NORTHEAST OHIO REGIONAL SEWER DISTRICT

2014 Mill Creek Environmental Monitoring: Biological, Water Quality, and Habitat Survey Results

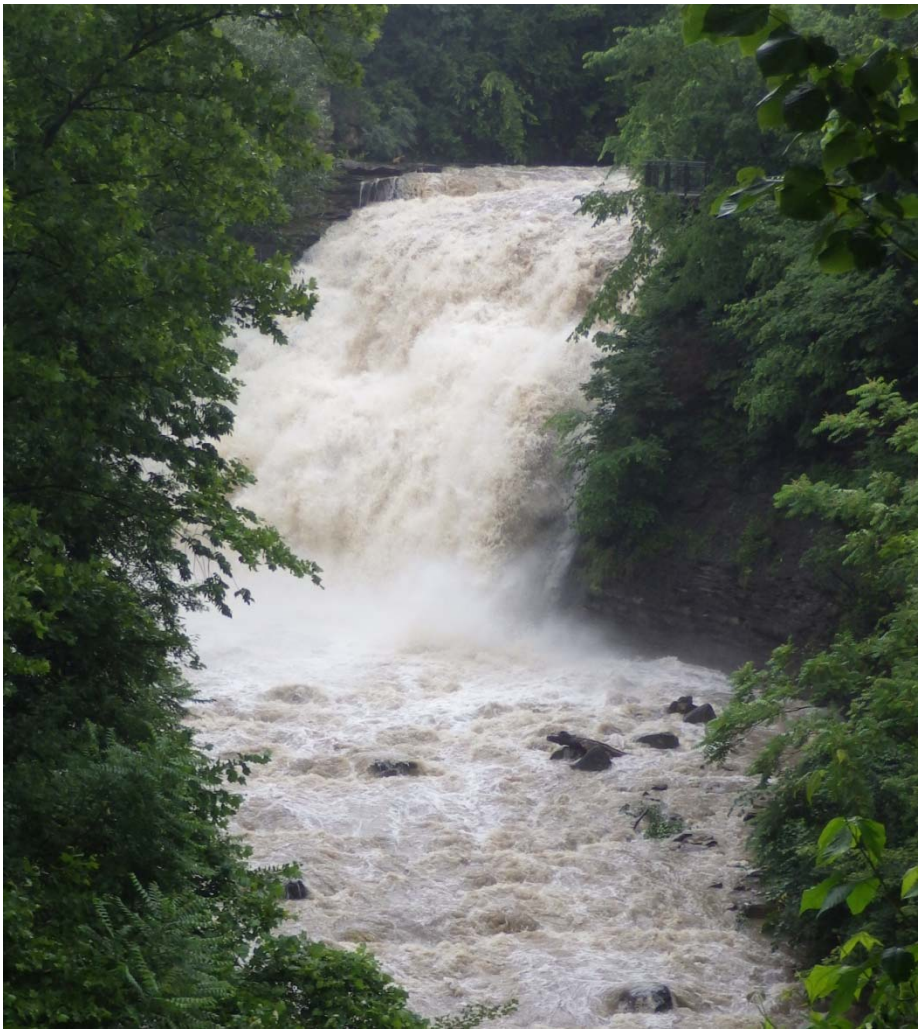


Photo: Mill Creek Falls on June 25, 2014, upstream of Mill Creek River Mile 2.75

Prepared by
The Water Quality and Industrial Surveillance Division

Introduction

In 2014, the Northeast Ohio Regional Sewer District (NEORSD) conducted stream monitoring activities at seven sites on Mill Creek, an urbanized tributary to the Cuyahoga River. NEORSD assessed habitat and water chemistry conditions and evaluated the health of the fish and benthic macroinvertebrate communities at each site. The purpose of the 2014 monitoring was to gain an overall picture of the health of the creek and evaluate potential impacts. The seven sites, which are along Mill Creek's Main Branch, were located at river miles (RM) 10.13, 8.30, 6.80, 3.15, 2.75, 0.70, and 0.12. Mill Creek has a natural waterfall preventing the upstream migration of fish at RM 2.80. The waterfall drops approximately 48-feet from the top to the bottom. These sites were first surveyed in 1995 as part of the Mill Creek Watershed Management Project, and were all surveyed yearly from 2011 to 2014.

The 2014 survey sites were in support of several NEORSD capital improvement projects designed to provide wet weather flow relief, stormwater storage capacity, and reduction/elimination of CSOs for several communities in the Mill Creek watershed. The Miles Avenue Relief Sewer (MARS) and the Lee Road Relief Sewer (LRRS) were completed in May 2012. The LRRS connects to the Mill Creek Tunnel, the third and final leg of which was completed in February 2013. In addition, NEORSD completed a bank stabilization project on Mill Creek near Warner Road (RM 0.30) in April 2013. The watershed monitoring surveys will assist in evaluating improvements in the health of Mill Creek as a result of these projects.

Stream monitoring activities were conducted at each site by NEORSD Level 3 Qualified Data Collectors certified by Ohio EPA in Fish Community Biology, Benthic Macroinvertebrate Biology, Chemical Water Quality, and Stream Habitat Assessment as explained in the NEORSD Study Plan *2014 Mill Creek Environmental Monitoring*, approved by Ohio EPA on July 10, 2014. 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 (2013a) and compared to the Ohio Water Quality Standards (Ohio EPA, 2011) to determine attainment of applicable uses. An examination of the biological information was used in conjunction with the water quality data and QHEI results in order to assess the health of the stream, and the results were compared to historical data to show temporal as well as spatial trends.

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

Table 1. 2014 Mill Creek Sampling Locations					
Location	Latitude	Longitude	River Mile	Location Information	Purpose[1]
Northfield Road	41.4460	-81.5312	10.13	Northfield Road	Evaluate overall watershed health, monitor in support of Capital Improvement projects
Upstream of South Miles Road	41.4305	-81.5442	8.30	Upstream of South Miles Road, upstream of Kerruish Park stormwater basin, first site upstream of NEORSD CSOs	Upstream of NEORSD CSOs, evaluate overall watershed health, monitor in support of Capital Improvement projects
Rex Avenue	41.4233	-81.5659	6.80	Rex Avenue, upstream of Wolf Creek, downstream of Kerruish Park stormwater basin	Evaluate overall watershed health, monitor in support of Capital Improvement projects
Upstream of Mill Creek Falls	41.4422	-81.6216	3.15	Broadway Avenue, upstream of Mill Creek Falls and downstream of Wolf Creek	Evaluate overall watershed health, monitor in support of Capital Improvement projects
Downstream of Mill Creek Falls	41.4451	-81.6271	2.75	Downstream of the Mill Creek Falls	Evaluate overall watershed health, monitor in support of Capital Improvement projects
Upstream of Warner Road Tributary	41.4240	-81.6376	0.70	Upstream of the Warner Road Tributary, adjacent to 5000 Warner Road	Evaluate overall watershed health, monitor in support of Capital Improvement projects
Upstream of Canal Road	41.4178	-81.6387	0.12	Upstream of Canal Road	Evaluate overall watershed health, monitor in support of Capital Improvement projects. Site required by Ohio EPA NPDES Permit No. 3PA00002*FD[2]

[1] Water Chemistry, habitat, fish, and benthic macroinvertebrates were evaluated at each site.
[2] Water chemistry and benthic macroinvertebrate monitoring was required at RM 0.12 by Ohio EPA NPDES Permit No. 3PA00002*FD.

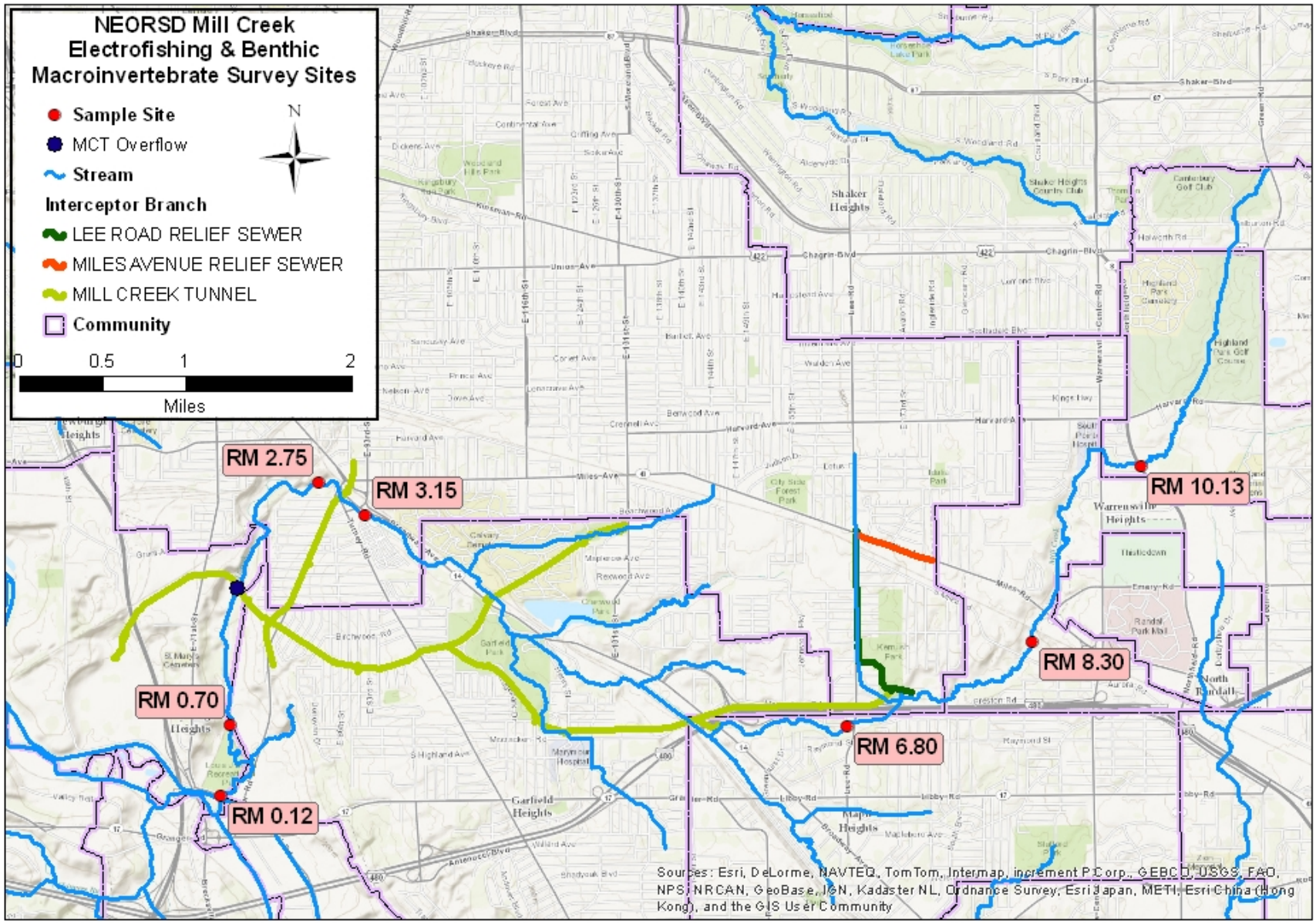


Figure 1. Sampling Locations

Water Chemistry Sampling

Methods

Water chemistry and bacteriological sampling was conducted five times on Mill Creek at RMs 10.13, 8.30, 6.80, 3.15, 2.75, 0.70, and 0.12. To fulfill permit requirements under Ohio EPA NPDES Permit Number 3PA00002*FD, a sixth sample was collected at RM 0.12 on July 22, 2014. Techniques used for sampling and analyses followed the Ohio EPA *Surface Water Field Sampling Manual* (2013a). Chemical water quality samples from each site were collected with a 4-liter disposable polyethylene cubitainer with a disposable polypropylene lid, three 473-mL plastic bottles and a 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 an YSI 600XL or EXO1 sonde. Duplicate samples and field blanks were each collected at randomly selected sites, at a frequency not less than 5% of the total samples collected. Relative percent difference (RPD) was used to determine the degree of discrepancy between the primary and duplicate sample (Formula 1).

Formula 1:
$$RPD = \left(\frac{|X-Y|}{((X+Y)/2)} \right) * 100$$

X= is the concentration of the parameter in the primary sample
Y= is the concentration of the parameter in the duplicate sample

The acceptable percent RPD is based on the ratio of the sample concentration and detection limit (Formula 2) (Ohio EPA, 2013a).

Formula 2: 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.

Mercury analysis for all of the sampling events was done using EPA Method 245.1. Because the detection limit for this method is above the criteria for the Human Health Nondrinking and Protection of Wildlife Outside Mixing Zone Averages (OMZA),

it generally cannot be determined if Mill Creek was 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 creek.

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

Results and Discussion

Two field blanks and two duplicate samples were collected during this study. For the field blanks, there were a total of five parameters that showed possible contamination. It is unclear how the field blanks became contaminated and may have been the result of inappropriate sample collection, handling, contaminated blank water and/or bottles. Table 2 lists water quality parameters that were qualified based on Ohio EPA (2013a) data validation protocol. It should be noted that not all seven sites were collected by the same sampling crew each event; two groups were sometimes utilized in order to more efficiently complete the water chemistry sampling. Field blanks were only compared to samples collected by the same crew on the same day for a single study plan.

Table 2. Data Qualified Based on Applicable Field Blank Comparison

RM	Date	Parameter	Sample Result	Field Blank Result	Qualifier
2.75	06/25/14	Alkalinity	24.3	j2.5	Estimated
2.75	06/25/14	COD	29	2.9	Estimated
2.75	06/25/14	DRP	0.068	j0.01	Estimated
2.75	06/25/14	Sb	j0.702	j0.104	Estimated
3.15	06/25/14	DRP	0.073	0.01	Estimated
3.15	06/25/14	Sb	j0.815	j0.104	Estimated
6.80	06/25/14	DRP	0.049	0.01	Level 2
6.80	06/25/14	Sb	j0.572	j0.104	Estimated
8.30	06/25/14	DRP	0.057	0.01	Estimated
8.30	06/25/14	Sb	j0.584	j0.104	Estimated
8.30	07/09/14	Zn	11.24	j1.3	Estimated
10.13	06/25/14	DRP	0.063	0.01	Estimated
10.13	06/25/14 *	DRP	0.059	0.01	Estimated
10.13	06/25/14	Sb	j0.528	j0.104	Estimated
10.13	06/25/14 *	Sb	j0.523	j0.104	Estimated
10.13	07/09/14	Zn	10.64	j1.3	Estimated

* Duplicate Sample.

Both of the duplicate samples collected had parameters in which the RPD between the sample results was greater than acceptable (Table 3). The difference in the metals on July 9, 2014, was the field crew did not have enough nitric preservative for the sample and the duplicate sample. Only one of the samples received preserved in the field for nitric acid, and could be the cause for the discrepancies. Potential sources of

contamination include lack of precision and consistency in sample collection and/or analytical procedures, environmental heterogeneity and/or improper handling of samples.

Table 3. Duplicate samples with greater than acceptable RPDs			
Rive Mile	Date	Parameters	Qualifier
0.70	07/09/14	Al	Reject
0.70	07/09/14	COD	Reject
0.70	07/09/14	Fe	Reject
0.70	07/09/14	Sn	Reject
0.70	07/09/14	Ti	Reject
0.70	07/09/14	Zn	Reject
10.13	06/25/14	TDS	Reject

An analysis of paired parameters for all sites showed only issues with samples listed in Table 4. The only parameters qualified by the comparison were the result of the total dissolved solid (TDS) being greater than the total solids (TS). The reason for the TDS being greater is unknown, but may be due to the fact that there are two separate methods for analyzing the individual parameters.

Table 4. Pair Parameters with greater than acceptable RPDs			
River Mile	Date	Parameters	Qualifier
0.12	07/02/14	TS/TDS	Estimated
0.70	07/02/14	TS/TDS	Estimated
2.75	07/02/14	TS/TDS	Estimated

Each of the seven sites on Mill Creek is designated as warmwater habitat (WWH), agricultural water supply, industrial water supply, and Class B primary contact recreation waters. Exceedances of the water quality standards associated with these uses occurred for multiple parameters. The bacteriological criteria for *E. coli* consist of two components: a seasonal geometric mean and a value not to be exceeded in more than 10% of the samples collected during a 30-day period (single sample maximum). For those streams designated Class B primary contact recreation, these criteria are 161 colony counts/100mL and 523 colony counts/100mL, respectively. The seasonal geometric mean criterion was exceeded at all seven sites (Table 5). The single sample maximum criterion was also exceeded in the majority of the 30-day periods that contained multiple samples at all of the sites. Wet-weather[1] sampling events coincided with many of the elevated bacterial levels found during sampling.

[1]NEORSD considers a sampling event to be affected by wet weather, when: 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.

Table 5. 2014 Mill Creek *E. coli* Densities (most probable number/100mL)							
Date	RM 10.13	RM 8.30	RM 6.80	RM 3.15	RM 2.75	RM 0.70	RM 0.12
06/18/14*	4,383	27,520	58,180	82,120	57,020	40,280	11,846
06/25/14*	22,439	24,547	23,254	41,463	33,586	77,100	63,100
07/02/14	1,412	2,938	340	370	722	213	255
07/09/14*	4,066	8,702	12,346	12,760	10,779	12,380	11,281
07/16/14*	2,060	5,957	9,460	1,955	1,662	924	1,492
07/22/14	--	--	--	--	--	--	108
Seasonal Geomean	4,103.26	10,057.01	8,831.48	7,933.44	7,564.61	5,967.37	2,650.21
*Wet-weather event -- No sample collected							

On June 16, 2014, NEORSD personnel discovered a sanitary sewer overflowing to an unnamed tributary of Mill Creek, which enters Mill Creek at RM 5.30. The overflow was estimated at approximately 20,000 gallons per day and a sample just downstream of the discharge recorded over 120,000 most probable number (MPN)/100mL of *E. coli*. The sewer was cleared of a blockage and returned to working as intended on August 8, 2014. This collection system failure impacted the stream and ultimately the downstream sampling locations; however, to what extent is not known.

Mercury analysis for all of the sampling events was performed using EPA Method 245.1. The detection limit for this mercury method is above the Human Health Nondrinking Water and Protection of Wildlife Outside Mixing Zone Averages (OMZA), so it generally cannot be determined if the water body was in attainment of those criteria. Instead, this type of mercury sampling was used as a screening tool to determine whether contamination was present above the detection limit. Each site had at least one mercury result above the method detection limit (MDL). However, no site had more than two samples above the MDL and only one sample result was recorded above the practical quantitation limit (RM 0.12 on 06/25/14).

Exceedances occurred for two other parameters during the sampling in 2014. On June 25th, the copper outside mixing zone maximum (OMZM) for the protection of aquatic life was exceeded at six of the sampling locations (Table 6). The concentration that was measured at RM 0.12 also resulted in an exceedance of the outside mixing zone average (OMZA) for the 30-day period from June 18th-July 17th. There was also an exceedance of the zinc OMZM for the sample that was collected on June 25th at RM 0.12. June 25th was considered a wet-weather sampling event and therefore, the cooper and zinc that was found there may have been due to that.

Table 6. 2014 Mill Creek Parameter Exceedances					
RM	Date (Range)	Parameter	Type	Result	Criterion
0.12	06/25/14	Cu	OMZM	46.34	15.84
0.12	06/18/14-07/17/14	Cu	OMZA	17.7	17.27
0.12	06/25/14	Zn	OMZM	161.5	133.88
0.70	06/25/14	Cu	OMZM	28.07	15.18
2.75	06/25/14	Cu	OMZM	18.67	13.74
3.15	06/25/14	Cu	OMZM	15.8	13.87
6.80	06/25/14	Cu	OMZM	12.97	12.41

In 2013, the Ohio EPA released a draft Trophic Index Criterion (TIC) designed to determine a water body's condition relative to nutrient enrichment. According to the draft document, the index identifies and ranks the following items: nutrients; periphyton; dissolved oxygen swings; and the biological communities (Ohio EPA, 2013b). NEORSD did not look at periphyton densities or dissolved oxygen swings during this study, but did measure nutrient values. The nutrient targets are assigned based on the water body's designated aquatic life use and its Qualitative Habitat Evaluation Index (QHEI) score. Warmwater habitat sites fall into two categories and the TIC suggests target values for both total phosphorus (TP) and dissolved inorganic nitrogen (DIN), which includes ammonia, nitrate and nitrite. The first category reflects sites with QHEI scores between 12 and 64 and sets target values of 0.13 milligram per liter (mg/L) for TP and 3.0 mg/L for DIN. The second category reflects all other QHEI scores and has target values for TP and DIN of 0.30 mg/L and 3.0 mg/L, respectively. Other parameters that are important for nutrient assessment are dissolved reactive phosphorus (DRP) and total Kjeldahl nitrogen (TKN); the results for the nutrient averages can be found in Table 7. In terms of bioavailability, DRP is the most readily available form of phosphorus, whereas TKN is a fraction of total nitrogen that remains unavailable. Only the average TP target for RM 10.13 was not met during the 2014 sampling. However, as shown below in the Habitat Assessment Section, the QHEI score was close to being in the second category and the site would have met that target value.

Table 7. 2014 Mill Creek Average Nutrient Concentrations (mg/L)									
	Targets		RM 10.13	RM 8.30	RM 6.80	RM 3.15	RM 2.75	RM 0.70	RM 0.12
Category	1	2	1	2	2	2	2	2	2
TP	0.13	0.30	0.14	0.13	0.18	0.16	0.17	0.16	0.14
DRP			0.07	0.06	0.07	0.08	0.07	0.05	0.027
DIN	3.0	3.0	0.66	0.64	0.57	0.77	0.78	1.36	1.17
TKN			0.71	0.72	0.78	0.66	0.66	1.18	0.93
	Shading reflects that the average value met the target for that site								

Habitat Assessment

Methods

Instream habitat assessments were conducted once at each site on Mill Creek in 2014 using the 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 suggests that sufficient habitat exists to support a fish community that attains the warmwater habitat criterion (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 scores for each of the sites are shown in Table 8. A natural waterfall is located just upstream of RM 2.75. The waterfall prevents the natural passage of fish migration upstream. The evaluation of the QHEI does, however, suggest that the current habitat could support a warmwater fish community for all sites both historically and presently, as they all met the target of 55 (Jeff DeShon and Dennis Mischne, personal communication, April 16, 2014), as seen in Table 7.

Table 8. Mill Creek QHEI scores

Year	RM 10.13	RM 8.30	RM 6.80	RM 3.15	Mill Creek Falls	RM 2.75	RM 0.70	RM 0.12
1995	78.00	74.00	62.25	70.25		69.50	70.50	72.00
2011	81.75	71.50	61.00	63.00		74.25	69.75	68.00
2012	73.00	72.00	63.50	63.00		73.25	72.50	64.75
2013	70.25	72.00	63.50	60.50		78.00	66.00	64.50
2014	61.00	74.00	65.00	67.00		82.50*	66.50	66.00

* Score obtained after the field season (10/23/14)

The most upstream site, RM 10.13, continued to show considerable erosion. The alluvial gravel substrate has been washed out from the majority of the lower fish zone and the exposed hardpan is evident. In addition, the stream is starting to take out a hill that protects a stormwater dry basin. The continued erosion is the major cause for the lower score. The increase in score at RM 3.15 was the function of a slight increase in almost every category, whereas RM 2.75 improvement was found in the substrate category.

Table 9 lists attributes defined by the Ohio EPA, as interpreted by NEORSD, which have both positive and negative influences on the fish community. It should be noticed that the sites that received a narrative rating of Excellent (or a score above 70 [Ohio EPA, 2006]) had less than 3 negative influences, and none being highly influenced. The negative influences have been identified as attributes that can have the greatest influence on whether the system can support a WWH fish community. Please note that the habitat rating is to help determine if the habitat can support a fish community and does not necessarily reflect what type of community is actually found at the site.

The Cleveland Metroparks Mill Creek Connector Trail (Phase 2) is under construction and will span the creek approximately 0.3 miles upstream of the RM 0.12. Work to place a new bridge structure upstream of the sampling location had just started around the end of the sampling period. Additional work, including a modification of the connection point of an unnamed tributary to Mill Creek and some bank stabilization were also beginning around the same time.

Table 9. Qualitative Habitat Evaluation Index Physical Attributes Summary																																
		Warmwater Attributes											Modified Warmwater Attributes																			
													High Influence						Moderate Influence													
River Mile	QHEI Score	Dominate Substrates: Boulder, Cobble and/or Gravel	Overall Substrate, Silt: Free	Overall Embeddedness: None or Normal	In-stream Cover Amount: Extensive or Moderate	Channel Sinuosity: Moderate or High	Channel Development: Excellent or Good	Channelization: None or Recovered	Maximum Site Depth greater than 40 cm	Current Velocity: Fast Current and Eddies	Riffle and Run Embeddedness: None or Low	**Total Positive Attributes**	Dominate Substrates: Silt and/or Muck	In-stream Cover Amount: Sparse or Nearly Absent	Channel Sinuosity: None	Channelization: Recent or No Recovery	Maximum Site Depth less than 40 cm	**Negative High Influence Attributes**	Dominate Substrate, Boat Sites Only: Sand	Substrate Origin: Hardpan	Overall Substrate, Silt: Heavy or Moderate	Overall Embeddedness: Moderate or Extensive	In-stream Cover Types: Only 1 or 2 Indicated	Channel Sinuosity: Low	Channel Development: Fair or Poor	Channelization: Recovering	Pool Width and Current Velocity: Less than or equal to Riffle Width and Intermittent, Respectively	Current Velocity: No Fast Current	Riffle Embeddedness: Moderate or Extensive	No Functional Riffle Indicated at the Site	**Negative Moderate Influence Attributes**	**Total Negative Influence Attributes**
10.13	61.00					x		x	x			3		x				1			x	x			x			x	x		5	6
8.30	74.00	x					x	x	x			4						0				x							x		2	2
6.80	65.00	x		x					x			3						0						x	x			x	x		4	4
3.15	67.00			x					x			2			x			1							x			x	x		3	4
2.75	82.50	x	x	x	x			x			x	6						0						x							1	1
0.70	66.50					x			x			2						0				x				x			x		3	3
0.12	66.00					x		x	x			3		x				1			x	x							x		3	4

Electrofishing

Methods

At least one quantitative electrofishing passes was conducted at each site in 2014. A list of the dates when the surveys were completed, along with flow as measured at the United States Geological Survey gage station in Garfield Heights, is given in Table 10. Sampling was conducted using longline or backpack electrofishing techniques and consisted of shocking all habitat types within a sampling zone while moving from downstream to upstream. The sampling zone was 0.15 kilometers for each site. The methods that were used followed Ohio EPA protocol methods as detailed in *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987a) and *III* (1987b). Fish collected during the surveys were identified and examined for the presence of anomalies, including DELTs (deformities, eroded fins, lesions, and tumors). All fish were then released to the waters from which they were collected, except for vouchers and those that could not be easily identified in the field.

Table 10. Sampling Dates and River Flows*

Date	Sites sampled (RMs)	Daily Mean Flow (CFS)	Method
06/17/14	0.12, 0.70	7.8	Longline
	8.30, 10.13		Backpack
06/23/14	2.75, 3.15	19	Longline
	6.80		Backpack
08/06/14	0.70	7.7	Longline
09/03/14	0.12	7.3	Longline

From June 15 to October 15, 2014 Median Flow was 11 CFS

*Measured at USGS 04208460 Mill Creek flow gauge in Garfield Heights, Ohio. (USGS, 2014)

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 headwater are listed in Table 11.

Table 11. 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

Lists of the species, numbers, 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.

Results and Discussion

The WWH IBI criterion in the Erie-Ontario Lake Plain (EOLP) ecoregion is 40 for headwater sites. A site is considered in non-significant departure if it is within 4 IBI units of the criterion. Therefore, an IBI score of 36 is considered to be in attainment. The two most downstream sites were in attainment of this criterion, while the other ones failed to meet it (Table 12, Figure 3). Generally, no significant changes in IBI scores have occurred at the four most upstream sites since the first time that NEORSD surveyed the sites, see Table 13. For the other three sites, however, there has been an overall increase in scores.

The only significant change in scoring from the 2013 sample was found at RM 2.75. Please note that the scoring at RM 2.75 has been consistent since 2011 except for the year 2013. The year 2013 appears uncharacteristically high because two additional species were found (*Pimephales notatus* [Bluntnose Minnow] and *Clinostomus elongates* [Redsided Dace]) during the single survey. The additional species had a total of 5 individuals in the 2013 survey and none were found in the 2012 or 2014 surveys.

It should be noted that for the three most upstream sites, the fish assessments were completed using backpack electrofishing methods instead of longline ones. Although the results for the backpack surveys may not be directly comparable to the surveys completed

using longline methods, the change in methodology does not appear to have had a significant impact on the overall results.

Table 12. 2014 Mill Creek IBI Results							
River Mile	Pass	IBI Score	Narrative Rating	Total No. of Species	No. of Native Species	% Tolerant Species	No. of fish collected
10.13	1	20	Poor	2	2	100	22
8.30	1	22	Poor	4	4	99.5	217
6.80	1	22	Poor	3	3	100	106
3.15	1	22	Poor	2	2	100	329
Mill Creek Falls							
2.75	1	30	Fair	7	7	46.3	307
0.70	1	38	Marg. Good	12	12	35.1	581
0.70	2	36	Marg. Good	12	11	31.2	1345
0.12	1	36	Marg. Good	11	11	31.9	213
0.12	2	42	Good	16	16	22.1	1141
WWH Criterion IBI units ≥ 40 Non-significant departure from WWH criterion ≥36 IBI units							

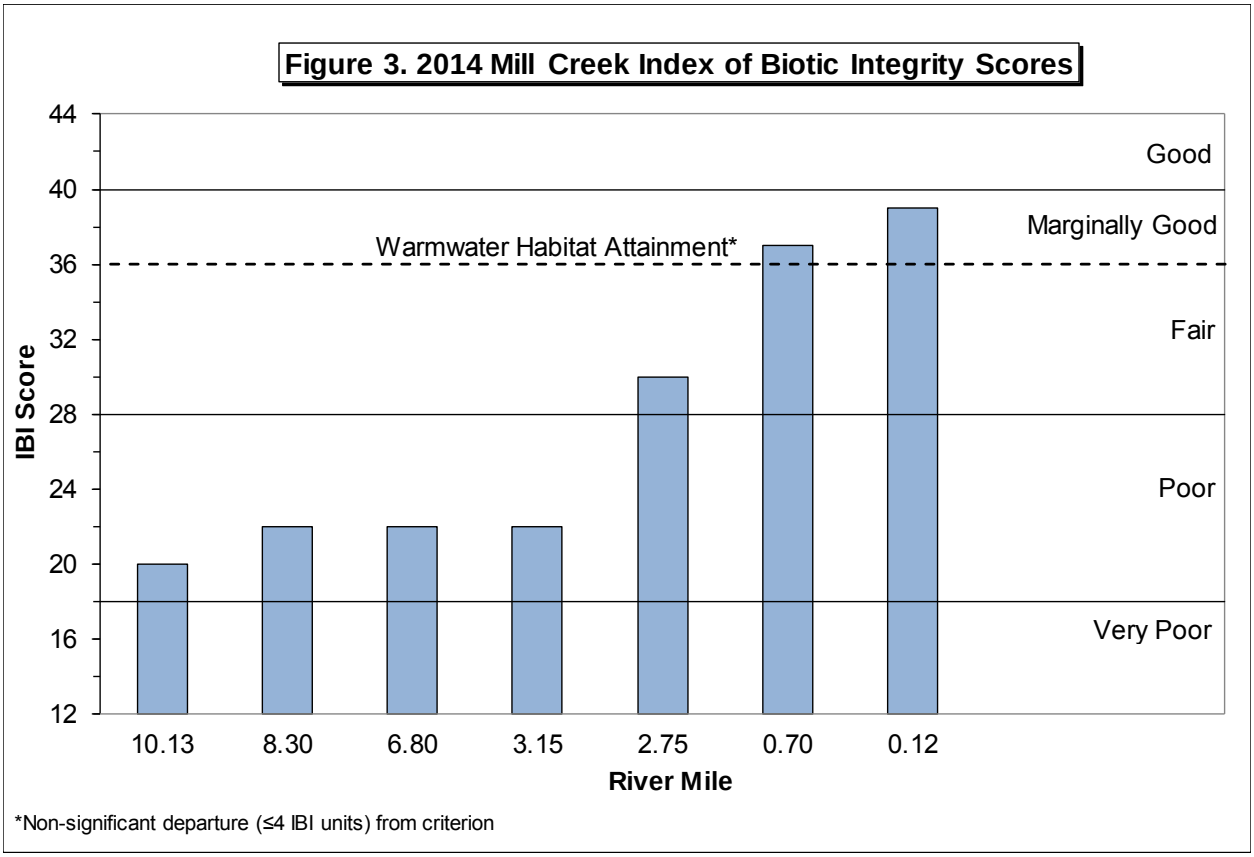


Table 13. Mill Creek Average IBI scores (1995-2014)							
Year	RM 10.13	RM 8.30	RM 6.80	RM 3.15	RM 2.75	RM 0.70	RM 0.12
1995	17	13	16	12	19	19	18
2007	---	22	---	---	---	---	32
2008	---	20	---	---	---	---	24
2009	---	22	---	---	---	---	36
2010	---	23	---	---	---	---	33
2011	20	22	22	23	31	36	36
2012	20	22	22	20	30	38	38
2013	22	22	22	18	38	36	38
2014	20	22	22	22	30	37	39
WWH Criterion ≥ 40 IBI units Non-significant departure from WWH criterion ≥36 IBI units							

As reflected above, the Mill Creek Falls plays a significant role in fish passage that could potentially improve scoring at the upstream sites. The sites below the falls had a far lesser percentage of tolerant species and greater number of fish species. Upstream of the falls, the sites had only tolerant fish species; all of the sites had at least 96% of the fish being highly tolerant species *Rhinicthvs atratulus* (western blacknose dace) and *Semotilus atromaculatus* (creek chub).

At the sites downstream of the falls, the fish community appeared healthier. For the two most downstream sites, 2014 was the third year in a row in which the IBI criterion was met. Reductions in combined and sanitary sewage, removal of the log jam and habitat stabilization projects may have allowed a greater number of migrating fish from the Cuyahoga River to move into and up the creek. A lack of darter and headwater species indicates, though, that there may still be some water quality issues remaining in the creek as these species are typically found in areas with low environmental stress (Ohio EPA, 1987b). Erosion, water level fluctuations, and urban runoff could all be contributing sources of impairment.

Macroinvertebrate Sampling

Methods

Macroinvertebrates were sampled quantitatively using modified Hester-Dendy (HD) samplers in conjunction with a qualitative assessment of Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly), also referred to as EPT taxa, inhabiting available habitats at the time of HD retrieval. Sampling was conducted at all of the

locations listed in 1. Methods for sampling followed the Ohio EPA's Biological Criteria for the Protection of Aquatic Life, Volume III (1987b). The recommended period for HDs to be installed is six weeks.

The majority of the macroinvertebrate samples were sent to Third Rock Consulting (TRC) of Lexington, Kentucky for identification and enumeration. RMs 6.80, 8.30 and 10.13 were sent to EnviroScience Incorporated of Stow, Ohio. 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.

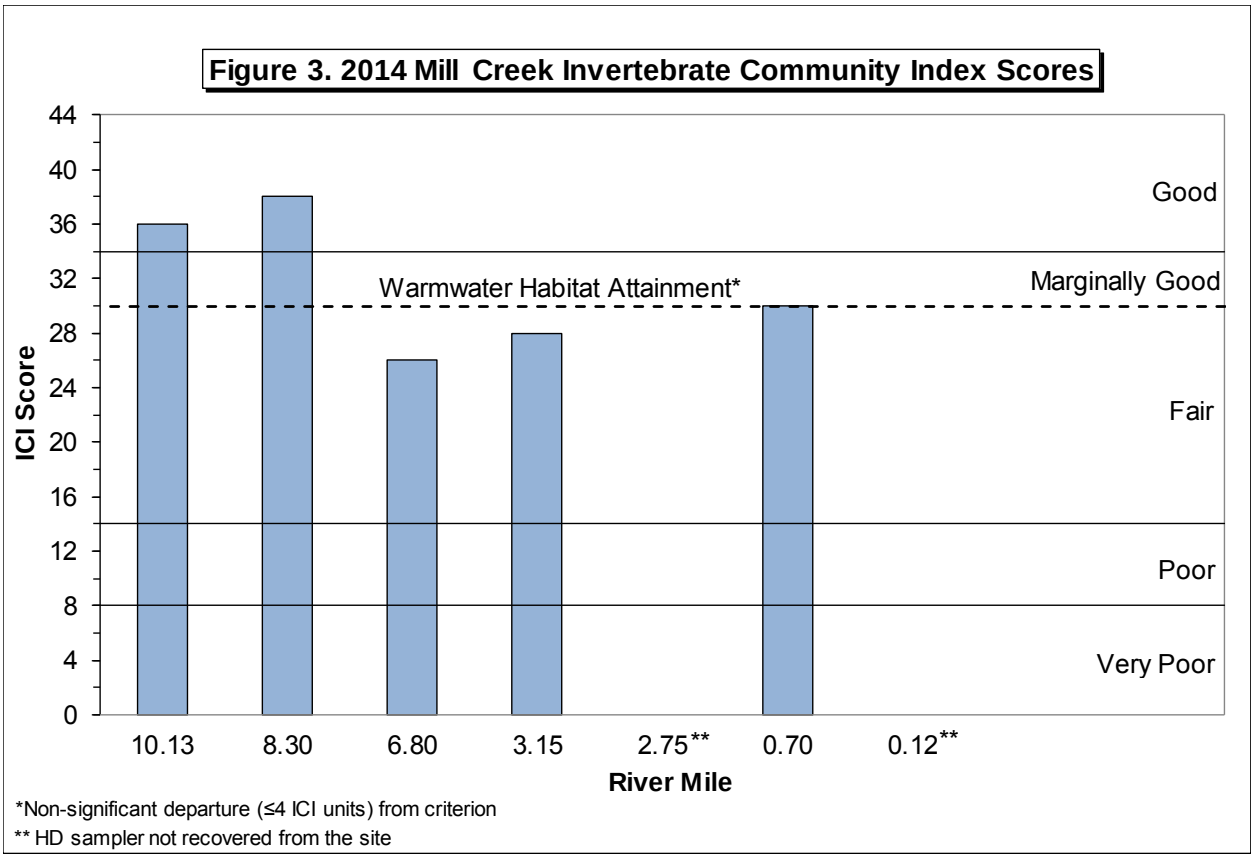
The overall aquatic macroinvertebrate community in the stream was evaluated using Ohio EPA's Invertebrate Community Index (ICI) (OEPA, 1987a, 2014a, 2014b). The ICI consists of ten community metrics (Table 14), each with four scoring categories. Metrics 1-9 are based on the quantitative sample, while 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 14. ICI Metrics	
1.	The total number of taxa on HD.
2.	Total number of Ephemeroptera taxa on HD.
3.	Total number of Trichoptera taxa on HD.
4.	Total number of Dipteran taxa on HD.
5.	Percent of Ephemeroptera in HD sample.
6.	Percent Trichoptera in HD sample.
7.	Percent Tribe Tanytarsini midges in HD sample.
8.	Percent Dipterans (excluding Tribe Tanytarsini) and all non-insects in HD sample.
9.	Percent Tolerant organisms (as defined by metric) in HD sample.
10.	Total number of Ephemeroptera, Plecoptera and Trichoptera collected in the qualitative sample.

Results and Discussion

The WWH ICI criterion in the EOLP ecoregion is 34. A site is considered in non-significant departure if it is within 4 ICI units of the criterion and therefore would also be in attainment. Three of the sites that were sampled in 2014 had ICI scores that met or within non-significant departure from the criterion while an additional site was given a narrative rating of *Marginally Good* (Table 15, Figure 3). Table 16 shows the historic ICI scores and narrative rating.

Table 15. 2014 Macroinvertebrate Results							
River Mile	ICI Score	Narrative Rating	Total Number of Taxa	Number of Qualitative Taxa	Number of Qualitative EPT Taxa	Number of Qualitative Sensitive Taxa	Density (Organisms per square foot)
10.13	36	*Good*	43	28	5	1	155.7
8.30	38	*Good*	40	24	5	1	117.4
6.80	26	*Fair*	34	23	5	1	30.2
3.15	28	*Fair*	44	31	6	2	269.6
2.75	---	*Fair*	---	26	6	2	---
0.70	30	*Marg. Good*	38	28	6	4	745.8
0.12	---	*Marg. Good*	---	31	8	4	---
WWH criterion is ≥ 34 ICI units Non-significant departure from WWH criterion is ≥30 ICI units							



An HD sampler has not been collected from Mill Creek RM 0.12 in three of the last four sampling years, as the artificial substrate samplers were missing during the initial and subsequent planned retrievals. Assigning a narrative rating based on best professional judgment has been very difficult for this site. The qualitative sample showed improvement over the 2013 results. As such, a narrative rating of *Marginally Good* was assigned to the sampling site, based on best professional judgment. Positive factors of the qualitative sampling suggesting attainment in an urban system included: number of EPT (8); dominant taxa (Baetidaes); and field narrative rating (Marg. Good). But in contrast, areas that could use improvement to reach a full attainment narrative rating include: more sensitive taxa (only 4 found); increased total qualitative taxa (31 taxa present); and improved diversity (noted as low).

The other site that was assigned a narrative rating was just downstream of the falls. RM 2.75 received the narrative rating of *Fair*, based on best professional judgment. The total number of taxa (26), low number of sensitive taxa (2) and the number of EPT taxa (6) resulted in the lower scoring from last year. The field notes did record a *Marginally Good* narrative rating; however, the high number and specific species of non-insects and other dipterans (15 taxa) were the reason for reevaluating the field rating.

Table 16. Mill Creek ICI Scores or Narrative Ratings Comparisons

Year	RM 10.13	RM 8.30	RM 6.80	RM 3.15	RM 2.75	RM 0.70	RM 0.12
1995	22	---	---	---	38	20	18
1999	---	---	---	---	---	---	32
2000	---	---	---	---	---	---	28
2001	---	---	---	---	---	---	12
2002	---	17	---	---	---	---	30
2003	---	3	---	---	---	---	9
2004	---	16	---	---	---	---	10
2005	---	10	---	---	---	---	28
2006	---	7	---	---	---	---	20
2007	---	14	---	---	---	---	22
2008	---	21	---	---	---	---	31
2009	---	24	---	---	---	---	34
2010	---	30	---	---	---	---	28
2011	32	*Fair*	*Poor*	*Poor*	40	34	*Fair*
2012	36	38	30	34	40	36	38
2013	28	24	28	26	*Fair*	*Fair*	*Fair*
2014	36	38	26	28	*Fair*	30	*Marg. Good*

WWH criterion is ≥ 34 ICI units
Non-significant departure from WWH criterion is ≥30 ICI units
--- No ICI score or narrative rating available

The scores appeared to show improvement, except for RM 6.80, toward their 2012 status. RM 6.80 has been singled out almost every sampling season as getting unexpected results or not following the trends of the rest of the stream. There are several potential causes between RM 6.80 and 8.30 and they include the Kerruish Park stormwater basin, Lee Road Storm Sewer, and Interstate 480. The stormwater basin has documented difficulty managing flow and the sediment load. Sites closer to the basin were sampled from 2001 to 2005 and never received a narrative rating above *Fair*, often falling in the *Poor* range.

Conclusions

The Mill Creek watershed was evaluated in 2014 to continue the documentation on the health of the watershed as several capital improvement projects have been recently completed on the watershed, see Table 17. Overall, the fish community has not changed in recent sampling (except for the one score at RM 2.75 in 2013). The macroinvertebrate communities continue to fluctuate between sampling seasons. Biological surveys of fish and macroinvertebrate showed there may still be some impact to those communities.

Table 17. 2014 Mill Creek Survey Results.

River Mile	Aquatic Life Use Attainment Status	IBI Score	ICI Score	Habitat	Water Quality Exceedances
10.13	NON	20	36	61.00	*E. coli*
8.30	NON	22	38	74.00	*E. coli*
6.80	NON	22	26	65.00	*E. coli*, Copper
3.15	NON	22	28	67.00	*E. coli*, Copper
2.75	NON	30	*Fair*	82.50	*E. coli*, Copper
0.70	FULL	37	30	66.50	*E. coli*, Copper
0.12	FULL	39	*Marg. Good*	66.00	*E. coli*, Copper, Zinc
Warmwater Habitat Criteria		40	34		
Nonsignificant Departure from Criteria		≤4	≤4		
Target				55	

Note: Poor narrative fish scores above the falls resulted in automatically assigning a non-attainment status.

Exceedances of the bacteriological criteria indicate the presence of sewage within the creek, with at least one documented incident caused by a failing collection system within the watershed. The exceedances of the water quality came during significant rain and could be causing water quality impairments from urban runoff. The Kerruish Park Basin is also a potential source of stream quality issues. Severe erosion problems were noted at the most upstream site. Not to mention Mill Creek Falls being probably the most influential impact preventing establishment of a healthy fish community in the upper section of the river, as the habitat suggests that it should be capable of supporting the community.

Because a HD has not been recovered at the RM 0.15 site in three of the last four years, it is suggested that the HD be moved further upstream. The sediment is getting deposited and shifting rapidly in the area. In addition, the site currently is influenced by the Cuyahoga River during high flows. It is also suggested that the sites below the falls continued to be monitored to track changes in the communities at RM 2.75. In addition, at least one site upstream of the falls should be sampled to represent the upper section of the watershed.

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References

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

Ohio Environmental Protection Agency. (1987). Biological Criteria for the Protection of Aquatic Life: Volume II: Users Manual for Biological Field Assessment of Ohio Surface Waters. Columbus, OH: Division of Water Quality Planning and Assessment,

Ecological Assessment Section.

Ohio Environmental Protection Agency. (1989). Biological Criteria for the Protection of Aquatic Life: Volume III. Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities. Columbus, OH: Division of Water Quality Monitoring and Assessment.

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

Ohio Environmental Protection Agency, Division of Surface Water. (2009, Revision Adopted July 9, 2009, Effective October 9, 2009). State of Ohio Water Quality Standards, Chapter 3745-1.

Ohio Environmental Protection Agency. (2013a). Surface Water Field Sampling Manual for Water Column Chemistry, Bacteria and Flows. Version 4.0. Columbus, OH: Division of Surface Water.

Ohio Environmental Protection Agency. (2013b). Trophic Index Criterion – Rationale and Scoring. Retrieved from http://epa.ohio.gov/Portals/35/rules/TIC_rationaleandscoring.pdf

Ohio Environmental Protection Agency. (2014a). 2014 Updates to Biological Criteria for the Protection of Aquatic Life: Volume II and Volume II Addendum. Users Manual for Biological Field Assessment of Ohio Surface Waters. Columbus, OH: Division of Surface Water, Ecological Assessment Section.

Ohio Environmental Protection Agency. (2014b). 2014 Updates to Biological Criteria for the Protection of Aquatic Life: Volume III. Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities. Columbus, OH: Division of Surface Water, Ecological Assessment Section.

USGS. (2014). USGS Surface-Water Daily Data for Ohio. Retrieved from http://waterdata.usgs.gov/oh/nwis/dv/?site_no=04208460&agency_cd=USGS&referred_module=sw