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Ohio Environmental Protection Agency

Total Maximum Daily Loads for the Portage River Watershed

Final Report
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Photo caption: Portage River at river mile 15.7 near Slemmer-Portage Road in Ottawa County.

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Acronyms and Abbreviations

AFG	allowance for future growth
ALU	aquatic life use
AU	assessment unit
AWS	agricultural water supply
BMP	best management practices
BNA	base neutral and acid extractable compounds
BW	bathing water
CAFO	confined animal feeding operation
CFR	Code of Federal Regulations
cfs	cubic feet per second
Corps	United States Army Corps of Engineers
CREP	Conservation Reserve Enhancement Program (USDA program)
CRP	Conservation Reserve Program (USDA program)
CSO	combined sewer overflow
CSP	Conservation Security Program (USDA program)
CWA	Clean Water Act
CWH	coldwater habitat
D.O.	dissolved oxygen
DA	drainage area
DMR	discharge monitoring report
DNAP	Division of Natural Areas and Preserves (part of ODNR)
DOW	Division of Wildlife (part of ODNR)
DSW	Division of Surface Water (part of Ohio EPA)
DSWC	Division of Soil and Water Conservation (part of ODNR)
ECBP	Eastern Corn Belt Plains (ecoregion)
EPA	Environmental Protection Agency, see U.S. EPA
EQIP	Environmental Quality Incentive Plan (USDA program)
EWH	exceptional warmwater habitat
FCA	fish consumption advisory
FFY	federal fiscal year (October 1 to September 30)
FSA	Farm Service Agency
FWPCA	Federal Water Pollution Control Act
gpd	gallons per day
GRP	Grassland Reserve Program (USDA program)
HELP	Huron Erie Lake Plain (ecoregion)
HSTS	home sewage treatment system
HU	hydrologic unit
HUC	hydrologic unit code
I/I	infiltration and inflow
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
IR	Integrated Report
IWS	industrial water supply
kg	kilogram
L	liter
LA	load allocation
LaMP	Lakewide Management Plan
LEC	(Ohio) Lake Erie Commission

LEL	lowest effect level
LEPF	Lake Erie Protection Fund (LEC program)
LRAU	large river assessment unit
LRW	limited resource water
LTCP	long-term control plan
mg	milligram
MGD	million gallons per day
MHP	mobile home park
MIwb	Modified Index of well being
mi^2	square miles
ml	milliliter
MOS	margin of safety
MPN	most probable number
MS4	municipal separate storm sewer system
MWH	modified warmwater habitat
n	number (of data points in a grouping)
NHD	National Hydrography Dataset
NOI	notice of intent
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NRCS	Natural Resource Conservation Service
OAC	Ohio Administrative Code
ODA	Ohio Department of Agriculture
ODH	Ohio Department of Health
ODNR	Ohio Department of Natural Resources
ODOT	Ohio Department of Transportation
OEPA	Ohio Environmental Protection Agency
Ohio EPA	Ohio Environmental Protection Agency (preferred nomenclature)
ORC	Ohio Revised Code
ORSANCO	Ohio River Valley Water Sanitation Commission
OSC	on-site coordinator
OSUE	Ohio State University Extension
OWDA	Ohio Water Development Authority
OWRC	Ohio Water Resources Council
PAHs	polyaromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCR	primary contact recreation
PEC	probable effect concentration
PDWS	public drinking water supply
PEC	probable effect concentration
ppb	parts per billion
PS	point source
PTI	permit to install
PTO	permit to operate
PWS	public water supply
QA	quality assurance
QC	quality control
QHEI	qualitative habitat evaluation index
RM	river mile
SCR	secondary contact recreation
SDWA	Safe Drinking Water Act

SEL	severe effect level
SFY	state fiscal year (July 1 to June 30)
SMP	sludge management plan
sq mi	square miles
SRW	state resource water
SSH	seasonal salmonid habitat
SSM	single-sample maximum
SSO	sanitary sewer overflow
STORET	STOrage and RETrieval (a U.S. EPA water quality database)
SWIMS	Surface Water Information Management System
SWCD	Soil and Water Conservation District
TEC	threshold effect concentration
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TOC	total organic carbon
TSS	total suspended solids
ug	microgram
µg	microgram
U.S. EPA	United States Environmental Protection Agency
UAA	use attainability analysis
USACOE	United States Army Corps of Engineers
USC	United States Code
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VOC	volatile organic compound
WAU	watershed assessment unit
WHIP	Wildlife Habitat Incentives Program (USDA program)
WLA	wasteload allocation
WPCLF	Water Pollution Control Loan Fund
WQ	water quality
WQS	water quality standards
WRP	Wetland Reserve Program (USDA program)
WRRSP	Water Resource Restoration Sponsor Program (Ohio EPA program)
WTP	water treatment plant
WWH	warmwater habitat
WWTP	wastewater treatment plant

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County health departments
Toledo Metropolitan Area Council of Governments (TMACOG)

The Ohio EPA appreciates the cooperation of the property owners who allowed Ohio EPA personnel access to the project area.

Executive Summary

The Portage River watershed is located in northwest Ohio, extending from its headwaters near Findlay and Fostoria north to Lake Erie. This watershed drains 585 square miles and is home to more than 67,000 people. The watershed encompasses all or part of 28 municipalities in Wood, Hancock, Ottawa, Sandusky, and Seneca counties. From 2006 through 2008, Ohio EPA sampled 84 sites on streams in this watershed to evaluate the recreation and aquatic life uses. Details of the water quality survey are available[1,2].

Forty percent of the sites on the Portage River mainstem did not meet standards for aquatic life uses. The tributary streams showed slightly lower water quality with a 47 percent overall impairment rate. The dominant water quality problem impacting aquatic life uses is excess fine sediment, or siltation, cited at 37 percent of all sites. Poor habitat, nutrients, and altered stream flow accounted for impacts at 18, 16 and 12 percent of all sites, respectively. By far, impacts from crop production and channel maintenance are the most significant and widespread, contributing to degradation at 35 and 31 percent of all sites, respectively. Point sources of pollution, such as wastewater treatment plants and combined sewer systems, are cited at 13 percent of all of the sites.

Recreation uses were impaired due to the elevated risk for water-borne illness from pathogen contamination, evidenced by high concentrations of bacteria associated with fecal matter. Reasons for these failures include poorly treated human waste coming from home septic systems, bacteria associated with urban runoff, and ineffective wastewater treatment and system overflows.

Total maximum daily loads (TMDLs) were calculated for *E. coli* bacteria, nutrients, oxygen demanding substances, sediment, and habitat quality. Watershed hydrology and estimates of nutrient loading from all significant sources were approximated using a watershed loading model which also simulates in-stream transport and pollutant decay. The sediment and habitat TMDLs were generated through a direct comparison of scores from a habitat evaluation index to target scores for that index.

Some of the watershed's point sources will require an improvement in the quality of their effluent primarily in relation to effluent concentrations of total phosphorus. There is also a need for some facilities to comply with existing permit limits and separate sewers per existing long term control plans.

Nonpoint sources can be addressed through system upgrades or better management of home septic systems. Sediment loading primarily originates from cropland; cover crops, conservation crop rotation, improvements in tillage methods, and sediment capture areas such as filter areas or wetlands would alleviate a large proportion of the problem. These practices, along with good nutrient management based on soil testing and application reductions, as well as better timing and methods of application will help nutrient enriched streams. Storm water impacts from existing urbanized areas could be minimized by retrofitting storm water infrastructure as opportunities arise and by using a proactive storm water management approach for new development.

[1] Biological and Water Quality Survey of the Portage River Basin, Select Maumee River Tributaries, and Select Lake Erie Tributaries, 2006 - 2008. Hancock, Lucas, Ottawa, Sandusky, Seneca, and Wood Counties, Ohio (Ohio EPA, 2010) (http://www.epa.state.oh.us/portals/35/documents/PortageLETribsMaumeeTribs2010.pdf)

[2] Data via interactive maps at http://wwwapp.epa.ohio.gov/dsw/gis/bio/index.php

1 INTRODUCTION

The Portage River watershed is located in northwest Ohio extending from its headwaters near Findlay and Fostoria in the south to Lake Erie in the north. This watershed is 585 square miles in area and, based on Census 2000 estimates, is home to more than 67,000 people. The watershed encompasses all or part of 28 municipalities in Wood, Hancock, Ottawa, Sandusky, and Seneca counties.

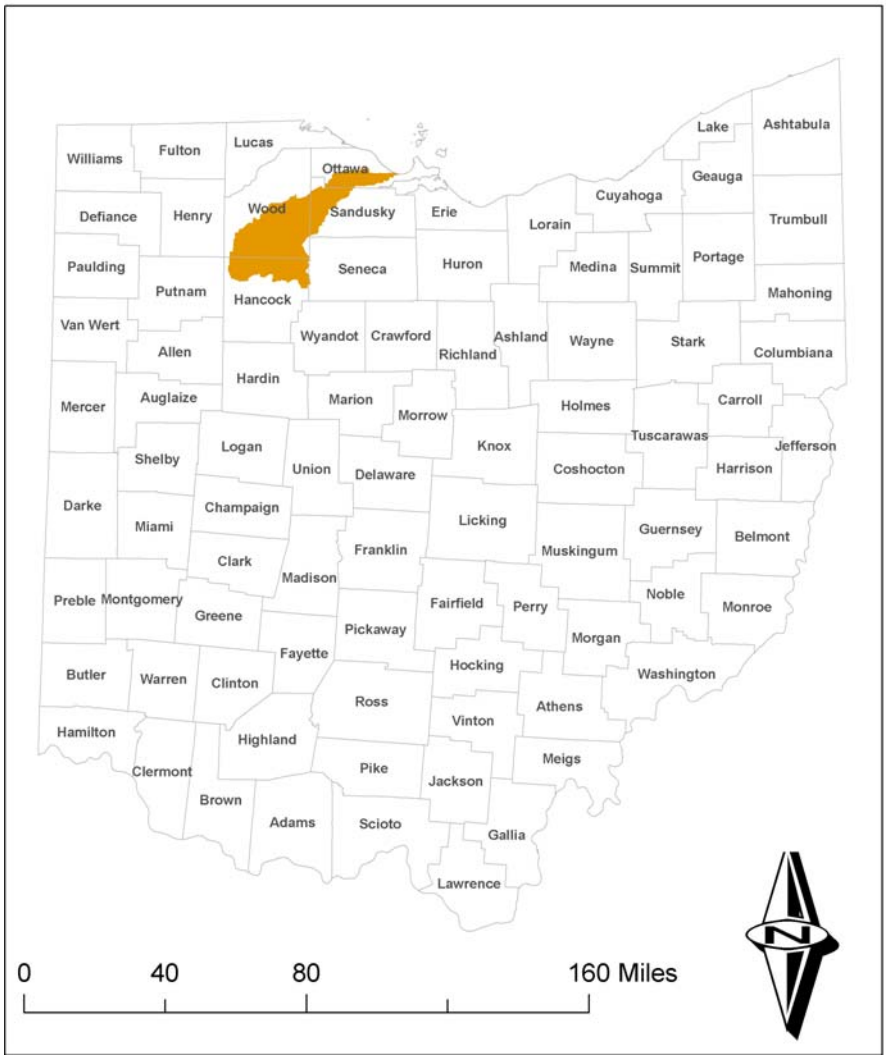

Figure 1-1. State map with the Portage River watershed highlighted.

Ohio EPA conducted a comprehensive physical, chemical and biological survey in the Portage River watershed through the years of 2006 to 2008. The water quality survey included monitoring of Portage River and several tributary streams. There were stream segments identified during the survey as not meeting Ohio's water quality standards. These findings and other information regarding water quality and habitat conditions are summarized in this report.

Total maximum daily loads (TMDL) have been developed for pollutants and stressors that have impaired water uses and precluded attainment of applicable water quality standards. This report summarizes the approach taken and results for these TMDL analyses. This report also includes a discussion about actions and land management that can abate the identified water resource problems.

Specific TMDLs that have been developed and are described in this report include:

- Pathogens (using *E. coli* as an indicator of contamination)
- Nutrients (using total phosphorus as the indicator)
- Dissolved oxygen and organic enrichment (using CBOD 5-day as the indicator)
- Sediment (using a qualitative index to assess the degree of in-stream sedimentation)
- Habitat (using a qualitative index to assess the quality of habitat features)

Chapter six in this report provides strategies for restoring the designated uses for surface waters in the Portage River watershed. Strategies for control of point sources and some nonpoint sources involve use of regulatory wastewater and storm water permits to control pollutant loading in the watershed. Corrective measures have already been initiated to address use impairment caused by some regulated entities while others have yet to be addressed.

1.1 The Clean Water Act Requirement to Address Impaired Waters

The Clean Water Act (CWA) Section 303(d) requires States, Territories, and authorized Tribes to list and prioritize waters for which technology-based limits alone do not ensure attainment of water quality standards. Lists of these impaired waters (the Section 303(d) lists) are made available to the public for comment then submitted to the U.S. Environmental Protection Agency (U.S. EPA) for approval in even-numbered years. Further, the CWA and U.S. EPA regulations require that Total Maximum Daily Loads (TMDLs) be developed for all waters on the Section 303(d) lists. The Ohio EPA identified several subwatersheds (12-digit Hydrologic Unit Code) as impaired on the 2010 303(d) list (contained in the 2010 Integrated Report (Ohio EPA, 2010), available at http://www.epa.ohio.gov/dsw/tmdl/2010IntReport/index.aspx.

In the simplest terms, a TMDL can be thought of as a cleanup plan for a watershed that is not meeting water quality standards. A TMDL is defined as a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards and an allocation of that quantity among the sources of the pollutant. Ultimately, the goal of Ohio's TMDL process is full attainment of Water Quality Standards (WQS), which would subsequently lead to the removal of the waterbodies from the 303(d) list. Figure 1-2 shows the phases of TMDL development in Ohio.

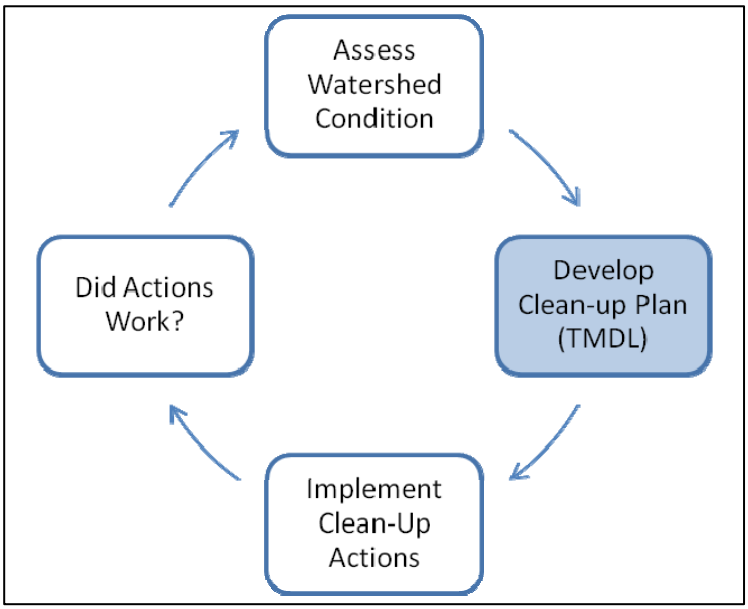

Figure 1-2. Overview of the TMDL project process.

Table 1-1 summarizes how the impairments identified in the Portage River watershed are addressed in this TMDL report.

Table 1-1. Summary of impairments in the Portage River watershed and methods used to address impairments.

Assessment Unit (04100010)	Narrative Description	Causes of Impairment (Beneficial use in parentheses)	Action Taken
Rocky Ford-Middle Branch Portage River (04100010-01)			
01-01 *Priority points: 8*	Rader Creek	phosphorus (total) (ALU)	TMDL for nutrients
		sedimentation/siltation (ALU)	TMDL for sediment
		oxygen, dissolved (ALU)	TMDL for nutrients (w/ D.O. as a modeling endpoint)
		nitrate/nitrite (nitrite+nitrate as N) (ALU)	TMDL for nutrients
		E. coli (RU)	TMDL for *E. coli*
		Insufficient data to assess use (PDWSU)	No action necessary
01-02 *Priority points: 4*	Needles Creek	direct habitat alterations (ALU)	TMDL for habitat
		low flow alterations (ALU)	TMDL for sediment
		sedimentation/siltation (ALU)	TMDL for sediment
		E. coli (RU)	TMDL for *E. coli*
01-03 *Priority points: 8*	Rocky Ford	sedimentation/siltation (ALU)	TMDL for sediment
		low flow alterations (ALU)	TMDL for sediment
		direct habitat alterations (ALU)	TMDL for habitat
		E. coli (RU)	TMDL for *E. coli*
		Insufficient data to assess use (PDWSU)	No action necessary
01-04 *Priority points: 3*	Town of Rudolph-Middle Branch Portage River	No impairment (ALU)	No action necessary
		E. coli (RU)	TMDL for *E. coli*
Portage River (04100010-02)			
02-01 *Priority points: 7*	Bull Creek	direct habitat alterations (ALU)	TMDL for habitat
		sedimentation/siltation (ALU)	TMDL for sediment
		E. coli (RU)	TMDL for *E. coli*
02-02 *Priority points: 10*	East Branch Portage River	low flow alterations (ALU)	TMDL for sediment
		organic enrichment (sewage) biological indicators (ALU)	TMDL for CBOD
		nutrient eutrophication biological indicators (ALU)	Not addressed
		sedimentation/siltation (ALU)	TMDL for sediment
		nitrate/nitrite (nitrite + nitrate as N) (ALU)	TMDL for nutrients
		ammonia (total) (ALU)	TMDL for CBOD 5-day (CSO)
		E. coli (RU)	TMDL for *E. coli*
		Insufficient data to assess use (PDWSU)	No action necessary
02-03 *Priority points: 7*	Town of Bloomdale-South Branch Portage River	direct habitat alterations (ALU)	TMDL for habitat
		sedimentation/siltation (ALU)	TMDL for sediment
		total dissolved solids (ALU)	Not addressed (unknown source)
		organic enrichment (sewage) biological indicators	Not addressed
		E. coli (RU)	TMDL for *E. coli*

Assessment Unit (04100010)	Narrative Description	Causes of Impairment (Beneficial use in parentheses)	Action Taken
		Insufficient data to assess use (PDWSU)	No action necessary
02-04 *Priority points: 3*	Rhodes Ditch-South Branch Portage River	No impairment (ALU)	No action necessary
		E. coli (RU)	TMDL for *E. coli*
02-05 *Priority points: 4*	Cessna Ditch-Middle Branch Portage River	No impairment (ALU)	No action necessary
		E. coli (RU)	TMDL for *E. coli*
Upper Portage River (04100010-03)			
03-01 *Priority points: 12*	North Branch Portage River	sedimentation/siltation (ALU)	TMDL for sediment
		phosphorus (total) (ALU)	Not addressed
		direct habitat alterations (ALU)	TMDL for habitat
		oxygen, dissolved (ALU)	Not addressed
		nitrate/nitrite (nitrite + nitrate as N) (ALU)	Not addressed
		E. coli (RU)	TMDL for *E. coli*
03-02 *Priority points: 8*	Town of Pemberville-Portage River	No impairment (ALU)	No action necessary
		E. coli (RU)	TMDL for *E. coli*
Middle Portage River (04100010-04)			
04-01 *Priority points: 7*	Sugar Creek	direct habitat alterations (ALU)	TMDL for habitat
		nutrient/eutrophication biological indicators (ALU)	TMDL for nutrients
		sedimentation/siltation (ALU)	TMDL for sediment
		E. coli (RU)	TMDL for *E. coli*
04-02 *Priority points: 12*	Lacarpe Creek Outlet #4-Portage River	direct habitat alterations (ALU)	TMDL for habitat
		E. coli (RU)	TMDL for *E. coli*
Lower Portage River-Frontal Lake Erie (04100010-05)			
05-01 *Priority points: 6*	Little Portage River	sedimentation/siltation (ALU)	TMDL for sediment
		nutrient/eutrophication biological indicators (ALU)	TMDL for nutrients
		low flow alterations (ALU)	TMDL for sediment
		direct habitat alterations (ALU)	TMDL for habitat
		E. coli (RU)	TMDL for *E. coli*
05-02 *Priority points: 9*	Portage River	nutrient/eutrophication biological indicators (ALU)	TMDL for nutrients
		sedimentation/siltation (ALU)	TMDL for sediment
		sediment screening value (exceedence) (ALU)	Not addressed (legacy toxics)
		phosphorus (total) (ALU)	TMDL for nutrients
		E. coli (RU)	TMDL for *E. coli*
05-03 *Priority points: 2*	Lacarpe Creek-Frontal Lake Erie	No data available (ALU)	No action necessary
		No data available (RU)	No action necessary

ALU = aquatic life use
RU = recreation use
PDWSU = public drinking water supply use

1.2 Public Involvement

Public involvement is key to the success of water restoration projects, including TMDL efforts. From the beginning, Ohio EPA has invited participation in all aspects of the TMDL program. The Ohio EPA convened an external advisory group in 1998 to assist the Agency with the development of the TMDL program in Ohio. The advisory group issued a report in July 2000 to the Director of Ohio EPA on their findings and recommendations. The Portage River watershed TMDL project has been completed using the process endorsed by the advisory group.

Consistent with Ohio's current Continuous Planning Process (CPP), the draft TMDL report will be available for public review from July 15 through August 15, 2011. A copy of the draft report will be posted on Ohio EPA's web page (http://www.epa.ohio.gov/dsw/tmdl/index.aspx). A summary of the comments received and the associated responses will be completed after the public comment period and included in an appendix to the final report.

Ohio EPA has been in contact with interested parties in the watershed throughout the TMDL process. Organizations external to the agency (representatives for wastewater plants, watershed groups, and other state and county agencies) have been invited to study planning meetings and have had survey results presented at several different times and locations. Additionally, Ohio EPA has worked with the Portage River Basin Council regarding information sharing and education efforts with the public and other interested parties.

Continued public involvement is critical to the success of any TMDL project. Ohio EPA will continue to support the implementation process and will facilitate, to the fullest extent possible, restoration actions that are acceptable to the communities and stakeholders in the study area and to Ohio EPA. Ohio EPA is reluctant to rely solely on regulatory actions and strongly advocates voluntary actions facilitated by the local stakeholders, watershed organization, and agency partners to restore the Portage River watershed.

1.3 Organization of Report

Chapter 2 gives an overview of water quality standards applicable in the watershed. Chapter 3 gives an overview of the water quality conditions in the watershed. Chapter 4 briefly discusses the methods used to calculate load reductions. Chapter 5 provides the load reduction results. Chapter 6 discusses suggested restoration methods to improve water quality.

More detailed information on selected topics is contained in appendices. Appendix A lists the permitted facilities in the watershed. Appendix B summarizes the findings of the watershed survey. Appendix C is a primer on Ohio's water quality standards. Appendix D contains details of the loading analysis. Appendix E discusses programs and actions available to improve water quality.

2 PROJECT OVERVIEW

The purpose of this chapter is to summarize the existing conditions within the TMDL project area. This includes physical and demographic attributes of the watershed as well as the most recent water quality information.

2.1 Description of Project Area

The following four subsections provide background information regarding the TMDL project area. Here the project area is clearly defined including an overview of the stream system. Also, important physical attributes such as land cover types, soils, and topography is discussed along with demographic information since human land use and development patterns impact water quality.

2.1.1 Project Delineation and Water Resources

In the nationwide numbering system for watersheds (similar to postal codes)[1], the Portage River watershed is assigned the 8-digit number 04100010 (indicating that it flows into Lake Erie). The Portage River watershed is further subdivided into five 10-digit areas as follows:

- Rocky Ford-Middle Branch Portage River – 04100010-01
- South Branch Portage River-Middle Branch Portage River – 04100010-02
- Upper Portage River – 04100010-03
- Middle Portage River – 04100010-04
- Lower Portage River-Frontal Lake Erie – 04100010-05

The five 10-digit watersheds are further subdivided into 16 12-digit subwatersheds. Ohio has adopted the 12-digit watershed size as the assessment unit for 305(b) and 303(d) reporting. This report will discuss the watershed at the 10- and 12-digit scales.

Table 2-1 lists the 10- and 12-digit HUCs of the Portage River watershed. Figure 2-1 shows the Portage River watershed's numbering system.

The Portage River is nearly 36 miles long and begins where the North Branch and South Branch of the Portage River meet and continues until discharging in to Lake Erie. Figure 2-2 is a map showing some of the named tributaries in the watershed.

[1] The numbers are referred to as hydrologic unit codes (HUCs). Each pair of numbers is meaningful; 8-, 10-, and 12-digit codes are also referred to as 4th-, 5th-, and 6th-level codes.

Principle tributaries to Portage River include:

- North Branch Portage River
- Rader Creek
- Rocky Ford Creek
- South Branch Portage River
- Sugar Creek
- Ninemile Creek
- Bull Creek
- Needles Creek
- East Branch Portage River
- Little Portage River
- Middle Branch Portage River
- Wolf Creek

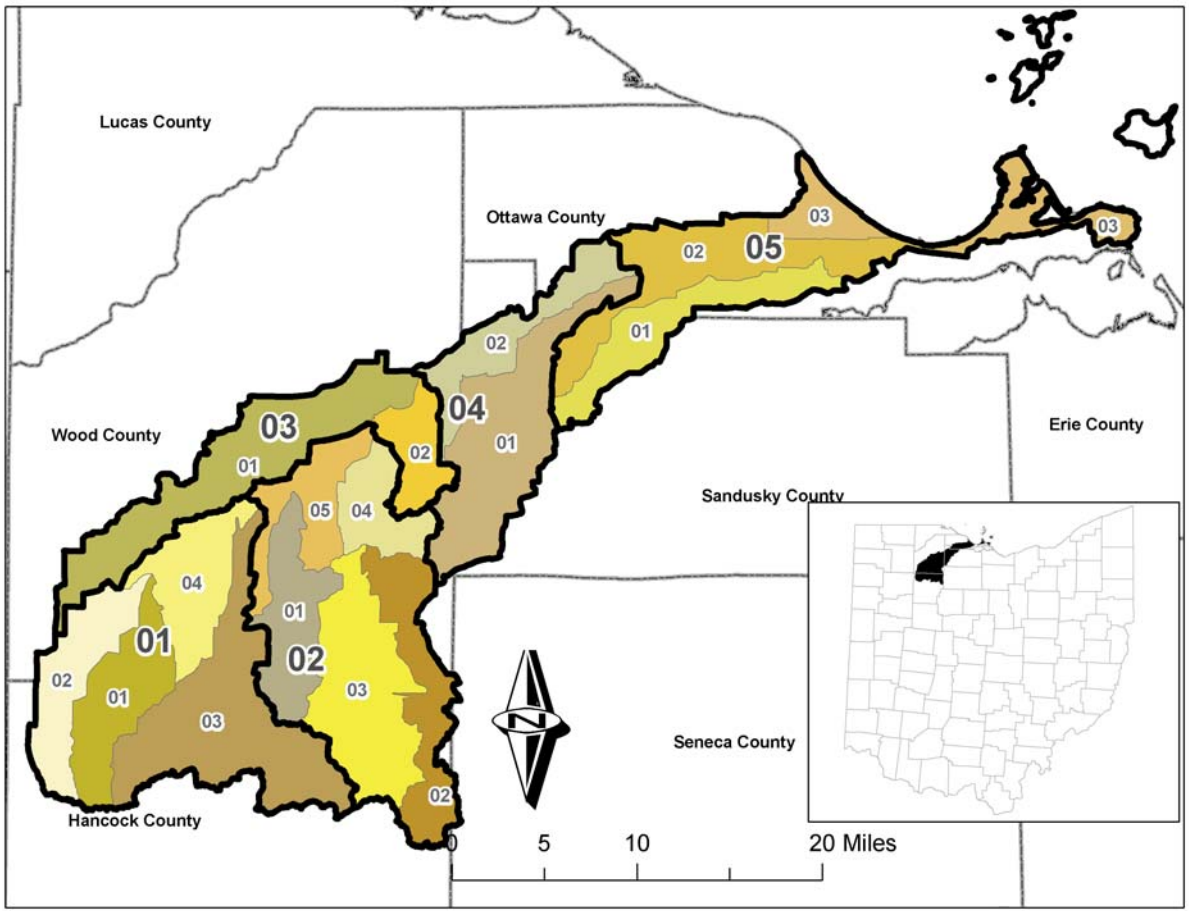

Figure 2-1. Portage River watershed's 12-digit HUC assessment units.

Table 2-1. Twelve-digit HUC watersheds within the Portage River TMDL project area.

HUC (10- and 12-digit)	Description	Area (square miles)
04100010-01	**Rocky Ford-Middle Branch Portage River**	**168.7**
04100010-01-01	Rader Creek	32.7
04100010-01-02	Needles Creek	31.4
04100010-01-03	Rocky Ford	73.5
04100010-01-04	Town of Rudolph-Middle Branch Portage River	31.1
04100010-02	**South Branch Portage River-Middle Branch Portage River**	**166.2**
04100010-02-01	Bull Creek	30.5

HUC (10- and 12-digit)	Description	Area (square miles)
04100010-02-02	East Branch Portage River	36.1
04100010-02-03	Town of Bloomdale-South Branch Portage River	53.5
04100010-02-04	Rhodes Ditch-South Branch Portage River	20.6
04100010-02-05	Cessna Ditch-Middle Branch Portage River	25.4
04100010-03	**Upper Portage River**	**82.4**
04100010-03-01	North Branch Portage River	64.4
04100010-03-02	Town of Pemberville-Portage River	18.0
04100010-04	**Middle Portage River**	**87.2**
04100010-04-01	Sugar Creek	59.3
04100010-04-02	Lacarpe Creek Outlet #4-Portage River	27.9
04100010-05	**Lower Portage River-Frontal Lake Erie**	**121.6**
04100010-05-01	Little Portage River	32.6
04100010-05-02	Portage River	48.8
04100010-05-03	Lacarpe Creek-Frontal Lake Erie	40.3
GRAND TOTAL		**626.2**

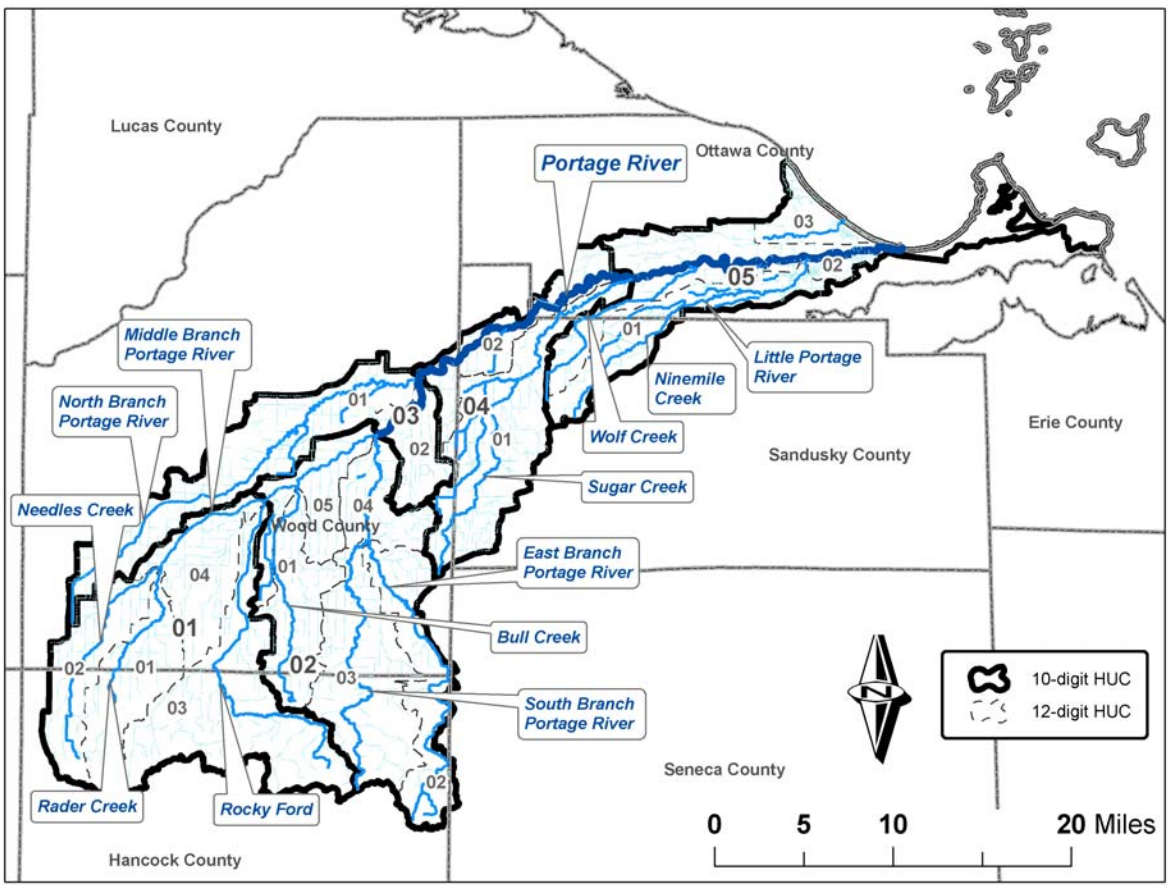

Figure 2-2. Map of streams in the Portage River watershed.

2.1.2 Land Cover

Row crop agriculture is by far the dominant land use accounting for over 76 percent of the total Portage River watershed area. Developed land, typically the land cover type that produces the most stressors to water quality, as measured on a per unit area basis, amount to over eleven percent of the total. Forest and wetlands, among the most beneficial land cover types in terms of the quality of rivers and streams constitute 5.5 and 2.3 percent of the total, respectively. The remaining land cover types include open water, grasslands, pasture, barren land, and high density development, which, in total, is less than five percent of the watershed area. Figure 2-3 is a map of the land cover found in the TMDL project area while Table 2-2 lists the area and proportion associated with these types of cover and Figure 2-4 is a pie chart showing the same.

Table 2-2. Cumulative acres of various land cover types.

Land cover class	Percent coverage	Area (sq mi)	Area (ac)
Cultivated Crop	76.5%	479	306,745
Developed	11.4%	71	45,589
Forest	5.5%	35	22,229
Wetlands	2.3%	14	9,077
Open Water	1.6%	10	6,402
Grassland/Herbaceous	1.2%	7	4,694
Pasture/Hay	0.7%	4	2,676
Barren Land	0.5%	3	1,813
Developed, High Density	0.4%	2	1,556
GRAND TOTAL		**626**	**400,782**

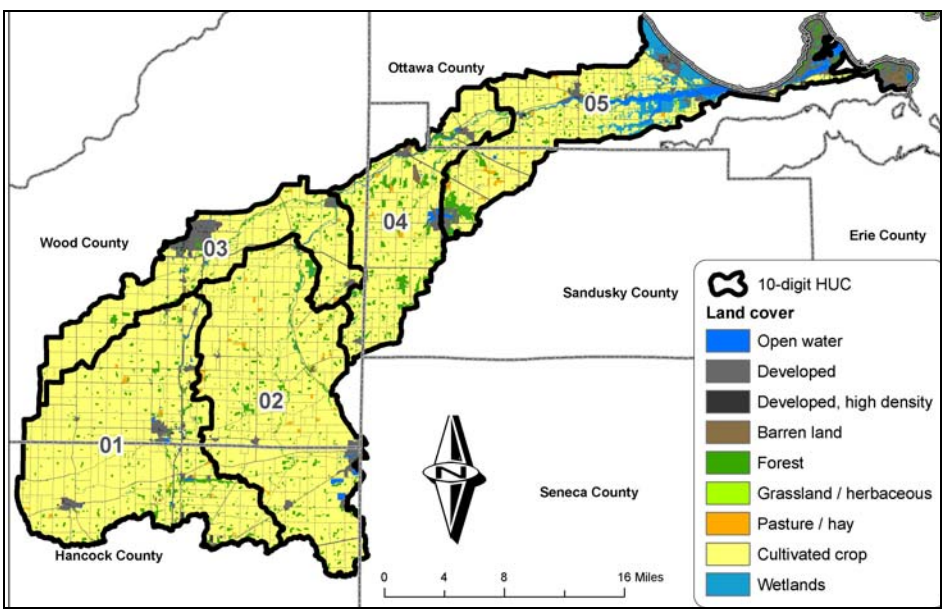

Figure 2-3. Map of land cover classes. Land cover is based on Landsat 7 imagery taken around 2001 and compiled in 2006 by the Multi-Resolution Land Characteristics (MRLC) consortium.

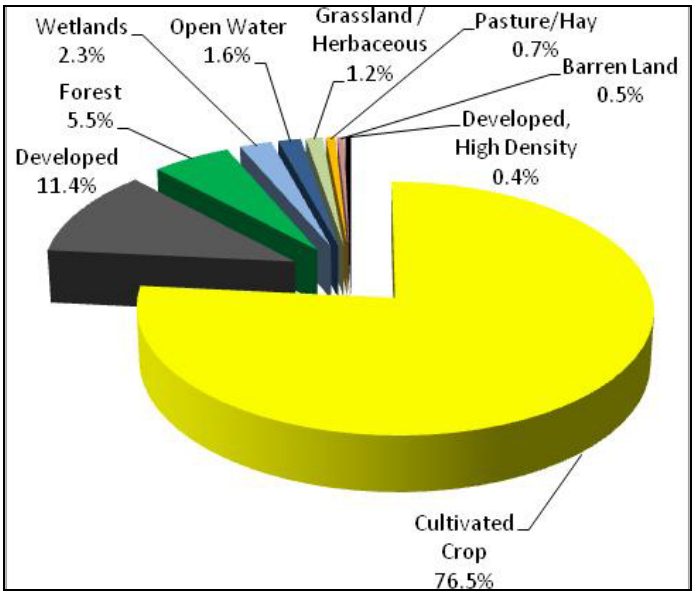

Figure 2-4. Pie chart of the distribution of land cover types.

2.1.3 Soils, Geology, Native Vegetation and Topography

The topography of the Portage River watershed has been influenced by glaciations which left fine, poorly-drained, water-worked glacial till and lacustrine sediment (lake deposited); also coarser end moraine and beach ridge deposits. This characterizes the Huron-Erie Lake Plain ecoregion which constitutes the majority of the watershed. However, the southwest part of the watershed is within the Eastern Corn Belt Plains ecoregion, which is characterized broad nearly level glacial till plains also with basins and end moraines and low gradient streams. The range in the elevation of this is 871 to 558 feet above sea level, with an overall drop of 313 feet.

Native vegetation is mostly comprised of elm-ash swamp forest of the Black Swamp and beech forest. Scattered mixed oak forests occur on dolomitic ridges and on sandy-silty areas while fens occur along portions of the Lake Erie shoreline and scattered wet prairies. Land cover: however, as described in Section 2.1.2, is dominated by row crops consisting mainly of corn, soybeans and to a smaller extent, wheat.

The majority of the soils are loams where silty clay loams, silt loams and clay loams are the most abundant. Hoytville is the most commonly found soil (about 48 percent) while other significant soils include Nappanee, Glynwood, and Pewamo; however, each occur at less than four percent of the total. Over eighty-four percent of the soils range from very poorly drained to somewhat poorly drained leaving only thirteen percent well drained to moderately well drained and three percent not classified in terms of drainage. The implications for this relate to a strong need for enhanced land drainage in this row crop, dominated watershed. Hydric soils indicate the likelihood for wetlands to be present or the potential to develop naturally (if land is left unmanaged). About three percent of the soils are listed in the extremes of being either fully hydric or not at all hydric. Ninety-two percent are listed as partially hydric and five percent are classified as unknown for this category. However, another classification system suggests that up to 65 percent of the soils show significant signs of hydric qualities. Flooding frequently occurs on about two percent of the soils while ninety-six percent typically experience no flooding. Table 2-3 shows the distribution of several soils characteristics as they occur in the watershed and Figure 2-5 is a map showing the distribution of poorly drained soils and Figure 2-6 demonstrates the topographic relief of the watershed.

Table 2-3. Soils information within the Portage River TMDL project area.

Category	Area (acres)	Percent of overall area
Flood frequency		
None	379,058	96%
Frequent	8,071	2%
Not categorized	5,631	1%
Occasional	2,471	1%
Pond frequency		
75-100%	246,699	62%
0-14%	137,082	35%
50-74%	10,873	3%
15-49%	577	0%
Drainage classifications		
Very poorly drained	257,969	65%
Somewhat poorly drained	73,002	18%
Moderately well drained	34,163	9%
Well drained	17,958	5%
Not categorized	11,409	3%
Poorly drained	730	0%
Hydric classifications		
Partially hydric	362,613	92%
Unknown	19,291	5%
Not hydric	12,820	3%
All hydric	507	0%
Hydric list		
Yes	258,539	65%
No	136,692	35%
Hydrologic soil group		
C	215,957	55%
D	62,680	16%
B	59,521	15%
C/D	21,896	6%
B/D	16,178	4%
Not categorized	11,422	3%
A	7,324	2%
A/D	253	0%
Soil texture distribution[1]		
Loam	311,379	79%
Clay	243,661	62%
Silt	180,539	46%
Sand	50,906	13%
Other	40,118	10%
Till substratum	5,233	1%
Total watershed area	**395,231**	**100%**

[1] The area in acres and the percent based proportion of the overall watershed area is determined based on the sum of the acres of soils that are classified as having a significant fraction of the particle size (i.e., texture) so indicated. Some soils may have significant proportions of more than one texture class and therefore the sum of the percents for each of the classes exceed 100 percent.

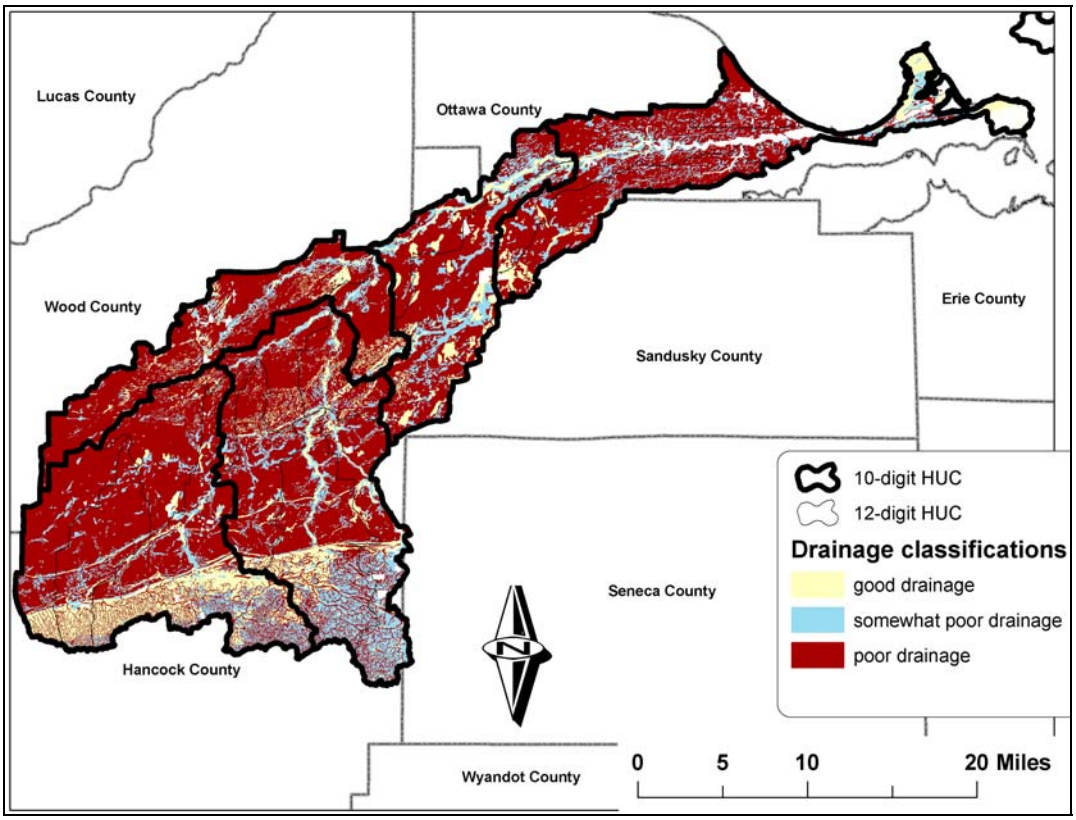

Figure 2-5. Soil drainage classifications in the Portage River watershed.

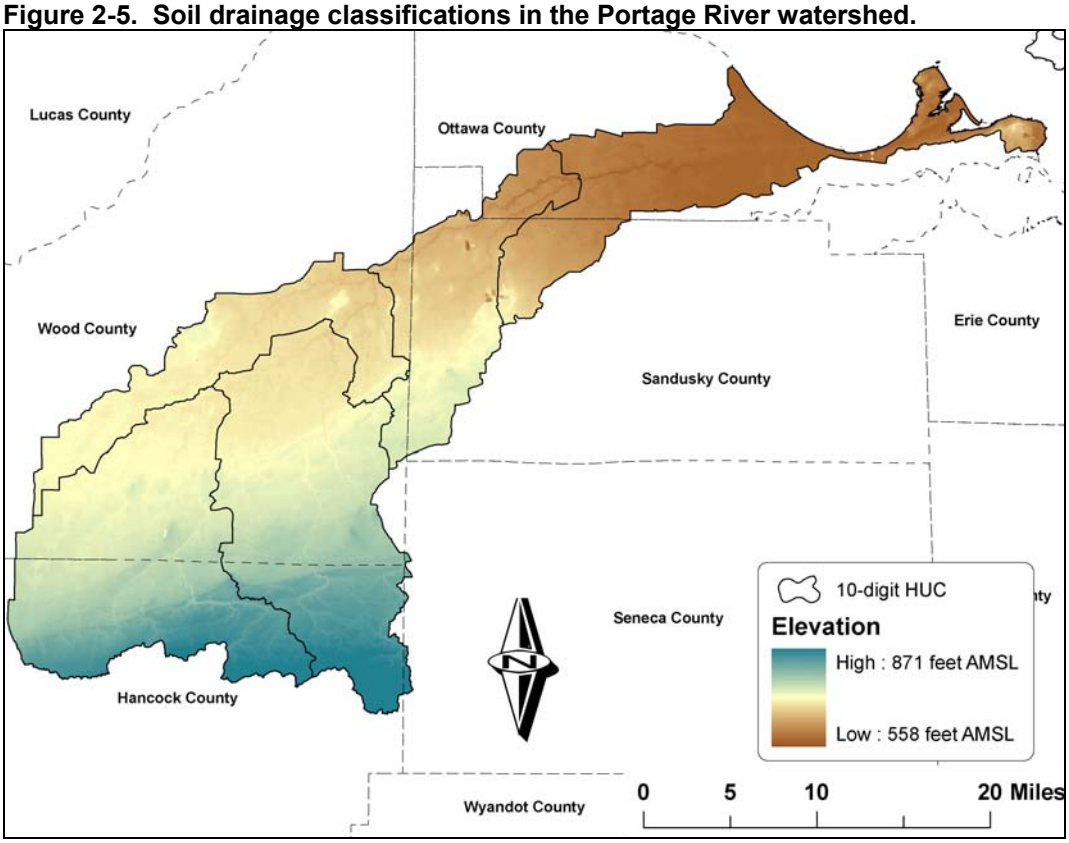

Figure 2-6. Representation of the topographic relief of the Portage River watershed.

2.1.4 Population and Distribution

The population of the Portage River watershed is estimated to be over 67,000 people with an overall density of 107 people per square mile. Based on U.S. census blocks, the range in population density is 38 to 8,782 persons per square mile. Figure 2-7 shows the U.S. census blocks color-coded based on population density and the municipalities in the watershed. There are 26 incorporated entities with a combined population estimated at nearly 49,000 people (71 percent of the total population) and a total land area of 30.6 square miles (4.9 percent of the total watershed). These municipalities have an average population density of 1,381 persons per square mile with a range from 268 to 3,013. The top five municipalities contributing to the overall watershed population include Bowling Green (14,272), Fostoria (5,324), North Baltimore (3,362), Port Clinton (3,341), and Oak Harbor (2,849). Excluding all of the municipalities, the remaining 594 square miles of the watershed have an average population density of about 30 people per square mile. Table 2-4 shows demographic information for the 26 municipalities in the watershed.

In terms of households it is estimated that there are nearly 24,000 in the watershed where 75 percent (18,026) are found within the municipal areas leaving nearly 6,000 homes in the rural areas or areas surrounding the municipalities. Excluding the municipal areas the average density of households is nearly ten per square mile.

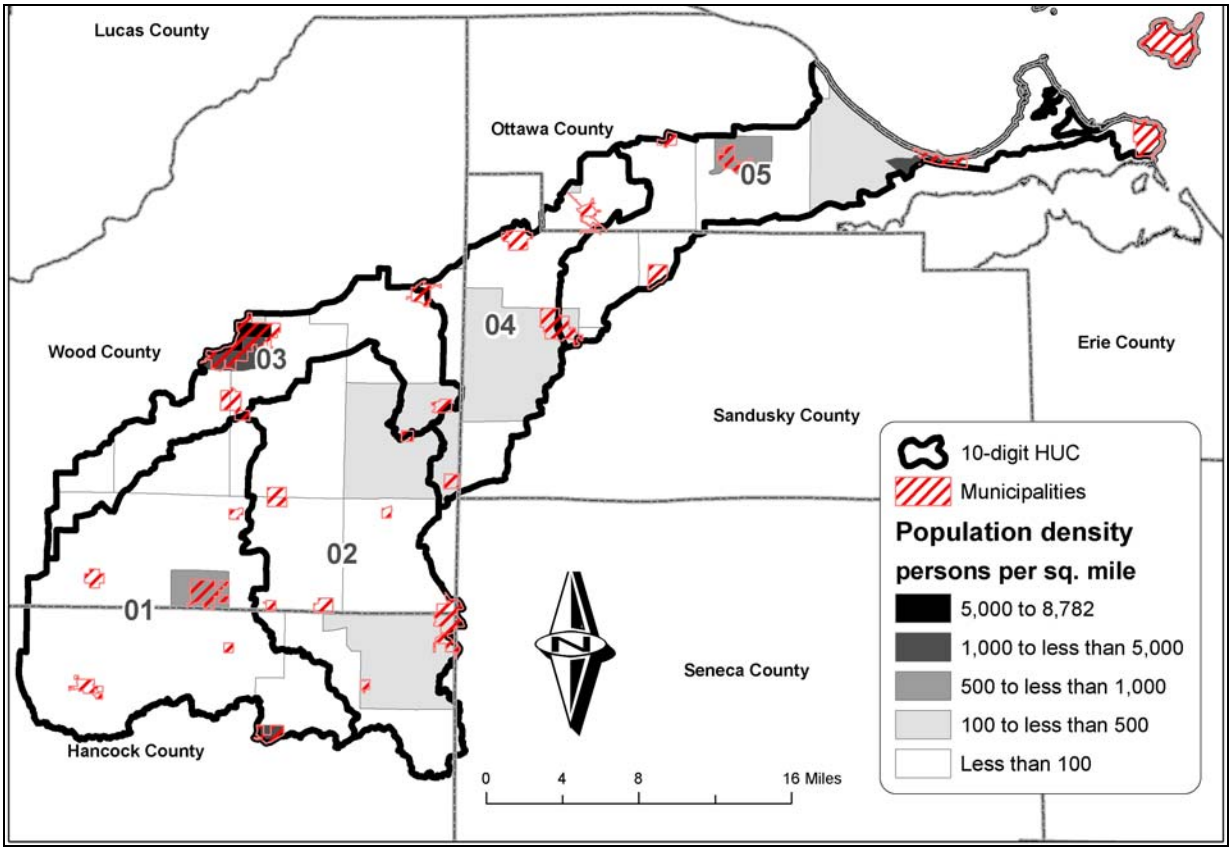

Figure 2-7. Map of population density. Based on the 2000 census provided by the Ohio Department of Development in a spatially referenced database.

Table 2-4. Municipalities within the Portage River TMDL watershed area.

Place	Area within the watershed (sq mile)	Population density (persons per sq mile)	Actual population	Population estimate in the watershed	Estimated number of households in the watershed
Findlay	0.9	2,282	39,241	2,006	818
Bowling Green	4.9	2,912	29,562	14,272	4,923
Fostoria	2.8	1,926	13,990	5,324	2,122
Port Clinton	1.1	3,013	6,346	3,341	1,474
North Baltimore	2.3	1,492	3,316	3,316	1,283
Oak Harbor	1.5	2,146	2,849	2,849	1,273
Gibsonburg	2.5	1,015	2,532	2,490	947
Woodville	1.2	1,592	1,985	1,960	771
McComb	1.0	1,845	1,685	1,685	614
Elmore	0.8	1,750	1,454	1,454	599
Pemberville	1.1	1,243	1,376	1,324	501
Bradner	0.6	1,932	1,181	1,181	444
Wayne	0.3	2,682	864	864	296
Marblehead	2.4	268	759	637	270
Bloomdale	0.7	1,092	730	730	268
Risingsun	0.6	1,079	623	623	229
Cygnet	0.3	1,622	547	547	209
Arcadia	0.3	2,052	533	533	187
Lindsey	1.0	328	505	330	128
Jerry City	1.0	452	455	455	162
Portage	1.5	289	433	433	150
Rocky Ridge	0.5	379	386	173	56
Hoytville	0.8	429	319	319	108
Van Buren	0.2	1,197	298	298	112
Bairdstown	0.3	490	131	131	54
West Millgrove	0.3	397	103	103	26

2.1.5 Point Source Discharges

Industrial and municipal point sources include wastewater treatment plants and factories. Wastewater treatment plants can contribute to bacteria, nutrient enrichment, siltation, and flow alteration problems. Industrial point sources, such as factories, sometimes discharge water that is excessively warm or cold, changing the temperature of the stream. Point sources may contain other pollutants such as chemicals, metals and silt.

NPDES dischargers are entities that possess a permit through the National Pollutant Discharge Elimination System (NPDES). NPDES permits limit the quantity of pollutants discharged and impose monitoring requirements. NPDES permits are designed to protect public health and the aquatic environment by helping to ensure compliance with state and federal regulations. NPDES entities generally discharge wastewater continuously. They primarily affect water quality under average- to low-flow conditions because the potential for dilution is lower. NPDES dischargers located near the origin of a stream or on a small tributary are more likely to cause

severe water quality problems because their effluent can dominate the natural stream flow. Appendix A lists the NPDES permittees in the Portage River watershed.

There is over 20 million gallons of wastewater per day being discharged throughout the watershed through 78 different outfalls. The total design capacity for wastewater treatment in the watershed is over 32 million gallons per day. In comparison, based on average daily flow record of the Portage River at Woodville (drainage area of 428 square miles) from 1980 to 2005 these values of daily wastewater discharge can be eight or thirteen percent for existing discharge rates and design discharge capacity, respectively. Fifty-three dischargers hold individual NPDES permits and there are no dischargers in the basin covered under a general permit. The 02 and 03 ten-digit HUCs receive the highest volume of wastewater each at a little more than seven million gallons per day. The Fostoria WWTP is located in the 02 HUC and Bowling Green WWTP in the 03 HUC each comprising 73 and 84 percent of the flow volume in those HUCs, respectively.

There are three entities permitted to discharge storm water under a general permit for municipal separate storm sewer system, namely Findlay, Fostoria, and Bowling Green. There are combined sewer discharge outfalls from several communities as well including, Fostoria, Bowling Green, Port Clinton, Woodville, Oak Harbor, North Baltimore, McComb, and Gibsonburg.

2.1.6 Public Drinking Water Supplies

Some communities supply public drinking water from ground water (underground aquifers). Other communities supply public drinking water by withdrawing water from surface waters, including lakes and streams. Surface water public drinking water supplies for the communities of McComb, North Baltimore and Fostoria are located in the Portage River watershed. More details are available in Appendix B.

2.2 Water Quality Standards and Targets

TMDLs are required when a waterbody fails to meet water quality standards (WQS). Every state must adopt WQS to protect, maintain, and improve the quality of the nation's surface waters. WQS represent a level of water quality that will support the Clean Water Act goal of swimmable and fishable waters. Ohio's WQS, set forth in Chapter 3745-1 of the Ohio Administrative Code (OAC), include three major components: beneficial use designations, criteria and antidegradation provisions. Where criteria have not been developed, the State can develop project-specific targets.

Beneficial use designations describe the existing or potential uses of a waterbody, such as public water supply; protection and propagation of aquatic life; and recreation in and on the water. Ohio EPA assigns beneficial use designations to each waterbody in the state. Use designations are defined in paragraph (B) of rule 3745-1-07 of the OAC and are assigned in rules 3745-1-08 to 3745-1-32. Attainment of uses is based on specific numeric and narrative criteria.

Numeric criteria are estimations of chemical concentrations, degree of aquatic life toxicity, and physical conditions allowable in a waterbody without adversely impacting its beneficial uses. Narrative criteria, located in rule 3745-1-04 of the OAC, describe general water quality goals that apply to all surface waters. These criteria state that all waters shall be free from sludge,

floating debris, oil, scum, color and odor-producing materials; substances that are harmful to human or animal health; and nutrients in concentrations that may cause excessive algal growth. Much of Ohio EPA's present strategy regarding water quality based permitting is based upon the narrative criterion stating that surface waters be "free from toxics in toxic amounts." Ohio EPA developed its strategy based on an evaluation of the potential for significant toxic impacts within the receiving waters. Very important components of this evaluation are the biological survey program and the biological criteria used to judge aquatic life use attainment.

Antidegradation provisions describe the conditions under which water quality may be lowered in surface waters. Under such conditions water quality may not be lowered below criteria protective of existing beneficial uses unless lower quality is deemed necessary to allow important economic or social development. Antidegradation provisions are in Sections 3745-1-05 and 3745-1-54 of the OAC.
The following sub-sections describe the applicable water quality standards for the Portage River watershed.

2.2.1 Recreation Uses

Recreation use designations are defined in Section 3745-1-07 of the OAC. Water quality criteria are established to protect recreational water uses by limiting risk for human illness due to exposure to pathogenic microorganisms. Pathogenic microorganisms include bacteria, viruses, and protozoa. Criteria are set for concentrations of *E. coli* in surface waters. *E. coli* bacteria typically are not pathogenic organisms; however, if their numbers exceed a threshold value it becomes increasingly probable that pathogenic organisms are present in sufficient numbers to threaten public health.

There are three recreation use designations applicable to stream segments in the Portage River watershed, Primary Contact Recreation (PCR), Classes A and B, and Secondary Contact Recreation (SCR). SCR is applied to waters suitable for partial-body contact recreation such as wading. PCR is applied to waters suitable for full-body contact such as swimming and canoeing. Ohio EPA assigns the PCR use designation to a stream unless it is demonstrated through use attainment analysis that the combination of remoteness, accessibility, and depth makes full-body contact recreation by adults or children unlikely. In those cases, the SCR designation is assigned.

PCR is broken in to three subcategories, classes A, B and C. Waterbodies in each of these classes are able to support the same types of water activities; however, distinctions are made based on the frequency or intensity of such activities. Class A PCR reflects the greatest use of the waterbody for recreation while B to C reflect progressively less frequent recreation use. For waterbodies throughout Ohio, PCR class B is the use assigned to the majority of streams.

Attainment of the recreation use designation is evaluated by comparison to bacteriological numeric and narrative criteria. Ohio currently has bacteriological criteria for *E. coli*. Bacteriological criteria apply outside the mixing zone of permitted wastewater discharges and during the defined recreation season (May 1st through October 31st). The concentration values of *E. coli* are based on the geometric mean of at least two samples collected at a single site within the same recreational season. If only one sample is available, the single sample maximum concentration can be used to determine if water quality standards are met, otherwise when more than one sample is available attainment is exclusively predicated on the geometric mean value. Table 2-5 shows the *E. coli* water quality criteria for recreation uses.

There are 280 stream miles designated as Class B PCR while 25.5 miles are designated SCR. Nearly forty-nine miles are designated as PCR Class A, the most protective PCR designation due to the high level of recreation on the Portage River mainstem (41.5 miles) and North Branch of the Portage River (7 miles). Figure 2-8 is a map of the respective recreation use designations in the TMDL project area. Table 2-5 shows the applicable *E. coli* concentration criteria for the respective recreation uses.

Table 2-5. Quality criteria for recreation use designations.

Recreation use	*E. coli* (colony counts per 100 ml)	
	Seasonal geometric mean	Single sample maximum[1]
Bathing water	126	235
Class A primary contact recreation	126	298
Class B primary contact recreation	161	523
Class C primary contact recreation	206	940
Secondary contact	1030	1030

[1] Except as noted in footnote 2, these criteria shall not be exceeded in more than ten per cent of the samples taken during any thirty-day period.

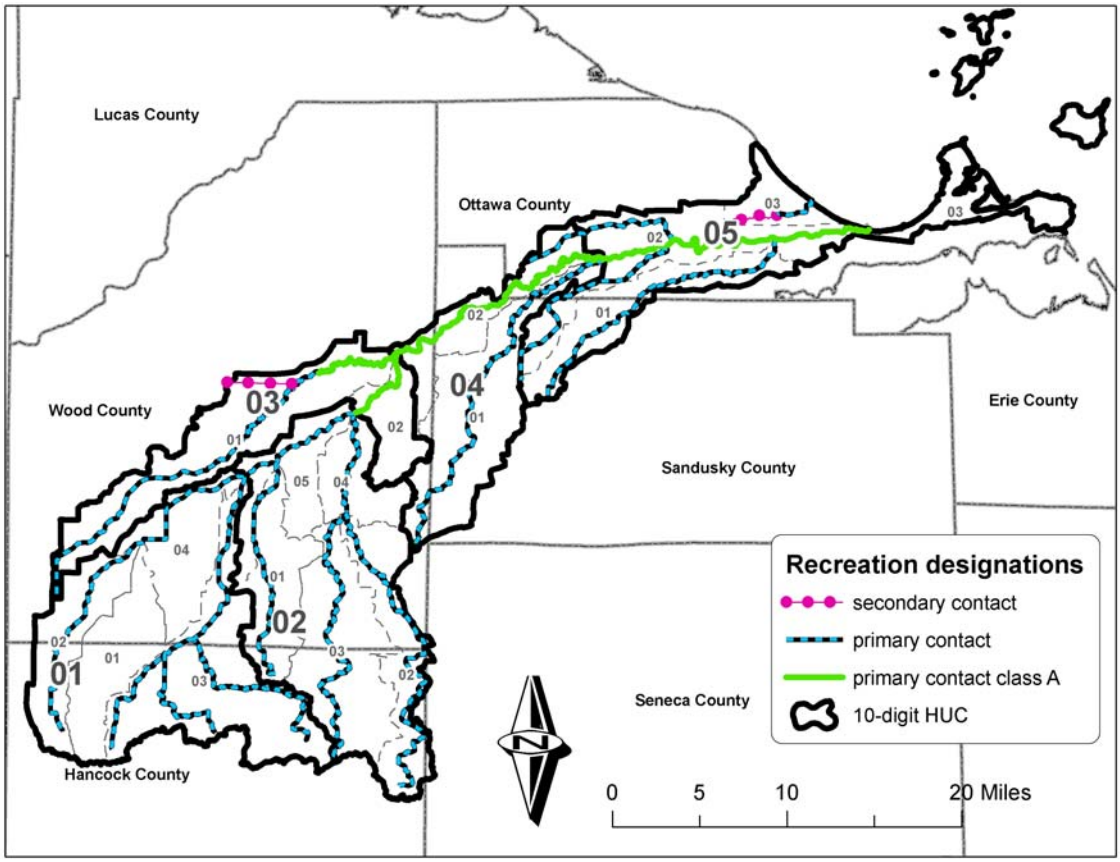

Figure 2-8. Map of recreation use designations in the Portage River watershed.

2.2.2 Aquatic Life Uses

Ohio's WQS have seven subcategories of aquatic life uses (see http://www.epa.ohio.gov/portals/35/rules/01-07.pdf). The WQS rule contains a narrative for

each aquatic life use and the three most commonly assigned aquatic life uses have quantitative, numeric biological criteria that express the minimum acceptable level of biological performance based on three separate biological indices. The indices measure the health of aquatic communities of both fish and insects.

In the Portage River basin study area, the aquatic life use designations that currently apply are Warmwater Habitat (WWH) and Limited Resource Waters (LRW). Waters designated as WWH are considered capable of supporting and maintaining a balanced integrated community of warmwater aquatic organisms. Limited resource waters, in contrast, are permanently precluded from the likelihood of supporting such a community due to irretrievable human caused alterations to the stream system. In the Portage River watershed these alterations are almost exclusively due to channel excavation and continued maintenance that eliminates needed aquatic habitat. In the TMDL project area, over 280 miles are designated in rule as WWH, while over 25 miles are designated LRW. Figure 2-9 is a map showing the distribution of aquatic life uses throughout the TMDL project area.

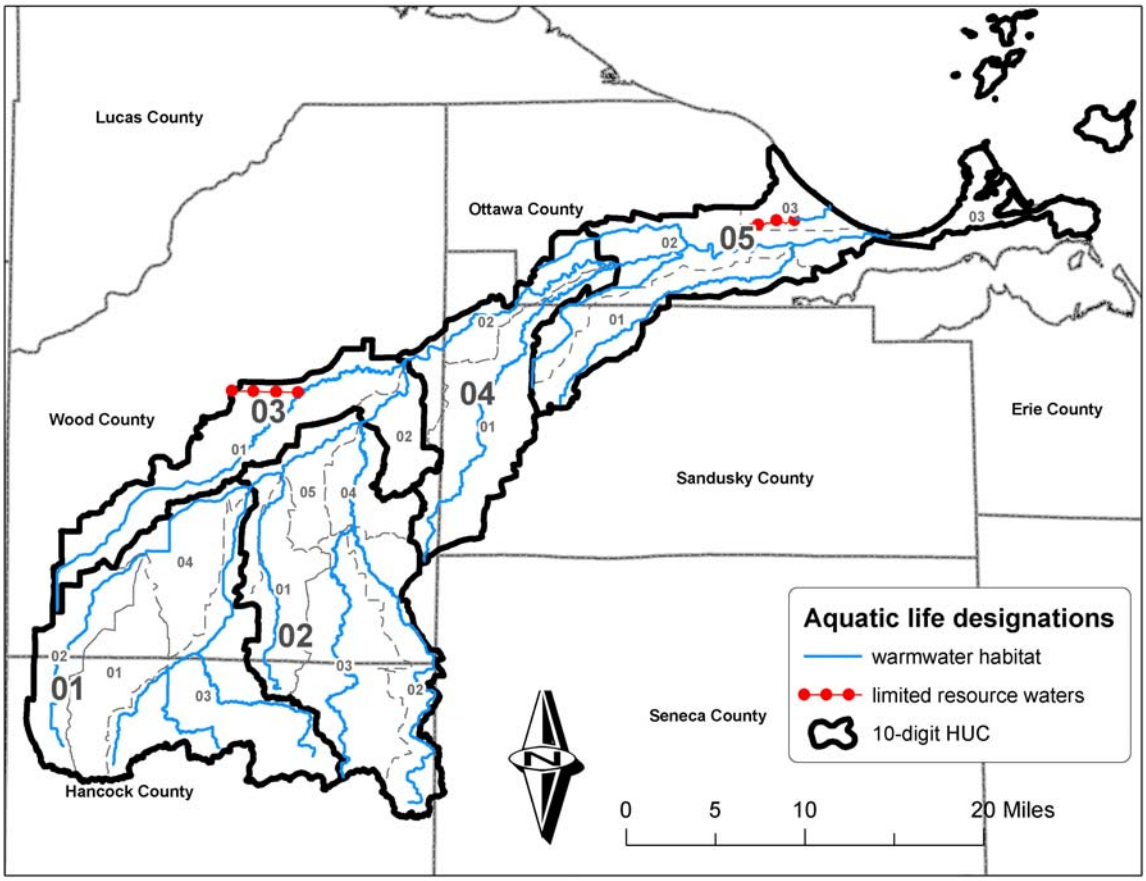

Figure 2-9. Map of aquatic life use designations in the Portage River watershed.

Attainment of WQS is measured using data results from both biological community surveys and analysis of water chemistry samples. Attainment benchmarks from these least impacted areas are established in the WQS in the form of "biocriteria," which are then compared to the measurements obtained from the study area. If measurements of a stream do not achieve the three biocriteria (fish: Index of Biotic Integrity (IBI) and modified Index of Well-being (MIwb); aquatic insects: Invertebrate Community Index (ICI)) the stream is considered in "non-attainment". If the stream measurements achieve some of the biological criteria, but not all, the

stream is said to be in "partial attainment." A stream that is in "partial attainment" is not achieving its designated aquatic life use, and requires a TMDL, whereas a stream that meets all of the biocriteria, is in "full attainment." A more detailed explanation of Ohio's biocriteria can be found in the Ohio EPA publication *The Role of Biological Criteria in Water Quality Monitoring, Assessment, and Regulation* (Ohio EPA, 1995). The criteria for the individual biological metrics applicable to the TMDL project area is found in Table 2-6.

Table 2-6. Biological criteria applicable to rivers and streams throughout Ohio for three aquatic life use designations. Criteria are established based on ecoregion and assessment method.

Ecoregion	Biological Index	Assessment Method[2, 3]	Biological Criteria for the Applicable Aquatic Life Use Designations[1]		
			WWH	EWH	MWH[4]
Eastern Cornbelt Plains (ECBP)	IBI	Headwater	40	50	24
		Wading	40	50	24
		Boat	42	48	24 / 30
	MIwb	Wading	8.3	9.4	6.2
		Boat	8.5	9.6	5.8 / 6.6
	ICI	All[5]	36	46	22
Huron-Erie Lake Plains (HELP)	IBI	Headwater	28	50	20
		Wading	32	50	22
		Boat	34	48	20 / 22
	MIwb	Wading	7.3	9.4	5.6
		Boat	8.6	9.6	5.7 / 5.7
	ICI	All[5]	34	46	22

[1] Coldwater habitats (CWH), limited warmwater habitat (LWH), resource waters (LRW) and seasonal salmonid habitat (SSH) do not have associated biological criteria.
[2] 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.
[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).
[5] Limited to sites with appropriate conditions for artificial substrate placement.

2.2.3 Public Drinking Water Supply Use

The public drinking water supply (PDWS) use includes surface waters from which public drinking water is supplied. This beneficial use provides an opportunity to strengthen the connection between Clean Water Act and Safe Drinking Water Act (SDWA) activities by employing the authority of the CWA to meet SDWA objectives of source water protection and reduced risk to human health. Criteria associated with this use designation apply within five hundred yards of surface water intakes. There are numerous chemical constituents for which concentration criteria have been established; however, the most commonly sampled pollutants in assessing PDWS attainment (selected based on the historic pollution patterns) are nitrates and atrazine (an organo-phosphate pesticide in the triazine family). Rules 3745-1-32 and 3745-1-34 list the criteria for PDWS.

There are three purveyors of surface water public drinking water supplies (Villages of McComb and North Baltimore, and the City of Fostoria) in the Portage River watershed project area with

a total of seven stream intake locations and one from an upground reservoir. Figure 2-10 is a map showing the locations of these public water supplies.

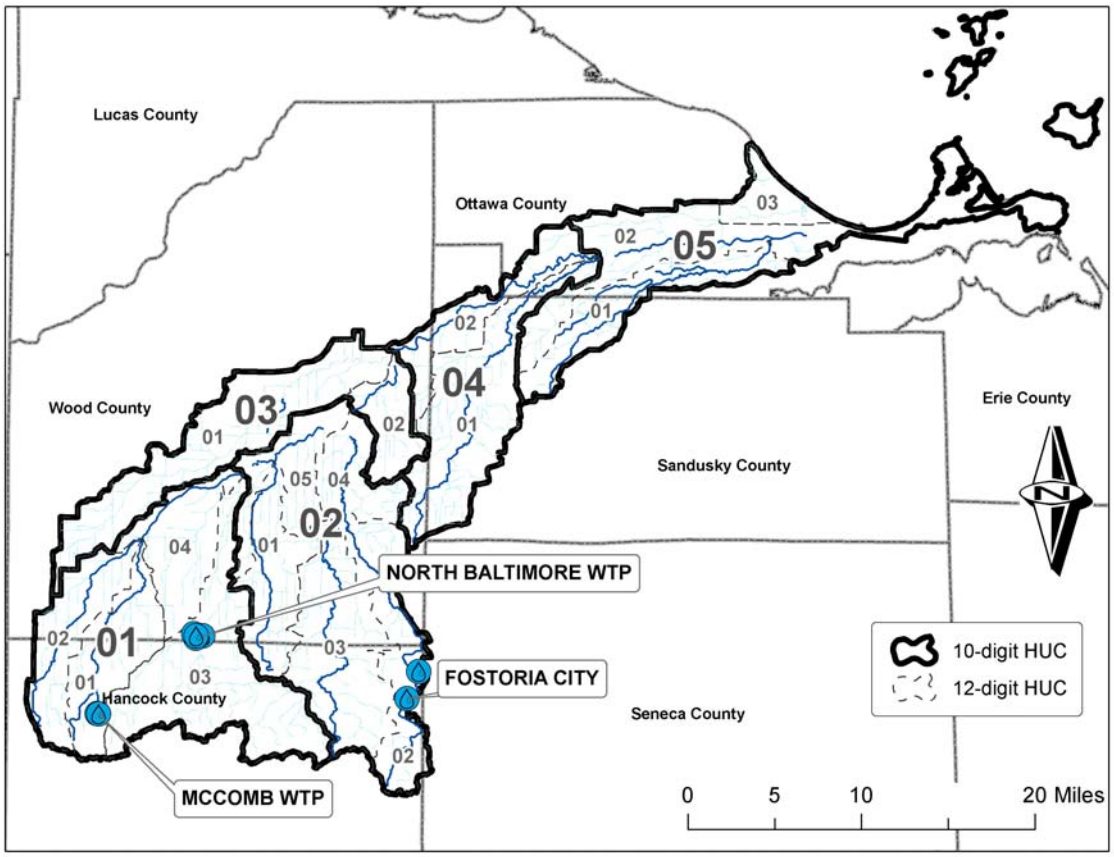

Figure 2-10. Map of surface water intakes in the Portage River watershed.

2.2.4 Human Health Use (Fish Tissue)

Ohio has adopted human health WQS criteria to protect the public from adverse impacts of polluted waters caused by exposure through drinking water (applicable at public water supply intakes) and by exposure in the flesh of contaminated sport fish (applicable in all surface waters). The latter criterion, called the non-drinking water human health criterion, ensures that levels of a chemical in water do not bio-accumulate in fish to levels harmful to people who catch and eat the fish. Ohio measures contaminants in fish tissue and uses the data in two comparisons: (1) to determine if the human health criteria are being violated, thus identifying the water for restoration through a TMDL or other action, or (2) to determine the quantity of sport fish that may be safely consumed. The first comparison can result in the water being identified as impaired on the 303(d) list; the second can result in the issuance of a sport fish consumption advisory.

The two most common contaminants in fish tissue are polychlorinated biphenyls (PCBs) and mercury. Two streams were listed in the 2010 Integrated Report as being impaired for sport fish consumption within this watershed. Specifically, the East and North Branches of the Portage River produced fish in the 2008 survey that showed elevated PCBs in their tissue. Other streams in the watershed that showed similar results in past surveys but do not have recent enough data to either re-list or de-list for impaired fish consumption uses include: Sugar Creek,

LaCarpe Creek, Little Portage River and certain locations on the Portage River mainstem. PCBs are currently banned from use in the U.S. and are expected to decrease in streams over time. Therefore, no further action other than continued monitoring for PCBs in fish in Portage River watershed will be taken.

Additional information regarding fish consumption can be found at: http://www.epa.ohio.gov/dsw/fishadvisory/index.aspx.

3 WATER QUALITY CONDITIONS IN THE WATERSHED

This chapter summarizes the results of the watershed survey including discussion of the stressors ("causes") and their respective sources responsible for impairing designated uses. Complete data is available in the Ohio EPA report Biological and Water Quality Survey of the Portage River Basin, Select Maumee River Tributaries, and Select Lake Erie Tributaries, 2006 - 2008. Hancock, Lucas, Ottawa, Sandusky, Seneca, and Wood Counties, Ohio. (http://www.epa.state.oh.us/portals/35/documents/PortageLETribsMaumeeTribs2010.pdf).

Ohio EPA staff surveyed the Portage River basin 10-digit Hydrologic Unit Codes (HUC), 04100010-01, 04100010-02, 04100010-03, 04100010-04, and 04100010-05 from 2006 to 2008. Designated water resource uses related to aquatic life and chemical integrity were evaluated to determine if minimum quality standards are being achieved. For waterbodies that do not meet water quality standards, the causes of impairment and the associated pollution sources were determined. Causes of impairment addressed by this report are *E. coli* bacteria, nutrient enrichment, organic enrichment, habitat and flow alteration, and sedimentation of the stream.

3.1 Aquatic Life and Recreation Use Attainment

In terms of aquatic life uses, thirty-seven (54%) of the evaluated sites fully met the existing or recommended life use. Eighteen (26%) of the sites partially met and thirteen (19%) of the sites were not attaining their designated or recommended use. Only ten (12%) of the sites surveyed met the recreation use criteria while the remaining 76 sites did not meet standards.

The remainder of this section presents the results of the water quality assessment for aquatic life and recreation uses by the respective subwatersheds. Figure 3-1 is a group of pie charts showing the respective aquatic life use attainment statuses for each of the subwatersheds while Figure 3-2 shows the same distribution but for recreation uses. Figure 3-3 shows recreation use attainment for sites along the larger streams in the project area which are more likely to be used for recreation.

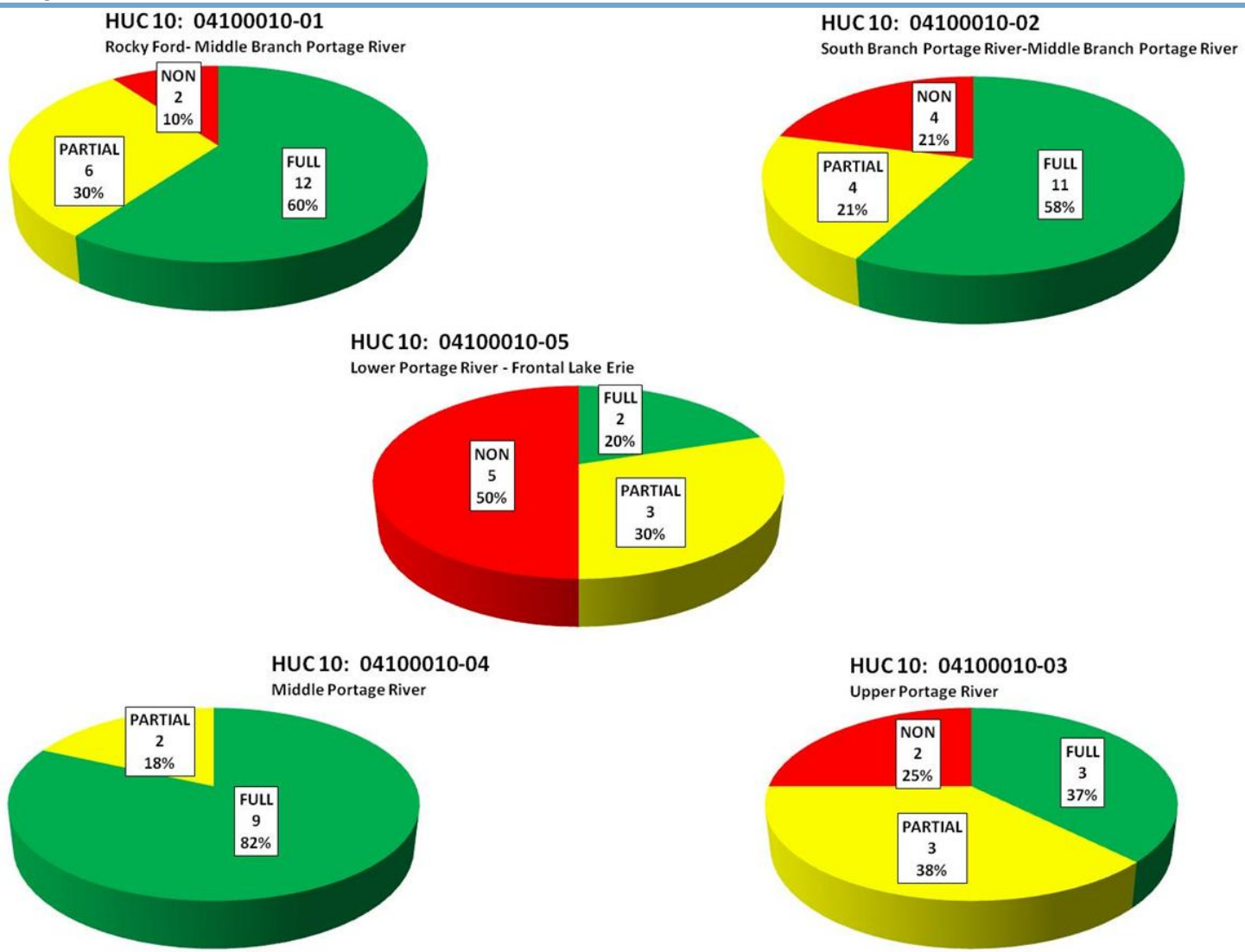

Figure 3-1. Aquatic life use attainment for each of the four ten digit HUCs in the TMDL project area. Proportions are based on the number of sites assessed in that area,

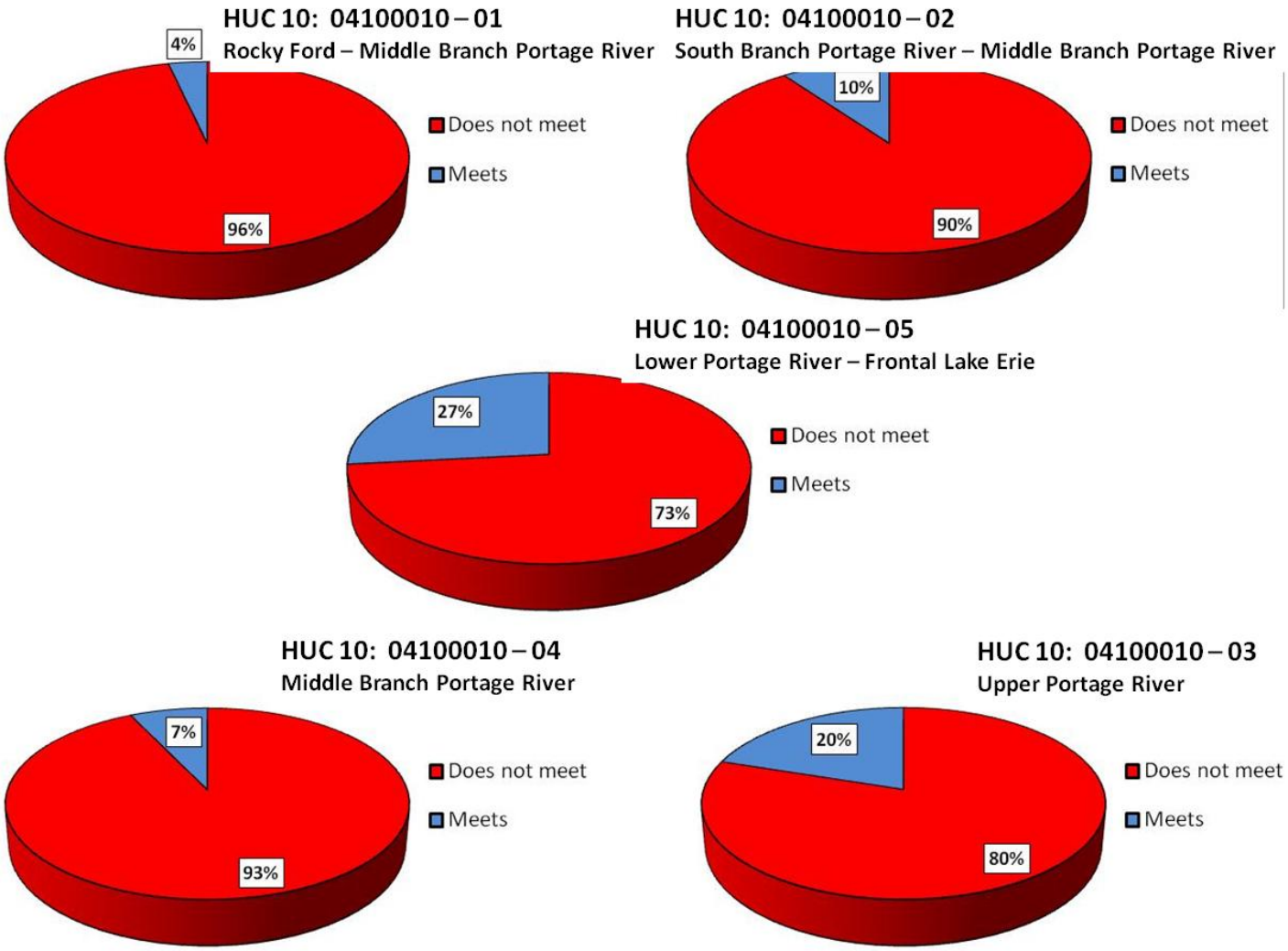

Figure 3-2. Recreation use attainment for each of the four ten digit HUCs in the TMDL project area. Proportions are based on the number of sites assessed in that area,

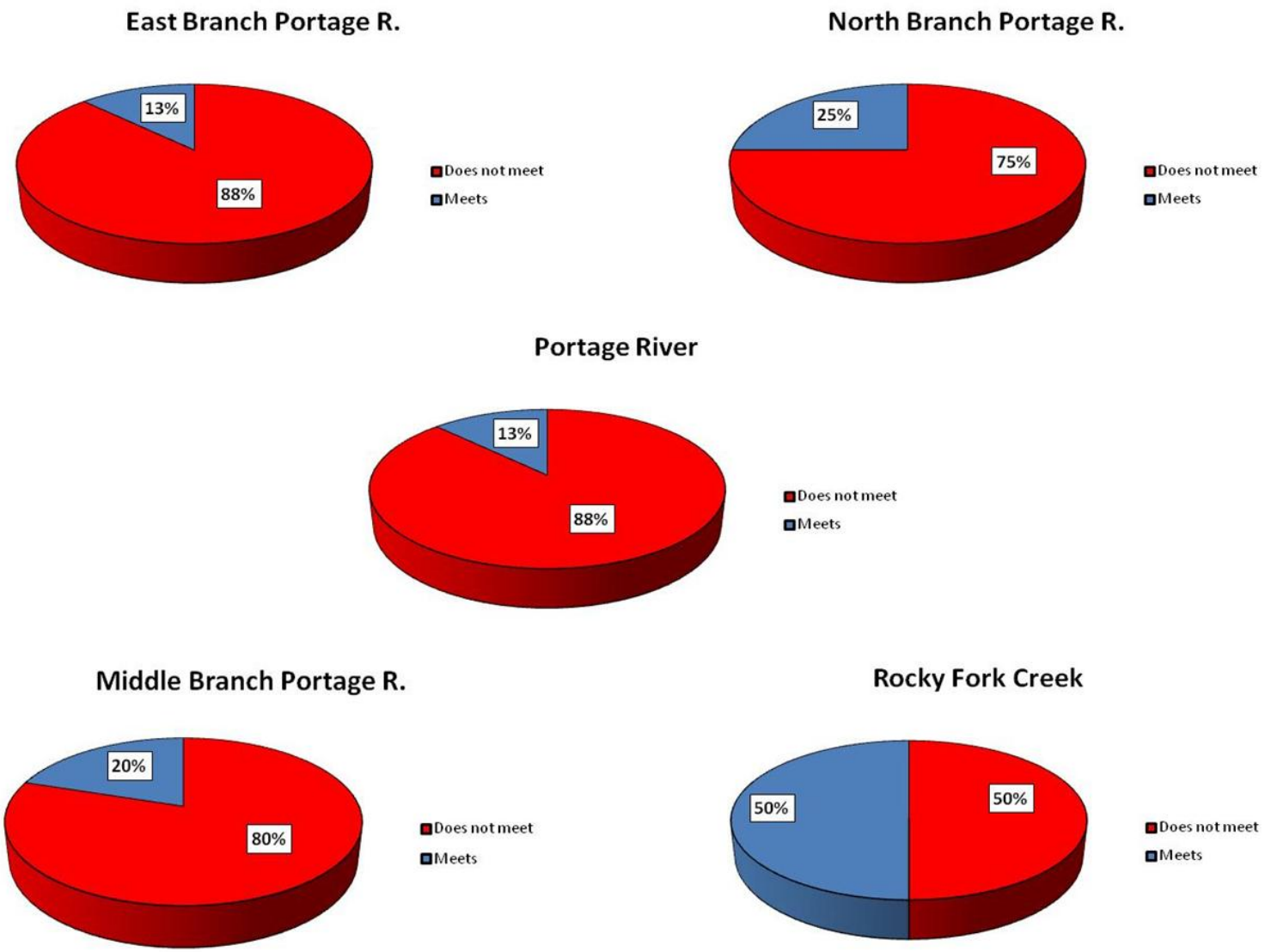

Figure 3-3. Recreation use attainment for largest stream in the project area. Proportions are based on the number of sites assessed in that area,

3.1.1 Rocky Ford-Middle Branch Portage River (04100010-01)

This subwatershed represents the southern portion of the watershed and contains the municipalities of Findlay, North Baltimore, McComb and Hoytville. Significant streams include the Middle Branch Portage River and Rocky Ford Creek. Twelve out of 20 sites (60 percent) surveyed fully meet aquatic life use criteria; however ten percent meet none of the criteria and 30 percent met some but not all of the criteria (Figure 3-4). The majority of the impairment was found Rocky Ford where only one of the seven sites fully met aquatic life use criteria. Needles and Rader Creeks were also impaired at one site each.

Recreation uses were impaired at 26 of the 27 sites (96 percent) surveyed in this ten digit HUC. Aquatic life and recreation use attainment for HUC -01 is presented in Figure 3-4. The bar chart in Figure 3-5 is the site by site geometric mean of the *E. coli* concentrations within the ten-digit HUC subwatershed. The numbers after the stream name on the x-axis indicate the river mile in which the sample was taken. The standard deviation for each of the component 12-digit HUCs nested subwatershed and the applicable water quality criteria are shown on the graph as horizontal lines.

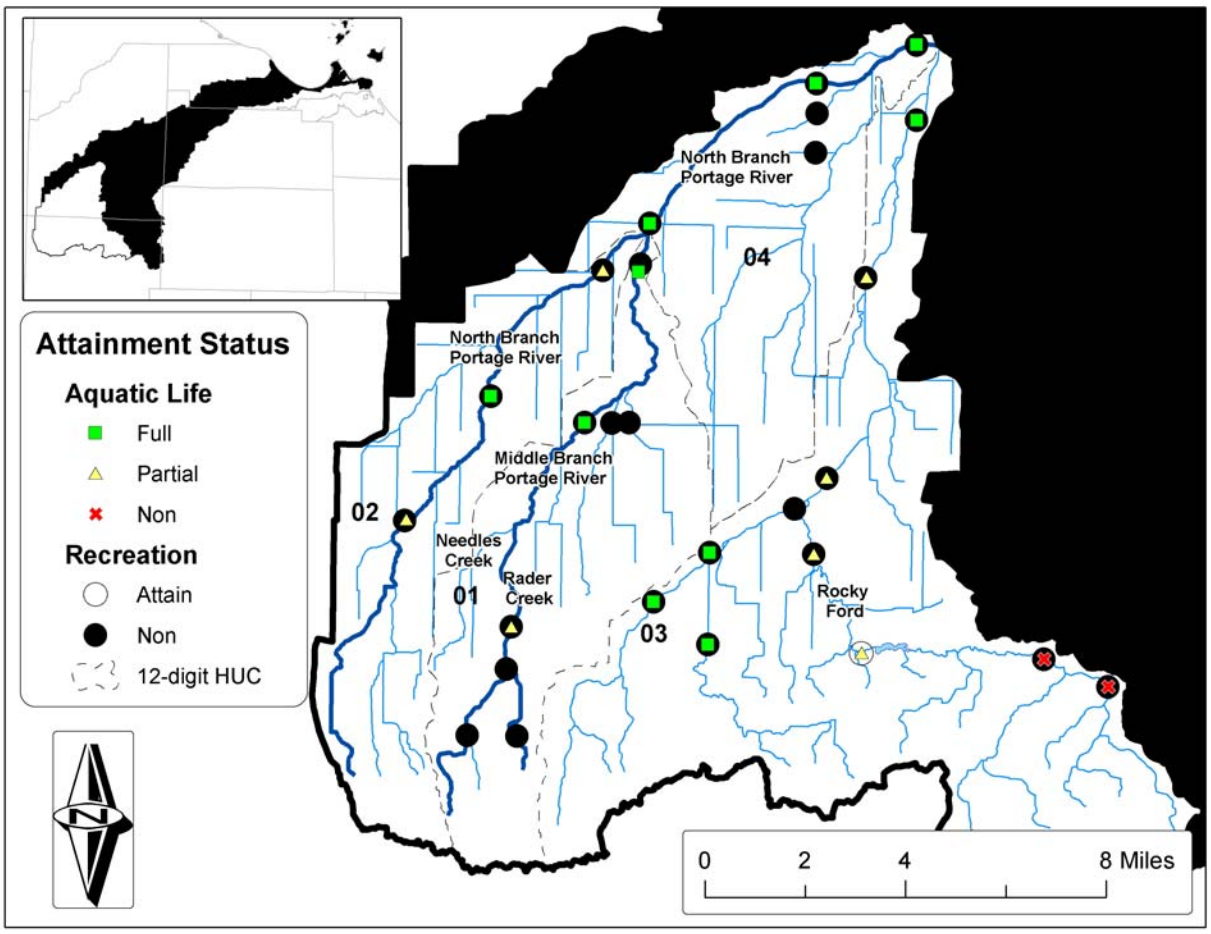

Figure 3-4. HUC 04100010-01 aquatic life and recreation use attainment.

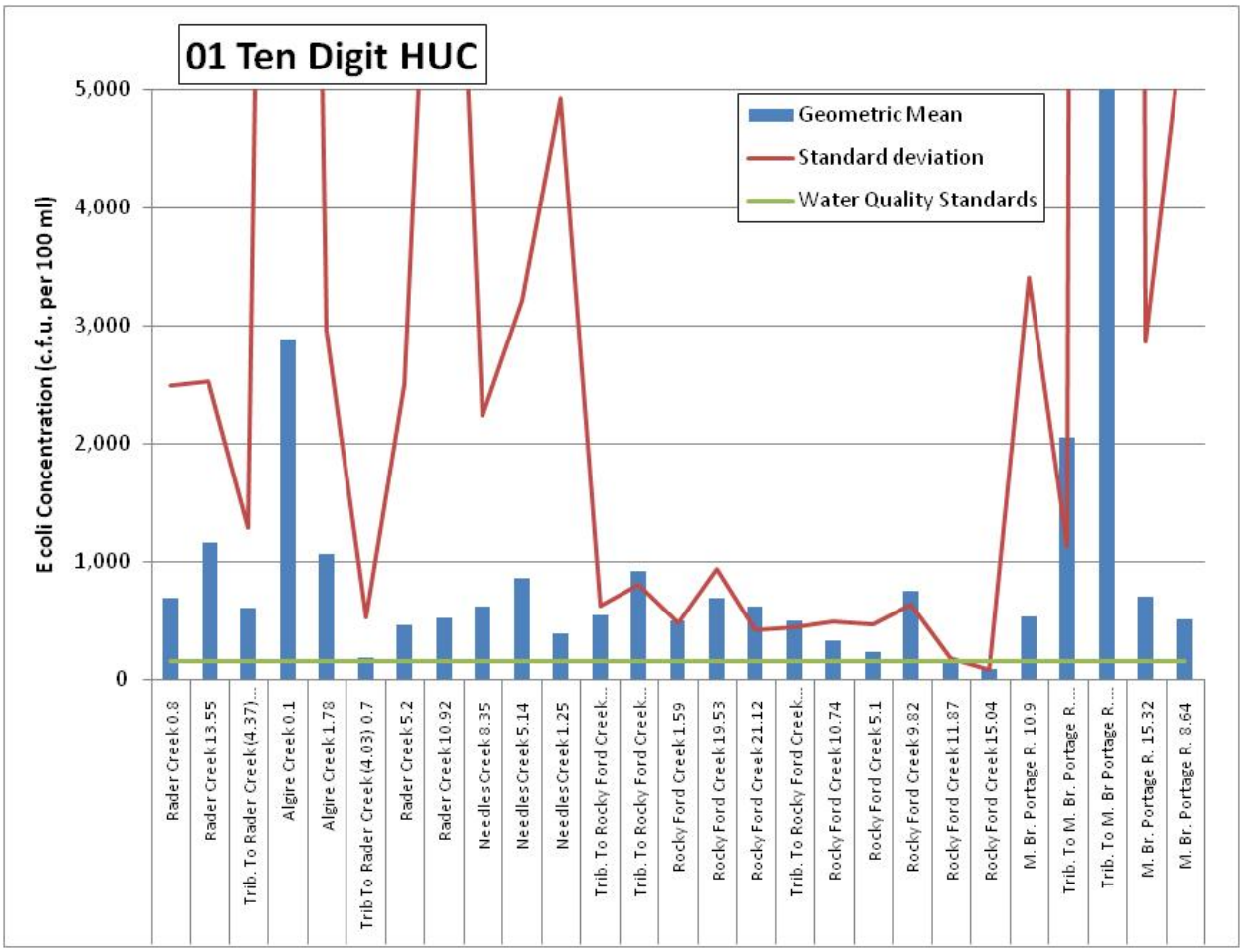

Figure 3-5. Site by site geometric mean for *E. coli* concentrations for the HUC 04100010-01 watershed.

3.1.2 South Branch Portage River-Middle Branch Portage River (04100010-02)

This subwatershed represents the southeastern portion of the watershed and contains the municipalities of Fostoria, Jerry City, West Milgrove and Bloomdale. Significant streams include South Branch Portage River and the Middle Branch Portage River. Eleven out of 19 sites surveyed (58 percent) fully meet aquatic life use criteria; however 21 percent meet none of the criteria and 21 percent met some but not all of the criteria (Figure 3-6). Non attainment was found in the East Branch Portage River and the South Branch Portage River and partial attainment was also found in these two streams as well as Bull Creek. Recreation uses were impaired at 18 of the 20 sites surveyed (90 percent) in this subwatershed. Aquatic life and recreation use attainment for HUC -02 is presented in Figure 3-6. The bar chart in Figure 3-7 is the site by site geometric mean of the *E. coli* concentrations within the subwatershed. The numbers after the stream name on the x-axis indicate the river mile in which the sample was taken. The standard deviation for each of the component nested subwatersheds and the applicable water quality criteria are shown on the graph as horizontal lines.

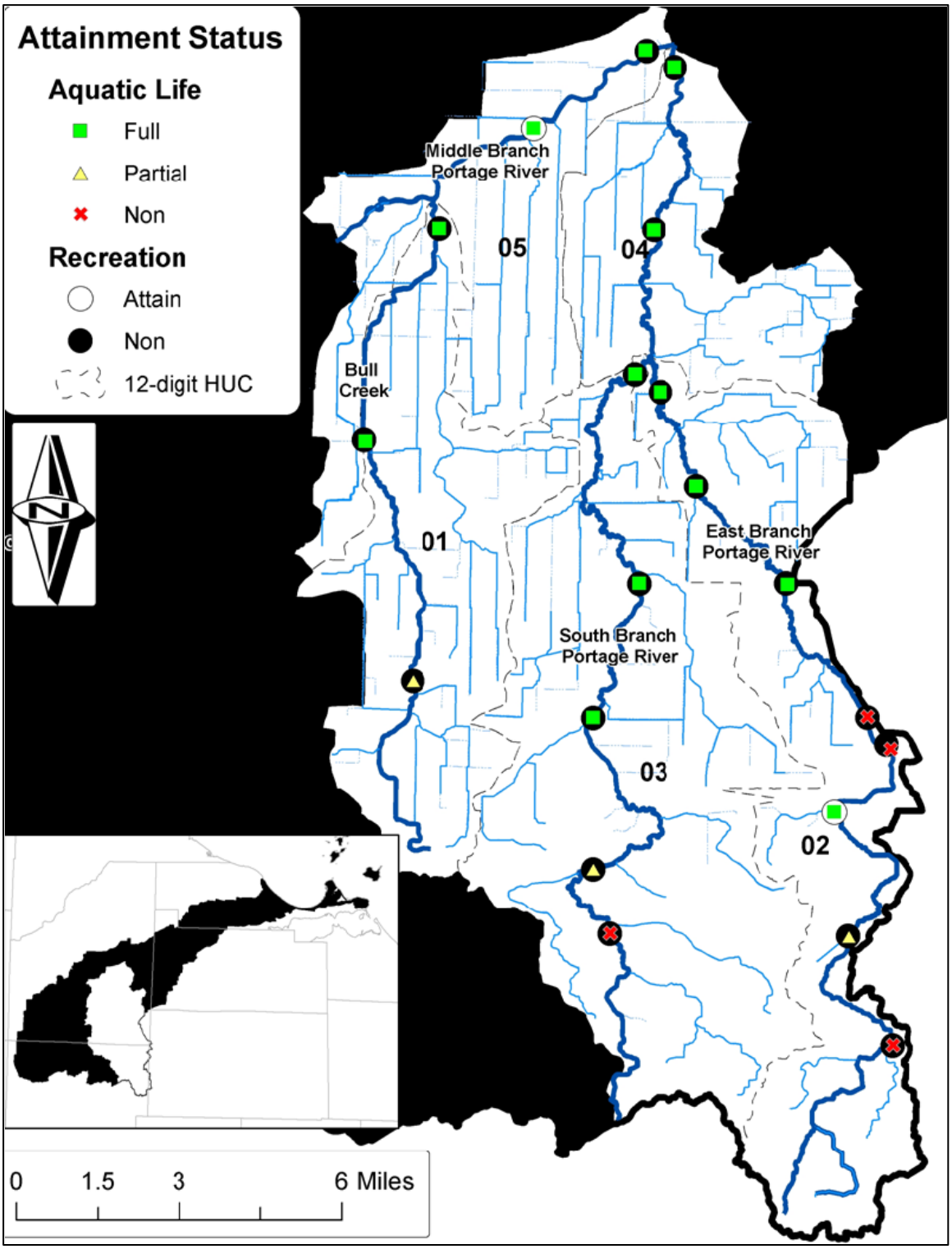

Figure 3-6. HUC 04100010-02 aquatic life and recreation use attainment.

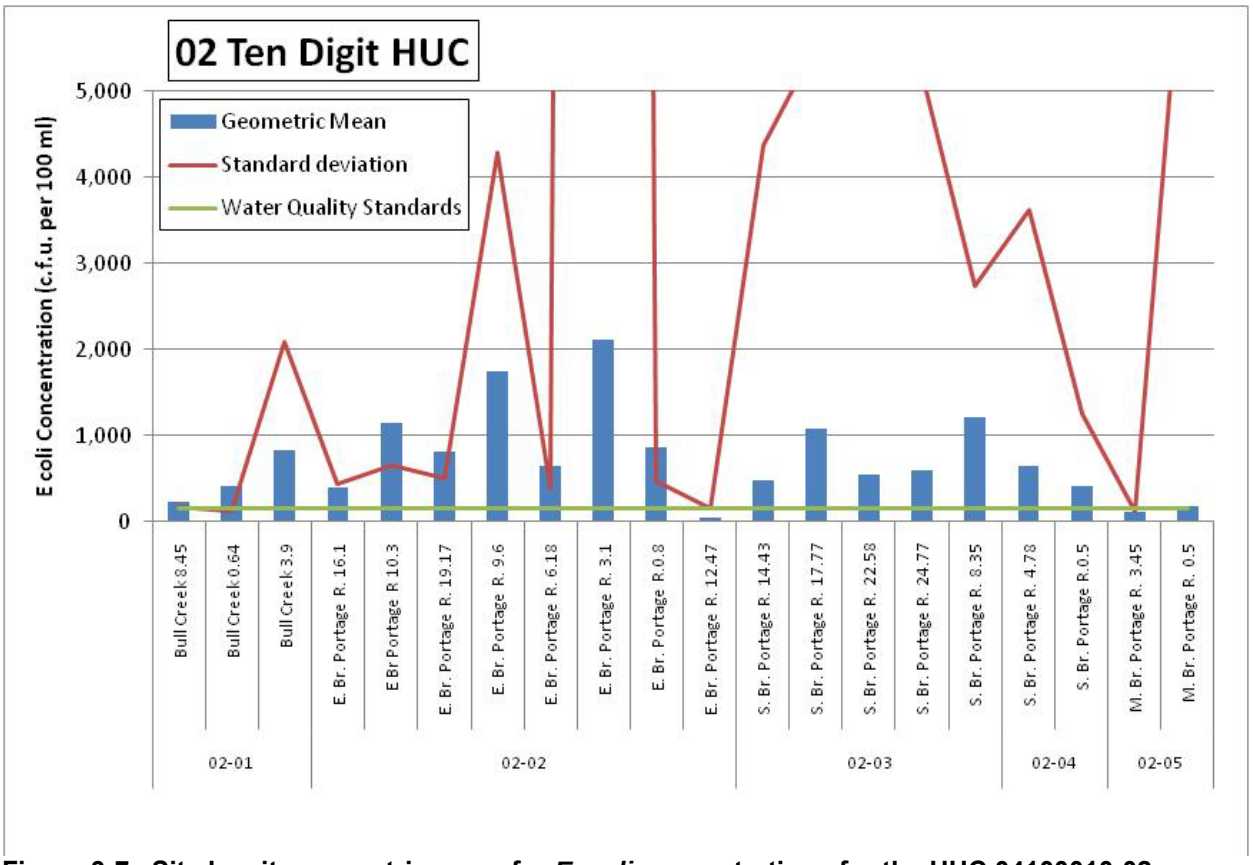

Figure 3-7. Site by site geometric mean for *E. coli* concentrations for the HUC 04100010-02 watershed.

3.1.3 Upper Portage River (04100010-03)

This subwatershed represents the western portion of the watershed and contains the municipalities of Bowling Green and Portage. Significant streams include the North Branch Portage River and part of the South Branch Portage River. Three out of 8 sites (38 percent) surveyed fully meet aquatic life use criteria; however 25 percent meet none of the criteria and 38 percent met some but not all of the criteria (Figure 3-8). All of the impairment was found on North Branch Portage River where it was fairly evenly split between non-attainment and partial attainment. Recreation uses were impaired at 8 sites (80 percent) of the ten sites surveyed in this subwatershed. Aquatic life and recreation use attainment for HUC -03 is presented in Figure 3-8. The bar chart in Figure 3-9 is the site by site geometric mean of the *E. coli* concentrations within the subwatershed. The numbers after the stream name on the x-axis indicate the river mile in which the sample was taken. The standard deviation for each of the component nested subwatersheds and the applicable water quality criteria are shown on the graph as horizontal lines.

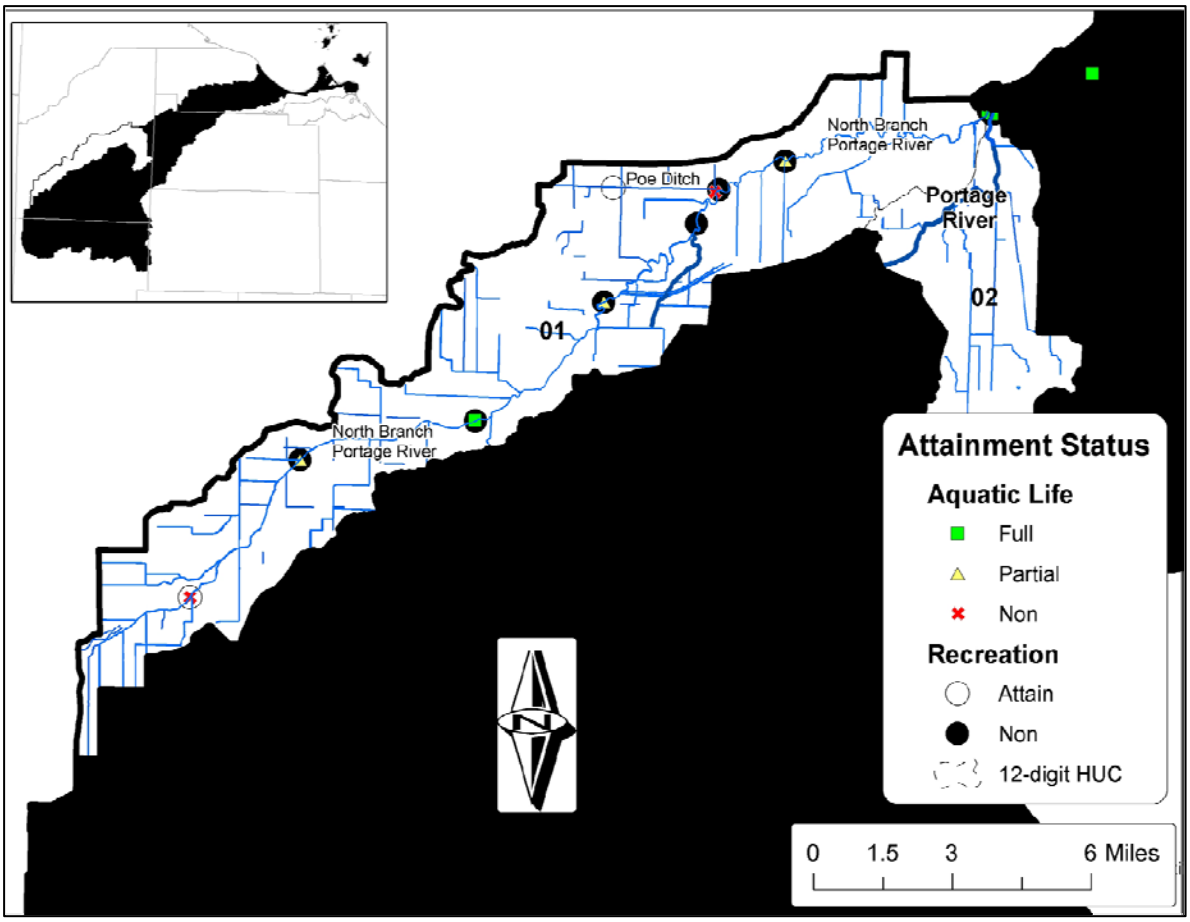

Figure 3-8. HUC 04100010-03 aquatic life and recreation use attainment.

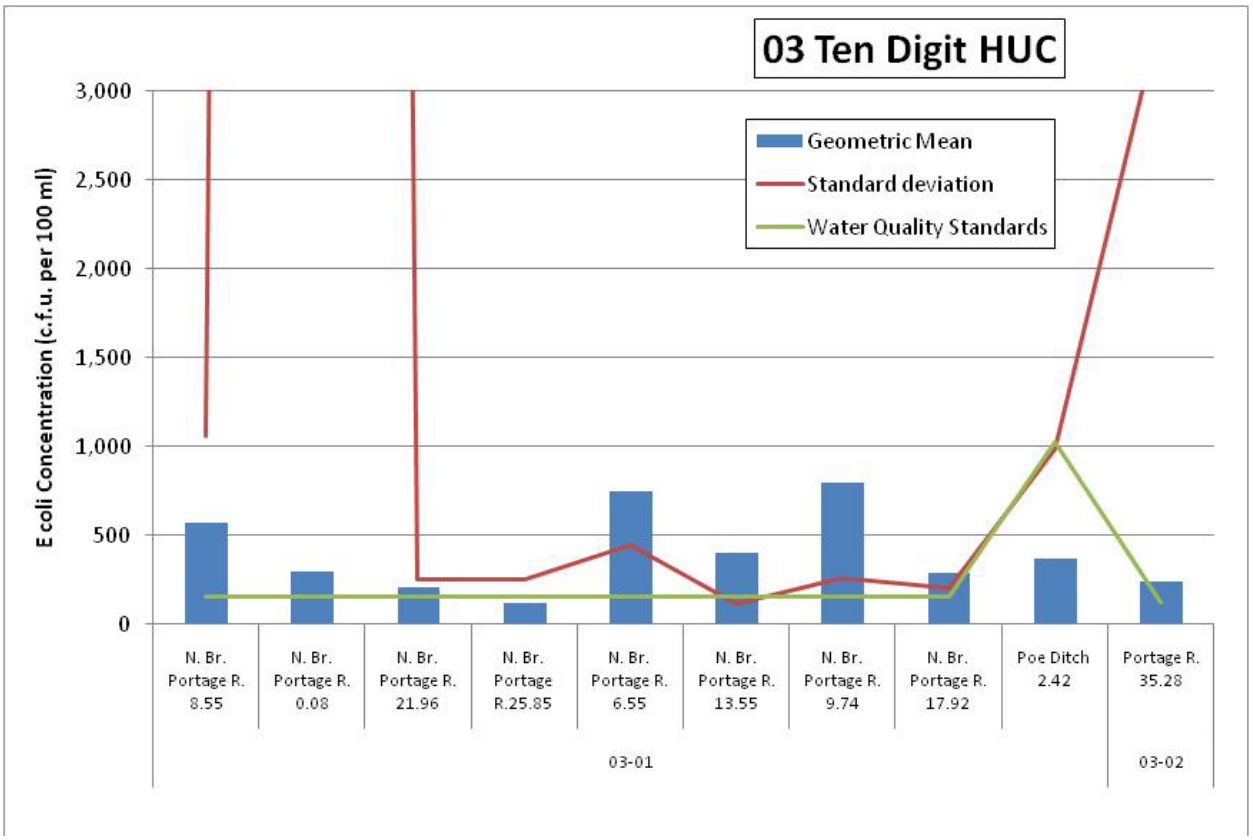

Figure 3-9. Site by site geometric mean for *E. coli* concentrations for the HUC 04100010-03 watershed.

3.1.4 Middle Portage River (04100010-04)

This subwatershed represents the northern portion of the watershed and contains the municipalities of Gibsonburg, Woodville, Elmore, and part of Pemberville. Significant streams include Sugar Creek and a small part of the Portage River. Nine out of eleven sites (82 percent) surveyed fully meet aquatic life use criteria; however 18 percent met some but not all of the criteria (Figure 3-10). All of the impairment was found at one site each on Coon Creek and the mainstem of the Portage River. Recreation uses were impaired at 13 sites (93 percent) of the 14 sites surveyed in this subwatershed. Aquatic life and recreation use attainment for HUC -04 is presented in Figure 3-10. The bar chart in Figure 3-11 is the site by site geometric mean of the *E. coli* concentrations within the subwatershed. The numbers after the stream name on the x-axis indicate the river mile in which the sample was taken. The standard deviation for each of the component nested subwatersheds and the applicable water quality criteria are shown on the graph as horizontal lines.

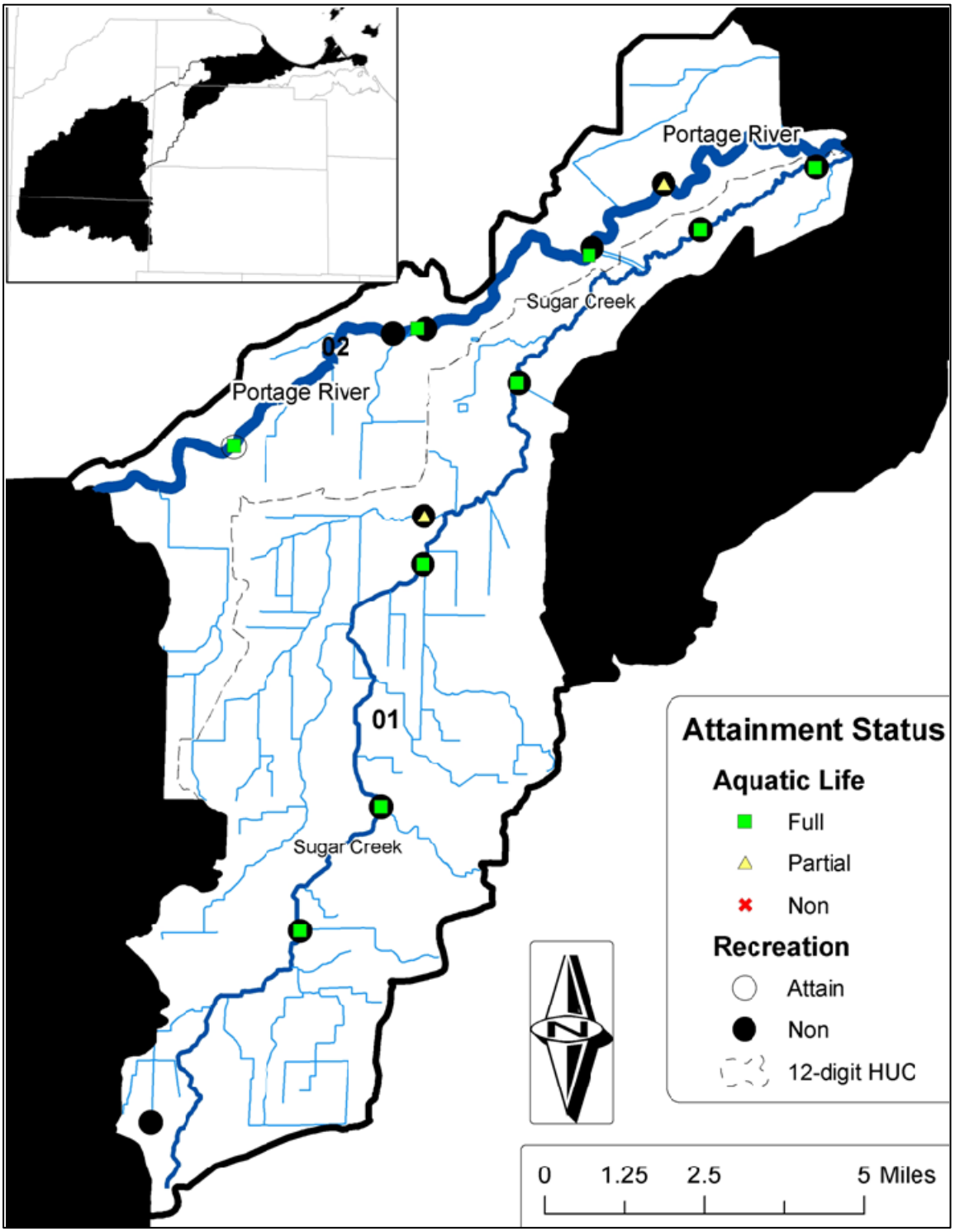

Figure 3-10. HUC 04100010-04 aquatic life and recreation use attainment.

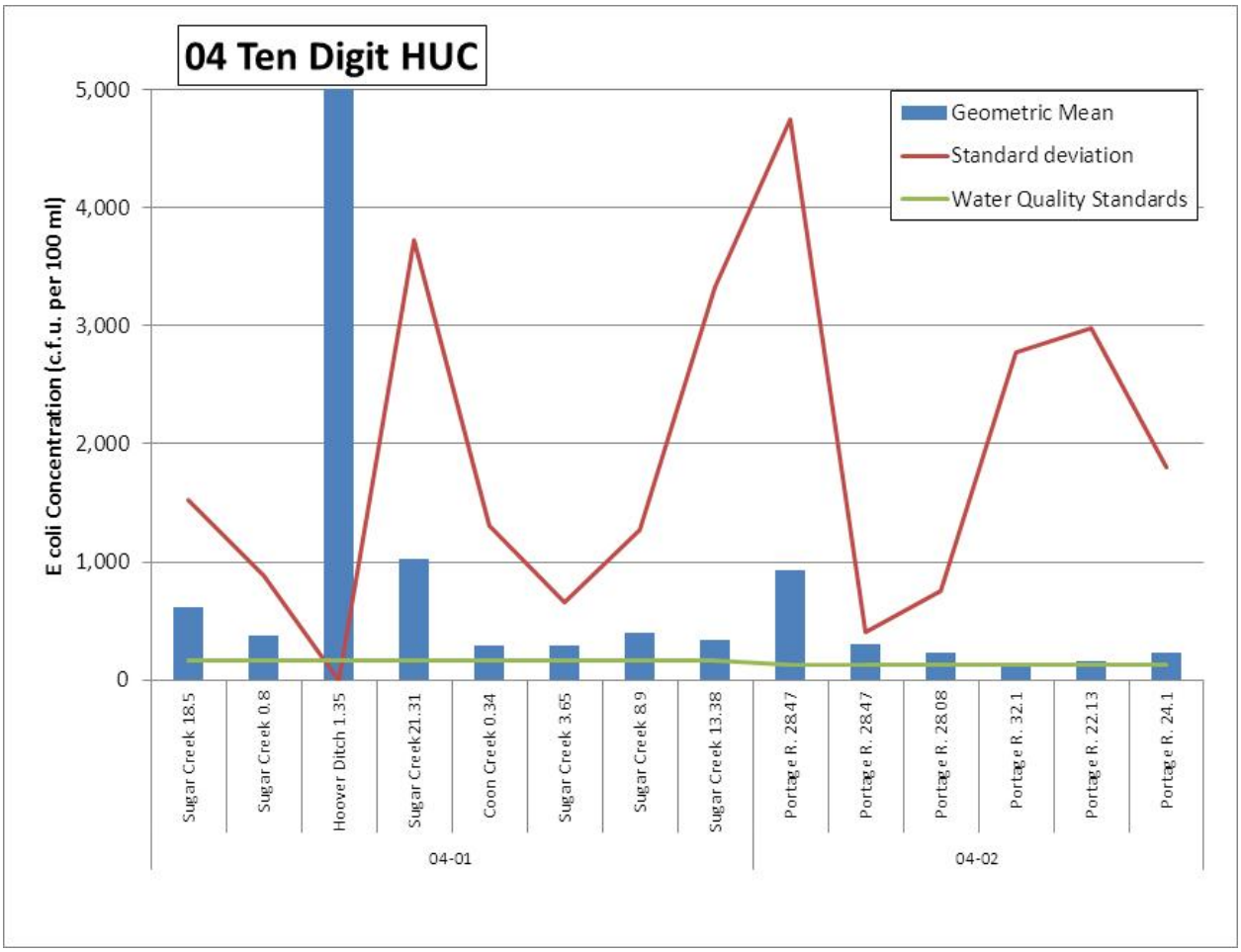

Figure 3-11. Site by site geometric mean for *E. coli* concentrations for the HUC 04100010-04 watershed.

3.1.5 Lower Portage River-Frontal Lake Erie (04100010-05)

This subwatershed represents the very northeastern portion of the watershed and contains the municipalities of Oak Harbor and part of Lindsey. The Lake Erie islands that are a part of this subwatershed were not; however, evaluated for attainment of any designated uses. Significant streams include the Little Portage River, Indian Creek, Wolf Creek and part of the Portage River. Two out of 10 sites (20 percent) surveyed fully meet aquatic life use criteria; however, 50 percent meet none of the criteria and 30 percent met some but not all of the criteria (Figure 3-12). Impairment was fairly evenly spread across the Portage River, Little Portage River, Ninemile Creek and Wolf Creek; however, the majority of the non-attainment was found on the Portage River mainstem. Recreation uses were impaired at 11 sites (73 percent) of the 15 sites surveyed in this subwatershed. Aquatic life and recreation use attainment for HUC -05 is presented in Figure 3-12. The bar chart in Figure 3-13 is the site by site geometric mean of the *E. coli* concentrations within the subwatershed. The numbers after the stream name on the x-axis indicate the river mile in which the sample was taken. The standard deviation for each of the component 12-digit HUCs and the applicable water quality criteria are shown on the graph as horizontal lines.

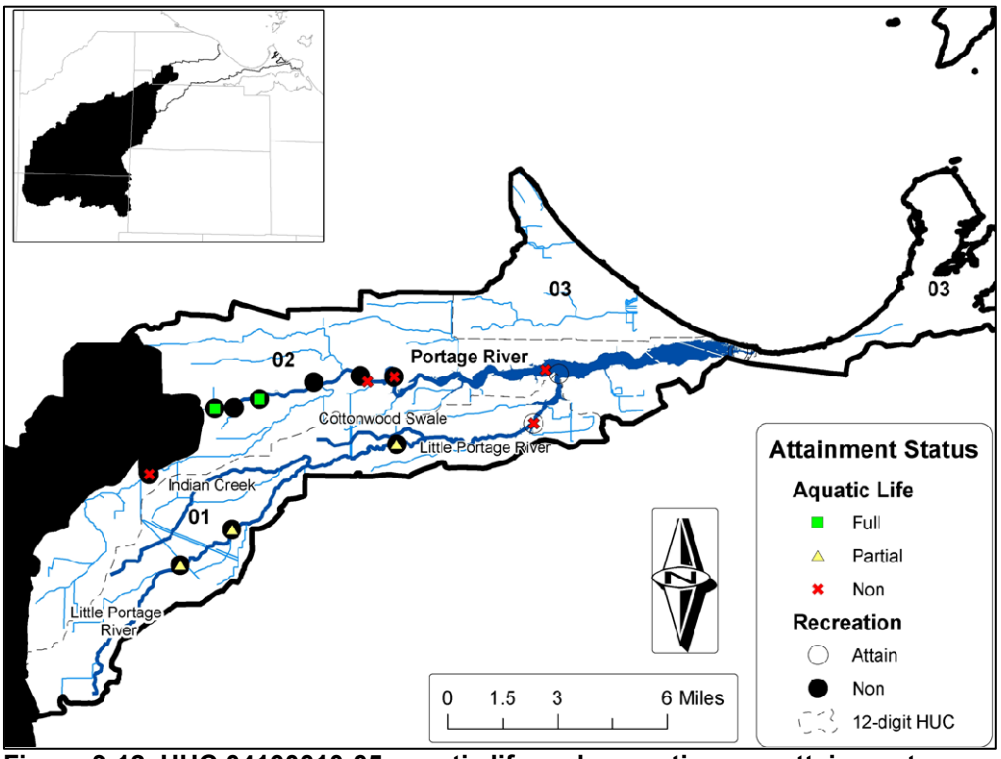

Figure 3-12. HUC 04100010-05 aquatic life and recreation use attainment.

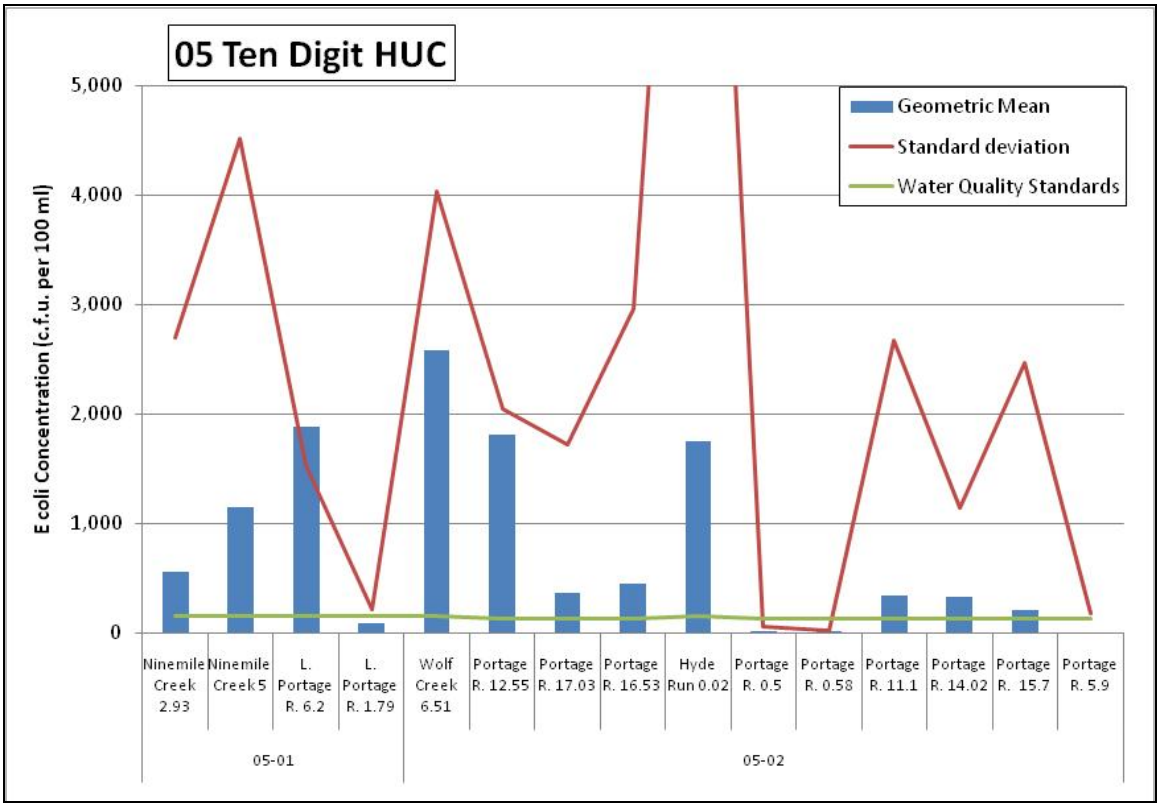

Figure 3-13. Site by site geometric mean for *E. coli* concentrations for the 04100010-04 HUC.

3.1.6 Summary of the Causes and Sources of Aquatic Life and Recreation Use Impairments

The most substantial problem identified in the technical support document (Ohio EPA, 2010) is inadequately treated sewage from decentralized home sewage treatment systems. The majority of the recreation use impairments caused by high bacteria loading stem from this type of source; however, other sources include runoff from cropland and urban areas, inadequately treated wastewater, and overflows from combined sewer systems.

Many of the sites that failed to meet the recreation use criteria; however, exceeded the standard by only a modest amount relative to many other watersheds throughout the state. This is to say that it is fairly common place for the recreation use criteria to be exceeded by an order of magnitude or more whereas this was infrequently the case in this watershed.

Regarding aquatic life use impairments, excessive amount of fine sediment in the stream channel is the dominant problem impacting aquatic communities. In fact, 77 percent of all of the impaired sites and 35 percent out of all of the sites have these sediment impairments. The effects of high nutrient loading as well as poor habitat quality each impact about half as many sites as those impaired by sediment amounting to 18 and 16 percent of all of the sites, respectively. Low flow conditions affected 12 percent of all sites which amounts to 26 percent of the impaired sites. Other causes of impairment include organic enrichment, low dissolved oxygen and high ammonia concentrations, PCBs in the channel sediment, high dissolved solids and low pH. Each of these is less than six percent of the total number of sites surveyed. See Figure 3-14 for a bar chart showing the distribution of these causes of aquatic life use impairment.

Sources associated with the cause described above include cropland runoff and subsurface drainage in regard to sediment and nutrients. Channelization degrades habitat, diminishes assimilative capacity of the stream for sediment and nutrients and can exacerbate channel erosion. Other sources include inadequacies of central sewage collection and treatment systems, failing HSTSs, and manure runoff from crop fields where it is land applied which contributes nutrients, organic materials (i.e., oxygen demanding substances) and ammonia. Industrial wastewater is also causing impaired aquatic life due to degradation of water quality as well as accumulation of toxins in the channel sediment over years of operation. See Figure 3-15 for a bar chart showing the distribution of these sources of aquatic life use impairment.

3.2 Public Drinking Water Supply Attainment

There was not sufficient data available to evaluate attainment status of the three public drinking water suppliers in the Portage River watershed. For this reason no TMDLs are needed at this time for Rader Creek (McComb Water Treatment Plant) in the 04100010- 01-01, 12-digit HUC; Rocky Fork Creek (North Baltimore Water Treatment Plant) in the 04100010- 01-03, 12-digit HUC; and East Branch Portage River (Fostoria Water Treatment Plant) in the 04100010- 02-02, 12-digit HUC.

3.3 Human Health Use (Fish Tissue)

Three 12-digit HUC assessment units are impaired for human health uses based on concentrations of PCBs in the tissue of sport fish. These are the East Branch Portage River (04100010–02–02); North Branch Portage River (04100010–03–01); and Portage River

(04100010–05–02). Six other 12-digit HUCs were not able to be evaluated due to insufficient data. Likewise, only one of four reservoirs in basin had sufficient data to make an attainment status determination. As such, the Veteran's Memorial Reservoir did not show impairment of human health uses. No TMDLs were developed to address the human health impairments in the Portage River watershed.

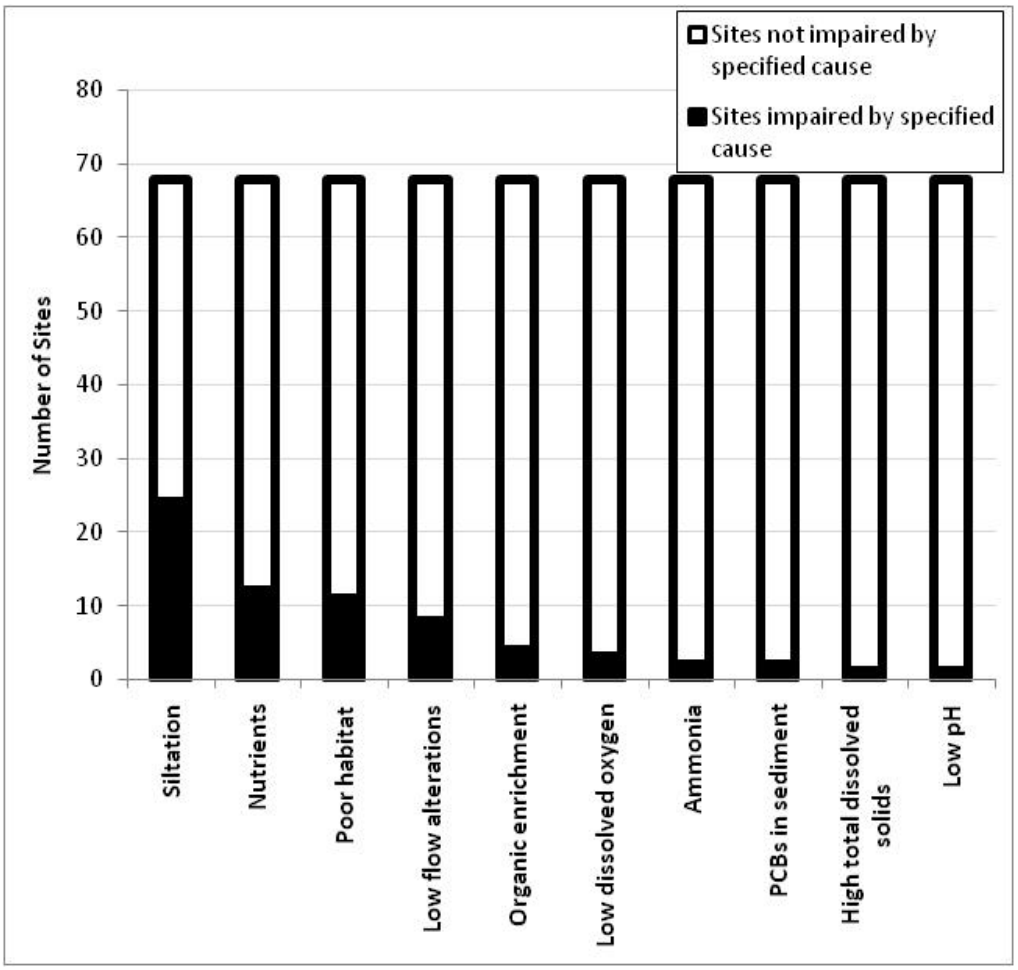

Figure 3-15. Bar graph of the distribution of causes of impairment for ALU impaired sites throughout the entire TMDL project area.

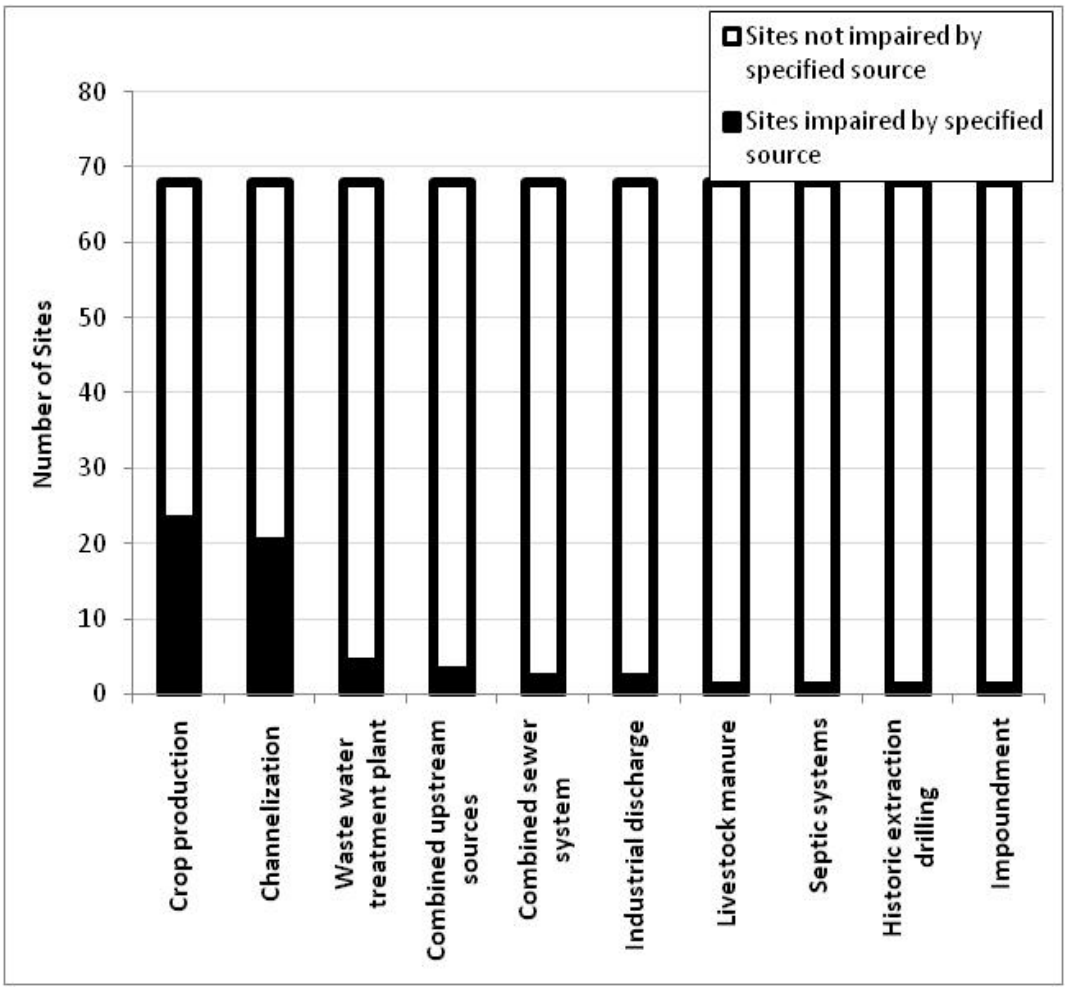

Figure 3-16. Bar graph of the distribution of sources of impairment for ALU impaired sites throughout the entire TMDL project area.

4 METHODS TO CALCULATE LOAD REDUCTIONS

TMDLs are developed in order to provide the knowledge needed to appropriately manage water quality so that water quality standards are able to be met. TMDLs have been developed for causes of impairment to recreation and aquatic life uses and include the following water quality stressors:

- Pathogens (using *E. coli* as an indicator of contamination)
- Nutrients (using total phosphorus as the indicator)
- Dissolved oxygen and organic enrichment (using CBOD 5-day as the indicator)
- Sediment (using a qualitative index to assess the degree of in-stream sedimentation)
- Habitat (using a qualitative index to assess the quality of habitat features)
- Flow alterations (using a qualitative index to assess the degree of in-stream sedimentation as a surrogate for the impact that low flow has)

This chapter summarizes the methods that were used in TMDL development and the following brief discussion draws the connection between these stressors and the established water quality standards.

Pathogenic (disease-causing) organisms are typically present in the environment in such small amounts that it is impractical to monitor them directly. Fecal coliform bacteria, including *E. coli*, by themselves are usually not pathogenic. However, some strains of *E. coli* can be pathogenic, causing serious illness. Although not necessarily agents of disease, fecal coliform bacteria and *E. coli* may indicate the potential presence of pathogenic organisms that enter the environment through the same pathways. When fecal coliform bacteria or *E. coli* are present in high numbers in a water sample, it invariably means that the water has received fecal matter from one source or another. Swimming or other recreational-based contact with water having a high fecal coliform or *E. coli* count may result in ear, nose, and throat infections, as well as stomach upsets, skin rashes, and diarrhea. Young children, the elderly, and those with depressed immune systems are most susceptible to infection.

In freshwater systems, phosphorus is typically the nutrient that is in short supply relative to biological needs, which means that the productivity of aquatic plants and algae can be controlled by limiting the amount of phosphorus entering the water. Large diurnal swings in pH and dissolved oxygen may occur as excessive amounts of nutrients are metabolized by aquatic plants and algae. The range of these swings often exceeds the state water quality criteria established to protect fish and other aquatic organisms in their various life stages. The amount of phosphorus currently entering these waters exceeds the seasonal loading capacity and must be reduced if these water quality problems are to be resolved. The sources of phosphorus loading vary depending on the human activities and conditions in a specific watershed (U.S. EPA, 2007).

Dissolved oxygen is essential for aquatic life. The suffocating effects of low dissolved oxygen impact several aspects of the behavior of aquatic organisms including feeding and reproduction.

The minimum and average dissolved oxygen concentration limits are tiered values and linked to aquatic life use designations (Administrative Code 3745-1-07, Table 7-1). A primary cause of critically low dissolved oxygen is organic enrichment which refers to a high concentration of carbon-based substances. These carbon materials are a food source that spurs bacterial growth leading to a substantial increase in bacteria concentrations. This results in increased respiration of the system and oxygen is consumed faster than it is replenished (e.g., through reaeration at the surface).

Sedimentation refers to the loading of fine grained sediments to the water column and the subsequent deposition of these materials on the streambed. When fine sediment is in suspension, it limits light penetration and causes light scatter which impairs visibility for sight feeding fishes and other organisms. Fine sediment can be abrasive to organisms and clog gill structures of fishes and macroinvertebrates. Fine sediment also damages aquatic life by blanketing eggs that were deposited on the streambed and reducing their survival. Sediment also fills void spaces between larger gravels, cobbles, and boulders rendering these areas inaccessible to organisms and restricting water flow. This adversely impacts resident organisms by limiting replenishment of oxygen and food sources, and it limits pollutant processing in these otherwise efficient processing areas.

Habitat alterations impact biological communities directly by limiting the complexity of living spaces available to aquatic organisms. This is significant to freshwater organisms because they have become specialized over millions of years of evolution to the niche habitats afforded in streams undisturbed by human management (i.e., pre-settlement). Consequently, fish and macroinvertebrate communities tend to lose diversity as stream habitat becomes less diverse. The primary functions of habitat for freshwater organisms are to provide protection from stressful environmental conditions, cover for species to species interactions (e.g., predator-prey) and support for specific food resources.

Flow alterations in the Portage River watershed are typically manifest by streams experiencing drying conditions earlier in the summer and those dry periods extending for a longer duration. The reason for this is believed to be largely due to a decrease in overall water storage in the soil profile as well as a more substantial lowering of the water table associated with drainage improvements and land uses in heavily row crop farmed areas (i.e., the dominant land use in this watershed). Making streams more efficient conveyances, use of sub-surface drain tiles, land smoothing, and soil compaction all associated with row crop production are likely to have profound impacts on infiltration and storage of precipitation. The resulting increase in dry conditions provides stress to aquatic communities by increasing mortality, and disrupting normal growth and reproductive cycles. The ultimate result is a loss of biodiversity and a less healthy stream community. However, increasing the availability of refugia in stream substrate will improve the aquatic community by decreasing mortality and abating other deleterious impacts. Reduction in fine sediment and the associated stream embeddedness will enhance the availability of stream substrate as refuge from stream drying, therefore the sediment TMDLs will be used as a surrogate for the flow alteration causes of impairment.

Tables 4-1 through 4-3 indicate how the applicable causes of impairment are addressed in each of the assessment units. Figures 4-1 and 4-2 are maps that capture the primary listed causes of impairment and the coverage for the TMDL analyses based on the 12-digit HUCs. Impairments associated with low dissolved oxygen have been addressed through the development of nutrient TMDLs for two assessment units. Nutrients are used as surrogates to simulate algae production and the associated impact on dissolved oxygen concentrations (i.e., 01-01 and 03-01). Two different causes of impairment are not at all addressed in assessment units 02-03 and

05-02 for total dissolved solids (TDS) and contaminated stream sediment, respectively. The TDS has an unknown source which precludes development of TMDLs, and the sediment toxicity is associated with legacy conditions and likewise is not amenable to TMDL development.

Table 4-1. Summary of causes of impairment and actions taken to address them in assessment units within the 04100010 01 and 04100010 02 ten-digit hydrologic units.

	Watershed Assessment Units								
	04100010 01				04100010 02				
Causes of Impairment	**01**	**02**	**03**	**04**	**01**	**02**	**03**	**04**	**05**
Aquatic Life Use									
Nutrient enrichment	D					N			
Habitat alterations	D	D	D		D		D		
Sedimentation/siltation	D	D	D		D	D	D		
Low flow alterations		S	S			S			
Dissolved oxygen/organic enrichment	S					D	N		
Total dissolved solids							N		
Ammonia						S			
Recreation Use									
E. coli	D	D	D	D	D	D	D	D	D

D – direct	Means that TMDLs are calculated for this parameter
S – surrogate	Means that TMDLs are calculated for a closely related cause and actions to reduce the impact of that cause should be sufficient to address this cause. There is substantial overlap in the sources of the loading of both parameters
N – not addressed	Means that the impairment is not addressed in this report.
Blank	Indicates that the assessment unit is not impaired for this cause.
4B	Means that the 4B option is being used to address impairment.

Table 4-2. Summary of causes of impairment and actions taken to address them in assessment units within the 04100010 03 and 04100010 04 ten-digit hydrologic units.

	Watershed Assessment Units			
	04100010 03		04100010 04	
Causes of Impairment	**01**	**02**	**01**	**02**
Aquatic Life Use				
Nutrient enrichment	N		D	
Habitat alterations	D		D	D
Sedimentation/siltation	D		D	
Dissolved oxygen/organic enrichment	N			
Recreation Use				
E. coli	D	D	D	D

D – direct	Means that TMDLs are calculated for this parameter
S – surrogate	Means that TMDLs are calculated for a closely related cause and actions to reduce the impact of that cause should be sufficient to address this cause. There is substantial overlap in the sources of the loading of both parameters
N – not addressed	Means that the impairment is not addressed in this report.
Blank	Indicates that the assessment unit is not impaired for this cause.

Table 4-3. Summary of causes of impairment and actions taken to address them in assessment units within the 04100010 05 ten-digit hydrologic unit.

	Watershed Assessment Units	
	04100010 05	
Causes of Impairment	**01**	**02**
Aquatic Life Use		
Nutrient enrichment	D	D
Habitat alterations	D	
Sedimentation/siltation	D	D
Low flow alterations	S	
Sediment screening value		N
Recreation Use		
E. coli	S	D

D – direct	Means that TMDLs are calculated for this parameter
S – surrogate	Means that TMDLs are calculated for a closely related cause and actions to reduce the impact of that cause should be sufficient to address this cause.
N – not addressed	Means that the impairment is not addressed in this report.
Blank	Indicates that the assessment unit is not impaired for this cause.

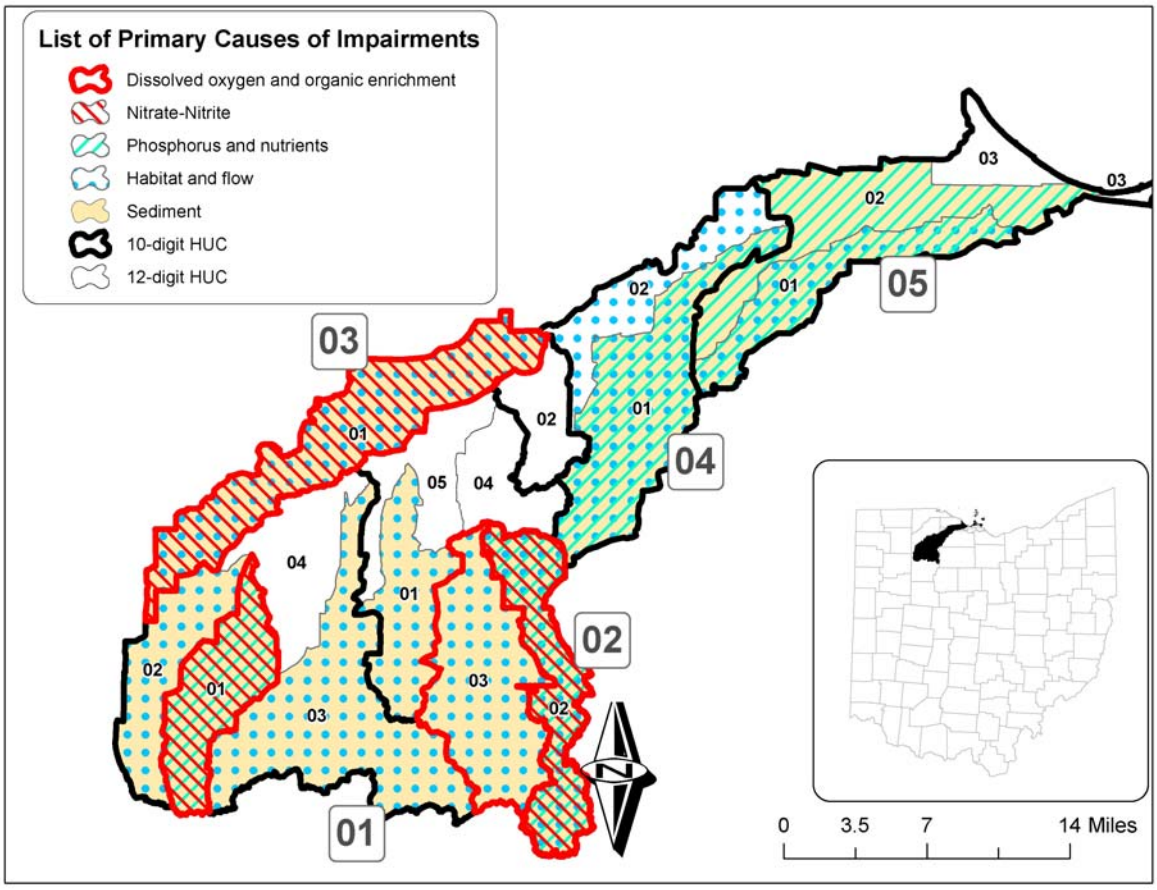

Figure 4-1. Assessment areas that have demonstrated aquatic life use impairment based on the specified parameters.

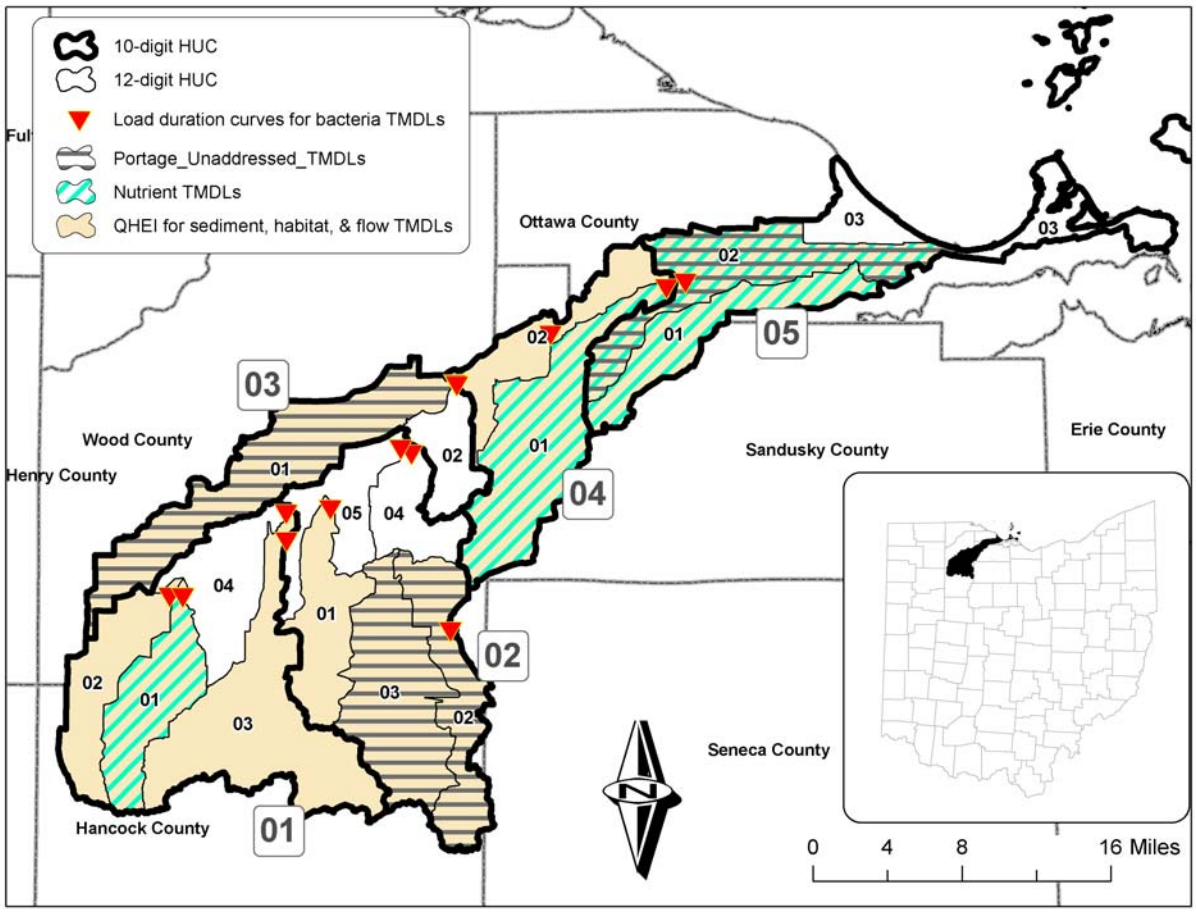

Figure 4-2. Areas analyzed for TMDL development. Areas without shading or lines were not subject to TMDL analysis.

4.1 Loading Simulation Program in C++ (LSPC) - Nutrient TMDLs

Loading Simulation Program in C++ (LSPC)

Portage River watershed hydrology and water quality nutrients are modeled by the LSPC version 3.1 (Tetra Tech, Inc. 2009). This model is a streamlined version of the Hydrologic Simulation Program Fortran (HSPF). The model includes algorithms for hydrology, sediment and general water quality on land as well as simplified stream transport. The model includes a module to assist in TMDL calculation and source allocations. Model output can be expressed in hourly or daily intervals; daily expression of the output is used for the Portage River model.

For the LSPC model, the Portage River watershed is broken up into 20 subwatersheds. Each subwatershed includes one stream reach, and these reaches are connected in the model. Figure 4-3 shows these subwatersheds with land uses also noted. Most of the subwatersheds are HUC 12s; however, some are smaller for various reasons (dischargers, sampling points, lakes, etc). Input data described in Section 4.2.2 are entered into the model for these 20 subwatersheds in order to calibrate hydrology.

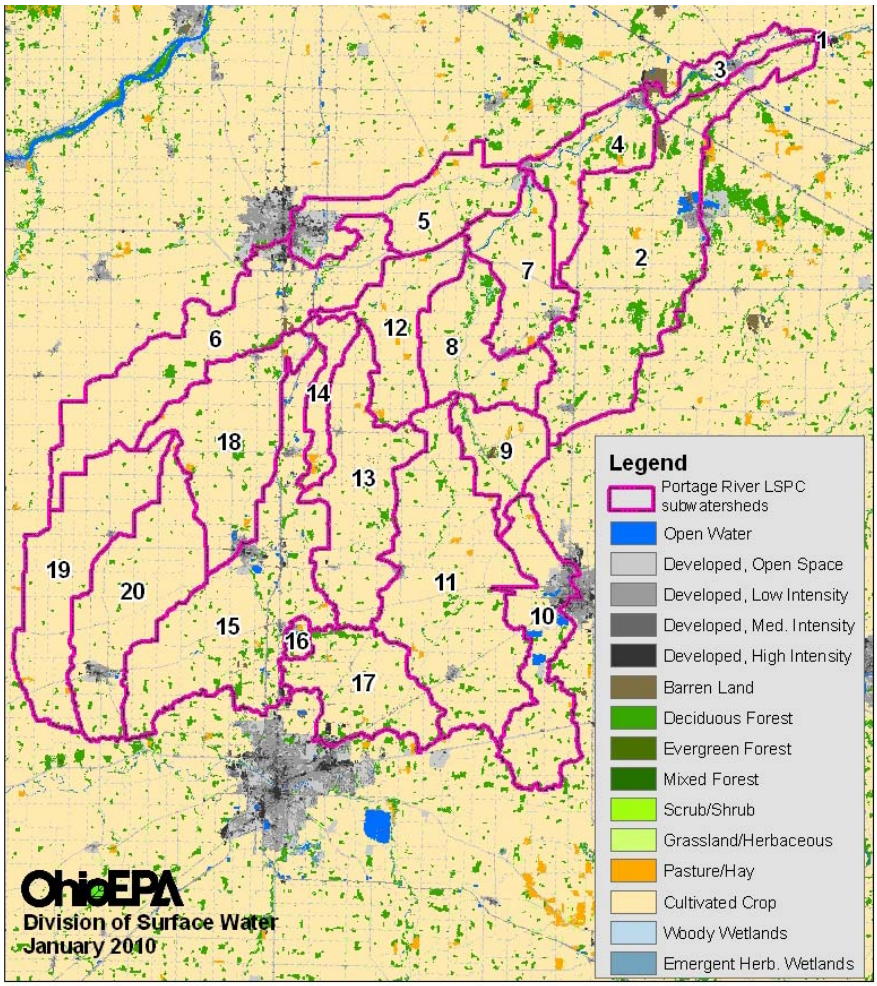

Figure 4-3. LSPC Portage River model subwatersheds

4.1.1 Selection of Method

This model is selected based on the fact that nutrient loads come from both point and nonpoint sources in the Portage River watershed. The inclusion of point source loading data is streamlined in this model and LSPC works well with input from Ohio EPA's NPDES discharger monitoring records (DMRs) database. Likewise, LSPC was designed to facilitate data management for large-scale or complex watershed modeling applications which is important since the model is setup to simulate total phosphorus entering streams from cropland runoff, a large source in this predominantly row crop watershed. The model has been successfully used to model watershed systems composed of over 1,000 subwatersheds at a National Hydrography Dataset (NHD) stream-segment scale. The system is also tailored for source representation and TMDL calculation.

Two twelve-digit HUC watersheds, the Little Portage River (HUC 04100010 05 01) and Wolf Creek (partial HUC 04100010 05 02) had total phosphorus TMDLs developed using a different method than the others. This is because these watersheds are downstream of the Portage River at RM 17.13 and are not included in the LSPC model. These streams discharge to the Portage River in its lacustuary (estuary) zone and the LSPC model as used here is not an acceptable application. The existing total phosphorus loads for these watersheds are calculated using a

watershed area yield based on all other Portage River modeled HUCs excluding the two HUCs that receive a large effluent load (the North and East Branches of the Portage River).

Existing nitrate+nitrite (NOX) loads are calculated in the same manner as the total phosphorus existing loads used for the TMDLs. No formal load reductions are suggested; however, and no TMDLs are developed for this pollutant. This information may be used for future watershed management programs, and is available in Appendix D of this report.

4.1.2 Sources of Data

LSPC model inputs are derived extensively from Geographic Information System (GIS) data. These include soil erodibility (USDA, 2008), basic stream channel cross-sectional hydraulics (OIT, 2006), channel slope (Ohio EPA, 2003) and land use (Homer, 2004), slope and elevations (Ohio EPA, 2003). Land use types are grouped into like imperviousness. Hydrologic soil groups are created in areas of similar soils and geology.

Hourly weather data drives the hydrology of the model. National Climatic Data Center (NCDC) weather data as tabulated by a third party, EarthInfo, is used for this modeling (EarthInfo, 2009). These data include air temperature, precipitation, potential evaporation, wind speed, solar radiation, dew point and cloud cover. Missing weather data are patched using the Meteorological Data Analysis and Preparation Tool version 2.1 (MetAdapt).

Effluent flow and pollutant concentration from NPDES dischargers are included in the model using discharge monitoring reports (DMRs) or default values. Default values are only used for parameters not monitored by an NPDES facility, which varies from facility to facility. Default values are also used for soil and water runoff pollutant quality. All of these default values are from the model's user's manual (Dai, 2000).

4.1.3 Water Quality Targets

Nutrients rarely approach concentrations in the ambient environment that are toxic to aquatic life. However, nutrient concentrations exceeding the needs of balanced ecosystems causes stress on the system by increasing the production of algae and aquatic plant life (Sharpley, 1999). This increases turbidity, decreases average dissolved oxygen concentrations and increases fluctuations in diel dissolved oxygen and pH levels. Such changes shift species composition away from functional assemblages comprised of intolerant species, benthic insectivores and top carnivores typical of high quality streams towards less desirable assemblages of tolerant species, niche generalists, omnivores and detritivores typical of degraded streams (Ohio EPA, 1999). Such a shift in community structure lowers the diversity of the system; the IBI and ICI scores reflect this shift and a stream may be precluded from achieving its aquatic-life use designation.

Phosphorus is selected as the nutrient to focus on because it is frequently the limiting nutrient to algal growth in the fresh water streams of Ohio. While the Ohio EPA does not currently have statewide numeric criteria for phosphorus, potential targets have been identified in a technical report titled *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA, 1999). This document provides the results of a study analyzing the effects of nutrients and other parameters on the biological communities of Ohio streams. It recommends total phosphorus (TP) target concentrations based on observed concentrations associated with acceptable ranges of biological community performance. The targets applicable to the Portage River watershed are shown in Table 4-4. It is important to note that these targets

are not codified in Ohio's water quality standards; therefore, there is a certain degree of flexibility as to how they can be used in a TMDL setting.

Table 4-4. Total phosphorus targets applicable to the Portage River watershed.

Watershed size	WWH
Headwaters (drainage area < 20 mi^2)	0.08
Wadable (drainage area ≥ 20 mi^2 < 200 mi^2)	0.10
Small Rivers drainage area ≥ 200 mi^2 < 1000 mi^2)	0.17

4.1.4 Calibration of the Model

Calibration refers to the adjustment or fine-tuning of modeling parameters to produce output that approximates values observed in the field. Hydrologic calibration precedes water quality calibration because runoff is the primary transport mechanism by which nonpoint pollution occurs. Once the hydrology was calibrated, nutrient results were compared to sample values collected by Ohio EPA at these locations.

Calibration entails several iterations of parameter adjustment and evaluation of the model output versus the field observations until reaching an acceptable correspondence between the two. Hydrologic calibration is typically based on ten years of simulation to evaluate parameters under a variety of climatic conditions, while water quality calibration usually spans only the time period in which water quality data was collected in the watershed.

Hydrologic calibration
Model calibration for hydrology involves comparing daily stream discharge values to model predictions. The closer the model's hydrology output is to actual data the better the model performance. The long term USGS gage at the Portage River's RM 17.03 (USGS gage 04195820) is used for this comparison.

A first step to calibrating model hydrology deals with the weather stations. Of the more than ten stations examined, two, Toledo Express Airport (NCDC gage #8357) and the Bowling Green WWTP (#7236), predict stream flow more accurately than the others and therefore were chosen for the hydrology calibration.

Sensitivity analyses were conducted to examine model response to changing parameter values for the system's hydrology. Data from 1999 and 2000 were used due to the various climatic conditions that occurred during those years. The analyses involved testing the model's sensitivity to changes in the default values (higher or lower) for 12 variables, which included variables that account for the partitioning of surface versus subsurface flow, infiltration rate, surface and subsurface storage, evapotranspiration and surface runoff and snow. Guidance for reasonable values of the flow parameters and error statistics utilized in this process were from US EPA, (2000). Some of these parameters vary by month so many more than 24 model simulations were made in this stage. Careful tracking of various flow error statistics were recorded, then there was further review of an additional 30 model simulations that were carried out using combinations of parameter adjustments, resulting in reduced errors in the flow predictions. Testing these combinations to the two different weather stations was also done. Final parameters are determined and data from the Bowling Green WWTP weather station yielded better results than the Toledo station.

Model hydrologic validation is a comparison of model results with an independent dataset. Input values from the watershed draining to the other USGS gage (#04195500) were used to simulate

stream flow which was then compared to the measured flow at the gage. The model simulation to another gage excludes the Sugar Creek drainage and some other small portion of the watershed area. None of the model hydrologic parameters were altered from what was established based on the model calibration. The error results from this model validation are included in Table 4-5. The same two error fields that exceeded recommended limits in calibration exceed in validation. Also the error in total volume is 28.11% while the recommended limit is 10%. Considering this is validation, less accuracy than calibration is acceptable.

Table 4-5. Hydrologic calibration error types and statistics for model calibration and validation.

Type of error (%)	Recommended limit	Portage R. calibration*	Portage R. validation†
Error in total volume:	10	7.1	*28.1*
Error in 50% lowest flows:	10	*147.6*	*148.3*
Error in 10% highest flows:	15	-2.7	11.9
Seasonal volume error - Summer:	30	-7.6	26.1
Seasonal volume error - Fall:	30	*66.3*	*120.6*
Seasonal volume error - Winter:	30	-9.5	6.9
Seasonal volume error - Spring:	30	10.5	28.1
Error in storm volumes:	20	-14.4	3.6
Error in summer storm volumes:	50	-48.5	-31.3

* Portage River at RM 17.13 at USGS gage 04195820
† Portage River at RM 28.08 at USGS gage 04195500

Water quality calibration

Two parameters, NOX and TP are simulated using the GQUAL in-stream processes module of LSPC, where instream decay of TP is considered. The same site used in hydrologic calibration, the Portage River at RM 17.13, is used for calibration of nutrient concentrations. For the first model simulation all water runoff and soil washoff parameters are set to default values.

Since the weather data available for modeling this watershed is only current through 2006, direct calibration using the water quality data Ohio EPA collected in 2008 and 2009 was not possible. Therefore a calibration method examining the nutrient concentration/load response to flow was developed. To do this water quality is simulated by LSPC for a reasonably long period of time, 1995-2006. This is done to increase the number of observations which reduces the standard deviation of the averaged daily values and adds confidence in the use of those values. Flows are sorted by magnitude along with the corresponding loads and concentrations for that day's flow. Based on cumulative frequency of exceedance curve, the data are grouped into flow exceedance intervals. The median value within each of the flow intervals is plotted as a box and whisker plot on the load duration curves and concentration duration curves in the place where a TMDL line normally occurs. On these graphs, the observed nutrient load and concentrations, respectively, are plotted. Calibration then proceeds as an iterative process where sensitive variables are adjusted to get the best fit between the load duration curves derived from model output (which changes with the successive iterations) and the plotted real water quality data.

The model parameters altered for water quality calibration were sediment washoff susceptibility and chemistry, water runoff and ground water quality. TP instream decay is included in this model simulation and this is adjusted throughout calibration. All values are adjusted using best professional judgment and following Dai (2000). Figures 4-4 and 4-5 are examples of these plots. These are the final calibrated load and concentration duration curves for TP.

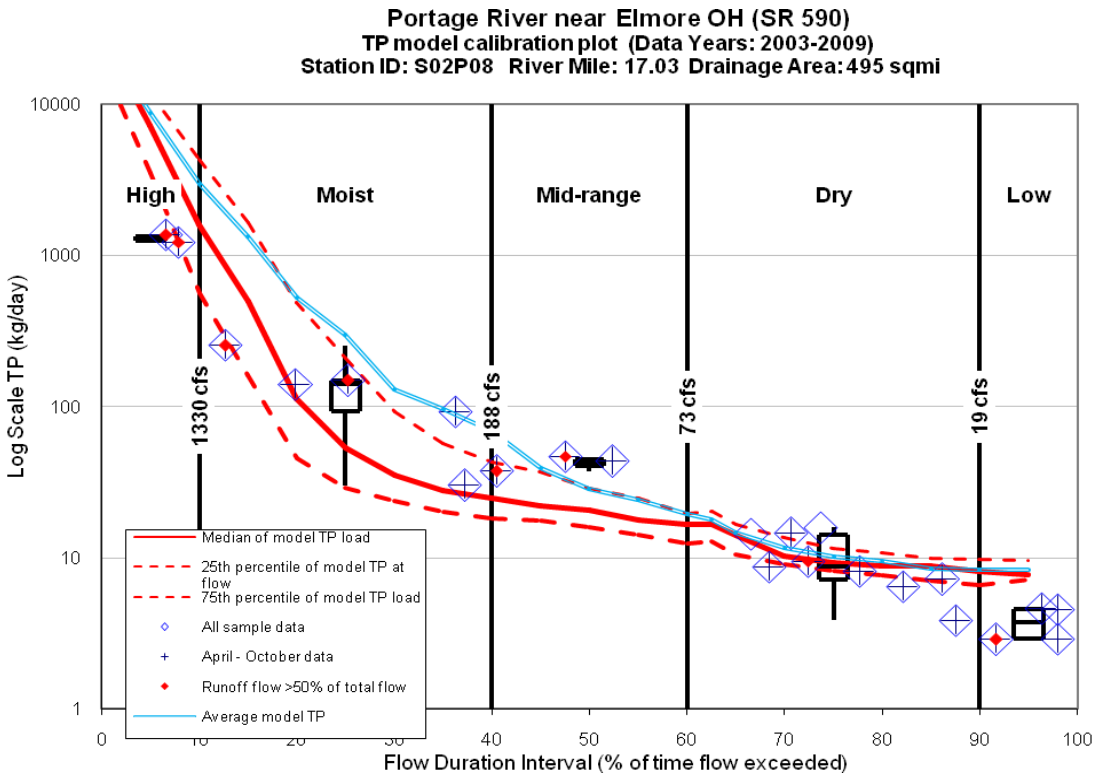

Figure 4-4. TP calibration load duration curve.

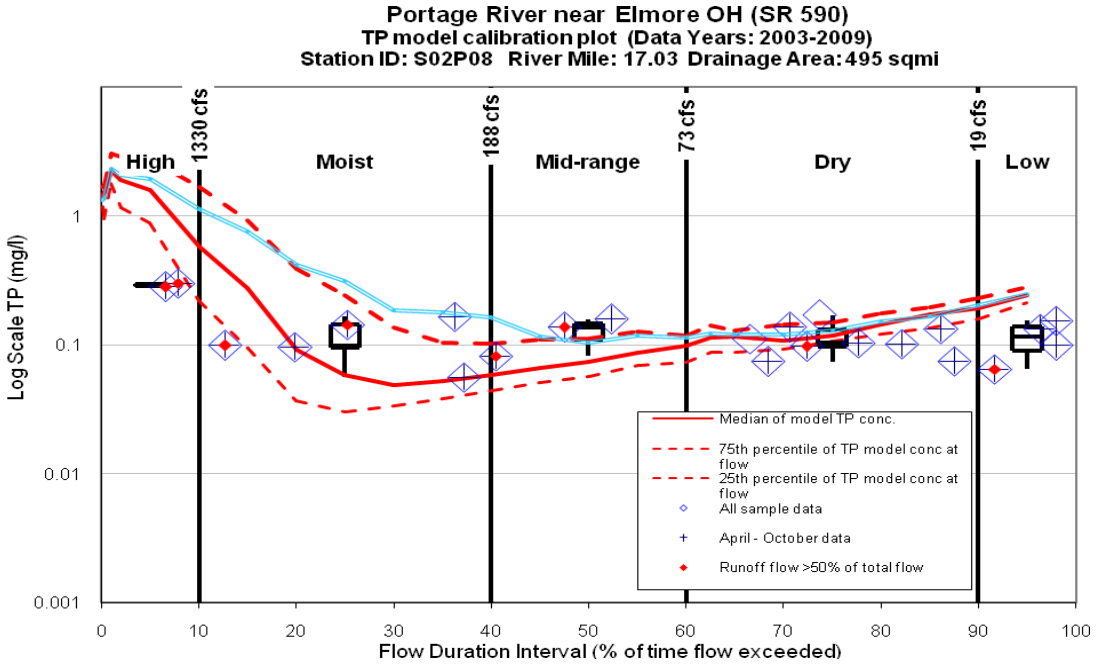

Figure 4-5. TP calibration concentration duration curve.

4.1.5 Margin of Safety

The Clean Water Act requires that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality. U.S. EPA guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS).

To account for model uncertainty an explicit margin of safety (MOS) is included in the TP nutrient TMDLs. Much of the simulated total phosphorus loading in this watershed is based on runoff or other precipitation driven transport processes, therefore the simulated hydrology had a great deal of relevance not only in terms of the potential for dilution of point source loading but also in terms of the nonpoint source loading itself. For this reason, the error determined from hydrologic model calibration of total volume, 7.1%, is used as this explicit MOS. In all of the HUC 12s, this amount of the calculated existing load is reserved as the MOS load.

Addressing nutrient impairment in the downstream reaches of the Portage River requires that all contributing HUC 12s reduce nutrient loading. The HUC 12s that are not directly impaired by nutrients have an equal load reduction, which is calculated by running the LSPC model to approximate the load near the outlet of the entire watershed under a median flow condition for the summertime (see Section 4.2.7). This load is 128.5 kg/day of TP at a TP concentration of 0.19 mg/l, and the flow is 208.5 cfs, A reduction of 32.5% is required in order to meet the 0.17 mg/l target, therefore all HUC 12s a baseline TP load reduction of 32.5%.

An implicit MOS is incorporated in the modeling/allocation of this TMDL. HUC 12s with nutrient impairment all require TP load reductions greater than 32.5% of the existing load, which is the reduction set for all HUCs regardless if they are not nutrient impaired. In actuality, in order to meet the TMDL for the Portage River at RM 17.13, the additional reduction at HUC12s impaired by nutrients would allow for lower nutrient reductions at the HUCs not impaired by nutrients (i.e., less than the 32.5% reduction); however, the 32.5% reduction remains the target for those HUCs. This additional reduction is an implicit MOS.

Using the LSPC model, each HUC 12 is simulated separately in order to create the TMDL. Allocation occurs after the MOS is removed. Two or four allocation scenarios are presented for most HUC 12s to provide managers with options for nutrient reduction implementation practices. The scenarios vary in the proportion of TP nonpoint source runoff and TP WWTP load reductions. Since row crop agriculture is the dominate land use of this watershed, considerations of nonpoint source load reduction is restricted to it alone, and other land uses are considered minimal sources. Part of three HUC 12s lie within permitted municipal separate storm sewer system (MS4) boundaries. TP wasteload allocations are provided for only one of these areas (Findlay's MS4 in the 01-03 12-digit HUC). Finally, several communities in the Portage River have combined sewer overflows. All of these communities are underway separating the sanitary sewage from these discharges. During the critical flow condition these TMDLs are targeting, the median summertime flow, CSOs would not be flowing. For both of these reasons all CSOs are given a TP allocation load of 0 kg/day.

4.1.6 Allowance for Future Growth

The Portage River LSPC model is used to simulate hypothetical conditions applicable for future resource management of the watershed. Therefore the setup of the model simulations used to create TMDLs is different from those for the calibration. For calibration, all WWTP discharges

are set to what has been observed and reported to Ohio EPA in the discharge monitoring reports (DMRs). In most cases these flows are less than what facilities' NPDES permits allow (i.e., design flow). Based on correspondence Ohio EPA staff has had with officials from most of the wastewater treatment facilities in the watershed, it is believed that none intend to increase plant design flow within the next 10 years. Also, population projections for this watershed do not show significant growth. Wood and Hancock counties expect less than 5% population growth in the next 10 years, while Sandusky and Ottawa counties expect a population decrease in the same time period. Because of this, setting all WWTPs to the full permitted design flow for modeling for TMDLs allows for future growth.

Many Portage River watershed WWTPs currently have TP effluent limits. In these cases the initial TMDL simulations for TP the discharge loads are set at this level. Facilities that only monitor TP are modeled with their TP set at the average projected effluent quality (PEQ) statistic for the last five years. This statistic is calculated using DMRs following Ohio EPA modeling guidance 1 (Ohio EPA, 2006). Finally for WWTPs that do not monitor TP, a default value of 3.0 mg/l is used based on historical trends and professional judgment. No WWTP facilities have NOX effluent limits therefore average PEQs or, if no data is available, a default value of 19.43 mg/l, is used. This default value is the average of the average PEQs of all Portage River LSPC modeled area WWTPs that report NOX.

The model run adjusted for the WWTP factors described above is termed "existing" conditions in this report.

4.1.7 Seasonality and Critical Conditions

The critical condition for nutrients loading is the growing season particularly when flows are low. In Ohio, this is most manifest in mid to late summer and early fall. Low flows have limited potential to dilute nutrient loads and the slow flow velocities and lower stream power better foster accumulation of filamentous and/or other types of algae. Nutrients impact the aquatic community by increasing algae and plant production leading to wide oscillations in diurnal dissolved oxygen concentrations and seasonal low concentrations when this plant material dies and is consumed by microbes (creating tremendous respiration in the system). The daytime/nighttime swings in dissolved oxygen concentrations is also believed to cause significant stress on aquatic life.

The most relevant nonpoint sources of phosphorus are seasonally loaded to the system. Fertilized cropland typically yields its highest loading when precipitation is high and crop cover is low corresponding to spring and early summer. Livestock will have direct contact with streams in the warmer months and their impact is most severe when flows are low (low dilution) corresponding to late summer and early fall. Loading from non-discharging HSTSs is precipitation driven whereas direct discharging systems and other point sources typically discharge at a constant rate throughout the year.
CSOs will be given a zero wasteload allocation because following implementation of the long term control plan, only four overflow excursions are expected per year and based on the discharge patterns observed over years of monitoring data, December and January are the most likely months to experience these flows. As a result, the critical condition for which water quality is being protected with these TMDLs should not be impacted by CSO flows and a zero wasteload allocation is thus justified.

4.2 Qualitative Habitat Evaluation Index (QHEI) - Habitat and Sediment TMDLs

Habitat alteration is a cause of impairment throughout the Portage River watershed. Poor habitat quality is an environmental condition, rather than a pollutant load, so development of a load-based TMDL to address this cause of impairment is not possible. However, the QHEI is an index to evaluate stream habitat quality. This index has six metrics (e.g., substrate quality) each of which is further divided by sub-metrics that account for discrete habitat features (e.g., a specific size class of substrate). Based on a visual assessment of a study reach (typically 150-200 meters in length), a numeric value is assigned to indicate the quality of the local habitat. The number values do not represent the quantity of any physical properties but solely provide a means for comparing the quality of stream habitat between various locations. Even though this value is derived qualitatively, subjectivity is minimized because scores are based on the presence and absence and relative abundance of unambiguous habitat features. Objectivity was an important consideration in developing the QHEI and has since been evidenced through minimal variation between scores from various trained investigators at a given site as well as consistency with repeated evaluations (Rankin, 1989).

The six general aspects of physical habitat that the QHEI evaluates include channel substrate, instream cover, riparian characteristics, channel condition, pool/riffle quality, and gradient. Within each of these metrics, points are assigned to the sub-metrics based on their ecological utility as well as their relative abundance in the system. Demerits (i.e., negative points) are also assigned if certain habitat features or conditions are present which reduce the overall utility of the habitat (e.g., heavy siltation and embedded substrate). These points are summed within each of the six metrics to give a score for that particular aspect of stream habitat. The overall QHEI score is the sum of all of the metric scores.

4.2.1 Selection of Method

For decades the Ohio EPA has used the QHEI to help understand the causes of aquatic life use impairment as well as in assigning appropriate aquatic life uses to stream segments. The strong correlation between the paired scores of the QHEI and the Index of Biotic Integrity (IBI), an important biometric in Ohio's water quality standards, supports the idea that the QHEI is assessing aspects of the stream system that are relevant to biological performance. The reliability that the QHEI demonstrates in predicting biological performance (the basis for aquatic life use attainment) as well as the relative ease of its application is the reason it is selected as the basis for the sediment and habitat TMDLs.

In terms of TMDLs for sediment, the QHEI characterizes sediment problems with the substrate metric, which has several sub-metrics that deal with fine material (sediment). Despite not providing an absolute quantity (or load) of fine material, it does deal with the relative quantity expressed as a percent of embeddedness of the channel and the percent of silt cover. Likewise the dominant substrate particle size (e.g., sands or silts) is to be scored and finer sized material score fewer points than coarser substrates. These connections are believed to be strong enough and the fact that they can reflect what is adversely impacting the biological community makes the QHEI suitable for developing sediment TMDLs. Also, other methods for developing sediment TMDLs are problematic. An example is using total suspended solids (TSS) as a surrogate for sedimentation (which is commonly done). Data gathered for modeling TSS (e.g., using GWLF, LSPC, or SWAT models) is often unreliable for calibration and validation since TSS demonstrates a high degree of variability both over space and time and is very sensitive to

local disturbances which could significantly inflate the concentration well above what is representative of the system. Additionally, there are few models that adequately account for in-stream sediment dynamics (e.g., erosion and deposition processes) or they require very high resource expenditures (e.g., much data collection) that are often not feasible (e.g., CONCEPTS).

Sediment TMDL targets and the qualitative habitat evaluation index (QHEI)
Numeric targets for sediment are based upon metrics of the QHEI, specifically those that consider particular aspects of stream habitat 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 and riparian zone. Table 4-6 lists targets for each of these metrics.

- The substrate sub-metric evaluates the dominant substrate materials (i.e., based on texture size and origin) and the functionality of coarser substrate materials in light of the amount of silt cover and degree of embeddedness. This is a qualitative evaluation of the amount of excess fine material in the system and the degree to which the channel has assimilated (i.e., sorts) the loading.
- 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 and consequently how sediment is transported, eroded, and deposited within the channel itself (i.e., this is related to both the system's assimilative capacity and loading rate). Stability reflects the degree of channel erosion which indicates the potential of the stream as being a significant source for the sediment loading.
- The bank erosion and riparian zone sub-metric also reflects the likely degree of instream sediment sources. The evaluation of floodplain quality is included in this sub-metric which is related to the capacity of the system to assimilate sediment loads.

In summary, the reasonable connection between sedimentation and the QHEI, the strong correlation between QHEI score and biometrics, and the fact that other quantifiable indicators of sedimentation are typically problematic in their own right, justifies use of the QHEI for sediment TMDLs.

4.2.2 Water Quality Targets

Since its development the QHEI has been used to evaluate habitat at most biological sampling sites and currently there is an extensive database that includes QHEI scores and other water quality variables. Strong correlations exist between QHEI scores and some its component sub-metrics 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). For the aquatic life use designation of warm water habitat (WWH) an overall QHEI score of 60 is targeted to provide reasonable certainty that habitat is not deficient to the point of precluding attainment of the biocriteria. An overall score of 75 is targeted for streams designated as exceptional warm water habitat (EWH) and a minimum score of 45 is targeted for modified warm water habitat (MWH) streams.

One of the strongest correlations found through these statistical analyses described above is the negative relationship between the number of "modified attributes" and the IBI scores. Modified attributes are features or conditions that have low value in terms of 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”.

In addition to the overall QHEI scores, targets for the maximum number of modified and high influence modified attributes have been developed. For streams designated as WWH, there should no more than four modified attributes of which no more than one should be a high influence modified attribute. Table 4-6 lists modified and high influence modified attributes and provides the QHEI targets used for this habitat TMDL. For simplicity, a pass/fail distinction is made telling whether each of the three targets are being met. Targets are set for: 1) the total QHEI score, 2) maximum number of all modified attributes, and 3) maximum number of high influence modified attributes only. 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 4-6. QHEI targets for the habitat TMDL that are applicable to warmwater habitats.

	QHEI categories	Modified attributes	
		High influence	**Moderate modified attributes**
Range of Possibilities	QHEI score	- Channelized or no recovery - Silt/muck substrate - Low sinuosity - Sparse/no cover - Max pool depth < 40 cm (wadeable streams only)	- Recovering channel - Sand substrate (boat sites) - Hardpan substrate origin - Fair/poor development - Only 1-2 cover types - No fast current - High/moderate embeddedness - Ext/mod riffle embeddedness - No riffle
Target	Overall score >= 60	Total number < 2	Total number < 5[a]
TMDL Points Assigned if Target is Satisfied	+ 1	+ 1	+ 1

[a] Total number of modified attributes includes those counted towards the high influence modified attributes.

Flow alteration

Habitat alteration can result in flow alteration, which is a listed cause of impairment in the Portage River watershed. Under certain circumstances flow alteration is the consequence of habitat alteration. For example, in an agricultural setting, as is much of the Portage River watershed, channelization exacerbates hydrological extremes; high flows get higher in downstream areas and low flows get lower due to decreased detention in the stream network. The high flows contribute to channel erosion liberating additional fine sediment in the stream system, and the low flows exhibit low dissolved oxygen and high temperatures (US EPA, 2007). For stream assessment areas where flow alteration is identified as the cause of impairment, the habitat QHEI is carried out in this report. An examination of actual QHEI score’s metrics that relate to stream flow is presented in Chapter 5 wherever this is applied.

Sediment
The individual components of the sediment TMDL are QHEI metric scores for substrate, channel and riparian. These metric target scores are based on the same associations made between QHEI and IBI results as explained in the habitat TMDL above (Ohio EPA, 1999). Table 4-7 shows the minimum scores expected for the sediment TMDL.

Table 4-7. Targets of the sediment TMDL.

Sediment TMDL =	Substrate	+	Channel Morphology	+	Riparian Zone/Bank Erosion	
For WWH >=	13	+	14	+	5	>= 32

Components of the Qualitative Habitat Evaluation Index (QHEI) are used for the habitat and sediment TMDLs in this report. This subsection contains explanations of the QHEI and the development of using it as TMDLs.

4.2.3 Margin of Safety

A MOS is implicitly incorporated into the sediment and habitat TMDLs through the use of conservative target values. The target values are developed though a comparison of paired IBI and QHEI evaluations. Using an IBI score of 40 as representative of the attainment of WWH, individual components of the QHEI are analyzed to determine their magnitude at which WWH attainment is probable. Attainment does, however, occur at levels lower than the established targets. The difference between the habitat and sediment targets and the levels at which attainment actually occurs is an implicit margin of safety.

4.2.4 Seasonality and Critical Conditions

Sediment loading from cropland is most severe when vegetation cover is at a minimum or non-existent, soils are moist and/or saturated, and rain events are frequent. This corresponds to the non-growing or early growing season especially in the spring when rain events are frequent. Habitat, separate from sediment loading, is not tied to seasonality.

The critical condition for the habitat and sediment TMDLs is the summer dry period when environmental stress upon aquatic organisms is the greatest. It is during this period that the presence of high-quality habitat features, such as deep pools and unembedded substrate, is essential to provide refuge for aquatic life. QHEI scores, the basis of the habitat and sediment TMDLs, are assessed during the summer field season. The habitat and sediment TMDLs are therefore reflective of the critical condition.

4.3 Biochemical Oxygen Demand (BOD) TMDLs Method

The assessment site of East Branch Portage River at RM 10.42 has organic enrichment as the cause of aquatic life use attainment. Combined sewer overflows (CSOs) operated by the City of Fostoria (2PD00031) have been identified as the sole source of this impairment. This sampling site is immediately downstream of the largest and most active of the three active CSO outfalls in this stream's watershed. This is outfall 004; pictured in Figure 4-6 with signs of a recent discharge. The other two CSOs draining to East Branch are outfalls 005 and 006. The outfall 007 has been determined not to be an active CSO, and outfall 008 does not drain to the Portage River watershed.

The City of Fostoria is developing a long-term control plan for CSO abatement as well as plans to make improvements to their wastewater treatment facility. Several alternatives have been submitted to U.S. EPA Region 5 regarding sewer separation and other CSO control measures. Pending feedback from U.S. EPA regarding the preliminary documents, the City expects to complete its long term control plan sometime in 2011. The City is also taking measures to increase capacity of the existing system to reduce overflow frequency and volume and make water quality improvements based on actions outlined in its draft long term control plan. The City has also initiated a study of its treatment works to best determine which upgrades are most efficient and most needed to meet effluent limits. The results of the study are expected in late 2011 and engineering plans should begin being drafted immediately following. Permits to Install (PTIs) based on these plans may be forthcoming as soon as late 2012.

The next assessment site downstream from RM 10.42, at RM 9.60, is impaired by elevated ammonia and nitrate/nitrite concentrations. This site is downstream of the City's WWTP discharge, which is, along with the CSOs, the source of this non-attainment. However, the magnitude of the ammonia loading due to noncompliance with effluent limits is small in comparison to the loading from the combined sewer system overflows, therefore the TMDL developed for BOD is to be used as a surrogate to address the impacts of ammonia on water quality and aquatic life uses.

The approach taken in developing BOD TMDLs follows the 1995 guidance issued by the U.S. EPA for CSO discharges (US EPA, 1995). The basic tenet to this approach is to quantify the existing CSO loading and then apply an 85 percent reduction to this calculated CSO discharge volume. The loading resulting from this reduction in CSO discharge (i.e., including loading associated with rerouted storm water to a separate collection system) is the TMDL for the pollutants of concern and allocations are given to the applicable sources. In determining the existing CSO loading the discharge volume must be evaluated either with monitoring data or model output that simulates CSO behavior. Likewise, pollutant concentration of the effluent must be evaluated to determine the loading rate of the CSO system. For this TMDL, real data based on routine discharge monitoring that is required in the City's NPDES permit (see Section 4.3.2 for explanation) is used to evaluate the existing loads.

Figure 4-6. Fostoria CSO outfall 004.

4.3.1 Selection of Method

The approach outlined in the 1995 federal guidance (US EPA, 1995) was selected based on consideration of data availabilities and the likely response of the aquatic community to abatement made based on the resulting TMDL targets. This approach also has a record of success and is consistent with many other TMDLs addressing CSO sources. In sum, the expected outcomes of TMDLs developed with this approach and its relatively efficient means for developing the TMDL values were key factors in its selection.

4.3.2 Sources of Data

Fostoria is currently developing a long term control plan to address CSOs and extensive sewerage flow modeling has been done; however, the monitoring involved with this work does not appear to have included water quality parameters. This flow modeling also does not appear to include stream flow considerations. Due to this, none of this support information used for the long term planning process are used in developing the BOD TMDL for this impairment.

Fostoria's NPDES permit requires all CSO volume be monitored during each discharge event. The permit requires monitoring of CBOD 5-day concentration via a grab sample once a month (NPDES permit Part II E.). The CBOD 5-day measurements are not required, "when the plant is not normally staffed (Saturdays, Sundays, and Holidays)." The permit does not give this exclusion for CSO flow measurements (NPDES permit Part II C). However, it is believed that the city is not sampling for flow and/or water quality parameters often when the CSO events occur at night or on weekends (Ohio EPA, 2010). With this in mind, the submitted Discharge Monitoring Reports (DMRs) data shows very few days where discharge volume and CBOD 5-day concentration values are reported simultaneously. The five year period of 2005-2009 finds this occurred 26, 8 and 5 times for outfalls 004, 005 and 006 respectively. The DMRs report that overflows occurred 164, 46 and 32 times at these same outfalls respectively, and, as stated above in this paragraph, these data are very likely not including all overflow events.

Table 4-8 shows the minimum, maximum, average and standard deviation of the CBOD 5-day daily loads calculated from the matching each event's volume and water quality DMR data described in the preceding paragraph. In all three outfalls a very large range of data exists.

Table 4-8. CBOD 5-day loads (in kg/day) for Fostoria CSOs draining to the East Branch Portage River based on DMR reported events.

CSO outfall #	Min	Max	Average	Standard deviation	n
4	2	4,739	753	1,194	26
5	0	1,902	535	687	8
6	128	4,958	1,478	2,029	5

Applying an 85% reduction to each reported CSO volume and using the same reported CBOD 5-day concentration is applied in order to meet this TMDL target. The same statistics shown in Table 4-9 are applied to the resulting loads from this 85 percent volume reduction in Table 4-9. The average load for each outfall will be used to represent the daily TMDL.

Table 4-9. CBOD 5-day loads (in kg/day) for Fostoria CSOs draining to the East Branch Portage River with 85% volume reduced.

CSO outfall #	Min	Max	Average	Standard deviation
4	0.3	711	113	179
5	0	285	80	103
6	19	744	222	304

Data showing the amount of precipitation during a wet weather event that will cause their CSOs to flow was not available at the time of the development of these TMDLs, therefore the background CBOD 5-day load was calculated by using the following process. A reference value of 0.1 in of precipitation is used (Lijklema, 1993) when applying the runoff model TR-55 (USDA, 1986) in the East Branch Portage River watershed up to the point of the impaired site at RM 10.42. The result is a stream flow of 17.04 cfs. Since a portion of this flow would be included in the storm water of the CSOs the flow is reduced 20%, to 13.6 cfs. The reduction is based on the fact that 15% of this watershed is categorized as urban land use (Homer, 2004). Since urban areas are more impervious than this watershed's predominant land use of row crops, more than 15% of the runoff will be expected to be included in Fostoria's CSOs. A reference value of 10.0 mg/l of CBOD 5-day in storm water (US EPA 2001) and this flow are used to determine the non-CSO load; this value is 333.0 kg/day of CBOD 5-day. This is portioned to the MS4 wasteload allocation (33.0 kg/day) and non-MS4 load allocation (300.0 kg/day) based on a land area ratio of the two.

The CSOs wasteload allocations, as explained above are the average of the load reduction of several overflow events where the 85% reduction in CSO flow applies (Table 4-10). These results are summarized in Chapter 5, Table 5-21.

4.3.3 Water Quality Targets

Biochemical oxygen demand, in the form of CBOD5-day, is often a parameter used in order to address organic enrichment; however, the State of Ohio does not have numeric water quality criteria for CBOD 5-day. The document often used in TMDLs to develop numeric targets when criteria do not exist, *Association Between Nutrients and the Aquatic Biota of Ohio River and Streams* (Ohio EPA, 1999), is not suitable for this application because urban sites are excluded from the data used to determine the reference values that are often used as targets. The fact

that these values would be inappropriate is reinforced when they are compared to expected (non-CSO) urban storm water concentrations (US EPA, 2001). In short, the lowest expected urban storm water concentrations for these parameters are at or above the 95th percentile of expected values for the reference sites in the Ohio EPA document.

An alternative target utilized for these TMDLs is from US EPA guidance, Combined Sewer Overflows Guidance for Long-Term Control Plan (US EPA, 1995). This document outlines, "demonstrative and presumptive" approaches to successful control of CSOs. One of these approaches is described as 85% control of volume of annual average total CSO discharges (page 3-7 of that document). This implementation based target is believed to be reasonable as it is predicated on a substantial level of abatement which will no doubt result in ambient conditions that are much more tolerable to pollution sensitive aquatic life communities and conducive to an aquatic community that is healthier than the existing community.

4.3.4 Margin of Safety

This method of TMDL calculation is implicitly conservative because no instream decay is considered. This constitutes an implicit margin of safety.

4.3.5 Seasonality and Critical Conditions

Based on reporting data from 1/1/2005 through 12/31/2009, the largest volume of CSO discharge occurred in the months of January and December with the remaining months of the year relatively consistent in volume. Discharge events also happened at a greater frequency during the winter months. Figure 4-7 illustrates these data. This is consistent with runoff patterns in urban environments and therefore reflects the seasonal nature of CSO discharge and pollutant loading to the stream system.

The critical condition is the warm summer low flow period. During this period water temperatures are their highest of the year making dissolved oxygen most susceptible for depletion in organically enriched environments. Specifically, bacteria growth and consequently respiration is highest in these temperatures. Likewise, the holding capacity of oxygen is lower (e.g., lower saturation) as water temperature increases. This oxygen stress is the dominant means for impairing the aquatic community and therefore, the summer low flow conditions is most critical in terms of aquatic life uses relative to organic enrichment.

Based on the apparent lack of overlap between the seasonal loading and the critical condition, especially following CSO abatement through implementation of a long term control plan, the CSO will be given a zero wasteload allocation for nutrients and *E. coli* bacteria (see also Sections 4.1 and 4.4).

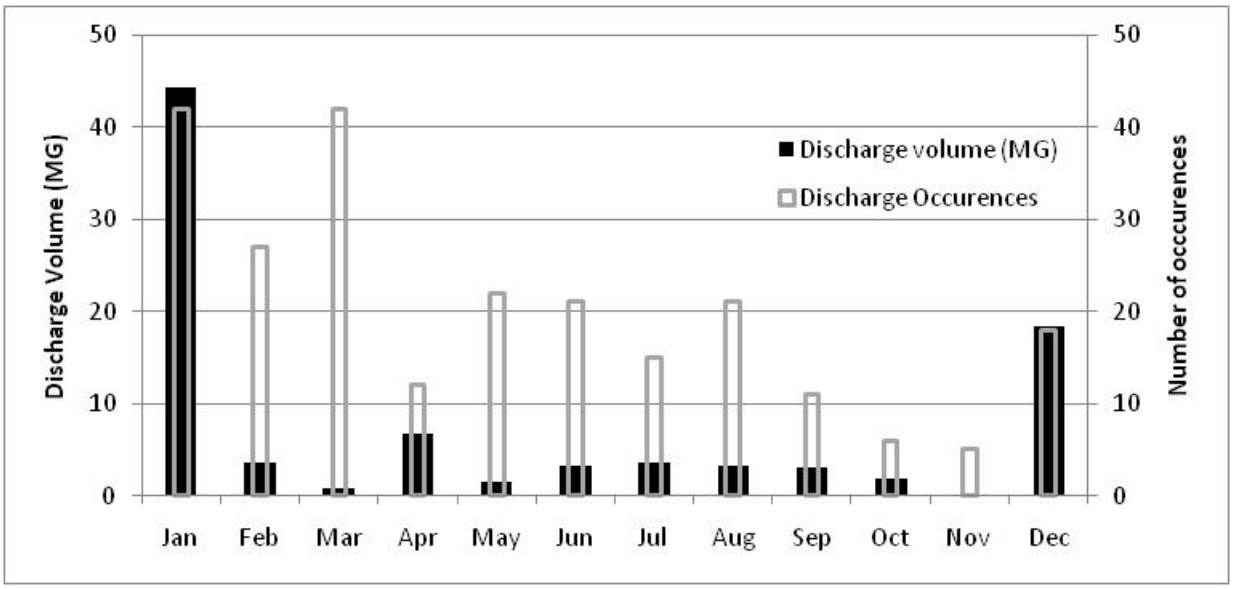

Figure 4-7. Temporal distribution of CSO discharge based on five years of reporting data from the City of Fostoria.

4.4 Load Duration Curves – Pathogens

Bacteria load reductions were determined through the use of load duration curves. This approach involves calculating the allowable loadings over the range of flow conditions expected to occur in the impaired stream by taking the following steps:

1. Generate a flow frequency table and plotting the data points to form a curve. The data reflect a range of natural occurrences from extremely high flows to extremely low flows. The flow record only includes data acquired from May through the end of October for each year analyzed.

2. Translate into a load duration (or TMDL) curve by multiplying each flow value by the water quality standard/target for a particular contaminant, then multiplying by a conversion factor. The resulting points are plotted to create a load duration curve (LDC).

3. Convert water quality samples to loads by multiplying the sample concentration by the average daily flow on the day the sample was collected. Then, the individual loads are plotted as points on the TMDL graph and can be compared to the water quality standard/target, or LDC.

4. Points plotting above the curve exceed the water quality standard/target and the daily allowable load. Those plotting below the curve represent compliance with standards and the daily allowable load. Further, it can be determined which types of flows contribute loads above or below the water quality standard/target (e.g., high flows versus low flows).

5. The area beneath the TMDL curve is interpreted as the loading capacity of the stream. The difference between this area and the area representing the current loading conditions is the load that must be reduced to meet water quality standards/targets.

6. The final step is to determine where reductions need to occur. Those exceedences at the right side of the graph occur during low flow conditions, and significant sources might

include HSTSs, illicit sewer connections, or animals depositing waste directly to the stream; exceedences on the left side of the graph occur during higher flow events, and potential sources include a variety of activities related to runoff.

Using the LDC approach allows Ohio EPA and local planners to determine which implementation practices are most effective for reducing loads based on flow regime. If loads are significant during wet weather events, implementation efforts can target those BMPs that will most effectively reduce storm water runoff.

Table 4-10 lists the locations at which the various load duration curves were developed including the drainage area associated with each of those sites. The sites with LDC used to create bacteria TMDLs are all at what Ohio EPA calls sentinel sites. These sites are picked to represent HUC 12s and/or important drainage areas. The sites are sampled more frequently than the other survey sites. Water stage to stream discharge relationships are also created for each sentinel site. Knowing the stream discharge at each sampling of these sites allows for load calculations to be made without relying on the extrapolations to gages. Table 4-10 shows the sentinel sites and their drainage area. In order to calculate the load duration curve, each site's full flow duration interval must be calculated. In order to determine the load duration curve for each LDC site, stream flows are extrapolated to a USGS gage (station # 04195500 Portage River at Woodville, OH). A simple drainage area ratio of the LDC site to the USGS gage is applied to the gage flows to determine the LDC site's flows. The actual gage site is a sentinel site and no drainage area ratio is required for this site. Also a USGS gage is present at the Portage River at SR 590 site therefore no drainage area ratio is necessary.

Table 4-10. Load duration curves for *E. coli* TMDL sites and their drainage areas.

12-Digit HUC	Stream Name	Location	River Mile	Drainage Area (Sq. mi.)
04100010 01 01	Rader Creek	Cygnet Road	0.80	32
04100010 01 02	Needles Creek	Cygnet Road	1.25	32
04100010 01 03	Rocky Ford Ck	Solether Road	1.59	72
04100010 01 04	Middle Branch Portage River	Solether Road	8.64	95
04100010 02 01	Bull Creek	Greensburg Pike	0.64	30
04100010 02 02	East Branch Portage River	Eagleville Road	6.18	23
04100010 02 04	South Branch Portage River	Kenner Road	0.50	110
04100010 02 05	Middle Branch Portage River	Caskie Road	0.55	224
04100010 03 01	North Branch Portage River	River Road in Pemberville	0.08	59
04100010 03 02	Portage River	Bridge Street in Pemberville	35.28	353
04100010 04 01	Sugar Creek	Hessville Road	0.80	58
04100010 04 02	Portage River	US Rt. 20 in Woodville	28.08	429
04100010 05 02	Portage River	State Route 590	17.03	495

The load duration curves are grouped into five flow regimes noted with vertical lines and labels. These regimes are defined as the following:

High flow zone:	Stream flows in the 0 to 5 exceedance percentile range; these are related to flood flows.
Wet weather zone:	Flows in the 5 to 40 exceedance percentile range; these are flows in wet weather conditions.
Normal range zone:	Flows in the 40 to 80 exceedance percentile range; this are the median stream flow conditions.
Dry weather zone:	Flows in the 80 to 95 exceedance percentile range; these are related to dry weather flows.
Low flow zone:	Flows in the 95 to 100 exceedance percentile range; related to drought conditions.

Figure 4-8 is an example load duration curve to provide explanation of the various symbols used in the curve. The symbols are as follows: 1) water quality samples on the LDC curves are noted as diamonds; 2) samples taken when storm flow is greater than 50% of the stream flow are noted with the diamond with a red dot in the center (noted as “>50% SF” in the figures legend), this flow condition is determined using the sliding-interval method for streamflow hydrograph separation contained in the USGS HYSEP program (Sloto, 1996); 3) box plots are shown for each flow regime with data where the center line of these boxes represents the median *E. coli* load for that flow regime, the top and bottom of the boxes represents the 75th and 25th percentiles respectively, and the upper and lower vertical bar tails are the maximum and minimum observed loads respectively.

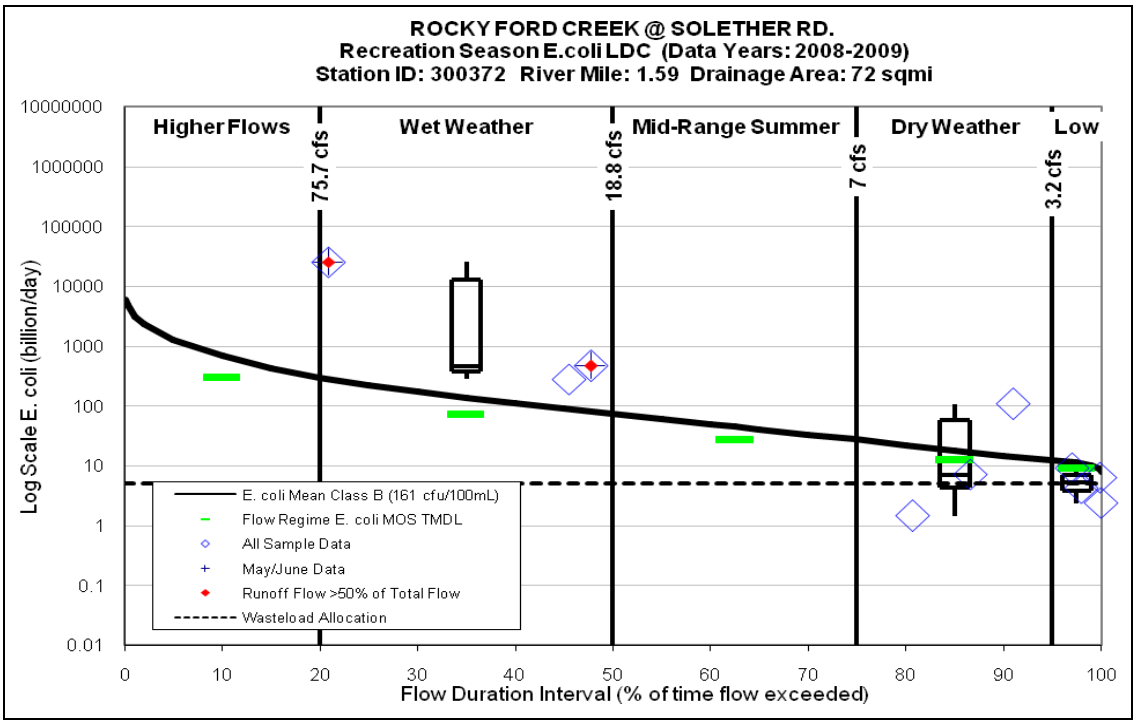

Figure 4-8. An example of a load duration curve for *E. coli* LDC in the 12-digit HUC 04100010 01 03.

All of the area beneath the TMDL curve is considered the *E. coli* loading capacity of the stream. The difference between this area and the area representing the current loading conditions is the

load that must be reduced to meet water quality standards/targets. The final step to create an LDC, is to determine where reductions need to occur. Samples in exceedance at the right side of the graph occur during low flow conditions, and significant sources might include wastewater treatment plants, malfunctioning home sewage treatment systems, illicit sewer connections and/or animals depositing waste directly to the stream. Any exceedance on the left side of the graph occurs during higher flow events and potential sources are likely land uses or management practices such as manure spreading or livestock production and sewer system overflows. These supply bacteria that are washed off upland areas with runoff. The LDC approach helps determine which implementation practices are most effective for reducing loads. Table 4-11 shows various pollutant sources and the loads they are associated with.

Table 4-11. Load duration curve flow zones and typical contributing sources.

	Duration Curve Zone				
Contributing Source Area	**High**	**Wet weather**	**Normal**	**Dry**	**Low**
Point source				M	H
Livestock direct access to streams				M	H
Home sewage treatment systems	M	M-H	H	H	H
Riparian areas		H	H	M	
Storm water: Impervious		H	H	H	
Combined sewer overflow (CSO)	H				
Storm water: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M-H	L-M	
Bank erosion	H	M			

H = high influence; M = moderate influence; L = low influence

4.4.1 Selection of Method

This method was selected to assess pathogen loading based on much of the same reasoning provided in Section 4.1.1. This method is appropriate since the sources of bacteria in Ohio streams can be differentiated by stream flow regime. The main advantage of the use of LDCs is the ability to discriminate loading based on flow. The main shortcoming of this method is the lack of differentiation between various loading sources that may occur under the same flow regime (such as cows in stream and poorly operating home sewage treatment systems). Additionally, alternatives methods to LDCs are mostly unreliable or prohibitive in terms of needed staff and funding resources to use them. For example, modeling bacteria in a dynamic, watershed manner, such as TP in this report, occurs in some studies in order to best determine bacteria sources but using methods such as this is time consuming and has been found by Ohio EPA to often yield similar results as those generated through simpler methods. More complicated modeling would also require more bacteria data than what is normally collected during routine surveys for calibration. DNA tracking of bacteria sources has also been used in TMDL studies and the USGS recently tested this technology in the Portage River watershed; however, on a scale too small to be used directly in this TMDL.

4.4.2 Water Quality Targets

Elevated bacteria loading is the cause of recreation use impairment for most streams in the Portage River watershed. TMDL numeric targets for *E. coli* bacteria are derived from

bacteriological water quality standards. The criterion for *E. coli* specified in §OAC 3745-1-07 are applicable outside the mixing zone and vary for waters that are classified as primary contact recreation (PCR). North Branch Portage River downstream of Poe Ditch and the mainstem Portage River are designated Class A streams. With the exception of two, the remainder of streams assessed in this watershed is Class B primary contact recreation streams. The unnamed tributary to Rocky Ford Creek at river mile 10.75 and Poe Ditch are designated secondary contact recreation, indicating infrequent primary contact recreation activities. For Class A streams the standard states that the geometric mean of more than one *E. coli* sample taken in each recreational season (May through October) shall not exceed 126 colony forming units (cfu) per 100 ml. The standard for Class B streams states that the geometric mean of more than one *E. coli* sample taken in each recreational season shall not exceed 161 cfu per100 ml.

TMDLs are created for watersheds that drain to an assessment site that is not meeting the recreation use criterion described in the paragraph above.

4.4.3 Margin of Safety

The Clean Water Act requires that a TMDL include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality. U.S. EPA guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS).

A substantial implicit MOS is incorporated by not considering the die-off of pathogens as part of the TMDL calculations, which conserves the entire bacteria loading from upstream sources to the calculation point some distance downstream. In addition, an explicit MOS has been applied as part of the bacteria TMDLs by reserving 20% of the allowable load. This is done because of the relatively low numbers of data points available for this analysis. Explicitly reserving 20 percent of the TMDL is especially significant at lower flow conditions since pathways are fewer and more predictable (i.e., no runoff-driven pathways) and there is less uncertainty associated with these conditions.

In four cases involving point sources, the combination of explicit and implicit MOS meant that not enough load was available to calculate the TMDL at the lowest stream flows. In just these instances, a moderate amount of die-off was applied in the TMDL calculation from their discharge points to the calculation point (a lessening of the implicit MOS). The proportion of die-off from the “no die-off” loading ranges from 10 to 40 percent over distances ranging from 4.02 to 8.70 miles. Current published scientific findings suggest that enteric bacteria die-off rates are as high as a ninety-nine percent reduction in the population within as little as 20.1 hours from the time upon entering the freshwater systems (Barcina et al., 1986). Similar bacteria population declines have been documented in time spans ranging from 30 hours to 150 hours (6.25 days) (Jamieson et al., 2004) and 2.8 to 10.6 days (Avery et al., 2008). Even with the relaxation of the implicit MOS in this way, a substantial portion of the implicit MOS and an explicit MOS was preserved in these calculations. The facilities for which this die-off was applied are indicated by footnotes in the results tables.

4.4.4 Allowance for Future Growth

In order to account for all expected future growth in the watershed, an additional flow consideration must be taken into account for several LDC sites in the Portage River watershed. Most permitted public wastewater treatment facilities in the watershed do not currently

discharge at their full permitted design flow. Because of this the additional flow must be added into the flow duration curve. Since this flow is expected no matter what the flow regime of the stream, the missing flow is added across all flow conditions. In several streams, most particularly the East and North Branches of the Portage River due to Fostoria and Bowling Green WWTPs respectively, this additional flow makes a large difference to the flow regime. A noticeable flattening of the LDC in the lower half of the flow duration (percentile exceedance) occurs due to these plants being considered at full flow. In effect these plants will dominate the stream flow for much of the duration when the plants meet their design flow.

Permitted dischargers with NPDES permits that currently require disinfection (mostly WWTPs), are assigned a WLA based on their design flow and the target *E. coli* concentration. Since these facilities operate no matter what the stream flow, their WLA is the same for all five flow regimes.

4.4.5 Seasonality and Critical Conditions

The critical condition for pathogens is the summer dry period when flows are lowest, and thus the potential for dilution is the lowest. Growth rates are higher and mortality rates lower in the warmer months further making this a critical time of the year for bacteria contamination. Likewise, summer is the period when the probability of recreational contact is the highest. For these reasons recreation use designations are only applicable in the period May through the end of October. Pathogen TMDLs are developed for the same time period in consideration of the critical condition, and for agreement with Ohio WQS.

Loading of *E. coli* from home sewage treatment systems or direct manure deposits from livestock are given a zero allocation because 1) properly functioning HSTSs should not discharge pollutants and it is reasonable to expect homeowners to maintain properly functioning systems and 2) proper livestock management should preclude such intense pollution of surface waters, again a reasonable expectation that livestock operators carry out basic conservation practices. Discharges from CSOs will likewise be given a zero wasteload allocation because following implementation of the long term control plan, only four overflow excursions are expected per year and based on the discharge patterns observed over years of monitoring data, December and January are the most likely months to experience these flows. As a result, the critical condition for which water quality is being protected with these TMDLs should not be impacted by CSO flows and a zero wasteload allocation is thus justified.

In terms of the MS4, the runoff loads are divided between runoff from MS4 areas and non-MS4 areas. Since runoff from MS4s is regulated by Ohio EPA, this allocation is considered a WLA. The non-MS4 runoff is a LA. This division is carried out simply by applying the land area ratio of each type (MS4 and non-MS4) to the remaining E. coli load allowed for each TMDL. Specific MS4s are subdivided and identified.

5 WATERSHED ANALYSIS, LOADING CAPACITY, AND ALLOCATIONS

This section of the report presents the results of the TMDL analyses whose methods are described in Chapter four. These methods are to quantify watershed specific water quality restoration goals and allocate pollutant loading to address the impairments presented in Chapter three. The five parameters causing water quality impairments that were evaluated are:

- Pathogens (using *E. coli* bacteria only)
- Nutrients (using total phosphorus only)
- Organic enrichment (using carbonaceous biological oxygen demand only)
- Sediment (using the QHEI only)
- Habitat (using the QHEI only)

These results are organized according to the five watershed divisions of the entire project area, namely the 10-digit HUCs. Within each of these sections, the results of the analyses for the applicable water quality parameters constitute their own subsections. For *E. coli* and total phosphorus the existing loads, TMDLs, load and wasteload allocations, explicit margin of safety, and load reductions are presented in a series of tables. The TMDLs and allocations for total phosphorus are presented as two to four management scenarios which progress from the highest nonpoint source and lowest point source load reductions to the opposite scenario that has the lowest nonpoint source and highest point source load reductions. The reason for presenting the several management options is to better inform water quality management decision making process and illustrate the flexibility associated with achieving water quality goals. However, the scenarios that are indicated by yellow highlighting are the preferred options and the ones for which TMDL approval is requested. Wasteload allocations for each CSO outfall for Fostoria's combined system as well as the load allocation and TMDL values are presented for CBOD.

For the sediment and habitat TMDLs, the score of the total QHEI and its individual metrics are presented along with the any deficits in reaching the target is presented for all sites sampled for biology. The sites for which sediment and habitat TMDLs are developed are denoted as bold italics and bold underline respectively.

5.1 Mainstem of the Portage River

In order to use the nutrient model to develop TMDLs, first a load duration curve for the Portage River at RM 17.03 (Figure 5-1) was created. This curve shows TP loads (vertical axis) vs. annual flow duration interval (horizontal axis). In this figure, hollow blue diamonds indicate TP loading based on water quality sampling, and of those, the samples that were collected during warmer months and/or during high runoff events have solid orange diamonds in the center. The two curves running across the graph show the target loads based on a concentration of 0.17 mg/l, and also a reference concentration of 0.10 mg/l. The flow duration is divided into five flow intervals indicated on the figure with vertical black lines and labels. A box plot summarizing the observed TP data is in the middle of each flow group. These indicate the minimum, 25th

percentile, median, 75th percentile and maximum observed loads in the flow group by the bottom tail, bottom line of the box, line through the middle of the box, top line of the box and top tail, respectively.

The target value of 0.17 mg/l which is applicable to this specific site (classified as a small river) is only exceeded in the top two flow duration intervals and primarily for the top ten percent of stream discharges. However the median TP concentration for all flow groups is above the wadeable stream target of 0.10 mg/l, which is applicable to the large tributaries to this point on the mainstem of the Portage River.

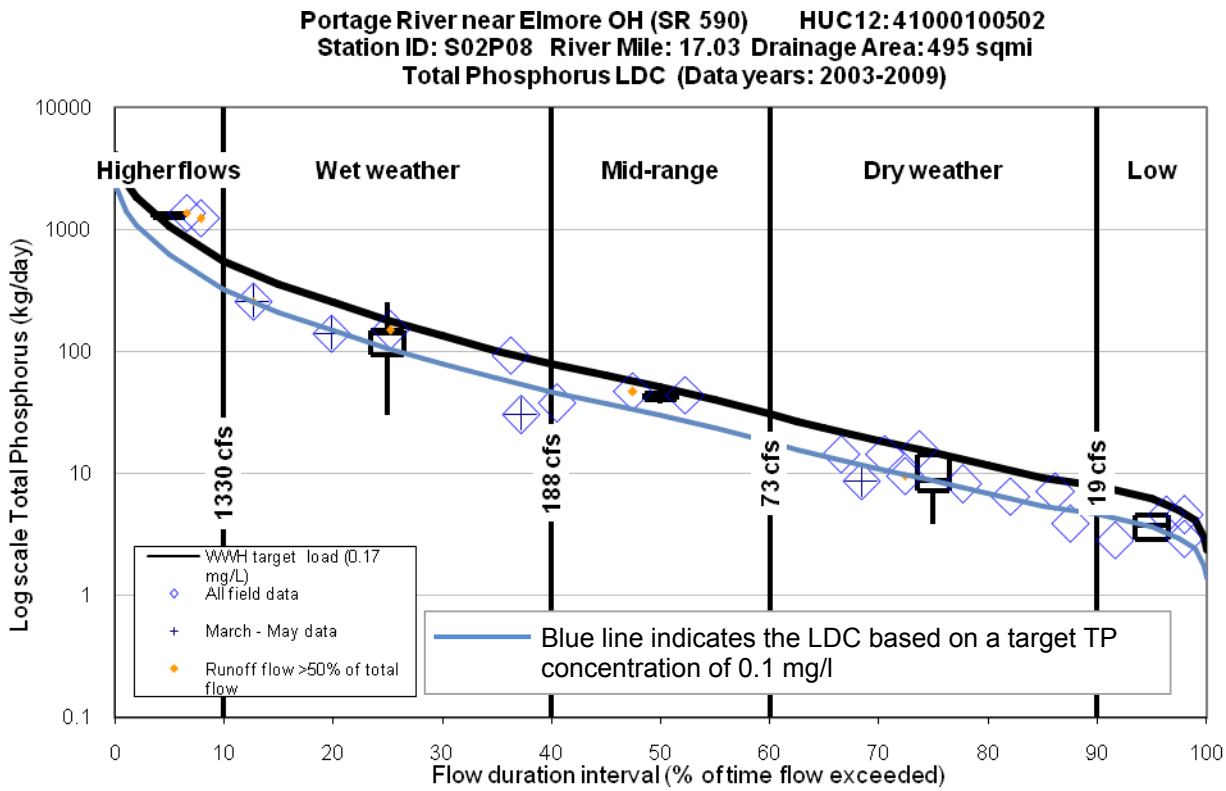

Figure 5-1. Portage River TP load duration curve.

Downstream of the RM 17.03 site, the Portage River's velocity slows as it transitions into a lacustuary (estuary) of Lake Erie. The assessment sites in this area (RMs 12.55, 11.10 and 6.00) are determined impaired due to nutrient eutrophication. Upstream of the RM 17.03 site many of the tributaries to the river are impaired from nutrients. Because nutrients are being delivered at an elevated amount throughout the flow duration both point and nonpoint sources will be modeled to address required nutrient reductions. To carry this out, the LSPC nutrient model is simulated at expected future conditions based on the design flow of the facility rather than current discharge rates which are typically significantly less (see Section 4.1.6). Additionally, TMDL target loads are based on median stream flow values.

Impairment occurs in the Portage River downstream of all assessed tributaries therefore, the entire watershed upstream of RM 17.03 is included in the nutrient model. All TP load allocations for the individual upstream HUC 12s are based on an equal percent load reduction to maximize fairness and equity. These reductions ensure the river will not exceed the target concentration at RM 17.03. Upon analysis it was determined that the May through October

delivered load will be used as benchmark load to base TP load reductions. Table 5-1 outlines the modeled load and this required reduction. This results in a 32.5% required load reduction from all HUC 12s in this watershed draining to the RM 17.03 site. HUC 12s that are impaired by nutrients within their streams are required to meet TP target concentrations at the mouth of that HUC 12. Due to this, allocations that require further load reductions exist for these watersheds.

Table 5-1. Future conditions LSPC model results, target concentration and required reductions for the Portage River at river mile 17.03.

Existing	Conc. (mg/l)	Load (kg/day)
Median modeled TP at median flow conditions	0.25	128.5
Target TP concentration	0.17	-
Required load reduction	32.5%	

5.2 Rocky Ford-Middle Branch Portage River (04100010-01)

TMDLs were developed in these three 12-digt HUCs for bacteria (*E. coli*), sediment and habitat (QHEI), and nutrients (total phosphorus). The results are presented for the applicable assessment units (i.e., 12-digit HUCs) in the following sub-sections.

5.2.1 Total Phosphorus (HUCs 01-01, 01-02, 01-03, and 01-04)

Of the four 12-digit HUCs in this subsection, 01, Rader Creek is the only one with sites impaired by nutrient enrichment. A total load reduction of 70% is required for the Rader HUC to meet its TMDL. Because of this all management scenarios require at least some NPDES total phosphorus reduction. The other three 12-digit HUCs in this section require the general watershed 32.5% load reduction.

Table 5-2. TP existing conditions for 04100010 01.

Existing	Conc. (mg/l)	Load (kg/mi^2/day)[1]	Load (kg/day)
04100010 01 01- Rader Creek			
Load (nonpoint source)	-	0.13	4.36
Wasteload (total point sources)	-	-	6.40
2PG00117 (Evansville)	3.00	-	0.06
2PB00002 (McComb)	4.32	-	6.34
CSOs- 2PB00002 (McComb)	0.00	-	0.00
Total watershed conditions	0.33	-	9.05
04100010 01 02- Needles Creek			
Load (nonpoint source)	-	0.21	6.44
Wasteload (total point source)	-	-	0.41
2PA00083 (Hoytville)	3.00	-	0.41
Total watershed conditions	0.27	-	6.73
04100010 01 03- Rocky Ford			

Existing	Conc. (mg/l)	Load (kg/mi^2/day)[1]	Load (kg/day)
Load (nonpoint source)	-	0.16	11.57
Wasteload (total point sources)	-	-	7.48
MS4 - Findlay	-	-	0.16
2PR00095 (Pilot Oil)	3.00	-	0.11
2PA00000 (Cygnet)	3.00	-	0.37
2PB00033 (North Baltimore)	2.30	-	7.00
CSOs- 2PB00033 (North Baltimore)	0.00	-	0.00
Total watershed conditions	0.23	-	15.0
04100010 01 04- Town of Rudolph-Middle Branch Portage River			
Load (nonpoint source)	-	0.13	3.92
Wasteload (point source)	-	-	0.00
Total watershed conditions	0.16	-	3.92

1 To convert to a yield expressed as pounds per acre per year (lb/ac/yr), multiply the values by 3.865639666
Values were adjusted for rounding.

Table 5-3. TP TMDL and allocations scenarios for 04100010 01 01- Rader Creek.

For all scenarios (kg/day): Explicit MOS 7.1%: 0.20 TMDL: 2.76	Conc. (mg/l)	Yield (kg/mi^2/day)	Load (kg/day)	Conc. (mg/l)	Yield (kg/mi^2/day)	Load (kg/day)
	Scenario 1			**Scenario 2**		
Load (nonpoint source)	-	0.01	0.13	-	0.03	1.03
Wasteload (total point sources)	2.00	-	2.98	1.00	-	1.53
2PG00117 (Evansville)	2.00	-	0.04	3.00	-	0.06
2PB00002 (McComb)	2.00	-	2.94	1.00	-	1.47
CSOs- 2PB00002 (McComb)	0.00	-	0.00	0.00	-	0.00
	Scenario 3			**Scenario 4**		
Load (nonpoint source)	-	0.05	1.51	-	0.06	1.79
Wasteload (total point sources)	0.75	-	1.12	0.50	-	0.74
2PG00117 (Evansville)	0.75	-	0.014	0.50	-	0.0095
2PB00002 (McComb)	0.75	-	1.10	0.50	-	0.73
CSOs- 2PB00002 (McComb)	0.00	-	0.00	0.00	-	0.00

Scenario 1 = 97% NPS reduction NPDES to 2 mg/l limits
Scenario 2 = 76.4% NPS reduction NPDES limits as indicated
Scenario 3 = 65.5% NPS reduction NPDES to 0.75 mg/l limits
Scenario 4 = 59.0% NPS reduction NPDES to 0.5 mg/l limits
Values were adjusted for rounding.

Table 5-4. TP TMDL and allocations scenarios for 04100010 01 02- Needles Creek.

For all scenarios (kg/day): Explicit MOS 7.1%: 0.32 TMDL: 4.55	Conc. (mg/l)	Yield (kg/mi²/day)	Load (kg/day)	Conc. (mg/l)	Yield (kg/mi²/day)	Load (kg/day)
	Scenario 1			**Scenario 2**		
Load (nonpoint source)	-	0.13	3.74	-	0.13	3.83
Wasteload (total point source)	3.00	-	0.41	2.00	-	0.27
2PA00083 (Hoytville)	3.00	-	0.41	2.00	-	0.27
	Scenario 3			**Scenario 4**		
Load (nonpoint source)	-	0.13	3.93	-	0.13	3.96
Wasteload (total point source)	1.00	-	0.14	0.50	-	0.10
2PA00083 (Hoytville)	1.00	-	0.14	0.50	-	0.10

Scenario 1 = 42.0% NPS reduction and No NPDES reduction
Scenario 2 = 40.5% NPS reduction and NPDES to 2 mg/l limits
Scenario 3 = 39.0% NPS reduction and NPDES to 1 mg/l limits
Scenario 4 = 38.5% NPS reduction and NPDES to 0.75 mg/l limits
Values were adjusted for rounding.

Table 5-5. TP TMDL and allocations scenarios for 04100010 01 03- Rocky Ford.

For all scenarios (kg/day): Explicit MOS 7.1% 0.72 TMDL: 10.11	Conc. (mg/l)	Yield (kg/mi²/day)	Load (kg/day)	Conc. (mg/l)	Yield (kg/mi²/day)	Load (kg/day)
	Scenario 1			**Scenario 2**		
Load (nonpoint source)	-	0.07	4.86	-	0.08	5.79
Wasteload (total point sources)	-	-	7.54	-	-	6.46
MS4 - Findlay	-	-	0.07	-	-	0.08
2PR00095 (Pilot)	3.00	-	0.11	2.00	-	0.08
2PA00000 (Cygnet)	3.00	-	0.37	2.00	-	0.24
2PB00033 (North Baltimore)	2.31	-	7.00	2.00	-	6.06
CSOs- 2PB00033 (North Baltimore)	0.00	-	0.00	0.00	-	0.00
	Scenario 3			**Scenario 4**		
Load (nonpoint source)	-	0.08	5.79	-	0.13	9.14
Wasteload (total point sources)	-	-	3.60	-	-	2.52
MS4 - Findlay	-	-	0.09	-	-	0.13
2PR00095 (Pilot)	3.00	-	0.11	0.75	-	0.03
2PA00000 (Cygnet)	3.00	-	0.37	0.75	-	0.09
2PB00033 (North Baltimore)	1.00	-	3.03	0.75	-	2.27
CSOs- 2PB00033 (North Baltimore)	0.00	-	0.00	0.00	-	0.00

Scenario 1 = 58% NPS/MS4 reduction and No NPDES reduction
Scenario 2 = 50% NPS/MS4 reduction and NPDES to 2 mg/l limits
Scenario 3 = 50% NPS/MS4 reduction and NPDES limits as indicated
Scenario 4 = 21% NPS/MS4 reduction and NPDES to 0.75 mg/l limits
Values were adjusted for rounding.

Table 5-6. TP TMDL and allocations scenarios for 04100010 01 04- Town of Rudolph-Middle Branch Portage River.

For scenario (kg/day): Explicit MOS 7.1%: 0.19 TMDL: 2.65	Conc. (mg/l)	Yield (kg/mi^2/day)	Load (kg/day)
	Scenario 1		
Load (nonpoint source)	-	0.08	2.46
Wasteload (point source)	-	-	0.00

Scenario = 37.5 % NPS reduction
Values were adjusted for rounding.

5.2.2 Habitat, Flow, and Sediment (HUCs 01-01, 01-02, and 01-03)

The TMDLs displayed in Tables 5-7 and 5-8 are to address aquatic life impairments associated with excessive fine sediment, poor habitat and low and/or altered flow conditions. Flow alterations are to be addressed through the sediment TMDLs.

In general, these TMDLs show large deviations from targets of these modified channel streams. Tables 5-7 and 5-8 have the deviation from target for the QHEI scores for the habitat and sediment TMDLs, respectively.

Table 5-7. Habitat TMDLs for 10-digit HUC 04100010 01.

Habitat TMDL	TMDL Targets	Allocations						TMDL
		QHEI Score	# of High Influence Attributes	Total # of Modified Attributes				
		≥ 60= *1 pt*	< 2 = *1 pt*	< 5 = *1 pt*				*3 pts*
Existing Scores Stream/River (Use)	**River mile**	**QHEI Score**	**# of High Influence Attributes**	**Total # of Modified Attributes**	**QHEI Score**	**High Influence**	**Tot # Mod Attributes**	**Total Habitat Score**
04100010 01 01- Rader Creek								
Rader Creek	10.92	37.5	2	9	0	0	0	0
04100010 01 02- Needles Creek								
Needles Creek	8.35	33.5	3	10	0	0	0	0
	1.25	44.5	1	8	0	1	0	1
04100010 01 03- Rocky Ford								
Rocky Ford Creek	15.04	66	0	6	1	1	0	2
	9.80	70.5	0	5	1	1	0	2
	5.10	35	2	9	0	0	0	0

Table 5-8. Sediment TMDLs for 10-digit HUC 04100010 01.

TMDL Target For WWH		Sediment TMDL					
		QHEI Categories			TOTAL TMDL SCORE		
		Substrate	Channel	Riparian			
		Allocations					
		≥ 13	≥ 14	≥ 5	32		
Existing Scores Stream/River (Use)	**River mile**	**QHEI Categories**			**Total Sediment Score**	**Deviation from target (%)**	**Main impairment category**
		Substrate	**Channel**	**Riparian**			
04100010 01 01- Rader Creek							
Rader Creek	10.92	7	7.5	2	16.5	48.4	riparian
04100010 01 02- Needles Creek							
Needles Creek	1.25	11	9	3.5	23.5	26.6	channel
04100010 01 03- Rocky Ford							
Rocky Ford Creek	21.12	9	7.5	3.5	20	37.5	channel
	19.53	6	12.5	5.5	24	25.0	substrate
	11.87	2	11	8	21	34.4	substrate
	5.10	9.5	4.5	3	17	46.9	channel

5.2.3 *E. coli* Bacteria (HUCs 01-01, 01-02, 01-03, and 01-04)

While most sites assessed for recreation use exceed the criteria, a large variation in the amount to which these sites exceed is noted. The following TMDLs reflect this variation in the percent of load reduction that is required.

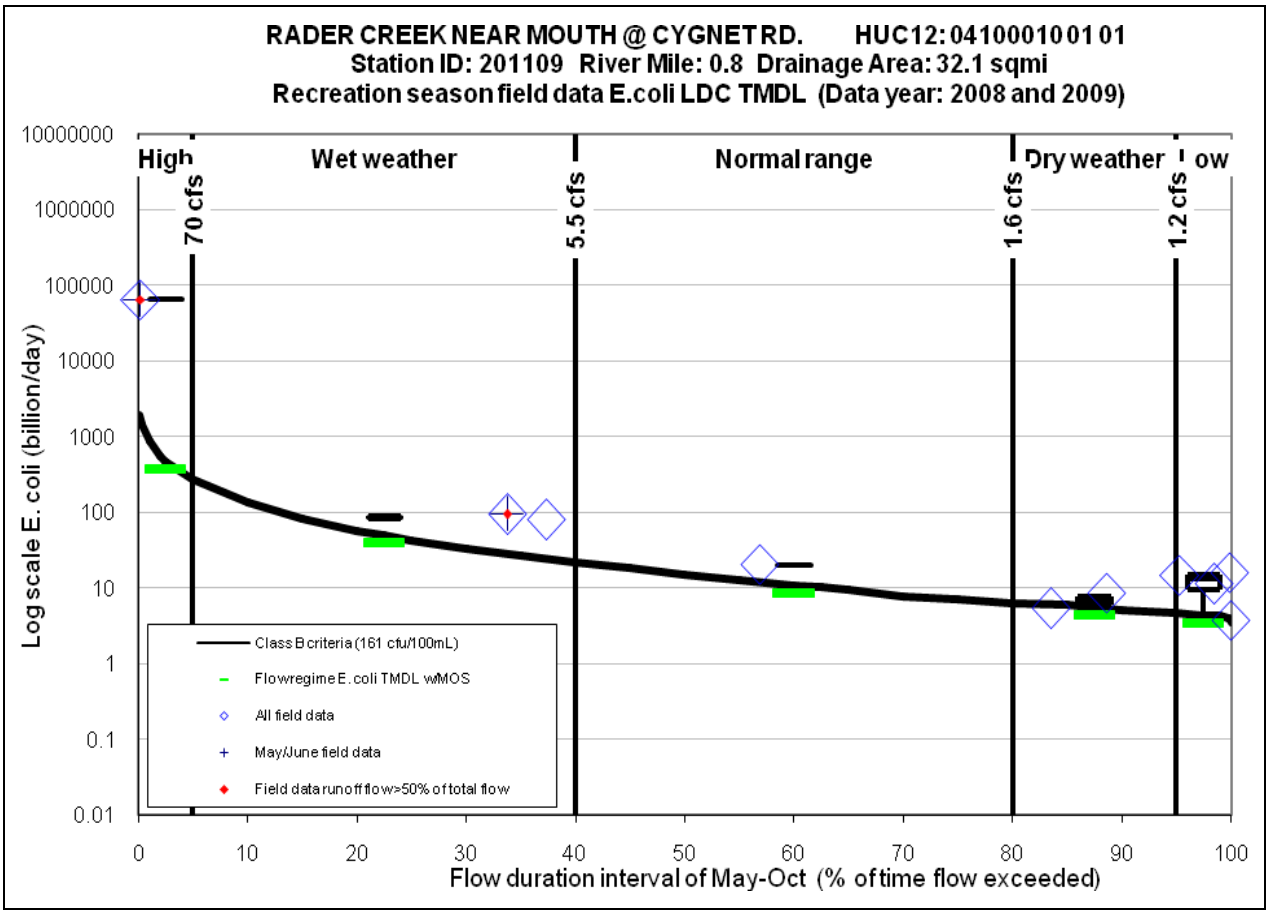

Figure 5-2. Portage River TP load duration curve.

Table 5-9. Pathogen existing loads and TMDL for HUC 04100010 01 01 Rader Creek.

E. coli (billion count/day)	High	Wet weather	Normal range	Dry weather	Low
Flow exceedance percentile	**0-5**	**5-40**	**40-80**	**80-95**	**95-100**
Median of existing load	64,006	86.3	20.2	6.9	13.1
TMDL= LA+WLA+MOS	459.23	49.23	10.63	5.51	4.33
LA	364.99	36.99	6.11	2.02	1.07
WLA: WWTPs total	2.39	2.39	2.39	2.39	2.39
2PB00002 (McComb WWTP)	2.36	2.36	2.36	2.36	2.36
2PG00117 (Evansville Western RR (CSX))	0.03	0.03	0.03	0.03	0.03
MOS	91.85	9.85	2.13	1.10	0.87
LA reduction (%)	99.4%	57.1%	69.8%	71.0%	91.8%

Values were adjusted for rounding.

Table 5-10. Pathogen existing loads and TMDL for 04100010 01 02 Needles Creek.

E. coli (billion count/day)	High	Wet weather	Normal range	Dry weather	Low
Flow exceedance percentile	**0-5**	**5-40**	**40-80**	**80-95**	**95-100**
Median of existing load	23,411	No Data	14.0	2.4	2.2
TMDL= LA+WLA+MOS	526.6	54.0	9.8	3.5	2.4
LA	421.0	42.9	7.7	2.6	1.7
WLA: 2PA00083 (Hoytville WWTP)	0.2	0.2	0.2	0.2	0.2
MOS	105.3	10.8	2.0	0.7	0.5
LA reduction (%)	98.2%	No Data	45.2%	None	25.6%

Values were adjusted for rounding.

Table 5-11. Pathogen existing loads and TMDL for HUC 04100010 01 03 Rocky Ford.

E. coli (billion count/day)	High	Wet weather	Normal range	Dry weather	Low
Flow exceedance percentile	**0-5**	**5-40**	**40-80**	**80-95**	**95-100**
Median of existing load	No Data	462.0	4.3	58.3	4.2
TMDL= LA+WLA+MOS	1190.2	126.4	27.2	13.0	10.6
LA	934.1	94.7	16.4	5.2	3.3
WLA: MS4 (Findlay)[1]	12.9	1.3	0.2	0.1	0.0
WLA: WWTPs total	5.1	5.1	5.1	5.1	5.1
2PA00000 (Cygnet)	0.2	0.2	0.2	0.2	0.2
2PB00033 (North Baltimore)	4.9	4.9	4.9	4.9	4.9
2PR00095 (Pilot Oil Co Findlay No 360)	0.06	0.06	0.06	0.06	0.06
MOS	238.0	25.3	5.4	2.6	2.1
LA reduction (%)	No Data	79.2%	None	91.0%	20.5%

[1] Wasteload allocations presented here reflect bacteria die-off that occurs over the distance between the facility and the location of this analysis. See Section 4.4.3 (margin of safety discussion) for more details.

Table 5-12. Pathogen existing loads and TMDL for HUC 04100010 01 04 Town of Rudolph-Middle Branch Portage River.

E. coli (billion count/day)	High	Wet weather	Normal range	Dry weather	Low
Flow exceedance percentile	**0-5**	**5-40**	**40-80**	**80-95**	**95-100**
Median of existing load	298,098	34,391	23.1	No Data	0.4
TMDL= LA+WLA+MOS	1,564	159.9	28.8	10.6	7.1
LA	1,248	125.3	20.4	5.9	3.1
WLA: WWTPs total	2.6	2.6	2.6	2.6	2.6
2PB00002 (McComb)	2.4	2.4	2.4	2.4	2.4
2PG00117 (Evansville Western RR (CSX))	0.03	0.03	0.03	0.03	0.03
2PA00083 (Hoytville)	0.2	0.2	0.2	0.2	0.2
MOS	312.7	32.0	5.8	2.1	1.4
LA reduction (%)	99.6%	99.6%	11.8%	No Data	None

Values were adjusted for rounding.

5.3 South Branch Portage River-Middle Branch Portage River (04100010-02)

5.3.1 Total Phosphorus (HUCs 02-01, 02-02, 02-03, 02-04, and 02-05)

Of the five 12-digit HUCs in this subsection, 02, East Branch Portage River is the only one with localized nutrient impairments. The Fostoria WWTP creates a significant portion of the flow to this stream and contributes the largest TP load. Fostoria's WWTP is; however, currently in the process of developing a long-term control plan to abate sewer system overflows related to both its combined system as well as problems with its separate system. Additionally, the plant will be undergoing improvements that will substantially reduce the amount of solids being discharged, which will likewise reduce nutrient and organic loading as well as bacteria. In light of the anticipated improvements to wastewater treatment for the City of Fostoria, no TMDLs will be developed at this time to address some of identified causes of impairment, including nutrients (i.e., total phosphorus) within this assessment unit (i.e., the 04100010 02 02 twelve-digit HUC).

Table 5-13 displays the existing water quality conditions and source loading with respect to total phosphorus. Table 5-15 similar output as other 12-digit HUCs where nutrient TMDLs are developed; however, none of the scenarios provided are being submitted for approval as TMDLs and the associated load and wasteload allocations.

Table 5-13. TP existing conditions for 04100010 02.

Existing	Conc. (mg/l)	Load ($kg/mi^2/day$)[1]	Load (kg/day)
04100010 02 01- Bull Creek			
Load (nonpoint source)	-	0.19	5.82
Wasteload (total point source)	-	-	0.34
2PT00038 (Elmwood HS)	3.00	-	0.34
Total watershed conditions	0.27	-	6.06
04100010 02 02- East Branch Portage River			
Load (nonpoint source)	-	0.10	3.70
Wasteload (total point sources)	-	-	31.50
MS4 – Fostoria	-	-	0.27
2PD00031 (Fostoria)	1.00	-	31.23
CSOs- 2PD00031 (Fostoria)	0.00	-	0.00
Total watershed conditions	0.38	-	22.7
04100010 02 03- Town of Bloomdale-South Branch Portage River			
Load (nonpoint source)	-	0.22	11.93
Wasteload (total point source)	-	-	0.91
2PA00074 (Bloomdale)	3.00	-	0.91
Total watershed conditions	0.30	-	12.57
04100010 02 04- Rhodes Ditch-South Branch Portage River			
Load (nonpoint source)	-	0.29	6.08
Wasteload (total point source)	-	-	0.59
2PA00071 (Wayne)	3.00	-	0.59
Total watershed conditions	0.31	-	6.38
04100010 02 05- Cessna Ditch-Middle Branch Portage River			

Existing	Conc. (mg/l)	Load (kg/mi^2/day)[1]	Load (kg/day)
Load (nonpoint source)	-	0.18	4.50
Wasteload (point source)	-	-	0.00
Total watershed conditions	0.22	-	4.50

1 To convert to a yield expressed as pounds per acre per year (lb/ac/yr), multiply the values by 3.865639666
Values were adjusted for rounding.

Table 5-14. TP TMDL and allocations scenarios for 04100010 02 01- Bull Creek.

For all scenarios (kg/day): Explicit MOS 7.1%: 0.29 TMDL: 4.09	Conc. (mg/l)	Yield (kg/mi^2/day)	Load (kg/day)	Conc. (mg/l)	Yield (kg/mi^2/day)	Load (kg/day)
	Scenario 1			**Scenario 2**		
Load (nonpoint source)	-	0.11	3.46	-	0.12	3.64
Wasteload (total point source)	3.00	-	0.34	2.00	-	0.23
2PT00038 (Elmwood HS)	3.00	-	0.34	2.00	-	0.23
	Scenario 3			**Scenario 4**		
Load (nonpoint source)	-	0.12	3.72	-	0.12	3.74
Wasteload (total point source)	1.00	-	0.11	0.50	-	0.09
2PT00038 (Elmwood HS)	1.00	-	0.11	0.50	-	0.09

Scenario 1 = 40.60% NPS reduction and No NPDES reduction
Scenario 2 = 37.50% NPS reduction and NPDES to 2 mg/l limits
Scenario 3 = 36.00% NPS reduction and NPDES to 1 mg/l limits
Scenario 4 = 35.75% NPS reduction and NPDES to 0.5 mg/l limits
Values were adjusted for rounding.

Table 5-15. TP TMDL and allocations scenarios for 04100010 02 02- East Branch Portage River.

For all scenarios (kg/day): Explicit MOS 7.1% 0.43 TMDL: 6.05	Conc. (mg/l)	Yield (kg/mi^2/day)	Load (kg/day)	Conc. (mg/l)	Yield (kg/mi^2/day)	Load (kg/day)
	Scenario 1			**Scenario 2**		
Load (nonpoint source)	-	0.00	0.0	-	0.02	0.87
Wasteload (total point sources)	-	-	31.24	-	-	7.87
MS4 – Fostoria	-	-	0.01	-	-	0.06
2PD00031 (Fostoria)	1.0	-	31.233	0.25	-	7.81
CSOs- 2PD00031 (Fostoria)	0.00	-	0.00	0.00	-	0.00
	Scenario 3			**Scenario 4**		
Load (nonpoint source)	-	0.05	1.74	-	0.10	3.50
Wasteload (total point sources)	-	-	6.37	-	-	3.38
MS4 – Fostoria	-	-	0.13	-	-	0.26
2PD00031 (Fostoria)	0.20	-	6.25	0.10	-	3.12
CSOs- 2PD00031 (Fostoria)	0.00	-	0.00	0.00	-	0.00

Scenario 1 = 100.0% NPS/MS4 reduction and NPDES limits as indicated
Scenario 2 = 76.5% NPS/MS4 reduction and NPDES to 0.25 mg/l limit
Scenario 3 = 53.0% NPS/MS4 reduction and NPDES to 0.2 mg/l limit

Scenario 4 = 5.5% NPS/MS4 reduction and NPDES to 0.1 mg/l limit
Values were adjusted for rounding.

Table 5-16. TP TMDL and allocations scenarios for 04100010 02 03- Town of Bloomdale-South Branch Portage River.

For all scenarios (kg/day): Explicit MOS 7.1%: 0.60 TMDL: 8.48	Conc. (mg/l)	Yield (kg/mi^2/day)	Load (kg/day)	Conc. (mg/l)	Yield (kg/mi^2/day)	Load (kg/day)
	Scenario 1			**Scenario 2**		
Load (nonpoint source)	-	0.13	6.97	-	0.14	7.46
Wasteload (total point source)	3.00	-	0.91	2.00	-	0.61
2PA00074 (Bloomdale)	3.00	-	0.91	2.00	-	0.61
	Scenario 3			**Scenario 4**		
Load (nonpoint source)	-	0.14	7.66	-	0.14	7.75
Wasteload (total point source)	1.00	-	0.30	0.50	-	0.15
2PA00074 (Bloomdale)	1.00	-	0.30	0.50	-	0.15

Scenario 1 = 41.60% NPS reduction and No NPDES reduction
Scenario 2 = 37.50% NPS reduction and NPDES to 2 mg/l limits
Scenario 3 = 35.75% NPS reduction and NPDES to 1 mg/l limits
Scenario 4 = 35.00% NPS reduction and NPDES to 0.5 mg/l limits
Values were adjusted for rounding.

Table 5-17. TP TMDL and allocations scenarios for 04100010 02 04- Rhodes Ditch-South Branch Portage River.

For all scenarios (kg/day): Explicit MOS 7.1%: 0.31 TMDL: 4.31	Conc. (mg/l)	Yield (kg/mi^2/day)	Load (kg/day)	Conc. (mg/l)	Yield (kg/mi^2/day)	Load (kg/day)
	Scenario 1			**Scenario 2**		
Load (nonpoint source)	-	0.18	3.68	-	0.19	3.83
Wasteload (total point source)	3.00	-	0.59	2.00	-	0.39
2PA00071 (Wayne)	3.00	-	0.59	2.00	-	0.39
	Scenario 3			**Scenario 4**		
Load (nonpoint source)	-	0.18	3.80	-	0.19	3.92
Wasteload (total point source)	1.00	-	0.20	0.50	-	0.10
2PA00071 (Wayne)	1.00	-	0.20	0.50	-	0.10

Scenario 1 = 39.5% NPS reduction and No NPDES reduction
Scenario 2 = 37.0% NPS reduction and NPDES to 2 mg/l limits
Scenario 3 = 37.5% NPS reduction and NPDES to 1 mg/l limits
Scenario 4 = 35.5% NPS reduction and NPDES to 0.5 mg/l limits
Values were adjusted for rounding.

Table 5-18. TP TMDL and allocations scenarios for 04100010 02 05- Cessna Ditch-Middle Branch Portage River.

For scenario (kg/day): Explicit MOS 7.1%: 0.22 TMDL: 3.06	Conc. (mg/l)	Yield (kg/mi²/day)	Load (kg/day)
	Scenario 1		
Load (nonpoint source)	-	0.11	2.84
Wasteload (point source)	-	-	0.00

Scenario = 37.5% NPS reduction
Values were adjusted for rounding.

5.3.2 Habitat, Flow, and Sediment (HUCs 02-01, 02-02, and 02-03)

The TMDLs displayed in Tables 5-19 and 5-20 are to address aquatic life impairments associated with excessive fine sediment, poor habitat and low and/or altered flow conditions. Flow alterations are to be addressed through the sediment TMDLs.

These TMDLs show significant deviations from targets of these modified channel streams.

Table 5-19. Habitat TMDLs for 10-digit HUC 04100010 02.

Habitat TMDL	TMDL Targets	Allocations						TMDL
		QHEI Score	# of High Influence Attributes	Total # of Modified Attributes				
		≥ 60= *1 pt*	< 2 = *1 pt*	< 5 = *1 pt*				*3 pts*
Existing Scores Stream/River (Use)	River mile	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	QHEI Score	High Influence	Tot # Mod Attributes	Total Habitat Score
04100010 02 01- Bull Creek								
Bull Creek	8.45	43.5	2	8	0	0	0	0
04100010 02 02- East Branch Portage River								
East Branch Portage River	19.17	43	2	8	0	0	0	0
	16.10	48.5	2	8	0	0	0	0
04100010 02 03- Town of Bloomdale-South Branch Portage River								
S. Branch Portage R.	24.77	48	2	6	0	0	0	0

Table 5-20. Sediment TMDLs for 10-digit HUC 04100010 02.

TMDL Target For WWH		Sediment TMDL					
		QHEI Categories			TOTAL TMDL SCORE		
		Substrate	Channel	Riparian			
		Allocations					
		≥ 13	≥ 14	≥ 5	32		
Existing Scores Stream/River (Use)	**River mile**	**QHEI Categories**			**Total Sediment Score**	**Deviation from target (%)**	**Main impairment category**
		Substrate	**Channel**	**Riparian**			
04100010 02 01- Bull Creek							
Bull Creek	8.45	11.5	10	3	24.5	23.4	riparian
04100010 02 02- East Branch Portage River							
East Branch Portage River	19.17	7	11	4	22	31.3	substrate
	16.10	5	11	4.5	20.5	35.9	substrate
04100010 02 03- Town of Bloomdale-South Branch Portage River							
South Branch Portage River	24.77	8.5	12.5	5	26	18.8	substrate
	22.58	13	12	5	30	6.3	channel

5.3.3 Biological Oxygen Demand (HUC 02-02)

The TMDL addressing pollution with the source of the Fostoria CSOs is in this subsection. The wasteload allocations on the table below reflect the 85% control of volume of annual average total CSO discharges.

Table 5-21. CBOD 5-day allocations and TMDL loads for East Branch Portage River at RM 10.42 in kg/day.

TMDL: 747.8 CSO outfall #	CSO (Fostoria) WLA	WLA MS4 (Fostoria)	LA
004	112.9	-	-
005	80.3	-	-
006	221.6	-	-
Total	414.8	33	300

5.3.4 *E. coli* Bacteria (HUCs 02-01, 02-02, 02-03, and 02-05)

While most sites assessed for recreation use exceed the criteria, a large variation in the amount to which these sites exceed is noted. The following TMDLs reflect this variation in the percent of load reduction that is required.

Table 5-22. Pathogen existing loads and TMDL for HUC HUC 04100010 02 01 Bull Creek.

E. coli (billion count/day)	High	Wet weather	Normal range	Dry weather	Low
Flow exceedance percentile	**0-5**	**5-40**	**40-80**	**80-95**	**95-100**
Median of existing load	13,693	79.7	10.0	5.5	0.9
TMDL= LA+WLA+MOS	424.2	43.3	7.9	2.8	2.0
LA	339.2	34.5	6.1	2.0	1.4
WLA: 2PT00038 (Elmwood HS)	0.2	0.2	0.2	0.2	0.2
MOS	84.8	8.6	1.6	0.6	0.4
LA reduction (%)	97.5%	56.7%	38.9%	63.2%	None

Values were adjusted for rounding.

Table 5-23. Pathogen existing loads and TMDL for HUC 04100010 02 02 East Branch Portage River.

E. coli (billion count/day)	High	Wet weather	Normal range	Dry weather	Low
Flow exceedance percentile	**0-5**	**5-40**	**40-80**	**80-95**	**95-100**
Median of existing load	No Data	617.6	155.0	132.5	165.3
TMDL= LA+WLA+MOS	428.9	89.0	57.1	52.8	52.0
LA	272.7	19.5	0.0	0.0	0.0
WLA: MS4 - Fostoria	20.1	1.4	0.0	0.0	0.0
WLA: 2PD00031 (Fostoria)[1]	50.3	50.3	45.7	42.2	41.6
MOS	85.8	17.8	11.4	10.6	10.4
LA reduction (%)	No Data	96.6%	100.0%	100.0%	100.0%

[1] Wasteload allocations presented here reflect bacteria die-off that occurs over the distance between the facility and the location of this analysis. See Section 4.4.3 (margin of safety discussion) for more details.
Values were adjusted for rounding.

Table 5-24. Pathogen existing loads and TMDL for HUC 04100010 02 03 Town of Bloomdale-South Branch Portage River and 04100010 02 04 Rhodes Ditch-South Branch Portage River.

E. coli (billion count/day)	High	Wet weather	Normal range	Dry weather	Low
Flow exceedance percentile	**0-5**	**5-40**	**40-80**	**80-95**	**95-100**
Median of existing load	No Data	4,094	83.8	112.8	86.0
TMDL= LA+WLA+MOS	1,853	233.2	84.7	63.4	59.5
LA	1,411	134.1	16.7	0.0	0.0
WLA: MS4 (Fostoria)	20.1	1.4	0	0	0
WLA: WWTPs total	51.1	51.1	51.1	51.1	51.1
2PD00031 (Fostoria)	50.3	50.3	50.3	50.3	50.3
2PA00074 (Bloomdale)	0.5	0.5	0.5	0.5	0.5
2PA00071 (Wayne)	0.3	0.3	0.3	0.3	0.3
MOS	370.5	46.6	16.9	11.5	7.6
LA reduction (%)	No Data	96.7%	80.1%	100.0%	100.0%

Values were adjusted for rounding.

Table 5-25. Pathogen existing loads and TMDL for HUC 04100010 02 05 Cessna Ditch-Middle Branch Portage River.

E. coli (billion count/day)	High	Wet weather	Normal range	Dry weather	Low
Flow exceedance percentile	**0-5**	**5-40**	**40-80**	**80-95**	**95-100**
Median of existing load	418,018	24,927	13.1	5.3	1.9
TMDL= LA+WLA+MOS	3,686.42	377.32	68.12	24.92	16.52
LA	2928.3	292.6	46.4	11.9	5.3
WLA: MS4 (Findlay)	12.9	1.3	0.2	0.1	0
WLA: WWTPs total	7.92	7.92	7.92	7.92	7.92
2PB00002 (McComb WWTP)	2.36	2.36	2.36	2.36	2.36
2PG00117 (Evansville Western RR (CSX))	0.03	0.03	0.03	0.03	0.03
2PA00083 (Hoytville WWTP)	0.22	0.22	0.22	0.22	0.22
2PA00000 (Cygnet)	0.20	0.20	0.20	0.20	0.20
2PB00033 (North Baltimore)	4.87	4.87	4.87	4.87	4.87
2PR00095 (Pilot Oil Co Findlay No 360)	0.06	0.06	0.06	0.06	0.06
2PT00038 (Elmwood HS)	0.18	0.18	0.18	0.18	0.18
MOS	737.3	75.5	13.6	5.0	3.3
LA reduction (%)	99.3%	98.8%	None	None	None

Values were adjusted for rounding.

5.4 Upper Portage River (04100010-03)

5.4.1 Total Phosphorus (HUCs 03-01 and 03-02)

The 12 digit HUCs, 03-01, North Branch Portage River has localized nutrient impairment. A total load reduction of 78.4% is required for this HUC to meet its TMDL. The Bowling Green WWTP is a large proportion of the flow and TP load in this HUC. Table 5-27 lays out four scenarios that show that meeting the TMDL (Scenarios 2, 3, 4) would require that Bowling Green significantly lower its total phosphorus effluent concentration. Reducing the effluent concentration to 0.5 mg/l (Scenario 1), while not technically meeting the target, should result in improvements in the stream. A reevaluation of the attainment status should occur before additional reductions are required from the Bowling Green WWTP. Because the target is not projected to be reached at this recommended effluent level, a TMDL cannot be calculated for this assessment unit. The other 12-digit HUCs in this section only require the general watershed 32.5% load reduction.

Table 5-26. TP existing conditions for 04100010 03.

Existing	Conc. (mg/l)	Load (kg/mi^2/day)[1]	Load (kg/day)
04100010 03 01- North Branch Portage River			
Load (nonpoint source)	-	0.15	9.36
Wasteload (total point sources)	-	-	38.82
MS4 – Bowling Green	-	-	0.94
2PD00009 (Bowling Green)	1.00	-	37.85
2PR00245 (Helena Chemical)	3.00	-	0.02
CSO- 2PD00009- B.Green	0.00	-	0.00
Total watershed conditions	0.46	-	42.76
04100010 03 02- Town of Pemberville-Portage River			
Load (nonpoint source)	-	0.07	1.35
Wasteload (total point source)	-	-	2.05
2PA00077 (Bradner WWTP)	4.17	-	2.05
Total watershed conditions	0.21	-	2.83

1 To convert to a yield expressed as pounds per acre per year (lb/ac/yr), multiply the values by 3.865639666
Values were adjusted for rounding.

Table 5-27. TP TMDL and allocations scenarios for 04100010 03 01- North Branch Portage River.

For all scenarios (kg/day): Explicit MOS 7.1% 0.66 TMDL: 9.23	Conc. (mg/l)	Yield (kg/mi^2/day)	Load (kg/day)	Conc. (mg/l)	Yield (kg/mi^2/day)	Load (kg/day)
	Scenario 1			**Scenario 2**		
Load (nonpoint source)	-	0.00	0.00	-	0.03	1.87
Wasteload (total point sources)	-	-	19.01	-	-	7.77
MS4 – Bowling Green	-	-	0.04	-	-	0.19
2PD00009 (Bowling Green)	0. 50	-	18.95	0.20	-	7.57
2PR00245 (Helena Chemical)	3.00	-	0.023	2.00	-	0.015
CSO- 2PD00009 (Bowling Green)	0.00	-	0.00	0.00	-	0.00
	Scenario 3			**Scenario 4**		
Load (nonpoint source)	-	0.05	3.32	-	0.07	4.82
Wasteload (total point sources)	-	-	6.02	-	-	4.28
MS4 – Bowling Green	-	-	0.33	-	-	0.48
2PD00009 (Bowling Green)	0.15	-	5.68	0.10	-	3.79
2PR00245 (Helena Chemical)	1.00	-	0.008	1.00	-	0.008
CSO- 2PD00009 (Bowling Green)	0.00	-	0.00	0.00	-	0.00

Scenario 1 = 100.0% NPS/MS4 reduction, 2PD00009 to 0.50 mg/l limit, 2PR00245 to 3.0 mg/l limit
Scenario 2 = 80.0% NPS/MS4 reduction, 2PD00009 to 0.20 mg/l limit, 2PR00245 to 2.0 mg/l limit
Scenario 3 = 64.5% NPS/MS4 reduction, 2PD00009 to 0.15 mg/l limit, 2PR00245 to 1.0 mg/l limit
Scenario 4 = 48.5% NPS/MS4 reduction, 2PD00009 to 0.10 mg/l limit, 2PR00245 to 1.0 mg/l limit
Values were adjusted for rounding.

Table 5-28. TP TMDL and allocations scenarios for 04100010 03 02- Town of Pemberville-Portage River.

For all scenarios (kg/day): Explicit MOS 7.1%: 0.14 TMDL: 1.91	Conc. (mg/l)	Yield (kg/mi²/day)	Load (kg/day)	Conc. (mg/l)	Yield (kg/mi²/day)	Load (kg/day)
	Scenario 1			Scenario 2		
Load (nonpoint source)	-	0.02	0.30	-	0.05	0.89
Wasteload (total point source)	4.17	-	2.05	2.50	-	1.23
2PA00077 (Bradner)	4.17	-	2.05	2.50	-	1.23
	Scenario 3			Scenario 4		
Load (nonpoint source)	-	0.06	1.07	-	0.07	1.28
Wasteload (total point source)	2.00	-	0.98	1.00	-	0.49
2PA00077 (Bradner)	2.00	-	0.98	1.00	-	0.49

Scenario 1 = 78% NPS reduction and No NPDES reduction
Scenario 2 = 34% NPS reduction and NPDES to 2.5 mg/l limits
Scenario 3 = 21% NPS reduction and NPDES to 2 mg/l limits
Scenario 4 = 5.2% NPS reduction and NPDES to 1.0 mg/l limits
Values were adjusted for rounding.

5.4.2 Habitat, Flow, and Sediment (HUC 03-01)

The TMDLs displayed in Tables 5-29 and 5-30 are to address aquatic life impairments associated with excessive fine sediment, poor habitat and low and/or altered flow conditions. Flow alterations are to be addressed through the sediment TMDLs.

North Branch Portage River is the only stream in this 10-digit HUC that is receiving habitat and sediment TMDLs. Upstream of Poe Ditch (at RM 8.6), this stream is extremely hydromodified. The severity of channel deposited sediment makes wading in this stream nearly impossible. Significant restoration actions are required to expect any aquatic life improvements.

Table 5-29. Habitat TMDLs for 10-digit HUC 04100010 03.

Habitat TMDL	TMDL Targets	Allocations						TMDL
		QHEI Score	# of High Influence Attributes	Total # of Modified Attributes				
		≥ 60= *1 pt*	< 2 = *1 pt*	< 5 = *1 pt*				*3 pts*
Existing Scores Stream/River (Use)	River mile	QHEI Score	# of High Influence Attributes	Total # of Modified Attributes	QHEI Score	High Influence	Tot # Mod Attributes	Total Habitat Score
04100010 03 01- North Branch Portage River								
North Branch Portage River	25.85	29	3	9	0	0	0	0
	21.96	25.5	4	10	0	0	0	0

Table 5-30. Sediment TMDLs for 10-digit HUC 04100010 03.

TMDL Target For WWH		Sediment TMDL					
		QHEI Categories			TOTAL TMDL SCORE		
		Substrate	Channel	Riparian			
		Allocations					
		≥ 13	≥ 14	≥ 5	32		
Existing Scores		**QHEI Categories**					
Stream/River (Use)	**River mile**	**Substrate**	**Channel**	**Riparian**	**Total Sediment Score**	**Deviation from target (%)**	**Main impairment category**
04100010 03 01- North Branch Portage River							
North Branch Portage River	25.85	0	6	3	9	71.9	substrate
	21.96	0	4.5	3	7.5	76.6	substrate
	13.55	1.5	12	7.5	21	34.4	substrate
	8.60	0	8	6.5	14.5	54.7	substrate
	6.55	0.5	8	5.5	14	56.3	substrate

5.4.3 *E. coli* Bacteria (HUCs 03-01 and 03-02)

The two recreation use/bacteria TMDL tables in this section show the need for nearly 100% reductions of nonpoint source bacteria load in most flow regimens. Fully 100% reduction of the nonpoint source load is required in the lowest two flow regimes for North Branch Portage River and the lowest regime for the mainstem site.

Table 5-31. Pathogen existing loads and TMDL for HUC 04100010 03 01 North Branch Portage River.

***E. coli* (billion count/day)**	**High**	**Wet weather**	**Normal range**	**Dry weather**	**Low**
Flow exceedance percentile	**0-5**	**5-40**	**40-80**	**80-95**	**95-100**
Median of existing load	298,098	34,391	165.2	17.7	7.3
TMDL= LA+WLA+MOS	808.8	125.4	61.6	52.7	51.2
LA	544.7	47.9	1.5	0.0	0.0
WLA: MS4 (Bowling Green)	54.7	4.8	0.1	0.0	0.0
WLA: 2PD00009 (Bowling Green)[1]	47.7	47.7	47.7	42.2	40.9
MOS	161.7	25.0	12.3	10.5	10.3
LA reduction (%)	99.8%	99.8%	99.0%	100.0%	100.0%

[1] Wasteload allocations presented here reflect bacteria die-off that occurs over the distance between the facility and the location of this analysis. See Section 4.4.3 (margin of safety discussion) for more details.
Values were adjusted for rounding.

Table 5-32. Pathogen existing loads and TMDL for HUC 04100010 03 02 Town of Pemberville-Portage River.

E. coli (billion count/day)	High	Wet weather	Normal range	Dry weather	Low
Flow exceedance percentile	**0-5**	**5-40**	**40-80**	**80-95**	**95-100**
Median of existing load	No Data	118,689	78.6	62.6	53.5
TMDL= LA+WLA+MOS	4,594	512.0	130.7	77.4	67.5
LA	3,582	347.2	44.7	2.2	0.0
WLA: MS4 (Fostoria)	20.1	1.4	0.0	0.0	0.0
WLA: MS4 (Findlay)	12.9	1.3	0.2	0.1	0.0
WLA: WWTPs total	59.6	59.6	59.6	59.6	59.6
2PB00002 (McComb)	2.4	2.4	2.4	2.4	2.4
2PG00117 (Evansville Western RR (CSX))	0.03	0.03	0.03	0.03	0.03
2PA00083 (Hoytville)	0.2	0.2	0.2	0.2	0.2
2PA00000 (Cygnet)	0.2	0.2	0.2	0.2	0.2
2PB00033 (North Baltimore)	4.9	4.9	4.9	4.9	4.9
2PR00095 (Pilot Oil Co Findlay No 360)	0.1	0.1	0.1	0.1	0.1
2PT00038 (Elmwood HS)	0.2	0.2	0.2	0.2	0.2
2PD00031 (Fostoria)[1]	50.3	50.3	50.3	50.3	50.3
2PA00074 (Bloomdale)	0.5	0.5	0.5	0.5	0.5
2PA00071 (Wayne)	0.3	0.3	0.3	0.3	0.3
2PA00077 (Bradner)	0.6	0.6	0.6	0.6	0.6
MOS	918.7	102.4	26.1	15.5	7.9
LA reduction (%)	No Data	99.7%	42.8%	96.4%	100.0%

[1] Wasteload allocations presented here reflect bacteria die-off that occurs over the distance between the facility and the location of this analysis. See Section 4.4.3 (margin of safety discussion) for more details.
Values were adjusted for rounding.

5.5 Middle Portage River (04100010-04)

5.5.1 Total Phosphorus (HUCs 04-01 and 04-02)

Of the two 12-digit HUCs in this subsection, 01, Sugar Creek is the only one with nutrient impairments of its own waters. A total load reduction of 69% is required for the Sugar Creek HUC to meet its TMDL. Because of this all management scenarios require at least some NPDES TP reduction. The other 12-digit HUC in this section requires the general watershed 32.5% load reduction.

Table 5-33. TP existing conditions for 04100010 04.

Existing	Conc. (mg/l)	Load ($kg/mi^2/day$)[1]	Load (kg/day)
04100010 04 01- Sugar Creek			
Load (nonpoint source)	-	0.09	5.56
Wasteload (total point sources)	-	-	16.32
2PR00190 (Fuel Mart No 767)	3.00	-	0.05
2PA00005 (Gibsonburg)	16.00	-	15.14
2PA00094 (Risingsun)	3.00	-	1.08
2PR00202 (US 6 23 Retail Sale Inc)	3.00	-	0.06
CSOs- 2PA00005 (Gibsonburg)	0.00	-	0.00
Total watershed conditions	0.32	-	15.09
04100010 04 02- Lacarpe Creek Outlet #4-Portage River			
Load (nonpoint source)	-	0.04	1.19
Wasteload (total point sources)	-	-	5.27
2PB00012 (Pemberville)	3.00	-	2.27
2PB00051 (Elmore)	4.26	-	2.90
2PY00059 (Green Valley MHP)	3.00	-	0.10
2PB00052 (Woodville)	3.08	-	3.50
CSOs- 2PB00052 (Woodville)	0.00	-	0.00
Total watershed conditions	0.32	-	6.37

1 To convert to a yield expressed as pounds per acre per year (lb/ac/yr), multiply the values by 3.865639666
Values were adjusted for rounding.

Table 5-34. TP TMDL and allocations scenarios for 04100010 04 01- Sugar Creek.

For all scenarios (kg/day): Explicit MOS 7.1% 0.33 TMDL: 4.68	Conc. (mg/l)	Yield (kg/mi²/day)	Load (kg/day)	Conc. (mg/l)	Yield (kg/mi²/day)	Load (kg/day)
	Scenario 1			**Scenario 2**		
Load (nonpoint source)	-	0.04	2.21	-	0.06	3.73
Wasteload (total point sources)	-	-	2.14	-	-	1.34
2PR00190 (Fuel Mart No 767)	3.00	-	0.05	1.00	-	0.02
2PA00005 (Gibsonburg)	1.00	-	0.95	1.00	-	0.95
2PA00094 (Risingsun)	3.00	-	1.08	1.00	-	0.36
2PR00202 (US 6 23 Retail Sales)	3.00	-	0.06	1.00	-	0.02
CSOs- 2PA00005 (Gibsonburg)	0.00	-	0.00	0.00	-	0.00
	Scenario 3			**Scenario 4**		
Load (nonpoint source)	-	0.07	3.87	-	0.05	2.86
Wasteload (total point sources)	-	-	1.01	-	-	0.67
2PR00190 (Fuel Mart No 767)	0.75	-	0.011	0.50	-	0.008
2PA00005 (Gibsonburg)	0.75	-	0.71	0.50	-	0.47
2PA00094 (Risingsun)	0.75	-	0.27	0.50	-	0.18
2PR00202 (US 6 23 Retail Sales)	0.75	-	0.01	0.50	-	0.01
CSOs- 2PA00005 (Gibsonburg)	0.00	-	0.00	0.00	-	0.00

Scenario 1 = 60% NPS reduction and NPDES limits as indicated
Scenario 2 = 33.0% NPS/MS4 reduction and NPDES to 1.00 mg/l limits
Scenario 3 = 30.5% NPS/MS4 reduction and NPDES to 0.75 mg/l limits
Scenario 4 = 49.0% NPS/MS4 reduction and NPDES to 0.50 mg/l limits
* Only half of the load from the Gibsonburg WWTP (2AP00005) discharges to Sugar Creek; therefore this load only represents half of the plant's discharge.
Values were adjusted for rounding.

Table 5-35. TP TMDL and allocations scenarios for 04100010 04 02- Lacarpe Creek Outlet #4- Portage River.

For all scenarios (kg/day): Explicit MOS 7.1% 0.31 TMDL: 4.30	Conc. (mg/l)	Yield (kg/mi²/day)	Load (kg/day)	Conc. (mg/l)	Yield (kg/mi²/day)	Load (kg/day)
	Scenario 1			**Scenario 2**		
Load (nonpoint source)	-	0.01	0.18	-	0.04	1.16
Wasteload (total point sources)	-	-	6.52	-	-	2.83
2PB00012 (Pemberville)	2.50	-	1.89	1.00	-	0.76
2PB00051 (Elmore)	2.50	-	1.70	1.00	-	0.68
2PY00059 (Green Valley MHP)	2.50	-	0.09	3.00	-	0.10
2PB00052 (Woodville)	2.50	-	2.84	1.00	-	1.30
CSOs- 2PB00052 (Woodville)	0.00	-	0.00	0.00	-	0.00

Scenario 1 = 84.5% NPS reduction and NPDES to 2.5 mg/l limits
Scenario 2 = 2.5% NPS reduction and NPDES limits as indicated
Values were adjusted for rounding.

5.5.2 Habitat, Flow, and Sediment (HUCs 04-01, 04-02, and 04-03)

The TMDLs displayed in Tables 5-36 and 5-37 are to address aquatic life impairments associated with excessive fine sediment, poor habitat and low and/or altered flow conditions. Flow alterations are to be addressed through the sediment TMDLs.

The Sugar Creek tributary of Coon Creek in the 12-digit HUC 01 in this section is a small stream with poor general habitat. Its channel is modified, there is no riffle and its substrates are extremely embedded. The Portage River site at RM 22.1, in the 02 12-digit HUC in this section is impaired due its modified channel and lack of any riffles.

Table 5-36. Habitat TMDLs for 10-digit HUC 04100010 04.

Habitat TMDL	TMDL Targets	Allocations						TMDL
		QHEI Score	# of High Influence Attributes	Total # of Modified Attributes				
		≥ 60= *1 pt*	< 2 = *1 pt*	< 5 = *1 pt*				*3 pts*
Existing Scores Stream/River (Use)	**River mile**	**QHEI Score**	**# of High Influence Attributes**	**Total # of Modified Attributes**	**QHEI Score**	**High Influence**	**Tot # Mod Attributes**	**Total Habitat Score**
04100010 04 01- Sugar Creek								
Coon Creek	0.34	30.5	3	10	0	0	0	0
04100010 04 02- Lacarpe Creek Outlet #4-Portage River								
Portage River	22.10	48.5	2	6	0	0	0	0

Table 5-37. Sediment TMDLs for 10-digit HUC 04100010 04.

TMDL Target For WWH		Sediment TMDL					
		QHEI Categories			TOTAL TMDL SCORE		
		Substrate	Channel	Riparian			
		Allocations					
		≥ 13	≥ 14	≥ 5	32		
Existing Scores Stream/River (Use)	**River mile**	**QHEI Categories**			**Total Sediment Score**	**Deviation from target (%)**	**Main impairment category**
		Substrate	**Channel**	**Riparian**			
04100010 04 01- Sugar Creek							
Coon Creek	0.34	6	5	5.5	16.5	48.4	channel

5.5.3 *E. coli* Bacteria (HUCs 04-01 and 04-02)

The two LDC sites in this subsection show the need for great reductions in existing nonpoint source loads.

Table 5-38. Pathogen existing loads and TMDL for HUC HUC 04100010 04 01 Sugar Creek.

E. coli (billion count/day)	High	Wet weather	Normal range	Dry weather	Low
Flow exceedance percentile	**0-5**	**5-40**	**40-80**	**80-95**	**95-100**
Median of existing load	20,812	3,517	11.3	20.1	13.3
TMDL= LA+WLA+MOS	951.1	97.3	18.9	7.5	5.5
LA	758.7	75.6	12.9	3.8	2.2
WLA: WWTPs total	2.2	2.2	2.2	2.2	2.2
2PA00094 (Risingsun)	0.6	0.6	0.6	0.6	0.6
2PR00190 (Fuel Mart No 767)	0.02	0.02	0.02	0.02	0.02
2PR00202 (US 6 23 Retail Sales Inc)	0.03	0.03	0.03	0.03	0.03
2PA00005 (Gibsonburg)	1.5	1.5	1.5	1.5	1.5
MOS	190.2	19.5	3.8	1.5	1.1
LA reduction (%)	96.4%	97.8%	None	80.9%	83.1%

* Only half of Gibsonburg's effluent is discharged to Sugar Creek therefore this is only half of the plants waste load allocation.
Values were adjusted for rounding.

Table 5-39. Pathogen existing loads and TMDL for HUC 04100010 04 02 Lacarpe Creek Outlet #4-Portage River.

E. coli (billion count/day)	High	Wet weather	Normal range	Dry weather	Low
Flow exceedance percentile	**0-5**	**5-40**	**40-80**	**80-95**	**95-100**
Median of existing load	No Data	14,274	167.2	34.1	115.5
TMDL= LA+WLA+MOS	5,582	650.54	197.44	132.64	120.64
LA	4269.7	404.5	49.2	0.0	0.0
WLA: MS4 (Fostoria)	20.1	1.4	0.0	0.0	0.0
WLA: MS4 (Findlay)	12.9	1.3	0.2	0.0	0.0
WLA: MS4 (Bowling Green)	54.7	4.8	0.1	0.0	0.0
WLA: WWTPs total	108.44	108.44	108.44	106.14	96.64
2PB00002 (McComb)	2.4	2.4	2.4	2.4	2.4
2PG00117 (Evansville Western RR (CSX))	0.03	0.03	0.03	0.03	0.03
2PA00083 (Hoytville)	0.2	0.2	0.2	0.2	0.2
2PA00000 (Cygnet WWTP)	0.2	0.2	0.2	0.2	0.2
2PB00033 (North Baltimore)	4.9	4.9	4.9	4.9	4.9
2PR00095 (Pilot Oil Co Findlay No 360)	0.1	0.1	0.1	0.1	0.1
2PT00038 (Elmwood HS)	0.2	0.2	0.2	0.2	0.2
2PD00031 (Fostoria)[1]	50.3	50.3	50.3	49.2	44.4
2PA00074 (Bloomdale)	0.5	0.5	0.5	0.5	0.5
2PA00071 (Wayne)	0.3	0.3	0.3	0.3	0.3
2PA00077 (Bradner)	0.6	0.6	0.6	0.6	0.6
2PD00009 (Bowling Green)[1]	47.7	47.7	47.7	46.5	41.8
2PR00245 (Helena Chemical)	0.01	0.01	0.01	0.01	0.01
2PB00012 (Pemberville)	1.0	1.0	1.0	1.0	1.0
MOS	1,116	130.1	39.5	26.5	24.0
LA reduction (%)	No Data	97.1%	70.4%	100.0%	100.0%

[1] Wasteload allocations presented here reflect bacteria die-off that occurs over the distance between the facility and the location of this analysis. See Section 4.4.3 (margin of safety discussion) for more details.
Values were adjusted for rounding.

5.6 Lower Portage River-Frontal Lake Erie (04100010-05)

5.6.1 Total Phosphorus (HUCs 05-01 and 05-02)

The Little Portage River, 12-digit HUC 01 in this subsection is impaired for nutrients within its HUC. A total 62.4% TP load reduction is required for this watershed. Since there are no point sources of TP, the full reduction of load must come from nonpoint sources. Also, because of the reserved margin of safety, this reduction comes to 65.1% of the existing load. Within the 02 12-digit HUC, Wolf Creek is impaired for nutrients. Since this HUC also includes other waters not impaired by nutrients, only a partial HUC nutrient TMDL is developed to be applied to Wolf Creek's watershed only. A large 93.6% reduction is required for this watershed. Because of this all management scenarios include some stricter than existing NPDES TP limits.

Table 5-40. TP existing conditions for 04100010 05.

Existing	Conc. (mg/l)	Load (kg/mi^2 day)[1]	Load (kg/day)
04100010 05 01- Little Portage River			
Load (nonpoint source)	-	0.22	7.05
Wasteload (point source)	-	-	0
Total watershed conditions	0.27	-	7.05
04100010 05 02 (Partial)- Wolf Creek			
Load (nonpoint source)	-	0.22	2.81
Wasteload (total point sources)	-	-	15.14
2PA00005 (Gibsonburg)	16.00	-	15.14
CSOs- 2PA00005 (Gibsonburg)	0.00	-	0.00
Total watershed conditions	1.56	-	17.96

1 To convert to a yield expressed as pounds per acre per year (lb/ac/yr), multiply the values by 3.865639666
Values were adjusted for rounding.

Table 5-41. TP TMDL and allocations scenarios for 04100010 05 01- Little Portage River.

For scenario (kg/day): Explicit MOS 7.1%: 0.19 TMDL: 2.65	Conc. (mg/l)	Yield (kg/mi^2/day)	Load (kg/day)
	Scenario 1		
Load (nonpoint source)	-	0.08	2.46
Wasteload (point source)	-	-	0.00

Scenario = 65.1 % NPS reduction
Values were adjusted for rounding.

Table 5-42. TP TMDL and allocations scenarios for 04100010 05 02 (Partial)- Wolf Creek.

For all scenarios (kg/day): Explicit MOS 7.1% 0.08 TMDL: 1.15	Conc. (mg/l)	Yield (kg/mi²/day)	Load (kg/day)	Conc. (mg/l)	Yield (kg/mi²/day)	Load (kg/day)
	Scenario 1			**Scenario 2**		
Load (nonpoint source)	-	0.01	0.12	-	0.03	0.36
Wasteload (total point sources)	1.00	-	0.95	0.75	-	0.71
2PA00005 (Gibsonburg)	1.00	-	0.95	0.75	-	0.71
CSOs- 2PA00005 (Gibsonburg)	0.00	-	0.00	0.00	-	0.00
	Scenario 3			**Scenario 4**		
Load (nonpoint source)	-	0.05	0.60	-	0.06	0.83
Wasteload (total point sources)	0.50	-	0.47	0.25	-	0.24
2PA00005 (Gibsonburg)	0.50	-	0.47	0.25	-	0.24
CSOs- 2PA00005 (Gibsonburg)	0.00	-	0.00	0.00	-	0.00

Scenario 1 = 95.5% NPS reduction and NPDES to 1.00 mg/l limits
Scenario 2 = 87.0% NPS reduction and NPDES to 0.75 mg/l limits
Scenario 3 = 78.0% NPS reduction and NPDES to 0.50 mg/l limits
Scenario 4 = 70.5% NPS reduction and NPDES to 0.25 mg/l limits
* Only half of the load from the Gibsonburg WWTP (2AP00005) discharges to Wolf Creek; therefore this load only represents half of the plants discharge.
Values were adjusted for rounding.

5.6.2 Habitat, Flow, and Sediment (HUCs 05-01, 05-02, and 05-03)

The TMDLs displayed in Tables 5-43 and 5-44 are to address aquatic life impairments associated with excessive fine sediment, poor habitat and low and/or altered flow conditions. Flow alterations are to be addressed through the sediment TMDLs.

Table 5-43. Habitat TMDLs for 10-digit HUC 04100010 05.

Habitat TMDL TMDL Targets		Allocations						TMDL
		QHEI Score	# of High Influence Attributes	Total # of Modified Attributes				
		≥ 60= *1 pt*	< 2 = *1 pt*	< 5 = *1 pt*				*3 pts*
Existing Scores Stream/River (Use)	**River mile**	**QHEI Score**	**# of High Influence Attributes**	**Total # of Modified Attributes**	**QHEI Score**	**High Influence**	**Tot # Mod Attributes**	**Total Habitat Score**
04100010 05 01- Little Portage River								
Ninemile Creek	5.00	26	5	12	0	0	0	0
	2.93	43.5	2	8	0	0	0	0

Table 5-44. Sediment TMDLs for 10-digit HUC 04100010 05.

TMDL Target For WWH		Sediment TMDL					
		QHEI Categories			TOTAL TMDL SCORE		
		Substrate	Channel	Riparian			
		Allocations					
		≥ 13	≥ 14	≥ 5	32		
Existing Scores		**QHEI Categories**					
Stream/River (Use)	**River mile**	**Substrate**	**Channel**	**Riparian**	**Total Sediment Score**	**Deviation from target (%)**	**Main impairment category**
04100010 05 01- Little Portage River							
Little Portage River	6.20	6	8.5	3.5	18	43.8	substrate
	1.79	0	6.5	10	16.5	48.4	substrate
Ninemile Creek	5.00	3.5	4.5	3	11	65.6	substrate
	2.93	10.5	9	3	22.5	29.7	riparian
04100010 05 02 - Portage River							
Portage River	12.55	1	8.5	9	18.5	42.2	substrate
	11.1	0	6	7	13	59.4	substrate
	6.00	0	6	7	13	59.4	substrate

5.6.3 *E. coli* Bacteria (HUCs 05-01and 05-02)

This TMDL LDC table includes all of the public WWTPs upstream of the assessment site, of which there are many.

Table 5-45. Pathogen existing loads and TMDL for HUC 04100010 05 02 Portage River.

E. coli (billion count/day)	High	Wet weather	Normal range	Dry weather	Low
Flow exceedance percentile	**0-5**	**5-40**	**40-80**	**80-95**	**95-100**
Median of existing load	236,328	4,200	179.7	353.8	97.5
TMDL= LA+WLA+MOS	9,000	1,041	274.5	195.7	168.2
LA	6,998.0	711.0	105.0	42.2	20.3
WLA: MS4 (Fostoria)	20.1	1.4	0	0	0
WLA: MS4 (Findlay)	12.9	1.3	0.2	0.1	0
WLA: MS4 (Bowling Green)	54.7	4.8	0.1	0.0	0.0
WLA: WWTPs total	114.3	114.3	114.3	114.3	114.3
2PB00002 (McComb))	2.4	2.4	2.4	2.4	2.4
2PG00117 (Evansville Western RR (CSX))	0.03	0.03	0.03	0.03	0.03
2PA00083 (Hoytville)	0.2	0.2	0.2	0.2	0.2
2PA00000 (Cygnet)	0.2	0.2	0.2	0.2	0.2
2PB00033 (North Baltimore)	4.9	4.9	4.9	4.9	4.9
2PR00095 (Pilot Oil Co Findlay No 360)	0.06	0.06	0.06	0.06	0.06
2PT00038 (Elmwood HS)	0.2	0.2	0.2	0.2	0.2
2PD00031 (Fostoria)	50.3	50.3	50.3	50.3	50.3
2PA00074 (Bloomdale)	0.5	0.5	0.5	0.5	0.5
2PA00071 (Wayne)	0.3	0.3	0.3	0.3	0.3
2PA00077 (Bradner)	0.6	0.6	0.6	0.6	0.6
2PD00009 (Bowling Green)	47.7	47.7	47.7	47.7	47.7
2PR00245 (Helena Chemical)	0.01	0.01	0.01	0.01	0.01
2PB00012 (Pemberville)	1.0	1.0	1.0	1.0	1.0
2PA00005 (Gibsonburg)[2]	3.0	3.0	3.0	3.0	3.0
2PA00094 (Risingsun)	0.6	0.6	0.6	0.6	0.6
2PR00190 (Fuel Mart No 767)	0.02	0.02	0.02	0.02	0.02
2PR00202 (US 6 23 Retail Sales)	0.03	0.03	0.03	0.03	0.03
2PB00051 (Elmore)	0.9	0.9	0.9	0.9	0.9
2PB00052 (Woodville)	1.4	1.4	1.4	1.4	1.4
2PY00059 (Green Valley MHP)	0.04	0.04	0.04	0.04	0.04
MOS	1,800	208.2	54.9	39.1	33.6
LA reduction (%)	97.0%	82.9%	41.4%	88.0%	79.2%

[1] Wasteload allocations presented here reflect bacteria die-off that occurs over the distance between the facility and the location of this analysis. See Section 4.4.3 (margin of safety discussion) for more details.
[2] Only half of Gibsonburg's effluent is discharged to this watershed (via Sugar Creek) therefore this is only half of the plants waste load allocation.
Values were adjusted for rounding.

5.7 Point Source Wasteload Allocation Summary

5.7.1 *E. coli* Bacteria

Below is a summary table of all the waste load allocations for the public NPDES permitted facilities in the Portage River watershed that discharge to streams with impairment of the state's recreation use.

Table 5-46. Combined NPDES *E. coli* waste load allocations.

Facility name	NPDES permit #	Design flow (MGD)	Conc. Limit	Waste load allocation (billion/day)
McComb Village WWTP	2PB00002	0.388	161	2.4
Evansville Western Railroad (CSX) WWTP	2PG00117	0.005	161	0.03
Hoytville WWTP	2PA00083	0.036	161	0.2
Cygnet WWTP	2PA00000	0.032	161	0.2
North Baltimore WWTP	2PB00033	0.800	161	4.9
Pilot Oil Co Findlay No 360	2PR00095	0.010	161	0.06
Elmwood High School	2PT00038	0.030	161	0.2
Fostoria WWTP*	2PD00031	8.250	161	50.3
Bloomdale STP	2PA00074	0.080	161	0.5
Wayne WWTP	2PA00071	0.052	161	0.3
Bowling Green WWTP	2PD00009	10.000	126	47.7
Helena Chemical Co	2PR00245	0.002	126	0.01
Bradner STP	2PA00077	0.130	126	0.6
Gibsonburg WWTP	2PA00005	0.500	161	3.0
Risingsun WWTP	2PA00094	0.095	161	0.6
Fuel Mart No 767	2PR00190	0.004	161	0.02
US 6 23 Retail Sales Inc	2PR00202	0.005	161	0.03
Pemberville WWTP	2PB00012	0.200	126	1.0
Elmore STP	2PB00051	0.180	126	0.9
Woodville WWTP*	2PB00052	0.300	126	1.4
Green Valley MHP	2PY00059	0.009	126	0.04

6 WATER QUALITY IMPROVEMENT STRATEGY

A series of tables list actions appropriate for abating the water quality stressors at specific locations in the basin. The recommended actions are well established practices with proven effectiveness. Details regarding these practices are included in Appendix E of this report. Additionally, Appendix E compiles various programs and organizations that can be sources for assistance in carrying out the recommended actions.

The actions recommended are not the only means for making the water quality improvements but rather highlight some common approaches. Additionally, there is redundancy in these recommendations because certain stressors can be addressed by a variety of approaches (e.g., both naturalizing watershed hydrology and stream restoration improve habitat quality). The abatement options were selected considering effectiveness coupled with efficiency. In other words more costly actions may produce similar or greater levels of improvement but this may go beyond the minimum level of abatement needed in addressing the stressors causing impairments. Additionally, good land management practices are applicable everywhere so not specifically recommending a management practice does not necessarily suggest that a given management practice is inappropriate in that location. The recommendations are made to prioritize watershed restoration activities and not merely list what is beneficial. A primary objective of these recommendations is to assist watershed planning and/or provide guidance regarding investments that are made to improve water quality.

Table 6-1 lists the actions that are to be taken through regulatory authority. These are relegated to the Ohio EPA and deal with the National Pollution Discharge Elimination System (NPDES)program permitting and compliance. This table is used separately and placed first in this section because these actions have the highest assurances of being implemented. The subsequent tables provide more detail about the recommendations for each assessment area.

Following discussion about actions to be taken that fall under the regulatory process, the remainder of the chapter discusses all recommendations to address water quality stressors organized by ten digit hydrologic units (HUC 10s). Within each of these sub-sections the individual sub-watersheds (HUC 12s) are discussed individually.

6.1 Regulatory Measures for Abatement

This section summarizes recommendations from this TMDL that can be implemented using Ohio EPA's regulatory authority. This differs from other recommendations found in this plan regarding land management or other measures that currently have no associated regulations. The National Pollution Discharge Elimination System (NPDES) is the primary regulatory means for making improvements to restore water quality. Table 6-1 shows the recommendations for total phosphorus effluent concentrations and loads for NPDES permit holders.

Table 6-1. Recommended total phosphorus permit limits for facilities in the Portage River watershed.

Nested Subwatershed (04100010)	Entity	Ohio EPA Permit Number	Receiving Stream	Design Flow (million gallons/day)	Total Phosphorus	
					Wasteload Allocation (kg/day)	Concentration Based Effluent Limit (mg/l)
01 01	Evansville Western Railroad	2PG00117	Rader Creek Tributary	0.005	0.06	3.0
01 01	McComb WWTP	2PB00002	Algire Creek	0.388	1.47	1.0
01 02	Hoytville WWTP	2PA00083	Unnamed Tributary to Stove Ditch	0.300	0.14	1.0
01 03	Pilot Oil Co. Findlay No. 360	2PR00095	Rocky Ford Creek	0.000	0.11	3.0
01 03	Cygnet WWTP	2PA00000	Rocky Ford Creek	0.032	0.37	3.0
01 03	North Baltimore WWTP	2PB00033	Rocky Ford Creek	0.300	3.03	1.0
02 01	Elmwood High School	2PT00038	Tributary to Eckert Ditch	0.000	0.34	3.0
02 02	Fostoria WWTP	2PD00031	East Branch Portage River	8.250	31.23	1.0
02 03	Bloomdale WWTP	2PA00074	Unnamed Tributary to Stove Ditch	0.000	0.91	3.0
02 04	Wayne WWTP	2PA00071	S Wayne Ditch	0.300	0.20	1.0
03 01	Bowling Green WWTP	2PD00009	Poe Ditch	10.000	18.95	0.5
03 01	Helena Chemical	2PR00245	Unnamed Tributary to Portage River	0.002	0.02	3.0
03 02	Bradner STP	2PA00077	Unnamed Tributary to Stove Ditch	0.130	0.50	1.0
04 01	Fuel Mart No 767	2PR00190	Unnamed Tributary to Coon Creek	0.000	0.05	3.0
04 01	Gibsonburg WWTP[1]	2PA00005	Hurlbut Ditch & St.Rt 300 Ditch	0.250	0.95	1.0
04 01	Risingsun WWTP	2PA00094	Sugar Creek	0.000	1.08	3.0
04 01	US 6 23 Retail Sales	2PR00202	Unnamed Ditch	0.000	0.06	3.0
04 02	Pemberville WWTP	2PB00012	Algire Creek	0.200	0.75	1.0
04 02	Elmore WWTP	2PB00051	Portage River	0.180	0.68	1.0
04 02	Green Valley MHP	2PY00059	Unnamed Tributary to Portage River	0.009	0.10	3.0
04 02	Woodville WWTP	2PB00052	Portage River	0.300	1.30	1.0
05 02	Gibsonburg WWTP[1]	2PA00005	Hurlbut Ditch & St. Rt. 300 Ditch	0.250	0.95	1.0

[1] Gibsonburg WWTP is listed in two different 12-dgiit HUCs because it has two different outfalls discharging to streams are each in the 04-01 and 05-02 HUCs.

6.2 Rocky Ford-Middle Branch Portage River – 04100010-01

Twelve out of 20 sites (60 percent) surveyed fully meet aquatic life use criteria; however 10 percent meet none of the criteria and 30 percent met some but not all of the criteria. Water quality problems were associated mostly with siltation, low flow and habitat alteration affecting 25, 20 and 15 percent of the sites, respectively, in this ten-digit HUC. Nutrients impaired ten percent of the sites while organic enrichment, ammonia, and low dissolved oxygen levels each were problems at one of the twenty sites. Primary sources of these pollutants are cropland, and the negative impacts of channelization on the stream system. Additionally, wastewater treatment plants and HSTSs also contributed pollutants at one site each.

Recreation uses were impaired at 23 of the 25 sites (92 percent) surveyed in this ten digit HUC with failed HSTSs as a source of bacteria at 76 percent of all sites. Inadequate wastewater treatment caused problems at four sites (16 percent of total) including those receiving discharges from the McComb and North Baltimore WWTPs and CSOs located in North Baltimore. Livestock operations accounted for some of the bacteria loading at two sites (eight percent of total number of sites) and land application of manure is suspected sources of cropland contributions which impacted nearly 50 percent of the sites monitored.

Table 6-2 is an account of all the basic recommendations for making water quality improvements in the 01 ten-digit HUC.

6.2.1 Rader Creek - 01 - 01

The recommended point source control in this 12-digit subwatershed is that McComb address overflowing sewage from its combined system. Effluent limits for total phosphorus will be issues to Evansville Western Railroad and the McComb WWTP. Otherwise the majority of water quality improvement should be from abatement of nonpoint sources. Failing HSTSs is the most pervasive problem impacting nearly every site that was monitored for bacteria. Diligent inspection of these systems and appropriate enforcement is encouraged of the Hancock and Wood County Health Departments. Cropland sources of sediment and nutrients can be reduced with grassed waterways, cover cropping and conservation tillage, creation or restoration of vegetated buffers or wetlands and general nutrient management. In particular, fields draining to an unnamed tributary to West Creek around river mile 2.0 (in the area of Old SR 235 and TR 97) show signs of rill and gulley erosion and would benefit by grassed waterways in those concentrated flow paths. Streamside areas are primarily without trees or grass buffering and this management practice is encouraged.

6.2.2 Needles Creek - 01 - 02

Effluent limits for total phosphorus will be issued to the Hoytville WWTP. However, the majority of water quality improvement should be from abatement of nonpoint sources. Failing HSTSs is the most pervasive problem impacting nearly every site that was monitored for bacteria. Diligent inspection of these systems and appropriate enforcement is encouraged of the Hancock and Wood County Health Departments.

Siltation of the streambed, habitat alteration, and low flows are the only listed causes of impairment in this 12-digit subwatershed. Channel improvements that allow stream channels to overflow to floodplains during annual peak flow events are encouraged and may include over-wide or two-stage ditch construction, or more robust stream restoration. Although more

streamside buffering is noted in this subwatershed than in others in this ten-digit HUC, many streamside areas remain without appreciable buffering. Buffers are encouraged to protect against eroded cropland soils from entering streams. Other practices to abate sedimentation of the stream include: cover cropping, conservation tillage, and creation or restoration of wetlands. Soils in this area are appropriate for wetland development and controlled drainage practices due to their poor drainage classification and relatively low slopes.

6.2.3 Rocky Ford - 01 - 03

Effluent limits for total phosphorus will be issued to the Cygnet and North Baltimore WWTPs as well as the Pilot Oil Co Findlay No 360. However, the majority of water quality improvement should be from abatement of nonpoint sources. Failing HSTSs is the most pervasive problem impacting nearly every site that was monitored for bacteria. Diligent inspection of these systems and appropriate enforcement is encouraged of the Wood County Health Department.

Siltation of the streambed, habitat alteration, and low flows are the only listed causes of impairment in this 12-digit subwatershed. Channel improvements that allow stream channels to overflow to floodplains during annual peak flow events are encouraged and may include over-wide or two-stage ditch construction, or more robust stream restoration. Although more streamside buffering is noted in this subwatershed than in others in this ten-digit HUC, many streamside areas remain that are without appreciable buffering. Buffers are encouraged to protect against eroded cropland soils from entering streams. Other practices to abate sedimentation of the stream include: cover cropping, conservation tillage, and creation or restoration of wetlands. Soils in this area are appropriate for wetland development and controlled drainage practices due to their poor drainage classification and relatively low slopes.

6.2.4 Town of Rudolph-Middle Branch Portage River - 01 - 04

There are no recommendations for point source controls in this 12-digit subwatershed and the majority of water quality improvement should be from abatement of nonpoint sources. Failing HSTSs is the most pervasive problem impacting nearly every site that was monitored for bacteria. Diligent inspection of these systems and appropriate enforcement is encouraged of the Hancock and Wood County Health Departments. There are no impairments to aquatic life uses in this subwatershed.

Table 6-2. Restoration and abatement actions recommended for the 01 ten-digit HUC.

Restoration Categories		Specific Restoration Actions	04100010 01			
			01	02	03	04
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering				
		Restore streambank by recontouring or regrading				
	planted	Plant grasses in riparian areas	x		x	
		Plant prairie grasses in riparian areas	x		x	
		Remove/treat invasive species				
		Plant trees or shrubs in riparian areas			x	
Stream Restoration		Restore flood plain	x	x	x	
		Restore stream channel	x	x	x	
		Install in-stream habitat structures				
		Install grade structures				
		Construct 2-stage channel		x		

Restoration Categories		Specific Restoration Actions	04100010 01			
			01	02	03	04
		Restore natural flow		x		
Wetland Restoration		Reconnect wetland to stream				
		Reconstruct & restore wetlands		x	x	
		Plant wetland species				
Conservation Easements		Acquire agriculture conservation easements			x	
		Acquire non-agriculture conservation easements				
Home Sewage Planning and Improvement		Develop HSTS plan	x	x	x	x
		Inspect HSTS	x	x	x	x
		Repair or replace traditional HSTS	x	x	x	x
		Repair or replace alternative HSTS	x	x	x	x
Point Source Controls (Regulatory Programs)	collection and new treatment	Install sewer systems in communities				
		Develop and/or implement long-term control plan (CSOs)	x		x	
		Eliminate SSOs/CSOs/by-passes	x		x	
	storm water	Implement an MS4 permit				
		Implement an industrial permit				
		Implement a construction permit				
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)	x		x	
		Improve quality of effluent	x			
	monitoring	Establish ambient monitoring program				
		Increase effluent monitoring				
	alternatives	Establish water quality trading				
Agricultural Best Mgt Practices	farmland	Plant cover/manure crops		x	x	
		Implement conservation tillage practices		x	x	
		Implement grass/legume rotations		x	x	
		Convert to permanent hayland		x	x	
		Install grassed waterways	x			
		Install vegetated buffer strips		x	x	
		Install / restore wetlands		x	x	
	nutrients / agro-chemicals	Conduct soil testing				
		Install nitrogen reduction practices				
		Develop nutrient management plans				
	drainage	Install sinkhole stabilization structures				
		Install controlled drainage system		x	x	
		Implement drainage water management		x	x	
		Construct overwide ditch		x	x	
		Construct 2-stage channel		x	x	

6.3 South Branch Portage River-Middle Branch Portage River – 04100010-02

Five out of 11 sites (45 percent) surveyed fully met aquatic life use criteria, while approximately 36 percent meet none of the criteria and 18 percent met some but not all of the criteria. Water

quality problems were associated mostly with siltation (26 percent of the sites in this ten-digit HUC), while nutrients, low flow, habitat alteration, and organic enrichment each affected 11 percent of the sites in this ten-digit HUC. Elevated concentration of ammonia was a problem at one site. Primary sources of these pollutants are cropland, and the negative impacts of channelization on the stream system. Additionally, combined sewer overflows were listed as a source at two sites, and wastewater treatment plants, HSTSs and livestock manure contributed pollutant at one site each.

The most significant source of bacteria is listed as failing HSTSs, but runoff from cropland is listed as a secondary source. At five impaired sites it is believed that sources of bacteria include wastewater treatment facilities (i.e., inadequate treatment) and from illicit discharges from two unsewered small communities (West Milgrove and Jerry City).

Table 6-3 is an account of all the basic recommendations for making water quality improvements in the 02 ten-digit HUC.

6.3.1 Bull Creek - 02 - 01

Only one site is impaired for aquatic life uses in this 12-digit HUC (Bull Creek at river mile 8.45) and it's listed for habitat and sediment with channelization and cropland runoff as sources. Bacteria is an issue at each of the three sites surveyed with the Bull Creek at river mile 3.89 having highest geometric mean (834 cfu/100ml) and highest maximum geometric mean (5,200 cfu/100ml). HSTSs and cropland are likely bacteria sources for all three sites.

Reducing or eliminating the failure of HSTSs will alleviate much of the burden of bacteria loading to the streams. Inspection of HSTSs and appropriate compliance action are a logical and necessary first step for local and state authorities to take in addressing these problems. The most severe means of system failure is when it is by-passed and a direct line goes from the home or perhaps the septic tank to the stream. These illicit discharges are illegal and should be the highest priority to identify in inspection and compliance surveying efforts. Homes that are in very close proximity to streams or ditches may be one of the more obvious places to focus initial inspection efforts.

In terms of aquatic life water quality goals, addressing local issues is primarily restricted to reducing sediment loading to the stream and improving in-stream habitat quality. Opportunity to restore floodplain function would yield benefit in increasing the assimilative capacity of the stream to handle the upland sediment loading. It would also introduce greater sinuosity in the stream channels which provides benefits associated with habitat and stream geo-morphological and hydraulic characteristics. In particular, better developed riffle-run sequencing should occur where gradients are steep enough, likewise there should be more diversity in flow hydraulics which allows for a greater number of species that are specialized for a variety of flow and habitat conditions.

Controlling upland soil losses will be beneficial to both local and downstream water quality goals. Cropland management practices that have perhaps the greatest potential benefits are cover cropping and residue management that reduces surface erosion and improves soil quality and tilth. It is likely that such practices must be fairly widely adopted in order to provide tangible water quality benefits. Stream-side buffering, filter strips and wetland creation and restoration can provide the hydraulic buffering to detain and treat a significant portion of runoff from crop fields. These practices will move towards meeting nutrient reduction goals, which for this 12-digit HUC near 40 percent of the approximated existing load. The existing nonpoint source yield

(per unit area loading rate) for total phosphorus is approximated to be 0.73 lb per acre per year. In order to achieve downstream water quality goals, the Elmwood High School will be considered for a total phosphorus effluent limit.

6.3.2 East Branch Portage River - 02 - 02

Four out of eight sites are impaired for aquatic life uses in this 12-digit HUC. Sediment, nutrient and organic enrichment, and low flow are the primary causes of impairment with sources that include crop and livestock production, channelization, as well as wastewater from combined sewer overflows and inadequately treated wastewater that is discharged. Estimates of existing loading rates of total phosphorus are 0.39 pounds per acre per year. Only one out of eight sites met the criteria for recreation uses with HSTSs and cropland runoff most responsible for the bacteria loading. Other bacteria sources include combined sewer overflows and wastewater discharges.

The headwaters of East Branch Portage River are suffering from organic and nutrient enrichment and bacteria loading from HSTSs as well as cropland runoff. There are no point sources dischargers or sludge application fields in this part of the 12-digit watershed. To improve water quality in this area, HSTSs around West Independence and other scattered homes should be inspected to better determine failure rates and begin correcting such systems. Addressing HSTSs and using livestock exclusion where needed is likely to abate all water quality problems associated with bacteria and organic enrichment.

Cropland management should include cover cropping and residue management to abate soils and nutrient losses and improve soil tilth and infiltration potential. Developing and implementing nutrient management plans would also reduce nutrient inputs to the stream system. Buffers and wetlands can likewise provide treatment of runoff and shallow sub-surface flow making its way to streams. As of 2007 there were over 100 acres of land set asides through the Conservation Reserve Program along streams and ditches upstream of the impaired site at river mile 19.17 on the East Branch Portage River. This amounts to about a third of the stream miles in this nearly ten square mile drainage area. Most of these buffers were approximately 100 feet wide and therefore have the potential to provide significant treatment for surface runoff.

Controlled drainage also has the potential to reduce nutrient loading by limiting the amount of loading of the soluble fraction of nutrients by reducing the overall annual volume of discharge from this flow pathway. Controlled drainage may also improve flows during dry times of the year as the amount of water stored in the soil profile would likely be greater in fields employing controlled drainage. Soil slopes are low enough to be conducive to efficient use of this management practice.

Further down East Branch Portage River problems are associated with low flows and excessive fine sediment in the channel as well as bacteria. Land drainage improvements and channelization are responsible for the flow issues and crop production and possibly channelization for the sediment loading to the stream system. Land uses and overall watershed conditions are similar and the above management practices are likewise appropriate to address issues in this area.

At the downstream end of the City of Fostoria the East Branch suffers from combined sewer overflows and inadequately treated wastewater. The City is in the planning stages of correcting both the combined systems and the problems with its wastewater treatment system.

Aquatic life uses are met at all of the sites downstream of river mile nine; however, bacteria remain a problem due to loading from HSTSs and possibly land applied manure or sewage sludge. Identifying and correcting failing systems will improve quality for recreation uses.

6.3.3 Town of Bloomdale-South Branch Portage River - 02 - 03

Two out of five sites are impaired for aquatic life uses in this 12-digit HUC. Sediment, organic enrichment, and poor habitat are the primary causes of impairment with sources that include crop production, channelization, as well as past oil drilling. None of the five sites met the criteria for recreation uses with HSTSs and cropland runoff most responsible for the bacteria loading.

The upper seven miles or so of the South Branch Portage River suffer from excessive amounts of fine sediment and poor habitat. The small size of the stream in this area and its relatively low gradient suggests that a two-stage approach to maintaining this drainage conveyance is appropriate. This approach should improve the assimilative capacity of the system for sediment and possibly nutrients and likewise reduce susceptibility for channel erosion. Other options include much of what was suggested for the upper reaches of the East Branch Portage River regarding the agriculture related impacts to water quality including cover and residue management, as well as buffers and wetlands. Likewise, failing HSTSs should be addressed.

To meet downstream water quality goals, the Bloomdale WWTP will receive a total phosphorus effluent limit.

6.3.4 Rhodes Ditch-South Branch Portage River - 02 - 04

Only two sites were evaluated in this 12-digit HUC. At both sites aquatic life uses were met; however, relatively high concentrations of bacteria caused impaired recreation uses. Sources are primarily HSTSs in addition to noncompliance with effluent standards at the Wayne WWTP. Despite attainment of aquatic life uses, this 12-digit HUC is estimated to yield a total phosphorus loading of 1.12 pounds per acre per year. To meet downstream water quality goals, the Wayne WWTP will receive a total phosphorus effluent limit.

Abatement options include compliance sampling and any needed enforcement of the point source dischargers as well as the recommendations found in previous sub-sections regarding failed HSTSs. With respect to downstream nutrient loading, many nutrient related management practices would be beneficial; however, they are of lower priority than other nutrient impacted areas in the entire Portage River watershed.

6.3.5 Cessna Ditch-Middle Branch Portage River - 02 - 05

Only two sites were evaluated in this 12-digit HUC. At both sites aquatic life uses were met; however, relatively high concentrations of bacteria caused impaired recreation uses at one site. Sources are primarily HSTSs. Despite attainment of aquatic life uses, this 12-digit HUC is estimated to yield a total phosphorus loading of 0.70 pounds per acre per year.

Abatement options include the recommendations found in previous sub-sections regarding failed HSTSs. With respect to downstream nutrient loading, many nutrient related management practices would be beneficial; however, they are a lower priority than other nutrient impacted areas in the entire Portage River watershed.

Table 6-3. Restoration and abatement actions recommended for the 02 ten-digit HUC.

Restoration Categories		Specific Restoration Actions	04100010 02				
			01	02	03	04	05
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering					
		Restore streambank by recontouring or regrading					
	planted	Plant grasses in riparian areas	x	x	x		
		Plant prairie grasses in riparian areas	x	x	x		
		Remove/treat invasive species					
		Plant trees or shrubs in riparian areas		x	x		
Stream Restoration		Restore flood plain	x	x	x		
		Restore stream channel					
		Install in-stream habitat structures					
		Install grade structures					
		Construct 2-stage channel	x	x	x		
		Restore natural flow					
Wetland Restoration		Reconnect wetland to stream		x	x		
		Reconstruct & restore wetlands		x	x		
		Plant wetland species					
Conservation Easements		Acquire agriculture conservation easements					
		Acquire non-agriculture conservation easements					
Home Sewage Planning and Improvement		Develop HSTS plan	x	x	x	x	x
		Inspect HSTS	x	x	x	x	x
		Repair or replace traditional HSTS	x	x	x	x	x
		Repair or replace alternative HSTS	x	x	x	x	x
Education and Outreach		Distribute educational materials					
		Host meetings, workshops and/or other events					
Storm Water Best Mgt Practices	quantity controls	Post-construction BMPs: innovative BMPs					
		Post-construction BMPs: infiltration					
		Post-construction BMPs: retention/detention					
	quality controls	Post-construction BMPs: filtration					
		Construction BMPs: erosion control					
		Construction BMPs: runoff control					
		Construction BMPs: sediment control					
Point Source Controls (Regulatory Programs)	collection and new treatment	Install sewer systems in communities	x		x		
		Develop and/or implement long-term control plan (CSOs)		x			
		Eliminate SSOs/CSOs/by-passes		x			
	storm water	Implement an MS4 permit		x			
		Implement an industrial permit					
		Implement a construction permit					
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)		x			
		Improve quality of effluent		x		x	
	monitoring	Establish ambient monitoring program					
		Increase effluent monitoring					

Restoration Categories		Specific Restoration Actions	04100010 02				
			01	02	03	04	05
	alternatives	Establish water quality trading					
Agricultural Best Mgt Practices	farmland	Plant cover/manure crops	x	x	x		
		Implement conservation tillage practices	x	x	x		
		Implement grass/legume rotations	x	x	x		
		Convert to permanent hayland	x	x	x		
		Install grassed waterways					
		Install vegetated buffer strips		x	x		
		Install / restore wetlands		x	x		
	nutrients / agro-chemicals	Conduct soil testing	x	x			
		Install nitrogen reduction practices	x	x			
		Develop nutrient management plans	x	x			
	drainage	Install sinkhole stabilization structures					
		Install controlled drainage system		x			
		Implement drainage water management		x			
		Construct overwide ditch	x	x	x		
		Construct 2-stage channel	x	x	x		
	livestock	Implement prescribed & conservation grazing practices					
		Install livestock exclusion fencing					
		Install livestock crossings					
		Install alternative water supplies					
		Install livestock access lanes					
	manure	Implement manure management practices		x			
		Construct animal waste storage structures					
		Implement manure transfer practices					
		Install grass manure spreading strips					
	misc. infra-structure and mgt	Install chemical mixing pads					
		Install heavy use feeding pads					
		Install erosion & sediment control structures					
		Install roof water management practices					
		Install milkhouse waste treatment practices					
		Develop whole farm management plans					

6.4 Upper Portage River – 04100010-03

Three out of eight sites (38 percent) surveyed fully meet aquatic life use criteria; however approximately 25 percent meet none of the criteria and 38 percent met some but not all of the criteria. Water quality problems were associated mostly with siltation (63 percent of the sites in this ten-digit HUC), while nutrients, habitat alteration, and low dissolved oxygen each affected 25 percent of the sites in this ten-digit HUC. Primary sources of these pollutants are cropland, and the negative impacts of channelization on the stream system, both impacting 63 percent of the sites. Additionally, wastewater treatment plants were listed as a source for one site.

Recreation uses were impaired at 10 sites (91 percent) of the 11 sites surveyed in this ten digit HUC. The one site not impaired is in the headwaters of the North Branch Portage River. The remaining eight sites on the North Branch (from river mile 21.96 to 0.08) and one site on Poe Ditch and one on the Portage River itself, are all impaired for recreation. There is a general trend of increasing bacteria concentration moving downstream along North Branch Portage River except for the site near the confluence with the Portage River. Likewise the Portage River itself exceed the maximum allowable concentration but by a relatively small amount. Both of these sites may have the benefit of dilution as stream flow is substantially greater than the other sites. Sources of bacteria are primarily failing HSTSs, but there are areas of the subwatershed where point source dischargers are not treating adequately and failures in compliance with the standards are causing problems. Runoff carrying land applied manure or sewage sludge is another possible source of bacteria.

Table 6-4 is an account of all the basic recommendations for making water quality improvements in the 03 ten-digit HUC.

6.4.1 North Branch Portage River - 03 - 01

There are five out of seven sites with impaired aquatic life uses in this 12-digit HUC. The most upstream site on North Branch Portage River and the site at river mile 6.55 are impaired by nutrient enrichment and every site (including these two) is impaired by excessive fine sediment in the substrate. The two upper most sites (river miles 25.85 and 21.96) are within the headwaters and are also impaired by poor habitat. Crop production and channelization are sources of the excessive fine sediment and associated poor habitat quality. Cropland and, in one case, a major wastewater treatment plant, are responsible for the nutrient loading that is impairing aquatic life. The existing nonpoint source yield (per unit area loading rate) for total phosphorus is approximated to be 0.58 lb per acre per year. To meet downstream water quality goals, the Bowling Green WWTP and the Helena Chemical Co will receive a total phosphorus effluent limit.

Nine out of ten sites are impaired for recreation uses with the most upstream site on North Branch Portage River meeting established criteria. Failing HSTSs and, in two cases, inadequately treated wastewater, are the sources of bacteria. Manure and sludge application may also contribute bacteria loads under runoff conditions.

Management aimed at reducing sediment erosion potential and minimizing nutrient losses in runoff or sub-surface drainage are appropriate throughout the 12-digit HUC. Cover cropping, residue management, buffers, wetlands and nutrient management are all recommended practices. In terms of the amount of land set-aside as buffers or grassland in 2007 (the year prior to the survey), about 1.5 percent (821 acres) was enrolled in the Conservation Reserve Program (CRP). Most of the stream side buffers enrolled in CRP are relatively narrow providing limited effectiveness in treating pollutant in surface and shallow sub-surface flows to steams. In smaller streams a two-stage channel approach is appropriate to increase the assimilative capacity of the stream or if funding resources are available more robust floodplain and channel restoration.

Failing HSTSs again are significant sources of bacteria loading throughout the 12-digit HUC. Inspections and efforts to gain compliance with local standards for these systems are recommended, particularly on the periphery of Bowling Green and Portage.

6.4.2 Town of Pemberville-Portage River - 03 - 02

Only one site was surveyed in this 12-digit HUC. Aquatic life uses were met; however, elevated concentrations of bacteria from failing HSTSs impaired recreation uses. Inspections and efforts to better ensure compliance with local ordinances regarding the functionality and maintenance of these systems is recommended. Despite attainment of aquatic life uses, this 12-digit HUC is estimated to yield a total phosphorus loading of 0.27 pounds per acre per year. To meet downstream water quality goals, the Bradner STP will receive a total phosphorus effluent limit.

Table 6-4. Restoration and abatement actions recommended for the 03 ten-digit HUC.

Restoration Categories		Specific Restoration Actions	04100010 03	
			01	02
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering		
		Restore streambank by recontouring or regrading		
	planted	Plant grasses in riparian areas	x	
		Plant prairie grasses in riparian areas	x	
		Remove/treat invasive species		
		Plant trees or shrubs in riparian areas	x	
Stream Restoration		Restore flood plain	x	
		Restore stream channel	x	
		Install in-stream habitat structures		
		Install grade structures		
		Construct 2-stage channel	x	
		Restore natural flow		
Wetland Restoration		Reconnect wetland to stream	x	
		Reconstruct & restore wetlands	x	
		Plant wetland species		
Conservation Easements		Acquire agriculture conservation easements		
		Acquire non-agriculture conservation easements		
Home Sewage Planning and Improvement		Develop HSTS plan	x	x
		Inspect HSTS	x	x
		Repair or replace traditional HSTS	x	x
		Repair or replace alternative HSTS	x	x
Education and Outreach		Distribute educational materials		
		Host meetings, workshops and/or other events		
Storm Water Best Mgt Practices	quantity controls	Post-construction BMPs: innovative BMPs		
		Post-construction BMPs: infiltration		
		Post-construction BMPs: retention/detention		
	quality controls	Post-construction BMPs: filtration		
		Construction BMPs: erosion control		
		Construction BMPs: runoff control		
		Construction BMPs: sediment control		
Point Source	collection and new	Install sewer systems in communities	x	
		Develop and/or implement long-term control plan (CSOs)		

Restoration Categories		Specific Restoration Actions	04100010 03	
			01	02
Controls (Regulatory Programs)	treatment	Eliminate SSOs/CSOs/by-passes		
	storm water	Implement an MS4 permit	x	
		Implement an industrial permit		
		Implement a construction permit		
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)	x	
		Improve quality of effluent	x	
	monitoring	Establish ambient monitoring program		
		Increase effluent monitoring		
	alternatives	Establish water quality trading		
Agricultural Best Mgt Practices	farmland	Plant cover/manure crops	x	
		Implement conservation tillage practices	x	
		Implement grass/legume rotations	x	
		Convert to permanent hayland	x	
		Install grassed waterways		
		Install vegetated buffer strips	x	
		Install / restore wetlands	x	
	nutrients / agro-chemicals	Conduct soil testing	x	
		Install nitrogen reduction practices	x	
		Develop nutrient management plans	x	
	drainage	Install sinkhole stabilization structures		
		Install controlled drainage system	x	
		Implement drainage water management	x	
		Construct overwide ditch	x	
		Construct 2-stage channel	x	
	livestock	Implement prescribed & conservation grazing practices		
		Install livestock exclusion fencing		
		Install livestock crossings		
		Install alternative water supplies		
		Install livestock access lanes		
	manure	Implement manure management practices		
		Construct animal waste storage structures		
		Implement manure transfer practices		
		Install grass manure spreading strips		
	misc. infra-structure and mgt	Install chemical mixing pads		
		Install heavy use feeding pads		
		Install erosion & sediment control structures		
		Install roof water management practices		
		Install milkhouse waste treatment practices		
		Develop whole farm management plans		

6.5 Middle Portage River – 04100010-04

Nine out of 11 sites (82 percent) surveyed fully meet aquatic life use criteria; however, 18 percent met some but not all of the criteria. Water quality problems were associated mostly with habitat alteration (18 percent of the sites in this ten-digit HUC) while nutrients and siltation only impacted one site each or nine percent of the sites, respectively. Primary sources of these pollutants are cropland, and the negative impacts of channelization on the stream system.

Recreation uses were impaired at 10 sites (91 percent) of the 11 sites surveyed in this ten digit HUC. The one site not impaired is on the Portage River between the towns of Pemberville and Woodville. The ten impaired sites are distributed across the length of Sugar Creek (six sites) and the Portage River (four sites) down from the unimpaired site to the confluence with Sugar Creek. The only site on Coon Creek (river mile 0.34) is also impaired. Failing HSTSs are responsible for bacteria loading at all of these impaired sites; however noncompliance with water quality standards at five wastewater facilities as well as combined sewer overflows in Woodville are also significant contributors of bacteria. Runoff from cropland receiving manure land applications from a nearby concentrated animal feeding operation (CAFO) likewise are sources of this pollution.

Table 6-5 is an account of all the basic recommendations for making water quality improvements in the 04 ten-digit HUC.

6.5.1 Sugar Creek - 04 - 01

Only one site is impaired for aquatic life uses in this 12-digit HUC and seven are impaired for recreation uses. Aquatic life uses are impaired due to excessive fine sediment and poor habitat quality as well as nutrient enrichment. The sources are cropland runoff and subsurface drainage along with channelization done to enhance land drainage. Bacteria sources are primarily failing HSTSs, runoff from fields receiving land applied manure, and from nearby CAFOs. Additionally, this 12-digit HUC is estimated to yield a total phosphorus loading of 0.35 pounds per acre per year. Four minor wastewater dischargers will be required to meet an effluent limit for total phosphorus in their discharge, namely Fuel Mart No 767, Gibsonburg WWTP, Risingsun WWTP, and US 6 23 Retail Sales Inc..

Sandy soils are located just north of Coon Creek near a meander bend. Based on aerial photography, it appears that this bank is eroding which could liberate a substantial amount of fine sediment and impair downstream aquatic life communities. Although not indicated as in an active state of erosion through the QHEI scoring, rapid re-colonization of vegetation could mask bank erosion processes therefore precluding this from being indicated in the QHEI scoring. It is recommended that trees or other deep rooted vegetation be planted to stabilize what appears to be a largely unprotected bank from rapid lateral erosion. Likewise, bio-engineering techniques may be fairly low cost and environmentally friendly ways to curb erosion problems in this area. Other more system wide approaches to abating this issue include channel restoration, or the more cost effective two-stage channel approach. This would increase the assimilative capacity of the system and improve habitat to the benefit of aquatic community health. Areas to target for such channel work would be those that are in an active state of bank erosion, which is most likely along the sharper meander bends.

A reduction in landscape sediment loading can likewise make improvements to the system. Providing cover to crop fields during the non-growing season with cover crops or year round

cropping such as haylands or grasses or trees established through land set-aside programs would in combination reduce some of the landscape derived water or wind transported sediment. Residue management and mulching also protects against surface erosion. Filter strips along stream margins and other areas that are within critical flow paths for runoff (i.e., especially where flows are concentrated as rills or gullies) will also reduce the fine sediment loading to the channel.

The manifestation of severe nutrient loading is illustrated in Figure 6-3 where filamentous algae fill the stream channel at the survey location at river mile 0.34. Since there is only one very small wastewater discharger (5,000 gallons per day) upstream of this point, runoff and subsurface drainage from crop production are believed to be by far the most substantial source of nutrients. Nutrient management involving soil testing, reduced quantities of land applied nutrients (including manure based nutrients), and conservation based timing and methods of application is highly recommended for this area. Practices that abate soils losses discussed above will also be very instrumental in reducing nutrient loading to the stream. In abating nutrient loading from sub-surface pathways, controlled drainage and wetland creation and restoration are recommended.

Inspections of HSTSs should be carried out steps towards compliance made to prevent significant bacteria loading.

Figure 6-1. Coon Creek at river mile 0.34 where filamentous algae fills the stream channel.

6.5.2 Lacarpe Creek Outlet #4-Portage River - 04 - 02

Only one of the four sites surveyed in this 12-digit HUC was impaired for aquatic life uses. Poor habitat quality due to channelization is listed as the reason for this impairment at river mile 22.13 on the Portage River. Recreation uses were impaired at three of the four sites surveyed with failing HSTSs, combined sewer overflows, and noncompliance issues with wastewater dischargers being the listed sources. Additionally, this 12-digit HUC is estimated to yield a total phosphorus loading of 0.15 pounds per acre per year. Three minor wastewater dischargers will be required to meet an effluent limit for total phosphorus in their discharge, namely Elmore WWTP, Green Valley MHP, and Woodville WWTP.

Inspections of HSTSs should be carried out and steps towards compliance made to prevent significant bacteria loading.

Table 6-5. Restoration and abatement actions recommended for the 04 ten-digit HUC.

Restoration Categories		Specific Restoration Actions	04100010 04	
			01	02
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering	x	
		Restore streambank by recontouring or regrading	x	
	planted	Plant grasses in riparian areas	x	
		Plant prairie grasses in riparian areas	x	
		Remove/treat invasive species		
		Plant trees or shrubs in riparian areas	x	
Stream Restoration		Restore flood plain	x	
		Restore stream channel	x	
		Install in-stream habitat structures		
		Install grade structures		
		Construct 2-stage channel	x	
		Restore natural flow		
Wetland Restoration		Reconnect wetland to stream		
		Reconstruct & restore wetlands		
		Plant wetland species		
Conservation Easements		Acquire agriculture conservation easements		
		Acquire non-agriculture conservation easements		
Home Sewage Planning and Improvement		Develop HSTS plan	x	x
		Inspect HSTS	x	x
		Repair or replace traditional HSTS	x	x
		Repair or replace alternative HSTS	x	x
Education and Outreach		Distribute educational materials		
		Host meetings, workshops and/or other events		
Storm Water Best Mgt Practices	quantity controls	Post-construction BMPs: innovative BMPs		
		Post-construction BMPs: infiltration		
		Post-construction BMPs: retention/detention		
	quality controls	Post-construction BMPs: filtration		
		Construction BMPs: erosion control		
		Construction BMPs: runoff control		
		Construction BMPs: sediment control		
Point Source Controls (Regulatory Programs)	collection and new treatment	Install sewer systems in communities		
		Develop and/or implement long-term control plan (CSOs)		
		Eliminate SSOs/CSOs/by-passes	x	x
	storm water	Implement an MS4 permit	x	
		Implement an industrial permit		
		Implement a construction permit		
	enhanced treatment	Issue permit(s) and/or modify permit limit(s)	x	
		Improve quality of effluent	x	x
	monitoring	Establish ambient monitoring program		
		Increase effluent monitoring		
	alternatives	Establish water quality trading		
Agricultural	farmland	Plant cover/manure crops	x	

Restoration Categories		Specific Restoration Actions	04100010 04	
			01	02
Best Mgt Practices		Implement conservation tillage practices	x	
		Implement grass/legume rotations	x	
		Convert to permanent hayland	x	
		Install grassed waterways		
		Install vegetated buffer strips	x	
		Install / restore wetlands	x	
	nutrients / agro-chemicals	Conduct soil testing	x	
		Install nitrogen reduction practices	x	
		Develop nutrient management plans	x	
	drainage	Install sinkhole stabilization structures		
		Install controlled drainage system	x	
		Implement drainage water management	x	
		Construct overwide ditch	x	
		Construct 2-stage channel	x	
	livestock	Implement prescribed & conservation grazing practices		
		Install livestock exclusion fencing		
		Install livestock crossings		
		Install alternative water supplies		
		Install livestock access lanes		
	manure	Implement manure management practices	x	
		Construct animal waste storage structures		
		Implement manure transfer practices		
		Install grass manure spreading strips		
	misc. infra-structure and mgt	Install chemical mixing pads		
		Install heavy use feeding pads		
		Install erosion & sediment control structures		
		Install roof water management practices		
		Install milkhouse waste treatment practices		
		Develop whole farm management plans		

6.6 Lower Portage River-Frontal Lake Erie – 04100010-05

Two out of 10 sites (20 percent) surveyed fully meet aquatic life use criteria; however 50 percent meet none of the criteria and 30 percent meet some but not all of the criteria. Water quality problems were associated mostly with siltation (80 percent of the sites in this ten-digit HUC), while nutrients impacted 60 percent of the sites. Habitat alteration and low flows each affected 20 percent of the sites in this ten-digit HUC. Primary sources of these pollutants are cropland, and the negative impacts of channelization on the stream system, impacting 50 and 40 percent of the sites, respectively. Additionally, wastewater treatment plants were listed as a source for three sites.

Recreation uses were impaired at 11 of the 15 sites surveyed (73 percent) in this ten digit HUC. Failing HSTSs are by far the most substantial source of bacteria, with cropland runoff and wastewater discharges also contributing bacteria at some of the sites.

Table 6-6 is an account of all the basic recommendations for making water quality improvements in the 05 ten-digit HUC.

6.6.1 Little Portage River - 05 - 01

All four of the sites are impaired for aquatic life uses in this 12-digit HUC and three are impaired for recreation uses. An excessive amount of fine sediment is a problem at every site and habitat, low flows, and nutrients were each problematic at two of the four sites. In all cases cropland was a source of these water quality problems and the negative impacts of channelization were listed for three of the four sites. Likewise failing HSTSs and cropland runoff are the only sources of bacteria for each of the recreation use impaired sites. Additionally, this 12-digit HUC is estimated to yield a total phosphorus loading of 0.85 pounds per acre per year.

The first two sites on Ninemile Creek at river miles 5.00 and 2.95 respectively, occur along a relatively small stream that is substantially impacted by channelization, vegetation suppression along the riparian zone and drainage from cropland in the form of runoff and sub-surface tile flows which transport sediment and nutrients. There are ample opportunities to install vegetated buffers along the majority of the stream miles since cropland dominated this area and there are few existing buffers. Other management for consideration is nutrient management and planning, cover cropping and residue management, wetland restoration and controlled drainage.

The three sites that are impaired by high concentrations of bacteria each are immediately downstream of homes that are widely spread out but very near the stream. If the HSTSs of these homes are not functioning properly they can be a significant source of bacteria. Inspections and compliance with local specifications is recommended.

6.6.2 Portage River - 05 - 02

Of the six sites surveyed only two fully meet aquatic life use standards while four meet none of the established criteria. Each of the impaired sites suffers from high nutrients and excessive amounts of fine sediment, and two sites on the Portage River immediately down from where Brush Wellman wastewater discharges enter the river suffer from contaminated stream sediments. Sources of the pollutants range from loading that occurs both locally and much farther up in the watershed; however, this 12-digit HUC is estimated to yield a total phosphorus loading of 0.85 pounds per acre per year. One site on Wolf Creek is impaired by nutrients and fine sediment with sources being cropland runoff and channelization. Also the Gibsonburg wastewater treatment plant is a source of the nutrient loading and will be given an effluent limit for total phosphorus.

Eight of eleven sites are impaired for recreation uses with failing HSTSs a source at all of these locations. Runoff from cropland that is receiving land applied manure and possibly sludge as well as the Oak Harbor wastewater treatment plant is also a source of bacteria.

Addressing nutrients for the sites on the Portage River will largely depend on reductions made upstream in the watershed. However, impairment on Wolf Creek can be addressed in a manner similar to many of the other nutrient and sediment impacted small streams in the basin. Buffers, nutrient management, cover cropping and residue management, wetland creation and

restoration, and controlled drainage each are appropriate to be applied in the Wolf Creek watershed. Likewise, bacteria sources can be abated primarily by addressing failing HSTSs and gaining compliance from all point source dischargers in the watershed.

Table 6-6. Restoration and abatement actions recommended for the 05 ten-digit HUC.

Restoration Categories		Specific Restoration Actions	04100010 05	
			01	02
Bank & Riparian Restoration	constructed	Restore streambank using bio-engineering		
		Restore streambank by recontouring or regrading		
	planted	Plant grasses in riparian areas	x	x
		Plant prairie grasses in riparian areas	x	x
		Remove/treat invasive species		
		Plant trees or shrubs in riparian areas	x	x
Stream Restoration		Restore flood plain	x	x
		Restore stream channel	x	x
		Install in-stream habitat structures		
		Install grade structures		
		Construct 2-stage channel	x	x
		Restore natural flow		
Wetland Restoration		Reconnect wetland to stream		
		Reconstruct & restore wetlands	x	x
		Plant wetland species		
Conservation Easements		Acquire agriculture conservation easements		
		Acquire non-agriculture conservation easements		
Home Sewage Planning and Improvement		Develop HSTS plan	x	x
		Inspect HSTS	x	x
		Repair or replace traditional HSTS	x	x
		Repair or replace alternative HSTS	x	x
Education and Outreach		Distribute educational materials		
		Host meetings, workshops and/or other events		
Storm Water Best Mgt Practices	quantity controls	Post-construction BMPs: innovative BMPs		
		Post-construction BMPs: infiltration		
		Post-construction BMPs: retention/detention		
	quality controls	Post-construction BMPs: filtration		
		Construction BMPs: erosion control		
		Construction BMPs: runoff control		
		Construction BMPs: sediment control		
Point Source Controls (Regulatory Programs)	collection and new treatment	Install sewer systems in communities		
		Develop and/or implement long-term control plan (CSOs)		
		Eliminate SSOs/CSOs/by-passes		
	storm water	Implement an MS4 permit		
		Implement an industrial permit		
		Implement a construction permit		
	enhanced	Issue permit(s) and/or modify permit limit(s)		

Restoration Categories		Specific Restoration Actions	04100010 05	
			01	02
	treatment	Improve quality of effluent (Gibsonburg)		x
	monitoring	Establish ambient monitoring program		
		Increase effluent monitoring		
	alternatives	Establish water quality trading		
Agricultural Best Mgt Practices	farmland	Plant cover/manure crops	x	x
		Implement conservation tillage practices	x	x
		Implement grass/legume rotations	x	x
		Convert to permanent hayland	x	x
		Install grassed waterways		
		Install vegetated buffer strips	x	x
		Install / restore wetlands	x	x
	nutrients / agro-chemicals	Conduct soil testing	x	x
		Install nitrogen reduction practices	x	x
		Develop nutrient management plans	x	x
	drainage	Install sinkhole stabilization structures		
		Install controlled drainage system	x	x
		Implement drainage water management	x	x
		Construct overwide ditch	x	x
		Construct 2-stage channel	x	x
	livestock	Implement prescribed & conservation grazing practices		
		Install livestock exclusion fencing		
		Install livestock crossings		
		Install alternative water supplies		
		Install livestock access lanes		
	manure	Implement manure management practices	x	
		Construct animal waste storage structures		
		Implement manure transfer practices		
		Install grass manure spreading strips		
	misc. infra-structure and mgt	Install chemical mixing pads		
		Install heavy use feeding pads		
		Install erosion & sediment control structures		
		Install roof water management practices		
		Install milkhouse waste treatment practices		
		Develop whole farm management plans		

6.7 Reasonable Assurances

The recommendations made in this TMDL report will be carried out if the appropriate entities work to implement them. In particular, activities that do not fall under regulatory authority require that there be a committed effort by state and local agencies, governments, and private groups to carry out and/or facilitate such actions. The availability of adequate resources is also imperative for successful implementation.

When a TMDL is developed for waters impaired by point sources only, the issuance of a NPDES permit(s) provides the reasonable assurance that the wasteload allocations contained in the TMDL will be achieved. This is because 40 C.F.R. 122.44(d)(1)(vii)(B) requires that effluent limits in permits be consistent with the assumptions and requirements of any available wasteload allocation in an approved TMDL.

When a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source load reductions will occur, U.S. EPA's 1991 TMDL Guidance states that the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions. To this end, Appendix E discusses organizations and programs that have an important role or can provide assistance for meeting the goals and recommendations of this TMDL. Efforts specific to this watershed are described in this section.

6.7.1 Local Zoning and Regional Planning

Local zoning is typically controlled at the county or municipality level. Local zoning can be a useful tool for implementing some recommendations of the TMDL, such as streambank setbacks for developing land. Local governments typically conduct planning to meet the sewage disposal needs of the community. Ohio EPA has established guidelines for planning that are useful in the context of Section 208 and the State Water Quality Management Plan. Local governments that follow these guidelines are more likely to have the results of their planning work incorporated into the State 208 plan prepared by Ohio EPA. The Areawide Planning Agencies have established their own operating protocols, committees and processes to involve local governments in shaping their 208 plans.

Planning should account for long range sewer and treatment needs by looking at projections for community growth and development. Comprehensive land use planning, where available, is an excellent tool that can help those assessing the sewage disposal needs of a community or group of communities. In highly populated areas regional solutions involving several communities have proven to be a cost-effective means to solve sewage disposal problems in urban and suburban areas.

TMACOG is one of Ohio's Areawide agencies so it has a local role in developing areawide water quality plans; all four counties are in their service area. TMACOG's website (http://www.tmacog.org/enviro_body.htm) describes the role of the Environmental Council, which oversees and manages the environmental planning functions of TMACOG:

> The Council recommends regional environmental policies and procedures to define and achieve TMACOG's mission for adoption by the Board of Trustees. Through these policies, the strategic, long-term Environmental Council goals of TMACOG are established, and the methods to achieve short-term tactical objectives are determined. The Environmental Council also establishes the administrative support necessary to achieve these goals and objectives.

Also, the Wood County and Ottawa County Plan Commissions are usually represented on Portage River Basin Council.

6.7.2 Local Watershed Groups

The Portage River Basin Council, a committee of TMACOG and its many partners, has been active since 1994 in engaging the public in protecting the Portage River. In addition to early emphasis on educating stakeholders on water quality issues, the Basin Council later moved into planning and implementing projects to control non-point source pollution from agricultural and rural home sewage sources. Since 2007, TMACOG has employed a full time coordinator funded through the ODNR watershed coordinator grant program. A watershed action plan is being developed and will be submitted for state endorsement in 2009. It will become the implementation plan for this TMDL document (TMACOG/Portage River Basin Council, 2009).

6.7.3 Other Sources of Funding and Special Projects

Two Section 319 grants have been implemented in the Portage River watershed since the last survey in 1994. The three year grant awarded in 1999 paid landowners cost share to install filter strips and concentrated flow filter areas along streams and ditches in the Portage River watershed. This grant in conjunction with other farm bill funding has yielded substantial adoption of multiple agricultural Best Management Practices (BMPs) throughout the watershed, but especially in the tributaries of Bull Creek and Rocky Ford Creek in Wood County.

Another Section 319 grant awarded in 2005 provided cost share funding for home sewage system replacement in critical areas identified by TMACOG and the four local Health Departments. A total of 75 failing systems were replaced with on-site treatment systems. Two alternative demonstration projects in Needles Creek and a tributary to Bull Creek in southern Wood County involved the construction of a two-stage ditch as an alternative to the traditional trapezoid drainage ditch. Early results indicate that this BMP provided enhanced water storage during peak flows. Further research is needed

6.7.4 Past and Ongoing Water Resource Evaluation

The Ohio EPA has surveyed various sections of the Portage River basin in the past. Table 6-7 is a brief overview of this activity.

Table 6-7. Ohio EPA reports on water quality in the Portage River watershed.

Survey year	Area covered	Publication year
2006 – 2008	Portage watershed (HUC 10s - 01, 02, 03, 04, and 05).	2010 TSD
1994	The Portage River and several tributaries located throughout the watershed	1995 TSD

According to the Ohio 2010 Integrated Water Quality Monitoring and Assessment Report (Ohio EPA, 2010), the next scheduled Ohio EPA evaluation of this watershed is in 2023. Due to a number of factors, schedules are subject to change.

The Wood County Health Department and BGSU have partnered in a bacteria study focusing on the increased dairy development in the area. As early as 2005, the Portage River watershed was attracting interest from a large dairy development company. As of July 2007, two large-scale dairies were already operating and three more were proposed. Local officials and the public are concerned that these CAFOs will result in the degradation of water quality. The Wood County Health Department committed to sampling private water wells near each proposed dairy and began collecting samples to establish baseline stream water quality, since there was not much information on existing bacterial contamination sources within the

watershed. The USGS began a research study of microbial source tracking in 2008, and sampled the Portage River watershed as a test area for characterizing sources of fecal contamination in a watershed. Scientists with the U.S. Geological Survey, Bowling Green State University, and the Wood County Health Department collected and analyzed 17 environmental water samples and 13 source samples for Bacteroide based host-specific DNA markers. Although the study validated their method, it has not been used yet in routine stream monitoring or complaint investigations in this watershed (USGS, 2008).

There are multiple ongoing watershed restoration projects in the Maumee AOC being administered by Partners for Clean Streams, Duck and Otter Creeks Partnership, TMACOG and many other local partners. Projects range from stream restoration to wetland mitigation, and sediment remediation studies to “green” storm water infrastructure. Agricultural incentives for nutrient and sediment reduction are led by the Natural Resources Conservation Service (NRCS) and the Soil and Water Conservation districts in the three counties. In addition, numerous projects are identified in the Maumee AOC report in the Phase 2 Watershed Restoration Plan.

Early communications should take place between the Ohio EPA and any potential collaborators to discuss research interests and objectives. Areas of overlap should be identified and ways to make all parties research efforts more efficient should be discussed. Ultimately, important questions can be addressed by working collectively and through pooling resources, knowledge and data.

6.7.5 Potential and Future Evaluation

The Ohio EPA is currently scheduled to return to this study area in 2023 to perform another robust water quality survey of the basin. At that time, it will be shown whether improvements have been made to water quality (particularly in response to implementing recommendations of this report) and whether other TMDL development is needed.

6.7.6 Revision to the Improvement Strategy

The Portage River watershed would benefit from an adaptive management approach to restoring water quality. An adaptive management approach allows for changes in the management strategy if environmental indicators suggest that the current strategy is inadequate or ineffective. Adaptive management is recognized as a viable strategy for managing natural resources (Baydack *et al.* 1999).

If chemical water quality does not show improvement and/or water bodies are still not attaining water quality standards after the improvement strategy has been carried out, then a TMDL revision would be initiated. The Ohio EPA would initiate the revision if no other parties wish to do so.

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