NORTHEAST OHIO REGIONAL SEWER DISTRICT

2015 Euclid Creek Environmental Monitoring
Biological, Water Quality and Habitat Survey Results

Prepared by
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Introduction

In 2015, 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 the Ohio Environmental Protection Agency (Ohio EPA) in Fish Community and Benthic Macroinvertebrate Biology, Chemical Water Quality and Stream Habitat Assessments as explained in the NEORSD study plan *2015 Euclid Creek Environmental Monitoring* approved by Ohio EPA on June 17, 2015.

The study objective at river miles (RM) 0.55 and RM 1.65, on the main branch of Euclid Creek, was to assess the attainment status of the stream segments. Stream monitoring at these sites included: fish community surveys, macroinvertebrate community surveys, habitat assessments, and water chemistry sampling. The sites at RM 0.55 and 1.65 are also required under the Ohio EPA National Pollutant Discharge Elimination System (NPDES) Permit No. 3PA00002*GD.

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 began in late 2014 and the Tunnel Dewatering Pump Station and Euclid Creek Tunnel projects began in December 2010. Once complete, these construction projects are anticipated to control the number of CSO discharges to Euclid Creek to less than or equal to one overflow in a typical year.

Post-construction monitoring was also conducted at RM 0.40 where restoration work was completed in January 2013. The purpose of the project was to restore coastal and lacustrine wetlands, increase fish habitat and increase overall ecological function in the lower Euclid Creek. Results from the spring fish community survey will determine what effect, if any, the restoration had on the fish species spawning in the restored areas.

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.

Table 1. 2015 Euclid Creek Sampling Sites

Water Body	Latitude	Longitude	River Mile	Location Information	USGS HUC 8 Number Name	Purpose
Euclid Creek, Main Branch	41.5741	-81.5467	1.65	Upstream of Saint Clair Avenue	04110003 Ashtabula-Chagrin	Evaluate water chemistry, habitat, fish & macroinvertebrates in support of Ohio EPA Permit No. 3PA00002*GD
Euclid Creek, Main Branch	41.5833	-81.5594	0.55	Downstream of Lake Shore Boulevard	04110003 Ashtabula-Chagrin	Evaluate water chemistry, habitat, fish & macroinvertebrates in support of Ohio EPA Permit No. 3PA00002*GD
Euclid Creek, Main Branch	41.5857	-81.5622	0.40	Upstream of Villa Angela Drive bridge	04110003 Ashtabula-Chagrin	Evaluate spring fish population post-restoration.

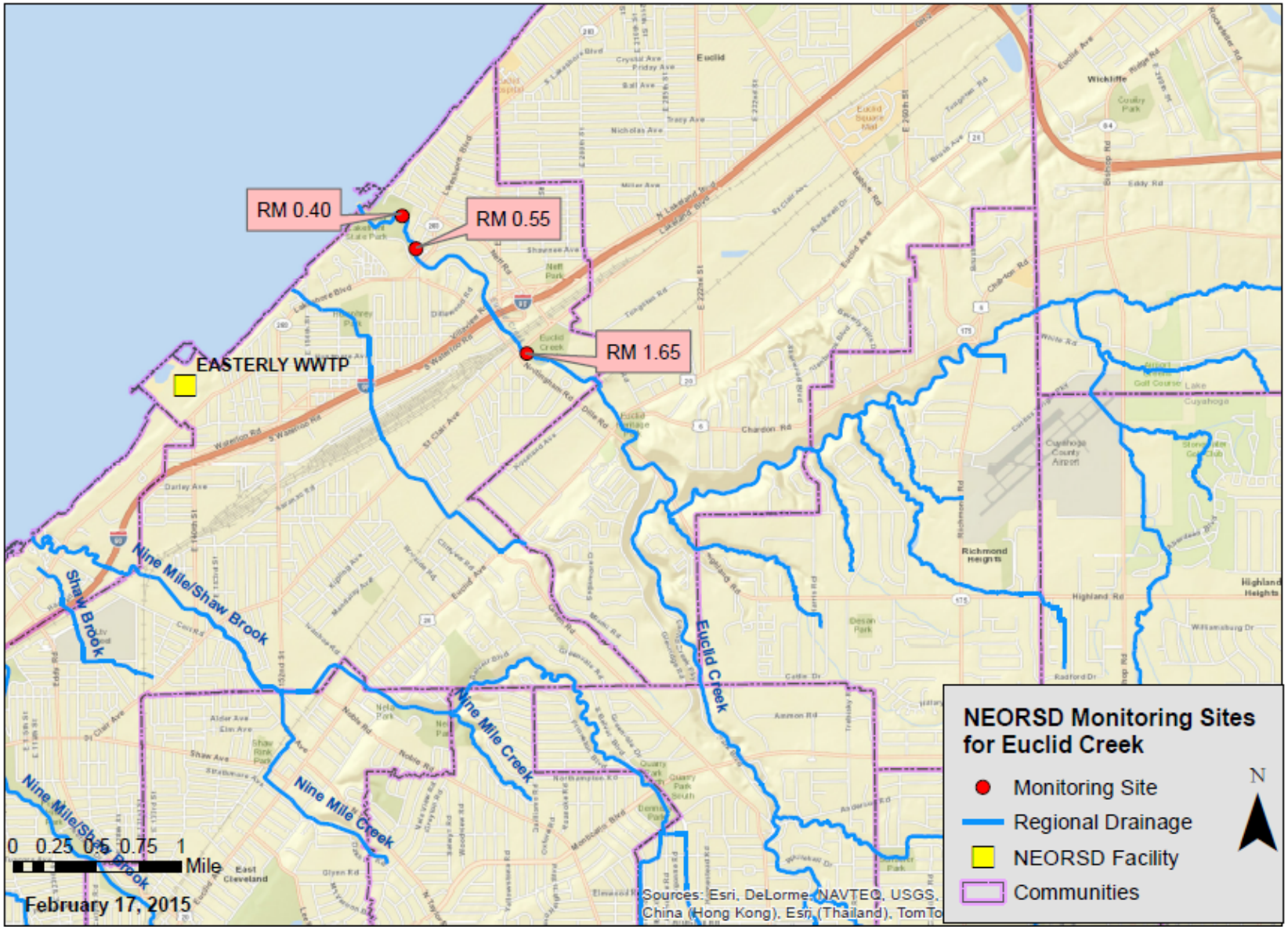


Figure 1. 2015 Sampling Locations on Euclid Creek

Water Chemistry & Bacteriological Sampling

Methods

Water chemistry and bacteriological sampling was conducted five times between June 16 and July 14, 2015. 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 one 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-µm 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 either a YSI 600XL sonde or YSI EXO1 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:

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

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, 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, two field blanks were collected for QA/QC purposes. A total of six water quality parameters were 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

Cr	DRP	NH3
Sn	Ti	Zn

One duplicate sample was collected on July 7, 2015 at RM 0.55 for QA/QC purposes. The duplicate sample collected at RM 0.55 revealed two parameters that were rejected due to RPDs that were greater than the acceptable RPD (Table 3). There are numerous reasons for why 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.

Table 3. Unacceptable Duplicate RPDs

Date	River Mile	Parameter	Acceptable RPD (%)	Actual RPD (%)	Qualifier
7/7/2015	0.55	NH3	29.1	39.1	Rejected
		Zn	35.0	131.4	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 four instances in which the subset parameter was greater than the total parameter, but the RPDs still met the acceptable RPD. In these instances, the data is listed as being estimated (Table 4).

Table 4. Unacceptable Paired Parameter RPDs

River Mile	Date	Paired Parameters	Acceptable RPD (%)	Actual RPD (%)	Qualifier
0.55	7/7/15	NO3+NO2/NO3	32.0	5.1	J
0.55	7/14/15	NO3+NO2/NO3	26.3	1.7	J
1.65	7/7/15	NO3+NO2/NO3	29.4	3.8	J
1.65	7/14/15	NO3+NO2/NO3	25.2	1.1	J

All sites on Euclid Creek are designated as Warmwater Habitat (WWH), Agricultural Water Supply, Industrial Water Supply, and Primary Contact Recreation (Ohio EPA, 2016). 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 noted for *Escherichia coli* (*E. coli*) and copper.

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 (USEPA, 2004).

The Primary Contact Recreation criteria for Euclid Creek includes an *E. coli* criterion not to exceed a statistical threshold value (STV) of 410 colony counts per 100 milliliters in more than ten percent of the samples taken during any ninety-day period, and a ninety-day geometric mean criterion of 126 colony counts/100mL (Ohio EPA, 2016). The STV of 410 colony counts/100mL in more than ten percent of the samples taken was exceeded at both RM 0.55 and RM 1.65 for all 90-day periods. Additionally, all sites exceeded the ninety-day geometric mean criterion of 126 colony counts/100mL for all 90-day periods (Table 5).

Table 5. 2015 Euclid Creek *E. coli* Densities (most probable number/100mL)

	RM 0.55		RM 1.65	
Sample Date	*E. coli* (MPN/100 mL)	90-Day Geomean	*E. coli* (MPN/100 mL)	90-Day Geomean
6/16/15*	7116	2447.6	7174	2052.4
6/23/15*	31600	1874.4	22800	1501.0
6/30/15	902	731.0	577	606.1
7/7/15	534	658.1	683	621.2
7/14/15*	811	811.0	565	656.0
*Wet weather event[1]				
	Exceeds statistical threshold value criterion for 90-day period starting on that date			
	Exceeds 90-day geometric mean criterion			

[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.

There are several possible reasons why these sites exceeded the STV and ninety-day geometric mean criteria. The NEORSD has three CSOs on Euclid Creek and there are additional CSOs upstream in the city of Euclid, all of which may cause elevated *E. coli* densities in the creek during wet-weather overflows. Three sampling days were considered wet-weather events, with June 23 exhibiting *E. coli* densities higher than any other day at all of the sites. Approximately 0.77 inches of rain fell the day before the June 23 sampling with additional rainfall of 1.03 inches shortly before sampling occurred on June 23. Wet-weather events may contribute to elevated bacteria levels by causing discharges from CSOs, storm sewer runoff, and urban runoff into Euclid Creek.

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 water quality in Euclid Creek during dry weather conditions. The issue of storm sewer bacteriological contamination within the Euclid Creek watershed has been thoroughly investigated since 2012 and communicated to the appropriate community for eventual remediation. In 2013, 2014, and 2015, NEORSD revisited many of the documented issues and have found that the majority were still active problems. Finally, bacteriological contamination from failing septic systems in the Euclid Creek watershed may also be impacting the water quality at the sample sites.

On June 23, copper exceeded the Aquatic Life Outside Mixing Zone Maximum (OMZM) and the Tier I OMZM at RM 0.55. As previously mentioned, June 23 was considered a significant wet-weather event, which may have caused substantial runoff from the surrounding urban area as well as potential CSO discharges. This runoff may have potentially introduced pollutants and/or chemicals into the creek.

In 2015, the Ohio EPA Nutrients Technical Advisory Group released a proposed Stream Nutrient Assessment Procedure (SNAP) designed to determine the degree of impairment in a stream due to nutrient enrichment. SNAP assigns designations for quality of surface waters based on factors including DO swings, benthic chlorophyll *a*, total phosphorous, and dissolved inorganic nitrogen (Ohio EPA, 2015). NEORSD did not assess DO swings, or benthic chlorophyll in 2015; however, nutrients were assessed.

Table 6 shows the nutrient concentrations for the Euclid Creek sites in 2015. The results of dissolved inorganic nitrogen and total phosphorous were compared to Table 2 of SNAP. According to this section of SNAP, both sites on Euclid Creek exhibit "levels typical of modestly enriched condition in nitrogen limited systems; low risk to beneficial use if allied responses are within normal ranges," (SNAP, 2015). This indicates that neither phosphorous or nitrogen are of a significant concern as a primary source of impairment at these two sites.

Table 6. 2015 Euclid Creek Nutrient Trophic Index Scores

River Mile	Average Total Phosphorus (mg/L)	Average Dissolved Inorganic Nitrogen (mg/L)
1.65	0.104	0.421
0.55	0.096	0.405

Habitat Assessment

Methods

Instream habitat assessments were conducted once at each site on Euclid Creek in 2015 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, 2005). 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.

Results and Discussion

QHEI scores on Euclid Creek ranged from *Good* to *Excellent* in 2015. Both of the sites met Ohio EPA's target score of 60, meaning that these sites have habitat suitable to support a community of warmwater habitat fish species (Table 7).

Table 7. 2015 Euclid Creek QHEI Results

River Mile	Type	Date	QHEI Score	Narrative
1.65	Wading	7/6/15	79.5*	*Excellent*
0.55	Wading	7/6/15	62.0*	*Good*
* Site met Ohio EPA target score of 60 (>20 square miles) or 55 (<20 square miles)				

Euclid Creek RM 1.65 had the highest QHEI score in 2015, receiving *Excellent* narrative rating. There were pools greater than 70 centimeters, deep riffles and runs with moderate to high stability. Cobble and sand were the predominant substrate types with stable riffles and runs. There was a moderate amount of instream cover including undercut banks, shallows, rootwads, boulders and woody debris. The QHEI score at this site increased by 5.5 from 2014, which may be attributed to a greater amount of instream cover and more stability in 2015.

RM 0.55 also exceeded the Ohio EPA's target score of 60 for streams >20 square miles. RM 0.55 was comprised of predominately sand substrate with moderate instream cover including undercut banks, shallows, logs or woody debris, rootwads, and boulders. This site exhibited low to moderate stability with no functional riffles. The QHEI score at this site increased by 2.25 from 2014 and received the same narrative rating in 2014.

Electrofishing

Methods

Two quantitative electrofishing passes were conducted at each wading site and one qualitative electrofishing pass was conducted at the lacustuary site in 2015. 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, except RM 0.40, are considered wading (gradient >20 square miles). Sampling was conducted using longline and boat 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 for the wading sites. Euclid Creek RM 0.40 was sampled using boat electrofishing techniques and consisted of shocking all habitat types within a sampling zone (0.5 kilometers) while moving from upstream to downstream. 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. 2015 Euclid Creek Electrofishing Surveys

Site	Date	Stream Flow (ft^3/s)[#]
1.65	7/6/15	34
	8/21/15	7.2
0.55	7/6/15	34
	8/21/15	7.2
0.40	5/4/15	7.6

[#] Approved 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*. The 12 metrics utilized for wading sites are listed in Table 9.

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 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: $$MIwb = 0.5\ lnN + 0.5\ lnB + \overline{H}(No.) + \overline{H}(Wt.)$$

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

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

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

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

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 lacustuary biocriterion for boat sites in the EOLP ecoregion.

Results and Discussion

RM 0.55 met the MIwb biocriterion for the second pass, but received an average MIwb score of 6.9 (*Fair*) and an average IBI score of 32 (*Fair*); which is in non-attainment of the WWH biocriterion. Collections from the second pass consisted of one species of fish that is moderately intolerant to pollution: sand shiner (*Notropis stramineus*). This pass also consisted of one species of fish that is commonly intolerant to pollution: mimic shiner (*Notropis volucellus*). More than 30% of the catch from this second pass consisted of these two species, which may account for the MIwb score meeting the biocriterion on August 21, 2015. The IBI Metrics that received the highest scores (5) for both passes was the Number of Native Species and Proportion of DELT anomalies. Both passes also consisted of a high number of moderately tolerant and highly tolerant fish which may account for the decrease in average IBI score by 4 from 2014 (Table 10).

Table 10. 2015 Euclid Creek IBI & MIwb Results

Site	Type		
		IBI	MIwb
RM 1.65	Wading	24	4.7
		26	6.1
RM 0.55	Wading	32	5.9
		32	**7.9**
IBI wading criteria ≥38; MIwb ≥7.9 **Bold** = meets biocriterion			

RM 1.65 was in non-attainment of the WWH biocriterion and received an average IBI score of 25 and an average MIwb score of 5.4. The IBI metrics that received the highest scores (5) were for the Proportion of Omnivores and Proportion with DELT anomalies for both passes. The majority of the remainder of the metrics received the lowest score (1), with a majority of the fish collected being highly tolerant to pollution such as common white sucker (*Catostomus commersonii),* western blacknose dace *(Rhinicthys atratulus),* and creek chub *(Semotilus atromaculatus).* The low score at this site may be due to the East 185th Street dam located at RM 1.50, which acts as a migration barrier preventing upstream fish passage. Therefore, attainment of the fish biocriterion at this site may never be achievable unless the dam is removed. Other contributing factors such as CSO discharges, improper connections, and urban runoff may be negatively impacting the fish community at this site as well.

On May 4, 2015, a qualitative electrofishing survey was conducted in the restoration area at RM 0.40. The water temperature in the creek, as measured at the YSI data sonde installed at Lakeshore Avenue (USGS 04208700) was 58.8°F; the temperature in Lake Erie was 41°F. This survey resulted in the collection of 18 different species. Most of the species collected were similar to those that were found in 2014. Additional species that were collected in 2015 included yellow bullhead (*Ictalurus natalis),*

quillback carpsucker (*Carpiodes cyprinus*), black bullhead (*Ictalurus melas)* and rainbow (steelhead) trout (*Oncorhynchus mykiss)*. These fish were found in small quantities and may not necessarily represent new species inhabiting the wetland area. Overall, the 2015 results were similar to those from 2014, and no significant changes in habitat were noticed between the two years. Potentially, changes in the fish community may occur as more aquatic vegetation becomes established in the wetland. Continued biological monitoring at this site is important in order to evaluate the effectiveness of the habitat improvements made.

RMs 1.65 and 0.55 have been evaluated for fish since as early as 2007 in order to determine the impact that NEORSD-owned CSOs may have on downstream biological communities. In 2015, RM 0.55 scored higher than the upstream site; 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 RM 1.65 shows consistent scoring, again possibly attributable to the dam that may be preventing a diverse and healthy fish community at these sites (Table 11). RM 0.55 has shown an overall increase in scoring, with 2014 being the highest ever IBI score for the site since NEORSD began conducting sampling.

Table 11. 2007 - 2015 Euclid Creek Average IBI & MIwb Scores

	RM 1.65		RM 0.55	
Year	IBI	MIwb	IBI	MIwb
2007	25	5.2	27	7.4
2008	23	6.2	28	7.4
2009	24	6.2	28	6.9
2010	25	5.5	26	6.6
2011	25	4.9	26	6.8
2012	27	6.2	31	**7.6**
2013	28	5.6	32	7.3
2014	24	4.9	**36**	7.0
2015	25	5.4	32	6.9

Bold indicates nonsignificant departure of WWH biocriterion

In 2015, both RMs 0.55 and 1.65 were in non-attainment of the WWH biocriteria for IBI and MIwb. However, Euclid Creek RM 0.55 met the WWH MIwb biocriterion for the second pass.

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 RMs 0.55 and 1.65 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). The ICI consists 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

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
Percent tolerant organisms (as defined)
Number of qualitative EPT taxa

Results and Discussion

In 2015, HDs were installed at Euclid Creek RM 0.55 and 1.65 and both were retrieved along with a qualitative sampling at both sites. RM 1.65 was in attainment of the WWH ICI biocriterion; however, RM 0.55 was not (Table 13).

RM 1.65 obtained the highest ICI score (36) in 2015 with a narrative rating of *Good.* The highest scoring metrics were Number of Caddisfly Taxa, Percent Caddisflies, and Percent Tolerant Organisms. Additionally, five taxa collected were considered moderately intolerant of pollution. RM 1.65 has been sampled for macroinvertebrates since 2002 (Table 14). Of the samples, five years were in attainment of the WWH ICI

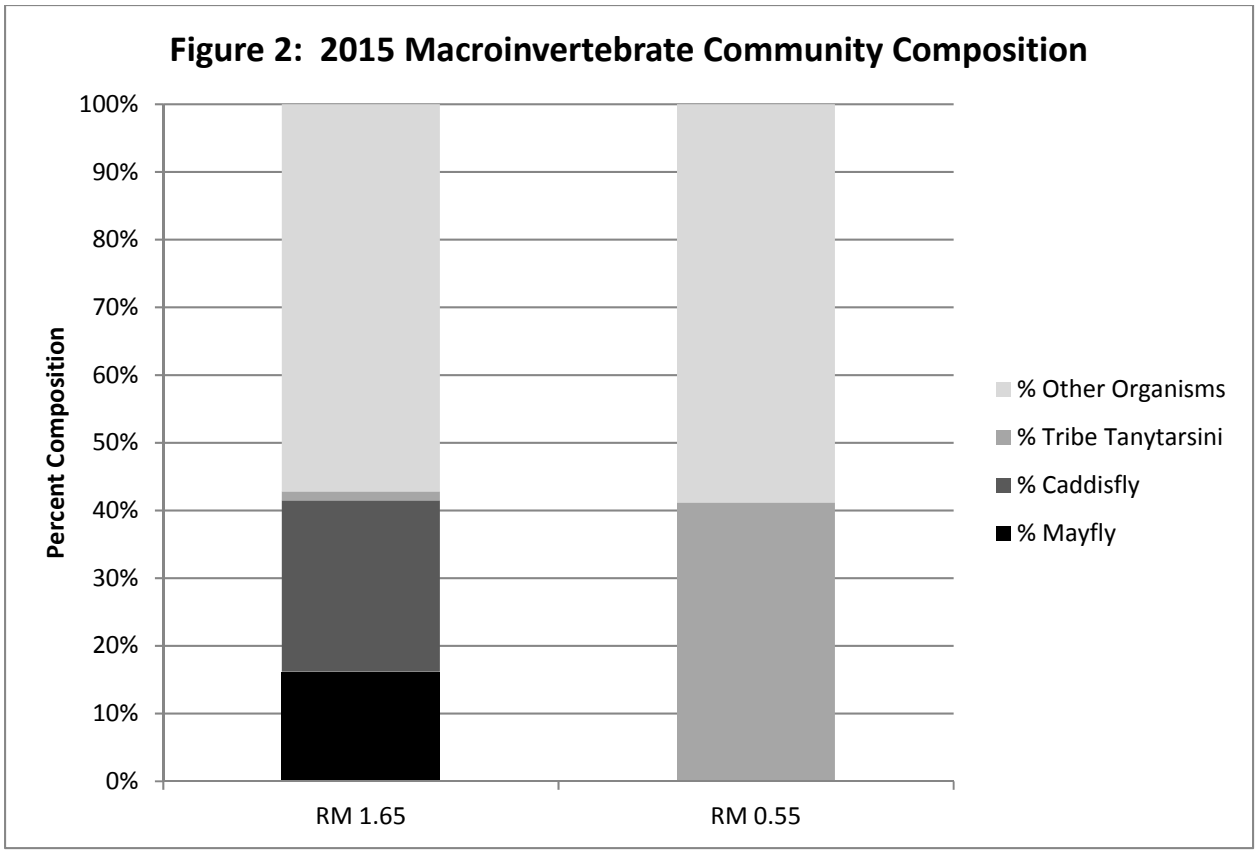
biocriterion. This site received an ICI score of 30 in 2014. The reason the score increased in 2015 is due to the increase in the Percent Tolerant Organisms, Percent Mayflies, and Percent Other Diptera and Non-Insects metrics (Figure 2).

RM 0.55 received an ICI score of 18 in 2015 with a narrative rating of *Fair*. The highest scoring metric was Percent Tanytarsini Midges. Additionally, one taxa collected was considered moderately intolerant to pollution. RM 0.55 has been sampled for macroinvertebrates since 2002 (Table 14). Of these samples, two years were in attainment of the WWH ICI biocriterion. This site received a score of 34 in 2013 and 2014. The reason for the significant score decrease in 2015 is due to a decrease in Total Number of Taxa, Number of Caddisfly Taxa, Number of Dipteran Taxa, Percent Mayflies, Percent Caddisflies, and Percent Tolerant Organisms, and Number of Qualitative EPT Taxa metric scores.

Table 13. 2015 Euclid Creek Macroinvertebrate Results

River Mile	ICI Score	Narrative Rating	Total Quantitative Taxa	Total Qualitative Taxa	Total Qualitative EPT Taxa
RM 1.65	**36**	*Good*	29	29	7
RM 0.55	18	*Fair*	18	27	4

Bold indicates attainment of WWH biocriterion



RMs 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 2015, RM 1.65 was in attainment and RM 0.55 was not in attainment of the WWH ICI biocriterion; therefore, NEORSD-owned CSOs may have had a negative impact on the health of the macroinvertebrate community in 2015. However, other factors may have also had an influence on the score. Historical data at RMs 0.55 and 1.65 shows an overall increase in ICI scores since sampling began (Table 14). At RM 0.55 in 2015, the HD was in shallower water during the sampling, which may account for some of the difference in scores from 2014 to 2015. During the qualitative sampling at RM 0.55, 27 total taxa were found in 2015. In 2014, 30 taxa were found. The small difference in qualitative sampling numbers may indicate that the decrease in ICI score from 2014 to 2015 may be due to a disturbance to the installed HD. The site is located within a recreational park and has the potential to be disturbed by visitors. Additionally, there are known illicit connections that discharge to Euclid Creek near RM 0.55. Sampling of RM 0.55 and 1.65 will be conducted again in 2016. This will help determine if the low ICI score at RM 0.55 in 2015 is a trend. Furthermore, RM 0.55 is considered to have Lacustuary influences. These influences may have an impact on the macroinvertebrate populations contributing to non-attainment of the WWH ICI biocriterion.

Table 14. 2002– 2015 Euclid Creek ICI Scores

Year	RM 1.65	RM 0.55
2002	--	25
2003	--	26
2004	--	14
2005	--	16
2006	--	24
2007	26	22
2008	26	12
2009	**38**	24
2010	**42**	18
2011	**36**	24
2012	**36**	24
2013		**34**
2014	*30*	**34**
2015	**36**	18

Bold indicates attainment of WWH biocriterion

Italics indicates non-significant departure 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. Biological assessments that were conducted at both sites showed non-attainment of the WWH biological criteria. The East 185th Street dam, located downstream of RM 1.65, is inhibiting fish migration to the upper reaches of the watershed. This may account for RM 1.65 being in attainment for the macroinvertebrate community assessment, but being in non-attainment for the fish community assessments. There is sufficient habitat present at both sites to support a robust fish community. Water chemistry results at both sites exhibit exceedances for *E. coli*, an indicator of sewage contamination (Table 5). Potential sources of pollution include illicit discharges, CSO discharges and urban runoff. This contamination may be responsible for the non-attainment of RM 0.55 and may also be negatively impacting RM 1.65.

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 not meeting the WWH ICI biocriterion, but has only met the criteria twice in 14 years of sampling. RM 1.65, which is located upstream of NEORSD-owned CSOs, was in attainment of the WWH ICI

biocriterion. Additionally, a restoration project was recently completed at RM 0.40 and was anticipated to increase the overall health of lower Euclid Creek. It is recommended that further fish assessments at RM 0.40 continue in order to monitor attainment status as the site has time to further stabilize.

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 contamination in Cleveland and Euclid remains 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 began in the fall of 2014 with an anticipated 2016 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. 2015 Euclid Creek Survey Results

River Mile	Aquatic Life Use Attainment Status	Average IBI Score (*Narrative Rating*)	Average MIwb Score (*Narrative Rating*)	ICI Score (*Narrative Rating*)	QHEI Score (*Narrative Rating*)	Water Quality Exceedances
1.65	NON	25 *Poor*	5.4 *Poor*	36 *Good*	79.5 *Excellent*	*E. coli*
0.55	NON	32 *Fair*	6.9 *Fair*	18 *Fair*	62.0 *Good*	*E. coli*
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						

Acknowledgments

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

Kelsey Amidon, Author
Donna Friedman

Seth Hothem
Ron Maichle
Mark Matteson
Denise Phillips
John Rhoades
Eric Soehnlen
Tom Zablotny

WQIS Co-ops: Bryanna Boggan, Kyle Connelly, Julia Klepach, and Joseph Schiel.

Analytical Services Division – Completed analysis for all water chemistry sampling

References

DeShon, J. E. (1995). Development and Application of the Invertebrate Community Index (ICI). In W. Davis and T. Simon (Ed.), *Biological assessment and criteria, tools for water resource planning and decision making* (pp. 217-243). Boca Raton, FL: Lewis Publishers.

McCabe, D.J. (2010). Rivers and Streams: Life in Flowing Water. *Nature Education Knowledge* 1(12):4.

Ohio Environmental Protection Agency. (1987a). *Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters.* Columbus, OH: Division of Water Quality Monitoring and Assessment. (Updated January 1988; September 1989; November 2006; August 2008).

Ohio Environmental Protection Agency. (1987b). *Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities.* Columbus, OH: Division of Water Quality Monitoring and Assessment. (Updated September 1989; March 2001; November 2006; and August 2008).

Ohio Environmental Protection Agency. (1997). Draft. *Biological Criteria for the Protection of Aquatic Life: Volume IV: Fish and Macroinvertebrate Indices for Ohio's Lake Erie Nearshore Waters, Harbors, and Lacustuaries*. Columbus, OH: Division of Surface Water, Ecological Assessment Unit.

Ohio Environmental Protection Agency. (2005). *Total Maximum Daily Loads for the Euclid Creek Watershed*. Columbus, OH: Ohio EPA, Division of Surface Water.

Ohio Environmental Protection Agency. (2006). *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)* (Ohio EPA Technical Bulletin EAS/2006-06-1). Columbus, OH: Division of Surface Water; Division of Ecological Assessment Section.

Ohio Environmental Protection Agency. (2008). *Delisting Targets for Ohio Areas of Concern*. Columbus, OH: Division of Surface Water, Lake Erie Program Staff.

Ohio Environmental Protection Agency. (2016). *State of Ohio Water Quality Standards Ohio Administrative Code Chapter 3745-1* (Revision: Adopted October 2, 2015; Effective January 4, 2016). Columbus, OH: Division of Surface Water, Standards and Technical Support Section.

Ohio Environmental Protection Agency. (2010). Draft. *Methods of Assessing Habitat in Lake Erie Shoreline Waters Using the Qualitative Habitat Evaluation Index (QHEI) Approach (Version 2.1)*. Columbus, OH: Division of Surface Water.

Ohio Environmental Protection Agency. (2012). *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practice.* Columbus, OH: Division of Surface Water; Division of Environmental Services.

Ohio Environmental Protection Agency. (2013a). *Surface Water Field Sampling Manual for water chemistry, bacteria, and flows.* Columbus, OH: Division of Surface Water.

Ohio Environmental Protection Agency. (2013b). *Trophic Index Criterion—Rational and Scoring.* Columbus, OH: Division of Surface Water, Division of Environmental Services.

Ohio Environmental Protection Agency. (2015a). *Proposed Stream Nutrient Assessment Procedure*. Columbus, OH: Division of Surface Water, Ohio EPA Nutrients Technical Advisory Group.

Posius, C. (2013). Wildwood Stream and Wetland Restoration Project / Lacustrine Refuge in the Cuyahoga AOC Project. Retrieved from http://www.cuyahogaswcd.org/EuclidCreekFiles/EC_LacustrineRefuge.htm (accessed on January 29, 2014).

Trautman, M. B. (1981). *The Fishes of Ohio*. Columbus, Ohio: The Ohio State University Press.

United States Environmental Protection Agency (2004). Mercury Pollutant Minimization Program Guidance. Region 5, NPDES Programs Branch. Retrieved from http://www.epa.gov/r5water/npdestek/ pdfs/2004mercury_pmp_guidance.pdf.