TUNKHANNOCK CREEK

MONROE AND CARBON COUNTIES

WATER QUALITY STANDARDS REVIEW

STREAM REDESIGNATION EVALUATION REPORT

Segment: Basin
Stream Code: 04376
Drainage List: D

WATER QUALITY MONITORING SECTION (MJL)
DIVISION OF WATER QUALITY STANDARDS
BUREAU OF CLEAN WATER
DEPARTMENT OF ENVIRONMENTAL PROTECTION

2016

INTRODUCTION

The Department conducted an evaluation of the Tunkhannock Creek basin on April 17-18, 2012 in response to a petition from the Tobyhanna Creek/Tunkhannock Creek Watershed Association and the Tunkhanna Fishing Association, which was accepted for study by the Environmental Quality Board (EQB) on March 2, 2005. The petition requests that the entire basin be redesignated to Exceptional Value (EV). The Tunkhannock Creek basin is currently designated High Quality – Cold Water Fishes, Migratory Fishes (HQ-CWF, MF). Components of this evaluation include field surveys conducted in April of 2012 as well as water quality protective measures implemented within the Tunkhannock Creek basin.

GENERAL WATERSHED DESCRIPTION

Tunkhannock Creek is a tributary to Tobyhanna Creek and is located southwest of Mount Pocono Borough and southeast of Blakeslee, PA. The candidate basin is located in Tobyhanna and Tunkhannock Townships in western Monroe County and Kidder Township in northeastern Carbon County. The Tunkhannock Creek basin drains approximately 32.1 square miles of the Glaciated Pocono Plateau and consists of 47.7 total stream miles (Figures 1 - 3). The upper reaches of the basin is best described as low gradient, and is dominated by pool/glide channel morphology, naturally lacking riffles. Gradient progressively increases through the basin's middle and lower reaches becoming a riffle/run dominant waterbody. Land use is approximately 88% forested, 10% agricultural, 1.5% wetlands and 0.5% low density urban. Much of the basin is in private and Bethlehem Water Authority ownership with the exception of relatively small land holdings owned by the PA Chapter of the Nature Conservancy, Hickory Run State Park, Weiser State Forest, State Game Lands 129, and State Game Lands 38. The basin contains the Long Pond and Fern Ridge Bog (Adams Swamp) Nature Reserves. The basin also contains developed areas including the Pocono International Speedway, Split Rock Resort, Big Boulder Resort, a few cul-de-sac developments, and Interstate 80 that cuts through the northern most portion of the basin.

WATER QUALITY AND USES

Surface Water

Biological data was collected to evaluate water quality conditions in the petitioned basin since the indigenous aquatic community is a better indicator of long-term water quality conditions. There are a total of 7 NPDES permits (1 mining discharge, 3 sewage treatment facilities, 2 pesticide application permits and 1 stormwater permit) and 2 active surface water withdrawals within the basin.

Water Chemistry

Water chemistry data were collected monthly beginning in 2005 through 2010 at the Department's Water Quality Network Station # 198 (WQN0198), which spatially coincides with station 1TC in the upper reaches of Tunkhannock Creek (Table 2). The Water Quality Network (WQN) is a statewide, fixed station water quality sampling system operated by the Department that is designed to assess both the quality of Pennsylvania's surface waters and the effectiveness of the water quality management program. One objective of the WQN is to monitor temporal water quality trends in selected reference waters. In addition, discrete water quality measurements were collected at 9 stations (6 candidate and 3 reference) during the April 2012 survey (Table 3).

The water chemistry in the upper reaches of Tunkhannock Creek can generally be described as acidic, with very low alkalinity and minimal evidence of anthropogenic influence. The minimum pH value was 4.7 and the maximum was 6.6 of approximately 60 water chemistry grab samples collected over the 5-year period. Alkalinity ranged from absolutely 0.0 mg/l to a maximum 5.2 mg/l. Aluminum and Iron concentrations are low to moderate. Other metals results ranged from below reporting limits to very low concentrations. As a result of acidic conditions, dissolved metals concentration results constitute most of the total metals concentration results. Nitrogen and Phosphorous range from below reporting limits to very low concentrations. No violations of water quality criteria, with the exception of pH, existed (Tables 2 & 3). The low pH conditions observed are expected in the wetland complexes that dominate the upper portions of the basin.

Aquatic Biota

The indigenous aquatic community is an excellent indicator of long-term conditions and is used as a measure of both water quality and ecological significance. Department staff collected habitat and benthic macroinvertebrate data at 9 stations (6 candidate and 3 reference) during the April 2012 survey (Figures 1 - 3, Table 1).

Habitat. Instream habitat was assessed at each station where benthic macroinvertebrates were sampled (Tables 4 & 5). The habitat evaluation consists of rating nine habitat parameters for low gradient stations and twelve parameters for riffle/run prevalence stations to derive a station habitat score. The total habitat scores for the low gradient reaches were 159 (1TC) and 171 (2TC) and ranged from 189 (3UNT) to 213 (6TC) throughout the riffle/run prevalence reaches. Tunkhannock Creek basin scores reflect optimal habitat conditions at all sites, with the exception of the suboptimal score at 3UNT.

Benthos. Benthic macroinvertebrate samples were collected at all stations using the Department's Rapid Bioassessment Protocols (RBP) benthic macroinvertebrate sampling technique, which is a modification of the US Environmental Protection Agency's (EPA) RBPs (Plafkin et al. 1989 and Barbour et al. 1999).

The Tunkhannock Creek basin supports a diverse benthic macroinvertebrate population dominated by genera sensitive to organic pollution and at least moderately tolerant of acidic conditions. Elevated taxa richness across most candidate stations (ranging 21-34) were very similar to reference stations (ranging 26-32) with the exception of 3UNT with only 9 taxa . Individuals from the Chironimidae family dominated all low gradient stations (candidate stations 1TC & 2TC and reference station 1LBK). Low gradient reaches typically have an elevated concentration of headwater ponds and wetlands and are optimal habitat for Chironomidae and other filter feeding macroinvertebrates. The lower reaches of the basin, with the exception of 3UNT, is dominated by taxa indicative of a healthy riffle/run prevalence community including Heptageniidae and Perlidae (Table 6).

BIOLOGICAL USE QUALIFICATIONS

The biological use qualifying criterion applied to the Tunkhannock Creek basin was the Department's integrated benthic macroinvertebrate scoring test

described at 25 Pa. Code § 93.4b(b)(1)(v). Selected benthic macroinvertebrate community metrics calculated for the Tunkhannock Creek basin stations were compared to those from EV reference streams of comparable drainage areas and stream type. Dimmick Meadow Brook (DMK) in Pike County, and Little Bush Kill (1LBK and 2LBK) in Pike County (Table 1) were used as the reference streams because they are of similar stream type, have comparable drainage areas and are found in similar geologic settings as their respective candidate stations. In addition, these streams have served as EV reference streams in other Departmental surveys. Low gradient stations 1TC and 2TC were compared to low gradient reference station 1LBK. Small (< 5 square miles) riffle/run prevalence stations 3UNT and 5UNT were compared to reference station DMK. Larger (21-32 square miles) riffle/run prevalence stations 4TC and 6TC were compared to reference station 2LBK. The comparisons were done using the following metrics that were selected as being indicative of community health: taxa richness, modified EPT index, modified Hilsenhoff Biotic Index (HBI), percent dominant taxon, and percent modified mayflies.

Based on these five metrics, candidate stations 1TC, 4TC, and 6TC exceeded the EV qualifying criterion of 92% (§ 93.4b(b)(1)(v)) (Table 7).

A total of 21.7 stream miles qualify as EV Waters under this criterion.

ADDITIONAL EXCEPTIONAL VALUE WATERS QUALIFYING CRITERIA

Based on petitioner information suggesting that additional EV regulatory criteria may apply, DEP evaluated additional antidegradation criteria listed in § 93.4b(b). These additional criteria include:

A. The water is an outstanding National, State, regional or local resource water [§ 93.4b(b)(1)(iii) – see Appendix A[1]];

B. The water is a surface water of exceptional ecological significance [§ 93.4b(b)(2) – see Appendix A[2]].

A. Waters qualifying as EV as outstanding National, State, regional or local resource waters under § 93.4b(b)(1)(iii):

The “outstanding resource waters” EV criterion may be applied to the petitioned waters since they already have the prerequisite HQ designation. The definition of “Outstanding National, State, regional or local resource waters” in § 93.1 requires

adoption of “water quality protective measures” by National or State government agencies. “Coordinated water quality protective measures”, also defined at § 93.1, are required for regional or local governments (See Appendix A). Such water quality protective measures have been applied through management activities implemented on lands situated along watershed corridors in a manner that provide protection to substantial reaches of the Tunkhannock Creek basin as described below:

Outstanding National or State Resource Waters

The Department evaluated water quality protective measures developed by the Pennsylvania Game Commission (PGC) to protect aquatic and adjacent riparian areas as important habitats on state game lands. The PGC has issued aquatic habitat buffer guidelines with inner buffer zones of 100 feet for EV and 50 feet for HQ streams and with outer buffer zones of 50 and 100 feet respectively, for a total of 150 feet of protection. The management plans allow limited activities within the buffered areas, recommend elimination or minimization of existing roads or parking areas, and encourage restoration of riparian areas.

The water quality protective measures described in PGC resource management plans meet the **“**outstanding National, State, regional or local resource waters” definition and apply to stream segments where State Game Lands 129 are situated along watershed corridors in a manner that provides protection to substantial reaches of the corridor within the Tunkhannock Creek basin.

A total of 0.9 stream miles qualify as EV waters under this criterion.

Outstanding Regional or Local Resource Waters

The Department evaluated local ordinances described below, as “coordinated water quality protective measures” adopted by local governments along the Tunkhannock Creek watershed corridor. Tunkhannock and Tobyhanna Townships in Monroe County and Kidder Township in Carbon County have adopted water quality protective measures through ordinances that aim to conserve natural features, including land or water resource areas (e.g. wetlands, floodplain, vernal pools, springs, and steep slopes). The purpose of the regulations is to ensure that land uses minimize disturbances to natural features and that reasonable measures are taken to mitigate any adverse impacts from such uses.

Although the protective measures provided by these townships could enhance water quality protection, the regulations require that such measures be "coupled with" an interest in real estate, as described at § 93.1. Definitions - "*Coordinated water quality protective measures*". Such requisite real estate interests have not been identified along Tunkhannock Creek basin.

The Department evaluated the Bethlehem Authority Wild Creek and Tunkhannock Creek Forest Management Plan developed to guide the management activities of the Bethlehem Authority properties. The Bethlehem Authority properties encompass approximately 40% of the Tunkhannock Creek basin, primarily the upper portions of the basin. The Plan indicates that the Bethlehem Authority has entered into a conservation easement with The Nature Conservancy that establishes a primary goal of producing high quality potable drinking water. In addition, the properties will be managed as part of the Nature Conservancy's Working Woodlands program, managed in accordance with the Forest Stewardship Council (FSC) US 2010 National Standards (Woodland Management Services & The Nature Conservancy 2012).

FSC US 2010 National Standards define Streamside Management Zones (SMZ) for specific US regions. SMZ are defined as land and vegetation located next to waterbodies (riparian) where management practices are modified to protect water quality, fish, and other aquatic resources. Within the Appalachia Region Inner Zones for perennial streams are set at 25 feet and Outer Zones range from 55 to 140 feet dependent on slope for a Total Zone of 80 to 165 feet. Total Zone width for intermittent streams range 80 to 165 feet dependent on slope. Limited activities are permitted within zones, and additional restrictions are applied to HQ and EV waters (FSC-US 2010).

The Bethlehem Authority Wild Creek and Tunkhannock Creek Forest Management Plan indicates that all FSC US National SMZ management guidelines will be met or exceeded. Inner Zones will be increased to 50 feet and Outer Zones to 100 feet (Total Zone 150 feet) to be recognized along all surface waters. Inner and Outer Zones will be doubled along Tunkhannock Creek and around the perimeter of Long Pond. In addition, no harvesting will occur within the Inner Zones and no roads or main skid trails will be located within the Total Zone (Woodland Management Services & The Nature Conservancy 2012).

The water quality protective measures described in the FSC US 2010 National Standards and the Bethlehem Authority Wild Creek and Tunkhannock Creek Forest Management Plan meet the **"**outstanding National, State, regional or local

resource waters" definition and apply to stream segments where Bethlehem Authority properties are situated along watershed corridors in a manner that provides protection to substantial reaches of the corridor within the Tunkhannock Creek basin (Figure 1). The Bethlehem Authority properties are owned in simple fee by the Authority and are "coupled with" water quality protective measures incorporated into the Forest Management Plan.

A total of 24.2 stream miles qualify as EV waters under this criterion.

B. Waters Qualifying as EV as Surface Waters of Exceptional Ecological Significance under § 93.4b (b)(2):

The Department reviewed information gathered for the Pennsylvania Natural Heritage Program and reported in the Carbon County Natural Heritage Inventory (The Nature Conservancy 2005); the Monroe County Natural Heritage Inventory (The Nature Conservancy 1991, updated 1999) as well as the 2003 Tunkhannock Creek Watershed Plant and Aquatic Communities, and Rare Species Assessment (The Nature Conservancy 2003). The Monroe County Natural Heritage Inventory identified two areas with statewide or local ecological significance that is based upon the rarity and uniqueness of the areas' endemic ecological community types. The two areas, Long Pond Macrosite Preserve and Fern Ridge Bog (Adams Swamp) (Figure 2), contain Acidic Shrub Swamp Natural Communities. Long Pond Macrosite Preserve also contains Glacial Bog and Boreal Conifer Swamp Natural Communities. All three Natural Communities are wetlands hydrologically connected to riverine surface waters and therefore, are water quality dependent.

The Long Pond Macrosite Preserve is also considered to be the most important site in Pennsylvania for the preservation of rare and endemic species and Natural Communities. Many of these unique and endemic plant communities are relics of past glaciations and are typical of the more northern latitudes of northern New England and Canada. In Pennsylvania, most of these endemic communities are found only in the Pocono region and are dependent on water quality and/or hydrology for their continued existence. The Natural Communities along with seven rare and endemic species that have been identified make this the highest concentration of rare and endemics in the State (The Nature Conservancy 1991, updated 1999).

The Monroe County Natural Areas Inventory referenced classifications of Pennsylvania's plant communities first published by Tom Smith in 1983 with

revisions in 1991 and again in 1994. The classifications by Smith identified Natural Communities or community types, which included a range of classifications from broad habitat definitions to specific areas with unique landscape and soil characteristics. The Natural Communities classified by Smith could contain multiple plant communities. Pennsylvania's plant community classification was revised in 1999 by Jean Fike for DCNR's Bureau of Forestry. Fike applied a plant community approach using species and physiognomy based on the International Vegetation Classification (Zimmerman et al. 2012).

The 2003 Tunkhannock Creek Watershed Plant and Aquatic Communities, and Rare Species Assessment reference classifications by Fike. Plant communities identified include leatherleaf – sedge wetland, leatherleaf – bog rosemary peatland, dry oak – heath forest, red spruce – mixed hardwood palustrine forest, red spruce palustrine woodland, dry oak – heath forest, and northern hardwood forest (Figure 3). All of which, except dry oak – heath forest and northern hardwood forest, are rare and endemic community types hydrologically connected to riverine surface water and therefore, are water quality dependent. The presence of endemic plant communities dependent on water quality or hydrology and their rarity in Pennsylvania satisfies the exceptional ecological significance criterion at § 93.4b(b)(2).

Dry oak – heath forest and northern hardwood forest areas are terrestrial communities with no direct connection to riverine surface water. While they are not particularly rare in Pennsylvania, they provide an important function as ecological filtering systems (much like riparian buffers) for the Tunkhannock Creek basin. It is widely understood that the larger a buffer area is surrounding a body of water, the more effective it is in filtering pollutants; preventing them from entering the water. Thus, it is not just wetlands that are important in filtering potential pollutants but terrestrial areas as well.

The Long Pond Macrosite Preserve, Fern Ridge Bog (Adams Swamp) Preserve and the documented rare and endemic aquatic plant communities interspersed with significant and intact terrestrial communities are located in the upper portions of Tunkhannock Creek basin. In addition, over 14 square miles of the total 32.1 square mile Tunkhannock Creek basin is protected through Conservation Easements held by The Nature Conservancy, including Bethlehem Authority properties. The Conservation Easements spatially coincide with the documented rare and endemic aquatic plant communities and are subsequently located in the upper portions or headwater reaches of the basin. Disturbances to otherwise intact hydrological and biogeochemical processes in headwaters will

directly affect water quality in downstream reaches of the basin. Degradation of upstream reaches like headwaters has been demonstrated to impact downstream reaches (Alexander et al. 2007, Nadeau et al. 2007, Wipfli et al. 2007). The co-occurrence of rare and unique wetland and other terrestrial plant communities, the areas protected by Conservation Easements, and the excellent water quality demonstrated by the Department's benthic macroinvertebrate tests demonstrates an important ecological connectance that supports the significance of these areas of the Tunkhannock Creek basin. Because of the distribution of the ecologically significant rare and unique endemic natural communities and the protection afforded to headwater and interstitial watercourse segments, the reaches of Tunkhannock Creek basin within these areas as well as those reaches that flow to them are recommended for EV designation as surface waters of exceptional ecological significance (Figures 2 & 3).

A total of 24.7 stream miles qualify as EV waters under this criterion.

PUBLIC RESPONSE AND PARTICIPATION SUMMARY

Notice of acceptance of the petition by the EQB for study was published in the Pennsylvania Bulletin on July 9, 2005. The Department provided public notice of this stream redesignation evaluation and requested any technical data from the general public through publication in the Pennsylvania Bulletin on August 13, 2005 (35 Pa.B 4671). A similar notice was published in the Pocono Record on August 19, 2005. In addition, Tobyhanna, Tunkhannock, Kidder, Barrett Townships, the Carbon County Office of Planning, and the Monroe County Planning Commission were notified of the redesignation evaluation in a letter dated July 13, 2005.

RECOMMENDATIONS

Based on applicable regulatory definitions and requirements of § 93.4b, the Department recommends that the Tunkhannock Creek basin, from the source to and including UNT 04393, UNT 04392 and UNT 04391 be redesignated Exceptional Value, Migratory Fishes (EV, MF) based on § 93.4b (b)(2) (exceptional ecological significance) (Figures 2 & 3); Tunkhannock Creek mainstem from UNT 04393 to mouth be redesignated EV, MF based on § 93.4b(b)(1)(v) (the Department's integrated benthic macroinvertebrate scoring test), and UNT 04388 from the source to State Game Land 129 border be redesignated EV, MF based on § 93.4b(b)(1)(iii) (outstanding State resource waters) (Figures 1 – 3). In addition Tunkhannock Creek basin from the source to

UNT 04398 also meets the Department's benthic macroinvertebrate scoring test (Figures 1 – 3), and Tunkhannock Creek basin from the source to UNT 04391 also meets the outstanding National, State, regional or local resource waters qualifier (Figure 1). This recommendation adds approximately 32.1 stream miles of EV waters to Chapter 93.

APPENDIX A

[1]Definition at 25 Pa. Code § 93.1: *Outstanding National, State, regional or local resource water*—A surface water for which a National or State government Agency has adopted water quality protective measures in a resource management plan, or regional or local governments have adopted coordinated water quality protective measures[3] along a watershed corridor.

[2]Definition at 25 Pa. Code § 93.1: *Surface water of exceptional ecological significance*—A surface water which is important, unique or sensitive ecologically, but whose water quality as measured by traditional parameters (for example, chemical, physical or biological) may not be particularly high, or whose character cannot be adequately described by these parameters. These waters include:

(i) Thermal springs.

(ii) Wetlands which are exceptional value wetlands under § 105.17(1) (relating to wetlands).

[3]Definition at 25 Pa. Code § 93.1: *Coordinated water quality protective measures*—

(i) Legally binding sound land use water quality protective measures coupled with an interest in real estate which expressly provide long-term water quality protection of a watershed corridor.

(ii) Sound land use water quality protective measure include: surface or ground water protection zones, enhanced stormwater management measures, wetland protection zones or other measures which provide extraordinary water quality protection.

(iii) Real estate interests include:

(A) Fee interests.

(B) Conservation easements.

(C) Government owned riparian parks or natural areas

(D) Other interests in land whish enhance water quality in a watershed corridor area.

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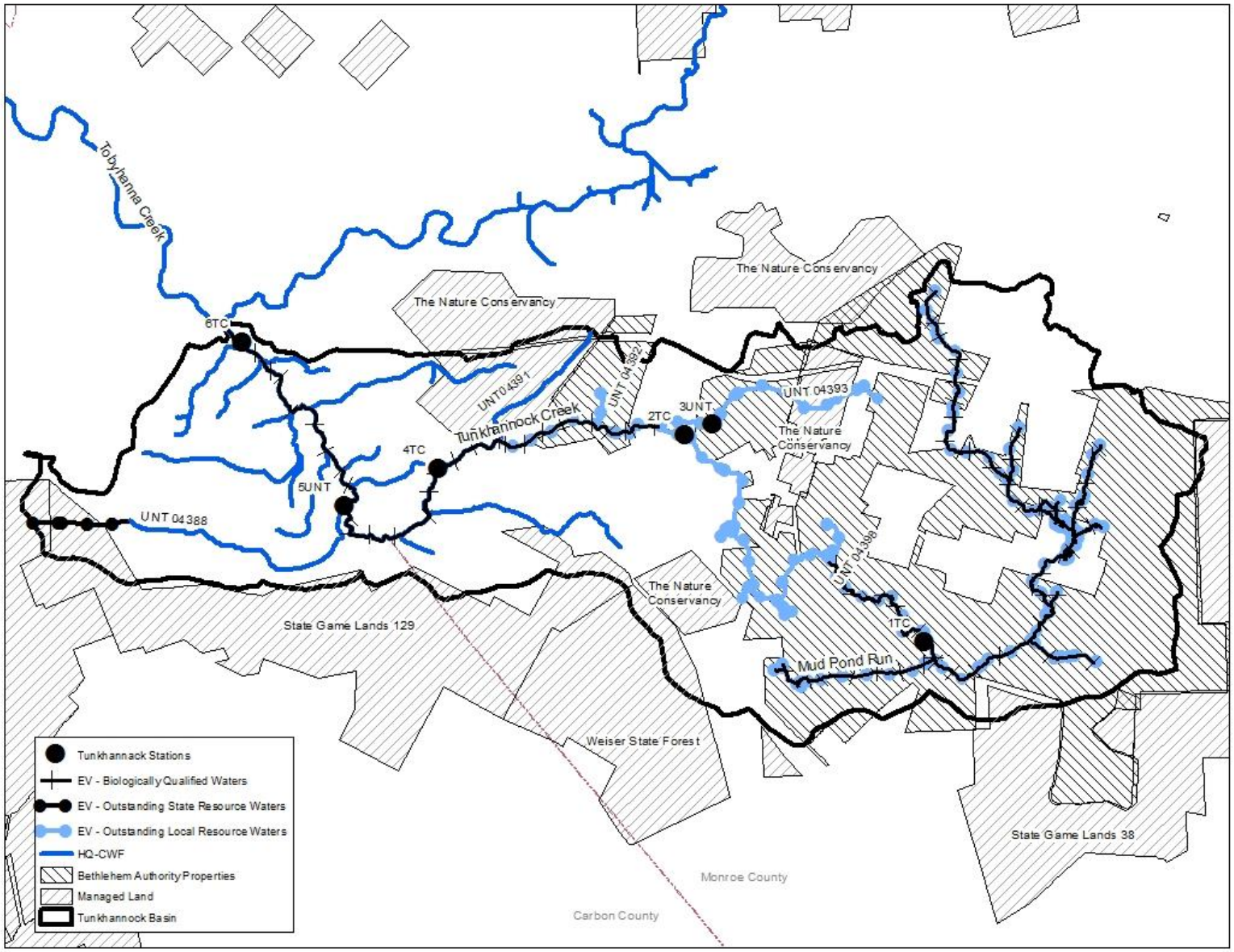

Figure 1. Tunkhannock Creek Basin – Station Locations

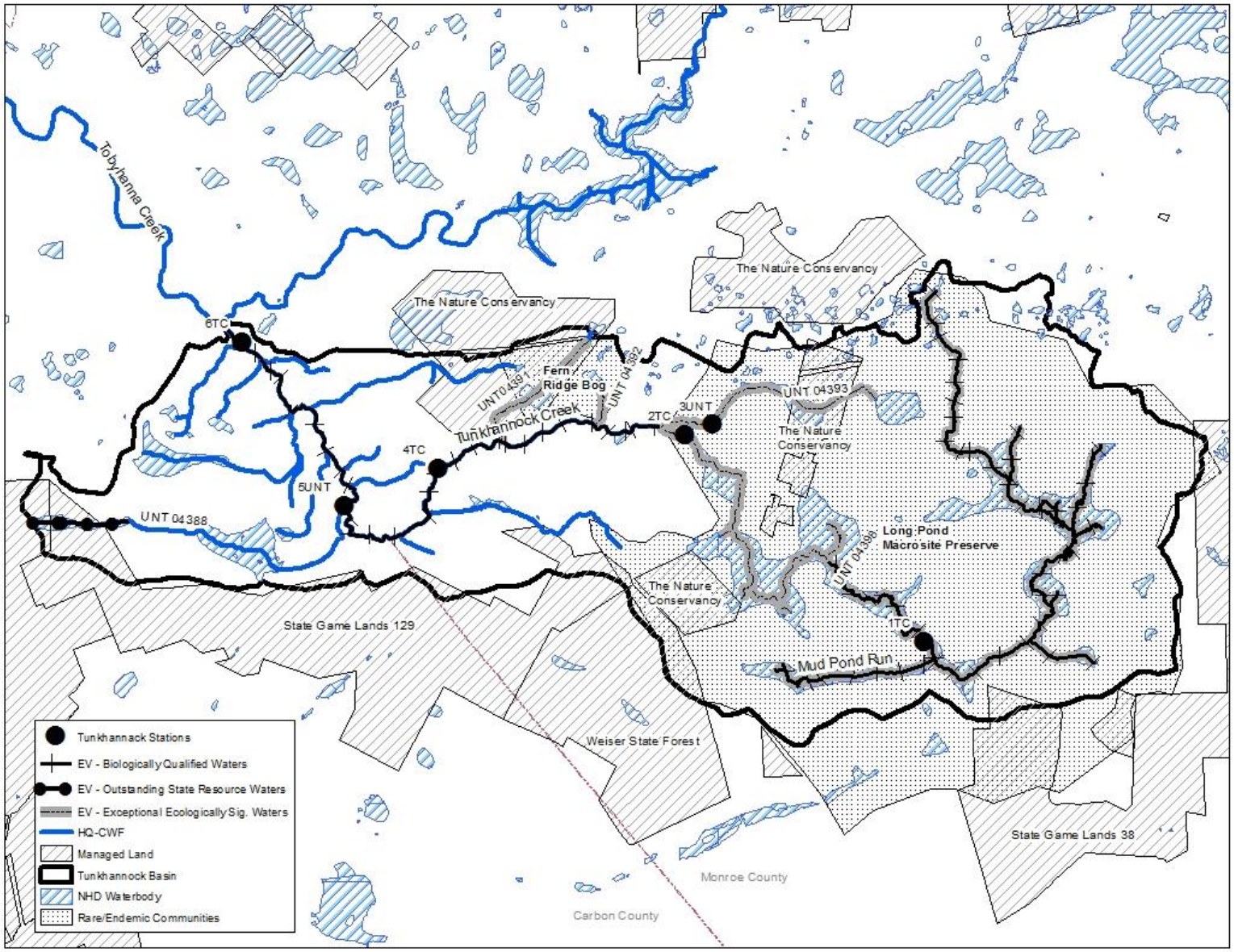

Figure 2. Tunkhannock Creek Basin – Station Locations and Rare/Endemic Natural Communities (The Nature Conservancy 1991, updated 1999)

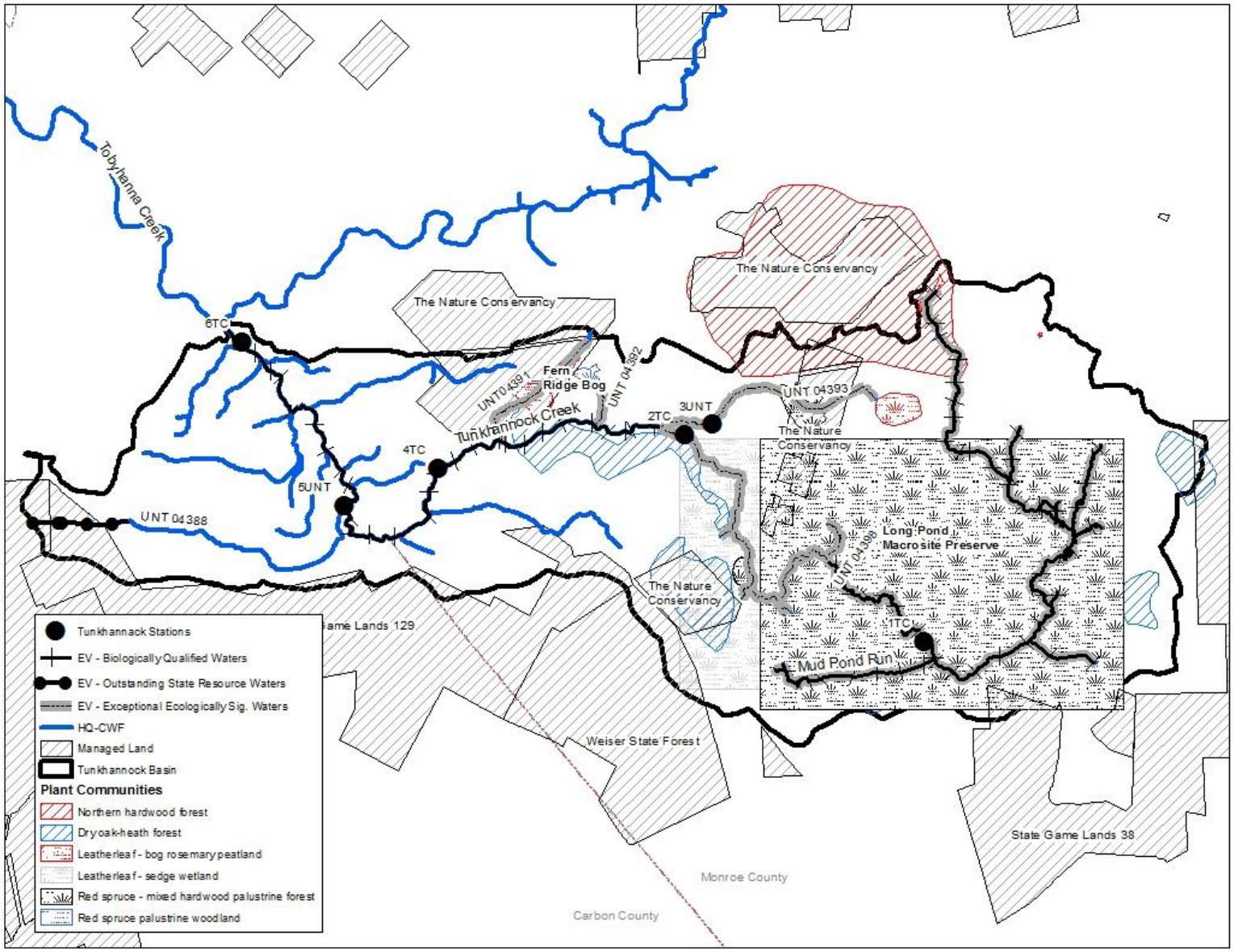

Figure 3. Tunkhannock Creek Basin – Station Locations and Rare/Endemic Plant Communities (The Nature Conservancy 2003)

Table 1. Tunkhannock Creek Basin – Station Locations

STATION	LOCATION
1TC	Tunkhannock Creek, 100 meters downstream of Kuhenbeaker Road bridge. Tunkhannock Township, Monroe County Lat: 41.0346 Long: -75.4602
2TC	Tunkhannock Creek, 200 meters downstream of Long Pond Road bridge. Tunkhannock Township, Monroe County Lat: 41.0643 Long: -75.5058
3UNT	UNT 04393 to Tunkhannock Creek, 20 meters upstream of Stony Hollow Road crossing. Tunkhannock Township, Monroe County Lat: 41.0658 Long: -75.5005
4TC	Tunkhannock Creek, 100 meters upstream of Rt. 115. Tunkhannock Township, Monroe County Lat: 41.0595 Long: -75.5527
5UNT	UNT 04388 to Tunkhannock Creek (Boulder Run), 50 meters upstream of mouth. Kidder Township, Carbon County Lat: 41.0542 Long: -75.5707
6TC	Tunkhannock Creek, 50 meters upstream of mouth. Kidder Township, Carbon County Lat: 41.0805 Long: -75.5937
DMK (Ref)	Dimmick Meadow Brook, riffle/run prevalence, 50 meters upstream of bridge. Milford Township, Pike County Lat: 41.3492 Long: -74.8361
1LBK (Ref)	Little Bush Kill, low gradient, 200 meters downstream of bridge. Porter Township, Pike County Lat: 41.2574 Long: -74.9968
2LBK (Ref)	Little Bush Kill, riffle/run prevalence, 120 meters upstream of bridge. Bushkill Township, Pike County Lat: 41.1000 Long: -75.0041

Table 2. Tunkhannock Creek Water Quality Network Station (WQN0198) – Water Chemistry

PARAMETER	UNITS	2005			2006			2007			2008			2009			2010		
		Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
ALUMINUM D	UG/L	35.100	220.000	94.400	< 10	239.000	133.883	< 10	189.000	90.573	< 10	213.000	115.242	< 10	258 000	126.883	< 10	192.000	84.150
ALUMINUM T	UG/L	49.400	226.000	115.418	< 10	285.000	157.583	< 10	206.000	113 000	< 10	237.000	137.400	< 10	276 000	141.942	< 10	252.000	107.255
ARSENIC D	UG/L	< 4	< 4	< 4	< 4	< 4	< 4	< 3	< 4	< 3.25	< 3	< 3	< 3	< 3	< 3	< 3	< 3	3.000	3.000
BARIUM T	UG/L	9.400	14.700	11.182	< 2	19.000	11.267	< 2	18.800	11.545	< 2	14.200	10.900	< 2	13.900	11.250	< 2	44.900	14.418
CADMIUM D	UG/L	< 0.2	< 0.2	< 0.2	< 0.2	0.210	0.210	< 0.2	< 0.2	< 0 2	< 0.2	< 0.2	< 0.2	< 0.2	< 0 2	< 0.2	< 0.2	< 0.2	< 0.2
CALCIUM D	MG/L	1.560	2.117	1.784	0.030	2.212	1.512	< 0.03	2.660	1.926	< 0.03	1.890	1.640	< 0.03	2 397	1.819	< 0.03	3.032	1.824
CALCIUM T	MG/L	1.540	2.144	1.847	< 0.03	2.208	1.707	< 0.03	2.810	1.919	< 0.03	2.030	1.718	< 0.03	2.472	1.882	< 0.03	3.057	1.842
CHLORIDE T	MG/L	4.210	11.400	7.593	< 0.5	10.600	7.868	< 0.5	15.300	8.629	< 0.5	11.500	8.654	< 0.5	17.300	10.960	< 0.5	18.300	9.149
COPPER D	UG/L	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4
COPPER T	UG/L	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	52.800	52.800
FLOURIDE T	MG/L	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0 2	< 0.2	< 0.2	< 0.2	< 0.2	< 0 2	< 0.2	< 0.2	< 0.2	< 0.2
IRON D	UG/L	74.000	454.000	209.364	< 20	514.000	268.333	< 20	457.000	248.636	< 20	582.000	245.667	< 20	686 000	283.417	< 20	216.000	149.700
IRON T	UG/L	105.000	568.000	259.455	< 20	614.000	311.917	< 20	606.000	328.182	< 20	803.000	360.000	< 20	583 000	319.417	< 20	378.000	239.364
LEAD D	UG/L	< 1	1.100	1.100	< 1	1.200	1.133	< 1	< 1	< 1	< 1	1.600	1.310	< 1	1.600	1.400	< 1	< 1	< 1
LEAD T	UG/L	< 1	1.200	1.100	< 1	1.400	1.225	< 1	1.100	1.100	< 1	1.600	1.310	< 1	1.600	1.400	< 1	1.200	1.130
MAGNESIUM D	MG/L	0.535	0.726	0.641	< 0.01	0.716	0.562	< 0.01	0.916	0.701	< 0.01	0.711	0.585	< 0.01	0.754	0.637	< 0.01	1.107	0.635
MAGNESIUM T	MG/L	0.546	0.732	0.669	0.408	0.734	0.585	0.542	0.976	0.700	0.427	0.767	0.616	0.544	0.788	0.659	0.115	1.107	0.640
MANGANESE D	UG/L	7.400	47.400	22.518	< 2	36.400	25.025	< 2	69.000	25.791	14.100	34.700	24.692	< 2	37.100	25.275	< 2	23.400	16.636
MANGANESE T	UG/L	8.500	47.100	23.409	< 2	37.500	26.433	< 2	70.700	27.000	11.600	35.500	24.262	< 2	37.400	25.692	< 2	25.300	17.236
NICKEL D	UG/L	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4
NICKEL T	UG/L	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4
SULFATE T	MG/L	< 1	5.190	1.876	< 1	6.950	2.487	< 1	7.110	2.211	< 1	2.320	1.755	< 1	2.440	1.770	< 1	5.010	1.932
ZINC D	UG/L	5.400	30.000	14.791	< 5	34.900	18.950	< 5	33.800	16.218	< 5	23.100	17.317	< 5	22.200	16.400	< 5	25.700	16.889
ZINC T	UG/L	6.100	30.000	15.073	< 5	41.000	19.450	< 5	34.200	15.991	< 5	26.500	17.500	< 5	22.400	16.408	5.300	61.700	18.373

"<" indicate concentrations below the reporting limit

Table 2 (cont.). Tunkhannock Creek Water Quality Network Station (WQN0198) – Water Chemistry

PARAMETER	UNITS	2005			2006			2007			2008			2009			2010		
		Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
PHENOLS T	UG/L	< 5	85.010	85.010	< 5	10.390	8.490	< 5	19.880	8.140	< 5	23.990	10.546	< 5	8.470	6.803	< 5	14.310	8.512
ALKALINITY	MG/L	0.600	5.200	2.840	< 0	2.600	1.320	1.400	3.600	2.475	< 0	4.000	2.025	< 0	2.200	1.338	0.400	5.200	2.433
ACIDITY T	MG/L	-47.60	32.400	16.160	0.200	22.600	9.677	2.200	45.400	22.089	-1.800	13.800	6.900	1.600	17.200	8.015	2.000	9.600	5.983
HARDNESS T	MG/L	6.000	8.000	7.364	0.000	8.000	6.154	0.000	11.000	6.917	0.000	8.000	6.308	0.000	9.000	6.923	0.000	12.000	6.750
OSMOTIC PRESSURE	MOS/KG	< 1	3.000	1.889	< 1	2.000	1.300	< 1	3.000	1.889	< 1	< 1	< 1	< 1	3.000	1.500	< 1	2.000	1.333
pH	pH units	5.2	6.4	5.9	4.7	6.4	5.66	5.7	6.6	6.2	5.0	6.2	5.7	5.4	6.2	5.7	5.5	6.4	6.0
SPECIF COND @ 25 C	umhos/cm	32.000	47.000	39.636	36.000	56.000	41.923	36.000	64.000	44.455	35.000	56.000	45.231	38.000	68.000	52.417	33.000	70.000	51.500
TDS	MG/L	24.000	380.000	104.545	16.000	132.000	68.462	16.000	300.000	93.000	10.000	60.000	47.846	12.000	66.000	46.769	< 5	54.000	38.909
TOC	MG/L	2.770	13.200	6.110	< 0.5	16.600	8.238	3.300	12.600	5.859	< 0.5	12.600	6.980	< 0.5	13.600	6.634	< 0.5	9.870	5.099
TSS	MG/L	< 2	8.000	4.400	< 2	52.000	16.333	< 2	14.000	10.000	< 2	10.000	6.667	< 5	6.000	6.000	< 5	12.000	12.000
AMMONIA T	MG/L	< 0.02	0.040	0.026	< 0.02	0.020	0.020	< 0.02	0.060	0.036	< 0.02	0.030	0.030	< 0.02	0.040	0.031	< 0.02	0.050	0.031
NITRATE T	MG/L	0.080	0.210	0.143	< 0.04	0.170	0.105	< 0.04	0.240	0.126	< 0.04	0.180	0.098	< 0.04	0.160	0.116	< 0.04	0.210	0.144
NITRITE T	MG/L	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0 04	< 0.04
NITROGEN T	MG/L	0.260	6.060	0.903	0.240	0.670	0.364	0.080	0.490	0.366	< 0.064	0.620	0.370	< 0.064	0.550	0.378	< 0.064	0.580	0.393
ORTHO PHOSPH. T	MG/L	< 0.01	0.012	0.011	< 0.01	0.012	0.012	< 0.01	0.012	0.012	< 0.01	0.012	0.011	< 0.01	0.013	0.011	< 0.01	0.014	0.012
PHOSPHORUS T	MG/L	< 0.01	0.017	0.012	< 0.01	0.015	0.013	< 0.01	0.021	0.013	< 0.01	0.022	0.014	< 0.01	0.017	0.013	< 0.01	0.023	0.015
DISSOLVED OXYGEN	MG/L	8.390	14.730	11.069	6.620	13.360	10.609	9.910	17.880	12.347	6.180	14.190	10.250	6.510	12.200	9.785	8.320	12.390	10.318
BOD	MG/L	< 0.2	1.000	0.590	0.280	3.300	2.028	< 0.2	2.800	0.814	< 0.2	2.500	1.150	0.400	4.400	1.054	< 0.2	1.600	0.790

"<" indicate concentrations below the reporting limit

Table 3. Tunkhannock Creek Basin April 2012 – Discrete Measurements

FIELD PARAMETER	STATIONS[1]						REFERENCE[2]		
	1TC	2TC	3UNT	4TC	5UNT	6TC	DMK	1LBK	2LBK
Temp (^{o}C)	16.3	16.6	13.3	14.5	12.9	13.6	11	11.9	11.6
pH	5.91	6.26	4.29	6.63	6.42	7.13	6.98	6.78	7.05
Sp. Cond. (µS/cm^{c})	52.5	63.9	157.5	62.4	68	81.8	16.7	36.5	48.7
D.O. (mg/L)	10.62	8.91	10.44	9.45	8.06	11.06	10.46	10.2	10.36

[1] Refer to Figures 1 - 3 & Table 1 for station locations
[2] Reference Stations– Refer to Table 1 for locations

Table 4. Tunkhannock Creek Basin – Habitat Assessment Results, Riffle/Run Prevalence

PARAMETER	STATIONS[1]				REFERENCE[2]	
	3UNT	4TC	5UNT	6TC	DMK	2LBK
1. instream cover	14	16	18	17	19	20
2. epifaunal substrate	13	19	16	18	20	18
3. embeddedness	12	16	15	16	19	16
4. velocity/depth	10	19	13	15	19	17
5. channel alterations	19	19	19	18	20	15
6. sediment deposition	17	14	17	17	18	14
7. riffle frequency	15	17	16	18	20	19
8. channel flow status	18	17	17	17	19	16
9. bank condition	17	18	19	17	19	18
10. bank vegetative protection	17	17	20	20	20	16
11. grazing/disruptive pressures	18	17	19	20	20	18
12. riparian vegetation zone width	19	15	18	20	20	11
Total Score	189	204	207	213	233	198
Rating[3]	SUB	OPT	OPT	OPT	OPT	OPT

[1] Refer to Figures 1 - 3 & Table 1 for station locations
[2] Reference Stations– Refer to Table 1 for locations
[3] OPT=Optimal (≥192); SUB=Suboptimal (132-192)

Table 5. Tunkhannock Creek Basin – Habitat Assessment Results, Low Gradient

PARAMETER	STATIONS[1]		REFERENCE[2]
	1TC	2TC	1LBK
1. epifaunal substrate/available cover	19	19	19
2. pool substrate characterization	18	18	13
3. pool variability	16	16	16
4. sediment deposition	14	19	14
5. channel flow status	18	19	19
6. channel alteration	18	20	20
7. bank stability	18	20	20
8. vegetative protection	18	20	20
9. riparian vegetative zone width	20	20	20
Total Score	159	171	161
Rating[3]	OPT	OPT	OPT

[1] Refer to Figures 1 - 3 & Table 1 for station locations
[2] Reference Stations– Refer to Table 1 for locations
[3] OPT=Optimal (≥144)

Table 6. Tunkhannock Creek Basin – Semi-Quantitative Benthic Macroinvertebrate Data

TAXA		Low Gradient			Small (<5mi^2) Riffle/Run			Large (21-32mi^2) Riffle/Run		
		STATIONS[1]		REF[2]	STATIONS[1]		REF[2]	STATIONS[1]		REF[2]
		1TC	2TC	1LBK	3UNT	5UNT	DMK	4TC	6TC	2LBK
Ephemeroptera (Mayflies)										
Ameletidae	***Ameletus***						1			
Baetidae	***Acentrella***									1
	Acerpenna	22	3	6		17	3			
	Baetis					1	35			9
	Diphetor						2			
Heptageniidae	***Epeorus***					3	54	3	19	4
	Heptagenia							2		
	Leucrocuta						3	2		
	Stenonema					2			1	
	Maccaffertium	7	6			3	1	7	1	1
	Cinygmula						16			
Ephemerellidae	***Drunella***								1	12
	Ephemerella					34	15	33	13	11
	Eurylophella	8	1	22		9	1	8		
	Serratella								11	16
Caenidae	***Caenis***		4	1						
Leptophlebiidae	***Habrophlebia***			3		19		9		
	Habrophlebiodes					2	1		2	
	Leptophlebia	11	3	7						
	Paraleptophlebia	1	3	3			4	5	56	
Plecoptera (Stoneflies)										
Pteronarcidae	***Pteronarcys***						5			
Peltoperlidae	***Tallaperla***					1				1
Nemouridae	***Amphinemura***		1	1	110	4	4	1	5	2
	Ostrocerca		1		12					
Leuctridae	***Leuctra***	5		1	5	18	19	8	2	2
Perlidae	***Paragnetina***								2	
	Acroneuria					1	2	9	3	1
	Perlesta			1				16		
Perlodidae	***Isoperla***					10	8	1	15	8
Chloroperlidae	***Sweltsa***			1			2			4

[1] Refer to Figures 1 - 3 & Table 1 for station locations
[2] Reference Stations – Refer to Table 1 for locations

Table 6 (cont.). Tunkhannock Creek Basin – Semi-Quantitative Benthic Macroinvertebrate Data

TAXA		Low Gradient			Small (<5mi^2) Riffle/Run			Large (21-32mi^2) Riffle/Run		
		STATIONS[1]		REF[2]	STATIONS[1]		REF[2]	STATIONS[1]		REF[2]
		1TC	2TC	1LBK	3UNT	5UNT	DMK	4TC	6TC	2LBK
Tricoptera (Caddisflies)										
Philopotamidae	***Chimarra***							7		
	Dolophilodes						3		6	38
	Wormaldia	1								
Polycentropodidae	***Polycentropus***	1		2	1	1		3	1	1
Hydropsychidae	***Diplectrona***			1		7	8			3
	Ceratopsyche	6		1		6		7	13	13
	Cheumatopsyche	1				1			2	
Rhyacophilidae	***Rhyacophila***				1	7	4		2	1
Glossosomatidae	***Agapetus***					1		1		1
Hydroptilidae	***Hydroptila***		2	2				1		
Brachycentridae	***Micrasema***		1					11		
Lepidostomatidae	***Lepidostoma***	3			2	1	1			1
Limnephilidae	***Limnephilus***	1								
	Platycentropus	7		2						
	Pycnopsyche	7		1				1		
Uenoidae	***Neophylax***			4						
Odontoceridae	***Psilotreta***			2				1		
Molannidae	***Molanna***	1				2				
Helicopsychidae	***Helicopsyche***		2							
Leptoceridae	***Ceraclea***	2	3							
	Mystacides	3	1							
	Nectopsyche			4						
	Oecetis			1						
	Setodes							1		

[1] Refer to Figures 1 - 3 & Table 1 for station locations
[2] Reference Stations – Refer to Table 1 for locations

Table 6 (cont.). Tunkhannock Creek Basin – Semi-Quantitative Benthic Macroinvertebrate Data

TAXA		Low Gradient			Small (<5mi^2) Riffle/Run			Large (21-32mi^2) Riffle/Run		
		STATIONS[1]		REF[2]	STATIONS[1]		REF[2]	STATIONS[1]		REF[2]
		1TC	2TC	1LBK	3UNT	5UNT	DMK	4TC	6TC	2LBK
Diptera (True Flies)										
Blephariceridae	***Blepharicera***						1			
Ceratopogonidae	***Probezzia***		1	3						
Empididae	***Chelifera***	1								
	Clinocera								3	
Tabanidae	***Chrysops***			1						
Tipulidae	***Antocha***					1		1		
	Dicranota					2				
	Hexatoma					1			2	
	Limnophila					2				
Simuliidae	***Prosimulium***				9					36
	Simulium							1		
	Stegopterna				32	1			3	
Chironomidae		99	133	100	39	38	8	39	38	22
Megaloptera (Dobson/ Fishflies)										
Sialidae	***Sialis***							1		
Corydalidae	***Nigronia***		1			2		2		1
Odonata (Dragon/ Damselflies)										
Gomphidae	***Gomphus***		2							
	Lanthus									1
	Stylogomphus			1						
Calopterygidae	***Calopteryx***	1	1					1		
Coenagrionidae	***Argia***		3	2						

[1] Refer to Figures 1 - 3 & Table 1 for station locations
[2] Reference Stations – Refer to Table 1 for locations

Table 6 (cont.). Tunkhannock Creek Basin – Semi-Quantitative Benthic Macroinvertebrate Data

TAXA		Low Gradient			Small (<5mi^2) Riffle/Run			Large (21-32mi^2) Riffle/Run		
		STATIONS[1]		REF[2]	STATIONS[1]		REF[2]	STATIONS[1]		REF[2]
		1TC	2TC	1LBK	3UNT	5UNT	DMK	4TC	6TC	2LBK
Coleoptera (Aquatic Beetles)										
Crambidae	***Parapoynx***	1								
Psephenidae	***Psephenus***						2	2	2	
Elmidae	***Ancyronyx***			3						
	Dubiraphia		4	1						
	Macronychus									1
	Oulimnius		1			9			1	
	Promoresia	2		9		13	4	12	2	
	Stenelmis			1		4	1	4	3	3
Ptilodactylidae	***Anchytarsus***					1				
Miscellaneous Insect Taxa										
Corixidae	***Sigara***	2								
Non-Insect Taxa										
Asellidae	***Caecidotea***	1		1						
Cambaridae	***Cambarus***						1			
Hyalellidae	***Hyalella***			21						
Sphaeriidae		2		4		1				
Oligochaeta							1	2		
Richness		25	21	32	9	34	29	32	26	26
Total number of individuals		196	177	213	211	225	210	202	209	194

[1] Refer to Figures 1 - 3 & Table 1 for station locations
[2] Reference Stations – Refer to Table 1 for locations

Table 7. Tunkhannock Creek Basin – RBP Metric Comparison

METRIC	Low Gradient			Small (<5mi^2) Riffle/Run			Large (21-32mi^2) Riffle/Run		
	STATIONS[1]		REF[2]	STATIONS[1]		REF[2]	STATIONS[1]		REF[2]
	1TC	2TC	1LBK	3UNT	5UNT	DMK	4TC	6TC	2LBK
1. TAXA RICHNESS	25	21	32	9	34	29	32	26	26
Cand/Ref (%)	78	66		31	117		123	100	
Biol. Cond. Score	7	2	8	0	8	8	8	8	8
2. MOD. EPT INDEX	12	10	14	5	15	18	22	14	17
Cand/Ref (%)	86	71		28	83		129	82	
Biol. Cond. Score	8	5	8	0	8	8	8	8	8
3. MOD. HBI	5.16	5.59	5.33	3.82	3.27	1.95	3.23	2.6	2.26
Cand-Ref	-0.17	0.26		1.87	1.32		0.97	0.34	
Biol. Cond. Score	8	8	8	0	0	8	5	8	8
4. % DOMINANT TAXA	50.51	75.14	46.95	52.13	16.89	25.71	19.31	26.79	19.59
Cand-Ref	3.56	28.19		26.42	-8.82		-0.28	7.2	
Biol. Cond. Score	8	0	8	8[3]	8	8	8	8	8
5. % MOD. MAYFLIES	13.78	7.34	16.43	0	31.11	45.24	34.16	48.8	23.2
Ref-Cand	2.65	9.09		45.24	14.13		-10.96	-25.6	
Biol. Cond. Score	8	8	8	0	7	8	8	8	8
TOTAL BIOLOGICAL CONDITION SCORE	39	23	40	8	31	40	37	40	40
% COMPARABILITY TO REFERENCE	**98**	**58**		**20**	**78**		**93**	**100**	

[1] Refer to Figures 1 - 3 & Table 1 for station locations
[2] Reference Stations – Refer to Table 1 for locations
[3] Dominant Taxa ≤ 3 HBI