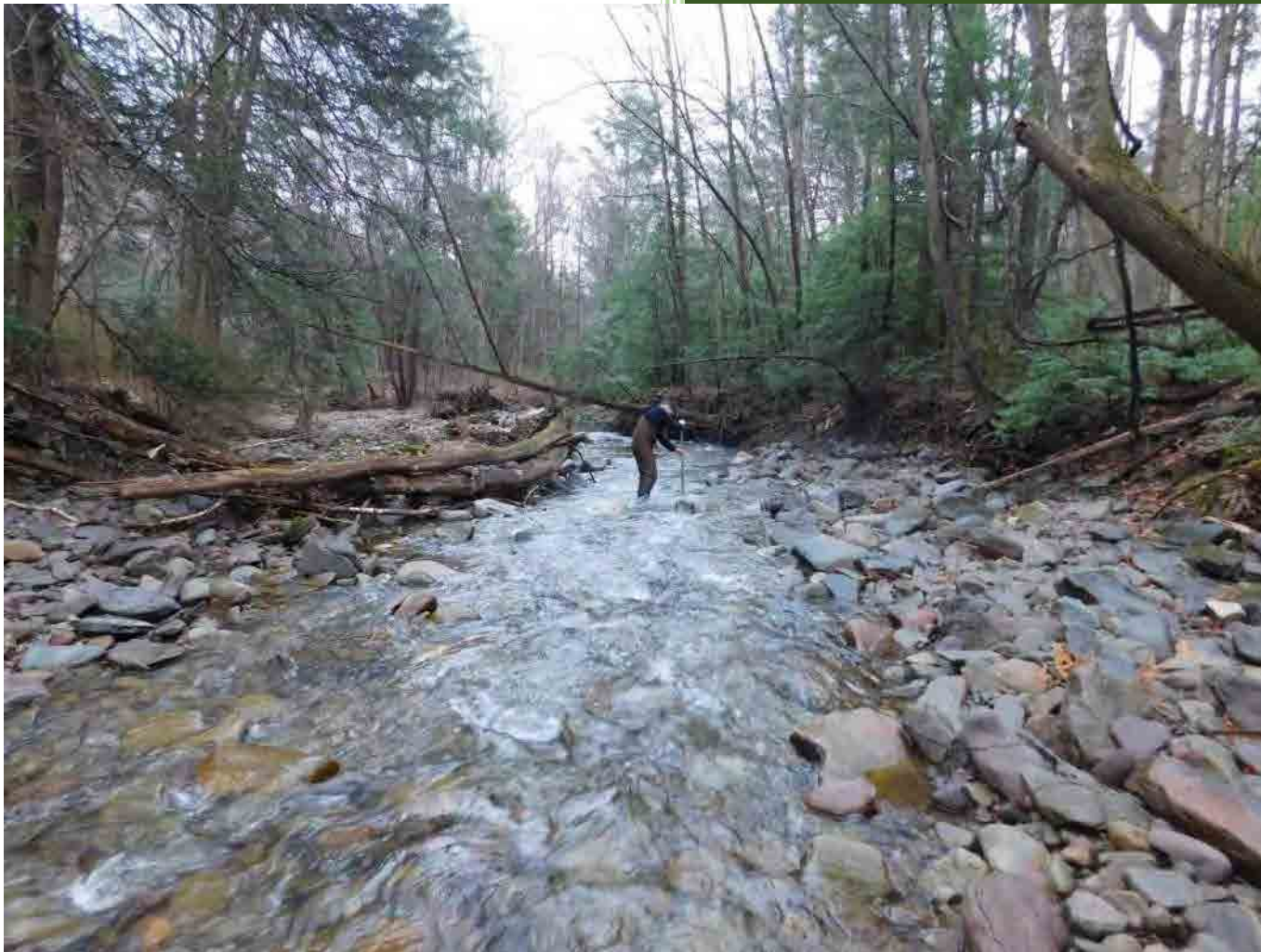


2021

Monroe County Water Quality Study



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Section I. 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 meter was calibrated to known standards/solutions at the beginning of each sampling day, and the following parameters were collected and recorded on standard data forms at each sampling location:

- Potential of Hydrogen (pH)
- Temperature
- Dissolved Oxygen (D.O.) Concentration
- D.O. %
- Conductivity



Figure 1: Field chemistry being sampled by Steven Baade, April 2021.

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

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 within 100-meter reach

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

Multi-Habitat Collection – Ten samples within 100-meter reach

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



Figure 2: Collecting macroinvertebrates.

Each sample was placed in 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

Section II. 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 process 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 change in temperature 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; 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 waters 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 waterbody 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 $\mu\text{S}/\text{cm}$, but inland freshwater streams supporting good mixed fisheries generally range from 150 to 500 $\mu\text{S}/\text{cm}$ (EPA, 2012).

Field Measurement Data Form

2021 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 (similarity 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 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 storm water 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 of 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.), 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 $\mu\text{g/L}$. According to the Final Aquatic Life Ambient Water Quality Criteria for Aluminum, the concentration varied as a function of the sites pH, DOC, and total hardness but ranged between 1-4,800 $\mu\text{g/L}$ (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 of 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 waterbodies (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 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 waterbodies 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).

Section III. Benthic Macroinvertebrates

What Are 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 frequent or prolonged 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 drastic change in conditions, offer a clearer picture of water quality, and provide overall environmental oversight in a stream (Penn State Extension, 2020).



Figure 3: Collecting macroinvertebrates.

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 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 because 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 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 size which is 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 mi², while larger stream values are appropriate for fifth and larger streams draining more than 50 mi². 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 calculation 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 to 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 Metric Score	Adjusted Standardized Metric Score Maximum = 100
Total Taxa Richness	$(\text{Observed value} / 33) * 100$			
EPT Taxa Richness	$(\text{Observed value} / 19) * 100$			
Beck's Index	$(\text{Observed value} / 38) * 100$			
Hilsenhoff Biotic Index	$[(10 - \text{observed value}) / (10 - 1.89)] * 100$			
Shannon Diversity	$(\text{Observed} / 2.86) * 100$			
Percent Sensitive Individuals	$(\text{Observed value} / 84.5) * 100$			
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.

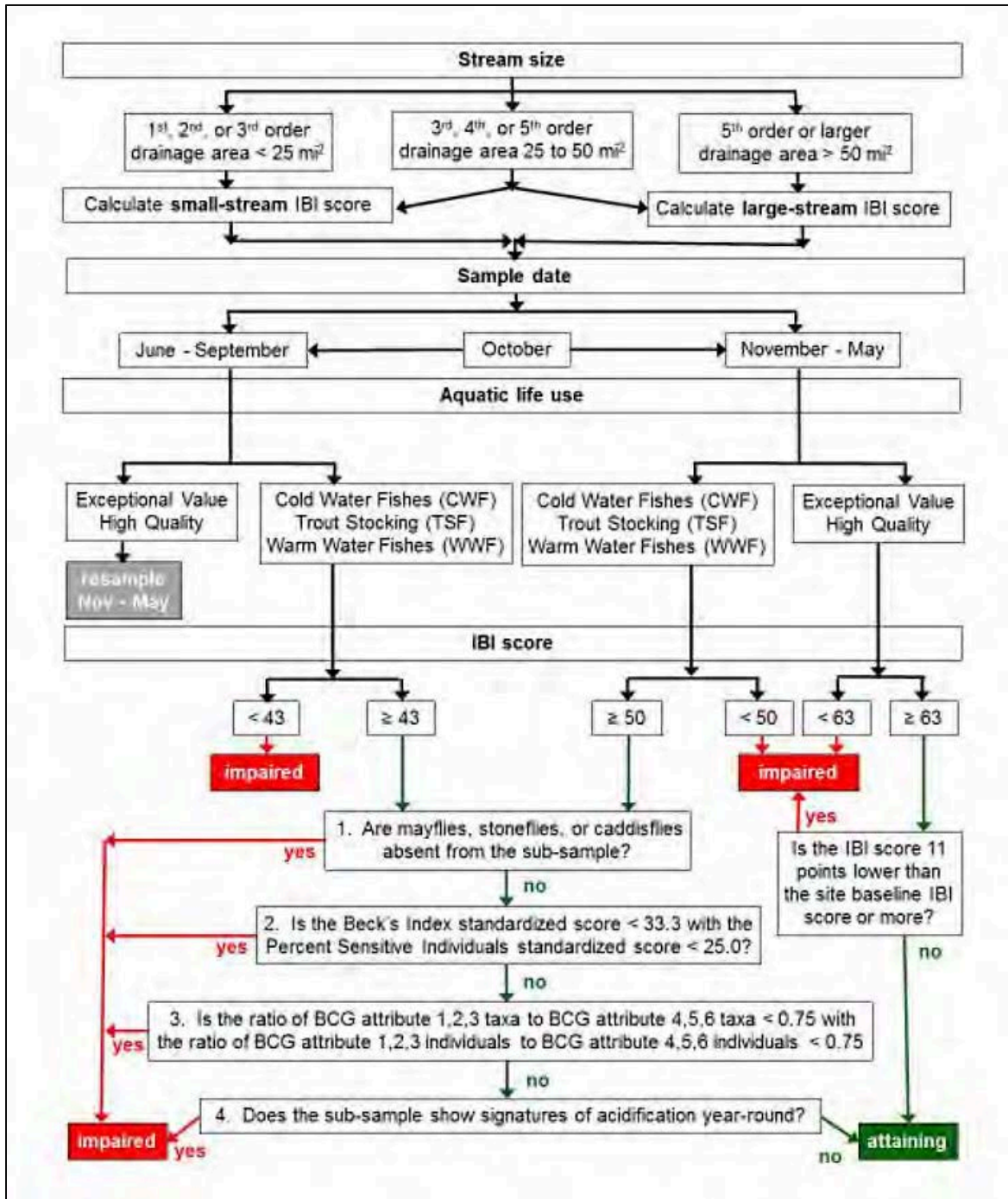


Figure 1: Aquatic Life Use Simplified Assessment Schematic (Shull & Pulket, 2018).

Considerations for the stream must be made prior to 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 prior to 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 Use 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 its Aquatic Life Use when it was sampled. An IBI score ≥ 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 the 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 high abundance of Amphinemura and/or Leuctra stoneflies, occasionally combined with 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 in 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.
Coarse Particulate Organic Matter (CPOM)	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.
Submerged Aquatic Vegetation (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 taxa 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 score. This is chosen because it better represents low-gradient streams. For Beck4, taxa with a 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 to 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	$(\text{Observed} / 31) * 100$			
EPT Taxa Richness	$(\text{Observed} / 17) * 100$			
Beck4	$(\text{Observed} / 22) * 100$			
Shannon Diversity	$(\text{Observed} / 2.43) * 100$			
# of Caddisfly Taxa	$(\text{Observed} / 11) * 100$			
# of Mayfly Taxa	$(\text{Observed} / 6) * 100$			
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 multihabitat 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 in order 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. Calibration of field equipment was performed daily.

Section IV. Physical Habitat Evaluation

PA DEP Physical Habitat Evaluation Method

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 from the Shull and Lookenbill (2018) *Water Quality Monitoring Protocols for Streams and Rivers* and is followed by examples of the data sheets from the protocols:

Riffle/Run Habitat Evaluation 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 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 bankfull 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 evaluate the impact to 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 of riparian zone >18 meters; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

TOTAL _____

Low Gradient Habitat Evaluation 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 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 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 bankfull 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 Habitat 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 of riparian zone >18 meters; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Location Descriptions

Site ID	Stream Name	Location	Municipality	Latitude	Longitude
AQUACR19	Aquashicola Creek	315 meters east from intersection of Upper Smith Gap Rd and Camp Hill Rd	Eldred	40.845611	-75.394982
BUCKCR01	Buckwha Creek	200 meters west of Chestnut Ridge Rd bridge	Eldred	40.847275	-75.451532
POHOCR01	Pohopoco Creek	330m southeast from intersection of Merwinsburg Rd. and Burger Hollow Rd.	Chestnuthill	40.961684	-75.465
POHOCR29	Pohopoco Creek	700 meters west on Whitey B Ln. from intersection of Whitey B Ln. and Rt. 209.	Polk	40.89951	-75.506215
MIDDCR04	Middle Creek	Downstream of observation deck on Cliff Woodring Trail.	Polk	40.905822	-75.496614
JONACR01	Jonas Creek	150m north of the Laurel Ln cul-de-sac	Polk	40.97567	-75.507843
APPFCR02	Appenzell Creek	Near residential housing, 160m west of the Foundry St. bridge.	Hamilton	40.946838	-75.310513
MCMICR22	McMichael Creek	115m south of intersection of McIlhane Rd. and Kennel Rd.	Chestnuthill	40.930902	-75.363567
MCMICR37	McMichael Creek	Hickory Valley Park 60m southeast from parking area.	Stroud	40.962041	-75.236508
CHERCR01	Cherry Creek	Edge of the Woods Outfitters 100m from the intersection of 611 and Broad St.	Delaware Water Gap	40.984712	-75.145848
CHERCR06	Cherry Creek	25 meters south of bridge on Kemmertown Rd.	Hamilton	40.93657	-75.252769
CHERCR06R	Cherry Creek	25 meters south of bridge on Kemmertown Rd.	Hamilton	40.93657	-75.252769
BRODCR27	Brodhead Creek	170 meters northeast of Pasold Farm Dr. parking area.	Barrett	41.180941	-75.25091
BRODCR27R	Brodhead Creek	170 meters northeast of Pasold Farm Dr. parking area.	Barrett	41.180941	-75.25091
MILLCR03	Mill Creek	560m west of intersection of Sand Spring Rd. and Mill Creek Rd.	Barrett	41.163201	-75.251528
BUHICR07	Buck Hill Creek	165 meters upstream of Buck Hill Golf Club off of Cresco Rd.	Barrett	41.194403	-75.281357
BRODCR22	Brodhead Creek	Sugar Cane Ln. access off of Rt. 191 Bridge upstream of confluence of PARACR08.	Stroud	41.066523	-75.220216
PARACR08	Paradise Creek	Sugar Cane Ln. access off of Rt. 191 Bridge. 150m west from Sugar Cane Rd.	Stroud	41.066498	-75.221395
BRODCR30	Brodhead Creek	120 meters southeast of Rt. 191 bridge near intersection of Rt.191 and Rt.447	Stroud	41.036093	-75.209176
BRODCR31	Brodhead Creek	55 meters east of Paper Mill Rd near entrance of paper mill	Smithfield	40.998746	-75.143353
BUTZRN01	Birtz Run	1.14 miles down Sylvan Cascades Rd from intersection of Rt. 191	Paradise	41.076071	-75.235002
BUSHCR07	Bushkill Creek	340 meters north of Route 209 through ROW.	Middle Smithfield	41.084861	-75.019417
MARSCR11	Marshall's Creek	385 meters north of intersection of Marshall's Creek Rd. and Golfcart Rd.	Middle Smithfield	41.054246	-75.13672
MARSCR18	Marshall's Creek	Next to Minisink Hotel parking lot off of Post Office Rd.	Smithfield	40.998555	-75.139952
MARSCR19	Marshall's Creek	40 meters north of one land bridge on Tallyrand Dr.	Middle Smithfield	41.108419	-75.155693
LISAER21	Little Sambo Creek	Downstream of Lake Valhalla	Smithfield	41.029313	-75.182482
SAMBCR02	Sambo Creek	45m east of Levee Loop Trail, north of John Konawalick Field	Stroudsburg	41.009419	-75.190549
POCOCR09	Pocono Creek	65m north of Old Mill Rd. bridge.	Pocono	41.039252	-75.309729
POCOCR14	Pocono Creek	70m south from S. 10th St and Ann St.	Stroudsburg	40.981165	-75.197009
SWIFCR10	Swiftwater Creek	25m north of Manor Dr. bridge.	Pocono	41.100894	-75.346355
INDIRN03	Indian Run	150 meters north of Manor Dr. Bridge upstream of confluence with Swiftwater Creek.	Pocono	41.10221	-75.346358
POCOCR01	Pocono Creek	300m south on Camelback Rd from intersection of Camelback Rd. and Wilke Rd.	Pocono	41.058983	-75.34886
SASPRN01	Sand Spring	600m west of Wilke Rd. dead end.	Jackson	41.061595	-75.37459
SASPRN02	Sand Spring	700m west of Wilke Rd. dead end.	Jackson	41.061234	-75.375798
TOBYCR01	Tobyhanna Creek	Upstream of 423 bridge.	Coolbaugh	41.1613287	-75.4530568
TOBYCR14	Tobyhanna Creek	50m east of Rt. 115 bridge near Austin T. Blakeslee Natural Area.	Tobyhanna	41.082791	-75.583083
TUNKCR03	Tunkhannock Creek	160m north of Tunkhannock Fishing Association Parking area off SR115.	Tunkhannock	41.059541	-75.552735
TUNKCR04	Tunkhannock Creek	Off Fire Ln. Near Bethlehem Water Authority dam	Tunkhannock	41.029496	-75.451954
UPTNCR01	Upper Tunkhannock Creek	Between Stillwater lake and Lake Naomi near 201 Tanglewood Dr.	Tobyhanna	41.116941	-75.433578
UPTNCR02	Upper Tunkhannock Creek	50 meters southwest of Old Route 940 Bridge	Tobyhanna	41.105984	-75.487852
KEIPRN02	Keiper Run	70 meters east of Rt. 903 bridge, upstream of bridge	Tunkhannock	41.053224	-75.552658

Site Summary Sheets

Site Summary Sheet: AQUACR19

Stream Name	Aquashicola Creek	Latitude	40.845611
Date Sampled	4/5/2021	Longitude	-75.394982
Time Sampled	8:40:00 AM	Municipality	Eldred
Drainage Area (sq mi)	12.7	Habitat Type	Low Gradient
Location Description	315 meters east from intersection of Upper Smith Gap Rd and Camp Hill Rd		

Field Measurements

pH	7.53
Dissolved Oxygen (%)	97.8
Dissolved Oxygen (mg/L)	11.51
Conductivity (µS/cm)	138.0
Total Dissolved Solids (mg/L)	89.665
Temperature (°C)	8.2

Lab Chemistry Results

Total Organic Carbon (mg/L)	1.51	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	9.73	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	57.4	pH (Lab)	7.2
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<2.00	Calcium (mg/L)	16.4
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.13	Magnesium (mg/L)	3.98
Total Dissolved Solids (Lab) (mg/L)	54.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	42
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Cobble/Gravel	2
Snag	2
CPOM	2
Submerged Aquatic Vegetation	2
Sand/Fine Sediment	2

Macroinvertebrate Metrics

Total Taxa Richness	27
EPT Taxa Richness	20
Beck4	23
Shannon Diversity Index	2.40
# of Caddisfly Taxa	11
# of Mayfly Taxa	6
Index of Biotic Integrity	97.6

Habitat Assessment Metrics

Pool Substrate Characterization + Sediment Deposition	30
Bank Vegetative Protection + Bank Stability	31
Habitat Assessment Score (Overall)	140

Site Summary Sheet: APPECR02

Stream Name	Appenzell Creek	Latitude	40.946838
Date Sampled	4/12/2021	Longitude	-75.310513
Time Sampled	9:15:00 AM	Municipality	Hamilton
Drainage Area (sq mi)	15.1	Habitat Type	Riffle/Run
Location Description	Near residential housing, 160m west of the Foundry St. bridge.		

Field Measurements

pH	7.44
Dissolved Oxygen (%)	98.5
Dissolved Oxygen (mg/L)	10.98
Conductivity (µS/cm)	113.0
Total Dissolved Solids (mg/L)	73.586
Temperature (°C)	10.5

Lab Chemistry Results

Total Organic Carbon (mg/L)	1.94	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	18.3	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	28.4	pH (Lab)	7.1
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	0.50	Calcium (mg/L)	7.64
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.03	Magnesium (mg/L)	2.27
Total Dissolved Solids (Lab) (mg/L)	127	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	12.6
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	20
EPT Taxa Richness	12
Beck's Index	24
Shannon Diversity Index	1.78
Hilsenhoff Biotic Index	4.01
Percent Sensitive Individuals	42.0
Index of Biotic Integrity	62.0

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	29
Condition of Banks + Vegetative Protection	26
Habitat Assessment Score (Overall)	183

Site Summary Sheet: BRODCR27

Stream Name	Brodhead Creek	Latitude	41.180941
Date Sampled	4/6/2021	Longitude	-75.25091
Time Sampled	11:54:00 AM	Municipality	Barrett
Drainage Area (sq mi)	30.4	Habitat Type	Riffle/Run
Location Description	170 meters northeast of Pasold Farm Dr. parking area.		

Field Measurements

pH	7.16
Dissolved Oxygen (%)	101.0
Dissolved Oxygen (mg/L)	11.95
Conductivity (µS/cm)	63.0
Total Dissolved Solids (mg/L)	40.837
Temperature (°C)	8.0

Lab Chemistry Results

Total Organic Carbon (mg/L)	2.1	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	9.80	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	13.4	pH (Lab)	6.8
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	3.69
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	1.01
Total Dissolved Solids (Lab) (mg/L)	55.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	8.4
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	24
EPT Taxa Richness	14
Beck's Index	31
Shannon Diversity Index	2.43
Hilsenhoff Biotic Index	2.38
Percent Sensitive Individuals	71.6
Index of Biotic Integrity	81.9

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	35
Condition of Banks + Vegetative Protection	35
Habitat Assessment Score (Overall)	197

Site Summary Sheet: BRODCR27R

Stream Name	Brodhead Creek	Latitude	41.180941
Date Sampled	4/6/2021	Longitude	-75.25091
Time Sampled	11:50:00 AM	Municipality	Barrett
Drainage Area (sq mi)	30.4	Habitat Type	Riffle/Run
Location Description	170 meters northeast of Pasold Farm Dr. parking area.		

Field Measurements

pH	7.13
Dissolved Oxygen (%)	101.5
Dissolved Oxygen (mg/L)	12.00
Conductivity (µS/cm)	63.0
Total Dissolved Solids (mg/L)	40.837
Temperature (°C)	8.1

Lab Chemistry Results

Total Organic Carbon (mg/L)	1.99	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	9.84	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	14.9	pH (Lab)	6.9
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	4.13
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	1.11
Total Dissolved Solids (Lab) (mg/L)	129	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	8.4
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	22
EPT Taxa Richness	17
Beck's Index	28
Shannon Diversity Index	2.37
Hilsenhoff Biotic Index	2.76
Percent Sensitive Individuals	63.3
Index of Biotic Integrity	79.5

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	35
Condition of Banks + Vegetative Protection	35
Habitat Assessment Score (Overall)	197

Site Summary Sheet: BRODCR22

Stream Name	Brodhead Creek	Latitude	41.066523
Date Sampled	4/6/2021	Longitude	-75.220216
Time Sampled	10:15:00 AM	Municipality	Stroud
Drainage Area (sq mi)	70.6	Habitat Type	Riffle/Run
Location Description	Sugar Cane Ln. access off of Rt. 191 Bridge upstream of confluence of PARACR08.		

Field Measurements

pH	7.14
Dissolved Oxygen (%)	102.9
Dissolved Oxygen (mg/L)	12.68
Conductivity (µS/cm)	68.0
Total Dissolved Solids (mg/L)	44.271
Temperature (°C)	6.4

Lab Chemistry Results

Total Organic Carbon (mg/L)	1.66	Phosphorus as P (mg/L)	0.263
Chloride (mg/L)	10.3	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	15.7	pH (Lab)	7
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	4.31
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	1.19
Total Dissolved Solids (Lab) (mg/L)	48.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	<6.0
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	3
Slow/Deep	1
Fast/Deep	1

Macroinvertebrate Metrics

Total Taxa Richness	28
EPT Taxa Richness	18
Beck's Index	29
Shannon Diversity Index	2.54
Hilsenhoff Biotic Index	2.27
Percent Sensitive Individuals	75.4
Index of Biotic Integrity	96.5

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	35
Condition of Banks + Vegetative Protection	34
Habitat Assessment Score (Overall)	201

Site Summary Sheet: BRODCR30

Stream Name	Brodhead Creek	Latitude	41.036093
Date Sampled	4/6/2021	Longitude	-75.209176
Time Sampled	9:00:00 AM	Municipality	Stroud
Drainage Area (sq mi)	122	Habitat Type	Riffle/Run
Location Description	120 meters southeast of Rt. 191 bridge near intersection of Rt. 191 and Rt. 447		

Field Measurements

pH	7.27
Dissolved Oxygen (%)	102.5
Dissolved Oxygen (mg/L)	12.58
Conductivity (µS/cm)	118.0
Total Dissolved Solids (mg/L)	76.944
Temperature (°C)	6.5

Lab Chemistry Results

Total Organic Carbon (mg/L)	2.01	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	22	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	10.5	pH (Lab)	6.8
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	6.71
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	1.75
Total Dissolved Solids (Lab) (mg/L)	93.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	10.5
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	2
Fast/Shallow	1
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	27
EPT Taxa Richness	15
Beck's Index	25
Shannon Diversity Index	2.56
Hilsenhoff Biotic Index	3.39
Percent Sensitive Individuals	56.2
Index of Biotic Integrity	91.6

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	34
Condition of Banks + Vegetative Protection	32
Habitat Assessment Score (Overall)	183

Site Summary Sheet: BRODCR31

Stream Name	Brodhead Creek	Latitude	40.998746
Date Sampled	4/8/2021	Longitude	-75.143353
Time Sampled	8:25:00 AM	Municipality	Smithfield
Drainage Area (sq mi)	261	Habitat Type	Riffle/Run
Location Description	55 meters east of Paper Mill Rd near entrance of paper mill		

Field Measurements

pH	7.49
Dissolved Oxygen (%)	100.5
Dissolved Oxygen (mg/L)	11.46
Conductivity (µS/cm)	183.0
Total Dissolved Solids (mg/L)	118.868
Temperature (°C)	9.6

Lab Chemistry Results

Total Organic Carbon (mg/L)	1.47	Phosphorus as P (mg/L)	0.036
Chloride (mg/L)	31.2	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	39.8	pH (Lab)	7.2
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	12.3
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	2.20
Total Dissolved Solids (Lab) (mg/L)	106	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	23.1
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	2
Fast/Shallow	2
Slow/Deep	0
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	21
EPT Taxa Richness	13
Beck's Index	19
Shannon Diversity Index	1.94
Hilsenhoff Biotic Index	4.59
Percent Sensitive Individuals	27.2
Index of Biotic Integrity	70.3

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	22
Condition of Banks + Vegetative Protection	31
Habitat Assessment Score (Overall)	172

Site Summary Sheet: BUHICR07

Stream Name	Buck Hill Creek	Latitude	41.194403
Date Sampled	4/14/2021	Longitude	-75.281357
Time Sampled	8:30:00 AM	Municipality	Barrett
Drainage Area (sq mi)	5.9	Habitat Type	Riffle/Run
Location Description	165 meters upstream of Buck Hill Golf Club off of Cresco Rd.		

Field Measurements

pH	6.83
Dissolved Oxygen (%)	95.9
Dissolved Oxygen (mg/L)	11.73
Conductivity (µS/cm)	37.0
Total Dissolved Solids (mg/L)	24.000
Temperature (°C)	6.7

Lab Chemistry Results

Total Organic Carbon (mg/L)	2.81	Phosphorus as P (mg/L)	0.027
Chloride (mg/L)	5.08	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	9.36	pH (Lab)	6.3
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	0.215	Calcium (mg/L)	2.65
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.01	Magnesium (mg/L)	0.67
Total Dissolved Solids (Lab) (mg/L)	67.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	<6.0
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	3
Slow/Deep	1
Fast/Deep	1

Macroinvertebrate Metrics

Total Taxa Richness	17
EPT Taxa Richness	11
Beck's Index	27
Shannon Diversity Index	2.13
Hilsenhoff Biotic Index	1.16
Percent Sensitive Individuals	90.9
Index of Biotic Integrity	75.8

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	37
Condition of Banks + Vegetative Protection	36
Habitat Assessment Score (Overall)	217

Site Summary Sheet: BUCKCR01

Stream Name	Buckwha Creek	Latitude	40.847275
Date Sampled	4/5/2021	Longitude	-75.451532
Time Sampled	9:30:00 AM	Municipality	Eldred
Drainage Area (sq mi)	19.5	Habitat Type	Riffle/Run
Location Description	200 meters east of Chestnut Ridge Rd bridge		

Field Measurements

pH	7.17
Dissolved Oxygen (%)	101.7
Dissolved Oxygen (mg/L)	12.42
Conductivity (µS/cm)	101.0
Total Dissolved Solids (mg/L)	65.404
Temperature (°C)	6.7

Lab Chemistry Results

Total Organic Carbon (mg/L)	0.89	Phosphorus as P (mg/L)	0.025
Chloride (mg/L)	11.6	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	31	pH (Lab)	7.2
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<2.00	Calcium (mg/L)	8.29
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.13	Magnesium (mg/L)	2.51
Total Dissolved Solids (Lab) (mg/L)	87.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	14.7
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	2
Fast/Shallow	2
Slow/Deep	1
Fast/Deep	1

Macroinvertebrate Metrics

Total Taxa Richness	23
EPT Taxa Richness	13
Beck's Index	20
Shannon Diversity Index	2.42
Hilsenhoff Biotic Index	4.19
Percent Sensitive Individuals	37.5
Index of Biotic Integrity	65.2

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	16
Condition of Banks + Vegetative Protection	20
Habitat Assessment Score (Overall)	159

Site Summary Sheet: BUSHCR07

Stream Name	Bushkill Creek	Latitude	41.084861
Date Sampled	4/8/2021	Longitude	-75.019417
Time Sampled	10:00:00 AM	Municipality	Middle Smithfield
Drainage Area (sq mi)	120	Habitat Type	Riffle/Run
Location Description	340 meters north of Route 209 through ROW.		

Field Measurements

pH	7.19
Dissolved Oxygen (%)	104.4
Dissolved Oxygen (mg/L)	12.02
Conductivity (µS/cm)	60.0
Total Dissolved Solids (mg/L)	39.339
Temperature (°C)	9.2

Lab Chemistry Results

Total Organic Carbon (mg/L)	3.18	Phosphorus as P (mg/L)	0.032
Chloride (mg/L)	8.18	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	14.8	pH (Lab)	6.9
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	4.21
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	1.05
Total Dissolved Solids (Lab) (mg/L)	69.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	10.5
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	2
Fast/Shallow	2
Slow/Deep	0
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	29
EPT Taxa Richness	17
Beck's Index	31
Shannon Diversity Index	2.42
Hilsenhoff Biotic Index	2.75
Percent Sensitive Individuals	63.7
Index of Biotic Integrity	95.6

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	35
Condition of Banks + Vegetative Protection	35
Habitat Assessment Score (Overall)	201

Site Summary Sheet: BUTZRN01

Stream Name	Butz Run	Latitude	41.076071
Date Sampled	4/6/2021	Longitude	-75.235002
Time Sampled	10:54:00 AM	Municipality	Paradise
Drainage Area (sq mi)	3.7	Habitat Type	Riffle/Run
Location Description	1.14 miles down Sylvan Cascades Rd from intersection of Rt. 191		

Field Measurements

pH	7.5
Dissolved Oxygen (%)	100.2
Dissolved Oxygen (mg/L)	12.18
Conductivity (µS/cm)	118.0
Total Dissolved Solids (mg/L)	76.770
Temperature (°C)	6.9

Lab Chemistry Results

Total Organic Carbon (mg/L)	2.50	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	17.9	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	29.5	pH (Lab)	7
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	8.94
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	1.75
Total Dissolved Solids (Lab) (mg/L)	77.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	16.8
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	1
Slow/Deep	2
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	26
EPT Taxa Richness	15
Beck's Index	31
Shannon Diversity Index	2.11
Hilsenhoff Biotic Index	2.17
Percent Sensitive Individuals	81.7
Index of Biotic Integrity	84.4

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	36
Condition of Banks + Vegetative Protection	33
Habitat Assessment Score (Overall)	209

Site Summary Sheet: CHERCR01

Stream Name	Cherry Creek	Latitude	40.984712
Date Sampled	4/12/2021	Longitude	-75.145848
Time Sampled	12:25:00 PM	Municipality	Delaware Water Gap
Drainage Area (sq mi)	20.4	Habitat Type	Riffle/Run
Location Description	Located near Edge of the Woods Outfitters 100m from the intersection of 611 and Broad St.		

Field Measurements

pH	7.82
Dissolved Oxygen (%)	96.9
Dissolved Oxygen (mg/L)	10.76
Conductivity (µS/cm)	160.0
Total Dissolved Solids (mg/L)	103.697
Temperature (°C)	10.7

Lab Chemistry Results

Total Organic Carbon (mg/L)	5.93	Phosphorus as P (mg/L)	0.038
Chloride (mg/L)	8.98	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	67.4	pH (Lab)	7.3
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.40	Calcium (mg/L)	20.6
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.03	Magnesium (mg/L)	3.87
Total Dissolved Solids (Lab) (mg/L)	146	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	52.5
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	3
Slow/Deep	0
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	24
EPT Taxa Richness	14
Beck's Index	21
Shannon Diversity Index	2.21
Hilsenhoff Biotic Index	2.41
Percent Sensitive Individuals	75.0
Index of Biotic Integrity	76.9

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	32
Condition of Banks + Vegetative Protection	32
Habitat Assessment Score (Overall)	175

Site Summary Sheet: CHERCR06

Stream Name	Cherry Creek	Latitude	40.93657
Date Sampled	4/12/2021	Longitude	-75.252769
Time Sampled	11:15:00 AM	Municipality	Hamilton
Drainage Area (sq mi)	9	Habitat Type	Low Gradient
Location Description	25 meters south of bridge on Kemmertown Rd.		

Field Measurements

pH	7.9
Dissolved Oxygen (%)	98.5
Dissolved Oxygen (mg/L)	11.14
Conductivity (µS/cm)	150.0
Total Dissolved Solids (mg/L)	97.825
Temperature (°C)	9.9

Lab Chemistry Results

Total Organic Carbon (mg/L)	3.39	Phosphorus as P (mg/L)	0.024
Chloride (mg/L)	6.37	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	67.2	pH (Lab)	7.4
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.40	Calcium (mg/L)	20.4
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.03	Magnesium (mg/L)	3.94
Total Dissolved Solids (Lab) (mg/L)	123	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	50.4
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Cobble/Gravel	2
Snag	3
CPOM	3
Submerged Aquatic Vegetation	0
Sand/Fine Sediment	2

Macroinvertebrate Metrics

Total Taxa Richness	25
EPT Taxa Richness	18
Beck4	23
Shannon Diversity Index	2.40
# of Caddisfly Taxa	11
# of Mayfly Taxa	6
Index of Biotic Integrity	90.1

Habitat Assessment Metrics

Pool Substrate Characterization + Sediment Deposition	27
Bank Vegetative Protection + Bank Stability	33
Habitat Assessment Score (Overall)	147

Site Summary Sheet: CHERCR06R

Stream Name	Cherry Creek	Latitude	40.93657
Date Sampled	4/12/2021	Longitude	-75.252769
Time Sampled	11:15:00 AM	Municipality	Hamilton
Drainage Area (sq mi)	9	Habitat Type	Low Gradient
Location Description	25 meters south of bridge on Kemmertown Rd.		

Field Measurements

pH	7.9
Dissolved Oxygen (%)	98.5
Dissolved Oxygen (mg/L)	11.14
Conductivity (µS/cm)	150.0
Total Dissolved Solids (mg/L)	97.825
Temperature (°C)	9.9

Lab Chemistry Results

Total Organic Carbon (mg/L)	3.04	Phosphorus as P (mg/L)	0.025
Chloride (mg/L)	6.43	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	66.8	pH (Lab)	7.3
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.40	Calcium (mg/L)	20.3
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.03	Magnesium (mg/L)	3.92
Total Dissolved Solids (Lab) (mg/L)	246	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	50.4
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Cobble/Gravel	2
Snag	3
CPOM	3
Submerged Aquatic Vegetation	0
Sand/Fine Sediment	2

Macroinvertebrate Metrics

Total Taxa Richness	22
EPT Taxa Richness	17
Beck4	17
Shannon Diversity Index	1.98
# of Caddisfly Taxa	6
# of Mayfly Taxa	8
Index of Biotic Integrity	85.7

Habitat Assessment Metrics

Pool Substrate Characterization + Sediment Deposition	27
Bank Vegetative Protection + Bank Stability	33
Habitat Assessment Score (Overall)	147

Site Summary Sheet: INDIRN03

Stream Name	Indian Run	Latitude	41.10221
Date Sampled	4/7/2021	Longitude	-75.346358
Time Sampled	8:40:00 AM	Municipality	Pocono
Drainage Area (sq mi)	1.94	Habitat Type	Riffle/Run
Location Description	150 meters upstream of confluence with Swiftwater Creek		

Field Measurements

pH	7.08
Dissolved Oxygen (%)	97.5
Dissolved Oxygen (mg/L)	11.8
Conductivity (µS/cm)	218.0
Total Dissolved Solids (mg/L)	142.054
Temperature (°C)	7.1

Lab Chemistry Results

Total Organic Carbon (mg/L)	0.61	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	51.8	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	40.1	pH (Lab)	6.6
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	10.9
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	3.10
Total Dissolved Solids (Lab) (mg/L)	154	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	10.5
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	12
EPT Taxa Richness	7
Beck's Index	14
Shannon Diversity Index	1.61
Hilsenhoff Biotic Index	2.45
Percent Sensitive Individuals	64.6
Index of Biotic Integrity	56.0

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	35
Condition of Banks + Vegetative Protection	23
Habitat Assessment Score (Overall)	194

Site Summary Sheet: JONACR01

Stream Name	Jonas Creek	Latitude	40.97567
Date Sampled	4/5/2021	Longitude	-75.507843
Time Sampled	12:50:00 PM	Municipality	Polk
Drainage Area (sq mi)	2.1	Habitat Type	Riffle/Run
Location Description	150m north of the Laurel Ln cul-de-sac		

Field Measurements

pH	6.54
Dissolved Oxygen (%)	99.5
Dissolved Oxygen (mg/L)	11.72
Conductivity (µS/cm)	87.0
Total Dissolved Solids (mg/L)	56.501
Temperature (°C)	8.2

Lab Chemistry Results

Total Organic Carbon (mg/L)	0.56	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	17.9	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	13.5	pH (Lab)	7
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<2.00	Calcium (mg/L)	3.19
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.13	Magnesium (mg/L)	1.34
Total Dissolved Solids (Lab) (mg/L)	122	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	<6.0
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	3
Slow/Deep	0
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	24
EPT Taxa Richness	16
Beck's Index	34
Shannon Diversity Index	2.59
Hilsenhoff Biotic Index	2.19
Percent Sensitive Individuals	73.0
Index of Biotic Integrity	86.6

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	36
Condition of Banks + Vegetative Protection	36
Habitat Assessment Score (Overall)	212

Site Summary Sheet: KEIPRN02

Stream Name	Keiper Run	Latitude	41.053224
Date Sampled	4/14/2021	Longitude	-75.552658
Time Sampled	10:00:00 AM	Municipality	Tunkhannock
Drainage Area (sq mi)	1.6	Habitat Type	Riffle/Run
Location Description	Immediately upstream of SR 903 Bridge		

Field Measurements

pH	6.65
Dissolved Oxygen (%)	87.1
Dissolved Oxygen (mg/L)	10.12
Conductivity (µS/cm)	130.0
Total Dissolved Solids (mg/L)	84.220
Temperature (°C)	8.8

Lab Chemistry Results

Total Organic Carbon (mg/L)	2.51	Phosphorus as P (mg/L)	0.452
Chloride (mg/L)	31.8	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	14.6	pH (Lab)	6.3
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	0.208	Calcium (mg/L)	3.99
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.01	Magnesium (mg/L)	1.13
Total Dissolved Solids (Lab) (mg/L)	172	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	8.5
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	3
Slow/Deep	0
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	15
EPT Taxa Richness	2.00
Beck's Index	7
Shannon Diversity Index	1.65
Hilsenhoff Biotic Index	5.36
Percent Sensitive Individuals	14.9
Index of Biotic Integrity	34.5

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	27
Condition of Banks + Vegetative Protection	34
Habitat Assessment Score (Overall)	179

Site Summary Sheet: LISACR21

Stream Name	Little Sambo Creek	Latitude	41.029353
Date Sampled	4/14/2021	Longitude	-75.182539
Time Sampled	11:30:00 AM	Municipality	Smithfield
Drainage Area (sq mi)	4.8	Habitat Type	Riffle/Run
Location Description	Downstream of Lake Valhalla		

Field Measurements

pH	7.80
Dissolved Oxygen (%)	112.4
Dissolved Oxygen (mg/L)	12.26
Conductivity (µS/cm)	215.0
Total Dissolved Solids (mg/L)	139.767
Temperature (°C)	11.5

Lab Chemistry Results

Total Organic Carbon (mg/L)	4.10	Phosphorus as P (mg/L)	0.373
Chloride (mg/L)	29.7	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	63.7	pH (Lab)	7.4
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	0.266	Calcium (mg/L)	21.7
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.01	Magnesium (mg/L)	2.30
Total Dissolved Solids (Lab) (mg/L)	208	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	42.3
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	2
Fast/Shallow	1
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	21
EPT Taxa Richness	9
Beck's Index	19
Shannon Diversity Index	1.89
Hilsenhoff Biotic Index	5.51
Percent Sensitive Individuals	6.36
Index of Biotic Integrity	48.3

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	26
Condition of Banks + Vegetative Protection	31
Habitat Assessment Score (Overall)	171

Site Summary Sheet: MARSCR11

Stream Name	Marshalls Creek	Latitude	41.054246
Date Sampled	4/8/2021	Longitude	-75.13672
Time Sampled	11:51:00 AM	Municipality	Middle Smithfield
Drainage Area (sq mi)	11.9	Habitat Type	Riffle/Run
Location Description	385 meters north of intersection of Marshalls Creek Rd. and Golfcart Rd.		

Field Measurements

pH	7.43
Dissolved Oxygen (%)	103.9
Dissolved Oxygen (mg/L)	11.87
Conductivity (µS/cm)	79.0
Total Dissolved Solids (mg/L)	51.469
Temperature (°C)	9.6

Lab Chemistry Results

Total Organic Carbon (mg/L)	1.66	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	4.49	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	22.7	pH (Lab)	7
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	6.66
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	1.47
Total Dissolved Solids (Lab) (mg/L)	64.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	10.5
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	27
EPT Taxa Richness	16
Beck's Index	34
Shannon Diversity Index	2.71
Hilsenhoff Biotic Index	3.12
Percent Sensitive Individuals	56.0
Index of Biotic Integrity	83.6

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	35
Condition of Banks + Vegetative Protection	34
Habitat Assessment Score (Overall)	202

Site Summary Sheet: MARSCR18

Stream Name	Marshalls Creek	Latitude	40.998555
Date Sampled	4/8/2021	Longitude	-75.139952
Time Sampled	9:09:00 AM	Municipality	Smithfield
Drainage Area (sq mi)	26.3	Habitat Type	Riffle/Run
Location Description	Next to Minisink Hotel parking lot off of Post Office Rd.		

Field Measurements

pH	7.67
Dissolved Oxygen (%)	101.9
Dissolved Oxygen (mg/L)	11.54
Conductivity (µS/cm)	190.0
Total Dissolved Solids (mg/L)	123.441
Temperature (°C)	9.9

Lab Chemistry Results

Total Organic Carbon (mg/L)	1.89	Phosphorus as P (mg/L)	0.024
Chloride (mg/L)	24.3	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	55.4	pH (Lab)	7.4
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	18.3
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	2.38
Total Dissolved Solids (Lab) (mg/L)	154	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	35.7
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	1
Slow/Deep	1
Fast/Deep	3

Macroinvertebrate Metrics

Total Taxa Richness	25
EPT Taxa Richness	10
Beck's Index	12
Shannon Diversity Index	2.01
Hilsenhoff Biotic Index	3.30
Percent Sensitive Individuals	56.6
Index of Biotic Integrity	63.5

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	33
Condition of Banks + Vegetative Protection	33
Habitat Assessment Score (Overall)	189

Site Summary Sheet: MARSCR19

Stream Name	Marshalls Creek	Latitude	41.108419
Date Sampled	4/8/2021	Longitude	-75.155693
Time Sampled	11:00:00 AM	Municipality	Middle Smithfield
Drainage Area (sq mi)	3.1	Habitat Type	Riffle/Run
Location Description	40 meters north of one lane bridge on Tallyrand Dr.		

Field Measurements

pH	6.99
Dissolved Oxygen (%)	96.9
Dissolved Oxygen (mg/L)	11.26
Conductivity (µS/cm)	48.0
Total Dissolved Solids (mg/L)	30.862
Temperature (°C)	8.8

Lab Chemistry Results

Total Organic Carbon (mg/L)	2.23	Phosphorus as P (mg/L)	0.02
Chloride (mg/L)	4.14	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	13.9	pH (Lab)	6.9
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	4.18
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	0.84
Total Dissolved Solids (Lab) (mg/L)	54.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	8.4
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	2
Fast/Shallow	1
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	13
EPT Taxa Richness	5
Beck's Index	12
Shannon Diversity Index	1.21
Hilsenhoff Biotic Index	1.99
Percent Sensitive Individuals	78.7
Index of Biotic Integrity	55.2

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	34
Condition of Banks + Vegetative Protection	38
Habitat Assessment Score (Overall)	206

Site Summary Sheet: MCMICR22

Stream Name	McMichael Creek	Latitude	40.930902
Date Sampled	4/12/2021	Longitude	-75.363567
Time Sampled	8:30:00 AM	Municipality	Chestnuthill
Drainage Area (sq mi)	17.7	Habitat Type	Riffle/Run
Location Description	115m south of intersection of McIlhaney Rd. and Kennel Rd.		

Field Measurements

pH	7.04
Dissolved Oxygen (%)	95.9
Dissolved Oxygen (mg/L)	11.05
Conductivity (µS/cm)	68.0
Total Dissolved Solids (mg/L)	44.195
Temperature (°C)	9.1

Lab Chemistry Results

Total Organic Carbon (mg/L)	3.04	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	10.4	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	18.3	pH (Lab)	6.8
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	0.45	Calcium (mg/L)	4.63
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.03	Magnesium (mg/L)	1.63
Total Dissolved Solids (Lab) (mg/L)	49.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	10.5
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	0
Fast/Deep	3

Macroinvertebrate Metrics

Total Taxa Richness	29
EPT Taxa Richness	17
Beck's Index	35
Shannon Diversity Index	2.61
Hilsenhoff Biotic Index	2.67
Percent Sensitive Individuals	68.0
Index of Biotic Integrity	88.6

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	26
Condition of Banks + Vegetative Protection	37
Habitat Assessment Score (Overall)	188

Site Summary Sheet: MCMICR37

Stream Name	McMichael Creek	Latitude	40.962041
Date Sampled	4/12/2021	Longitude	-75.236508
Time Sampled	10:08:00 AM	Municipality	Stroud
Drainage Area (sq mi)	63.1	Habitat Type	Riffle/Run
Location Description	Hickory Valley State Park 60m southeast from parking area.		

Field Measurements

pH	7.50
Dissolved Oxygen (%)	96.4
Dissolved Oxygen (mg/L)	10.82
Conductivity (µS/cm)	150.0
Total Dissolved Solids (mg/L)	97.608
Temperature (°C)	10.2

Lab Chemistry Results

Total Organic Carbon (mg/L)	2.86	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	20.5	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	43.1	pH (Lab)	6.9
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	0.45	Calcium (mg/L)	13.5
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.03	Magnesium (mg/L)	2.30
Total Dissolved Solids (Lab) (mg/L)	68.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	23.1
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	0
Fast/Deep	3

Macroinvertebrate Metrics

Total Taxa Richness	18
EPT Taxa Richness	9
Beck's Index	14
Shannon Diversity Index	2.16
Hilsenhoff Biotic Index	3.96
Percent Sensitive Individuals	35.0
Index of Biotic Integrity	65.4

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	22
Condition of Banks + Vegetative Protection	32
Habitat Assessment Score (Overall)	166

Site Summary Sheet: MIDDCR04

Stream Name	Middle Creek	Latitude	40.905822
Date Sampled	4/5/2021	Longitude	-75.496614
Time Sampled	1:31:00 AM	Municipality	Polk
Drainage Area (sq mi)	18.1	Habitat Type	Riffle/Run
Location Description	Downstream of observation deck on Cliff Woodring Trail.		

Field Measurements

pH	7.09
Dissolved Oxygen (%)	103.9
Dissolved Oxygen (mg/L)	12.03
Conductivity (µS/cm)	74.0
Total Dissolved Solids (mg/L)	48.010
Temperature (°C)	8.9

Lab Chemistry Results

Total Organic Carbon (mg/L)	0.91	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	12.0	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	18.6	pH (Lab)	7.3
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<2.00	Calcium (mg/L)	4.29
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.13	Magnesium (mg/L)	1.92
Total Dissolved Solids (Lab) (mg/L)	<10.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	8.4
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	2
Fast/Shallow	2
Slow/Deep	0
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	25
EPT Taxa Richness	14
Beck's Index	34
Shannon Diversity Index	2.76
Hilsenhoff Biotic Index	2.59
Percent Sensitive Individuals	60.0
Index of Biotic Integrity	83.0

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	27
Condition of Banks + Vegetative Protection	32
Habitat Assessment Score (Overall)	174

Site Summary Sheet: MILLCR03

Stream Name	Mill Creek	Latitude	41.163201
Date Sampled	4/6/2021	Longitude	-75.251528
Time Sampled	12:50:00 PM	Municipality	Barrett
Drainage Area (sq mi)	6.8	Habitat Type	Riffle/Run
Location Description	560m west of intersection of Sand Spring Rd. and Mill Creek Rd.		

Field Measurements

pH	7.19
Dissolved Oxygen (%)	98.6
Dissolved Oxygen (mg/L)	11.69
Conductivity (µS/cm)	83.0
Total Dissolved Solids (mg/L)	53.951
Temperature (°C)	7.9

Lab Chemistry Results

Total Organic Carbon (mg/L)	1.28	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	14.7	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	17.4	pH (Lab)	6.9
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	4.60
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	1.31
Total Dissolved Solids (Lab) (mg/L)	61.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	8.4
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	21
EPT Taxa Richness	13
Beck's Index	34
Shannon Diversity Index	1.95
Hilsenhoff Biotic Index	1.68
Percent Sensitive Individuals	77.3
Index of Biotic Integrity	80.2

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	36
Condition of Banks + Vegetative Protection	35
Habitat Assessment Score (Overall)	209

Site Summary Sheet: PARACR08

Stream Name	Paradise Creek	Latitude	41.066498
Date Sampled	4/6/2021	Longitude	-75.221395
Time Sampled	9:51:00 AM	Municipality	Stroud
Drainage Area (sq mi)	43.5	Habitat Type	Riffle/Run
Location Description	Sugar Cane Ln. access off of Rt. 191 Bridge. 150m west from Sugar Cane Rd, walk across Brodhead to site.		

Field Measurements

pH	7.55
Dissolved Oxygen (%)	103.6
Dissolved Oxygen (mg/L)	12.74
Conductivity (µS/cm)	194.0
Total Dissolved Solids (mg/L)	125.971
Temperature (°C)	6.5

Lab Chemistry Results

Total Organic Carbon (mg/L)	1.50	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	40.9	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	31.2	pH (Lab)	7.1
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	8.72
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	2.28
Total Dissolved Solids (Lab) (mg/L)	120	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	16.8
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	2
Fast/Deep	1

Macroinvertebrate Metrics

Total Taxa Richness	21
EPT Taxa Richness	12
Beck's Index	21
Shannon Diversity Index	2.20
Hilsenhoff Biotic Index	3.28
Percent Sensitive Individuals	59.9
Index of Biotic Integrity	83.6

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	31
Condition of Banks + Vegetative Protection	15
Habitat Assessment Score (Overall)	181

Site Summary Sheet: POCOCR09

Stream Name	Pocono Creek	Latitude	41.039252
Date Sampled	4/7/2021	Longitude	-75.309729
Time Sampled	12:20:00 PM	Municipality	Pocono
Drainage Area (sq mi)	18.6	Habitat Type	Riffle/Run
Location Description	65m north of Old Mill Rd. bridge.		

Field Measurements

pH	7.37
Dissolved Oxygen (%)	101.4
Dissolved Oxygen (mg/L)	11.74
Conductivity (µS/cm)	202.0
Total Dissolved Solids (mg/L)	131.224
Temperature (°C)	8.9

Lab Chemistry Results

Total Organic Carbon (mg/L)	1.52	Phosphorus as P (mg/L)	0.027
Chloride (mg/L)	46.3	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	35.4	pH (Lab)	7
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	10.1
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	2.48
Total Dissolved Solids (Lab) (mg/L)	110	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	10.5
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	16
EPT Taxa Richness	7.00
Beck's Index	15
Shannon Diversity Index	1.72
Hilsenhoff Biotic Index	4.72
Percent Sensitive Individuals	25.5
Index of Biotic Integrity	46.7

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	33
Condition of Banks + Vegetative Protection	31
Habitat Assessment Score (Overall)	189

Site Summary Sheet: POCOCR14

Stream Name	Pocono Creek	Latitude	40.981165
Date Sampled	4/7/2021	Longitude	-75.197009
Time Sampled	1:17:00 PM	Municipality	Stroudsburg
Drainage Area (sq mi)	49.4	Habitat Type	Riffle/Run
Location Description	70m south from S. 10th St and Ann St.		

Field Measurements

pH	8.10
Dissolved Oxygen (%)	112.3
Dissolved Oxygen (mg/L)	12.51
Conductivity (µS/cm)	246.0
Total Dissolved Solids (mg/L)	160.101
Temperature (°C)	10.5

Lab Chemistry Results

Total Organic Carbon (mg/L)	1.83	Phosphorus as P (mg/L)	0.251
Chloride (mg/L)	52.9	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	47.7	pH (Lab)	7.3
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.40	Calcium (mg/L)	14.3
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.03	Magnesium (mg/L)	2.93
Total Dissolved Solids (Lab) (mg/L)	115	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	21.0
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	18
EPT Taxa Richness	12
Beck's Index	21
Shannon Diversity Index	1.38
Hilsenhoff Biotic Index	4.70
Percent Sensitive Individuals	25.0
Index of Biotic Integrity	65.1

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	31
Condition of Banks + Vegetative Protection	32
Habitat Assessment Score (Overall)	182

Site Summary Sheet: POCOCR01

Stream Name	Pocono Creek	Latitude	41.058983
Date Sampled	4/7/2021	Longitude	-75.34886
Time Sampled	10:05:00 AM	Municipality	Pocono
Drainage Area (sq mi)	8.8	Habitat Type	Riffle/Run
Location Description	300m south on Camelback Rd from intersection of Camelback Rd. and Wilke Rd.		

Field Measurements

pH	7.16
Dissolved Oxygen (%)	99.0
Dissolved Oxygen (mg/L)	11.88
Conductivity (µS/cm)	111.0
Total Dissolved Solids (mg/L)	72.216
Temperature (°C)	7.5

Lab Chemistry Results

Total Organic Carbon (mg/L)	1.54	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	24.5	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	16.7	pH (Lab)	6.6
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	4.71
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	1.20
Total Dissolved Solids (Lab) (mg/L)	93.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	8.4
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	23
EPT Taxa Richness	15
Beck's Index	34
Shannon Diversity Index	2.25
Hilsenhoff Biotic Index	2.56
Percent Sensitive Individuals	64.0
Index of Biotic Integrity	80.7

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	32
Condition of Banks + Vegetative Protection	30
Habitat Assessment Score (Overall)	193

Site Summary Sheet: POHOCR01

Stream Name	Pohopoco Creek	Latitude	40.961684
Date Sampled	4/5/2021	Longitude	-75.465
Time Sampled	12:00:00 PM	Municipality	Chestnuthill
Drainage Area (sq mi)	5.9	Habitat Type	Riffle/Run
Location Description	330m southeast from intersection of Merwinsburg Rd. and Burger Hollow Rd.		

Field Measurements

pH	6.91
Dissolved Oxygen (%)	100.9
Dissolved Oxygen (mg/L)	11.91
Conductivity (µS/cm)	127.0
Total Dissolved Solids (mg/L)	82.375
Temperature (°C)	8.1

Lab Chemistry Results

Total Organic Carbon (mg/L)	0.76	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	27.1	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	24.4	pH (Lab)	6.8
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<2.00	Calcium (mg/L)	5.57
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.13	Magnesium (mg/L)	2.54
Total Dissolved Solids (Lab) (mg/L)	93.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	8.4
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	24
EPT Taxa Richness	12
Beck's Index	26
Shannon Diversity Index	2.53
Hilsenhoff Biotic Index	2.64
Percent Sensitive Individuals	71.0
Index of Biotic Integrity	77.8

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	29
Condition of Banks + Vegetative Protection	33
Habitat Assessment Score (Overall)	198

Site Summary Sheet: POHOCR29

Stream Name	Pohopoco Creek	Latitude	40.89951
Date Sampled	4/5/2021	Longitude	-75.506215
Time Sampled	10:15:00 AM	Municipality	Polk
Drainage Area (sq mi)	50	Habitat Type	Riffle/Run
Location Description	700 meters west on Whitey B Ln. from intersection of Whitey B Ln. and Rt. 209.		

Field Measurements

pH	6.92
Dissolved Oxygen (%)	101.7
Dissolved Oxygen (mg/L)	12.23
Conductivity (µS/cm)	111.0
Total Dissolved Solids (mg/L)	71.882
Temperature (°C)	7.4

Lab Chemistry Results

Total Organic Carbon (mg/L)	1.14	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	19.4	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	28.1	pH (Lab)	6.7
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<2.00	Calcium (mg/L)	6.80
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.13	Magnesium (mg/L)	2.70
Total Dissolved Solids (Lab) (mg/L)	84.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	10.5
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	26
EPT Taxa Richness	12
Beck's Index	22
Shannon Diversity Index	2.45
Hilsenhoff Biotic Index	3.41
Percent Sensitive Individuals	49.0
Index of Biotic Integrity	85.4

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	32
Condition of Banks + Vegetative Protection	36
Habitat Assessment Score (Overall)	205

Site Summary Sheet: SAMBCR02

Stream Name	Sambo Creek	Latitude	41.009419
Date Sampled	4/14/2021	Longitude	-75.190549
Time Sampled	12:10:00 PM	Municipality	East Stroudsburg
Drainage Area (sq mi)	10	Habitat Type	Riffle/Run
Location Description	45m east of Levee Loop Trail, north of John Konawalick Field		

Field Measurements

pH	8.50
Dissolved Oxygen (%)	125.4
Dissolved Oxygen (mg/L)	13.57
Conductivity (µS/cm)	214.0
Total Dissolved Solids (mg/L)	139.270
Temperature (°C)	11.8

Lab Chemistry Results

Total Organic Carbon (mg/L)	2.68	Phosphorus as P (mg/L)	0.254
Chloride (mg/L)	32.7	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	57.0	pH (Lab)	8.1
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	0.357	Calcium (mg/L)	19.0
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.01	Magnesium (mg/L)	2.31
Total Dissolved Solids (Lab) (mg/L)	184	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	33.8
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	2
Fast/Deep	1

Macroinvertebrate Metrics

Total Taxa Richness	22
EPT Taxa Richness	10
Beck's Index	13
Shannon Diversity Index	2.06
Hilsenhoff Biotic Index	5.12
Percent Sensitive Individuals	19.3
Index of Biotic Integrity	51.4

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	27
Condition of Banks + Vegetative Protection	31
Habitat Assessment Score (Overall)	171

Site Summary Sheet: SASPRN01

Stream Name	Sand Spring	Latitude	41.061595
Date Sampled	4/7/2021	Longitude	-75.37459
Time Sampled	10:50:00 AM	Municipality	Jackson
Drainage Area (sq mi)	1.2	Habitat Type	Riffle/Run
Location Description	600m west of Wilke Rd. dead end		

Field Measurements

pH	6.77
Dissolved Oxygen (%)	97.6
Dissolved Oxygen (mg/L)	11.16
Conductivity (µS/cm)	59.0
Total Dissolved Solids (mg/L)	38.221
Temperature (°C)	9.4

Lab Chemistry Results

Total Organic Carbon (mg/L)	1.76	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	13.2	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	6.36	pH (Lab)	6
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	1.75
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	0.48
Total Dissolved Solids (Lab) (mg/L)	103	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	6.3
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	9
EPT Taxa Richness	2.00
Beck's Index	4
Shannon Diversity Index	1.05
Hilsenhoff Biotic Index	2.87
Percent Sensitive Individuals	73.3
Index of Biotic Integrity	43.3

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	31
Condition of Banks + Vegetative Protection	18
Habitat Assessment Score (Overall)	183

Site Summary Sheet: SASPRN02

Stream Name	Sand Spring	Latitude	41.061234
Date Sampled	4/7/2021	Longitude	-75.375798
Time Sampled	11:26:00 AM	Municipality	Jackson
Drainage Area (sq mi)	1.2	Habitat Type	Riffle/Run
Location Description	700m west of Wilke Rd. dead end.		

Field Measurements

pH	6.65
Dissolved Oxygen (%)	97.3
Dissolved Oxygen (mg/L)	11.05
Conductivity (µS/cm)	28.0
Total Dissolved Solids (mg/L)	18.006
Temperature (°C)	9.8

Lab Chemistry Results

Total Organic Carbon (mg/L)	1.57	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	4.32	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	5.02	pH (Lab)	6.2
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	1.26
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	0.46
Total Dissolved Solids (Lab) (mg/L)	22.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	6.3
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	3
Slow/Deep	0
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	9
EPT Taxa Richness	3.00
Beck's Index	6
Shannon Diversity Index	1.27
Hilsenhoff Biotic Index	3.54
Percent Sensitive Individuals	56.9
Index of Biotic Integrity	41.7

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	28
Condition of Banks + Vegetative Protection	19
Habitat Assessment Score (Overall)	176

Site Summary Sheet: SWIFCR10

Stream Name	Swiftwater Creek	Latitude	41.100894
Date Sampled	4/7/2021	Longitude	-75.346355
Time Sampled	9:07:00 AM	Municipality	Pocono
Drainage Area (sq mi)	3.4	Habitat Type	Riffle/Run
Location Description	Immediately Downstream of Route 314 Bridge (above confluence of Indian Run)		

Field Measurements

pH	7.13
Dissolved Oxygen (%)	98.2
Dissolved Oxygen (mg/L)	11.98
Conductivity (µS/cm)	153.0
Total Dissolved Solids (mg/L)	99.494
Temperature (°C)	6.8

Lab Chemistry Results

Total Organic Carbon (mg/L)	0.77	Phosphorus as P (mg/L)	0.021
Chloride (mg/L)	36.0	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	25.1	pH (Lab)	6.5
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<0.80	Calcium (mg/L)	6.83
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.05	Magnesium (mg/L)	1.94
Total Dissolved Solids (Lab) (mg/L)	78.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	8.4
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	25
EPT Taxa Richness	15
Beck's Index	36
Shannon Diversity Index	2.31
Hilsenhoff Biotic Index	3.25
Percent Sensitive Individuals	3.25
Index of Biotic Integrity	78.5

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	33
Condition of Banks + Vegetative Protection	35
Habitat Assessment Score (Overall)	194

Site Summary Sheet: TOBYCR01

Stream Name	Tobyhanna Creek	Latitude	41.160987
Date Sampled	4/13/2021	Longitude	-75.45212
Time Sampled	9:00:00 AM	Municipality	Coolbaugh
Drainage Area (sq mi)	21.9	Habitat Type	Riffle/Run
Location Description	Upstream of Route 423 bridge in SGL 127		

Field Measurements

pH	7.08
Dissolved Oxygen (%)	93.6
Dissolved Oxygen (mg/L)	10.94
Conductivity (µS/cm)	151.0
Total Dissolved Solids (mg/L)	98.115
Temperature (°C)	8.5

Lab Chemistry Results

Total Organic Carbon (mg/L)	5.79	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	33.5	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	22.4	pH (Lab)	6.6
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<2.00	Calcium (mg/L)	6.67
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.13	Magnesium (mg/L)	1.40
Total Dissolved Solids (Lab) (mg/L)	125	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	8.5
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	23
EPT Taxa Richness	12.00
Beck's Index	23
Shannon Diversity Index	2.34
Hilsenhoff Biotic Index	4.13
Percent Sensitive Individuals	42.78
Index of Biotic Integrity	66.4

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	36
Condition of Banks + Vegetative Protection	36
Habitat Assessment Score (Overall)	216

Site Summary Sheet: TOBYCR14

Stream Name	Tobyhanna Creek	Latitude	41.082791
Date Sampled	4/13/2021	Longitude	-75.583083
Time Sampled	1:55:00 PM	Municipality	Tobyhanna
Drainage Area (sq mi)	82.6	Habitat Type	Riffle/Run
Location Description	50m east of Rt. 115 bridge near Austin T. Blakeslee Natural Area.		

Field Measurements

pH	6.93
Dissolved Oxygen (%)	99.2
Dissolved Oxygen (mg/L)	10.53
Conductivity (µS/cm)	123.0
Total Dissolved Solids (mg/L)	79.684
Temperature (°C)	12.7

Lab Chemistry Results

Total Organic Carbon (mg/L)	4.79	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	29.0	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	17.9	pH (Lab)	6.4
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<2.00	Calcium (mg/L)	5.30
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.13	Magnesium (mg/L)	1.13
Total Dissolved Solids (Lab) (mg/L)	122	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	6.4
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	0
Fast/Shallow	1
Slow/Deep	2
Fast/Deep	3

Macroinvertebrate Metrics

Total Taxa Richness	26
EPT Taxa Richness	12.00
Beck's Index	17
Shannon Diversity Index	2.66
Hilsenhoff Biotic Index	3.89
Percent Sensitive Individuals	51.9
Index of Biotic Integrity	86.2

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	27
Condition of Banks + Vegetative Protection	33
Habitat Assessment Score (Overall)	185

Site Summary Sheet: TUNKCR03

Stream Name	Tunkhannock Creek	Latitude	41.059541
Date Sampled	4/13/2021	Longitude	-75.552735
Time Sampled	1:30:00 PM	Municipality	Tunkhannock
Drainage Area (sq mi)	21.7	Habitat Type	Riffle/Run
Location Description	160m north of Tunkhannock Fishing Association Parking area.		

Field Measurements

pH	5.47
Dissolved Oxygen (%)	94.9
Dissolved Oxygen (mg/L)	10.67
Conductivity (µS/cm)	50.0
Total Dissolved Solids (mg/L)	32.727
Temperature (°C)	10.2

Lab Chemistry Results

Total Organic Carbon (mg/L)	12.0	Phosphorus as P (mg/L)	0.02
Chloride (mg/L)	11.0	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	7.45	pH (Lab)	5.1
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<2.00	Calcium (mg/L)	1.88
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.13	Magnesium (mg/L)	0.67
Total Dissolved Solids (Lab) (mg/L)	177	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	<6.0
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	0
Fast/Shallow	2
Slow/Deep	1
Fast/Deep	3

Macroinvertebrate Metrics

Total Taxa Richness	24
EPT Taxa Richness	8.00
Beck's Index	14
Shannon Diversity Index	2.68
Hilsenhoff Biotic Index	3.51
Percent Sensitive Individuals	54.4
Index of Biotic Integrity	65.0

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	31
Condition of Banks + Vegetative Protection	36
Habitat Assessment Score (Overall)	191

Site Summary Sheet: TUNKCR04

Stream Name	Tunkhannock Creek	Latitude	41.029676
Date Sampled	4/13/2021	Longitude	-75.453822
Time Sampled	12:25:00 PM	Municipality	Tunkhannock
Drainage Area (sq mi)	8.8	Habitat Type	Low Gradient
Location Description	Off Fire Ln. Near Bethlehem Water Authority dam		

Field Measurements

pH	5.44
Dissolved Oxygen (%)	84.1
Dissolved Oxygen (mg/L)	9.69
Conductivity (µS/cm)	53.0
Total Dissolved Solids (mg/L)	34.255
Temperature (°C)	9.1

Lab Chemistry Results

Total Organic Carbon (mg/L)	12.5	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	12.9	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	6.85	pH (Lab)	5
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<2.00	Calcium (mg/L)	1.79
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.13	Magnesium (mg/L)	0.58
Total Dissolved Solids (Lab) (mg/L)	110	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	<6.0
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Cobble/Gravel	1
Snag	3
CPOM	2
Submerged Aquatic Vegetation	3
Sand/Fine Sediment	1

Macroinvertebrate Metrics

Total Taxa Richness	14
EPT Taxa Richness	6
Beck4	11
Shannon Diversity Index	1.57
# of Caddisfly Taxa	4
# of Mayfly Taxa	4
Index of Biotic Integrity	49.7

Habitat Assessment Metrics

Pool Substrate Characterization + Sediment Deposition	30
Bank Vegetative Protection + Bank Stability	38
Habitat Assessment Score (Overall)	157

Site Summary Sheet: UPTNCR01

Stream Name	Upper Tunkhannock Creek	Latitude	41.116651
Date Sampled	4/13/2021	Longitude	-75.434099
Time Sampled	10:05:00 AM	Municipality	Tobyhanna
Drainage Area (sq mi)	13.6	Habitat Type	Riffle/Run
Location Description	BT Stillwater and Lake Naomi, 201 Tanglewood Dr		

Field Measurements

pH	7.04
Dissolved Oxygen (%)	94.3
Dissolved Oxygen (mg/L)	10.47
Conductivity (µS/cm)	221.0
Total Dissolved Solids (mg/L)	143.529
Temperature (°C)	10.7

Lab Chemistry Results

Total Organic Carbon (mg/L)	3.56	Phosphorus as P (mg/L)	0.024
Chloride (mg/L)	54.2	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	26.8	pH (Lab)	6.5
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<2.00	Calcium (mg/L)	7.86
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.13	Magnesium (mg/L)	1.75
Total Dissolved Solids (Lab) (mg/L)	138	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	8.5
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

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

Macroinvertebrate Metrics

Total Taxa Richness	12
EPT Taxa Richness	2.00
Beck's Index	3
Shannon Diversity Index	1.87
Hilsenhoff Biotic Index	5.28
Percent Sensitive Individuals	5.3
Index of Biotic Integrity	30.8

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	34
Condition of Banks + Vegetative Protection	33
Habitat Assessment Score (Overall)	197

Site Summary Sheet: UPTNCR02

Stream Name	Upper Tunkhannock Creek	Latitude	41.10608
Date Sampled	4/13/2021	Longitude	-75.485932
Time Sampled	11:05:00 AM	Municipality	Tobyhanna
Drainage Area (sq mi)	19.8	Habitat Type	Riffle/Run
Location Description	Downstream of Lake Naomi off Old 940		

Field Measurements

pH	6.94
Dissolved Oxygen (%)	96.9
Dissolved Oxygen (mg/L)	10.70
Conductivity (µS/cm)	181.0
Total Dissolved Solids (mg/L)	117.573
Temperature (°C)	10.9

Lab Chemistry Results

Total Organic Carbon (mg/L)	4.43	Phosphorus as P (mg/L)	<0.020
Chloride (mg/L)	46.6	Temperature (Lab) (°C)	-
Hardness (mg CaCO ₃ /L)	22.4	pH (Lab)	6.4
Ammonia as N (mg/L)	<0.30	Aluminum (mg/L)	-
Nitrate as N (mg/L)	<2.00	Calcium (mg/L)	6.67
Nitrate-Nitrite as N (mg/L)	-	Iron (mg/L)	-
Nitrite as N (mg/L)	<0.13	Magnesium (mg/L)	1.39
Total Dissolved Solids (Lab) (mg/L)	83.0	Alkalinity to pH 4.5 (mg CaCO ₃ /L)	8.5
Total Kjeldahl Nitrogen (mg/L)	<1.25	Biochemical Oxygen Demand (mg/L)	<4.0

Habitat Sampled

Slow/Shallow	1
Fast/Shallow	2
Slow/Deep	1
Fast/Deep	2

Macroinvertebrate Metrics

Total Taxa Richness	14
EPT Taxa Richness	4.00
Beck's Index	8
Shannon Diversity Index	2.31
Hilsenhoff Biotic Index	5.08
Percent Sensitive Individuals	28.6
Index of Biotic Integrity	43.3

Habitat Assessment Metrics

Embeddedness + Sediment Deposition	33
Condition of Banks + Vegetative Protection	33
Habitat Assessment Score (Overall)	202

Section VI. Discussion & Conclusion

Detailed results for each site (USGS discharge data, field data sheets, habitat assessment sheets, lab analysis results and macroinvertebrate scoring sheets) can be found in the Technical Appendix. Sites with IBI scores below the Aquatic Life Use attainment thresholds are discussed below.

(APPECR02) **Appenzell Creek 02:** 62.0
(MARSCR19) **Marshall's Creek 19:** 55.2
(LISACR21) **Little Sambo Creek 21:** 48.3
(POCOCR09) **Pocono Creek 09:** 46.7
(SASPRN01) **Sand Spring Run 01:** 43.3
(SASPRN02) **Sand Spring Run 02:** 41.7
(TUNKCR04) **Tunkhannock Creek 04:** 49.7
(UPTNCR01) **Upper Tunkhannock 01:** 30.8
(UPTNCR02) **Upper Tunkhannock 02:** 43.3
(KEIPRN02) **Keiper Run 02:** 34.5

Appenzell Creek 02 (HQ-CWF)

This is the second year in a row that APPECR02 has scored slightly below the HQ Aquatic Life Use attainment threshold. Of the 6 metrics used in the IBI analysis, 5/6 scored near ($\pm 2\%$) or above the ALU threshold. APPECR02 had a value of 49.7% for the Percent Sensitive Individuals metric due to a large number of *Chironomidae* sp. in the sample. This brought the average of the six metrics below the ALU threshold. Continued monitoring is necessary to determine if this is a result of site conditions at the time of sampling or if there has been a decline in the health of the aquatic community.

Marshall's Creek 19 (HQ-CWF)

The results for this reach came back with 141/207 individuals being of the *Ephemerella* genus. This resulted in a high value for Percent Sensitive Individuals, 93.7%, but the lack of diversity within the sample resulted in low values for the other 5 metrics. Habitat within this reach was limited to mostly large boulders and aquatic vegetation. The lack of diversity in habitat may have contributed to the lack of diversity in the macroinvertebrate community. The high percentage of pollution sensitive individuals indicates that overall water quality was not the reason for the low IBI value.

Little Sambo Creek 21 (CWF)

This reach scored low by all six metrics. There was minimal diversity in the sample, with approximately 64% of the 236 individuals being *Simulium* sp. (54 individuals) or *Chironomidae* sp. (97 individuals). Both of the dominant species have pollution tolerance scores of six, contributing to the Percent Sensitive Individuals score of 7.5%. Siltation was noted as an issue in this reach, with both Embeddedness and Sediment Deposition being scored as sub-optimal on the habitat assessment sheets. There was also a heavy presence of filamentous algae throughout this reach. These factors may have contributed to the low IBI score for this stream.

Pocono Creek 09 (HQ-CWF)

Similar to Little Sambo Creek, this reach scored low by all six metrics due to lack of species diversity and the presence of large quantities of pollution tolerant individuals. *Baetis sp.*, a genus of pollution tolerant mayflies, made up 39.1% of the sample. Due to historic channelization of the Pocono Creek between Rt. 80 and 611, this site has little connection to its floodplain. This results in a lack of diversity in flow regimes, with most of the habitat consisting of riffles with very few pools and runs. The lack of habitat diversity, entrenchment of the stream and other upstream factors may have contributed to the low IBI score of this reach.

Sand Spring Run 01 & Sand Spring Run 02 (HQ-CWF, Existing Use EV)

We began sampling these reaches in 2019 in order to evaluate the long-term efficacy of a restoration project occurring upstream. Construction has not yet begun, but is scoped to begin in January of 2022. The IBI scores for both sites have continued to score below the EV Aquatic Life Use attainment threshold, indicating potential impairment. These reaches have headwaters in largely undeveloped areas, limiting the number of potential sources for impairment. These two sites will continue to be monitored to determine if the upstream habitat restoration improves the health of the aquatic community.

Tunkhannock Creek 04 (HQ-CWF, Existing Use EV)

This reach is surrounded by a large tract undeveloped forest and wetlands, which may have actually contributed to the low IBI score in this reach. The biota of the forest and wetlands have created a high concentration of tannic acid in Tunkhannock Creek, leading to the “tea stained” water and low pH observed on site. The high concentration of tannic acid and subsequent low pH create a habitat that’s inhospitable for many macroinvertebrates. Another influence may have been that our sample period coincided with a hatch of *Simulium sp.*, which comprised 60.6% of our sampled individuals. The large number of *Simulium sp.* lowered the scores of the diversity metrics used in the analysis.

*The IBI score for this site was analyzed as riffle/run habitat by our consultant. A table with the low gradient scores used in this report can be found in the technical appendix.

Upper Tunkhannock 01 & 02 (HQ-CWF)

Both of these sites are located within narrow reaches between two large lake systems. The short distance between these lake systems may not have allowed enough time for the natural development of a stream channel & community. Only 76 individuals were found in the entire sample for UPTNCR01 and 49 in UPTNCR02. A minimum of 160 individuals are required to generate an accurate assessment. The metrics were still calculated, the results are considered unreliable. No determination can be made based on the data collected at these sites.

Keiper Run 02 (HQ-CWF)

The low score seen at this reach is due to a lack of diversity in the macroinvertebrate community combined with a heavy presence of both *Simulium sp.* (84/188 individuals) and *Chironomidae sp.* (57/188 individuals). This may be caused by the lack of diverse habitat within the reach. The reach is comprised almost entirely of riffles with few runs and almost no pools. The stream bed substrate was also classified as suboptimal for the amount of embeddedness and sediment deposition observed. Those two factors can impact colonization of the substrate due to the lack of interstitial space.

Highlights for 2021

The macroinvertebrate populations sampled at the following five sites were some of the most diverse and pollution sensitive communities found in the county. The scores came in well above the Aquatic Life Use attainment threshold.

(AQUACR19) **Aquashicola Creek 19**: 97.7

(BRODCR22) **Brodhead Creek 22**: 96.5

(BRODCR30) **Brodhead Creek 30**: 91.6

(BUSHCR07) **Bushkill Creek 07**: 95.6

(CHERCR06) **Cherry Creek 06**: 90.1

Recommendations

After reviewing the data from the 2021 Water Quality Study, the lead agencies recommend the following:

- Further analysis of the low-scoring sites listed above in our conclusions. If these sites continue to trend below the ALU attainment threshold, contact PA DEP's Water Quality Division.
- Addition of discharge measurements to compare year-to-year flow conditions during sampling.
- Continue to collect data at existing sites to further develop long-term trends of Monroe County's water quality. As part of this ongoing effort, results for the past six years of sampling at these sites can be found in Table 6 on the following page.

Table 6: IBI trends 2015 to 2021.

Site ID	IBI 2015	IBI 2016	IBI 2017	IBI 2018	IBI 2019	IBI 2020	IBI 2021
AQUACR19					74.2	78.3	97.6
BUCKCR01			73.5	62.5	76.1	81.9	65.2
POHOCCR01			88.5	86.2	93.8	88.9	77.8
POHOCCR29			83.8	74.0	75.9	92.8	85.4
MIDDCR04				72.4	86.6	93.8	83.0
JONACR01			81.6	77.6	89.5	79.6	86.6
APPECR02					92.6	62.0	62.0
MCMICR22			81.9	95.7	85.6	92.8	88.6
MCMICR37	93.6	76.2	78.6	52.1	78.5	78.6	65.4
CHERCR01				61.1	66.6	72.0	76.9
CHERCR06*	80.8	56.5	64.4	-	73.2	73.0	90.1
CHERCR06R*	67.2	73.6	68.7	-	72.0	67.6	85.7
BRODCR27			93.0	99.0	59.3	97.2	81.9
BRODCR27R						97.4	79.5
MILLCR03		83.2	97.0	80.4	89.5	90.0	80.2
BUHICR07	89.2	91.3	86.1	82.5	78.2	93.3	75.8
BRODCR22		74.1	87.1	84.6	87.5	95.0	96.5
PARACR08		85.2	82.5	86.5	85.9	95.4	83.6
BRODCR30						87.4	91.6
BRODCR31						70.4	70.3
BUTZRN01			76.0	70.9	82.8	75.7	84.4
BUSHCR07	86.7	95.3	88.6	91.0	89.8	81.4	95.6
MARSCR11	95.7	89.1	80.5	80.5	79.7	74.1	83.6
MARSCR18			76.0	70.9	80.8	92.9	63.5
MARSCR19					66.3	66.6	55.2
LISACR21							48.3
SAMBCR02						47.1	51.4
POCOCR09			80.2	72.4	55.7	90.4	46.7
POCOCR14	62.3	72.5	82.1	73.1	74.5	78.5	65.1
POCOCR01			75.9	80.7	78.2	76.4	80.7
SWIFCR10	75.8	83.2	90.6	48.2	77.5	90.3	78.5
INDIRN03				85.6	69.1	78.1	56.0
SASPRN01		50.8	-	-	56.8	48.8	43.3
SASPRN02					58.0	47.7	41.7
TOBYCR01	85.6	-	68.2	66.2	-	-	66.4
TOBYCR14	76.0	64.8	88.0	74.6	83.9	86.4	86.2
TUNKCR03	81.5	-	67.8	73.0	78.2	62.6	65.0
TUNKCR04							49.7
UPTNCR01							30.8
UPTNCR02							43.3
KEIPRN02						33.5	34.5

* IBI Scores from 2015 through 2017 assessed as Riffle Run, not as Low Gradient

Section VII. References

25 Pa. Code § 93.7. Specific water quality criteria.

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