BEAVER CREEK

DELAWARE COUNTY

WATER QUALITY STANDARDS REVIEW

DRAFT STREAM EVALUATION REPORT

Segment: Basin
Stream Code: 00005
Drainage List: G

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

2020

INTRODUCTION

The Department of Environmental Protection (DEP) conducted an evaluation of the Beaver Creek basin in response to a petition submitted to the Environmental Quality Board (EQB) by the Beaver Valley Conservancy. On August 19, 2014, the EQB accepted the petition for further evaluation. The entire Beaver Creek basin is currently designated Warm Water Fishes, Migratory Fishes (WWF, MF). The petition requests the Beaver Creek basin be redesignated to High Quality – Warm Water Fishes, Migratory Fishes (HQ-WWF, MF).

The stream redesignation process begins with an evaluation of the "existing uses" and the "designated uses" of a stream. "Existing uses" are water uses actually attained in the waterbody. Existing uses are protected through permit or approval actions taken by the DEP. "Designated uses" are water uses identified in regulations that protect a waterbody. Candidates for stream redesignation may be identified by the DEP based on routine waterbody investigations or based on requests initiated by other agencies or from the general public through a rulemaking petition to the EQB.

GENERAL WATERSHED DESCRIPTION

Beaver Creek is a tributary to Brandywine Creek within the lower Delaware River basin and is located within Chadds Ford and Concord townships, Delaware County. Beaver Creek has a drainage area of approximately 4.10 square miles and consists of 7.80 stream miles. The current land use within the basin consists of forested (53%), developed lands (29%), and agricultural lands (18%). Unnamed tributary (UNT) 00006 to Beaver Creek, locally known as South Branch Beaver Creek, meanders along the Pennsylvania/Delaware state border and confluences with the mainstem of Beaver Creek at the border. The First State National Historic Park encompasses the lower half of the Beaver Creek basin (Figure 1). There is one stormwater discharge to the UNT 00006 to Beaver Creek upstream of State Route 202. Two small tributaries to UNT 00006 are not delineated on the United States Geological Survey (USGS) 7.5-minute quadrangle maps, in the Pennsylvania Gazetteer of Streams or the National Hydrography Dataset (NHD). Stations 4UNT and 6UNT are located on these tributaries and described in Table 1 and Figure 1.

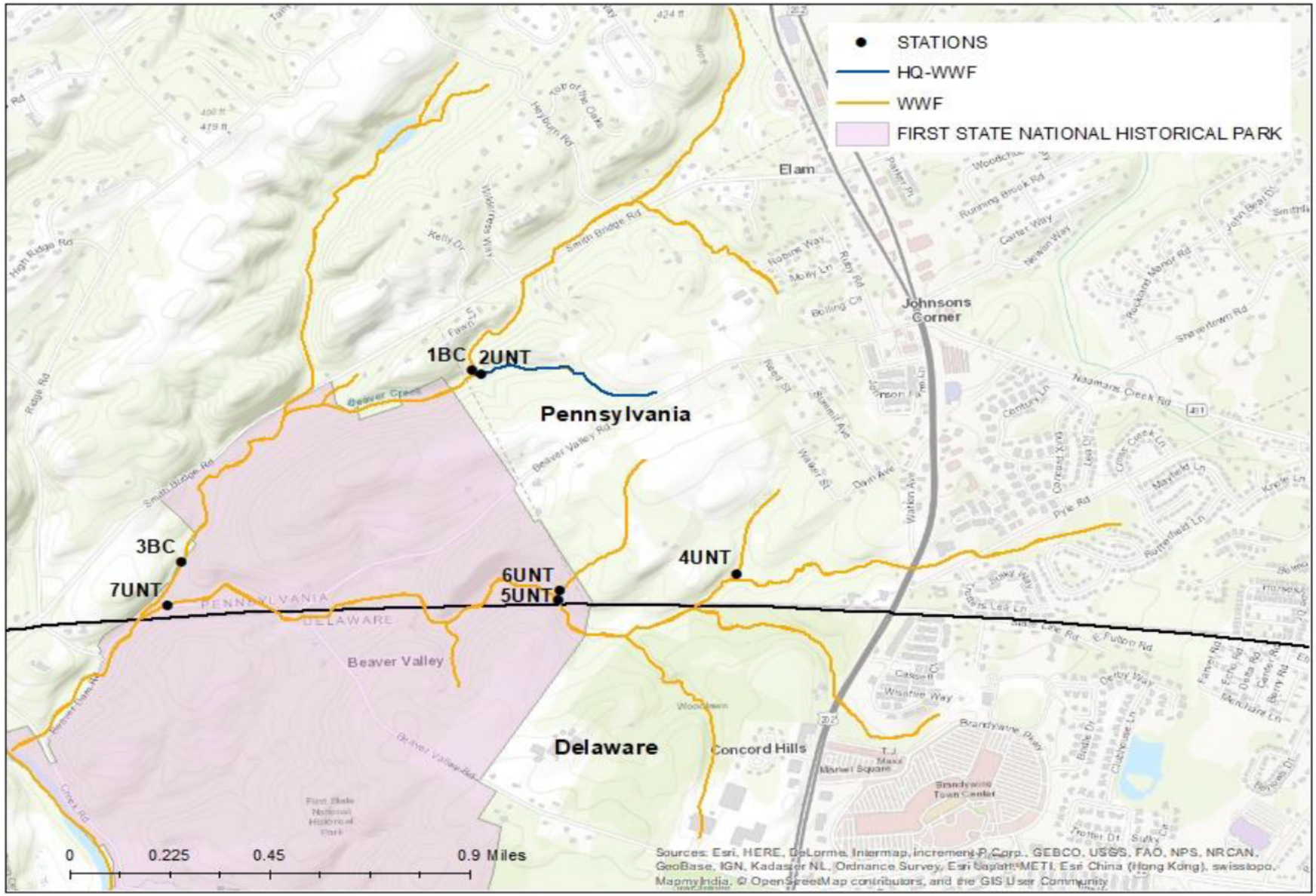

Figure 1. Beaver Creek – station locations

Table 1. Beaver Creek basin and reference station locations

STATION	DESCRIPTION
1BC	Beaver Creek mainstem, upstream of UNT 00009 Concord Township, Delaware County Lat: 39.848173 Long: -75.557025
2UNT	UNT 00009 to Beaver Creek, upstream of confluence with Beaver Creek Concord Township, Delaware County Lat: 39.848022 Long: -75.556659
3BC	Beaver Creek mainstem, upstream of UNT 00006 Chadds Ford Township, Delaware County Lat: 39.848173 Long: -75.557025
4UNT	UNT to UNT 00006 to Beaver Creek Stream is not represented on USGS 7.5-minute quadrangle map Concord Township, Delaware County Lat: 39.840428 Long: -75.546112
5UNT	UNT 00006 to Beaver Creek, upstream of UNT Chadds Ford Township, Delaware County Lat: 39.839614 Long: -75.553686
6UNT	UNT to UNT 00006 to Beaver Creek Stream is not represented on USGS 7.5-minute quadrangle map Chadds Ford, Delaware County Lat: 39.83997 Long: -75.553612
7UNT	UNT 00006 to Beaver Creek upstream of confluence with Beaver Creek Chadds Ford Township, Delaware County Lat: 39.839779 Long: -75.570193
UNTSC (REF)	UNT 64027 to Sixpenny Creek Union Township, Berks County Lat: 40.240552 Long: -75.777632

WATER QUALITY AND USES

Water Chemistry

DEP staff collected in-situ field meter data as well as comprehensive water chemistry samples in April 2015 from six of seven candidate stations throughout the Beaver Creek basin (Figure 1, Table 1). In-situ field meter data, but not water chemistry data was collected at candidate station 5UNT and the UNT Sixpenny Creek reference station (UNTSC).

Water chemistry results indicate variable water quality conditions throughout the basin. Samples from stations 3BC and 7UNT were analyzed using a much-reduced list of analytes than stations 1BC, 2UNT, 4UNT and 6UNT (Table 2). Specific conductance results from all stations were variable and ranged from 59.8 at 6UNT to 563.0 µS/cm at 7UNT. Specific conductance at the UNT Sixpenny reference was

65.7 µS/cm. Specific conductance often increases with anthropogenic activity and can be used as an indication of accumulative impacts. Following this logic, stations 2UNT and 6UNT would be the least impacted. There were no exceedances of water quality criteria, however several additional water chemistry results are consistent with specific conductance results indicating some level of impact at most stations. All metals, ion and nutrient concentrations were lowest at 6UNT. Station 1BC had the highest magnesium, manganese, potassium, sodium, strontium and nitrate concentrations. Station 4UNT had the highest barium and dissolved iron concentrations. Station 7UNT had the highest calcium and chloride concentrations and station 2UNT had the highest total aluminum, total iron, and dissolved zinc concentrations (Table 2).

The elevated aluminum and iron readings may be indicative of bound aluminum and iron in soils being captured in the total suspended sediment. Total suspended sediment concentrations were highest at 2UNT and 3BC both with concentrations of 10 mg/L (Table 2). Aluminum and iron are the two most abundant elements in the earth's crust and have been classified by the USGS as "major rock forming elements" (USGS 2005). The Environmental Protection Agency (EPA) method 200.7, used for the analysis of total metals, dissolves and thus reports soil-bound aluminum. He and Ziemkeiwicz (2016) have found that EPA method 200.7 can dissolve significant quantities of clay-bound aluminum, which is not considered bioavailable. Because Pennsylvania measures and assesses "total recoverable" aluminum, and aluminum laden soil is mixed into the water column; the unfiltered water chemistry grab sample results reported for aluminum "concentration" (referred to Aluminum T in Table 2) may be over-estimating the actual bioavailable aluminum in the water column at the time. Because iron is the second most abundant rock forming metal after aluminum, which can also be dissolved during the harsh digestion conditions of EPA method 200.7, it is reasonable to expect elevated total iron reported for samples where higher total aluminum is observed.

Table 2. Water chemistry results

	PARAMETER	UNITS	STATIONS[1]							
			1BC	2UNT	3BC	4UNT	5UNT	6UNT	7UNT	UNTSC
METALS AND IONS	ALUMINUM D	µg/L	<200	<200		<200.0		<200.0		
	ALUMINUM T	µg/L	88.8	257	<200	138		47	<200	
	ARSENIC D	µg/L	<3.0	<3.0		<3.0		<3.0		
	ARSENIC T	µg/L	<3.0	<3.0		<3.0		<3.0		
	BARIUM T	µg/L	53	26		57		16		
	BROMIDE	mg/L	<0.20	<0.20		<0.20		<0.20		
	CADMIUM D	µg/L	<.20	<.20		<.20		<.20		
	CADMIUM T	µg/L	<0.2	<0.2	<0.2	<0.2		<0.2	<0.2	
	CALCIUM T	mg/L	22	7.963	20.6	17.7		3.947	22.7	
	CHLORIDE	mg/L	86.5	19.7	51.6	66.2		2.6	133.1	
	CHROMIUM T	µg/L	<50	<50	<4	<50		<50	<4	
	COPPER D	µg/L	<4	<4		<4		<4		
	COPPER T	µg/L	<4	<4	<10	<4		<4	<10	
	IRON D	µg/L	69	28		145		<20		
	IRON T	µg/L	205	469	178	386		95	140	
	LEAD D	µg/L	<1.0	<1.0		<1.0		<1.0		
	LEAD T	µg/L	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	
	MAGNESIUM T	mg/L	9.71	4.29	9.15	8.17		2.46	9.65	
	MANGANESE T	µg/L	39	15	34	22		<10.0	<10.0	
	MOLYBDENUM T	µg/L	<70	<70		<70		<70		
	NICKEL D	µg/L	<4.0	<4.0		<4.0		<4.0		
	NICKEL T	µg/L	<4.0	<4.0	<50	<4.0		<4.0	<50	
	POTASSIUM T	mg/L	2.94	1.91		2.81		<1.00		
	SODIUM T	mg/L	33.3	9.85		32.1		2.80		
	STRONTIUM T	µg/L	128	64		99		28		
	SULFATE T	mg/L	<20.0	<20.0	14.53	<20.0		<20.0	14.66	
	ZINC D	µg/L	<5.0	16.1		10.5		8.2		
	ZINC T	µg/L	<5.0	7.66	<10.0	10.3		8.02	<10.0	
NUTRIENTS	AMMONIA-N T	mg/L	<.02	<.02	<.02	<.02		<.02	0.03	
	Nitrate-N	mg/L	1.9	0.86	1.18	1.57		0.37	1.78	
	NITRITE-N	mg/L	<.01	<.01	<.01	<.01		<.01	<.01	
	PHOSPHORUS T	mg/L	0.014	0.016	0.008	0.025		<.01	0.02	
PHYSICAL /OTHER	ALKALINITY	mg/L	51.4	17.6	49	50.8		12.6	47.6	16
	DISS. OXYGEN	mg/L	10.17	9.21	12.67	10.19	10.32	9.74	12.53	10.34
	HARDNESS T	mg/L	95	38	89	78		20	97	
	HOT ACIDITY	mg/L	-47	-16.6		-41.6		-10		
	pH	units	7.74	7.35	7.33	7.52	7.24	6.92	7.32	7.14
	SP. CONDUCTANCE	µS/cm[c]	434.1	136.4	298	347.4	647	59.6	563	65.7
	TEMPERATURE	°C	15.1	15	9.52	12.8	12.8	10.6	9.5	12.1
	TSS	mg/L	<5	10	10	<5		<5	6	
	TDS	mg/L	280	102	176	216		58	318	

[1] Refer to Table 1 and/or Figure 1 for station locations

Aquatic Biota

The indigenous aquatic community is an excellent indicator of long-term conditions and is used as a measure of water quality. DEP staff collected habitat and benthic macroinvertebrate data at seven locations throughout the Beaver Creek basin in April 2015 as well as a reference sample from UNT Sixpenny Creek, Berks County.

Habitat. Instream habitat was assessed at each station where benthic macroinvertebrates were sampled (Table 3). The habitat evaluation consists of rating twelve parameters to derive a station habitat score. The total habitat score for station 4UNT (208) fell within the optimal range. All remaining total habitat scores for candidate stations were within the suboptimal range with scores ranging from 148 at 1BC to 173 at 2UNT. The suboptimal scores were influenced by low scores for embeddedness, sediment deposition and bank condition. The total habitat score at the reference (223) was optimal (Table 3).

Benthos. Benthic macroinvertebrate samples were collected using the DEP Rapid Bioassessment Protocols (RBP) benthic sampling methodology, which is a modification of EPA's RBP (Barbour et al. 1999, Plafkin et al. 1989, Shull and Lookenbill 2018) (Table 4). Macroinvertebrate samples were collected from the Beaver Creek basin stations on May 22, 2015. Taxa richness ranged from 20 at stations 1BC and 7UNT to 28 at 3BC. Station 2UNT had the most intolerant macroinvertebrate community with 85% of the sample represented by taxa with pollution tolerance values (PTVs) of 3 or lower, and with 70% of the sample exclusively represented by *Ephemerella* (mayfly), *Amphinemura* (stonefly), and *Leuctra* (stonefly) taxa, which all have PTVs of 0 or 1. The remainder of the stations had macroinvertebrate communities that were dominated by moderately pollution sensitive taxa (PTVs 3-7).

Table 3. Habitat Assessment Results

PARAMETER	STATIONS[1]							
	1BC	2UNT	3BC	4UNT	5UNT	6UNT	7UNT	UNTSC
1. INSTREAM COVER	13	10	12	16	12	6	16	18
2. EPIFAUNAL SUBSTRATE	13	12	15	17	17	12	18	18
3. EMBEDDEDNESS	8	14	5	17	6	12	10	18
4. VELOCITY/DEPTH	15	10	9	15	14	6	18	15
5. CHANNEL ALTERATIONS	14	18	16	18	20	18	9	20
6. SEDIMENT DEPOSITION	6	10	5	15	5	4	8	17
7. RIFFLE FREQUENCY	16	13	18	16	18	11	20	18
8. CHANNEL FLOW STATUS	15	16	13	18	15	15	15	20
9. BANK CONDITION	7	16	7	18	8	18	10	19
10. BANK VEGETATIVE PROTECTION	17	18	16	18	18	18	10	20
11. GRAZING/DISRUPTIVE PRESSURES	10	18	19	20	17	20	9	20
12. RIPARIAN VEG. ZONE WIDTH	14	18	19	20	18	20	10	20
Total Score	148	173	154	208	168	160	153	223
Rating[2]	SUB	SUB	SUB	OPT	SUB	SUB	SUB	OPT

[1] Refer to Table 1 and/or Figure 1 for station locations
[2] OPT = Optimal (≥192); SUB= Suboptimal (132-192)

Table 4. Semi-quantitative benthic macroinvertebrate data

TAXA		STATIONS[1]							
		1BC	2UNT	3BC	4UNT	5UNT	6UNT	7UNT	UNTSC
Ephemeroptera (Mayflies)									
Baetidae	*Acentrella*	1	2	8		2		19	
Baetidae	*Baetis*								1
Ephemerellidae	*Ephemerella*		69	7				2	34
Ephemerellidae	*Eurylophella*				5		3		
Heptageniidae	*Cinygmula*								9
Heptageniidae	*Epeorus*								12
Heptageniidae	*Leucrocuta*								2
Heptageniidae	*Maccaffertium*	28	4	3	30		1		
Leptophlebiidae	*Habrophlebiodes*						4		
Leptophlebiidae	*Paraleptophlebia*	1	4				16		
Plecoptera (Stoneflies)									
Chloroperlidae	*Sweltsa*								1
Leuctridae	*Leuctra*	1	21						1
Nemouridae	*Amphinemura*		37	17	1		6		1
Nemouridae	*Nemoura*			1					
Peltoperlidae	*Tallaperla*						1		
Perlidae	*Acroneuria*	1	1	10	1			2	8
Perlidae	*Perlesta*			1					
Perlodidae	*Isoperla*		5						8
Perlodidae	*Remenus*								1
Pteronarcidae	*Pteronarcys*								4
Trichoptera (Caddisflies)									
Glossosomatidae	*Glossosoma*			2	2				
Hydropsychidae	*Cheumatopsyche*	10		29	1			9	
Hydropsychidae	*Diplectrona*	13	7	1	34	2	5		22
Hydropsychidae	*Hydropsyche*	4	1	20	3	14		38	
Lepidostomatidae	*Lepidostoma*		1				1		
Leptoceridae	*Setodes*							1	
Limnephilidae	*Nyctiophylax*				1				
Limnephilidae	*Pycnopsyche*						3		1
Philopotamidae	*Chimarra*			4	3	6		6	
Philopotamidae	*Dolophilodes*	1	1			1			
Polycentropodidae	*Polycentropus*				1				1
Psychomyiidae	*Lype*					1			
Rhyacophilidae	*Rhyacophila*		1	1			5		8
Uenoidae	*Neophylax*	1		1					1
Megaloptera (Dobson/ Fishflies)									
Corydalidae	*Nigronia*						1		
Odonata (Dragon/ Damselflies)									
Aeshnidae	*Boyeria*	1				1			
Cordulegastridae	*Cordulegaster*		1						
Gomphidae	*Arigomphus*			1					
Gomphidae	*Gomphus*								1
Gomphidae	*Stylogomphus*	2			1				

Table 4 (cont.). Semi-quantitative benthic macroinvertebrate data

TAXA		STATIONS							
		1BC	2UNT	3BC	4UNT	5UNT	6UNT	7UNT	UNTSC
Diptera (True Flies)									
Blephariceridae	*Blepharicera*								1
Ceratopogonidae	*Ceratopogon*						3		
Ceratopogonidae	*Probezzia*								2
Chironomidae		59	10	41	35	78	67	47	14
Empididae	*Chelifera*			1		1		2	
Empididae	*Clinocera*	37		17	13	24		20	
Empididae	*Hemerodromia*			1	1	2		2	
Empididae	*Neoplasta*	2			1				
Ptychopteridae	*Ptychoptera*						2		
Simuliidae	*Prosimulium*		1	4		1			13
Simuliidae	*Simulium*	2	3	5	1	12	2	3	
Stratiomyidae						1			
Tabanidae	*Chrysops*		1						
Tipulidae	*Antocha*	6		14	5	31		25	
Tipulidae	*Dicranota*		1						2
Tipulidae	*Hexatoma*						3		
Tipulidae	*Psuedolimnophila*						5		
Tipulidae	*Tipula*	1			4	3			2
Coleoptera (Aquatic Beetles)									
Dryopidae	*Helichus*						1		
Elmidae	*Dubiraphia*					1			
Elmidae	*Optioservus*	1	8	9	15	3		2	5
Elmidae	*Oulimnius*			8	8	3		12	5
Elmidae	*Promoresia*								1
Elmidae	*Stenelmis*			3	17	13		1	
Psephenidae	*Ectopria*		1			1			
Psephenidae	*Psephenus*				7	5		5	
Ptilodactylidae	*Anchytarsus*					1	50		
Non-Insect Taxa									
Asellidae	*Caecidotea*					2		1	
Cambaridae	*Cambarus*		1	2			1		
Hirudinea									1
Lymnaeidae				1					
Oligochaeta		3		4	1	6	3	4	1
Physidae							1		
Turbellaria						3		1	
Taxa Richness		20	22	28	24	26	22	20	29
Total Organisms		175	181	216	191	218	184	202	163

[1] Refer to Table 1 and/or Figure 1 for station locations

BIOLOGICAL USE QUALIFICATIONS

The qualifying criterion applied to Beaver Creek was the DEP integrated benthic macroinvertebrate scoring test described at 25 Pa. Code § 93.4b(a)(2)(i)(A). Selected benthic macroinvertebrate community metrics from the Beaver Creek basin were compared to the reference station from UNT Sixpenny Creek (Table 5). UNT Sixpenny Creek was used as a reference because it has demonstrated

an existing use of exceptional value based on biological measures and the macroinvertebrate community has demonstrated best attainable biological communities by scoring well above the top 25th percentile of Pennsylvania EV reference streams. In addition, the UNT Sixpenny Creek reference has optimal habitat and similar gradient, drainage area, pH and alkalinity to the candidate stream stations (DEP 2013). Comparisons with the following metrics were used as an indicator of community health: taxa richness, modified Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (EPT) index, modified Hilsenhoff Biotic Index (HBI), percent dominant taxon, and percent modified mayflies (Table 5).

The April 2015 Beaver Creek basin samples when compared to the reference station on UNT Sixpenny Creek had a Biological Condition Score (BCS) ranging from 38% to 88%. The UNT to Beaver Creek (2UNT) scored higher than the 83% required for redesignation to High Quality. All other stations in the Beaver Creek basin did not meet the 83% HQ qualifying criterion (Table 5).

Table 5. RBP metric comparison

METRIC	STATIONS[1]							REFERENCE[1]
	1BC	2UNT	3BC	4UNT	5UNT	6UNT	7UNT	UNTSC
TAXA RICHNESS	20	22	28	24	26	22	20	29
Cand/Ref (%)	69	76	97	83	90	76	69	
Biol. Cond. Score	5	6	8	8	8	6	5	8
MOD. EPT INDEX	8	11	5	7	5	9	5	16
Cand/Ref (%)	50	69	31	44	31	56	31	
Biol. Cond. Score	1	5	0	0	0	2	0	8
MOD. HBI	4.86	1.99	4.59	3.78	5.28	4.65	5.02	1.84
Cand-Ref	3.02	0.15	2.75	1.94	3.44	2.81	3.18	
Biol. Cond. Score	0	8	0	0	0	0	0	8
% DOMINANT TAXA	33.7	38.1	19	18.3	35.8	36.4	23.3	20.7
Cand-Ref	13	17.4	-1.7	-2.4	15.1	15.7	2.6	
Biol. Cond. Score	6	8	8	8	5	4	8	8
% MOD. MAYFLIES	17.1	42.5	8.3	18.3	0.9	10.9	10.4	34.8
Ref-Cand	17.7	-7.7	26.5	16.5	33.9	23.9	24.4	
Biol. Cond. Score	6	8	4	6	2	5	4	8
TOTAL BIOLOGICAL CONDITION SCORE	18	35	20	22	15	17	17	40
% COMPARABILITY TO REFERENCE	45	88	50	55	38	43	43	

[1] Refer to Table 1 and/or Figure 1 for station locations

SURFACE WATER OF EXCEPTIONAL ECOLOGICAL SIGNIFICANCE

Based on petitioner information suggesting that the Beaver Creek basin may qualify as a surface water of exceptional ecological significance, the DEP evaluated this qualification based on the criteria listed at 25 Pa. Code § 93.4b(b)(2) and the definition at § 93.1. A surface water of exceptional ecological

significance is defined as 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 thermal springs or wetlands which are exceptional value wetlands under 25 Pa. Code § 105.17(1) (relating to wetlands). The DEP reviewed information gathered for the Pennsylvania Natural Heritage Program and reported in *A Natural Heritage Inventory of Delaware County, Pennsylvania* (Western Pennsylvania Conservancy 2011). The information did not identify any surface waters with statewide or local ecological significance. No areas were identified that tie the petitioned surface water to rare or endemic ecological community types.

PUBLIC NOTICE AND REQUEST FOR TECHNICAL DATA

The DEP provided public notice of this redesignation evaluation and requested any technical data from the general public through publication in the Pennsylvania Bulletin on September 27, 2014 (44 Pa.B. 6149) and on the DEP website on August 24, 2014. Delaware County, Chadds Ford and Concord townships, the Pennsylvania Fish and Boat Commission, Delaware River Basin Commission, Delaware Riverkeeper Network, Trout Unlimited were notified of the redesignation evaluation in a letter dated August 29, 2014. No technical data were received.

RECOMMENDATION

Based on applicable regulatory definitions in 25 Pa. Code § 93.4b(a)(2)(i)(A) (the DEP's integrated benthic macroinvertebrate scoring test), the DEP recommends that UNT 00009 to Beaver Creek (2UNT) be redesignated to High Quality – Warm Water Fishes, Migratory Fishes (HQ-WWF, MF) based on a score greater than 83% when compared to a reference station. Based on applicable regulatory definitions in 25 Pa. Code § 93.4b, the DEP recommends that the remainder of the Beaver Creek basin maintain its current designated use in Chapter 93 as WWF, MF. This recommendation adds 0.4 miles of High Quality streams to Chapter 93 and partially reflects the High Quality designation sought in the petition.

REFERENCES

Barbour, M.T., Gerritsen, J., Snyder, B.D., Stribling, J.B. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish. Second Edition. United States Environmental Protection Agency. EPA 841-B-99-002.

He, Y.T., Ziemkiewic, P.F. 2016. Bias in Determining Aluminum Concentrations: Comparison of Digestion Methods and Implications on Al Management. Chemosphere 159: 570–576.

DEP. 2013. Water Quality Antidegradation Implementation Guidance. http://www.depgreenport.state.pa.us/elibrary/GetDocument?docId=7842&DocName=WATER%20QUALITY%20ANTIDEGRADATION%20IMPLEMENTATION%20GUIDANCE.PDF%20

Plafkin, J.L., Barbour, M.T., Porter, K.D., Gross, S.K., Hughes, R.M. 1989. Rapid Bioassessment Protocols for use in streams and rivers: Benthic Macroinvertebrates and Fish. United States Environmental Protection Agency. EPA/444/4-89-001.

Shull, D.R., and M. Lookenbill (editors). 2018. Biological Data Collection Protocols. Pennsylvania Department of Environmental Protection, Harrisburg, Pennsylvania. http://files.dep.state.pa.us/Water/Drinking%20Water%20and%20Facility%20Regulation/WaterQualityPortalFiles/Technical%20Documentation/MONITORING_BOOK.pdf

Western Pennsylvania Conservancy. 2011. A Natural Areas Inventory of Delaware County, Pennsylvania. Pennsylvania Natural Heritage Program.