Eighteenmile Creek
Baseline Benthic Community
Sampling Report

April 2013

Prepared for:

NIAGARA COUNTY SOIL AND WATER CONSERVATION DISTRICT
Lockport, New York

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Table of Contents

Table of Contents (cont.)

List of Tables

List of Figures

List of Abbreviations and Acronyms

AOC	Area of Concern
AVS	acid volatile sulfides
BAP	Biological Assessment Profile
BUI	Beneficial Use Impairment
COC	chain-of-custody
DDD	dichlorodiphenyl-dichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	chlorodiphenyl-trichloroethane
DOM-3	three most abundant taxa
E & E	Ecology and Environment, Inc.
EPT	Ephemeroptera, Trichoptera, and Plecoptera
GLRI	Great Lakes Restoration Initiative
HBI	Hilsenhoff Biotic Index
IJC	International Joint Commission
LEL	low effect level
NCSWCD	Niagara County Soil and Water Conservation District
NYSDEC	New York State Department of Environmental Conservation
PCB	polychlorinated biphenyl
PEC	probable effect concentrations
PMA	percent model affinity
RAC	Remedial Advisory Committee
RAP	Remedial Action Plan
REIC	REI Consulting Inc.
SEM	simultaneously extracted metals
SQT	Sediment Quality Triad
TEC	threshold effect concentration
USEPA	United States Environmental Protection Agency

Executive Summary

This report describes the results of a study designed to evaluate the current condition of the benthic macroinvertebrate community in the Eighteenmile Creek Area of Concern (AOC). The study results are to be used for two purposes: (1) as a baseline against which future changes in the benthic community can be measured; and (2) to reevaluate the status of Beneficial Use Impairment (BUI) Number (No.) 6 (Degradation of Benthos) within the Eighteenmile Creek AOC. In August 2012, the benthic macroinvertebrate community was sampled at two riffle/run habitat sites and three pool habitat sites in the AOC. In addition, sediment samples for contaminant analysis and sediment toxicity testing were collected from the three pool locations. The following findings are noteworthy:

- The benthic community in riffle and run/glide habitats in the AOC is not impaired or slightly impaired according to New York State Department of Environmental Conservation (NYSDEC) indices. This finding satisfies the first delisting criterion for BUI No. 6 for the Eighteenmile Creek AOC (i.e., benthic communities are not impacted or slightly impacted according to NYSDEC indices) and, therefore, supports delisting this BUI.

- The benthic community in pool habitats in the AOC is not impaired according to NYSDEC indices. Also, sediment bioassay and bioavailability data collected for this study found no sediment toxicity and low bioavailability of contaminants in sediment in the locations sampled. These findings satisfy the first and third delisting criteria for BUI No. 6 for the Eighteenmile Creek AOC and, therefore, support delisting this BUI.

Based on the findings of the current study, we recommend the following:

- The Niagara County Soil and Water Conservation District (NCSWCD) and Eighteenmile Creek Remedial Advisory Committee (RAC) should consider moving forward with delisting BUI No. 6.

- Another round of benthic community monitoring should be implemented in 2017 as suggested in the *Eighteenmile Creek Area of Concern (AOC) Strategic Plan for Beneficial Use Impairment (BUI) Delisting* (E & E 2011). Future monitoring data will provide insight into how sediment remedial actions and other activities upstream from the AOC affect the benthic community therein.

1 Introduction

This report describes the results of a study designed to evaluate the current condition of the benthic macroinvertebrate community in the Eighteenmile Creek Area of Concern (AOC). The study results are to be used for two purposes:

- As a baseline against which future changes in the benthic community can be measured; and
- To reevaluate the status of Beneficial Use Impairment (BUI) No. 6 (Degradation of Benthos) within the Eighteenmile Creek AOC.

The Sediment Quality Triad (SQT) approach was employed for the current investigation (USEPA 1994). This approach is based on concurrently evaluating sediment chemistry, sediment toxicity, and benthic community composition to draw a conclusion regarding the overall health of the benthic community.

The baseline sampling study described in this report was first identified in the *Eighteenmile Creek Area of Concern (AOC) Strategic Plan for Beneficial Use Impairment (BUI) Delisting* (E & E 2011) and described in detail in the *Quality Assurance Project Plan* (E & E 2012a) prepared to guide the work. This work was supported by a grant from the United States Environmental Protection Agency (USEPA) Great Lakes Restoration Initiative (GLRI) to the Niagara County Soil and Water Conservation District (NCSWCD).

This remainder of this report is organized as follows:

- Section 2 describes field and laboratory methods;
- Section 3 describes the study results;
- Section 4 provides a summary and recommendations; and
- Section 5 provides references.

Appendix A includes a copy of the final QAPP and Appendices B through F include field data collection forms and full analytical results from the laboratories that supported the project. A Data Usability Summary Report is included in Appendix G.

1.1 Background on Eighteenmile Creek AOC Status and BUIs

In 1987, the International Joint Commission (IJC) identified 43 AOCs in the Great Lakes Basin where the beneficial uses of the water body were considered impaired. Eighteenmile Creek was identified as one of the 29 United States AOCs. The creek has been polluted by past industrial and municipal discharges, the disposal of waste, and the use of pesticides. Currently, there are five documented BUIs at the Eighteenmile Creek AOC: (1) restrictions on fish and wildlife consumption; (2) degradation of fish and wildlife populations; (3) bird or animal deformities or reproductive problems; (4) degradation of benthos; and (5) restrictions on dredging activities (USEPA 2010). These five BUIs are largely driven by elevated levels of polychlorinated biphenyls (PCBs) in sediment and fish (E & E 2011), but elevated levels of metals and pesticides also are present in sediment throughout the creek (E & E 2012b). Table 1-1 lists the site-specific BUI delisting criteria developed by the NCSWCD for the Eighteenmile Creek system.

Table 1-1 Beneficial Use Impairments and Delisting Criteria for the Eighteenmile Creek AOC

BUI	BUI Status	Delisting Criteria
1. Restrictions on Fish and Wildlife Consumption	Impaired	There are no AOC-specific fish and wildlife consumption advisories issued by New York State; **AND**
		Contaminant levels in fish and wildlife must not be due to contaminant input from the watershed upstream of Burt Dam
3. Degradation of Fish and Wildlife Populations	Impaired	Fish and wildlife diversity, abundance and condition are statistically similar to diversity, abundance and condition of populations at non-AOC control sites; **AND**
		PCB levels in bottom-dwelling fish do not exceed the critical PCB tissue concentration for effects on fish (440 micrograms per kilogram of weight; Dyer et al. 2000)
5. Bird or Animal Deformities or Reproduction Problems	Impaired	No reports of wildlife population deformities or reproductive problems from wildlife officials above expected natural background levels; **AND**
		Contaminant levels in bottom-dwelling fish do not exceed the level established for the protection of fish-eating wildlife (NYSDEC Fish Flesh Criteria); **OR**
		In the absence of fish data, the toxicity of sediment-associated contaminants does not exceed levels associated with adverse effects on wildlife (NYSDEC Fish & Wildlife Bioaccumulation Sediment Criteria)

Table 1-1 Beneficial Use Impairments and Delisting Criteria for the Eighteenmile Creek AOC

BUI	BUI Status	Delisting Criteria
6. Degradation of Benthos	Impaired	Benthic macroinvertebrate communities are "non-impacted" or "slightly impacted" according to NYSDEC indices; **OR**
		In the absence of NYSDEC data, riffle habitats require benthic macroinvertebrate communities with a species richness higher than 20, EPT richness greater than 6, a biotic index value greater than 4.51, and a percent model affinity greater than 50; **OR**
		In the absence of benthic community data, this use will be considered restored when the level of toxic contaminants in sediments is not significantly higher than controls.
7. Restrictions on Dredging Activities	Impaired	When contaminants in AOC sediments (located within the actual or potential dredging areas identified for the improvement of ship navigation) do not exceed standards, criteria, or guidelines such that there are restrictions on dredging or disposal activities.

Source: USEPA 2010a

Key:
AOC = Area of Concern
BUI = Beneficial Use Impairment
EPT = Ephemeroptera, Plecoptera, and Trichoptera
NYSDEC = New York State Department of Environmental Conservation
PCB = Polychlorinated Biphenyl

Both human and ecological receptors using the Eighteenmile Creek system may be at risk from PCBs and other chemicals in fish and sediment based on recent investigations (E & E 2009a, E & E 2012b) and current fish consumption advisories (NYSDOH 2011). Elevated levels of PCBs in fish in Eighteenmile Creek appear to be the result of bioaccumulation from sediment (USACE 2004a, b; von Stackelberg and Gustavson 2012). Recent sediment data from the Remedial Investigation (RI) for Eighteenmile Creek show that surface sediment levels of PCBs and metals are greater in the portion of the creek near the source areas in Lockport, New York, compared with downstream reaches (E & E 2012b). Contaminant source areas along the creek in Lockport were characterized by NYSDEC (2006) and E & E (2009b). Remediation of these upstream sources areas and contaminated sediment throughout the creek is necessary to eliminate BUIs in the Eighteenmile Creek system and eventually delist this Great Lakes AOC (E & E 2011).

1.2 Site Location and Description

The Eighteenmile Creek AOC is located in Niagara County, New York (see Figure 1-1). The creek flows generally north through central Niagara County and discharges via Olcott Harbor into Lake Ontario, approximately 18 miles east of the mouth of the Niagara River. The AOC includes Olcott Harbor and extends upstream to the farthest point at which backwater conditions exist during Lake Ontario's highest monthly average lake level (see Figure 1-1). This point is locat-

ed just downstream of Burt Dam, approximately 2 miles south of Olcott Harbor. This portion of the watershed is a unique gorge habitat that attracts recreational boaters, anglers, birders, and waterfowl hunters.

Only a small portion of the Eighteenmile Creek basin was originally designated an AOC by the IJC. However, for two reasons, since the Eighteenmile Creek Remedial Action Plan (RAP) process began, the AOC has been considered the impact area and the upper watershed as the source area (NYSDEC 1997). First, except for potential impacts from agricultural operations adjacent to the current AOC boundary, there are no documented sources or source areas of contamination within the AOC. Second, various investigations conducted over the past 35 years have suggested that contaminants may enter the AOC from upstream areas. Specifically, PCBs, copper, lead, and other metals have been found in creek sediment and bank fill in Lockport, New York, at concentration well above applicable New York State Department of Environmental Conservation (NYSDEC) standards, indicating that contaminant sources exist in this area (NYSDEC 2006, E & E 2009b and 2012b). Other contaminant source areas may exist along the creek between Lockport and the AOC (NYSDEC 2001).

Additional information regarding the characteristics of the Eighteenmile Creek AOC and watershed are available in the *Eighteenmile Creek State of the Basin Report* (E & E 2007), *Beneficial Use Impairment (BUI) Investigation Report for Eighteenmile Creek* (E & E 2009a), *Sediment Remedial Investigation Report* (E & E 2012b), and additional publications and factsheets available from the Eighteenmile Creek RAP Web site (http://www.eighteenmilerap.com/).

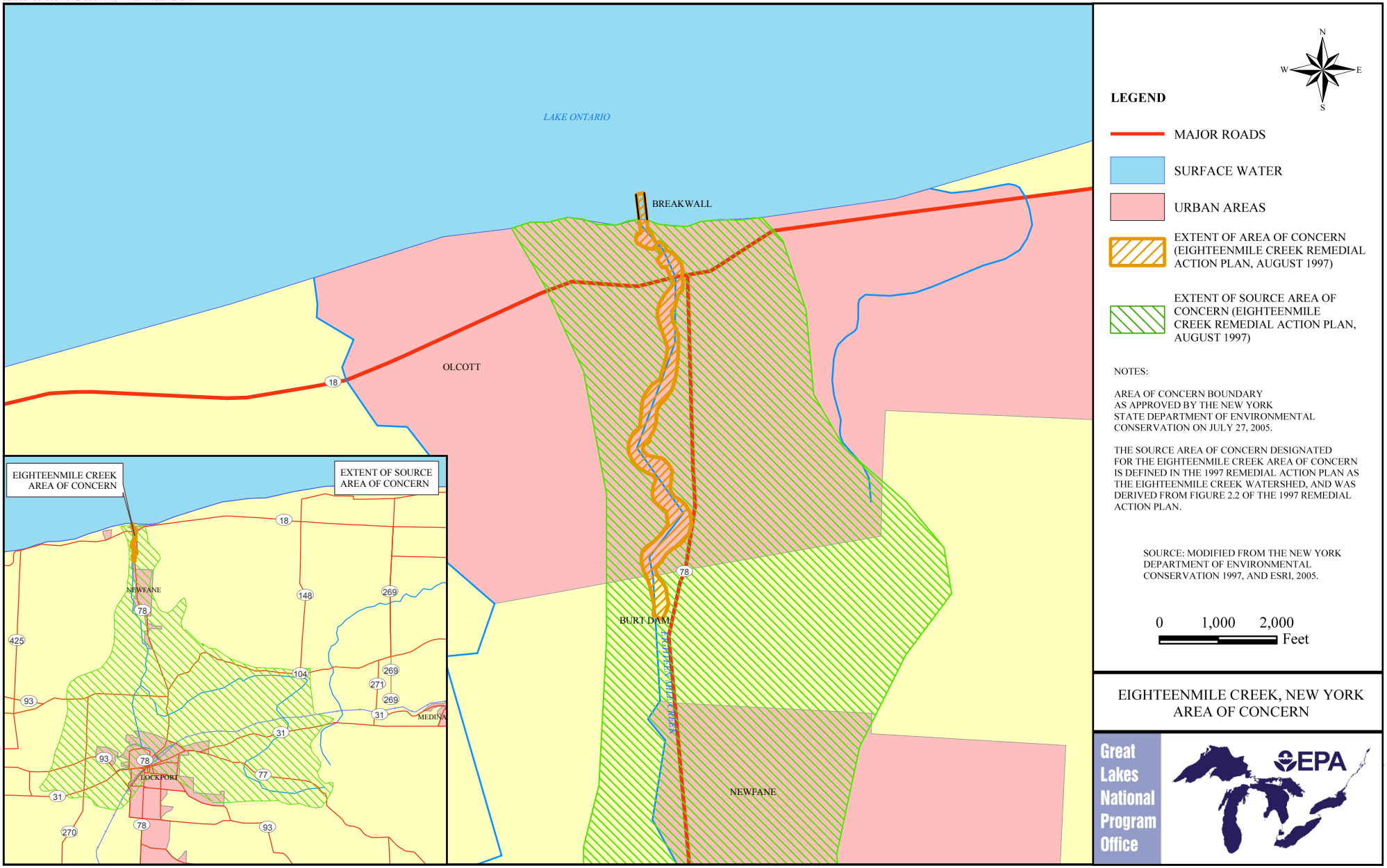

Figure 1-1 Eighteenmile Creek Area of Concern

2 Methods

2.1 Field Sampling Methods

Ecology and Environment, Inc. (E & E) biologists sampled the benthic community and associated chemical and physical parameters at two riffle/run habitat sites and three pool habitat sites in the Eighteenmile Creek AOC on August 21 and 22, 2012. In addition, sediment samples for chemical analysis and sediment toxicity testing were collected from the three pool locations. Table 2-1 provides a summary of the sample types collected at each location. As per the final QAPP (E & E 2012a), all sampling sites were located downstream of Burt Dam (see Figures 2-1 and 2-2). Riffle sample 1BR1 was located in the only area of true riffle habitat in this section of the creek, just downstream from Burt Dam. Because this riffle is relatively short (approximately 45 meters (~148 feet) long), the field team did not collect a second sample of riffle benthos from this area. Instead, a run /glide habitat (sample 1BR2) located approximately 200 meters (~656 feet) downstream from where 1BR1 was sampled (see Figure 2-1). Suitable pool habitats that could be sampled effectively with a petite Ponar dredge could not be located in the upstream portion of the AOC due to the presence of either gravelly substrate or dense submerged aquatic vegetation. E & E biologists were able to successfully collect benthos as well as sediment chemistry and bioassay samples in pool areas with finer substrates farther downstream, as shown on Figure 2-2.

Table 2-1 Summary of Baseline Benthic Community Samples

		Parameter		
Sample	Habitat Type	Benthic Community Composition[a]	Sediment Chemistry[b]	Sediment Toxicity[c]
1BR1	Riffle	X		
1BR2	Run/Glide	X		
1BP1	Pool	X	X	X
1BP2	Pool	X	X	X
1BP3	Pool	X	X	X

Notes:
[a] Macroinvertebrate abundance and diversity and metrics.
[b] PCB Aroclors and congeners, TAL inorganic analytes, AVS/SEM, TOC, grain size, and density.
[c] 10-day sediment bioassays with *Hyalella azteca* (amphipod) and *Chironomus dilutes* (midge).

Key:
AVS/SEM = Acid Volatile Sulfide/Simultaneously Extracted Metals
TAL = target analyte list
TOC = total organic carbon

2.1.1 Water Chemistry

Temperature, conductivity, pH, dissolved oxygen, and total dissolved solids were measured at all sites using a Horiba U-22 multi-parameter meter and probe. The unit was calibrated according to manufacturer's specifications at the beginning of each sampling day.

2.1.2 Physical and Benthic Sampling Procedures

Physical and benthic sampling procedures are described separately for riffle/glide and pool sample sites.

2.1.2.1 Riffle/Glide Habitat

Macroinvertebrate samples in riffle and run/glide habitats were collected according to standard procedures used by the NYSDEC Stream Biomonitoring Unit for riffle habitat (NYSDEC 2009). In addition, data for the following physical parameters were recorded:

- Water depth – using a meter stick;
- Wetted stream width – estimated using paces of one of the field biologists;
- Stream velocity/current – using Geopaks flow-averaging velocity meter;
- Embeddedness – visually estimated;
- Canopy cover – visually estimated; and
- Percent composition of substrate – visually estimated.

Copies of field data sheets are included in Appendix B. Benthic macroinvertebrates were collected using the "traveling kick method" using a rectangular-framed aquatic net with a 9 by 18-inch opening and 0.8 mm by 0.9 mm mesh. Samples were collected by the same person for consistency. The net was placed in the water approximately 0.5 meters (~1.6 feet) downstream from the sampler and the stream bottom was disturbed by foot, so that the dislodged organisms and debris were carried by the current into the net. Sampling was continued in a downstream direction along a diagonal transect for 5 minutes over a distance of 5 meters (~16 feet) (NYSDEC 2009). Once the sample was collected, the contents of the net were emptied and rinsed into an enamel pan. Invertebrates observed clinging to the sides of the net were removed and placed in the enamel pan. Large stones and debris were rinsed of organisms and returned to the water. Readily observable orders of invertebrates present in the pan were recorded on data sheets. Field personnel then poured the contents of the pan through a No. 30 mesh soil sieve, transferred the captured material into a plastic sample jar, and added enough 95% ethanol to achieve an approximately 70% final concentration of ethanol. The sample code was written on the side of the sample jar, and a small slip of Rite-in-the-Rain™ labeled with the sample code was placed inside the jar prior to closure.

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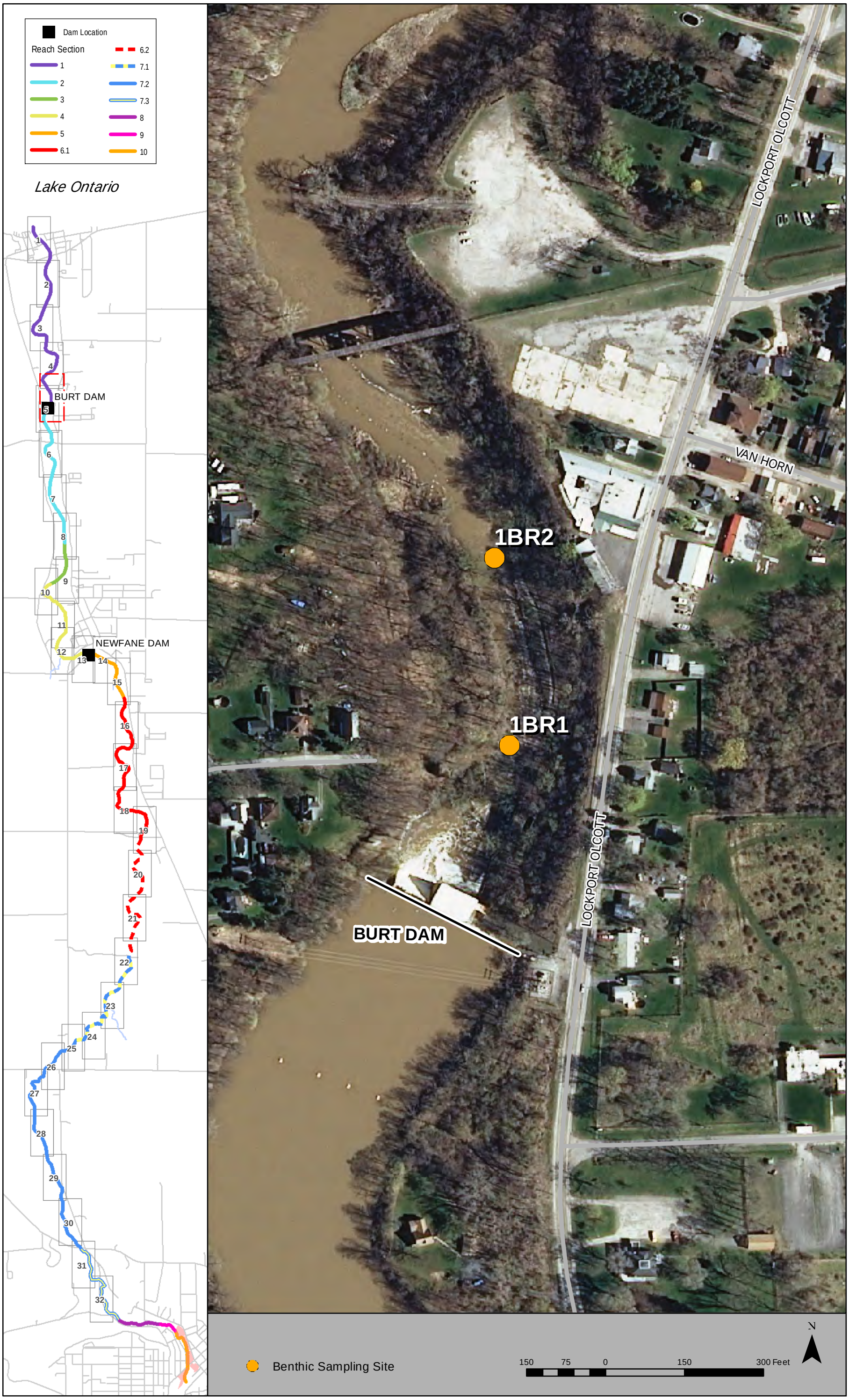

Figure 2-1 Riffle and Run/Glide Habitat Benthic Sites

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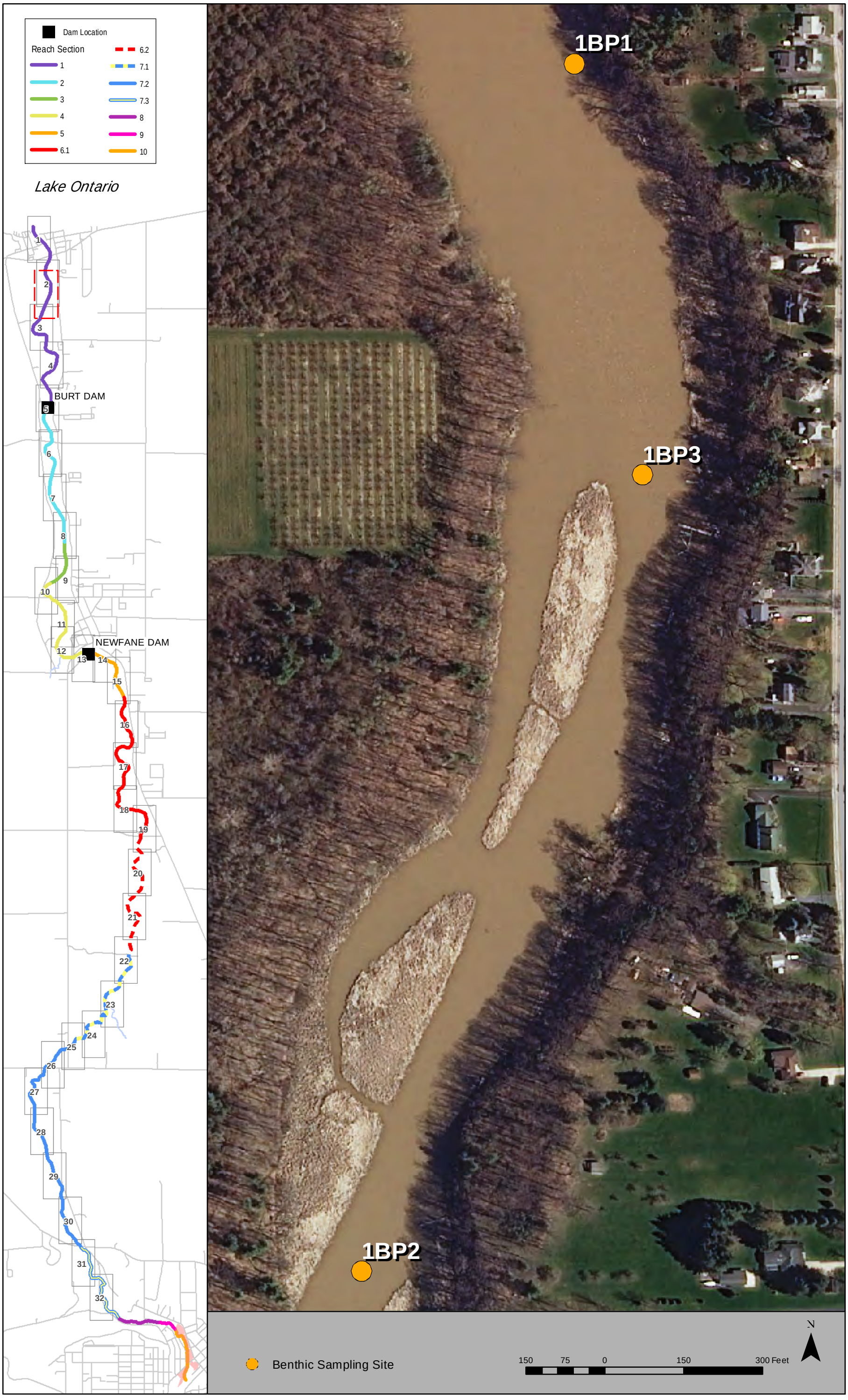

Figure 2-2 Pool Habitat Benthic Sites

2.1.2.2 Pool Habitat

Samples in the pool habitats were collected according to standard procedures used by the NYSDEC Stream Biomonitoring Unit for pool habitat (NYSDEC 2009). Also, data for the following physical parameters were recorded:

- Water depth – visually estimated using the length of rope attached to the petite Ponar dredge;
- Wetted stream width – visually estimated;
- Stream velocity/current – visually estimated;
- Canopy cover – visually estimated; and
- Percent composition of substrate – visually estimated based on material collected via the petite Ponar dredge.

Copies of field data sheets are included in Appendix B. Access to the pool sampling locations was made via a flat-bottomed Jon boat. Benthos was collected using a petite Ponar dredge (opening 6 by 6.5 inches or 0.0929 square meters) attached to a rope. The number of sediment grabs collected for samples 1BP1, 1BP2, and 1BP3, respectively, were 4, 2, and 3. The petite Ponar grabs for each sample were emptied into a rinsed 5-gallon plastic bucket, and the collected sediment screened through a No. 30 soil sieve to remove finer particles. Field personnel transferred the screened samples into jars and added enough 95% ethanol to achieve an approximately 50 to 70% final concentration of ethanol. The sample code was written on the side of the sample jar, and a small slip of Rite-in-the-Rain labeled with the sample code was placed inside the jar prior to closure. The dredge was rinsed thoroughly with stream water between each pool benthic sampling location.

2.1.3 Sediment Chemistry Sampling

Surface sediment (0 to 6 inches below the sediment water interface) was collected for chemical analysis in proximity to each of the pool benthos sampling locations. At each location, one or more sediment grabs with a petite Ponar dredge were emptied into a large pre-cleaned bucket, homogenized, and distributed to sample containers. Table 2-2 lists analytical parameters, number of samples, and sample-handling details. A field duplicate sample was collected for sediment chemistry at location 1BP1. The dredge was thoroughly cleaned and rinsed between sample areas.

Table 2-2 Analytical Parameters and Methods, Sample Containers, Preservatives, and Holding Times for Sediment Sampling at Eighteenmile Creek, Niagara County, New York

Sample Type	Preparation/Analysis	Method	Number of Samples	Sample Container	Preservation	Maximum Holding Time
Sediment[a]	Total Organic Carbon	ASTM D4129-05 modified.	4	Amber 4-oz glass jar with Teflon-lined cap	4°C	28 days
	Grain Size Distribution (percent sand, silt, clay)	ASTM D422	4	Amber 8-oz glass jar with Teflon-lined cap	4°C	28 days
	PCB Congeners and Aroclors (8082 list) and chlorinated pesticides	EPA 8082 and 8081B	4	Amber 8-oz glass jar with Teflon-lined cap	4°C	14 days to extraction; 35 days from extraction to analysis
	Density, wet	ASTM D854	4	Amber 4-oz glass jar with Teflon-lined cap	4°C	NA
	Total Metals (TAL list)	EPA 200.8, 6010B, 7471A	4	Amber 4-oz glass jar with Teflon-lined cap	4°C	180 days
	AVS/SEM (Cd, Cu, Ni, Pb, Hg, Zn, Ag)	EPA (1991) draft method for AVS/SEM in sediment and EPA 6010, 6020, and 7471 for metals.	4	Amber 4-oz glass jar filled to the brim with no air space	4°C	14 days for AVS
Sediment Toxicity	Toxicity - *Hyalella azteca* (10-day)	EPA 100.1	3	1-gal Ziploc bag (double bagged)	4°C	8 weeks
	Toxicity - *Chironomus dilutus* (10-day)	EPA 100.2	3	1-gal Ziploc bag (double bagged)	4°C	8 weeks

Notes:
[a] Three original samples and one field duplicate.

Key:
AOC = Area of Concern
ASTM = American Society of Testing and Materials
AVS = acid volatile sulfide
NA = not applicable
PCB = polychlorinated biphenyl
SEM = simultaneously extracted metal
TAL = target analyte list

2.1.4 Sample Handling and Shipping

Sediment samples were cooled to 4°C and shipped in coolers under chain-of-custody (COC) by overnight courier to ALS Environmental of Kelso, Washington, for chemical analysis and to Aquatic Biological Sciences of Williston, Vermont, for toxicity testing. Benthic macroinvertebrate samples were shipped under COC by overnight courier to REI Consulting Inc. (REIC) of Beaver, West Virginia, for processing.

2.2 Laboratory Methods

2.2.1 Benthic Macroinvertebrate Laboratory Methods

Benthic sample processing was performed by REIC. Sample 1BR1 was subsampled at a ratio of 6 to 100 (six cells of a 100-cell grid were selected for sorting and identification) to yield estimates of taxa in the entire sample. Sample 1BR2 was subsampled at a ratio of 2 to 100. The entirety of the benthic samples from the pool habitats were sorted and processed; subsampling was not performed. REIC identified macroinvertebrates to genus where possible for all insects. Clams and flatworms were only identified to family level. A full description of REIC's standard procedures for sorting and identifying benthic macroinvertebrates and for quality assurance/quality control is provided in the final Quality Assurance Project Plan (QAPP) (E & E 2012a, see Appendix A). Based on the numbers of each taxa of macroinvertebrates identified in a sample, REIC calculated 12 metrics, including family/generic richness; number of Ephemeroptera, Trichoptera, and Plecoptera (EPT) genera identified; percent of Chironomids in the sample; Shannon-Wiener Diversity index; and Hilsenhoff Biotic Index (HBI) (see Appendix F for full REIC report).

E & E calculated additional indices based on the reported results in order to assess impairment based on NYSDEC standards. These additional metrics included percent comprised by the three most abundant taxa (DOM-3), percent model affinity (PMA), and the Biological Assessment Profile (BAP) of index values, as described in NYSDEC's *Standard Operating Procedure: Biological Monitoring of Surface Waters in New York State* (NYSDEC 2009).

The assessed level of impairment was then compared to the delisting criteria for BUI 6 (Degradation of Benthos) for the Eighteenmile Creek AOC (see Table 1-1). It should be noted that the assessed level of impairment reported for the riffle and run/glide habitats in the results section below includes an adjustment by one level of impairment to account for the effect of the impoundments upstream of the sample sites, as recommended by NYSDEC (2009).

2.2.2 Chemical and Toxicity Testing Methods

Sediment from pool sampling locations was submitted for chemical analysis and toxicity testing. Table 2-2 lists the methods used, numbers of samples, and sample-handling details.

3 Results and Discussion

The results of the present investigation are presented and discussed under three main headings: (1) Benthic Community Composition; (2) Sediment Chemistry; and (3) Sediment Toxicity Testing.

3.1 Benthic Community Composition

The benthic macroinvertebrate samples collected from the AOC indicate slight to no impairment of water quality based on NYSDEC criteria in the riffle and run/glide habitats, and moderate impairment in pool habitat (see Table 3-1). All samples were dominated by taxa moderately-tolerant to tolerant of pollution, and contained virtually no sensitive taxa (see Appendix F). More detail is provided below for the riffle and run/glide samples and pool samples. A summary of the physical and water chemistry parameters is provided in Table 3-2.

3.1.1 Riffle/Glide Habitat

The riffle community at 1BR1 was dominated by midge larvae (Chironomidae) of genera Chironomus, Polypedlium, and Tanytarsus, and *Cheumatopsyche* sp., a genus of filtering caddisflies. The run/glide community of 1BR2 was dominated by large numbers of *Cheumatopsyche* sp. and *Hydropsyche* sp., another genus of filtering caddisflies, and also midges of the genus *Polypedlium*. Interestingly, no mayfly species were collected at the run/glide habitat (1BR2). E & E biologists observed large numbers of zebra mussels on the rocks in both the riffle and run/glide locations. Incidental observations by E & E biologists indicated that zebra mussels attach to rock surfaces much more strongly than filtering caddisflies, making them less susceptible to dislodgement by simple foot-disturbance compared with other invertebrates. While some zebra mussels were collected in the kick samples, results indicate that perhaps they were not sampled as efficiently as other taxa using this collection method.

Much greater numbers of invertebrates, especially filtering caddisflies, were found at 1BR2 versus 1BR1. This difference may relate partly to the higher proportion of rock and rubble substrate at 1BR2; such substrates are necessary as stable attachment sites for filtering caddisflies (see Table 3-2). The difference may also be related to the presence of round goby (*Neogobius melanstomus*). Round goby were observed to be very common in the benthic environment of 1BR2, where the current is slower. Because round goby are known to feed on zebra

Table 3-1 Calculated Benthic Community Indices, Biological Assessment Profile of Index Values (BAP), and Assessed Impairment by Benthic Sample Location, Eighteenmile Creek Area of Concern, August 2012

Benthic Sample	Inv Density (per m^2)	PMA	PMA 1-10 scale	HBI	HBI 1-10 scale	EPT Rich-ness	EPT Rich-ness 1-10 scale	Generic Rich-ness	Generic Rich-ness 1-10 scale	DOM 3	DOM 3 1-10 scale	SHAN-WIENER	SHAN-WIENER 1-10 scale	BAP	Impact	Impact Corrected For Impoundment Effect
BR1	NA	48.4	4.82	6.23	5.34	7	5.91	24	6.76	65.41	NA	3.1	NA	5.71	slight	non-impacted
BR2	NA	26.6	1.14	5.1	6.75	3	3.61	23	6.47	91.25	NA	1.71	NA	4.49	moderate	slight impact
BP1	3,080	58.1	5.62	7.57	6.08	3	NA	23	9.04	58.71	7.72	3.32	8.30	7.35	non-impacted	NA
BP2	944	53.7	4.74	7.74	5.65	2	NA	19	7.50	61.05	7.33	3.26	8.15	6.67	non-impacted	NA
BP3	1,113	49.5	3.90	7.87	5.33	2	NA	21	8.27	52.38	8.77	3.6	9.00	7.05	non-impacted	NA

Key:

BAP = Biological Assessment Profile of index values for benthic macroinvertebrate communities (NYSDEC 2009, page 62). The BAP for a sample is determined by calculating the indices appropriate for the habitat type (riffle, pool, etc.), converting each index to a common 1-10 scale, and averaging those values. For riffle communities, the appropriate indices are species richness, HBI, EPT species richness, and PMA. For pool samples, the appropriate indices are species richness, HBI, Shannon-Wiener diversity, and PMA.

DOM 3 = Percentage of total number of animals in sample comprised by the three most numerous (dominant) taxa.

EPT = Number of genera of Ephemeroptera, Plecoptera, and Trichoptera in sample.

Inv Density = Density of benthic macroinvertebrates per square meter sampled.

HBI = Hilsenhoff Biotic Index,based on NYSDEC (2009) methodology.

NA = Not applicable.

PMA = Percent Model Affinity, based on NYSDEC (2009) methodology specific to riffle and pool habitats.

SHAN-WIENER = Shannon-Wiener Diversity index, based on NYSDEC (2009) methodology.

Table 3-2 Field Measured Physical and Chemical Parameters at Each Benthic Sample Location, Eighteenmile Creek Area of Concern, August 2012

Benthic Sample	Water Depth (meters)	Stream Width (meters)	Water Velocity (cm/s)	Canopy Cover (%)	Substrate Embeddedness (%)	Percent substrate Composition					Water Temp. (°C)	Conductance (mS/m)	pH	Dissolved Oxygen (mg/L)	Total Dissolved Solids (g/L)
						Rock	Rubble	Gravel	Sand	Silt					
BR1	0.33	10	100	40	10-20	30	30	30	10	0	18.1	70.8	7.2	14.7	0.45
BR2	0.315	30	23	20	20-25	25	50	15	5	5	18.1	70.4	7.4	14.4	0.35
BP1	4	60	0	0	NA	0	0	0	0	100	19	70.6	7.5	13.7	0.41
BP2	4	50	0	0	NA	0	0	0	15	85	18.1	74	7.06	12.1	0.47
BP3	4	65	0	0	NA	0	0	0	0	100	18.3	74.3	7.12	13.4	0.48

Key:
cm/s = centimeters per second
g/L = grams per liter
mg/L = milligrams per liter
mS/m = milliSiemens per meter

mussels, it is possible that they may suppress zebra mussel densities at 1BR2 enough to make a greater area of stable attachment sites available to filtering caddisflies.

In general, the benthic communities at 1BR1 and 1BR2 are consistent with assemblages found routinely by NYSDEC in surveys of other lake and impoundment outlets – such sites are characterized by lower diversity indices and dominance by filter feeders. NYSDEC protocols use species richness in calculations of BAP to assess impairment. Because the samples collected for this study were identified to the genus or family level, the richness levels reported herein may underestimate the true species richness, especially for Chironomidae. This may have resulted in a slight underestimate of BAP values calculated for the riffle and run/glide habitat samples. The BAP values of 5.71 and 4.49 for 1BR1 and 1BR2, respectively, would be classified by NYSDEC as slightly and moderately impaired if these samples were not collected from a lake-outlet stream. Because they were collected downstream from Burt Dam, samples 1BR1 and 1BR2 are classified as non-impaired and slightly impaired, respectively, after applying NYSDEC's lake-outlet adjustment (NYSDEC 2009). Consequently, locations 1BR1 and 1BR2 satisfy the first delisting criterion for BUI No. 6 (i.e., benthic macroinvertebrate communities are "non-impacted" or "slightly impacted" according to NYSDEC indices [see Table 1-1]).

3.1.2 Pool Habitat

Pool habitat benthic sample results show consistently high diversity scores (due to midge genera), and PMAs between 49.5 and 58.1 (see Table 3-1). Individuals from pollution tolerant taxa represented 96% to 99% of all invertebrates identified in the pool habitat samples (see Appendix F). Total invertebrate densities per square meter at 1BP1, 1BP2, and 1BP3 were 3,080, 944, and 1,113, respectively. Midges of tribe Chironomini and genus *Procladius*, and aquatic worms of family Naididae, were the dominant taxa. The three most common taxa represented between 52.4% and 61.0% of the invertebrates collected at each pool site. Calculated BAPs for the three pool sites ranged from 6.7 to 7.4, indicating non-impairment.

3.2 Sediment Chemistry

Metals, PCBs, and chlorinated pesticides as well as parameters to help with data interpretation were collected from the three pool locations (1BP1, 1BP2, and 1BP3) identified in Figure 2-1. A field duplicate sample was collected at 1BP1. A summary of the analytical data is provided in Table 3-3 along with sediment screening levels for protection of benthos. NYSDEC has indicated a preference for the threshold effect concentrations (TECs) and probable effect concentrations (PECs) from MacDonald et al. (2000), so these sediment screening levels were used preferentially. Chemical concentrations less than the TEC are presumed to pose no risk to benthos, whereas those greater than the PEC are presumed to have a high likelihood of causing an adverse effect. The TEC and PEC do not provide

Table 3-3 Eighteenmile Creek AOC Sediment Data (August 2012) Compared with Sediment Screening Levels.

Analyte[a]	Sediment Screening Levels			Source	Sample and Concentration			
	TEC	PEC	Other[b]		1BP1	1BP1 (R)	1BP2	1BP3
Metals (mg/kg)								
Aluminum	--	--	58,000	MacDonald et al. 1999	13,300	14,600	12,300	13,900
Antimony	--	--	2.9	MacDonald et al. 1999, PAETA	0.33 N	0.379 N	0.575 N	0.287 N
Arsenic	9.8	33	--	MacDonald et al. 2000	3.48	3.54	3.21	3.25
Barium	--	--	--	--	143	154	124	138
Beryllium	--	--	--	--	0.609	0.593	0.569	0.601
Cadmium	1	4.98	--	MacDonald et al. 2000	1.92	1.68	1.74	1.29
Chromium	43.4	111	--	MacDonald et al. 2000	88	89	88	55
Cobalt	--	--	50	MacDonald et al. 1999, criterion, Ont.	11	10	11	10
Copper	31.6	149	--	MacDonald et al. 2000	152	147	127	103
Iron	--	--	20,000	Persaud et al. 1993	22,400	24,000	22,200	22,900
Lead	35.8	128	--	MacDonald et al. 2000	217	211	265	141
Manganese	--	--	460	Persaud et al. 1993	516	529	551	529
Mercury	0.18	1.06	--	MacDonald et al. 2000	0.541	0.525	0.343	0.338
Nickel	22.7	48.6	--	MacDonald et al. 2000	**81**	**68**	**81**	39
Selenium	--	--	5	MacDonald et al. 1999, criterion, B.C.	0.9 J	0.9 J	0.8 J	1
Silver	--	--	0.5	USEPA 2003, ESL	0.596	0.893	0.439	0.399
Thallium	--	--	--	--	0.243	0.264	0.22	0.194
Vanadium	--	--	--	--	23	25	23	24
Zinc	121	459	--	MacDonald et al. 2000	**956**	**873**	**908**	**541**
Acid Volatile Sulides (AVS) and Simultaneously Extracted Metals (SEMs) (µmol/g)								
AVS	--	--	--	--	39	40	29	35
Sum of SEM Metals	--	--	--	--	7.2	5.4	6.7	3.8
ΣSEM / AVS ratio (unitless)	--	--	1	USEPA 1994	0.18	0.13	0.23	0.11
Ancillary Parameters								
Bulk Density (g/mL)	--	--	--	--	1.1	1.1	1.3	1.2
Solids (%)	--	--	--	--	34	32	42	35
Total Organic Carbon (%)	--	--	--	--	4.2	3.9	3.6	4.8
% Sand	--	--	--	--	23	21	40	28
% Silt	--	--	--	--	55	60	42	48
% Clay	--	--	--	--	22	18	18	24

Table 3-3 Eighteenmile Creek AOC Sediment Data (August 2012) Compared with Sediment Screening Levels.

Analyte[a]	Sediment Screening Levels TEC	PEC	Other[b]	Source	Sample and Concentration 1BP1	1BP1 (R)	1BP2	1BP3
Polychlorinated Biphenyls (µg/kg)								
Aroclor 1248	60	676	--	MacDonald et al. (2000)	390	320	420	320
Sum of Aroclors (ND = 0)	60	676	--	MacDonald et al. (2000)	390	320	420	320
Sum of Aroclors (ND = 0.5)	60	676	--	MacDonald et al. (2000)	399	330	428	329
Sum of Congeners (ND = 0)	60	676	--	MacDonald et al. (2000)	157	131	176	138
Sum of Congeners (ND = 0.5)	60	676	--	MacDonald et al. (2000)	162	134	176	138
Pesticides (µg/kg)								
Alpha Endosulfan	--	--	0.9	NYSDEC 1999 for endosulfan, 3% OC	2 P	1.6 JP	1.8 P	1.8 P
Alpha Chlordane	3.2	17.6	--	MacDonald et al. (2000) for chlordane	1.5 Ui	1.6 Ui	1.2 Ui	0.34 JP
Beta-Endosulfan	--	--	0.9	NYSDEC 1999 for endosulfan, 3% OC	1.7 P	0.77 JP	1.2 Ui	0.21 U
Dieldrin	1.9	61.8	--	MacDonald et al. (2000)	5.5 P	5.5 P	5.3 P	5 P
Endosulfan Sulfate	--	--	0.9	NYSDEC 1999 for endosulfan, 3% OC	0.17 Ui	0.2 JP	0.14 U	0.27 JP
Endrin	2.2	207	--	MacDonald et al. (2000)	1.1 J	0.91 J	0.97 J	0.85 J
Endrin Aldehyde	2.2	207	--	MacDonald et al. (2000) for endrin	1.1 Ui	0.92 Ui	0.87 J	0.75 J
Gamma-Chlordane	3.2	17.6	--	MacDonald et al. (2000) for chlordane	4.9 P	3.3 P	3.9 P	2.8 P
Hexachlorobenzene	--	--	20	Persaud et al. 1993	0.7 J	0.38 JP	0.76 JP	0.45 JP
p,p'-DDD	4.9	28	--	MacDonald et al. (2000)	3	2.5	1.8	2.8
p,p'-DDE	3.2	31	--	MacDonald et al. (2000)	16	13	11	14
p,p'-DDT	4.2	63	--	MacDonald et al. (2000)	9.3	7.5	8	8

Notes:
[a] Detected chemicals only are listed.
[b] Screening level analogous to TEC.

Key:
-- (double dash) = not available or not applicable
AOC = Area of Concern
AVS = Acid volatile sulfide
B.C. = British Columbia, Canada
GC = gas chromatograph
HPLC = high-performance liquid chromatography
i = detection limit elevated due to chromatographic interference
J = estimated value
N = matrix spike not within control limits
na = Not applicable
ND = Non-detect
OC = Organic carbon
Ont. = Ontario, Canada
P = GC or HPLC confirmation criteria exceeded. Relative % difference > 40% between results
PAETA = Probable apparent effect threshold approach
PCB = Polychlorinated biphenyl
PEC = Probable effect concentration (MacDonald et al. 2000)
SEM = Simultaneously extracted metals
TEC = Threshold effect concentration (MacDonald et al. 2000)
U = not detected
USEPA = United States Environmental Protection Agency
Value = Exceeds TEC or other benchmark.
Value = Exceeds PEC. Adverse effect possible.

guidance regarding possible adverse impacts when the concentration of a chemical lies between the TEC and PEC. Chronic freshwater sediment screening levels from NYSDEC (1999) and low effect level (LEL) screening levels from Persaud et al. (1993) were used for chemicals for which TECs and PECs were not available. The NYSDEC chronic screening levels and LELs are analogous to the TECs; that is, sediment chemical concentrations less than these screening levels are presumed to pose no risk. The following points are noteworthy regarding the August 2012 sediment sample data (see Table 3-3):

- Sediment concentrations of nine metals (cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc) exceeded the TEC, LEL, or NYSDEC chronic screening level in all samples. Nickel and zinc concentrations exceeded their respective PECs in all or most samples;

- Aroclor 1248 was the only Aroclor detected, consistent with previously collected data for Eighteenmile Creek (E & E 2012b). All samples collected in August 2012 contained PCBs in excess of the TEC. No samples exceeded the PEC; and

- Five pesticides (alpha-endosulfan, beta-ebdosulfan, gamma-chlordane, dichlorodiphenyl-trichloroethane [DDT], and dichlorodiphenyldichloroethylene [DDE]) exceeded the TEC or NYSDEC chronic screening level. No pesticides exceeded the available PECs.

Sediment data for acid volatile sulfides (AVS) and simultaneously extracted metals (SEM) were collected to help understand the bioavailability of divalent metals (cadmium, copper, lead, mercury, nickel, and zinc) in Eighteenmile Creek sediments. In brief, the AVS and SEM data indicate that there was more than ample AVS available to bind the available divalent metals (i.e., the ratio or SEM to AVS in the samples was less than one in all samples [see Table 3-3]). This result suggests that divalent metals in Eighteenmile Creek sediment, although present at concentrations above screening levels, are not bioavailable and, therefore, unlikely to adversely affect benthic life.

3.3 Sediment Toxicity Testing

Sediment bioassays are an important tool for evaluating sediment quality because they provide a direct measure of sediment toxicity, or the lack thereof. As part of the present study, 10-day sediment bioassays with *Hyalella azteca* (amphipod) and *Chironomus dilutus* (midge) were conducted with sediment from the three pool habitat locations downstream from Burt Dam (see Figure 2-2 for sample locations). Sediment from a clean reference stream near Aquatec Biological Sciences, where the bioassays were conducted, was tested concurrently and used as a point of comparison with the Eighteenmile Creek samples. Table 3-4 summarizes the results. Appendix E contains a copy of the bioassay testing report from Aquatec. There was no significant difference in midge or amphipod survival and growth between the Eighteenmile Creek samples and control (see Table 3-4). These results suggest that metals, PCBs, and pesticides in sediment in pool habi-

tats downstream from Burt Dam, although in excess of screening levels (see Table 3-3), do not adversely impact benthic life. This finding agrees with the AVS/SEM results, which indicate that divalent metals in sediment in pool habitats below the dam are not bioavailable (see Section 3.2).

Table 3-4 Summary of Eighteenmile Creek Sediment Bioassay Results[a]

E & E Sample Number	Laboratory Sample Number	Mean Percent (%) Surviving	Significantly Different than Control ($p < 0.05$)?	Mean Weight (mg) per Surviving Organism	Significantly Different than Control ($p < 0.05$)?
10-day *Chironomus dilutus* (Midge) Test Results					
Control[b]	43434	95	--	1.65	--
1BP1	43435	93	No	1.73	No
1BP2	43436	96	No	1.67	No
1BP3	43437	90	No	1.79	No
10-day *Hyalella azteca* (Amphipod) Test Results					
Control[b]	43434	88	--	0.095	--
1BP1	43435	95	No	0.104	No
1BP2	43436	94	No	0.105	No
1BP3	43437	91	No	0.121	No

Notes:
[a] See Appendix E for complete bioassay laboratory report.
[b] Natural sediment collected from reference stream near bioassay laboratory.

Key:
E & E = Ecology and Environment, Inc.
p = probability

4 Summary, Conclusions, and Implications for BUI Delisting

Table 4-1 summarizes the findings of the present investigation and their implication for delisting BUI No. 6 (Degradation of Benthos) at the Eighteenmile Creek AOC. The following points are noteworthy:

- The benthic macroinvertebrate community in riffle and run/glide habitats in the AOC is not impaired or slightly impaired according to NYSDEC (2009) indices. This finding satisfies the first delisting criterion for BUI No. 6 for the Eighteenmile Creek AOC (see Table 1-1) and, therefore, supports delisting of this BUI.

- The benthic macroinvertebrate community in pool habitats in the AOC is non-impaired according to NYSDEC (2009) indices. Also, sediment bioassay and bioavailability data for pool habitats show no toxicity and low bioavailability of contaminants. These findings satisfy the first and third delisting criteria for BUI No. 6 for the Eighteenmile Creek AOC (see Table 1-1) and, therefore, support delisting this BUI.

Based on the findings of the current study, we recommend the following:

- The NCSWCD and Eighteenmile Creek Remedial Advisory Committee (RAC) should consider moving forward with delisting (re-designating) BUI No. 6.

- Another round of benthic community monitoring should be implemented in 2017 as suggested in the *Eighteenmile Creek Area of Concern (AOC) Strategic Plan for Beneficial Use Impairment (BUI) Delisting* (E & E 2011). Future monitoring data will provide insight into how anticipated sediment remedial actions and other activities upstream from the AOC affect the benthic community therein.

Table 4-1 Weigh-of-Evidence Regarding Benthic Community Impairment and Implications for BUI #6 Delisting

Sample	Habitat Type	Weight-of-Evidence Variables: Sediment Contamination[a]	SEM/AVS[b]	Sediment Toxicity[c]	Benthic Community Impairment[d]	Conclusions and Remarks	Implications for BUI #6 Status
1BR1	Riffle	ns	ns	ns	-	Benthic community not impaired according to NYSDEC indices (see Section 3.1.1).	First delisting criterion in Table 1-1 is satisfied. BUI may be delisted.
1BR2	Run/Glide	ns	ns	ns	+	Benthic community slightly impaired according to NYSDEC indices (see Section 3.1.1)	First delisting criterion in Table 1-1 is satisfied. BUI may be delisted.
1BP1	Pool	+	-	-	-	Benthic community non-impaired according to NYSDEC indices (see Section 3.1.2) and no sediment toxicity observed (see Section 3.3).	First and third delisting criteria in Table 1-1 are satisfied. BUI may be delisted.
1BP2	Pool	+	-	-	-	Same as above.	Same as above.
1BP3	Pool	+	-	-	-	Same as above.	Same as above.

Notes:

[a] Sediment Contamination:
+ = contaminant concentration > screening level
- = contaminant concentration < screening level

[b] SEM/AVS Ratio
+ = ratio > 1 (divalent metals are bioavailable)
- = ratio < 1 (divalent metals are not bioavailable)

[c] Sediment Toxicity
+ = measurable difference between site and control for survival or growth
- = no significant difference between site and control for survival or growth

[d] Benthic Community Impairment
- = no impairment according to NYSDEC indices
+ = slight impairment according to NYSDEC indices
++ = moderate impairment according to NYSDEC indices
+++ = severe impairment according to NYSDEC indices

Key:

AOC = area of concern
AVS = acid volatile sulfide
BUI = beneficial use impairment
ns = not sampled (no sediment deposition occurs at these locations)
NYSDEC = New York State Department of Environmental Conservation
SEM = simultaneously extracted metals

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A Final Quality Assurance Project Plan

Provided on CD.

B Field Data Sheets

Provided on CD.

C Electronic Data Deliverable

Provided on CD.

D Chemistry Lab Report

Provided on CD.

E Toxicity Test Report

Provided on CD.

F

REIC Benthic Report

Provided on CD.

G

Data Usability Summary Report

Provided on CD.