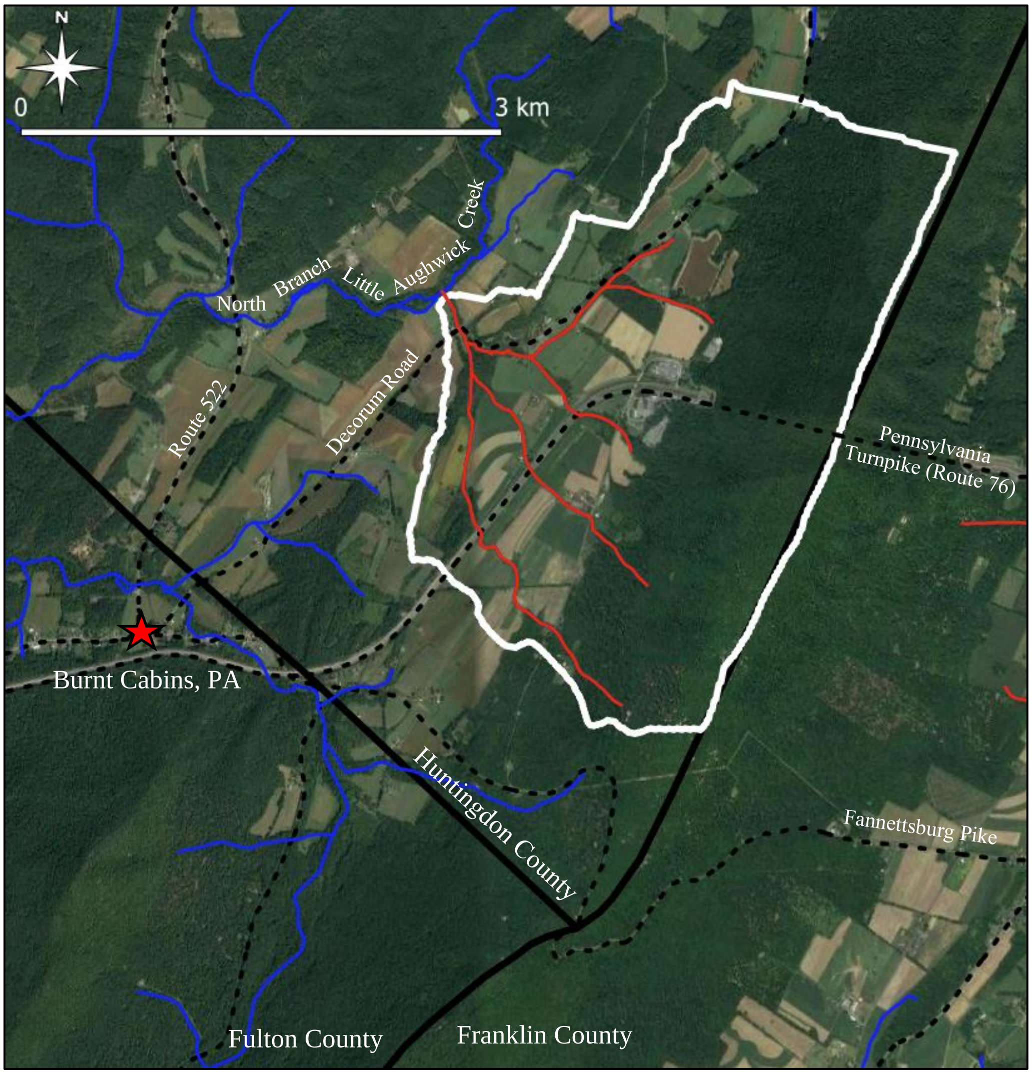
Water Quality Assessment Report

UNT North Branch Little Aughwick Creek

Huntingdon County, Pennsylvania



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Huntingdon County Conservation District

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Introduction

Purpose

In 2020, the Huntingdon County Conservation District (HCCD) partnered with the Chesapeake Conservancy to begin implementing the Conservancy's Rapid Stream De-listing Strategy in Huntingdon County, Pennsylvania. This conservation strategy aims to focus water quality improvement projects where they can yield the greatest environmental benefits for the cost of project implementation. Specifically, the Conservancy set the goal of working with its partners to de-list agriculturally impaired streams over the next 10-12 years. During the early planning stages of this partnership, the HCCD and the Conservancy identified an unnamed tributary (UNT) to the North Branch of Little Aughwick Creek as a priority watershed for this conservation strategy.

Therefore, in 2021 HCCD staff conducted a detailed water quality assessment of this watershed to collect current water quality data. The following report summarizes the methods, results, and conclusions for this 2021 assessment.

Watershed Description

This unnamed tributary (UNT) to the North Branch Little Aughwick Creek is a small watershed located in southeast Huntingdon County, Pennsylvania along the Huntingdon, Fulton, and Franklin County boundaries (Figure 1). In total, this watershed encompasses 3 square-miles (1,920 acres), approximately 14% of the entire 22 square-mile North Branch Little Aughwick Creek basin. In its entirety, this basin contains 5.1 miles of streams, including 4.7 miles of first order streams and 0.4 miles of second order streams. Approximately 61% of this drainage area is forested, 28% is in agriculture (including cropland, pasture, and hay), and 11% is developed space (Stroud Water Research Center 2017).

According to the Pennsylvania Department of Environmental Protection (PADEP), all 5.1 miles of this UNT North Branch Little Aughwick Creek have a High-Quality, Coldwater Fishery (HQ-CWF) designated use. A designated use is determined by Title 25 PA Code, Chapter 93 Water Quality Standards and are used to determine regulations and protection standards for a specific body of water. A HQ-CWF waterway is described as having "surface water quality that exceeds levels necessary to support the maintenance or propagation of coldwater species", including trout. Streams and rivers designated as HQ-CWF receive the second highest level of protections as they are often considered to be some of the healthiest and cleanest waters in Pennsylvania. Only an Exceptional-Value, Cold Water Fishery (EV-CWF) designated use receives higher levels of protection restrictions (Title 25 PA Code Chapter 93).

In addition, PADEP also assigns an "attaining" (healthy) listing to bodies of water if their respective designated use water quality standards are observed. If a waterway fails to meet one or more of these standards, the water may be listed as an "impaired" (unhealthy) waterway (Clean Water Act Section 303d). In 1998, PADEP staff assessed this watershed for Aquatic Life and determined that all 5.1 miles of stream are impaired due to unnatural levels of sedimentation and nutrients likely resulting from crop production (PADEP 2020).

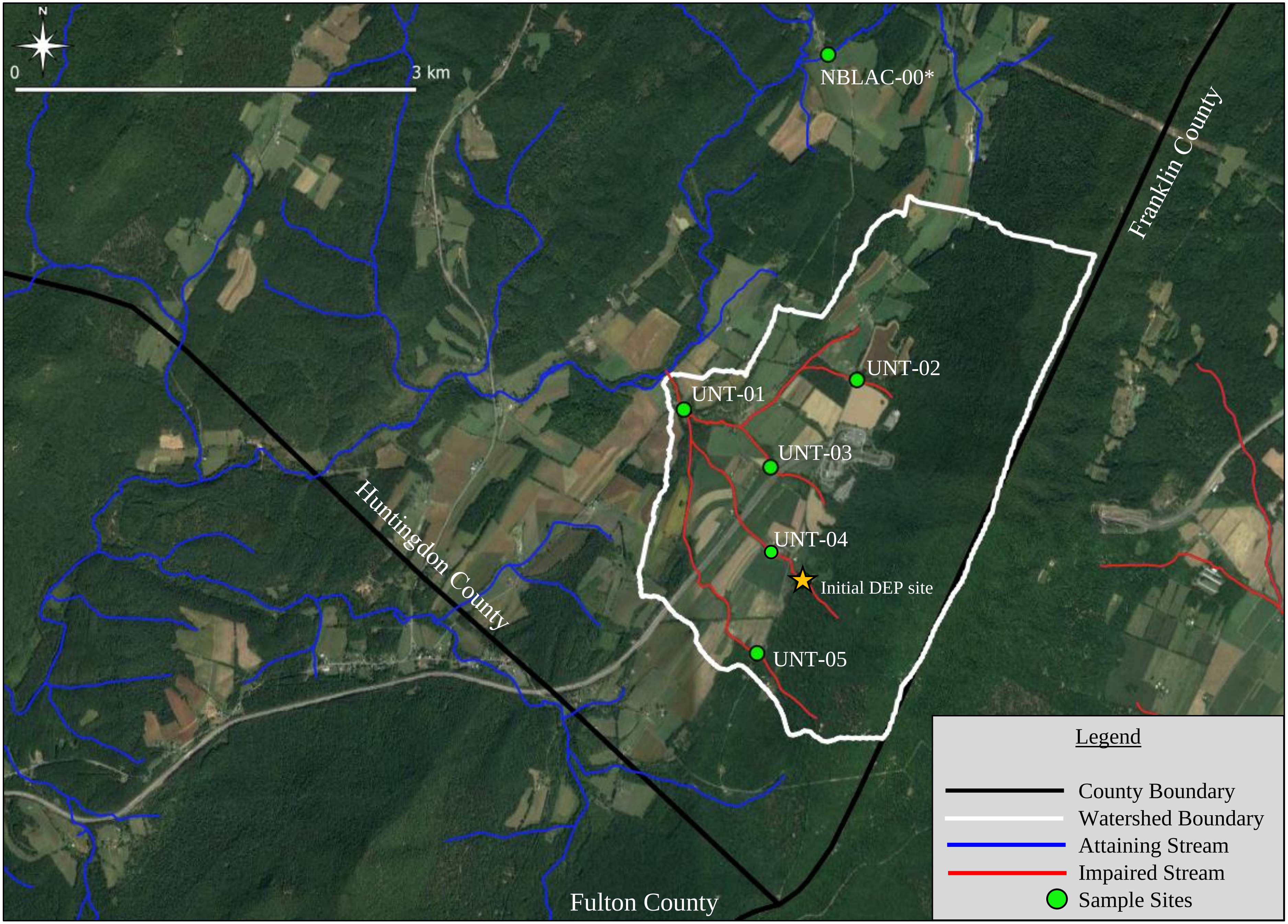

Figure 1. Map of 2021 sample sites in the UNT North Branch Little Aughwick Creek watershed.

Methods

Study Sites

To accurately provide a snapshot analysis of the entire watershed's current health, a total of five sites were selected throughout the UNT North Branch Standing Stone Creek watershed (Figure 1). Specifically, the 2021 study sites were the same sites sampled by PADEP in 2012 (Table 1). However, one study site (site UNT-04) had to be moved downstream approximately 1,000 feet from PADEP's 2012 assessment site due to low flow conditions and access restrictions upstream of Locke Road. In addition to the five sample sites within the UNT watershed, a reference site was selected on the main stem of the North Branch Little Aughwick Creek for comparison. This reference site was also sampled by PADEP back in 2012. Water chemistry, physical habitat, and benthic macroinvertebrates were all measured at each study site. An upstream and downstream facing photo at each study site is available in Appendix I.

Table 1. Summary of 2021 sample sites. *Indicates upstream reference site.

Stream Name	DEP Code	HCCD Code	Site ID	Latitude	Longitude
UNT North Branch Little Aughwick Creek	20120412-0945-jeremmille	20210407-0945-LRS	UNT-01	40.094800	-77.872323
UNT North Branch Little Aughwick Creek	20120412-1000-jeremmille	20210407-1115-LRS	UNT-02	40.096501	-77.857046
UNT North Branch Little Aughwick Creek	20120411-1300-jeremmille	20210407-1215-LRS	UNT-03	40.091620	-77.865144
UNT North Branch Little Aughwick Creek	20120411-1245-jeremmille	20210407-1430-LRS	UNT-04	40.084962	-77.864443
UNT North Branch Little Aughwick Creek	20120411-1230-jeremmille	20210407-1315-LRS	UNT-05	40.078279	-77.866238
North Branch Little Aughwick Creek	20120412-1130-jeremmille	20210407-1530-LRS	NBLAC-00*	40.118195	-77.859549

Water Chemistry

Comprehensive water chemistry measurements were taken with a Yellow Springs Instrument (YSI) Professional Series Pro2030 meter for temperature (C°), dissolved oxygen (mg/L), and specific conductance (uS/cm), and a YSI Ecosense pH100 meter for pH (standard units). Meter calibration and data collection was completed in accordance with PADEP protocols described in Shull and Lookenbill (2018).

While this method of measuring chemical parameters at a single point in time, known as "in-situ" collection, provides valuable insight towards water quality, our interpretation of these results is limited. Chemical parameters, especially temperature and dissolved oxygen, can be highly variable and influenced by factors such as time of collection, season, flow, and more.

Therefore, our results provide a short-term "snapshot" of the watershed's chemical parameters rather than a long-term analysis. To draw more detailed conclusions from water chemistry, continuous water chemistry data would need be collected either through regular monitoring activities or the installation of permanent data loggers.

Physical Habitat

A physical habitat assessment was completed at each sample site in accordance with PADEP protocols for high gradient, riffle-run, wadable streams (Shull and Lookenbill 2018). This process involves ranking 12 parameters over a 100-meter reach that represent potential limitations to the quality and quantity of instream habitat. The observer classifies each parameter as optimal, suboptimal, marginal, and poor by assigning each parameter a value ranging from 1-20. Parameters evaluated include instream cover, epifaunal substrate, embeddedness, velocity/depth regimes, channel alterations, sediment deposition, frequency of riffles, channel flow status, condition of banks, bank vegetative protection, grazing or other disruptive pressure, and riparian vegetative zone width (Appendix I). After all parameters are evaluated, the scores are combined to calculate a Total Habitat Score and rated as follows: optimal (240-181); suboptimal (180-121); marginal (120-61); and poor (60-0).

To further assess the quality of a stream's physical habitat, scores are compared to multiple PADEP impairment thresholds (Shull and Pulket 2018). The first impairment threshold for high gradient, riffle-run, wadable streams includes a Total Habitat Score ≤ 140. In addition, certain habitat parameters are exceptionally strong indicators of habitat degradation. Therefore, two additional impairment thresholds for 1) Embeddedness + Sediment Deposition and 2) Condition of Banks + Bank Vegetative Protection were calculated and compared across all sample sites. The impairment threshold for either parameter combination is a total score of ≤ 24.

Benthic Macroinvertebrate Sample Collection

Benthic macroinvertebrates are small, aquatic organisms such as aquatic insects (mayflies, stoneflies, "hellgrammites", etc.), crayfish, snails, mussels, and more that inhabit the stream bottom. Different species of benthic macroinvertebrates are sensitive to different levels of pollution, making them excellent bioindicators of stream health. By examining a stream's benthic macroinvertebrate community to determine the abundance of "pollution-intolerant" (healthy) and "pollution-tolerant" (unhealthy) species, biologists can accurately assess water quality.

Benthic macroinvertebrate samples were collected at each sample site following PADEP methodology for wadeable, freestone, riffle-run streams (Shull and Lookenbill 2018). Collection begins by delineating a 100-meter reach along the stream of interest. A six-kick composite sample is collected from the reach using a 12-inch wide x 10-inch high D-frame net with 500-micron mesh. For each kick, the collector places the net against the stream bottom and disturbs a one square meter area immediately upstream of the net for approximately one minute. The collector attempts to distribute the kicks among a variety of riffle habitats (e.g., slow-flowing, shallow riffles and fast-flowing, deeper riffles). Kicks were also conducted throughout the width of the stream to include the left, middle, and right areas. This is done to ensure the composited sample provides an accurate representation of the macroinvertebrate community throughout the stream reach.

The composited sample is placed into a jar and preserved with 95% ethanol. Jars are labelled inside and outside with the date, time, collector, and location. Upon completion of the six collection kicks, the net is thoroughly examined for any attached organisms, which are added back into the sample jar. The net is then rinsed to prevent contamination at succeeding sample sites.

Photo 1. HCCD Watershed Specialist collecting a benthic macroinvertebrate sample.

Benthic Macroinvertebrate Subsampling

In the laboratory, benthic macroinvertebrate samples were sorted and processed following PADEP methodology for macroinvertebrate samples collected from freestone streams (Shull and Lookenbill 2018). Prior to subsampling, the composited sample is removed from the collection container and placed in a 500-micron sieve. The sample is gently rinsed under running water to remove ethanol and minimize damage to the macroinvertebrates. The sample is then placed in an 18-inch x 12-inch x 3½-inch pan, marked off into (28) 2-inch x 2-inch grids. Water is added to the pan before sample placement to ensure the macroinvertebrates are evenly distributed throughout the pan, and to prevent the contents of the sample from drying out during the subsampling process. Once the contents of the sample are placed in the pan, four 2-inch x 2-inch grids are randomly selected.

The materials and organisms from the selected grids are removed from within four-square inch circular “cookie cutters” placed in the randomly selected grids and removed using spoons, turkey basters, tweezers, and other implements as needed. The extracted contents are then placed into a second pan with water. Identifiable organisms are then picked and counted from the second pan.

If less than 180 identifiable organisms are picked from the second pan, an additional grid is randomly selected and extracted from the first pan. The materials and organisms from this additional grid are moved to the second pan, and the organisms are picked. This process goes on until a subsample target number of 200 ± 20 organisms is reached.

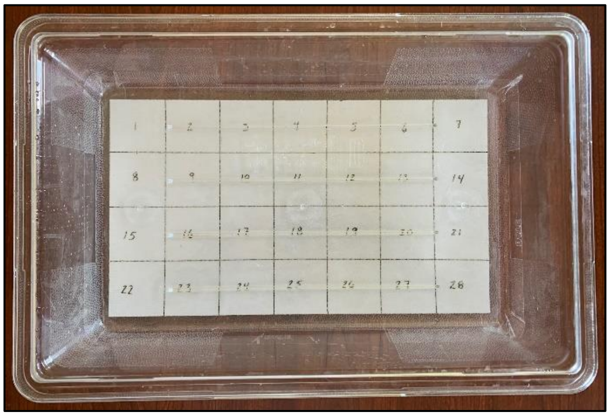

Photo 2. Example of gridded subsampling pan.

Photo 3. Subsampling pan with sample contents and one "cookie cutter" grid selected.

If more than 220 identifiable organisms are picked from the initial four grids, then those organisms are all placed and evenly distributed into another pan with the same dimensions and gridding as the first pan. A grid is then randomly selected, and the organisms are picked from the selected grid. This process continues until the subsample target number of 200 ± 20 organisms is reached.

Photos 4-6. Contents of the subsampling grid are removed using spoons, turkey basters, etc.

Each grid selected during the subsampling process is picked in its entirety. The total number of grids selected from each pan and the count of organisms picked from each grid is recorded. Once the subsampling is complete and the target number of organisms is achieved, all organisms are placed in a clean, 125mL container with 70% - 80% ethanol. The container is labelled both inside and outside with date, time, collector, and location. The container is then stored for later identification.

Benthic Macroinvertebrate Identification

The HCCD Watershed Specialist served as the macroinvertebrate taxonomist for this study and is certified by the Society for Freshwater Science (SFS) for those tests that covered the identifications performed (Ephemeroptera, Plecoptera, & Trichoptera East and General Arthropods East). To begin identification, organisms are removed from the subsample vial and placed under a microscope for identification and enumeration. All macroinvertebrates are identified to the genus level, except for those taxonomic groups listed in Table 2. Once identification is complete, all organisms are returned to the labelled vial with 70% - 80% ethanol.

Table 2. Taxonomic groups that are identified to a higher taxonomic level than genus (Shull and Lookenbill 2018).

Taxonomic Group	Identification Level
Midges	Family
Snails	Family
Mussels & Clams	Family
Aquatic Earthworms & Tubificid Worms	Class (Oligochaeta)
Leeches	Class (Hirudinea)
Flatworms	Phylum (Turbellaria)
Proboscis Worms	Phylum (Nemertea)
Roundworms	Phylum (Nematoda)
Moss Animalcules	Phylum (Bryozoa)
Water Mites	Hydracarina (artificial grouping of several water mite superfamilies)

Index of Biological Integrity Metric Calculation

The index of biological integrity (IBI) is a method used to quantify stream health through benthic macroinvertebrates. By examining the diversity and abundance of the different benthic macroinvertebrates present in a stream community, we can calculate multiple metrics that exhibit a strong ability to discern between streams considered relatively pristine and heavily degraded (Shull and Pulket 2018). The following six metric calculations were included in the IBI analysis for each sampling site: Total Taxa Richness, Ephemeroptera + Trichoptera + Plecoptera (EPT) Richness (Pollution Tolerance Values 0-4 only), Becks Index (version 3), Shannon Diversity, Hilsenhoff Biotic Index, and Percent Sensitive Individuals (Pollution Tolerance Values 0-3 only). To compare biological conditions between each sample site, each metric is standardized to a value of 0-100. Higher scores are associated with unimpacted, “natural” environments, while lower scores are associated with anthropogenically degraded environments. The six standardized metrics are then averaged to produce a final total IBI score. A description of each metric and standardization process is given in detail by Shull and Pulket (2018).

Results and Discussion

Water Chemistry

In total, four water chemistry parameters were measured at each sample site, including temperature, dissolved oxygen (DO), pH, and specific conductance (SPC) (Table 3).

Table 3. Summary of 2021 water chemistry measurements

UNT North Branch Little Aughwick Creek - Spring 2021 Water Chemistry Results						
Sample Site	UNT-01	UNT-02	UNT-03	UNT-04	UNT-05	NBLAC-00*
Date	4/7/2021	4/7/2021	4/7/2021	4/7/2021	4/7/2021	4/7/2021
Temperature (C°)	11.1	13.4	13.4	15.8	15.3	16.2
DO (mg/L)	12.25	10.64	10.53	9.79	9.14	10.32
pH	8.35	8.02	7.85	7.45	6.62	8.59
SPC (uS/cm)	455	165.4	638	60.0	35.6	138.1

According to Title 25 PA Code Chapter 93, all six study sites recorded temperatures above the 8.9 C° maximum standard for coldwater stream measured between April 1-15. However, pH levels were all recorded within Chapter 93's criteria of 6.0 to 9.0. Chapter 93 does not list criteria for in-situ dissolved oxygen measurements but instead requires a 7-day continuous average.

In addition, Chapter 93 does not list specific water quality criteria for specific conductivity. Since specific conductivity is a measure of dissolved ions such as metals, salts, and other conductive materials, it can be greatly influenced by elevation and geology, and therefore difficult to set "normal" thresholds. Typically, headwater streams tend to have lower conductivity values that gradually increase as surface water flows downstream and begins accumulating more conductive materials from the surrounding landscape. In addition, streams receiving water that flows through limestone geology tend to have higher concentrations of dissolved calcium carbonate ($CaCO3$), and thus have naturally higher conductivity values than normal freestone streams. However, conductivity can also be greatly impacted by human activity, and streams receiving abandoned mine, urban stormwater, or agricultural runoff tend to have unnaturally high conductivity measurements due to increased levels of dissolved heavy metals, road salt, nitrates, phosphates, and more.

Given their position in the watershed, both sample sites UNT-04 and UNT-05 appear to have relatively "normal" SPC measurements for first order headwater streams. However, sample sites UNT-01, UNT-02, and UNT-03 all appear to have unusually higher specific conductivity readings. These values are concerning and may be indicative that UNT North Branch Little Aughwick Creek is being actively impacted by some level of human disturbance. While no abandoned mines are in this area, the surrounding landscape was observed to be in active agriculture (pasture, hay, and cropland) and development (the Pennsylvania Turnpike runs directly through the watershed). Therefore, while we cannot determine a conclusive source of disturbance, it is likely that the surrounding activities have some degree of impact on the water quality in these sections of stream, and ultimately the North Branch Little Aughwick Creek.

Physical Habitat

Twelve habitat parameters were assessed and combined to determine a total habitat score for each sample site (Table 4). During this assessment, five sites received scores in the suboptimal range (180-121) while only one site scored in the marginal range (120-61). However, it should be noted that the five suboptimal sites scored on lower end of the suboptimal range and are probably on the line of being either marginal or suboptimal. Overall, only sites UNT-03 and UNT-04 scored below PADEP's total habitat impairment threshold of less than 140. Habitat parameters appear to be relatively similar to those reported by DEP in 2012, with the exception of site UNT-04. This is likely due to the fact that the 2021 assessment was completed approximately 1,000 feet downstream of DEP's 2012 site due to low flow conditions and access restrictions upstream of Locke Road.

Table 4. Comparison of 2012 and 2021 physical habitat assessment results.

UNT North Branch Little Aughwick Creek - 2012 and 2021 Habitat Assessment Results						
Red text indicates habitat scores from 2012 PADEP surveys.						
Sample Site	UNT-01	UNT-02	UNT-03	UNT-04	UNT-05	NBLAC-00*
Instream Cover	10	8	11	3	6	14
Epifaunal Substrate	16, 13	16, 17	16, 13	16, 5	15, 13	14
Embeddedness	15, 10	15, 8	15, 8	13, 5	11, 7	14
Velocity/Depth Regimes	13, 11	10, 8	10, 7	10, 4	11, 7	18
Channel Alteration	12, 14	11, 17	11, 13	16, 11	16, 13	16
Sediment Deposition	15, 12	15, 9	11, 8	16, 5	13, 6	10
Riffle Frequency	16, 16	16, 17	14, 18	16, 4	16, 17	15
Channel Flow Status	16, 16	16, 8	16, 11	14, 11	16, 12	16
Condition of Banks	11, 11	15, 17	9, 9	15, 13	10, 10	7
Bank Vegetative Protection	16, 13	18, 15	16, 15	18, 2	18, 11	9
Grasing or Other Disruptive Pressure	5, 11	18, 15	5, 12	18, 13	6, 14	7
Riparian Vegetative Zone	5, 7	12, 15	5, 7	16, 3	10, 8	7
Total Habitat Score	**154, 144**	**173, 154**	**138, 132**	**179, 79**	**152, 147**	**147**

In addition, further analyses show that all six sites received scores below the impairment threshold (≤ 24) for Embeddedness + Sediment Deposition, and five sites scored below the impairment threshold (≤ 24) for Condition of Banks + Bank Vegetative Protection (Table 5). In 2012, only one site scored below the impairment threshold for Embeddedness + Sediment Deposition, and no sites scored below the impairment threshold for Condition of Banks + Bank Vegetative Protection.

Table 5. Comparison of 2012 and 2021 physical habitat impairment results.

UNT North Branch Little Aughwick Creek - 2012 and 2021 Physical Habitat Impairment Results						
Red text indicates habitat impairment scores from 2012 PADEP surveys.						
Sample Site	UNT-01	UNT-02	UNT-03	UNT-04	UNT-05	NBLAC-00*
Embeddedness + Sediment Deposition	30, 22	30, 17	26, 22	29, 10	24, 13	24
Condition of Banks + Bank Vegetative Protection	27, 24	33, 32	25, 24	33, 15	28, 21	16

Benthic Macroinvertebrate Analysis

To develop an inventory of the benthic macroinvertebrates identified and recorded in the UNT North Branch Little Aughwick Creek watershed, the 2021 taxonomic data was combined with PADEP's 2012 taxonomic data in Appendix III. In total, 55 distinct taxa were identified across the 6 sites during the HCCD's spring 2021 assessment, including 18 new taxa that were not identified in 2012. However, an additional 18 taxa were identified by PADEP in 2012 that were not identified in 2021 (Appendix III). The presence and absence of certain taxa between 2012 and 2021 could be attributed to recent taxonomic changes published in Merritt et al. 2019. Benthic macroinvertebrate samples have yet to be submitted to PADEP for quality assurance.

A summary of index of biological integrity (IBI) metrics for each study site is provided in Table 6. In Pennsylvania, PADEP utilizes IBI assessments to determine whether a stream is "attaining" (meets water quality standards) or "impaired" (fails to meet water quality standards). For HQ-CWF streams, the PADEP impairment threshold is an IBI score less than 63 for samples collected between November-May (Shull and Pulket 2018). In both 2012 and 2021, five sites scored below this impairment threshold, while only one site (UNT-02) scored above this threshold in both 2012 and 2021. Both the 2012 and 2021 assessments followed freestone collection methods.

Table 6. Comparison of 2012 and 2021 index of biological integrity metrics.

UNT North Branch Little Aughwick Creek - 2012 and 2021 IBI Results						
Red text indicates IBI metrics from 2012 PADEP surveys.						
Sample Site	UNT-01	UNT-02	UNT-03	UNT-04	UNT-05	NBLAC-00*
Total Taxa Richness	10, 16	22, 29	17, 23	12, 19	11, 13	27
EPT Richness	3, 8	13, 14	3, 6	7, 10	6, 6	9
Beck's Index	2, 11	22, 28	6, 6	9, 13	11, 10	8
Hilsenhoff-Biotic Index	4.37, 4.15	2.63, 3.02	3.78, 4.24	3.04, 4.59	1.85, 3.45	4.40
Shannon Diversity	1.42, 1.81	2.46, 2.71	1.54, 2.12	1.68, 1.64	1.55, 1.91	2.38
% Sensitive Individuals	19.7	68.0	29.4	13.1	57.1	26.6
Total IBI Score	**32.0, 46.4**	**75.4, 82.7**	**47.3, 49.4**	**51.2, 47.3**	**58.0, 51.9**	**59.2, 55.6**

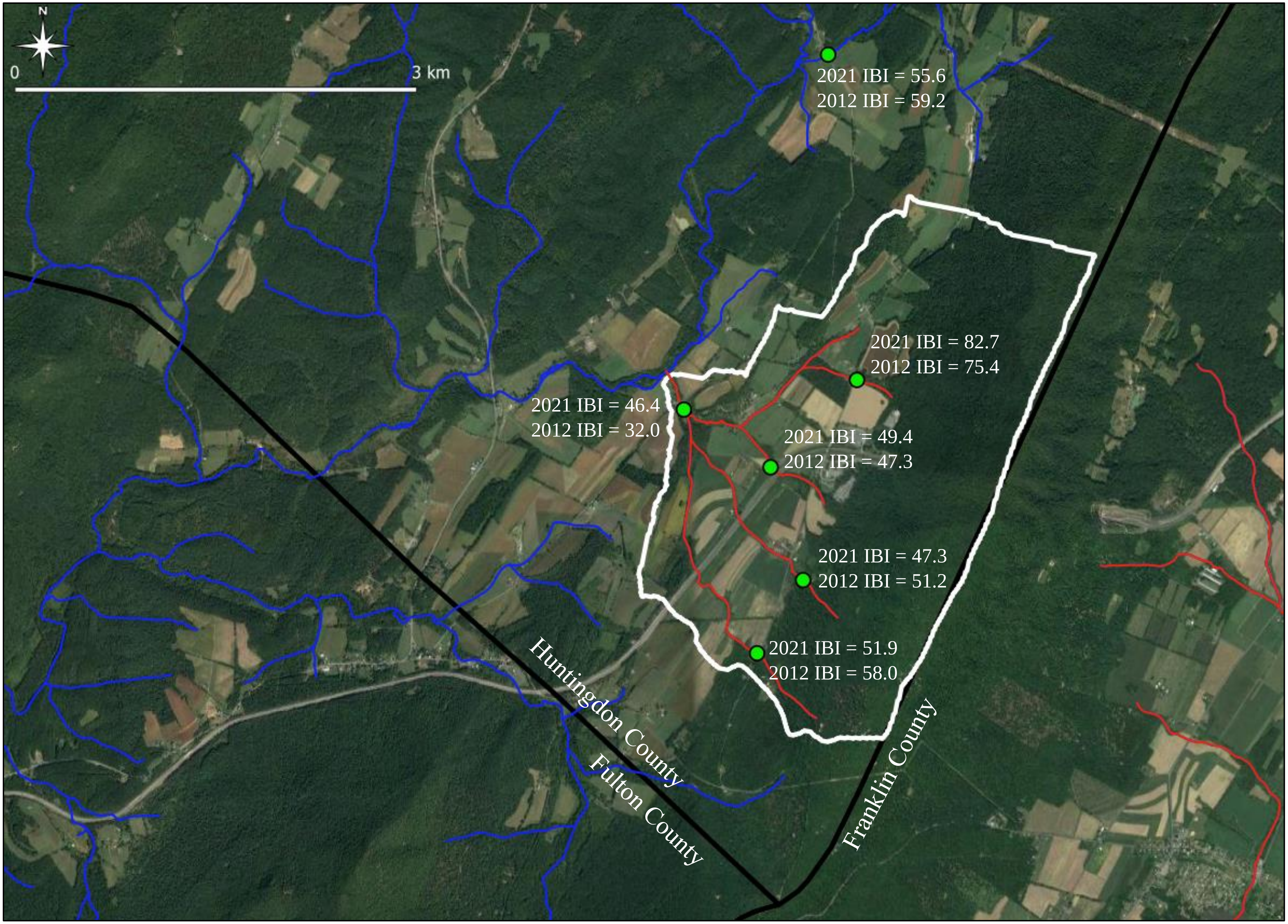

Figure 2. Map of sample sites with corresponding IBI metric scores.

Conclusions

In April 2021, five sites on an impaired unnamed tributary (UNT) to North Branch Little Aughwick Creek in southeast Huntingdon County, Pennsylvania, were sampled for water chemistry, physical habitat, and benthic macroinvertebrates by the HCCD for comparison to similar assessments conducted by PADEP in 2012.

Temperature and specific conductance appear to be the most concerning chemical parameters across this watershed. Water temperatures across all six sample sites exceeded Title 25 PA Code Chapter 93 specific water quality criteria for coldwater streams for measurements taken between April 1-15. In addition, multiple sites recorded unnaturally high specific conductance measurements which can likely be attributed to localized anthropogenic disturbance.

Habitat parameters remained relatively consistent between sample sites assessed in both 2012 and 2021, with only slight decreases observed in 2021. Only sample site UNT-04 recorded a significant decrease in score, but this is likely due to the fact that the 2021 assessment was completed approximately 1,000 feet downstream of DEP's 2012 site due to low flow conditions and access restrictions upstream of Locke Road.

There was a noticeable lack in abundance of pollution-intolerant taxa, such as mayflies, stoneflies, and caddisflies, and a noticeable abundance of "pollution-tolerant" taxa, such as midges and beetles, across all six study site macroinvertebrate samples in both 2012 and 2021. IBI metrics appear to be relatively consistent between 2012 and 2021 with only slight increases or decreases observed at each site.

The results of this study support the evidence that in order to de-list this stream as a 303(d) impaired waterbody there needs to be an emphasis on better conservation practices in this watershed. To achieve the goal of de-listing, the HCCD and Chesapeake Conservancy intend to work with local landowners and partner organizations to design, fund, and implement Best Management Practices (BMPs). BMPs include many different methods landowners can use to manage their land while reducing pollution and conserving natural resources. Specifically, the HCCD and Chesapeake Conservancy will aim to implement BMPs associated with improving water quality. Some popular examples of stream BMPs include cover cropping, installing fence to exclude livestock from a stream, constructing in-stream erosion control and fish habitat structures, and planting riparian forest buffers. Both the HCCD and the Conservancy have implemented such strategies in several watersheds throughout Huntingdon County which has improved water quality in those areas. Typically, these projects incorporate multiple BMPs to ensure the stream receives the best environmental improvements possible. It is expected that the implementation of such projects would likely bring the IBI scores closer to an attaining value of $\geq$63 and this partnership's overarching goal of de-listing this stream as an impaired waterbody.

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Appendix I: 2021 Sample Site Photos

<u>UNT North Branch Little Aughwick Creek:</u> **Site UNT-01**

<u>UNT North Branch Little Aughwick Creek:</u> **Site UNT-02**

Appendix I cont.

UNT North Branch Little Aughwick Creek: **Site UNT-03**

UNT North Branch Little Aughwick Creek: **Site UNT-04**

Appendix I cont.

UNT North Branch Little Aughwick Creek: **Site UNT-05**

North Branch Little Aughwick Creek: **Site NBLAC-00* (upstream reference)**

Appendix II: Habitat evaluation form (Shull and Lookenbill 2018)

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

Appendix II cont.

Parameter	Optimal	Suboptimal	Marginal	Poor
7. Riffle Frequency	Occurrence of riffles relatively frequent;; distance between riffles divided by the width of the stream equals 5 to 7; variety of habitat.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream equals 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is >25.
_______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Channel Flow Status	Water reaches base of both lower banks and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
_______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach have areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; on side slopes, 60-100% of bank has erosional scars.
_______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the stream bank surfaces covered by vegetation.	70-90% of the stream bank surfaces covered by vegetation.	50-70% of the stream bank surfaces covered by vegetation.	Less than 50% of the stream bank surfaces covered by vegetation.
_______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetative disruption through grazing or mowing is minimal or not evident; almost all plants allowed to grow naturally.	Disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of stream bank vegetation is very high; vegetation has been removed to 2 inches or less in average stubble height.
_______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone	Width or riparian zone >18 meters; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
_______	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

TOTAL ______

Appendix III: Benthic Macroinvertebrate Inventory

UNT North Branch Little Aughwick Creek - Spring 2012 and 2021 Benthic Macroinvertebrate Comparison									
Red text indicates macroinvertebrate counts from 2012 PADEP surveys.									
Taxa				Sample Sites					
Order	**Family**	**Genus**	**PTV**	**UNT-01**	**UNT-02**	**UNT-03**	**UNT-04**	**UNT-05**	**NBLAC-00***
Ephemeroptera (Mayflies)	Ameletidae	Ameletus	0				14, 1	11, 25	1
	Baetidae	Acentrella	4				1		2
		Baetis	6		9	1			1
		Diphetor	6		22, 15				
		Plauditus	4						1
	Ephemerellidae	Dannella	3	1					
		Ephemerella	1	21, 26	40, 14	3	1	115, 4	34, 12
		Eurylophella	4		1		2		
		Serratella	2						1
		Teleganopsis	2						10
	Heptageniidae	Leucrocuta	1		5				
		Maccaffertium	3		4				6
		Stenonema	4		2				2
	Isonychiidae	Isonychia	3						5
	Leptophlebiidae	Habrophlebia	4		20				
		Paraleptophlebia	1		9, 25		1	20	
Plecoptera (Stoneflies)	Capniidae	Allocapnia	3					1	
	Chloroperlidae	Haploperla	0		5, 3				
	Nemouridae	Amphinemura	3	12, 7	47, 54	127, 43	1	4, 3	2, 14
	Leuctridae	Leuctra	0		19, 1		40, 1	4	2
	Peltoperlidae	Peltoperla	2		3				
	Perlidae	Acroneuria	0			1			
		Eccoptura	2		1, 2				
	Perlodidae	Isoperla	2		1, 3	1	28, 15	49, 52	3
Tricoptera (Caddisflies)	Glossosomatidae	Agapetus	0	1	4				
	Hydropsychidae		5			4			
	Hydropsychidae	Ceratopsyche	5			3			2
		Diplectrona	0		8, 12	4			
		Hydropsyche	5	16		8, 3			1, 18
		Cheumatopsyche	6	1, 10		4, 18			3, 6
	Limnephilidae	Frenesia	4				63		
		Ironoquia	3				1		
		Pycnopsyche	4	1			3		1
	Philopotamidae	Chimarra	4	5		7			4, 9
		Wormaldia	0	1	2				
	Polycentropidae	Ploycentropus	6						1
	Rhyacophilidae	Rhyacophila	1	1	3, 5	4	6	10	
	Thremmatidae	Neophylax	3	1	2	4	2, 1		2, 5

*PTV = Pollution Tolerance Value. This value is assigned to individual organisms based on their tolerance to pollution levels. Scores range from 0-10 with lower scores associated with "pollution-intolerant" taxa, while higher scores are associated with "pollution-tolerant" taxa.

Appendix III cont.

UNT North Branch Little Aughwick Creek - Spring 2012 and 2021 Benthic Macroinvertebrate Comparison									
Red text indicates macroinvertebrate counts from 2012 PADEP surveys.									
Taxa				**Sample Sites**					
Order	**Family**	**Genus**	**PTV**	**UNT-01**	**UNT-02**	**UNT-03**	**UNT-04**	**UNT-05**	**NBLAC-00***
Coleoptera (Beetles)	Dryopidae	Helichus	5						1
	Dytiscidae	Agabus	5		1	1	2		
	Elmidae	Dubiraphia	6	1, 1		7			1, 1
		Optioservus	4	90, 79	1, 6	39, 76	26	1	65, 38
		Oulimnius	5		5				
		Stenelmis	5			1			3
	Psephenidae	Ectopria	5		3, 6	2			
		Psephenus	4						1
	Ptilodactylidae	Anchytarsus	5	1, 1		1		3	
Diptera (Flies)	Athericidae	Atherix	2						4
	Ceratopogonidae	Bezzia	6		4	1			
		Ceratopogon	6		5				
		Probezzia	6				2, 1		2
	Chironomidae		6	69, 44	3, 15	25, 40	62, 89	10, 19	57, 65
	Dixidae	Dixa	1		2, 2				
	Empididae	Clinocera	6			1			1
		Hemerodromia	6			1			2, 1
	Limoniidae	Antocha	3	4		2			3, 3
		Hexatoma	2		1				2
		Limnophila	3		1				
		Pilaria	7		1		2		
		Pseudolimnophila	2		2		1	1	2
	Pediciidae	Dicranota	3			1			
	Simuliidae	Prosimulium	2	2	6	12	5	9	1
		Simulium	6	7, 2	1	2, 2	1	1, 52	2, 1
	Stratiomyidae	Stratiomys	5			1			
	Tabanidae	Chrysops	7		3	3, 1			
	Tipulidae	Tipula	4			1, 1	1, 1	2	1
Megaloptera (Donsonflies/Fishflies)	Corydalidae	Nigronia	2						4
Hemiptera (True Bugs)	Veliidae	Microvelia	9						1
Odonata (Dragonflies/Damselflies)	Gomphidae	Lanthus	5						1
		Stylogomphus	4						1
Decapoda (Crayfish)	Cambaridae	Cambarus	6		4		1, 1	2	
Gastropoda (Snails/Clams/Mussels)	Physidae		8			1			
Oligochaeta (Aquatic Earthworm)			10		1	1		9, 4	

*PTV = Pollution Tolerance Value. This value is assigned to individual organisms based on their tolerance to pollution levels. Scores range from 0-10 with lower scores associated with "pollution-intolerant" taxa, while higher scores are associated with "pollution-tolerant" taxa.