NORTHEAST OHIO REGIONAL SEWER DISTRICT

2018 Euclid Creek Environmental Monitoring
Biological, Water Quality and Habitat Survey Results

Prepared by
Water Quality and Industrial Surveillance Division

Introduction

In 2018, 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 *2018 Euclid Creek Environmental Monitoring* approved by Ohio EPA on April 3, 2018.

One of the study objectives at river miles (RM) 0.40, 0.55 and 1.65, on the main branch of Euclid Creek, was to assess the attainment status of the stream segments. 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*HD. The site at RM 0.40 was evaluated post restoration for water chemistry, fish, macroinvertebrates, and habitat.

An additional objective at RMs 0.40, 0.55 and 1.65 was to collect pre- and post-construction data of three NEORSD Project Clean Lake capital improvement projects that will reduce the current amount of over 60 combined sewer overflow (CSO) discharges per year to less than 2 per year entering Euclid Creek. The Euclid Creek Pump Station Project, the Euclid Creek Tunnel, and the Easterly Tunnel Dewatering Pump Station went online July 13, 2018.

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. 2018 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*HD
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*HD
Euclid Creek, Main Branch	41.5857	-81.5622	0.40	Upstream of Villa Angela Drive bridge	04110003 Ashtabula-Chagrin	Evaluate water chemistry, fish, macroinvertebrates, and habitat post-restoration.

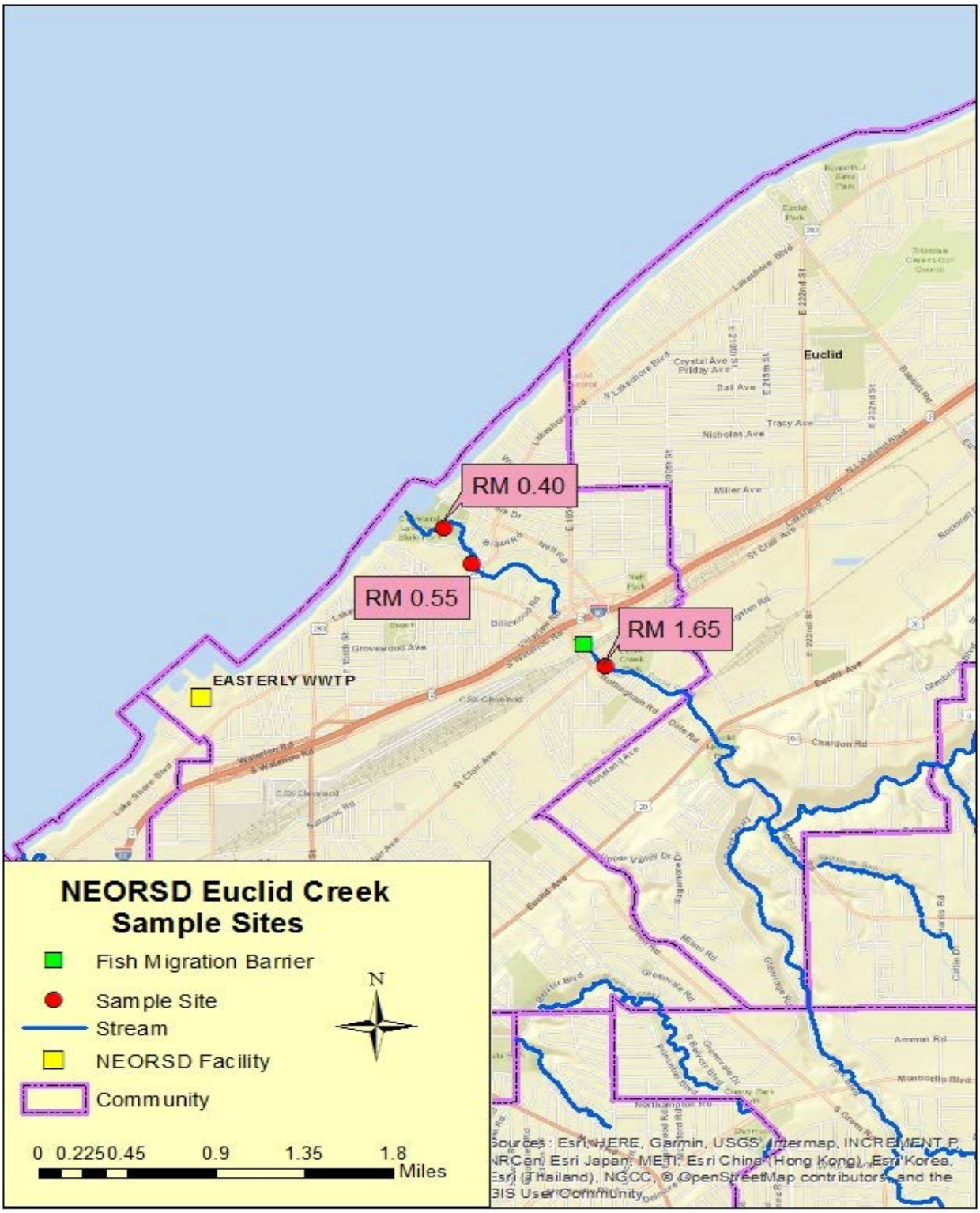


Figure 1. 2018 Sampling Locations on Euclid Creek

Water Chemistry & Bacteriological Sampling

Methods

Water chemistry and bacteriological sampling was conducted five times between June 19 and July 17, 2018. Techniques used for sampling and analyses followed the Ohio EPA *Surface Water Field Sampling Manual for water quality parameters and flows* (2018b). 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, 2018b).

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, one field blank was collected for QA/QC purposes on June 26, 2018, at RM 0.40. One of the water quality parameters was rejected due to potential field blank contamination. It is unclear how the field blanks became contaminated and may be due to inappropriate sample collection, handling, and/or

contaminated blank water. Table 2 lists the water quality parameters that were rejected based on Ohio EPA data validation protocol.

Table 2. Potential Field Blank Contamination
COD (Chemical Oxygen Demand)
Zn (zinc)

One duplicate sample was collected on June 19, 2018, at RM 1.65 for QA/QC purposes. The duplicate sample collected at RM 1.65 revealed one parameter that was rejected due to an RPD that was greater than the acceptable RPD (Table 3). There are numerous reasons for why parameters needed to be rejected, such as the collector mishandling the sample, environmental heterogeneity, inconsistent sampling methods and/or analytical errors.

Table 3. Unacceptable Duplicate RPDs					
River Mile	Date	Parameter	Acceptable RPD (%)	Actual RPD (%)	Qualifier
1.65	6/19/2018	Ti (Titanium)	53.3	56.9	Rejected

Paired parameters for all samples collected were also evaluated and compared for QA/QC purposes using the same RPD formula. Based on this evaluation, there were no paired parameters that needed to be qualified.

Euclid Creek is designated as Primary Contact Recreation. The criteria for this are based on a statistical threshold value (STV); the *E. coli* cannot be over 410 colony counts per 100 milliliters in more than ten percent of the samples take over a 90-day period and a 90-day geometric mean, the *E. coli* cannot be greater than 126 colony counts per 100 mL. For the 2018 data, Table 4 show the *E. coli* results and exceedances of the STV and 90-day geomean. In 2018, both criteria were exceeded at all the sites. For most of the samples collected, the *E. coli* densities were elevated. High *E. coli* densities can be the result of illicit discharges, storm sewer runoff, combined sewer overflow, and wild/domesticated animals such as birds, squirrels, cats and dogs. There should be some improvement with the *E. coli* densities decreasing over the next few years due to the completion of the Euclid Creek Underground storage project, which will keep a large amount of untreated water from entering Lake Erie.

Table 4. 2018 Cuyahoga River *E. coli* Densities (most-probable number/100mL)			
Date	RM 0.40	RM 0.55	RM 1.65
6/19/2018*	19,180	21,520	8,110
6/26/2018	803	624	332
7/02/2018	1,215	588	575
7/10/2018	820	589	359
7/17/2018	7,940	3,380	5,500
90-day Geomean	2,613	1,735	1,250

Exceeds statistical threshold value

Exceeds geometric mean criterion for 90-day period

*Wet-Weather Event: 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.

Mercury analysis for 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).

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 dissolved oxygen (DO) swings, benthic chlorophyll *a*, total phosphorous, and dissolved inorganic nitrogen (Ohio EPA, 2015a). NEORSD did not assess DO swings or benthic chlorophyll *a* in 2018; however, nutrients were assessed.

Nutrients were assessed for the Euclid Creek watershed monitoring sites. Table 5 shows the results for dissolved inorganic nitrogen, total phosphorus, and dissolved reactive phosphorus. The concentrations of total phosphorus and dissolved inorganic nitrogen were computed using Table 2 of the SNAP Analysis. RM 0.40, 0.55, and 1.65 have relatively low levels of total phosphorus and dissolved inorganic nitrogen, which is typical of developed lands and poses little or no risk to beneficial uses (Ohio EPA, 2015a). This suggest that neither phosphorus or nitrogen are of major concern at these sites. These results are a positive aspect for Euclid Creek because too much nitrogen and phosphorus in water can lead to harmful algae blooms in Lake Erie. It is important to prevent algal blooms because they can deplete the oxygen in water and release toxins, which could be a problem for humans and aquatic life.

	Table 5. Nutrient Results for Euclid Creek used for SNAP Analysis			
River Mile	Sample Date	Total Phosphorus (mg/L)	DRP (mg/L)	Dissolved Inorganic Nitrogen (mg/L)
0.40	6/19/2018	0.087	0.039	0.636
	6/26/2018	0.037	0.022	0.322
	7/2/2018	0.081	0.023	0.139
	7/10/2018	0.038	0.022	0.314
	7/17/2018	0.072	0.031	0.542
	GeoMean	0.059	0.027	0.344
0.55	6/19/2018	0.079	0.044	0.587
	6/26/2018	0.04	0.028	0.294
	7/2/2018	0.032	0.018	0.263
	7/10/2018	0.037	0.025	0.270
	7/17/2018	0.067	0.032	0.500
	GeoMean	0.048	0.028	0.361
1.65	6/19/2018	0.0695	0.04	0.632
	6/26/2018	0.04	0.03	0.431
	7/2/2018	0.044	0.026	0.400
	7/10/2018	0.038	0.028	0.458
	7/17/2018	0.068	0.036	0.476
	GeoMean	0.050	0.032	0.473

Land Cover Analysis

In 2018, a land cover analysis was performed of the Euclid Creek Watershed, which shows the drainage into each of the three sites. Figure 2 and 3 show the different types of land coverage and their percentages; this area is highly urbanized. There is a small percentage of grassland, pasture and forest in the watershed. Since these sites have a lot of pavement, concrete, houses, and various businesses in the area, this will impact the water quality. Impervious surfaces increase storm water runoff. Storm water runoff contains a variety of pollutants that may make their way into Euclid Creek watershed such as, fecal matter from animals, fertilizer residue, salts, and other impurities. NEORSD has been working on ways to improve impurities from entering the Euclid Creek and Lake Erie. The Euclid Creek tunnel project went online in 2018 and will prevent a large amount of untreated combined sewage from entering Lake Erie during wet weather events. This was accomplished by constructing a storage tunnel that will hold the wet-weather flow until it is ready to be treated at NEORSD's Easterly Wastewater Treatment Plant.

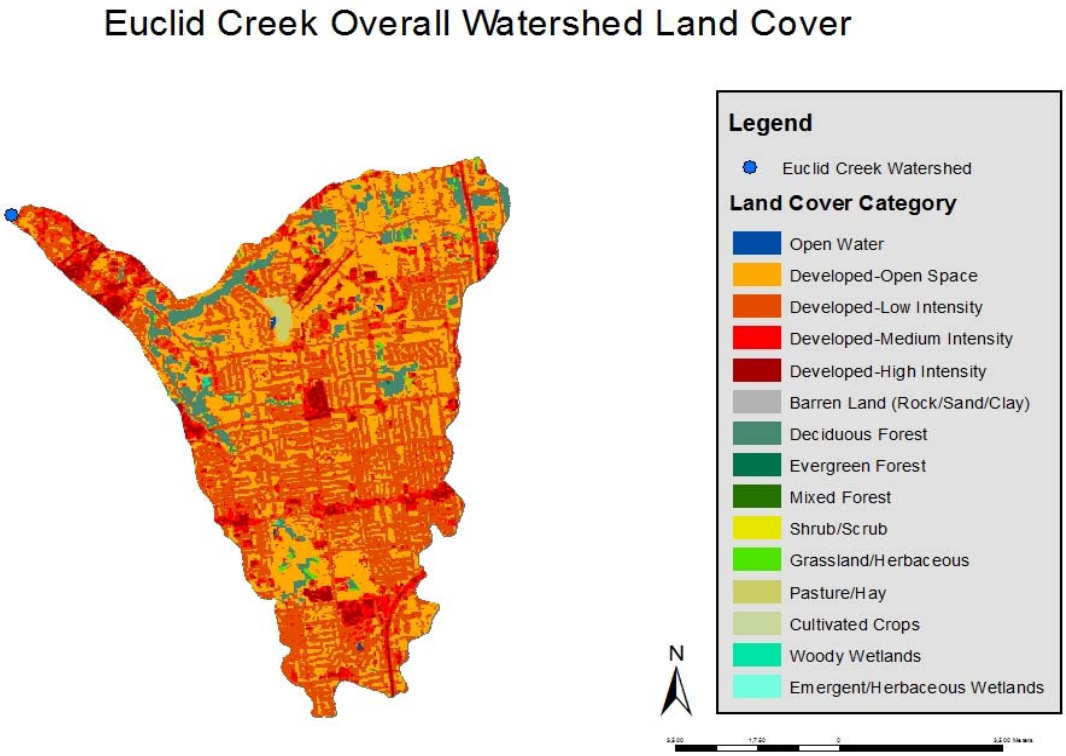
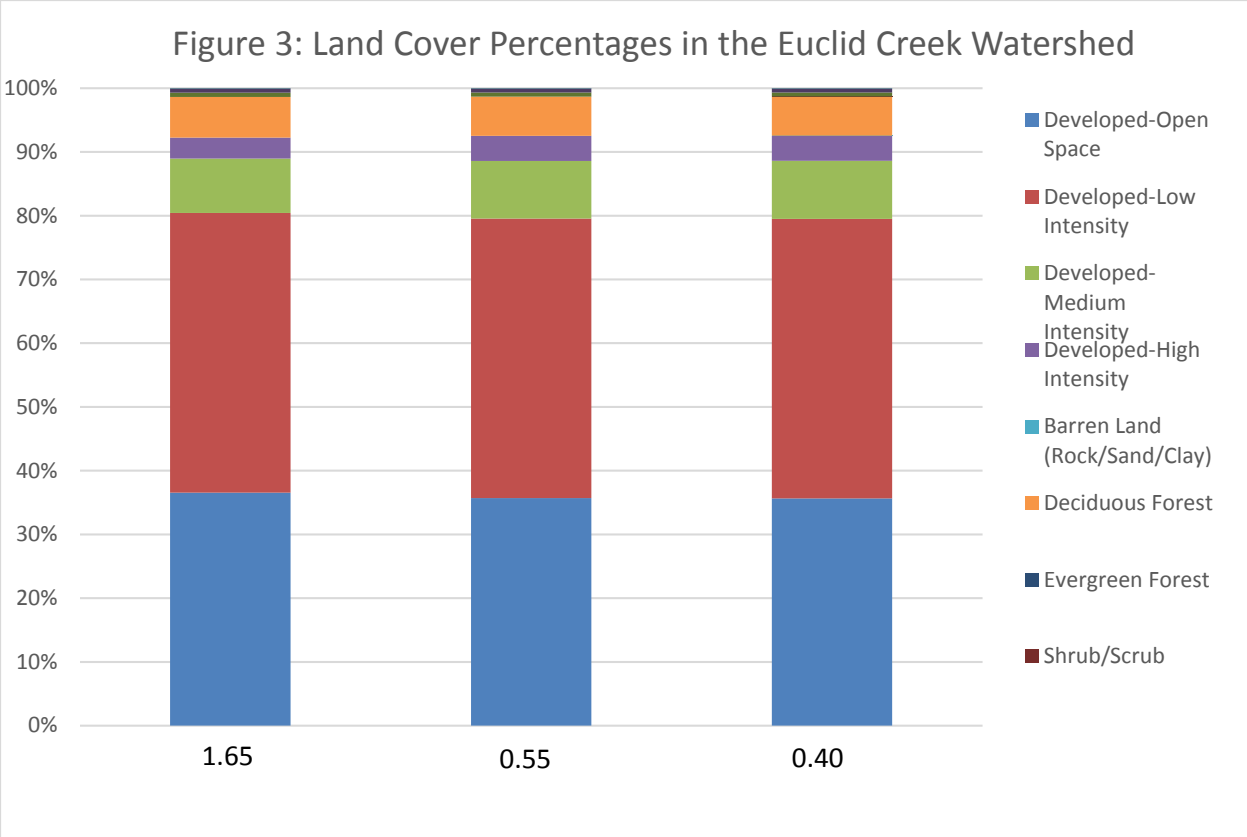


Figure 2: Euclid Creek Watershed Land Cover Map



Habitat Assessment

Methods

Instream habitat assessments were conducted once at each site on Euclid Creek in 2018 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 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.

A lacustuary QHEI (LQHEI) was conducted at RMs 0.40 and 0.55. The LQHEI is similar to the QHEI in that it assesses aquatic habitat conditions; however, the LQHEI is specific to lacustuary zones. Lacustuary 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 LQHEI is based on only five metrics: stream substrate, cover types, shoreline morphology, riparian bank erosion, and aquatic vegetation quality. A more detailed description of the LQHEI 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 LQHEI score greater than 55 is considered an acceptable target.

Results and Discussion

The Ohio EPA's target score for the QHEI is 60, which means that the body of water's habitat should be able to support a community of warmwater fish species. In Table 6, it shows the QHEI results for each site. RM 1.65 and 0.40 met the targeted score, this means that these sites are suitable to support a community of fresh water fish. RM 0.55 was below the target. In addition, RM 0.55 and 0.40 did not met the Ohio EPA Lacustuary QHEI targeted score of 55; RM 0.55 scored 45.75 and RM 0.40 scored 54.5.

RM 1.65 had the highest QHEI score with an *Excellent* narrative rating. The past four years, this site has received an excellent QHEI score. This site is in a residential, park, and urban area. The predominant types of substrate at this site were cobble and bedrock. There were 6 best types of substrate present in the pool and 5 in the riffle. The riffle was greater than 10 centimeters and the run depth was less than 50 centimeters. The channel morphology's highly stable sinuosity was low, but with good development. There was little to moderate bank erosion. The pool was over 1 meter with a velocity for the entire reach ranging from very fast to slow. There was sparse to moderate instream cover such as shallows, root wads, boulders, woody debris at this site.

RM 0.55 had the lowest QHEI score and received a habitat narrative rating of *Fair*. This site's QHEI score has been declining over the past 3 years, with each year receiving a lower score than the year before. This site is in a residential and park area. In the past, this site had a functional riffle that is now functioning as a shallow habitat. RM 0.55 scored low in the pool, riffle, glide and run quality section. Although there were no riffles, this stream has two good pools that were greater than 1 meter and had slow velocity. There was also backflow that comes from Lake Erie, which may have been negatively impacting the site. The predominant substrate at this site was gravel and sand. There were 3 other best substrates in the pool. Other types of substrate were muck and silt. This stream had sparse instream cover such as undercut banks, overhanging vegetation, root wads, boulders and logs. There was little erosion at this site.

RM 0.40 had exceeded the QHEI target score and received a *Good* habitat narrative rating. This site is in a residential and park area. The predominant substrate was gravel and sand; 3 other best types of substrate were present. There were other substrates such as muck and silt also present. The instream cover was moderate consisting of undercut banks, overhanging vegetation, pools, root wads, boulders and woody debris. The channel morphology at this site was stable with moderate sinuosity,

but it had poor development. There was little bank erosion and no riffle present. The pool was greater than 1 meter, with slow to moderate velocity.

Table 6. 2018 Qualitative Habitat Evaluation Index Scores and Physical Attributes

			WWH Attributes											MWH Attributes: High Influence						MWH Attributes: Moderate Influence										
River Mile	**QHEI Score**	**Habitat Rating**	No Channelization or Recovered	Boulder/Cobbler/Gravel Substrates	Silt Free Substrates	Good/Excellent Development	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max. Depth > 40 cm	Low-Normal Riffle Embeddedness	**Total WWH Attributes**	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max. Depth < 40 cm (WD, HW sites)	**Total High Influence Attributes**	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrate Origin (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	No Riffle	**Total Moderate Influence Attributes**
1.65	78.25	*Excellent*	X	X		X		X	X	X	X	X	**8**				X		**1**		X				X						**2**
0.55	56.25	*Fair*	X	X		X					X		**4**				X		**1**		X			X	X			X	X		**5**
0.40	64.00	*Good*	X	X			X	X		X	X		**6**						**0**	X				X				X			**3**

Electrofishing

Methods

Two quantitative electrofishing passes were conducted at each site in 2018. 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 7. Sampling at RMs 1.65 and 0.55 was conducted using longline 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 site at 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 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 7. 2018 Euclid Creek Electrofishing Surveys		
Site	Date	Stream Discharge (ft^3/s)[#]
1.65	6/21/2018	8.2
	10/9/2018	20
0.55	6/21/2018	8.2
	10/10/2018	20
0.40	6/15/2018	5.8
	8/20/2018	18

[#] 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*. RM 0.40 was also evaluated using the lacustuary IBI (LIBI), due to its location near the mouth of the creek. The 12 metrics utilized for wading, boat and lacustuary sites are listed in Table 8.

Table 8. IBI Metrics		
Wading	Boat	Lacustuary
Total Number of Native Species	Total Number of Indigenous Fish Species	Total Number of Native Species
Number of Darter species	Percent Round-bodied Suckers	Number of Benthic Species
Number of Sunfish Species	Number of Sunfish Species	Number of Sunfish Species
Number of Sucker Species	Number of Sucker Species	Number of Cyprinid Species
Number of Intolerant Species	Number of Intolerant Species	Percent of Phytophilic Individuals
Percent Tolerant Species	Percent Tolerant Species	Percent of Top Carnivores
Percent Omnivores	Percent Omnivore Species	Number of Intolerant Species
Percent Insectivores	Percent Insectivore Species	Percent of Omnivores
Percent Top Carnivores	Percent of Top Carnivore Species	Percent of Non-indigenous Individuals
Percent Simple Lithophils	Number of Individuals in a Sample	Percent of Tolerant Individuals
Percent DELT Anomalies	Percent Simple Lithophils	Percent with DELT Anomalies

Table 8. IBI Metrics		
Wading	Boat	Lacustuary
Number of Fish	Percent of Individuals with DELTs	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. The IBI criterion for wading is 38 or greater. The non-significant departure for the IBI is ≤ 4 units from the criterion.

Results and Discussion

In 2018, RM, 1.65 was in non-attainment of the WWH biocriteria; there were two passes of electrofishing conducted and both passes received an average IBI score of 24 (*Poor*). The site received an average MIwb score of 4.9 (*Poor*). This site lacks in a diverse population of fish, as only 6 different types of species were found during the survey. Highly tolerant to pollution fish were collected in both passes such as, common white sucker (*Catostomus commersonii*), blacknose dace (*Rhinicthys atratulus*), creek chub (*Semotilus atromaculatus*), and bluntnose minnow (*Pimephales notatus*. Other highly tolerant to pollution fish that were found on separate passes were the northern fathead minnow (*pimephales promelas*) and yellow bullhead (*Ictalurus natalis*). Finding fish that are highly tolerant to pollution does not show that the creek is in a healthy state. There were not any notable differences between the two passes. All the fish were native

to the area, which is a good sign. Some of the high metric scores were from proportion of omnivores (5), proportion of simple lithophils (5), and proportion with deformities, erosions, lesions, tumors, and multiple anomalies on one fish (DELTS) (5). The rest of the metrics received a score of 1 through 3 and therefore this site received a low score. Downstream of this site, NEORSD is working with the U.S. Army Corp of Engineers and other local stakeholders to potentially modify a dam located near East 185th Street; a date has not been set to when this project will begin. This change may impact the creek by allowing more fish to swim upstream to RM 1.65 and therefore, potentially improve the diversity of the fish community.

Table 9. 2017 Euclid Creek IBI & MIwb Results

Site	Type	Date	IBI	MIwb
RM 1.65	Wading	6/21/2018	24	4.3
		10/9/2018	24	5.5
RM 0.55	Wading	6/21/2018	30	7.1
		10/10/2018	28	5.8
RM 0.40	Boat	6/15/2018	26	**8.7**
		8/20/2018	28	8.4
RM 0.40	Lacustuary	6/15/2018	27	**8.7**
		8/20/2018	26	8.4

IBI criteria wading ≥38, boat ≥40 ; MIwb criteria wading ≥7.9, boat ≥8.7

Bold = meets biocriterion

Italics=Non-significant departure [IBI wading ≥34, boat ≥36; MIwb wading ≥7.4, boat ≥8.2]

*=Lacustuary Proposed Interim Criteria IBI ≥42; MIwb ≥8.6

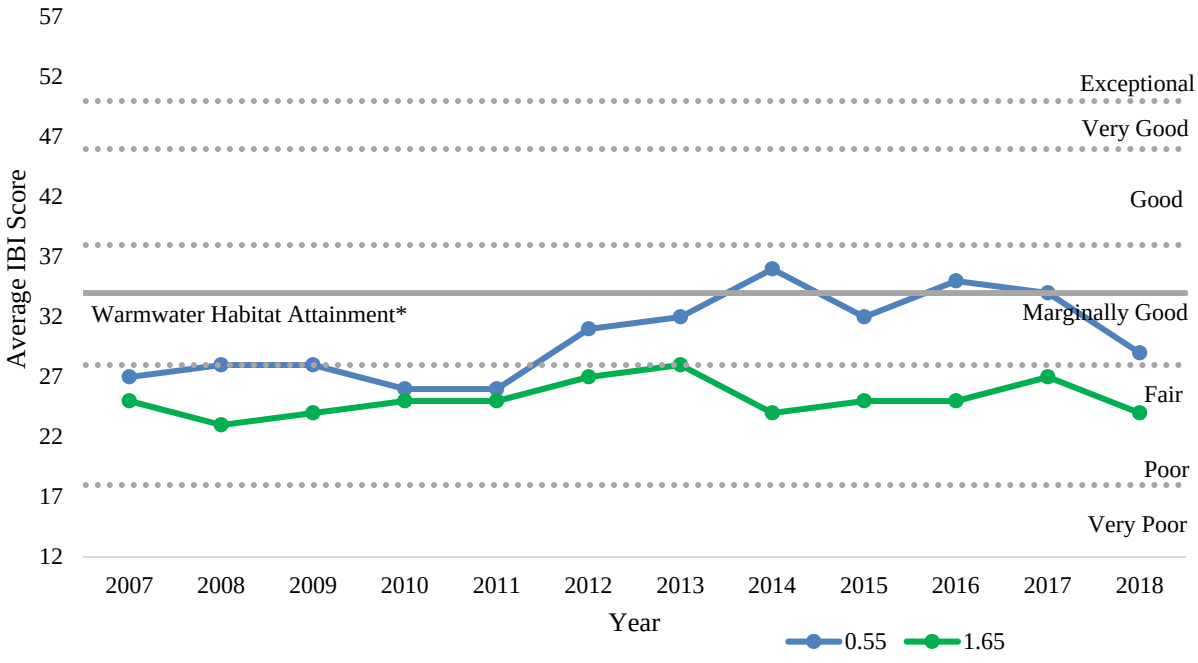
Two electrofishing surveys were performed at RM 0.55 in 2018. This site was in non-attainment of the WWH biocriteria for both passes, receiving an average IBI score of 29; with a narrative rating of *Fair* for both passes. The site received a MIwb score of 6.5 (*Fair*). The fish at this site were common intolerant, moderately intolerant to highly intolerant species. Some of the moderately intolerant species were golden redhorse (*Moxostoma erythrurum*), sand shiner (*Notropis stramineus*), and northern logperch darter (*Percina caprodes*). The high metric scores at this site were from proportion with DELTS (5) and proportion of simple lithophils (5).

Electrofishing was conducted at RM 0.40; there were two passes. RM 0.40 was in nonattainment of the WWH biocriterion and received an average IBI score of 28 (*Fair*). This site met the MIwb criterion, with a score of 8.6 (*Good*). The fish at this site ranged from moderately tolerant to highly tolerant. High metric scores came from proportion of carnivores (5), number of sunfish species (5), and DELTS (5). Between the two passes, 60 percent of the species were the same. Some of the same species were bowfin (*Amia calva*), goldfish (*Carassius auratus*), yellow bullhead (*Ictalurus natalis*), and yellow perch (*Perca flavescens*). A few examples of fish that were only found during the first or second pass were freshwater drum (*Aplodinotus grunniens*), rosyface shiner (*Notropis rubellus*), eastern gizzard shad (*Dorosoma cepedianum*) and brown bullhead (*Ictalurus*

nebulosus). These fish were all native species and as more of these uncommon native fish return, the IBI score will increase. There were six species collected during the two passes that were non-native species, including the common carp (*Cyprinus carpio*) and white perch (*Morone Americana*).

At RM 0.40, the lacustuary was evaluated using the Lacustuary IBI and compared to the proposed Interim Criteria of IBI ≥42 and MIwb ≥8.6. The LIBI score at RM 0.40 did not met the criterion with an average score of 27 (*Poor*). The MIwb average score was 8.6 (*Good*) and did not met criterion. This site's LIBI score made a small improvement compared to previous years. In both 2014 and 2016, this site was evaluated post restoration and received a LIBI score of 24.

Figure 4: Historic IBI Scores at Euclid Creek RMs 1.65 and 0.55



*Non-significant departure (≤4 IBI units) from applicable criterion.

Table 10. 2007 - 2018 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
2016	25	4.9	**35**	**8.0**
2017	27	5.7	**34**	**8.3**
2018	24	4.9	29	6.5

Bold indicates nonsignificant departure of WWH biocriterion

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 all three sites. 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) (Ohio EPA 1987a) and the lacustuary ICI (LICI) for RM 0.40. 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 11. 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 2018, HDs were at Euclid Creek RM 1.65, 0.55, 0.40. A second HD was installed at RM 0.40 inside of the wetland area. They were retrieved except for the HDs at RM 0.55 and RM 0.40 in the wetland area. Qualitative sampling was performed at all sites. RM 1.65 was in attainment of the WWH ICI biocriterion with a score of 38; RM 0.40 was in non-attainment (Table 12).

Table 12. 2018 Euclid Creek Macroinvertebrate Results						
River Mile	ICI Score	LICI Score	Narrative Rating	Total Quantitative Taxa	Total Qualitative Taxa	Total Qualitative EPT Taxa
1.65	**38**		*Good*	34	29	7
0.55			*Fair*		38	5
0.40	20	**34**	*Fair*	26	33	2
Bold indicates attainment of WWH biocriterion						

RM 1.65 received the highest ICI score (38) out of the three sites, and it had a narrative rating of *Good*. Some factors that contributed to this score were the qualitative EPT Taxa, percent Tanytarsini Midges, Percent Tolerant organisms, and Number of Caddisfly Taxa. The different species of qualitative EPT Taxa included *Baetis flavistriga*, *Baetis intercalaris*, *Chimarra aterrima*, *Cheumatopsyche sp*, *Ceratopsyche morosa*, *Ceratopsyche sparna*, *Hydropsyche depravata group*, and *Hydroptila sp*. EPT taxa are important to the health of a stream because a lot of species in these groups are

not tolerant to pollution; however, some are facultative. RM 1.65 has been sampled for macroinvertebrates since 2007 (Table 13). Of twelve years of sampling, eight of the years were in attainment of the WWH ICI biocriterion.

Table 13. 2002– 2018 Euclid Creek ICI Scores

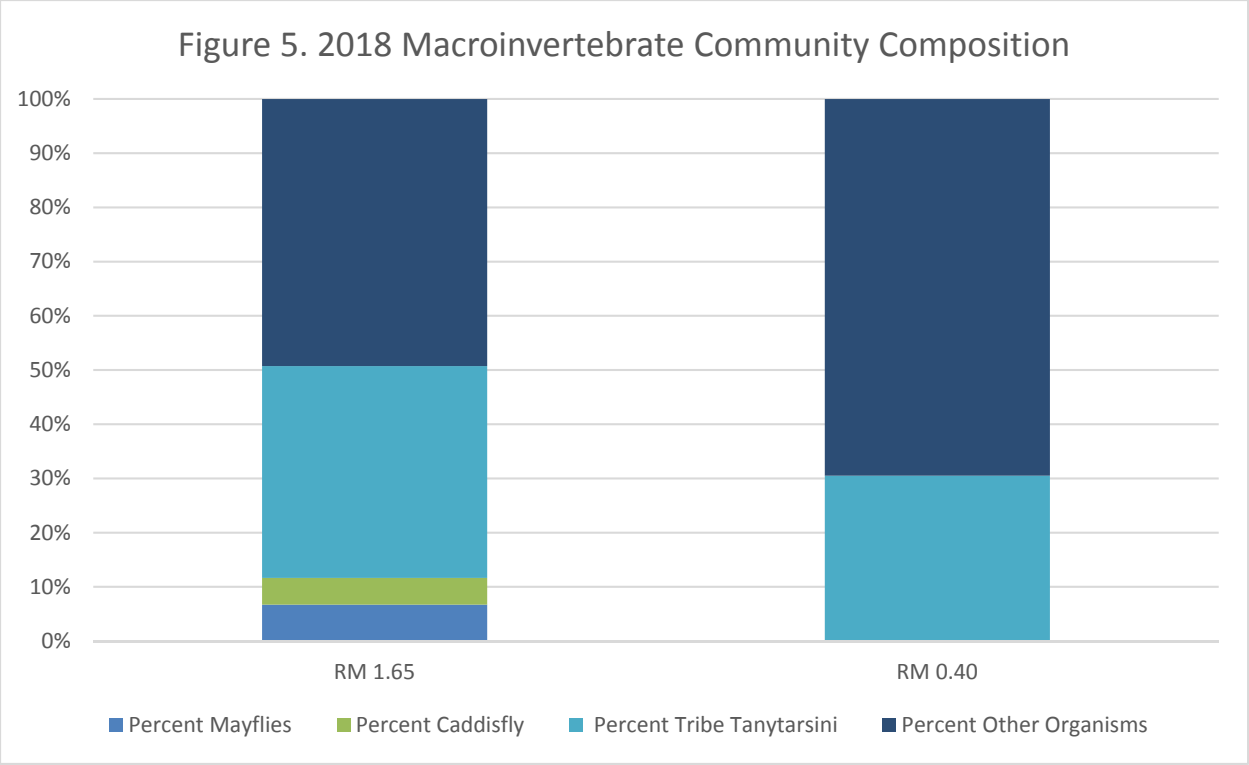
Year	RM 1.65	RM 0.55
2002	--	25
2003	--	26
2004	--	14
2005	--	16
2006	--	24
2007	26	22
2008	26	12
2009	**38**	24
2010	**42**	18
2011	**36**	24
2012	**36**	24
2013	Fair	**34**
2014	*30*	**34**
2015	**36**	18
2016	**38**	16
2017	**40**	16
2018	**38**	--

Bold indicates attainment of WWH biocriterion

Italics indicates non-significant departure of WWH biocriterion

--Macroinvertebrates not evaluated

HD not collected; qualitative assessment only



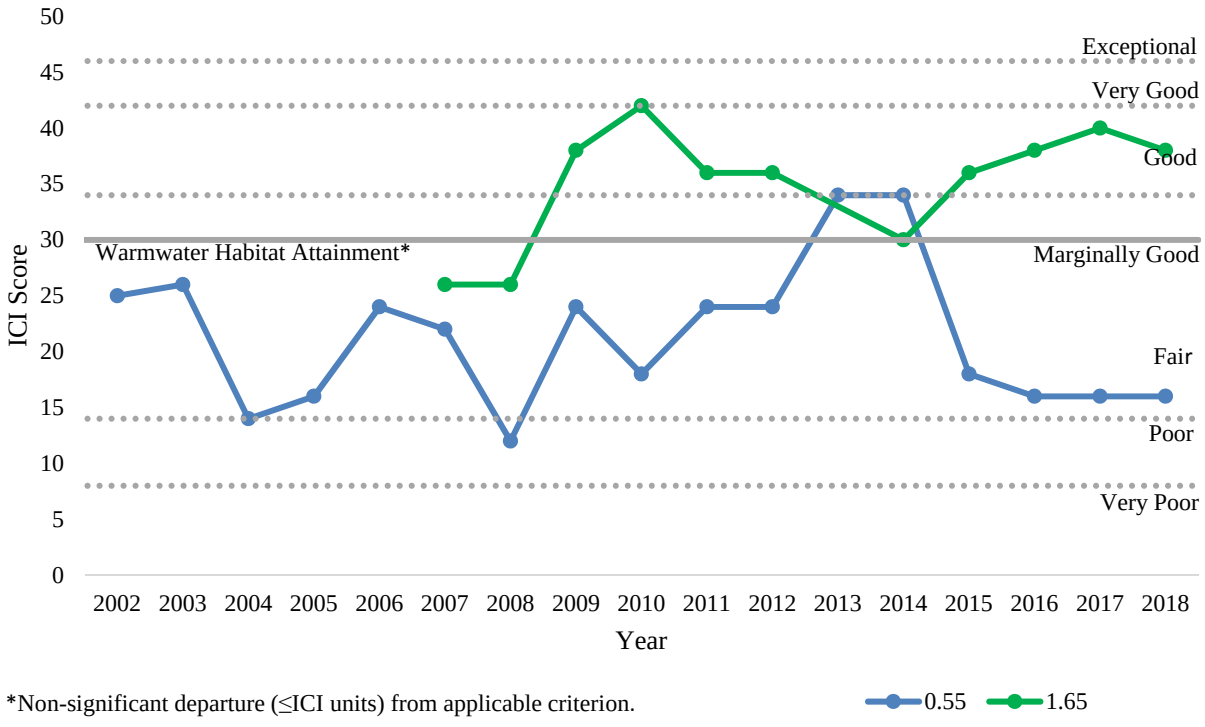
At RM 0.55, the HD was located; however, it was out of the water and the benthic macroinvertebrates could not be used to calculate an ICI score. There were 38 species in the qualitative sample. The EPT taxa that were obtained were *Baetis flavistriga*, *Baetis intercalaris*, *Cheumatopsyche sp,*, *Hydropsyche depravata group*, *Hydroptila sp.* All the macroinvertebrates that were collected were facultative, moderately tolerant and tolerant to pollution. Healthier creeks have more macroinvertebrates that are sensitive to pollution. For 2018, best professional judgment was used to determine a narrative rating for this site based on the qualitative sample; it received at narrative rating of *Fair*.

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 (Figure 5). RM 1.65 is usually in attainment of the WWH ICI biocriterion, except for two years. It appears CSOs do not negatively impact RM 1.65. However, RM 0.55 has been monitored and it has been in attainment for only two years in 2013 and 2014. From 2002-2017, this site has had an average ICI score of 21. This part of the creek is very different from upstream. It is in the park, which is used by the public often, and the HD has the potential to be disturbed by park visitors. It is expected that this may have been the reason to why the HD was out of water on August 6, 2018. This site also has some lacustuary influences that may impact the creek. At times, water from the lake flows backwards into the creek. There used to be a riffle at this site and this may have influenced the macroinvertebrates population as there are certain macroinvertebrates that thrive in riffles. There are also known illicit discharges at RM 1.65 and 0.55; this may impact the sites in a negative way. RM 0.55 and 1.65 will be

monitored again in 2019. This will help determine if there are changes at these sites. It will also help to determine if there are any improvements at RM 0.55 due to completion of the Euclid Creek Tunnel, which went online in August 2018.

HDs were set at RM 0.40 in both the main channel and the wetland area as part of the post restoration monitoring. At RM 0.40, in the main channel, the LICI score was calculated at 34 and met the proposed interim criterion. In 2014, the LICI score was 52, but in 2016, the score had dropped to 28. The increased score in 2018 compared to 2016 was the result of a greater amount of percent collector-gatherer taxa, percent other diptera, and percent predominant taxon. The total number of taxa found on the HD were 26. The wetland at RM 0.40 was also assessed for macroinvertebrates. The ICI and LICI scores are not considered at wetlands due to the lack of flow and the habitat conditions. The 0.3f/s flow minimum was unable to be achieved because of the wetland's habitat. Instead of these scores, other factors were considered to determine if the wetland was functional. One of the goals for the restoration project was to increase the number of filter-feeding midges (*Dicrotendipes neomodestus*, *Paratendipes albimanus*, *Tanytarsus glabrescens grp*. and *Paratanytarsus*) in the wetland area (Riverworks, 2013). *Dicrotendipes neomodestus* was found in the qualitative sample and the total number of taxa found was 30. In addition, there were two macroinvertebrates from the EPT taxa category collected, *Callibaetis sp.* and *Caenis sp.* All the species in the qualitative sample were facultative, tolerant or moderately tolerant to pollution.

Figure 6: Historic ICI Scores at Euclid Creek RMs 1.65 and 0.55



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 previously. There were no sites that met full attainment (Table 18). The dam that is upstream of RM 0.55 is preventing fish migration to the upper reaches of the watershed and may be causing the fish community assessment to be in non-attainment; typically dams have a negative impact. The dam may be modified soon to solve the migration problem, and there should be a change in the creek because the habitat is going to change. Water chemistry results at all sites exhibited exceedances for *E. coli*, an indicator of sewage contamination. Potential sources of pollution include illicit discharges, CSO discharges and urban runoff.

Table 14. 2018 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	24 *Poor*	4.9 *Poor*	38 *Good*	78.25 *Excellent*	*E. coli*
0.55	NON	29 *Poor*	6.5 *Fair*	*Fair*	56.25 *Good*	*E. coli*
0.40	NON	27 *Poor*	8.9 *Good*	20 *poor*	65.5 *Good*	*E. coli*
0.40 Lacustuary	NON	27 *Poor*	8.5 *Good*	34 *Fair*	54.4 *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						
Lacustuary criteria for LQHEI, LIBI, and LICI						

RM 0.40 and 0.55 may have some negative impacts from pollution which is causing these sites to be in non-attainment. There are other factors that are influencing this area including the wetland, lacustuary area, park area and back flow from the lake. RM 0.55 has met the WWH ICI biocriterion only twice in the past 17 years. As improvements are made in in this area, there should be a turnaround in the biological communities. A few years ago, there was a restoration project completed at RM 0.40 and the MIwb score improved in 2016, but then dropped in 2018. Continued monitoring will help determine the trend for the post-restoration project. RM 1.65 met the ICI score and it has 8 times in the past 12 years and its habitat is also good, with a QHEI rating of *Excellent*. This part of the creek has room for improvement and should show more positive signs of a healthy creek as projects are completed.

In August 2018, the Tunnel Dewatering Pump Station and Euclid Creek Tunnel construction went online and is expected to reduce and or eliminate a significant amount of the CSO overflows. 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.

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