

NORTHEAST OHIO REGIONAL SEWER DISTRICT

2013 Big Creek Environmental Monitoring: Biological, Water Quality, and Habitat Survey Results



**Prepared by
The Water Quality and Industrial Surveillance Division**

Introduction

In 2013, the Northeast Ohio Regional Sewer District (NEORS) conducted stream monitoring activities at River Mile (RM) 0.15 on Big Creek, an urbanized tributary to the Cuyahoga River. RM 0.15 is located downstream of Jennings Road on the Big Creek Main Branch and is downstream of NEORS-owned combined sewer overflows (CSOs). NEORS assessed stream habitat, water chemistry, and fish and benthic macroinvertebrate community health to evaluate the impact of CSOs and other environmental factors on the creek. Macroinvertebrate and water chemistry sampling at RM 0.15 was required by Ohio Environmental Protection Agency (Ohio EPA) National Pollutant Discharge Elimination System (NPDES) Permit No. 3PA00002*FD.

Stream monitoring activities were conducted by NEORS Level 3 Qualified Data Collectors certified by Ohio EPA in Fish Community Biology, Benthic Macroinvertebrate Biology, Chemical Water Quality, and Stream Habitat Assessment as explained in the NEORS Study Plan *2013 Big Creek Environmental Monitoring*, approved by Ohio EPA on July 10, 2013. The results obtained from these assessments were evaluated using the Ohio EPA's Qualitative Habitat Evaluation Index (QHEI), Index of Biotic Integrity (IBI), Modified Index of Well-Being (MIwb), and Invertebrate Community Index (ICI). Water chemistry data was compared to the Ohio Water Quality Standards (Ohio EPA, 2011) to determine attainment of designated uses. An examination of the individual metrics that comprise the IBI and ICI was used in conjunction with the water quality data, NEORS Macroinvertebrate Field Sheet, and QHEI results to identify impacts to the fish and benthic macroinvertebrate communities. Results were also compared to historic data to show temporal trends.

Figure 1 is a map of the sampling location on Big Creek, and Table 1 lists the sampling location and its respective river mile, latitude/longitude, site description, and surveys conducted. A digital photo catalog of the sampling locations is available upon request by contacting the NEORS Water Quality and Industrial Surveillance (WQIS) Division.

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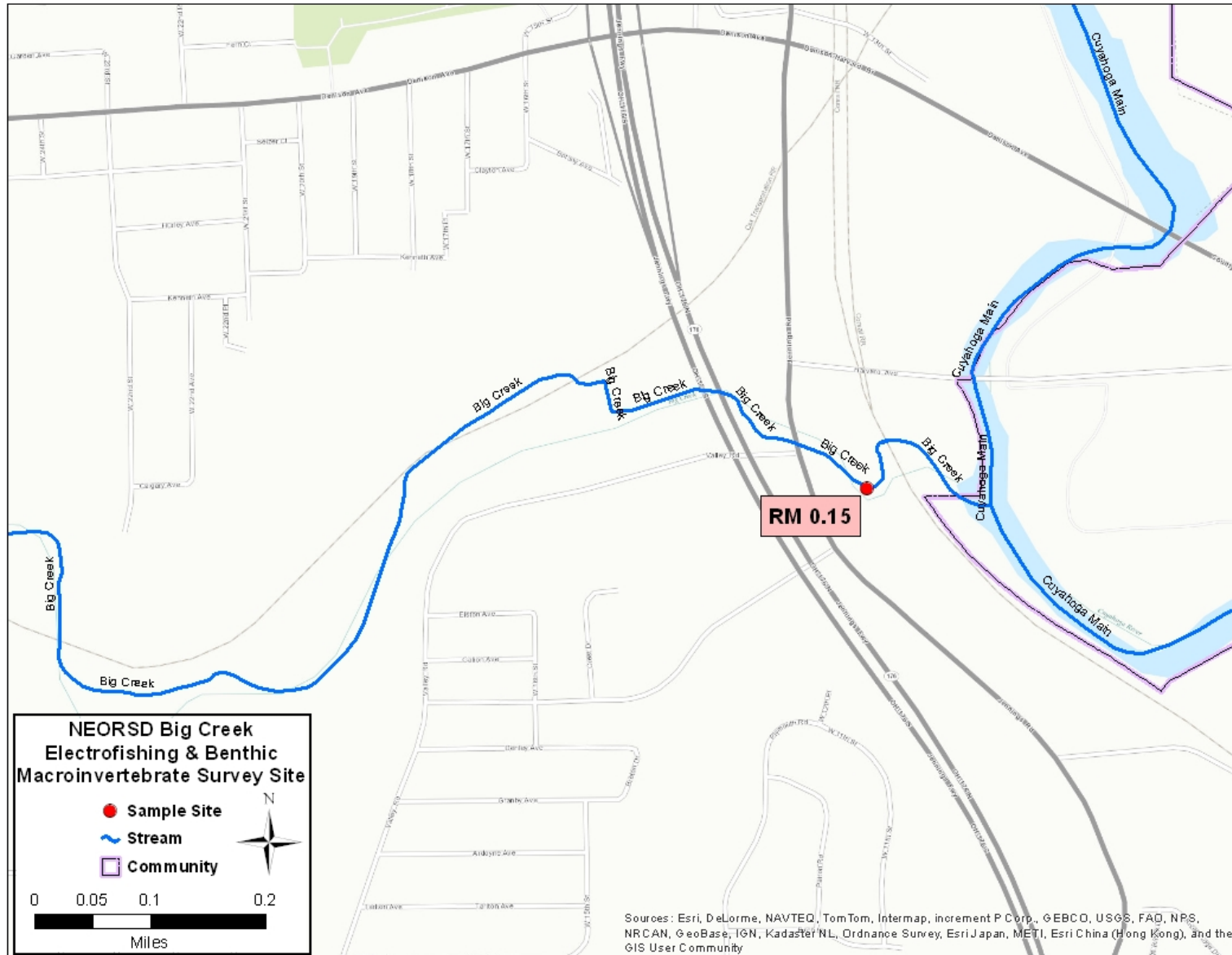


Figure 1. Sampling Location

Table 1. 2013 Big Creek Sampling Location						
Water Body	Latitude	Longitude	River Mile	Location Information	USGS HUC 8 Number - Name	Purpose
Big Creek	41.4460	-81.6865	0.15	Downstream of Jennings Road	04110002 Cuyahoga	Evaluate water chemistry and macroinvertebrates as required by Ohio EPA Permit #3PA00002*FD, and evaluate the fish community and instream habitat as supplemental data

Water Chemistry Sampling

Methods

Water chemistry and bacteriological sampling was conducted six times between June 18 and July 23, 2013, on Big Creek at RM 0.15. Techniques used for sampling and analyses followed the Ohio EPA *Surface Water Field Sampling Manual* (2013). Chemical water quality samples from each site were collected with two 4-liter disposable polyethylene cubitainers with disposable polypropylene lids and two 473-mL plastic bottles. One of the plastic bottles was field preserved with trace nitric acid and the other was field preserved with trace sulfuric acid. All water quality samples were collected as grab samples. Bacteriological samples were collected in sterilized plastic bottles. At the time of sampling, measurements for dissolved oxygen, pH, temperature, and conductivity were collected using a YSI 600XL sonde. Duplicate samples and field blanks were collected at randomly selected sites, at a frequency not less than 5% of the total samples collected. Relative percent difference (RPD) was used to determine the degree of discrepancy between the primary and duplicate sample (Formula 1).

$$\text{Formula 1: } \text{RPD} = \left(\frac{|X-Y|}{((X+Y)/2)} \right) * 100$$

X= is the concentration of the parameter in the primary sample
 Y= is the concentration of the parameter in the duplicate sample

The acceptable percent RPD is based on the ratio of the sample concentration and detection limit (Formula 2) (Ohio EPA, 2013).

$$\text{Formula 2: } \text{Acceptable \% RPD} = [(0.9465X^{-0.344}) * 100] + 5$$

X = sample/detection limit ratio

Those RPDs that are higher than acceptable may indicate potential problems with sample collection and, as a result, the data was not used for comparison to the water quality standards.

Mercury analysis for all of the sampling events was done using EPA Method 245.1. Because the detection limit for this method is above the criteria for the Human Health Nondrinking and Protection of Wildlife Outside Mixing Zone Averages (OMZA), it generally cannot be determined if Big Creek was in attainment of those criteria. Instead, this type of mercury sampling was used as a screening tool to determine whether contamination was present above those levels typically found in the river.

Water chemistry analysis sheets for each site are available upon request from the NEORSWQIS Division.

Results and Discussion

One field blank was collected during the study on July 2, 2013 and the validation results are listed in Table 2.


Table 2. Parameters Requiring Qualification				
Date	Parameter	Qualifier	Blank Result	Sample Result
7/02/13	Cr	J*	J 0.26	2.506

*estimated

For the one duplicate sample that was collected during the study, the RPD for the ammonia results was greater than acceptable and resulted in rejection of the data. Potential reasons for this discrepancy include lack of precision and consistency in sample collection and/or analytical procedures, environmental heterogeneity and/or improper handling of samples. Because all other parameters had acceptable RPDs between the two samples, it is difficult to ascertain the cause of the high RPD observed for ammonia content.

The final QA/QC check for the samples was a comparison of paired parameters. This comparison showed that total solids and total dissolved solids results for one sample needed to be listed as estimated. The reason for these parameters not meeting Ohio EPA's requirements may include differences in sampling and analysis methods.

RM 0.15 on Big Creek is designated as warmwater habitat (WWH), agricultural water supply, industrial water supply, and Class B primary contact recreation water. Exceedances of the water quality standards associated with these uses occurred for only bacteria and mercury. The bacteriological criteria for *E. coli* consist of two components: a seasonal geometric mean and a value not to be exceeded in more than 10% of the samples collected during a 30-day period (single sample maximum). For those streams designated Class B primary contact recreation, these criteria are 161 colony-forming units (CFU)/100mL and 523 CFU/100mL, respectively. The seasonal geometric mean criterion was exceeded at RM 0.15 in 2013 (Table 3). The single sample maximum criterion was also exceeded for 4 samples collected in a 30-day period.

Table 3. 2013 Big Creek <i>E. coli</i> Densities (colony-forming units/100mL)	
Date	RM 0.15
6/18/2013	380
6/25/2013*	300
7/2/2013*	2295
7/09/2013*	1100
7/16/2013	580
7/23/2013*	6500
Seasonal Geomean	1013.69
*Wet weather event  Exceeds single sample maximum criterion for 30-day period starting on that date	

Four of the samples were collected as part of wet weather events¹. In total, 22 recorded wet weather overflows to Big Creek or its tributaries occurred from June 18 to July 23, 2013, for those CSOs with monitoring capabilities (Table 4). These overflows contained a mixture of rainwater, urban and stormwater runoff, and raw sewage and were likely sources of elevated *E. coli* densities in the creek.

¹ Wet weather sampling events: greater than 0.10 inches of rain but less than 0.25 inches, samples collected that day and the following day are considered wet weather samples; greater than 0.25 inches, the samples collected that day and the following two days are considered wet weather samples.

Table 4. Wet Weather Overflows to Big Creek from June 18 to July 23, 2013				
Outfall Name	Location	Receiving Water	Number of Overflows	Million Gallons (MG)
CSO 051	W. 38th/Muriel	Big Creek	8	Unknown
CSO 055	Bellaire/Kensington Dam	Big Creek	4	Unknown
CSO 056	Bellaire/Kensington Gate	Big Creek	4	8.32
CSO 058	W. 145th/Puritas	Big Creek	6	16.71

Mercury analysis for all of the sampling events was done using EPA Method 245.1. Because the detection limit for this method is above the criteria for the Human Health Nondrinking and Protection of Wildlife Outside Mixing Zone Averages (OMZA), it generally cannot be determined if Big Creek was in attainment of those criteria. Instead, this type of mercury sampling was used as a screening tool to determine whether contamination was present above those levels typically found in the creek.

Ohio EPA's Trophic Index Criterion (TIC) is an index that looks at the measures of nutrients, benthic algae, dissolved oxygen, and the biological components and assigns points to ranges of each indicator. Nutrients were assessed in 2013. For Big Creek the samples collected showed average concentrations of total phosphorus at 0.10 mg/L and DIN at 0.57 mg/L. Based on these concentrations, the Big Creek site for the nutrient component of the TIC indicates that the nutrient concentrations are acceptable because they are typical of healthy streams in working landscapes.

Habitat Assessment

Methods

An instream habitat assessment was conducted once at RM 0.15 in 2013 using the Qualitative Habitat Evaluation Index (QHEI). The QHEI was developed by the Ohio EPA to assess aquatic habitat conditions that may influence the presence or absence of fish species by evaluating the physical attributes of a stream. The index is based on six metrics: stream substrate, instream cover, channel morphology, riparian zone and bank condition, pool and riffle quality, and stream gradient. The QHEI has a maximum score of 100, and a score of 60 or more suggests that sufficient habitat exists to support a fish community that meets the warmwater habitat criterion (Ohio EPA, 2003). A more detailed description of the QHEI can be found in Ohio EPA's *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)*

(2006). QHEI field sheets for each site are available upon request from the NEORSW WQIS Division.

Results and Discussion

The QHEI score was 73.50 for RM 0.15 in 2013 (Table 6). This site met the target QHEI score of 60, as it has the past six years. The site has a predominantly gravel and sand substrate and features a large riffle, runs, and deep pools. Instream cover is moderate and consists of undercut banks, overhanging vegetation, slow shallows, boulders, rootwads and logs or woody debris. The creek has a very narrow riparian zone to buffer the surrounding urban and industrial land use, and the bank on river right has heavy to severe erosion. The sediments at this site appear to be prone to shifting, presumably during wet weather events and high flows.

River Mile	Year	QHEI Score	Narrative
0.15	2007	68.75	<i>Good</i>
	2008	64.00	<i>Good</i>
	2009	73.25	<i>Good</i>
	2010	70.50	<i>Good</i>
	2011	69.50	<i>Good</i>
	2012	71.50	<i>Good</i>
	2013	73.50	<i>Good</i>

Fish Community Assessment

Methods

One quantitative electrofishing pass was conducted at Big Creek RM 0.15 on August 16, 2013. Sampling was conducted using backpack electrofishing techniques and consisted of shocking all habitat types within a sampling zone while moving from downstream to upstream. The sampling zone was 0.20 kilometers. The methods that were used followed Ohio EPA protocol methods as detailed in *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987a) and *III* (1987b). Fish collected during the surveys were identified, weighed and examined for the presence of anomalies, including DELTs (deformities, eroded fins, lesions, and tumors). All fish were then released to the waters from which they were collected, except for vouchers and those that could not be easily identified in the field.

The electrofishing results for each pass were compiled and utilized to evaluate fish community health through the application of two Ohio EPA indices, the Index of Biotic

Integrity (IBI) and the Modified Index of Well-Being (MIwb). The IBI incorporates 12 community metrics representing structural and functional attributes. The structural attributes are based upon fish community aspects such as fish numbers and diversity. Functional attributes are based upon fish community aspects such as feeding strategies, environmental tolerances, and disease symptoms. These metrics are individually scored by comparing the data collected at the survey site with values expected at reference sites located in a similar geographical region. The maximum possible IBI score is 60 and the minimum possible score is 12. The summation of the 12 individual metrics scores provides a single-value IBI score, which corresponds to a narrative rating of *Exceptional*, *Good*, *Marginally Good*, *Fair*, *Poor* or *Very Poor*. The 12 metrics utilized for wading sites are listed in Table 7.

Table 7. IBI Metrics (Wading)
Total number of Native Species
Number of Darter species
Number of Sunfish Species
Number of Sucker Species
Number of Intolerant Species
Percent Tolerant Species
Percent Omnivores
Percent Insectivores
Percent Top Carnivores
Percent Simple Lithophils
Percent DELT Anomalies
Number of Fish

The second fish index utilized by Ohio EPA is the Modified Index of Well-being (MIwb). The MIwb, Formula 1 below incorporates four fish community measures: numbers of individuals, biomass, and the Shannon Diversity Index (H) (Formula 2 below) based on numbers and weight of fish. The MIwb is a result of a mathematical calculation based upon the formula.

Formula 1: $MIwb = 0.5 \ln N + 0.5 \ln B + \bar{H}(No.) + \bar{H}(Wt.)$

N = Relative numbers of all species excluding species designated as highly tolerant, hybrids, or exotics

B = Relative weights of all species excluding species designated as highly tolerant, hybrids, or exotics

$\bar{H}(No.)$ = Shannon Diversity Index based on numbers

$\bar{H}(Wt.)$ = Shannon Diversity Index based on weight

$$\bar{H} = - \sum \left[\left(\frac{n_i}{N} \right) \log_e \left(\frac{n_i}{N} \right) \right]$$

Formula 2:

n_i = Relative numbers or weight of species

N = Total number or weight of the sample

Lists of the species, numbers, weights, pollution tolerances and incidence of DELT anomalies for fish collected during the electrofishing pass are available upon request from the NEORSD WQIS Division.

Results and Discussion

The Warmwater Habitat (WWH) IBI criterion in the Erie-Ontario Lake Plain (EOLP) ecoregion is 38 for wading sites. A site is considered in non-significant departure if it is within 4 IBI units of its applicable criterion. The MIwb criterion for wading sites is 7.9; non-significant departure is within 0.5 units. Table 8 lists the average IBI and MIwb scores where applicable. Figure 2 illustrates temporal trends in IBI and MIwb scores from 2007-2013.

Table 8. 2007 – 2013 Average Big Creek IBI & MIwb Scores					
		IBI		MIwb	
River Mile	Year	Score	Narrative Rating	Score	Narrative Rating
0.15	2007	28 ^a	Fair	5.3 ^a	Poor
	2008	32 ^a	Fair	6.6 ^a	Fair
	2009	26	Poor	5.6	Poor
	2010	29 ^a	Fair	6.1 ^a	Fair
	2011	30 ^a	Fair	6.1 ^a	Fair
	2012	31 ^a	Fair	7.0 ^a	Fair
	2013	32	Fair	5.4	Poor

^aAverage score

The fish community at RM 0.15 in 2013 had an IBI score of 32 (*Fair*) and a MIwb score of 5.4 (*Poor*), failing to meet the WWH biocriteria. The 2013 score remains consistent with previous four years IBI scores (Table 8) and MIwb scores for this site. Ten species of fish were collected in the one electrofishing pass, and about 60% of the total catch consisted of pollution-tolerant individuals such as common white sucker (*Catostomus commersonii*), yellow bullhead (*Ictalurus natalis*), and green sunfish (*Lepomis cyanellus*). A total of 30 CSO overflow events from June 18, 2013 to July 23, 2013, contributed more than 35 million gallons of combined sewage to Big Creek; these overflows may detract from a movement of more desirable pollution sensitive species from inhabiting the site. There are also a large number of illicit discharges located upstream of the sampling area. The fish community would likely improve with the

reduction/removal of overflow events and illicit discharges, as the habitat should be capable of supporting a more diverse population of fish.

Macroinvertebrate Sampling

Methods

Macroinvertebrates were sampled quantitatively using modified Hester-Dendy (HD) samplers in conjunction with a qualitative assessment of Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly), also referred to as EPT taxa, inhabiting available habitats at the time of HD retrieval. Methods for sampling followed the Ohio EPA's Biological Criteria for the Protection of Aquatic Life, Volume III (1987b). The recommended period for HDs to be installed is six weeks.

The macroinvertebrate qualitative samples were sent to Third Rock Consultants, LLC for identification and enumeration. Specimens were identified to the lowest practical taxonomic level as recommended in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volume III* (1987, updated September 30, 1989; November 8, 2006; and August 26, 2008). The taxa lists and enumerations are available upon request from NEORSD's WQIS Division.

The overall aquatic macroinvertebrate community in the stream was evaluated using Ohio EPA's Invertebrate Community Index (ICI) (OEPA 1987a, Ohio EPA undated). The ICI consists of ten community metrics (Table 9), each with four scoring categories. Metrics 1-9 are based on the quantitative sample, while Metric 10 is based on the qualitative EPT taxa. The total of the individual metric scores result in the overall score. This scoring evaluates the community against Ohio EPA's reference sites for each specific eco-region.

Table 9. ICI Metrics
Total number of taxa
Number of mayfly taxa
Number of caddisfly taxa
Number of dipteran taxa
Percent mayflies
Percent caddisflies
Percent Tanytarsini midges
Percent other diptera and non-insects

Table 9. ICI Metrics
Percent tolerant organisms (as defined)
Number of qualitative EPT taxa

Results and Discussion

In 2013, HD samplers had to be reinstalled several times on Big Creek at RM 0.15 due to missing samplers or the samplers being buried. Initial installation was on June 18, 2013, and an additional installation took place on July 17, 2013. The HD was retrieved on August 30, 2013. The ICI score was calculated at 24 with a narrative rating of *Fair*, and a decrease from the 2012 score of 32. Twenty-four percent of the taxa were comprised of *Oligochaeta*. Two moderately-intolerant taxa were collected on the HD, *Hydropsyche dicantha* and *Ceratopsyche morose*. The qualitative sample showed 36 taxa collected with the predominant organisms being Chironomids and Isopods. The WWH ICI criterion for the EOLP ecoregion is 34, which applies to RM 0.15. Table 10 summarizes the sampling results from 2007-2013.

Table 10. 2013 Big Creek Invertebrate Community Index (ICI) Results						
Date	ICI Score	Narrative Rating	Quantitative Taxa	Qualitative Taxa	Qualitative EPT Taxa	% Tolerant (as defined)
2007	22	<i>Fair</i>	29	16	5	43.9
2008	22	<i>Fair</i>	24	15	6	57.4
2009	28	<i>Fair</i>	26	24	6	19.0
2010	20	<i>Fair</i>	31	27	3	58.5
2011	--	--	--	25	7	--
2012	32	<i>Marginally Good</i>	31	25	6	18.2
2013	24	<i>Fair</i>	36	27	3	45.8

Bold indicates attainment of WWH criterion

Conclusions

Sampling on Big Creek in 2013 was conducted to determine point source and non-point source impairments. From the water chemistry portion of this sampling, it was found that exceedences of the applicable water quality standards occurred for bacteria. Combined sewer overflows due to wet weather events, along with illicit discharges were most likely responsible for the elevated *E. coli* densities that were found.

An outfall was identified (BGMB1680) approximately three-tenths of a mile upstream of RM 0.15 that may be a potential impairment to the aquatic life. The outfall was found to have an estimated 830 pounds of chloride per day entering the stream (sampled on 11/20/13).

The fish and macroinvertebrate communities in Big Creek indicated some impairment, and may be the result of these above mentioned point source discharges, as the WWH criteria for the IBI, MIwb and ICI were not met. The majority of the population of fish consisted of highly pollution-tolerant fish, such as white suckers, yellow bullheads and green sunfish. A good proportion of the macroinvertebrate community was comprised of *Oligochaeta*, a classification of organisms listed in the ICI metrics as extremely pollution tolerant. The water quality, fish and macroinvertebrate communities are expected to improve in Big Creek over time, if CSO overflows are reduced and or eliminated and illicit outfall discharge are remediated.

Table 12. 2013 Big Creek Survey Results						
River Mile	Aquatic Life Use Attainment Status	IBI Score (Narrative Rating)	MIwb Score (Narrative Rating)	ICI Score (Narrative Rating)	QHEI Score (Narrative Rating)	Water Quality Exceedences
0.15	Non-Attainment	32 (<i>Fair</i>)	5.4 (<i>Poor</i>)	24 (<i>Fair</i>)	73.50 (<i>Good</i>)	<i>E. coli</i>
WWH Biocriteria attainment IBI score of 38 ; ICI Score of 34 Non-significant departure: ≤ 4 IBI units; ≤ 0.5 MIwb units						

Acknowledgements

Field activities and/or report review completed by the following, except where otherwise noted:

Jonathan Brauer
 Donna Friedman
 Seth Hothem
 Ron Maichle
 Jill Novak
 John Rhoades
 Eric Soehnlén
 Tom Zablony, Author

WQIS Co-ops: Rachel Dannemiller, Jana Nagle, Shane Page, Ian Reider

Analytical Services Division – Completed analysis for all water chemistry sampling

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