NORTHEAST OHIO REGIONAL SEWER DISTRICT

2019 Euclid Creek Environmental Monitoring
Biological, Water Quality, and Habitat Survey Results

Prepared by
Water Quality and Industrial Surveillance Division

Introduction

Euclid Creek is a heavily urbanized stream whose watershed encompasses several Northeast Ohio communities across Cuyahoga and Lake counties. Drainage from South Euclid, Lyndhurst, Willoughby Hills, Richmond Heights, Highland Heights, Euclid, and Cleveland ultimately discharges to Lake Erie via the stream and its tributaries. In 2018, the Ohio EPA again identified Euclid Creek as a Prioritized Impaired Water under section 303(d) of the Clean Water Act (Ohio EPA, 2018a). Of primary concern is the impact of combined sewer overflow (CSO) events that contribute significantly to bacteriological loading of the stream during wet-weather events. That same year, three NEORSD "Project Clean Lake" capital improvement projects were implemented: the Euclid Creek Pump Station, the Euclid Creek Storage Tunnel, and the Easterly Tunnel Dewatering Pump Station. Each aims to reduce the frequency of CSO discharges from NEORSD to Euclid Creek to less than two discharge events per year.

In 2019, the Northeast Ohio Regional Sewer District (NEORSD) continued its environmental monitoring assessments of Euclid Creek, including water chemistry sampling, habitat evaluation, and fish and macroinvertebrate community surveys. As required under the Ohio Environmental Protection Agency (Ohio EPA) National Pollutant Discharge Elimination System (NPDES) Permit Number 3PA00002*HD, the objective of this assessment was to conduct environmental monitoring to determine attainment of the Ohio EPA water quality and aquatic life standards. This objective was outlined in the NEORSD *2019 Euclid Creek Environmental Monitoring* study plan approved by the Ohio EPA on May 14, 2019. The data collected during the 2019 environmental assessment season is also be a part of ongoing monitoring of the long-term impact of Project Clean Lake infrastructure on the overall health of Euclid Creek.

The 2019 environmental monitoring of Euclid Creek was conducted by Level 3 Qualified Data Collectors (QDCs) certified by the Ohio EPA in Fish Community and Benthic Macroinvertebrate Biology, Chemical Water Quality, and Stream Habitat Assessments. These individuals are members of the Environmental Assessment group of the Water Quality and Industrial Surveillance (WQIS) Division of NEORSD. Assessments of Euclid Creek occurred between June 15 through September 30, 2019 (through October 15 for fish community assessments), as required in the *Ohio EPA Biological Criteria for the Protection of Aquatic Life Volume III* (1987b).

Assessments were conducted at Euclid Creek River Miles (RMs) 1.65 and 0.55 (Figure 1). Each location with respect to river mile, latitude/longitude, site description, and the types of surveys conducted are listed in Table 1. A digital photo catalog of each location is available upon request by contacting the NEORSD WQIS Division.

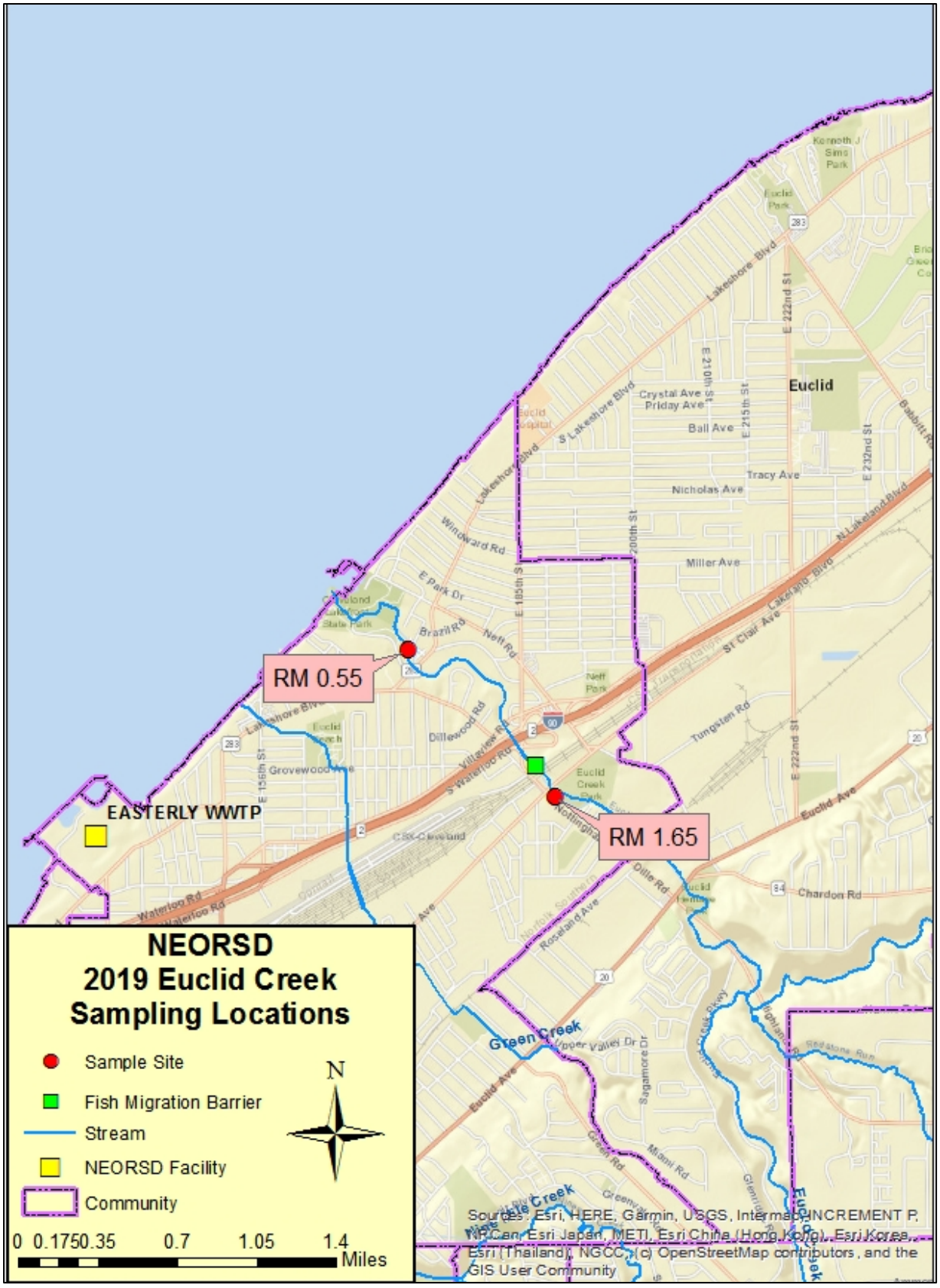


Figure 1. 2019 Euclid Creek Sampling Locations

Table 1. 2019 Euclid Creek Sampling Locations						
Site Location	**Latitude**	**Longitude**	**River Mile**	**Description**	**USGS HUC 8 Number Name**	**Purpose**
Euclid Creek	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	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

Water Chemistry Sampling

Methods

Five separate water chemistry and bacteriological sampling events were conducted between June 19 and July 17, 2019. Techniques used for sampling and analysis were conducted according to methods found in *Surface Water Field Sampling Manual for water quality parameters and flows* (Ohio EPA, 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 = concentration of the parameter in the primary sample
y = 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, this data will not be used for comparison to the water quality standards.

Water chemistry analysis sheets for each sampling location are available upon request from the NEORSD WQIS Division.

Results and Discussion

<u>Quality Assurance and Quality Control</u>

For this study, one field blank and one duplicate sample were collected in support of quality assurance and quality control (QA/QC) guidelines for field sampling. The duplicate sample was collected at Euclid Creek RM 1.65 on June 19, 2019. No parameters assessed in the duplicate

sample were rejected based on RPD values outside of the acceptable RPD range. The field blank sample was collected on July 17, 2019, at Euclid Creek RM 0.55. While no parameters assessed were rejected, one parameter, sulfate (SO_4), was qualified as estimated. Estimated values are established when the ratio of the sample results to field blank is greater than 5x, but less than 10x. This data is valid according to protocol, but could potentially demonstrate contamination, although it is unlikely.

Paired parameters for all samples collected from each of the two sampling locations within Euclid Creek were also evaluated in accordance with QA/QC protocols. The comparisons revealed no rejected data for the sampling sites, and one set of parameters with estimated data, on multiple dates during the sampling season (Table 2). Because there were no exceedances associated with these parameters, qualification of these results did not significantly change the overall water chemistry assessment of Euclid Creek.

Table 2. Paired Data Parameter Analysis

Site Location	Date	Parameter	Data Pair	Acceptable RPD (%)	Actual RPD (%)	Qualifier
RM 1.65	6/19/2019	NO_3	NO_3+NO_2	27.7	0.7	*Estimated*
	6/19/2019*	NO_3	NO_3+NO_2	27.8	0.5	*Estimated*
	6/26/2019	NO_3	NO_3+NO_2	28.2	1.5	*Estimated*
	7/1/2019	NO_3	NO_3+NO_2	28.2	1.0	*Estimated*
RM 0.55	6/19/2019	NO_3	NO_3+NO_2	27.9	0.7	*Estimated*
	6/26/2019	NO_3	NO_3+NO_2	28.5	1.3	*Estimated*
	7/1/2019	NO_3	NO_3+NO_2	29.8	1.8	*Estimated*

* - Duplicate Sample

Designated Use Comparison

Within the study area, Euclid Creek is designated as Warmwater Habitat (WWH), Agricultural Water Supply (AWS), Industrial Water Supply (IWS), and Primary Contact Recreation (PCR). The water chemistry samples collected at each site were compared to the applicable Ohio Water Quality Standards for the designated uses to determine attainment (Ohio EPA, 2018c).

Mercury

Water chemistry sampling in 2019 for Euclid Creek resulted in mercury concentrations that were below the method detection limit for EPA Method 245.1 at both RMs 1.65 and 0.55. The detection limit for this method is above the criteria for the Human Health Non-Drinking and Protection of Wildlife OMZAs, 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 those levels typically found in the stream. It is expected that the use of EPA Method 1631E, a low-level method, as opposed to EPA Method 245.1, would have resulted in exceedances of the criteria throughout the sampling period. Mercury may be introduced into Euclid Creek from urban runoff and atmospheric deposition within the watershed.

E. coli

The Primary Contact Recreation (PCR) criteria for Euclid Creek includes an *Escherichia coli* (*E. coli*) criterion not to exceed a Statistical Threshold Value (STV) of 410 colony counts (MPN) per 100mL in more than ten percent of the samples taken during any 90-day period, and a 90-day geometric mean criterion of 126 colony counts (MPN) per 100mL (Ohio EPA, 2018c). In accordance with Ohio EPA procedure and practice to qualify *E. coli* exceedances for the Primary Recreation criteria, the geometric mean and STV are only calculated and compared when a minimum of five bacteriological samples have been collected.

Both sampling locations on Euclid Creek exceeded the STV and geometric mean criteria for the 90-day period, as RMs 1.65 and 0.55 averaged above the maximum ten percent of days greater than 410 colony counts allowed (Table 3). Sampling events on June 19, June 26, July 1, and July 17, 2019, occurred during wet-weather conditions[1], in which stormwater runoff may have contributed to these exceedances. *E. coli* exceedances may also have been a result of domestic and/or wild animal waste, improper sanitary sewage connections to stormwater outfalls, failing household sewage treatment systems (HSTSs), or combined sewer outfall (CSO) discharges to Euclid Creek upstream of the sampling locations.

[1] Wet-weather sampling events: when precipitation is greater than 0.10 inches but less than 0.25 inches, samples collected that day and the following day are considered wet-weather samples. When precipitation is greater than 0.25 inches, the samples collected that day and the following two days are considered wet-weather samples.

Table 3. 2019 Euclid Creek *E. coli* Densities (MPN/100mL)		
Date	RM 1.65	RM 0.55
6/19/2019*	613	436
6/26/2019*	1,235	1,320
7/1/2019*	518	980
7/10/2019	870	589
7/17/2019*	9,330	14,395
90-Day Geometric Mean	1,261	1,368

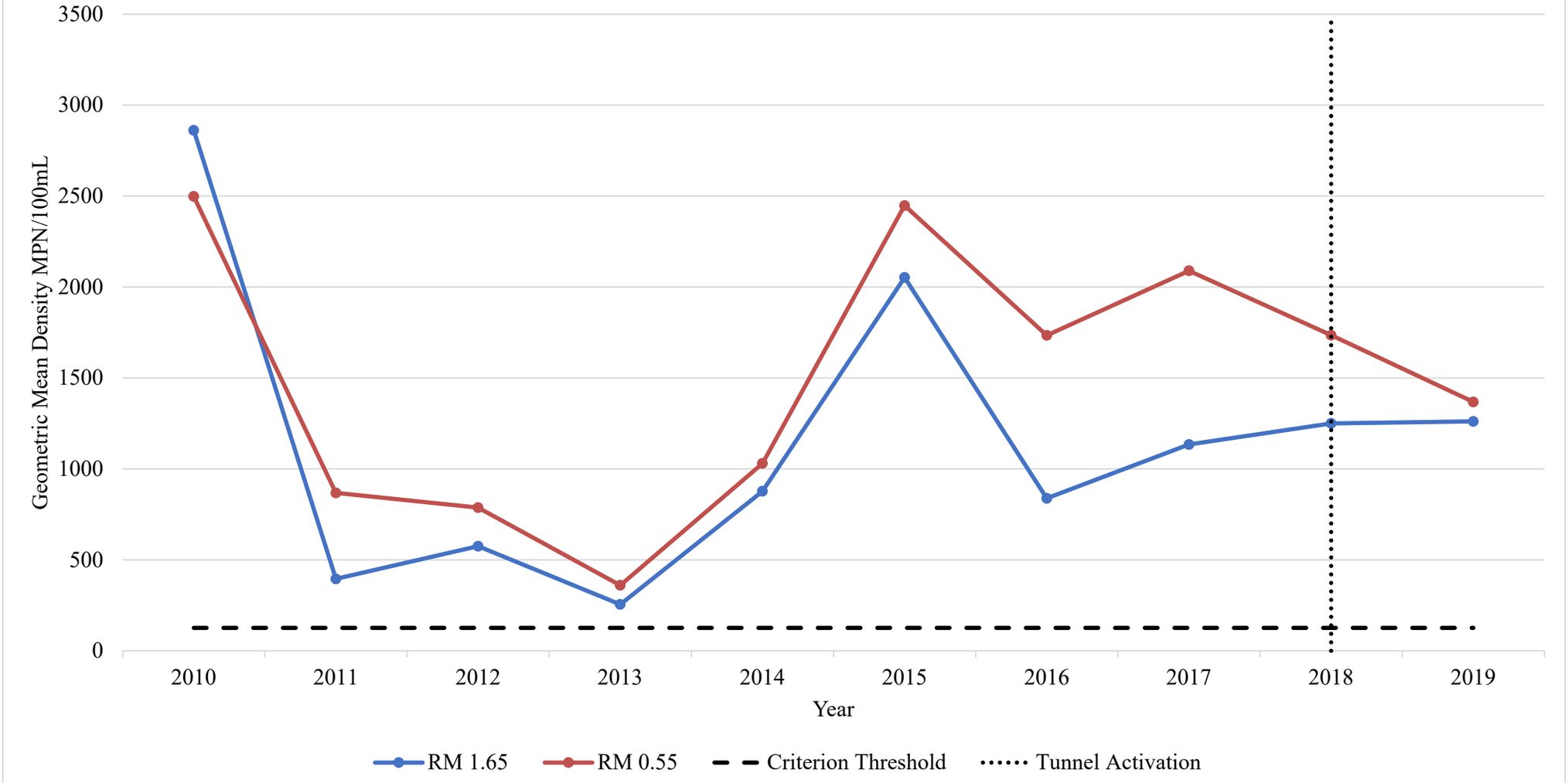
Exceeds statistical threshold value (STV) of 410 MPN/100mL
Exceeds geometric mean criterion for 90-day period of 126 MPN/100mL
* - Wet-Weather Sampling Event

Discharges to Euclid Creek from NEORSD-owned CSOs have sharply declined since the 2018 activation of the Euclid Creek Tunnel Project. During large rain events, excessive storm water and untreated sanitary wastewater is now diverted to a large underground tunnel. This wastewater is later treated at NEORSD's Easterly Wastewater Treatment Plant. Because of the reduction and potential elimination of overflow discharges, it was expected that densities of *E. coli* in Euclid Creek would begin to decline over subsequent seasons. In Figure 2, *E. coli* geometric mean sample data collected from 2010 to 2019 is displayed for Euclid Creek RMs 1.65 and 0.55.

The sampling reach at RM 1.65 is located upstream of any NEORSD-owned CSOs and is sampled as a reference site for the RM 0.55 location. While NEORSD CSOs are absent upstream of RM 1.65, there are other influences upstream of this sampling reach that complicate improvement efforts. Primarily, the stretch of Euclid Creek just upstream of the sampled reach is located within the service area of the City of Euclid, which operates a CSO and a separate sanitary overflow (SSO) that discharge to the creek. Additionally, any illicit discharges or improper connections to storm outfalls in this area may significantly impact the input of *E. coli* into the Euclid Creek watershed.

Observed variation in *E. coli* densities from year to year may be due to dry and wet weather variation, as major rain events can cause elevated densities of *E. coli* due to stormwater run-off and CSO discharges upstream. Natural variability from year to year may also have influenced these elevated densities.

Figure 2. Euclid Creek *E. coli* Geomean Densities 2010 - 2019



While both sites remain above the 126 MPN/100mL 90-day average criterion threshold, infrastructure improvements like the Euclid Creek tunnel project as well as a continued effort to detect and eliminate illicit discharges upstream of these locations may contribute to eventual attainment of this criterion. Ongoing monitoring efforts will verify the efficacy of these improvements.

Nutrients

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, 2015). NEORSD did not assess DO swings or benthic chlorophyll *a* in 2019; however, nutrients were assessed.

Maintenance of low levels of nutrients such as nitrogen and phosphorus in Euclid Creek is imperative in limiting loading to Lake Erie. An excess of nitrogen and phosphorus can lead to nutrient enrichment in the lake, encouraging the growth of harmful algal blooms (HABs). HABs pose a health risk to the aquatic life of Lake Erie, as they quickly impact dissolved oxygen levels. This results in large hypoxic (low oxygen) or anoxic (oxygen depleted) zones in the water column. Some species of blue-green algae (a type of cyanobacteria) also produce toxins, including microcystins, which can cause illness in aquatic and terrestrial wildlife, as well as in humans and domestic animals. Microcystins are not easily removed via water treatment and can cause a wide range of illnesses, from mild skin irritation to severe liver damage and death.

Table 4 shows the mean calculated nutrient concentrations for the Euclid Creek sampling locations assessed in 2019. The results of dissolved inorganic nitrogen and total phosphorous were compared to Table 2 listed in the SNAP document. According to this section of SNAP, both RMs 1.65 and 0.55 exhibit "levels typical of developed lands; little or no risk to beneficial uses" (Ohio EPA, 2015). This indicates that neither phosphorus nor nitrogen are of a significant concern as a primary source of impairment at these sampling sites.

Table 4. 2019 Euclid Creek Nutrient Concentrations

Site	Total Phosphorus Geometric Mean (mg/L)	Dissolved Inorganic Nitrogen Geometric Mean (mg/L)
RM 1.65	0.062	0.413
RM 0.55	0.068	0.365

Habitat Assessment

Methods

In 2019, an instream habitat assessment was conducted once at the each of the stream sampling locations within Euclid Creek 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 greater suggests that sufficient habitat exists to support a fish community that attains the WWH criterion. 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

The habitat for the stream segment at Euclid Creek RM 1.65 was assessed on June 24, 2019. A QHEI score of 71 was calculated with a narrative rating of *Good* (Table 5), exceeding the target score of 60 for WWH. Important contributing factors to the attainment of WWH included the low embeddedness of the riffle (as well as the stream overall), the good development and sinuosity of the reach, and the lack of channelization. The dominant substrates of cobble and bedrock, with gravel and boulders throughout, is an additional characteristic that gave the segment a high score. Some factors that negatively impacted the score were the moderate levels of silt in the pools and a sparse amount of instream cover for resident or transient fish populations. These refugia were also minimally diverse, with only some boulders, rootwads, and a few pools available. The banks had evident issues with erosion, ranging from little/moderate to severe, also negatively impacting the QHEI score. In an urban residential flood plain, like that surrounding Euclid Creek, a greater percentage of impervious surface can lead to excessive flow to the stream, which may magnify erosion issues and lead to greater sediment deposition in the stream. An abundance of sediment deposition may explain the moderate amount of silt and embeddedness of the pool substrate. Despite scoring low in some areas, the overall QHEI assessment indicates that this stream reach is suitable to sustain a healthy fish community. The stream reach's WWH qualities of sinuosity, development, and lack of channelization may be key in the stabilization of the reach under adverse flow conditions.

The habitat for the stream segment at Euclid Creek RM 0.55 was also assessed on June 24, 2019. At this location, a QHEI score of 55.75 was calculated with a narrative rating of *Fair (*Table 5), failing to meet the target score of 60 for WWH. One high impact MWH attribute that affected this score was the lack of instream cover. While a few types were present in the reach, including vegetation, deep pools, and boulders, the overall quality and quantity of cover was sparse, which can inhibit the establishment of fish communities. Additional important score impacts were a substrate dominated by sand and cobble, as well as the lack of a riffle. Riffles provide important areas of cover for young or small fish species and serve as habitat for macroinvertebrates, which are a food source for fish or other biota. Riffles also serve an important function in oxygenation of the stream, and without their presence, levels of dissolved oxygen are reduced, especially in

slow moving water. The reach also suffered from a small to nonexistent riparian buffer. As the area is predominantly residential and adjacent to a park with plenty of impervious surfaces, large rainstorms could very easily introduce sediment from the banks as well as pollutants from stormwater runoff. The low sinuosity and low gradient result in a slow current in this portion of the stream, allowing this sediment to settle, contributing to the moderate substrate embeddedness and silt content. Because Euclid Creek RM 0.55 failed to meet the target score for QHEI, it could be expected that the reach may not be able to sustain a healthy biological community.

Table 5. Euclid Creek Qualitative Habitat Evaluation Index Scores and Physical Attributes

			WWH Attributes											MWH Attributes																
														High Influence						Moderate Influence											
River Mile	QHEI Score	Habitat Rating	No Channelization or Recovered	Boulder/Cobble/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 Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total Moderate Influence Attribute**
1.65	71.00	*Good*	x	x		x	x		x	x	x	x	**8**				x		**1**		x										**1**
0.55	55.75	*Fair*	x	x		x					x		**4**				x		**1**		x			x	x			x	x	x	**6**

Fish Community Assessment

Methods

Two quantitative electrofishing passes were conducted at each sampling site on Euclid Creek for the 2019 sampling season. Sampling was conducted using longline or roller pram 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 both RMs 1.65 and 0.55. The sampling techniques 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 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 voucher specimens and those that could not be easily identified in the field.

The electrofishing results for each pass were compiled and utilized to evaluate fish community health through the application of the Ohio EPA Index of Biotic Integrity (IBI). 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 sampling locations are listed in Table 6.

Table 6. Index of Biotic Integrity (IBI) Metrics
Wading Sites
Total Number of Native Species
Number of Darter Species
Number of Sunfish Species
Number of Sucker Species
Number of Intolerant Species
Proportion of Tolerant Species
Proportion of Omnivores
Proportion of Insectivores
Proportion of Top Carnivores
Number of Individuals (less Tolerant Organisms)
Proportion of Simple Lithophilic Species
Proportion of Individuals with DELTs

The second fish index utilized by Ohio EPA is the Modified Index of Well-being (MIwb). The MIwb, Formula 3 listed below, incorporates four fish community measures: numbers of individuals, biomass, and the Shannon Diversity Index (*H*; Formula 4) 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

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

Results and Discussion

RM 1.65

For the 2019 electrofishing events, the stream segment at Euclid Creek RM 1.65 averaged an IBI score of 23, and an MIwb score of 5.0, both narratively *Poor*, and therefore was not in attainment of either the IBI or MIwb WWH criteria (Table 7 and Figure 3).

The first electrofishing pass, completed on June 24, 2019, resulted in an IBI score of 24, and an MIwb score of 4.6, both narratively *Poor* (Table 7). RM 1.65 scored low in several individual metric areas due to absence of key taxa including darters, suckers, and a low number of sunfish species. Only seven species of fish were collected during this sampling event, most of which are considered tolerant to pollution, including the dominating blacknose dace (*Rhinichthys atratulus*) and creek chub (*Semotilus atromaculatus*), and there was an absence of fish species classified as intolerant. A low proportion of omnivorous taxa (1.44%) and the absence of DELTs in any fish provided for a small positive contribution to the IBI score but did not ultimately influence attainment of the criterion.

The second electrofishing pass, completed on October 14, 2019, resulted in an IBI score of 22, and an MIwb score of 5.4, both narratively *Poor,* and again not in attainment of either WWH criteria (Table 7). While individual metrics were relatively similar in scoring, there was a slight decrease in the omnivore metric due to an increased proportion of omnivorous species (31.8%). Overall, a loss of two taxa from the first event, the largemouth bass (*Micropterus salmoides*) and northern bluegill (*Lepomis macrochirus*), but the addition of the green sunfish (*Lepomis*

cyanellus), resulted in a taxa diversity of six species. The sample population was again dominated by tolerant species, drawing attention to potential issues with water quality in the area.

The habitat assessment of Euclid Creek RM 1.65 indicated that the stream reach would be suitable to support a quality fish community. However, the low IBI score calculated in 2019 contradicts this QHEI score. While there has been no outright declining trend in IBI scores for RM 1.65 over time, the score has not improved, and remains in non-attainment of the WWH criterion (Figure 3). Given the "*Good*" QHEI habitat rating, the low IBI score may also be due to the inability for fish to reach this site. A dam located downstream at Euclid Creek RM 1.50 stands as a significant barrier to the migration of fish to the reach at RM 1.65 (Figure 1). Removal or modification of this structure may allow for fish passage, increasing the likelihood for improved quality of the population composition, as well as an increase in density. Currently, discussions are being held on such a project, with construction expected within the next couple of years.

For fish able to reach the area, minimal refugia may not support large species in times of low flow or small species from predation. Anthropogenic impacts including storm and combined sewer outfall discharges, while improved, may still also be affecting the fish population through the introduction of bacteria and sediment deposition. This may explain why the present population is dominated by tolerant taxa. Past monitoring downstream of the dam at RM 1.00 showed a similarly impacted fish community. Although more fish species were present at that location, the community was still dominated by pollution-tolerant taxa, indicating that water quality impacts may be widespread throughout the stream.

RM 0.55

The stream segment at Euclid Creek RM 0.55 averaged an IBI score of 34 (*Marginally Good*), and an MIwb score of 7.05 (*Fair*), therefore only attaining the WWH criterion for IBI, and nearly attaining the MIwb criterion (Table 7 and Figure 3).

The first electrofishing pass, conducted on June 24, 2019, resulted in an IBI score of 32 and an MIwb score of 6.8, both narratively *Fair*, and narrowly in non-attainment of both the IBI and MIwb criteria (Table 7). Nearly twice as many species were present in the sample population (a total of 16) compared to the first electrofishing event at RM 1.65, which may confirm the impact of the barrier at RM 1.50. Positively contributing to the IBI score was the presence of four different sunfish species, which included the green sunfish and northern bluegill, as well as the pumpkinseed sunfish (*Lepomis gibbosus*) and the northern rockbass (*Ambloplites rupestris*). Field sampling reported one lesion present on a yellow bullhead catfish (*Ictalurus natalis*), but this low incidence did not significantly impact the metric score. Darter species were also absent at this location, negatively impacting the individual metric and overall scores. These fish prefer riffle habitats comprised of gravel and cobble, which offer cover as well as habitat for their common diet of aquatic macroinvertebrates. The absence of a riffle at this stream reach has effectively eliminated this habitat, and the likelihood that darters or similar fish will occupy the stream reach.

While this pass was dominated by tolerant taxa, two of the collected species are considered to be pollution sensitive: the mimic shiner (*Notropis atherinoides*), which was the second most

populous species in the sample population, and smallmouth bass (*Micropterus salmoides*). The most common species in the sample population, accounting for 62.4% of all specimens, was the common white sucker (*Catostomus commersonii*), which is classified as highly tolerant. Sampling also revealed the presence of two non-native species, the goldfish (*Carassius auratus*) and the round goby (*Neogobius melanostomus*). Non-native or invasive species compete with native fish for resources, which can negatively affect the fish community composition.

The second electrofishing pass at Euclid Creek RM 0.55, completed on October 14, 2019, resulted in an IBI score of 36 (*Marginally Good*), and an MIwb score of 7.3 (*Fair*), and therefore again in attainment of the WWH criterion for IBI and near attainment for the MIwb criterion (Table 7). While the total quantity of species remained consistent, six taxa were replaced in the second sample population. The addition of the sand shiner (*Notropis stramineus*) and northern logperch darter (*Percina caprodes*), two species classified as moderately intolerant, and a reduction in the number of common white suckers created a population shift toward more sensitive species, which positively impacted the IBI score. The improvement in score was also due to the number of individuals (less tolerant organisms) metric, which significantly increased from the first electrofishing pass. In contrast to the first electrofishing pass at RM 0.55, no fish surveyed in the sample population were reported to have any DELTs.

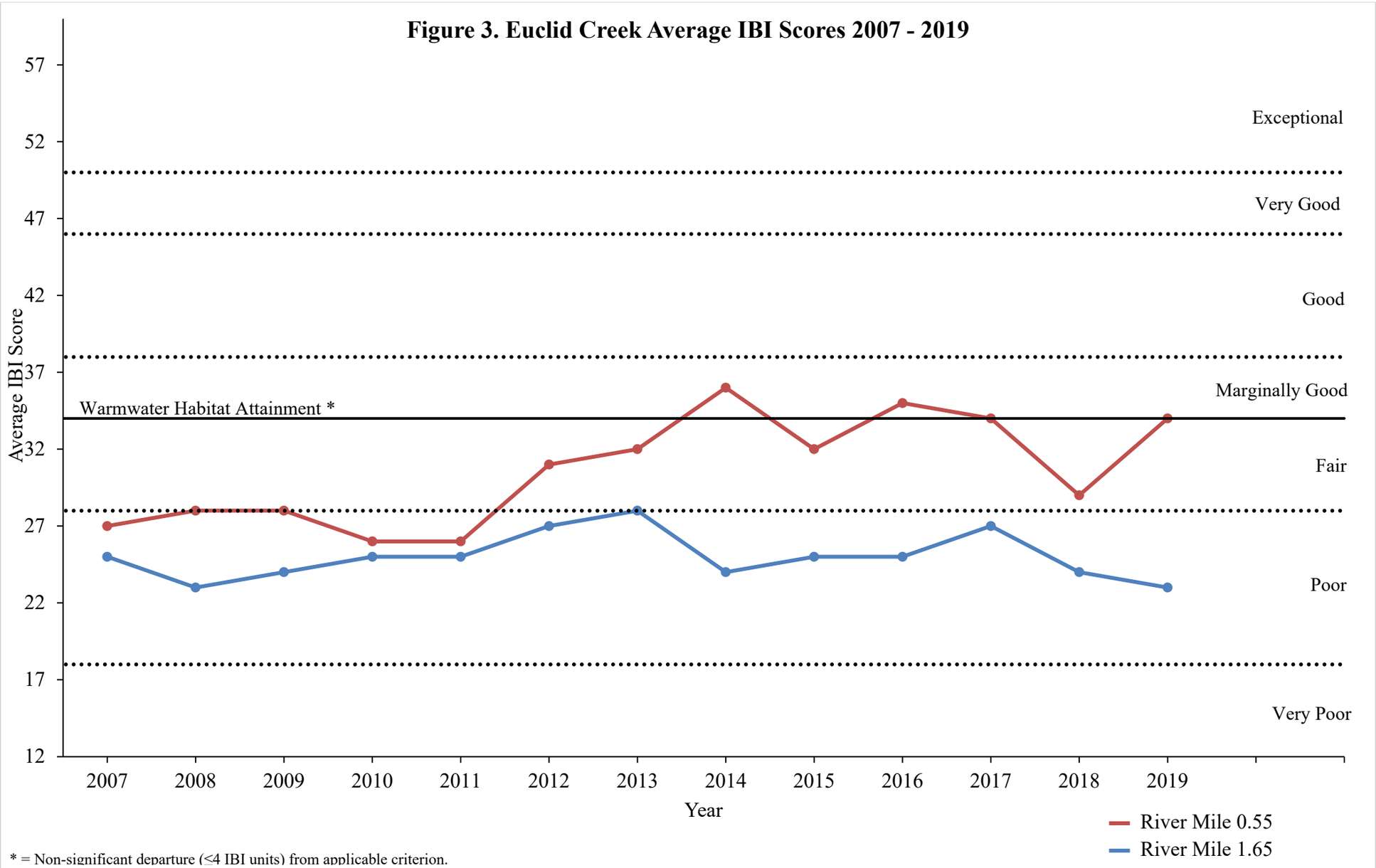
The addition of the logperch darter, while adding to the overall species diversity, was not enough to positively impact the darter metric score. Again, the absence of a riffle at this location eliminates potential habitat for various fish species including darters. The logperch darter, which is among the largest of the darter species, is an exception, as it can be found in habitats other than riffles, even including lakes and reservoirs. It is possible that the fish in the sample population were transient from Lake Erie.

The habitat assessment of Euclid Creek RM 0.55 indicated a QHEI score that did not meet the WWH target, suggesting the reach had limited ability to sustain a healthy fish community. However, the presence of some pollution-sensitive taxa indicated that the stream may still be suitable for some species. Since 2014, the reach has been in attainment of the WWH IBI criterion several times, suggesting that improvements to infrastructure, elimination of illicit discharges, and overall water quality may to some extent offset issues with habitat structure (Figure 3).

Table 7. 2019 Euclid Creek IBI/MIwb Results								
	1st Pass			2nd Pass			Average	
River Mile	Date	IBI (*Narrative Rating*)	MIwb (*Narrative Rating*)	Date	IBI (*Narrative Rating*)	MIwb (*Narrative Rating*)	IBI (*Narrative Rating*)	MIwb (*Narrative Rating*)
Euclid Creek RM 1.65	06/24/2019	24 (*Poor*)	5.4 (*Poor*)	10/14/2019	22 (*Poor*)	5.4 (*Poor*)	23 (*Poor*)	5.0 (*Poor*)
Euclid Creek RM 0.55	06/24/2019	32 (*Fair*)	6.8 (*Fair*)	10/14/2019	36 (*Marginally Good*)*	7.3 (*Fair*)	34 *(Marginally Good)**	7.1 (*Fair*)

Bold = Meets WWH criterion [IBI ≥38 (Wading Site); MIwb ≥ 7.9 (Wading Site)]
* = Non-significant departure from WWH criterion [IBI ≥ 34; MIwb ≥ 7.4]

Figure 3. Euclid Creek Average IBI Scores 2007 - 2019



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

Macroinvertebrate Community Assessment

Methods

Macroinvertebrates were sampled quantitatively using modified Hester-Dendy (HD) samplers in conjunction with a qualitative assessment of the presence of Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) taxa, collectively referred to as EPT taxa, at the time of HD retrieval. Sampling was conducted at the Euclid Creek sampling 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 HD deployment is six weeks.

The macroinvertebrate samples were sent to EA Engineering, Science, and Technology of Deerfield, IL 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 are available upon request from the NEORSD WQIS Division.

The overall aquatic macroinvertebrate community in the stream was evaluated using Ohio EPA's Invertebrate Community Index (ICI) (Ohio EPA 1987b, DeShon 1995). The ICI consists of ten community metrics (Table 8), 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 8. 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 2019, HDs were installed at Euclid Creek RM 1.65 and 0.55 and qualitative sampling was performed at both sites. RM 1.65 was in attainment not only of the WWH ICI criterion, but

also that of the exceptional warmwater habitat biocriterion with a score of 46; RM 0.55 was in non-attainment of WWH with a score of 18 (Table 9).

Table 9. 2019 Euclid Creek Macroinvertebrate Results				
River Mile	ICI Score	Total Quantitative Taxa	Total Qualitative Taxa	Total Qualitative EPT Taxa
1.65	**46** *Exceptional*	33	23	8
0.55	18 *Low Fair*	25	21	3
Bold indicates attainment of WWH biocriterion				

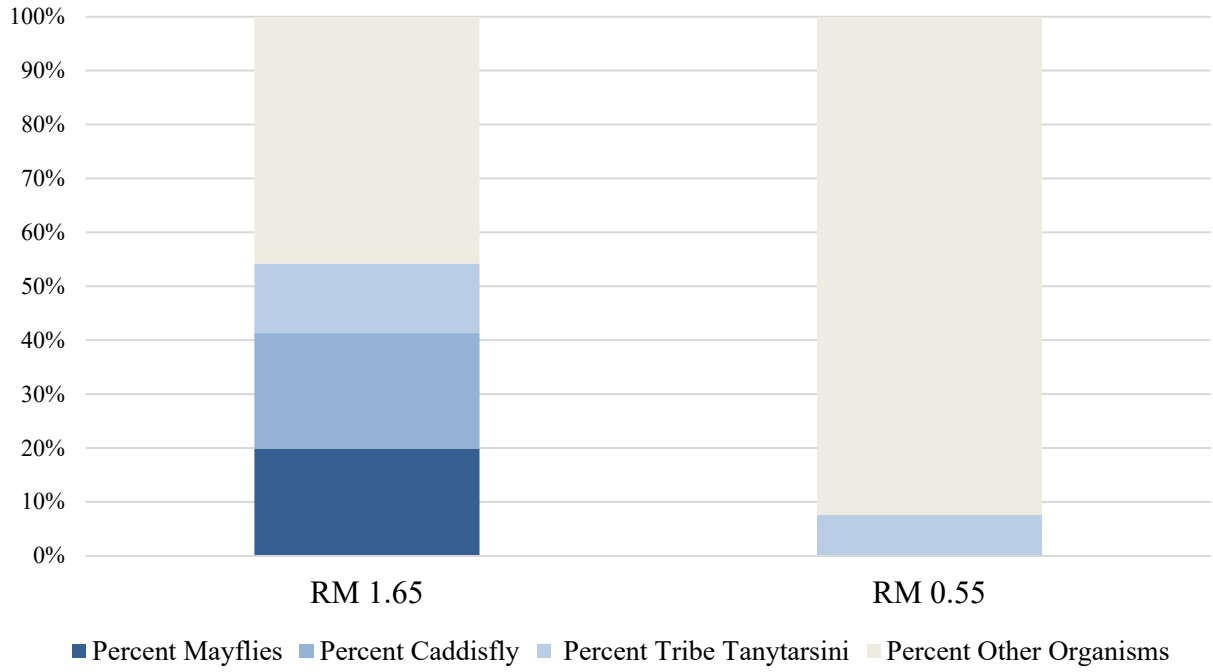
RM 1.65 saw a significant increase in ICI score from 38 in 2018 to 46 (*Exceptional*) in 2019. Some factors that contributed to this improvement were the number of dipteran taxa, the increase in percent mayfly and caddisfly composition (Figure 4), and the increase in qualitative EPT taxa. The different species of qualitative EPT Taxa observed included *Baetis flavistriga*, *Baetis intercalaris*, *Stenoma Feomoratum*, *Caenis sp*, *Chimarra obscura*, *Cheumatopsyche sp*, *Ceratopsyche morosa*, and the *Hydropsyche depravata group*. EPT taxa are often indicative of overall water quality as many species in these groups are very sensitive to pollution. RM 1.65 has been sampled for macroinvertebrates since 2007 (Table 10). Of twelve years of sampling, eight of the years were in attainment of the WWH ICI biocriterion, with 2019 receiving the highest ICI score since sampling began.

At RM 0.55, the ICI score was 18 (*Low Fair*), which is consistent with the field narrative rating of *Poor*. The very low numbers and percent composition of mayfly and caddisfly taxa contributed substantially to the non-attainment of WWH, as did the high percentage of pollution-tolerant organisms present at the site (Figure 4). The EPT taxa that were obtained were *Baetis flavistriga*, *Casenis sp.,* and the *Hydropsyche depravata group.* While many EPT taxa are pollution intolerant - and their presence usually indicative of good water quality - these particular species are facultatively tolerant of pollution, and their presence is not incongruent with the low score. Additionally, only one of the EPT species was found during both assessments, while the other two were found only in the qualitative assessment.

Table 10. 2002– 2019 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

Table 10. 2002– 2019 Euclid Creek ICI Scores		
Year	RM 1.65	RM 0.55
2011	**36**	24
2012	**36**	24
2013	Fair	**34**
2014	*30*	**34**
2015	**36**	18
2016	**38**	16
2017	**40**	16
2018	**38**	--
2019	**46**	18
Bold indicates attainment of WWH biocriterion		
Italics indicates non-significant departure of WWH biocriterion		
--Macroinvertebrates not evaluated		
	HD not collected; qualitative assessment only	

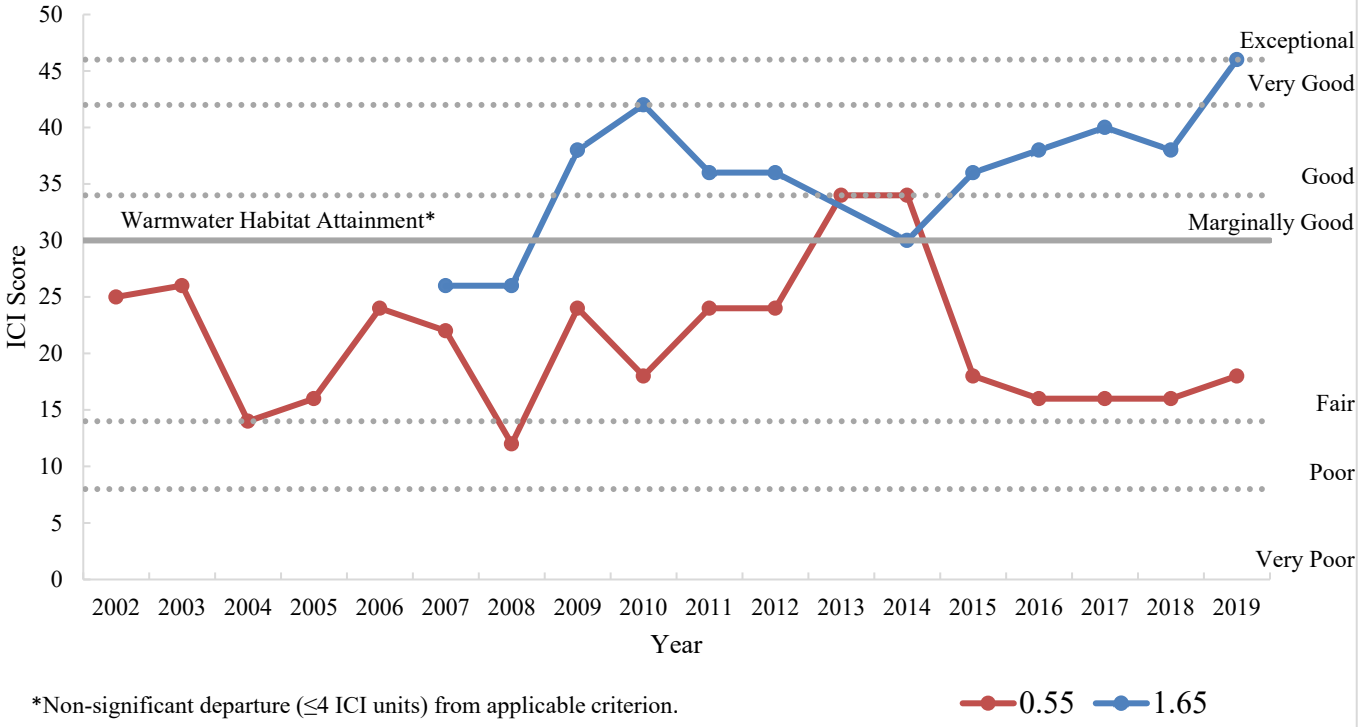
Figure 4. 2019 Macroinvertebrate Community Composition



RMs 1.65 and 0.55 have historically been evaluated for macroinvertebrates to 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: 2013 and 2014. These same two years were the only occasions that RM 0.55 was found to be in

attainment of the WWH biocriterion since its monitoring began in 2002. This part of the creek is compositionally different than RM 1.65, lacking a riffle, which not only oxygenates stream waters, but also provides habitat for macroinvertebrates. This site also has some lacustuary influences that may impact the creek; during high lake levels or particular weather events, water from the lake flows upstream into the creek. Both locations are subject to illicit discharge, stormwater run-off, and CSO from the surrounding communities. The activation of the Euclid Creek Tunnel Project in 2018 has significantly reduced the number of CSO events from NEORSD-owned outfalls, and future monitoring will potentially reveal what long-term impacts this reduction has had on the local aquatic invertebrate community.

Figure 5: Historic ICI Scores at Euclid Creek RMs 1.65 and 0.55



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

Conclusions

The results of NEORSD's water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys indicate that despite improvements to sewer and stormwater infrastructure, the Euclid Creek watershed is still impacted by a variety of aquatic habitat limitations and environmental stressors.

Neither the stream reach at RM 0.55 nor at RM 1.65 were in attainment at all categories (Table 11). Water quality exceedances at both sites were due to the excessive presence of *E. coli*, indicating there is still improvement needed in the control of wastewater, stormwater runoff, and combined sewer outfalls into the watershed. Additionally, the failure of habitat attainment and ICI attainment at RM 0.55 is likely most impacted by its lack of a riffle. While this impairs its ability to host vibrant macroinvertebrate communities, its IBI and MIwb scores are near or at attainment, indicating the potential for the establishment of some fish species. Conversely, despite having reached attainment in habitat quality and possessing an exceptional macroinvertebrate community, the dam at RM 1.5 is likely preventing fish migration to the upper reaches of the watershed, driving the non-attainment of IBI and MIwb for RM 1.65.

Table 11. 2019 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	23 *Poor*	5.0 *Poor*	46 *Exceptional*	71.00 *Good*	*E. coli*
0.55	PARTIAL	34 *Marginally Good**	7.1 *Fair*	*18* *Fair*	55.75 *Fair*	*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

Continued monitoring of both sites will determine whether the NEORSD's Project Clean Lake infrastructure improvements will have a significant, long-term impact on the biological communities and bacteriological loading of Euclid Creek. This combined with future stream remediation projects such as the potential removal of the dam at RM 1.50 will be integral in restoring the stream to warmwater habitat.

Acknowledgments

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

Kelsey Amidon
Hannah Boesinger
Seth Hothem
Mark Matteson
Mario Meany
Denise Phillips
John W. Rhoades
Francisco Rivera
Eric Soehnlen
Justin Telep
Nya Dreyfuss, co-author
Daniel Neelon, co-author

WQIS Interns: Zachary Bayer, Kevin Fitzgibbons, Brandon Fitzpatrick, Matthew Johnson

NEORSD Analytical Services Division – Completed analysis for all water chemistry sampling

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