2008 Upstream of NEORSD CSO Areas Biological, Water Quality and Habitat Survey Results

Introduction

During 2008, the Northeast Ohio Regional Sewer District[1] (NEORSD) conducted electrofishing, benthic macroinvertebrate, water chemistry sampling and habitat assessments on waterways upstream from areas of Northeast Ohio Regional Sewer District (NEORSD)-owned combined sewer overflows (CSOs). The resulting upstream data were compared with the data obtained from these waterways downstream of the NEORSD CSO areas, in order to comply with Ohio EPA NPDES Permit No. 3PA00002*FD. This was to determine the extent to which downstream sites may be impacted by CSOs or other environmental factors. The downstream sampling is required on Big Creek, Mill Creek, Doan Brook, and Euclid Creek. Maps of the sampling locations are located in Appendix A. Table 1 and Table 2 indicate the sampling site locations with respect to river mile (RM), description, latitude and longitude.

Table 1. List of Sampling Locations Upstream of Combine Sewer Overflows.

Stream Location	Latitude	Longitude	River Mile	Description	Purpose
Big Creek	N41.4460°	W81.7540°	4.40	Memphis MetroPark	Evaluate macroinvertebrates and habitat upstream of CSOs
Big Creek-Ford Branch	N41.4230°	W81.8019°	4.70	West 150th Street	Evaluate macroinvertebrates and habitat upstream of CSOs
Doan Brook-North Branch	N41.4838°	W81.5643°	6.70	Upstream of Lee Road	Evaluate macroinvertebrates and habitat upstream of CSOs
Doan Brook-South Branch	N41.4739°	W81.5593°	1.40	US Attleboro Road	Evaluate macroinvertebrates and habitat upstream of CSOs
Euclid Creek	N41.5658°	W81.5358°	2.70	Upstream of Highland Road	Evaluate macroinvertebrates and habitat upstream of CSOs
Euclid Creek	N41.5738°	W81.5470°	1.65	Upstream of St. Clair Avenue	Evaluate macroinvertebrates and habitat upstream of CSOs
Mill Creek	N41.4305°	W81.5442°	8.30	Upstream of South Miles Road	Evaluate macroinvertebrates and habitat upstream of CSOs

[1] Sampling was conducted by NEORSD Level 3 Qualified Data Collectors certified by Ohio EPA in Fish Community and Benthic Macroinvertebrate Biology, and Chemical Water Quality and Stream Habitat Assessments as explained in the NEORSD study plan (*2008 Benthic Macroinvertebrate Sampling Upstream of NEORSD CSO Areas*).

Table 2. List of Sampling Locations Required for Ohio EPA Permit No. 3PA00002*FD. These locations are included for comparison purposes only.

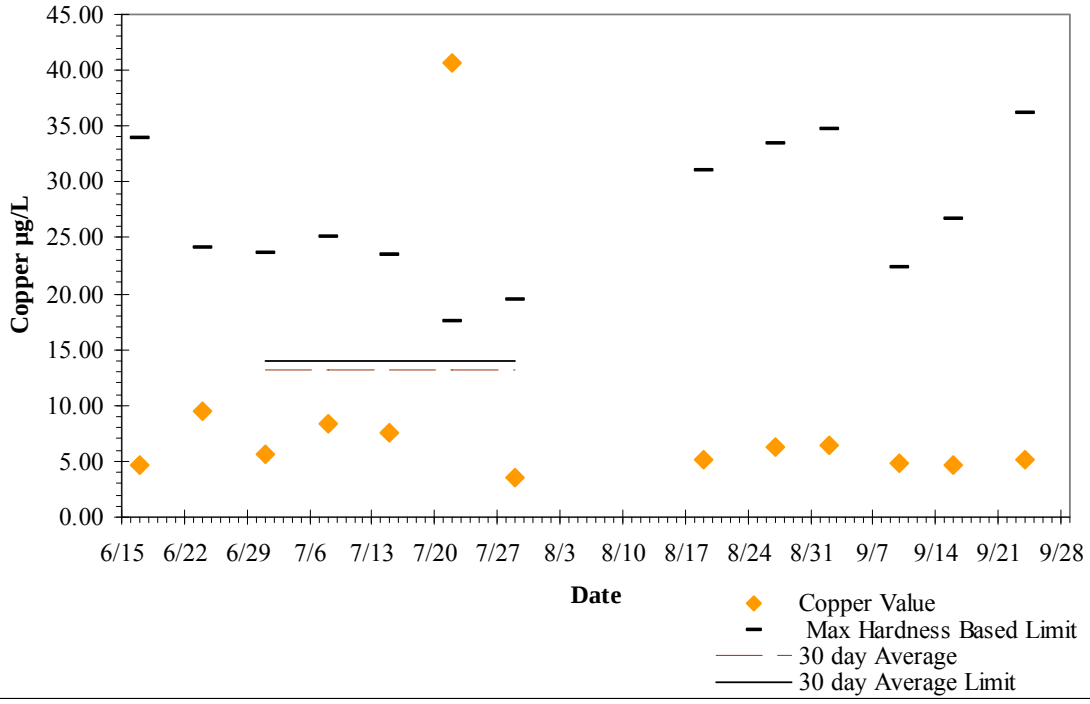
Stream Location	Latitude	Longitude	River Mile	Description	Purpose
Big Creek	N41.4460°	W81.6865°	0.15	Downstream of Jennings Road	Ohio EPA Permit No. 3PA00002*FD
Doan Brook	N41.5330°	W81.6296°	0.75	Downstream of St. Clair Avenue	Ohio EPA Permit No. 3PA00002*FD
Euclid Creek	N41.5833°	W81.5594°	0.55	Downstream of Lakeshore Avenue	Ohio EPA Permit No. 3PA00002*FD
Mill Creek	N41.4178°	W81.6387°	0.12	Upstream of Canal Road	Ohio EPA Permit No. 3PA00002*FD

Water Chemistry

Water chemistry samples were collected each week during the macroinvertebrate colonization periods. The techniques that were used for the water chemistry sampling and chemical analyses followed the *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices* (2006). Field analyses included the use of two meters during the sampling. An YSI-556 MPS Multi-Parameter Water Quality Meter was calibrated weekly and utilized to measure dissolved oxygen, pH, water temperature and conductivity. During the study, a Hanna HI 98129 was utilized for pH when the calibration failed to meet quality assurance and quality control (QA/QC) requirements on the YSI-556 MPS. Raw sampling field sheets and certificate of analysis are available upon request.

Of the 143 samples collected over thirteen weeks of sampling, only one exceedance of applicable outside mixing zone maximum (OMZM) water quality criteria for the protection of aquatic life occurred in 2008. . The exceedance occurred for copper at Doan Brook RM 0.75 on July 22, 2008. The exceedance result was 40.6 micrograms per liter (µg/L) of copper; with hardness based criterion of 17.53 µg/L. See Figure 1, which shows the results of copper along with the OMZM hardness based criterion, and for the month of July, the outside mixing zone average (OMZA) along with the OMZA hardness based limit. It was determined that an isolated thunderstorm on the east side of Cleveland caused high stream flows on that day that may have contributed to the water quality exceedence. Subsequent samples collected indicated no elevated occurrences for copper. No exceedances of 30-day OMZA water quality criteria for the protection of aquatic life occurred.

Figure 1. 2008 Copper Values from Doan Brook RM 0.75



The quality assurance and quality control of water sample collections included a sample duplicate and field blank during each sampling event. A total of thirteen (13) sample duplicates were obtained during the study. The sample duplicate results were compared to the sample results using relative percent difference (RPD), see Formula 1.

Formula 1)

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

X= is an individual parameter result from the sample
Y= is the same parameter as the sample but the result from the sample duplicate

The sample and the sample duplicate were compared for each of the 41 individual parameters reported on the Certificate of Analysis. After a RPD was calculated, any result over thirty percent was investigated to determine the reason for the discrepancy. A total of 29 discrepancies were found. Fifteen of the parameter values were less than 10 times the practical quantitation limit, and it was determined that the differences in concentrations from the relatively small numbers caused the increased RPD value. An additional eight parameter

discrepancies were associated with a wet weather sampling day[2]. The last six discrepancies could not be explained and are listed in Table 3. The accuracy of these results is suspect; however the results are still considered valid and should be averaged when used.

Table 3. Unexplained water quality discrepancies.

Stream	River Mile	Date Collected	Parameter	Units	Sample ID	Sample Result	Duplicate ID	Duplicate Result	RPD Value
Euclid Creek	1.65	7/22/2008	Iron	µg/L	R-0807220014	672	R-0807220024	1270	61.6
Euclid Creek	1.65	7/22/2008	Total Suspended Solids	mg/L	R-0807220014	24	R-0807220024	33	31.6
Big Creek	4.40	8/19/2008	COD	mg/L	R-0808190008	32	R-0808180026	9	112.2
Doan Brook	1.40	9/2/2008	Nitrate	mg/L	R-0809030003	0.36	R-0809020025	0.02	178.9
Doan Brook	1.40	9/2/2008	Iron	µg/L	R-0809030003	348	R-0809020025	63.2	138.5
Doan Brook	1.40	9/2/2008	Manganese	µg/L	R-0809030003	47.4	R-0809020025	6.8	149.8

Habitat Assessment

Methods and Results

Qualitative Habitat Evaluation Index scores (QHEI) were determined for each site in 2008. The QHEI, as described in Ohio EPA's, *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)* (2006) was used to assess aquatic habitat conditions at each sample location. While primarily used to supplement the fish community assessment health, the QHEI measures the quality of substrate, instream cover, channel morphology, riparian zone and bank erosion, pool/glide and riffle/run quality and gradient.

The majority of the sites scored in the *Good* range, while Mill Creek at South Miles (RM 8.30) scored *Excellent* and Big Creek (RM 4.70), Doan Brook (RM 0.75) and Euclid Creek (RM 2.70) scored *Fair* (Table 4). Those with scores of at least 60 met Ohio EPA's target for Warmwater Habitat (WWH) streams and are expected to be capable of meeting applicable biological criteria. QHEI sheets

[2] A wet weather day is defined as: 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 were considered wet weather samples.

for each site are available upon request. Relevant habitat characteristics for each site are discussed below.

Table 4.	
Qualitative Habitat Evaluation Index Scores	
Site Location	Score (Rating)
Big Creek RM 0.15	64(G)
Big Creek RM 4.40	66.5(G)
Big Creek RM 4.70	46.5(F)
Doan Brook RM 0.75	51(F)
Doan Brook RM 6.70	65(G)
Doan Brook RM 1.40	59(G)
Euclid Creek RM 0.55	68(G)
Euclid Creek RM 1.65	64.5(G)
Euclid Creek RM 2.70	58.5(F)
Mill Creek RM 0.12	68.75(G)
Mill Creek RM 8.30	73(E)

*Excellent (E), Good (G), Fair (F)

Big Creek

Big Creek RM 4.70 scored a 46.5 (*Fair*), this site is located off of West 150th Street north of Interstate 480. Gravel and muck were the main substrate types with sparse amounts of instream habitat cover. This section of the creek had a slow current velocity and was predominately a pool and glide habitat with no functional riffle present. The surrounding stream consists of urban industrial land use.

Big Creek RM 4.40 scored a 66.5 (*Good*). This site is located at the Cleveland Metroparks Memphis Picnic Area on the east branch, 100 feet upstream of the confluence of the west branch. The instream habitat cover consisted of shallows, rootmats, and boulders with sparse to moderate instream cover. Boulder and cobble were the main substrate types, and the creek had only a few pooled areas. Little to no stream bank erosion was apparent. This residential park setting site had a very narrow to moderate riparian width.

Big Creek RM 0.15 obtained a QHEI score of 64 (*Good)*. The habitat zone begins just downstream of the Jennings Road Pump Station CSO 045 and extends to approximately 300 feet upstream of the Cuyahoga River confluence. This section of Big Creek was primarily a gravel and cobble substrate with instream

cover consisting of undercut banks, shallows, rootmats, boulders and woody debris. Little to moderate erosion was noted along both banks. The land use in the area is primarily urban and industrial, and the riparian habitat width is very narrow.

All three Big Creek sites had similar QHEI scores in 2007.

Doan Brook

Doan Brook RM 1.40 scored a 59 (*Good)*. This site is located near Attleboro Road and is located on the south branch of the brook. Cobble and gravel were the best types of substrates present. Instream cover consisted of undercut banks, overhanging vegetation, shallows, and rootmats. The surrounding narrow riparian width consists of residential park use with the stream banks showing little to no erosion. This score was an improvement from a narrative rating of *Fair* in 2007.

Doan Brook RM 6.70 scored a 65 (*Good*). This site is located near Lee Road and is located on the north branch of the brook upstream of the Shaker Lakes Nature Center. Four substrate types were present and the best substrate type consisted primarily of cobble and gravel. This highly sinuous stream with fairly good channel development is surrounded by residential homes and a park setting. A *Good* rating was also obtained at this site in 2007.

Doan Brook RM 0.75 scored a 51 (*Fair*) in the QHEI scoring. This site is located north of St. Clair Avenue and east of Martin Luther King, Jr. Drive. This section of the brook is predominately a straight channel with no sinuosity. The fairly poor scoring is attributed to the poorly developed channel with poor pool development and no riffles present. Instream cover types such as boulders and pools greater than 70 centimeters were sparse or nearly absent. This site scored a 57 (*Good*) in 2007; the score was higher in 2007 because of the presence of a functional riffle.

Euclid Creek

Euclid Creek RM 2.70 obtained a score of 58.5 (*Fair*). The entire habitat zone was primarily bedrock with sparse instream cover consisting of shallows, deep pools, boulders, and logs. The moderately wide riparian zone was in a park setting. All three Euclid Creek sites scored the same narrative rating (*Good*) in 2007.

Euclid Creek RM 1.65 obtained a score of 64.4 (*Good*). The habitat zone begins about 10 feet south of the St. Clair Avenue Bridge and extends upstream. Cobble and gravel were the best types of substrates present. Instream cover

consisted of overhanging vegetation, shallows, deep pools, boulders and logs. The surrounding moderately narrow riparian width consists of residential park use with the stream banks showing moderate erosion.

Euclid Creek RM 0.55 scored 68 (*Good*). This site is located about 300 feet downstream of Lakeshore Boulevard. This section of Euclid Creek was primarily a cobble and sand substrate with instream cover consisting of undercut banks, overhanging vegetation, shallows, deep pools, rootmats, boulders and woody debris. Very little instream cover was present. The pool, riffle and run quality was very good with pools and runs greater than 3 feet deep and riffle depths about 4 inches.

Mill Creek

Mill Creek RM 8.30 scored a 73 (*Excellent)*. The habitat zone begins approximately 500 feet upstream of the South Miles Road Bridge. Boulders and sand were the best types of substrates present. Small to moderate amounts of undercut banks, overhanging vegetation, shallows, deep pools, boulders, logs and rootmats and rootwads were present. The surrounding very narrow riparian width consists of urban industrial land use with the stream banks showing little to no erosion. Moderately developed stable riffles were present in the habitat zone. This site improved to *Excellent* from *Good* in 2007.

Mill Creek RM 0.12 obtained a QHEI score of 68.75 (*Good)*. This site is located on the main stem of Mill Creek, approximately 600 feet upstream of the confluence with the Cuyahoga River. This section of Mill Creek was primarily a gravel and sand substrate with instream cover consisting of overhanging vegetation, shallows, deep pools, rootmats, rootwads, boulders and woody debris. Very little instream cover was present.

Electrofishing

Methods

Electrofishing passes were conducted one time at each headwater site (drainage area < 20 square miles) and two times at each wading site (drainage area 20-500 square miles) in 2008. Sampling was conducted using longline electrofishing techniques and consisted of shocking all habitat types within a sampling zone, which was either 0.15 or 0.20 kilometers in length, while moving from downstream to upstream. The methods that were used followed Ohio Environmental Protection Agency protocol methods described in *Biological Criteria for the Protection of Aquatic Life, Volume III: Standardized Biological*

Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities (Updated September 30, 1989; November 8, 2006; and August 26, 2008). Fish were identified to species level, counted, and examined for the presence of external anomalies including deformities, erosions, lesions, and tumors (DELTs). The results from this sampling were used to calculate Index of Biotic Integrity (IBI) and, if applicable, Modified Index of Well-Being (MIwb) scores for each site.

Results

Table 5 shows the IBI and, where applicable, MIwb scores that were calculated for each site. A list of the species, numbers, weights, pollution tolerances and incidence of DELT anomalies for fish collected during the electrofishing passes at each site is available upon request.

Table 5. 2008 IBI and MIwb Scores

			IBI Scores			MIwb Scores		
Stream	RM	Type	Pass 1	Pass 2	Average	Pass 1	Pass 2	Average
Big Creek	0.15	Wading	34	30	32	6.9	6.3	6.6
Big Creek	4.40	Headwater	32	---	32	---	---	---
Big Creek	4.70	Headwater	12	---	12	---	---	---
Doan Brook	0.75	Headwater	22	---	22	---	---	---
Doan Brook	6.70	Headwater	20	---	20	---	---	---
Doan Brook	1.40	Headwater	22	---	22	---	---	---
Euclid Creek	0.55	Wading	30	26	28	7.6	7.1	7.4
Euclid Creek	1.65	Wading	22	24	23	6.5	5.9	6.2
Euclid Creek	2.70	Wading	28	24	26	6.9	6.3	6.6
Mill Creek	0.12	Headwater	24	---	24	---	---	---
Mill Creek	8.30	Headwater	20	---	20	---	---	---

Big Creek

The site at Big Creek RM 4.70 had the lowest IBI score of the three Big Creek sites. This site is designated as Limited Resource Water (LRW) and no biocriteria apply, however the IBI was evaluated for comparison to other sites. With a score of 12, it fell into the narrative range of *Very Poor*. This extremely low fish community score was attributed to the fish community population being composed of northern fathead minnow, common white sucker, and goldfish, which are highly pollution tolerant species. Habitat limitations include slow moving water with no functional riffle present.

The site at RM 4.40 had an IBI score in the *Fair* range. An IBI score of 32 was obtained at this site. IBI metric scores revealed four metrics receiving the highest score of five. The highest scores were obtained in the following: Number of Minnow Species, Proportion of Pioneering Species, Number of Individuals, and Proportion of DELT Anomalies. Additionally, a total of seven minnow species were collected at this site, including nine bigmouth shiners. The bigmouth shiner is limited in its distribution in Ohio streams inhabiting only the Rocky and Black River. It is listed as a threatened species by the Ohio Division of Wildlife. It is also intermediately tolerant to pollution (USEPA's *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers, July 1999, second edition*).

The downstream site at RM 0.15 is a wading site; therefore, two electrofishing passes were conducted in 2008. The average IBI score and MIwb score were both in the *Fair* range. IBI scores of 34 and 30 were obtained on August 18, and September 19, 2008, respectively. The Proportion of Top Carnivores received a high score during the first pass with the collection of smallmouth and largemouth bass. No DELT anomalies were recorded on either of the two electrofishing passes.

Doan Brook

All three sites on Doan Brook received a narrative rating of *Poor* in the IBI scores. At RM 6.70, an IBI score of 20 was obtained, and green sunfish, creek chubs, and western blacknose dace, all highly pollution tolerant species, were collected. A score of 22 was obtained at RM 1.40 and only green sunfish were collected. Both sites lacked functional riffles and have fair channel development. The site at RM 1.40 is also located upstream of a lake that could be impeding fish movement. All of these things may be contributing to the poor IBI scores at these sites.

Doan Brook RM 0.75 obtained an IBI score of 22. With the exception of the northern bluegill sunfish, the majority of fish collected were highly pollution tolerant or hybrid fish. Six different species were collected at this site with a total of twenty-six fish collected. Although the guidelines for low-end IBI scoring was not applied because greater than twenty-five total fish were collected, the metric that scored very well at this site was the proportion of pioneering species. The main limitations to a healthy fish population include channelization, poor development, and sparse instream cover.

Euclid Creek

Euclid Creek RM 2.70 had average IBI and MIwb scores in the *Poor* range. This site scored very well in the proportion of omnivores and number of DELTs during the two electrofishing passes that were conducted. An IBI score of 28 and

24 were obtained on August 21, and October 10, 2008, respectively. The fish community composition consisted of common white suckers, western blacknose dace, northern creek chubs, northern fathead minnows, bluntnose minnows, central stoneroller minnows, pumpkinseed and green sunfish. The central stoneroller minnow was the dominant fish, comprising twenty-seven percent of the total fish collected.

Euclid Creek RM 1.65 scored poorly in the IBI fish community score and *Fair* in the MIwb scoring. An IBI score of 22 and 24 and MIwb of 6.5 and 5.9 were obtained on August 13, and September 19, 2008, respectively. The fish community composition consisted of common white suckers, western blacknose dace, northern creek chubs, northern fathead minnows, bluntnose minnows, central stoneroller minnows, and a hybrid bluegill/pumpkinseed sunfish.

Euclid Creek RM 0.55 had an average IBI score in the *Fair* range. An IBI score of 26 and 30 and MIwb of 7.6 and 7.1 were obtained on July 18, and October 9, 2008, respectively. Twenty-one species of fish were collected at this site during the two electrofishing passes. Some of the pollution-sensitive species collected were the mimic shiner, sand shiner, golden redhorse and brook silverside. With the exception of the mimic shiner, the other fish were moderately intolerant to pollution. Of more importance is the collection of the mimic shiner, which is designated a "common intolerant" species. Mimic shiners (*Notropis volucellus*) are found in streams of highest quality (Ohio EPA's *Biological Criteria for the protection of Aquatic Life Volumes II (*1987, Updated January 11,1988) and III (1989)). This fish is also a designated Exceptional Warmwater Habitat characteristic species and its presence shows exceptional diversity and biotic integrity in a stream (Ohio EPA's *VAP Biocriteria Training Manual Biocriteria Program overview, Fish Sampling Methods July, 1998*).

The IBI metrics that scored good at this site were the number of individuals, the number of native fish, sunfish species, and sucker species that were collected. Also scoring well was the proportion of omnivores, carnivores, simple lithophils, and DELT anomalies.

Mill Creek

The site at Mill Creek RM 8.30 yielded an IBI score in the *Poor* range. This score is indicative of the four fish species that were obtained during the electrofishing pass. The four fish species consisted of the western blacknose dace, creek chub, northern fathead minnow and green sunfish, which are all pollution tolerant species. An excellent QHEI score (73) was obtained at this site, however, with the site being adjacent to a landfill, stormwater runoff from the landfill may be impeding higher fish community scores.

The site at RM 0.12 also had an IBI score in the *Poor* range. An IBI score of 24 was obtained at this site. The Proportion of Pioneering Species and Proportion of DELT Anomalies received a score of 5. The total number of common white suckers, creek chubs, yellow bullheads, and blacknose dace comprised fifty-five percent of the total fish collected, and this decreased the overall IBI score because these species are highly tolerant to pollution.

Macroinvertebrate Sampling

Methods

Macroinvertebrates were sampled quantitatively for two six-week periods in 2008 using a modified Hester-Dendy (HD) sampler in conjunction with a qualitative assessment done during retrieval. The modified HD is a type of passive sampling that has been utilized by the Ohio Environmental Protection Agency (Ohio EPA) since 1973[3].

The overall aquatic macroinvertebrate community was evaluated using Ohio EPA's Invertebrate Community Index (ICI). The ICI consists of ten functional and structural community metrics based on drainage, each with four scoring categories. Metrics 1-9 are based on the quantitative sample, while Metric 10 is based on the number of mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) in the qualitative sample. Metric 10 is often referred to as the EPT Taxa. The total of the individual metric categories determine the ICI score; where the higher the ICI score, the less of a deviation from relatively unimpacted reference sites utilized by the Ohio EPA.

If a quantitative sample was not collected, then a qualitative sample was collected in its place and compared to a Qualitative Community Tolerance Value (QCTV) score. A tolerance value is the median value of the weighted ICI scores for sites in which a specific taxon was found. The median of all tolerance values for a sample equals the QCTV score. Higher QCTV scores relate to the presence of taxa associated with high ICI scores (good water quality); and the lower the QCTV score, the more likely that the taxa present reflects low ICI scores (poor water quality).

Quantitative and qualitative macroinvertebrate samples were shipped to EA Engineering, Science and Technology for identification and enumeration.

[3] DeShon, J.E. Development and Application of the Invertebrate Community Index (ICI). In: Davis and Simon, editors. Biological assessment and criteria, tools for water resource planning and decision making. Boca Raton, FL: Lewis Publishers; 1995. p 217-43.

Specimens were identified to the lowest practical taxonomic level and whenever possible, to the level of taxonomy recommended in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volume III* (1987, updated September 30, 1989; November 8, 2006; and August 26, 2008). The taxa lists and enumerations are available upon request.

Results and Discussion

NEORSD has been sampling Big Creek, Doan Brook, Euclid Creek and Mill Creek for macroinvertebrates since the mid- to late 1990s. Upstream sites were added in 2002 to understand the macroinvertebrate communities not impacted by NEORSD CSOs. The aquatic life habitat use designation for each site is WWH, except for Big Creek River Mile (RM) 4.70, which is LRW. An ICI score of 34 is considered to be in attainment for the WWH biocriterion, within the Erie/Ontario Lake Plain ecoregion. Non-significant departure from attainment, which is ≤4 ICI units, is also considered as being in attainment. LRW does not have a biocriterion for macroinvertebrates, so the results from Big Creek RM 4.70 were evaluated against the WWH biocriterion for comparison purposes only.

The ICI is a complex system of measurement or classification. In order for a direct comparison of the ICI results, some deployment recommendations should be adhered to. During deployment, if the flow for a HD is under 0.3 feet per second (fps), the data should be used with caution. This is because the stream flow over the HD has been determined to have one of the greatest influences on the macroinvertebrate community represented, the other being water quality.[4] The ICI metrics are also not calibrated to drainage areas less than 10 square miles. Due to the inability to score such locations, the drainage areas that were less than 10 square miles were calculated as 10 square miles. Even though there are problems with utilizing this measurement system on some of the samples collected, the information collected was used to determine temporal and spatial trends or relationships between multiple years.

Big Creek

Overall, the Big Creek sites in 2008 showed little variation from the previous sampling season. Table 6 shows the ICI scoring and the narrative rating for each of the Big Creek sites.

[4] DeShon, J.E. Development and Application of the Invertebrate Community Index (ICI). In: Davis and Simon, editors. Biological assessment and criteria, tools for water resource planning and decision making. Boca Raton, FL: Lewis Publishers; 1995. p 217-43.

Table 6. 2008 Big Creek ICI Scores

Stream	River Mile	Drainage Area (mi²)	First colonization	Narrative Rating	Second colonization	Narrative Rating	Average ICI Score
Big Creek	0.15	37.1	18[c]	*fair*	22	*fair*	20
Big Creek	4.40	19.3	36[e]	*good*	-[a]	-[d]	36
Big Creek	4.70	4.3[b]	12[c]	*poor*	12	*poor*	12

[a]No HD was collected.
[b]Drainage area of site is less than 10 square miles.
[c]During either retrieval or installation, the flow over the HDs was less than 0.3 fps.
[d]The QCTV score suggests a *Fair* to *Poor* range and that WWH use is not being achieved.
[e]WWH attainment is being achieved.

Even though Big Creek RM 4.70 had an ICI score of 12, this site showed dramatic improvement compared to the past several years. The LWR site never achieved an ICI score above a six during any colonization period. The individual metrics were also compared with the historical results; the major difference in 2008 was the collection of caddisflies, noted during both colonization periods on the HD.

Big Creek RM 4.40 was in attainment for macroinvertebrates. The ICI score was above 34 and received a narrative rating of *Good*. This WWH biocriterion attainment occurred during the first deployment. As expected with any site in attainment, a relatively high proportion and abundance of pollution sensitive organisms was demonstrated in the scoring. However, no HD was obtained for the 2nd colonization period, due to the HD being out of the water. From the qualitative sampling, a QCTV score revealed that the WWH biocriterion, for macroinvertebrates, was not obtained. The change in narrative rating is believed to be due to construction of a temporary dam out of stream bed material and plastic sheeting just upstream of the HD. This structure created a pool the width of the stream and the flow of the creek, which resulted in the HD being completely out of water. The flow had changed in such a way that a large pool was created and the margins were no longer functional, along with the channeling of the flow. It is believed that if the dam was not constructed, then the scoring may have maintained attainment for both colonization periods.

Big Creek RM 0.15 had an average ICI narrative rating of *Fair*, which is in non-attainment of the biocriterion. The samples obtained in 2008 showed no signs of significant change from the previous sampling season. This site had no more than a four ICI unit change from 2008 to 2007 sampling season and showed no significant signs of change in taxa or abundance. According to a study done in

1983 by the Ohio EPA, a variation of four ICI units or less is deemed insignificant, and can be attributed to natural variation and/or sampling error.[5]

Doan Brook

Doan Brook scoring showed no variation from the previous sampling season. Table 7 shows the ICI scoring and the narrative rating for each of the Doan Brook sites.

Table 7. 2008 Doan Brook ICI Scores

Site	River Mile	Drainage Area (mi²)	First colonization	Narrative Rating	Second colonization	Narrative Rating	Average ICI Score
Doan Brook	0.75	9.1[b]	-[a]	-[d]	-[a]	-[d]	-
Doan Brook	1.40	3.4[b]	8[c]	*poor*	8[c]	*poor*	8
Doan Brook	6.70	1.2[b]	4[c]	*poor*	-[a]	-[d]	4

[a]No HD was collected.
[b]Drainage area of site is less than 10 square miles.
[c]During either retrieval or installation, the flow over the HDs was less than 0.3 fps.
[d]The QCTV score suggests that a *Fair* to *Poor* range and that WWH use is not being achieved.

Doan Brook RM 1.40 had a narrative rating of *Poor* and showed no signs of significant change from the previous sampling season. The organisms collected in 2008 were similar to those collected in 2007. During the 2nd colonization period, a natural gas well was being installed near the HD on river right. A three inch boring under the creek was going to be completed in order to attach the well to a 140 barrel storage tank on river left.

Doan Brook RM 6.70 had a narrative rating of *Poor* during the first colonization period and showed a decrease by four ICI units from the previous sampling season. The score indicated that the WWH biocriterion is not being achieved. The difference was the absence of Tribe Tanytarsini Midges. In 2007, this pollution intolerant midge made up almost fourteen percent of the sample, and none were found in 2008. An HD was not retrieved during the second colonization period, since it was buried downstream in a gravel bar. A QCTV score was completed on the qualitative sample and indicated that the score was indeterminate to conclude if attainment was being achieved. An indeterminate QCTV score is obtained when the result of the scoring falls between the 25-75 percentiles and no correlation to water quality can be made from the result.

[5] DeShon, J.E. Development and Application of the Invertebrate Community Index (ICI). In: Davis and Simon, editors. Biological assessment and criteria, tools for water resource planning and decision making. Boca Raton, FL: Lewis Publishers; 1995. p 217-43.

However, with the specific taxa collected and NEORSD best professional judgment, it is believed that the site was not meeting the WWH biocriterion.

Doan Brook RM 0.75 had no HDs retrieved during 2008 because they could not be found during retrieval. The QCTV scores suggested that attainment was not being met during both collections. In 2007, a narrative rating of *Fair* was obtained. During examination of the qualitative sampling and field sheets for both years, the results appeared to be similar.

Euclid Creek

The Euclid Creek sites showed little overall variation from the previous sampling season. Table 8 shows the ICI scoring and the narrative rating for each of the Euclid Creek sites.

Table 8. 2008 Euclid Creek ICI Scores

Site	River Mile	Drainage Area (mi²)	First colonization	Narrative Rating	Second colonization	Narrative Rating	Average ICI Score
Euclid Creek	0.55	23.0	16[c]	*fair*	8	*poor*	12
Euclid Creek	1.65	21.8	26[c]	*fair*	26[c]	*fair*	26
Euclid Creek	2.70	21.4	30[c, f]	*marginally good*	26	*fair*	28

[c]During either retrieval or installation, the flow over the HDs was less than 0.3 fps.
[f]Score is in non-significant departure from meeting WWH attainment.

Euclid Creek RM 2.70 had an average narrative rating of *Fair*. The ICI scores during the 2008 sampling appeared to be consistent with the 2007 QCTV results. Also, no significant signs of change in taxa or abundance were noted. HDs for the 1st deployment were also in place almost 3 weeks longer than recommended, due to staffing issues.

Euclid Creek RM 1.65 had a narrative rating of *Fair*. The ICI scoring did not change from the previous sampling season. This site was added in 2007 to determine if there were any impacts from the City of Euclid between RM 2.70 and NEORSD CSOs. It was noted, however, that the HDs for the 1st deployment were in place almost 3 weeks longer than recommended, due to staffing issues. The Ohio EPA protocol for deployment of HDs is for six weeks. It is thought that by six weeks the HD community is in a steady state; however, the extra time may also allow a greater density of macroinvertebrates to colonize the HD and skew the metrics.

Euclid Creek RM 0.55 had an average narrative rating of *Poor* in 2008. This average narrative rating is a decrease from the 2007 average rating of *Fair*.

The major factor appeared to be the absence of caddisflies during HD retrieval. The HD is set in about three feet of water, where it is determined to be in a complete mix zone downstream of two storm water outfalls. This site is not the ideal placement of the HD, however, due to our permit requirement; it is the best possible location. Just upstream of the HD, a riffle is impacted by both outfalls; however during high flows, the outfalls are not completely mixed. This riffle produced many of the Ephemeroptera and Trichoptera for the qualitative sampling. During the 2008 field season, the riffle substrate changed from dominantly gravel to sand. The deposition of sand at the riffle changed the habitat to a run that went from being about 15 feet wide to only about 2 feet wide. The sand also deposited on the HD, and when retrieved, was noted to have moderate to heavy silt and solids. This deposition of sand most likely contributed to the negative scoring.

Mill Creek

Mill Creek RM 0.12 showed signs of improvement from the previous sampling season. Mill Creek RM 8.30 also appears to be in the early stages of recovery. Table 9 shows the ICI scoring and the narrative rating for each of the Mill Creek sites.

Table 9. 2008 Mill Creek ICI Scores

Site	River Mile	Drainage Area (mi^2)	First colonization	Narrative Rating	Second colonization	Narrative Rating	Average ICI Score
Mill Creek	0.12	19.5	30[f]	*marginally good*	32[f]	*marginally good*	31
Mill Creek	8.30	3.9[b]	18[c]	*fair*	24	*fair*	21

[b]Drainage area of site is less than 10 square miles.
[c]During either retrieval or installation, the flow over the HDs was less than 0.3 fps.
[f]Score is in non-significant departure from meeting WWH attainment.

Mill Creek RM 8.30 had an average narrative rating of *Fair*. This site showed signs of improvement, with the 2nd colonization period showing the most improvement. Three types of trichoptera taxa were collected on the HD, which made up almost three percent of the total abundance of organisms on the HD. Ephemeroptera were also found in both the quantitative and qualitative assessments.

Mill Creek RM 0.12 was in non-significant departure from attainment with a *Marginally Good* narrative rating, during both colonization periods. This is the first time that this site has had both colonization periods attaining the WWH

biocriterion. The abundance and percentage of Ephemeroptera, Trichoptera, and Diptera (flies) taxa accounted for the site meeting attainment of the biocriterion.

Comparisons among Streams

Figure 2 shows the variability of ICI scores for each site, using the averaged ICI score (when appropriate) each year from 2002 through 2008. In the six years of collecting two HD's per site, as much as a 16 score swing has been demonstrated multiple times. It is unknown what causes such variability, however some explanations of the variability includes acute and chronic stresses such as: flow regime; flow over the HDs; small drainage area; amount of precipitation during deployment; construction in the area affecting the site; and/or the difference in colonization periods.

The difference in colonization periods (1st and 2nd) were examined at each site, see Figure 3. For use of the ICI metrics, the Ohio EPA states that the HD colonization period should be between mid-June and the end of September. The Ohio EPA further confines their retrieval period from mid-August to the end of September to minimize the possibility of seasonal variability.[6] The eleven sites with scores between the two different colonization periods were examined. Taking into account that non-significant departure of an ICI scoring is four metric units, the only site that shows a difference greater than four is Mill Creek RM 0.12. The 1st colonization period median score demonstrates a six unit increase from the 2nd period. Big Creek RM 4.40 and RM 0.15 and Doan Brook RM 0.75 all showed a difference of four metric units. Doan Brook RM 1.40, Euclid Creek RM 2.70 and RM 0.55 showed no change over the two colonization periods.

[6] DeShon, J.E. Development and Application of the Invertebrate Community Index (ICI). In: Davis and Simon, editors. Biological assessment and criteria, tools for water resource planning and decision making. Boca Raton, FL: Lewis Publishers; 1995. p 217-43.

Figure 2. Intersite Variability 2002 through 2008

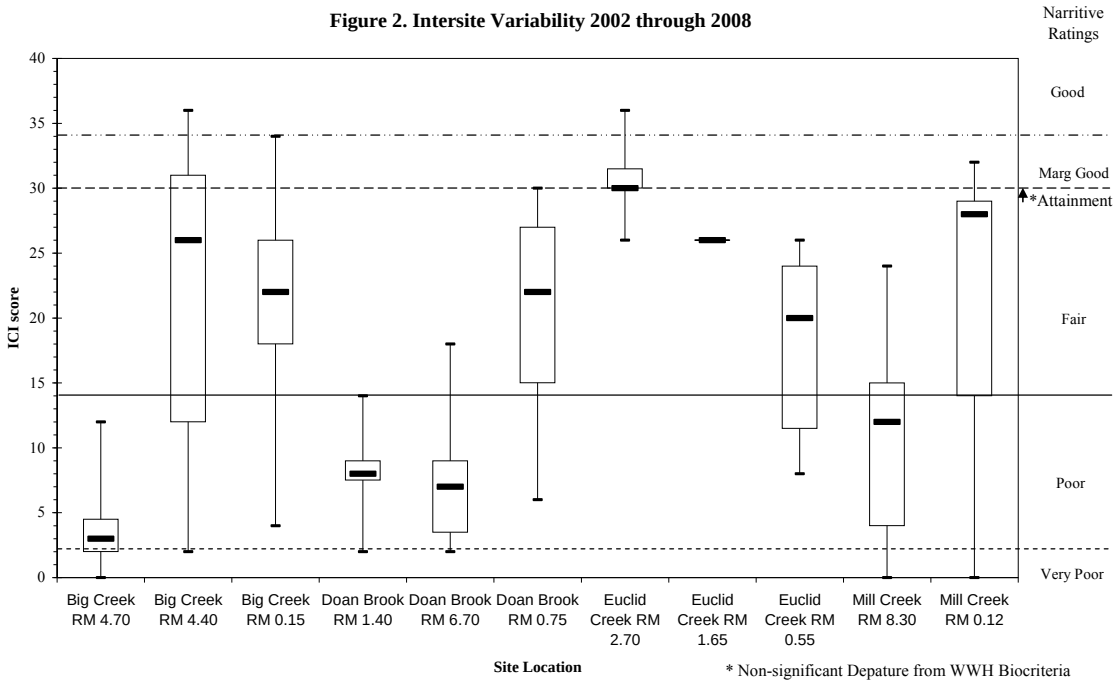
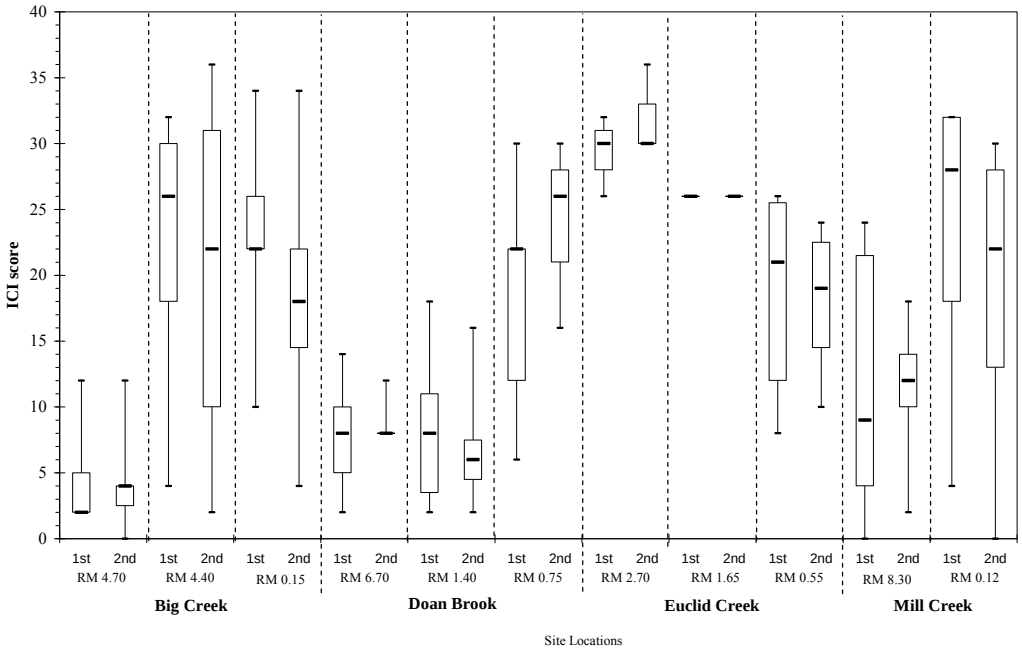


Figure 3. Seasonal Variability 2002 through 2008



The upstream sites were chosen because they are upstream of NEORSD CSOs. So, it would be expected that any of the downstream sites would demonstrate lower median scores if CSOs were having a negative impact on the streams. However, since they have different drainage areas, number of urban impacts and difficulty in obtaining the proper current velocities at some of the upstream sites, caution should be used in trying to make a direct comparison of all the scores. It would appear that while CSOs may be having some impact on benthic macroinvertebrate communities, other factors such as point/non-point sources, the lack of suitable macroinvertebrate colonization habitat and stream order could be causing even lower ICI scores upstream of the CSOs. Point sources with potential impact include sanitary sewer overflows, storm sewer outfalls, upstream tributaries and home sewage treatment systems. Non-point sources with potential impact include urban runoff, landfill leachate and spills.

Conclusions

In 2008, only Big Creek RM 4.40, Mill Creek 0.12 sites, and Euclid Creek RM 0.55 were in partial attainment status of the WWH biocriteria. The first two sites met the ICI criterion, while the Euclid Creek site met the criterion for the MIwb. Big Creek RM 4.70 is a LWR and has no biocriteria established. All of the other locations were in non-attainment status.

Discharges from combined and storm sewer outfalls may be one reason for the fish community to not be meeting warmwater habitat attainment in Euclid Creek. WQIS investigators continue to monitor the ongoing issue of elevated levels of *Escherichia coli* entering Euclid Creek via the outfalls between River Miles 0.55 and 2.70. These dry weather flows may be an indication of other pollutants that may negatively impact fish communities at these locations.

Overall, macroinvertebrate and fish communities at the downstream locations of all of the streams generally indicate nearly as good, if not better, water quality conditions than their respective upstream locations. This is supported by only one exceedance of water quality criteria for the protection of aquatic life. The ICI scores may be affected by the small drainage areas and slow flow velocities. Since these conditions are often also seen at the downstream sites, this may be an indication that CSOs are not the only variable adversely affecting the communities located downstream of the discharges. Continued monitoring of the streams may help to clarify what those variables are.