

NORTHEAST OHIO REGIONAL SEWER DISTRICT

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



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

Introduction

In 2013, the Northeast Ohio Regional Sewer District (NEORSD) conducted water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys on Euclid Creek. Euclid Creek drains the communities of South Euclid, Lyndhurst, Willoughby Hills, Richmond Heights, Highland Heights, Euclid and Cleveland before emptying into Lake Erie. Sampling was conducted by NEORSD Level 3 Qualified Data Collectors certified by Ohio EPA in Fish Community and Benthic Macroinvertebrate Biology, Chemical Water Quality and Stream Habitat Assessments as explained in the NEORSD study plan *2013 Euclid Creek Environmental Monitoring* approved by Ohio EPA on July 10, 2013.

The study objective at river mile (RM) 0.55 and RM 1.65, on the main branch of Euclid Creek, was to evaluate the impact of NEORSD combined sewer overflow (CSO) discharges and other environmental factors on the downstream water quality, macroinvertebrate and fish communities. This was accomplished by comparing the benthic macroinvertebrate data from the upstream site, at RM 1.65, with data obtained from the downstream site, at RM 0.55. Stream monitoring at these sites also included fish community surveys, habitat assessments and water chemistry sampling. The site at RM 0.55 is required under the Ohio Environmental Protection Agency (Ohio EPA) National Pollutant Discharge Elimination System (NPDES) Permit No. 3PA00002*FD.

An additional objective at RMs 0.55 and 1.65 was to collect baseline data in support of two NEORSD capital improvement projects. The Euclid Creek Pump Station project is set to begin in 2014 and the Tunnel Dewatering Pump Station and Euclid Creek Tunnel projects began in December 2010. These construction projects are anticipated to control the number of CSO discharges to Euclid Creek.

Post-construction monitoring was also conducted at RM 0.40 where restoration work was completed in January 2013. Results from the post-monitoring determined what effect, if any, the restoration had on the chemical, biological and physical characteristics of the creek.

Additional sites within the Euclid Creek watershed were also sampled for the purpose of general watershed monitoring. Sampling was conducted at multiple sites across the watershed to identify issues that might be impacting the aquatic biota. Additionally, this study continued to monitor and establish baseline conditions for multi-year sampling stations for trend assessments.

Table 1 lists the sampling sites with respect to RM, latitude/longitude, description, and types of surveys conducted, and Figure 1 is a map of the sampling locations on the creek.

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Table 1. 2013 Euclid Creek Sampling Sites

Water Body	Latitude	Longitude	River Mile	Location Information	USGS HUC 8 Number Name	Purpose
Euclid Creek, Main Branch	41.5196	-81.5115	6.90	DS of Mayfield Road	4110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, macroinvertebrates and habitat upstream unnamed tributary
Euclid Creek, Main Branch	41.5612	-81.5315	3.30	US of confluence with the East Branch	4110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, macroinvertebrates and habitat upstream of confluence with East Branch
Euclid Creek, Main Branch	41.5658	-81.5358	2.70	US of Highland Road	4110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, macroinvertebrates and habitat upstream of CSOs
Euclid Creek, Main Branch	41.5738	-81.5470	1.65	Upstream of Saint Clair Avenue	4110003 Ashtabula-Chagrin	Evaluate water chemistry, habitat, fish & macroinvertebrates upstream of NEORSD CSOs
Euclid Creek, Main Branch	41.5828	-81.5552	1.00	Concrete Structure US of Lakeshore Blvd	4110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, macroinvertebrates and habitat in the Concrete Flood Control Structure
Euclid Creek, Main Branch	41.5833	-81.5594	0.55	Downstream of Lake Shore Boulevard	4110003 Ashtabula-Chagrin	Evaluate water chemistry, habitat, fish & macroinvertebrates in support of Ohio EPA Permit No. 3PA00002*FD
Euclid Creek, Main Branch	41.5855	-81.5604	0.40	Upstream of Villa Angela Drive bridge	4110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, macroinvertebrates and habitat post-restoration.
Unnamed Tributary to Euclid Creek, Main Branch	41.532	-81.4970	1.50	US of Richmond Road	4110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, macroinvertebrates and habitat on the unnamed tributary
Euclid Creek, East Branch	41.5743	-81.4948	2.80	DS of Richmond Road	4110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, macroinvertebrates and habitat downstream of airport
Euclid Creek, East Branch	41.5618	-81.5277	0.25	US of Highland Road	4110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, macroinvertebrates and habitat on the East Branch tributary

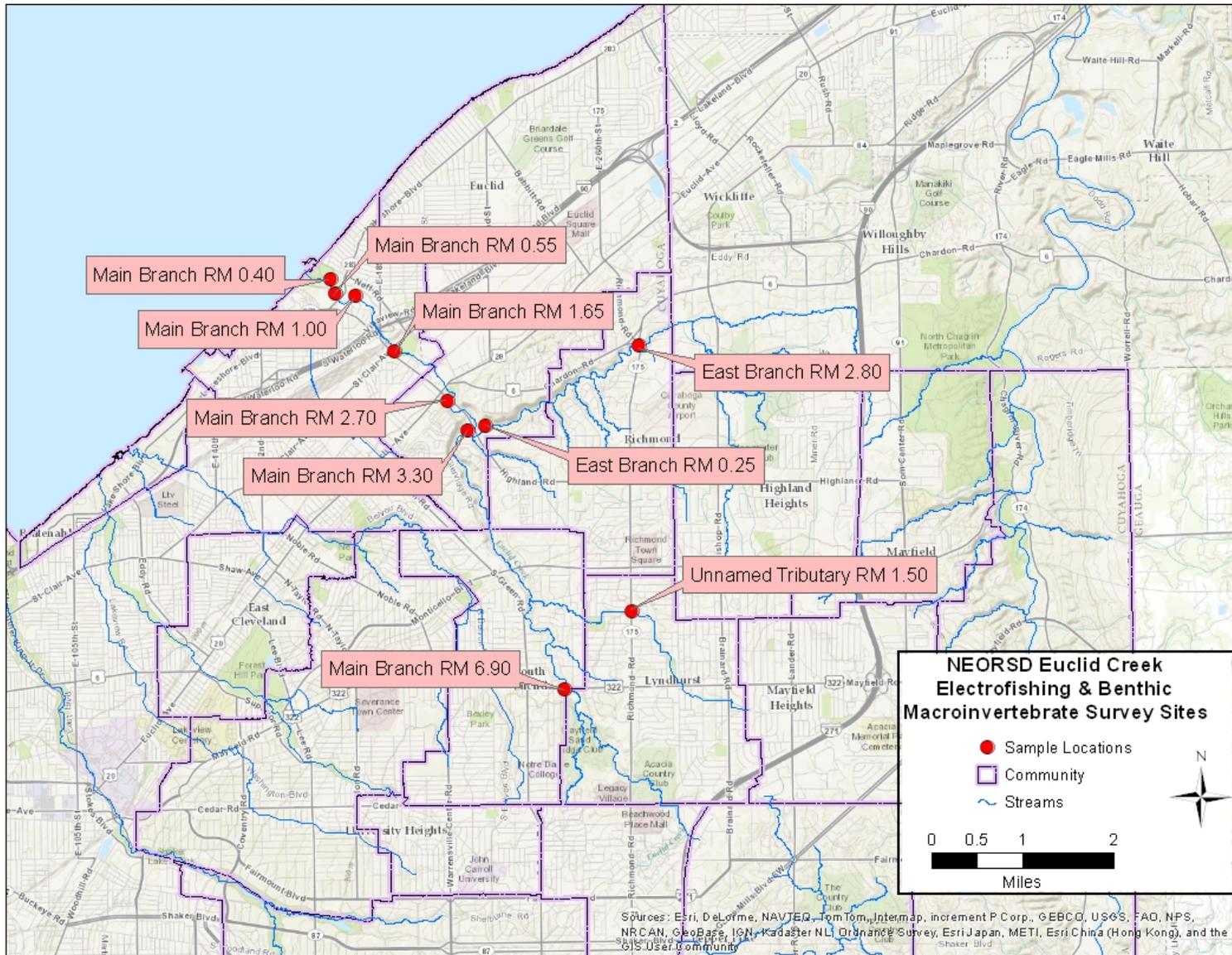


Figure 1. 2013 Sampling Locations on Euclid Creek

Water Chemistry & Bacteriological Sampling

Methods

Water chemistry and bacteriological sampling was conducted five times between June 17 and July 15. The final sampling event on July 23 was only conducted at RM 0.55 to satisfy permit requirements. Techniques used for sampling and analyses followed the Ohio EPA's *Surface Water Field Sampling Manual for water chemistry, bacteria, and flows* (2013a). Chemical water quality samples from each site were collected with a 4-liter disposable polyethylene cubitainer with a disposable polypropylene lid, three 473-mL plastic bottles and a 125-mL plastic bottle. The first 473-mL plastic bottle was field preserved with trace nitric acid, the second was field preserved with trace sulfuric acid and the third bottle received no preservative. The sample collected in the 125-mL plastic bottle (Dissolved Reactive Phosphorus) was filtered using a 0.45- μ m PVDF syringe filter. All water quality samples were collected as grab samples. Bacteriological samples were collected in sterilized plastic bottles preserved with sodium thiosulfate. 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 each 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).

Formula 1:

$$\text{RPD} = \frac{|X-Y|}{((X+Y)/2)} * 100$$

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, 2013a).

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.

Results and Discussion

Over the course of the sampling, three field blanks were collected for QA/QC purposes. A total of five water quality parameters were either rejected, estimated or downgraded due to potential field blank contamination. It is unclear how the field blanks

became contaminated and may be due to inappropriate sample collection, handling, contaminated blank water and/or interference during analysis. Table 2 lists water quality parameters that were rejected, estimated or downgraded from Level 3 to Level 2 data based on Ohio EPA data validation protocol.

Table 2. Potential Field Blank Contamination		
COD	NH ₃	Sn
Cr	DRP	

Three duplicate samples were collected on June 17 at RM 0.55, June 24 at RM 1.00 and July 1 at RM 2.80 for QA/QC purposes. The duplicate sample collected at RM 1.00 and the duplicate sample collected at RM 2.80 revealed three parameters each that were rejected due to RPDs that were greater than the acceptable RPD (Table 3). There are numerous reasons for why a large number of parameters were rejected, such as a lack of precision and consistency in sample collection and/or analytical procedures, environmental heterogeneity and/or improper handling of samples. The duplicate sample collected at RM 0.55 did not have any parameters that required qualification of the data.

Table 3. Unacceptable Duplicate RPDs					
Date	River Mile	Parameter	Acceptable RPD (%)	Actual RPD (%)	Qualifier
6/24/2013	1.00	COD	61.3	86.9	Rejected
		Fe	36.0	70.8	Rejected
		Mn	34.3	36.4	Rejected
7/1/2013	2.80 (East Branch)	Al	27.1	57.6	Rejected
		Fe	24.2	44.5	Rejected
		Mn	24.1	67.9	Rejected

Paired parameters for all samples collected were also evaluated and compared for QA/QC purposes using the same RPD formula as with the duplicate samples. These comparisons revealed five instances in which the RPDs were less than the acceptable RPD, leading to the data being estimated (Table 4).

Table 4. Unacceptable Paired Parameter RPDs					
River Mile	Date	Paired Parameters	Acceptable RPD (%)	Actual RPD (%)	Qualifier
0.25 (East Branch)	6/17/2013	TS/TDS	16.6	5	J
	7/8/2013	TS/TDS	16.9	4.3	J
0.40	6/17/2013	Total-P/DRP	59.8	52.1	J
2.70	6/24/2013	TS/TDS	15.2	2.7	J
2.80 (East Branch)	6/17/2013	TS/TDS	15.9	4.4	J

All sites on Euclid Creek are designated as Warmwater Habitat (WWH), Agricultural Water Supply, Industrial Water Supply, and Class B Primary Contact Recreation (Ohio EPA, 2009). The results of the water chemistry and bacteriological samples were compared to the applicable water quality standards to determine attainment status for those designated uses. Of that comparison, exceedances were only noted for *Escherichia coli*.

Mercury analysis for all of the sampling events was completed using EPA Method 245.1. The detection limit for this method is above the criteria for the Human Health Nondrinking and Protection of Wildlife Outside Mixing Zone Averages (OMZA), so it generally cannot be determined if the sites were in attainment of those criteria. Instead, this type of mercury sampling was used as a screening tool to determine whether contamination was present above the detection limit. Based on the sampling that was completed, mercury was not present at levels above those normally found in the watershed.

The Class B Primary Contact Recreation criteria for Euclid Creek includes an *E. coli* criterion not to exceed a single sample maximum (SSM) of 523 colony-forming units per 100 milliliters (CFU/100mL) in more than ten percent of the samples taken during any thirty-day period, and a seasonal geometric mean (SGM) criterion of 161 CFU/100mL (Ohio EPA, 2009). The SSM of 523 CFU/100mL in more than ten percent of the samples taken was exceeded at all of the sites for all 30-day periods except for at RMs 6.90 (Main Branch) and 0.25 and 2.80 on the East Branch. Additionally, all sites exceeded the SGM criterion of 161 CFU/100mL except for RMs 3.30, 2.70 and 0.25 (East Branch) (Table 5).

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Table 5. 2013 Euclid Creek <i>E. coli</i> Densities (colony forming units/100mL)										
	RM 6.90	RM 3.30	RM 2.70	RM 1.65	RM 1.00	RM 0.55	RM 0.40	RM 1.50 (Unnamed Tributary)	RM 2.80 (East Branch)	RM 0.25 (East Branch)
6/17/2013*	390	66	55	125	255	208	280	2633	350	64
6/24/2013	370	74	165	354	190	270	355	4000	EC 470	115
7/1/2013*	265	71	48	140	105	100	328	1533	293	32
7/8/2013*	EC 485	EC 785	EC 745	EC 770	EC 961	EC 765	EC 913	EC 800	EC 415	8
7/15/2013	215	72	EC 93	225	2200	440	600	3000	185	EC 82
7/23/2013*	--	--	--	--	--	1150	--	--	--	--
Seasonal Geomean	331	114	125	255	404	360	447	2078	326	43
*Wet weather event ¹										
--Sample not taken										
EC=Estimated Count										
	Exceeds simple sample maximum criterion for 30-day period starting on that date									
	Exceeds seasonal geomean criterion									

There are several possible reasons why many of these sites exceeded the SSM and SGM criteria. The NEORSD owns three CSOs on Euclid Creek and there are additional CSOs in the city of Euclid, all of which may cause elevated *E. coli* densities in the creek during wet weather overflows. Additionally, there are numerous documented improper connections and bacteriological contaminated storm sewers in the cities of Cleveland and Euclid, which could have an impact on the *E. coli* densities seen during dry weather. The issue of storm sewer bacteriological contamination within the Euclid Creek watershed was thoroughly investigated in 2012 and communicated to the appropriate community for eventual remediation. In 2013, NEORSD revisited many of the documented issues and have found that the majority were still active problems. Finally, bacteriological contamination from failing septic systems or from urban runoff in the Euclid Creek watershed may also be impacting the water quality at the sample sites.

In 2013, the Ohio EPA released a draft Trophic Index Criterion designed to determine the degree of nutrient enrichment in a stream. The Trophic Index Criterion assigns designations for quality of surface waters based on many factors including nutrients, periphyton, dissolved oxygen, and biological assemblages. This criterion was published in 2011 as a draft, and in March 2013, some aspects of the paper were published in a document called, “Trophic Index Criterion- Rationale and Scoring” (Ohio EPA, 2013b). NEORSD does not assess periphyton; however, nutrients were assessed.

¹Wet 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 6 shows the nutrient concentrations for the Euclid Creek sites in 2013. All sites scored in the “acceptable” category and are indicative of a stream with minimal nutrient enrichment. Therefore, it is expected that at the concentrations of nutrients observed in Euclid Creek, nutrients may not be having a negative effect on the biological communities at the sites.

Table 6. 2013 Euclid Creek Nutrient Concentrations		
River Mile	Average Total Phosphorus (mg/L)	Average Dissolved Inorganic Nitrogen (mg/L)
6.90	0.057	0.313
3.30	0.029	0.387
2.70	0.045	0.412
1.65	0.042	0.407
1.00	0.040	0.308
0.55	0.036	0.437
0.40	0.043	0.335
1.50 (Unnamed Tributary)	0.118	0.746
2.80 (East Branch)	0.103	0.300
0.25 (East Branch)	0.064	0.395

Habitat Assessment

Methods

Instream habitat assessments were conducted once at each site on Euclid Creek 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 in streams >20 square miles or a score of 55 or more in streams <20 square miles, 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 NEORSD WQIS Division.

A lacustrine QHEI (L-QHEI) was conducted at RM 0.40. The L-QHEI is similar to the QHEI in that it assesses aquatic habitat conditions; however, the L-QHEI is specific to lacustrine zones. Lacustrine is defined as a transition zone in a river that flows into a freshwater lake and is the portion of the river affected by the water level of the lake (Ohio EPA, 1997). Additionally, the L-QHEI is based on only five metrics: stream substrate, cover types, shoreline morphology, riparian zone and bank erosion, and aquatic vegetation quality. A more detailed description of the L-QHEI can be found in Ohio EPA’s draft *Methods of Assessing Habitat in Lake Erie Shoreline Waters Using the Qualitative Habitat Evaluation Index (QHEI) Approach (Version 2.1)*(2010). According to Ohio EPA (2008), an L-QHEI score greater than 55 is considered an acceptable target.

Results and Discussion

QHEI scores on Euclid Creek ranged from *Fair* to *Excellent* in 2013. Seven of the 10 sites met Ohio EPA’s target score of 60 (Table 7), meaning that these sites have habitat suitable to support a community of warmwater habitat fish species.

Table 7. 2013 Euclid Creek QHEI Results				
River Mile	Type	Date	QHEI Score	Narrative
6.90	Headwater	10/11/2013	70.5*	<i>Excellent</i>
3.30	Headwater	10/10/2013	62.25*	<i>Good</i>
2.70	Wading	10/10/2013	63.25*	<i>Good</i>
1.65	Wading	10/10/2013	78.5*	<i>Excellent</i>
1.00	Wading	10/3/2013	64*	<i>Good</i>
0.55	Wading	10/3/2013	57.75	<i>Fair</i>
0.40	Wading	10/3/2013	44.75**	<i>Fair</i>
1.50 (Unnamed Tributary)	Headwater	10/11/2013	62.5*	<i>Good</i>
2.80 (East Branch)	Headwater	10/11/2013	67.75*	<i>Good</i>
0.25 (East Branch)	Headwater	10/10/2013	58.5*	<i>Good</i>
* Site met Ohio EPA target score of 60 (>20 square miles) or 55 (<20 square miles)				
**LQHEI				

Euclid Creek RMs 6.90 and 1.65 on the Main Branch had the highest QHEI scores, receiving *Excellent* narrative ratings. RM 6.90 was comprised of mainly cobble and gravel. There was little to no bank erosion and a moderate to wide riparian width. The site consisted of deep riffles and runs that were moderately stable. RM 1.65 received the highest QHEI score of all the sites in 2013. There were pools greater than one meter, deep riffles and runs with “good” development. Cobble and gravel were the predominant substrate types with stable riffles and runs. There was a diverse amount of instream cover including undercut banks, shallows, rootmats, pools >70cm, rootwads, boulders and woody debris. This is the second year in a row that this site has scored *Excellent*.

RMs 0.55 received the lowest QHEI score in 2013 and thus did not meet the Ohio EPA's target score of 60. RM 0.55 was comprised of predominately sand substrate with sparse to moderate instream cover. This site exhibited moderate to heavy silt cover, low stability and no functional riffle. Over the last four years, the stream habitat narrative rating at RM 0.55 has been *Fair*.

According to Environmental Supervisor William Zawiski of the Ohio EPA Division of Surface Water, it is believed that RM 0.40 is most likely within a lacustrary zone that ends near RM 0.55, which means that it may be influenced by lake levels (Personal communication, October 27, 2010). An L-QHEI score of 44.75 (*Fair*) was calculated at RM 0.40; therefore, this site did not meet the L-QHEI target, indicating possible degraded habitat. RM 0.40 was predominantly composed of sand and silt with sparse to moderate instream cover and a low abundance of aquatic vegetation. The limited aquatic vegetation may be due to scouring of the immature vegetation from flooding during storm events in 2013 that caused erosion (Posius, 2013). In October, new vegetation was planted, which may help increase the L-QHEI score in future years; therefore continued monitoring at this site is imperative.

Electrofishing

Methods

One quantitative electrofishing pass was conducted at each site in 2013. A list of the dates when the surveys were completed, along with flow as measured at the United States Geological Survey gage station 04208700 in Cleveland, is given in Table 8. All of the sampling sites are considered either headwater (gradient <20 square miles) or wading (gradient >20 square miles). Sampling was conducted using longline and backpack electrofishing techniques and consisted of shocking all habitat types within a sampling zone while moving from downstream to upstream. The sampling zone was 0.15 kilometers for the headwater sites and 0.20 kilometers for the wading sites. 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 (for wading sites only) 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.

Table 8. 2013 Euclid Creek Electrofishing Surveys		
River Mile	Date	Stream Flow (ft ³ /s) [#]
6.90	7/12/2013	22
3.30	7/17/2013	11
2.70	7/17/2013	11
1.65	7/17/2013	11
1.00	7/16/2013	12
0.55	7/16/2013	12
0.40	7/16/2013	12
1.50 (Unnamed Tributary)	7/12/2013	22
2.80 (East Branch)	7/12/2013	22
0.25 (East Branch)	7/18/2013	10
[#] Provisional flow data obtained from USGS 04208700 Euclid Creek flow gauge in Cleveland, Ohio		

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*. RM 0.40 was evaluated using the lacustrine IBI (LIBI), due to its location near the mouth of the river. The 12 metrics utilized for headwater, wading and lacustrine sites are listed in Table 9.

Table 9. IBI Metrics		
Headwater	Wading	Lacustrary
Total Number of Native Species	Total Number of Native Species	Total Number of Native Species
Number of Darters & Sculpins	Number of Darter species	Number of Benthic Species
Number of Headwater Species	Number of Sunfish Species	Number of Sunfish Species
Number of Minnow Species	Number of Sucker Species	Number of Cyprinid Species
Number of Sensitive Species	Number of Intolerant Species	Percent of Phytophilic Individuals
Percent Tolerant Species	Percent Tolerant Species	Percent of Top Carnivores
Percent Pioneering Species	Percent Omnivores	Number of Intolerant Species
Percent Omnivores	Percent Insectivores	Percent of Omnivores
Percent Insectivores	Percent Top Carnivores	Percent of Non-indigenous Individuals
Number of Simple Lithophils	Percent Simple Lithophils	Percent of Tolerant Individuals
Percent DELT Anomalies	Percent DELT Anomalies	Percent with DELT Anomalies
Number of Fish	Number of Fish	Number of Fish

The second fish index utilized by Ohio EPA is the Modified Index of Well-being (MIwb). The MIwb, Formula 3 below, incorporates four fish community measures: numbers of individuals, biomass, and the Shannon Diversity Index (H) (Formula 4 below) based on numbers and weight of fish. The MIwb is a result of a mathematical calculation based upon the formula.

Formula 3:
$$MIwb = 0.5 \ln N + 0.5 \ln B + \bar{H}(No.) + \bar{H}(Wt.)$$

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

Formula 4:
$$\bar{H} = - \sum \left[\left(\frac{n_i}{N} \right) \log_e \left(\frac{n_i}{N} \right) \right]$$

n_i = Relative numbers or weight of species

N = Total number or weight of the sample

An MIwb score ≥ 7.9 (*Good*) is in attainment of the WWH biocriterion for wading sites in the EOLP ecoregion. An MIwb score of 7.4 (*Marginally Good*) is also in attainment, as it is considered non-significant departure (≤ 0.5 MIwb units) from the criterion. An MIwb score of ≥ 8.6 (*Marginally Good*) is in attainment of the lacustrary biocriterion for boat sites in the EOLP ecoregion.

Results and Discussion

In 2013, all of the sites were in non-attainment of the WWH biocriteria and RM 0.40 was in non-attainment of the LIBI and MIwb criteria (Table 10). The LIBI is based upon using boat electrofishing methods, but due to the nature of the stream at this site, NEORSD could only utilize longline electrofishing techniques. Additionally, due to extremely deep pools located within the electrofishing zone, a comprehensive electrofishing assessment could not be completed.

The criterion for the LIBI is ≥ 42 (*Good*) and RM 0.40 received an LIBI score of 34 (*Fair*) and an MIwb score of 5.9 (*Poor*). The highest scoring metrics at RM 0.40 were Percent of Phytophilic Individuals, Percentage of Omnivores, Percentage of Non-Indigenous Individuals and Percentage of DELT anomalies. Forty percent of the catch was comprised of phytophilic fish (fish that spawn on vegetation) which included largemouth bass (*Micropterus salmoides*) and pumpkinseed sunfish (*Lepomis gibbosus*). During NEORSD's 2010 pre-restoration monitoring, RM 0.20 (located within the restoration zone) obtained an average LIBI score of 36 (*Fair*) and MIwb score of 8.1, both failing to meet the biocriteria. Continued biological monitoring at this site is important in order to evaluate the effectiveness of the habitat improvements made.

Table 10. 2013 Euclid Creek IBI & MIwb Results			
River Mile	Type	IBI	MIwb
6.90	Headwater	22	
3.30	Headwater	30	
2.70	Wading	26	6.1
1.65	Wading	28	5.6
1.00	Wading	24	7.3
0.55	Wading	32	7.3
0.40	Wading	34*	7.1
1.50 (Unnamed Tributary)	Headwater	22	
2.80 (East Branch)	Headwater	24	
0.25 (East Branch)	Headwater	28	
IBI wading criteria ≥ 38 ; MIwb ≥ 7.9 IBI headwater criteria ≥ 40 *LIBI (criteria ≥ 42 ; MIwb ≥ 8.6)			

The lowest IBI score for a wading site was at RM 1.00, which received an IBI score of 24. The IBI metric that received the highest score (5) was for the Proportion with DELT anomalies. The majority of the remainder of the metrics received a score of one. In 1988, an approximately half-mile concrete flume was installed by the Army Corps of Engineers to help control flooding in the area. This concrete flume may be inhibiting a healthy fish population from establishing the site. Although this site had the lowest IBI score, one smallmouth bass was collected, which is a moderately intolerant species.

The lowest IBI scores for a headwater site were at RMs 6.90 and 1.50, which both obtained an IBI score of 22. At RM 6.90, only five species of fish were collected and 96.7% of the fish collected were tolerant species. The electrofishing pass at RM 1.50 consisted of only two species of fish, both of which were highly tolerant species. Both RMs 6.90 and 1.50 had the lowest drainage areas of 3.90 and 1.20 square miles, respectively, and are in highly residential areas. Fish diversity tends to decrease with river size, which may explain the reduced species diversity and failure to meet the IBI biocriterion in these smaller streams (McCabe, 2010).

In 2008, Ohio EPA monitored for fish just downstream of RM 0.25 at RM 0.20. The purpose of the sampling was to collect baseline data prior to the start of a stream restoration project in this segment of stream. The restoration project consisted of removing a dam at RM 0.15 and installing cascading pools immediately upstream of the dam to improve the biological community and water quality. In 2008, an IBI score of 28 was obtained by Ohio EPA at RM 0.20 (within the restoration zone), which was non-attainment of the WWH IBI biocriterion. Ohio EPA also conducted a post-monitoring fish assessment at RM 0.20 in 2011. During this assessment, the IBI score increased to 34; however, the fish community still failed to meet the biocriterion. In 2013, NEORSD monitoring of RM 0.25, which is within the restoration zone and slightly upstream of Ohio EPA's RM 0.20 site, acquired an IBI score of 28. As part of the restoration, rock cross vanes were installed to help control stream bed grade, keep the stream from meandering, protect the Highland bridge from scour and center the flow through the bridge opening. However, these rock cross vanes may be inhibiting establishment of a WWH fish population due to the height of the rock, which may be preventing the fish from migrating upstream. Monitoring at this site should continue to determine if the fish community may improve over time.

The remainder of the sites received narrative ratings of *Fair* to *Poor*. At RMs 3.30 and 2.80, 75% and 69% of the catch, respectively, consisted of highly tolerant fish species. Although the collection of fish at RM 0.55 similarly consisted of an increased amount of highly tolerant species (66%), two moderately intolerant species, the Northern hog sucker (*Hypentelium nigricans*) and Sand shiner (*Notropis stramineus*), and one common intolerant species, Mimic shiner (*Notropis volucellus*), were collected; however, it is likely that these species migrated upstream from the lake. Additionally, RM 0.55

had the highest number of fish species collected of all of the Euclid Creek sites. It appears that the number of fish species collected at each site declines upstream of RM 1.00. The average number of fish species collected at RMs 1.00, 0.55 and 0.40 was 18 species; the average number of fish species collected at RM 1.65 and upstream was 7 species. This may be due to the East 185th Street dam located at RM 1.50, which acts as a migration barrier preventing upstream fish passage. Other contributing factors such as CSO discharges, improper connections, and urban runoff may be negatively impacting the fish community at these sites as well.

RMs 2.70, 1.65 and 0.55 have been evaluated for fish since as early as 2007 to determine the impact that NEORSD-owned CSOs may have on downstream biological communities. In 2013, RM 0.55 scored slightly higher than the two upstream sites; however, again, this is most likely due to the East 185th Street dam that is impeding fish movement upstream. Historical IBI data on Euclid Creek at RMs 2.70, 1.65 and 0.55 show an overall increase in scores (Table 11). RMs 1.65 and 0.55 obtained IBI scores in 2013 that were the highest ever received since NEORSD began conducting sampling.

Table 11. 2010 - 2013 Euclid Creek Average IBI & MIwb Scores						
Year	RM 2.70		RM 1.65		RM 0.55	
	IBI	MIwb	IBI	MIwb	IBI	MIwb
2007	25	5.1	25	5.2	27	7.4
2008	26	6.6	23	6.2	28	7.4
2009	26	6.9	24	6.2	28	6.9
2010	25	5.7	25	5.5	26	6.6
2011	--	--	25	4.9	26	6.8
2012	--	--	27	6.2	31	7.6
2013	26	6.1	28	5.6	32	7.3
--Fishing survey not completed						
<i>Italics indicate non-significant departure of WWH biocriterion</i>						

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. Sampling was conducted at both of the locations listed in Table 1. 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 samples were sent to Third Rock Consulting of Lexington, Kentucky, for identification and enumeration. Specimens were identified to the lowest practical taxonomic level as defined by the Ohio EPA (1987b). Lists of the species collected during the quantitative and qualitative sampling at each site are available upon request from the WQIS Division.

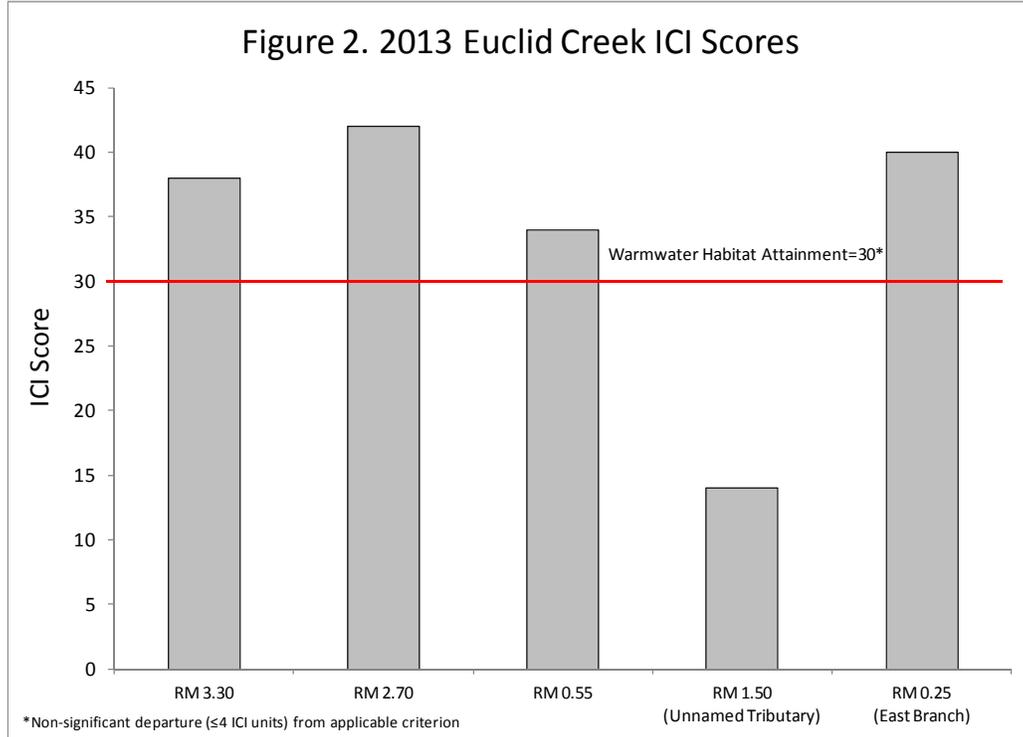
The overall aquatic macroinvertebrate community in the stream was evaluated using Ohio EPA’s Invertebrate Community Index (ICI) (OEPA 1987a) and the lacustuary ICI (LICI) for RM 0.40. The ICI and LICI consist of ten community metrics (Table 12), each with four scoring categories. Metrics 1-9 are based 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 12. ICI Metrics	
ICI	LICI
Total number of taxa	Total number of taxa
Number of mayfly taxa	Number of diptera taxa
Number of caddisfly taxa	Number of sensitive taxa
Number of dipteran taxa	Percent predominant taxon
Percent mayflies	Percent other diptera and non-insects
Percent caddisflies	Percent mayflies and caddisflies
Percent Tanytarsini midges	Percent sensitive taxa
Percent other diptera and non-insects	Percent collector-gather taxa
Percent tolerant organisms (as defined)	Dipteran abundance
Number of qualitative EPT taxa	Number of qualitative EPT taxa

Results and Discussion

In 2013, HDs were installed at all ten Euclid Creek sites. However, only six HDs were retrieved from RMs 3.30, 2.70, 0.55, 0.40, 1.50 (unnamed tributary) and 0.25 (east branch). The remaining four HDs at RMs 6.90, 1.65, 1.00 and 2.80 (east branch) are believed to have been buried or washed downstream, and therefore, only qualitative assessments were conducted. In these instances, best professional judgment in conjunction with an overall assessment of the site was used to determine the narrative rating.

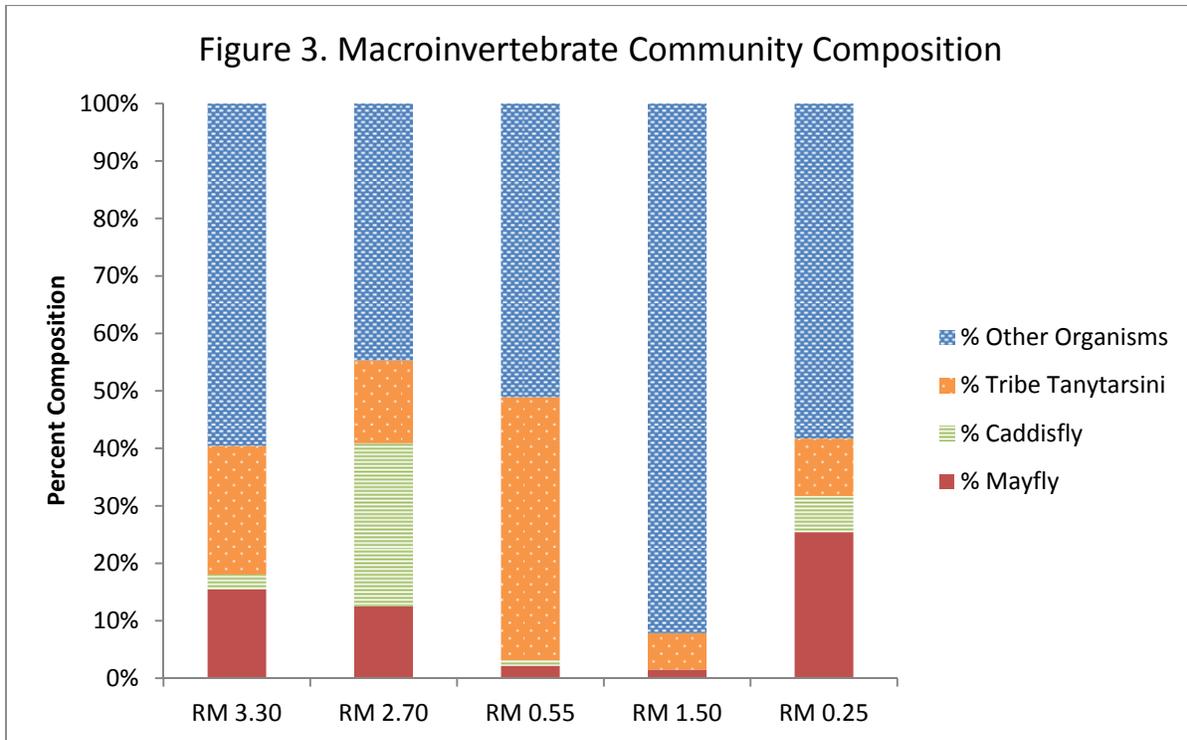
Of the retrieved HDs, RMs 3.30, 2.70, 0.55 and 0.25 (east branch) were in attainment of the WWH ICI biocriterion; however, RM 1.50 (unnamed tributary) was not (Figure 2). RM 0.40 did not meet the LICI biocriterion of 42; however, it did meet the intermediate criterion of 34.



RM 2.70 obtained the highest ICI score in 2013 with a narrative rating of *Very Good* (Table 13). Additionally, this site had the highest number of EPT taxa collected of all the Euclid Creek sites. Nearly 40% of the macroinvertebrate community was composed of mayfly and caddisfly taxa (Figure 3). Additionally, six taxa collected were considered moderately intolerant of pollution. RM 2.70 has been sampled for macroinvertebrates seven times since 2002 (Table 14). Of the seven sampling events, six events were in attainment of the WWH ICI biocriterion. This site received the same ICI score in 2010, when it was last sampled for macroinvertebrates.

Table 14. 2013 Euclid Creek Macroinvertebrate Results					
River Mile	ICI Score	Narrative Rating	Total Quantitative Taxa	Total Qualitative Taxa	Total Qualitative EPT Taxa
6.90		<i>Fair*</i>		29	5
3.30	38	<i>Good</i>	25	19	5
2.70	42	<i>Very Good</i>	34	21	8
1.65		<i>Fair*</i>		22	6
1.00		<i>Fair-Poor*</i>		22	4
0.55	34	<i>Good</i>	34	29	5
0.40	36**	<i>Fair</i>	25	18	1
1.50 (Unnamed Tributary)	14	<i>Fair</i>	16	26	2
2.80 (East Branch)		<i>Fair*</i>		21	4
0.25 (East Branch)	40	<i>Good</i>	33	19	5
Bold indicates attainment of WWH biocriterion					
*Narrative rating based on best professional judgment and habitat evaluation					
**LICI (LICI criterion ≥ 42 ; intermediate LICI criterion ≥ 34)					
HD not collected; qualitative assessment only					

RM 0.25 (east branch) obtained the second highest ICI score of 40 (*Good*) in 2013. Four metrics received the highest score (6): Number of Caddisfly Taxa, Percent Mayflies, Percent Caddisflies and Percent Tolerant Organisms. As previously mentioned, Ohio EPA monitored just downstream of RM 0.25 at RM 0.20 in 2008. The ICI score calculated by Ohio EPA was 24 and in non-attainment of the WWH ICI biocriterion. It appears that the biological monitoring should continue in order to evaluate the effectiveness of the restoration work.



The lowest ICI score in 2013 was at RM 1.50, an unnamed tributary to the main branch, which failed to meet the WWH ICI biocriterion. Over 90% of the community on the HD consisted of other dipterans and non-insects with only one mayfly taxa collected, and two EPT taxa collected during the qualitative assessment (Figure 3). All ICI metrics received a score of either a zero or two, with the exception of Percent Tolerant Organisms, which received the highest and only score of six. This site is extensively channelized within a residential area which may be having a negative effect on the macroinvertebrate community.

At RM 0.40, the LICI score was calculated at 36 (*Fair*), and failed to meet attainment of the LICI biocriterion. However, the site did meet the intermediate criterion goal of 34. Although the intermediate criterion goal represents a decreased quality macroinvertebrate community, it is considered an attainable goal for Lake Erie lacustraries given current altered habitat conditions in the absence of excessive sedimentation and water column enrichment or toxicity (Ohio EPA, 1997). Therefore, although RM 0.40 met the intermediate criterion, the macroinvertebrate community is representative of a site that is below achievable expectations.

The HD at RM 0.40 was comprised of 33 taxa and a low percentage of collector-gatherer taxa, which are taxa that tend to increase with increasing stream degradation. However, over 80% of the HD consisted of other dipterans and non-insects, which is a negative scoring metric. In 2010, only a qualitative assessment was performed at RM 0.20, which consisted of 30 taxa and zero EPT taxa. The site received a narrative rating

of “*Poor*.” Although the site may have slightly improved since 2010, further post-monitoring may show improved scores over time.

The remainder of the Euclid Creek sites had a range of ICI scores or narrative ratings (for those sites that were only qualitatively sampled). RMs 3.30 and 0.55, which were in attainment of the WWH ICI biocriterion in 2013, had a low percentage of tolerant organisms and each site had five EPT taxa collected during the qualitative assessment. For RMs 1.00, 1.65, 6.90 and 2.80, which only had qualitative assessments performed, the narrative ratings ranged from *Fair* to *Poor* (Table 14).

RMs 2.70, 1.65 and 0.55 have been evaluated for macroinvertebrates since as early as 2002 to help determine the impact that NEORSD-owned CSOs may have on downstream biological communities. In 2013, all three sites were in attainment for the WWH ICI biocriterion; therefore, NEORSD-owned CSOs may not be having a negative impact on the health of the macroinvertebrate community in 2013. Historical data at RMs 0.55, 1.65 and 2.70 shows an overall increase in ICI scores since sampling began (Table 14). This is the first year that RM 0.55 was in attainment of the WWH ICI biocriterion since sampling began in 2002. Attainment at this site may be attributed to the habitat improvements that occurred downstream at RM 0.40 (Posius, 2013). Improvements at RM 0.40 may have allowed for better flow conditions at RM 0.55, unlike pre-restoration conditions, in which flow over the HD was highly variable.

Table 14. 2002– 2013 Euclid Creek ICI Scores			
	RM 2.70	RM 1.65	RM 0.55
2002	33	--	25
2003	--	--	26
2004	31	--	14
2005	--	--	16
2006	--	--	24
2007	36	26	22
2008	28	26	12
2009	36	38	24
2010	42	42	18
2011	--	36	24
2012	--	36	24
2013	42		34
Bold indicates attainment of WWH biocriterion			
--Macroinvertebrates not evaluated			
	HD not collected; qualitative assessment only		

Conclusions

The results of NEORSD's water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys indicate that the Euclid Creek watershed may be impacted by a variety of aquatic habitat limitations and environmental stressors, as mentioned above. Water chemistry results at nearly all of the sites showed water quality exceedances for bacteria (Table 15). Potential sources of pollution include illicit discharges, CSO discharges and urban runoff.

Biological assessments that were conducted at all of the sites showed partial or non attainment of WWH biological criteria. Although no definitive pattern was evident, it appears that site-specific habitat characteristics are the major limiting factor affecting the biological communities at all of the locations. Additionally, the East 185th Street dam, which is located upstream of RM 1.00, is inhibiting fish migration to the upper reaches of the watershed.

One of the objectives of this study was to determine the impact of NEORSD-owned CSOs on the downstream biological community at RM 0.55. Macroinvertebrate assessments at RM 0.55 showed that the benthic community was meeting the WWH ICI biocriterion, the first time in nearly 12 years of sampling. Although this site lacked a functional riffle, the flow has improved greatly possibly due to the completion of a restoration project located downstream at RM 0.40. Similarly, RMs 1.65 and 2.70, both of which are located upstream of NEORSD-owned CSOs, were also in attainment of the WWH ICI biocriterion. Fish assessments at all three sites failed to meet the WWH IBI biocriteria.

A restoration project that was recently completed at RM 0.40 and was anticipated to increase the overall health of lower Euclid Creek failed to meet the LIBI and LICI biocriteria. With severe habitat limitations, such as heavy to moderate silt and a low abundance of aquatic vegetation, it is recommended that further assessments at RM 0.40 continue in order to monitor attainment status as the site has time to stabilize.

Restoration on the East Branch at RM 0.25 was completed in 2011, which consisted of a dam removal and installation of step-pools. This site was in partial attainment, meeting the WWH ICI biocriterion, but not the WWH IBI biocriterion. Additionally, RM 0.25 was the only site to not have an *E. coli* water quality exceedance. The establishment of a healthy WWH fish community at this site may be difficult due to the rock cross vanes that could be inhibiting upstream migration. Continued fish assessments are pertinent in order to monitor the fish population.

Overall, the water quality status of the Euclid Creek watershed is fair. Many of the sites may be negatively impacted by sources of pollution associated with bacteriological contamination from CSO discharges, improper connections, failing septic systems, and urban runoff. Moreover, documented storm sewer bacteriological

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contamination in Cleveland and Euclid remain an issue. Until these problems are remediated, bacteriological contamination remains an important concern by NEORSD for Euclid Creek.

Future monitoring of Euclid Creek will be vital as current and proposed NEORSD capital improvement projects are anticipated to control the number of CSO discharges to Euclid Creek. The Tunnel Dewatering Pump Station and Euclid Creek Tunnel projects began in December 2010 and the Euclid Creek Pump Station project is scheduled to begin in 2014 with an anticipated 2015 completion for these projects. Further sampling post-construction will help determine the effectiveness of the projects and any improvements on the water quality, habitat and biological communities in Euclid Creek.

Table 15. 2013 Euclid 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 Exceedances
6.90	NON	22 <i>Poor</i>		-- <i>Fair*</i>	70.5 <i>Excellent</i>	<i>E. coli</i>
3.30	PARTIAL	30 <i>Fair</i>		38 <i>Good</i>	62.25 <i>Good</i>	<i>E. coli</i>
2.70	PARTIAL	26 <i>Poor</i>	6.1 <i>Fair</i>	42 <i>Very Good</i>	63.25 <i>Good</i>	<i>E. coli</i>
1.65	NON	28 <i>Fair</i>	5.6 <i>Poor</i>	-- <i>Fair</i>	78.5 <i>Excellent</i>	<i>E. coli</i>
1.00	NON	24 <i>Poor</i>	7.3 <i>Fair</i>	-- <i>Fair-Poor</i>	64 <i>Good</i>	<i>E. coli</i>
0.55	PARTIAL	32 <i>Fair</i>	7.3 <i>Fair</i>	34 <i>Good</i>	57.75 <i>Fair</i>	<i>E. coli</i>
0.40	PARTIAL	34** <i>Fair</i>	5.9 <i>Poor</i>	36** <i>Fair</i>	44.75** <i>Fair</i>	<i>E. coli</i>
1.50 (Unnamed Tributary)	NON	22 <i>Poor</i>		14 <i>Fair</i>	62.5 <i>Good</i>	<i>E. coli</i>
2.80 (East Branch)	NON	24 <i>Poor</i>		-- <i>Fair*</i>	67.75 <i>Good</i>	<i>E. coli</i>
0.25 (East Branch)	PARTIAL	28 <i>Fair</i>		40 <i>Good</i>	58.5 <i>Good</i>	None
WWH biocriterion attainment: IBI score of 38; MIwb score of 7.9; ICI score of 34						
Non-significant departure: ≤4 IBI units; ≤0.5 MIwb units; ≤4 ICI units						
--HD not collected; qualitative assessment only						
*Narrative rating based on best professional judgment and habitat evaluation						
**Lacustrary scoring						

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