaCO3	56.8
Chloride mg/L	27.4
pH	7.6
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.455
Alkalinity to pH 4.5 mg CaCO3/L	51.5
Total Dissolved Solids mg/L	133
Phosphorus as P mg/L	0.041
Biochemical Oxygen Demand mg/L	<3.00

SAMBCR20

Location	220m south of Brushy Mtn. Rd. Downstream of Sambo Creek Lower Reservoir		
Site #	2020-35	Date	5/5/2020
Stream Name	Sambo Creek	Time	8:12:00 AM
Township	Smithfield	Latitude	41.042227
Habitat Asmt.	212	Longitude	-75.184488

Field Measurements	
Temp C	11.9
pH	7.36
Press inHg	
DO Percent	99.6
DO mg/L	10.75
Cond (uS/cm)	105

Macroinvertebrate Metrics	
Total Taxa	15
Shannon Diversity Index	2.38
EPT Taxa Richness	9
Hilsenhoff Biotic Index	3.83
Intolerant individuals (%)	49.1
Modified Becks Index	12
Index of Biotic Integrity	**57**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.52
Aluminum mg/L	<0.160
Calcium mg/L	7.32
Iron mg/L	<0.0800
Magnesium mg/L	1.76
Hardness CaCO3	25.5
Chloride mg/L	15.8
pH	6.3
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.178
Alkalinity to pH 4.5 mg CaCO3/L	12.7
Total Dissolved Solids mg/L	66
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

SASPR01

Location	600m west of Wilke Rd. dead end.		
Site #	2020-36	Date	5/4/2020
Stream Name	Sand Spring	Time	11:50:00 AM
Township	Jackson	Latitude	41.061595
Habitat Asmt.	173	Longitude	-75.37459

Field Measurements	
Temp C	13.9
pH	6.4
Press inHg	
DO Percent	94.9
DO mg/L	9.81
Cond (uS/cm)	21

Macroinvertebrate Metrics	
Total Taxa	12
Shannon Diversity Index	2.01
EPT Taxa Richness	7
Hilsenhoff Biotic Index	3.58
Intolerant individuals (%)	28.1
Modified Becks Index	14
Index of Biotic Integrity	**48.8**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

SASPR02

Location	700m west of Wilke Rd. dead end.		
Site #	2020-37	Date	5/4/2020
Stream Name	Sand Spring	Time	11:15:00 AM
Township	Jackson	Latitude	41.061234
Habitat Asmt.	172	Longitude	-75.375798

Field Measurements	
Temp C	13.8
pH	6.25
Press inHg	
DO Percent	94.4
DO mg/L	9.77
Cond (uS/cm)	20

Macroinvertebrate Metrics	
Total Taxa	11
Shannon Diversity Index	1.27
EPT Taxa Richness	4
Hilsenhoff Biotic Index	3.51
Intolerant individuals (%)	55.3
Modified Becks Index	16
Index of Biotic Integrity	**47.7**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

SWIFCR10

Location	25m north of Manor Dr. bridge.		
Site #	2020-38	Date	4/22/2020
Stream Name	Swiftwater Creek	Time	11:27:00 AM
Township	Pocono	Latitude	41.100894
Habitat Asmt.	196	Longitude	-75.346355

Field Measurements	
Temp C	5.6
pH	7.43
Press inHg	
DO Percent	96.8
DO mg/L	12.15
Cond (uS/cm)	134

Macroinvertebrate Metrics	
Total Taxa	31
Shannon Diversity Index	3
EPT Taxa Richness	19
Hilsenhoff Biotic Index	3.22
Intolerant individuals (%)	54.5
Modified Becks Index	44
Index of Biotic Integrity	**90.3**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	0.82
Aluminum mg/L	<0.160
Calcium mg/L	5.81
Iron mg/L	<0.0800
Magnesium mg/L	1.73
Hardness CaCO3	21.6
Chloride mg/L	35.5
pH	7.6
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.526
Alkalinity to pH 4.5 mg CaCO3/L	15
Total Dissolved Solids mg/L	95
Phosphorus as P mg/L	<0.020
Biochemical Oxygen Demand mg/L	<3.00

TOBYCR14

Location	50m east of Rt. 115 bridge near Austin T. Blakeslee Natural Area.		
Site #	2020-39	Date	4/20/2020
Stream Name	Tobyhanna Creek	Time	10:00:00 AM
Township	Tobyhanna	Latitude	41.082791
Habitat Asmt.	193	Longitude	-75.583083

Field Measurements	
Temp C	7.6
pH	7.1
Press inHg	
DO Percent	94
DO mg/L	11.23
Cond (uS/cm)	136

Macroinvertebrate Metrics	
Total Taxa	27
Shannon Diversity Index	2.8
EPT Taxa Richness	13
Hilsenhoff Biotic Index	3.67
Intolerant individuals (%)	49.7
Modified Becks Index	19
Index of Biotic Integrity	**86.4**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	5.43
Aluminum mg/L	<0.160
Calcium mg/L	5.72
Iron mg/L	0.242
Magnesium mg/L	1.25
Hardness CaCO3	19.4
Chloride mg/L	31.7
pH	6.6
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.17
Alkalinity to pH 4.5 mg CaCO3/L	6.4
Total Dissolved Solids mg/L	72
Phosphorus as P mg/L	0.021
Biochemical Oxygen Demand mg/L	<3.00

TUNKCR03

Location	160m north of Tunhannok Fishing Association Parking area.		
Site #	2020-40	Date	4/20/2020
Stream Name	Tunkhannock Creek	Time	10:30:00 AM
Township	Tunkhannock	Latitude	41.059541
Habitat Asmt.	213	Longitude	-75.552735

Field Measurements	
Temp C	6.2
pH	5.79
Press inHg	
DO Percent	94.4
DO mg/L	11.69
Cond (uS/cm)	50

Macroinvertebrate Metrics	
Total Taxa	25
Shannon Diversity Index	2.59
EPT Taxa Richness	10
Hilsenhoff Biotic Index	3.6
Intolerant individuals (%)	36.6
Modified Becks Index	13
Index of Biotic Integrity	**62.6**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	7.93
Aluminum mg/L	0.186
Calcium mg/L	1.94
Iron mg/L	0.214
Magnesium mg/L	0.718
Hardness CaCO3	7.79
Chloride mg/L	10.7
pH	5.4
Ammonia as N mg/L	<0.30
Total Kjeldahl N mg/L	<1.25
Nitrate as N mg/L	0.182
Alkalinity to pH 4.5 mg CaCO3/L	<6.0
Total Dissolved Solids mg/L	53
Phosphorus as P mg/L	0.02
Biochemical Oxygen Demand mg/L	<3.00

Conclusion

The sites where IBI Scores did not reach the recommended Aquatic Life Use Attainment Benchmarks are shown below:

(2020-18) **Keiper Run 02:** 33.5
(2020-28) **Paradise Creek 09:** 58.5
(2020-34) **Sambo Creek 02:** 47.1
(2020-36) **Sand Spring Run 01:** 48.8
(2020-37) **Sand Spring Run 02:** 47.7
(2020-40) **Tunkhannock Creek 03:** 62.6

Keiper Run 02 is a newly designated site that replaced Keiper Run 01. The new site is approximately 1.1 miles downstream from Keiper Run 01 and was moved to assess if the downstream portion of the tributary produced a higher macroinvertebrate count. In previous studies, there was a significant lack of individuals collected at Keiper Run 01 which potentially reflects the intermittent nature of the upstream segment. In 2019, only 16 individuals were collected which is less than the required minimum of 200 (+/- 20%) individuals for a reliable sample. During the 2020 study, 213 individuals were collected which is a significant improvement to previous studies. The bulk of the samples at 133 individuals were *Simulium spp.*, commonly named black flies which have a relatively high pollution tolerance therefore, the scoring metrics that are weighted by pollution tolerance values scored low. It will become increasingly important to baseline this sampling location and monitor the metrics to see if an improvement is made.

Paradise Creek 09 is a new location for the 2020 study and scored 58.5 in the first year of sampling. The site was sampled on May 4, 2020, which had an above-average discharge rate due to increased precipitation three days before the sampling date. The USGS stream discharge gage measurements are provided below. Historic aerial imagery and evidence of anthropogenic activity in the stream channel and banks may also be contributing to the low IBI.

Figure 3: Photograph taken during the sampling date of Paradise Creek 09 on May 5, 2020

The photograph taken in Figure 3 shows the flow conditions of Paradise Creek 09 during the time of sampling on May 4th, 2020. As seen in the photograph, the high flow channel can be seen on the embankment to the left. Figures 4 and 5 show the two closest stream gages to Paradise Creek from March 1, 2020, to May 31, 2020. Note the high discharge rate approaching the time of sampling and the above-average discharge amount around May 4th.

It should be noted that although the high flow could contribute to the low score through macroinvertebrate scouring, this section of Paradise Creek has not been previously sampled. Therefore, a baseline will need to be established to determine if this score is anomalous or if other historical anthropogenic changes have impacted this reach. Additional sampling at this site is recommended to determine trends.

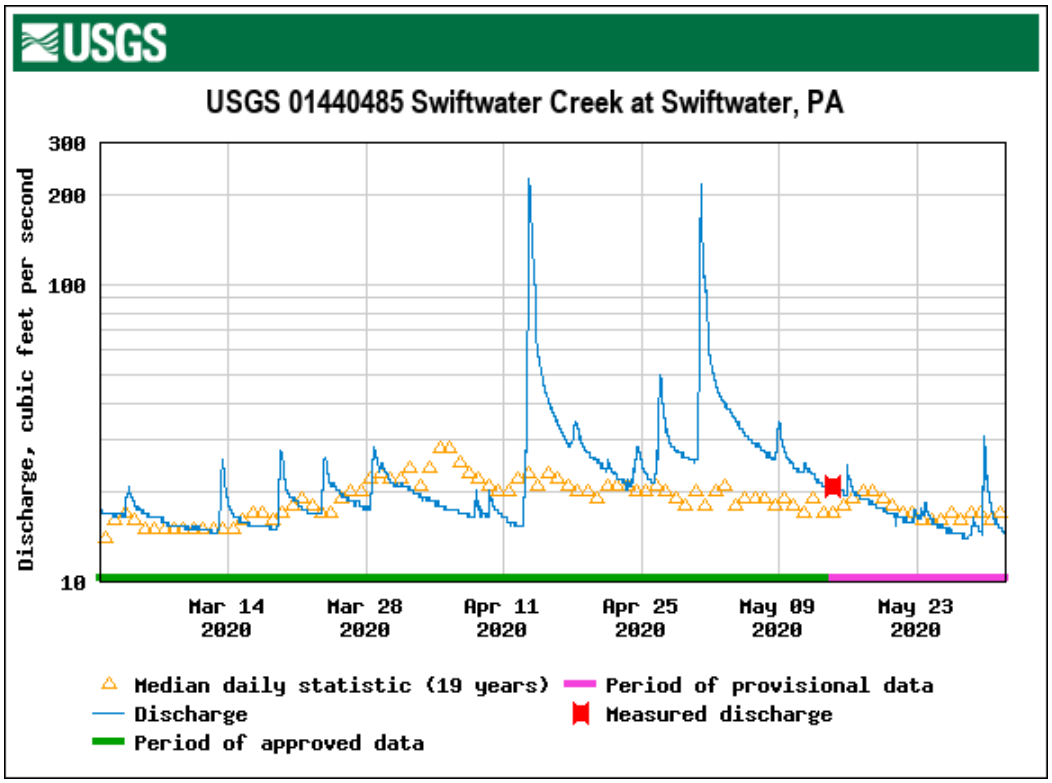

Figure 4: USGS 01440485 stream sage showing discharge (cfs) of Swiftwater Creek from March 1, 2020 to May 31, 2020 (USGS, 2020).

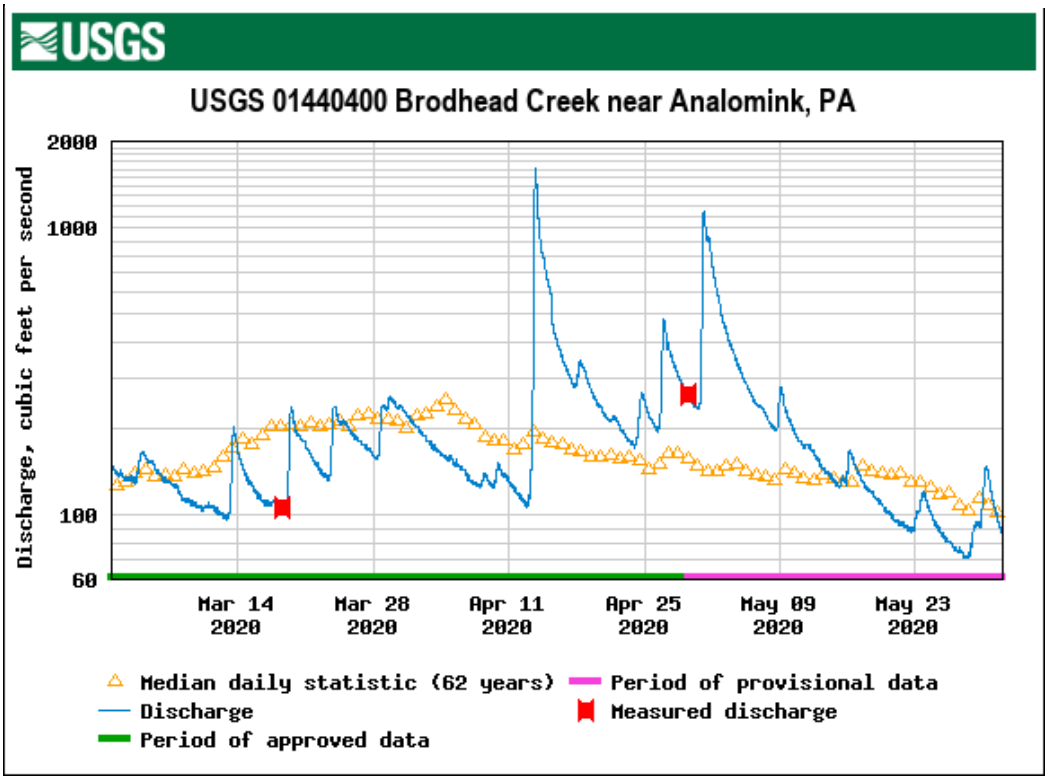

Figure 5: USGS 01440400 stream gage showing discharge (cfs) of Brodhead Creek from March 1, 2020 to May 31, 2020 (USGS, 2020).

Sambo Creek 02 also scored low at a 47.1 IBI. Per 25 Pa. Code § 93.9c, the Sambo Creek is designated as a Cold Water Fishery (CWF) which means the additional guidelines were considered while analyzing the IBI. The second guideline provided by Shull & Pulket (2018) in *Assessment Methodology for Rivers and Streams* serves as a check that the sample has substantial richness and abundance of the sensitive organisms and checks if the Beck's Index metric is < 33.3 with the standardized metric score for the Percent Intolerant Individuals < 25.0. In this case, Beck's Index metric is 11 with the standardized metric score for the Percent Intolerant Individuals at 14. This means that the Sambo Creek 02 site did not reach the recommended benchmark for attainment during the study. The data collected coincides with the DEP assessment for the stream which is listed as impaired due to urban runoff and storm sewers (PADEP, 2018). The stream is also included as impaired in the 2020 draft of the *Integrated Water Quality Report – 2020*. Establishing a baseline for the study provides the opportunity to use the data for repair or restoration in the future.

Sand Spring Run 01 and Sand Spring Run 02 have continued to score low. The scores are contributed to the failure of the historic Wilkes Barre and Eastern (WB&E) Railroad, passing Sand Spring Run beneath its former embankment. The railroad failure has triggered the ~75 ft. high, sand-dominated embankment to erode and impact water quality. The stream reaches encompassing these two sites was chosen by the Monroe County Conservation District and PADEP as a Growing Greener grant-funded stream restoration project due to significant erosion and sedimentation impacts.

Tunkhannock Creek 03 is the last sampling location that scored under the attainment benchmark for the 2020 study however, the sample did not meet the 200 +/- 20% threshold for a reliable sample (Shull & Lookenbill, 2018). The total for the sample consisted of 112 individuals. The graph in Figure 8 could offer a possible explanation for the lack of individuals found during the study. The sample was collected on April 20, 2020, which, as seen in Figure 8, had a higher than average discharge leading up to the collection date. This can have a scouring effect on macroinvertebrates which causes the samples to inaccurately reflect biological conditions (USEPA, 2012).

Additionally, this site in particular encounters the ambiguity between small/large-stream metric standardization highlighted in Shull & Pulket (2018) *Water Quality Monitoring Protocols for Streams and Rivers*. The protocols recommend when decisions diverge it can be especially useful to apply the additional screening questions during the assessment. These four additional questions indicated that the sampling location was attaining its Aquatic Life Use.

1. Mayflies, stoneflies, and caddisflies were not absent from the sample.
2. The Percent Sensitive individual's standardized score was >25.0.
3. The ratio of BCG attribute 1,2,3 taxa to BCG attribute 4,5,6 taxa was > 0.75
4. The sub-sample did not show signatures of acidification at the time of sampling.

It should be noted that two sites in the *2019 Water Quality Study*, Pocono Creek 09 and Brodhead Creek 27, did not meet their attainment benchmarks. Similar to Tunkhannock Creek 03, it was speculated that the above-average discharge rates of the stream during the time of sampling offered an explanation. In 2020, both sites scored well above their attaining benchmarks.

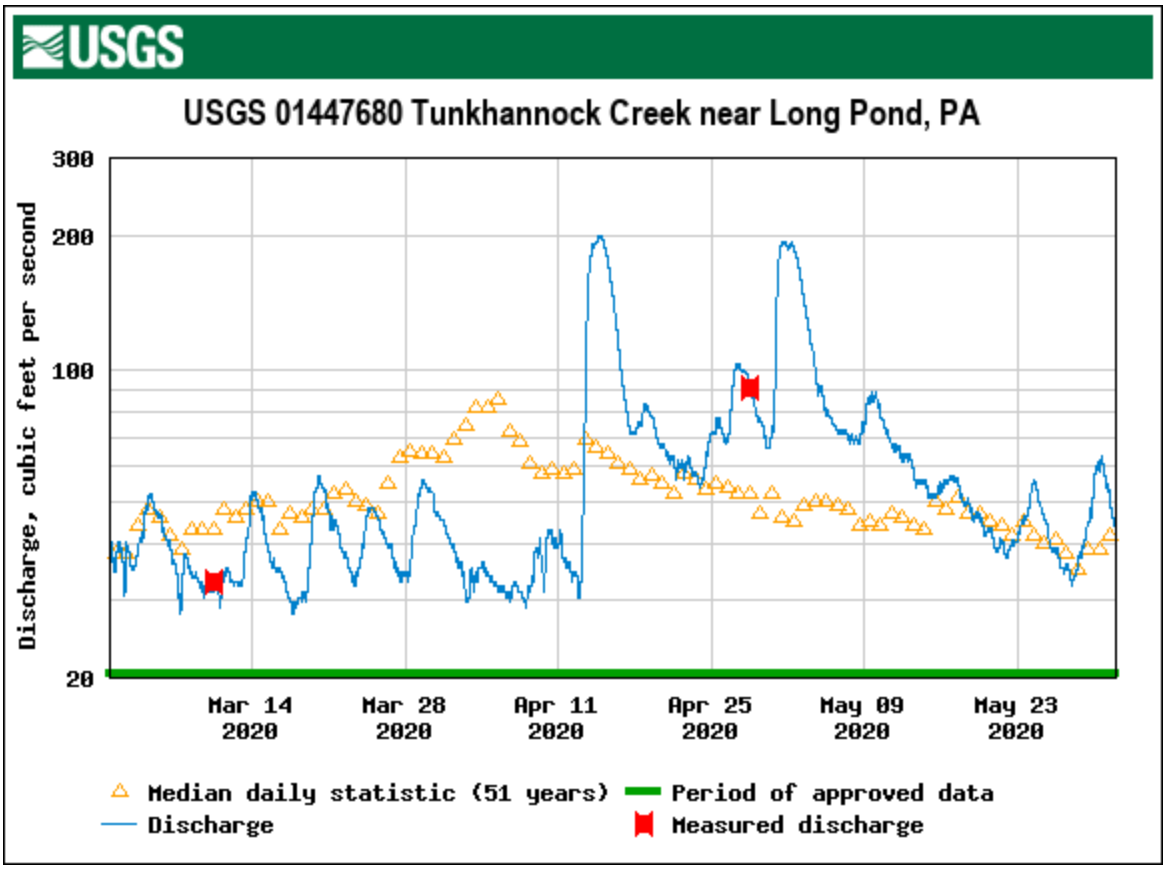

Figure 6: USGS 01447680 stream gage for Tunkhannock Creek from March 1, 2020, to May 31, 2020 (USGS, 2020).

Recommendations

After reviewing the data from the 2020 Water Quality Study, the lead and cooperating agencies recommend the following:

- We plan to ensure consistent trend data for the attaining and Exceptional/High-Quality streams which dominate Monroe County. See below for current trend information.
- Further inspection of the new Keiper Run 02 site to observe any changes to the diversity of macroinvertebrates.
- Increase the amount of time between storm events to allow the stream discharge and macroinvertebrate populations to recover from rain events.
- Further monitoring of Aquashicola, Appenzell, Sambo, Paradise, and Cherry creeks focusing on creating trend data and/or implementing corrective measures for impaired streams or streams that have not attained their Aquatic Life Use benchmark in 2020.

As part of the ongoing trend collection and analysis for sampling sites in Monroe County, the results shown below in Table 6 are sampling locations that have three years of consecutive data.

Table 6: IBI trends from 2015 to 2020.

Site ID	IBI 2015	IBI 2016	IBI 2017	IBI 2018	IBI 2019	IBI 2020
BRODCR22		74.1	87.1	85	87.5	95
BRODCR27			93	99	59.3	97.2
BUCKCR01			73.5	63	76.1	81.9
BUHICR07	89.2	91.3	86.1	83	78.2	93.3
BUSHCR07	86.7	95.3	88.6	91	89.8	81.4
BUTZRN01			76	71	82.8	75.7
CHERCR01				61	66.6	72
INDIRN03				86	69.1	78.1
JONACR01			81.6	78	89.5	79.6
MARSCR11	95.7	89.1	80.5	81	79.7	74.1
MARSCR18			76	71	80.8	92.9
MCMICR10			69.2	69	80.4	87.3
MCMICR22			81.9	96	85.6	92.8
MCMICR37	93.6	76.2	78.6	52	78.5	78.6
MIDDCR04				72	86.6	93.8
MILLCR03		83.2	97	80	89.5	90
PARACR08		85.2	82.5	87	85.9	95.4
POCOCR01			75.9	81	78.2	76.4
POCOCR09			80.2	72	55.7	90.4
POCOCR14	62.3	72.5	82.1	73	74.5	78.5
POHOCR01			88.5	86	93.8	88.9
POHOCR29			83.8	74	75.9	92.8
SWIFCR10	75.8	83.2	90.6	48	77.5	90.3
TOBYCR14	75.8	64.8	88	75	83.9	86.4
TUNKCR03	81.5		67.8	73	78.2	62.6

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