Dauphin County Streams:
A Health Report

Prepared by:
The Dauphin County Conservation District 2019

Dauphin County Conservation District

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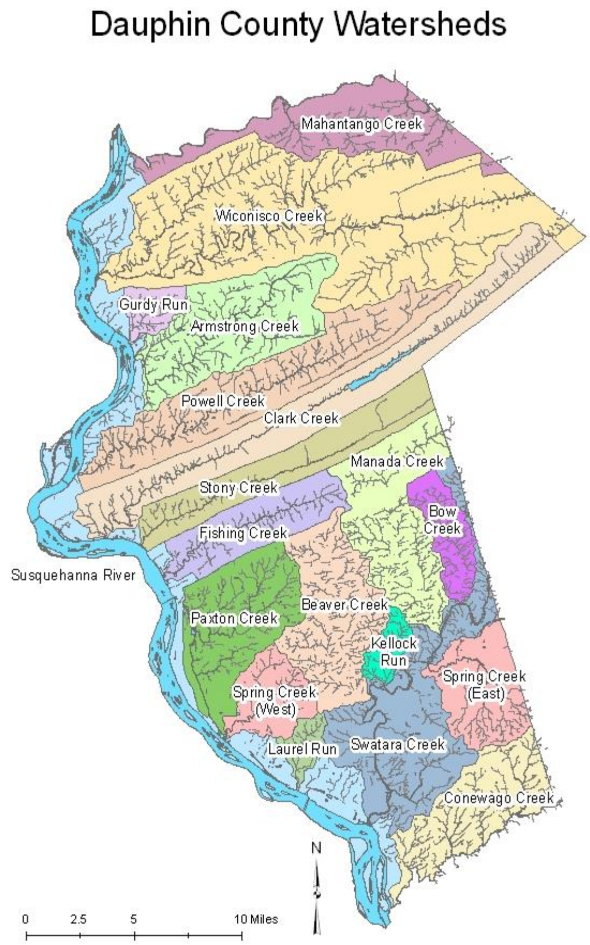
1.0 PURPOSE:

The purpose of the Countywide Stream Assessment Program (CSAP) of the Dauphin County Conservation District (DCCD) is to collect data to determine the present condition of Dauphin County's streams. The CSAP will document and measure changes in stream conditions occurring over time. In addition, CSAP will provide an evaluation of the factors affecting stream condition in order to protect, maintain, and restore streams to meet designated uses. The results of this 5 year study will be used to present water quality issues to the public to promote and support initiatives that increase direct participation in stream stewardship and the reduction of water pollution. The study will also focus DCCD programs and prioritize the most critical stream protection needs in the County's watersheds. To improve public education, this document contains information regarding the character of the County's watersheds and issues found within them. Data has been collected for the CSAP every year since 2004. This report focuses on data collected from 2014 to 2018. Upon completion, the results were reviewed and made understandable and accessible for all interested groups and individuals. Yearly assessments are continuing to note changes that are occurring.



2.0 SOURCES OF DEGRADATION:

When considering causes of degradation in specific local waterways, we must look at the possible sources of stream degradation within each individual watershed. Degradation can be attributed to a variety of factors. These factors can be categorized into two groups; stream degradation due to changes in hydrology and delivery of pollutants to the stream.

2.1 CHANGES IN STREAM HYDROLOGY

Increased Discharge - Under natural conditions, streams reach an equilibrium with the watershed in which they are located. That is, the depth and width of the stream adjust to the flow patterns within the watershed and remain fairly stable. When the natural conditions (i.e., forest) of the watershed are changed, the stream will change in response. As land use is altered from forest to farmland to developed conditions (i.e. residential, commercial, industrial and transportation uses), the amount of rainfall that becomes runoff increases. As the amount of runoff increases, the volume of runoff reaching streams also increases, thereby disrupting the equilibrium. Streams will attempt to reach a new equilibrium with the new runoff pattern by expanding the depth or width of the channel. These increases can be attributed too:

- Loss of vegetative land cover which decreases evapotranspiration
- Loss of soil and organic ground cover which absorb and retain rainfall
- Loss of uneven terrain which slows and retains runoff
- Increased impervious cover (i.e., roofs, parking lots, streets and sidewalks) which prevents rain from infiltrating into the ground.
- Faster delivery of runoff to streams though storm sewer systems

Increased runoff not only delivers greater volumes of water to streams, it also increases the peak flow of streams. Peak flows are the highest flows in the stream following a rainfall event. This is because many of the alterations to a watershed result in runoff reaching the stream faster. For example, runoff will move through a storm sewer pipe faster than it will through dense vegetation. Runoff will move over flat surfaces of developed areas faster than uneven natural terrain. These higher peaks are an additional stress on a stream already burdened by increased volumes of runoff.

During storm events, unprotected streambanks allow soil erosion and deposition along Nyes Run.

The stream will react to increased runoff by increasing its channel size. The increased flows in the stream will cause stream bank erosion. In addition to the physical damage to the stream banks, the eroded material will remain in the channel, slowly being washed downstream as in-stream sediment deposits.

Decreased Base Flow - Another impact of increased runoff is the decrease in groundwater recharge. The loss of recharge can negatively impact stream habitat and water supplies, both surface and subsurface. As more rainfall is lost to runoff, less is available to seep into the ground to recharge aquifers and shallow groundwater areas. The impact of decreased recharge to the stream is decreased dry weather flow. During drier months of the year, the shallow ground water slowly seeps into streams, sustaining stream flow during this time. Without this supply of water, streams become very shallow or even dry up completely during dry periods. This periodic loss of flow can be detrimental to the aquatic organisms living in the stream.

2.2 POLLUTANTS ENTERING STREAMS

Sources of pollutants in streams can be categorized as point sources or non-point sources. Point-source pollution, that which is directly added to streams (for example, storm sewer or treatment plant discharge pipes), can be monitored and enforced. On the other hand, non-point source pollution isn't directly added to waterways, but enters streams and rivers via rainwater and groundwater. There are a wide variety of contaminants, originating from an equally wide variety of sources, which enter streams. Discussed below are the major contaminants.

Sediment

Sediment, by volume, is the single largest source of pollutants in Pennsylvania. Sediment, in addition to being a pollutant itself, often carries with it other pollutants. For example, phosphorus, a polluting nutrient, adheres to sediment particles and is carried to streams with the sediment. Sediment from all sources causes a wide variety of problems, both physical and biological:

-Increased infrastructure damage and maintenance costs (Clogged culverts, under cut streets and roads near streams, exposed sewer lines, sediment deposits, eroded banks, etc.)
- Increased local flooding problems
- Degradation of aquatic habitat

Erosion is the removal of the surface of the land or stream bank due to stormwater runoff. When this transported soil, or sediment, enters streams it is considered a stream pollutant. Erosion of stream banks and stream beds are caused by increased volumes of runoff delivered to streams. In addition to in-stream sources, sediment can originate from the land surface. Commonly thought of activities such as agriculture and construction sites can be a significant source of sediment. But sediment can originate from many other sources. Timbering operations, dirt or gravel roads and driveways, unstable ditches and swales, bare areas in yards, fields, open space or idle land can all contribute significantly to sediment pollution. In short, any area that is bare soil and is not protected from runoff by some sort of stabilization can be a source of sediment.

Nutrients (Nitrogen and Phosphorous)

Nutrients, such as nitrogen and phosphorus, are beneficial in promoting plant growth for crops. Unfortunately, these nutrients also promote plant growth when they reach local streams. Algal blooms are common in areas that receive a high amount of phosphorus and nitrogen from various sources. Common sources are fertilizers from agriculture and lawn application, animal waste from livestock and pets, sewage discharge, and malfunctioning septic systems. Excessive algal blooms can change the chemistry of the water, block streambed sunlight, deplete oxygen levels and negatively affect aquatic habitat.

Thermal Changes

While not often thought of as a source of pollution, temperature increases, thermal pollution, do degrade aquatic habitat. Thermal pollution occurs when in-stream water temperatures are elevated beyond their normal level. There are several causes of thermal pollution. First, runoff flowing over hot impervious surfaces such as roofs, parking lots, roads and sidewalks is warmed by these surfaces. When this runoff enters streams, the stream temperature is elevated. A second cause of thermal pollution is the loss of riparian buffer areas along streams. Good buffers shade the stream from direct sunlight, thereby maintaining cooler water temperatures. A third source of thermal pollution is the discharge of warm water from various industrial sources. Increased stream temperatures affect aquatic organisms in several ways. First, the increased temperature itself can adversely affect forms of aquatic organisms that are sensitive to changes in temperature. One example is trout which are adversely affected by warm water temperatures. Additionally, dissolved oxygen levels decrease as water temperatures increase, lessening the amount of oxygen available to aquatic organisms.

Other Pollutants

In addition to the pollutants discussed above, there many other pollutants delivered to streams from various sources. Any chemical or substance that is deposited on the land surface is likely to find its way into a stream. Common examples are:

- Heavy metals such as lead, zinc and copper
- Detergents and other cleaning compounds
- Petroleum compounds such as gasoline and engine oils
- Auto fluids such as coolants, transmission and power steering fluids
- Pesticides and herbicides from both agriculture and home use
- De-icing compounds such as road salts and chemicals
- Organic materials such as leaves and grass clippings
- Other pollutants purposely or accidentally released to storm sewers or streams

An oil sheen left by a leaking vehicle

3.0 WATER QUALITY STANDARDS OVERVIEW:

East Branch of Rattling Creek (HQ-CWF/EV).

The Pennsylvania State Code Chapter 93 details the protection of water quality in surface water throughout the Commonwealth. These standards are based upon designated uses for each stream section, providing guidance to the protection of these uses. Designated uses can be for any of the following: Aquatic Life, Water Supply, Recreation and Fish Consumption, and Special Protection. This report focuses on uses for Aquatic Life and Special Protection.

Aquatic Life

A Stream is designated as a Cold Water Fishery or Warm Water Fishery when describing the aquatic organisms that find habitat in its waters. As defined in Chapter 93, a Cold Water Fishery (CWF) is a stream or a section of a stream that supports life of fish, flora, and fauna of a cold water habitat. Some waterways are protected by canopy, providing shade in the summer months, thus helping to keep the water temperature cooler for trout, among other organisms that can only survive in cool temperatures. A designation of Warm Water Fishery (WWF) supports species indigenous to warm water habitat. Other designations given for the protection of aquatic life are Migratory Fishes (MF) and Trout Stocked Fisheries (TSF). To be considered a Migratory Fishes, the stream section must maintain quality to support those fish species that move to and from flowing waterways to complete their life cycle in other waters. Trout Stocked Fisheries are streams that can support stocked trout from February 15 to July 31, and thereafter maintain quality of a Warm Water Fishery.

Special Protection

Special Protection streams fall into the category of either High Quality (HQ) or Exceptional Value (EV). These categories of streams are designated as special protection waters because they represent the highest quality of waters in the Commonwealth and merit special protection. A High Quality waterway meets the requirements for a chemistry assessment of multiple parameters, such as temperature, dissolved oxygen and pH, among others, or qualifies as High Quality based on the results of a biological assessment. Exceptional Value streams must meet more stringent requirements.

There are four special protection streams in Dauphin County. Rattling Creek, a tributary to Wiconisco Creek is designated as Exceptional Value on its East and West branches. Clark Creek is designated as a High Quality Stream. Stony Creek, from its source to Ellendale is designated as a High Quality stream. A section of Conley Run is designated HQ.

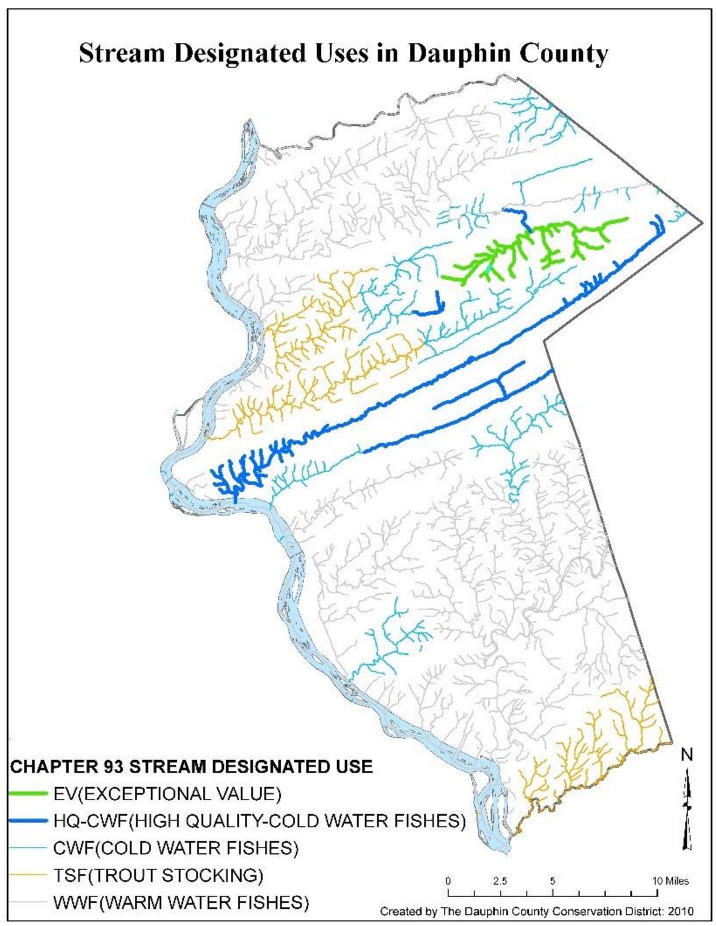


Figure 3.1 Designated Uses of Dauphin County Streams

Total Maximum Daily Loads:

Total Maximum Daily Load's (TMDL) are assigned to streams, allocating the amount of pollutant loads that can enter. Through modeling, an instream numeric endpoint represents the water quality goal that is to be achieved by implementing load reductions over time. Goals are represented in lbs./day, as well as annual totals for the specified pollutant.

Currently, there are TMDL's set for the following watersheds within Dauphin County:

- Armstrong Creek
- Bear Creek
- Pine Creek
- Conewago Creek
- Paxton Creek
- Wiconisco Creek
- An unnamed tributary to Bow Creek

4.0 MACROINVERTEBRATE ASSESSMENTS:

The impact of the previously discussed pollution sources is not always obvious and can change, creating a need to monitor stream conditions to assess a stream's status. A way of doing this is by collecting samples of the macroinvertebrate life in the streams. Macroinvertebrate samples were collected from various sites on streams throughout Dauphin County. Macroinvertebrates are small organisms such as insects, worms and crustaceans. The total number of macroinvertebrates and the different types present give an indication as to the overall health of a stream. Just as miners used to take canaries into coal mines to warn them of dangerous air conditions, macroinvertebrates can give us an idea that there are problems with a stream.

Biological assessments of macroinvertebrates are a good way to determine the general water quality of a stream in an inexpensive manner. By identifying the types and numbers of macroinvertebrates, a water quality rating can be given to the stream. This is possible because different species have differing tolerances to water pollution. For example, mayflies, stoneflies, and caddisflies do not survive well in polluted water while leeches, midges, and worms are tolerant to pollution. The various sources of degradation will adversely impact streams. It is the adverse impact that is reflected in the macroinvertebrate sample, not necessarily the specific cause itself. Where a sample does indicate degraded stream health, the specific cause will need to be determined. As discussed in Section 3, some streams in Dauphin County have had the general causes of degradation identified through DEP assessments.

It is also important to consider the interconnection of an ecosystem when determining the health of a stream. Stream degradation reflected in the macroinvertebrates does not affect only the macroinvertebrates. Macroinvertebrates feeding on microorganisms found on rocks, sediment, and submerged vegetation are the food source for fish and other aquatic life higher in the food chain. Changes in the number of any of these organisms can be the broken link of a stream ecosystem's health and productivity.

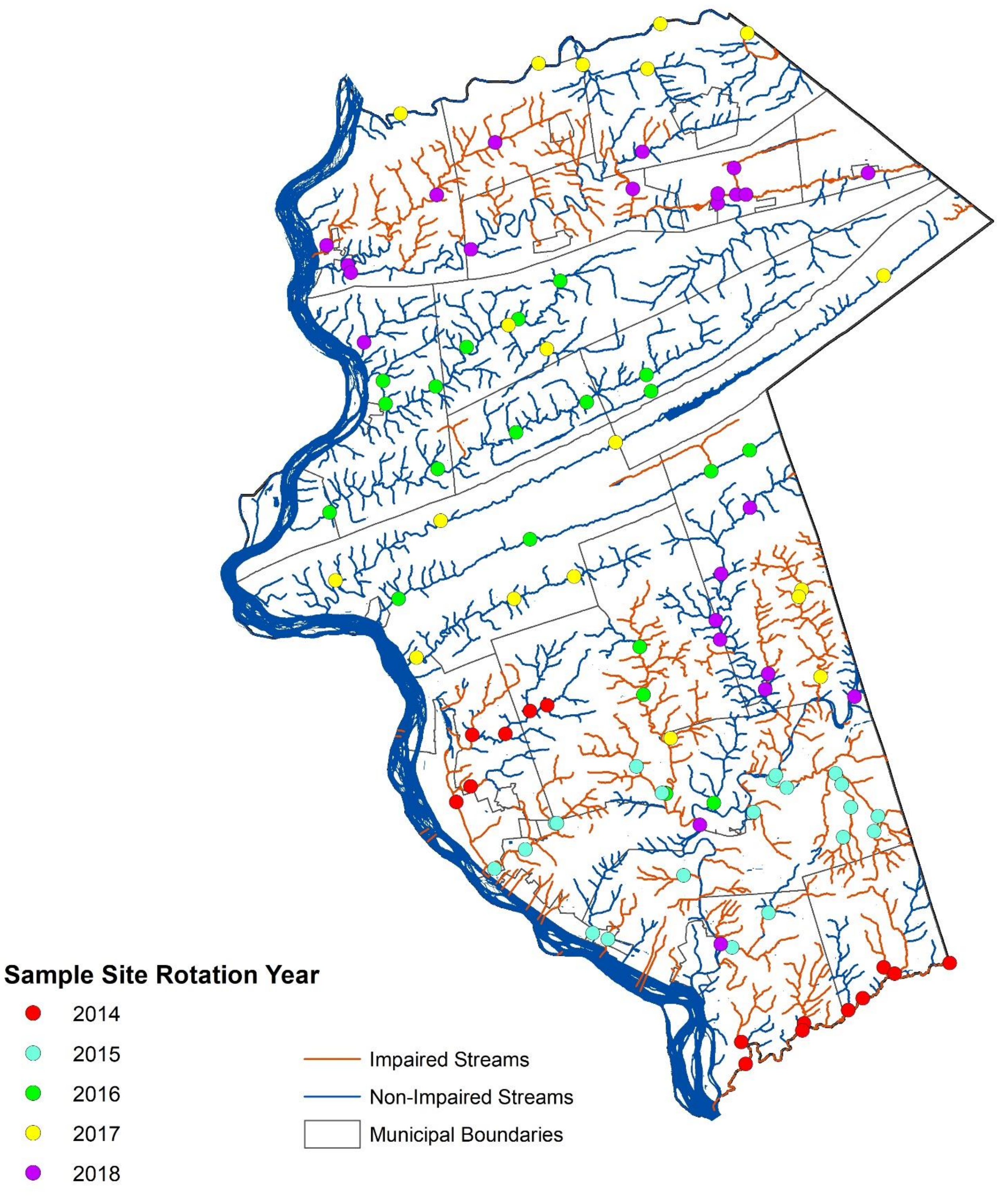


Figure 5.1 *Dauphin County Stream Assessment Sample Sites*

5.0 MONITORING METHODS:

5.1 BIOLOGICAL

Streams sampled in this assessment were evaluated using the aquatic macroinvertebrate community present at each monitoring site. As mentioned, aquatic macroinvertebrate communities such as aquatic insects, crustaceans, leeches, worms, and snails make ideal indicators of stream health because they respond to common environmental stressors. Macroinvertebrate organisms provide an efficient means of characterizing comprehensive stream health, which can indicate previous impacts due to varying stressors over time.

***Rhyacophila* - a pollution sensitive caddisfly**

To provide a comprehensive evaluation throughout Dauphin County, a careful examination of each watershed was conducted, and 102 sites were determined. Generally, major streams were sampled every 3-7 miles along their length and small streams with a drainage area of approximately 2.5 mi^2 or larger were sampled. The sites were sampled on a five-year rotation schedule; meaning that approximately 20 sites were sampled each year with each individual site sampled every fifth year. Each site within a given watershed was sampled during the same year to monitor trends and compare results. Figure 5.1 above, shows the distribution of sites sampled each year, shown with a different color for each year.

***Isonychia* - a pollution sensitive mayfly**

Sample collection and processing of these studies were as follows. Samples were taken between February and April depending on flow conditions**.** At each site, six samples were taken in riffle areas along a 100-m stretch. The material gathered from these six efforts was then combined in the field, coarse material washed and removed, and the remaining material preserved with 95% ethanol. Appendix I. details the rest of the sampling process, including the sub-sampling methods before macroinvertebrate identification.

After performing a set of calculations on the macroinvertebrate community found at each sampling station, a standardized value was given as a health score, called the Index of biotic Integrity (IBI). A full description of the analyses used to create an IBI can be found in Appendix II of this report. To summarize this process, six calculations were combined to form the IBI. These calculations each look at different strengths found in a sample, whether it is diverse, the number of sensitive types, the pollution tolerance of each type, and so on. When all calculations were completed, each site was assigned a category of health as shown below. See Appendix II-III for a more detailed discussion of the basis for these categories.

Good (63-100): Optimal site with a balanced community of pollution sensitive and tolerant organisms.

Fair (50-62): Significant decrease in pollution-sensitive species, unbalanced site with sub-optimal habitat.

Poor (0-49): Degraded site dominated by tolerant organisms. Site is not attaining aquatic life use.

The specific sample results are discussed in Section 7. Please note that the classifications of "good", "fair", "poor", are based on DEP's ICE Protocol, which is discussed further in Appendix III. When evaluating data derived from macroinvertebrate samples it is critical that the information be considered carefully. It is important to understand what the data is and what it is not. It is a general indicator of stream health. It is not evidence of a specific pollutant or source of pollutants.

5.2 PYSICAL HABITAT

Physical habitat related to the stream section and its surrounding drainage area plays a significant role in the quality of life for aquatic organisms. To monitor habitat, DEP's ICE Protocol provides a habitat assessment form which measures 12 characteristics of habitat on a scale of 0-20. These measures include:

- Instream Cover for fish	- Bank Condition	- Embeddedness: % silt covering rocks
- Depth Regime	- Channel Alteration	- Sediment Deposition
- Frequency of Riffles	- Channel Flow	- Epifaunal Substrate: Life on stream bottoms
- Bank Vegetation	- Grazing Pressure	- Riparian Vegetation Width

Documenting these conditions may show changes over time, which can drastically affect macroinvertebrates. For example, increased sediment deposition may show impacts to macroinvertebrates that depend on gravel stream beds to cling to. It is important to identify these changes as this can provide information useful on impacts to the macroinvertebrate community and provide clues as to the source of the degradation.

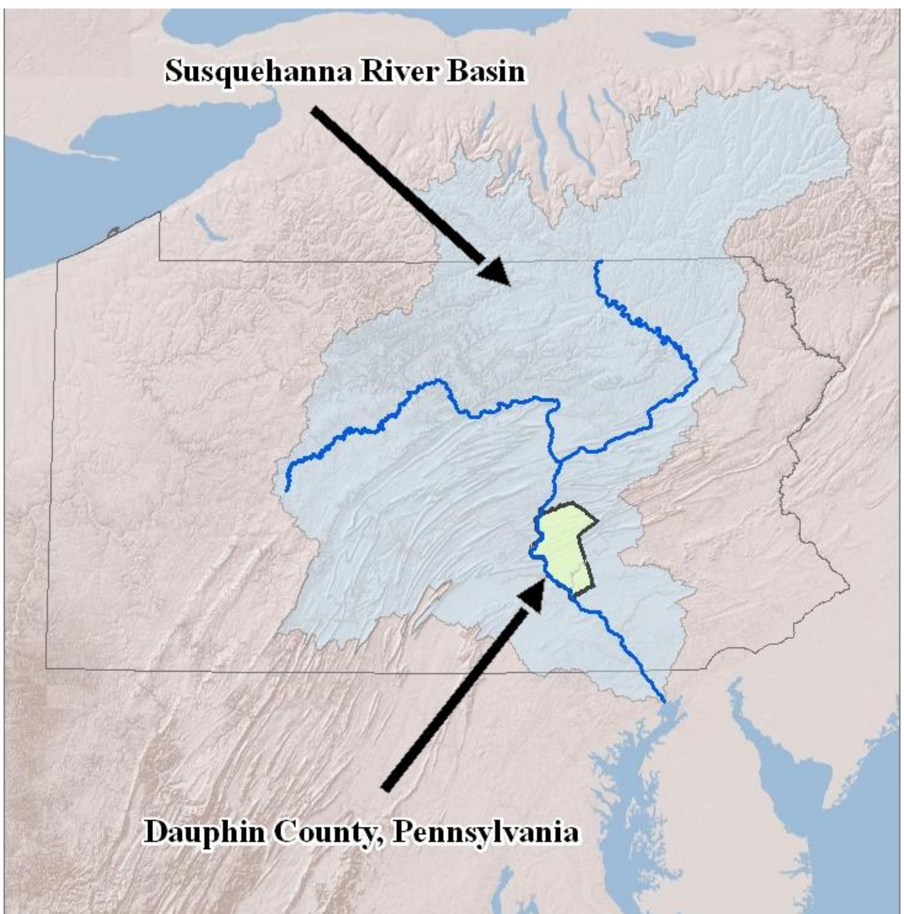


Figure 5.2 *Study Area Location*

Also important when considering the physical habitat of a stream is the local geology. Geologic information is documented in each watershed. For example, Limestone can provide buffering for streams, protecting them from increased acidity. This also influences habitat for communities of macroinvertebrates. Some types of macroinvertebrates do not do well in limestone streams, even if the stream is healthy. As these samples can be different from those found in non-limestone areas, this must be considered when assessing stream health. Stream gradient and watershed size are also important to consider when looking at the physical characteristics of a stream. The higher the gradient, the faster the current and usually less human impact. Likewise, watersheds covering a larger area have more tributaries influencing water quality.

6.0 STUDY AREA OVERVIEW:

The sites considered in this study were all located within Dauphin County, see Figure 5.2. The western shoreline of the Susquehanna River is the western boundary of Dauphin County. Mahantango Creek and Conewago Creek are the northern and southern boundaries, respectively. The eastern boundary is Schuylkill and Lebanon Counties.

Dauphin County is made up of a range of land uses. Northern areas of the county are predominantly rural, agricultural areas. The central area of Dauphin County is rural in character but is largely forested with minor agricultural and rural development. Much of the forested land in this area is public land.

In southern Dauphin County, the land use is a mix of highly urbanized, suburban and rural areas. Development in this area has been rapid in the past decade. In the southernmost area of Dauphin County is primarily a rural agricultural area, with some suburban uses. Development in this area, while not as rapid elsewhere in the southern region, has been occurring.

Geologically, the majority of the county is comprised of non-limestone formations. In southern Dauphin County there are areas where limestone geology is present. These areas are in bands running east to west from the southern Harrisburg area to the Hershey area.

The topography varies significantly by watershed. Some watersheds are narrow with step sides others are relatively flat to gently sloping on valley floors. The topography for each watershed is discussed later under each watershed analysis.

7.1 MAHANTANGO CREEK

Description

The Mahantango Creek watershed encompasses 164.6 square miles, 28.5 square miles of which are within northern Dauphin County. Originating in Schuylkill County, this large stream flows generally northeast to southwest to its junction with the Susquehanna River in Upper Paxton Township. Pine Creek, located in the northeast corner of Dauphin County, is a major tributary.

Very rural in character, population density is low with the majority of land use in agriculture and forestland. Populated areas in Dauphin County include the boroughs of Pillow and Gratz. Topography is characteristic of the ridge and valley province, dominated by flat to moderately sloping land of the valley floor with steeper slopes found on the mountains and ridges that are composed mainly of red sandstone.

Mahantango Creek before entering the Susquehanna River.

DEP Classification

The main stem of the stream is classified by the Department of Environmental Protection (DEP) as a warm water fishery (WWF). Pine Creek is classified as a cold-water fishery (CWF). DEP lists a section of Pine Creek in Dauphin County as impaired by siltation and nutrients, both sources of pollution are attributed to agricultural activities. Pine creek is also impaired by metals from abandoned mine drainage (AMD).

Site Locations

Six locations were monitored in the Mahantango creek watershed; three on the main stem, two sites on Deep Creek and one on Pine Creek. The locations of these sites are described in Figure 7.1 below.

QUICK FACTS

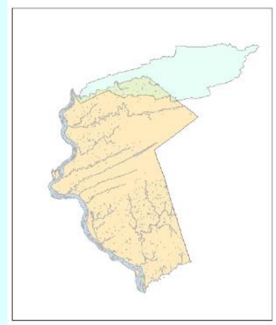
Watershed Size:

- 164.6 mi^2
- 28.5 mi^2 in Dauphin County

Stream Miles: 56.1

Impaired Stream Miles: 2.3

Land Uses: Predominantly forest and agriculture



Mahantango Creek watershed

DEP Stream Classification:

- Pine Creek – CWF
- Main Stem and Deep Creek – WWF

DEP Listed Impairments:

- Pine Creek - Siltation from agricultural activities
  - Nutrients from agricultural activities
  - Metals from abandoned mine drainage (AMD).

Watershed Municipalities:
Williams Twp, Lykens Twp, Gratz, Mifflin Twp, Pillow, Upper Paxton Twp, Wiconisco Twp

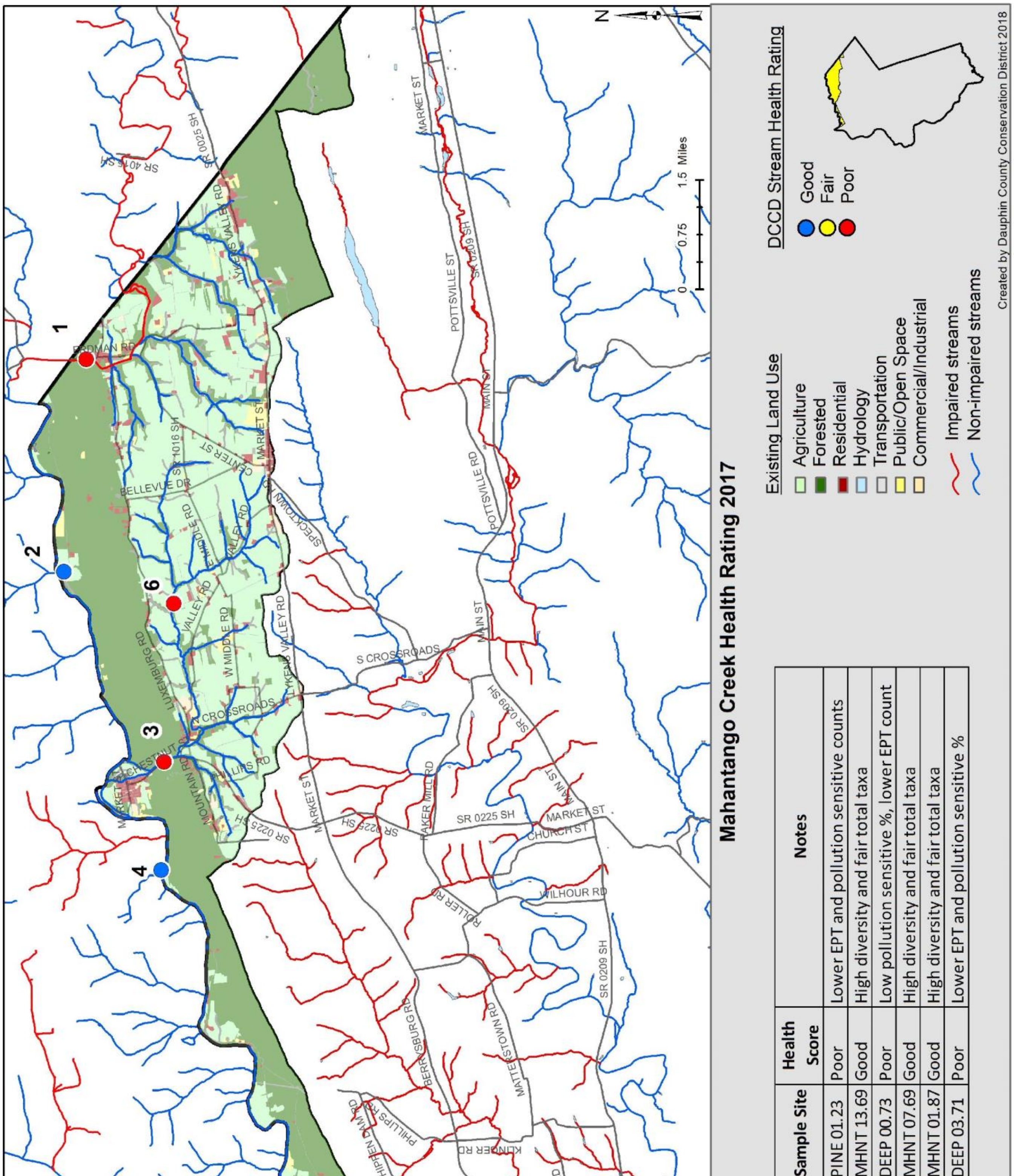
Study Results

Three sites, MHNT 13.69, MHNT 07.69, and MHNT 01.87, were located along the main stem of the Mahantango Creek. Due to their larger drainage area, the health scores for these sites were calculated based on large watershed metrics. MHNT 13.69, the furthest upstream, was located at Spain Road, MHNT 07.69 was located along Creek Road between Herb’s Lane and Roy’s Lane, and MHNT 01.87, the furthest downstream, was located at Malta Road. All three mainstem sites ranked as good, showing fairly good numbers of total macroinvertebrate types and high diversity rankings.

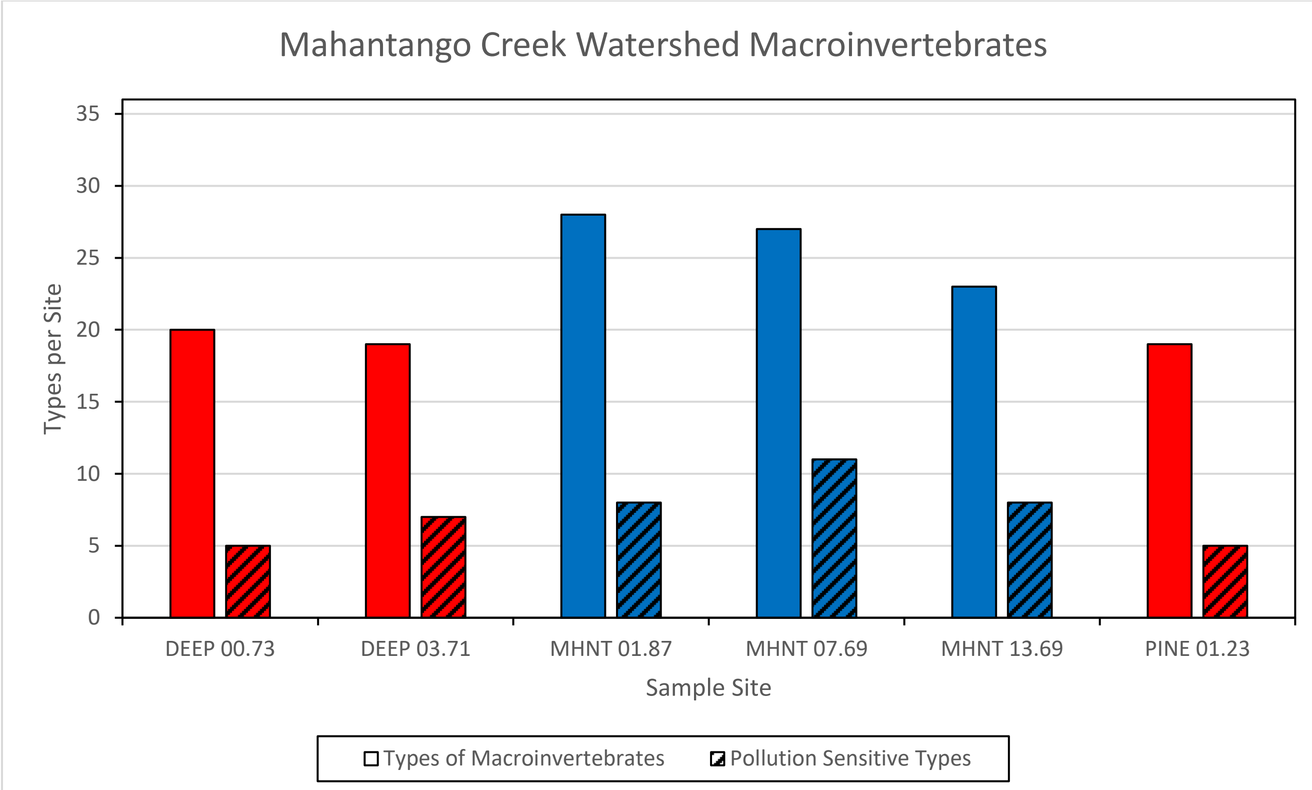
Two tributaries were also monitored. Pine Creek, PINE 01.23, was monitored at Erdman Road/Main Street south of Klingerstown. This site's health score was rated poor with higher diversity, but total numbers and pollution sensitive types were low.
The downstream site on Deep Creek, DEEP 00.73, was monitored at Luxemburg Road. The health score here was rated as poor. This site had a low percentage of pollution sensitive types as well as lower EPT types. The upstream site on Deep Creek, DEEP 03.71, also had a low percentage of pollution sensitive types and EPT types.

A complete table of metrics calculations and sample cycle score comparison charts can be found in Appendix VI-VII.

Figure 7.1

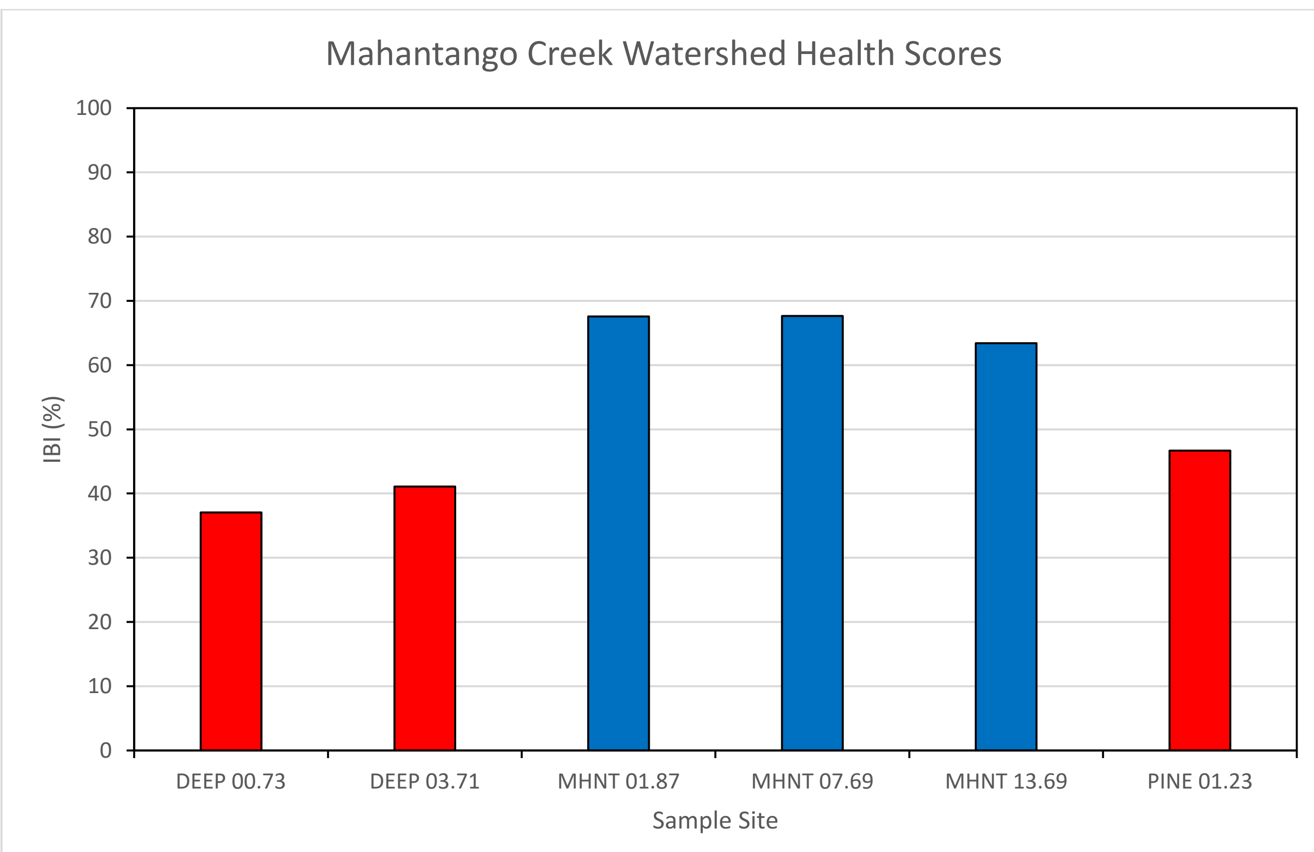


Site Number	Sample Site	Health Score	Notes
1	PINE 01.23	Poor	Lower EPT and pollution sensitive counts
2	MHNT 13.69	Good	High diversity and fair total taxa
3	DEEP 00.73	Poor	Low pollution sensitive %, lower EPT count
4	MHNT 07.69	Good	High diversity and fair total taxa
5	MHNT 01.87	Good	High diversity and fair total taxa
6	DEEP 03.71	Poor	Lower EPT and pollution sensitive %



Mahantango Creek Watershed Macroinvertebrates
Types per Site
35
30
25
20
15
10
5
0
DEEP 00.73
DEEP 03.71
MHNT 01.87
MHNT 07.69
MHNT 13.69
PINE 01.23
Sample Site
Types of Macroinvertebrates
Pollution Sensitive Types

Stream Health:
Good Fair Poor



Mahantango Creek Watershed Health Scores
IBI (%)
100
90
80
70
60
50
40
30
20
10
0
DEEP 00.73
DEEP 03.71
MHNT 01.87
MHNT 07.69
MHNT 13.69
PINE 01.23
Sample Site

7.2 WICONISCO CREEK

Description

The Wiconisco Creek watershed encompasses an area of approximately 102 square miles in northern Dauphin County, and 14.2 mi^2 outside of the county, classifying it by size as a large stream. Originating in Schuylkill County, the creek flows generally east to west to its junction with the Susquehanna River at Millersburg Borough. Two significant tributaries enter the Wiconisco Creek at Lykens, Bear Creek from the north and Rattling Creek from the south. Wiconisco Creek's largest tributary, Little Wiconisco Creek, enters farther west near Millersburg Borough. Many smaller un-named tributaries join Wiconisco Creek between Loyalton and Millersburg.

Wiconisco Creek before entering the Susquehanna River

Rural in character, population density is low with most land use in agriculture and forestland. Population centers include several small boroughs. Topography is characteristic of the ridge and valley province, dominated by flat to moderately sloping land of the valley floor. Steeper slopes are found on the mountains and ridges that form the basin boundary. The ridges of the Wiconisco Creek watershed are composed mainly of red and gray sandstone and conglomerate. The valley is underlain with sandstone and shale. A portion of the eastern section of the watershed is underlain with coal.

QUICK FACTS

Watershed Size: 116.2 mi^2, 102 mi^2 in Dauphin County

Land Uses: Primarily Agriculture and Forested

Stream Miles: 161.7

Impaired Stream Miles: 58.3

Wiconisco Creek watershed

DEP Stream Classification:

- Rattling Creek East and West Branch – EV
- Rattling Creek East and West Branch confluence to mouth – HQ-CWF
- Bear Creek – CWF

DEP Listed Impairments:

- Little Wiconisco Creek – Siltation and nutrients from agriculture activities
- Bear Creek – Metals from Abandoned Mine Drainage (AMD)
- Wiconisco Creek headwaters – Metals from AMD

Watershed Municipalities

Rush Twp, Jefferson Twp, Jackson Twp, Williams, Williamstown, Washington Twp, Elizabethville, Wiconisco Twp, Upper Paxton Twp, Millersburg, Mifflin Twp, Lykens Borough, Lykens Twp, Berrysburg, Gratz

DEP Classification

The main stem of Wiconisco Creek is classified as a WWF. Some tributaries to Wiconisco Creek (source to Route 209 at Bridge) are listed as CWF, while other tributaries from this bridge to the river are identified as Warm Water Fishery (WWF). Bear Creek is listed as a Coldwater Fishery (CWF). Rattling Creek's East and West Branches are classified as Exceptional Value (EV) with their confluence to the Wiconisco Creek classified as a high quality cold water fishery (HQ-CWF). Little Wiconisco Creek is identified as a WWF. PA DEP lists a portion of Wiconisco Creek and several of its tributaries in the watershed as impaired for one or more of their designated uses. A section of the Wiconisco Creek in the headwaters area is impaired by metals and low pH from abandoned mine drainage (AMD). Bear Creek is also listed as impaired by metals caused by AMD. Little Wiconisco Creek also appears on the list due to siltation and nutrient impairments attributed to agricultural activities. A few small tributaries of Wiconisco Creek are also listed due to similar impacts from agricultural activities.

Site Locations

Fourteen Locations were monitored within the Wiconisco Creek watershed. Five sites on the main stem, three on Little Wiconisco Creek, one on Rattling Creek, two on Bear Creek, and one on a small tributary called White Creek. The locations of these sites are described in Figure 7.2 below.

Study Results

Seven sites were located on the main stem of Wiconisco Creek. The furthest upstream site was WICO 34.02, located along Railroad Street in Williamstown. WICO 34.02 rated poor, with low diversity of macroinvertebrates and a low percentage of pollution sensitive types. WICO 29.71 was located near the Machamer Avenue bridge and ranked poor showing low diversity and low numbers of pollution sensitive EPT insects. WICO 27.68, located at the end of Division Street in Lykens, also rated poor, with low numbers pollution sensitive insects. WICO 23.26 was located at Fisher Road and had a health score rating of fair, with low numbers of pollution sensitive insects and high diversity of macroinvertebrate types. WICO 14.74 was located downstream of the North Church Street bridge and rated fair, having a high diversity of macroinvertebrate types but low numbers of pollution sensitive types. WICO 07.95 was located upstream of Shiffers Mill Road. Its health score rating was fair, with low numbers of pollution sensitive macroinvertebrate types but high diversity. The furthest site downstream, WICO 01.36, was located near Power Company Road. It rated with a health score of fair, having fair numbers of pollution sensitive EPT types and high diversity of macroinvertebrate types.

Three sites were located on the Little Wiconisco Creek. LWIC 10.74, the furthest upstream, was located at Kessler Road, LWIC 07.36 was located at Sams Road. These two upstream sites ranked as poor with low numbers of pollution sensitive macroinvertebrate types. The site furthest downstream, LWIC 00.18, was in Millersburg near power company road. LWIC 00.18 ranked fair, with high diversity and fair numbers of pollution sensitive EPT types.

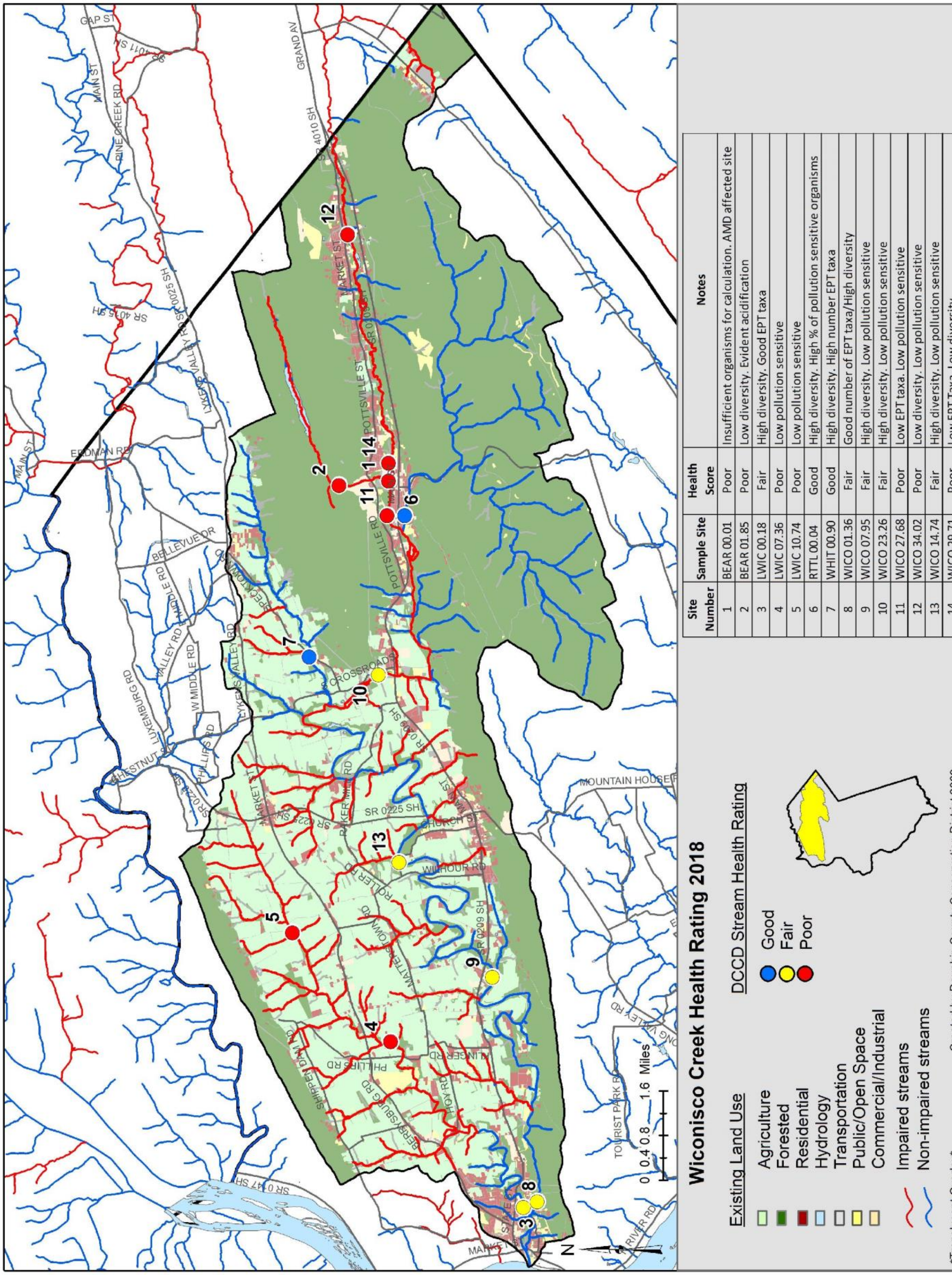
Rattling Creek had one site, RTTL 00.04, located at Edward Street in Lykens Borough. This site ranked as good with high percentages of pollution sensitive of macroinvertebrates and high diversity.

Two sites were sampled on Bear Creek. BEAR 01.85, located along a PA Game Commission access road above sources of abandoned mine drainage (AMD), ranked a poor health score, with low diversity in the macroinvertebrate community. This site is affected by acidification and the macroinvertebrate community reflects this showing an absence of mayflies and dominance of acid tolerant stoneflies and midges. The other site, BEAR 00.01, was located downstream from AMD sources and just upstream of its confluence with the Wiconisco Creek. Insufficient aquatic life was found at this site, giving it a ranking of poor.

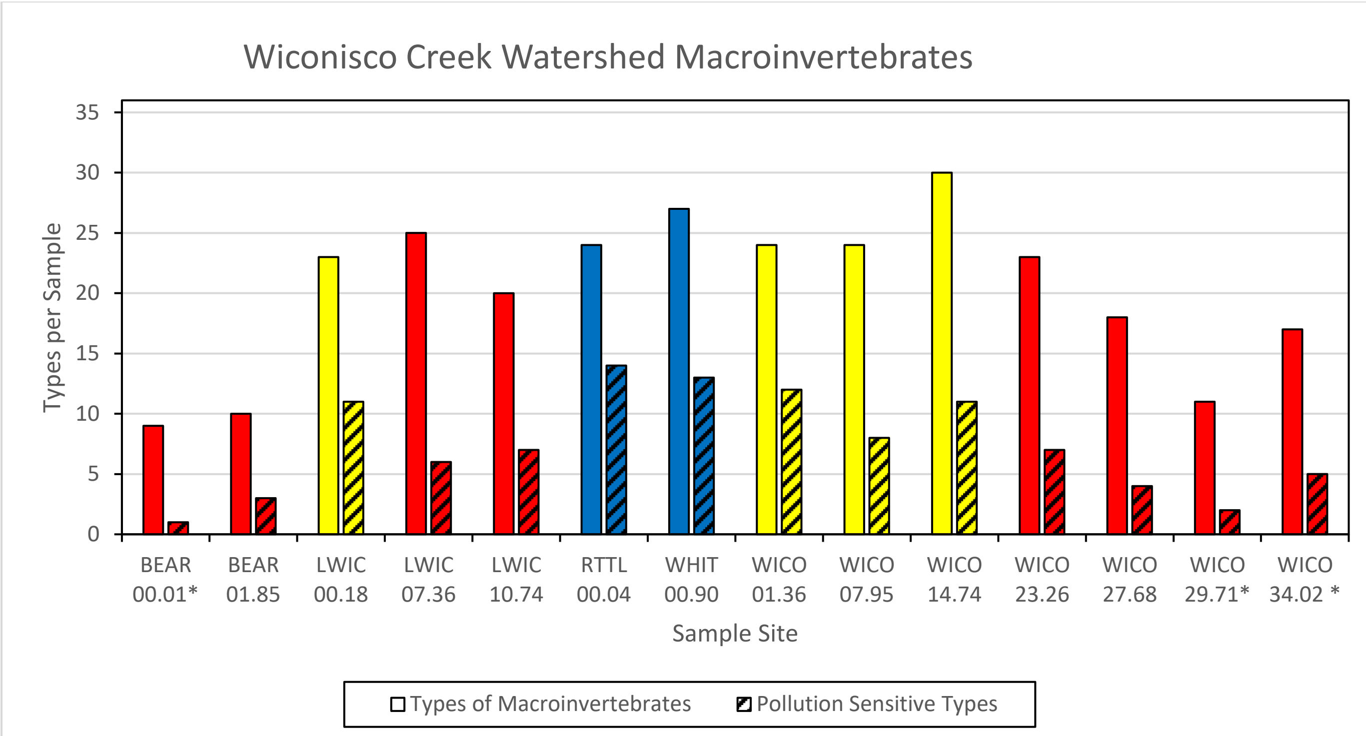
The White Creek site, WHIT 00.90 was located along Old Specktown Road. This site was rated as good, showing high diversity and high numbers of pollution sensitive EPT insects.

A complete table of metrics calculations and sample cycle score comparison charts can be found in Appendix VI-VII.

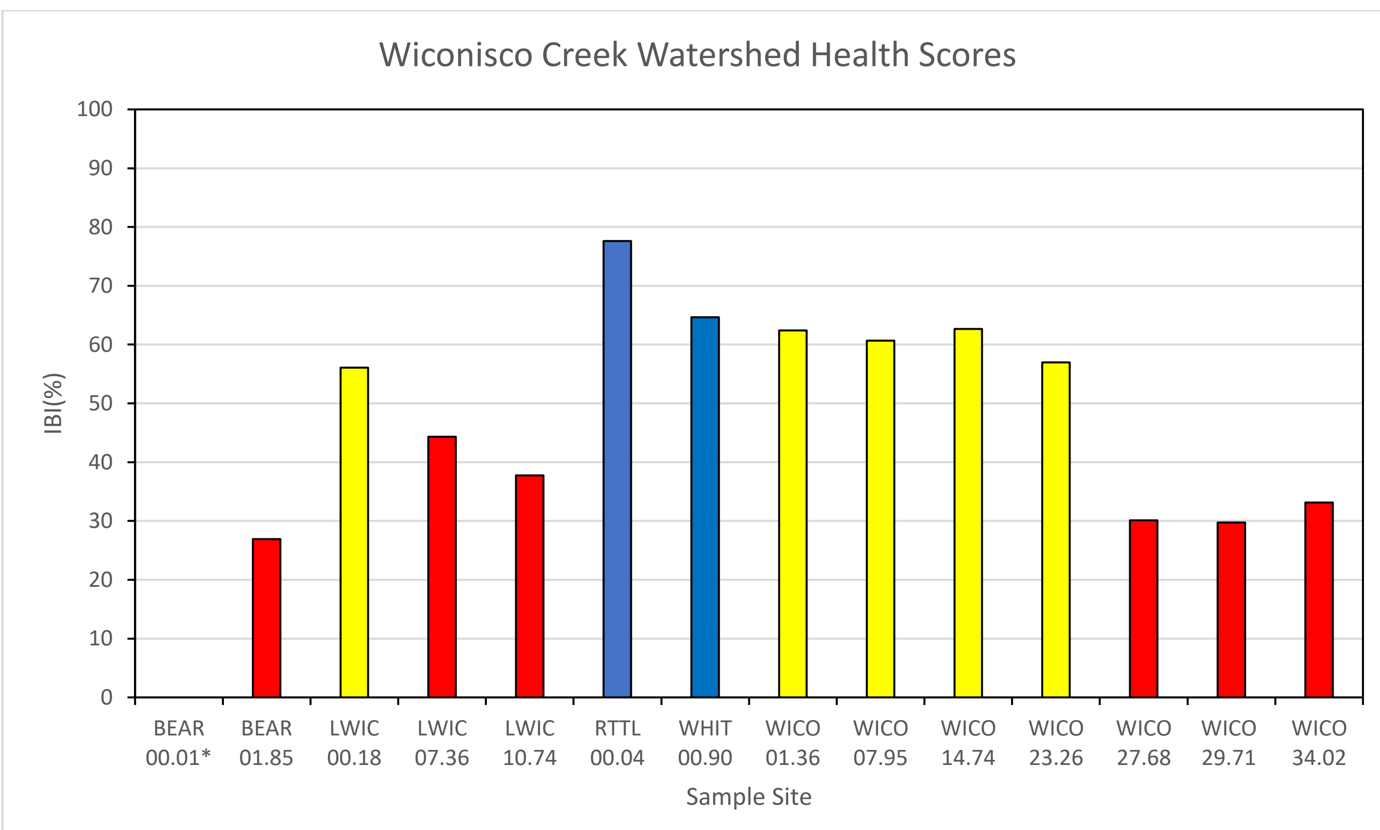
Figure 7.2



Site Number	Sample Site	Health Score	Notes
1	BEAR 00.01	Poor	Insufficient organisms for calculation. AMD affected site
2	BEAR 01.85	Poor	Low diversity. Evident acidification
3	LWIC 00.18	Fair	High diversity. Good EPT taxa
4	LWIC 07.36	Poor	Low pollution sensitive
5	LWIC 10.74	Poor	Low pollution sensitive
6	RTTL 00.04	Good	High diversity. High % of pollution sensitive organisms
7	WHIT 00.90	Good	High diversity. High number EPT taxa
8	WICO 01.36	Fair	Good number of EPT taxa/High diversity
9	WICO 07.95	Fair	High diversity. Low pollution sensitive
10	WICO 23.26	Fair	High diversity. Low pollution sensitive
11	WICO 27.68	Poor	Low EPT taxa. Low pollution sensitive
12	WICO 34.02	Poor	Low diversity. Low pollution sensitive
13	WICO 14.74	Fair	High diversity. Low pollution sensitive
14	WICO 29.71	Poor	Low EPT Taxa. Low diversity



**The BEAR 00.01 and WICO 29.71 samples had insufficient macroinvertebrates for a calculation and rank poor. WICO 34.02 had a slightly low count but was well established, still ranking poor.*



7.3 ARMSTRONG CREEK

Description

The Armstrong Creek watershed encompasses an area of approximately 32.5 square miles in northern Dauphin County. The entire watershed lies within Dauphin County. Armstrong Creek begins between Broad Mountain and Berry Mountain in north central Jackson Township. It flows generally southwest to where a tributary, New England Run, flows into it. Armstrong Creek discharges into the Susquehanna River near Halifax. The watershed is very rural in character with low population density. Land use in the Armstrong Creek basin is predominantly agriculture. Forested land is found mostly on the slopes of the mountains forming the basin and along stream corridors. Two small villages, Fisherville and Enders, and the Borough of Halifax are the largest concentrations of development. Topography throughout the basin is dominated by flat to moderately sloping land of the valley floor. Steeper slopes are found on the mountains and ridges that form the basin boundary.

Armstrong Creek before entering the Susquehanna River.

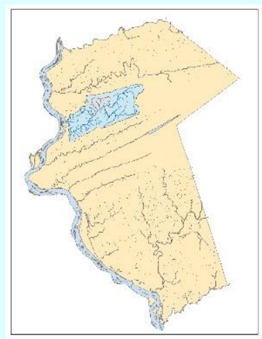
QUICK FACTS

Watershed Size: 32.5 mi^2 in Dauphin County

Stream Miles: 72.1

Impaired Stream Miles: 11.1

Land Uses: Predominantly forest and agriculture



Armstrong Creek watershed

DEP Stream Classification:

- HQ-CWF – Segment of Conley Run
- CWF – Conley Run to confluence with main stem
- WWF, TSF – Confluence to mouth

DEP Listed Impairments:

- Siltation from agricultural activities in small sections

Watershed Municipalities:

Halifax Twp, Jackson Twp, Jefferson Twp, Wayne Twp

DEP Classification

Armstrong Creek is classified as High Quality-Cold Water Fishery (HQ-CWF) for a segment of Conley Run's headwaters. Armstrong is a CWF from its headwaters to where it enters the main stem. The creek is classified as a Warm Water Fishery (WWF) with a section and of the main stem and several relatively small tributaries listed as impaired by siltation caused by agricultural activities. The Creek is a Trout Stocked Fishery (TSF).

Site Locations

Five sites were located on the main stem of Armstrong Creek, two on Conley Run, and one site was located on New England Run. Figure 7.3 seen below, describes the location of each site.

Study Results

Site ARMS 13.64, located upstream of Mountain House Road rated with a good stream health score with high percentages of pollution sensitive macroinvertebrates. ARMS 10.47, located near Miller Church Road, rated good, with a high total of macroinvertebrate types, high diversity, and high numbers of pollution sensitive EPT types. Site

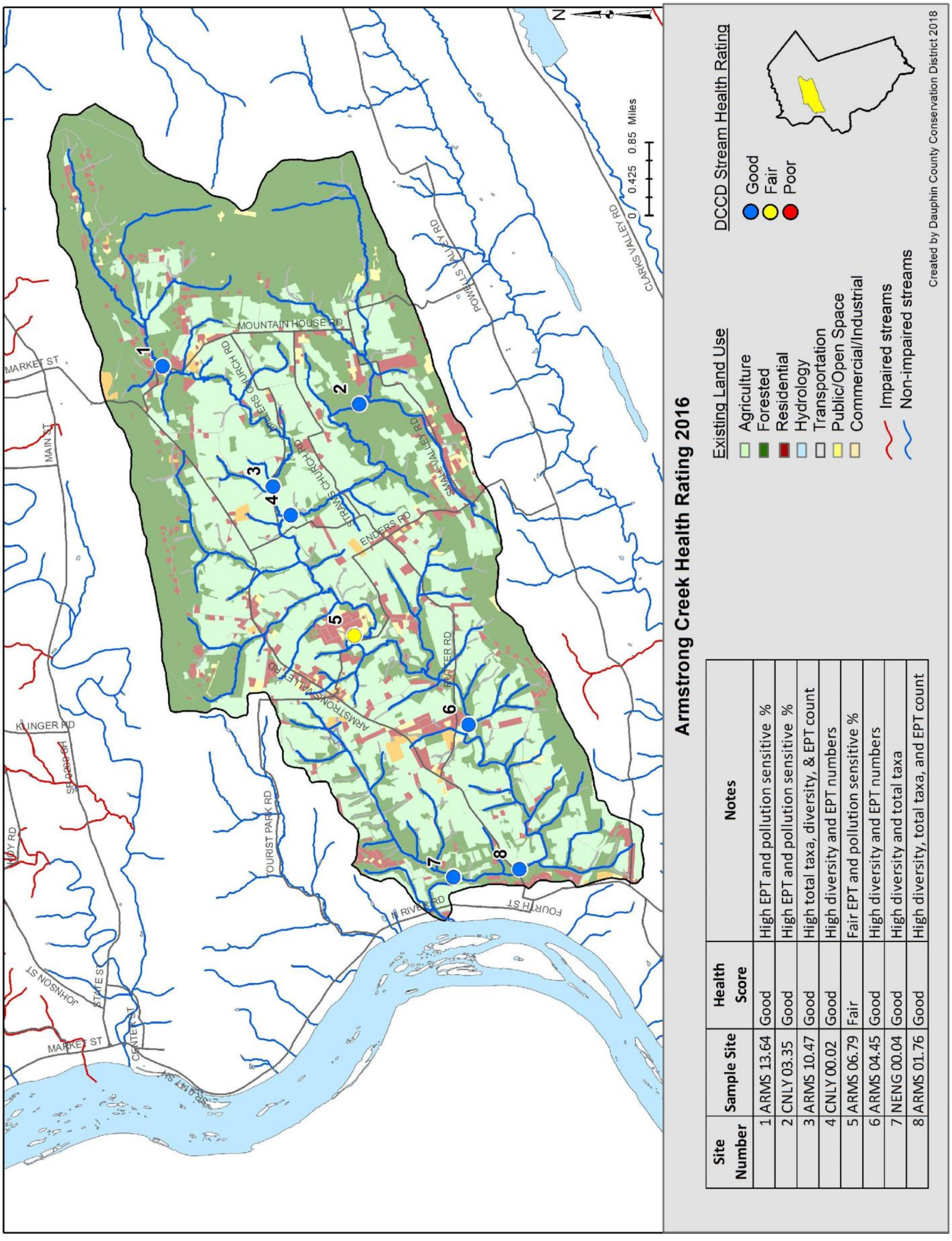
ARMS 6.79, located upstream of Hershey Road, rated a fair health score, with lower amounts of pollution sensitive macroinvertebrate types. The site downstream of Enders Road, ARMS 04.45, rated good, having high numbers of pollution sensitive mayflies, stoneflies, and caddisflies (EPT) and high diversity of macroinvertebrates. Site ARMS 01.76, located at Deppen Park east of Halifax, also rated good, with high numbers of total types, pollution sensitive EPT types, and diversity of macroinvertebrate types in the sample.

Two sites, CNLY 03.35 at Wolf Hole Road and CNLY 00.02 at Millers Church Road were located on Conley Run. Both sites had good health scores CNLY 03.35 had high numbers of EPT types and a high percentage of pollution sensitive types. CNLY 00.02 had high diversity and high numbers of EPT insect types.

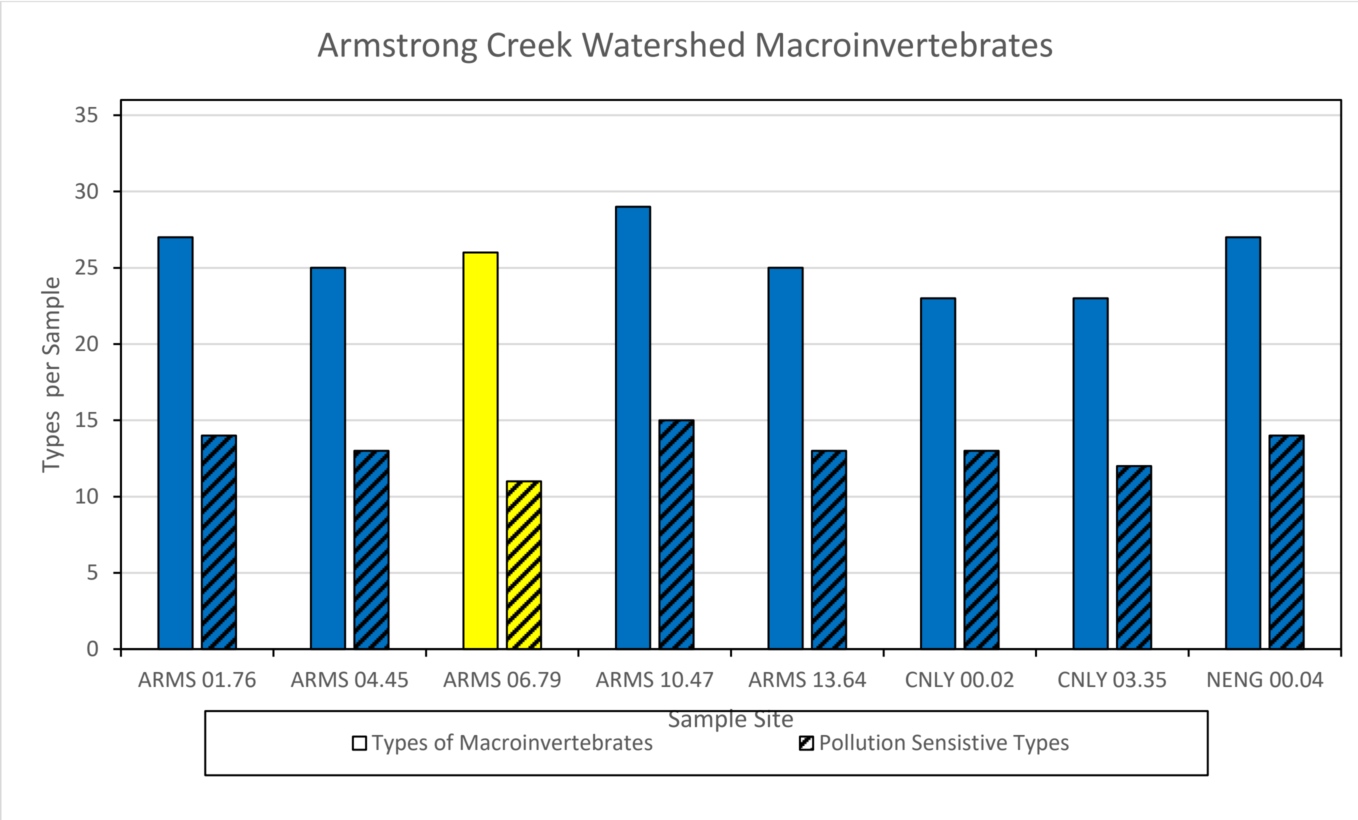
Site NENG 00.04 was located on New England Run at near its confluence with Armstrong Creek. This site rated as good, showing high diversity and high numbers of total macroinvertebrate types.

A complete table of metrics calculations and sample cycle score comparison charts can be found in Appendix VI-VII.

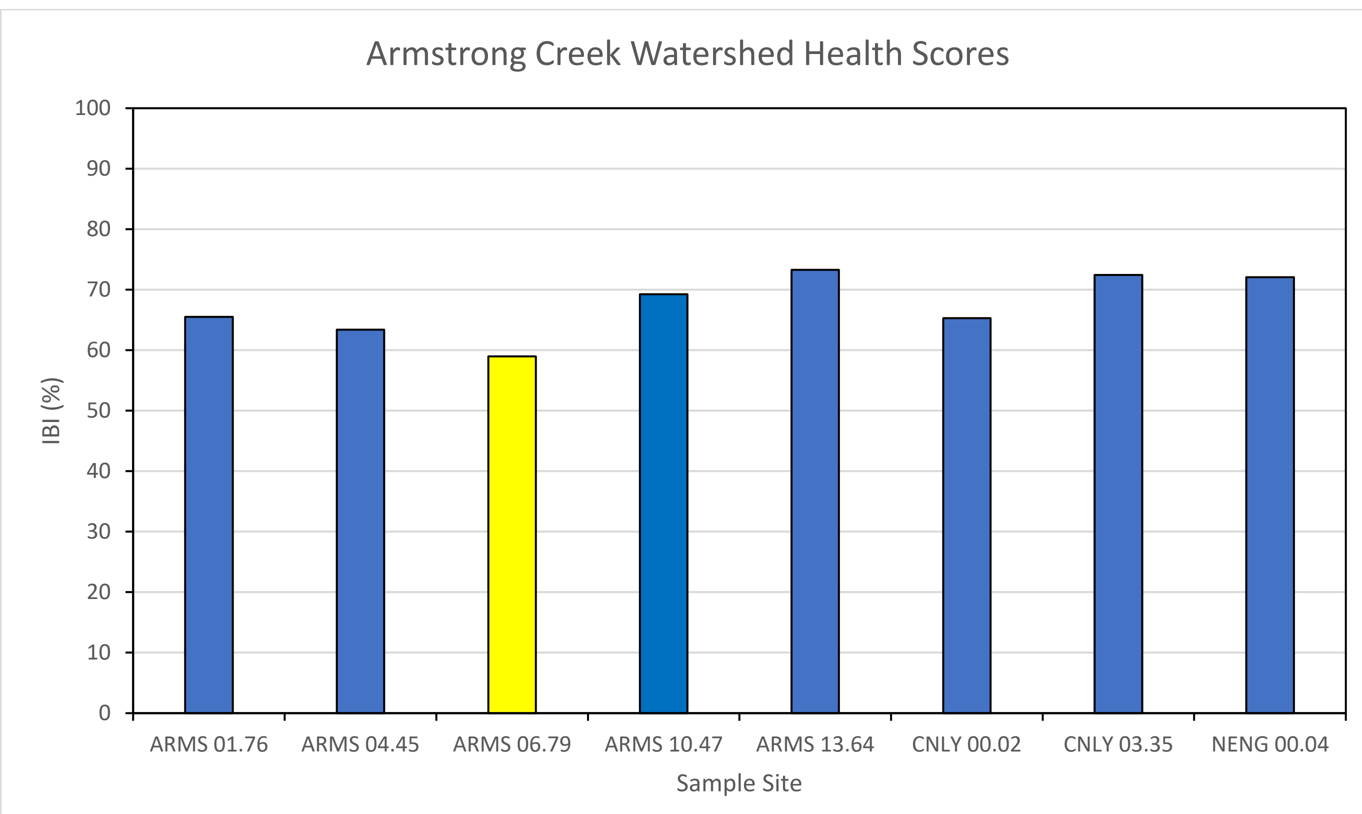
Figure 7.3



Site Number	Sample Site	Health Score	Notes
1	ARMS 13.64	Good	High EPT and pollution sensitive %
2	CNLY 03.35	Good	High EPT and pollution sensitive %
3	ARMS 10.47	Good	High total taxa, diversity, & EPT count
4	CNLY 00.02	Good	High diversity and EPT numbers
5	ARMS 06.79	Fair	Fair EPT and pollution sensitive %
6	ARMS 04.45	Good	High diversity and EPT numbers
7	NENG 00.04	Good	High diversity and total taxa
8	ARMS 01.76	Good	High diversity, total taxa, and EPT count



Stream Health:
Good **Fair** **Poor**



7.4 POWELL CREEK

Description

The Powell Creek watershed drains an area of approximately 39.6 square miles in north-central Dauphin County. The entire watershed lies within Dauphin County. Two streams, a north fork and a south fork, originate on the forested slopes between Peters Mountain and Broad Mountain. Both forks flow west and join about 2 miles west of Carsonville. Powell Creek continues west, flowing into the Susquehanna River about four miles southwest of Halifax Borough. This watershed is long, about 20 miles, and narrow, typically about two miles wide but with a broad valley floor. The main stem of the creek collects several small tributaries from the north and south.

Powell Creek before entering the Susquehanna River.

The watershed is mostly forested with a significant amount of agricultural land. Residential development is currently limited primarily in the form of frontage lots. Slightly denser residential use is found in the western end of the basin in and near the village of Matamoras. Commercial and industrial uses are not significant in the watershed.

Topography throughout the basin is dominated by flat to moderately sloping land of the valley floor. Steeper slopes are found on the mountains and ridges that form the basin boundary.

In 2017, PA Fish and Boat Commission designated Smoke Hole Run, a tributary to the South Fork of Powell Creek as a Class A Wild Trout Stream for Brook Trout.

DEP Classification

The North Fork and South Fork of Powell Creek are both classified as CWF. From the confluence of the North and South Forks to the mouth, Powell Creek is classified as trout stocking fishery (TSF). A small unnamed tributary along Dividing Ridge Road and Camp Hebron Road is listed as impaired by siltation caused by agricultural activity.

QUICK FACTS

Powell Creek watershed

Watershed Size: 39.6 mi^2 in Dauphin County

Stream Miles: 78.9

Impaired Stream Miles: 3.0

Land Uses: Predominantly agriculture and forest

DEP Stream Classification:

- North and South Forks – CWF
- Powell Creek – TSF

DEP Listed Impairments:

- An unnamed tributary –Siltation from agriculture activities

Watershed Municipalities:

Reed Twp, Halifax Twp, Wayne Twp

Site Locations

Powell Creek is surrounded by two mountain ridges with stream water flowing from each side into the valley. Before joining together as the main stem of Powell Creek, there are two main tributaries known as the North and South Powell Forks. One site was located on the North Fork, one on the South Fork, and four on the main stem of Powell Creek from Back Road to Mountain Road

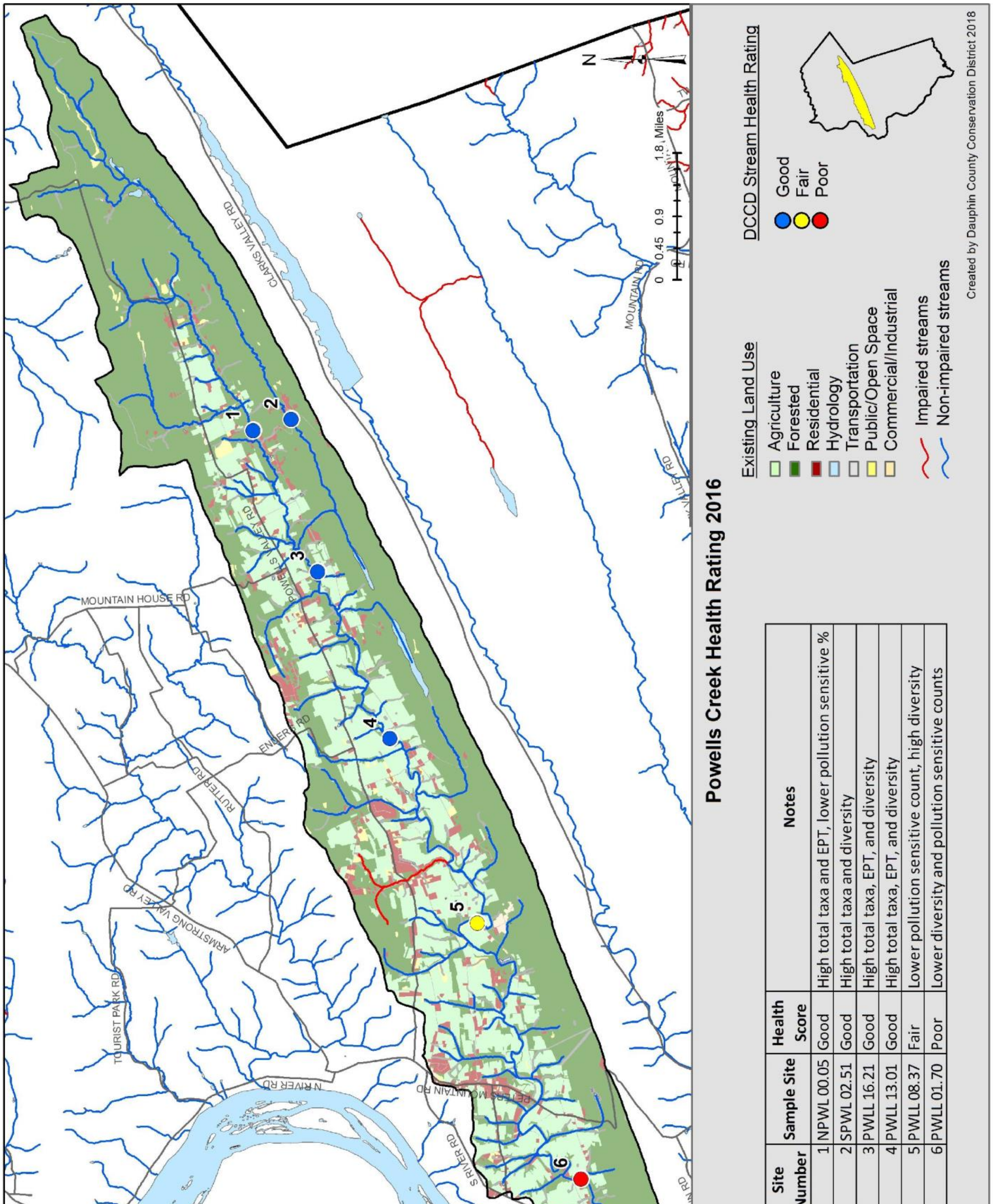
Study Results

Six sites were sampled in the Powell Creek watershed. Site PWLL 16.21, located near Back Road, downstream of the confluence of the North and South Powell Forks, had a good health score, showing high diversity, high numbers of total types of macroinvertebrates and pollution sensitive EPT types. The next site downstream, PWLL 13.01, located near the Lebo Road bridge, also ranked a good health score with high diversity, total types, and pollution sensitive EPT types. The next site downstream, PWLL 08.37, located near Camp Hebron by the Camp Hebron Road bridge, ranked fair, showing lower numbers of pollution sensitive macroinvertebrates but having a high diversity of macroinvertebrate types. The final mainstem site, PWLL 01.70, ranked poor, having a lower number of pollution sensitive types and a lower diversity.

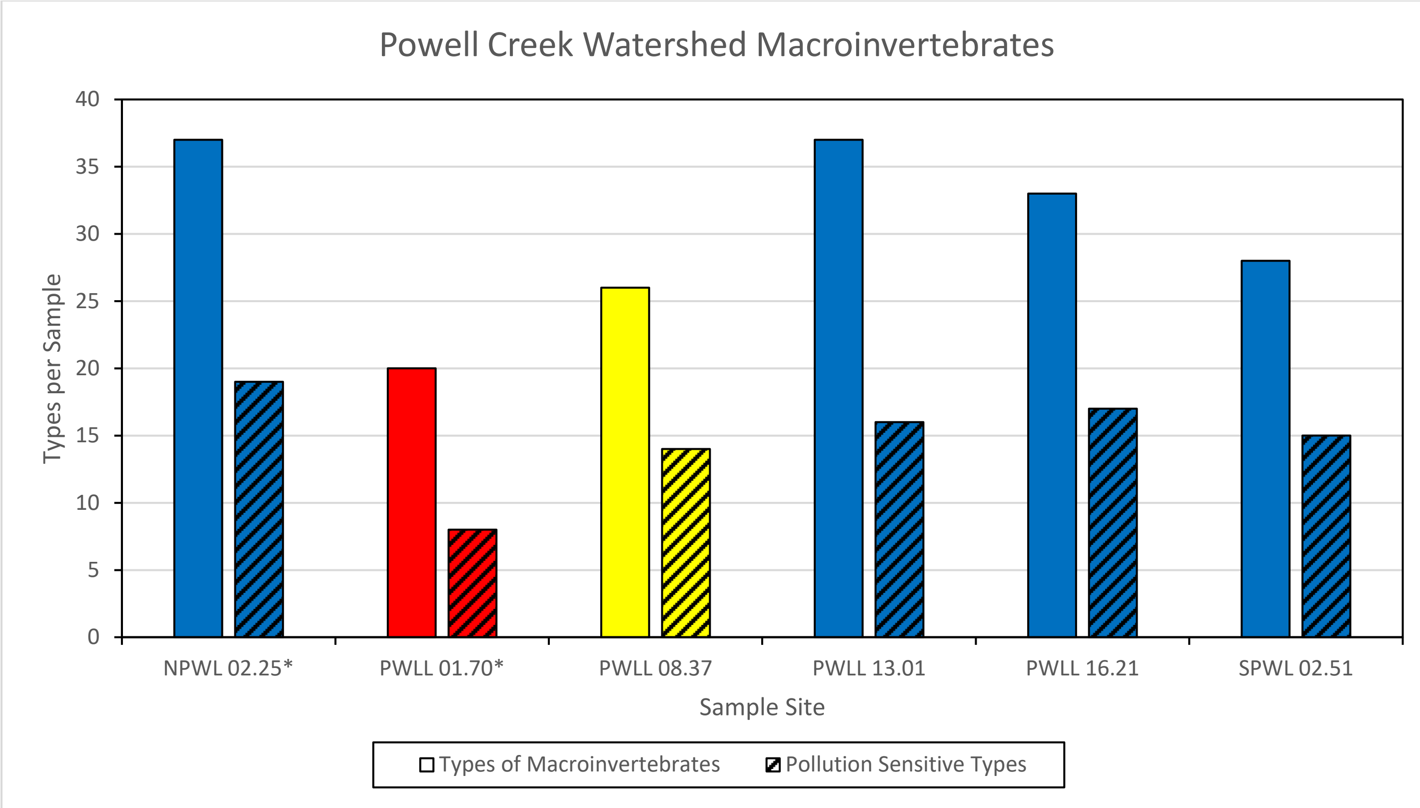
Site NPWL 02.25, on the North Fork of Powell Creek at Back Road, and site SPWL 02.51 on the South Fork of Powell Creek at Carsonville Road, also rated as good. The North Fork site had a high number of total macroinvertebrate types and high numbers of pollution sensitive EPT types. The South Fork site had a high diversity and high numbers of total macroinvertebrate types.

A complete table of metrics calculations and sample cycle score comparison charts can be found in Appendix VI-VII.

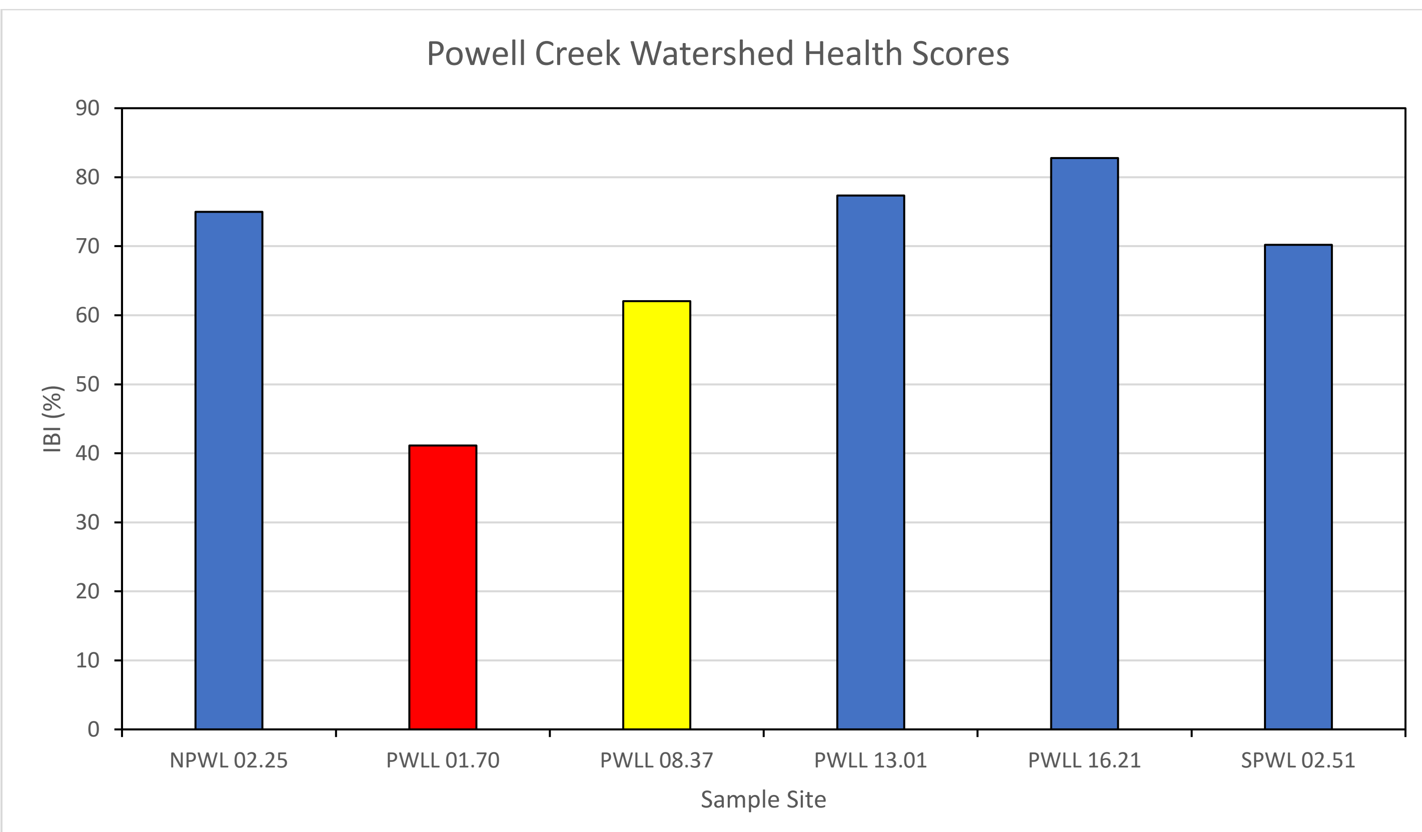
Figure 7.4



Site Number	Sample Site	Health Score	Notes
1	NPWL 00.05	Good	High total taxa and EPT, lower pollution sensitive %
2	SPWL 02.51	Good	High total taxa and diversity
3	PWLL 16.21	Good	High total taxa, EPT, and diversity
4	PWLL 13.01	Good	High total taxa, EPT, and diversity
5	PWLL 08.37	Fair	Lower pollution sensitive count, high diversity
6	PWLL 01.70	Poor	Lower diversity and pollution sensitive counts


Powell Creek Watershed Macroinvertebrates
Types per Sample
40
35
30
25
20
15
10
5
0
NPWL 02.25*
PWLL 01.70*
PWLL 08.37
PWLL 13.01
PWLL 16.21
SPWL 02.51
Sample Site
Types of Macroinvertebrates
Pollution Sensitive Types


Stream Health:
Good Fair Poor


Powell Creek Watershed Health Scores
IBI (%)
90
80
70
60
50
40
30
20
10
0
NPWL 02.25
PWLL 01.70
PWLL 08.37
PWLL 13.01
PWLL 16.21
SPWL 02.51
Sample Site

7.5 CLARK CREEK

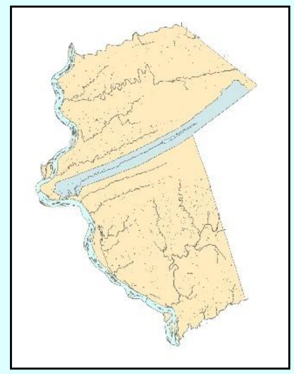
Description

Clark Creek before entering the Susquehanna River.

The Clark Creek watershed drains an area of 43.1 square miles in central Dauphin County. The watershed is a long narrow basin approximately 25 miles long with an average width of about 1.5 miles. The stream flows west joining the Susquehanna River northeast of Dauphin Borough. There are no significant tributaries, only small streams draining the steep mountainsides; Third and Stony Mountain to the south and Peters Mountain to the north.

Most of the watershed is forested with a significant amount of land in public ownership. Population density is very low. Located along the mainstem of Clark Creek in Rush Township is the DeHart Dam. Constructed from 1939 to 1940, the dam forms the DeHart Reservoir, a drinking water source the city of Harrisburg and the surrounding area. The reservoir has billions of gallons of capacity and has a required conservation release which provides year-round flow to Clark Creek. Topography is typical of the Ridge and Valley physiographic province in Pennsylvania. The ridges of the Clark Creek watershed are composed mainly of red and gray sandstone with some conglomerate. The valley is underlain with sandstone and shale.

QUICK FACTS



Clark Creek watershed

Watershed Size: 43.1 mi^2 in Dauphin County

Stream Miles: 46.9

Impaired Stream Miles: 0

Land Uses: Predominantly forested

DEP Stream Classification:

- Cold Water Fishery
- High Quality, Special Protection waters
- Trout Stocking Fishery

DEP Listed Impairments:

None

Watershed Municipalities:

Jackson Twp, Jefferson Twp, Middle Paxton Twp, Rush Twp

DEP Classification

Clark Creek is classified as a High Quality – Cold Water Fishery (HQ-CWF) designated special protection waters. The creek is also classified as a Trout Stocking Fishery (TSF).

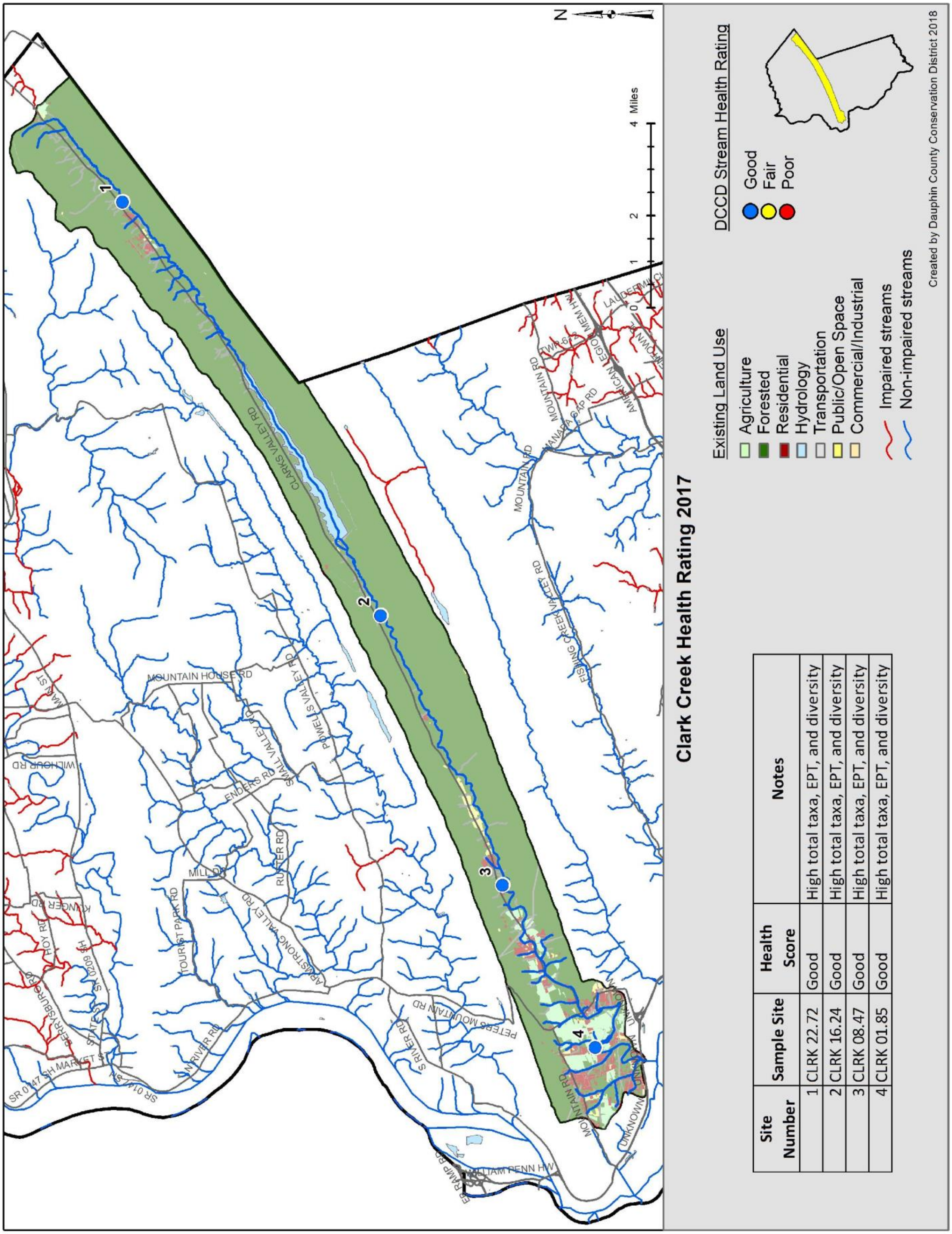
Site Locations

Four sites were located on Clark Creek, all on the main stem. Site CLRK 22.72, furthest upstream was located above the Dehart Dam. CLRK 16.24 was located near the intersection of Clark Creek and The Appalachian Trail. CLRK 08.47 was located near Victoria Furnace. CLRK 01.85 was located furthest downstream at McKelvey Road.

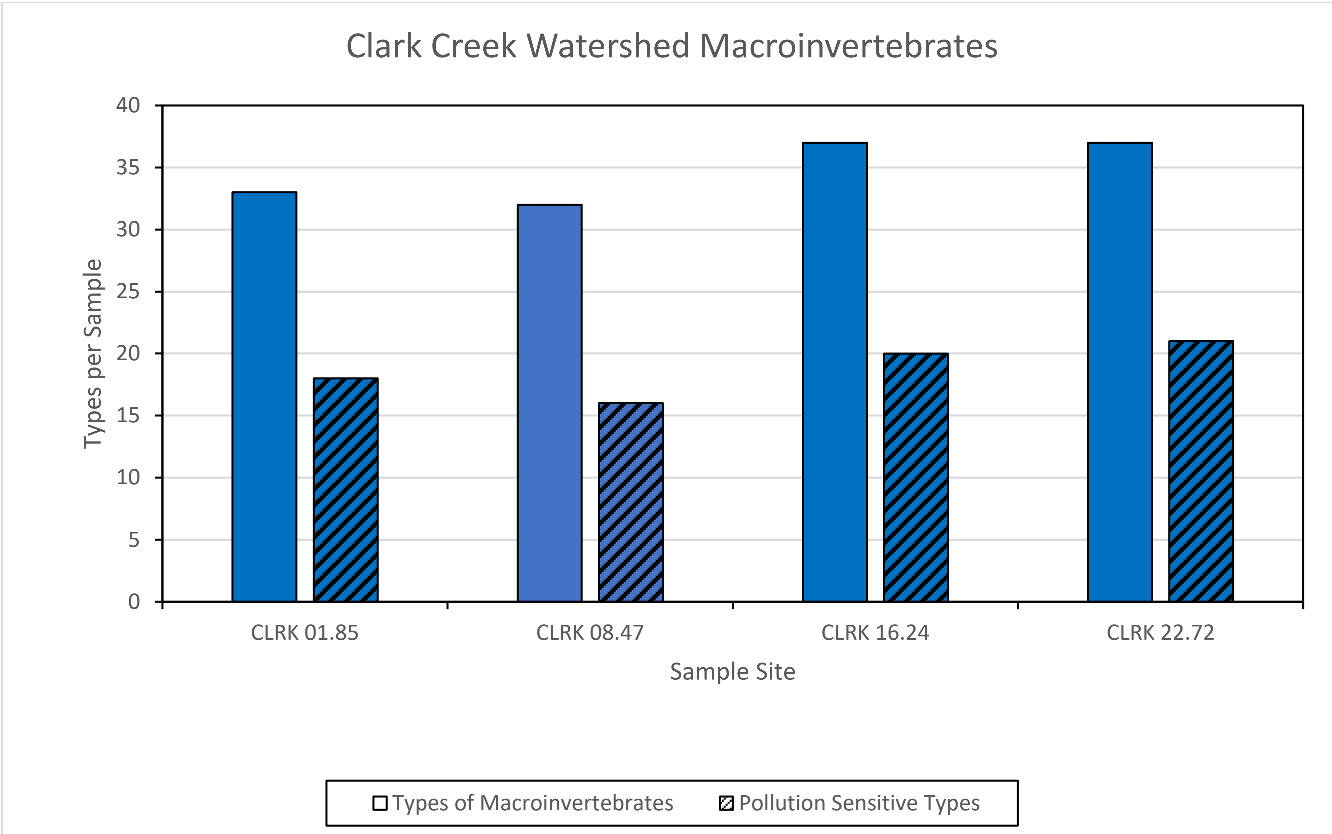
Study Results

The sites all recorded good health scores, with high numbers of total macroinvertebrate types, high numbers of pollution sensitive types, and high diversity.
A complete table of metrics calculations and sample cycle score comparison charts can be found in Appendix VI-VII.

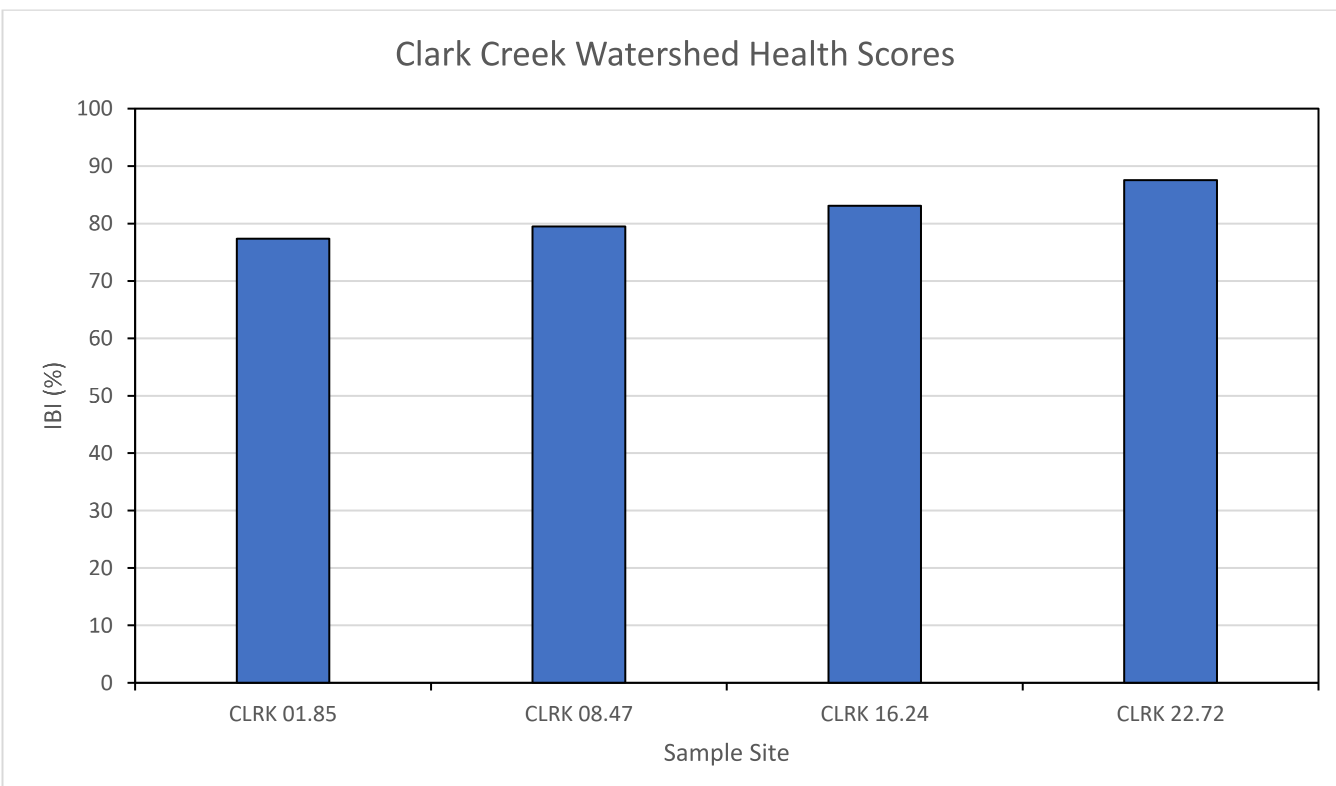
Figure 7.5



Site Number	Sample Site	Health Score	Notes
1	CLRK 22.72	Good	High total taxa, EPT, and diversity
2	CLRK 16.24	Good	High total taxa, EPT, and diversity
3	CLRK 08.47	Good	High total taxa, EPT, and diversity
4	CLRK 01.85	Good	High total taxa, EPT, and diversity



Stream Health:
Good Fair Poor



7.6 STONY CREEK

Description

Located between Second and Third Mountains in central Dauphin County, Stony Creek watershed drains an area of 24.0 square miles, with 12.4 mi^2 within the county. This mid-reach watershed is a long narrow basin about 21 miles long and 1.5 miles wide. Originating in northern Lebanon County, the Creek flows west to the Susquehanna River at Dauphin Borough. Two significant tributaries, Rausch Creek in Lebanon County and Rattling Run, drain small valleys located near the top of Third Mountain and paralleling the main basin.

The vast majority of the watershed is forested with over 80% of its land area in Pennsylvania Game Lands. The small portion of the watershed that is not forested is located at its western end. Population density for the watershed is very low. Dauphin Borough is the only population center in the watershed. Topography is typical of the Ridge and Valley physiographic province in Pennsylvania.

Stony Creek before entering the Susquehanna River.

QUICK FACTS

Watershed Size: 24.0 mi^2
12.4 mi^2 in Dauphin County

Land Uses: Predominantly forest

Stream Miles: 34.4

Impaired Stream Miles: 5.3

DEP Stream Classification:

- CWF
- HQ-CWF, Special Protection waters – Source to Ellendale Dam

DEP Listed Impairments:

- Rattling Run – AMD (low pH)

Watershed Municipalities:

Dauphin Borough, East Hanover Twp, Middle Paxton Twp

Stony Creek watershed

DEP Classification

Stony Creek is classified as a Cold Water Fishery (CWF) throughout its extent. From its headwaters to Ellendale Dam, the creek is considered High Quality (HQ). Rattling Run, a tributary running down from Stony Mountain, is impaired by low pH from Abandoned Mine Drainage (AMD). A tributary in Lebanon County, Rausch Creek, is also impaired by low pH from AMD.

Site Locations

Stony Creek was sampled at 3 sites were on the main stem and one site on Rattling Run, a tributary. A description of each sample site location can be found in Figure 7.6 below.

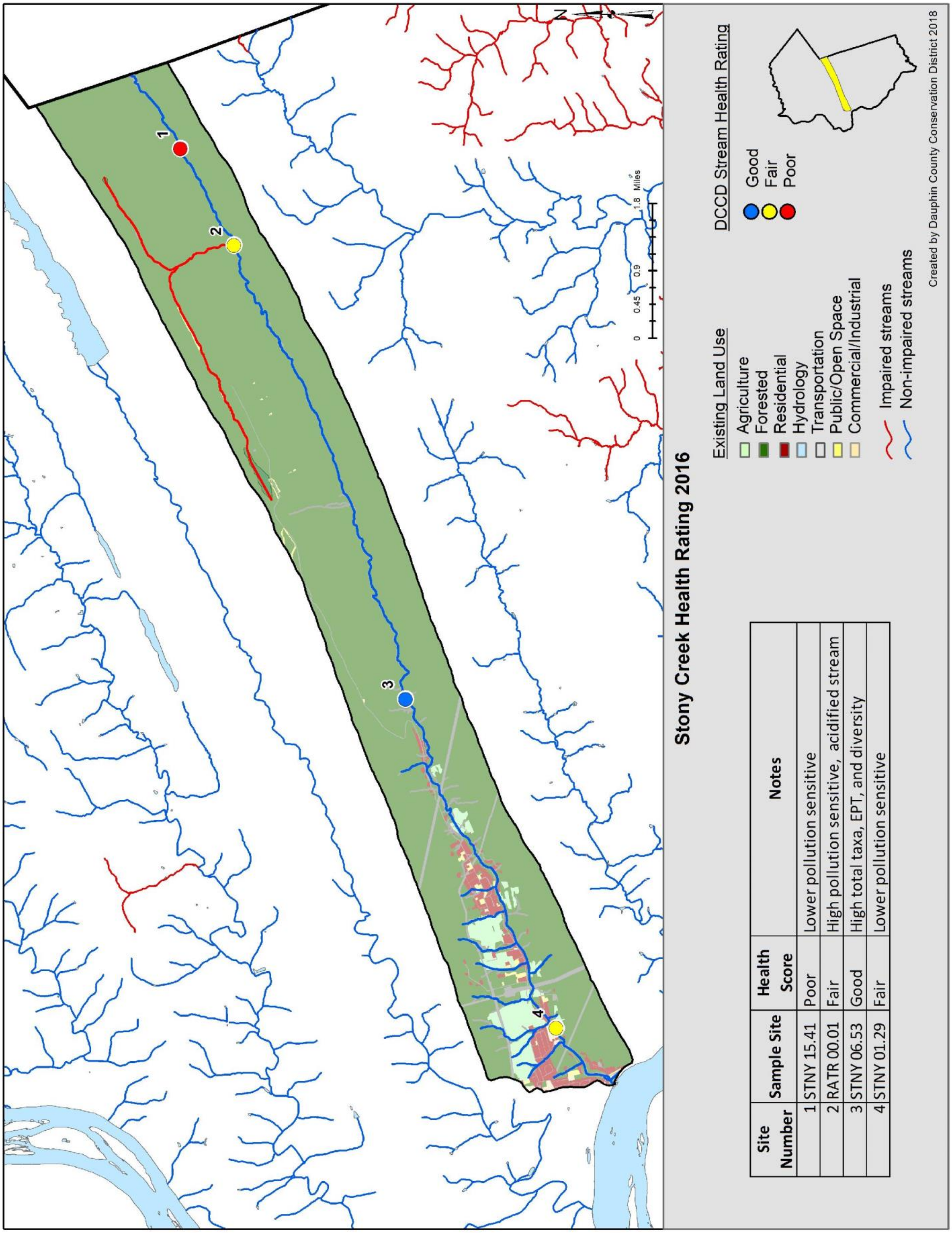
Study Results

The furthest upstream, STNY 15.41, was located near the Dauphin County line in State Game Lands 211. This site rated poor with a low percentage of pollution sensitive macroinvertebrates. Lower pH measurements were noted during this sample. STNY 06.53, near the Game Lands 211 gate, ranked good showing high numbers of total taxa, high diversity, and high numbers of mayfly, caddisfly, and stonefly types. STNY 01.29 at Denison Road, rated as fair, with low percentages of pollution sensitive types in the samples.

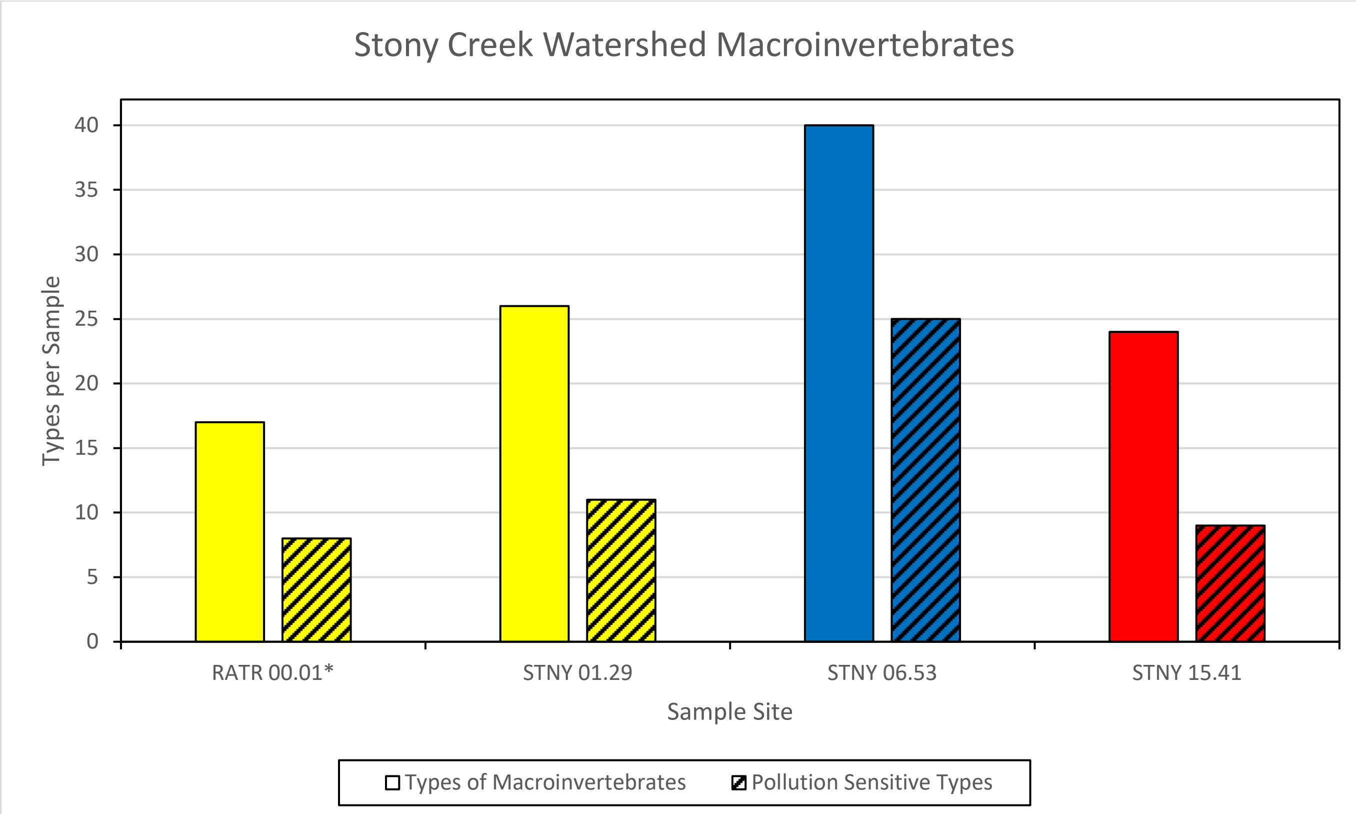
Site RATR 00.01, on Rattling Run, rated a with a fair health score. This stream is impaired by a low, acidic pH. Macroinvertebrate data reflected the acidified nature of the stream showing a dominance of acid tolerant stoneflies and midges and an absence of mayflies.

A complete table of metrics calculations and sample cycle score comparison charts can be found in Appendix VI-VII.

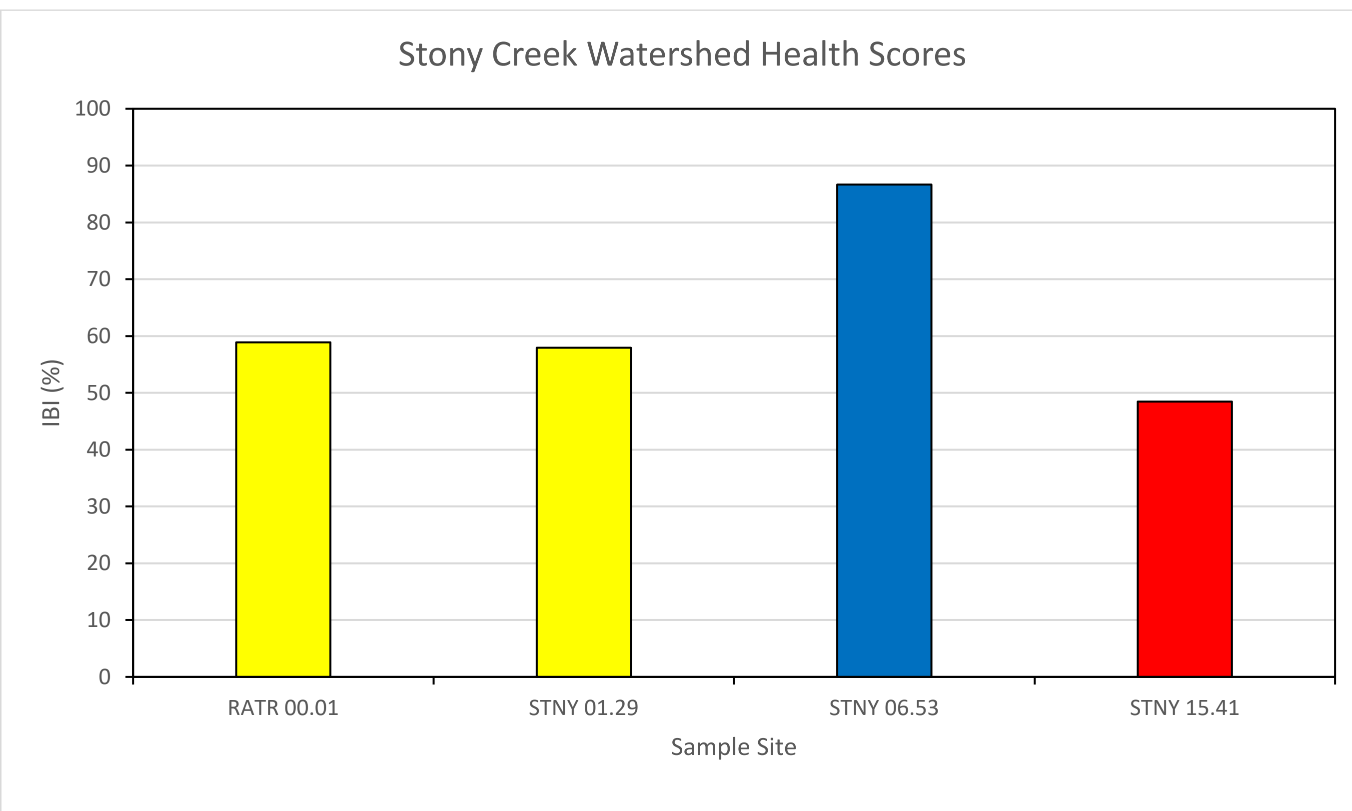
Figure 7.6



Site Number	Sample Site	Health Score	Notes
1	STNY 15.41	Poor	Lower pollution sensitive
2	RATR 00.01	Fair	High pollution sensitive, acidified stream
3	STNY 06.53	Good	High total taxa, EPT, and diversity
4	STNY 01.29	Fair	Lower pollution sensitive



Stream Health:
Good Fair Poor



7.7 FISHING CREEK

Description

Fishing Creek originates in northern West Hanover Township and flows west between Blue and Second Mountains in a narrow valley. Numerous small tributaries enter the stream from the mountains. It eventually flows into the Susquehanna River at Fort Hunter. The watershed is about 9.25 miles long and 2 miles wide and covers an area of 18.5 square miles. The entire watershed lies within Dauphin County.

Much of the watershed is forested with a low population density and a small amount of agriculture. Most of the development in the watershed is composed of residential road frontage at the west end of the watershed.

Topography is typical of the Ridge and Valley physiographic province in Pennsylvania with the stream located in a narrow, steep sided valley with flat to gentle slopes dominating the narrow valley floor. The mountain ridges of the watershed are composed of red and gray sandstone and conglomerate with shale being the dominate formation in the valley.

DEP Classification

Fishing Creek is listed as a Warm Water Fishery (WWF).

Site Locations

Each of the three sample sites within Fishing Creek watershed was located on the main stem of the waterway. For a description of each location, refer to Figure 7.7 below.

Fishing Creek before entering the Susquehanna River.

QUICK FACTS

Watershed Size: 18.5 mi^2 in Dauphin County

Stream Miles: 27.4

Impaired Stream Miles: 0

Land Uses: Predominantly forest, Some residential and Minimal agriculture

DEP Stream Classification:

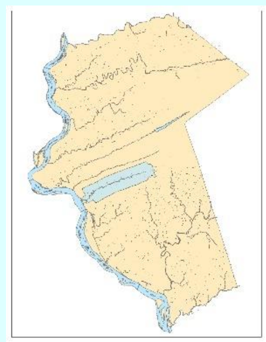
- WWF

DEP Listed Impairments:

None

Watershed Municipalities:

Lower Paxton Twp, Middle Paxton Twp, Susquehanna Twp, West Hanover Twp

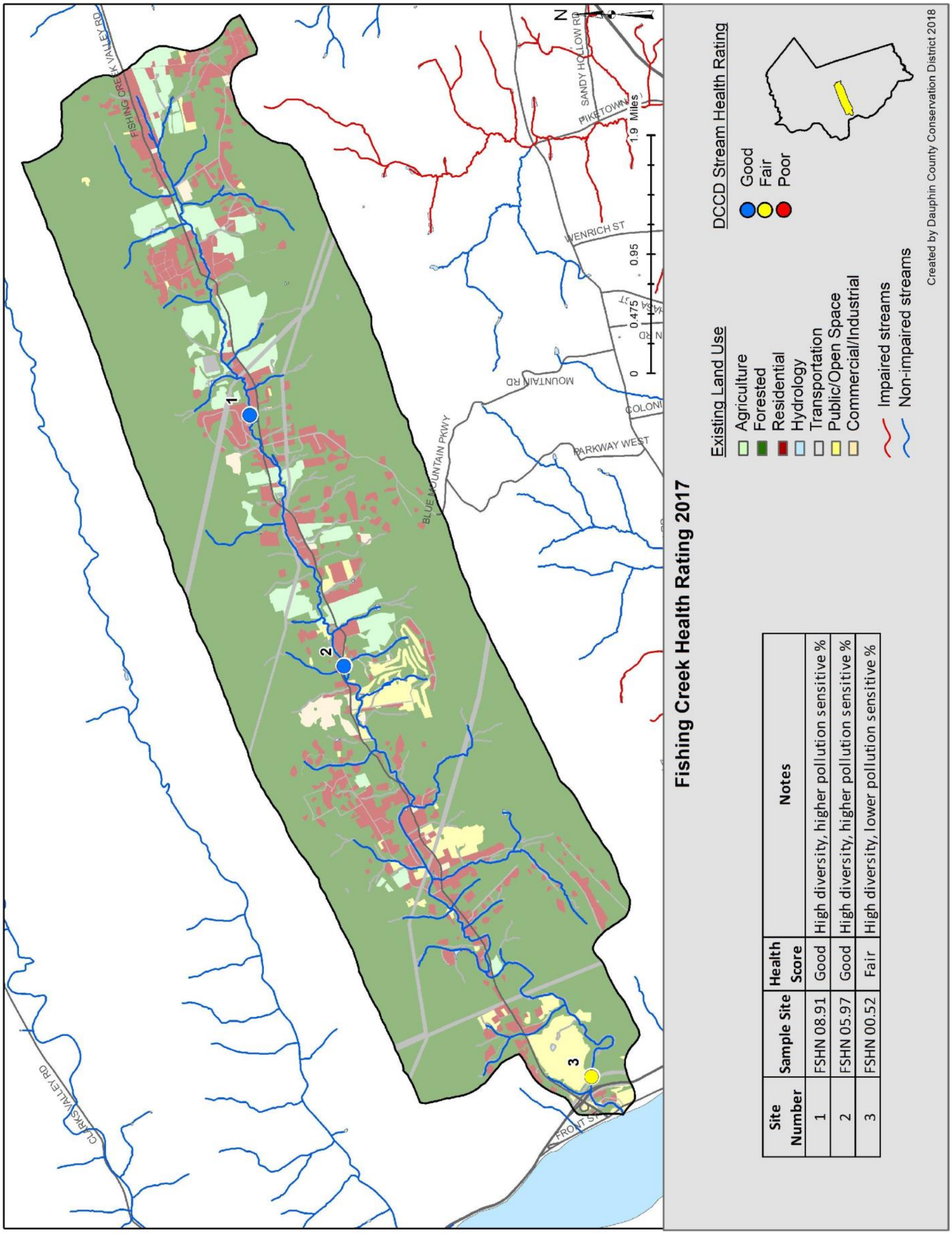


Fishing Creek watershed

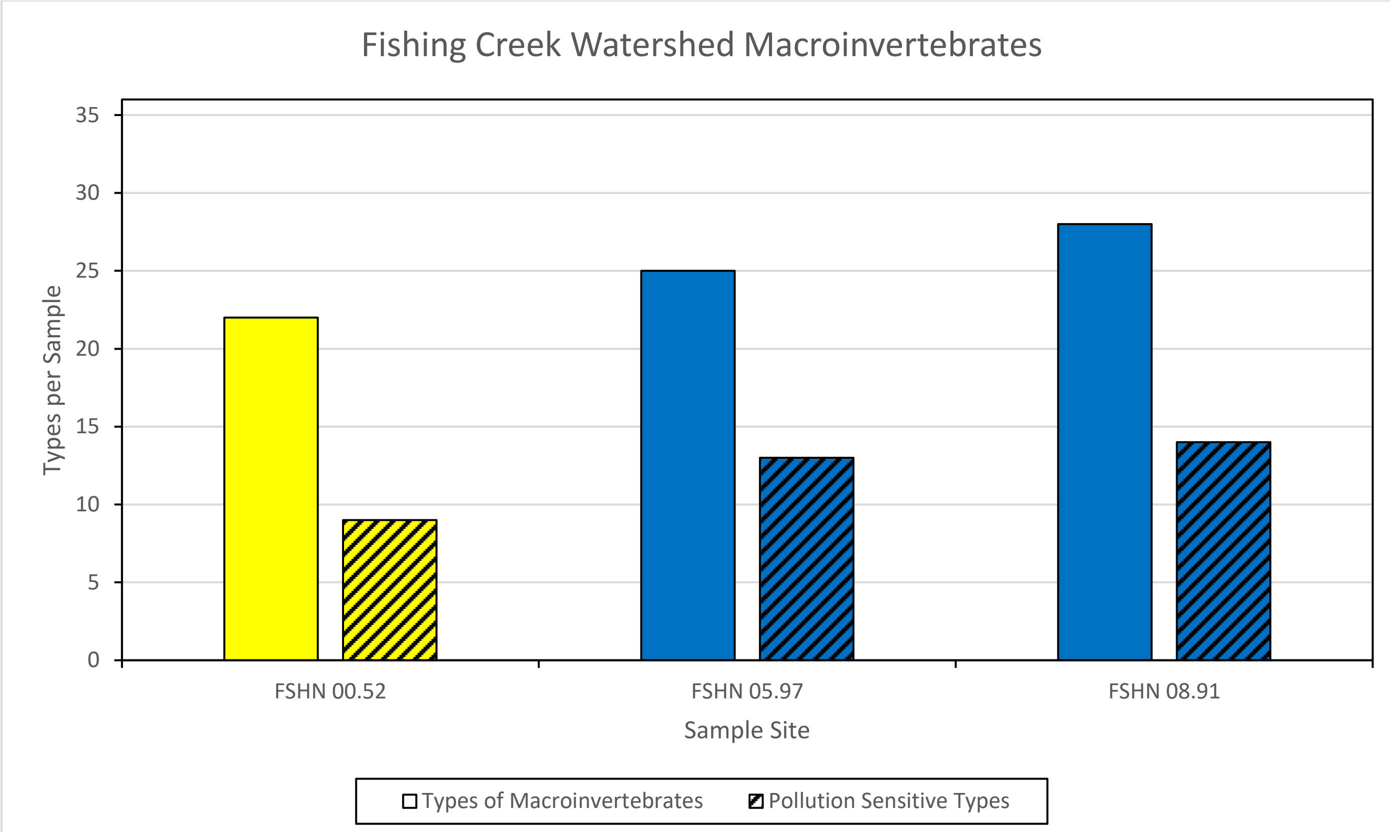
Study Results

The furthest upstream, FSHN 08.91 was located at Hickory Hollow Road and rated a health score of good, with high diversity and high percentages of pollution sensitive macroinvertebrates. FSHN 05.97 was located at Straw Hollow Road also rated a good health with high diversity and high percentages of pollution sensitive macroinvertebrates. FSHN 00.52 the furthest downstream was located upstream of Fort Hunter Park and rated a fair health score having lower percentages of pollution sensitive macroinvertebrates but high diversity.
A complete table of metrics calculations and sample cycle score comparison charts can be found in Appendix VI-VII.

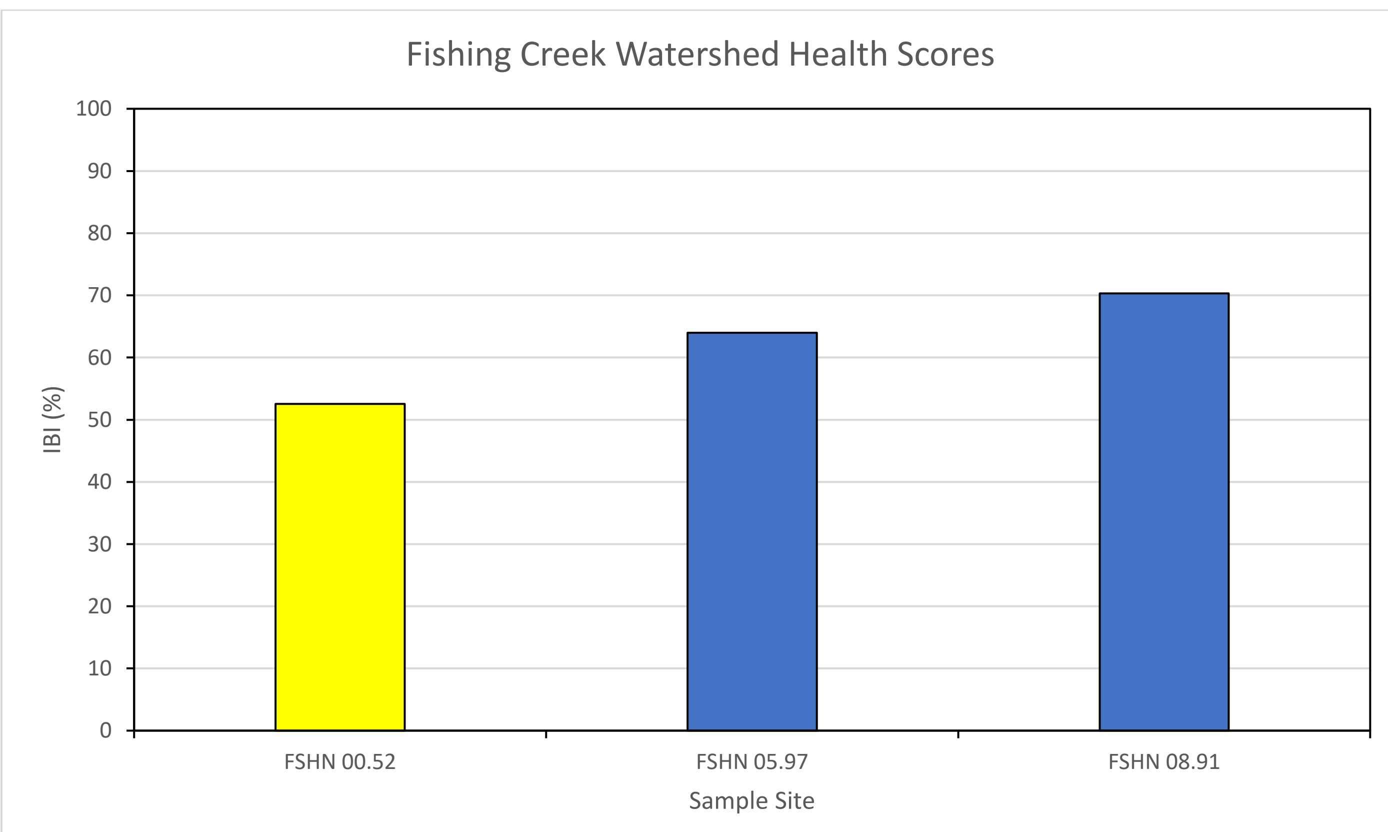
Figure 7.7



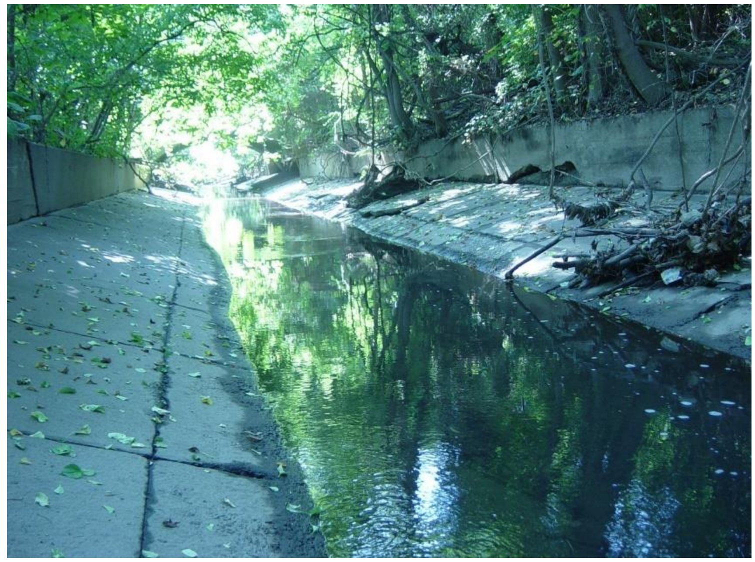
Site Number	Sample Site	Health Score	Notes
1	FSHN 08.91	Good	High diversity, higher pollution sensitive %
2	FSHN 05.97	Good	High diversity, higher pollution sensitive %
3	FSHN 00.52	Fair	High diversity, lower pollution sensitive %



Stream Health:
Good Fair Poor



7.8 PAXTON CREEK



Paxton Creek before entering the Susquehanna River.

Description

The 27 square mile Paxton Creek watershed is located in southwestern Dauphin County with headwaters on the southern slope of Blue Mountain in Susquehanna and Lower Paxton Townships. About 18 square miles of the stream, located in these townships, drains to Wildwood Lake. Upstream of the lake the watershed can be characterized as extensively developed suburban land dominated by low to medium density residential development. A small amount of the land area is in farmland with forestland confined to the slope of the Blue Mountain. Downstream of Wildwood Lake the stream flows south entering the heavily urbanized Harrisburg City. The stream channel throughout the City is confined to a concrete channel constructed to mitigate flooding. The creek joins the Susquehanna at the southern end of the city. Topography in most of the watershed is generally flat to gently sloping. The geology of the watershed is mostly shale, silt and sandstone.

QUICK FACTS

Watershed Size: 27 mi^2 in Dauphin County

Land Uses: Primarily Urban/Suburban, Residential
Stream Miles: 50.4

Impaired Stream Miles: 19.3

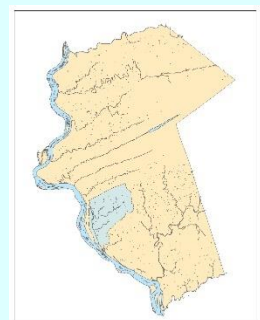
DEP Stream Classification:

- WWF

DEP Listed Impairments:

- Sedimentation from Urban runoff, agriculture, and storm sewers

Watershed Municipalities:
Lower Paxton Twp, Middle Paxton Twp, Harrisburg City, Penbrook Borough, Susquehanna Twp



Paxton Creek watershed

DEP Classification

Paxton Creek is classified as a Warm Water Fishery (WWF). A substantial section of Paxton Creek and two tributaries are listed as impaired by siltation and nutrients. The source of the impairments is identified as from urban runoff and storm sewers.

Site Locations

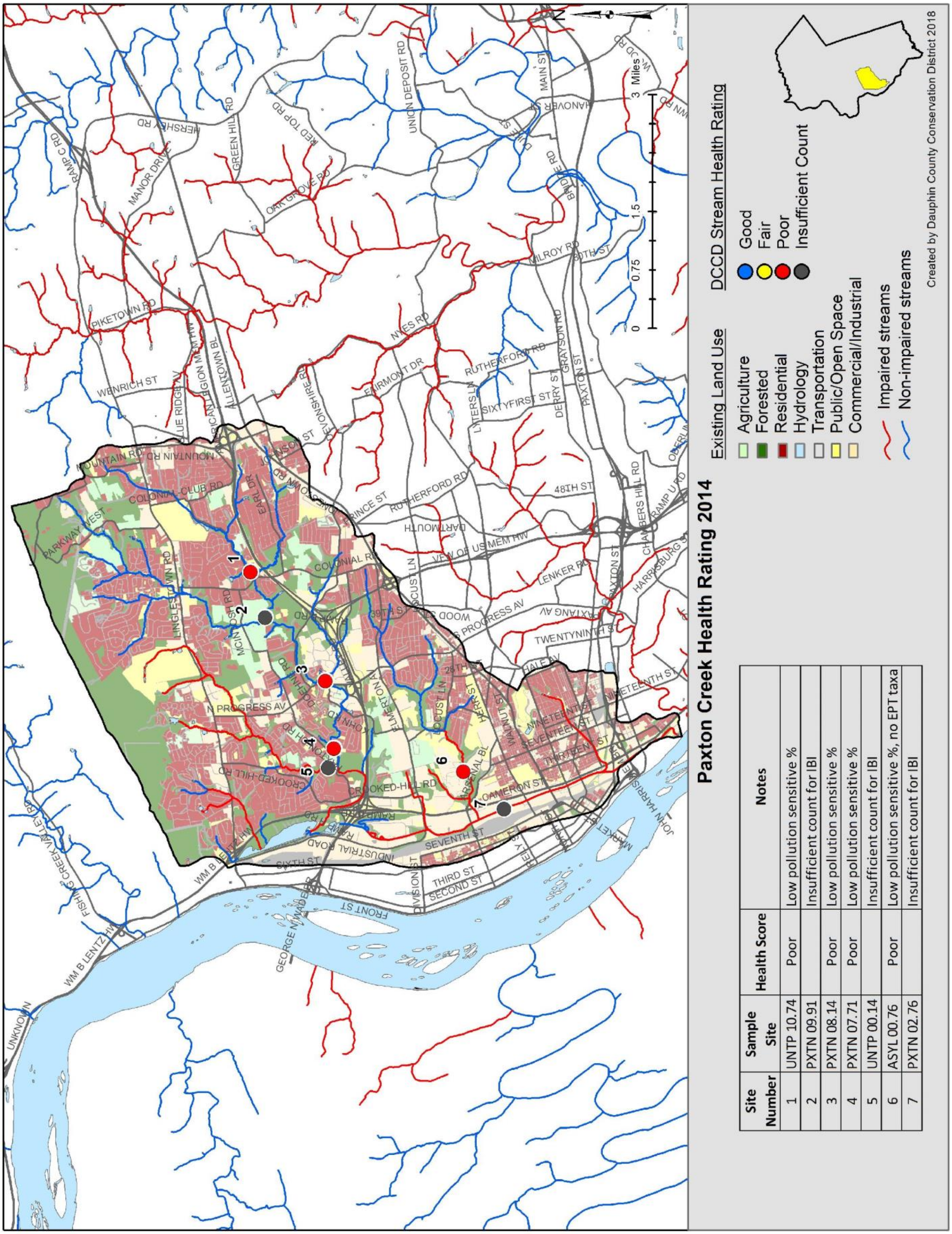
Seven sites were sampled in the Paxton Creek watershed. Four sites on the main stem; PXTN 09.91, downstream of the McIntosh Road Bridge near the end of Paxton Church road, PXTN 08.14 at Interstate Drive, PXTN 07.71 along Paxton Church Road upstream from the Walker Mill Road bridge, and PXTN 02.76 at Reily Street. Tributaries sampled were one site on Black Run, UNTP 00.14, near Shutt Mill Road and Paxton Church Road. An unnamed tributary was sampled at site UNTP 10.71, located near Geraldine Drive and Goose Valley Road. One site, ASYL 00.76 on Asylum Run along Sycamore Drive off near Elmerton Avenue. Figure 7.8 describes the locations of each of the Paxton Creek watershed sample sites, shown below.

Study Results

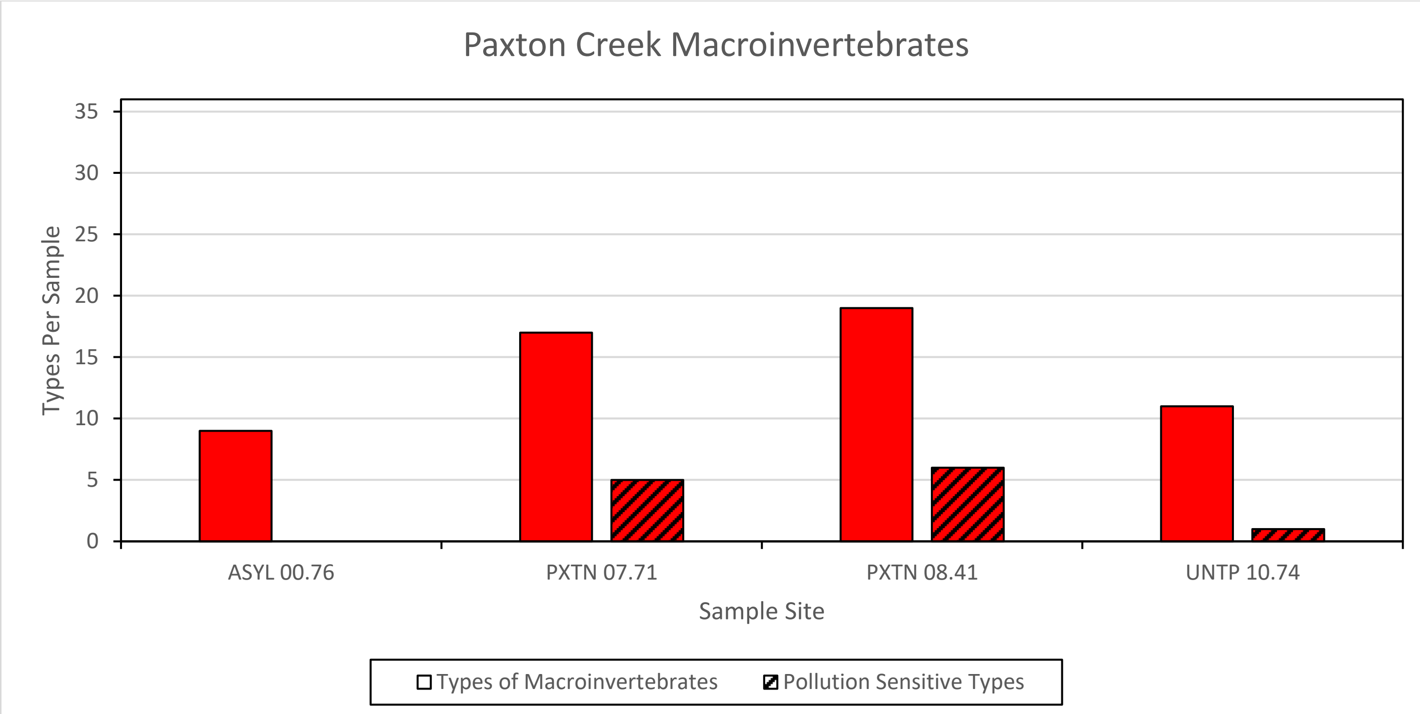
Several sites did not have sufficient numbers of macroinvertebrates to calculate a health score. All other sites rated as poor with low percentages of pollution sensitive macroinvertebrate types.

A complete table of metrics calculations and sample cycle score comparison charts can be found in Appendix VI-VII.

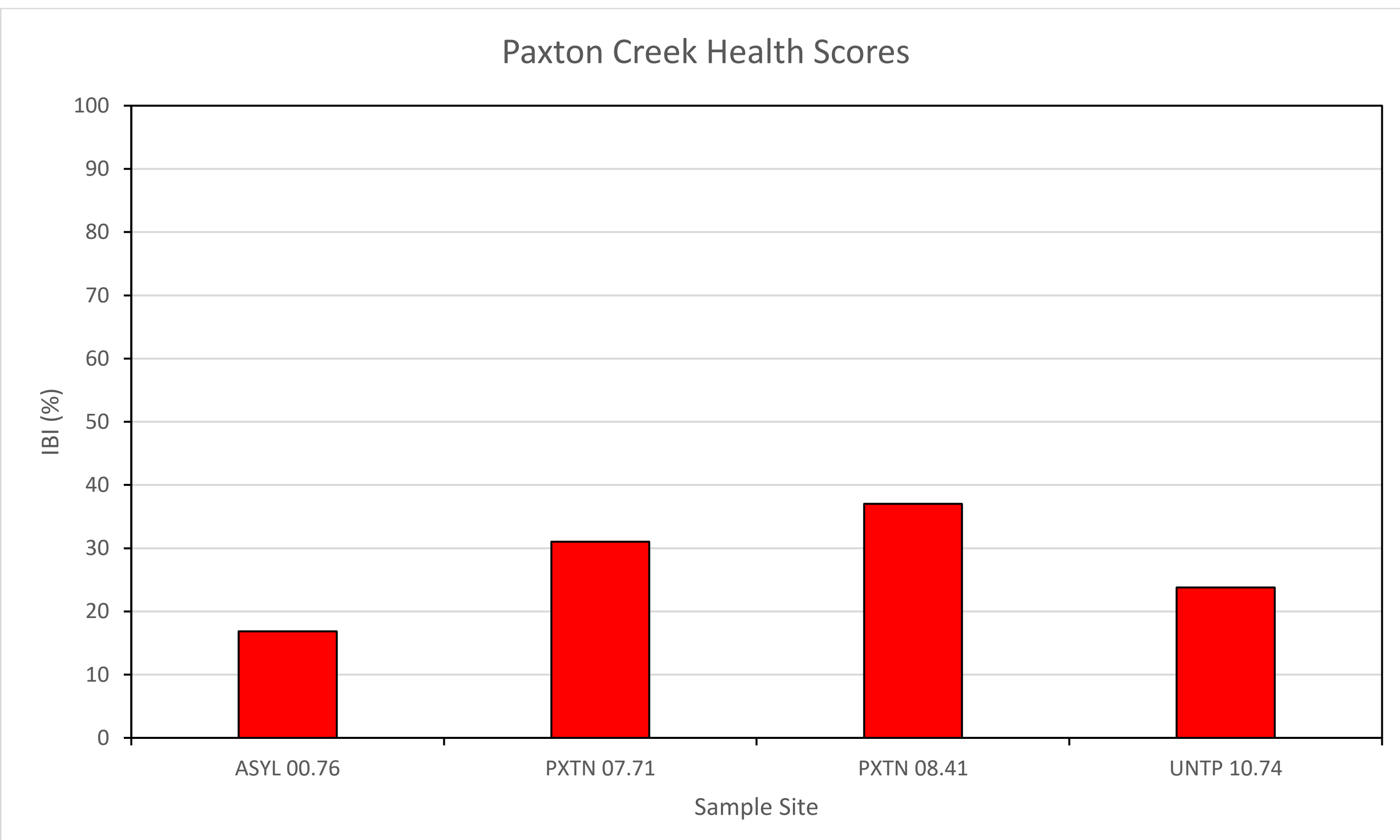
Figure 7.8



Site Number	Sample Site	Health Score	Notes
1	UNTP 10.74	Poor	Low pollution sensitive %
2	PXTN 09.91		Insufficient count for IBI
3	PXTN 08.14	Poor	Low pollution sensitive %
4	PXTN 07.71	Poor	Low pollution sensitive %
5	UNTP 00.14		Insufficient count for IBI
6	ASYL 00.76	Poor	Low pollution sensitive %, no EPT taxa
7	PXTN 02.76		Insufficient count for IBI



Stream Health:
Good Fair Poor



7.9 SPRING CREEK WEST

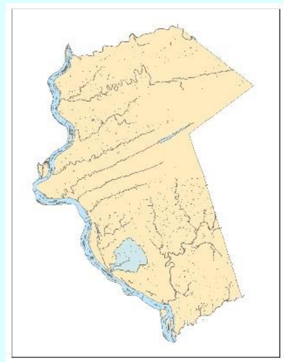
Spring Creek West before entering the Susquehanna River.

Description

The Spring Creek (West) watershed located in southwest Dauphin County, drains an area of about 11.6 square miles. The entire watershed lies in Dauphin County. The headwaters are in Lower Paxton Township and, to a lesser extent, in Susquehanna and Swatara Townships. The stream flows in a westerly direction eventually joining the Susquehanna River in southern Harrisburg City. The watershed has a widely varied mix of urban and suburban land uses and is highly urbanized as it nears its confluence with the Susquehanna River. Population centers include Harrisburg City, Paxtang Borough and Penbrook Borough.

Topography in most of the watershed is flat to gently sloping. The geology of the watershed is composed of shale, limestone, and sandstone.

QUICK FACTS



Spring Creek West

Watershed Size: 11.6 mi^2 in Dauphin County

Land Uses: Primarily Urban/Suburban, Residential

Stream Miles: 17.4

Impaired Stream Miles: 11

DEP Stream Classification:

- Coldwater Fishery

DEP Listed Impairments:

- Sedimentation from urban runoff and storm sewers

Watershed Municipalities:

Harrisburg City, Lower Paxton Twp, Paxtang Borough, Penbrook Borough, Susquehanna Twp, Swatara Twp

DEP Classification

Spring Creek (West) is classified as a Cold Water Fishery (CWF). A substantial section of the Creek is listed as impaired by siltation. The source of this impairment is identified as originating from urban runoff and storm sewers.

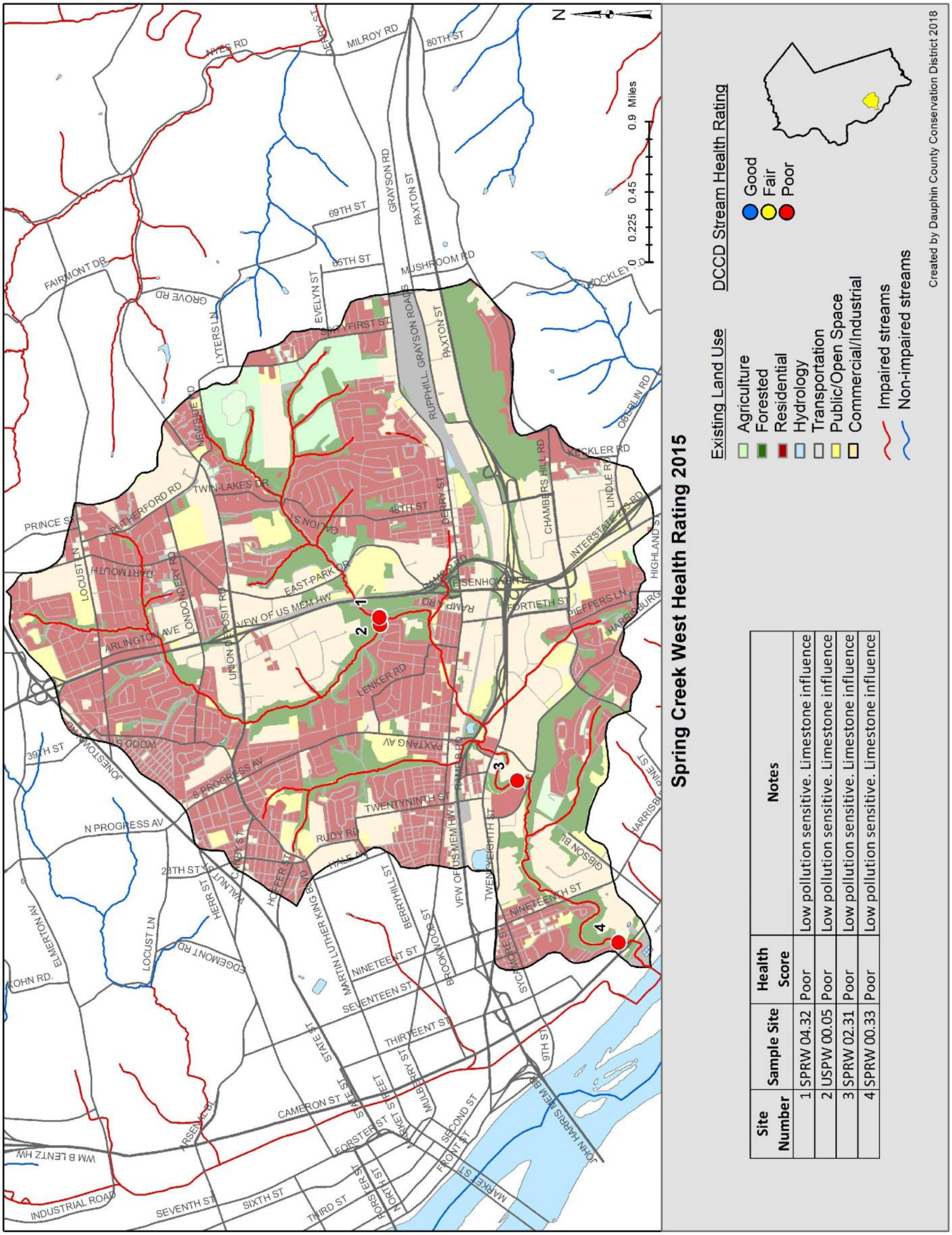
Site Locations

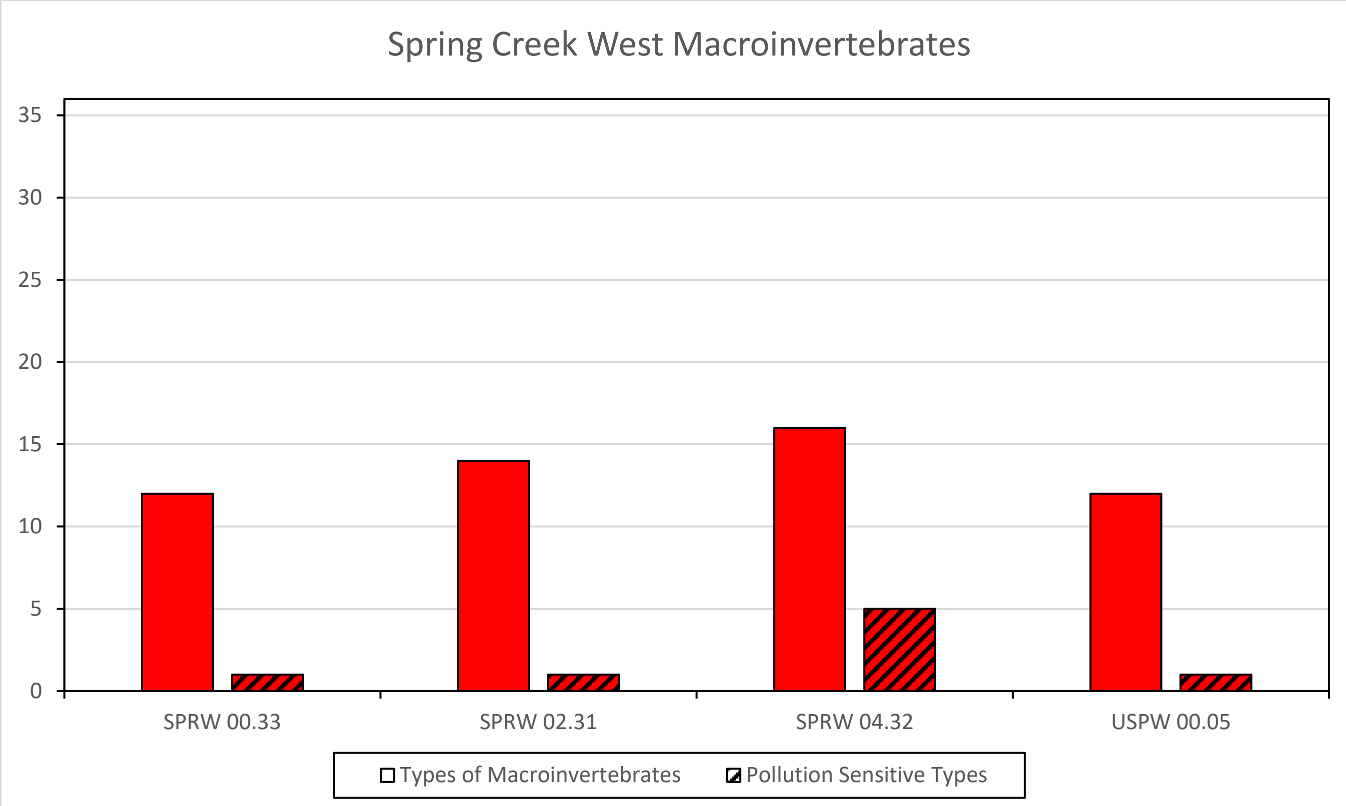
Four sites were sampled in this watershed; three on the main stem. From upstream to downstream these are site SPRW 04.32 at N 40th St/Cadden Parkway/ Spring Creek Road, SPRW 02.31 at the Five Senses Garden, and SPRW 00.33 near Elliot Street and Cameron Street. One site, USPW 00.05, site was located on an unnamed tributary at N 40th St/Cadden Parkway/ Spring Creek Road. Locations for each site are described in Figure 7.9, found below.

Study Results

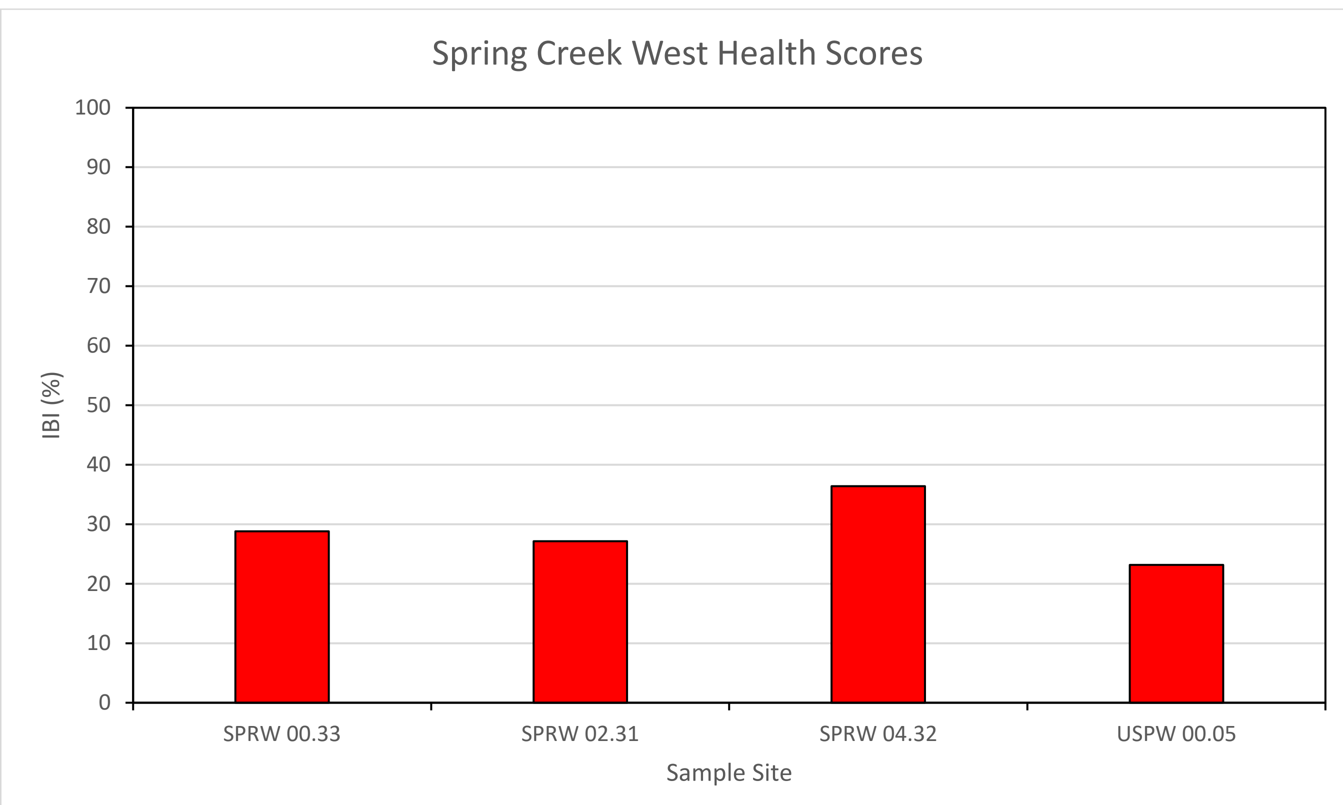
All sites rated as poor. Very low numbers of sensitive macroinvertebrate types were found in all samples. All samples showed pollution sensitive individual macroinvertebrates as a small percentage of the sample. Limestone influence was factored into the calculation, but the sites still rated low.
A complete table of metrics calculations and sample cycle score comparison charts can be found in Appendix VI-VII.

Figure 7.9


Spring Creek West Health Rating 2015
Existing Land Use
Agriculture
Forested
Residential
Hydrology
Transportation
Public/Open Space
Commercial/Industrial
Impaired streams
Non-impaired streams
DCCD Stream Health Rating
Good
Fair
Poor
0 0.225 0.45 0.9 Miles
Created by Dauphin County Conservation District 2018
Site Number | Sample Site | Health Score | Notes
1 | SPRW 04.32 | Poor | Low pollution sensitive. Limestone influence
2 | USPW 00.05 | Poor | Low pollution sensitive. Limestone influence
3 | SPRW 02.31 | Poor | Low pollution sensitive. Limestone influence
4 | SPRW 00.33 | Poor | Low pollution sensitive. Limestone influence



Stream Health:
Good Fair Poor



7.10 SWATARA CREEK

Description

Swatara Creek is a large watershed covering, 571 mi^2, 127.3 mi^2 of which are in Dauphin County. The stream originates in Berks and Schuylkill Counties, generally moving southwest through Lebanon and Dauphin Counties where it meets the Susquehanna River at Middletown Borough. Major tributaries in Dauphin County include Beaver Creek, Kellock Run, Manada Creek, and Bow Creek entering Swatara Creek from the north and Spring Creek East entering from the south. The watershed in Dauphin County is characterized by extensive suburban development with some areas of farmland and forestland. Population centers in the watershed include Hershey and surrounding area, Hummelstown Borough, and Middletown Borough.

Swatara Creek before entering the Susquehanna River.

Topography in the watershed is characterized by relatively low, rolling hills. The geology of the watershed is composed of two geologic formations. The formation in the northern and eastern portion of the watershed contains shale, limestone, dolomite, and sandstone. Geology in the southwestern portion is characterized by red sandstone, shale and conglomerate intruded by diabase. In areas of the watershed underlain by limestone, Karst topography dominates with many areas prone to sinkhole formation.

DEP Classification

Swatara Creek and its major tributaries are classified as a Warm Water Fishery (WWF) with the exception of Manada Creek which is listed as a Cold Water Fishery (CWF) from its source to Interstate-81. Sections of the Swatara Creek are listed as impaired by siltation from agricultural sources. Relatively small sections of Beaver Creek are impaired by siltation from urban/suburban and agriculture sources. A small section of Manada Creek is listed as impaired by pathogens and nutrients from a municipal point source and siltation from road runoff. Two small sections of Bow Creek are identified as impaired by priority organics and siltation from road runoff and agriculture. Extensive areas of Spring Creek East are listed as impaired by siltation, organic enrichment and low dissolved oxygen from agricultural activities, urban runoff and storm sewers.

QUICK FACTS

Watershed Size: 571 mi^2,
127 mi^2 in
Dauphin County

Land Uses: Wide variety

Stream Miles: 253.3

Impaired Stream Miles: 58.1

Swatara Creek watershed

DEP Stream Classification:

- Section of Manada Creek from source to I-81 – CWF
- Swatara Creek and all other tributaries – WWF

DEP Listed Impairments:

- Sections of Swatara Creek – siltation from agriculture
- Section of Beaver Creek – Siltation from urban/suburban runoff and agriculture
- Section of Manada Creek – Pathogens and nutrients from a municipal point source, siltation from road runoff
- Sections of Bow Creek – Priority organics and siltation from road runoff and agriculture
- Sections of Spring Creek East – Siltation, organic enrichment, and low dissolved oxygen from agriculture, urban runoff, and storm sewers

Watershed Municipalities:

Conewago Twp, Derry Twp, East/West/South Hanover Twps, Hummelstown Borough, Londonderry Twp, Lower Paxton Twp, Middletown Borough, Lower Swatara Twp, Swatara Twp

Site Locations

Four Sites were located on the main stem of Swatara Creek, while 28 locations were sampled in its sub-watersheds. The Manada Creek watershed had six sample sites, six sites were in the Beaver Creek watershed, one site was located on Kellock Run, three sites in the Bow Creek watershed, eight in the Spring Creek East watershed, two on Iron Run, and two sites on unnamed tributaries to Swatara Creek. The locations of these sites are described in Table 7.10 below.

Study Results

The Swatara Creek watershed had 32 sites located on the main stem and several tributaries. Due to the size of the watershed, the total number of sites, and the number large tributaries, the sampling results will be discussed by tributaries and by results on the main stem.

<u>Unnamed Tributary</u>
An unnamed tributary was sampled at site UNTS 00.63, located at Union Street. This site ranked as poor showing low numbers of pollution sensitive mayfly, stonefly, and caddisfly (EPT) insect types. High numbers of Amphipods and underlying geology support a limestone influence being present on this stream.

<u>Beaver Creek</u>
Six sites were sampled in the Beaver Creek Watershed. One site on the tributary Nyes Run, NYES 01.54, along Nyes road had insufficient numbers of undamaged macroinvertebrates to calculate a health score. The downstream site on Nyes Run, NYES 00.10, ranked a poor health score, having high numbers of total taxa types and high diversity but low numbers of pollution sensitive macroinvertebrates. The site located downstream of Knight Road on an unnamed tributary to Beaver Creek, UNTB 00.26, ranked poor, showing high total numbers of macroinvertebrate types, high diversity, but low numbers of pollution sensitive types. On the main stem of Beaver Creek, the upstream sites, BEVR 09.34, at Linglestown Road and Piketown Road and BEVR 07.35 located upstream of the bridge at Jonestown Road, both ranked poor with low numbers of pollution sensitive macroinvertebrates. The furthest downstream was BEVR 02.18 near the Nyes Road Bridge which ranked poor but showed high numbers of total types and high diversity but low numbers of pollution sensitive types.

<u>Kellock Run</u>
The one site on Kellock Run, KLCK 00.07 at Stonemill Road, ranked poor, showing low diversity and low numbers of pollution sensitive macroinvertebrate types.

<u>Manada Creek</u>
The Manada Creek watershed had six sites sampled, four on the main stem and two in tributaries. MNDA 13.64, located downstream of the bridge at McLean Road, ranked a health score of good with high numbers of macroinvertebrate types, high diversity, and high numbers of EPT types. The next site downstream, MNDA 10.17, was located near Furnace Road and rated as good, also showing with high numbers of macroinvertebrate types, high diversity, and high numbers of pollution sensitive EPT types. Located upstream of Fox Mill Drive, MNDA 05.94 rated a good health score, showing high diversity of macroinvertebrate types and high numbers of total types. The final site on the mainstem of Manada Creek, MNDA 02.26, was located near Devonshire Heights Road and ranked a health score of fair, with high numbers of total macroinvertebrate types and diversity, but a lower percentage of pollution sensitive types.
A site on an unnamed tributary near Crooked Hill Road, UMNA 00.31, rated poor, with high diversity but low numbers of pollution sensitive types. The Walnut Run tributary had one sample site, WLNT 00.57, located at Kiwanis Road which rated a fair health score with high diversity but lower numbers of pollution sensitive types.

Bow Creek

There were three sample sites in the Bow Creek watershed. The upstream site, BOWC 05.31, located downstream of Interstate 81, ranked fair, having fair numbers of EPT macroinvertebrates present. BOW 00.92, located downstream of Shady Lane, had low percentages of pollution sensitive macroinvertebrate types and ranked poor. A site on an unnamed tributary to Bow Creek located near the intersection of Jonestown Road and Spring Road, UNTB 00.05, ranked poor, showing low numbers of pollution sensitive macroinvertebrate types.

Spring Creek East

This tributary had eight sites, three on the mainstem and five on unnamed tributaries. All sites in the Spring Creek East watershed showed signs that indicate limestone influence from underlying geology which impact water chemistry and the types of macroinvertebrates present, often presenting as low stonefly numbers and high numbers of Amphipods, shrimp-like crustaceans commonly referred to as “scuds.” SPRN 00.06, located at Hanover Street near Spring Creek East’s confluence with Swatara Creek, rated poor had no EPT types present. SPRN 00.79 located by the North Hockersville Road Bridge also rated poor had no EPT types present. SPRE 03.03, located near Grenada Avenue, rated poor having a fair number of total taxa, but low numbers of pollution sensitive types.
The rest of the sites were on unnamed tributaries to Spring Creek East. UNTS 00.24 near the intersection of Meadow Lane and Crest Lane ranked poor with no EPT types present. UNTS 01.67, located near Spartan Road, had a poor health score and showed low numbers of pollution sensitive macroinvertebrate types. UNTS 02.71 near Eby Road, also rated poor with low numbers of pollution sensitive types. UNTS 02.90 by Route 743 and McCorkle Road, had high numbers of total macroinvertebrate types and good diversity but had low numbers of pollution sensitive types giving it a poor health score. UNTS 03.27 off Bachmanville Road also ranked poor with low numbers of pollution sensitive types.

Unnamed Tributary

An unnamed tributary was sampled at site UNTS 00.28, located at Walton avenue. This site rated as poor with no pollution sensitive EPT macroinvertebrate types found in the sample. Monitoring data indicates limestone influence.

Iron Run

Two sites, IRON 03.04 at Roundtop Road and IRON 00.49 at Lauffer Road, were located on Iron Run. The upstream site, IRON 03.04, ranked poor, with low numbers of pollution sensitive macroinvertebrates. The downstream site, IRON 00.49 had a sample that contained insufficient numbers of undamaged macroinvertebrates to calculate a health score.

Swatara Creek Main Stem

Four sites were located on the main stem of Swatara Creek and due to the large drainage area of the creek, a large stream metric was used for health score calculation. The sites, upstream to downstream, are SWTR 19.83, located at Bindnagle Road, SWTR 13.91 near Swatara Creek Park off South Hanover Street near Hershey, SWTR 08.70 at Keller Field in Hummelstown, and SWTR 00.80 at Hoffer Park in Middletown.
SWTR 19.83 rated good with high numbers of macroinvertebrate types, high diversity, and pollution sensitive EPT macroinvertebrates. SWTR 13.91 rated poor, with low numbers of pollution sensitive macroinvertebrate types. Site SWTR 08.70 rated a health score of fair with lower numbers of EPT macroinvertebrates, fair numbers of pollution sensitive types, but good diversity. The most downstream site, SWTR 00.80, rated good, with good numbers of EPT macroinvertebrates and high diversity.
A complete table of metrics calculations and sample cycle score comparison charts can be found in Appendix VI-VII.

Figure 7.10

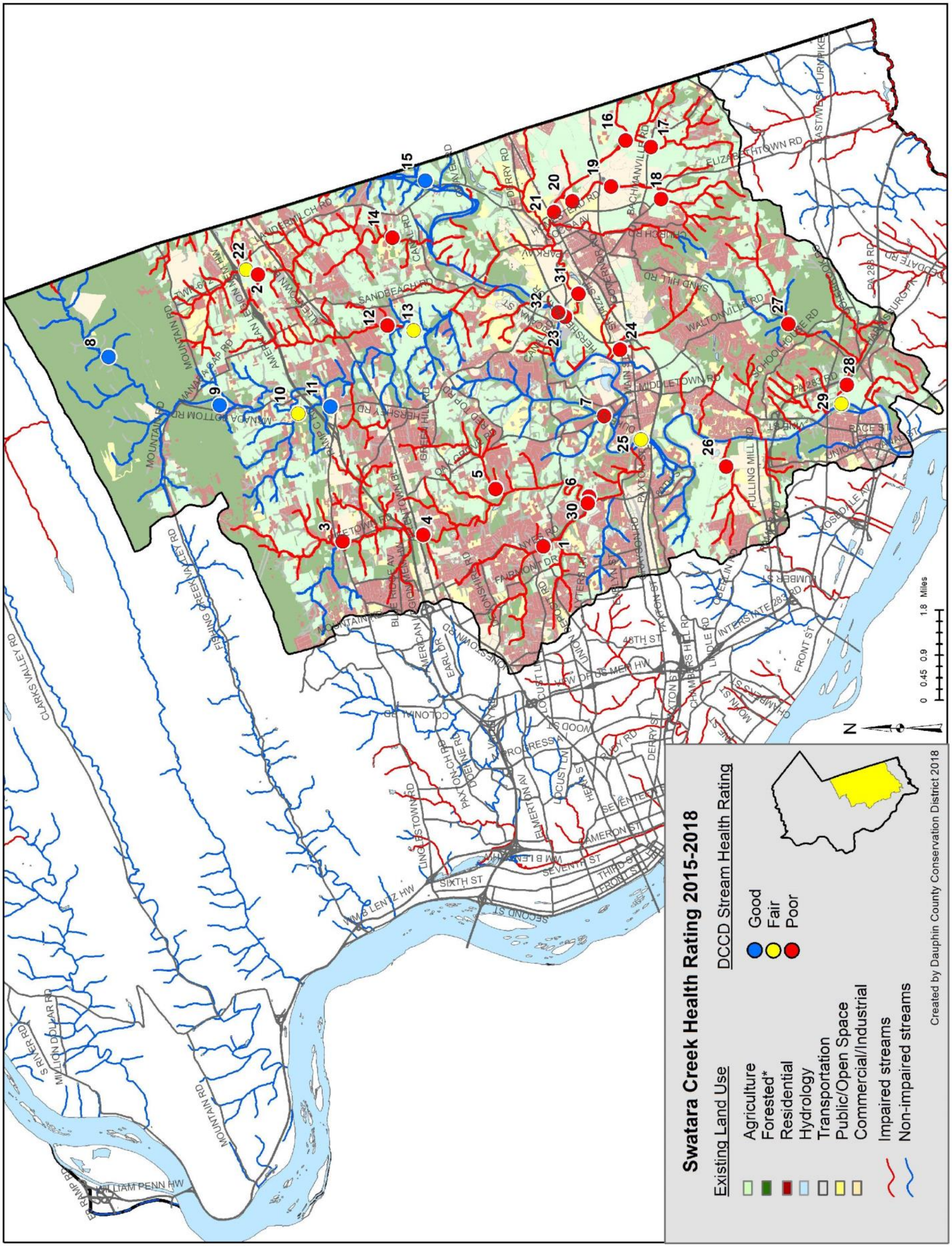
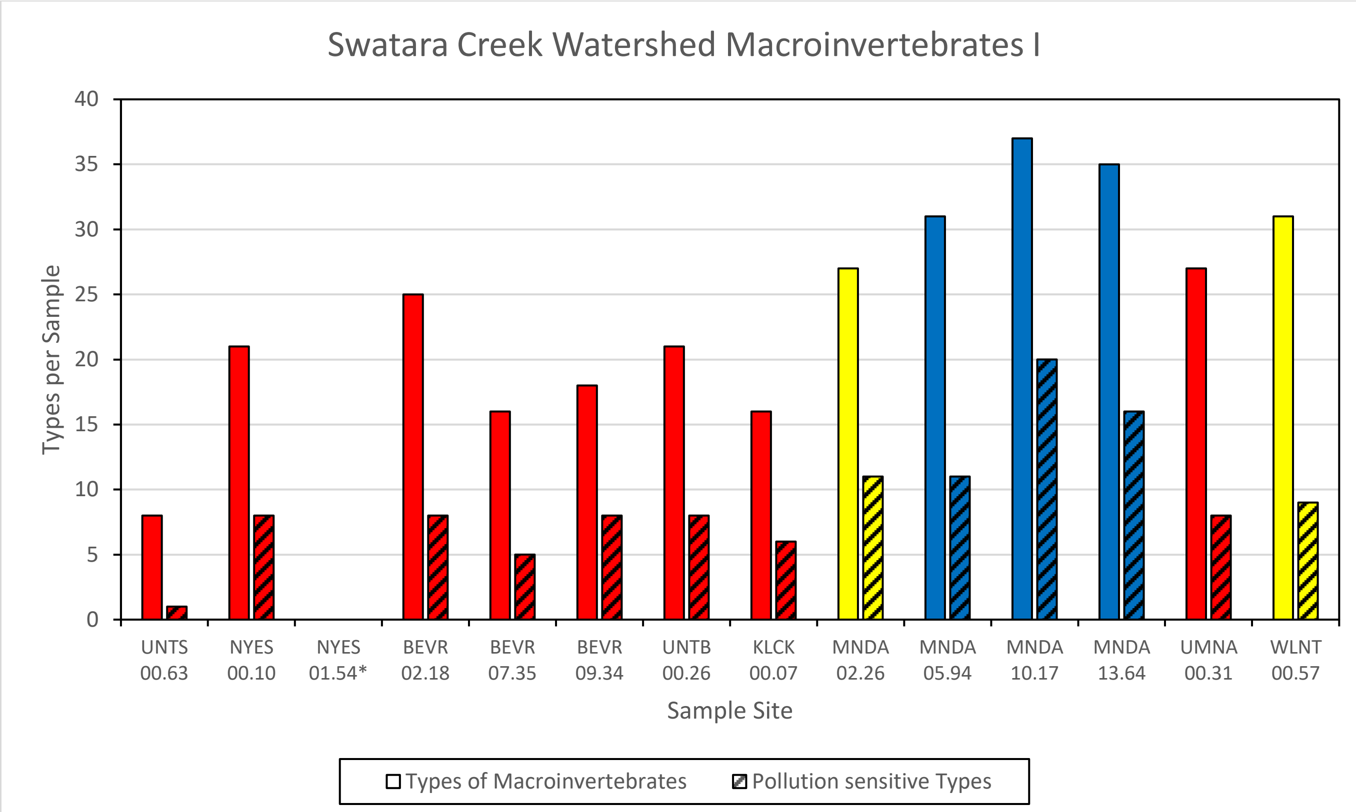
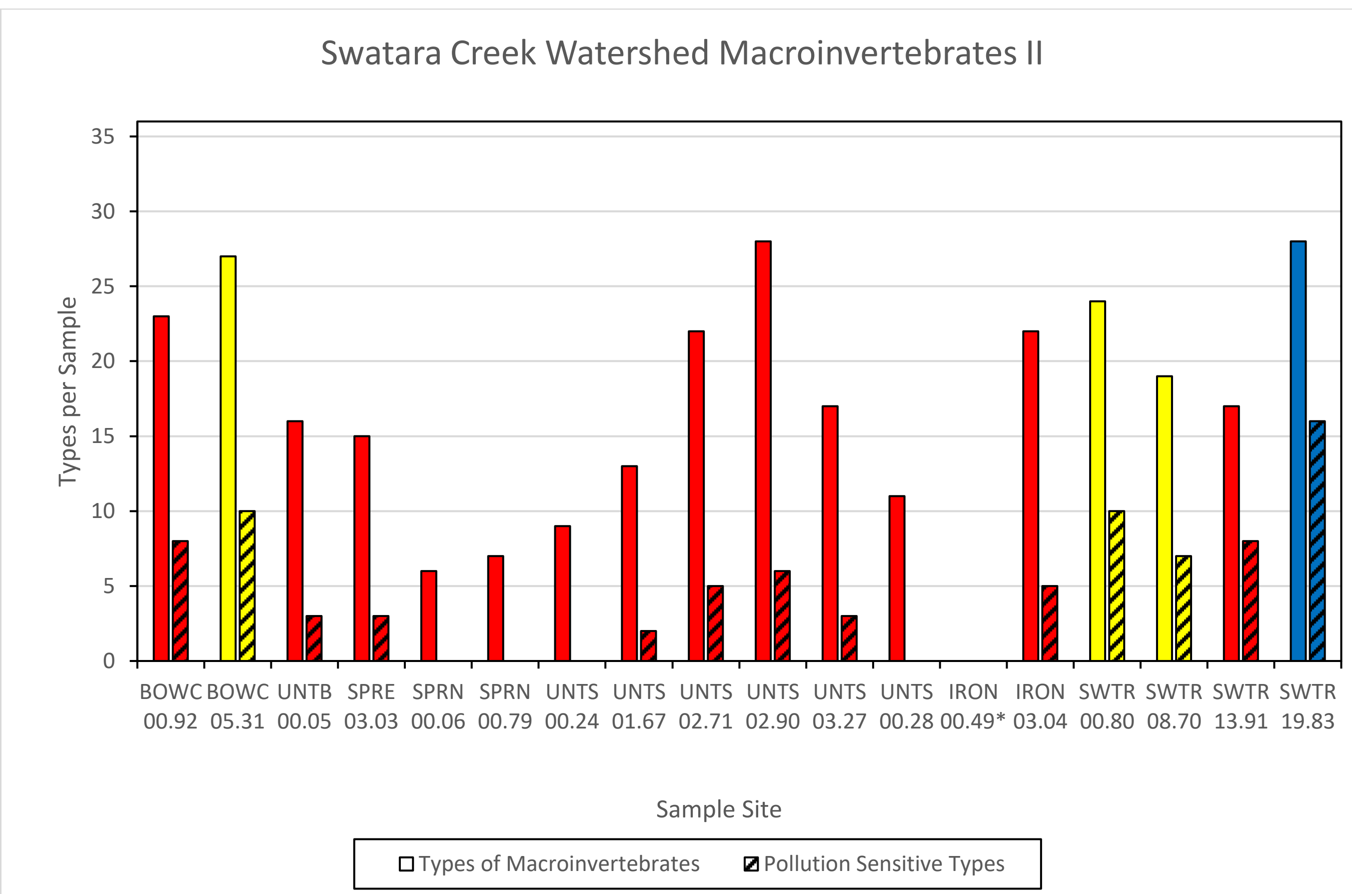

Swatara Creek Health Rating 2015-2018
Existing Land Use
Agriculture
Forested*
Residential
Hydrology
Transportation
Public/Open Space
Commercial/Industrial
Impaired streams
Non-impaired streams
DCCD Stream Health Rating
Good
Fair
Poor
Created by Dauphin County Conservation District 2018
0 0.45 0.9 1.8 Miles

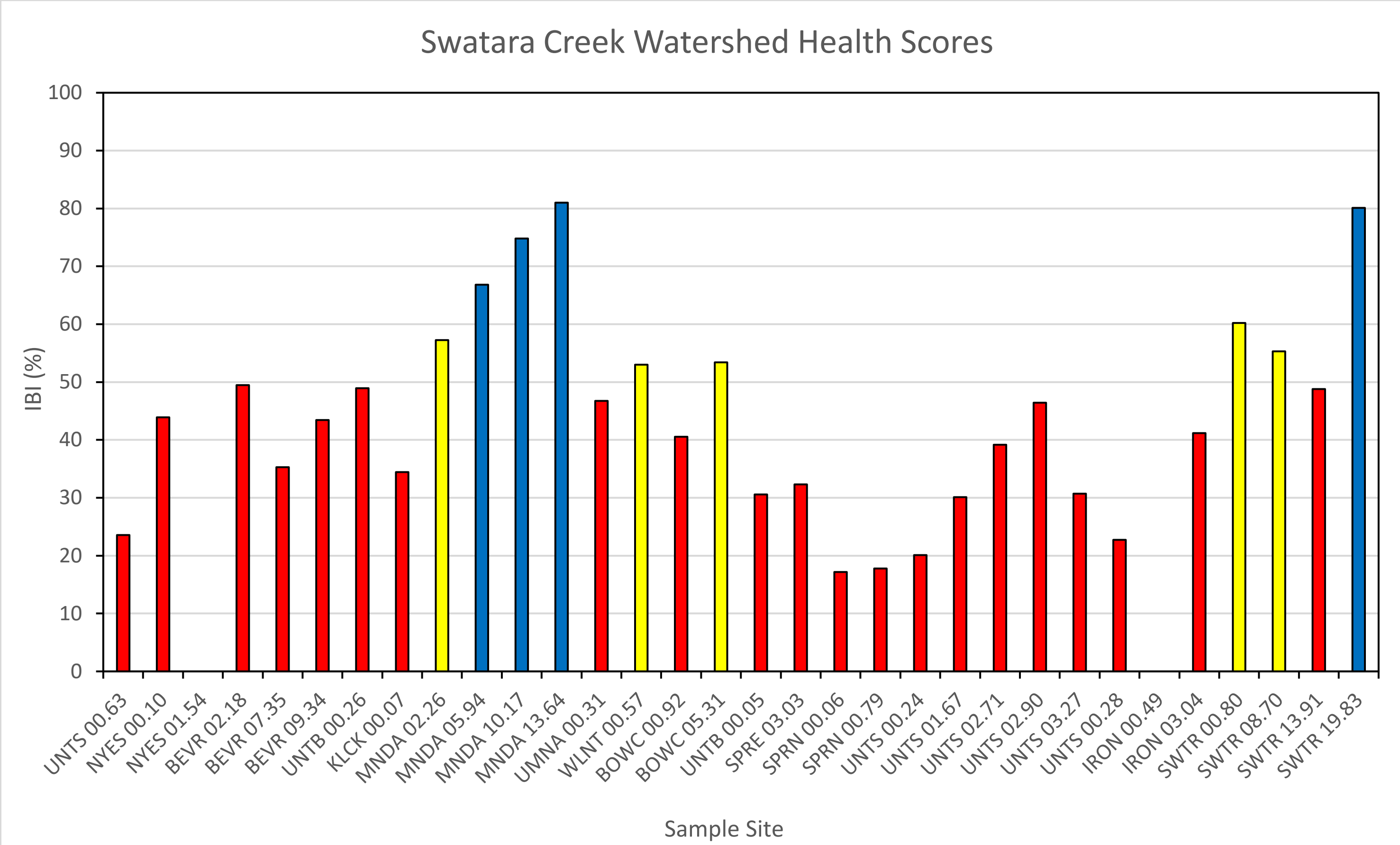
Table 7.10

Sample Site	Sample Site	Health Score	Notes
1	NYES 01.54	Poor	Sample damaged/insufficient for calculation
2	UNTB 00.05	Poor	Low pollution sensitive
3	BEVR 09.34	Poor	Low pollution sensitive
4	BEVR 07.35	Poor	Low pollution sensitive
5	UNTB 00.26	Poor	High total taxa and diversity. Low pollution sensitive
6	BEVR 02.18	Poor	High total taxa and diversity. Low pollution sensitive
7	KLCK 00.07	Poor	Low pollution sensitive. Low diversity
8	MNDA 13.64	Good	High diversity. High EPT taxa. High total taxa
9	MNDA 10.17	Good	High diversity. High EPT taxa. High total taxa
10	WLNT 00.57	Fair	High diversity. Low pollution sensitive
11	MNDA 05.94	Good	High diversity. High total taxa
12	UMNA 00.31	Poor	High diversity. Low pollution sensitive
13	MNDA 02.26	Fair	High total taxa and diversity. Fair pollution sensitive
14	BOWC 00.92	Poor	Low pollution sensitive
15	SWTR 19.83	Good	High total taxa, EPT taxa, and diversity
16	UNTS 02.71	Poor	Low EPT taxa and pollution sensitive. Limestone influence
17	UNTS 03.27	Poor	Low EPT taxa and pollution sensitive. Limestone influence
18	UNTS 02.90	Poor	High total taxa and diversity. Low pollution sensitive
19	UNTS 01.67	Poor	Low EPT taxa and pollution sensitive. Limestone influence
20	UNTS 00.24	Poor	No EPT present. Limestone influence stream
21	SPRE 03.03	Poor	Fair total taxa. Low pollution sensitive. Limestone influence
22	BOWC 05.31	Fair	Fair EPT taxa
23	SPRN 00.06	Poor	No EPT present. Limestone influence stream
24	UNTS 00.28	Poor	No EPT present. Probable limestone influence
25	SWTR 08.70	Fair	Lower EPT taxa. Fair pollution sensitive. Good diversity
26	UNTS 00.63	Poor	Low EPT taxa
27	IRON 03.04	Poor	Low pollution sensitive
28	IRON 00.49	Poor	Sample damaged/insufficient for calculation
29	SWTR 00.80	Fair	Good EPT taxa. High diversity
30	NYES 00.10	Poor	High total taxa and diversity. Low pollution sensitive
31	SPRN 00.79	Poor	No EPT present. Limestone influence stream
32	SWTR 13.91	Poor	Low pollution sensitive



Stream Health:
Good Fair Poor





Stream Health:
Good Fair Poor

7.11 CONEWAGO CREEK

Description

Conewago Creek is the southernmost watershed in Dauphin County. It forms the boundary between Dauphin and Lancaster Counties. The watershed drains an area of 52.2 mi^2, with 23.2 mi^2 in Dauphin County. The headwaters are located in Lebanon County where it flows in a westerly direction eventually joining the Susquehanna River in Londonderry Township. Rural in character, most land use is low density residential development and agriculture.

Conewago Creek before entering the Susquehanna River

Topography in the watershed is generally flat to gently sloping. The geology of the watershed is composed of red sandstone, shale, and conglomerate, intruded by diabase.

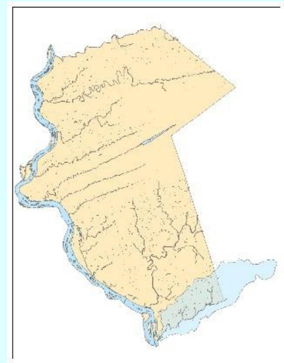
DEP Classification

Conewago Creek is classified as a Warm Water Fishery (WWF). The Creek and most of its major tributaries in Dauphin County are listed as impaired by nutrients and siltation. The source of these impairments is identified as originating from agriculture.

Site Locations

Nine sample sites were located in the Conewago Creek watershed. Four of these sites on the mainstem, CNWG 13.59 at Prospect Road, CNWG 09.23 at Aberdeen Mills, CNWG 06.24 at Deodate Road, and CNWG 01.73 at Engle Road. Five sites were located on tributaries; HOFR 00.02 on Hoffer Creek at Hershey Road, GALG 00.45 on Gallagher Run at Valley Road, BRIL 00.19 on Brills Run at Hoffer Road, LYNC 00.20 on Lynch Run at Hertzler Road, and UNTC 00.36 on an unnamed tributary at Zion Road. For a description of the general location of each sample site, refer to Table 7.11 below.

QUICK FACTS



Conewago Creek watershed

Watershed Size: 52.2 mi^2, 23.2 mi^2 in Dauphin County

Land Uses: Primarily Agriculture and Residential

Stream Miles: 59.0

Impaired Stream Miles: 40.9

DEP Stream Classification:

- Warm Water Fishery

DEP Listed Impairments:

- Sedimentation from agriculture activities

Watershed Municipalities:

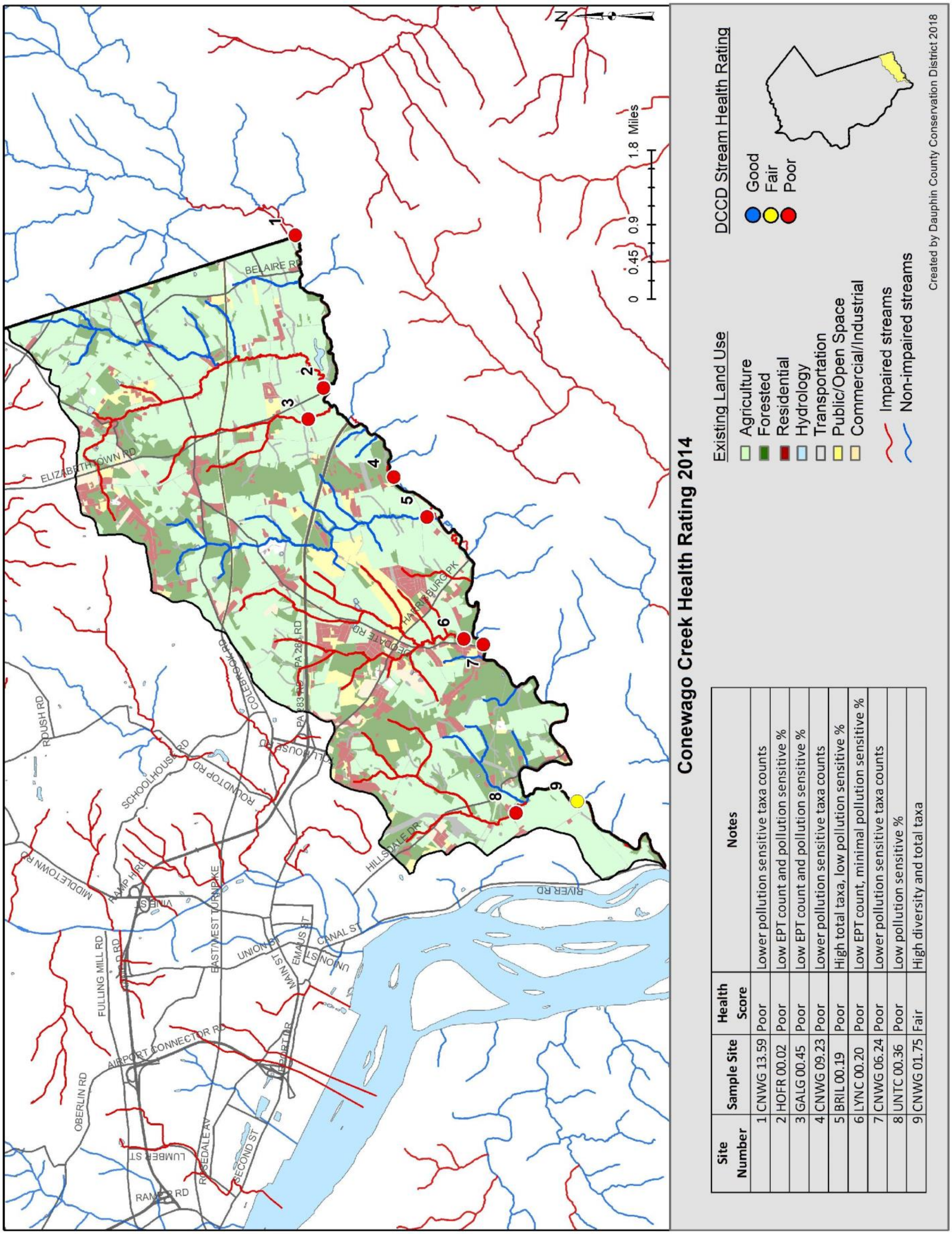
Conewago Twp and Londonderry Twp

Study Results

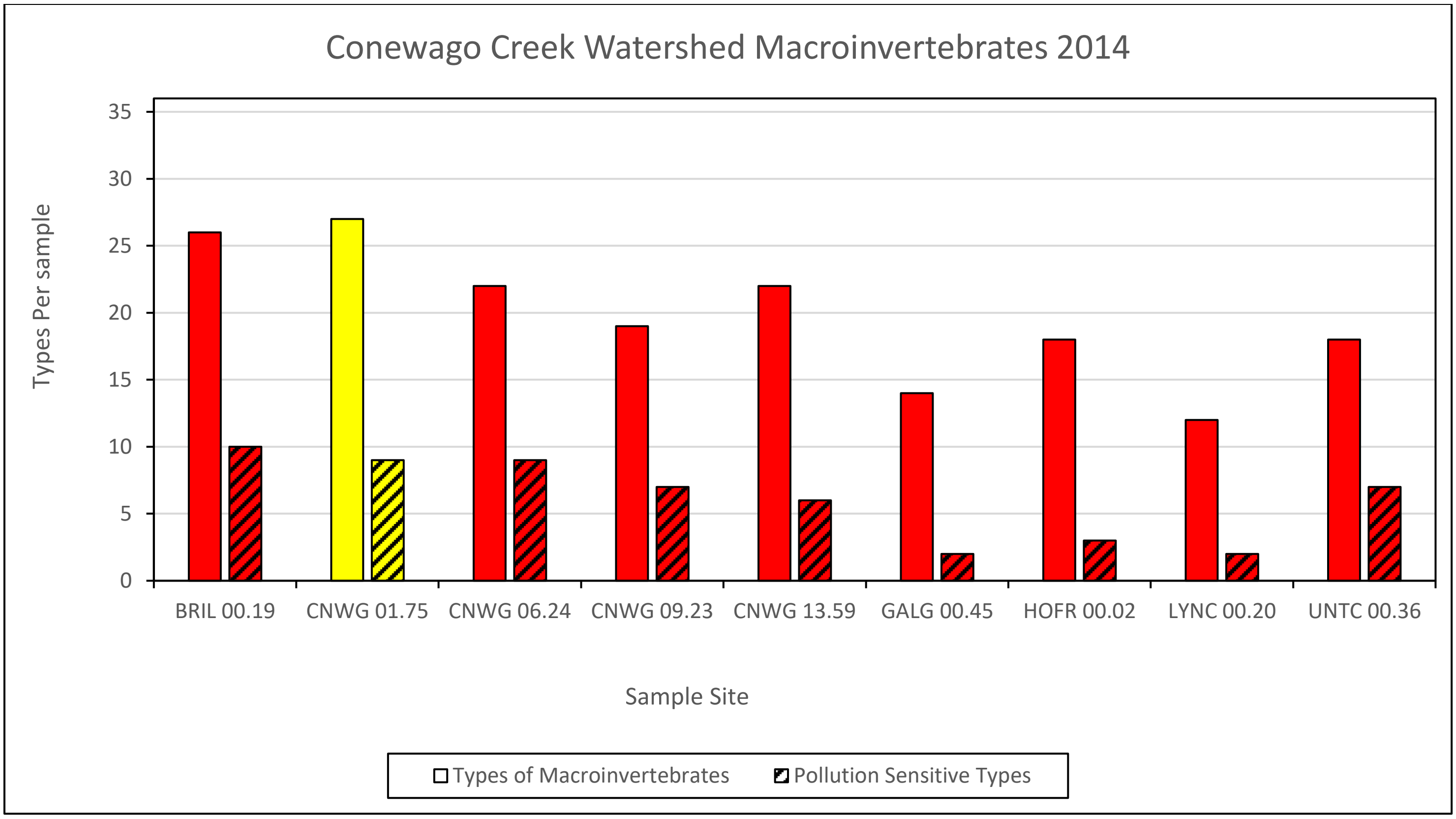
With one exception, all sites rated as poor, showing low levels of pollution sensitive macroinvertebrates. The furthest down steam site, CNWG 00.75, received a fair score, showing high diversity and high numbers of total macroinvertebrates.

A complete table of metrics calculations and sample cycle score comparison charts can be found in Appendix VI-VII.

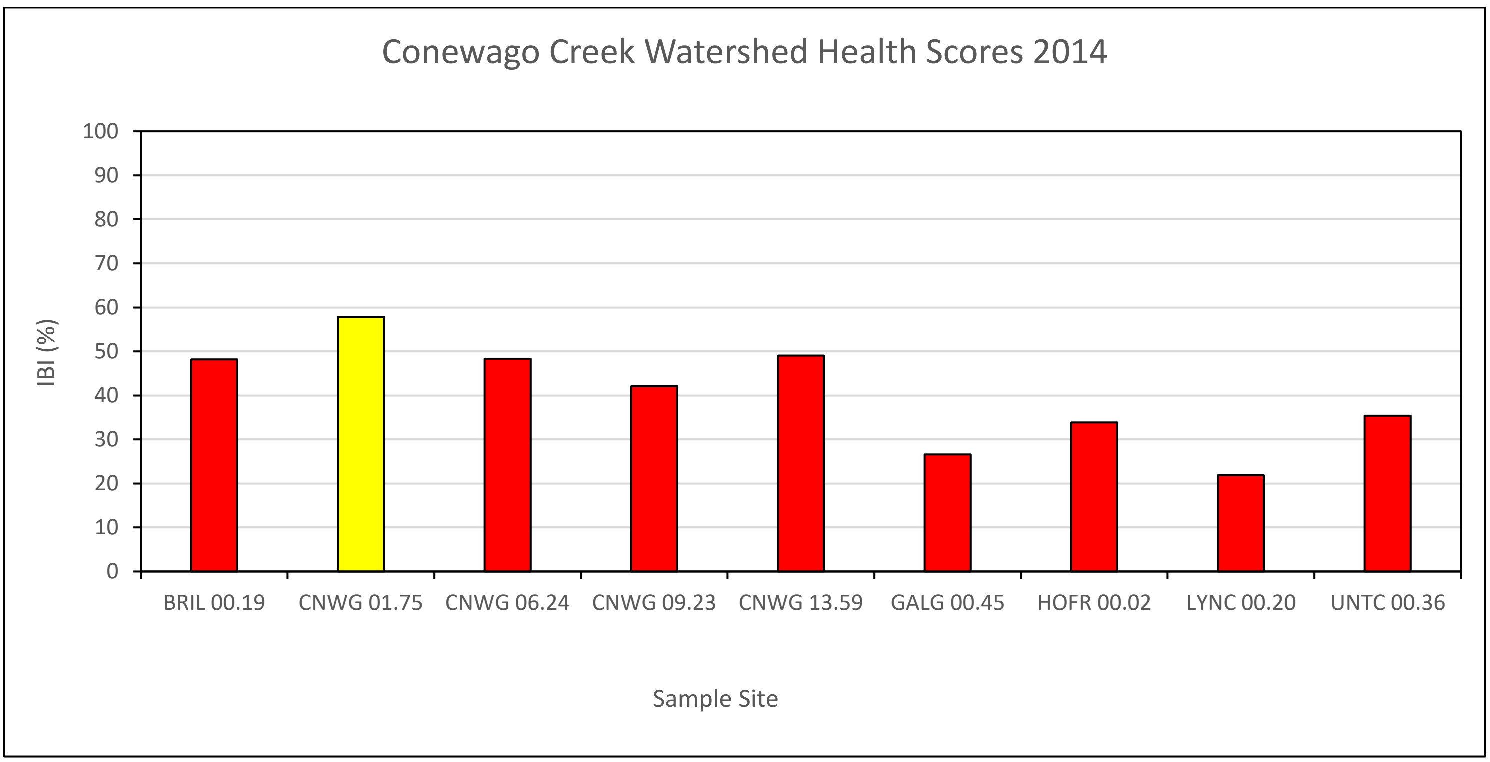
Figure 7.11



Site Number	Sample Site	Health Score	Notes
1	CNWG 13.59	Poor	Lower pollution sensitive taxa counts
2	HOFR 00.02	Poor	Low EPT count and pollution sensitive %
3	GALG 00.45	Poor	Low EPT count and pollution sensitive %
4	CNWG 09.23	Poor	Lower pollution sensitive taxa counts
5	BRIL 00.19	Poor	High total taxa, low pollution sensitive %
6	LYNC 00.20	Poor	Low EPT count, minimal pollution sensitive %
7	CNWG 06.24	Poor	Lower pollution sensitive taxa counts
8	UNTC 00.36	Poor	Low pollution sensitive %
9	CNWG 01.75	Fair	High diversity and total taxa



Stream Health:
Good Fair Poor



7.12 SUSQUEHANNA TRIBUTARIES

Description
Several other smaller tributaries that drain directly into the Susquehanna river were sampled during this study. From north to south they are Shippens Run, which enters the Susquehanna river at the north side of Millersburg borough, Gurdy Run, which enters the river near Tourist Park Road north of Halifax, Laurel Run, also called Buser Run, which enters the river downstream from the PA Turnpike 76 bridge, and Burd Run, which enters the river near Memorial Park in Highspire.

DEP Classification
Shippens Run, Gurdy Run, Laurel Run are listed as not impaired. Burd Run is listed as impaired due to urban runoff and storm sewers.

Site Locations
The site on Shippens Run, SHIP 01.89, was located upstream of the Shippen Dam Road bridge near its intersection with Oak Street and Race Street. This site was sampled in 2018.

The site on Gurdy Run, GRDY 00.57, was located near the Tourist Park Road Bridge. This site was sampled in 2018.

The site on Laurel Run, LARL 00.34 was located near 283 and Eisenhower Boulevard. This site was sampled in 2015.

The site on Burd Run, UNTS 00.43 was located along Highspire Memorial Park. This site was sampled in 2015.

Study Results

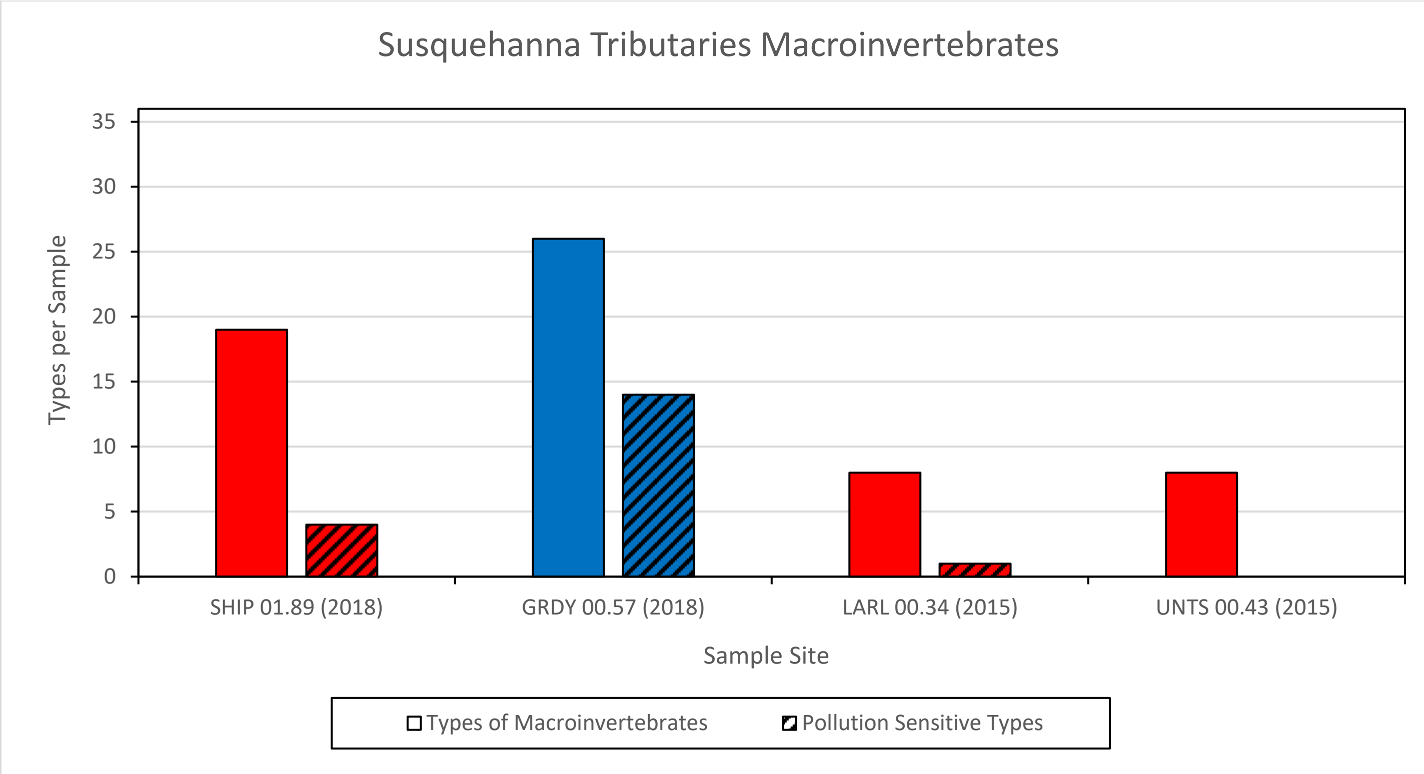
The Shippens Run site rated poor with a low diversity of macroinvertebrates and a low percentage of pollution sensitive types in the sample. Sedimentation was evident at this site.

The Gurdy Run site rated good, having high numbers of total macroinvertebrate types, high diversity and good percentages of pollution sensitive types. Site is extensively wooded and has good habitat for aquatic life.

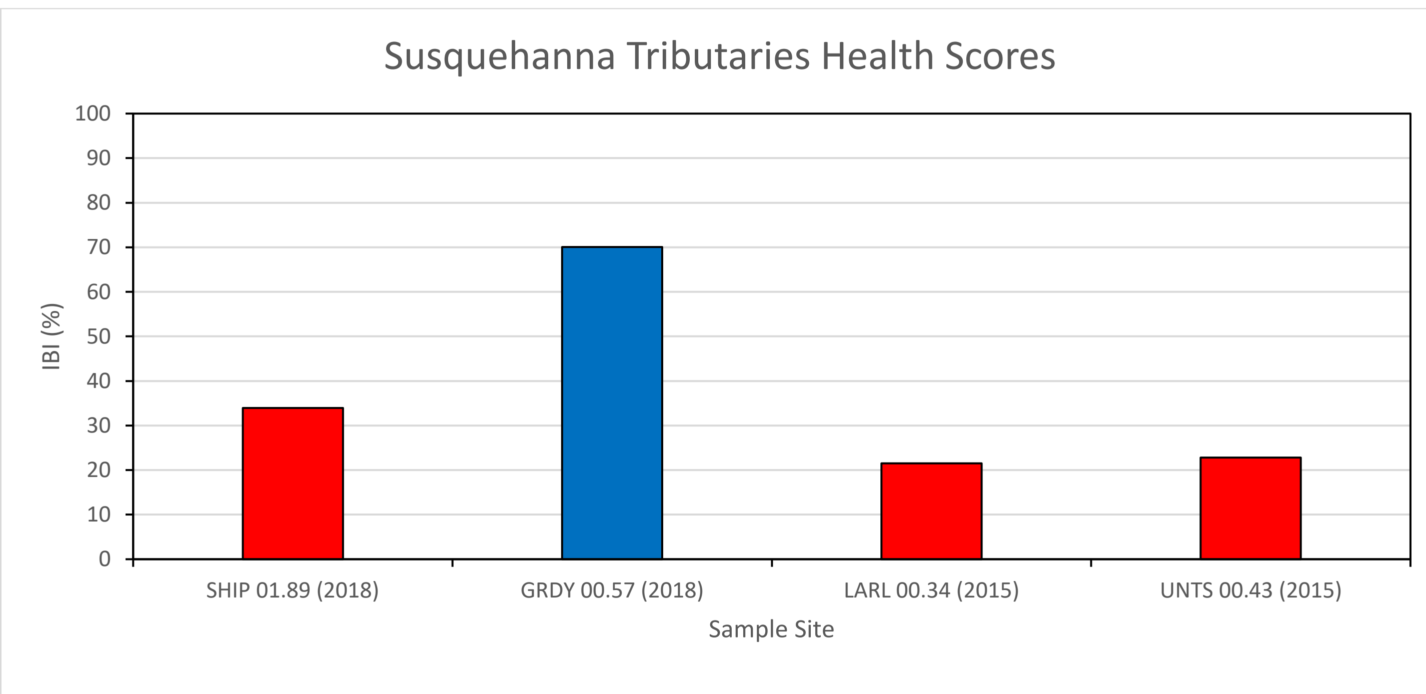
The Laurel Run site rated poor having low numbers of pollution sensitive macroinvertebrate types and at a low percentage. Sedimentation was evident at this site as well as reduced riparian vegetation width. Macroinvertebrate community representative of limestone influenced stream.

The Burd Run site rated poor with a low number of pollution sensitive macroinvertebrate types and at a low percentage in the sample. Lack of instream cover, sedimentation, and reduced riparian vegetation were noted at this site.

A complete table of metrics calculations and sample cycle score comparison charts can be found in Appendix VI-VII.



Stream Health:
Good Fair Poor



8.0 CONCLUSION

8.1 CONTEXT OF TEST RESULTS

When evaluating data derived from macroinvertebrate samples it is critical that the information be considered carefully. It is important to understand what the data is and what it is not. It is a general indicator of stream health. It is not evidence of a specific pollutant or source of pollutants. It is also important to consider the data in conjunction with other known information regarding the stream and its watershed. Are there chemical test results available for the site? What are the land uses and activities occurring in the watershed? Is there significant stream channel erosion in the stream itself? The value of the data should not be overstated, nor should it be understated. The following points should be kept in mind when considering the results of the macroinvertebrate sampling done for this project.

1. Macroinvertebrate samples can give us an idea of the general health of a stream. While the data does indicate the conditions present at the sample site, the specific causes of any degradation that manifest themselves in the macroinvertebrate sample are more difficult to determine and will require additional information.
2. The results of the sample are valid for the site itself and may not reflect the conditions throughout the watershed. This is particularly true in larger watersheds and in watersheds where the type, magnitude and location of watershed disturbances vary significantly.
3. The data collected is part of an ongoing Countywide Stream Assessment Program conducted by the Conservation District. As we accumulate more data, the picture of stream quality will become increasingly clear.
4. The data collected can be used to guide future data collection needs in order to gain better understanding of watershed conditions and sources of impacts.
5. The data collected now and, in the future, can be used to guide decisions on how and where to expend resources for stream improvements.
6. The information and data in this report are intended to increase public understanding of stream health in Dauphin County. It is hoped that this CSAP can help stimulate active citizens, organizations, and Municipalities within the county in stream protection and restoration efforts

As additional data is collected in the future, we will begin to have a better idea of the conditions at the sampling sites. Sampling at a site may warrant an expansion of efforts to determine whether the streams are impaired and if there is justification for removal from the impaired streams list.

8.2 OVERALL WATERSHED HEALTH

There is considerable variation of characteristics among watersheds in Dauphin County. As examples, land use varies from forested to highly urbanized, topography varies from steep slopes to flat and there are some areas of limestone geology. These variations in natural conditions and human impacts blend together to determine the condition of the streams in the watershed. The impact of human activities within a watershed cannot be overstated. It is not a coincidence that the streams that are most heavily impacted by human activity are the streams with the lowest health ratings. Given the considerable variation in watershed conditions, it is not surprising that there is also variation in the results of the macroinvertebrate sampling. Dauphin County streams vary from good to poor.

It is difficult to make an accurate assessment for an entire watershed and every stream segment within the watershed based on the data available. However, we can make some general conclusions based on the data. As the Countywide Stream Assessment Program moves forward and additional data is collected, we will be better able to make more accurate assessments.

Following is a general discussion of overall health of Dauphin County streams. Average watershed scores are presented first, followed by a subjective categorization. Note that because the Swatara Creek has several large tributaries, sub-watersheds are discussed individually below, and the Swatara Creek is discussed overall. The watersheds have been grouped by general category. For the strictly numeric averages, the categories of poor, fair and good are used. Keep in mind that these three categories contain scores that can vary greatly. A score as low as

Bear Creek, where no aquatic life was found, holds the same label as a stream that receives a 49.9, which is just below the "fair" stream health category.

Averages

Average scores of all sites by watershed are summarized in Table 9.1. Strict averages in broad categories must be considered carefully. While the averages may fall into a given category, the actual scores of the individual sites must also be considered. For example, there is a difference between a watershed which averages very low in the poor range with all sites scoring low and a watershed that averages very high in the poor range with some sites scoring fair or good. This is particularly true in larger watersheds with several large tributaries where the tributaries vary significantly as to the indicated quality. Swatara Creek and its sub-watersheds is an example. To say Swatara Creek is a watershed with poor water quality negates the results of Manada Creek watershed, for example. Likewise, much of the watershed is outside of the study area of this project. Average IBI health scores given by watershed is another way of analyzing data collected in this study.

WATERSHED	SAMPLE SITES	AVERAGE SCORE	HEALTH
Powell Creek	6	68.08	Good
Clark Creek	4	81.86	Good
Gurdy Run	1	*70.06	Good
Fishing Creek	3	62.27	Fair
Armstrong Creek	8	67.53	Good
Stony Creek	4	62.98	Fair
Swatara	32	44.31	Poor
Swatara Mainstem	4	61.10	Fair
Kellock Run	1	*34.44	Poor
Iron Run	1	*41.18	Fair
Manada Creek	6	63.27	Good
Unnamed Tributary 1	1	*23.56	Poor
Beaver Creek	5	44.21	Poor
Spring Creek (East)	8	29.23	Poor
Bow Creek	3	41.51	Poor
Unnamed Tributary 2	1	*22.73	Poor
Mahantango Creek	6	53.91	Fair
Wiconisco	14	46.27	Poor
Shippens Run	1	*33.91	Poor
Laurel Run	1	*21.53	Poor
Paxton Creek	4	27.17	Poor
Burd Run	1	*22.83	Poor
Conewago Creek	9	40.36	Poor
Spring Creek (West)	4	28.87	Poor

Table 8.1 *Watershed health score averages.* ** Indicates no average: only 1 site sampled.*

Significance

There were differences between the health scores from the 2004-2008, 2009-2013, and 2014-2018 assessment, which can be expected when measuring populations of wild organisms. These differences needed to be assessed to determine if the variation was significant.

Because the health score is based on population where each macroinvertebrate was ranked by a pollution tolerance value, a non-parametric statistical comparison method was used to measure the significance of the data.

The Wilcoxon Test compares paired samples from the same population. In this case, samples from sites in the 2004-2008, 2009-2013, and 2014-2018 rounds were paired with each other for each watershed and county wide. The Wilcoxon Test comparison produces a P value which if less than 0.05 is considered significantly different. An explanation of the Wilcox Test comparison can be found in Appendix III.

Watershed	Increase/ Decrease	Significance Value (P)	Significantly Different	Watershed	Increase/ Decrease	Significance Value (P)	Significantly Different
2004-2008 vs 2014-2018 Cycle				*2009-2013 vs 2014-2018 Cycle*			
Mahantango Creek	Increase	0.043	Yes	**Mahantango Creek**		0.138	No
Wiconisco Creek		0.308	No	**Wiconisco Creek**	Increase	0.025	Yes
Armstrong Creek		0.263	No	**Armstrong Creek**	Increase	0.012	Yes
Powell Creek	Decrease	0.028	Yes	**Powell Creek**		0.249	No
Clark Creek		0.285	No	**Clark Creek**		0.109	No
Stony Creek		0.465	No	**Stony Creek**		0.144	No
Fishing Creek		0.109	No	**Fishing Creek**		0.109	No
Paxton Creek		1	No	**Paxton Creek**		1	No
Spring Creek West		0.109	No	**Spring Creek West**		0.285	No
Swatara Creek		0.649	No	**Swatara Creek**		0.658	No
Conewago	Increase	0.012	Yes	**Conewago**		0.484	No
County Wide	Increase	0	Yes	**County Wide**		0.055	No

Table 8.2 *Watershed Health Score Difference 2004-2008 vs 2009-2013 Sample Cycle.*

The chart above demonstrates that the Conewago and Mahantango watersheds showed significant watershed health score improvements in a 10 year time frame from the first sample round to the third round and that countywide scores improved significantly overall. Powell Creek had a significant decrease in watershed health score over the same period. For the 5 year time scale of sample round two to round three, Wiconisco and Armstrong watersheds showed significant improvement. The causes of these changes are not definitively known. Continued data collection can help to demonstrate if this is part of a longer term trend or if there were other factors involved.

Land Use Decisions and Water Quality

In conclusion, Dauphin County has streams that vary in indicated health. The lowest scores are generally indicated in southern Dauphin County where development has caused greater disturbances to watershed. It is important to note that the Conewago Creek and Wiconisco Creek watersheds, which are largely rural, also indicate reduced stream health. Many of the higher scores, either by watershed or by site, are associated with watersheds with little human impact and significant forest cover.

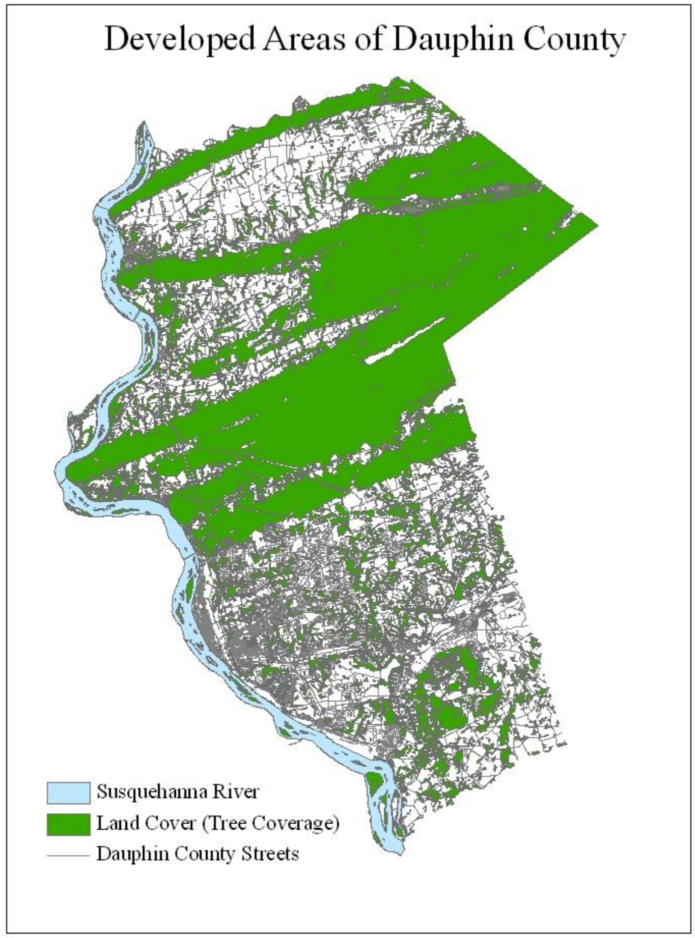


Figure 8.1 *Dauphin County roadways overlaid with forest coverage.*

In already developed areas of the county, the impacts have been cumulative for several decades. In these areas, stream and watershed repair and restoration projects (retrofits) will be needed in addition to sound stormwater management programs for new development. The need for retrofits far exceeds the resources available, but if the adverse impacts of future development are eliminated or minimized, over time improvements can be made.

In developing areas of the county, it is important to keep in mind natural stream and water resource conditions when evaluating the environmental consequences of land use. It is important to balance the need for housing, farming, roads, and economic development with the need to protect water resources. In these areas it is important to implement sound stormwater management planning mechanisms that will serve to minimize adverse impacts of development. By doing this, the need for costly retrofit projects can be minimized.

In rural areas of the county, there is tremendous opportunity to take actions now that will limit adverse impacts to streams. Implementation of sound stormwater management planning and regulations now will minimize the impacts of development as it occurs. In these areas, agriculture is often cited as one of the contributing factors in stream degradation. Continued implementation of conservation practices on farms will reduce this impact.

A Big Picture

Ongoing efforts at improving water quality tend to focus on cleaning up the Chesapeake Bay, but these efforts have a greater impact at the local level. It is valuable to view the measures being taken to reduce erosion related to development, agricultural operations, and degraded stream banks not only as something that benefits the Bay, but as protecting and improving the health of Dauphin County streams enjoyed by its residents and visitors. Working towards improving stream health protects drinking water sources and enhances recreation opportunities for fishing, hunting, boating, and hiking. The additive steps that gradually improve the Bay will more readily be seen at home in Dauphin County.

9.0 STREAM IMPROVEMENT RECOMMENDATIONS

9.1 GENERAL

There is considerable variation among the watersheds in Dauphin County. Some of our watersheds are primarily forested, others are dominated by farmland. Still others are heavily urbanized or mixes of urban and suburban development. The source of impacts on stream quality from these various land uses also differ. Regardless of the land use, there are steps that can be taken to reduce the impacts of all land uses on stream health. The discussion below outlines what can be done by municipalities, homeowners, farm owners and developers.

9.2 RECOMMENDATIONS

1. MUNICIPAL GOVERNMENTS

Local land use decisions are primarily a function of local government in Pennsylvania. As municipal decision makers, you play a significant role in determining how land use will impact streams in your municipality.

STORMWATER MANAGEMENT

Stormwater runoff from development has a large adverse impact on streams. These impacts were outlined in section 2. There are steps your municipality can take to limit the adverse impact of development. Consider revising your local ordinances to better address stormwater management issues.

- Ordinances can be revised to reduce impervious cover, thereby generating less stormwater runoff

- require open space to allow for infiltration

- Allow for innovative and effective use of stormwater best management practices

- Allow for flexibility in development design to facilitate use of the natural hydrology of sites in developing stormwater management plans.

- Adopt sound stormwater management ordinances and implement them.

- Adopt ordinances requiring erosion and sediment pollution control during earth disturbance activities. Many municipalities have entered into a Memorandum of Understanding with the Conservation District.

Flexible design standards allow for the use of swales to replace pipes. This swale helps filter pollutants and provides for some infiltration which reduces runoff volumes to streams. The small check dams in the swale help slow the runoff which allows settling of pollutants.

FLOODPLAINS AND RIPARIAN AREAS

Floodplains and riparian areas provide an excellent opportunity to provide protection for the stream. Regulated floodplains are shown on Federal Emergency Management Agency (FEMA) maps provided to your municipality. Riparian areas are similar to floodplains in that they are, by definition, areas located along streams. These areas do not, however, have a specific designated width as the 100 year floodplain does.

Most municipal floodplain ordinances allow development in floodplains provided the structures are elevated or floodproofed. However, it is within the authority of a municipality to prohibit development in floodplains. There are significant benefits to such an approach.

- The flood carrying capacity of the floodplain area is preserved. This helps to alleviate the severity of floods.
- Undeveloped floodplains can provide open space, recreation and habitat areas.
- By prohibiting development in floodplains, the cost of flood protection and emergency services during floods can be reduced.
- Preserved floodplains provide an area for filtration and pollutant removal.

A riparian buffer is a vegetated strip along the stream. There are many examples of riparian buffer ordinances available from very wide, complex buffers to narrower simpler buffers. Adopting ordinances requiring buffers can provide significant stream quality benefits:

- Filtering and storage of pollutants
- Storage of excess runoff
- Stream shading to reduce water temperature and provide habitat benefits.
- Stream bank stabilization to help prevent erosion and deposition of sediment into stream channels.
- Increased aesthetics, recreation opportunities and wildlife habitat
- Increases groundwater recharge
- maintain base flow in streams during dry weather and low flow conditions

TIMBER HARVESTS

Local governments can enact strong timber harvesting regulations to protect streams in harvest areas. At a minimum, this may be addressed through the erosion and sediment pollution control program administered by the Conservation District. Many municipalities have entered into a Memorandum of Understanding with the Conservation District. Beyond the minimum requirements of this program, municipalities may wish to consider adoption of a local timber ordinance with more stringent requirements such as required buffers for perennial streams.

2. HOMEOWNERS

Developed areas, including residential areas, contribute to non-point source pollution in Dauphin County's streams. As a homeowner, there are actions you can take to ensure that your property does not contribute to degradation of streams. Even if your property is not a streamside property, often runoff from these areas is captured by storm sewer systems which deliver pollutants to local streams.

- Excessive nutrients applied to lawns or landscaped areas can be washed into streams. Consider not fertilizing lawns. If these areas must be fertilized, apply only the minimum amount needed. Eliminating or minimizing fertilizer use will reduce pollution to streams and save money.

- Disconnect downspouts from storm sewer systems, gutters or roads. Allowing the downspout to drain over vegetated areas such as lawns or to rain gardens will promote infiltration of storm water. This reduces the volume of runoff entering streams.

- If your property is a stream side property, maintain good vegetation along the banks. Shrubs and trees help stabilize the bank, preventing erosion. This will not only help reduce sediment in streams, it will keep your property from being eroded away by the stream.

Porous pavers, like these installed at the Dauphin County Agriculture and Natural Resource Center, allow rain to infiltrate into the ground, instead of becoming runoff.

- When constructing driveways, patios, side walks or other areas, consider using porous pavers to allow infiltration.

- Consider installing a vegetated buffer along your stream. Forest or shrub buffers reduce pollutants that enter streams in runoff. Shade from buffers helps keep water temperatures cooler.

- Be careful with yard, auto, and other chemicals used outside. These substances should never be disposed of in streams, dumped in storm sewers or on the ground.

- Do not dispose of pet wastes in or near streams.

- Use chemicals, such as pesticides, coolants and cleansers according to directions. Use only as much as is needed. Try to make sure that these chemicals do not enter streams or storm sewers.

- Wash your car on grassed areas to prevent detergents and other cleaners from entering streams or storm sewers. An alternative is to use a commercial car wash that recycles wash water.

- Malfunctioning septic systems can contribute nutrients to groundwater and streams. Maintain your septic system by having it pumped out regularly. Do not flush or dump chemicals into your system. These can damage the functioning of the system or end up in groundwater. Regular maintenance can eliminate the need for costly repairs.

- Install a rain garden. Rain gardens can capture and filter or infiltrate runoff from driveways, roofs, walks, patios and other impervious surfaces. Rain gardens reduce pollution and can be very attractive additions to your property. Rain gardens are relatively inexpensive and can be designed to fit in almost any site.

This rain garden intercepts stormwater runoff from paved and lawn areas before it enters the storm sewer seen in the foreground. This helps filter out pollutants and reduces the volume of runoff entering streams.

3. FARM OWNERS

Agricultural activities can contribute nutrients and sediment to local streams. While pollution from agricultural activities is being reduced, agriculture is still a significant source of these pollutants. As the owner or operator of a farm, using sound conservation practices can not only reduce pollutants from your land, it can also maintain the productivity of your land and save you money.

- Have a conservation plan developed and follow it. The conservation practices in the plan are designed to reduce pollution and to ensure the productivity of the land by maintaining the soil.

- Implement a nutrient management plan. Managing nutrients properly will reduce stream pollution and save money.

- Apply fertilizers and pesticides carefully and only in quantities needed. This will help reduce pollution and save money.

- Many farms border streams. Consider establishing a buffer along your stream. This will help reduce pollution to the stream.

- Maintain the vegetation on stream banks. This reduces erosion which contributes pollutants to streams. Stream bank erosion can also wash your land away.

The vegetation on the banks of this stream helps to prevent erosion of the bank.

- Keep livestock out of streams. Unrestricted access contributes to pollution, degrades the banks and can threaten the health of your livestock. Installation of streambank fencing with constructed animal crossings, if needed, should be installed.

Unrestricted access of livestock to streams can cause severe streambank erosion. The sediment eroded from this bank becomes a pollutant in the stream. (Photo courtesy of Dick Brown).

4. DEVELOPERS

Land development can contribute significantly to stream degradation during and after construction. As a developer, you can ensure that pollution to streams from development activity is minimized.

Before construction…

- When planning a development, try to work with the natural conditions of the site in order to develop a good post construction stormwater management plan.

- Maintain natural drainage and hydrologic features and patterns. Incorporating these into the final stormwater management plan can provide attractive communities and save money.

- Avoid development in floodplains, even if allowable by local regulations. Maintaining floodplains as natural open space provides stream protection and contributes to the aesthetic quality of your development.

- Consider installing a forested stream buffer along streams. Leave the buffer in place if there is already a forested buffer on the site. A forested buffer can improve the aesthetics of your site and will provide many stream protection benefits.

The slope at this construction site has been stabilized. The grass prevents erosion of the slope which keeps sediment and pollutants from reaching streams.

During construction…

- Ensure that you have an approved erosion and sediment control plan, and ensure that needed control measures are implemented. This will prevent sediment from reaching streams and eliminate costly delays due to regulatory issues.

- Ensure that all erosion and sediment control measures are installed properly to prevent sediment pollution and prevent delays due to reinstallation or regulatory compliance issues.

- Inspect and maintain your sediment control measures, particularly after it rains. Repair any damage immediately.

- Ensure that all post construction stormwater BMPs are installed correctly. If not properly installed, these practices may not function.

- Leave topsoil in place where possible. Topsoil absorbs and stores rainwater which reduces the volume of runoff to streams

The silt fence below was not installed properly. It will not prevent sediment from reaching streams. Erosion control measures that are not installed properly waste your time and money.

Proper installation of erosion and sediment control measures, like the silt fence below, prevents sediment from reaching streams.

APPENDIX

Appendix I: Sub-sampling and Identification Techniques

In the laboratory, each sample was sub-sampled by spreading the material evenly in a 28-cell pan and randomly selecting four of these cells. All the materials found within these cells were then transferred to a second 28-cell pan with a small amount of water and swirled to distribute evenly. Numbered cells from the sub-sample were randomly selected and the macroinvertebrates in them were removed, or "picked", with the aid of a 1.75X magnifying lamp for identification. Cells were selected and picked until a sub-sample of 200 $\pm$ 20% (160-240) individuals was obtained. It should be noted that the goal was to get as close to 200 as possible at the completion of a cell, rather than simply exceeding the minimum number. Once the sub-sample was picked, the macroinvertebrates found within it were identified primarily to genera. Some exceptions are necessary, for example: Midges, snails, clams, and mussels were all identified to family levels. Moss animalcules, Roundworms, and proboscis worms were identified to the phylum levels of Bryozoa, Nematoda and Nemertea, respectively. Flatworms and leeches were identified to the class levels Turbellaria and Hirudinea, respectively. Likewise, segmented worms, aquatic earthworms, and tubificids were identified to the class level of Oligochaeta. All water mites were identified as Hydracarina.

Appendix II: Metrics Analyses

To compare data from each station, a multi-metric index approach was used to categorize the benthic macroinvertebrate conditions. The Pennsylvania DEP Instream Comprehensive Evaluation Surveys methods were followed for this study. This document established the collection procedures listed above and demonstrated a suggested metrics approach to analyzing the data. A combination of six metrics were calculated and compared to most accurately determine a health rating for the County streams. These six metrics represent different aspects of the biological communities found in each sampling station. When related together, these six metrics provide a balanced depiction of the overall health known as the Index for Biotic Integrity IBI (Instream Comprehensive Evaluation Surveys: 2013). The same six metrics are used by the Pennsylvania Department of Environmental Protection when calculating an IBI, taken from the ICE Protocol. The calculations use a standardization value based on the drainage area of the sample point and drainages were calculated for points in larger watersheds in order to follow ICE protocols.

1. Hilsenhoff's tolerance index gives values to a macroinvertebrate's tolerance to pollution on a scale of 0-10, 10 being most tolerant. Biotic Index scores have been used since 1964, when the Trent biotic index was first used to focus on organic pollution. Since then, indices have been used to focus on other pollutants such as acid and metals, as well as valuing the effects of different land uses. Using the tolerance value, the Hilsenhoff Biotic Index was then calculated to make a generalization for the entire sample. This is calculated as each taxa abundance multiplied by the tolerance value and summed with all taxa in the sample.

Family Biotic Index	Water Quality	Degree of Organic Pollution
0 - 3.75	Excellent	Organic Pollution Unlikely
3.76 - 4.25	Very Good	Possible Slight Organic
4.26 - 5.00	Good	Some Organic Pollution Probable
5.01 - 5.75	Fair	Fairly Substantial Pollution Likely
5.76 - 6.50	Fairly Poor	Substantial Pollution Likely
6.51 - 7.25	Poor	Very Substantial Pollution Likely
7.26 - 10.00	Very Poor	Severe Organic Pollution Likely

Figure II. *Hilsenhoff's Family Biotic Index from his 1988 study.*

2. Taxa Richness is one common metric used as an indicator of stream health. The number of taxa groups found within the sample defines the taxa richness, and each taxon is identified to the genus level to maintain a consistency between stations each year. Generally, the taxa richness will decrease with stress.

3. Another metric used in this study was the Pollution Tolerance Value (PTV). PTVs represent the number of Ephemeroptera (Mayflies), Plecoptera (Stoneflies), and Trichoptera (Caddisflies) (EPT) found in each sample. These three orders are generally very sensitive to pollution, making them good stream health indicators. Not all species of these three orders are sensitive, so only the number of taxa with a PTV score of 0-4 are tallied in this metric. Like taxa richness, this metric shows a decreasing value when environmental stressors are present, signifying the loss of pollution sensitive taxa.

4. Another way the PTV was used in calculating the set of metrics found the percent of individuals within EPT taxa having a PTV score under 4 (0-3). This total number of individuals was compared to the total number of taxa in the sample to form a percentage.

5. It was also important to look at the Shannon Diversity, which calculates the relationship between taxa abundance and the evenness of the sample. This calculation reflects the loss of pollution-sensitive taxa and the increasing dominance of pollution-tolerant taxa. This metric is expected to decrease in value with increasing stress to a stream ecosystem, reflecting loss of pollution-sensitive taxa and increasing dominance of a few pollution-tolerant taxa (Shannon 1968).

6. Another variation of metrics used in the study was Beck's index version 3, which represents the taxonomic richness and tolerance metric as a weighted count of taxa with tolerance values of 0, 1, or 2 (Beck 1955). In this metric, the total number of taxa found in the sample with a PTV of 0 were weighted, by multiplying that number by 3. The number of taxa with a PTV of 1 were multiplied by 2, and PTVs of 2 in the sample were multiplied by 1. Each of the totals for PTVs 0,1, and 2 were then added to summarize the Beck's index. This metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of pollution-sensitive taxa.

Statistical Significance Testing

There were differences between the health scores from the 2004-2008, 2009-2013, and 2014-2018 assessments, which are to be expected when measuring populations of wild organisms. These differences needed to be assessed to determine if the variation was significant. Because the health score is based on population where each macroinvertebrate was ranked by a pollution tolerance value, a non-parametric statistical comparison method was used to measure the significance of the data. The Wilcoxon T Test compares paired samples from the same population. In this case, samples from a site in the 2004-2008 round are paired with the 2014-2018 round for each watershed and county wide. This process is repeated pairing the same site samples from 2009-2013 with 2014-2018 samples.

Wilcoxon T Test Procedure

PSPP Statistical Software (Free Software Foundation 2007) was used to run the Wilcoxon T Test for IBI values.

The basic procedure is below:

Differences are calculated between the pairs ($x_{1i} - x_{2i}$), where x_{1i}= measurement for year 1 and x_{2i}=measurement for year 2. Pairs where $x_{1i} - x_{2i} = 0$ are excluded.

The absolute differences for each pair are then ranked from low to high. The signs are then applied to the ranks (signed ranks). The signed ranks are then summed by sign (negative values and positive values are summed separately): $W = \sum(x_{1i} - x_{2i})$= T+ and T-, respectively.

The critical value is then assigned based on the Wilcoxon (T) Test Table. If T+ < the critical value, H_o is rejected.

P values were then calculated by PSPP. P values less than 0.05 are considered to be statistically significant.

In this case, if the p value was below 0.05, the IBI was considered to be significantly different from one sample cycle to another.

Appendix III: DCCD Stream Health Classification

Because each of these totals has unrelated units, percentages, and values, a standardization value was used to connect each metric in calculating an overall score of the stream health. Dauphin County Conservation District chose to follow the Protocol that the PA DEP uses when analyzing macroinvertebrate metric scores. Standardized values for each of the 6 metrics were generalized for Pennsylvania streams. The Appendix Tables show the standardized value calculations along with final results for each sample station.

Rather than stating the IBI scores for each monitoring station, and listing the location as having water quality of either impaired or attaining aquatic life use, a designation system was created to aid in the understanding of individuals of all ages and scientific backgrounds. In order to do this, three categories describing stream health were given to IBIs depending on how high or low the resulting number. Using DEP's ICE Protocol mentioned earlier in this report, category classifications were based on the IBI scores for attaining aquatic life use. The categories divided up as such: Scores of 0 - 49.9 were considered "poor", 50 – 62.9: "Fair", and 63 – 100: "Good".

Good (63-100): Optimal site with a balanced community of pollution sensitive and tolerant organisms.

Fair (50-62): Significant decrease in pollution-sensitive species, unbalanced site with sub-optimal habitat.

Poor (0-49): Degraded site dominated by tolerant organisms. Site is not attaining aquatic life use.

Appendix IV: Aquatic Life Use Attainment

Section 3.0 provides a general description of aquatic life use (ALU). As mentioned, a stream is attaining aquatic life use if it passes criteria set for water quality or biological assessment. In order to attain ALU for a macroinvertebrate analysis, a stream must receive an IBI score of at least 63 after the designated 6 metrics were calculated. If the IBI falls between the range of 50-62.9, additional guidelines are considered in order to attain ALU. If the Beck's index score is less than 20 and the percent sensitive individuals is less than 20, the ALU should be impaired. If the sample is dominated by pollution tolerant taxa, ALU should be impaired as well. The third guideline states that if EPT taxa are absent from the sub-sample, ALU should be impaired.

For example, in studying Manada creek, some samples produced IBIs in the Fair range. After further evaluation, MNDA 02.26 could be considered not impaired as it has a Beck's index score of 32 and 25.9% of the organisms rank with a pollution tolerance value less than 4. Additionally, EPT type insects are present in the sample.

Another factor involving Biological Condition Gradient attribute scoring are considered for attainment by PA DEP.

The last factor considered for attainment is evidence of year-round acidification. Examples of where this could be relevant to attainment are Bear Creek and Rattling Creek in the Wiconisco Creek watershed, and Rattling Run in the Stony Creek watershed which are known to have lower pH due to underlying geology, acid precipitation, and mining influences.

Refer to Appendix VI for the full list of metrics analysis for all watersheds.

Appendix V: References

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Appendix VI: Watershed Sample Site Metrics Tables

2017: Mahantango Creek Watershed Metrics Analysis

	HBI=		Total Taxa =		Becks Index		Shannon Div=		% PTV <4		EPT taxa (0-4)	
Site Name	**OB**	**SV=(10-OB) /(10-1.89)**	**OB**	**SV=OB /33**	**OB**	**SV=OB / 38**	**OB**	**SV=OB / 2.86**	**OB**	**SV=OB / 84.5%**	**OB**	**SV=OB/19**
DEEP 00.73	5.94	0.50	20	0.61	6	0.16	1.67	0.58	9.4%	0.112	5	0.263
DEEP 03.71	5.02	0.61	19	0.58	3	0.08	1.96	0.68	12.1%	0.144	7	0.368
MHNT 01.87 **	4.85	0.74	28	0.90	13	0.59	2.31	0.81	34.1%	0.511	8	0.500
MHNT 07.69 **	5.04	0.71	27	0.87	10	0.45	2.54	0.89	29.6%	0.444	11	0.688
MHNT 13.69 **	4.83	0.74	23	0.74	7	0.32	2.51	0.88	41.4%	0.621	8	0.500
PINE 01.23	4.90	0.63	19	0.58	3	0.08	2.25	0.78	39.6%	0.469	5	0.263

***Large Stream standardization value metrics applied for these sites*

Adjusted Standardized Metric Score (max: 1.00)								
Report Name	**Site Name**	**HBI**	**Total Taxa**	**Becks**	**Shannon**	**% PTV**	**EPT taxa**	**IBI**
2017	DEEP 00.73	0.50	0.61	0.16	0.58	0.11	0.26	37.06
2017	DEEP 03.71	0.61	0.58	0.08	0.68	0.14	0.37	41.09
2017	MHNT 01.87 **	0.74	0.90	0.59	0.81	0.51	0.50	67.57
2017	MHNT 07.69 **	0.71	0.87	0.45	0.89	0.44	0.69	67.64
2017	MHNT 13.69 **	0.74	0.74	0.32	0.88	0.62	0.50	63.41
2017	PINE 01.23	0.63	0.58	0.08	0.78	0.47	0.26	46.68

***Large Stream standardization value metrics applied for these sites*

2018: Wiconisco Creek Watershed Metrics Analysis

	HBI=		Total Taxa =		Becks Index		Shannon Div=		% PTV <4		EPT taxa (0-4)	
Site Name	**OB**	**SV=(10-OB) /(10-1.89)**	**OB**	**SV=OB /33**	**OB**	**SV=OB / 38**	**OB**	**SV=OB / 2.86**	**OB**	**SV=OB / 84.5%**	**OB**	**SV=OB/19**
BEAR 00.01*	5.61	0.54	9	0.27	0	0.00	1.52	0.53	5.9%	0.070	1	0.053
BEAR 01.85	5.74	0.52	10	0.30	4	0.11	1.05	0.37	13.4%	0.159	3	0.158
LWIC 00.18	4.59	0.67	23	0.70	6	0.16	2.45	0.86	34.6%	0.409	11	0.579
LWIC 07.36	5.40	0.57	25	0.76	2	0.05	2.42	0.84	10.3%	0.122	6	0.316
LWIC 10.74	6.15	0.47	20	0.61	5	0.13	1.80	0.63	4.7%	0.055	7	0.368
RTTL 00.04	2.72	0.90	24	0.73	27	0.71	2.32	0.81	65.4%	0.774	14	0.737
WHIT 00.90	3.94	0.75	27	0.82	13	0.34	2.30	0.80	40.8%	0.483	13	0.684
WICO 01.36 **	5.11	0.70	24	0.77	11	0.50	2.23	0.78	19.8%	0.235	12	0.750
WICO 07.95 **	4.77	0.75	24	0.77	7	0.32	2.54	0.89	27.3%	0.409	8	0.500
WICO 14.74 **	5.11	0.70	30	0.97	6	0.27	2.55	0.89	15.8%	0.237	11	0.688
WICO 23.26 **	4.47	0.80	23	0.74	6	0.27	2.25	0.79	25.7%	0.385	7	0.438
WICO 27.68	5.85	0.51	18	0.55	4	0.11	1.20	0.42	1.3%	0.016	4	0.211
WICO 29.71*	5.28	0.58	11	0.33	4	0.11	1.31	0.46	16.9%	0.200	2	0.105
WICO 34.02	5.06	0.61	17	0.52	5	0.13	1.81	0.63	9.7%	0.114	5	0.263

**insufficient organisms found for calculation **Large Stream standardization value metrics applied for these sites*

Adjusted Standardized Metric Score (max: 1.00)								
Report Name	**Site Name**	**HBI**	**Total Taxa**	**Becks**	**Shannon**	**% PTV**	**EPT taxa**	**IBI**
2018	BEAR 00.01*	0.54	0.27	0.00	0.53	0.07	0.05	0
2018	BEAR 01.85	0.52	0.30	0.11	0.37	0.16	0.16	26.92
2018	LWIC 00.18	0.67	0.70	0.16	0.86	0.41	0.58	56.08
2018	LWIC 07.36	0.57	0.76	0.05	0.84	0.12	0.32	44.33
2018	LWIC 10.74	0.47	0.61	0.13	0.63	0.06	0.37	37.76
2018	RTTL 00.04	0.90	0.73	0.71	0.81	0.77	0.74	77.64
2018	WHIT 00.90	0.75	0.82	0.34	0.80	0.48	0.68	64.65
2018	WICO 01.36 **	0.70	0.77	0.50	0.78	0.23	0.75	62.41
2018	WICO 07.95 **	0.75	0.77	0.32	0.89	0.41	0.50	60.67
2018	WICO 14.74 **	0.70	0.97	0.27	0.89	0.24	0.69	62.66
2018	WICO 23.26 **	0.80	0.74	0.27	0.79	0.39	0.44	56.97
2018	WICO 27.68	0.51	0.55	0.11	0.42	0.02	0.21	30.11
2018	WICO 29.71*	0.58	0.33	0.11	0.46	0.20	0.11	29.74
2018	WICO 34.02	0.61	0.52	0.13	0.63	0.11	0.26	37.77

**insufficient organisms found for calculation **Large Stream standardization value metrics applied for these sites*

Appendix VI. Watershed Sample Site Metrics Tables

2016, 2017: Armstrong Creek Watershed Metrics Analysis

	HBI=		Total Taxa =		Becks Index		Shannon Div=		% PTV <4		EPT taxa (0-4)	
Site Name	**OB**	**SV=(10-OB) /(10-1.89)**	**OB**	**SV=OB /33**	**OB**	**SV=OB / 38**	**OB**	**SV=OB / 2.86**	**OB**	**SV=OB / 84.5%**	**OB**	**SV=OB/19**
ARMS 01.76*	4.34	0.70	27	0.82	15	0.39	2.69	0.94	29.0%	0.344	14	0.737
ARMS 04.45	3.99	0.74	25	0.76	13	0.34	2.48	0.87	34.8%	0.412	13	0.684
ARMS 06.79	4.22	0.71	26	0.79	10	0.26	2.37	0.83	31.2%	0.369	11	0.579
ARMS 10.47	3.95	0.75	29	0.88	17	0.45	2.68	0.94	30.1%	0.357	15	0.789
ARMS 13.64	2.63	0.91	25	0.76	18	0.47	2.38	0.83	62.4%	0.739	13	0.684
CNLY 00.02	3.61	0.79	23	0.70	11	0.29	2.29	0.80	55.6%	0.658	13	0.684
CNLY 03.35	2.77	0.89	23	0.70	16	0.42	2.21	0.77	78.8%	0.933	12	0.632
NENG 00.04	3.41	0.81	27	0.82	21	0.55	2.54	0.89	43.7%	0.517	14	0.737

Adjusted Standardized Metric Score (max: 1.00)								
Report Name	**Site Name**	**HBI**	**Total Taxa**	**Becks**	**Shannon**	**% PTV**	**EPT taxa**	**IBI**
2016	ARMS 01.76	0.70	0.82	0.39	0.94	0.34	0.74	65.53
2016	ARMS 04.45	0.74	0.76	0.34	0.87	0.41	0.68	63.38
2016	ARMS 06.79	0.71	0.79	0.26	0.83	0.37	0.58	58.98
2016	ARMS 10.47	0.75	0.88	0.45	0.94	0.36	0.79	69.25
2016	ARMS 13.64	0.91	0.76	0.47	0.83	0.74	0.68	73.28
2017	CNLY 00.02	0.79	0.70	0.29	0.80	0.66	0.68	65.29
2017	CNLY 03.35	0.89	0.70	0.42	0.77	0.93	0.63	72.44
2016	NENG 00.04	0.81	0.82	0.55	0.89	0.52	0.74	72.08

2016: Powell Creek Watershed Metrics Analysis

	HBI=		Total Taxa =		Becks Index		Shannon Div=		% PTV <4		EPT taxa (0-4)	
Site Name	**OB**	**SV=(10-OB) /(10-1.89)**	**OB**	**SV=OB /33**	**OB**	**SV=OB / 38**	**OB**	**SV=OB / 2.86**	**OB**	**SV=OB / 84.5%**	**OB**	**SV=OB/19**
NPWL 02.25*	4.44	0.69	37	1.00	28	0.74	2.20	0.77	25.9%	0.307	19	1.000
PWLL 01.70*	5.45	0.56	20	0.61	7	0.18	1.60	0.56	11.6%	0.137	8	0.421
PWLL 08.37	4.52	0.68	26	0.79	11	0.29	2.55	0.89	28.8%	0.341	14	0.737
PWLL 13.01	3.98	0.74	37	1.00	22	0.58	3.06	1.00	40.3%	0.477	16	0.842
PWLL 16.21	3.44	0.81	33	1.00	26	0.68	2.74	0.96	52.5%	0.621	17	0.895
SPWL 02.51	4.14	0.72	28	0.85	24	0.63	2.37	0.83	33.2%	0.392	15	0.789

**Total individuals in the samples were slightly low or high but established.*

Adjusted Standardized Metric Score (max: 1.00)								
Report Name	Site Name	HBI	Total Taxa	Becks	Shannon	% PTV	EPT taxa	IBI
2016	NPWL 02.25	0.69	1.00	0.74	0.77	0.31	1.00	74.99
2016	PWLL 01.70	0.56	0.61	0.18	0.56	0.14	0.42	41.13
2016	PWLL 08.37	0.68	0.79	0.29	0.89	0.34	0.74	62.05
2016	PWLL 13.01	0.74	1.00	0.58	1.00	0.48	0.84	77.34
2016	PWLL 16.21	0.81	1.00	0.68	0.96	0.62	0.89	82.77
2016	SPWL 02.51	0.72	0.85	0.63	0.83	0.39	0.79	70.23

2017: Clarks Creek Watershed Metrics Analysis

	HBI=		Total Taxa =		Becks Index		Shannon Div=		% PTV <4		EPT taxa (0-4)	
Site Name	OB	SV=(10-OB) /(10-1.89)	OB	SV=OB /33	OB	SV=OB / 38	OB	SV=OB / 2.86	OB	SV=OB / 84.5%	OB	SV=OB/19
CLRK 01.85	4.21	0.71	33	1.00	22	0.58	2.60	0.91	41.6%	0.492	18	0.947
CLRK 08.47	3.50	0.80	32	0.97	21	0.55	2.85	1.00	51.1%	0.605	16	0.842
CLRK 16.24	3.99	0.74	37	1.00	29	0.76	2.86	1.00	40.6%	0.480	20	1.000
CLRK 22.72	3.45	0.81	37	1.00	32	0.84	2.65	0.93	57.1%	0.675	21	1.000

Adjusted Standardized Metric Score (max: 1.00)								
Report Name	Site Name	HBI	Total Taxa	Becks	Shannon	% PTV	EPT taxa	IBI
2017	CLRK 01.85	0.71	1.00	0.58	0.91	0.49	0.95	77.34
2017	CLRK 08.47	0.80	0.97	0.55	1.00	0.60	0.84	79.48
2017	CLRK 16.24	0.74	1.00	0.76	1.00	0.48	1.00	83.07
2017	CLRK 22.72	0.81	1.00	0.84	0.93	0.68	1.00	87.56

2012: Stony Creek Watershed Metrics Analysis

	HBI=		Total Taxa =		Becks Index		Shannon Div=		% PTV <4		EPT taxa (0-4)	
Site Name	OB	SV=(10-OB) /(10-1.89)	OB	SV=OB /33	OB	SV=OB / 38	OB	SV=OB / 2.86	OB	SV=OB / 84.5%	OB	SV=OB/19
RATR 00.01*	2.68	0.90	17	0.52	11	0.29	1.80	0.63	65.6%	0.776	8	0.421
STNY 01.29	4.75	0.65	26	0.79	17	0.45	2.38	0.83	15.5%	0.184	11	0.579
STNY 06.53	3.71	0.78	40	1.00	36	0.95	3.00	1.00	40.3%	0.477	25	1.000
STNY 15.41	5.01	0.61	24	0.73	10	0.26	1.76	0.62	17.9%	0.212	9	0.474

Adjusted Standardized Metric Score (max: 1.00)								
Report Name	Site Name	HBI	Total Taxa	Becks	Shannon	% PTV	EPT taxa	IBI
2016	RATR 00.01	0.90	0.52	0.29	0.63	0.78	0.42	58.89
2016	STNY 01.29	0.65	0.79	0.45	0.83	0.18	0.58	57.94
2016	STNY 06.53	0.78	1.00	0.95	1.00	0.48	1.00	86.66
2016	STNY 15.41	0.61	0.73	0.26	0.62	0.21	0.47	48.46

Appendix VI. Watershed Sample Site Metrics Tables

2017: Fishing Creek Watershed Metrics Analysis

	HBI=		Total Taxa =		Becks Index		Shannon Div=		% PTV <4		EPT taxa (0-4)	
Site Name	OB	SV=(10-OB) /(10-1.89)	OB	SV=OB /33	OB	SV=OB / 38	OB	SV=OB / 2.86	OB	SV=OB / 84.5%	OB	SV=OB/19
FSHN 00.52	4.70	0.65	22	0.67	8	0.21	2.45	0.86	24.7%	0.292	9	0.474
FSHN 05.97	4.12	0.73	25	0.76	11	0.29	2.51	0.88	42.6%	0.504	13	0.684
FSHN 08.91	3.80	0.76	28	0.85	14	0.37	2.61	0.91	49.6%	0.587	14	0.737

Adjusted Standardized Metric Score (max: 1.00)								
Report Name	Site Name	HBI	Total Taxa	Becks	Shannon	% PTV	EPT taxa	IBI
2017	FSHN 00.52	0.65	0.67	0.21	0.86	0.29	0.47	52.54
2017	FSHN 05.97	0.73	0.76	0.29	0.88	0.50	0.68	63.97
2017	FSHN 08.91	0.76	0.85	0.37	0.91	0.59	0.74	70.29

2014: Paxton Creek Watershed Metrics Analysis

	HBI=		Total Taxa =		Becks Index		Shannon Div=		% PTV <4		EPT taxa (0-4)	
Site Name	OB	SV=(10-OB) /(10-1.89)	OB	SV=OB /33	OB	SV=OB / 38	OB	SV=OB / 2.86	OB	SV=OB / 84.5%	OB	SV=OB/19
ASYL 00.76	6.21	0.47	9	0.27	0	0.00	0.77	0.27	0.0%	0.000	0	0.000
PXTN 02.76	*											
PXTN 07.71	5.95	0.50	17	0.52	2	0.05	1.49	0.52	1.0%	0.012	5	0.263
PXTN 08.41	5.62	0.54	19	0.58	0	0.00	2.10	0.73	4.8%	0.057	6	0.316
PXTN 09.91	*											
UNTP 00.14	*											
UNTP 10.74	5.33	0.58	11	0.33	1	0.03	1.24	0.43	0.5%	0.006	1	0.053

Adjusted Standardized Metric Score (max: 1.00)								
Report Name	Site Name	HBI	Total Taxa	Becks	Shannon	% PTV	EPT taxa	IBI
2014	ASYL 00.76	0.47	0.27	0.00	0.27	0.00	0.00	16.83
2014	PXTN 02.76	*						
2014	PXTN 07.71	0.50	0.52	0.05	0.52	0.01	0.26	31.05
2014	PXTN 08.41	0.54	0.58	0.00	0.73	0.06	0.32	37.02
2014	PXTN 09.91	*						
2014	UNTP 00.14	*						
2014	UNTP 10.74	0.58	0.33	0.03	0.43	0.01	0.05	23.78

**Insufficient numbers of macroinvertebrates for metrics calculations*

Appendix VI. Watershed Sample Site Metrics Tables

2015: Spring Creek West Watershed Metrics Analysis

	HBI=		Total Taxa =		Becks Index		Shannon Div=		% PTV <4		EPT taxa (0-4)	
Site Name	**OB**	**SV=(10-OB) /(10-1.89)**	**OB**	**SV=OB /33**	**OB**	**SV=OB / 38**	**OB**	**SV=OB / 2.86**	**OB**	**SV=OB / 84.5%**	**OB**	**SV=OB/19**
SPRW 00.33	5.35	0.57	12	0.36	3	0.08	1.87	0.65	0.6%	0.007	1	0.053
SPRW 02.31	5.50	0.56	14	0.42	0	0.00	1.70	0.60	0.0%	0.000	1	0.053
SPRW 04.32	4.97	0.62	16	0.48	5	0.13	1.89	0.66	2.0%	0.023	5	0.263
USPW 00.05	5.71	0.53	12	0.36	1	0.03	1.18	0.41	0.5%	0.006	1	0.053

Adjusted Standardized Metric Score (max: 1.00)								
Report Name	**Site Name**	**HBI**	**Total Taxa**	**Becks**	**Shannon**	**% PTV**	**EPT taxa**	**IBI**
2015	SPRW 00.33	0.57	0.36	0.08	0.65	0.01	0.05	28.82
2015	SPRW 02.31	0.56	0.42	0.00	0.60	0.00	0.05	27.13
2015	SPRW 04.32	0.62	0.48	0.13	0.66	0.02	0.26	36.38
2015	USPW 00.05	0.53	0.36	0.03	0.41	0.01	0.05	23.15

2015-2018: Swatara Creek Watershed Metrics Analysis

		HBI=		Total Taxa =		Becks Index		Shannon Div=		% PTV <4		EPT taxa (0-4)	
Year	Site Name	OB	SV=(10-OB) /(10-1.89)	OB	SV=OB /33	OB	SV=OB / 38	OB	SV=OB / 2.86	OB	SV=OB / 84.5%	OB	SV=OB/19
2015	UNTS 00.63	4.13	0.72	8	0.24	0	0	1.13	0.39	0	0	1	0.053
2015	NYES 00.10	5.15	0.60	21	0.64	4	0.11	2.34	0.82	4.5%	0.053	8	0.421
2015	NYES 01.54*												
2016	BEVR 02.18	4.72	0.65	25	0.76	6	0.16	2.30	0.80	15.0%	0.177	8	0.421
2016	BEVR 07.35	5.14	0.60	16	0.48	2	0.05	1.80	0.63	7.4%	0.088	5	0.263
2016	BEVR 09.34	4.60	0.67	18	0.55	7	0.18	2.00	0.70	7.8%	0.092	8	0.421
2017	UNTB 00.26	4.72	0.65	21	0.64	11	0.29	2.27	0.79	12.4%	0.147	8	0.421
2016	KLCK 00.07	5.21	0.59	16	0.48	5	0.13	1.29	0.45	7.9%	0.093	6	0.316
2018	MNDA 02.26	4.84	0.64	27	0.82	12	0.32	2.36	0.83	21.9%	0.259	11	0.579
2018	MNDA 05.94	4.05	0.73	31	0.94	13	0.34	2.84	0.99	35.8%	0.424	11	0.579
2018	MNDA 10.17	4.76	0.65	37	1.00	23	0.61	2.46	0.86	31.8%	0.377	20	1.000
2018	MNDA 13.64	3.25	0.83	35	1.00	23	0.61	2.79	0.98	51.1%	0.604	16	0.842
2018	UMNA 00.31	5.42	0.56	27	0.82	6	0.16	2.22	0.78	5.7%	0.068	8	0.421
2018	WLNT 00.57	5.21	0.59	31	0.94	8	0.21	2.48	0.87	8.2%	0.097	9	0.474
2017	BOWC 00.92	5.63	0.54	23	0.70	3	0.08	1.86	0.65	3.9%	0.046	8	0.421
2017	BOWC 05.31	5.06	0.61	27	0.82	7	0.18	2.72	0.95	9.8%	0.116	10	0.526
2017	UNTB 00.05	5.88	0.51	16	0.48	1	0.03	1.82	0.64	1.8%	0.022	3	0.158
2015	SPRE 03.03	5.23	0.59	15	0.45	2	0.05	1.93	0.68	0.9%	0.011	3	0.158
2015	SPRN 00.06	4.07	0.73	6	0.18	0	0.00	0.34	0.12	0.0%	0.000	0	0.000
2015	SPRN 00.79	4.10	0.73	7	0.21	0	0.00	0.36	0.13	0.0%	0.000	0	0.000
2015	UNTS 00.24	5.35	0.57	9	0.27	0	0.00	1.03	0.36	0.0%	0.000	0	0.000
2015	UNTS 01.67	5.26	0.58	13	0.39	3	0.08	1.80	0.63	1.4%	0.016	2	0.105
2015	UNTS 02.71	5.18	0.59	22	0.67	4	0.11	1.87	0.65	5.8%	0.069	5	0.263
2015	UNTS 02.90	5.08	0.61	28	0.85	3	0.08	2.53	0.88	4.4%	0.052	6	0.316
2015	UNTS 03.27	5.72	0.53	17	0.52	3	0.08	1.46	0.51	4.5%	0.054	3	0.158
2015	UNTS 00.28	5.14	0.60	11	0.33	0	0	1.23	0.43	0.0%	0.000	0	0.000
2015	IRON 00.49*												
2015	IRON 03.04	4.50	0.68	22	0.67	5	0.13	1.92	0.67	5.0%	0.059	5	0.263
2018	SWTR 00.80 **	4.47	0.80	24	0.77	6	0.27	2.43	0.85	19.6%	0.294	10	0.625
2018	SWTR 08.70 **	4.10	0.85	19	0.61	5	0.23	2.40	0.84	23.7%	0.355	7	0.438
2018	SWTR 13.91 **	5.12	0.70	17	0.55	8	0.36	1.93	0.67	9.4%	0.140	8	0.500
2018	SWTR 19.83 **	4.15	0.84	28	0.90	15	0.68	2.64	0.92	30.5%	0.458	16	1.000

**insufficient individuals for metrics calculation. **Large Stream standardization value metrics applied for these sites*

2015-2018: Swatara Creek Watershed Metrics Analysis (Continued)

Adjusted Standardized Metric Score (max: 1.00)								
Report Name	**Site Name**	**HBI**	**Total Taxa**	**Becks**	**Shannon**	**% PTV**	**EPT taxa**	**IBI**
2015	UNTS 00.63	0.72	0.24	0	0.39	0	0.05	23.56
2015	NYES 00.10	0.60	0.64	0.11	0.82	0.05	0.42	43.91
2015	NYES 01.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016	BEVR 02.18	0.65	0.76	0.16	0.80	0.18	0.42	49.47
2016	BEVR 07.35	0.60	0.48	0.05	0.63	0.09	0.26	35.29
2016	BEVR 09.34	0.67	0.55	0.18	0.70	0.09	0.42	43.44
2017	UNTB 00.26	0.65	0.64	0.29	0.79	0.15	0.42	48.94
2016	KLCK 00.07	0.59	0.48	0.13	0.45	0.09	0.32	34.44
2018	MNDA 02.26	0.64	0.82	0.32	0.83	0.26	0.58	57.25
2018	MNDA 05.94	0.73	0.94	0.34	0.99	0.42	0.58	66.83
2018	MNDA 10.17	0.65	1.00	0.61	0.86	0.38	1.00	74.81
2018	MNDA 13.64	0.83	1.00	0.61	0.98	0.60	0.84	81.00
2018	UMNA 00.31	0.56	0.82	0.16	0.78	0.07	0.42	46.75
2018	WLNT 00.57	0.59	0.94	0.21	0.87	0.10	0.47	53.00
2017	BOWC 00.92	0.54	0.70	0.08	0.65	0.05	0.42	40.55
2017	BOWC 05.31	0.61	0.82	0.18	0.95	0.12	0.53	53.41
2017	UNTB 00.05	0.51	0.48	0.03	0.64	0.02	0.16	30.58
2015	SPRE 03.03	0.59	0.45	0.05	0.68	0.01	0.16	32.32
2015	SPRN 00.06	0.73	0.18	0.00	0.12	0.00	0.00	17.18
2015	SPRN 00.79	0.73	0.21	0.00	0.13	0.00	0.00	17.78
2015	UNTS 00.24	0.57	0.27	0.00	0.36	0.00	0.00	20.10
2015	UNTS 01.67	0.58	0.39	0.08	0.63	0.02	0.11	30.11
2015	UNTS 02.71	0.59	0.67	0.11	0.65	0.07	0.26	39.17
2015	UNTS 02.90	0.61	0.85	0.08	0.88	0.05	0.32	46.43
2015	UNTS 03.27	0.53	0.52	0.08	0.51	0.05	0.16	30.71
2015	UNTS 00.28	0.60	0.33	0.00	0.43	0.00	0.00	22.73
2015	IRON 00.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	IRON 03.04	0.68	0.67	0.13	0.67	0.06	0.26	41.18
2018	SWTR 00.80 **	0.80	0.77	0.27	0.85	0.29	0.63	60.21
2018	SWTR 08.70 **	0.85	0.61	0.23	0.84	0.35	0.44	55.31
2018	SWTR 13.91 **	0.70	0.55	0.36	0.67	0.14	0.50	48.79
2018	SWTR 19.83 **	0.84	0.90	0.68	0.92	0.46	1.00	80.10

**insufficient individuals for metrics calculation. **Large Stream standardization value metrics applied for these sites*

2014: Conewago Creek Watershed Metrics Analysis

	HBI=		Total Taxa =		Becks Index		Shannon Div=		% PTV <4		EPT taxa (0-4)	
Site Name	**OB**	**SV=(10-OB) /(10-1.89)**	**OB**	**SV=OB /33**	**OB**	**SV=OB / 38**	**OB**	**SV=OB / 2.86**	**OB**	**SV=OB / 84.5%**	**OB**	**SV=OB/19**
BRIL 00.19	5.21	0.59	26	0.79	5	0.13	2.07	0.72	11.3%	0.134	10	0.526
CNWG 01.75 **	4.83	0.74	27	0.87	3	0.14	2.36	0.82	22.0%	0.330	9	0.563
CNWG 06.24	4.73	0.65	22	0.67	7	0.18	2.03	0.71	18.3%	0.217	9	0.474
CNWG 09.23	5.10	0.60	19	0.58	4	0.11	1.97	0.69	15.4%	0.182	7	0.368
CNWG 13.59	4.45	0.68	22	0.67	9	0.24	2.16	0.75	24.2%	0.286	6	0.316
GALG 00.45	5.55	0.55	14	0.42	0	0.00	1.42	0.50	1.9%	0.022	2	0.105
HOFR 00.02	5.42	0.56	18	0.55	3	0.08	1.74	0.61	6.5%	0.077	3	0.158
LYNC 00.20	5.81	0.52	12	0.36	0	0.00	0.93	0.33	0.0%	0.000	2	0.105
UNTC 00.36	5.46	0.56	18	0.55	2	0.05	1.65	0.58	1.9%	0.022	7	0.368

. ***Large Stream standardization value metrics applied for this site.*

Adjusted Standardized Metric Score (max: 1.00)								
Report Name	**Site Name**	**HBI**	**Total Taxa**	**Becks**	**Shannon**	**% PTV**	**EPT taxa**	**IBI**
2014	BRIL 00.19	0.59	0.79	0.13	0.72	0.134	0.526	48.22
2014	CNWG 01.75 **	0.74	0.87	0.14	0.82	0.330	0.563	57.80
2014	CNWG 06.24	0.65	0.67	0.18	0.71	0.217	0.474	48.34
2014	CNWG 09.23	0.60	0.58	0.11	0.69	0.182	0.368	42.09
2014	CNWG 13.59	0.68	0.67	0.24	0.75	0.286	0.316	49.06
2014	GALG 00.45	0.55	0.42	0.00	0.50	0.022	0.105	26.60
2014	HOFR 00.02	0.56	0.55	0.08	0.61	0.077	0.158	33.86
2014	LYNC 00.20	0.52	0.36	0.00	0.33	0.000	0.105	21.87
2014	UNTC 00.36	0.56	0.55	0.05	0.58	0.022	0.368	35.43

***Large Stream standardization value metrics applied for this site.*

2011-2013: Susquehanna Tributaries Watersheds Metrics Analysis

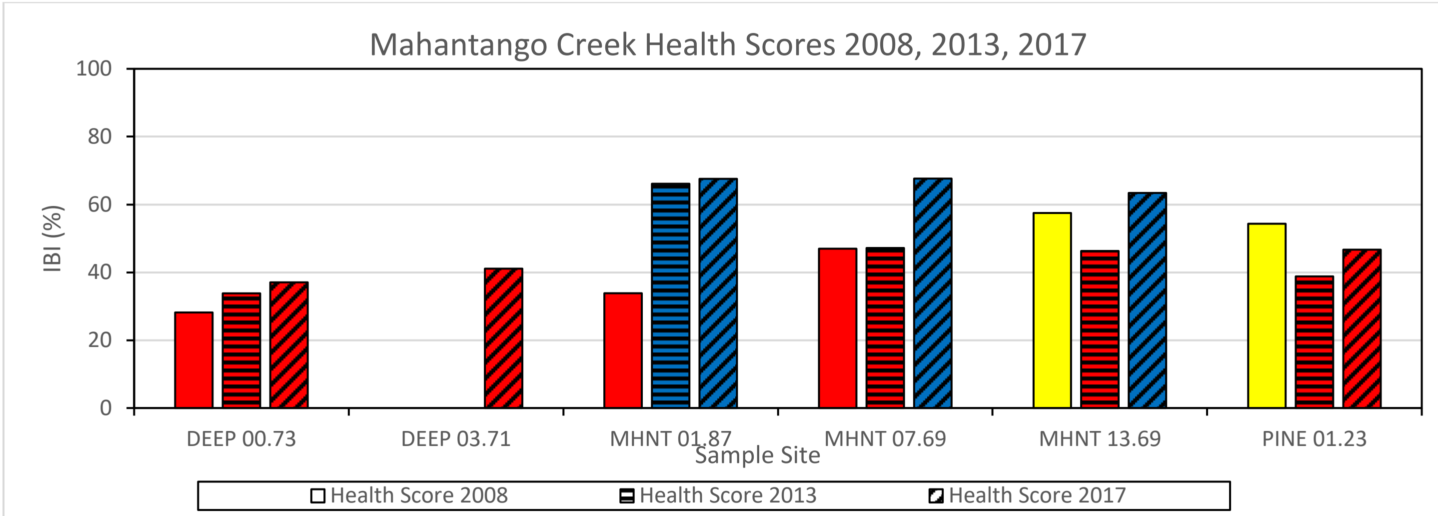
		HBI=		Total Taxa =		Becks Index		Shannon Div=		% PTV <4		EPT taxa (0-4)	
Tributary Name	**Site Name**	**OB**	**SV=(10-OB) /(10-1.89)**	**OB**	**SV=OB /33**	**OB**	**SV=OB / 38**	**OB**	**SV=OB / 2.86**	**OB**	**SV=OB / 84.5%**	**OB**	**SV=OB/19**
Shippens Run	SHIP 01.89 (2018)	5.57	0.55	19	0.58	4	0.11	1.60	0.56	3.1%	0.036	4	0.211
Gurdy Run	GRDY 00.57 (2018)	3.93	0.75	26	0.79	18	0.47	2.56	0.90	47.5%	0.562	14	0.737
Laurel Run	LARL 00.34 (2015)	4.01	0.74	8	0.24	2	0.05	0.48	0.17	3.1%	0.036	1	0.053
Burd Run	UNTS 00.43 (2015)	5.09	0.60	8	0.24	0	0.00	1.49	0.52	0.0%	0.000	0	0.000

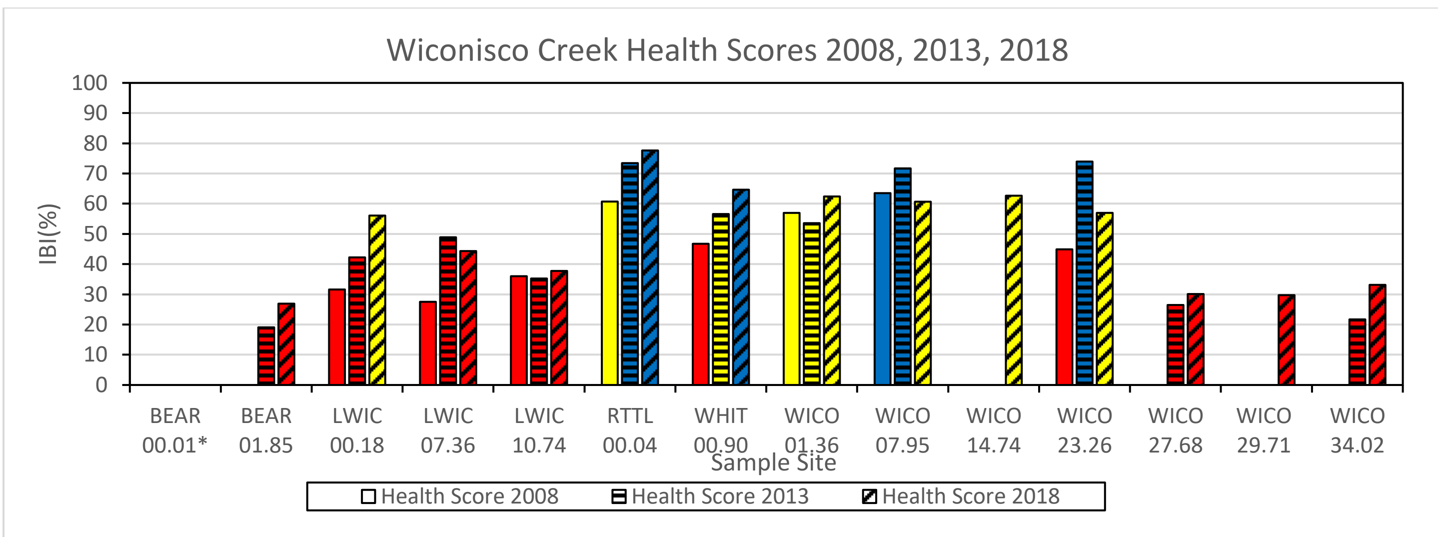
Adjusted Standardized Metric Score (max: 1.00)								
Report Name	**Site Name**	**HBI**	**Total Taxa**	**Becks**	**Shannon**	**% PTV**	**EPT taxa**	**IBI**
2018	SHIP 01.89	0.55	0.58	0.11	0.56	0.04	0.21	33.91
2018	GRDY 00.57	0.75	0.79	0.47	0.90	0.56	0.74	70.06
2015	LARL 00.34	0.74	0.24	0.05	0.17	0.04	0.05	21.53
2015	UNTS 00.43	0.60	0.24	0.00	0.52	0.00	0.00	22.83

Appendix VII. Watershed Health Score Sample Cycle Comparison

Watershed Site Health Score Comparison Charts: 2004-2008, 2009-2013, and 2014-2018 Sample Cycles

Stream Health:
Good Fair Poor

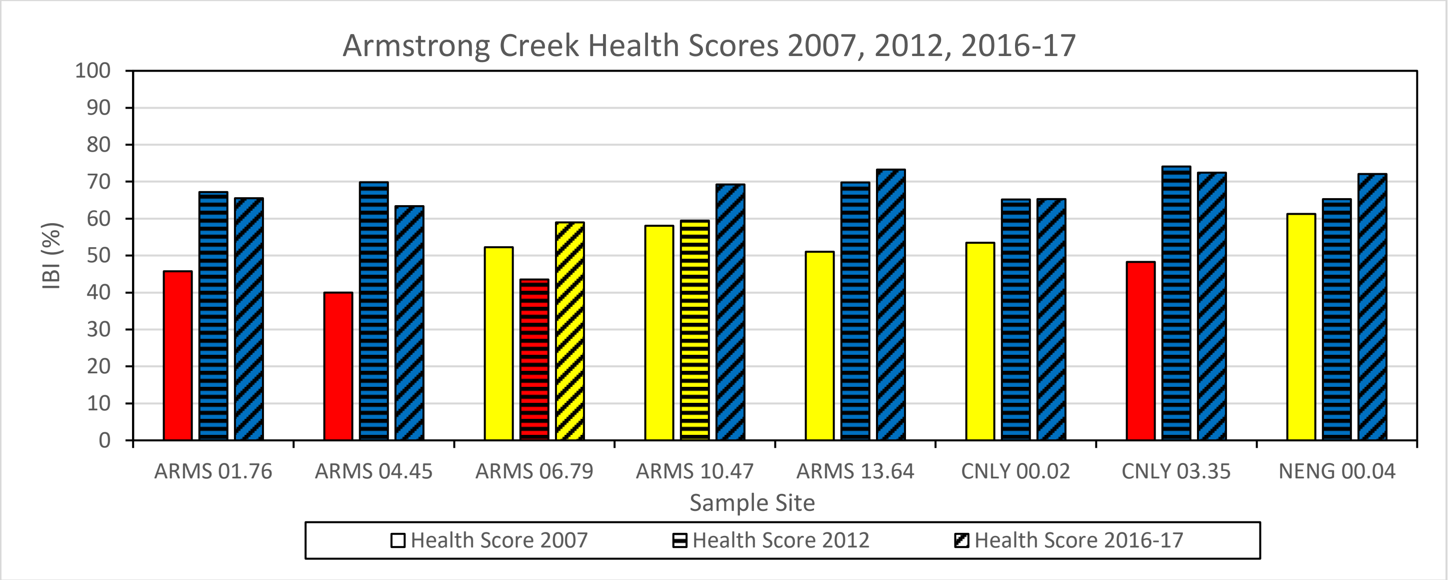


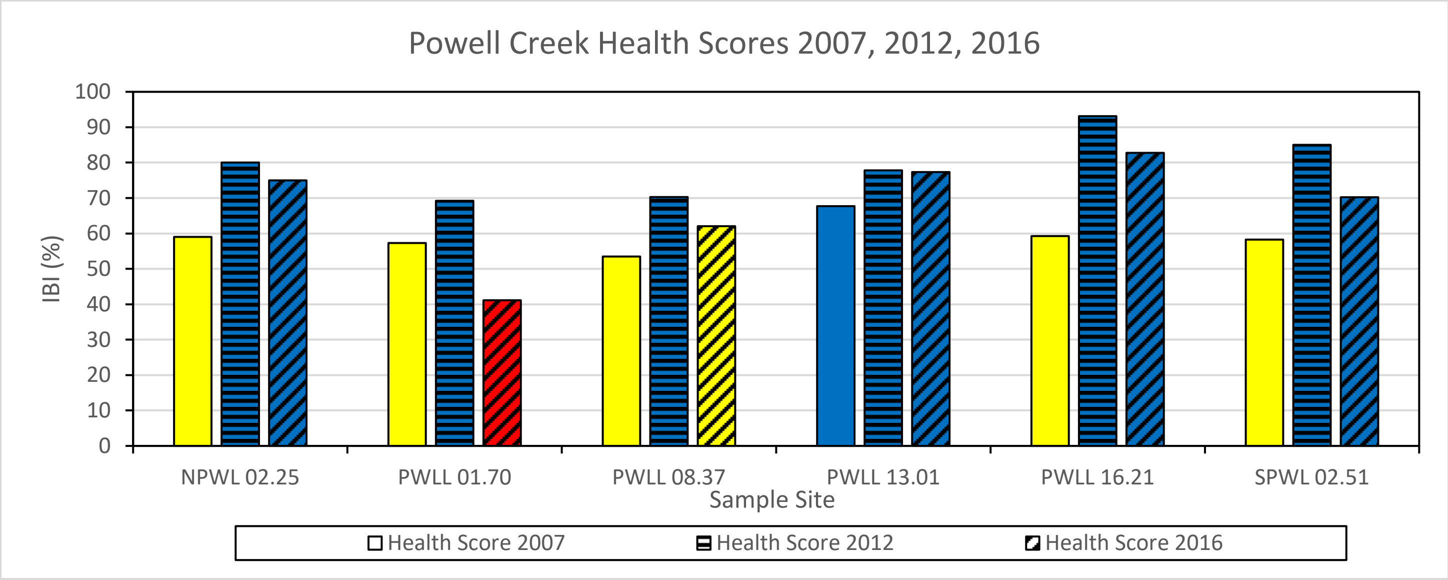


** BEAR 00.01 insufficient organisms for calculation*

Watershed Site Health Score Comparison Charts: 2004-2008, 2009-2013, and 2014-2018 Sample Cycles (cont.)

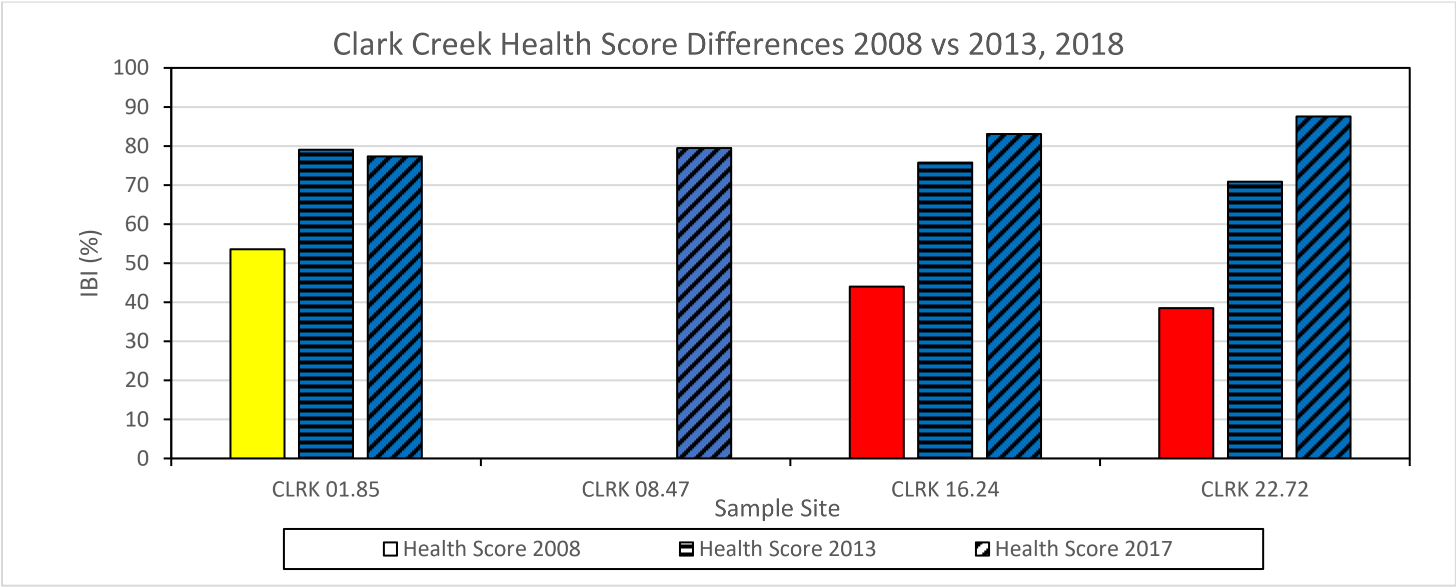
Stream Health:
Good Fair Poor

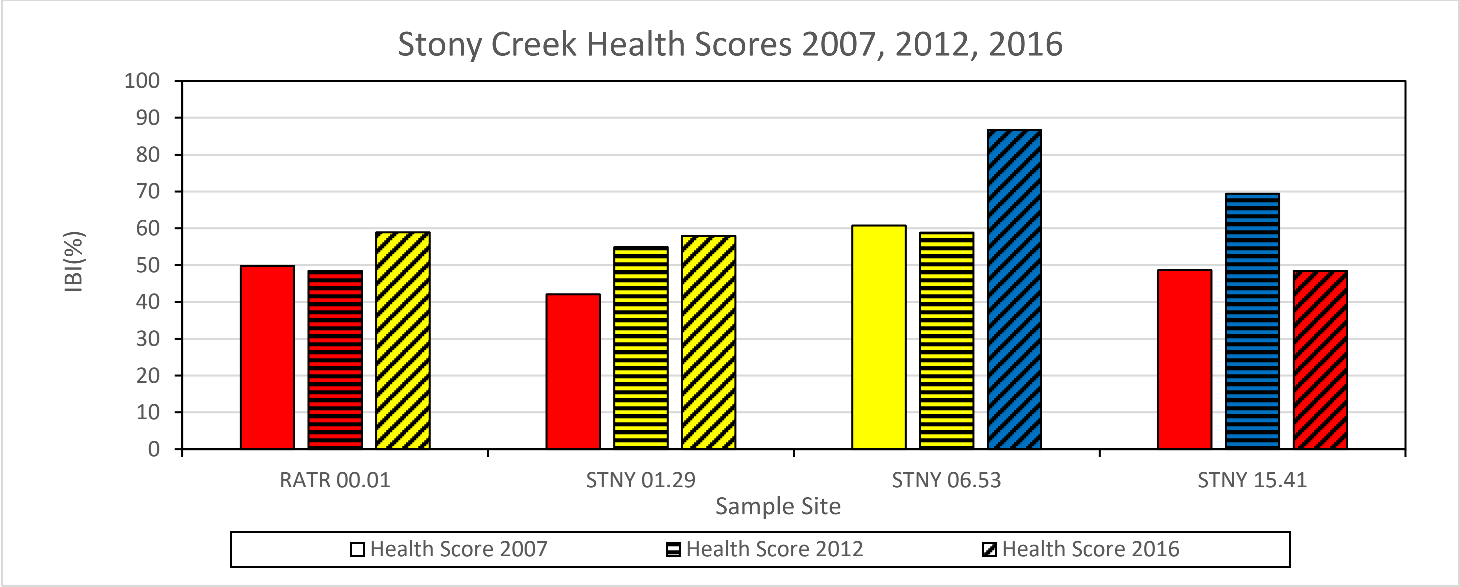




Watershed Site Health Score Comparison Charts: 2004-2008, 2009-2013, and 2014-2018 Sample Cycles (cont.)

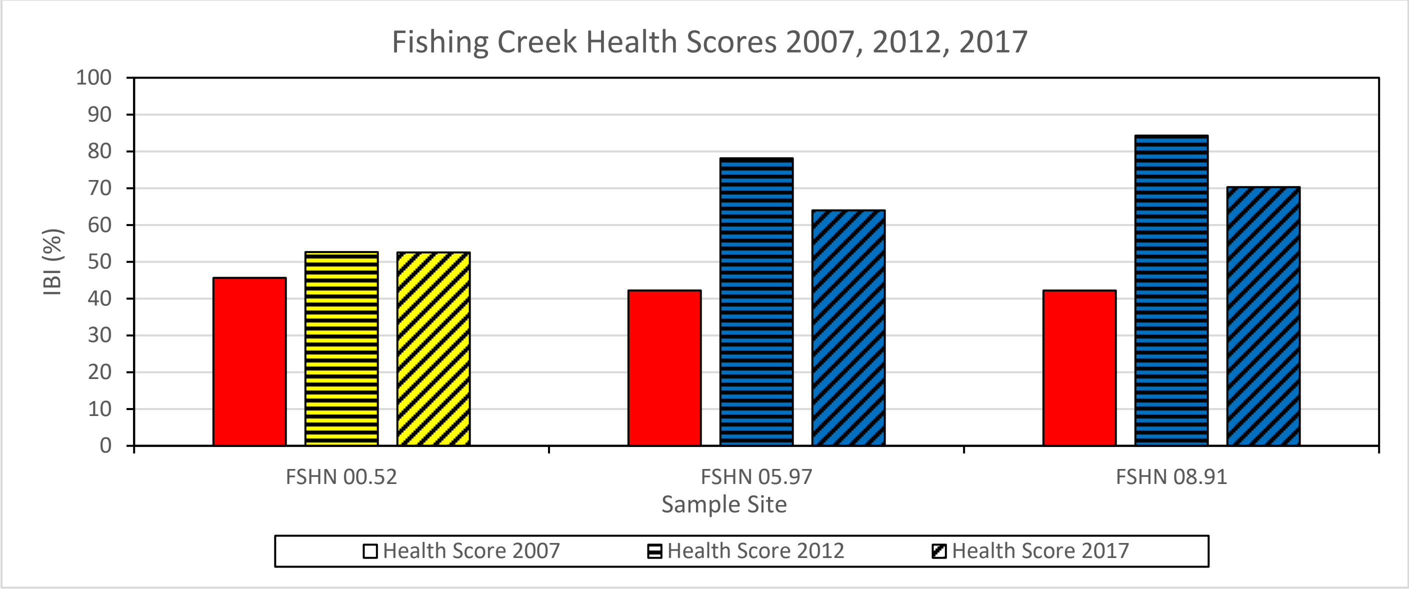
Stream Health:
Good Fair Poor

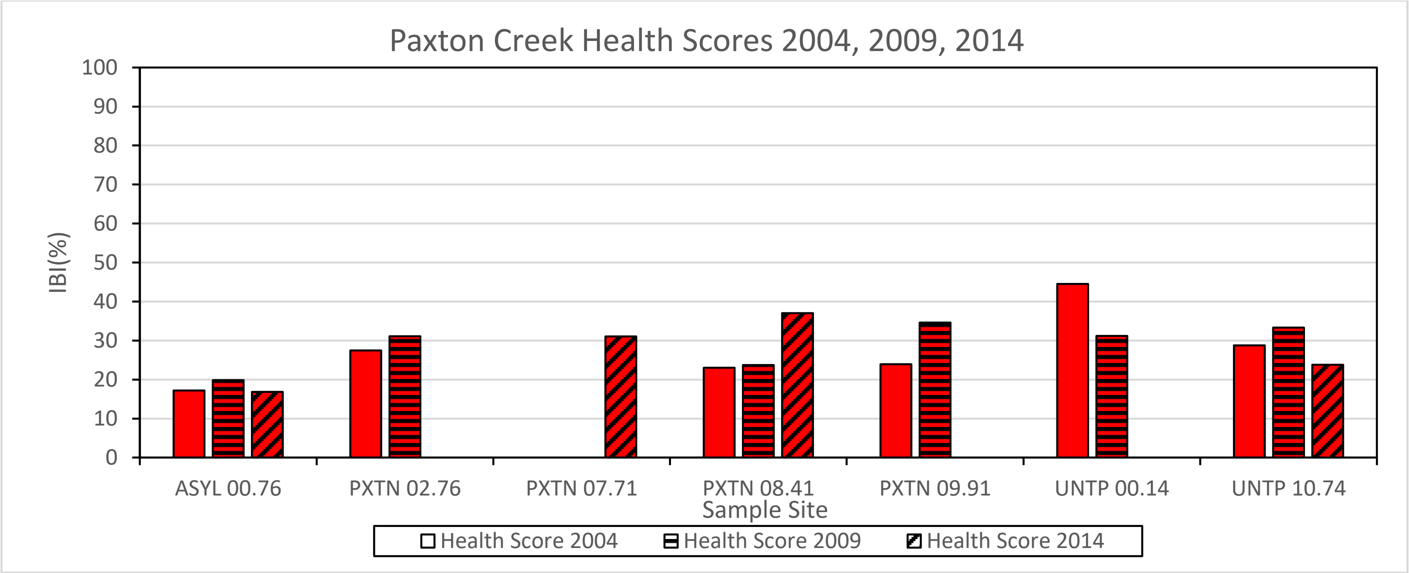




Watershed Site Health Score Comparison Charts: 2004-2008, 2009-2013, and 2014-2018 Sample Cycles (cont.)

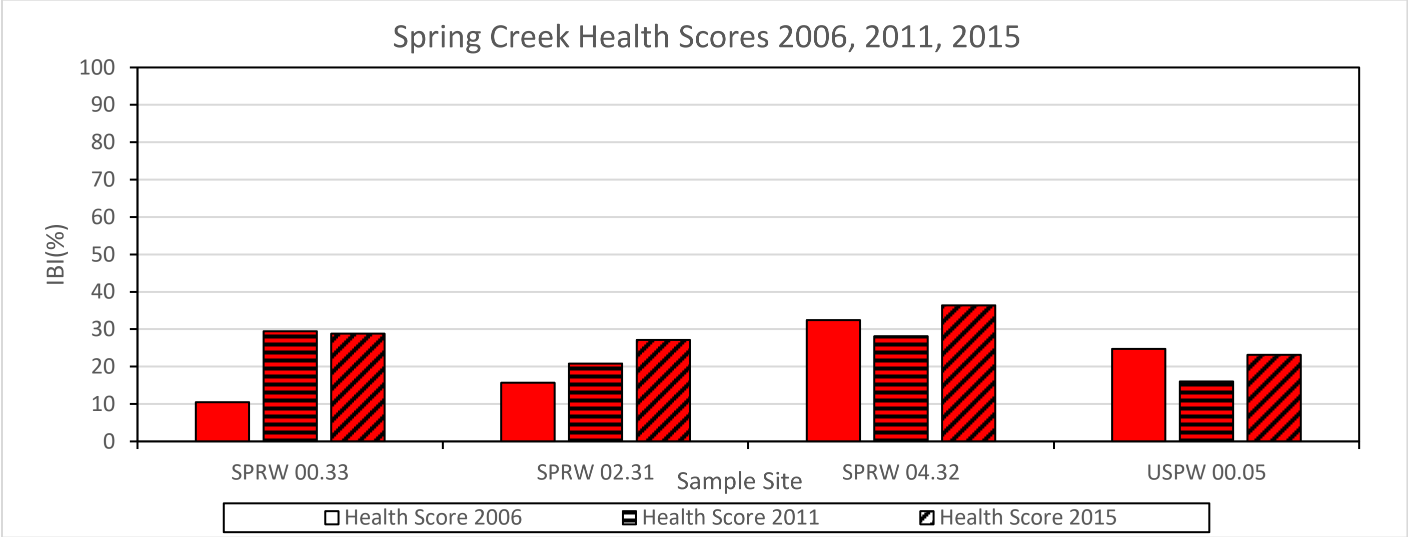
Stream Health:
Good Fair Poor





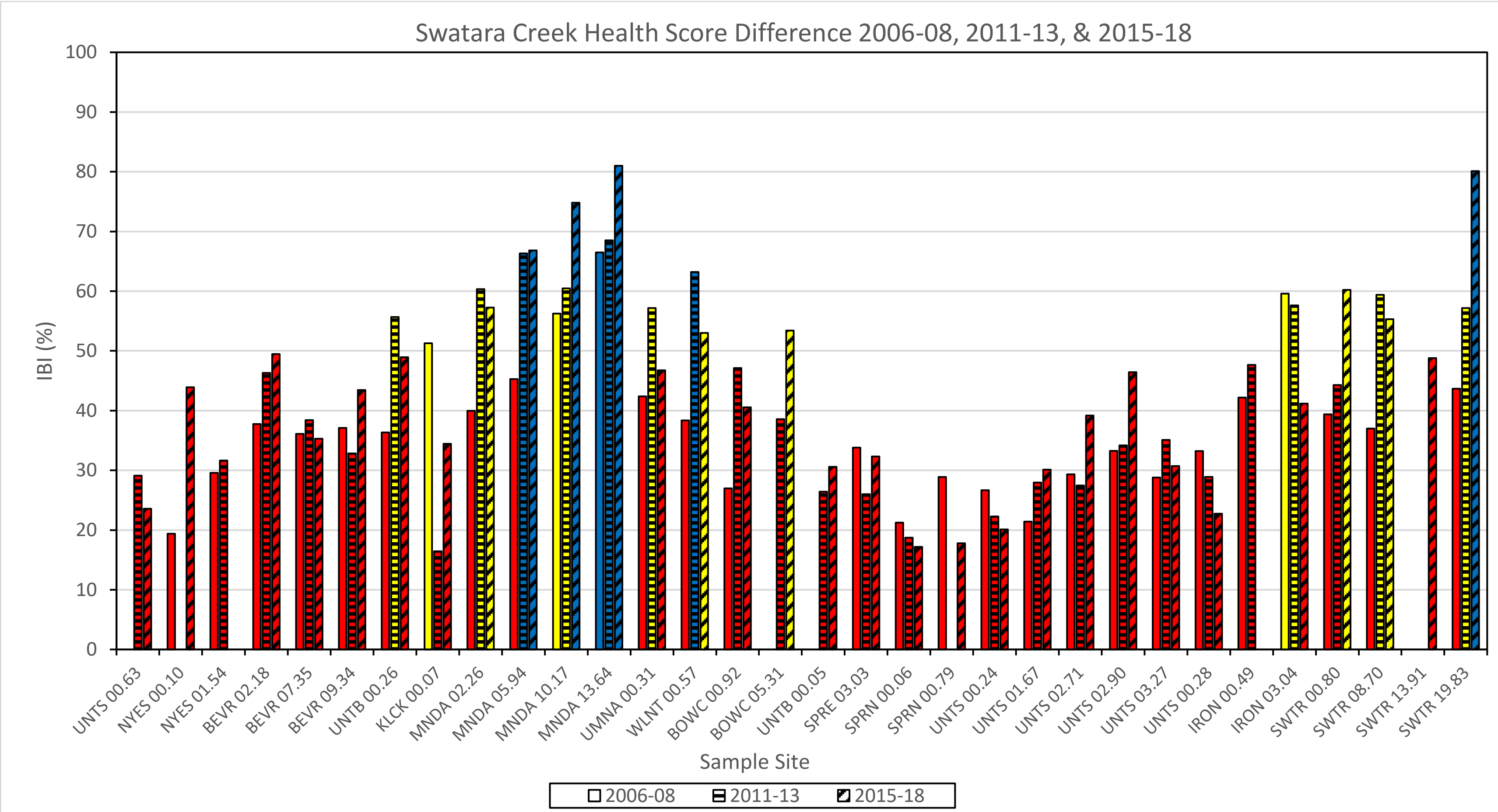
Watershed Site Health Score Comparison Charts: 2004-2008, 2009-2013, and 2014-2018 Sample Cycles (cont.)

Stream Health:
Good Fair Poor



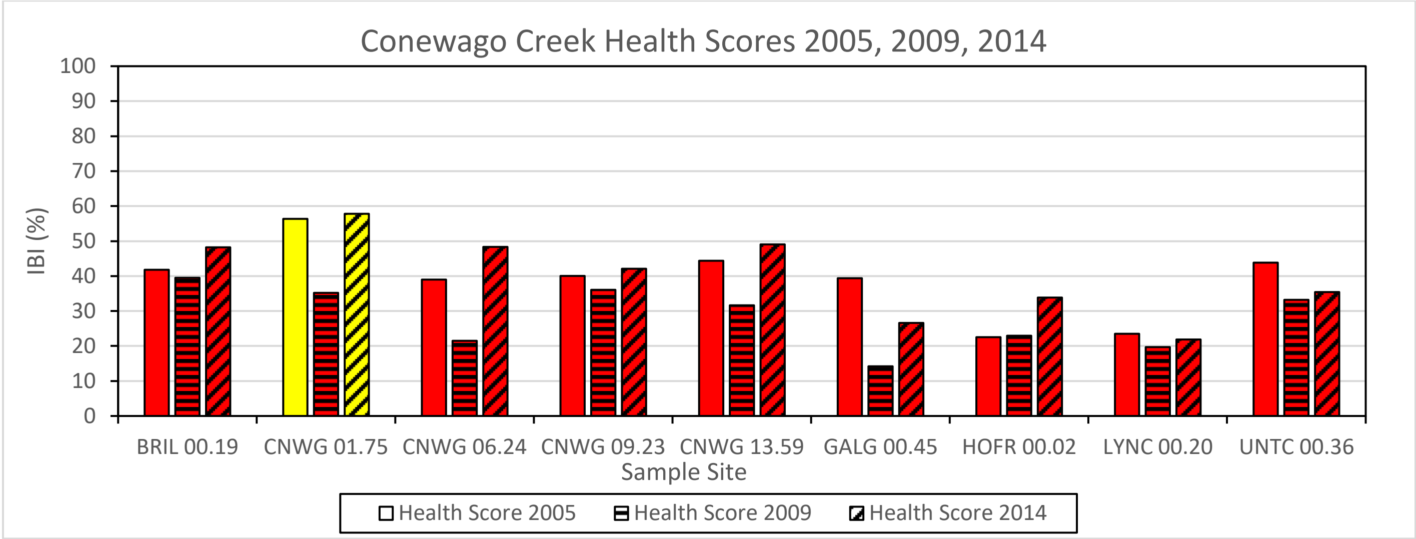
Watershed Site Health Score Comparison Charts: 2004-2008, 2009-2013, and 2014-2018 Sample Cycles (cont.)

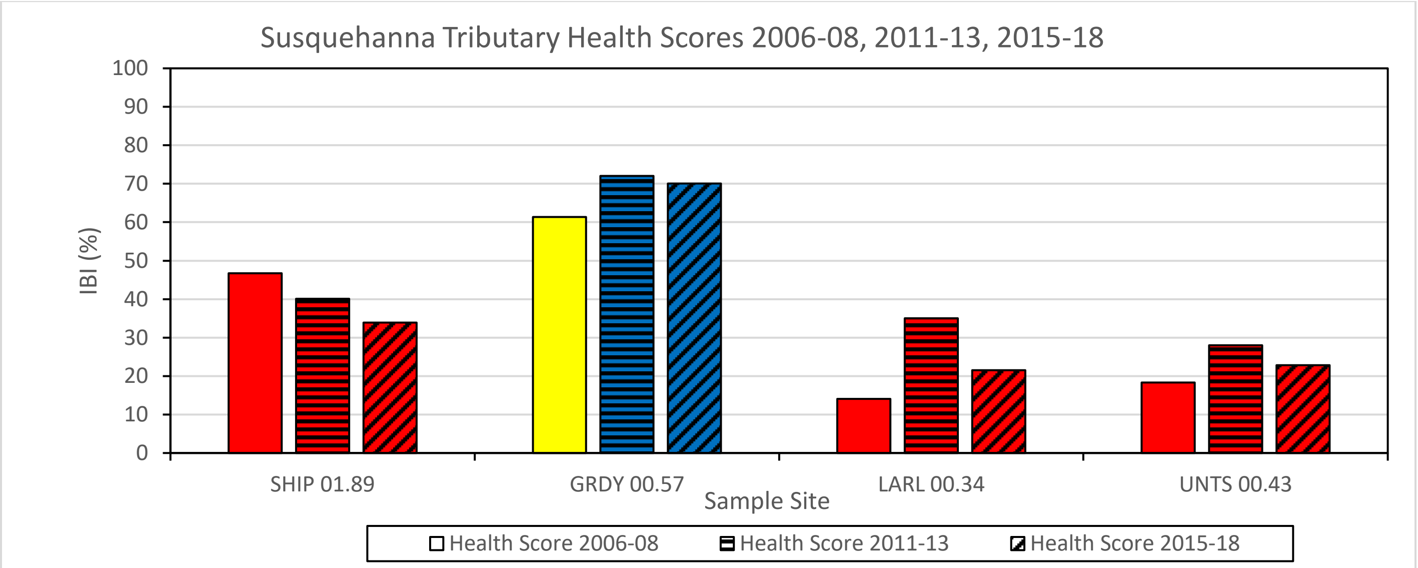
Stream Health:
Good Fair Poor



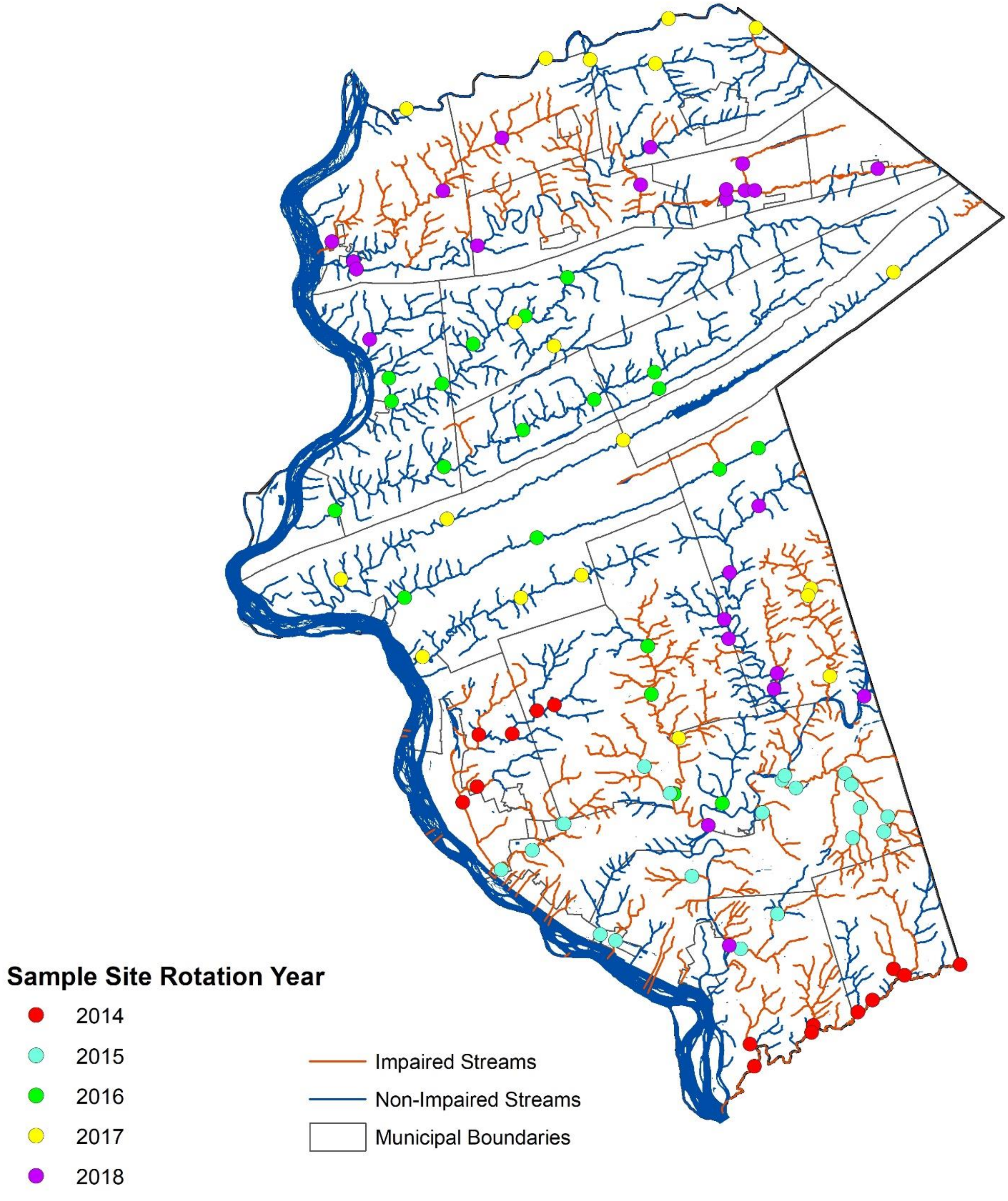
Watershed Site Health Score Comparison Charts: 2004-2008, 2009-2013, and 2014-2018 Sample Cycles (cont.)

Stream Health:
Good Fair Poor



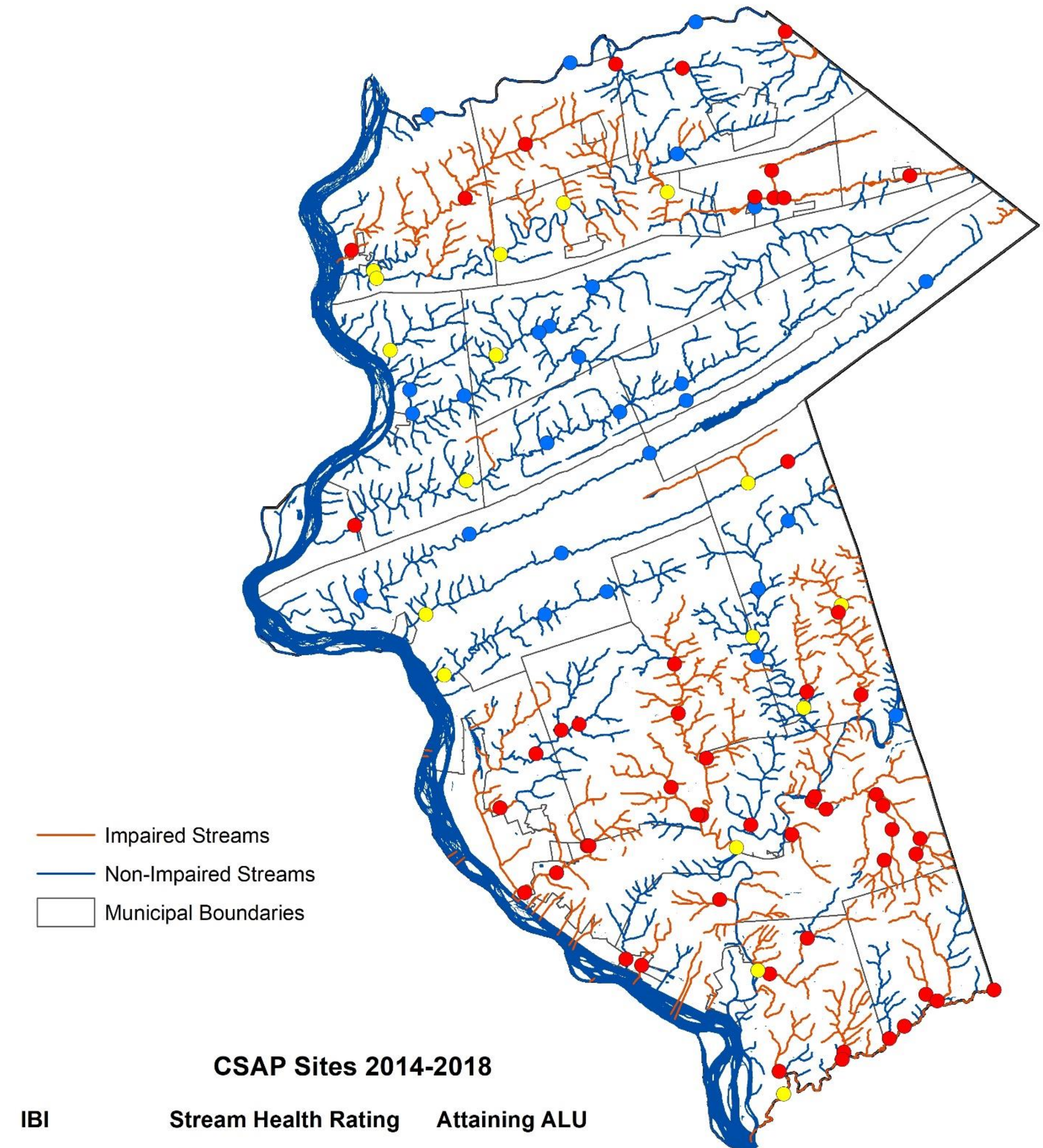


Appendix VIII: Countywide Stream Assessment Sample Sites



Countywide Stream Assessment Sample Sites.

Appendix IX: Countywide Stream Health Classifications by Sample Site



CSAP Sites 2014-2018

IBI	Stream Health Rating	Attaining ALU
63+	Good	Yes
≥ 50 - < 63	Fair	Requires Further Evaluation
0 - < 50	Poor	No