NORTHEAST OHIO REGIONAL SEWER DISTRICT

2017 Stickney Creek Restoration Environmental Monitoring: Biological, Water Quality, and Habitat Survey Results

Photo: Stickney Creek on June 15, 2017, River Mile 1.15

Prepared by
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Introduction

In 2017, the Northeast Ohio Regional Sewer District (NEORSD) conducted water chemistry sampling, habitat assessment, and fish and macroinvertebrate community surveys on Stickney Creek, a tributary to Big Creek in Brooklyn, Ohio. The objective of this study was to monitor the creek prior to a restoration project that will be completed in the near future. This project is currently in the pre-design phase, but may include relocating a reach of the stream to prevent it from causing structural damage to a nearby combined sewer, along with making habitat improvements. Once the restoration project is complete, additional monitoring will be conducted to determine any improvements in water quality, habitat, and biological communities that have occurred due to this project. The monitoring site is located at river mile (RM) 1.15, upstream of Ridge Road.

Stream monitoring activities were conducted by NEORSD Level 3 Qualified Data Collectors certified by the Ohio Environmental Protection Agency (EPA) in Fish Community Biology, Benthic Macroinvertebrate Biology, Chemical Water Quality, and Stream Habitat Assessment as explained in the NEORSD Study Plan *2017 Stickney Creek Restoration Environmental Monitoring*, and was approved by Ohio EPA on May 12, 2017. The results obtained from these assessments were evaluated using the Ohio EPA's Qualitative Habitat Evaluation Index (QHEI), Index of Biotic Integrity (IBI), and Invertebrate Community Index (ICI). Water chemistry data was validated per the methods outlined by the Ohio EPA (2015a) and compared to the Ohio Water Quality Standards for their designated use to determine attainment (Ohio EPA, 2017). An examination of the individual metrics that comprise the IBI and ICI was used in conjunction with the water chemistry data, and QHEI results to assess the health of the stream.

Table 1 lists the sampling location and its respective river mile, latitude/longitude, site description, and survey types conducted. Figure 1 is a map of the sampling location on Stickney Creek. A digital photo catalog of the sampling location is available upon request by contacting the NEORSD Water Quality and Industrial Surveillance (WQIS) Division.

Table 1: Stickney Creek Sampling location					
Location	**Latitude**	**Longitude**	**River Mile**	**Location Information**	**Purpose**
Upstream of Ridge Road	41.433399	-81.735081	1.15	Stickney Creek Upstream of Ridge Road	Evaluate water chemistry, fish and macroinvertebrate assemblages prior to stream restoration project

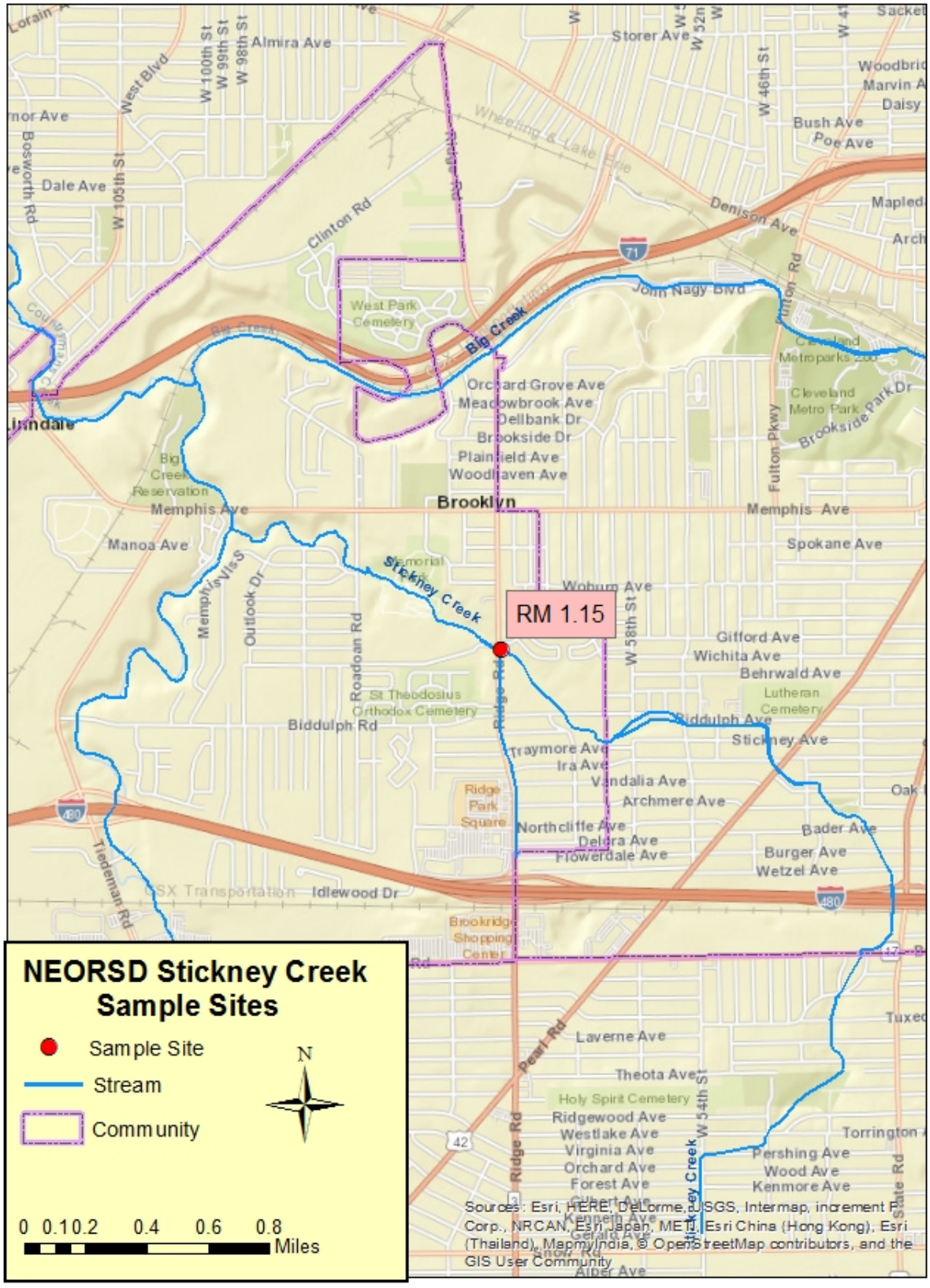

Figure 1. Sample Location

Water Chemistry Sampling

Methods

Water chemistry and bacteriological sampling was conducted five times on Stickney Creek at RM 1.15 in 2017. Techniques used for sampling and analysis followed the Ohio EPA *Surface Water Field Sampling Manual* (2015a). Chemical water quality samples 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 Polyvinyl Difluoride (PVDF) syringe filter. All water quality samples were collected as grab samples. Bacteriological samples were collected in sterilized plastic bottles preserved with sodium thiosulfate. At the time of sampling, measurements for dissolved oxygen, pH, temperature, and conductivity were collected using a YSI 600XL 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, 2015a).

Formula 2: 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.

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

Results and Discussion

Stickney Creek at RM 1.15 has been assigned an aquatic use designation described as warmwater habitat (WWH), agricultural water supply, industrial water supply, and primary contact recreation according to the Ohio EPA Water Quality Standards (2017). Over the course of five sampling events in 2017, there was one duplicate sample and one field blank sample collected as part of the study. The duplicate sample was collected on June 28 and contained nine parameters with RPDs greater than acceptable, which resulted in rejection of the data as shown in Table 2. Potential reasons for this discrepancy include lack of precision and consistency in sample collection and/or analytical procedures, environmental heterogeneity and/or improper handling of samples.

Table 2: 2017 Duplicate samples with greater than acceptable RPDs

Date	River Mile	Parameter	Acceptable RPD (%)	Actual RPD (%)	Qualifier
6/28/2017	1.15	Aluminum (Al)	22.0	49.7	Rejected
6/28/2017	1.15	Cobalt (Co)	42.1	44.3	Rejected
6/28/2017	1.15	Copper (Cu)	32.6	41.8	Rejected
6/28/2017	1.15	Iron (Fe)	17.7	49.1	Rejected
6/28/2017	1.15	Manganese (Mn)	17.4	47.4	Rejected
6/28/2017	1.15	Lead (Pb)	28.1	48.2	Rejected
6/28/2017	1.15	Titanium (Ti)	35.8	46.2	Rejected
6/28/2017	1.15	Total Phosphorus	19.3	28.2	Rejected
6/28/2017	1.15	Zinc (Zn)	27.3	40.7	Rejected

One field blank was collected on Stickney Creek on June 21. Table 3 lists two water quality parameters that qualified as "estimate" based on Ohio EPA (2015a) data validation protocol. It is unclear how the field blank results yielded contamination, but may have been the result of inappropriate sample collection, handling, or contaminated blank water and/or bottles.

Table 3: 2017 Data Qualified Based on Applicable Field Blank Comparison

Date	Parameter	Sample Result (ug/L)	Field Blank Result (ug/L)	Qualifier Added
6/21/2017	Nickel (Ni)	J 1.629	0.208	J*
6/21/2017	Titanium (Ti)	3.299	0.474	J*
*Estimated				

The bacteriological criteria for *Escherichia coli* (*E. coli*) consists of two components: a 90-day geometric mean and a value not to be exceeded in more than 10% of the samples collected during a 90-day period (statistical threshold value). For those streams designated primary contact recreation, these criteria are 126 colony counts or most-probable number (MPN)/100mL and 410 colony counts or MPN/100mL, respectively. Both criteria were exceeded at the sample site for all 90-day periods during

the study (Table 4). The *E. coli* exceedances that occurred on June 15, June 21, and July 12 are most likely due to recent significant wet-weather events where *E. coli* densities are generally found to be higher. There are many known illicit discharges tributary to Stickney Creek, which may greatly increase *E. coli* densities, that are currently being addressed. Other potential sources of bacteria to Stickney Creek could include failing household sewage treatment systems (HSTSs) and stormwater runoff.

Table 4: 2017 Stickney Creek *E. coli* Densities (Most-Probable Number/100mL)

Date	RM 1.15	90-Day Geomean
6/15/2017*	154,020	8,977
6/21/2017*	23,055	4,411
6/28/2017	2,113**	2,542
7/5/2017	2,153	2,788
7/12/2017*	1,080	7,195

*Wet-weather event
**Duplicate sample taken – results are averaged

Mercury analyses for all the sampling events were 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), therefore, it generally cannot be determined if the sites were in attainment of those criteria. This type of mercury sampling was used as a screening tool to determine whether contamination was present above the detection limit. Mercury exceedances of the human health nondrinking OMZA and the protection of wildlife OMZA criteria occurred during the study as the result on June 28 yielded a value above the minimum detection limit (Table 5). Sources of mercury contamination may be attributable to failing HSTSs, stormwater runoff, illicit discharges, and atmospheric deposition.

Table 5: 2017 Stickney Creek Mercury Concentrations (ug/L)

Date	RM 1.15
6/15/2017	<0.025*
6/21/2017	<0.025*
6/28/2017	j0.03*
7/5/2017	<0.025
7/12/2017	<0.025

Exceedance of Wildlife (0.0013 ug/L) and Human Health (0.0031 ug/L) OMZAs for 30-day period beginning on that date

* Wet-weather sampling events: greater than 0.10 inches of rain but less than 0.25 inches, samples collected that day and the following day are considered wet weather samples; greater than 0.25 inches, the samples collected that day and the following two days are considered wet weather samples.

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, 2015b).

While all the parameters necessary for SNAP were not assessed in 2017, some nutrients were assessed for general watershed monitoring purposes. Table 6 shows the results, as well as the seasonal geomeans and standard deviations, of all five sampling events in 2017. Table 2 of SNAP (Ohio EPA, 2015b) assesses a general ecological risk of nutrient enrichment based upon the dissolved inorganic nitrogen (DIN) and total phosphorus (TP) concentrations. The nutrient data from Stickney Creek was compared to Table 2 of SNAP, which yielded a narrative described as "levels typical of enriched condition; low risk to beneficial use if allied responses are within normal ranges; increased risk with poor habitat."

Table 6: Stickney Creek Nutrient Results used for 2017 SNAP Analysis

Sample Date	6/15/17	6/21/17	6/28/17	7/5/17	7/12/17	Geomean	Std Dev
Total Phosphorus (mg/L)	0.279	0.159	0.425*	0.218	0.208	0.243	0.103
DRP (mg/L)	0.172	0.117	2.63*	0.193	0.183	0.285	1.102
Dissolved Inorganic Nitrogen (mg/L)	1.759	1.394	1.204*	1.131	1.088	1.294	0.274

*Duplicate sample taken - results are averaged
Data used in Table 2 of SNAP (Ohio EPA, 2015b)

Table 7 below shows dissolved oxygen concentrations taken during all five sampling events. The field DO on June 15 exceeded the Aquatic Life OMZM & Tier I OMZM criterion as it was below 4.0 mg/L. There are many known illicit discharges of sanitary sewage tributary to Stickney Creek that are currently being addressed. Oxidizable wastes present in sanitary sewage can lead to depletion of dissolved oxygen in streams as they are metabolized by naturally occurring aerobic bacteria (California State University 2008). The elevated densities of bacteria, due to sanitary sewage, on this date may be consuming high quantities of oxygen which is measured as BOD, resulting in the low DO measurement.

Table 7: 2017 Dissolved Oxygen (DO) Concentrations

Date	Field DO (mg/L)	DO %	BOD (mg/L)
6/15/2017	3.9	42	14.8
6/21/2017	5.6	60	3.2
6/28/2017	7.6	79	<2.0
7/5/2017	8.1	89	<2.0
7/12/2017	7.0	78	<2.0

Exceedance of the Aquatic Life OMZM & Tier I OMZM

Habitat Assessment

Methods

An instream habitat assessment was conducted once at RM 1.15 in 2017 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 55 or more for headwater streams suggests that sufficient habitat exists to support a warmwater fish community (Ohio EPA, 2006). 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 QHEI score at Stickney Creek RM 1.15 was calculated at 59.75, which correlates to a *Good* narrative rating. This value exceeds the Ohio EPA's target score of 55 for headwater sites, which suggests that sufficient habitat exists to support a warmwater fish community (Ohio EPA, 2006). The most prominent substrate types present consisted of cobble and sand with a "normal" silt narrative. Sparse to moderate instream cover included undercut banks, overhanging vegetation, shallows, rootmats, rootwads, boulders and woody debris. Development of the riffle/pool complexes obtained a fair/good narrative indicating that riffles were present, but poorly developed, and a distinct transition between the pools and riffles habitats were observed. The sample site at RM 1.15 is one of the only unculverted sections of Stickney Creek, as the upstream sections are almost completely culverted and void of habitat. The zone had low sinuosity with no riparian width, both of which lowered the overall QHEI score.

Table 8 lists attributes defined by the Ohio EPA which have both positive and negative influences on the fish community. The negative influences have been identified as attributes that can have the greatest influence on whether the system can support a WWH fish community. Note that the habitat rating is to help determine if the habitat can support a robust fish community and does not necessarily reflect what type of community is found at the site.

The sample site contained seven WWH attributes, one high influence modified warmwater habitat (MWH) attributes, and four moderate influence MWH attributes as seen in Table 8. Based on the abundance of WWH attributes present, this site seems to have enough positive habitat attributes and suggests it is capable of supporting a WWH fish assemblage which is similar to the results found in the QHEI score.

Table 8: Stickney Creek Qualitative Habitat Evaluation Index Score and Physical Attributes

			MWH Attributes																													
			WWH 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 Sinousity	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. Dept <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**
1.15	59.75	*Good*	X	X		X		X	X		X	X	7				X		1					X	X				X	X		4

Electrofishing

Methods

Two quantitative electrofishing passes were conducted at RM 1.15 in 2017. The first pass on RM 1.15 was conducted on June 19, with the second pass on August 10. Sampling was conducted using the longline electrofishing techniques and consisted of sampling all habitat types within the zone while moving from downstream to upstream. The sampling zone was 0.15 kilometers. The fish sampling methods 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 to species, counted, 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.

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 twelve community metrics representing structural and functional attributes. The structural attributes are based upon fish community aspects such as fish abundance 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*.

Stickney Creek is a headwater stream located completely within the Erie-Ontario Lake Plains (EOLP) ecoregion and follows the EOLP IBI metric scoring. The 12 IBI metrics utilized for headwater sites are listed in Table 9. The WWH IBI scoring criterion in the EOLP ecoregion is 40 (Table 10) and a site is considered to be within non-significant departure of this criterion if the score falls within 4 IBI units of the criterion. Lists of the species diversity, abundance, pollution tolerances, and incidence of DELT anomalies for fish collected during the electrofishing passes at each site are available upon request from the NEORSD WQIS Division.

Table 9: IBI Metrics (Headwater)
Total Number of Native Species
Number of Darters & Sculpins
Number of Headwater Species
Number of Minnow Species
Number of Sensitive Species
Percent Tolerant Species
Percent Pioneering Species
Percent Omnivores
Percent Insectivores
Number of Simple Lithophils
Percent DELT Anomalies
Number of Fish

Table 10: IBI Ranges for EOLP Ecoregion							
Ohio EPA Narrative*	Very Poor	Poor	Fair	Marginally Good	Good	Very Good	Exceptional
IBI Score	12-17	18-27	28-35	36-39	40-45	46-49	50-60
	Non-Attainment			Attainment			
*Narrative scores for headwater sites							

Results and Discussion

In 2017, Stickney Creek RM 1.15 obtained an IBI score of 34 (*Fair*) and 36 (*Marginally Good*) as seen in Table 11. Even though this site obtained an average IBI score of 35, which is one point away from meeting the WWH IBI criterion, the second pass conducted on August 10 obtained a score that is within non-significant departure of the WWH IBI criterion (Ohio EPA, 1987a).

Table 11: Stickney Creek RM 1.15 IBI Scores	
Date	IBI Score
6/19/2017	34
8/10/2017	36*
*Nonsignificant Departure from WWH criterion	

The fish assemblage collected consisted of five species, four of which are listed as pollution-tolerant. No pollution-intolerant species and no darter species were collected. No DELT anomalies were found to be present on the fish collected. From the results of the habitat assessment, the QHEI score of 59.75 suggests that sufficient habitat exists to support a warmwater fauna. However, there may be other factors contributing to the non-attainment IBI score found on June 19. The Stickney Creek watershed is highly

developed and has been greatly altered from its naturally free flowing state. Degraded water quality indicated by high *E. coli* (Table 4) and low dissolved oxygen levels (Table 7) at RM 1.15 may be contributing to the abundance of pollution-tolerant fish species and the lack of pollution-intolerant species. Connectivity from Stickney Creek to the lower Big Creek and the Cuyahoga River is lost due to the John Nagy drop structure that acts as a fish barrier at Big Creek RM 2.10. Additionally, Stickney Creek is extensively culverted upstream of RM 1.15 and provides little to no habitat to support aquatic life beyond this reach.

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 the location listed in Table 1 in 2017. 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 specimens collected were sent to Third Rock Consulting (TRC) 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 NEORSD WQIS Division.

The macroinvertebrate sampling methods used followed Ohio EPA protocol methods as detailed in *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987a) and *III* (1987b). The overall aquatic macroinvertebrate community in the stream was evaluated using Ohio EPA's Invertebrate Community Index (ICI). 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 collected. The sum of the individual metric scores result in the overall ICI score. This scoring evaluates the macroinvertebrate community against Ohio EPA's reference sites for each specific eco-region. The WWH ICI criterion in the EOLP ecoregion is 34 (Table 13) and a site is within non-significant departure if the score falls within 4 ICI units of the criterion.

Table 12: ICI Metrics
Total Number of Taxa
Number of Mayfly Taxa
Number of Caddisfly Taxa
Number of Dipteran Taxa
Percent Mayflies
Percent Caddisflies
Percent Tanytarsini Midges
Percent Other Diptera and Non-insects
Percent Tolerant Organisms (As Defined)
Number of Qualitative EPT Taxa

Table 13: Invertebrate Community Index (ICI) Range for EOLP Ecoregion								
Ohio EPA Narrative	Very Poor	Poor	Low Fair	Fair	Marginally Good	Good	Very Good	Exceptional
ICI Score	0-6	8-12	14-20	22-28	30-32	34-40	42-44	46-60
	Non-Attainment				Attainment			

Results and Discussion

The ICI score at Stickney Creek RM 1.15 was calculated at 24, which correlates to a *Fair* narrative rating and does not meet the WWH attainment status (Ohio EPA 1987b).

A total of thirteen taxa were identified in the qualitative sample including one EPT taxon (*Baetis flavistriga)* and three species listed as pollution-tolerant. The most abundant organisms noted during field collection were Baetidae, Simuliidae, and amphipods. Baetidae was the predominant organism in the riffle, run, and pool habitats, and amphipods were the predominant organism in the margin habitat. Overall densities of these habitat specific organisms ranged from low to moderate. A total of thirty-one taxa were collected between the quantitative HD and the qualitative samples, nine of which are classified as moderately tolerant or tolerant to pollution according to the Ohio EPA Macroinvertebrate Taxa List (Ohio EPA, 2016). Four EPT taxa were collected including two mayfly species (*Baetis flavistriga* and *Tricorythodes sp*) and two caddisfly species (*Hydropsyche sp* and *Hydroptila sp)*. Pollution tolerance of the identified taxa ranged from facultative to tolerant. The majority of taxa were categorized as facultative (54.10%) and no pollution-intolerant taxa were collected. Sanitary sewage contamination, low velocity flows, low dissolved oxygen, and extensive urbanization may be contributing factors to the poor macroinvertebrate community assemblage in Stickney Creek.

Conclusions

The Ohio EPA has assigned Stickney Creek an aquatic life habitat use designation defined as WWH. According to the Ohio EPA (2017), warmwater habitats are capable of supporting and maintaining a balanced, integrated, adaptive community of warmwater organisms having a species composition, diversity, and functional organization comparable to the twenty-fifth percentile of the identified reference sites within its respective ecoregion. The results of water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys conducted by NEORSD indicate that the Stickney Creek watershed may be impacted by a variety of environmental stressors and various aquatic habitat limitations, as mentioned previously.

From water chemistry sampling, it was found that exceedances of the applicable water quality standards occurred for *E. coli* densities during all sampling events (Table 4), for DO (Table 7) on June 15, and for mercury on June 28. Failing HSTSs, stormwater runoff during wet-weather events, and illicit discharges are likely responsible for the elevated *E. coli* densities and low DO found in Stickney Creek.

Stream habitat in Stickney Creek was found to have many WWH physical attributes and received a QHEI score above 55, which suggests that sufficient habitat exists to support a warmwater fish community. Although the habitat received a "*Good*" narrative at RM 1.15, this narrative may not represent the entire Stickney Creek watershed as upstream reaches of the stream are completely culverted and void of habitat.

The fish community at RM 1.15 received narratives of *Fair* and *Marginally Good* during the two sampling events in 2017. Although the sampling event on August 10 was calculated to be within non-significant departure of the WWH biocriterion, the sampling event on June 19 was calculated to be two points below the WWH biocriterion and the average score failed to meet the IBI WWH biocriterion by one point (Ohio EPA 1987b). The fish assemblage consisted mostly of pollution-tolerant species, such as white sucker (*Catostomus commersonii*), blacknose dace (*Rhinichthys obtusus*), creek chub (*Semotilus atromaculatus*), and bluntnose minnow (*Pimephales notatus*). It should be noted that the John Nagy drop structure located downstream on Big Creek at RM 2.10 acts as a fish barrier and eliminates connectivity of Stickney Creek to Big Creek and the Cuyahoga River. Fish assemblages in Big Creek from RM 4.40 and 9.80, above the John Nagy drop structure, were sampled by NEORSD in 2016 and both received *Fair* narratives (IBI scores of 30). With similar fish assemblages observed in connected waterways, along with a predominately culverted stream, it is unlikely that the fish assemblage will greatly improve unless connectivity is restored, and water quality improves.

The macroinvertebrate community received a *Fair* narrative with an ICI score of 24 and failed to meet the ICI WWH biocriterion (Ohio EPA 1987b). The majority of taxa were categorized as facultative (54.10%) and no pollution-intolerant taxa were

collected during this study. Sanitary sewage contamination, low velocity flows, low dissolved oxygen, and extensive urbanization may be contributing factors to the poor macroinvertebrate community assemblage in Stickney Creek.

Stickney Creek did not meet the necessary standards for Aquatic Life Use and received non-attainment status at RM 1.15 during the 2017 sampling season (Table 14). The biological communities did not meet the WWH attainment criteria for fish or macroinvertebrates and numerous chemical water quality exceedances were observed.

Table 14: 2017 Stickney Creek Survey Results.

	River Mile	Aquatic Life Use Attainment Status	IBI Score	ICI Score	Habitat	Water Quality Exceedances
2017	1.15	NON	35*	24	59.75	*E. coli*, Dissolved Oxygen, Mercury
	Warmwater Habitat Criteria		40	34		
	Nonsignificant Departure from WWH Criteria		≤4	≤4		
	Target				55.00	
	*Average of the two fish sampling events					

Figure 2 below shows a watershed land cover map of the Stickney Creek watershed. Almost the entire Stickney Creek watershed is comprised of developed land with little to no forested land present. The extensive urbanization throughout the watershed may also be contributing to the poor water quality conditions that comprise Stickney Creek, therefore, contributing to the non-attainment status found in this study. Once the stream restoration project is complete, additional monitoring will be conducted to determine any improvements in water quality, habitat, and biological communities that have occurred due to this project.

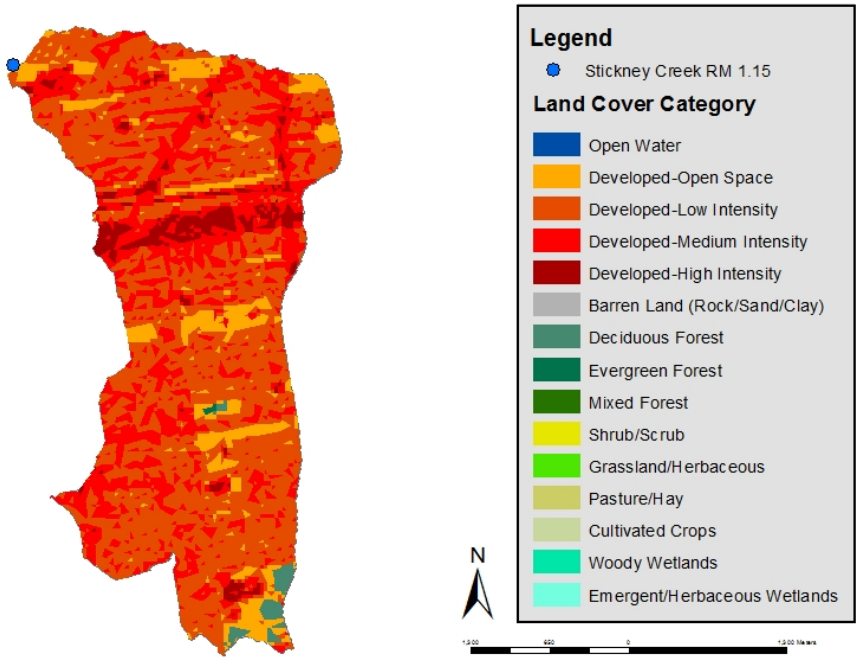

Figure 2: Stickney Creek RM 1.15 Watershed Land Cover Map

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