Environmental Protection Agency

Loading Analysis Plan and Supporting Data Acquisition Needed for the Mill Creek (Scioto River) Watershed

Total Maximum Daily Load Development

Mill Creek downstream from Scioto Darby Road (RM 19.5)

Ohio EPA Technical Report AMS/2013-MILLS-3

Division of Surface Water
Assessment and Modeling Section
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Introduction

This document provides an overview of the information considered in proposing the strategy to address water quality impairments in the Mill Creek watershed. These recommendations are based on data collected as part of a biological and water quality study in 2009, 2012 and 2013. A description of the project area, sites, data types and methods can be found in the Mill Creek watershed study plan document (Ohio EPA, 2012). A summary of the study results can be found in the biological and water quality report (Ohio EPA, 2014).

Sites in the Mill Creek watershed were assessed for aquatic life use (ALU), recreation use, and public drinking water supply use. There are no impairments of the public drinking water supply use in this study area (Ohio EPA, 2022). The attainment of aquatic life and recreation use is based on specific criteria. The attainment of the public drinking water supply use is detailed in the current cycle of Ohio's Integrated Report (Ohio EPA, 2022). This document examines those criteria and lays out proposals for addressing each impairment. Where appropriate, methods and targets are outlined to develop total maximum daily loads (TMDL) for specific pollutants.

The Mill Creek watershed was previously assessed in 1995 and the results were compiled in a biological and water quality report (Ohio EPA, 1997). A total maximum daily load (TMDL) report was developed based on the results in this survey and approved by the U.S. Environmental Protection Agency in 2003 (Ohio EPA, 2003). New recommendations based on the most recent survey, with considerations to the existing TMDL, are also proposed in this section.

The federal Clean Water Act (CWA) requires that states identify waters not meeting water quality goals and then prioritize them for action to restore their beneficial uses. The resulting list of prioritized impaired waters is known as the 303(d) list. The process of listing involves assigning a condition status (a category) for each of four beneficial uses (aquatic life, human health, recreation, and public water supply) for each assessment unit. For more information on impaired water listings and categories, please see Ohio's Integrated Water Quality Monitoring and Assessment Report (Ohio EPA, 2022).

Aquatic Life Use

Evaluation of Biocriteria

Aquatic life use attainment details are documented in the biological and water quality report (Ohio EPA, 2014). The attainment status for each site is shown in Figure 1. Table 1 lists assessment sites not meeting their aquatic life use designation. This table also contains the causes and sources of impairment for each site.

An ALU assessment was completed at 24 sites in the Mill Creek watershed in 2009, 2012, and 2013. Of the 24 biological stations assessed, 16 sites (67%) were fully meeting the designated ALU, three sites (12%) were partially attaining, and five sites (21%) were not attaining. The study encompassed one HUC-12 watershed in Delaware, Logan, and Union counties.

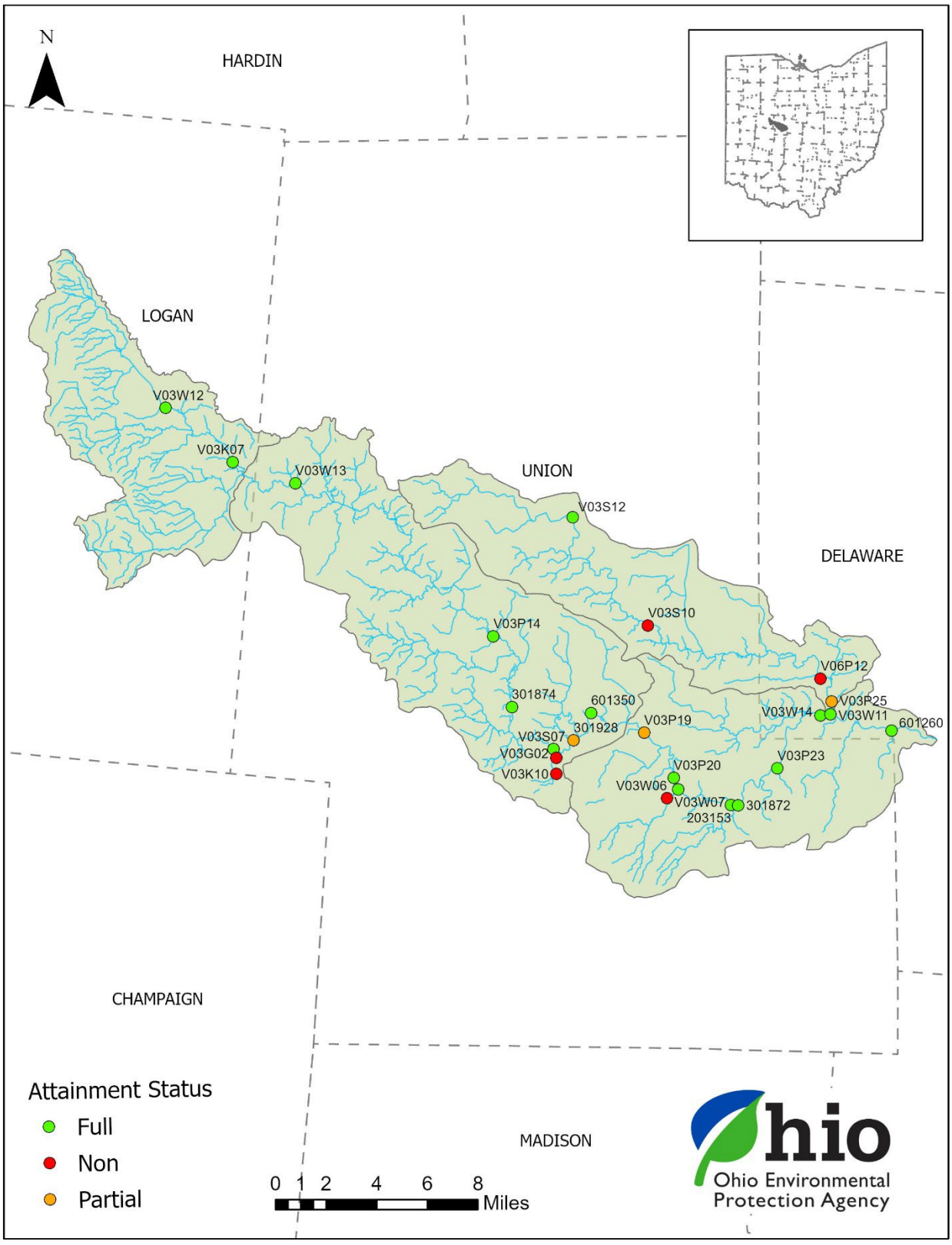

Figure 1 — Map summarizing ALU attainment status in the Mill Creek watershed in 2009, 2012, and 2013.

Table 1 – Aquatic life use attainment information for impaired sampling locations in the Mill Creek watershed, 2009, 2012 and 2013.

Station	Location	ALU	River Mile[a]	Drain. Area (mi^2)	IBI	MIwb[b]	ICI[c]	QHEI	Attain. Status	Causes	Sources
05060001 06 02 – Middle Mill Creek											
301928	Mill Creek at Marysville @ Cherry St.	WWH	18.14 W	82.0	36ns	7.24*	22*	61.5	Partial	Sedimentation / Siltation	Urban runoff / storm sewers
										Direct habitat alteration	Channelization
										Organic enrichment biological indicators	Illicit connections/hook-ups to sewer sewers
V03K10	Town Run at Marysville at Walnut street	WWH	0.7H	1.3	22*	--	--	44	Non	Direct habitat alteration	Channelization
										Organic enrichment biological indicators	Illicit connections/hook-ups to sewer sewers
										Solids (suspended/bedload)	Illicit connections/hook-ups to sewer sewers
V03G02	Town Run at Marysville at 5th street, dst Culvert	WWH	0.2W	1.7	20*	--	--	50	Non	Direct habitat alteration	Channelization
										Organic enrichment biological indicators	Illicit connections/hook-ups to sewer sewers
										Solids (suspended bedload)	Illicit connections/hook-ups to sewer sewers
05060001 06 03 – Blues Creek											
V03S10	Blues Creek @ Leeper-perkins Rd	WWH	10.15H	16.7	30*	--	--	47	Non	Sedimentation / Siltation	Agriculture
										Direct habitat alteration	Agriculture
V06P12	Blues Creek N of Ostrander @ Ostrander Rd	WWH	2.00W	33.8	33*	5.70*	--	66	Non	Sedimentation / Siltation	Agriculture
V03P25	Blues Creek dst. Ostrander	WWH	0.6W	37.1	39ns	7.19*	--	71.5	Partial	Sedimentation / Siltation	Agriculture

Station	Location	ALU	River Mile[a]	Drain. Area (mi^2)	IBI	MIwb[b]	ICI[c]	QHEI	Attain. Status	Causes	Sources
05060001 06 04 – Lower Mill Creek											
V03P19	Mill Creek at Marysville @ US Rt. 36	WWH	14.54^{H}	94.7	34*	7.83^{ns}	--	66.5	PARTIAL	Sedimentation / Siltation	Agricultural
										Organic enrichment (sewage) biological indicators	Illicit connections/hook-ups to sewer sewers
V03W06	Crosses Run E of Marysville @ Watkins Rd	WWH	0.8^{H}	4.4	34*	--	--	75.3	Non	Sedimentation / Siltation	Agriculture
										Sediment screening value (Exceedance)	Sediment resuspension (Contaminated sediment)

a River Mile (RM) represents the Point of Record for the station and may not be the actual sampling RM.
b MIwb is not applicable to headwater streams with drainage areas $\leq$ 20 mi^2.
c A narrative evaluation of the qualitative sample based on attributes such as EPT taxa richness, number of sensitive taxa and community composition was used when quantitative data was not available or considered unreliable. VP=Very Poor; P=Poor; LF=Low Fair; F=Fair; MG=Marginally Good; G=Good; VG=Very Good; E=Exceptional
ns Nonsignificant departure from biocriteria ($\leq$4 IBI or ICI units, or $\leq$0.5 MIwb units).
* Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.
H Headwater site (draining ≤20 miles^2).
W Wading site (non-boat site draining >20 miles^2).

Aquatic Life Use Proposed Actions

Ohio EPA considers many factors when deciding how to address impairments. For some projects, no TMDL is required. The sites within the watershed may be in attainment or the impairment is being addressed by another program/entity so no further action by the Division of Surface Water is necessary. Additionally, the cause of impairment may be natural (i.e., flow or habitat), in which case no action is required. For those needing a TMDL, the complexity of each impairment—including the primary origin of the pollutant, its delivery mechanisms and the waterbody kinetics involved—will determine the complexity needed in a model. Ohio EPA must also take into consideration ongoing efforts in the watershed, previous TMDL analyses, the questions to be answered by a model and the amount of effort required to complete the model. Depending on the method selected, the Agency may be required to return to the watershed and collect additional data and it is possible the modeling approach may change. A summary of Ohio EPA's preliminary modeling approaches is presented in Table 2.

Table 2 – Summary of ALU impairments and potential modeling approaches

Station	Stream Name	River Mile	Assessment Unit (05060001)	Cause(s) of Impairment	Source(s) of Impairment	IR Cat.[1]	Action[2]	Method[3]	Parameter[4]
301928	Mill Creek	18.14	06 02	Sedimentation / Siltation	Urban runoff / storm sewers	5	TMDL	QHEI-sed	Sediment
				Direct habitat alteration	Channelization	4C	Other	Restoration Plan	Habitat
				Organic enrichment biological indicators	Illicit connections/hook-ups to sewer sewers	5	Other	Follow up	-
V03K10	Town Run	0.7	06 02	Direct habitat alteration	Channelization	4C	Other	Restoration Plan	Habitat
				Organic enrichment biological indicators	Illicit connections/hook-ups to sewer sewers	5	Other	Follow up	-
				Solids (suspended/bedload)	Illicit connections/hook-ups to sewer sewers	5	Other	Follow up	-
V03G02	Towns Run	1.7	06 02	Direct habitat alteration	Channelization	4C	Other	Restoration Plan	Habitat
				Organic enrichment biological indicators	Illicit connections/hook-ups to sewer sewers	4C	Other	Follow up	-
				Solids (suspended bedload)	Illicit connections/hook-ups to sewer sewers	5	Other	Follow up	-
V03S10	Blues Creek	10.15	06 03	Sedimentation / Siltation	Agriculture	5	TMDL	QHEI-sed	Sediment
				Direct habitat alteration	Agriculture	4C	Other	Restoration Plan	Habitat
V06P12	Blues Creek	2.00	06 03	Sedimentation / Siltation	Agriculture	5	TMDL	QHEI-sed	Sediment

Station	Stream Name	River Mile	Assessment Unit (05060001)	Cause(s) of Impairment	Source(s) of Impairment	IR Cat.[1]	Action[2]	Method[3]	Parameter[4]
V03P25	Blues Creek	0.6	06 03	Sedimentation / Siltation	Agriculture	5	TMDL	QHEI-sed	Sediment
V03P19	Mill Creek	14.54	06 04	Sedimentation / Siltation	Agriculture	5	TMDL	QHEI-sed	Sediment
				Organic enrichment biological indicators	Illicit connections/hook-ups to sewer sewers	5	Other	Follow up	-
V03W06	Crosses Run	0.8	06 04	Sedimentation / Siltation	Agriculture	5	TMDL	QHEI-sed	Sediment
				Sediment screening value (Exceedance)	Sediment resuspension (Contaminated sediment)	5	Other	Follow up	-

[1] Due to space limitations there are several abbreviations used to describe the analysis or remediation method. Those abbreviations are defined as follows:

[1] IR Cat. (Integrated Report Category)

Category	Definition/interpretation
4C	Water body is impaired for this parameter, but the parameter is not considered a pollutant and therefore a TMDL is not required
5	Water body is impaired for this parameter, and it needs to be addressed by additional actions

[2] Action

Abbreviation	Definition/interpretation
N/A	Not applicable, no action needed
Other	Action will be taken outside of a new TMDL
TMDL	A Total Maximum Daily Load (TMDL) will be developed

[3] Method

Abbreviation	Definition/interpretation
Follow-up	Follow-up sampling is required to determine if the attainment status has changed after ongoing implementation has occurred or to clarify/verify the listed cause of impairment.
5-alt	Category 5-alternative restoration plan will be developed to outline restoration approaches more immediately beneficial or practicable than a TMDL.
Restoration Plan	A restoration plan will be developed to address a 4C impairment outside of the TMDL process.
QHEI-sed	Sub-metrics of the QHEI (Qualitative habitat evaluation index) will be used to address sedimentation and embeddedness.

[4] Parameter – For TMDL or Other actions, the parameter listed in this field will be the pollutant or non-pollutant stressor used to address impairment. This parameter will match a heading in the Proposed Targets section.

Restoration plan for habitat required: IR Cat: 4C - Action: Other

The cause of impairment for four sites as outlined in Table 2 for the Mill Creek watershed are due to impacts from direct habitat alteration. The habitat assessment indicated channelization and adjacent agricultural land use practices and are the two main sources of habitat disturbances. These sites will be handled with a QHEI habitat analysis. The restoration plan for this watershed will be developed in a separate report that will include several other watersheds. Updates to the restoration plan will be posted to ***Ohio EPA's multi-watershed TMDL webpage***. Town Run flows in an underground concrete culvert through the city of Marysville. The substrates in both sampling locations were covered in raw sewage from illicit discharges which turned the channel margins black and grey. While the upstream site had more natural features as it flowed through a city park, the downstream site was incised and channelized with riprap and surrounded by concrete and blacktop parking lots.

TMDL to address sediment impairments required: IR Cat: 5 - Action: TMDL

The cause of impairment for six sites outlined on Table 2 for Mill Creek watershed was due to impacts from sedimentation and/or siltation.

Sedimentation is seen widely throughout the watershed and is listed as the cause of impairment for six of the eight impaired sites. The upper Mill Creek (RM 18.14) sediment impairment is due to urban development; however, the other sites listed as impaired for sedimentation have agricultural sources. Sediment runoff at the other Mill Creek site and Blues Creek sites was attributed to upstream and adjacent agricultural land use practices.

A sediment TMDL calculated using QHEI sub-metrics will appropriately address this cause of impairment. Sediment impairments for this watershed will be developed in a separate report that will include several other watersheds. Updates to this separate sediment TMDL report will be posted to ***Ohio EPA's multi-watershed TMDL webpage***.

Follow-up monitoring is recommended prior to TMDL development to address some causes: IR Cat: 5 - Action: Other

There are several causes of impairment outlined on Table 2 for the Mill Creek watershed that may not persist. Since the 2012 assessment, there have been several actions that have occurred in the watershed. Further evaluation of these sites is required to determine if these actions have ameliorated previously existing causes of impairment. The actions implemented in the watershed since the 2012 assessment are summarized below:

- Marysville Wastewater Treatment Plant (WWTP) which was the dominant source of impairment to the Mill Creek (2003 TMDL), has been decommissioned and replaced with a new treatment plant to the southeast of the city of Marysville. The industrial park southeast of the city of Marysville, which was a source of impairment in stormwater runoff, is now served by the new plant. The elimination of the Marysville WWTP discharge, building a new WWTP and connection of the industrial park to the new facility is having a positive impact on downstream sites on Mill Creek.
- The Division of Environmental and Financial Assistance (DEFA) under the Water Pollution Control Loan Fund (WPCLF) program has been offering a low interest revolving loan to the Union County Health Department every year since 2016. This loan is administered to aid in the repair and replacement of failing Household Sewage Treatment Systems (HSTS). This remedy will fix HSTS as the

biggest contribution cause to Organic impairment for the upstream Mill creek sites (RM 18.14 and 14.52) and Town Run will eliminate Illicit discharge.

- City of Marysville constructed a new drinking water treatment plant with a capacity of 8 million gallons per day (MGD) that will not discharge into waters of state. The drinking Water Refinery Facility (WRF) which was built at Mill creek at RM 9.25 not only reduced TDS discharge but also it accommodates future growth including areas south of the city of Marysville.
- City of Marysville has also been complying with the terms of their Municipal Separate Storm Sewer System (MS4) permit, including mapping the storm sewer system and HSTS system within the city, marking storm drains, and conducting public outreach events and stream cleanups. The city also drafted an Illicit Discharge Detection and Elimination plan and conducted dry-weather screening of storm sewer outfalls in 2019 and has continued to monitor outfalls in subsequent years. Fulfilling the compliance with the terms of MS4 permit improves all the sites on the Mill Creek and Towns Run.

Ohio EPA will revisit the Mill Creek watershed in 2024 during the scheduled targeted assessment. Because of this, and the factors listed above, follow-up monitoring is recommended prior to the development of a TMDL. When this follow-up monitoring occurs, another study plan, biological and water quality report, and loading analysis plan will be published prior to any new TMDL development. All three of those future documents will include public comment periods before they are considered final.

Aquatic Life Use Proposed Targets

Habitat

Since its development, the Qualitative Habitat Evaluation Index (QHEI) has been used to evaluate habitat at most biological sampling sites and there is an extensive database that includes QHEI scores and other water quality variables. Strong correlations exist between QHEI scores, and the biological indices used in Ohio's water quality standards such as the Index of Biotic Integrity (IBI). Through statistical analyses of data for the QHEI and the biological indices, target values have been established for QHEI scores with respect to the various aquatic life use designations (Ohio EPA 1999). These targets are shown in Table 3.

One of the strongest correlations found through the statistical analyses described above is the negative relationship between the number of modified attributes and the IBI scores. Modified attributes are features or conditions of the stream that have poor habitat quality and therefore are assigned relatively fewer points or negative points in the QHEI scoring. A sub-group of the modified attributes shows a stronger impact on biological performance; these are termed high influence modified attributes (Table 4).

In addition to the overall QHEI scores, targets for the maximum number of modified and high influence modified attributes have been developed. For example, to meet the targets, streams designated as WWH cannot have more than four modified attributes, of which no more than one can be a high influence modified attribute. For simplicity, a pass/fail distinction is made indicating whether or not each of the three targets is being met. Targets are set for: 1) the total QHEI score; 2) the maximum number of all modified attributes; and 3) the maximum number of high influence modified attributes. If the minimum target is satisfied, then that category is assigned a "1", if not, it is assigned a "0". To satisfy the habitat TMDL, the stream segment in question should achieve a score of three.

Table 3 – QHEI targets for habitat TMDLs

Habitat TMDL Targets		
QHEI Category	*Target*	*Score*
	WWH	
QHEI Score	≥ 60	+ 1
High Influence #	≤ 1	+ 1
Total # Modified	≤ 4	+ 1
	Habitat TMDL ►	+ 3

Table 4 – Itemization of modified attributes for computing habitat TMDLs

High Influence Modified Attributes	Moderate Influence Modified Attributes	
• Recent channelization or no recovery • Silt/muck substrate • Low or no sinuosity (drainage area ≤ 20 mi^2) • Sparse/no cover • Maximum pool depth < 40 cm (wadable or headwater sites)	• Recovering channelization • Heavy/moderate silt cover • Sand substrate (boat sites) • Hardpan substrate origin • Fair/poor development • Low or no sinuosity (drainage area > 20 mi^2) • Only 1-2 cover types	• Intermittent pools and max pool depth < 40 cm • No fast current • High/moderate substrate embeddedness • High/moderate riffle embeddedness • No riffle

Sediment

Numeric targets for sediment are based on three sub-metrics of the QHEI. Although the QHEI evaluates the overall quality of stream habitat, some of its component sub-metrics consider particular aspects of stream habitat that are closely related to and/or impacted by the sediment delivery and transport processes occurring in the system. The QHEI sub-metrics used in the sediment TMDL are the substrate, channel morphology, and bank erosion/riparian zone. Table 5 lists targets for each of these metrics.

Table 5 – QHEI targets for sediment TMDLs

Sediment TMDL Targets	
QHEI Category	WWH
Substrate	≥ 13
Channel	≥ 14
Riparian	≥ 5
Sediment TMDL ►	≥ 32

The substrate sub-metric evaluates predominant substrate types, the amount and origin of these types and the degree of embeddedness and silt cover. This is a qualitative evaluation of the amount of excess fine material in the system and the ability of the channel to assimilate or sort the sediment load. The channel morphology sub-metric considers sinuosity, riffle and pool development, channelization, and channel stability. Except for stability, each of these aspects is directly related to channel form, sediment transport, erosion, and deposition within the channel. Stability reflects the degree of channel erosion, which indicates the potential of the stream to be a significant sediment source.

The bank erosion and riparian zone sub-metric also reflects the likely degree of in-stream sediment sources. The evaluation of floodplain quality is included in this sub-metric, which relates to the capacity of the system to assimilate sediment loads.

Recreation Use

Evaluation of Criteria

Attainment of recreation use goals is based on numeric criteria for *Escherichia coli* (*E. coli*) as an indicator bacterium. These criteria, shown in Table 6, are also the targets used for TMDLs. Table 7 lists attainment of recreation use based on criteria at the time of assessment, which were different than the current standards. However, any TMDLs created for those assessment units will use the updated values in Table 6.

Table 6 – Water quality criteria for recreation use

Recreation Use	*Escherichia coli* (colony forming units per 100 mL)	
	90-day geometric mean	Statistical threshold value[1]
Bathing water	126	410[a]
Primary contact recreation	126	410
Secondary contact recreation	1030	1030

[1] These criteria shall not be exceeded in more than 10 percent of the samples taken during any ninety-day period.

[a] A beach action value of 235 *E. coli* colony counts per 100 mL shall be used for the purpose of issuing beach and bathing water advisories.

Table 7 – Recreation use attainment information for impaired sampling locations in the Mill Creek (Scioto River) watershed, 2014.

Station	Stream Name	HUC-12 (05060001)	RM	# Samples	Geo. Mean	Max. Value	Attain. Status	Possible Source(s)
V03K07	Mill Creek	06 01	39.2	7	767	2600	NON	Small scale livestock, agriculture, Unsewered area
V03W13	Mill Creek	06 02	36.05	5	588	1200	NON	Small scale livestock, agriculture, Unsewered area
V03S17	Mill Creek	06 02	28.13	5	236	440	NON	Unsewered area, small scale livestock and agriculture
V03P14	Mill Creek	06 02	24.74	5	309	470	NON	Unsewered area, small scale livestock and agriculture
V03K10	Town Run	06 02	0.75	4	461	850	NON	Illicit sewage discharges
V03G02	Town Run	06 02	0.21	2	727	2200	NON	Illicit sewage discharges
301928	Mill Creek	09 03	18.2	7	531	1600	NON	Illicit sewage discharges
V03P25	Blues Creek	06 03	0.6	7	83	270	NON	
V03P20	Mill Creek	06 04	12.17	5	680	9300	NON	Unsewered area and agriculture
V03P23	Mill Creek	06 04	6.89	5	131	270	NON	
601260	Mill Creek	06 04	1.57	5	62	220	NON	

Proposed Actions

Concentrations of *E. coli* exceeding the water quality standard are due to both pervasive and direct sources. Two predominant pathways exist for pathogen delivery to water bodies. The first pathway is pathogen-rich discharge, including material such as poorly treated or untreated effluent from wastewater treatment plants, combined sewer overflows, sanitary sewer overflows, household sewage treatment systems and livestock access to streams. This is delivered to the stream by direct discharge. The second pathway is pathogen-rich runoff/drainage from nonpoint sources. The associated delivery mechanism is precipitation-driven wash-off. This type of transport involves the delivery of pathogen-rich material by overland flow during precipitation and runoff events (e.g., summer storms, snowmelt, etc.).

Due to these mechanisms of delivery, the sources of pathogens in surface waters can be determined to a certain extent via the level of stream flow observed. Therefore, Ohio EPA proposes using the load duration curve (LDC) framework for recreation use TMDLs. LDCs are an empirical method of determining TMDL pollutant loading and needed reductions. The main advantage of the use of LDCs is in this method's ability to differentiate loads from various types of sources based on stream flow regime. While this is a fairly simple modeling method, relationships between bacteria source contributions and flow regimes are straight forward. In-stream processes and interactions between sources are simplified, mitigating the major weaknesses of the technique. Figure 2 shows an example LDC with corresponding TMDL calculations represented in Table 8. Ohio EPA will handle recreation use impairment via LDC TMDLs.

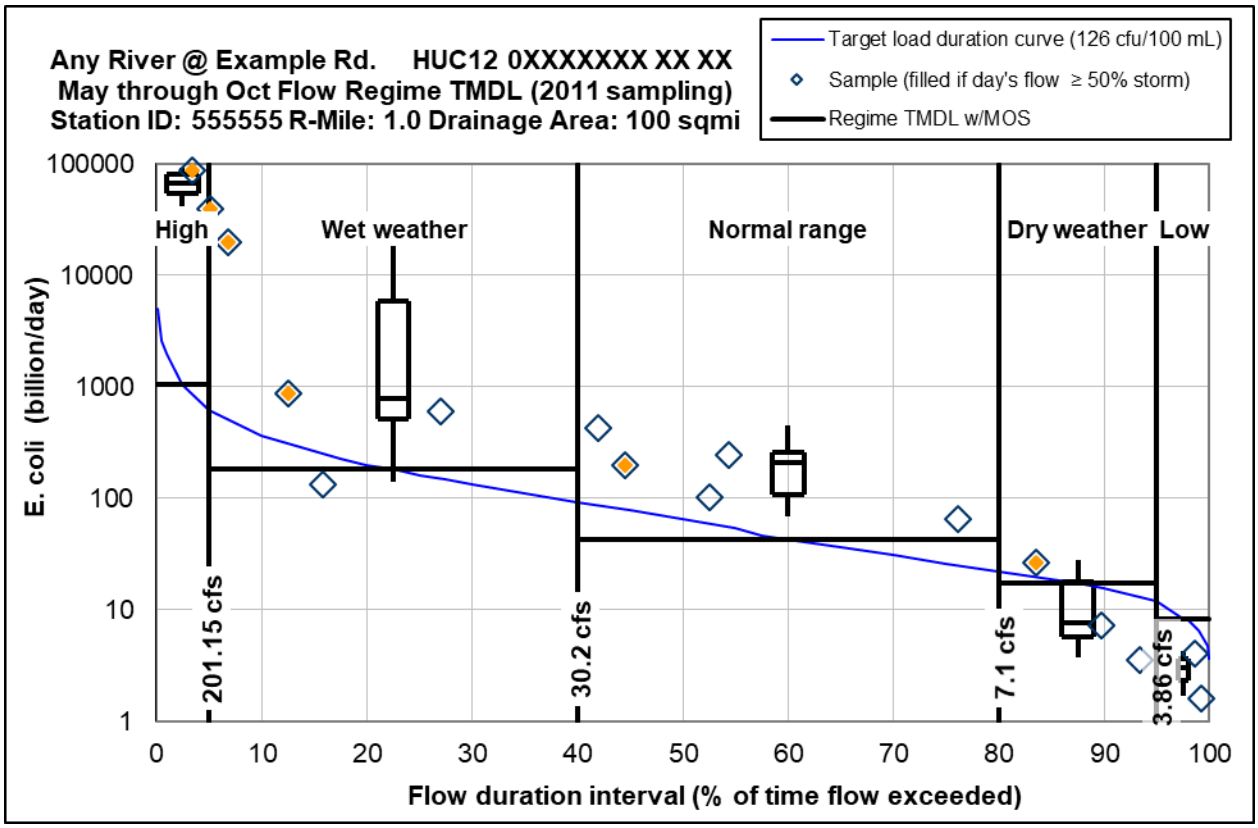

Figure 2 – Example load duration curve.

Table 8 – Example TMDL table calculations (from above load duration curve).

TMDL and duration intervals	High 0-5%	Wet weather 5-40%	Normal range 40-80%	Dry weather 80-95%	Low 95-100%
Samples Per Regime	2	4	5	3	2
Median Sample load	66807	781	209.25	7.72	2.99
Total Load Reduction Required	98.9%	82.8%	84.7%	NA	NA
Total Maximum Daily Load	1036.68	182.09	43.25	17.26	8.35
Margin of Safety: 20%	207.34	36.42	8.65	3.45	1.67
Allowance for Future Growth	62.20	10.93	2.60	1.04	0.50
Load Allocation	740.71	127.29	27.63	8.98	2.58
Wasteload Allocation Total	26.43	7.46	4.37	3.80	3.60
MS4	23.01	4.04	0.96	0.38	0.19
Example Town WWTP XPX00XXX	3.41	3.41	3.41	3.41	3.41

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