Ohio Environmental Protection Agency

Loading Analysis Plan and Supporting Data Acquisition Needed for the

Upper Little Miami River Watershed

Total Maximum Daily Load Development

East Fork, Little Miami River

Ohio EPA Technical Report AMS/2011-UPLMR-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 Upper Little Miami River watershed. These recommendations are based on data collected as part of a biological and water quality study in 2011. A description of the project area, sites, data types and methods, and a summary of the study results can be found in the biological and water quality report (Ohio EPA, 2014).

Sites in the Upper Little Miami River watershed were assessed for aquatic life use and recreation use. There are no impairments of the public drinking water supply use in this study area (Ohio EPA, 2022), and is therefore not further considered in this report. The attainment of aquatic life and recreation use is based on specific criteria. 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.

A TMDL report was developed based on the results of a previous survey and published in 2002 (Ohio EPA, 2002).

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 the 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 Ohio's Integrated Water Quality Monitoring and Assessment Report at: ***epa.ohio.gov/dsw/tmdl/OhioIntegratedReport***.

Aquatic Life Use

Evaluation of Biocriteria

Attainment of Ohio EPA's biocriteria are based on fish and macroinvertebrate scores, as measured by the Index of Biotic Integrity (IBI), Modified Index of well-being (MIwb) and Invertebrate Community Index (ICI). Further explanations of Ohio EPA's biocriteria can be found in Ohio Administrative Code (OAC) Chapter 3745-1-07 and additionally at ***epa.ohio.gov/dsw/bioassess/BioCriteriaProtAqLife***. Goals for those indices in the Upper Little Miami River watershed are shown in Table 1.

The most recent, 2011 assessment of Upper Little Miami River assessed 76 sites, with 50 (66%) meeting the designated ALU. Sites that did not meet designated ALU are assigned either partial or non-attainment and are shown in Table 2. This table also includes the causes and sources of impairment identified at each site.

Table 1 – Biological criteria applicable in the Upper Little Miami River watershed for aquatic life use designations.

Ecoregion	Biological Index	Assessment Method[2, 3]	Biological Criteria for the Applicable Aquatic Life Use Designations[1]		
			EWH	WWH	MWH[4]
Eastern Cornbelt Plains (ECBP)	IBI	Headwater	50	40	24
		Wading	50	40	24
		Boat	48	42	24 / 30
	MIwb	Wading	9.4	8.3	6.2
		Boat	9.6	8.5	5.8 / 6.6
	ICI	All[5]	46	36	22

[1] Aquatic Life Use (ALU) designations: warmwater habitat (WWH); exceptional warmwater habitat (EWH); modified warmwater habitat (MWH); coldwater habitat (CWH), limited resource waters (LRW) and seasonal salmonid habitat (SSH) do not have associated biological criteria.

[2] In general, the assessment method used at a site is determined by its drainage area (DA) according to the following: Headwater: DA ≤ 20 mi^2; wading: DA >20 mi^2 and ≤ 500 mi^2; boat: DA > 500 mi^2.

[3] MIwb not applicable to drainage areas less than 20 mi^2 (headwater sites).

[4] Biocriteria depend on type of MWH. MWH-C (due to channelization) is listed first, MWH-I (due to impoundment) is listed second, and MWH-A (mine affected) is listed third (only applicable in the WAP).

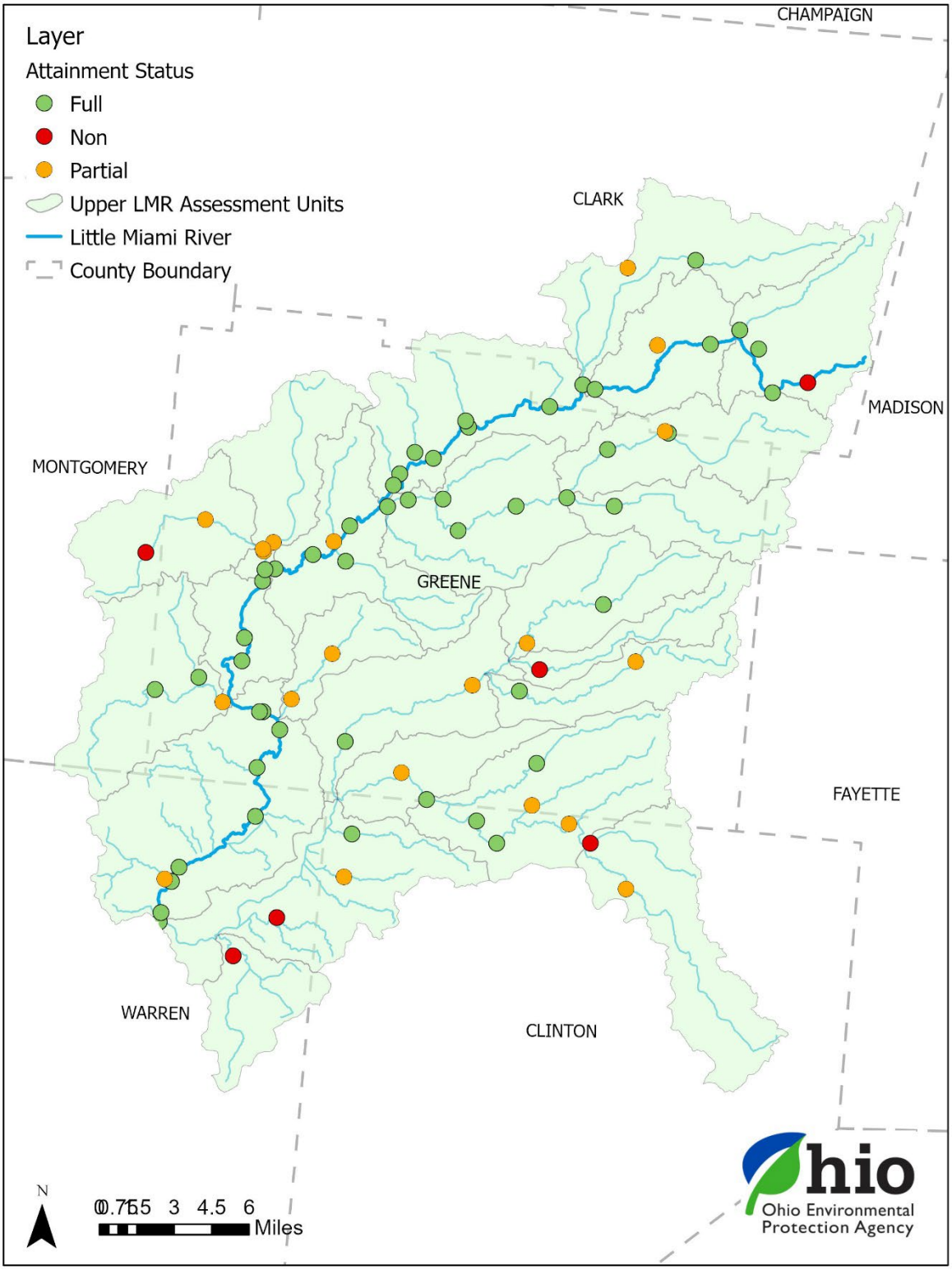

Figure 1 — Map summarizing ALU attainment status in the Upper Little Miami River watershed in 2011

Table 2 – Aquatic life use attainment information for impaired sampling locations in the Upper Little Miami River watershed, 2011.

Station	Location	ALU	River Mile[a]	Drain. Area (mi^2)	IBI	MIwb[b]	ICI[c]	QHEI	Attain. Status	Causes	Sources
05090202 01 01 – Headwaters Little Miami River											
M01S27	Little Miami River @ SR 41 SE of South Charleston	WWH	104.88	4.6	26*	N/A	G	59	NON	Direct habitat alterations	Channelization
										Organic enrichment	Agriculture
										Nutrient enrichment	Industrial point source discharge
05090202 01 02 – North Fork Little Miami River											
200562	UT to N. Fork Little Miami River, S. of Springfield @ Crabill Road	WWH	0.8	7.4	32*	N/A	MG[ns]	37.3	PARTIAL	Direct habitat alterations	Channelization
										Natural conditions (flow or habitat)	Natural sources
200565	UT to N. Fork Little Miami River, SE of Pitchin @ Buffenbarger Road	WWH	0.6	6	30*	N/A	MG[ns]	55.5	PARTIAL	Direct habitat alterations	Channelization
05090202 02 01 – North Fork Massies Creek											
301220	N. Fork Massies Creek @ US 42	WWH	5.73	17.9	34*	N/A	VG	55	PARTIAL	Nutrient enrichment	Onsite treatment systems (septic systems)
										biological indicators	Animal feeding operations
										Direct habitat alterations	Channelization
05090202 02 04 – Little Beaver Creek											
M01S04	L. Beaver Creek at Kettering @ Vale Drive	WWH	6.2	3.6	30*	9.6	LF*	80.3	NON	Sedimentation/siltation,	Urban runoff/Storm sewers
										Nutrient enrichment,	
										Biological indicators	
M01W06	L. Beaver creek @ Valleywood	WWH	2.83	17.1	46	N/A	F*	75.3	PARTIAL	Particle distribution (embeddedness)	Municipal point source discharges Municipal (urbanized high density area)
										Other flow regime alterations	
600630	L. Beaver Creek @ Factory Rd. near Alpha	WWH	0.05	26.4	43	7.5*	F*	64.5	PARTIAL	Nutrient enrichment biological indicators	Urban runoff/ Storm sewers
										Particle distribution (embeddedness)	Municipal point source discharges Municipal (urbanized high density area)
										Other flow regime alterations	

05090202 02 05 – Beaver Creek											
M01S37	Beaver Creek @ Dayton-Xenia Road	WWH	1.57	20.9	40	7.7*	48	62.8	PARTIAL	Natural conditions (flow or habitat)	Natural sources
M01W56	Beaver creek @ US 35 dst Little Beaver Creek	WWH	1.04	48.1	41	7.3*	42	67.8	PARTIAL	Nutrient enrichment biological indicators	Urban runoff/Storm sewers, municipal point source discharges
05090202 02 06 – Shawnee Creek - Little Miami River											
M01W84	Ludlow Creek @ Hilltop Road N. of Xenia	WWH	0.25	6.9	34*	N/A	G	64.8	PARTIAL	Sedimentation/siltation	Agriculture Site clearance (Land development or redevelopment)
05090202 03 01 – Headwaters Anderson Fork											
200478	Grassy Run SE of Port William @ Rd off Gallimore Rd	WWH	0.05	7.8	36^{NS}	N/A	P*	40	NON	Direct habitat alterations	Channelization
M02S12	Anderson Fork @ Haley Road SE of Port William	WWH	18.8	30	30*	7.9^{NS}	48	64	PARTIAL	Direct habitat alterations Fish passage barrier	Channelization Dam or impoundment
05090202 03 02 – Painters Run- Anderson Fork											
200476	Grog Run S of Paintersville @ Bone Road	WWH	0.9	8.3	54	N/A	F*	65	PARTIAL	Organic enrichment Biological indicators Sedimentation/siltation	Unrestricted cattle access
M02S02	Anderson Fork @ Port William Road W of Port William	WWH	13.87	50	53	10.6	F*	70.5	PARTIAL	Low flow alterations	Dam or impoundment
05090202 03 03 – Outlet Anderson Fork											
M02P12	Anderson Fork @ Engle Mill Road	EWH	3.27	88	48^{NS}	9.9	G*	77.5	PARTIAL	Natural conditions (flow or habitat)	Natural sources
05090202 04 01 – North Branch Caesar Creek											
M02S15	North Branch Caesar Creek @ Jasper Rd W of Shawnee Hills	WWH	1.23	25.7	46	7.7*	48	65	PARTIAL	Natural conditions (flow or habitat)	Natural sources
05090202 04 02 – Upper Caesar Creek											
M02S08	Caesar Creek @ Paintersville Rd. at New Jasper	WWH	26.5	12.9	26*	N/A	G	57.5	NON	Natural conditions (flow or habitat)	Natural sources
05090202 04 03 – South Branch Caesar Creek											
M02S14	South Branch Caesar	WWH	8.23	6.5	40	N/A	F*	55.5	PARTIAL	Sedimentation/siltation	Agriculture

	Creek @ Cemetary Rd dst Jamestown										
05090202 04 04 – Middle Caesar Creek											
M02S07	Caesar Creek @ Stone Road SE of Xenia	EWH	23.1	64.6	43*	9.2[NS]	50	76.8	NON	Natural conditions (flow or habitat)	Natural sources
05090202 04 05 – Flat Fork											
M02P07	Flat Fork @ Oregonia Rd	WWH	1.7	15.8	24*	N/A	F*	64.3	NON	Nutrient and organic enrichment, Biological indicators	Agriculture
05090202 04 06 – Lower Caesar Creek											
200537	Jonahs Run @ Oregonia Rd	WWH	2.1	4.1	30*	N/A	LF*	57.8	NON	Natural conditions (flow or habitat)	Natural sources
M02P08	Turkey Run@ Brimstone Mills Road	WWH	1.5	3.8	46	N/A	F*	66.5	PARTIAL	Natural conditions (flow or habitat)	Natural sources
05090202 05 01 – Sugar Creek											
M01P26	Sugar Creek @ Penewit Road near Spring Valley	WWH	0.4	33.2	45	8.6	F*	78	PARTIAL	Natural conditions (flow or habitat)	Natural sources
05090202 05 03 – Glady Run											
M01P16	Glady Run @ Hedges road near Xenia	WWH	4.08	6.9	38[NS]	N/A	F*	68	PARTIAL	Other**	Unspecified urban storm water, urban runoff/storm sewers
M01W60	Glady Run @ Schnebly Road, south crossing	WWH	1.1	12.4	34*	N/A	G	79	PARTIAL	Other**	Unspecified urban storm water, urban runoff/storm sewers
05090202 05 04 – Newman Run- Little Miami River											
M01P31	Newman Run @ US 42 near Waynesville	EWH	0.27	9.8	57	N/A	G*	72.3	PARTIAL	Natural conditions (flow or habitat)	Natural sources

a River Mile (RM) represents the Point of Record (POR) for the station and may not be the actual sampling RM.
b MIwb is not applicable to headwater streams with drainage areas ≤ 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 (≤4 IBI or ICI units, or ≤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 $miles^2$).
B Boat site (large or deep waters, necessitating the use of boat sampling methods)

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, 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.

The existing TMDL for this study area is also considered in determining the appropriate actions for the impairments found in the more recent assessment. When Ohio EPA revisits a survey area, sites are typically aligned to overlap with previous monitoring. In these cases, only the newest data is retained at a given site for attainment and causes/sources of impairment. If a site was previously impaired and a TMDL was calculated, but the most recent survey found it to be attaining ALU criteria, then that site is now in full attainment and will not be addressed in this Loading Analysis Plan. Note that those fully attaining sites may have TMDL pollutant reduction implementation actions currently paused, such as staying at an interim NPDES permit limit, however the TMDL for those sites still apply until the impairment is officially withdrawn by Ohio EPA's 303(d) process.

For sites that remain impaired, the Agency must evaluate if the causes of impairment addressed in the previous TMDL still exist and if any additional action is needed. When the same causes of impairment persist, proposed actions are often to continue TMDL implementation or update the implementation plan. For impaired sites with causes not addressed by the TMDL, or with new causes that supersede the previous ones, a new proposed action is required. This action may include a new TMDL or restoration plan, depending on the same factors outlined above.

Table 3 shows the proposed actions for the impaired ALU sites found in this more recent Upper Little Miami River study. Refer to Appendix A for a comparison of ALU attainment status and causes/sources of impairment from the 2011 survey to the previous 1999 assessment used for the 2002 TMDL report.

Table 3 – Summary of ALU impairments and potential modeling approaches.

Station	Stream Name	River Mile	Assessment Unit (05090202-)	Cause(s) of Impairment	Source(s) of Impairment	IR Cat.[1]	Action [2]	Method[3]	Parameter [4]
M01S27	Little Miami River	104.9	01 01	Direct habitat alterations	Channelization	4C	Other	Restoration plan	Habitat
				Organic enrichment	Agriculture	4A	N/A		
				Nutrient enrichment	Industrial point source discharge	4A	N/A		
200562	North Fork Little Miami River	0.8	01 02	Direct habitat alterations	Channelization	4C	Other	Restoration plan	Habitat
				Natural conditions (flow or habitat)	Natural sources	4C	N/A		
200565	North Fork Little Miami River	0.6	01 02	Direct habitat alterations	Channelization	4C	Other	Restoration plan	Habitat
301220	North Fork Massies Creek	5.73	02 01	Nutrient enrichment	Septic systems	5	Other	Follow up	
				Biological indicators	Animal feeding operations	5	Other	Follow up	
				Direct habitat alterations	Channelization	4C	Other	Restoration plan	Habitat
M01S04	Little Beaver Creek	6.2	02 04	Sedimentation/siltation	Urban runoff/Storm sewers	5	TMDL	QHEI-Sed	Sediment
				Nutrient enrichment	Urban runoff/Storm sewers	5	Other	Follow up	Nutrients
M01W06	Little Beaver Creek	2.83	02 04	Nutrient enrichment biological indicators	Municipal point source discharges	5	Other	Follow up	
				Particle distribution (embeddedness)	Urban runoff/Storm sewers	5	TMDL	QHEI-Sed	Embeddedness
				Other flow regime alterations	Urban runoff/Storm sewers	4C	Other	Restoration plan	Habitat
600630	Little Beaver Creek	0.05	02 04	Nutrient enrichment, biological indicators	Municipal point source discharges	5	Other	Follow up	
				Particle distribution (embeddedness)	Urban runoff/ Storm sewers	5	TMDL	QHEI-Sed	Sediment
				Other flow regime alterations	Urban runoff/Storm sewers	4C	Other	Restoration plan	Habitat
M01S37	Beaver Creek	1.57	02 05	Natural conditions (flow or habitat)	Natural sources	4C	N/A		
M01W56	Beaver Creek	1.04	02 05	Nutrient enrichment	Urban runoff/Storm sewers, municipal point source discharges	5	Other	Follow-up	Nutrients

				Biological indicators	Urban runoff/Storm sewers, municipal point source discharges	5	Other	Follow-up	Biological indicators
M01W84	Ludlow Creek	0.25	02 06	Sedimentation/siltation	Agriculture Site clearance (Land development or redevelopment)	5	TMDL	QHEI-Sed	Sediment
200478	Grassy Run	0.05	03 01	Direct habitat alterations	Channelization	4C	Other	Restoration plan	Habitat
M02S12	Anderson Fork	18.8	03 01	Direct habitat alterations	Channelization	4C	Other	Restoration plan	Habitat
				fish passage barrier	Dam or impoundment	4C	Other	Restoration plan	Habitat
200476	Grog Run	0.9	03 02	Organic enrichment, biological indicators	Unrestricted cattle access	5	Other	Follow-up	Organic enrichment
				Sedimentation/siltation	Unrestricted cattle access	5	TMDL	QHEI-Sed	Sediment
M02S02	Anderson Fork	13.87	03 02	Low flow alterations	Dam or impoundment	4C	Other	Restoration plan	Habitat
M02P12	Anderson Fork	3.27	03 03	Natural conditions (flow or habitat)	Natural sources	4C	N/A		
M02S15	North Branch Caesar Creek	1.23	04 01	Natural conditions (flow or habitat)	Natural sources	4C	N/A		
M02S08	Caesar Creek	26.5	04 02	Natural conditions (flow or habitat)	Natural sources	4C	N/A		
M02S14	South Branch Caesar Creek	8.23	04 03	Sedimentation/siltation	Agriculture	5	Other	QHEI-Sed	Sediment
M02S07	Caesar Creek	23.1	04 04	Natural conditions (flow or habitat)	Natural sources	4C	N/A		
M02P07	Flat Fork	1.7	04 05	Nutrient and organic enrichment	Agriculture	4A	N/A		
				Biological indicators	Agriculture	4A	N/A		
200537	Jonah's Run	2.1	04 06	Natural conditions (flow or habitat)	Natural sources	4C	N/A		
M02P08	Turkey Run	1.5	04 06	Natural conditions (flow or habitat)	Natural sources	4C	N/A		
M01P26	Sugar Creek	0.4	05 01	Natural conditions (flow or habitat)	Natural sources	4C	N/A		
M01P16	Glady Run	4.08	05 03	Other[5]	Unspecified urban storm water, urban runoff/storm sewers	5	Other	Follow up	Other[5]

M01W60	Glady Run	1.1	05 03	Other[5]	Unspecified urban storm water, urban runoff/storm sewers	5	Other	Follow up	Other[5]
M01P31	Newman Run	0.27	05 04	Natural conditions (flow or habitat)	Natural sources	4C	N/A		

[1] IR Cat. (Integrated Report Category)

Category	Definition/interpretation
4A	Water body is impaired for this parameter, and it has already been addressed by an approved TMDL
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 (or by an unknown cause), 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.
QHEI-sed	Sub-metrics of the QHEI (Qualitative habitat evaluation index) will be used to address sedimentation and embeddedness.
Restoration Plan	A restoration plan will be developed to address a 4C impairment outside of the TMDL process.

[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.

[5] "Other" as a cause refers to not readily identified impacts associated with runoff from impervious surfaces and lawns in urban setting

The following subsections are organized to explain the various methods being used to address the proposed actions outlined in Table 3 above.

Impairment addressed by previous TMDL: IR Cat: 4A - Action: Other

The cause of impairment for two sites outlined on Table 3 (M01S27 and M02P07) are being addressed by the previous TMDL effort for the Upper Little Miami River watershed. The original TMDL will stay in place at these locations until the impairments are no longer present. This is applicable to the impaired sites on Table 3 that are noted as being in IR category 4A with an action of N/A. The improvements resulting from the TMDL are described in the 2013 Technical Support Document as follows:

> "One of the primary recommendations of the TMDL was to reduce phosphorus loadings to the watershed and to the Little Miami River mainstem in particular. In the Little Miami River mainstem, total phosphorus levels were markedly lower in 2011, with an overall median of 0.100mg/L compared to 0.235mg/L in 1998. With respect to the TMDL target values, 70% of 2011 individual total phosphorus values were below the target, compared to only 29% of the 1998 concentrations,
>
> These reductions, owing in large part to phosphorus removal at 6 of the major WWTPs in the watershed, have aided in the full attainment of biological criteria at 53.23 miles of the upper Little Miami River mainstem. Only 19.89 miles were in full attainment in 1998,"

No action required due to natural causes of impairment: IR Cat: 4C - Action: N/A

The cause of impairment for ten sites outlined on Table 3 for the Upper Little Miami River watershed was due to natural sources. Impairments due to natural sources are exempt from TMDL requirements. For these sites, no other sources of impairment have been documented and no further action is required to address these impairments.

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

The cause of impairment for nine sites outlined on Table 3 for the Upper Little Miami River watershed was due to impacts from altered habitat. Because habitat is not a pollutant, a TMDL is not required for these impacts. At assessment sites where these impacts were from non-natural sources, e.g., channelization and agriculture, a restoration plan will be developed. This plan uses an empirical method providing benchmarks for certain sub-metrics of each impaired sites' Qualitative Habitat Evaluation Index (QHEI). The QHEI is measured at every aquatic life use assessment site by Ohio EPA. The restoration plan for this watershed will be developed in a separate report that will include several other watersheds.

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

Eight causes of impairment outlined on Table 3 for the Upper Little Miami River watershed were from impacts that may not persist. These include sites impaired by urban runoff, septic tanks, unrestricted cattle access, and municipal point source discharges. This is because several actions in the watershed that may have ameliorated these causes since the most recent 2011 assessment. All the counties comprising the watershed have since re-developed storm water management plans, and several have also created plans to address septic systems and unsewered communities.

Because of these factors, follow-up monitoring is recommended prior to a TMDL is developed. When this follow-up monitoring occurs another study plan, water quality results, 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.

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

The cause of impairment for six sites outlined on Table 3 for the Upper Little Miami River watershed was due to impacts from sedimentation and/or siltation. A sediment TMDL calculated using QHEI sub-metrics will appropriately address this cause of impairment.

Aquatic Life Use Proposed Targets

This section outlines the targets to be used to address the parameters that will be used to address impairments. The proposed actions for these parameters, and the parameters themselves, are listed in the preceding section.

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 5.

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 6).

In addition to the overall QHEI scores, targets for the maximum number of modified and high influence modified attributes have been developed. For example, in order 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 4 – QHEI targets for habitat TMDLs

Habitat TMDL Targets			
QHEI Category	*Target*		*Score*
	WWH	*EWH*	
QHEI Score	≥ 60	≥ 75	+ 1
High Influence #	≤ 1	0	+ 1
Total # Modified	≤ 4	≤ 2	+ 1
Habitat TMDL ▶			+ 3

Table 5 – 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 7 lists targets for each of these metrics.

Table 6 – QHEI targets for sediment TMDLs

Sediment TMDL Targets		
QHEI Category	WWH	EWH
Substrate	≥ 13	≥ 15
Channel	≥ 14	≥ 15
Riparian	≥ 5	≥ 5
Sediment TMDL ▶	≥ 32	≥ 35

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 8, are also the targets used for TMDLs. Table 9 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 8.

Table 7 – 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 90-day period.

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

Table 8 – Recreation use attainment information for impaired sampling locations in the Upper Little Miami River watershed, 2011.

Station	Stream Name	HUC-12 (05090202-)	RM	# Samples	Geo. Mean	Max. Value	Possible Source(s)
M01W62	Little Miami River	01 01	106.95	8	309	4800	Agricultural runoff
M01S27	Little Miami River	01 01	104.88	8	1357	12000	Agricultural runoff, animal feedlot operation
M01P02	Little Miami River	01 03	98.98	9	410	6600	Agricultural runoff, biosolids application
M01P06	Little Miami River	01 03	92.27	8	602	4500	Agricultural runoff, biosolids application
M01P12	Little Miami River	01 04	85.38	8	201	3200	Biosolids application
600570	Little Miami River	01 04	80.63	9	365	4700	Agricultural runoff
M01S25	Little Miami River	02 06	77.7	9	336	1100	Agricultural runoff, biosolids application
M01W30	Little Miami River	02 06	75.38	10	307	540	Urban runoff, agricultural runoff, biosolids application
M01P13	Little Miami River	05 02	72.3	9	312	1100	WWTP, urban runoff, agricultural runoff
M01W39	Little Miami River	05 02	68.54	10	266	770	Agricultural runoff
M01W40	Little Miami River	05 04	64.44	9	296	1200	Agricultural runoff
M01S30	Little Miami River	05 04	64.28	9	297	1300	WWTP, agricultural runoff
M01W45	Little Miami River	05 04	63.28	9	368	1100	WWTP, urban runoff, agricultural runoff
600600	Little Miami River	05 04	60.84	10	308	2400	Agricultural runoff
M01S29	Little Miami River	05 04	53.2	9	293	3100	WWTP, urban runoff, agricultural runoff
M01W55	Little Miami River	05 04	51.65	10	349	2400	Package plant, agricultural runoff
M01W08	Gilroy Ditch	01 01	1.4	8	206	8500	Unknown
M01W09	Gilroy Ditch	01 01	0.5	8	1329	7700	WWTP, urban runoff, agricultural runoff, biosolids application
M01P04	North Fork Little Miami River	01 02	0.37	8	353	2600	Agricultural runoff, biosolids application
M01P09	Yellow Spring Creek	01 04	0.1	8	358	3000	Urban runoff, agricultural runoff
M01S11	Massies Creek	02 03	7.7	8	266	4500	Urban runoff, agricultural runoff
M01P17	Massies Creek	02 03	4.38	9	264	4500	Urban runoff, agricultural runoff
M01W83	Massies Creek	02 03	1.2	8	447	5100	Agricultural runoff, biosolids application
200555	North Fork Massies Creek	02 01	5.9	8	447	6000	Agricultural runoff, biosolids application
301220	North Fork Massies Creek	02 01	5.73	9	725	28000	Agricultural runoff, animal feedlot application, biosolids application
M01P20	South Fork Massies Creek	02 02	0.14	8	233	2700	Urban runoff, agricultural runoff
M01P23	Shawnee Creek	02 06	0.65	9	395	3500	Urban runoff, biosolids application
M01S37	Beaver Creek	02 05	1.57	10	503	2200	Sanitary sewer overflows, urban runoff

M01S35	Beaver Creek	02 05	0.2	9	338	2100	WWTP, sanitary sewer overflows, urban runoff, wildlife
M01W01	Little Beaver Creek	02 04	4.76	9	324	2600	Urban runoff
M01S44	Little Beaver Creek	02 04	3.54	9	424	4900	Urban runoff
600630	Little Beaver Creek	02 04	0.05	10	475	1200	Urban runoff
M01P26	Sugar Creek	05 01	0.4	9	600	4000	Urban runoff, agricultural runoff
M01P16	Glady Run	05 03	4.08	9	468	990	WWTP, urban runoff, agricultural runoff
M01P15	Glady Run	05 03	0.54	10	422	1200	Urban runoff, agricultural runoff, biosolids application
M02S08	Caesar Creek	04 02	26.5	8	530	3300	Livestock access to stream, agricultural runoff, biosolids application, wildlife
M02S15	North Branch Caesar Creek	04 01	1.23	8	608	6900	Agricultural runoff, biosolids application
M02S14	South Branch Ceasar Creek	04 03	8.23	8	885	3100	WWTP, urban runoff, agricultural runoff
M02S13	South Branch Ceasar Creek	04 03	2.1	9	259	11000	Agricultural runoff
M02S12	Anderson Fork	03 01	18.8	8	472	5900	Agricultural runoff
301480	Anderson Fork	03 02	7.9	8	257	3000	Agricultural runoff
M02S01	Anderson Fork	03 02	4.9	9	396	5600	Agricultural runoff
M02P03	Painters Creek	03 02	0.43	8	469	11000	Agricultural runoff, biosolids application

Recreation Use 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 basic modeling method, relationships between bacteria source contributions and flow regimes are straight forward. In-stream processes and interactions between pathogen sources are assumed conservative (i.e., not occurring) in this method. Figure 2 shows an example LDC with corresponding TMDL calculations represented in Table 10.

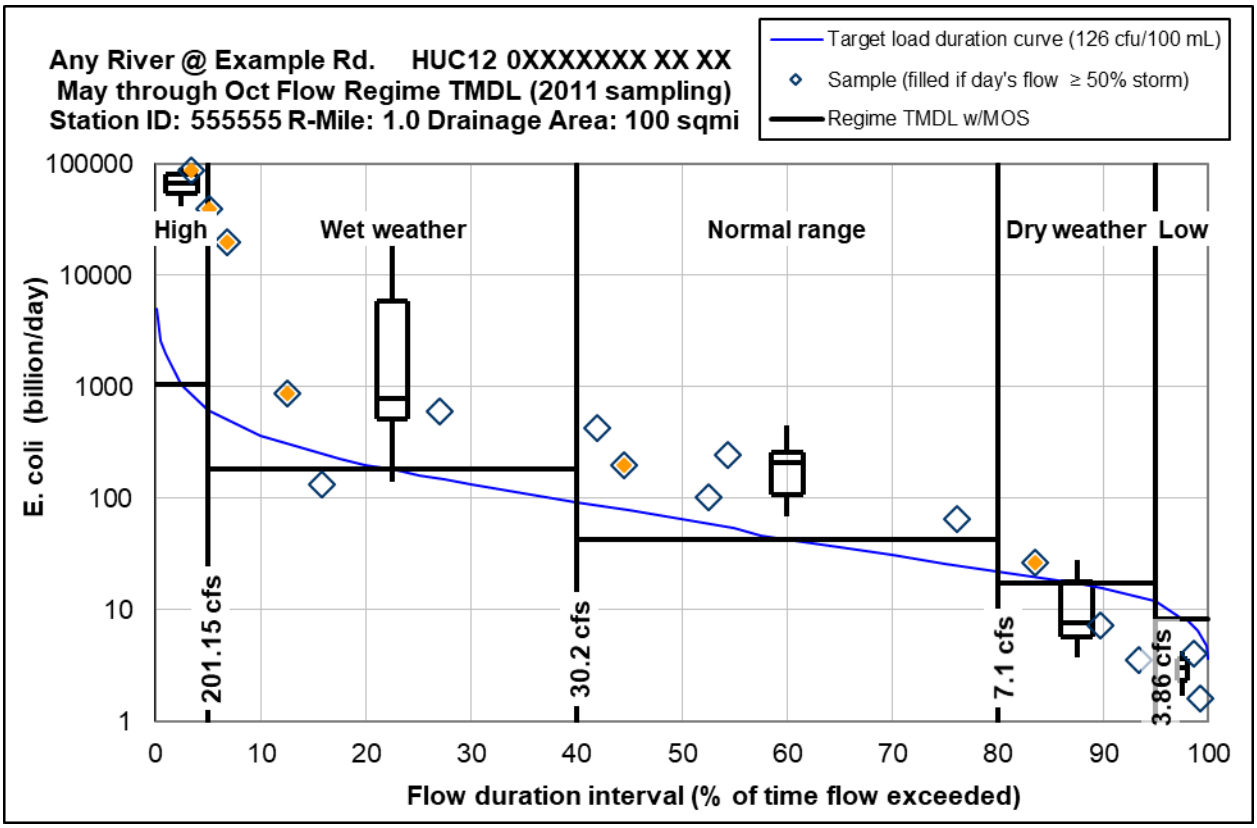

Figure 2 – Example load duration curve.

Table 9 – 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

Recreation Use Proposed Targets

The primary contact recreation geometric mean criterion of 126 colony forming units per 100 mL *E. coli* will be used as the target concentration for the recreation use TMDL. As shown as the blue curve in the example load duration curve of Figure 2, above, this target concentration is converted into a load throughout the calculated flow regime. The black horizontal lines in Figure 2 and the "Total Maximum Daily Load" row in Table 10 show the TMDL values for five flow regime categories. This TMDL is the median of the curve load within each flow regime category.

References

Ohio EPA (Ohio Environmental Protection Agency – Division of Surface Water). 1999. *Association between nutrients, habitat, and the aquatic biota of Ohio's rivers and streams.* Published at: ***epa.ohio.gov/portals/35/guidance/assoc_load.pdf***

Ohio EPA (Ohio Environmental Protection Agency – Division of Surface Water). 2000. *Legal and Technical Basis for Nutrient Target Values Used in TMDL Projects, Water Quality Standard Guidance 4*. Published at: ***epa.ohio.gov/portals/35/guidance/wqs4.pdf***

Ohio EPA (Ohio Environmental Protection Agency – Division of Surface Water). 2014. *Biological and Water Quality Study of the Little Miami River, 2011.* Published at: ***epa.ohio.gov/static/Portals/35/documents/LMR_Upper_Basin_2011_TSD.pdf.***