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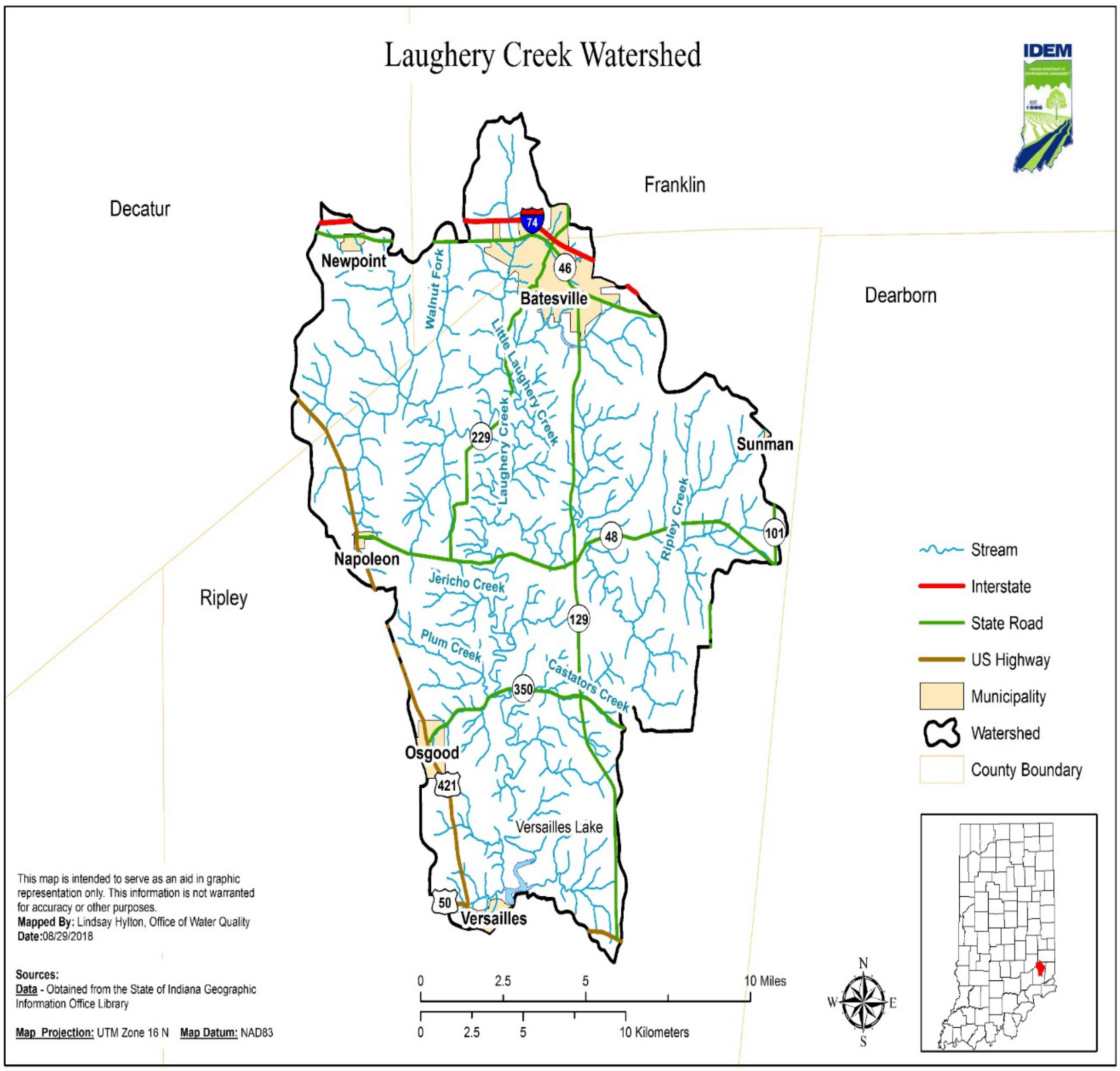
NORTH LAUGHERY CREEK WATERSHED

WATERSHED MANAGEMENT PLAN

PREPARED BY
HISTORIC HOOSIER HILLS RC&D

FUNDED THROUGH
INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT



Acronyms and Abbreviations

AQL	Aquatic Life
BMP	Best Management Practice
C	Celsius
CAFO	Concentrated Animal Feeding Operation
CFO	Confined Feeding Operation
CFS	Cubic Feet per Second
CFU	Colony Forming Unit (Bacteria)
CTIC	Conservation Technology Information Center
DO	Dissolved Oxygen
E.coli	Escherichia coli
FCA	Fish Consumption Advisory
FEMA	Federal Emergency Management Agency
FGDC	Federal Geographic Data Committee
GIS	Geographic Information System
HEL	Highly Erodible Land
HHH	Historic Hoosier Hills
HUC	Hydrologic Unit Code
IAC	Indiana Administrative Code
IBI	Index of Biotic Integrity
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
IGS	Indiana Geological Survey
ISDH	Indiana State Department of Health
LIDAR	Light Detection and Ranging
Mg/l	Milligrams per Liter
MIBI	Macroinvertebrate Index of Biotic Integrity
MS4	Municipal Separate Storm Sewer System
NHD	National Hydrography Dataset
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resource Conservation Service
NTU	Nephelometric Turbidity Units
OWQ	Office of Water Quality (IDEM)
QHEI	Qualitative Habitat Evaluation Index
RC&D	Resource, Conservation & Development
SWCD	Soil and Water Conservation District
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UWA	Unified Watershed Assessment
WQ	Water Quality
WWTP	Wastewater Treatment Plant

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ACKNOWLEDGEMENTS

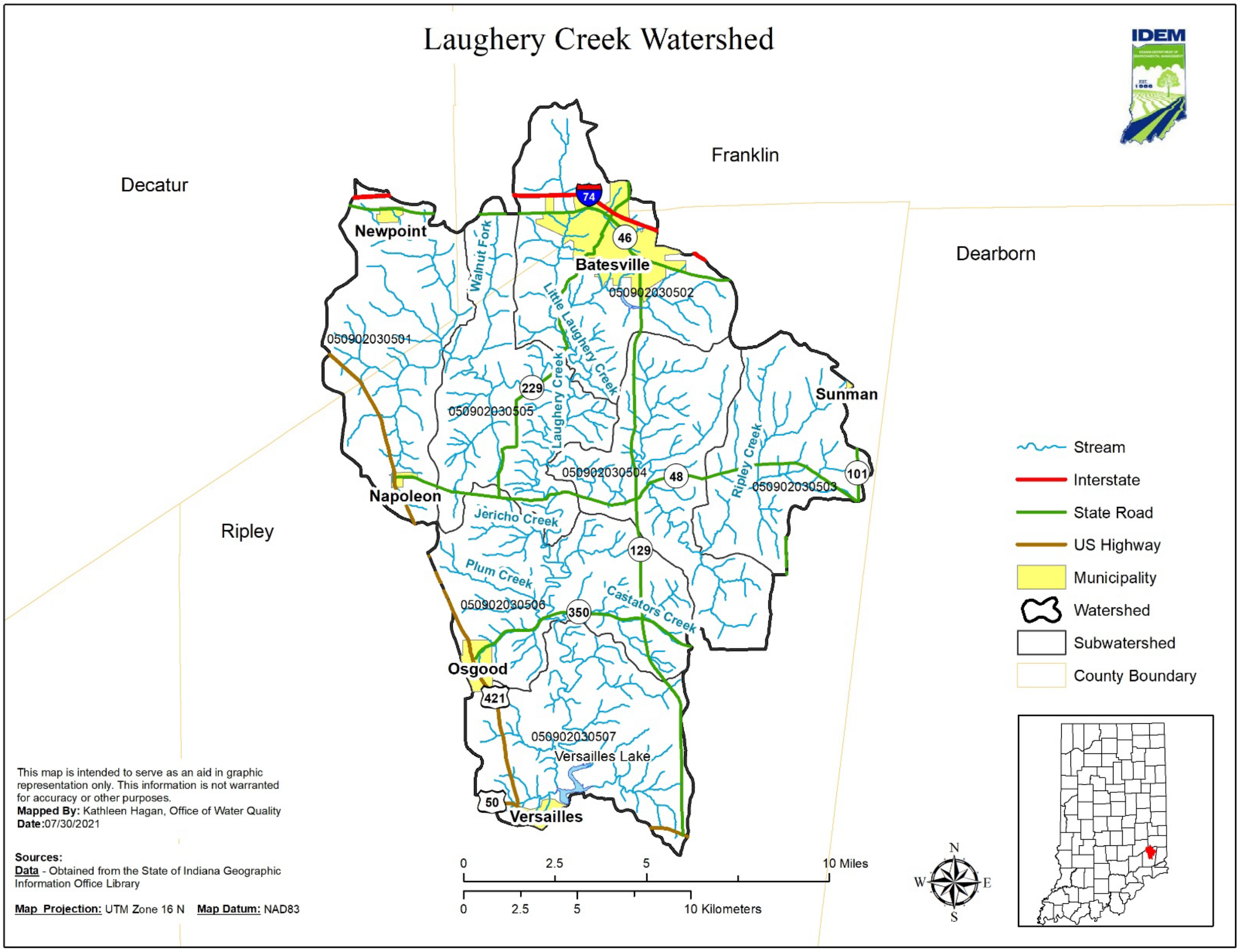
This plan was prepared by Historic Hoosier Hills RC&D along with guidance from the North Laughery Steering Committee. Much of the material and statistical findings included within this plan is thanks to Indiana Department of Environmental Management – Watershed Assessment and Planning Branch.

INTRODUCTION

The purpose of this watershed management plan (WMP) is to summarize available data that influences water quality in a watershed and develop a plan for the watershed community to achieve solutions to address water quality concerns. The North Laughery Creek WMP was funded through an EPA 319 grant administered through the Indiana Department of Environmental Management (IDEM). Much of the data found in this plan was obtained from the Total Maximum Daily Load (TMDL) report for the North Laughery Watershed prepared by the Indiana Department of Environmental Management.

A watershed is an area of land that water flows over and under on its way to a particular body of water. In the United States, watersheds are identified using a hierarchical coding system, Hydrologic Unit Codes (HUC). These HUCs are used as a way of cataloguing portions of the landscape according to drainage. Larger watersheds are identified by shorter codes and smaller watersheds are identified by longer codes; these longer codes are designed to be more specific. The map below shows the 10-digit North Laughery Creek watershed area with the 7 subwatersheds located in it, each with a 12-digit recognition code (HUC). The 7 subwatersheds shown below, encompass a total area of 107,139 acres. North Laughery Creek Watershed is located within portions of 3 counties in southeastern Indiana – Ripley, Franklin, and Decatur.

Figure 1: Location of North Laughery Creek Watershed



WATERSHED COMMUNITY INITIATIVE

Project initiation:

The North Laughery Creek Watershed is a continuation of the water quality improvement initiative that Historic Hoosier Hills started several years ago. Historic Hoosier Hills in partnership with local Soil & Water Conservation Districts, state & federal organizations, local businesses, and landowners within the area have set a goal to assess the quality of water sources within the area. In the North Laughery Creek Watershed, IDEM has identified 20.35 miles of impaired streams due to E. coli, impaired biotic communities, and impaired dissolved oxygen. These impairments are a concern to landowners, businesses, city, and county officials within the watershed; as well as many organizations responsible for providing guidance in the use and conservation of the natural resources within the watershed. By pooling our resources to address these water quality issues we feel we can make a difference in improving this precious resource.

Table 1: Steering Committee Members and Affiliations

Rob Chapman	Environmental Science Instructor at Ivy Tech
Duane Drockleman	Landowner in watershed
Steve Franklin	Ripley SWCD Conservation Technician
Kathleen Hardin	Franklin SWCD District Coordinator
Mike Hughes	NRCS District Conservationist
Kim Jolly	Ripley SWCD District Coordinator
Kim Lampert	NRCS District Conservationist
Brian Miller	Landowner in watershed
Tim Schwipps	NRCS District Conservationist
Terry Stephenson	HHH Project Director
Hermain Strumpf	Landowner in watershed
Mark Thomas	ISDA
Steve Thurnall	FSA County Executive Director
Bob Brewington	Landowner in watershed
Irvin Harmeyer	Landowner in watershed
Mike Bettice	Mayor of Batesville

Many of the stakeholders involved in the North Laughery Watershed Project are individuals from organizations and businesses that Historic Hoosier Hills has worked with in the past on other watershed projects. In addition, individuals representing the towns and counties within the watershed, environmental groups, natural resource professionals, agricultural and commercial representatives, and private citizens comprised the steering committee. Outreach efforts continued throughout the project using a mass media approach such as newspaper, radio, and electronic media. Stakeholder concerns were gathered electronically and through public meetings.

The steering committee has met nearly every quarter to develop the WMP, starting in February of 2020. The group continues to meet to discuss implementation strategies, progress of the cost-share program outreach, grant opportunities, and make revisions to the WMP. Table 1 identifies the steering committee members and their affiliation.

In order to gather information from the public on their views and perspective of the watershed, a stakeholder concern survey was developed. The survey was distributed to stakeholders primarily through the use of electronic means (due to COVID-19). The survey was also sent to 31 residents within the watershed using standard mailings.

Below are the results of the survey.

Table 2: Stakeholder concerns identified during public input sessions, and surveys conducted by electronic means.

Stakeholder Concerns Survey Results				
Stakeholder Concern	**Not a Problem**	**Slight Problem**	**Moderate Problem**	**Major Problem**
Water Quality throughout the Watershed	0	0	6	3
Contaminated Runoff entering Streams	0	1	4	4
Livestock Access to Streams/Sensitive Areas	0	3	3	3
Septic System Failures	0	1	4	4
Excessive Nutrients entering Streams	0	0	4	5
Streambank Erosion	0	1	5	3
Gully Erosion	0	3	5	1
Sediment entering Streams	0	0	4	5
Overgrazed Pastures	0	2	3	4
No Residue/Cover on Fields	0	2	3	4
Invasive Species invading Areas	0	1	4	4
Trash/Dumping Sites	0	4	4	1
Flooding	0	6	2	1
Pulling Stone from Creek	5	3	1	0
No Riparian Buffers	0	3	6	0

There was an additional concern listed within the Stakeholder Survey indicating the need for rural sewage development to include central and distributed treatment systems as well as septic technologies new to Indiana.

SECTION 1 WATERSHED INVENTORY

Topography & Geology of North Laughery Creek Watershed

The landscape of the North Laughery Watershed, as characterized in figure 2 is an upland consisting of broad flats, undulating plains, and steeper areas along streams and drainageways. Narrow bottom land is along the larger streams. The general direction of drainage is to the south. The highest point in the watershed is 1,060 feet above sea level, about a mile north of Sunman. The lowest point, about 590 feet above sea level, is at the base of Laughery Creek at the Ripley-Dearborn County line.

The North Laughery Watershed area is underlain with parent material composed of glacial till in the northern and central portion of the watershed. Certain areas within the watershed have parent material that varies from glacial till to sedimentary bedrock in steeper areas. These areas of exposed bedrock often have areas of karst topography which provides a direct channel to ground water. Karst regions are characterized by the presence of limestone or other soluble rocks, where drainage has been largely diverted into subsurface routes. The topography of such areas is dominated by sinkholes, sinking streams, large springs, and caves. Many subsurface drainage networks in this area are fed by surface streams that sink into caves or swallow holes. Activities that impact the surface water quality can thus be expected to affect ground water as well. Due to the nature of conduit flow, impacts are likely to be ephemeral, and determination of exact directions of transport or affected conduits may be problematic in the absence of detailed dye-tracing studies.

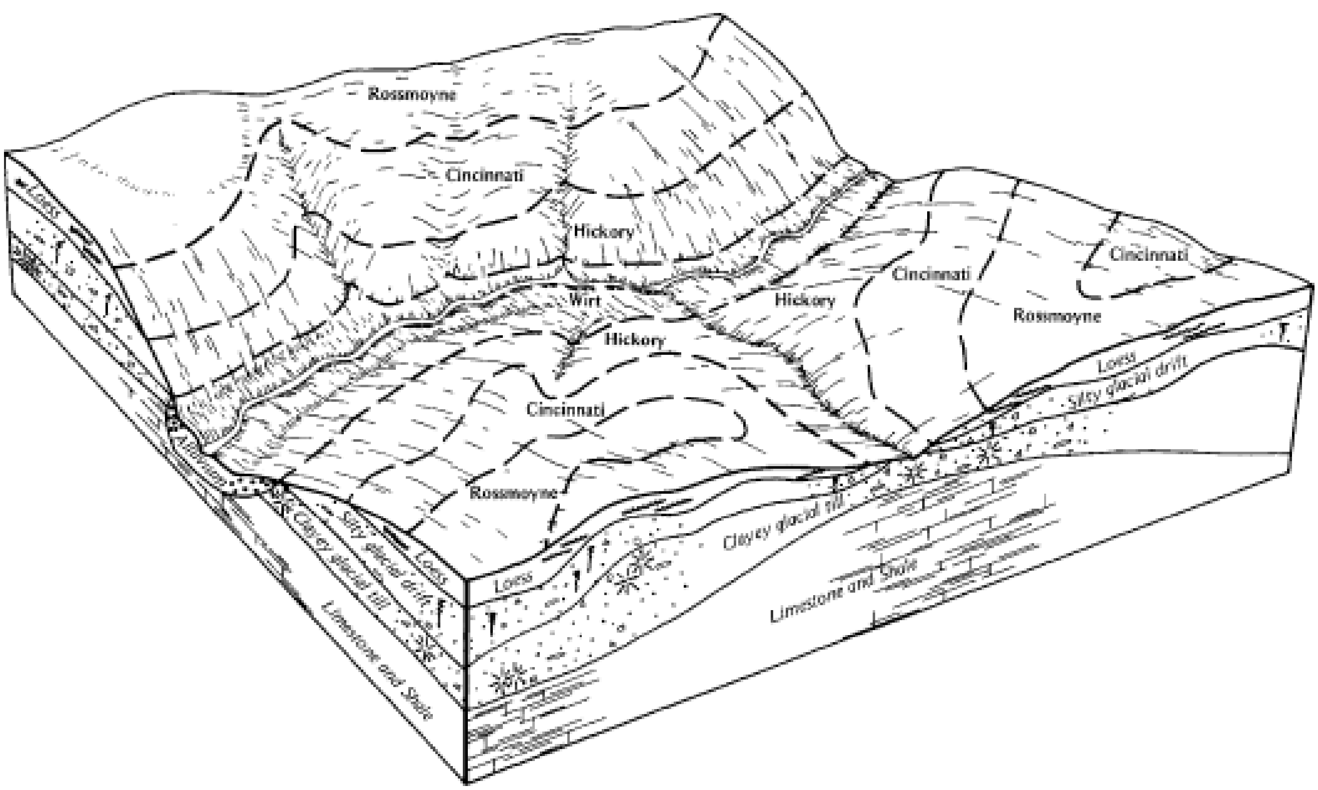
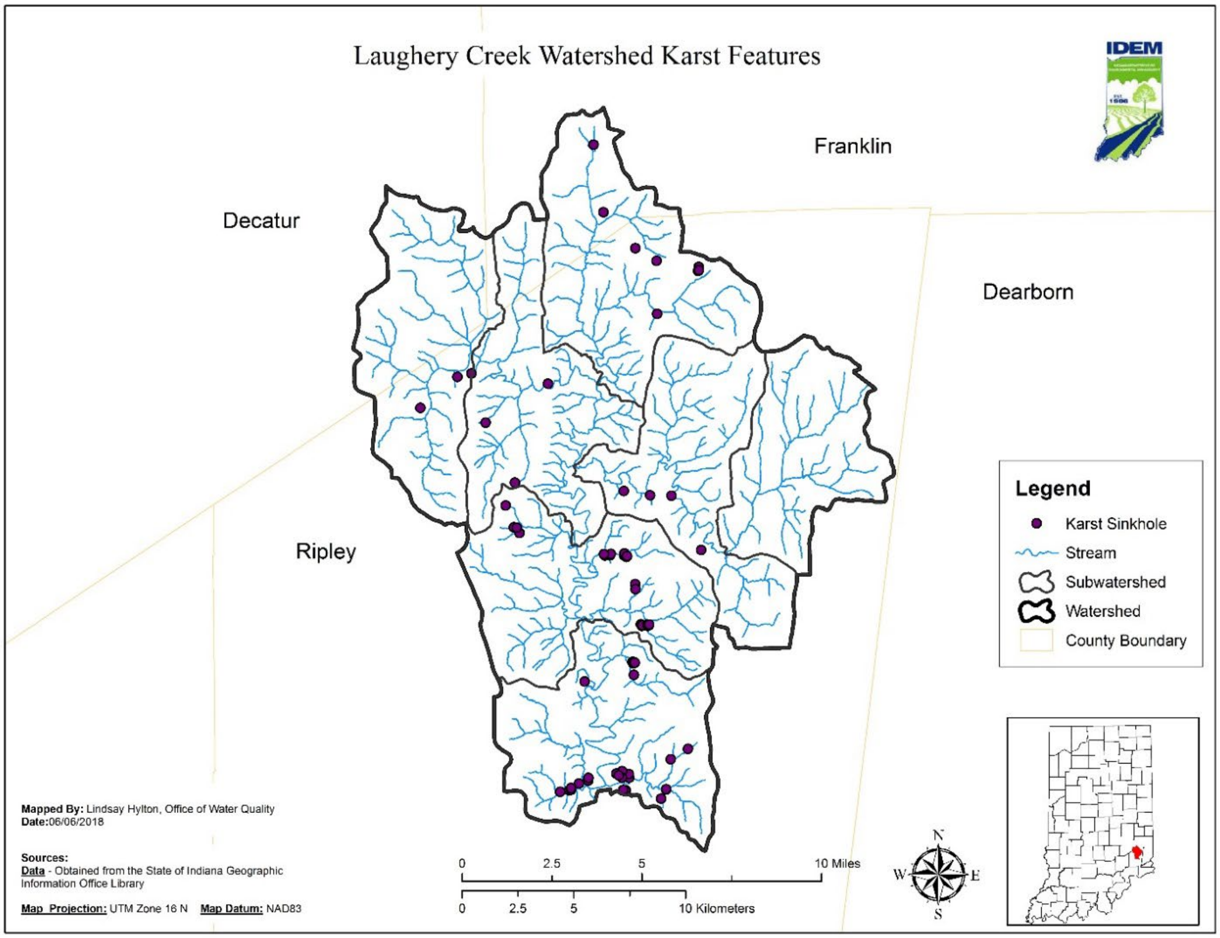


Figure 2: Topography & Soil Associations of North Laughery Watershed

Karst features of the North Laughery Creek Watershed

While the State of Indiana has performed dye-tracing studies in southern Indiana, none have been performed within the North Laughery Creek Watershed (Atlas of hydrogeologic terrains and settings of Indiana, 1995).
The Indiana Karst Conservancy (IKC) is a 501(c)(3) non-profit organization dedicated to the preservation and conservation of Indiana's unique karst features. Unfortunately, many karst features are subject to incompatible or damaging uses. Most are on private land, occasionally with owners unaware of their significance or apathetic to their preservation. There are approximately 40 sinkholes within the watershed. Locations of sinkholes are shown in figure 3. The IKC provides protection and awareness of karst features and the unique habitat they provide. For more information regarding the IKC, visit their website at http://www.ikc.caves.org/.

Figure 3: Location of the karst features of the North Laughery Creek watershed.

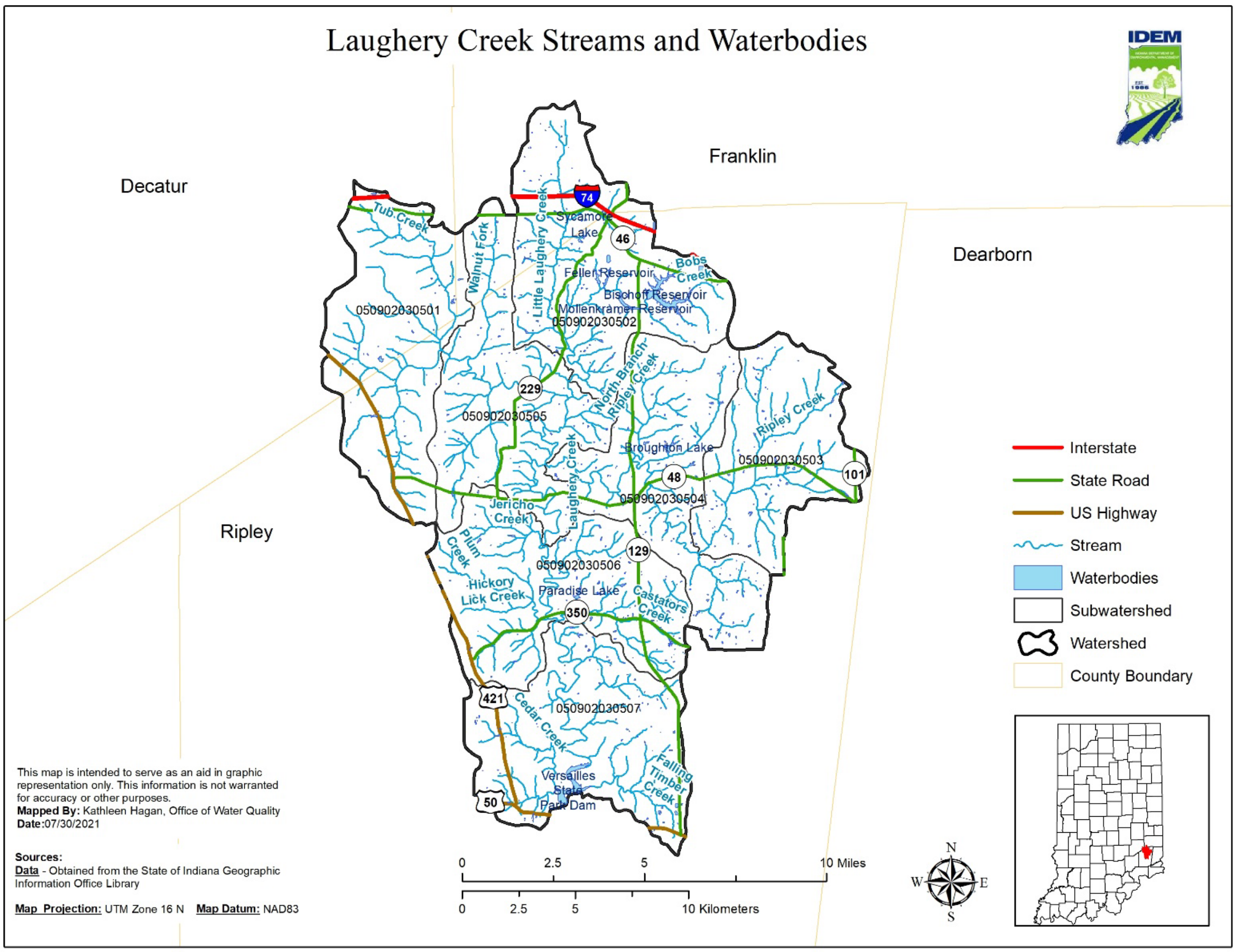


Hydrology of North Laughery Creek Watershed

Streams and Waterbodies of North Laughery Creek Watershed

The North Laughery Watershed (HUC 0509020305) comprises approximately 167.41 square miles (107,138.6 acres) and consists of approximately 341 stream miles. Northern tributaries of the watershed originate in Decatur and Franklin counties and flow south through Ripley County. Laughery is quite scenic and is used by a large number of visitors throughout the year, especially in the southern sector which includes Versailles State Park. Residents and visitors of the watershed often use the lakes and streams for fishing, canoeing, camping, and swimming. Major waterbodies include Bischoff Reservoir and Versailles Lake. There are 779 waterbodies in the watershed comprising 3,538 acres. Due to the many recreational uses of the streams within the watershed, one of the major concerns of the steering committee is overall water quality. There are no legal drains within the watershed.

Figure 4: Streams and Waterbodies located within the North Laughery Watershed



Subwatersheds of Laughery Creek Watershed

The North Laughery watershed is comprised of seven subwatersheds at the 12-digit HUC level. Figure 5 shown below identifies by map each subwatershed in North Laughery by name and location. Table 3 shown below contains information such as subwatershed area and drainage area.

Examining subwatersheds enables an identification of key factors that affect water quality and provides a better understanding of the historic and current conditions that affect water quality and contribute to the impairments. Understanding the natural and human factors affecting the watershed will assist in selecting and tailoring appropriate and feasible implementation activities to achieve water quality standards.

Name of Subwatershed	**12-digit HUC**	**Area Within Watershed (sq. mile)**	**Percent of Watershed Area**	**Drainage Area (sq. miles)**	**Percent of Total Drainage Area**
Tub Creek	050902030501	24.63	14.74%	24.63	14.71%
Walnut Creek	050902030505	23.18	13.88%	117.21	70.01%
Jericho Creek	050902030506	25.24	15.11%	142.45	85.08%
North Branch	050902030504	23.31	13.96%	42.11	25.15%
Headwaters Ripley Creek	050902030503	18.80	11.26%	18.80	11.23%
Little Laughery Creek	050902030502	27.28	16.34%	27.28	16.29%
Henderson Bend	050902030507	24.97	14.95%	167.43	100%

Table 3: Subwatershed drainage area and area within the North Laughery Watershed

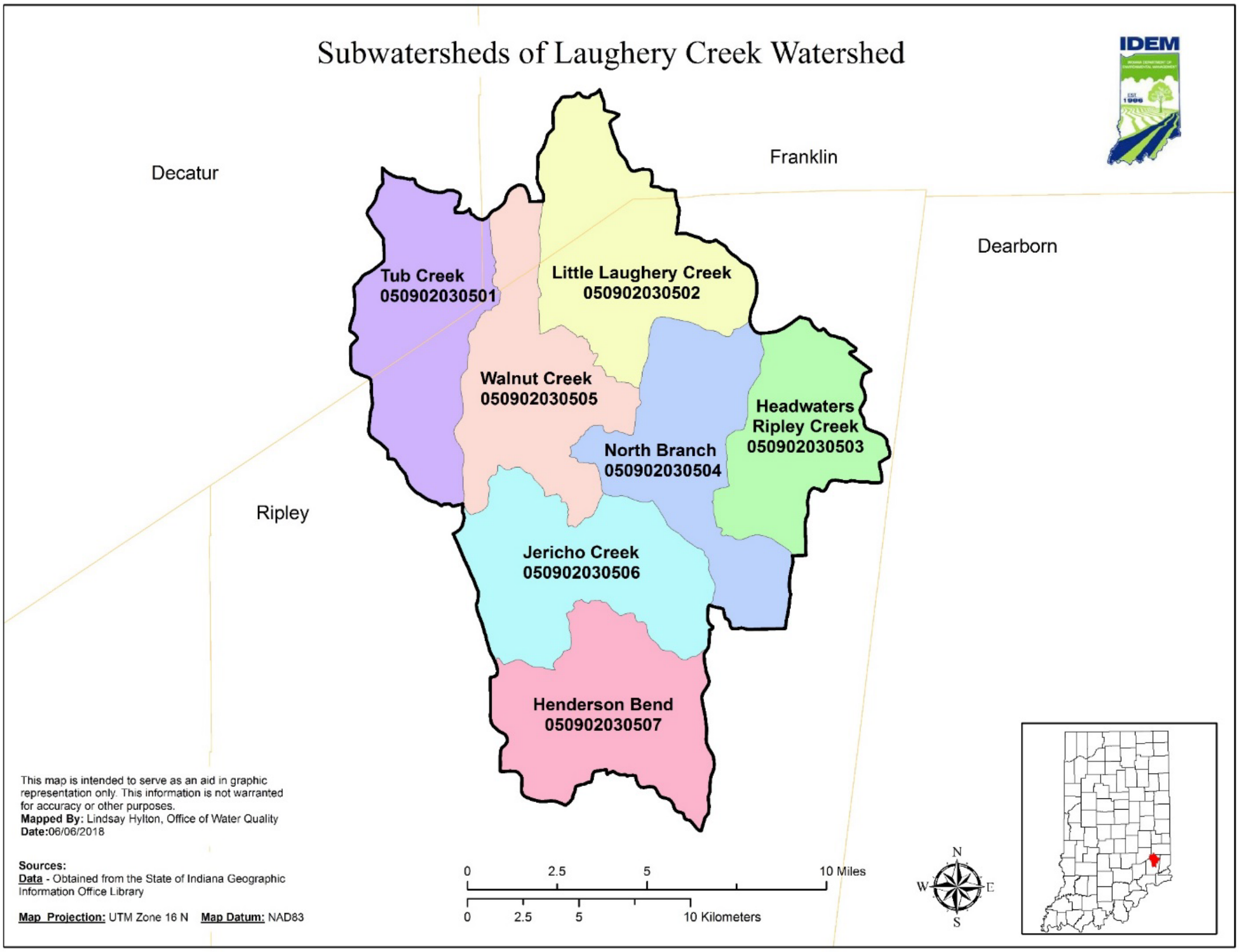
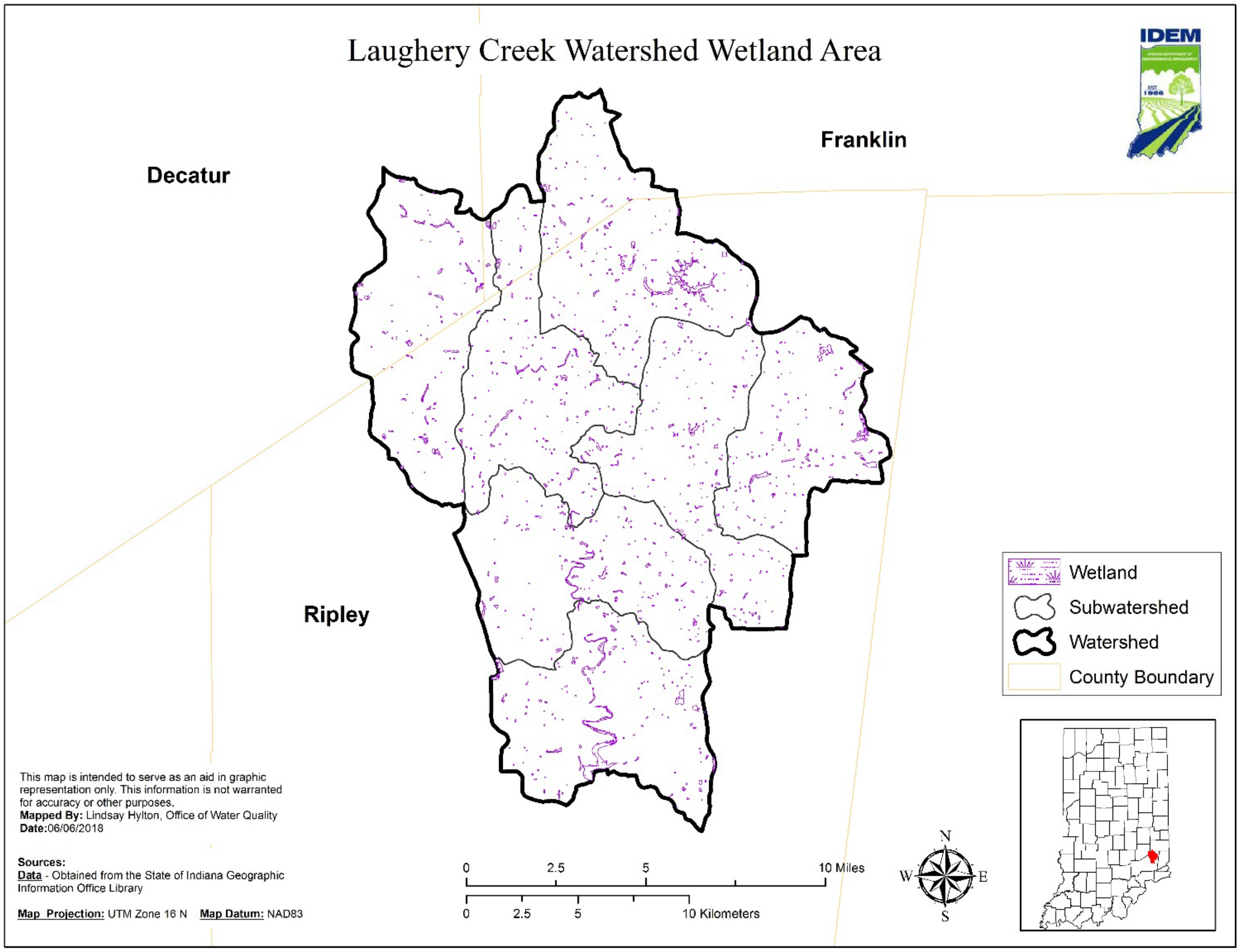


Figure 5: North Laughery Creek Subwatersheds

Wetlands of North Laughery Creek Watershed

Figure 6: Wetlands on North Laughery Creek Watershed



A wetland is an area saturated with water either seasonally or permanently, creating its own ecosystem. Wetlands play important roles for the environment including water purification, flood control, acting as a carbon sink, and shoreline stability. Wetlands are considered the most biologically diverse ecosystem, due to it being the home of a wide range of animal and plant life. There are approximately 1848 acres of wetland scattered throughout the North Laughery Watershed.

Nationally, since the late 1600s, we have lost roughly 50% of the wetlands in the lower 48 states. Indiana has lost a large number of its wetlands. In the 1800s and 1900s millions of acres of wetlands were converted into farms, cities, and roads. We also converted wetlands to protect our health. In the early 1700s, wetlands covered 25% of the total area of Indiana. That number has been greatly reduced. By the late 1980s over 4.7 million acres of wetlands had been lost. Before the conversion of these wetlands, there were over 5.6 million acres of them in the state, such as bogs, fens, wet prairies, dune and swales, cypress swamps, marshes, and swamps. Wetlands now cover less than 4% of Indiana (http://www.in.gov/idem/wetlands/2335.htm)

Wetlands are home to wildlife. More than one-third (1/3) of America's threatened and endangered species live only in wetlands, which means they need them to survive. Over 200 species of birds rely on wetlands for feeding, nesting, foraging, and roosting. Wetlands provide areas for recreation, education, and aesthetics. More than 98 million people hunt, fish, birdwatch, or photograph wildlife. Americans spend $59.5 billion annually on these activities (http://www.in.gov/idem/wetlands/2335.htm). Additionally, wetland plants and soils naturally store and filter nutrients and sediments. Calm wetland waters, with their flat surface and flow characteristics, allow these materials to settle out of the water column, where plants in the wetland take up certain nutrients from the water. As a result, our lakes, rivers and streams are cleaner and our drinking water is safer. Man-made wetlands can even be used to clean wastewater, when properly designed. Wetlands also recharge our underground aquifers - over 70% of Indiana residents rely on ground water for part or all of their drinking water needs (http://www.in.gov/idem/wetlands/2335.htm). Lastly, wetlands protect our homes from floods. Like sponges, wetlands soak up and slowly release floodwaters. This lowers flood heights and slows the flow of water down rivers and streams. Wetlands also control erosion. Shorelines along rivers, lakes, and streams are protected by wetlands, which hold soil in place, absorb the energy of waves, and buffer strong currents. Agencies such as the USGS and U.S. Fish and Wildlife Service (USFWS) estimate that Indiana has lost approximately 85 percent of the state's original wetlands.

Hydrologic Modifications within North Laughery Creek Watershed

Changes made to the natural drainage patterns of a watershed are referred to as hydromodification. Historically, drain tiles have been used throughout Indiana to drain marsh or wetlands and make them either habitable or tillable for agricultural purposes. While tile drainage is understood to be pervasive – estimated at thousands of miles in Indiana – it is extremely challenging to quantify on a watershed basis because these tiles were established by varying authorities, including County Courts, County Commissioners, or County Drainage Boards. Records were not kept by private landowners as to the location and quantity of these tiles.

Soil Characteristics of North Laughery Creek Watershed

The various soil characteristics can affect the health of a watershed in different ways. These characteristics include soil drainage, septic tank suitability, soil saturation, and soil erodibility.

Soil Drainage

The hydrologic soil group classification is a means for categorizing soils by similar infiltration and runoff characteristics during periods of prolonged wetting. The NRCS has defined four hydrologic groups for soils, described in Table 4 (NRCS, 2001). Data for the North Laughery Creek watershed were obtained from the USDA Soil Survey Geographic (SSURGO) database. Downloaded data were summarized based on the major hydrologic group in the surface layers of the map unit and are displayed below.

The majority of the watershed is covered by category D soils (71%) followed by category B soils (16%), category C soils (13%), and nearly no category A soils. Category D soils have a high clay content and slow infiltration rates. This means that regular flooding could be typical in much of this watershed, which in turn may transport pollutants across the landscape and into nearby streams. Sediment and nutrient load is a major concern of the steering committee.

Hydrologic Soils Group	Description
A	Soils with high infiltrations rates. Usually deep, well drained sands or gravels. Little runoff.
B	Soils with moderate infiltration rates. Usually moderately deep, moderately well drained soils.
C	Soils with slow infiltration rates. Soils with finer textures and slow water movement.
D	Soils with very slow infiltration rates. Soils with high clay content and poor drainage. High amounts of runoff.

Table 4: Hydrologic Soil Groups

Typically, clay soils that are poorly drained have lower infiltration rates, while well-drained sandy soils have the greatest infiltration rates. Soil infiltration rates can affect pollutant loading within a watershed. During high flows, areas with low soil infiltration capacity can flood and therefore discharge high pollutant loads to nearby waterways. In contrast, soils with high infiltration rates can slow the movement of pollutants to streams. The effect of clay soils and low infiltration rates are a concern in the functioning of septic systems which was identified in the list of concerns by the steering committee.

Subwatershed	Hydrologic Soil Group			
	A	B	C	D
Tub Creek	**0.00%**	**5.19%**	**4.08%**	**90.72%**
Little Laughery Creek	**0.00%**	**13.17%**	**11.75%**	**75.07%**
Headwaters Ripley Creek	**0.00%**	**10.23%**	**9.47%**	**80.30%**
North Branch	**0.00%**	**15.47%**	**12.10%**	**72.44%**
Walnut Creek	**0.01%**	**15.56%**	**8.04%**	**76.40%**
Jericho Creek	**0.00%**	**14.42%**	**11.57%**	**74.02%**
Henderson Bend	**0.00%**	**13.66%**	**13.70%**	**72.64%**

Table 5: Hydrologic Soil Group subwatershed percentages

Hydric Soils of North Laughery Creek Watershed

Soils that remain saturated or inundated with water for a sufficient length of time become hydric through a series of chemical, physical, and biological processes. Once a soil takes on hydric characteristics, it retains those characteristics even after the soil is drained. Hydric soils have been identified in the Laughery Creek Watershed and are important in consideration of wetland restoration activities. Approximately 75.8 square miles or 45 percent of the Laughery Creek Watershed area contains soils that are considered hydric. However, a large majority of these soils have been drained for either agricultural production or urban development and would no longer support a wetland. The location of remaining hydric soil can be used to consider possible locations of wetland creation or enhancement. There are many components in addition to soil type that must be considered before moving forward with wetland design and creation. Additional information on wetlands can be found on the IDEM website http://www.in.gov/idem/wetlands/

Figure 7: Map of Hydric Soils in North Laughery Creek Watershed

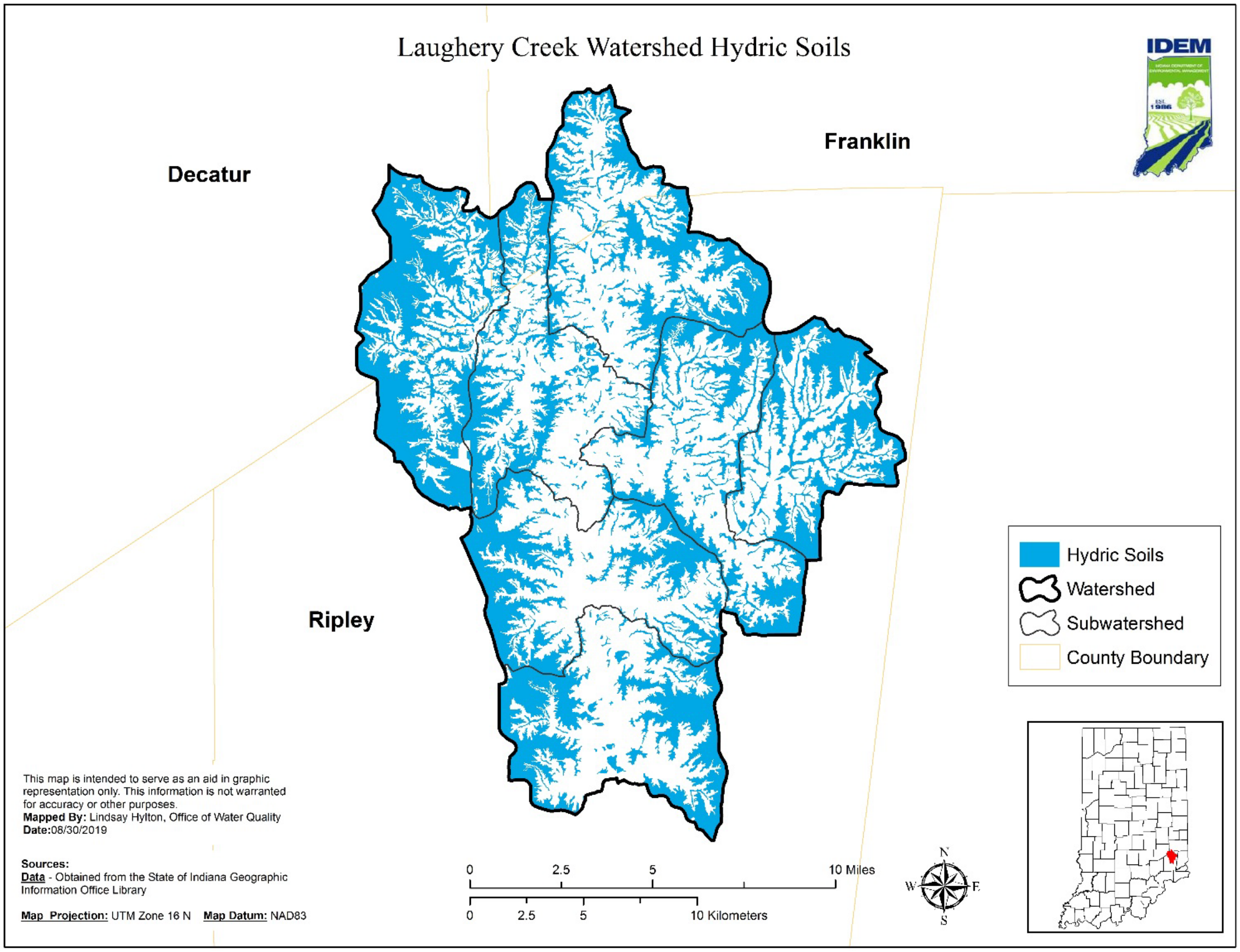


Table 6: Hydric soils by Subwatershed in the North Laughery Creek Watershed

Subwatershed	Map Symbol	Hydric Soil Types	Acres
Tub Creek	Ag	Algiers silt loam, frequently flooded	3
	AvA	Avonburg silt loam, 0 to 2% slopes	3251
	AvB	Avonburg silt loam, 2 to 4% slopes	207
	AvB2	Avonburg silt loam, 2 to 6% slopes, eroded	383
	BaA	Bartle silt loam, 0 to 2% slopes	31
	Cm	Cobbsfork silt loam, 0 to 1% slopes	5363
	Hn	Holton silt loam, frequently flooded	295
	Ht	Holton silt loam, occasionally flooded	15
	Or	Orrville silt loam, frequently flooded	670
	Wa	Wakeland silt loam, frequently flooded	30
		Total	**10,248**
Little Laughery Creek	Ag	Algiers silt loam, frequently flooded	11
	AvA	Avonburg silt loam, 0 to 2% slopes	2969
	AvB2	Avonburg silt loam, 2 to 6% slopes, eroded	171
	BaA	Bartle silt loam, 0 to 2% slopes	35

Subwatershed	Map Symbol	Hydric Soil Types	Acres
	Cm	Cobbsfork silt loam, 0 to 1% slopes	3444
	Hn	Holton silt loam, frequently flooded	267
	Ht	Holton silt loam, occasionally flooded	305
	Wa	Wakeland silt loam, frequently flooded	179
		Total	**7,381**
Headwaters Ripley Creek	Ag	Algiers silt loam, frequently flooded	329
	AvA	Avonburg silt loam, 0 to 2% slopes	2884
	AvB2	Avonburg silt loam, 2 to 6% slopes, eroded	166
	BaA	Bartle silt loam, 0 to 2% slopes	49
	Cm	Cobbsfork silt loam, 0 to 1% slopes	1830
	Hn	Holton silt loam, frequently flooded	363
	Wa	Wakeland silt loam, frequently flooded	255
		Total	**5,876**
North Branch	Ag	Algiers silt loam, frequently flooded	91
	AvA	Avonburg silt loam, 0 to 2% slopes	2231
	AvB2	Avonburg silt loam, 2 to 6% slopes, eroded	277
	BaA	Bartle silt loam, 0 to 2% slopes	52
	Cm	Cobbsfork silt loam, 0 to 1% slopes	2419
	Hn	Holton silt loam, frequently flooded	367
	Wa	Wakeland silt loam, frequently flooded	224
		Total	**5,661**
Walnut Creek	Ag	Algiers silt loam, frequently flooded	15
	AvA	Avonburg silt loam, 0 to 2% slopes	2542
	AvB2	Avonburg silt loam, 2 to 6% slopes, eroded	344
	BaA	Bartle silt loam, 0 to 2% slopes	103
	Cm	Cobbsfork silt loam, 0 to 1% slopes	1747
	Hn	Holton silt loam, frequently flooded	154
	Ht	Holton silt loam, occasionally flooded	184
	Wa	Wakeland silt loam, frequently flooded	279
		Total	**5,368**
Jericho Creek	AvA	Avonburg silt loam, 0 to 2% slopes	2556
	AvB2	Avonburg silt loam, 2 to 6% slopes, eroded	419
	BaA	Bartle silt loam, 0 to 2% slopes	17
	Cm	Cobbsfork silt loam, 0 to 1% slopes	3587
	Hn	Holton silt loam, frequently flooded	197
	Wa	Wakeland silt loam, frequently flooded	57
		Total	**6,833**
Henderson Bend	Ag	Algiers silt loam, frequently flooded	21
	AvA	Avonburg silt loam, 0 to 2% slopes	1279
	AvB2	Avonburg silt loam, 2 to 6% slopes, eroded	905
	BaA	Bartle silt loam, 0 to 2% slopes	157
	Cm	Cobbsfork silt loam, 0 to 1% slopes	4538
	Hn	Holton silt loam, frequently flooded	189
	Wa	Wakeland silt loam, frequently flooded	55
		Total	**7,144**

In the North Laughery Creek watershed, the Tub Creek subwatershed has the most acreage of hydric soils. Areas within this subwatershed and others might contain opportunities for wetland restoration activities that could help address water quality impairments.

Highly Erodible Soils of North Laughery Creek Watershed

Although erosion is a natural process within stream ecosystems, excessive erosion negatively impacts the health of watersheds. Erosion increases sedimentation of the streambeds, which impacts the quality of habitat for fish and other organisms. Erosion also impacts water quality as it increases nutrients and decreases water clarity. As water flows over land and enters the stream as runoff, it carries pollutants and other nutrients that are attached to the sediment. Sediment suspended in the water blocks light needed by plants for photosynthesis and clogs respiratory surfaces of aquatic organisms.

The NRCS maintains a list of highly erodible land (HEL) units for each county based upon the potential of soil units to erode from the land (https://efotg.sc.egov.usda.gov/references/public/NE/HEL_Intro.pdf). HELs are especially susceptible to the erosional forces of wind and water. Wind erosion is common in flat areas where vegetation is sparse or where soil is loose, dry, and finely granulated. Wind erosion damages land and natural vegetation by removing productive top soil from one place and depositing it in another. The classification for HELs is based upon an erodibility index for a soil, which is determined by dividing the potential average annual rate of erosion by the soil unit's soil loss tolerance (T) value, which is the maximum annual rate of erosion that could occur without causing a decline in long-term productivity. HELs and potential HELs in the Laughery Creek Watershed are mapped in Figure 8. The soil types and acreages in the Laughery Creek Watershed are listed in Table .

A total of 81,811 acres or 76 percent of the Laughery Creek watershed is considered highly erodible or potentially highly erodible. Rainfall throughout the Laughery Creek Watershed is moderately heavy, with an annual average of 44.8 inches. Rainfall and climate data specific to the watershed is available from the Midwestern Regional Climate Center Cli-MATE webpage (http://mrcc.isws.illinois.edu/CLIMATE/). Heavy rainfall increases flow rates within streams as the volume and velocity of water moving through the stream channels increases. Velocity of water also increases as streambank steepness increases.

Streambank erosion is potentially a significant source of the total suspended solids (TSS) in the North Laughery Watershed. Streambank erosion is a natural process but can be accelerated due to a variety of human activities:

Vegetation located adjacent to streams flowing through crop or pasture fields is often removed to promote drainage or cattle access to water. The loss of vegetation makes the streambanks more susceptible to erosion due to the loss of plant roots.

Extensive areas of agricultural tiles promote much quicker delivery of rainfall into streams than would occur without subsurface drainage, which could potentially contribute to streambank erosion due to high velocities and shear stress.

The creation of impervious surfaces (e.g., streets, rooftops, driveways, parking lots) can also lead to rapid runoff of rainfall and higher stream velocities that might cause streambank erosion.

Figure 8: Map showing location of HEL Soils within North Laughery Watershed

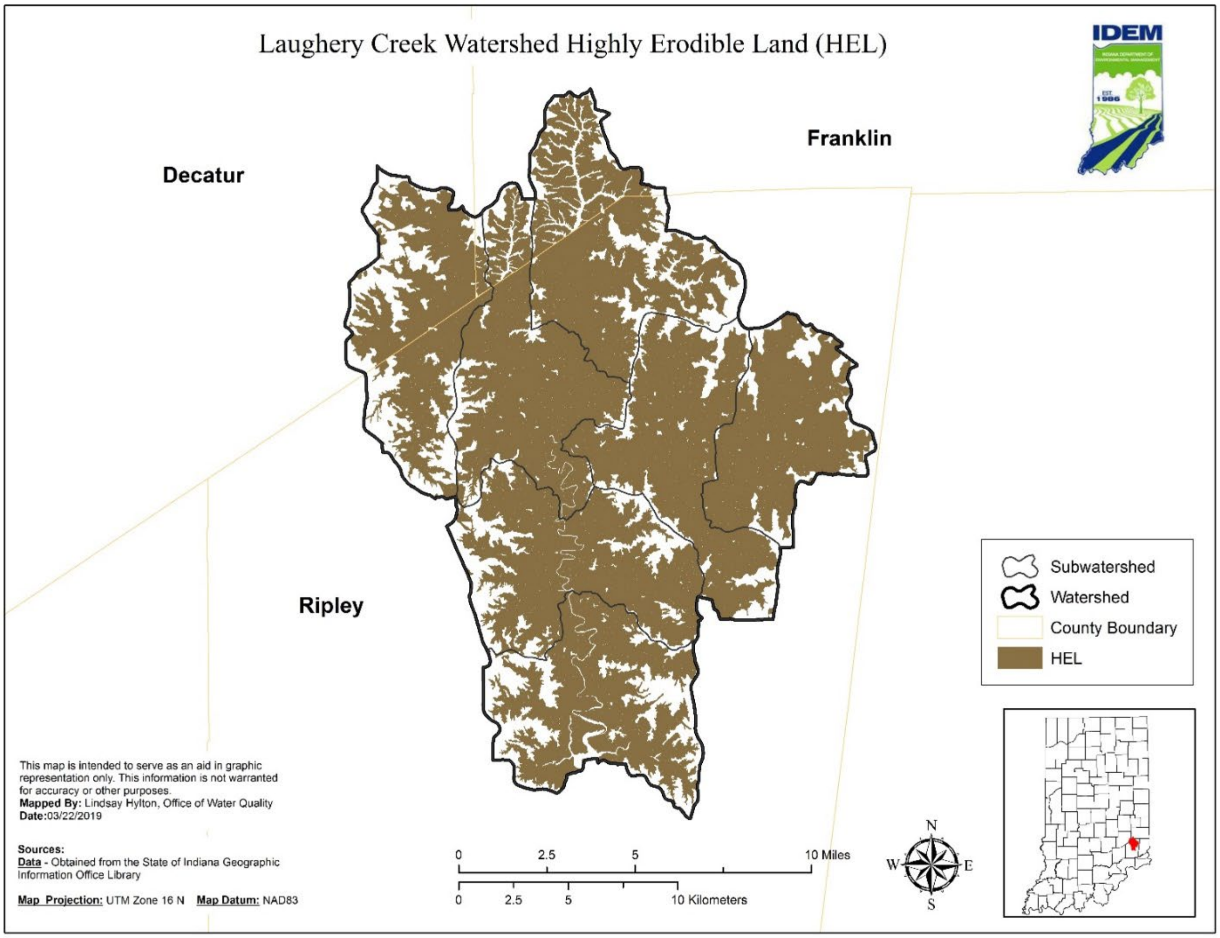


Table 7: HEL/Potential HEL Total Acres in the North Laughery Creek Watershed

Map Symbol	HEL/Potential HEL Soil Types	Acres
Ag	Algiers silt loam, frequently flooded	471
AlB	Alvin sandy loam, 2 to 6 percent slopes	2
AvA	Avonburg silt loam, 0 to 2 percent slopes	17712
AvB	Avonburg silt loam, 2 to 4 percent slopes	207
AvB2	Avonburg silt loam, 2 to 6 percent slopes, eroded	2666
BaA	Bartle silt loam, 0 to 2 percent slopes	443
BeD3	Bonnell silt loam, 12 to 18 percent slopes, severely eroded	8
BnF	Bonnell loam, 25 to 50 percent slopes	13
BoD2	Bonnell silt loam, 12 to 18 percent slopes, eroded	326
BoE2	Bonnell silt loam, 18 to 25 percent slopes, eroded	142
BpD3	Bonnell clay loam, 12 to 18 percent slopes, severely eroded	173
CbD2	Carmel silt loam, 12 to 18 percent slopes, eroded	749
CbE	Carmel silt loam, 18 to 35 percent slopes	495
CcB2	Cincinnati silt loam, 2 to 6 percent slopes, eroded	3194
CcC2	Cincinnati silt loam, 6 to 12 percent slopes, eroded	7012

CcC3	Cincinnati silt loam, 6 to 12 percent slopes, severely eroded	4686
CcD2	Cincinnati silt loam, 12 to 18 percent slopes, eroded	680
Cg	Chagrin loam, frequently flooded	54
Ch	Chagrin variant silt loam, frequently flooded	23
CkB2	Cincinnati silt loam, 2 to 6 percent slopes, eroded	233
CkC2	Cincinnati silt loam, 6 to 12 percent slopes, eroded	637
CkC3	Cincinnati silt loam, 6 to 12 percent slopes, severely eroded	1749
EdE	Eden flaggy silty clay loam, 18 to 25 percent slopes	228
EdF	Eden flaggy silty clay, 25 to 50 percent slopes	1455
EkB	Elkinsville silt loam, 2 to 6 percent slopes	130
EkC2	Elkinsville silt loam, 6 to 12 percent slopes, eroded	172
GfD	Grayford silt loam, 10 to 20 percent slopes	3
GrD2	Grayford silty clay loam, 12 to 18 percent slopes, eroded	13
GrE	Grayford silt loam, 18 to 35 percent slopes	26
Hd	Haymond silt loam, frequently flooded	784
HkD2	Hickory loam, 12 to 18 percent slopes, eroded	3655
HkD3	Hickory silt loam, Muscatatuck Plateau, 12 to 18 percent slopes, severely eroded	1718
HkE	Hickory loam, 18 to 35 percent slopes	8555
HkE2	Hickory loam, 18 to 25 percent slopes, eroded	251
HkF	Hickory loam, 25 to 50 percent slopes	8
HlD3	Hickory clay loam, 12 to 18 percent slopes, severely eroded	42
Hn	Holton silt loam, frequently flooded	1831
Map Symbol	**HEL/Potential HEL Soil Types**	**Acres**
Lb	Lobdell silt loam, frequently flooded	772
No	Nolin silt loam, frequently flooded	13
Or	Orrville silt loam, frequently flooded	670
PeB2	Pekin silt loam, 2 to 6 percent slopes, eroded	520
RoA	Rossmoyne silt loam, 0 to 2 percent slopes	1030
RoB2	Nabb silt loam, 2 to 6 percent slopes, eroded	11923
RsA	Rossmoyne silt loam, 0 to 2 percent slopes	17
RsB2	Nabb silt loam, 2 to 6 percent slopes, eroded	2993
RyC2	Ryker silt loam, 6 to 12 percent slopes, eroded	42
SwC2	Switzerland silt loam, 6 to 12 percent slopes, eroded	372
SwD2	Switzerland silt loam, 12 to 18 percent slopes, eroded	132
Wa	Wakeland silt loam, frequently flooded	1079
Wr	Wirt loam, flaggy clay substratum, frequently flooded	342
Wt	Wirt silt loam, frequently flooded	1354

Of the 3 counties within the North Laughery Creek Watershed, Ripley County has the most acreage of HEL/potential HEL soils. Areas within this county might contribute to water quality impairments associated with excessive erosion, including IBC/TSS, and might contain opportunities for restoration to decrease erosion.

Septic System Suitability

As stated in the North Laughery Watershed TMDL report, septic systems require soil characteristics and geology that allow gradual seepage of wastewater into the surrounding soils. Seasonal high water tables, shallow compact till and coarse soils present limitations for septic systems. While system design can often overcome these limitations (i.e., perimeter drains, mound systems or pressure distribution), sometimes the soil characteristics prove to be unsuitable for any type of traditional septic system.

Heavy clay soils require larger (and therefore more expensive) absorption fields; while sandier, well-drained soils are often suitable for smaller, more affordable gravity-flow trench systems.

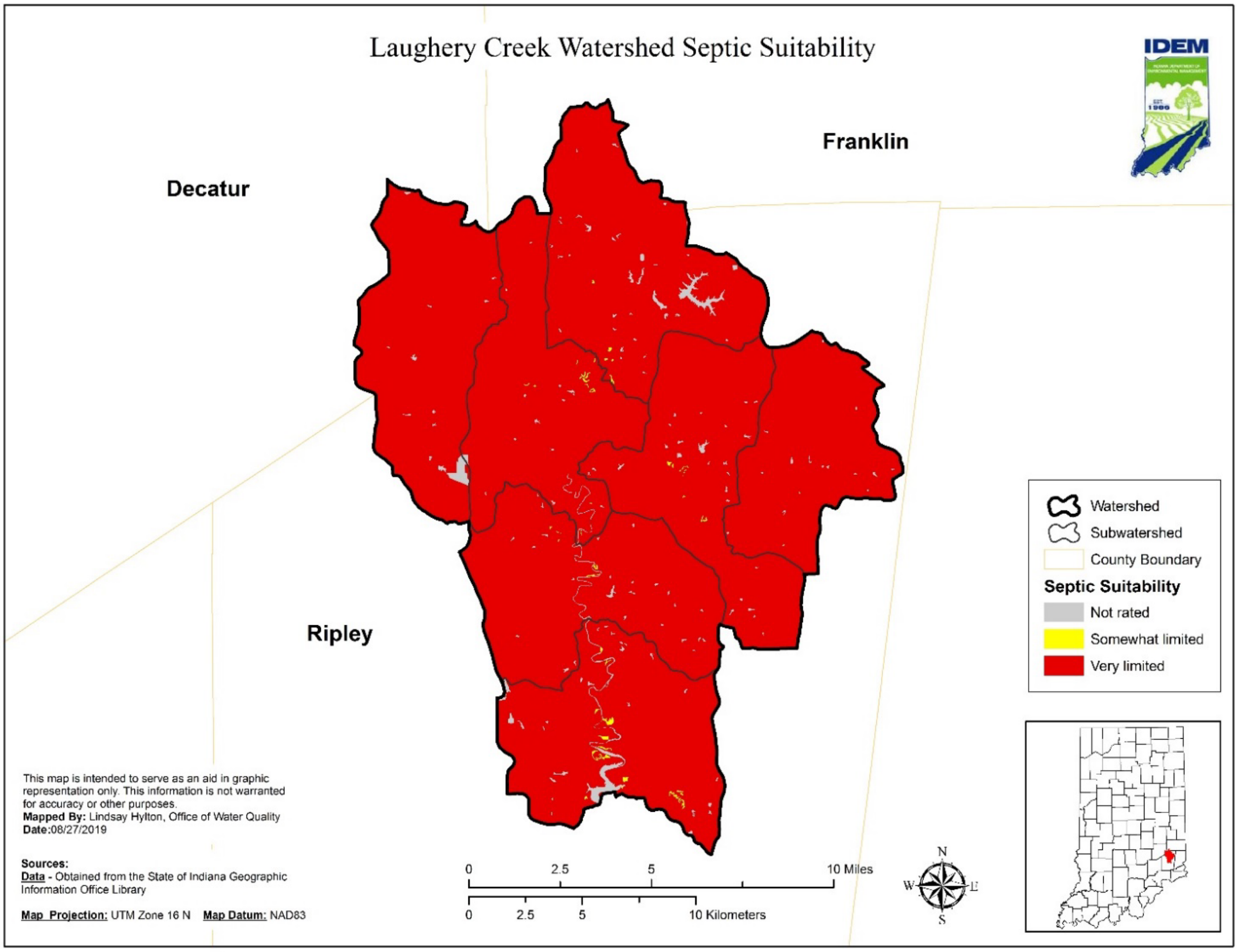
The septic system is considered failing when the system exhibits one or more of the following:

1. The system refuses to accept sewage at the rate of design application, thereby interfering with the normal use of plumbing fixtures
2. Effluent discharge exceeds the absorptive capacity of the soil, resulting in ponding, seepage, or other discharge of the effluent to the ground surface or to surface waters
3. Effluent is discharged from the system, causing contamination of a potable water supply, ground water, or surface water.

Figure 9 below shows ratings that indicate the extent to which the soils are suitable for septic systems within the Laughery Creek Watershed. Only the part of the soil between depths of 24 and 60 inches is evaluated for septic system suitability. The ratings are based on the soil properties that affect absorption of the effluent, construction, maintenance of the system, and public health.

Soils labeled “very limited” indicate that the soil has at least one feature that is unfavorable for septic systems. Approximately 98 percent of the Laughery Creek watershed is considered “very limited” in terms of soil suitability for septic systems. These limitations generally cannot be overcome without major soil reclamation or expensive installation designs. Approximately less than 2 percent of the soils within the Laughery Creek watershed are “not rated,” meaning these soils have not been assigned a rating class because it is not industry standard to install a septic system in these geographic locations. Approximately less than 1 percent of the soils in the Laughery Creek watershed are designated “somewhat limited,” meaning that the soil type could be suitable for septic systems.

Figure 9: Suitability of Soils for Septic Systems in the Laughery Creek Watershed



Onsite wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, onsite systems do fail for a variety of reasons. Common soil-type limitations which contribute to failure are: seasonal water tables, compact glacial till, bedrock, coarse sand and gravel outwash and fragipan. When these septic systems fail hydraulically (surface breakouts) or hydrogeological (inadequate soil filtration) there can be adverse effects to surface waters, due to *E. coli,* nitrate + nitrite, and total phosphorus (Horsely and Witten, 1996). Septic systems contain all the water discharged from homes and business and can be significant sources of pathogens and nutrients.

The Indiana State Department of Health (ISDH) regulates (410 IAC 6-8.3) through the local health departments the residential onsite sewage disposal program. Onsite sewage disposal systems (i.e. septic systems) are those which do not result in an off-lot discharge of treated effluent, typically consisting of a septic tank to settle out and digest sewage solids, followed by a system of perforated piping to distribute the treated wastewater for absorption into the soil. More than 800,000 onsite sewage disposal systems piping to distribute are currently used in Indiana. Local health departments in Indiana issue more than 15,000 permits per year for new systems, and about 6,000 permits for repairs.

410 IAC 6-8.3-52 General sewage disposal requirements Sec. 52. (a) No person shall throw, run, drain, seep, or otherwise dispose into any of the surface waters or ground waters of this state, or cause, permit, or suffer to be thrown, run, drained, allowed to seep, or otherwise disposed into such waters, any organic or inorganic matter from a dwelling or residential onsite sewage system that would cause or contribute to a health hazard or water pollution. (b)

The: (1) design; (2) construction; (3) installation; (4) location; (5) maintenance; and (6) operation; of residential onsite sewage systems shall comply with the provisions of this rule.

410 IAC 6-8.3-55 Violations; permit denial and revocation Sec. 55. (a) Should a residential onsite sewage system fail, the failure shall be corrected by the owner within the time limit set by the health officer. (b) If any component of a residential onsite sewage system is found to be: (1) defective; (2) malfunctioning; or (3) in need of service; the health officer may require the repair, replacement, or service of that component. The repair, replacement, or service shall be conducted within the time limit set by the health officer. (c) Any person found to be violating this rule may be served by the health officer with a written order stating the nature of the violation and providing a time limit for satisfactory correction thereof.

A comprehensive database of septic systems within the Laughery Creek watershed is not available; therefore, the rural population of each subwatershed was calculated to obtain a general representation of the number of systems. The US Census provides the total number of people within a county as well as the total urban and rural population of the county. Subwatershed population is estimated by dividing the subwatershed area by the total county area and multiplying it by the county census population. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural household density. An additional estimate of septic systems can be made using the 1990 US Census, as that is the last Census that inventoried how household wastewater is disposed. The rural households in the Laughery Creek subwatersheds are shown in Table 8, along with a calculated density (total rural households divided by total area). The rural household density can be used to compare the different subwatersheds within the Laughery Creek watershed.

Table 8: Rural and Urban Household Density in the Laughery Creek Subwatersheds

Subwatershed	Subwatershed Area (mi^2)	Households in Subwatershed	Urban Households	Rural Households	Rural Household Density (Houses/mi^2)	Urban Household Density (Houses/mi^2)
Tub Creek	24.6	532	240	292	11.9	9.8
Little Laughery Creek	27.3	3,261	2,594	667	24.4	95.0
Headwaters Ripley Creek	18.8	572	26	546	29.0	1.4
North Branch	23.3	384	0	384	16.5	0
Walnut Creek	23.2	371	0	371	16.0	0
Jericho Creek	25.2	1,128	631	497	19.7	25.0
Henderson Bend	25.0	750	325	425	17.0	13.0

The vast majority of the North Laughery Watershed is rural with no sewer service. The watershed does have some larger sewered areas including Batesville, Osgood, and Versailles. There are no known large unsewered communities within the watershed area. The majority of the watershed residents rely on septic systems for their waste treatment.

Landuse within the North Laughery Watershed

Land use patterns provide important clues to the potential sources of impairments in a watershed. Land use information for the Laughery Creek watershed is available from the National Agricultural Statistics Service (NASS) cropland data layer. These data categorize the land use for each 30 meters by 30 meters parcel of land in the watershed based on satellite imagery circa 2018. Table 9 displays the spatial distribution of the land uses and the data are summarized in Table 9. Additionally, Table 9 displays the breakdown of land uses within each of the seven subwatersheds.

Land use in the Laughery Creek watershed is primarily forested, comprising 41 percent of the entire watershed. Approximately 38 percent of the land is in agriculture. Corn and soybean crops are not typically associated with high E. coli loads, unless they have been fertilized with manure, but stakeholders are concerned that the high percentage of agricultural land may contribute to sediment and nutrient load within the watershed. Pasture/hay represents around 12 percent of the watershed and could indicate the presence of animal feedlots, which can be a significant sources of E. coli, TSS, and/or nutrients. The remaining land categories represent less than 10 percent of the total land area.

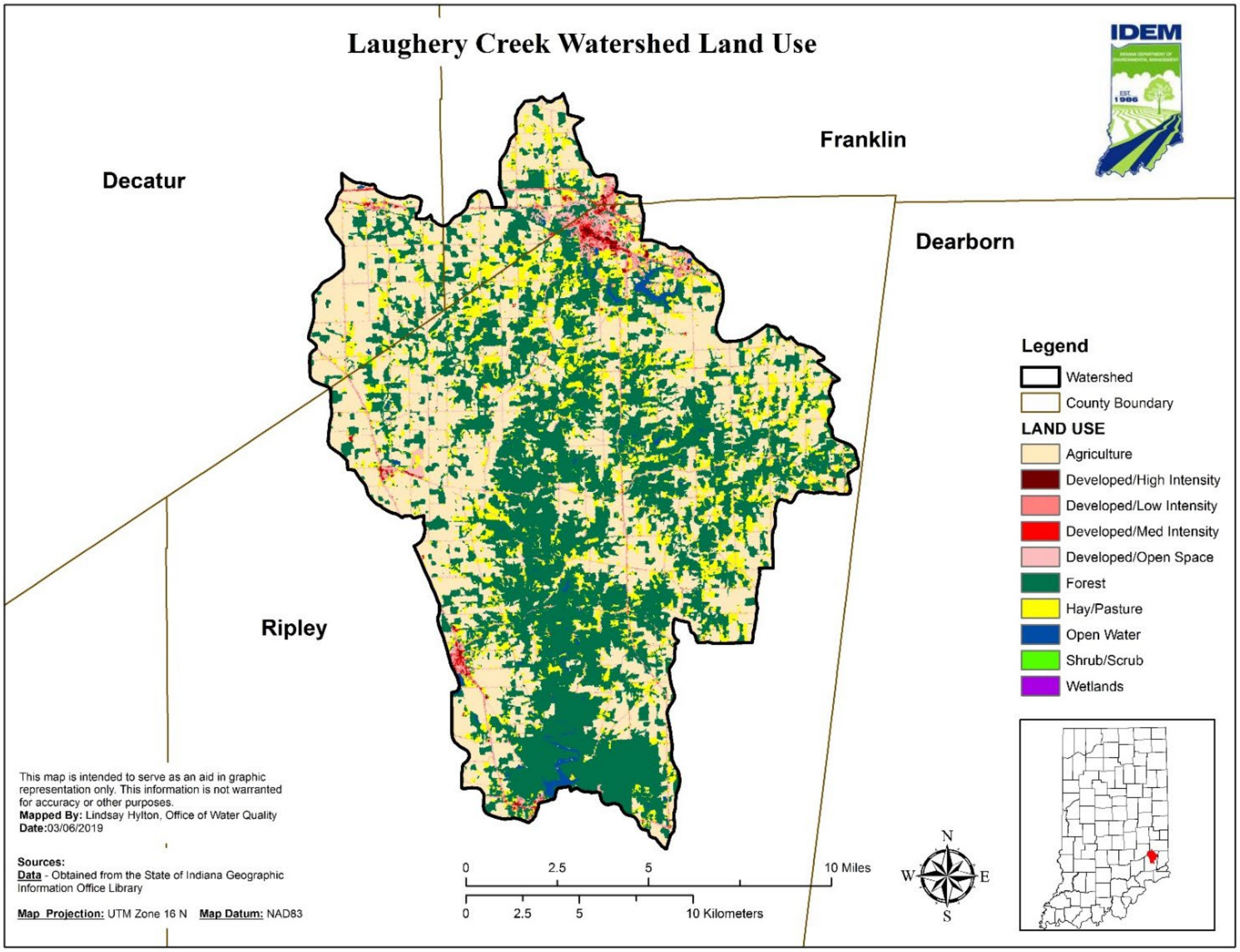
The Laughery Creek watershed has a diverse network of streams. Tributaries include Walnut Fork, Little Laughery Creek, Ripley Creek, Jericho Creek, Plum Creek, and Castators Creek, among others. Forested areas are more pronounced in the central and southern portions of the watershed, spanning much of the Walnut Creek, North Branch, and Jericho Creek subwatersheds, and also encompassing Versailles State Park and Versailles Lake. Urban areas consist primarily of the City of Batesville in the northern portion of the watershed, along with the small towns of Newpoint, Napoleon, and Osgood spanning the western side of the watershed. In the very southern end of the North Laughery watershed is the northern portion of the town of Versailles. Waters drain to Laughery Creek and eventually flow south leaving the North Laughery Watershed, then flowing east into the Ohio River. Many threatened and endangered species call this watershed home. The Clubshell mussel (Pleurobema clava), Northern Crawfish Frog (Lithobates areolatus circulosus), Eastern Hellbender (Cryptobranchus alleganiensis), and two fish species, the Redside Dace (Clinostomus elongatus) and Variegate Darter (Etheostoma variatum) can all be found in the watershed, and are dependent upon the health of the aquatic system. Additional information on state endangered, threatened, and rare species can be found on the DNR website (http://www.in.gov/dnr/naturepreserve/4666.htm).

Table 9: Land Use of the Laughery Creek Watershed (2018 CDL DATA)

	Watershed		
	Area		
Land Use	**Acres**	**Square Miles**	**Percent**
Agricultural Land	41,215.55	64.40	38
Developed Land	7,703.98	12.04	7
Forested Land	43,757.74	68.37	41
Hay/Pasture	13,372.16	20.89	12
Open Water	1,050.81	1.64	1
Shrub/Scrub	103.64	0.16	0.1
Wetlands	23.80	0.04	0.02
TOTAL	**107,225.6**	**167.54**	**100**

The predominant land use types in the Laughery Creek watershed can indicate potential sources of *E. coli*, TSS, and nutrient loadings. Different types of land uses are characterized by different types of hydrology. For example, developed lands are characterized by impervious surfaces that increase the potential of storm water events during high flow periods, delivering *E. coli*, TSS, and nutrients to downstream streams and rivers. Forested land and wetlands allow water to infiltrate slowly, thus reducing the risks of polluted water running off into waterbodies. In addition to differences in hydrology, land use types are associated with different types of activities that could contribute pollutants to the watershed. Understanding land use types will help identify implementation approaches that watershed stakeholders can use to achieve *E. coli*, TSS, and nutrient load reductions. There are several stakeholder concerns that were identified which correspond directly with landuse. Concerns related to agricultural/cropland and pasture/hay landuses include no residue/cover, overgrazed pastures and livestock access to streams. Other stakeholder concerns, such as streambank erosion, gully erosion, excessive nutrients entering the streams, and stream sedimentation are not landuse dependent and could occur throughout the entire watershed. Excess nutrients entering waterways is a stakeholder concern for the entire watershed across all land uses.

Figure 10: Land use in the Laughery Creek Watershed (2018 CDL DATA)



Subwatershed	Area	Land Use							Total
		Agriculture	Developed	Forest	Hay/ Pasture	Open Water	Shrub/ Scrub	Wetlands	
Tub Creek (050902030501)	Acres	9795	1220	3389	1315	49	23	0.44	15,791
	Sq. Mi.	15.31	1.91	5.30	2.05	0.08	0.04	0.00	24.69
	Percent	62%	8%	21%	8%	0%	0%	0%	100%
Little Laughery Creek (050902030502)	Acres	5980	2785	5333	3051	358	11	4	17,522
	Sq. Mi.	9.34	4.35	8.33	4.77	0.56	0.02	0.01	27.38
	Percent	34%	16%	30%	17%	2%	0%	0%	100%
Headwaters Ripley Creek (050902030503)	Acres	4403	602	4748	2258	39	15	2	12,067
	Sq. Mi.	6.88	0.94	7.42	3.53	0.06	0.02	0.00	18.85
	Percent	36%	5%	39%	19%	0%	0%	0%	100%
North Branch (050902030504)	Acres	5399	669	6734	2067	86	16	4	14,975
	Sq. Mi.	8.44	1.04	10.52	3.23	0.13	0.03	0.01	23.40
	Percent	36%	4%	45%	14%	1%	0%	0%	100%
Walnut Creek (050902030505)	Acres	6004	694	6520	1577	37	13	4	14,849
	Sq. Mi.	9.38	1.08	10.19	2.46	0.06	0.02	0.01	23.20
	Percent	40%	5%	44%	11%	0%	0%	0%	100%
Jericho Creek (050902030506)	Acres	5285	963	7902	1980	81	13	3	16,227
	Sq. Mi.	8.26	1.50	12.35	3.09	0.13	0.02	0.00	25.35
	Percent	33%	6%	49%	12%	1%	0%	0%	100%
Henderson Bend (050902030507)	Acres	4418	794	9224	1161	401	13	8	16,019
	Sq. Mi.	6.90	1.24	14.41	1.81	0.63	0.02	0.01	25.02
	Percent	28%	5%	58%	7%	3%	0%	0%	100%

Cropland

Croplands can be a source of *E. coli*, sediments, and nutrients. Accumulation of nutrients and *E. coli* on cropland occurs from the decomposition of residual crop material, fertilization with chemical (e.g., anhydrous ammonia) manure fertilizers, inorganic fertilizers, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. The majority of nutrient loading from cropland occurs from fertilization with commercial and manure fertilizers (USEPA, 2003). Use of manure for nitrogen supplementation often results in excessive phosphorus loads relative to crop requirements (USEPA, 2003).

Data available from the National Agricultural Statistic Service (NASS) were downloaded to estimate crop acreage in the subwatersheds. The 2018 NASS statistics were used in the analysis shown in Table 10 below. Figure 11 below is a map of the crop areas within the watershed area.

Table 10: Major Cash Crop Acreage in the Laughery Creek Watershed (2018 CDL DATA)

Subwatershed	Crop	Total Acreage	% of Subwatershed Cash Crop Acreage
Tub Creek (050902030501)	**Corn**	**4,248**	**44%**
	Soybean	**5,498**	**56%**
	Winter Wheat	**47**	**0%**
	Total	**9,765**	**100%**
Little Laughery Creek (050902030502)	**Corn**	**2,639**	**44%**
	Soybean	**3,162**	**53%**
	Winter Wheat	**174**	**3%**
	Total	**5,975**	**100%**
	Corn	**1,503**	**35%**
	Soybean	**2,794**	**65%**

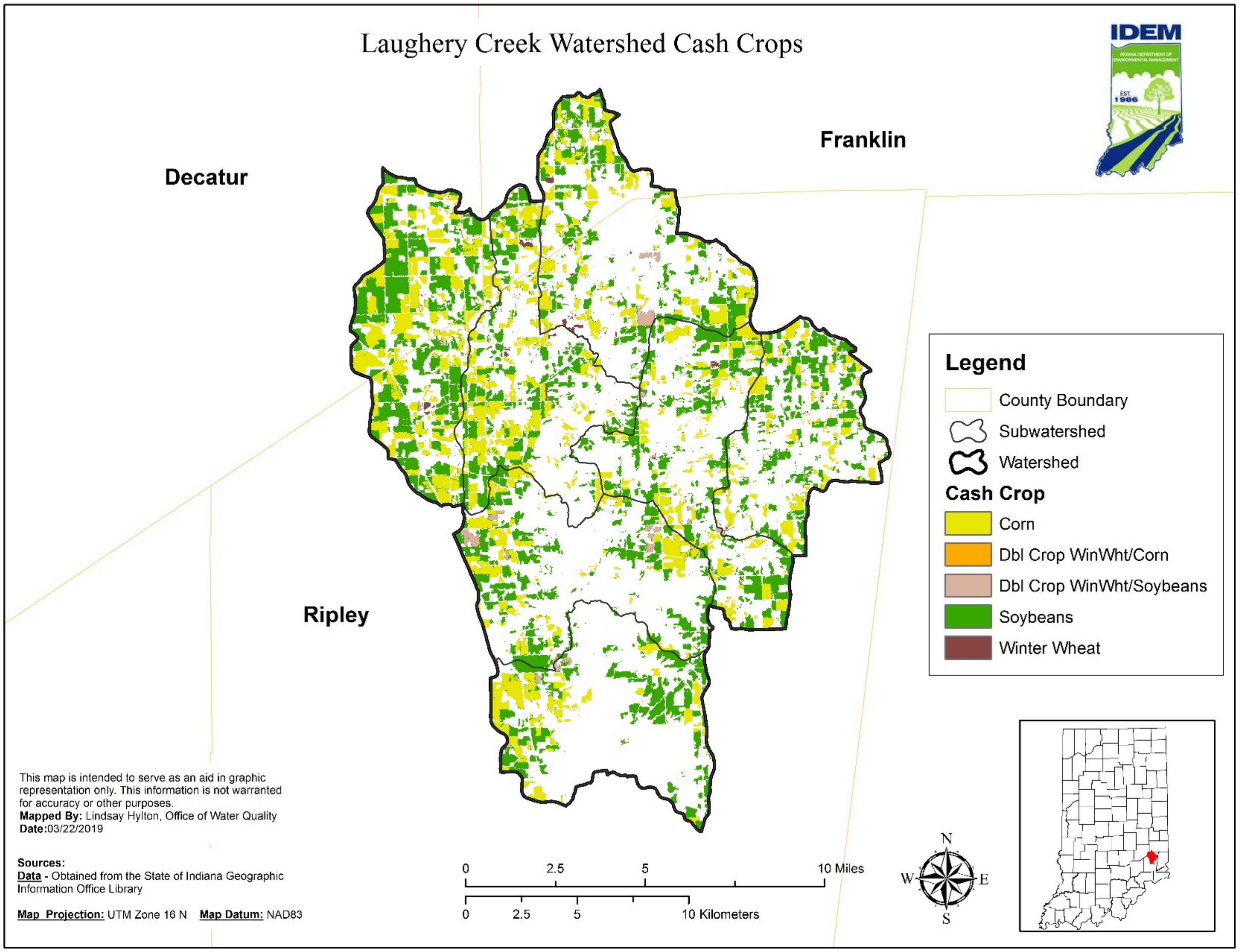
Headwaters Ripley Creek (050902030503)			
	Winter Wheat	30	1%
	Total	4,327	100%
North Branch (050902030504)	Corn	2,041	38%
	Soybean	3,295	61%
	Winter Wheat	62	1%
	Total	5,398	100%
Walnut Creek (050902030505)	Corn	2,868	48%
	Soybean	3,064	51%
	Winter Wheat	70	1%
	Total	6,002	100%
Jericho Creek (050902030506)	Corn	1,803	34%
	Soybean	3,352	63%
	Winter Wheat	129	2%
	Total	5,284	100%
Henderson Bend (050902030507)	Corn	1,658	38%
	Soybean	2,717	61%
	Winter Wheat	43	1%
	Total	4,418	100%

The Indiana State Department of Agriculture (ISDA) tracks trends in conservation and cropland through annual county tillage transects. Data collected through the tillage transect help determine adoption of conservation practices and estimate the average annual soil loss from Indiana's agricultural lands. Tillage practices captured in ISDA's tillage transect include No-Till, Mulch-Till, Reduced-Till and conventional tillage practices. ISDA defines No-Till as any direct seeding system including site preparation, with minimal soil disturbance. Mulch-Till is any tillage system leaving greater than 30 percent residue cover after planting, excluding no-till. Reduced-Till is a tillage system leaving 16 percent to 30 percent residue cover after planting. Conventional-Till is any tillage system leaving less than 30 percent residue cover after planting. The following information is from data collected during the spring 2019 Tillage Transect.

Table 11: No till & cover crop percentages during 2019 cropping season

Crop	Tillage Practice %	Ripley	Decatur	Franklin
Corn	No-Till	24%	30%	20%
	Cover Crop	14%	14%	14%
Soybeans	No-Till	54%	68%	56%
	Cover Crop	14%	14%	14%

Figure 11: Cash Crop Acreage in the Laughery Creek Subwatersheds

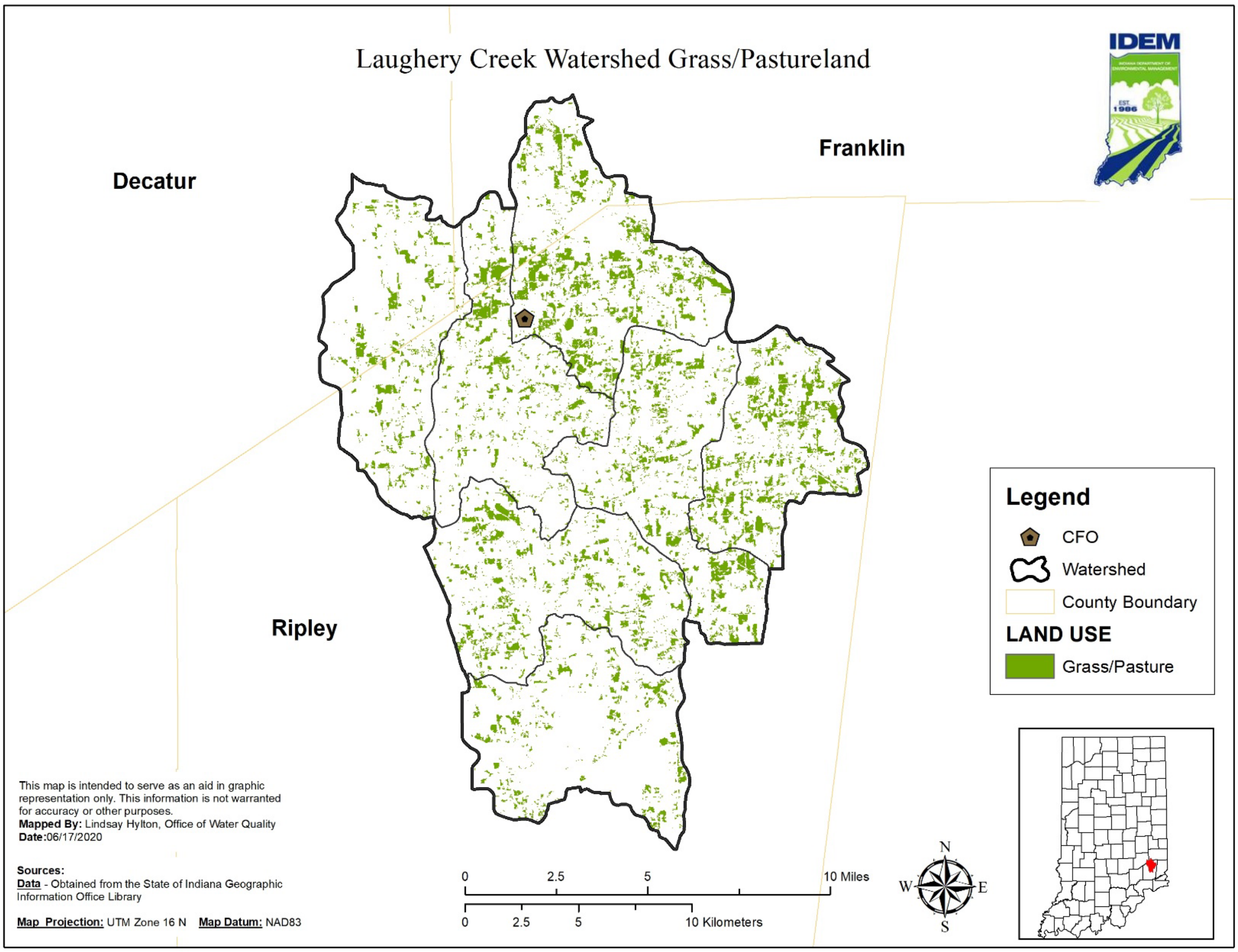


Hay/Pastureland

Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*, nutrients, and TSS to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. For example, animals grazing in pasturelands deposit manure directly upon the land surface and, even though a pasture may be relatively large and animal densities low, the manure will often be concentrated near the feeding and watering areas in the field. These areas can quickly become barren of plant cover, increasing the possibility of erosion and contaminated runoff during a storm event. Watershed specific data are not available for livestock populations.

The amount of hay/pasture land across the landscape can be used as an indicator for potential areas of higher densities of livestock. Information on permitted livestock facilities within the Laughery Creek watershed are presented below in Figure 12 .

Figure 12: Grassland and Pastureland areas along with CFO location in North Laughery Watershed



Confined Feeding Operations (CFOs)

A CFO is an agricultural operation where animals are kept and raised in confined situations. It is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over 50 percent of the lot or facility.
- The number of animals present meets the requirements for the state permitting action.

Feeding operations that are not classified as concentrated animal feeding operations (CAFOs) are known as confined feeding operations (CFOs) in Indiana. The CAFO designation is strictly a size designation in Indiana. CAFOs are larger in size and are permitted under the CFO rule, but have a few added requirements under Indiana regulations. Non-CAFO animal feeding operations identified as CFOs by IDEM are considered nonpoint sources by U.S. EPA. Indiana's CFOs have state issued permits and are therefore categorized as nonpoint sources for the purposes of this TMDL. CFO permit are "no discharge" permits. Therefore, it is prohibited for these facilities to discharge to any water of the State.

The CFO regulations (327 IAC 19, 327 IAC 15-16) require that operations "not cause or contribute to an impairment of surface waters of the state." IDEM regulates these confined feeding operations under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 19, which implement the statute regulating confined feeding operations, were effective on July 1, 2012. The rule at 327 IAC 15-16, which regulates CAFOs and incorporates by reference the federal NPDES CAFO regulations, became effective on July 1, 2012. It should be noted that there are currently zero facilities in Indiana that have an NPDES permit under 15-16.

The animals raised in CFOs produce manure that is stored in pits, lagoons, tanks and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. It also lessens the need for fuel and other natural resources that are used in the production of fertilizer.

However, CFOs can be a potential source of E. coli due to the following:

- Improper application of manure can contaminate surface water or run-off.
- Manure over-application or improper application can adversely impact soil productivity.

There is one CFO (see figure 12 above) in the Laughery Creek watershed, which is located in the Little Laughery Creek subwatershed in Ripley County and is permitted for 2600 head of finished animals.

Wildlife Issues

The Indiana Department of Natural Resources (IDNR) is the primary entity responsible for monitoring wildlife populations and habitats throughout Indiana. Wildlife such as deer, geese, ducks, etc. can be sources of E. coli and nutrients. Little information exist surrounding feces depositional patterns of wildlife and a direct inventory of wildlife populations is generally not available. However, based on the Bacteria Source Load Calculator developed by the Center for TMDL and Watershed Studies, bacteria production by animal type is estimated, as well as their preferred habitat. Higher concentrations of wildlife in the habitats, described in Table 12 below, could contribute E. coli and nutrients to the watershed, particularly during high flow conditions or flooding events.

Table 12: Bacteria Source Load Estimate by Species

Wildlife Type	*E. coli* Production Rate (cfu/day – animal)	Habitat
Deer	1.86×10^8	Entire Watershed
Raccoon	2.65×10^7	Low density on forests in rural areas; high density on forest near a permanent water source or near cropland
Muskrat	1.33×10^7	Near ditch, medium sized stream, pond or lake edge
Goose	4.25×10^8	Near main streams and impoundments
Duck	1.27×10^9	Near main streams and impoundments
Beaver	2.00×10^5	Near streams and impoundments in forest and pastures

Fertilization of Urban and Suburban Land

In areas not covered under the National Pollutant Discharge Elimination System / Municipal Separate Storm Sewer System (NPDES MS4) program, storm water runoff from developed areas are not regulated under a permit and are therefore considered a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Typically, urban sources of nutrients are fertilizer application to lawns and pet waste, which is also a source of *E. coli*. Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. However, inputs from urban sources are difficult to quantify. Estimates can be made of residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important causes of nutrients and *E. coli* in the Laughery Creek Watershed.

Urban Effects on Laughery Creek Watershed

Counties with land located in the Laughery Creek Watershed include Decatur, Franklin, and Ripley. Major government units with jurisdiction at least partially within the Laughery Creek watershed include Batesville, Osgood, Versailles, Newpoint, and Napoleon. U.S. Census data for each of the three counties during the past three decades are provided below in Table 13.

Table 13: Population Data for Counties in the Laughery Creek Watershed

County	1990	2000	2010	2019 (Estimate)
Decatur	23,645	24,555	25,740	26,599
Franklin	19,580	22,151	23,087	22,758

Ripley	24,616	26,523	28,818	28,324
TOTAL	***67,841***	***73,229***	***77,645***	***77,681***

Understanding Table 13: Water quality is linked to population growth because a growing population often leads to more development. This translates into more houses, roads, and infrastructure to support more people. Table 14 provides information that shows how the population has changed in each of the counties that are part of the Laughery Creek Watershed over time. In addition, understanding population trends can help watershed stakeholders to anticipate where pressures might increase in the future to help prevent further water quality degradation. The 2019 county population estimate can be found at https://www.census.gov/programs-surveys/popest/data/tables.html.

Estimates of population within Laughery Creek watershed are based on US Census data from 2010 and the percentage of census blocks in urban and rural areas. Based on this analysis, the estimated population of the watershed is 16,910 with approximately 48 percent of the population classified as rural residents and 52 percent classified as urban residents.

Table 14: Estimated Population in the Laughery Creek Watershed

Subwatershed	**2010 Population**	**Total Estimated Urban Population**	**Total Estimated Rural Population**	**Percent of Total Watershed Population**
Tub Creek	1,174	511	663	6.8%
Little Laughery Creek	8,033	6,241	1,792	47.5%
Headwaters Ripley Creek	1,531	0	1,531	9.1%
North Branch	959	0	959	5.7%
Walnut Creek	985	0	985	5.8%
Jericho Creek	2,594	1,391	1,203	15.3%
Henderson Bend	1,634	701	933	9.7%
Watershed Total	**16,910**	**8,844**	**8,066**	**100%**

Understanding Table 14: Understanding where the greatest population is concentrated within the Laughery Creek watershed will help watershed stakeholders know where different types of water quality pressures might currently exist. In general, watersheds with large urban populations are more likely to have problems associated with lots of impervious surfaces, poor riparian habitat, flashy stormwater flows, and large wastewater inputs. Alternatively, watersheds with mostly a non-urban population are more likely to suffer problems from failing septic systems, agricultural run-off, and other types of poor riparian habitat (e.g., channelized streams). Comparing the information in Table 13 with the information in table 14 can provide an understanding of how population might change in the Laughery Creek watershed and which subwatersheds are experiencing the most growth and shifts in urban and non-urban population.

Population change can serve as an indicator for changes in land uses. For example, growing populations might mean more development, resulting in increased impervious surfaces and more infrastructures (e.g., sanitary sewer and storm sewer). Declining population in areas of the Laughery Creek watershed might signify communities with under-utilized infrastructure and indicate opportunities to "rightsize" existing infrastructure and promote changes to land use that would benefit water quality (e.g., green infrastructure).

Figure 13: Watershed Population Density

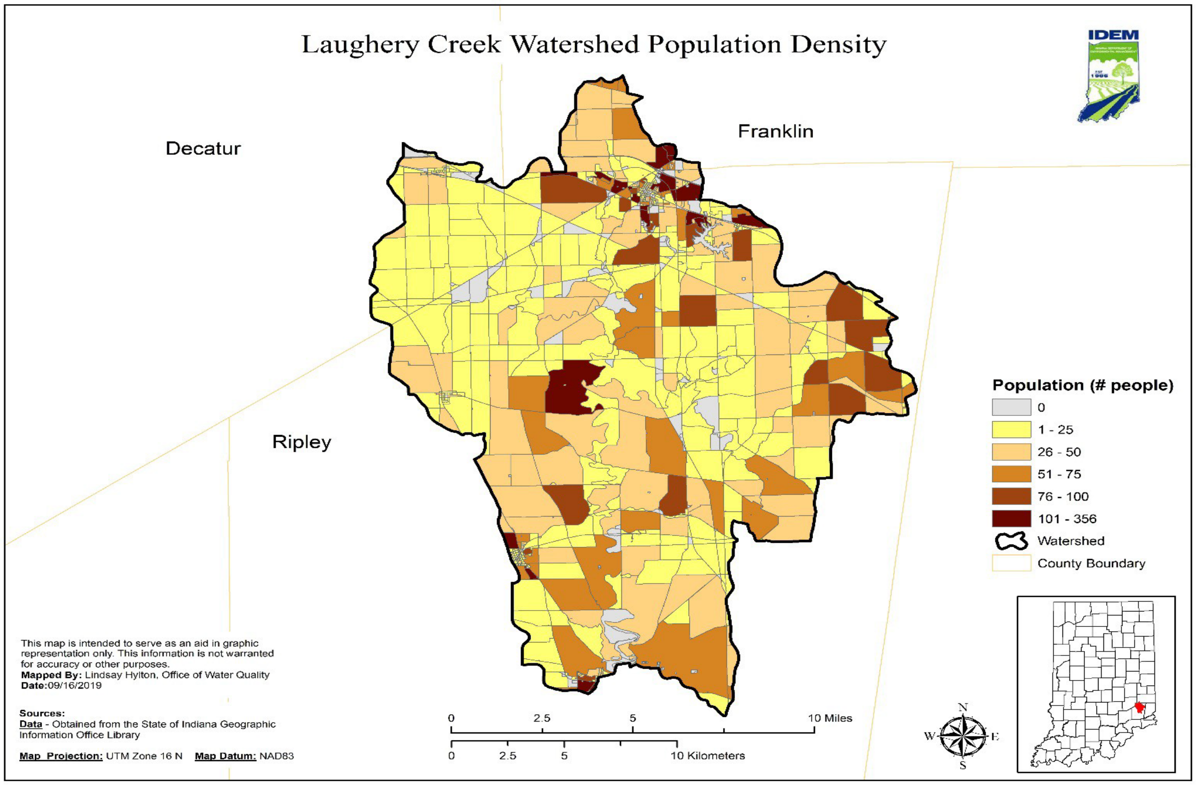
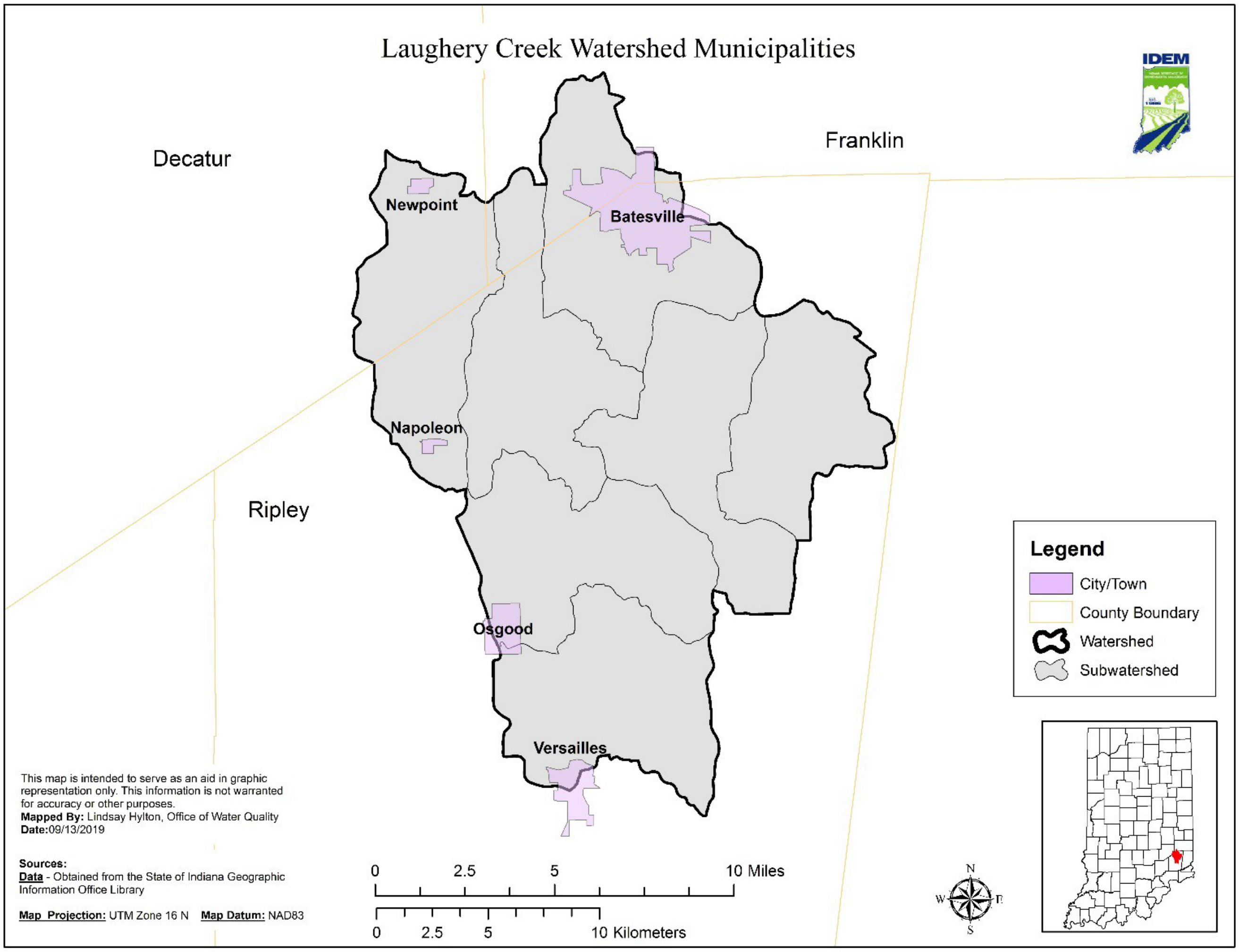


Figure 14: Municipalities in the Laughery Creek Watershed



Urban Stormwater

In areas not covered under the NPDES Municipal Separate Storm Sewer Systems (MS4) program, such as all areas of the North Laughery Watershed, stormwater run-off from developed areas is not regulated under a permit and is therefore considered a nonpoint source. Run-off from urban areas can carry a variety of pollutants originating from a variety of sources. Typically, urban sources of nutrients are fertilizer application to lawns and pet waste, which is also a source of *E. coli*. Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. However, inputs from urban sources are difficult to quantify. Estimates can be made of residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important causes of nutrients, TSS, and *E. coli* in the Laughery Creek watershed.

Communities without Sewers

Septic systems are underground wastewater treatment structures most commonly used in rural areas without centralized sewer systems. According to the U.S. EPA's SepticSmart Homeowners program, one in five U.S. homes has a septic system. Septic systems typically consist of a septic tank and a drainfield. The septic tank holds the wastewater to allow for separation of solids, fats, oil, and grease. The septic tank also contains microorganisms that aid in breaking down sludge and removing some contaminants from the wastewater. After traveling through the septic tank, wastewater is discharged into the drainfield. The drainfield allows for further removal of remaining contaminants through soil filtration.

Regular maintenance of septic systems, such as frequent inspections and pumping of the septic tank, is important to ensure the system is functioning safely and effectively. A septic system that is not functioning properly may inadvertently contaminate groundwater and surface water due to elevated levels of nutrients and bacteria that can be found in untreated or inadequately treated household wastewater.

Additional information regarding septic systems can be found on the U.S. EPA's SepticSmart Homeowners website (https://www.epa.gov/septic/septicsmart-homeowners).

A report by the Indiana Advisory Commission on Intergovernmental Relations (ACIR) surveyed county health department officials statewide from 2016 to 2017. Of the 444 unsewered communities reported statewide, the study was able to identify 192 of those communities where at least 25 percent of the individual wastewater treatment systems were failing. Unsewered communities were defined as "contiguous geographical areas containing at least 25 homes and/or businesses that are not served by sewers" (Palmer et. al, 2019). Table 15 reports unsewered communities by counties relevant to the Laughery Creek watershed.

Table 15: Unsewered Residences/Businesses Reported by County in 2016-2017

County	Unsewered Communities	Residences	Businesses
Decatur	1	35	1
Franklin	3	75	6
Ripley	1	100	4

As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches.

Municipal Wastewater Treatment Plants (WWTPs)

Municipal Wastewater Treatment Plants (WWTPs) that discharge wastewater through a point source to a surface water of the state are required to obtain a municipal NPDES wastewater permit. Some of the functions of a WWTP include sewage treatment and industrial waste treatment. Municipal wastewater facilities are required to disinfect their effluent for *E. coli* during the recreational season (April 1 to October 31) in accordance with 327 IAC 5-10-6. WWTPs are critical for maintaining sanitation and a healthy environment. However, WWTPs may discharge wastewater with elevated concentrations of pollutants into streams. Municipal wastewater permits include effluent limitations that are derived using water quality criteria developed to protect all designated and existing uses of the receiving water body and/or any more stringent technology-based limitations. There are four active WWTPs that discharge wastewater within the North Laughery Creek watershed (Table 16 and Figure 15). Table contains the average design flow for these active facilities.

Table 16: NPDES Permitted Municipal WWTP Facilities Discharging within the North Laughery Creek Subwatersheds

Subwatershed	Facility Name	Permit Number	Receiving Stream	Average Design Flow (MGD)
Little Laughery Creek	City of Batesville Wastewater Treatment Plant	IN0039268	Little Laughery Creek	2.644
Tub Creek	Town of Napoleon Wastewater Treatment Plant	IN0023868	Laughery Creek	0.04
Headwaters Ripley Creek	Town of Sunman Wastewater Treatment Plant	IN0021679	Unnamed Tributary of Ripley Creek	0.225
Jericho Creek	Town of Osgood Wastewater Treatment Plant	IN0021695	Unnamed Tributary to Plum Creek	0.5

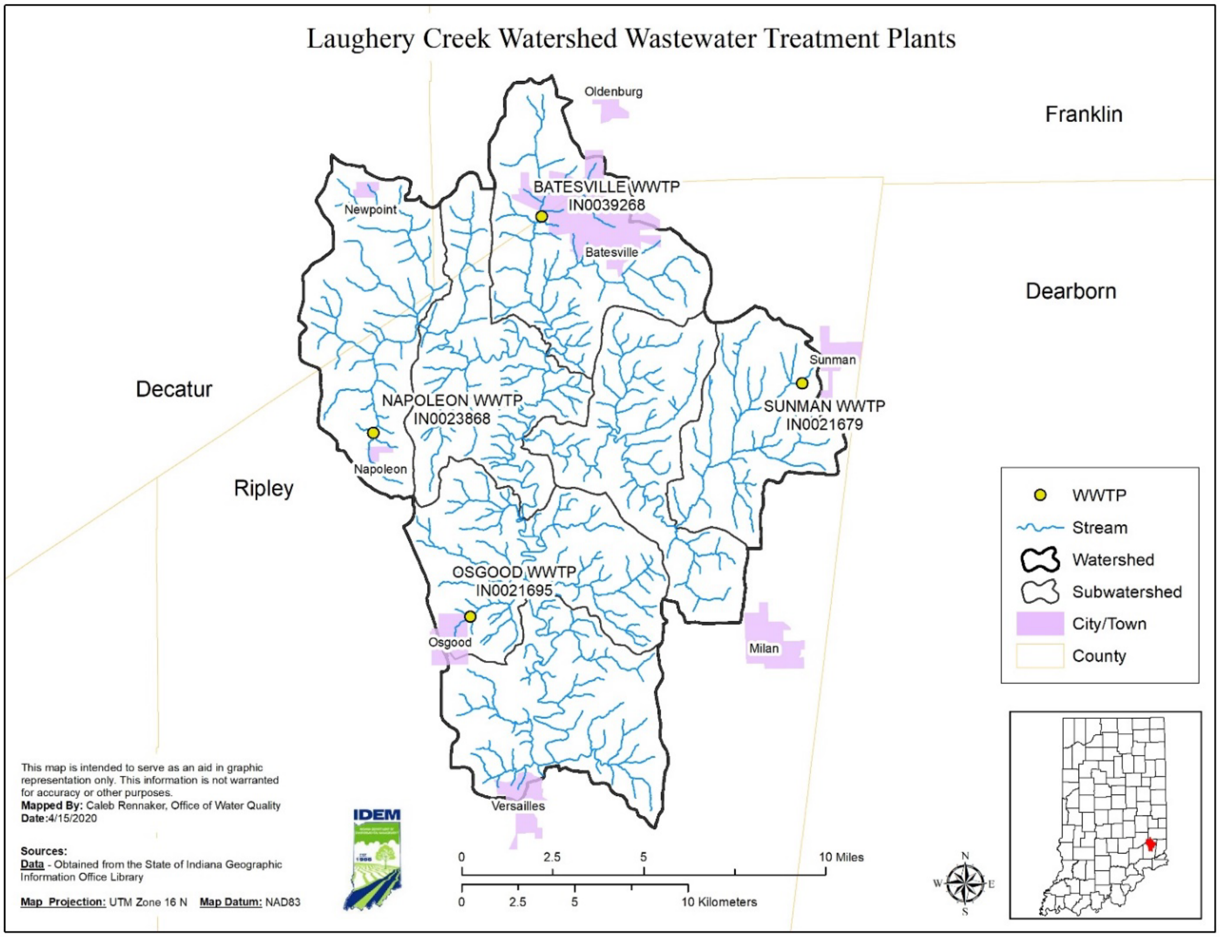


Figure 15: NPDES Permitted Municipal Wastewater Treatment Facilities Discharging within the Laughery Creek Watershed

Compliance and Inspections

Table 17 below presents a summary of permit compliance for NPDES facilities in the Laughery Creek watershed for the five year period between 2014 and 2019. Percentages in the exceedance/violation column reflect by how much a particular value exceeded its limit.

Table 17: Summary of Permit Violation in the Laughery Creek Watershed

Subwatershed	Facility Name	NPDES Permit Number	Receiving Stream	Violations for the Last Five Years		
				Violation Date	Parameter	Exceedance/Violation
Tub Creek	**Town of Napoleon WWTP**	**IN0023868**	Laughery Creek	December 2017	BOD, carbonaceous	Monthly Avg: 1% Max. Weekly Avg: 10%
				January 2018	BOD, carbonaceous	Monthly Avg: 35% Max. Weekly Avg: 28%
				February 2018	BOD, carbonaceous	Monthly Avg: 13%
				August 2018	Chlorine, total residual	Daily Max: 17% Daily Min: 1567%
				September 2018	Chlorine, total residual	Daily Max: 83%
				April 2019	E. coli, colony forming units	Daily Max: 133%
				May 2019	E. coli, colony forming units	Daily Max: 133%
				February 2019	pH	Daily Max: 6%
				March 2019	pH	Daily Max: 7%
				January 2019	Solids, total suspended	Monthly Avg: 41% Max. Weekly Avg: 204%
				July 2019	Solids, total suspended	Monthly Avg: 23%
Little Laughery Creek	**City of Batesville WWTP**	**IN0039268**	Little Laughery Creek	April 2016	Copper, total recoverable	Monthly Avg: 24%
				March 2019	Cyanide, free	Daily Max: 18%

Subwatershed	Facility Name	NPDES Permit Number	Receiving Stream	Violations for the Last Five Years		
				Violation Date	**Parameter**	**Exceedance/Violation**
				December 2015	Mercury, total recoverable	Monthly Avg: 64%
				June 2017	Mercury, total recoverable	Monthly Avg: 102% Daily Max: 21%
				October 2017	Mercury, total recoverable	Monthly Avg: 308% Daily Max: 380%
				January 2016	Nitrogen, ammonia total [as N]	Max. Weekly Avg: 45%
				June 2018	Nitrogen, ammonia total [as N]	Max. Weekly Avg: 143%
				October 2015	Solids, total suspended	Max. Weekly Avg: 17%
				September 2018	Solids, total suspended	Max. Weekly Avg: 6%
				May 2019	Solids, total suspended	Monthly Avg: 2%
Headwaters Ripley Creek	**Town of Sunman WWTP**	**IN0021679**	Unnamed Tributary to Ripley Creek	May 2017	Nitrogen, ammonia total [as N]	Monthly Avg: 16% Monthly Avg: 59% Max. Weekly Avg: 52%
				March 2019	Nitrogen, ammonia total [as N]	Monthly Avg: 1% Max. Weekly Avg: 27% Max. Weekly Avg: 26%
North Branch	NA	NA	NA	NA	NA	NA
Walnut Creek	NA	NA	NA	NA	NA	NA

Subwatershed	Facility Name	NPDES Permit Number	Receiving Stream	Violations for the Last Five Years		
				Violation Date	Parameter	Exceedance/Violation
Jericho Creek	**Town of Osgood WWTP**	**IN0021695**	Unnamed Tributary to Plum Creek	August 2015	Chloride (as Cl)	Monthly Avg: 4%
				September 2015	Chloride (as Cl)	Monthly Avg: 26%
				October 2015	Chloride (as Cl)	Monthly Avg: 33%
				September 2015	Copper, total recoverable	Monthly Avg: 48% Daily Max: 50%
				December 2018	Copper, total recoverable	Daily Max: 16%
				September 2015	Nitrogen, ammonia total [as N]	Max. Weekly Avg: 84%
				November 2018	Nitrogen, ammonia total [as N]	Max. Weekly Avg: 63% Max. Weekly Avg: 32%
				January 2019	Nitrogen, ammonia total [as N]	Max. Weekly Avg: 11%
				February 2019	Nitrogen, ammonia total [as N]	Max. Weekly Avg: 26%
				August 2018	Oxygen, dissolved	Daily Avg. Min: 7%
				November 2018	Oxygen, dissolved	Daily Avg. Min: 3%
				June 2019	Oxygen, dissolved	Daily Avg. Min: 2%

Subwatershed	Facility Name	NPDES Permit Number	Receiving Stream	Violations for the Last Five Years		
				Violation Date	Parameter	Exceedance/Violation
				September 2015	pH	Daily Min: 28%
				June 2015	Solids, total suspended	Max. Weekly Avg: 30% Max. Weekly Avg: 22%
				September 2015	Solids, total suspended	Max. Weekly Avg: 17%
				March 2016	Solids, total suspended	Max. Weekly Avg: 15%
				October 2014	Zinc, total recoverable	Daily Max: 6%
				September 2015	Zinc, total recoverable	Monthly Avg: 166% Daily Max: 238%
				August 2019	Zinc, total recoverable	Daily Max: 9%
Henderson Bend	NA	NA	NA	NA	NA	NA

Note: Violations/exceedances listed can be for concentration and/or mass-based permit limits.

Although these NPDES facilities were found to be in violation of their permit limits, the majority of the time effluent from permitted facilities meets water quality standards and/or targets.

Threatened and Endangered Species

The North Laughery Creek Watershed is home to several endangered plant and animal species on both the state and federal level.   These species are known to inhabit some of the sensitive habitats found in the watershed.

Mammals:

Indiana Bat (Myotis sodalis): The Indiana Bat is a medium sized mouse eared bat that was once commonly distributed across the Midwestern and Eastern states. Due to the rapid spread of White Nose Syndrome, populations have been reduced by as much as 50 percent. Currently the Indiana bat is listed as endangered in Indiana and also on the federal endangered species list.

Northern Long-Eared Bat (Myotis septentrionalis): This small-sized bat is listed as state endangered for Indiana. Its decline is attributed to the declining coniferous forests habitat and the outbreak of White Nose Syndrome.

Fish:

Variegate Darter (Etheostoma variatum): The variegate darter is one of the most colorful darter species and is restricted to the Ohio River drainage area. This colorful fish is listed as state endangered for Indiana.

Redside Dace (Clinostomus elongates): The redside dace is state endangered for Indiana and can only be found in the Whitewater River Watershed. Globally this small fish is rare and uncommon. Known for leaping into the air to capture insects, this little fish is found in small streams with high gradients and cool water.

Reptiles and Amphibians:

Eastern Hellbender (Cryptobranchus alleganiensis alleganiensis): The Eastern Hellbender is listed as endangered in the state of Indiana. These salamanders grow to be on average about 2 feet long. In addition, they serve to fill unique niches in ecosystems where they can be both predator and prey.

Timber Rattlesnake (Crotalus horridus): As one of the 4 venomous snake species found in Indiana, the timber rattlesnake is listed as state endangered. Due to human disturbances and general fear of its venomous nature, the timber rattlesnake's population has dwindled over the years.

Birds:

Bald Eagle (Haliaeetus leucocephalus): Known as the National Bird, the Bald eagle has been a national symbol since 1782. The eagle is designated as state endangered in Indiana, and is thought to be in decline because of decreasing wetland habitat.

Peregrine Falcon (Falco peregrinus): Although listed as a species of "least concern" internationally, the Peregrine Falcon is listed as endangered in the state of Indiana. The falcon is known for its high speeds. While hunting, a dive can reach speeds of over 200 mph, making it one of the fastest animals in the animal kingdom.

Loggerhead Shrike (Lanius ludovicianus): The Loggerhead Shrike is listed as endangered in Indiana. This bird has a long hooked beak and feeds on insects, smaller birds, and lizards. Their population decline has been attributed to loss of suitable habitat and pesticide use.

Black-crowned Night-heron (Nycticorax nycticorax): This large bird has been listed as endangered in Indiana mainly due to decreasing habitat, since they prefer either salt or freshwater wetland areas.

Interior Least Tern (Sternula antillarum athalassos): The Interior Least Tern is listed as state endangered in Indiana. This small bird is a migratory bird that overwinters in Central America.

Barn Owl (Tyto alba): Though they are listed as endangered in Indiana, Barn Owls are one of the most widely distributed owls worldwide. With their white faces, they have been the inspiration for many ghost tales and hauntings in the Indiana area.

Mollusks:

Fanshell (Cyprogenia stegaria): The Fanshell is listed as federally endangered. This species of mollusk is only known to have breeding populations in three rivers of the United States. The species is threatened by loss and degradation of its natural habitat.

Snuffbox mussel (Epioblasma triquetra): The Snuffbox mussel is listed as federally endangered in the Endangered Species Act. Known to attach to the gills of fish, this mollusk has experienced population declines because of human interference.

Sheepnose Mussel (Plethobasus cyphyus): The Sheepnose Mussel is listed as state endangered in Indiana. Known as a freshwater or river mussel, their population has been on the decline due to their sensitivity to water pollution.

Insects:

Cobblestone Tiger Beetle (Cicindela marginipennis): The Cobblestone Tiger Beetle is listed as state endangered for Indiana and can be found in Franklin County, Indiana. The small black beetle is native to the mid-eastern United States.

Vascular Plants:

Running Buffalo Clover (Trifolium stoloniferum): The Running Buffalo Clover is listed as endangered in Indiana. The plant is typically found in rich soils in woodland habitats. This species of plant was once thought to be extinct, until populations were discovered in West Virginia in the late 1980's and now can be found in Dearborn County, Indiana.

Shaggy False-Gromwell (Onosmodium hispidissimum): Shaggy False-Gromwell is a state endangered species in Indiana, found in Franklin County. This plant blooms from June to July and prefers partly shaded prairie habitat. Due to the decrease of prairies nationwide, the population of the Shaggy False-Gromwell has declined.

Lake Cress (Armoracia aquatic): The Lake Cress is listed as state endangered in Indiana. The Lake Cress prefers wetland habitat. Due to human development and expansion, numbers of this plant have declined. The Lake Cress is found in Dearborn County, Indiana.

Matted Broomspurge (Euphorbia serpens): Matted Broomspurge is a state endangered plant in Indiana. Originally from Central America, it was originally introduced in the United States as a weed. This small fruiting plant prefers shaded rich soils.

Gray Beardtongue (Penstemon canescens): The Gray Beardtongue is a state endangered plant in Indiana. The stems can reach a maximum height of 1 meter. The Gray Beardtongue is a native plant to the southeastern United States.

Other Planning Efforts in the Watershed Project Area

Other planning efforts within the watershed include:

IDEM TMDL Report: A TMDL report was published in 2020 and addressed *E. coli,* biotic communities, nutrients, and dissolved oxygen impairments in the Laughery Creek watershed, in accordance with the TMDL Program Priority Framework. Parameters chosen for TMDL development include *E. coli*, total suspended solids (TSS), and total phosphorus. The Laughery Creek Watershed TMDL was prioritized to be completed based on local interest in addressing water quality, IDEM interest in conducting baseline water quality monitoring for local planning, and a competitive Section 319 application from the local partners to develop a watershed management plan in conjunction with the IDEM sampling and TMDL development for streams impaired for *E. coli*, biological communities, nutrients, and dissolved oxygen.

Rule 5: This requires the development of a Construction Plan when there is 1 acre or more disturbed. An integral part of the Construction Plan is a Storm Water Pollution Prevention Plan. The Storm Water Pollution Prevention Plan addresses several issues. First, the plan outlines how erosion and sedimentation will be controlled on the project site to minimize the discharge of sediment off-site or to a water of the state. Second, the plan addresses other pollutants that may be associated with construction activity. This can include disposal of building materials, management of fueling operations, etc. Finally, the plan should also address pollutants that will be associated with the post-construction land use. This planning is handled through the local SWCD's within counties of the watershed and by the Building Commissioner when disturbance happens in the City of Batesville.

County / City Comprehensive Plans

Ripley County – The comprehensive plan was last updated in 2004 but is very general in nature, without information concerning natural resources or water quality.

Decatur County – The Comprehensive Plan was last updated in 2016 and was adopted May 15, 2017. The plan addresses the county's natural resources and water quality in several areas. The plan's Policy 12: *Preserve Natural Resources*, has 3 major themes: Conservation – creating a stronger relationship between the natural and built environments, Preservation – retaining and protecting existing environmental, agriculture and natural resources, and Restoration – adding to natural resources wherever possible. It states floodplains and wetlands should be protected from development and reduction in woodlands should be minimized. The plan's Policy 14: *Protect Water Quality*, has several recommendations to protect both ground water and surface water. They include creating a storm water management oversight committee to develop storm water runoff policies, insuring there is adequate separation between well sites and septic systems, and continuing to require a backup septic field location.

Franklin County – The comprehensive plan was last updated in March 2015 but does not contain any information about natural resources or water quality.

City of Batesville – The comprehensive plan was last updated in Jan. 2017 and contains brief/general information about wetlands and streams within and surrounding Batesville, but no specific actions or recommendations.

Conservation Planning through Government Agencies

Ripley / Decatur / Franklin – Over the past several years landowners have had the opportunity to complete customized conservation planning on their land with government agencies such as the Natural Resources Conservation Service, Indiana Department of Natural Resources, Indiana State Department of Agricultural, Purdue Extension, Soil & Water Conservation Districts and others. Landusers have also had the opportunity to participate with the Farm Service Agency and others to receive cost share and program benefits when implementing conservation on the land.

This planning and implementation has helped to address several of the water quality concerns voiced by stakeholders, such as sediment and nutrient reduction, but there is still much to do.

Relevant Relationships between Watershed Characteristics

After reviewing the different characteristics of the North Laughery Creek Watershed, there are three which stand out as major influencers on others. These are topography, soils, and landuse. These characteristics influence and are related to other characteristics. Some examples of these relationships are listed below.

Areas of the watershed with steeper terrain are also areas with hydrologic group ratings of C & D, with low infiltration rates and high runoff potential. The landuse of those areas are mainly forested with some hay/pasture, which are more natural conditions. The steepness of the land, low infiltration rates, and high runoff potential make these areas not as feasible for farmers to plant and harvest row crops like in the flatter terrain. The combination of those steep terrain characteristics and the forested and pasture landuse can lead to water quality issues like sedimentation and E.coli contamination from both livestock and wildlife.

There is also a very close relationship between Highly Erodible Land (HEL) soils and landuse. If the two maps are overlapped, the areas of the watershed which are classified as Non-Highly Erodible Land (NHEL) fall in line with the agricultural lands, Potentially Highly Erodible Land (PHEL) with hay/pasture, and HEL with forested lands. The watershed's topography is a key component of this relationship.

The steep slopes and slow infiltration of the soils leads to large amounts of runoff during heavy rainfalls. The runoff leads to flooding and streambank erosion potential which can significantly add to nutrient and sediment load within streams of the watershed.

SECTION TWO WATERSHED INVENTORY

MONITORING EFFORTS

During 2018 - 2019 IDEM completed a TMDL study to address *E. coli,* biotic communities, nutrients, and dissolved oxygen impairments in the Laughery Creek watershed, in accordance with the TMDL Program Priority Framework. Parameters chosen for TMDL development include *E. coli*, total suspended solids (TSS), and total phosphorus. Those parameters are included in this watershed management plan and are referred to cumulatively in this report as "pollutants."

Under the Clean Water Act (CWA), every state must adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the CWA's goal of "swimmable/fishable" waters. Water quality standards consist of three different components:

- Designated uses reflect how the water can potentially be used by humans and how well it supports a biological community. Examples of designated uses include aquatic life support, drinking water supply, and full body contact recreation. Every waterbody in Indiana has a designated use or uses; however, not all uses apply to all waters. The Laughery Creek Watershed TMDLs focus on protecting the designated aquatic life support and full body contact recreational uses of the waterbodies.
- Criteria express the condition of the water that is necessary to support the designated uses. Numeric criteria represent the concentration of a pollutant that can be in the water and still protect the designated use of the waterbody. Narrative criteria are the general water quality criteria ("free froms…") that apply to all surface waters. Numeric criteria for *E. coli*, Impaired Biotic Communities (IBC), and Dissolved Oxygen were used as the basis of the Laughery Creek Watershed TMDLs. In absence of state adopted numeric water quality standards, target values were used through interpretation of the narrative criteria.
- Antidegradation policies provide protection of existing uses and extra protection for high- quality or unique waters.

The water quality standards in Indiana pertaining to *E. coli*, IBC, and nutrients ("the impairments") are described below.

E. coli

E. coli is an indicator of the possible presence of pathogenic organisms (e.g., enterococcal *E. coli*, viruses, and protozoa) which may cause human illness. The direct monitoring of these pathogens is difficult; therefore, *E. coli* is used as an indicator of potential fecal contamination. *E. coli* is a sub-group of fecal coliform, the presence of *E. coli* in a water sample indicates recent fecal contamination is likely. Concentrations are typically reported as the count of organisms in 100 milliliters of water (count/100 mL) and may vary at a particular site depending on the baseline *E. coli* level already in the river, inputs from other sources, dilution due to precipitation events, and die-off or multiplication of the organism within the river water and sediments.

The numeric *E. coli* criteria associated with protecting the recreational use are described below.

"The criteria in this subsection are to be used to evaluate waters for full body contact recreational uses, to establish wastewater treatment requirements, and to establish effluent limits during the recreational season, which is defined as the months of April through October, inclusive. E. coli bacteria, shall not exceed one hundred twenty-five (125) per one hundred

(100) milliliters as a geometric mean based on not less than five (5) samples equally spaced over a thirty (30) day period nor exceed two hundred thirty-five (235) per one hundred (100) milliliters in any one (1) sample in a thirty (30) day period. . . However, a single sample shall be used for making beach notification and closure decisions." [Source: Indiana Administrative Code Title 327 Water Pollution Control Board. Article 2. Section 1-6(a).]

Nutrients

The term "nutrients" refers to the various forms of nitrogen and phosphorus found in a waterbody. Both nitrogen and phosphorus are necessary for aquatic life, and both elements are needed at some level in a waterbody to sustain life. The natural amount of nutrients in a waterbody varies depending on the type of system. A pristine mountain spring might have little to almost no nutrients, whereas a lowland, mature stream flowing through wetland areas might have naturally high nutrient concentrations. Streams draining larger areas are also expected to have higher nutrient concentrations.

Nutrients generally do not pose a direct threat to the designated uses of a waterbody. However, excess nutrients can cause an undesirable abundance of plant and algae growth, a process called eutrophication. Eutrophication can have many effects on a stream. One possible effect is low dissolved oxygen concentrations caused by excessive plant respiration and/or decay. Ammonia, which is toxic to aquatic life at elevated concentrations, can be released from decaying organic matter when eutrophication occurs. For these reasons, excessive nutrients can result in the nonattainment of bio-criteria and impairment of the designated use.

Like most states, Indiana has not yet adopted numeric water quality criteria for nutrients. The relevant narrative criteria that apply to the TMDLs presented in this report state the following:

"All surface waters at all times and at all places, including waters within the mixing zone, shall meet the minimum conditions of being free from substances, materials, floating debris, oil, or scum attributable to municipal, industrial, agricultural, and other land use practices, or other discharges that do any of the following:" [327 IAC 2-1-6. Sec. 6. (a)(1)]…

"are in concentrations or combinations that will cause or contribute to the growth of aquatic plants or algae to such degree as to create a nuisance, be unsightly, or otherwise impair the designated uses." [327 IAC 2-1-6. Sec. 6. (a) (1)(D)]

"are in amounts sufficient to be acutely toxic to, or to otherwise severely injure or kill, aquatic life, other animals, plants, or humans." [327 IAC 2-1-6. Sec. 6. (a) (1)(E)]

Biological Communities

The water quality regulatory definition of a "well-balanced aquatic community" is "an aquatic community which is diverse in species composition, contains several different trophic levels, and is not composed mainly of strictly pollution tolerant species" [327 IAC 2-1-9(49)].

IDEM has not yet adopted numeric water quality criteria for total suspended solids (TSS). The relevant narrative criteria that apply to the TMDLs presented in this report state the following:

"All surface waters at all times and at all places, including waters within the mixing zone, shall meet the minimum conditions of being free from substances, materials, floating debris, oil, or scum attributable to municipal, industrial, agricultural, and other land use practices, or other discharges that do any of the following:" [327 IAC 2-1-6. Sec. 6. (a)(1)]…

(a) re in concentrations or combinations that will cause or contribute to the growth of aquatic plants or algae to such degree as to create a nuisance, be unsightly, or otherwise impair the designated uses." [327 IAC 2-1-6. Sec. 6. (a) (1)(D)]

(a)re in amounts sufficient to be acutely toxic to, or to otherwise severely injure or kill, aquatic life, other animals, plants, or humans." [327 IAC 2-1-6. Sec. 6. (a) (1)(E)]

In addition, the narrative biological criterion [327 IAC 2-1-3(2)] states the following:

"All waters, except those designated as limited use, will be capable of supporting a well- balanced, warm water aquatic community."

Biological assessments for streams are based on the sampling and evaluation of either the fish communities, or benthic aquatic macroinvertebrate communities, or both. Indices of Biotic Integrity (IBI) for fish and macroinvertebrate IBI (mIBI) assessment scores, or both, were calculated and compared to regionally-calibrated models. In evaluating fish communities, streams rating as "poor" or worse are classified as non-supporting for aquatic life uses. For benthic aquatic macroinvertebrate communities, individual sites are compared to a statewide calibration at the lowest practical level of identification for Indiana. All sites at or above background for the calibration are considered to be supporting aquatic life uses. Those sites rated as moderately or severely impaired in the calibration are considered to be non- supporting. Waters with identified impairments to one or more biological communities are considered not supporting aquatic life use. The biological thresholds Indiana uses to make use attainment decisions are shown below in Table 18 to provide greater context for understanding the range of biological conditions that is considered either fully supporting or impaired.

IDEM's aquatic life use assessments are never based solely on habitat evaluations. However, habitat evaluations are used as supporting information in conjunction with biological data to determine aquatic life use support. Such evaluations, which take into consideration a variety of habitat characteristics as well as stream size, help IDEM to determine the extent to which habitat conditions may be influencing the ability of biological communities to thrive. If habitat is determined to be driving a biological community impairment (IBC) and no other pollutants that might be contributing to the impairment have been identified, the IBC is not considered for inclusion on IDEM's 303(d) List of Impaired Waters (Category 5). In such cases, the waterbody is instead placed in Category 4C for the biological impairment.

Table 18 below presents the criteria associated with the fish community Index of Biotic Integrity (IBI) and macroinvertebrate community Index of Biotic Integrity (mIBI) that indicate whether a waterbody is fully supporting, partially supporting, or not supporting the aquatic life use.

Table 18: Laughery Creek Watershed Aquatic Life Use Support Criteria for Biological Communities

Biotic Index Score and Associated Assessment Decision	Integrity Class	Corresponding Integrity Class Score	Attributes
Fish community Index of Biotic Integrity (IBI) Scores (Range of possible scores is 0-60)			
Fully Supporting IBI ≥ 36 Indicates Full Support	Excellent	53-60	Comparable to "least impacted" conditions, exceptional assemblage of species
	Good	45-52	Decreased species richness (intolerant species in particular), sensitive species present
	Fair	36-44	Intolerant and sensitive species absent, skewed trophic structure
Not Supporting IBI < 36 Indicates Impairment	Poor	23-35	Many expected species absent or rare, tolerant species dominant
	Very Poor	12-22	Few species and individuals present, tolerant species dominant
	No Organisms	12	No fish captured during sampling.
Benthic aquatic macroinvertebrate community Index of Biotic Integrity (mIBI) Scores Multihabitat MHAB methods(Range of possible scores is 12-60)			
Fully Supporting mIBI ≥ 36 Indicates Full Support	Excellent	53-60	Comparable to "least impacted" conditions, exceptional assemblage of species
	Good	45-52	Decreased species richness (intolerant species in particular), sensitive species present
	Fair	36-44	Intolerant and sensitive species absent, skewed trophic structure
Not Supporting mIBI < 36 Indicates Impairment	Poor	23-35	Many expected species absent or rare, tolerant species dominant
	Very Poor	12-22	Few species and individuals present, tolerant species dominant
	No Organisms	12	No macroinvertebrates captured during sampling.

Dissolved Oxygen

The target value used for the Laughery Creek Watershed TMDL was based on the water quality criterion [327 IAC 2-1-6] which states the following:

- *Concentrations of dissolved oxygen shall: (A) average at least (5.0) milligrams per liter per calendar day; and (B) not be less than four (4.0) milligrams per liter at any time.*

Due to standard operating procedures for the data collection of this project, the Laughery Creek Watershed TMDL used 4.0 mg/L as the target value during assessments since data was not collected more than one time per calendar day.

Water Quality Targets

Target values are needed for the development of TMDLs because of the need to calculate allowable daily loads. For parameters that have numeric criteria, such as *E. coli*, the target equals the numeric criteria. For parameters that do not have numeric criteria, target values must be identified from some other source. The target values used to develop the Laughery Creek Watershed TMDL are presented below. Note that the target values set for the North Laughery Watershed management plan are more stringent than those set for the TMDL target. Values set for the WMP are identified later in this document.

***E. coli* TMDLs**

The target value used for the Laughery Creek Watershed TMDL was based on the 235 counts/100 mL single sample maximum component of the water quality standard (i.e., daily loading capacities were calculated by multiplying flows by 235 counts/100 mL). The U.S. EPA report, "An Approach for Using Load Duration Curves in the Development of TMDLs" (EPA 2007) [1] describes how the monthly geometric mean (125 counts/100mL) is likely to be met when the single sample maximum value (235 counts/100mL) is used to develop the loading capacity. The process calculates the daily maximum bacteria value that is possible to observe and still attain the monthly geometric mean. If the single sample maximum is set as a never-to-be surpassed value then it becomes the maximum value that can be observed, and all other bacteria values would have to be less than the maximum.

IBC TMDLs

The following sections describe the TMDL target values used for nutrients and TSS when developing an IBC TMDL and are used as values set in the WMP.

Total Phosphorus

Although Indiana has not yet adopted numeric water quality criteria for nutrients, IDEM has identified the following nutrient benchmarks that are used to assess potential nutrient impairments:

- Total phosphorus should not exceed 0.30 mg/L (USEPA's nationwide 1986 Quality Criteria for Waters also known as the *Gold Book*).

The total phosphorus (0.30 mg/L) value was used as TMDL targets during the development of the Laughery Creek Watershed TMDL. IDEM has determined that meeting this target will result in achieving the narrative biological criterion by improving water quality and promoting a well-balanced aquatic community. Phosphorus is interpreted as an average in the NPDES permits. Monitoring data, reviewed by IDEM during the TMDL development process, indicated that when WWTPs were in compliance with their individual permit limit for phosphorus (1.0 mg/L), the in-stream target for phosphorus (0.30 mg/L) was typically met. As such, WWTPs were given waste load allocations (WLAs) based on their 1.0 mg/L permit limitation.

Total Suspended Solids (TSS)

Although Indiana has not yet adopted numeric water quality criteria for TSS, IDEM has identified a target value based on IDEM's NPDES permitting process. A target of 30.0 mg/L for total suspended solids TSS has been identified as a permit limit for NPDES facilities. A target value of 30.0 mg/L TSS was therefore used as the TSS TMDL target value to ensure consistency with IDEM's NPDES permitting process.

IDEM has determined that meeting the TSS target will result in achieving the narrative biological criterion by improving water quality and promoting a well-balanced aquatic community.

Various subwatersheds in the Laughery Creek watershed have IBC. Biological communities include fish and aquatic invertebrates, such as insects. These in-stream organisms are indicators of the cumulative effects of activities that affect water quality conditions over time. An IBC listing on Indiana's 303(d) List of Impaired Waters means IDEM's monitoring data show one or both of the aquatic communities are not as healthy as they should be. IBC is not a source of impairment but a symptom of other sources. To address these impairments in the Laughery Creek Watershed, TSS has been identified as a pollutant for TMDL development.

Table 19 reiterates the TMDL target values presented in Section 1.0. These are the target values IDEM uses to assess water quality data collected in the Laughery Creek watershed.

Table 19: Target Values Used for Development of the Laughery Creek Watershed TMDLs

Parameter	**Target Value**
Total Phosphorus	No value should exceed 0.30 mg/L
Total Suspended Solids	No value should exceed 30.0 mg/L
E. coli	No value should exceed 235 counts/100 mL (single sample maximum)

Target Values set in the North Laughery Watershed Management Plan

North Laughery WMP target values set by the North Laughery Steering Committee are more stringent than some of those set in the TMDL . Target values set for the North Laughery Watershed Management Plan are listed in Table 20 below.

TARGET VALUES SET BY NORTH LAUGHERY WATERSHED STEERING COMMITTEE

Parameter	Target	Reference
Dissolved Oxygen	not < 4 mg/L and not > 12 mg/L	327 IAC 2-1-6
Total Ammonia (NH3)	Range between 0.0 and 0.21 mg/L depending upon temperature and pH	(327 IAC 2-1-6)
pH	> 6 and < 9	327 IAC 2-1-6
Nitrate + Nitrite	< 1.5 mg/L	US EPA reference level (2000)
Total Phosphorus	< 0.076 mg/L	US EPA recommendation
Total Suspended Solids	< 25 mg/L	US EPA recommendation
Total Kjeldahl Nitrogen (TKN)	< 0.591 g/L	US EPA recommendation (2000)
Escherichia Coli	< 235 CFU/100 ml (single sample) or <125 CFU/100 ml (geo mean-5 equally spaced samples over a 30 day period)	327 IAC 2-1.5-8
Turbidity	< 10.4 NTU	US EPA recommendation (2000)
Macroinvertebrates Index of biotic Integrity (mIBI)	>35 points	IDEM
Fish Index of Biotic Integrity (IBI)	>35 points	IDEM
Qualitative Habitat Evaluation Index (QHEI)	>51 points	IDEM

Understanding Subwatersheds and Assessment Units

This section presents information concerning IDEM's segmentation process as it applies to the Laughery Creek watershed. IDEM identifies the Laughery Creek Watershed and its tributaries using a watershed numbering system developed by United States Geological Survey (USGS), Natural Resource Conservation Service (NRCS), and the U.S. Water Resources Council referred to as hydrologic unit codes (HUCs). HUCs are a way of identifying watersheds in a nested arrangement from largest (i.e., those with shorter HUCs) to smallest (i.e., those with longer HUCs). Figure 16 and Table 21 below show the 12- digit HUCs located in the Laughery Creek watershed.

Within each 12-digit HUC subwatershed, IDEM has identified several Assessment Unit IDs (AUIDs) which represent individual stream segments. Through the process of segmenting subwatersheds into AUIDs, IDEM identifies streams reaches and stream networks that are representative for the purposes of assessment. In practice, this process leads to grouping tributary streams into smaller catchment basins of similar hydrology, land use, and other characteristics such that all tributaries within the catchment basin can be expected to have similar potential water quality impacts. Catchment basins, as defined by the aforementioned factors and are typically very small, which significantly reduces the variability in the water quality expected from one stream or stream reach to another. Given this, all tributaries within a catchment basin are assigned a single AUID. Grouping tributary systems into smaller catchment basins also allows for better characterization of the larger watershed and more localized recommendations for implementation activities. Variability within the larger watershed will be accounted for by the differing AUIDs assigned to the different catchment basins.

Table 21 contains the AUIDs in the subwatersheds of the Laughery Creek watershed and the associated length.

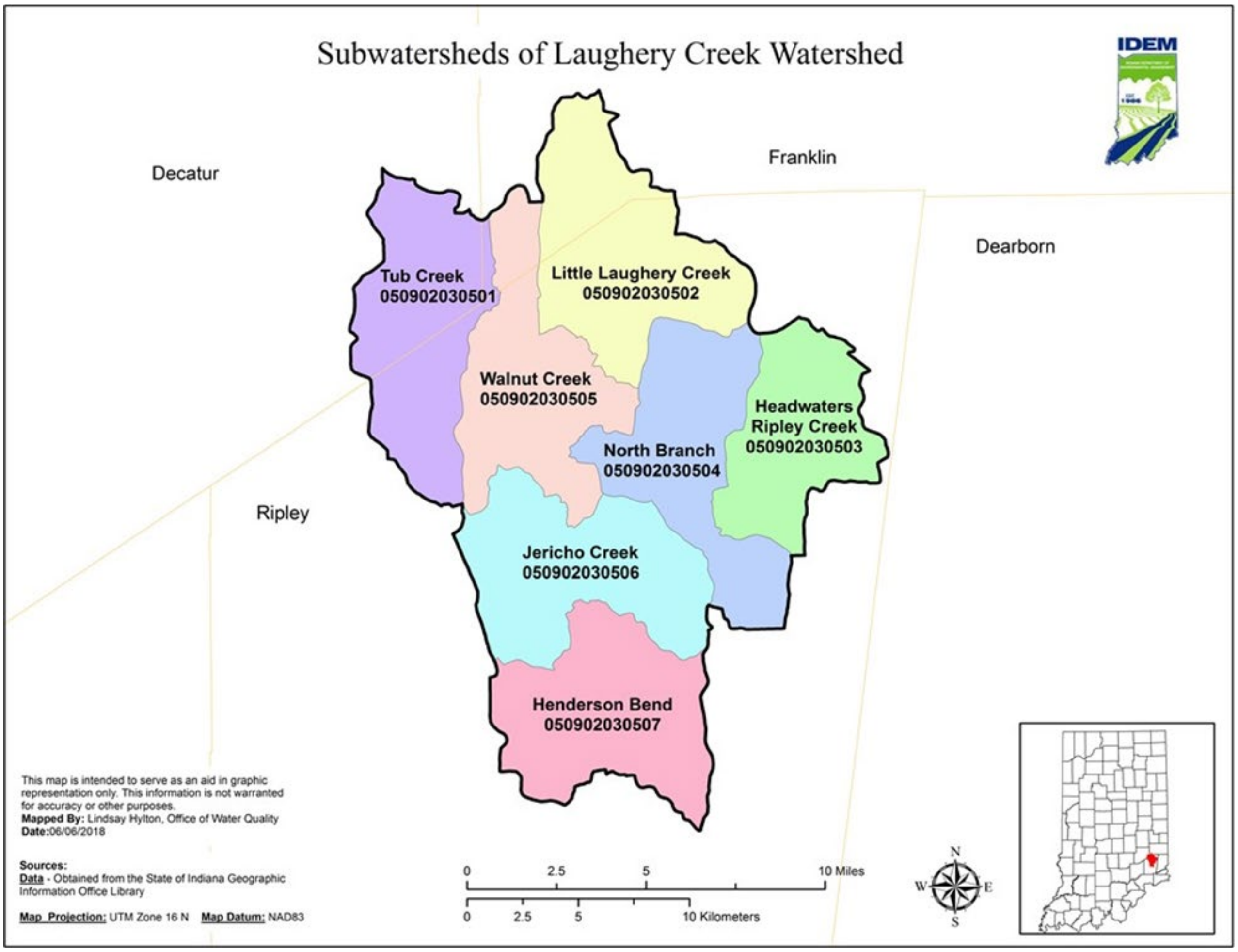


Figure 16: Map of Subwatersheds of North Laughery Creek Watershed

Understanding 303(d) Listing Information

There are a number of existing impairments in the Laughery Creek watershed from the approved 2018 303(d) List of Impaired Waters (Figure 17). Historical sites in the watershed where this data was collected are shown below in Figure 17. The listings and causes of impairment have been adjusted as a result of reassessment data collected at 24 sampling locations in the watershed in November 2018-October 2019. Samples were collected monthly. Within the Laughery Creek watershed, there are now a total of 20 assessment unit IDs (AUIDs) that will be cited as impaired for *E. coli,* six AUIDs cited as impaired for *IBC*, five AUIDs cited as impaired for dissolved oxygen*,* and two AUIDs cited as impaired for nutrients Figure 17. These impaired segments account for approximately 119 miles. Table 21 presents listing information for the Laughery Creek watershed, including a comparison of the updated 2022 listings with the 2018 listings and associated causes of impairments addressed by the TMDLs. The reassessment data used in updating the listings for the Laughery Creek watershed are available in Appendix B. Below is an assessment of the available biological and chemistry data for the Laughery Creek watershed.

Table 21: Assessment Units and Section 303(d) Listed Impairments for the Laughery Creek Watershed for 2018 and 2022

Name of Subwatershed	Current AUID	Length (mi)	2018 Section 303(d) Listed Impairment	Updated Impairments to be listed 2022 303(d)
Tub Creek 050902030501	INV0351_03	3.73		
	INV0351_04	3.23		
	INV0351_05	0.89		E. coli, IBC
	INV0351_T1001	1.94		
	INV0351_T1002	6.83		
	INV0351_T1003	13.51	E. coli, IBC, DO	
	INV0351_T1004	5.34		
	INV0351_T1005	0.72		
	INV0351_T1006	0.54		
	INV0351_T1007	0.38		
	INV0351_T1008	0.41		
	INV0351_T1009	1.01		
	INV0351_T1010	0.70		
	INV0351_T1011	0.82		
	INV0351_T1012	0.67		
	INV0351_T1013	0.81		
	INV0351_T1014	0.48		
	INV0351_T1015	1.27		
Walnut Creek 050902030505	INV0355_01	2.24		
	INV0355_02	2.79		
	INV0355_03	5.67		E. coli
	INV0355_06	6.68		E. coli, IBC
	INV0355_07	8.63		
	INV0355_T1001	8.71		E. coli, DO
	INV0355_T1002	13.63		E. coli
	INV0355_T1003	2.96		
	INV0355_T1004	3.62		
	INV0355_T1005	1.02		
	INV0355_T1006	0.72		
	INV0352_01	5.73		E. coli, DO
Little Laughery Creek 050902030502	INV0352_02	5.46		E. coli, Nutrients
	INV0352_03	5.08		E. coli
	INV0352_T1001	6.14		E. coli, IBC
	INV0352_T1002	0.67		
	INV0352_T1003	0.67		
	INV0352_T1004	2.05		
	INV0352_T1005	0.99		

Name of Subwatershed	Current AUID	Length (mi)	2018 Section 303(d) Listed Impairment	Updated Impairments to be listed 2022 303(d)
	INV0352_T1006	1.00		
	INV0352_T1007	1.94		
Little Laughery Creek 050902030502	INV0352_T1009A	1.14		
	INV0352_T1010A	0.50		
	INV0352_T1011	1.57		
	INV0352_T1012	1.89		
	INV0352_T1013	1.12		
	INV0352_T1014	1.82		
	INV0352_T1015	0.51		
	INV0352_T1016	1.14		
	INV03P1003_00	3.45		
	INV03P1005_00	0.69		
	INV03P1008_00	0.59		
	INV03P1009_00	1.43		
Jericho Creek 050902030506	INV0356_03	6.42	IBC	IBC
	INV0356_04	0.20	E. coli, IBC	
	INV0356_05	0.21	E. coli	E. coli
	INV0356_T1001	4.72		
	INV0356_T1002	1.05		
	INV0356_T1003	3.12		
	INV0356_T1004	6.63		
	INV0356_T1005	7.48		
	INV0356_T1006	0.27		E. coli
	INV0356_T1007	3.11		
	INV0356_T1008	3.00		
	INV0356_T1009	2.39		
	INV0356_T1010	4.29		
	INV0356_T1011	1.72		
	INV0356_T1012	0.71		
	INV0356_T1013	4.82		E. coli
	INV0356_T1013A	0.47		
	INV0356_T1014	4.31		
	INV0356_T1015	4.23		
	INV0356_T1016	2.01		
North Branch	INV0354_02	0.79		
050902030504	INV0354_03	6.83		E. coli
	INV0354_04	7.22		E. coli
	INV0354_T1001	4.06		
	INV0354_T1002	3.05		E. coli, IBC
	INV0354_T1003	1.87		
	INV0354_T1004	2.85		
	INV0354_T1005	1.16		
	INV0354_T1006	1.27		

Name of Subwatershed	Current AUID	Length (mi)	2018 Section 303(d) Listed Impairment	Updated Impairments to be listed 2022 303(d)
North Branch	INV0354_T1009	1.24		
050902030504	INV0354_T1010	2.17		
	INV0354_T1011	6.43		
	INV0354_T1012	2.38		
	INV0354_T1013	5.13		E. coli, DO
	INV0354_T1013A	0.63		
	INV03P1010_00	0.23		
Headwaters Ripley Creek 050902030503	INV0353_01	6.76		E. coli, DO, Nutrients
	INV0353_02	5.71		E. coli
	INV0353_T1001	2.37		
	INV0353_T1002	4.72		
	INV0353_T1003	8.56		E. coli, IBC
	INV0353_T1004	4.79		
	INV0353_T1005	3.88		
Henderson Bend 050902030507	INV0357_02	4.30		
	INV0357_03	7.57		
	INV0357_T1001	7.73		
	INV0357_T1002	2.82		
	INV0357_T1005A	0.81		
	INV0357_T1006	8.26		
	INV0357_T1007	6.24		
	INV0357_T1008	12.36		
	INV0361_03	0.01		
	INV03P1001_00	3.75		

Understanding Table 21:

- ***Column 1: Subwatershed (12-digit HUC). Shows the name of the subwatershed at the 12-digit HUC scale. The subwatershed found in this column is the appropriate scale for what the IDEM's WMP Checklist defines as a sub watershed for the purposes of watershed management planning.***
- ***Column 2: Current AUID. Identifies the AUID given to waterbodies within the 12-digit HUC subwatershed for purposes of the 2018 Section 303(d) listing assessment process.***
- ***Column 3: Length (mi). Provides the length in miles of the associated AUID.***
- ***Column 4: 2018 Section 303(d) Listed Impairment. Identifies the cause of impairment associated with the 2018 Section 303(d) listing.***
- ***Column 5: Updated Impairments to be listed 2022 303(d). Provides the updated causes of impairment if new data and information are available.***

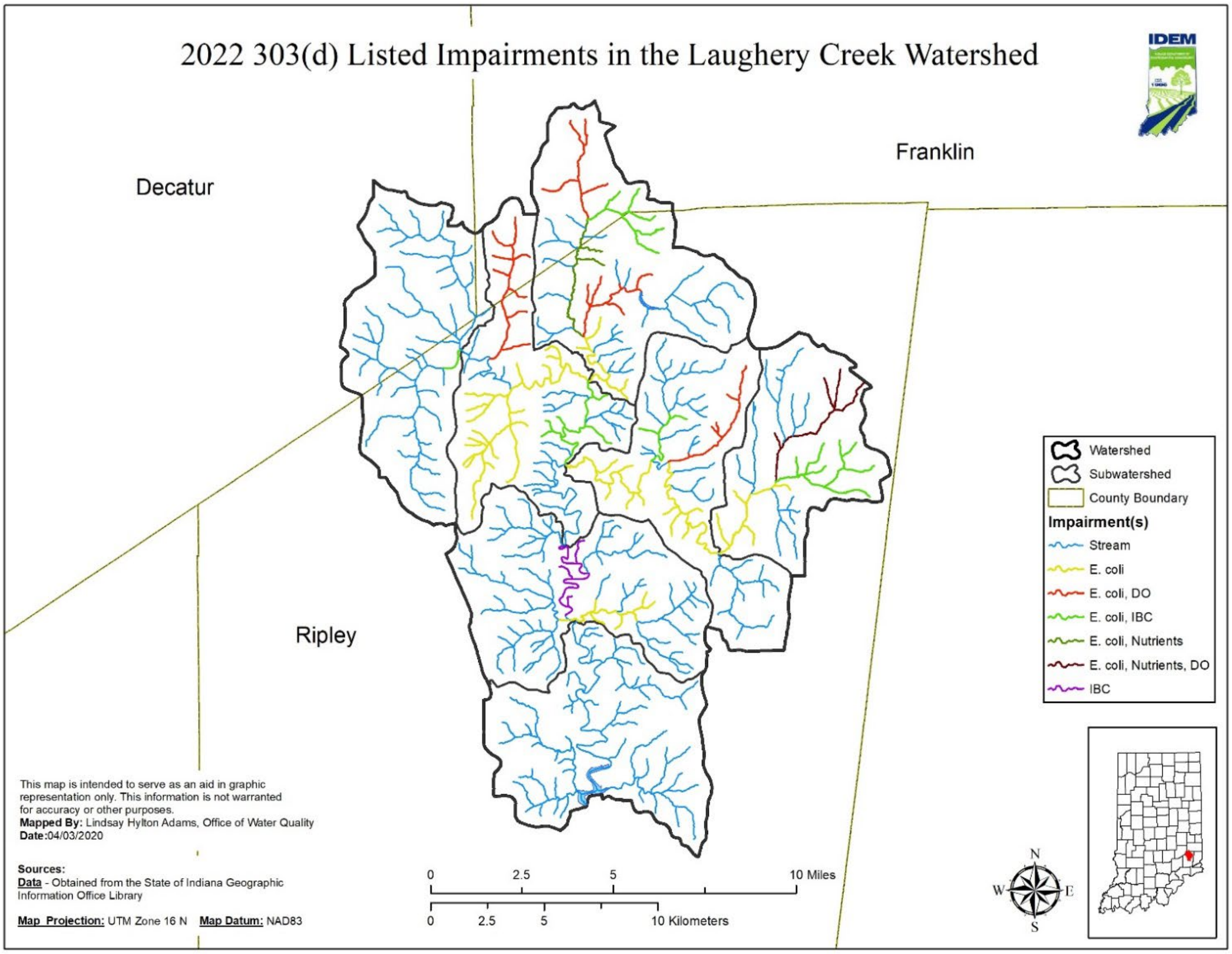


Figure 17: Streams Listed on the Draft 2022 Section 303(d) List of Impaired Waters in the Laughery Creek Watershed

Historical Watershed Sampling Locations

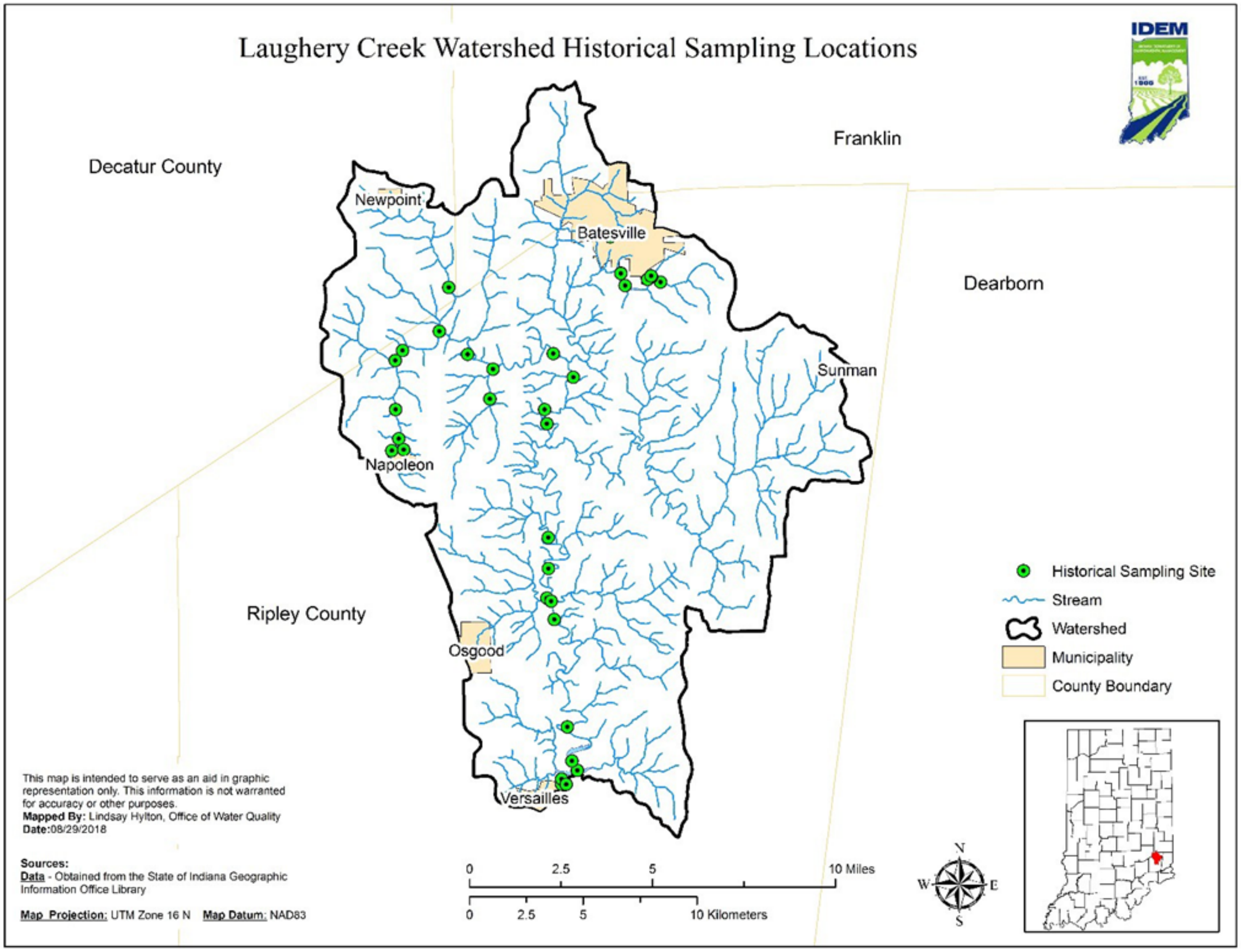
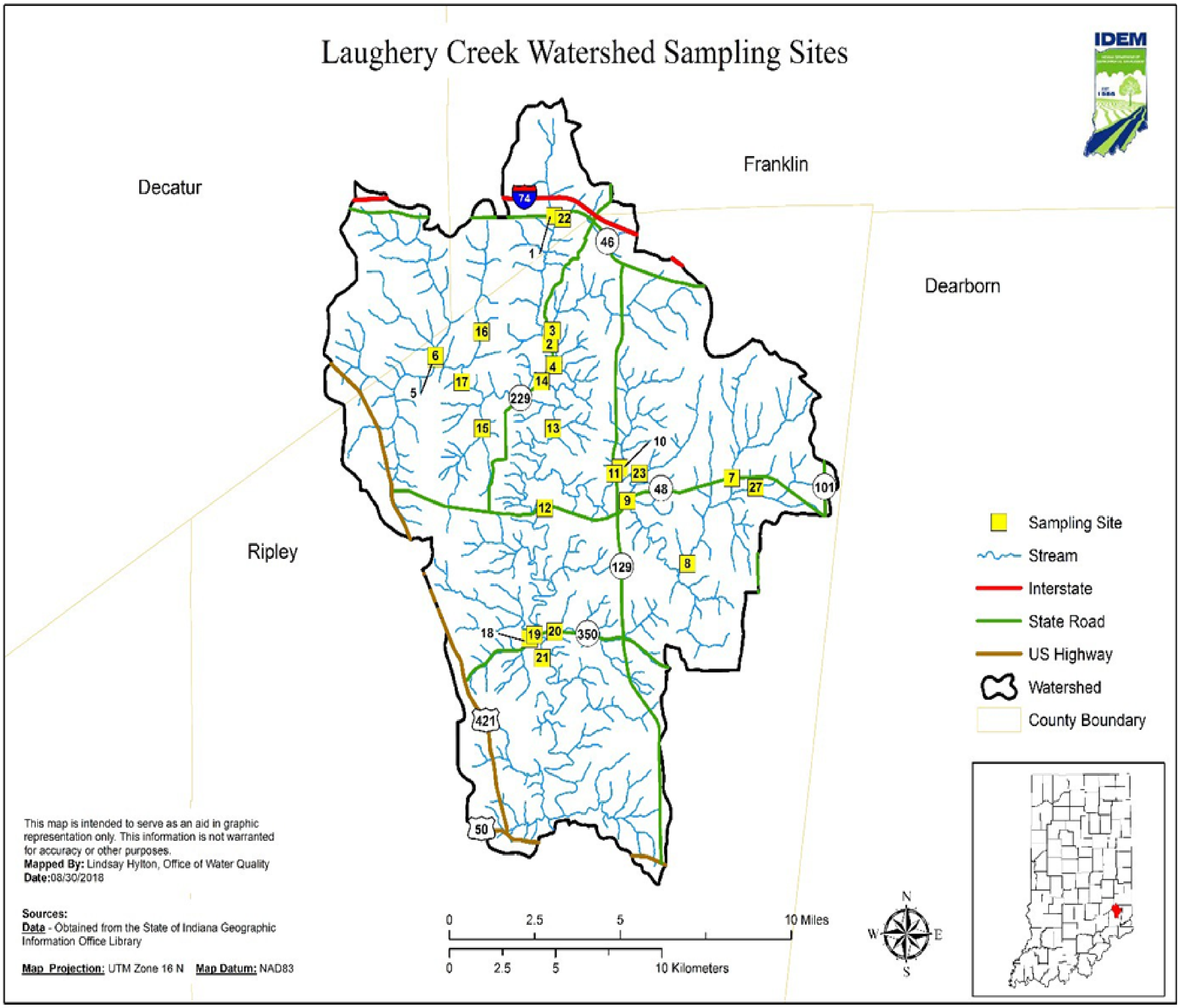


Figure 18: Shows historical IDEM sampling sites in the North Laughery Watershed.

TMDL Watershed Sampling Sites



The sampling sites identified in figure 19 above and table 22 below were used during the TMDL study completed by IDEM during the period 2018 – 2019.

Laughery Creek Sampling Site Information

Site #	Site ID #	Stream Name	Road Name	AUID
1	OML-05-0020	Little Laughery Creek	State Road 46	INV0352_01
2	OML-05-0021	Little Laughery Creek	State Road 229	INV0352_02
3	OML-05-0022	Bobs Creek	County Road 1300 N	INV0352_T1008
4	**OML-05-0023**	Little Laughery Creek	County Rd 1250 N/Legion Rd	INV0352_03
5	**OML-05-0009**	Laughery Creek	County Road 250 W	INV0351_05
6	**OML-05-0024**	Tub Creek	County Road 250 W	INV0351_T1003
7	OML-05-0025	Ripley Creek	State Road 48	INV0353_01
8	**OML-05-0026**	Ripley Creek	N Old Milan Road	INV0353_02
9	OML-05-0027	Ripley Creek	State Road 48	INV0354_03
10	OML-05-0028	North Branch Ripley Creek	N Adams Church Road	INV0354_T1002
11	**OML-05-0029**	Ripley Creek	State Road 129	INV0354_04
12	**OML-05-0030**	Laughery Creek	State Road 48	INV0355_07
13	OML-05-0031	Laughery Creek	E Salem Road	INV0355_06
14	OML060-0007	Laughery Creek	State Road 229	INV0355_03
15	OML060-0005	Tributary of Laughery Creek	County Road 1050 N	INV0355_T1002
16	OML-05-0032	Walnut Fork	County Road 1300 N	INV0355_T1001
17	OML060-0006	Laughery Creek	County Road 200 W	INV0355_02
18	OML-05-0033	Plum Creek	State Road 350	INV0356_T1006
19	**OML-05-0042**	Laughery Creek	State Road 350	INV0356_04
20	OML-05-0034	Castators Creek	State Road 350	INV0356_T1013
21	**OML-05-0012**	Laughery Creek	County Road 450 N	INV0357_02
22	OML-05-0035	Tributary of Little Laughery Creek	Huntersville Road	INV0352_T1001
23	OML-05-0036	Tributary of Ripley Creek	County Road 950 N	INV0354_T1013
27	OML-05-0040	Tributary of Ripley Creek	N Spades Rd/County Rd 700 E	INV0353_T1003

Understanding Table 22: **Bolded sites = pour point sites*

- *Column 1: Site #. Lists the site number that corresponds to the site location in Figure 19 .*
- *Column 2: Site ID #. Provides the U.S. EPA assigned number*
- *Column 3: Stream Name. Identifies the Stream Name that the site is located on.*
- *Column 4: Road Name. Identifies the Road Name that the site is located on*

- *Column 5: AUID. Identifies the AUID given to waterbodies within the 12-digit HUCsub watershed for purposes of the 2018 Section 303(d) listing assessment process.*

E. coli **Data**

For pathogens, 24 sites in the Laughery Creek were sampled. Table below is a summary of pathogen data for subwatersheds in the Laughery Creek watershed

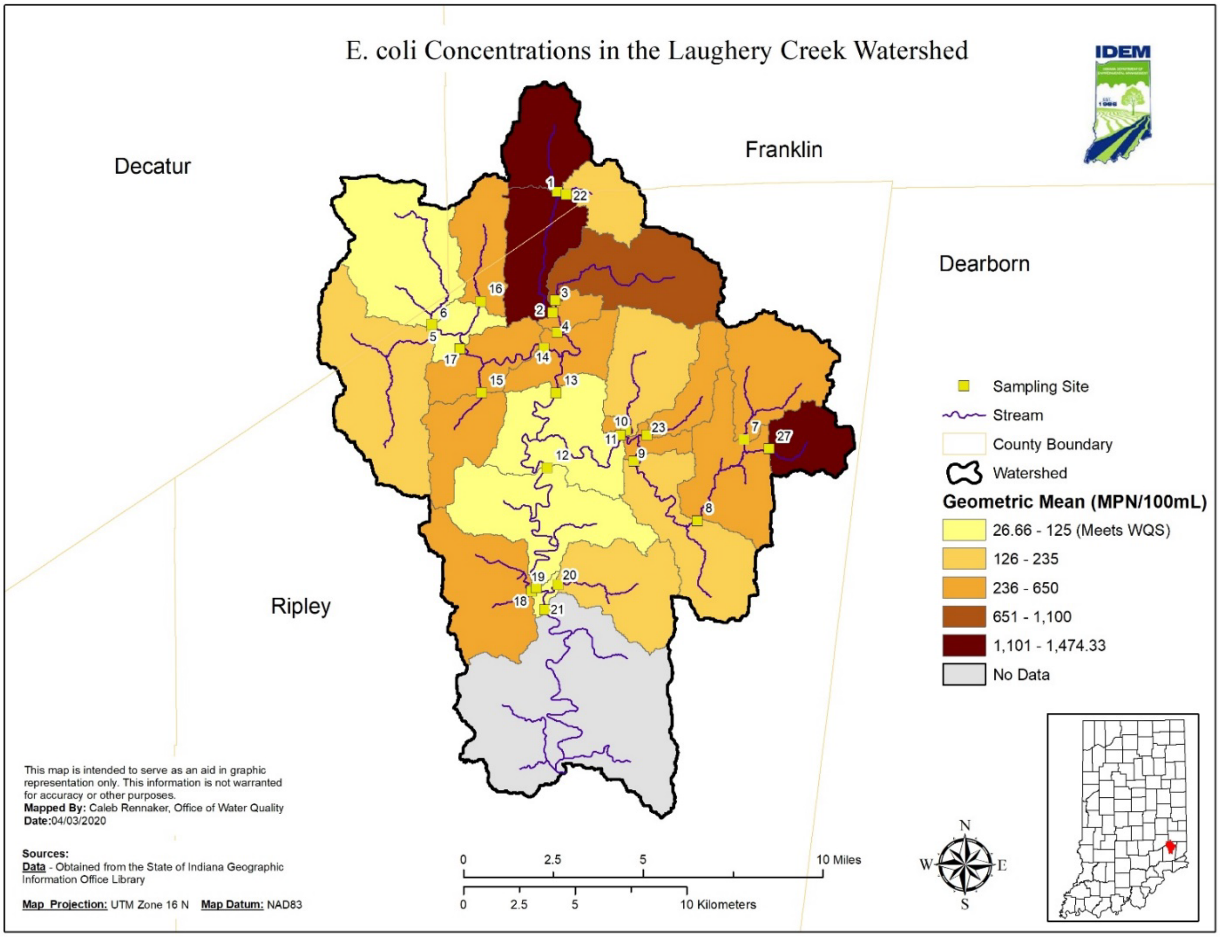
Table 23: Summary of Pathogen Data in Laughery Creek by Subwatershed

Subwatershed	Station #	AUID	Period of Record	Total Number of Samples	Percent of Samples Exceeding *E. coli* WQS (#/100 mL)		Geomean (#/ 100 mL)	Single Sample Maximum (#/ 100 mL)	Percent Reduction Based on Geomean (125/ 100mL)
					125	235			
Tub Creek	OML-05-0009	INV0351_05	4/1/19-9/9/19	8	75	50	181.55	866.4	31.15
	OML-05-0024	INV0351_T1003	4/1/19-9/9/19	8	25	25	101.58	488.4	0
Little Laughery Creek	OML-05-0020	INV0352_01	4/1/19-9/9/19	8	87.5	87.5	1474.33	>2419.6	91.52
	OML-05-0021	INV0352_02	4/1/19-10/7/19	9	100	88.89	1136.92	2419.6	89.01
	OML-05-0022	INV0352_T1008	4/1/19-8/5/19	7	100	85.71	934.49	>2419.6	86.62
	OML-05-0023	INV0352_03	4/1/19-10/7/19	9	100	77.78	420.58	2419.6	70.28
	OML-05-0035	INV0352_T1001	4/1/19-10/7/19	9	55.56	44.44	195.34	1986.3	36.01
Headwaters Ripley Creek	OML-05-0025	INV0353_01	4/2/19-10/8/19	9	77.78	66.66	434.58	2419.6	71.24
	OML-05-0026	INV0353_02	4/2/19-10/8/19	9	100	77.78	398.14	1553.1	68.60
	OML-05-0040	INV0353_T1003	4/2/19-10/8/19	9	100	77.78	1382.54	1986.3	90.96
North Branch	OML-05-0027	INV0354_03	4/2/19-9/10/19	8	62.5	37.5	202.46	579.4	38.26
	OML-05-0028	INV0354_T1002	4/2/19-8/6/19	7	85.71	42.86	172.47	461.1	27.52
	OML-05-0029	INV0354_04	4/2/19-9/10/19	8	75	25	242.6	461.1	48.47
	OML-05-0036	INV0354_T1013	4/2/19-8/6/19	7	57.14	57.14	382.34	2419.6	67.31
Walnut Creek	OML-05-0030	INV0355_07	4/2/19-10/8/19	9	66.67	22.22	98.72	325.5	0
	OML-05-0031	INV0355_06	4/1/19-10/7/19	9	88.89	77.78	609.13	1553.1	79.48
	OML060-0007	INV0355_03	4/1/19-10/7/19	9	100	77.78	529.41	920.8	76.39
	OML060-0005	INV0355_T1002	4/1/19-9/9/19	8	75	62.5	373.98	1119.9	66.58
	OML-05-0032	INV0355_T1001	4/1/19-9/9/19	8	87.5	75	347.53	727	64.03
	OML060-0006	INV0355_02	4/1/19-10/7/19	9	44.44	33.33	116.00	579.4	0
Jericho Creek	OML-05-0033	INV0356_T1006	4/2/19-10/8/19	9	55.56	44.44	407.87	1119.9	69.35
	OML-05-0042	INV0356_04	4/2/19-10/8/19	9	11.11	0	26.66	133.4	0
	OML-05-0034	INV0356_T1013	4/2/19-10/8/19	9	44.44	22.22	187.77	488.4	33.43
Henderson Bend	OML-05-0012	INV0357_02	4/2/19-10/8/19	9	22.22	11.11	74.89	248.9	0

Understanding Table 23: Pathogen data for the Laughery Creek Watershed indicated the following

- Reductions of 31 percent or greater are needed to meet the WMP & TMDL target values for *E. coli* in Tub Creek.
- Reductions of 92 percent or greater are needed to meet the WMP & TMDL target values for *E. coli* in Little Laughery Creek.
- Reductions of 91 percent or greater are needed to meet the WMP & TMDL target values for *E. coli* in Headwaters Ripley Creek.
- Reductions of 67 percent or greater are needed to meet the WMP & TMDL target values for *E. coli* in North Branch.
- Reductions of 79 percent or greater are needed to meet the WMP & TMDL target values for *E. coli* in Walnut Creek.
- Reductions of 69 percent or greater are needed to meet the WMP & TMDL target values for *E. coli* in Jericho Creek.
- Reductions of 0 percent are needed to meet the WMP & TMDL target values for *E. coli* in Henderson Bend.

Figure 20: *E. coli* concentrations based on 5-week geometric mean (MPN/100mL) and sampling site drainage areas for 2018-2019. Values over 125 MPN/100mL are not meeting the current WQS for *E. coli.*



Water Chemistry Data

Table 24: Summary of Chemistry Data in the Laughery Creek Watershed for Total Phosphorus, Total Suspended Solids, and Dissolved Oxygen (reductions based on TMDL targets)

Subwatershed	Sampling Station	Site #	AUID	Total Phosphorus Single Sample Maximum (mg/L)	Total Phosphorus % Reduction	Total Suspended Solids Single Sample Maximum (mg/L)	Total Suspended Solids % Reduction	Dissolved Oxygen Single Sample Minimum (mg/L)	Dissolved Oxygen % Below WQS
Tub Creek	OML-05-0009	5	INV0351_05	0.33	9.09	35	14.29	4.47	NA
	OML-05-0024	6	INV0351_T1003	0.34	11.76	67	55.22	6.81	NA
Little Laughery Creek	OML-05-0020	1	INV0352_01	0.09	NA	18	NA	1.89	111.64
	OML-05-0021	2	INV0352_02	0.34	11.76	19	NA	6.05	NA
	OML-05-0022	3	INV0352_T1008	0.15	NA	47	36.17	3.37	18.69
	OML-05-0023	4	INV0352_03	0.36	16.67	65	53.85	4.6	NA
	OML-05-0035	22	INV0352_T1001	0.58	48.28	13	NA	3.86	3.63
Headwaters Ripley Creek	OML-05-0025	7	INV0353_01	1.1	72.73	40	25	0.59	577.97
	OML-05-0026	8	INV0353_02	0.18	NA	36	16.67	3.13	27.80
	OML-05-0040	27	INV0353_T1003	0.05	NA	16	NA	7.46	NA
North Branch	OML-05-0027	9	INV0354_03	0.08	NA	17	NA	3.96	1.01
	OML-05-0028	10	INV0354_T1002	0.05	NA	23	NA	5.03	NA
	OML-05-0029	11	INV0354_04	0.16	NA	19	NA	4.57	NA
	OML-05-0036	23	INV0354_T1013	0.05	NA	9.5	NA	3.65	9.59
Walnut Creek	OML-05-0030	12	INV0355_07	0.18	NA	34	11.76	4.22	NA
	OML-05-0031	13	INV0355_06	0.18	NA	30	NA	4.95	NA
	OML060-0007	14	INV0355_03	0.1	NA	18	NA	4.61	NA
	OML060-0005	15	INV0355_T1002	0.05	NA	9	NA	5.94	NA
	OML-05-0032	16	INV0355_T1001	0.11	NA	15	NA	0.87	359.77
	OML060-0006	17	INV0355_02	0.10	NA	14	NA	5.35	NA
Jericho Creek	OML-05-0033	18	INV0356_T1006	0.16	NA	9	NA	7.38	NA
	OML-05-0042	19	INV0356_04	0.19	NA	37	18.92	3.89	2.83
	OML-05-0034	20	INV0356_T1013	0.05	NA	16	NA	6.91	NA

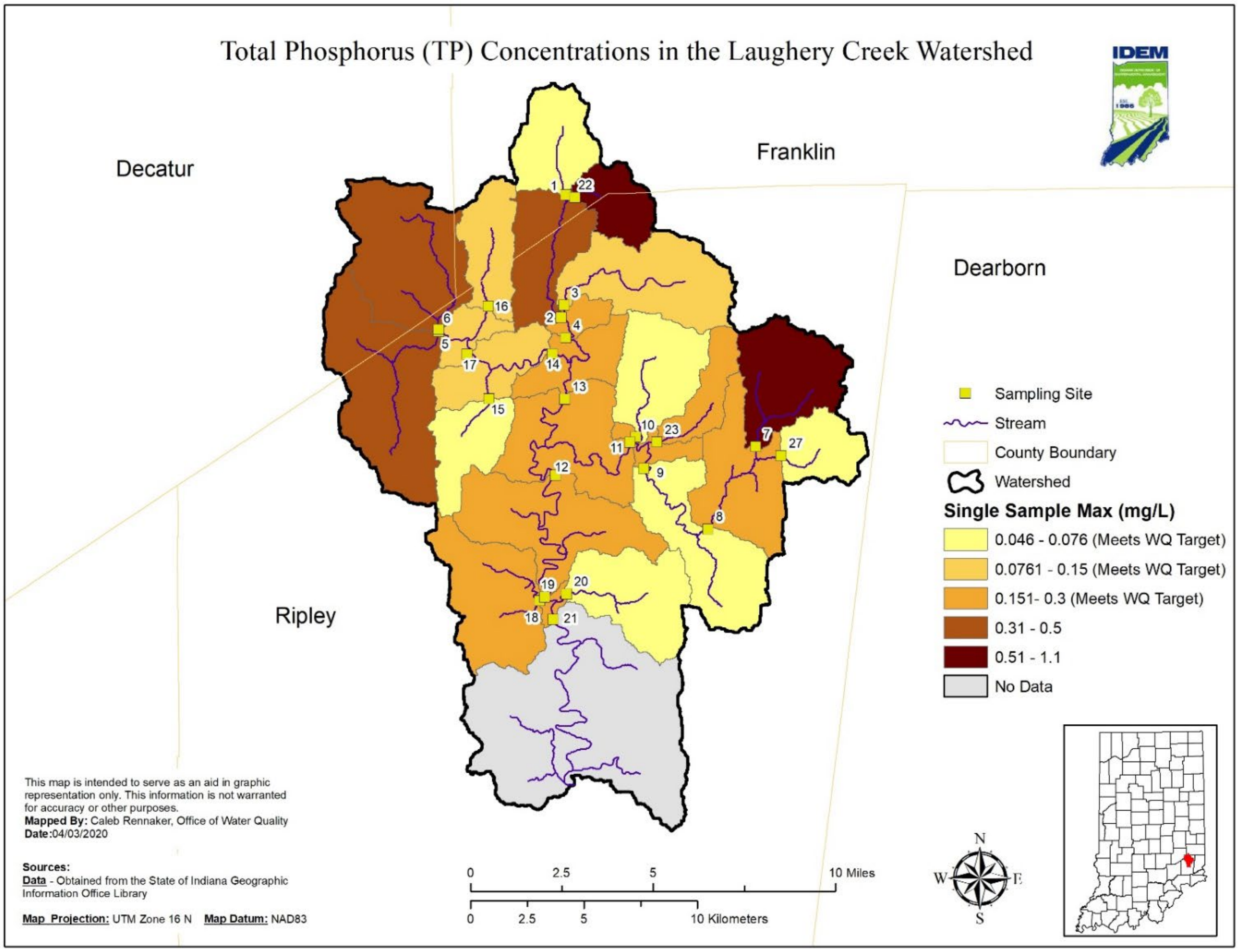
Subwatershed	Sampling Station	Site #	AUID	Total Phosphorus Single Sample Maximum (mg/L)	Total Phosphorus % Reduction	Total Suspended Solids Single Sample Maximum (mg/L)	Total Suspended Solids % Reduction	Dissolved Oxygen Single Sample Minimum (mg/L)	Dissolved Oxygen % Below WQS
Henderson Bend	OML-05-0012	21	INV0357_02	0.21	NA	35	14.29	6.61	NA

Understanding Table 24: Water chemistry data for the Laughery Creek Watershed indicated the following

- Reductions of 55 percent or greater are needed to meet the TMDL target values for TSS in Tub Creek
- Reductions of 53 percent or greater are needed to meet the TMDL target values for TSS in Little Laughery Creek.
- Reductions of 72 percent or greater are needed to meet the TMDL target values for total phosphorus in Headwaters Ripley Creek
- Reductions of 25 percent or greater are needed to meet the TMDL target values for TSS in Headwaters Ripley Creek.
- Reductions of 11 percent or greater are needed to meet the TMDL target values for TSS in Walnut Creek.
- Reductions of 18 percent or greater are needed to meet the TMDL target values for TSS in Jericho Creek.

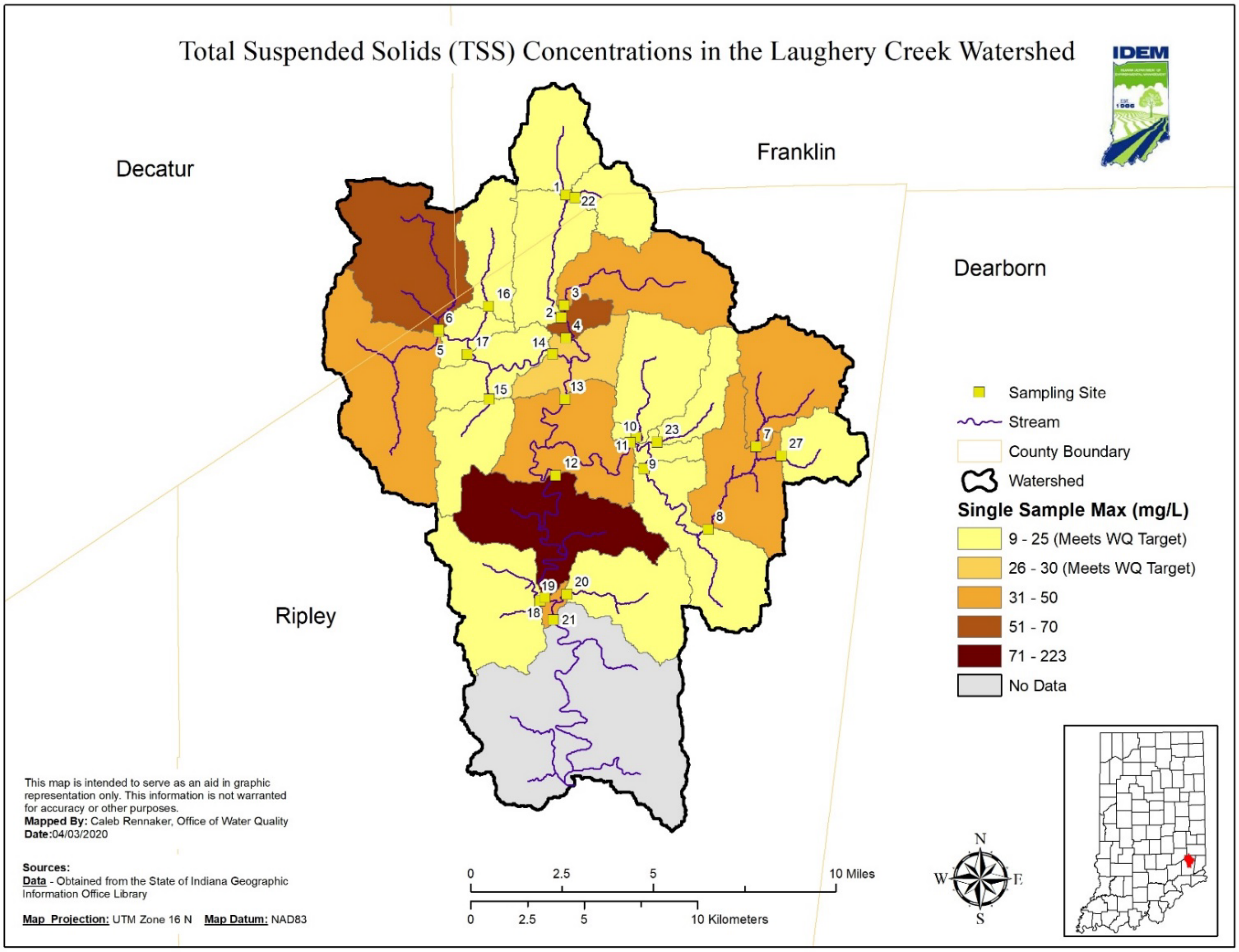
Total Phosphorus

Figure 21 total phosphorus concentrations based on single sample maximum concentration (mg/L) and sampling site drainage areas for 2018-2019. Values over 0.30 mg/L are not meeting the TMDL water quality target value for total phosphorus.



Total Suspended Solids

Figure 22 Total suspended solids concentrations based on single sample maximum concentration (mg/L) and sampling site drainage areas for 2018-2019. Values over 30 mg/L are not meeting the TMDL water quality target value for TSS.



Biological Data

Sampling performed by IDEM in August of 2019 documented biological impairments in the Laughery Creek Watershed as summarized below in Table 25 Fish and macroinvertebrate community sampling took place at 24 sampling sites in the Laughery Creek watershed. Sampling data indicate that the overall biological integrity of the Laughery Creek watershed was fair to good. Sampling resulted in 5 of the 24 sites failing established criteria for aquatic life support for fish and/or macroinvertebrates. A sixth site that failed for macroinvertebrates was passed based on best professional judgement (BPJ).

Through the TMDL efforts, IDEM has identified potential reasons for the impairments:

- TSS can reduce plants available for consumption by inhibiting growth of submerged aquatic plants, lowering dissolved oxygen levels by reducing light penetration which impairs algal growth, impairing the ability of fish to see and catch food, increasing stream temperature, clogging fish gills which may decrease disease resistance, slowing growth rates, and preventing the development of eggs and larvae.
- Decreased dissolved oxygen levels along with diurnal fluctuations may impact respiratory functions in fish and macroinvertebrates, resulting in lower stream diversity. Additionally, low and/or flashy flow patterns observed throughout the watershed may put additional stress on biological communities.

Attaining the TSS target values shown in Table 25 will address the causes of the IBC impairments.

Table 25: Impaired Biotic Community Stream Segments in the Laughery Creek Watershed Identified During August 2019 Sampling

	Sampling Site			Score	Integrity Class	QHEI	Score	Integrity Class	QHEI
Subwatershed	Site #	Station ID	Stream Name	mIBI	mIBI	mIBI	IBI	IBI	IBI
Tub Creek	5	OML-05-0009	Laughery Creek	32	Poor	58	44	Fair	62
	6	OML-05-0024	Tub Creek	36	Fair	58	40	Fair	53
Little Laughery Creek	1	OML-05-0020	Little Laughery Creek	42	Fair	32	42	Fair	47
	2	OML-05-0021	Little Laughery Creek	44	Fair	38	38	Fair	49
	3	OML-05-0022	Bobs Creek	40	Fair	41	36	Fair	49
	4	OML-05-0023	Little Laughery Creek	38	Fair	52	50	Good	57
	22	OML-05-0035	Tributary of Little Laughery Creek	34	Poor	47	46	Good	60
Headwaters Ripley Creek	7	OML-05-0025	Ripley Creek	40	Fair	44	38	Fair	53
	8	OML-05-0026	Ripley Creek	42	Fair	57	42	Fair	56
	27	OML-05-0040	Tributary of Ripley Creek	42	Fair	49	34	Poor	53
North Branch	9	OML-05-0027	Ripley Creek	38	Fair	71	50	Good	75
	10	OML-05-0028	North Branch Ripley Creek	NA	NA	NA	34	Poor	57

Subwatershed	Sampling Site		Stream Name	Score	Integrity Class	QHEI	Score	Integrity Class	QHEI
	Site #	Station ID		mIBI	mIBI	mIBI	IBI	IBI	IBI
	11	OML-05-0029	Ripley Creek	38	Fair	72	48	Fair	72
	23	OML-05-0036	Tributary of Ripley Creek	NA	NA	NA	38	Fair	49
Walnut Creek	12	OML-05-0030	Laughery Creek	38	Fair	61	54	Excellent	75
	13	OML-05-0031	Laughery Creek	32	Poor	57	48	Good	53
	14	OML060-0007	Laughery Creek	40	Fair	48	50	Good	66
	15	OML060-0005	Tributary of Laughery Creek	40	Fair	46	40	Fair	63
	16	OML-05-0032	Walnut Fork	40	Fair	32	40	Fair	55
	17	OML060-0006	Laughery Creek	40	Fair	53	38	Fair	73
Jericho Creek	18	OML-05-0033	Plum Creek	36	Fair	70	46	Good	67
	19	OML-05-0042	Laughery Creek	36	Fair	54	54	Excellent	64
	20	OML-05-0034	Castators Creek	36	Fair	59	42	Fair	64
Henderson Bend	21	OML-05-0012	Laughery Creek	34	Poor	54	56	Excellent	75

Notes: IBI = Index of Biotic Integrity. Scores were calculated using IDEM's *Summary of Protocols: Probability Based Site Assessment*. (IDEM, 2005).

Technical Approach for Using Water Quality Sampling Data

The information presented in this section helps to provide a better comprehensive understanding of the conditions and characteristics in the Laughery Creek watershed. In summary, the predominant land uses in the Laughery Creek watershed of forest and agriculture serve as indicators as to the type of sources that are likely to contribute to water quality impairments in the watershed. Human population, which is greatest in the Little Laughery Creek subwatershed, indicates where more infrastructure-related pressures on water quality might exist. The subsections on topography and geology, as well as soils, provide information on the natural features that affect hydrology in the Laughery Creek watershed. These features interact with land use activities and human population to create pressures on both water quality and quantity in the watershed. Lastly, the subsection on climate and precipitation provides information on water quantity and the factors that influence flow, which ultimately affects the influence of stormwater on the watershed. Collectively, this information plays an important role in understanding the sources that contribute to water quality impairments during TMDL development and crafting the linkage analysis that connects the observed water quality impairments to what has caused those impairments.

This section presents IDEM's technical approach for using water quality sampling data and flow data for each subwatershed to estimate the current allowable loads of *E. coli*, TSS, and total phosphorus in each subwatershed. This section focuses on describing the methodology and is helpful in understanding subsequent sections of the TMDL report.

Load Duration Curves

To determine allowable loads for the TMDL, IDEM uses a load duration curve approach. This approach helps to characterize water quality problems across flow conditions and provide a visual display that assists in determining whether loadings originate from point or nonpoint sources. Load duration curves present the frequency and magnitude of water quality violations in relation to the allowable loads, communicating the magnitude of the needed load reductions.

Developing a load duration curve is a multi-step process. To calculate the allowable loadings of a pollutant at different flow regimes, the load duration curve approach involves multiplying each flow by the TMDL target value or Water Quality Standard and an appropriate conversion factor. The steps are as follows:

- A flow duration curve for the stream is developed by generating a flow frequency table and plotting the observed flows in order from highest (left portion of curve) to lowest (right portion of curve).
- The flow curve is translated into a load duration (or TMDL) curve. To accomplish this, each flow value is multiplied by the TMDL target value or Water Quality Standard with the appropriate conversion factor and the resulting points are graphed. Conversion factors are used to convert the units of the target (e.g., #/100 mL for E. coli) to loads (e.g., MPN/day for E. *coli*) with the following factors used for this TMDL:
- *E. coli*: Flow (cfs) x TMDL Concentration Target (#/100mL) x Conversion Factor (24,465,758.4) = Load (MPN/day)
- Nutrients and TSS: Flow (cfs) x TMDL Concentration Target (mg/L) x Conversion Factor (5.39) = Load (lb/day)

- To estimate existing loads, each water quality sample is converted to a load by multiplying the water quality sample concentration by the average daily flow on the day the sample was collected and the appropriate conversion factor. Then, the existing individual loads are plotted on the TMDL graph with the curve.
- Points plotting above the curve represent violations of the applicable water quality standard or exceedances of the applicable target and the daily allowable load. Those points plotting below the curve represent compliance with standards and the daily allowable load.
- The area beneath the load duration curve is interpreted as the loading capacity of the stream. The difference between this area and the area representing the current loading conditions above the curve is the load that must be reduced to meet water quality standards.

The load duration curve approach can consider seasonal variation in TMDL development as required by the CWA and USEPA's implementing regulations. Because the load duration curve approach establishes loads based on a representative flow regime, it inherently considers seasonal variations and critical conditions attributed to flow conditions.

The stream flows displayed on water quality or load duration curves may be grouped into various flow regimes to aid with interpretation of the load duration curves. The flow regimes are typically divided into the following five "hydrologic zones" (USEPA, 2007):

- High Flows: Flows in this represent flooding or near flooding stages of a stream. These flows are exceeded 0 – 10 percent of the time.
- Moist Conditions: Flows in this range are related to wet weather conditions. These flows are exceeded 10 – 40 percent of the time.
- Mid-Range Flows: Flows in this range represent median stream flow conditions. These flows are exceeded 40 – 60 percent of the time.
- Dry Conditions: Flows in this range are related to dry weather flows. These flows are exceeded 60 -90 percent of the time.
- Low Flows: Flows in this range are seen in drought-like conditions. These flows are exceeded 90 -100 percent of the time.

The load duration curve approach helps to identify the sources contributing to the impairment and to roughly differentiate between sources. Exceedances of the load duration curve at higher flows (0-40 percent ranges) are indicative of wet weather sources (e.g., nonpoint sources, regulated stormwater discharges). Exceedances of the load duration curve at lower flows (60 to 100 percent range) are indicative of point source sources (e.g., wastewater treatment facilities, livestock in the stream). Table 26 summarizes the general relationship between the five hydrologic zones and potentially contributing source areas (the table is not specific to any individual pollutant). For example, the table indicates that impacts from wastewater treatment plants are usually most pronounced during dry and low flow zones because there is less water in the stream to dilute their loads. In contrast, impacts from channel bank erosion is most pronounced during high flow zones because these are the periods during which stream velocities are high enough to cause erosion to occur.

Table 26: Relationship Between Load Duration Curve Zones and Contributing Sources

Contributing Source Area	Duration Curve Zone				
	High	Moist	Mid-Range	Dry	Low
Wastewater treatment plants				M	H
Livestock direct access to streams				M	H
Wildlife direct access to streams				M	H
Pasture Management	H	H	M		
On-site wastewater systems/Unsewered Areas	M	M-H	H	H	H
Riparian Buffer areas		H	H	M	
Stormwater: Impervious		H	H	H	
Stormwater: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M-H	L-M	
Bank erosion	H	M			

Note: Potential relative importance of source area to contribute loads under given hydrologic condition (H: High; M: Medium; L: Low)

Stream Flow Estimates

Daily stream flows are necessary to implement the load duration curve approach. Load duration assessment locations in the Laughery Creek watershed were chosen based on the location of the impaired stream segments and the availability of water quality samples to estimate existing loads.

The USGS does not operate any stream flow gaging stations in the Laughery Creek watershed. Since there are no continuous flow data for the Laughery Creek watershed, flow data were estimated for the Laughery Creek watershed using flow data from a neighboring "surrogate" watershed. This is a standard practice when developing TMDLs for ungaged watersheds and is appropriate when the two watersheds are located close to one another and have similar land use and soil characteristics.

The USGS gage for the Vernon Fork Muscatatuck River at Vernon, IN (03369500), located southwest of the Laughery Creek watershed, was used for the development of the *E. coli*, TSS, and TP load duration curve analysis for the Laughery Creek watershed TMDL. USGS gage 03369500 is located in Jennings County. Gage 03369500 drains approximately 198 sq. miles in the Muscatatuck (HUC 8: 05120207) watershed.

Table 27: USGS Site Assignment for Development of Load Duration Curve

Gage Location	Gage ID	Period of Record for Analysis
Vernon Fork Muscatatuck River at Vernon, IN	03369500	2010-2020

Since the load duration approach requires a stream flow time series for each site included in the analysis, stream flows were extrapolated from USGS gage 03369500 for each assessment location by using a multiplier based upon the ratio of the upstream drainage area for a given location to the drainage area of the Laughery Creek watershed.

Flows were estimated using the following equation:

$$Q_{ungaged} = \frac{A_{ungaged}}{A_{gaged}} \times Q_{gaged}$$

Where,

$Q_{ungaged}$: Flow at the ungaged location
Q_{gaged}: Flow at surrogate USGS gage station
$A_{ungaged}$: Drainage area of the ungaged location
A_{gaged}: Drainage area of the gaged location

In this procedure, the drainage area of each of the load duration stations was divided by the drainage area of the surrogate USGS gage. The flows for each of the stations were then calculated by multiplying the flows at the surrogate gage by the drainage area ratios. Additional flows were added to certain locations to account for municipal wastewater treatment plants that discharge upstream and are not directly reflected in the load duration curve method.

Table 28: Load Duration Curve Key Flow Percentile Estimates

Subwatershed	Drainage Area (sq. miles)	Flow Duration Exceedance Interval Flows (cfs)				
		High (5%)	Moist (25%)	Mid-Range (50%)	Dry (75%)	Low (95%)
Tub Creek	24.63	168	38	10	2	1
Little Laughery Creek	27.28	180	37	14	6	4
Headwaters Ripley Creek	18.80	121	23	7	2	<1
North Branch	42.11	271	50	16	4	1
Walnut Creek	117.21	759	144	49	15	6
Jericho Creek	142.45	922	175	59	18	7
Henderson Bend	167.43	1083	204	69	20	8

Windshield Survey Summary Results

The windshield survey was conducted in May of 2021 to give a baseline of the problems and concerns in the watershed. It is also a tool that can be used in the future to see what types of best management practices are needed the most to address the current problems and concerns. A total of 426 sites were observed throughout the watershed. Below is a summary of the findings of the windshield survey.

Table 29: North Laughery Watershed Windshield Survey Results Summary

North Laughery Windshield Survey Results Summary	
Finding	**# Present**
Contaminated Runoff into Streams from livestock	142
Livestock Access to Streams	146
Excess Nutrients Entering Stream from livestock	139
Streambank Erosion	43
Gully Erosion	4
Sediment Entering Stream	66
Overgrazed Pasture	160
Conventional Tillage being used	241
Flooding	2
Lack of Riparian Buffers	49
Total	**992**

As you can see from the summary of the windshield survey results above, *Conventional Tillage* (241 occurrences) was the problem that was identified the most often in the North Laughery Watershed. *Overgrazed Pastures (*160 occurrences) scored second, *livestock access to streams* (146 occurrences) was third, followed closely by contaminated runoff into streams (142 occurrences) and excessive nutrients entering stream (139 occurrences). Contaminated runoff into streams from livestock was recorded when livestock dry lots or livestock access to the stream were observed. Excess nutrients entering the stream from livestock was recorded when livestock had open access to the stream. Other concerns of stakeholders were also identified but scored significantly lower in numbers, however they are still important to overall water quality within the watershed.

<u>Sub-watershed Land Use Information</u>

IDEM completed a TMDL based on data collected from 27 sites in 2018 and 2019. In addition, a windshield survey was completed in the spring of 2021 by the Historic Hoosier Hills staff. The windshield survey was completed by driving each mile of the watershed and observing cropland residue, tillage methods, livestock access to streams, and overgrazing of pastures. Riparian areas, flooding, and streambank erosion were also noted.

In the pages that follow, each subwatershed is described showcasing:

- Land use data including a table showcasing acres and % of subwatershed represented
- WQ monitoring data collected by the IDEM team including chemical data and stream flow and listing:
    - Number of E. coli sites exceeding water quality standards
    - IBI & QHEI scores
    - TSS concentrations
    - Streams to be listed on the 2022 proposed 303d list
    - Number of samples exceeding WMP targets
- Windshield survey results

- Summary of Sub-Watershed characteristics
- Any relevant information regarding the HUC that helps with understanding WQ in the subwatershed.

In addition, each subwatershed has load duration curves shown in figures. The Load Duration Curve approach was used by IDEM to determine allowable loads.

Tub Creek 050902030501

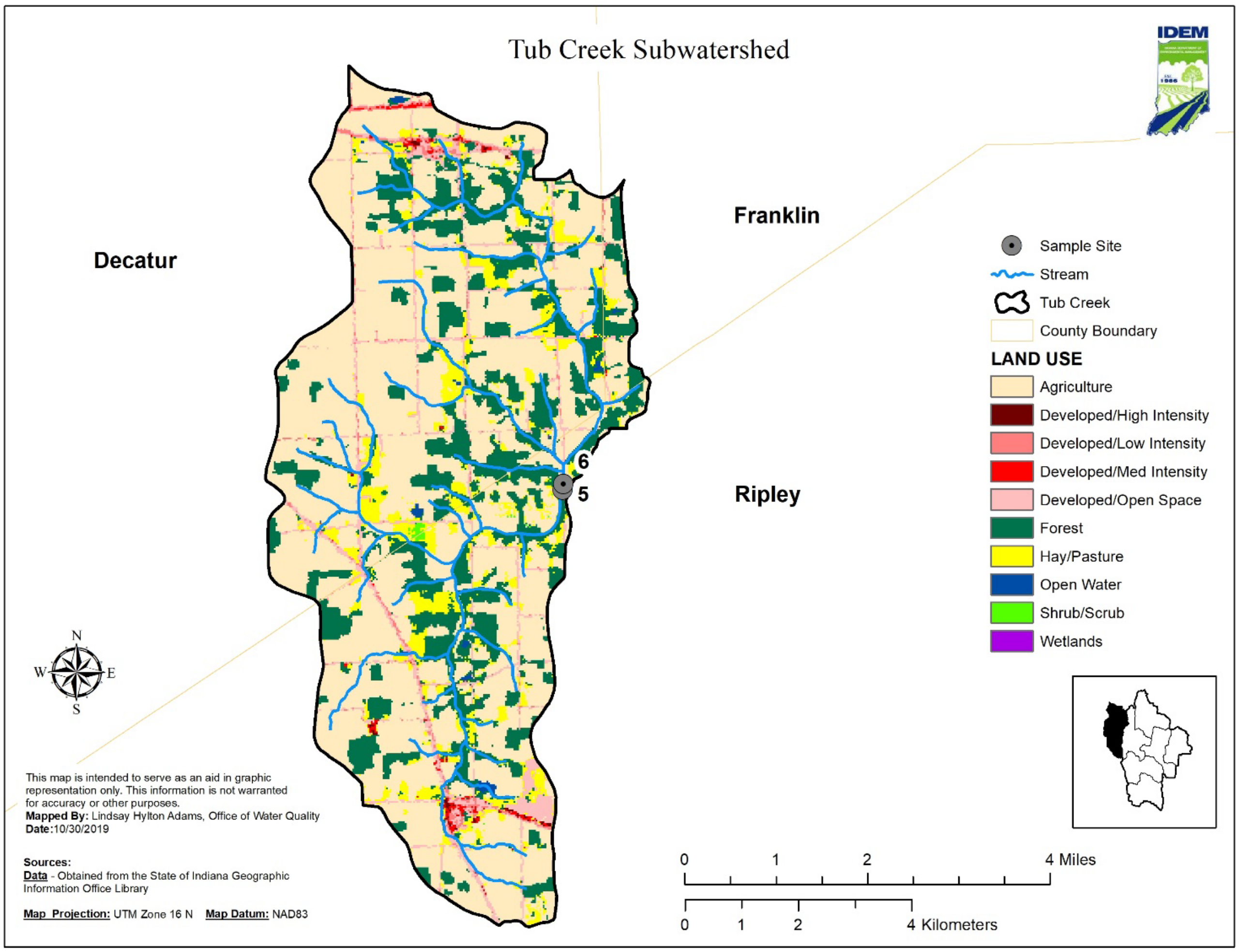


Figure 23: Sampling Stations and land use in the Tub Creek Subwatershed

The Tub Creek subwatershed drains approximately 25 square miles. The land use is primarily agriculture (62%) followed by forested land (21%) and hay/pasture and developed land (both 8%). There are three NPDES permits in the Tub Creek subwatershed, including the Town of Napoleon WWTP (IN0023868), New Point Stone- Napoleon Quarry (ING490005), and Napoleon Hardwood Inc. (INRM10877). There are no MS4 permits in this subwatershed or the entire Laughery Creek watershed. About half of the subwatershed is rural, indicating many homes pump to on-site septic systems. Based on the septic suitability of the soil, the entire Laughery Creek watershed is very limited. Maintenance and inspections of septic systems in the area are important to ensure proper function and capacity. While the landscape in the area is relatively hilly, 62% of the subwatershed has been converted to agricultural production and use. In parts of the subwatershed there are little to no remaining riparian buffers left along the banks, due to agricultural practices. The subwatershed does contain significant amounts of highly erodible soil types, which can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes.

Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential locations for wetland restoration. With less than 10 percent of land used as pasture land, a heavy presence of pasture animals is not expected. There are no permitted CFOs in the watershed.

There are two monitoring sites located in this subwatershed, which are located on Laughery Creek, OML-05-0009 (5), and Tub Creek, OML-05-0024 (6). In 2018-2019 this watershed was sampled 26 times between the two sites, with site 5 failing the WQS for *E.coli*. This stream reach will be placed on the 2022 303(d) List of Impaired Waters. The *E. coli* geomean for site 5 was 181.6 MPN with 4/8 samples in exceedance of the single sample maximum; while site 6 had a geomean of 101.6 with 2/8 samples in exceedance of the single sample maximum. The geomeans from sites 5 and 6 were taken on the same day for five consecutive weeks. High *E. coli* levels are reflective of high animal concentration and land application of waste.

The fish community IBI score for site 5 was 44 (fair) and the QHEI was 62 (good). The macroinvertebrate community mIBI score was 32 (poor) and the QHEI was 58 (good). This will impair site 5 for IBC. The fish community IBI score for site 6 was 40 (fair) and the QHEI was 53 (good). The macroinvertebrate community mIBI score was 36 (fair) and the QHEI was 58 (good).

TSS concentrations ranged from less than 3.5 mg/L to 67 mg/L across 20 sampling events within the watershed, and exceeded the target value two times. Given that targets for TSS were violated within the subwatershed, a TSS TMDL was developed to address the impaired biological communities within the subwatershed.

There are approximately 43 miles of stream in the subwatershed. Based on IDEM data collected in 2018-2019, there will be 0.89 stream miles impaired for *E. coli* and for biotic communities listed on the 2022 303(d) List of Impaired Waters. Therefore, *E. coli* TMDLs were developed to address all *E. coli* impairments, and TSS TMDLs were developed to address all impaired biological communities in the subwatershed.

Load duration and water quality duration curves were developed for the subwatershed and are summarized below. Below are graphs displaying water quality results with both TMDL and WMP targets included in the graphs. Evaluating these graphs, with consideration of the watershed characteristics, allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* and TSS concentrations. Elevated levels of pollutants during rain events can indicate contributions due to run-off. Based on the load duration curves, it can be concluded that the sources of pollutants in this watershed are likely nonpoint sources, with potential input from point sources. The *E. coli* load duration curve for these sites shows the streams are susceptible to high loads of *E. coli* from run-off, but also during drier conditions on the chart.

The TSS load duration curve for these sites shows the streams receive high loads of TSS during run-off events and moist flow conditions. These graphs indicate that nonpoint sources, including small animal operations, wildlife, animals with direct access to streams, illegal straight-pipes, leaking and failing septic systems, streambank erosion, and agricultural practices are potential issues in the subwatershed.

TUB CREEK WATERSHED			
Pollutant	**Range**	**Average**	**Samples Exceeding WMP Target**
E.Coli	62 cfu - 866 cfu	216 cfu	6 of 16 Samples (38%)
Phosphorus	.03mg/L - .34mg/L	0.11 mg/L	8 of 20 Samples (40%)
TSS	3.5 mg/L - 67mg/L	13.6mg/L	3 of 20 Samples (15%)
Nitrogen	0.10 mg/L - 4.30mg/L	2.6 mg/L	13 of 20 Samples (65%)

Table 30: Summary of Tub Creek Water Quality Testing Data

As shown in the table above, Tub Creek subwatershed's issues are elevated E. Coli and nutrient levels. The watershed's primary land use is agriculture. This may account for the high nutrient concentrations of nitrogen and phosphorus since a high percentage of the crop fields are conventionally tilled allowing nutrients to enter stream during runoff periods. Approximately 8% of this watershed is used for hayland and pasture with many sites allowing livestock access to the stream, and contaminated runoff from feeding areas to enter into the streams.

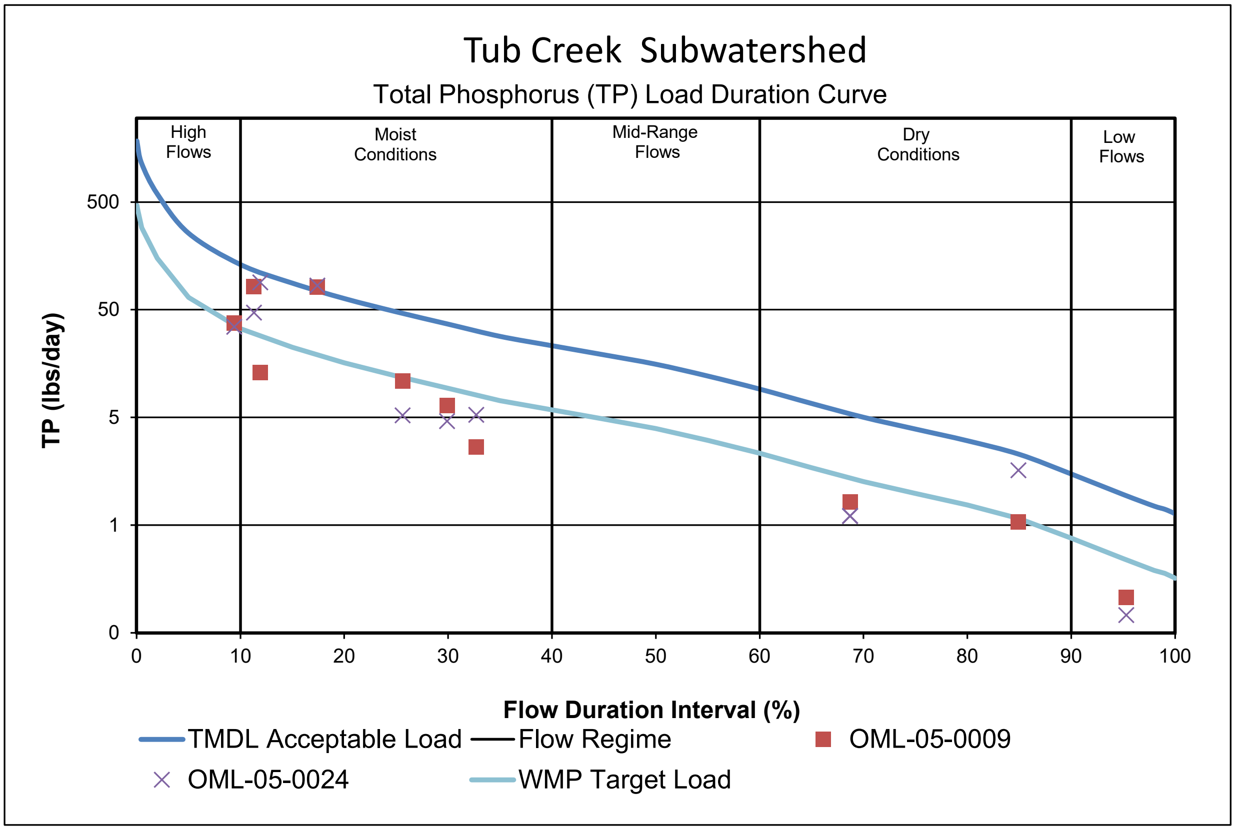


Figure 24: Tub Creek Total Phosphorus Load Duration Curve

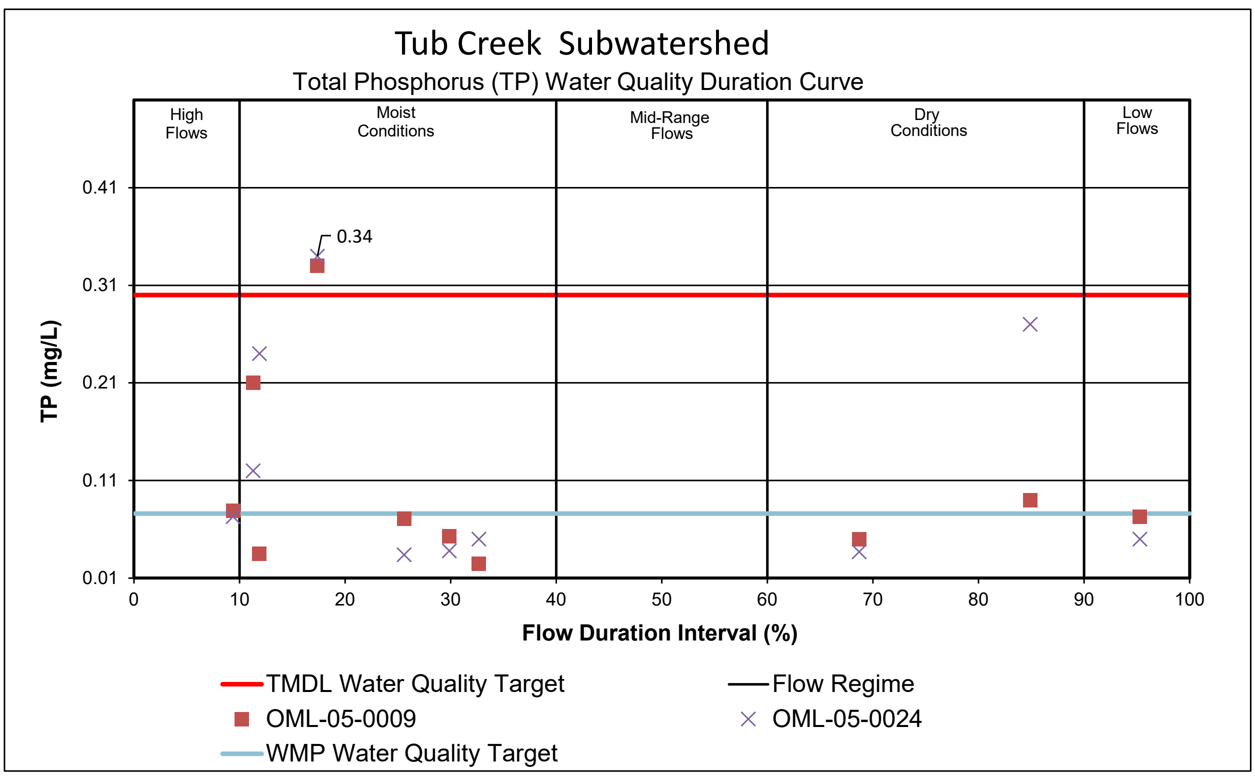


Figure 25: Tub Creek Total Phosphorus Water Quality Duration Curve

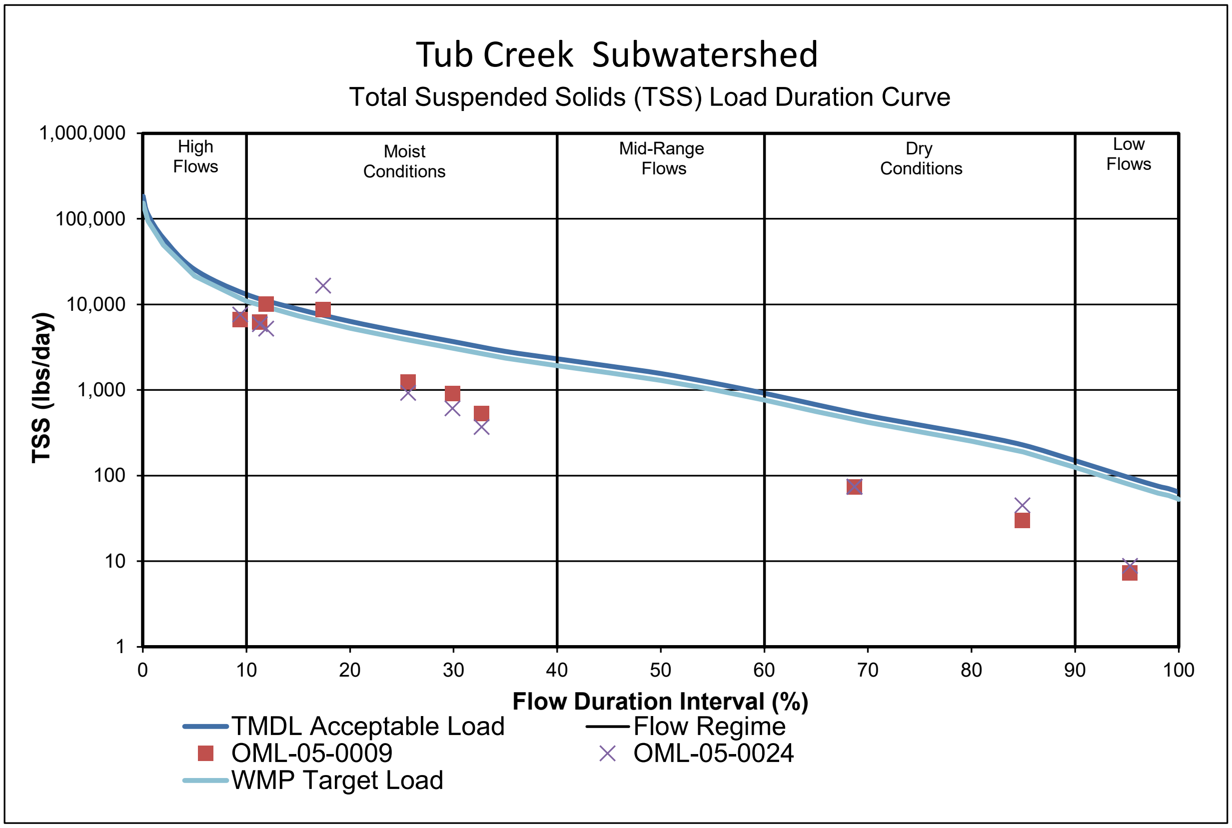


Figure 26: Tub Creek TSS Load Duration Curve

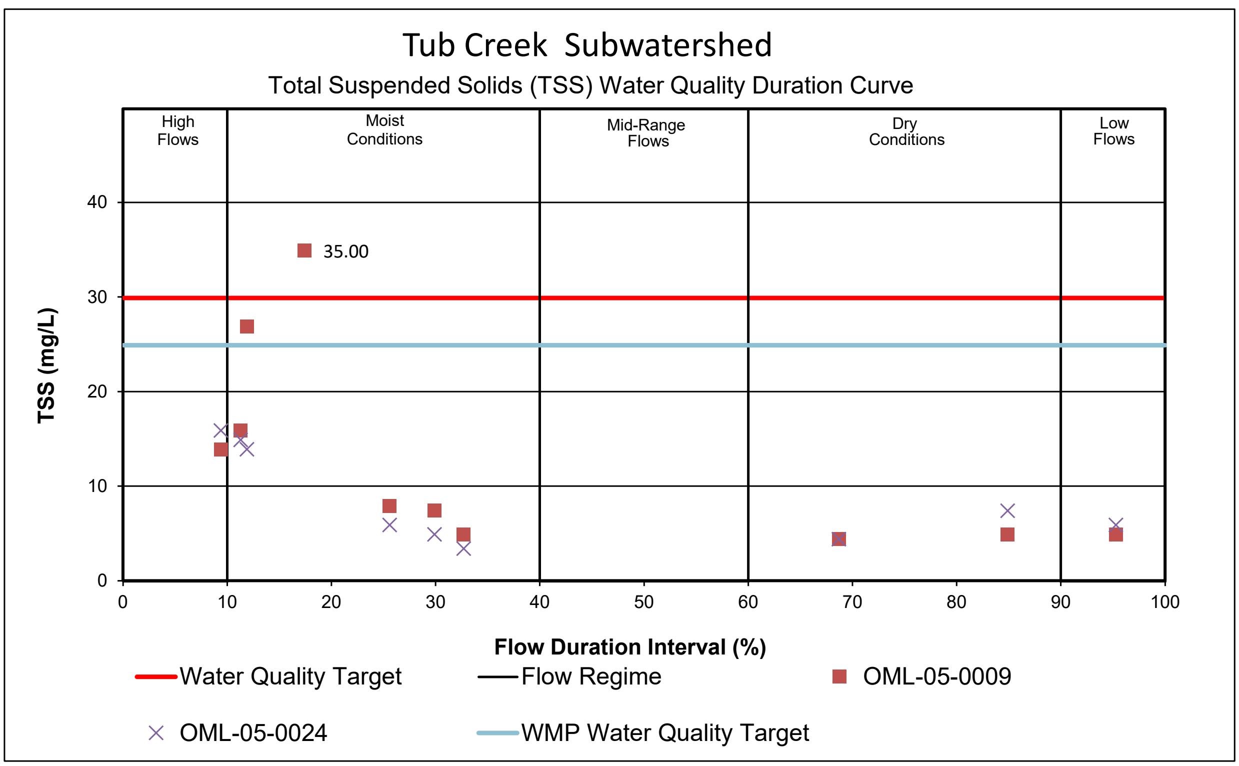


Figure 27: Tub Creek TSS Water Quality Duration Curve

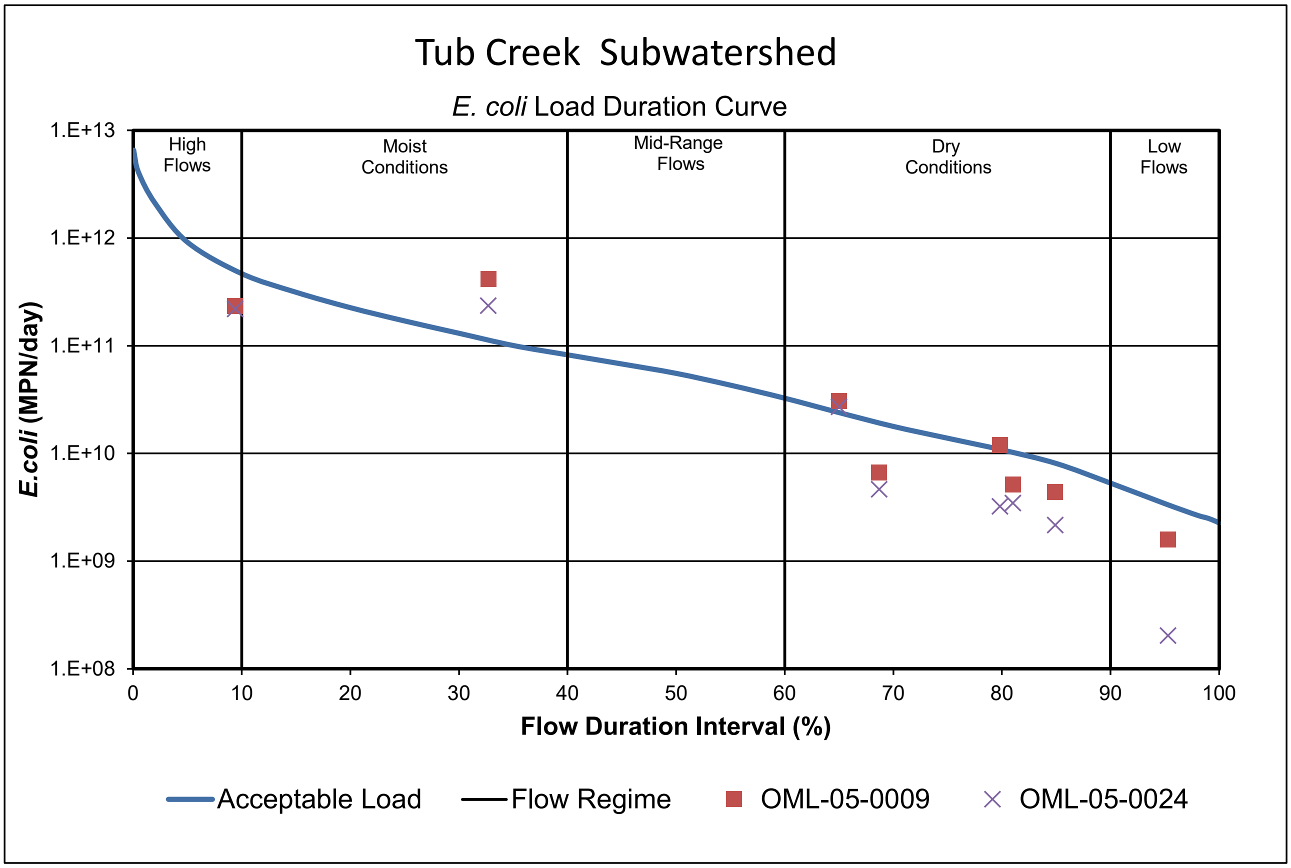


Figure 28: Tub Creek E coli Load Duration Curve

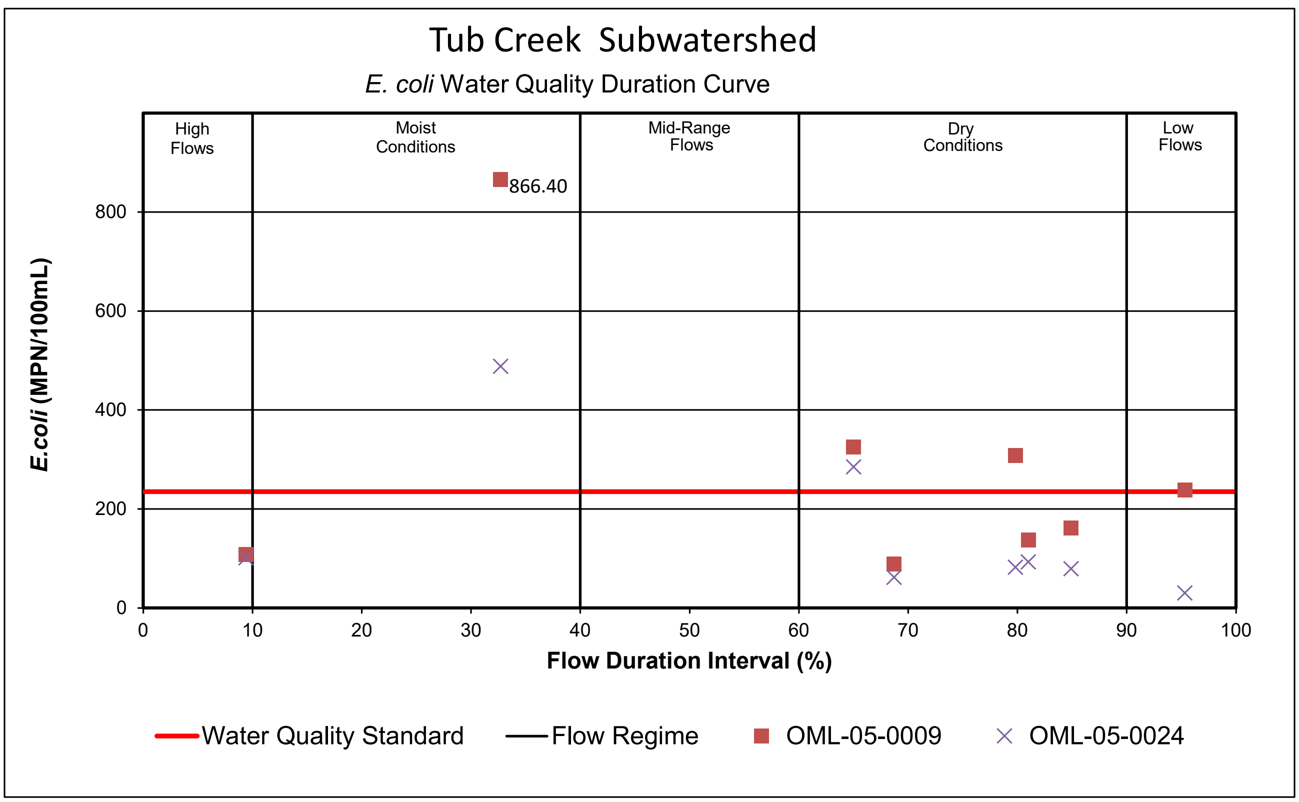


Figure 29: Tub Creek E. Coli Water Quality Duration Curve

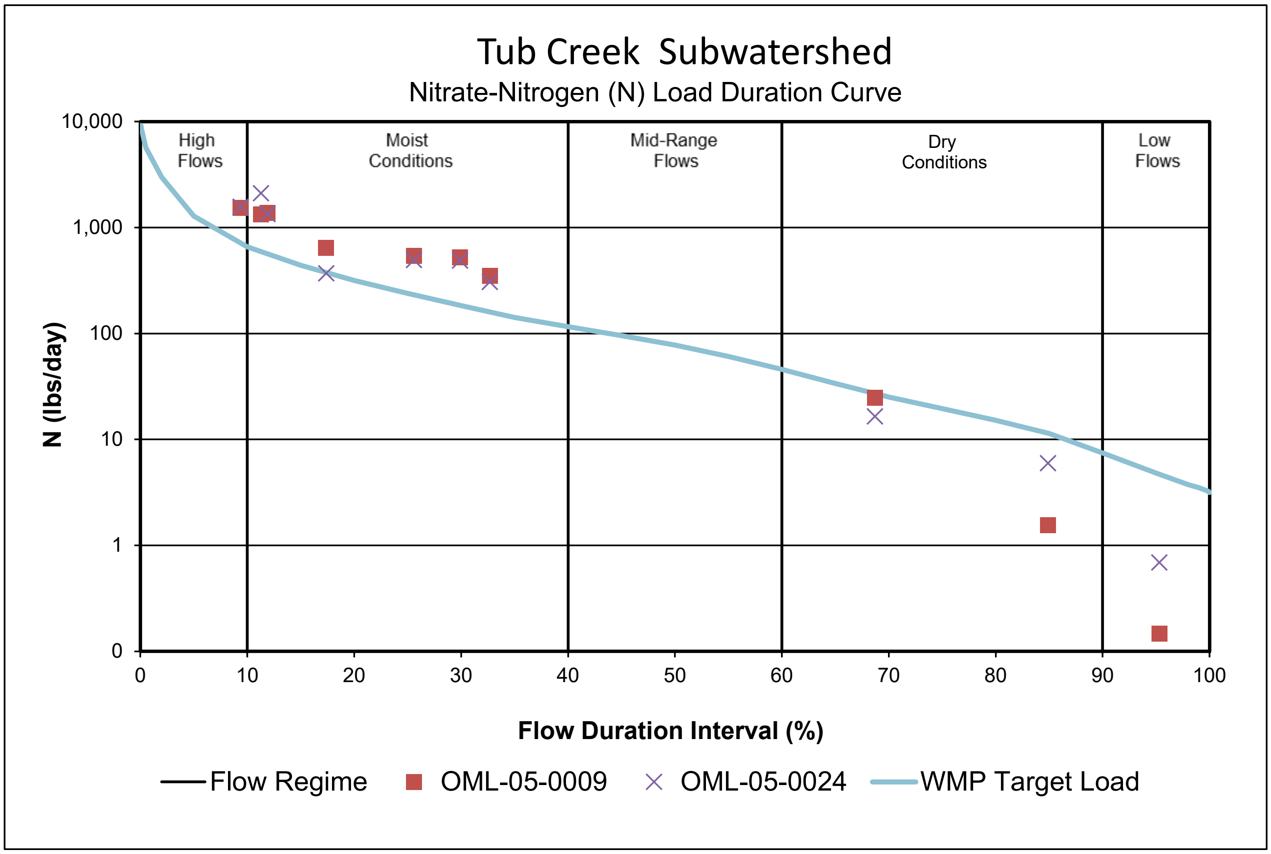


Figure 30: Tub Creek Nitrate Nitrogen Load Duration Curve

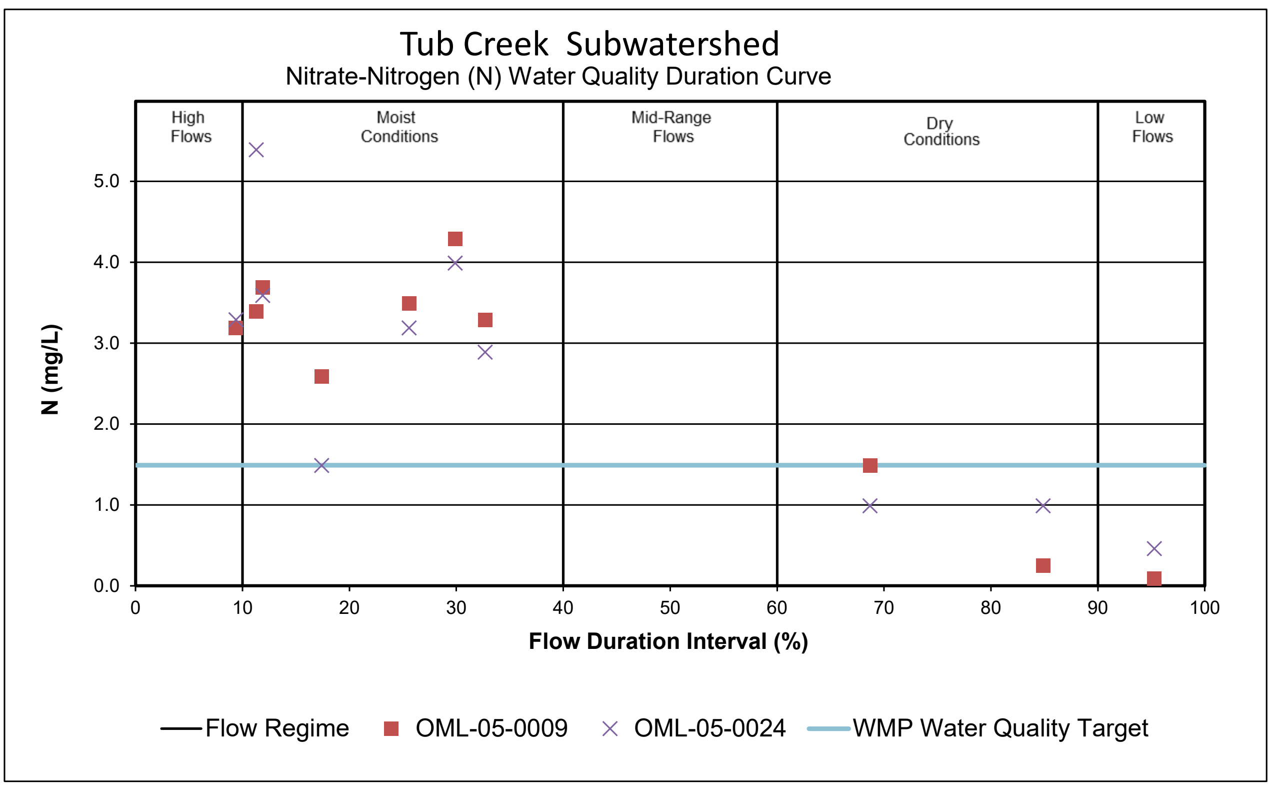


Figure 31: Tub Creek Nitrate Nitrogen Water Quality Duration Curve

Table 31: Summary of Tub Creek Subwatershed Characteristics

Tub Creek (050902030501)					
Drainage Area	24.63 square miles				
Surface Area	24.63 square miles				
TMDL Sample Site	OML-05-0009, OML-05-0024				
Listed Segments	INV0351_05				
Listed Impairments [TMDL(s)]	*E. coli* [*E. coli*], Impaired Biotic Communities [TSS]				
Land Use	Agricultural Land: 62% Forested Land: 21% Developed Land: 8% Open Water: <1% Pasture/Hay: 8% Grassland/Shrubs: <1% Wetland: <1%				
NPDES Facilities	Town of Napoleon WWTP (IN0023868), New Point Stone- Napoleon Quarry (ING490005), Napoleon Hardwood Inc. (INRM10877)				
CAFOs	NA				
CFOs	NA				
TMDL *E. Coli* Allocations (MPN/day)					
Allocation Category **Duration Interval (%)**	**High Flows 5%**	**Moist Conditions 25%**	**Mid-Range Flows 50%**	**Dry Conditions 75%**	**Low Flows 95%**
LA	7.232E+11	1.656E+11	4.154E+10	1.039E+10	2.566E+09
WLA (Total)	9.642E+10	2.208E+10	5.538E+09	1.385E+09	3.421E+08
MOS (10%)	9.642E+10	2.208E+10	5.538E+09	1.385E+09	3.421E+08
Future Growth (5%)	4.821E+10	1.104E+10	2.769E+09	6.924E+08	1.711E+08
TMDL = LA+WLA+MOS	**9.642E+11**	**2.208E+11**	**5.538E+10**	**1.385E+10**	**3.421E+09**
WLA (Individual)					
Town of Napoleon WWTP	9.642E+10	2.208E+10	5.538E+09	1.385E+09	3.421E+08
TMDL Total Suspended Solids Allocations (lbs/day)					
Allocation Category **Duration Interval (%)**	**High Flows 5%**	**Moist Conditions 25%**	**Mid-Range Flows 50%**	**Dry Conditions 75%**	**Low Flows 95%**
LA	15,228.10	2,351.15	921.60	200.40	19.36
WLA (Total)	7,837.30	2,930.42	403.20	130.85	62.48
MOS (10%)	2,713.58	621.36	155.86	38.97	9.63
Future Growth (5%)	1,356.79	310.68	77.93	19.49	4.81
TMDL = LA+WLA+MOS	**27,135.77**	**6,213.60**	**1,558.59**	**389.71**	**96.28**
WLA (Individual)					
Town of Napoleon WWTP	6,322.63	1,447.77	363.15	90.80	22.43
New Point Stone-Napoleon Quarry	1,476.80	1,476.80	40.05	40.05	40.05
Construction stormwater	1.07	0.16	0.00	0.00	0.00
Industrial stormwater	36.80	5.68	0.00	0.00	0.00

*Note – Facility discharges require a 1:10 dilution. Wasteload allocations based on receiving 10% of the flow and applicable permit limits.

The Tub Creek Windshield Survey was completed in April of 2021 and indicates that there is a high percentage of the cultivated cropland within the subwatershed using conventional tillage. Other sources of contamination included livestock having access to streams or livestock runoff into streams.

Tub Creek Subwatershed Windshield Survey Results (93 sites)	
Finding	**# Present**
Contaminated Runoff into Streams from livestock	16
Livestock Access to Streams	14
Excess Nutrients Entering Stream from livestock	16
Streambank Erosion	8
Gully Erosion	2
Sediment Entering Stream	2
Overgrazed Pasture	13
Conventional Tillage being used	69
Flooding	1
Lack of Riparian Buffers	19
Total	**160**

Table 32: Windshield Survey Results of Tub Creek Subwatershed

Little Laughery Creek 050902030502

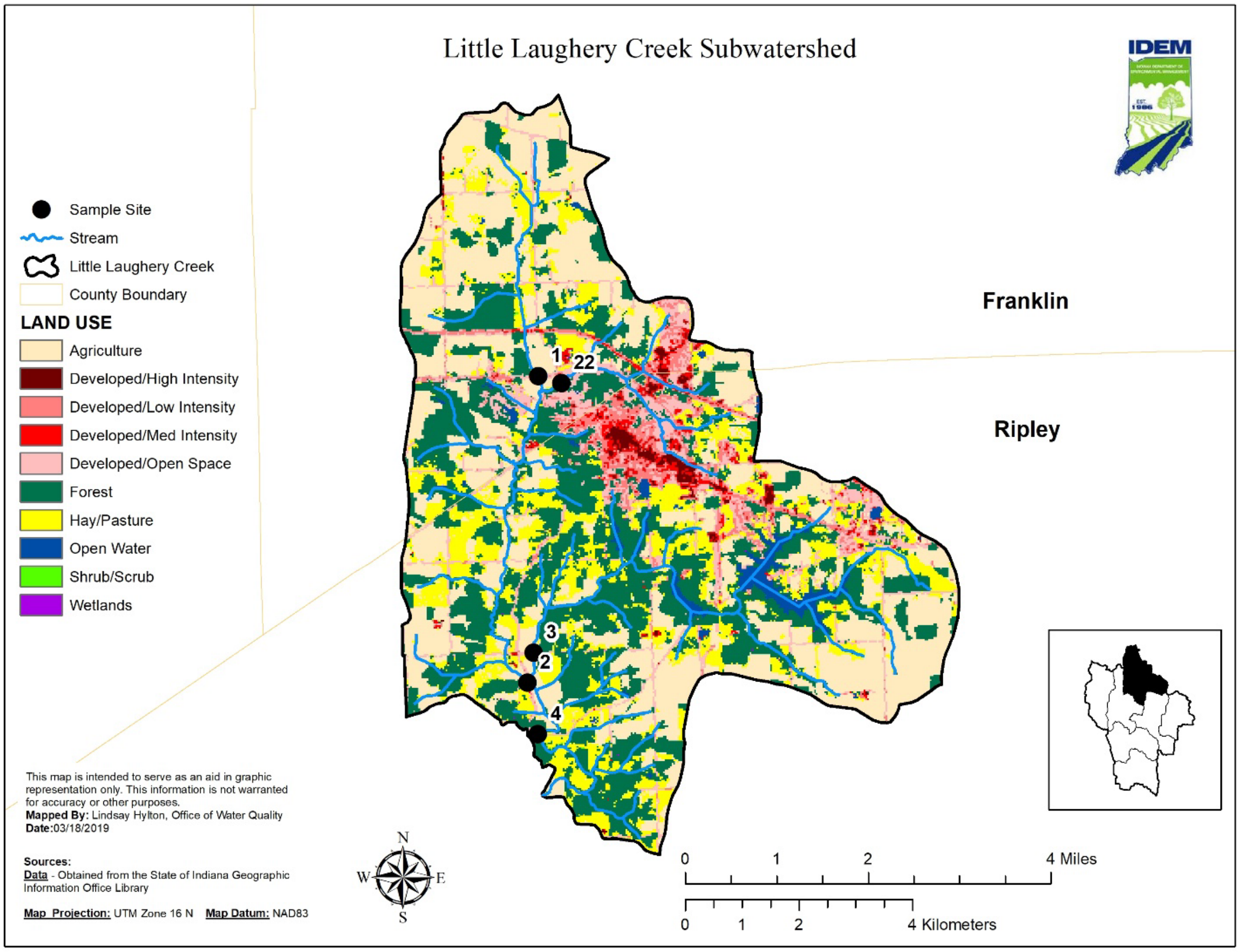


Figure 32: Sampling Stations and landuse in the Little Laughery Creek Subwatershed

The Little Laughery Creek subwatershed drains approximately 27 square miles. The land use is primarily agriculture (34%) and forest (30%), followed by hay/pasture land (17%) and developed land (16%). There are eight NPDES permitted dischargers in the subwatershed, including the City of Batesville WWTP (IN0039268), Hillenbrand, Inc. (IN0057118), Batesville Water & Gas Utility (IN0004642), Batesville Manufacturing Inc. Assembly (INRM00412), Batesville Tool & Die Inc. (INRM00618), Batesville Manufacturing Inc. Stamping Plant (INRM00921), Batesville Logistics Inc. (INRM01156), and Hill-Rom, Inc. (Ritter Plant) (IN0061484). The majority of the subwatershed is urban, indicating fewer homes likely pump to on-site septic systems. Based on the septic suitability of the soil, the entire Laughery Creek watershed is very limited. While the landscape in the area is relatively hilly, 34% of the subwatershed has been converted to agricultural production and use. In parts of the subwatershed there are little to no remaining riparian buffers left along the banks, due to agricultural practices. The subwatershed does contain significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes.

Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential areas for wetland restoration or high functioning two-stage ditch

implementation. With a land use of 17% pasture land, a low to moderate presence of pasture animals is expected. There is one permitted CFO in the watershed.

There are five monitoring sites located in this subwatershed, OML-05-0020 (1), OML-05-0021 (2), OML-05-0023 (4), on Little Laughery Creek, OML-05-0022 (3), on Bob's Creek, and OML-05-0035 (22), on a tributary of Little Laughery Creek. In 2018-2019 this watershed was sampled 47 times between the five sites, resulting in all sites failing the WQS for *E.coli*. These stream reaches will be placed on the 2022 303(d) List of Impaired Waters. The *E. coli* geomean for site 1 was 1474.33 MPN, the highest geomean score of any site in the study, with 7/8 samples in exceedance of the single sample max. Site 2 had a geomean of 1136.92 with 8/9 samples in exceedance of the single sample max. Site 3 had a geomean of 934.49 with 6/7 samples in exceedance of the single sample max. Site 4 had a geomean of 420.58 with 7/9 samples in exceedance of the single sample max. Site 22 had a geomean of 195.34 with 4/9 samples in exceedance of the single sample max. The geomeans from the five sites were taken on the same day for five consecutive weeks. High *E. coli* levels are reflective of high animal concentration, land application of waste, wildlife, leaking and failing septic systems, and run-off from urban areas.

The fish community IBI score for site 1 was 42 (fair) and the QHEI was 47 (poor). The macro community mIBI score was 42 (fair) and the QHEI was 32 (poor). The fish community IBI score for site 2 was 38 (fair) and the QHEI was 49 (poor). The macro community mIBI score was 44 (fair) and the QHEI was 38 (poor). The fish community IBI score for site 3 was 36 (fair) and the QHEI was 49 (poor). The macro community mIBI score was 40 (fair) and the QHEI was 41 (poor). The fish community IBI score for site 4 was 50 (good) and the QHEI was 57 (good). The macro community mIBI score was 38 (fair) and the QHEI was 52 (good). The fish community IBI score for site 22 was 46 (good) and the QHEI was 60 (good). The macro community mIBI score was 34 (poor) and the QHEI was 47 (poor). Site 22 will be impaired for IBC.

TSS concentrations ranged from 3 mg/L to 65 mg/L across 32 sampling events within the watershed, and exceeded the TMDL target once at site 3 and three times at site 4. Site 2 was determined to be impaired for nutrients, with total nitrogen values exceeding the TMDL target value of 10 mg/L at three sampling events, ranging from 11 to 23 mg/L. Two of these events co-occurred with slight total phosphorous exceedances. Additionally, dissolved oxygen was found to be below water quality standards on multiple occasions at sites 1 and 3. Given that targets for TSS were sporadically violated throughout the watershed, TSS TMDLs were developed to address the biological communities and dissolved oxygen impairments within the Little Laughery Creek subwatershed.

There are approximately 45 miles of stream in the subwatershed. Based on IDEM data collected in 2018-2019, there will be 28 stream miles impaired for *E. coli,* 12 miles impaired for dissolved oxygen, 5 miles impaired for nutrients, and 6 miles impaired for biotic communities listed on the 2022 List of Impaired Waters. Therefore, *E. coli* TMDLs were developed to address all *E. coli* impairments and TSS TMDLs were developed to address all biotic community and dissolved oxygen impairments. Total nitrogen is believed to be the primary driver of nutrients for the impaired reach within Little Laughery Creek. Both dissolved oxygen and aquatic communities in the nutrient impaired reach were fully supporting, for both fish and macroinvertebrates. IDEM has chosen not to develop a TMDL for nutrients at this time until more appropriate data is available. It is anticipated that additional water quality monitoring data on total nitrogen in the reach is collected from the City of Batesville WWTP. During the next permit renewal cycle it is expected that total nitrogen monitoring will be included as a compliance measure and permit values adjusted as necessary based on future monitoring results.

Load duration and water quality duration curves were developed for the subwatershed and are summarized in the graphs below. Evaluating these graphs, with consideration of the watershed characteristics, allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* and TSS concentrations. Elevated levels of pollutants during rain events can indicate contributions due to run-off. Based on the load duration curves, it can be concluded that the sources of pollutants in this watershed are likely both nonpoint and possibly point sources. The *E. coli* load duration curve for these sites shows the streams are susceptible to high loads of *E. coli* from runoff, but also during drier conditions on the chart. The TSS load duration curve for these sites shows the streams receive high loads of TSS during run-off events and high flow conditions. These graphs indicate that nonpoint sources, including small animal operations, wildlife, animals with direct access to streams, illegal straight-pipes, leaking and failing septic systems, streambank erosion, agricultural practices, and urban runoff are all potential issues in the subwatershed.

LITTLE LAUGHERY WATERSHED			
Pollutant	**Range**	**Average**	**Samples Exceeding WMP Target**
E.Coli	32.7 cfu - 2419.60 cfu	1001 cfu	32 of 42 Samples (76%)
Phosphorus	.02mg/L - 0.36mg/L	0.143 mg/L	18 of 32 Samples (56%)
TSS	3.0 mg/L - 65 mg/L	14.2 mg/L	4 of 32 Samples (13%)
Nitrogen	0.08 mg/L - 23.0 mg/L	4.55 mg/L	19 of 32 Samples (59%)

Table 33: Summary of Little Laughery Water Quality Testing Data

As shown in the table above, issues with Little Laughery Subwatershed include high levels of E. Coli and a high number of samples with excessive nutrient (nitrogen and phosphorus) levels. There is approximately 34% of this watershed used for agricultural use with many cropland acres using conventional tillage. There are also eight NPDES permitted dischargers in the subwatershed.

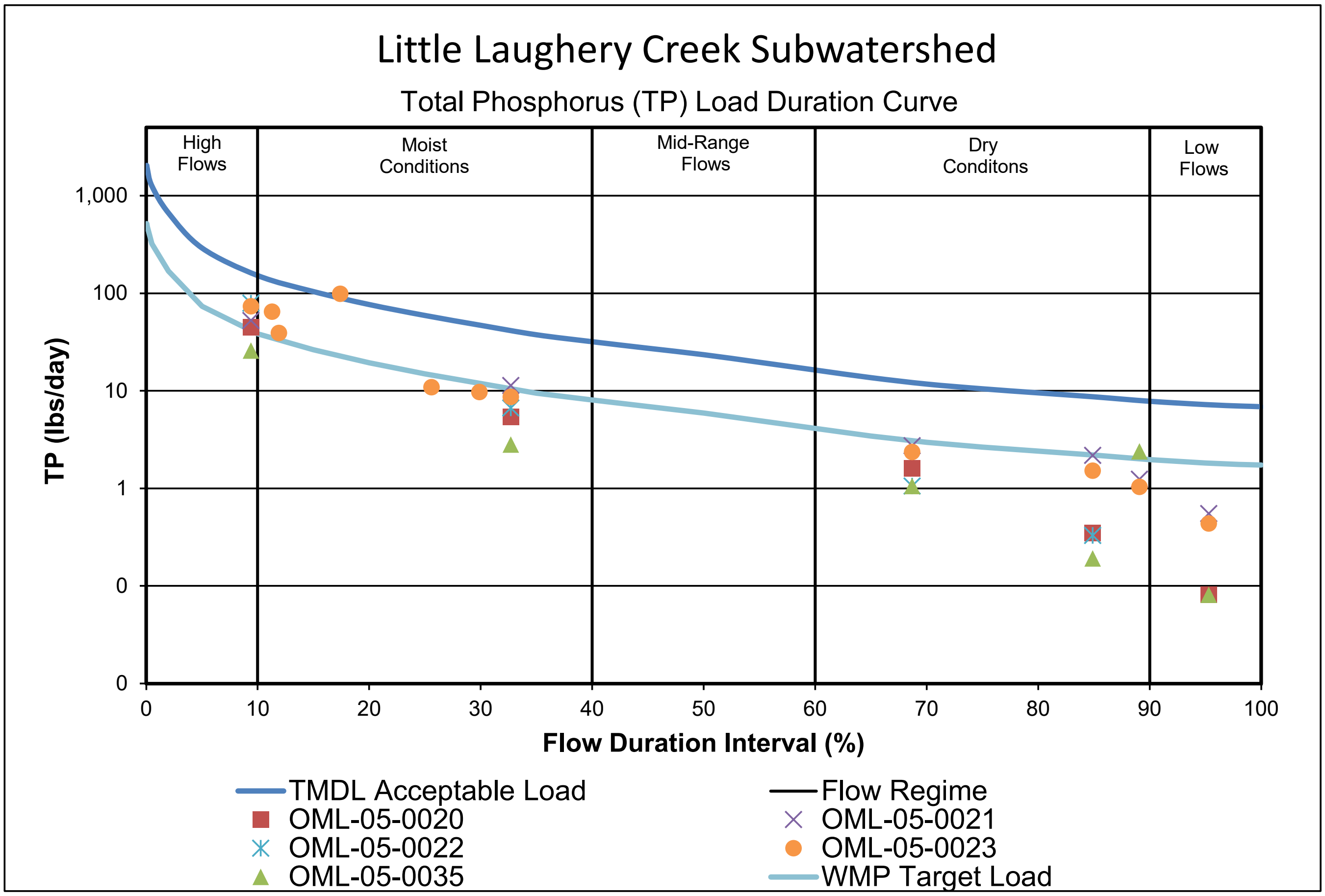


Figure 33: Little Laughery Creek Total Phosphorus Load Duration Curve

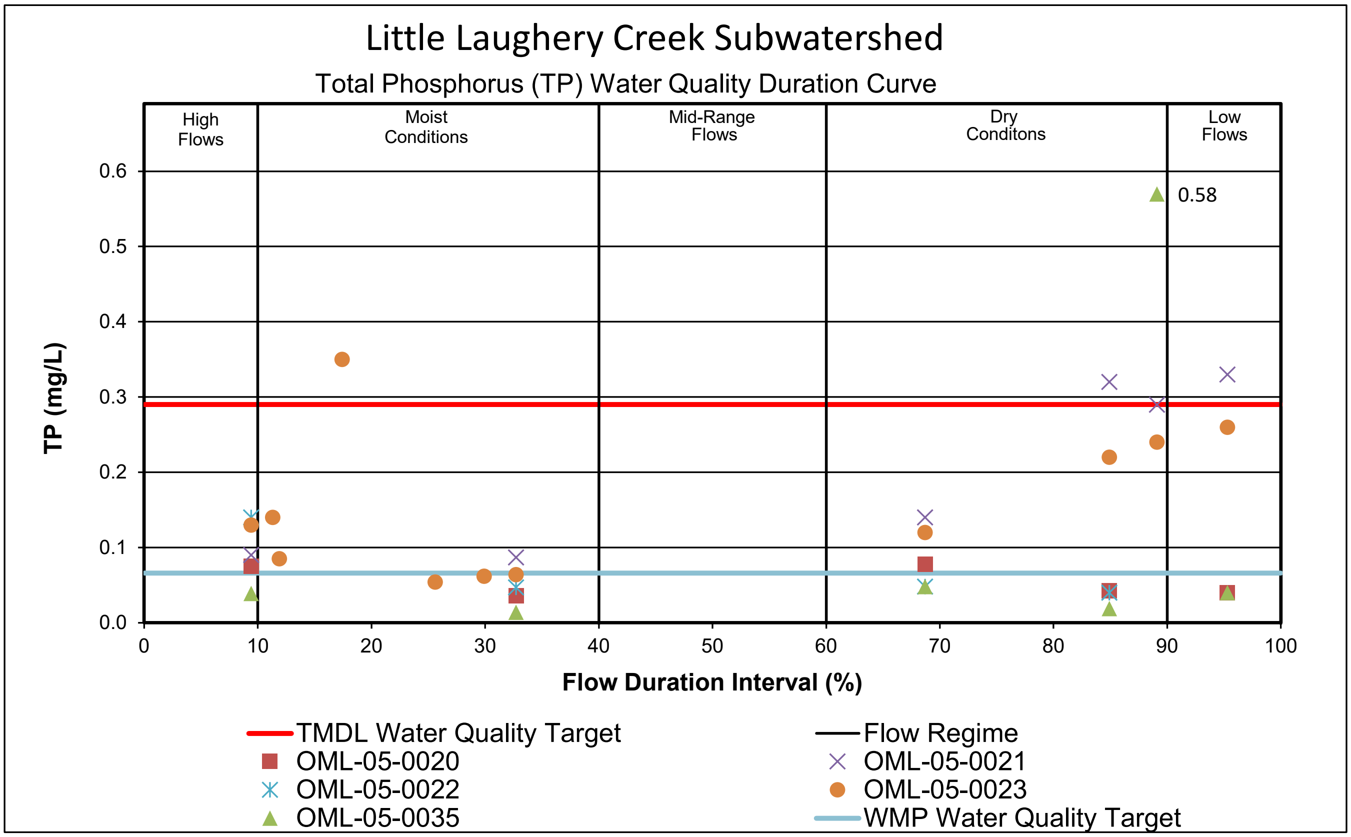


Figure 34: Little Laughery Creek Total Phosphorus Water Quality Duration Curve

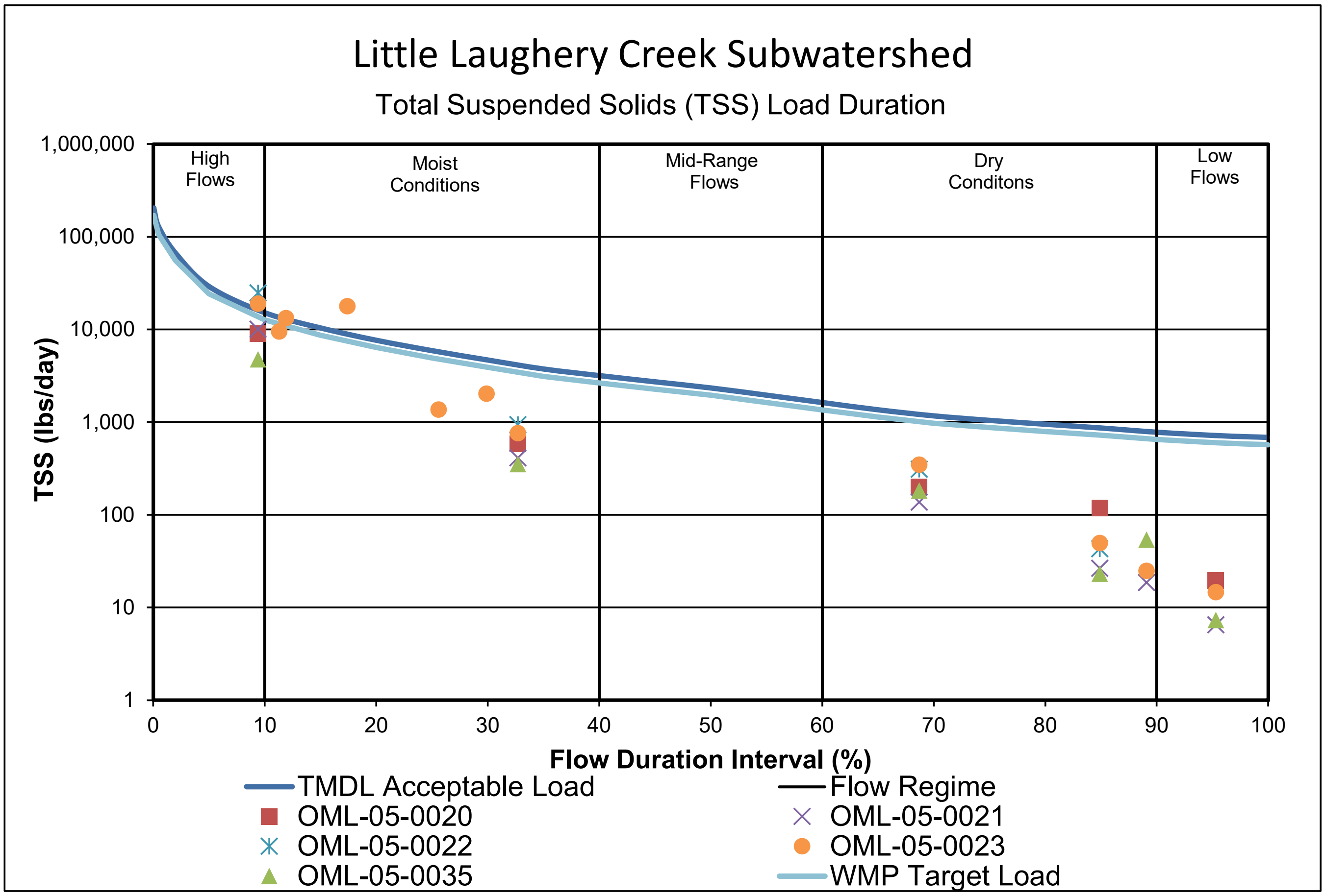


Figure 35: Little Laughery Creek TSS Load Duration Curve

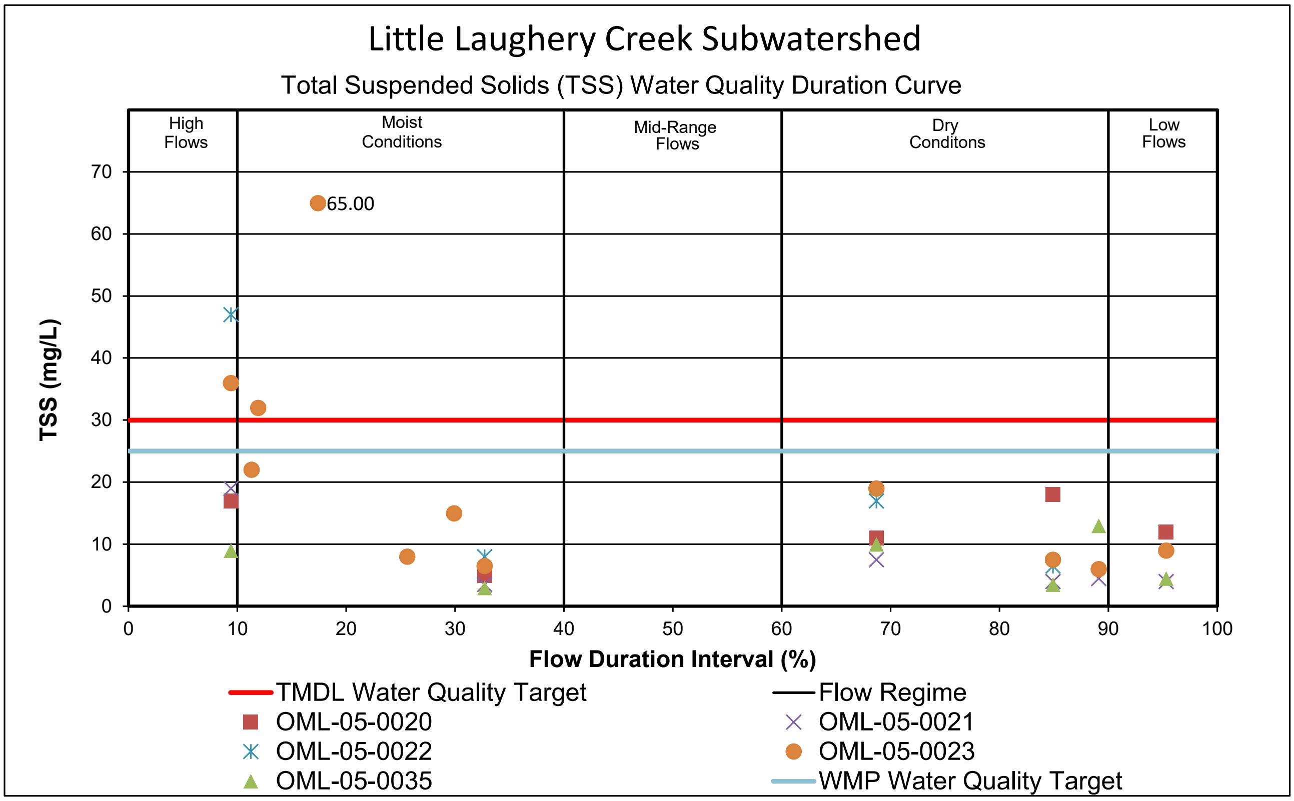


Figure 36: Little Laughery Creek TSS Water Quality Duration Curve

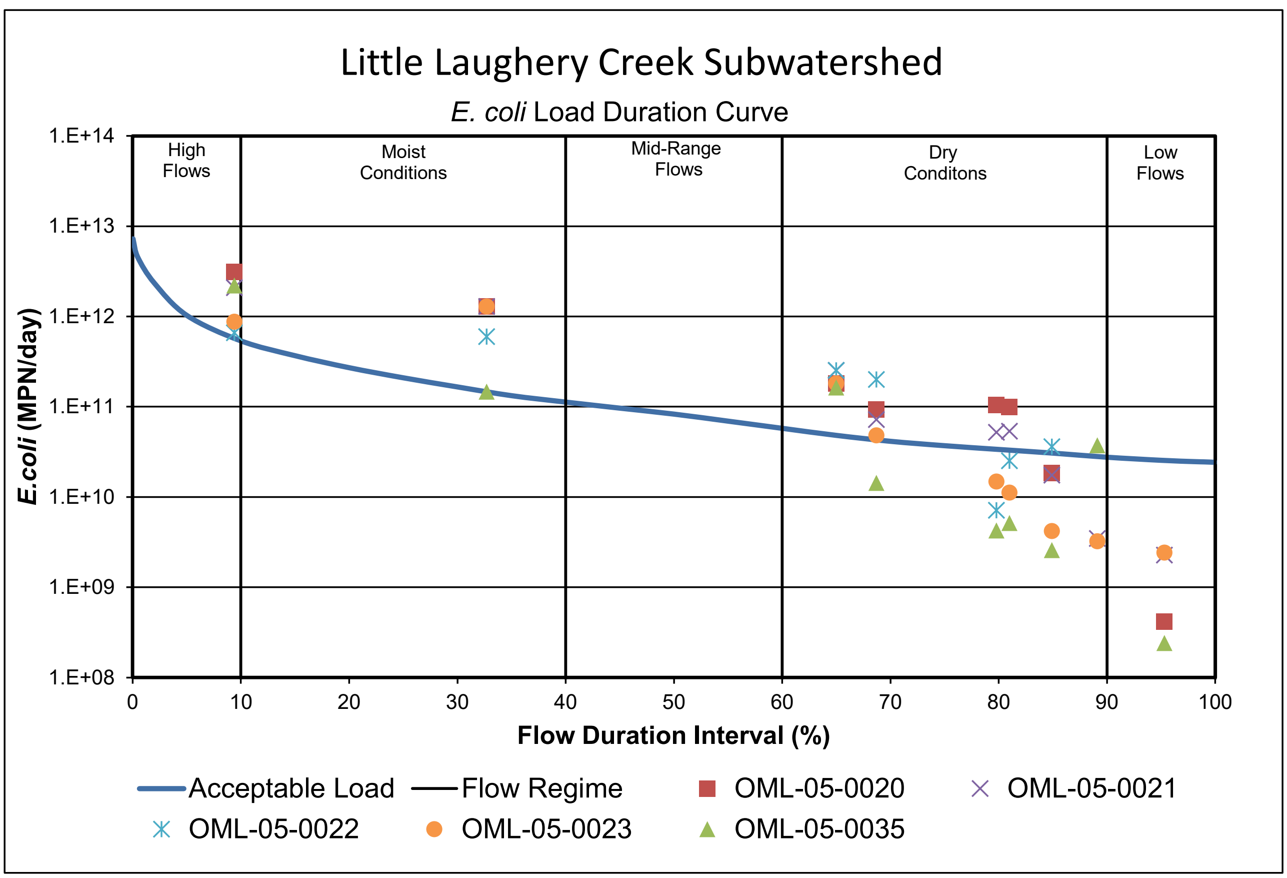


Figure 37: Little Laughery Creek E. Coli Load Duration Curve

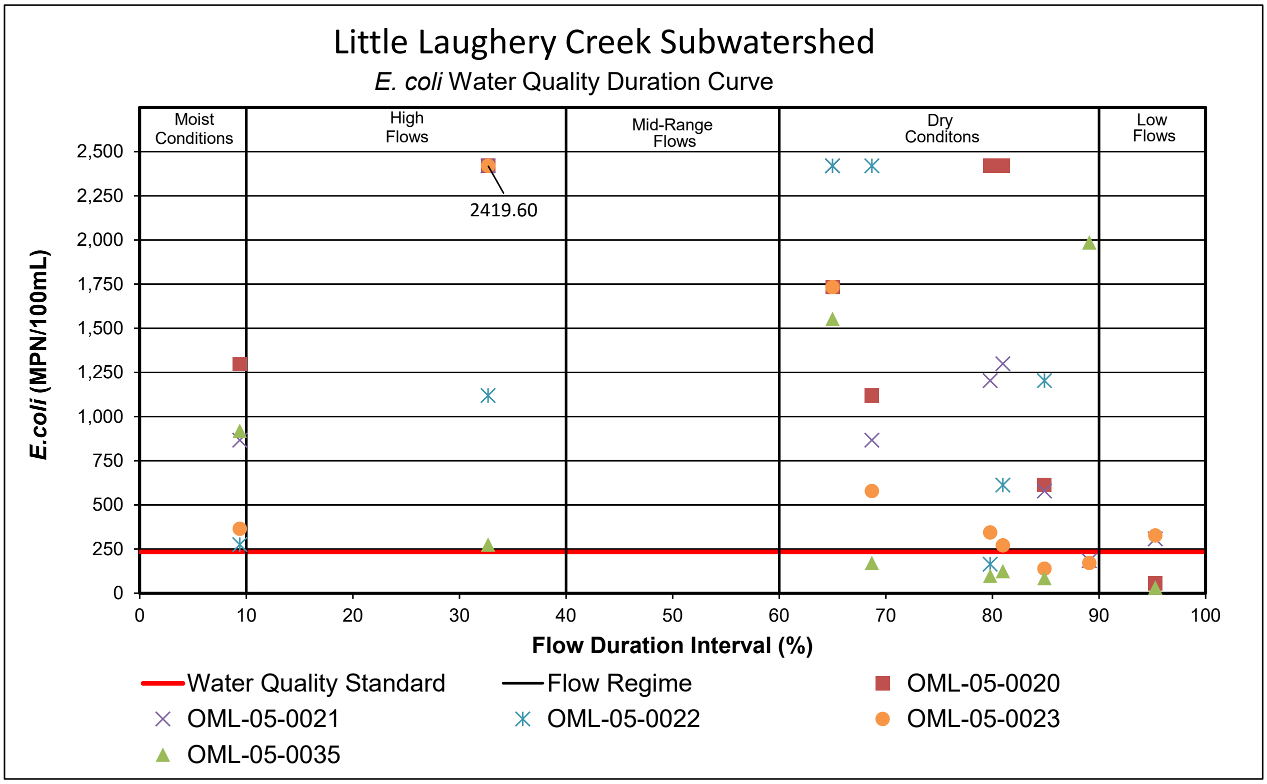


Figure 38: Little Laughery Creek E. coli Water Quality Duration Curve

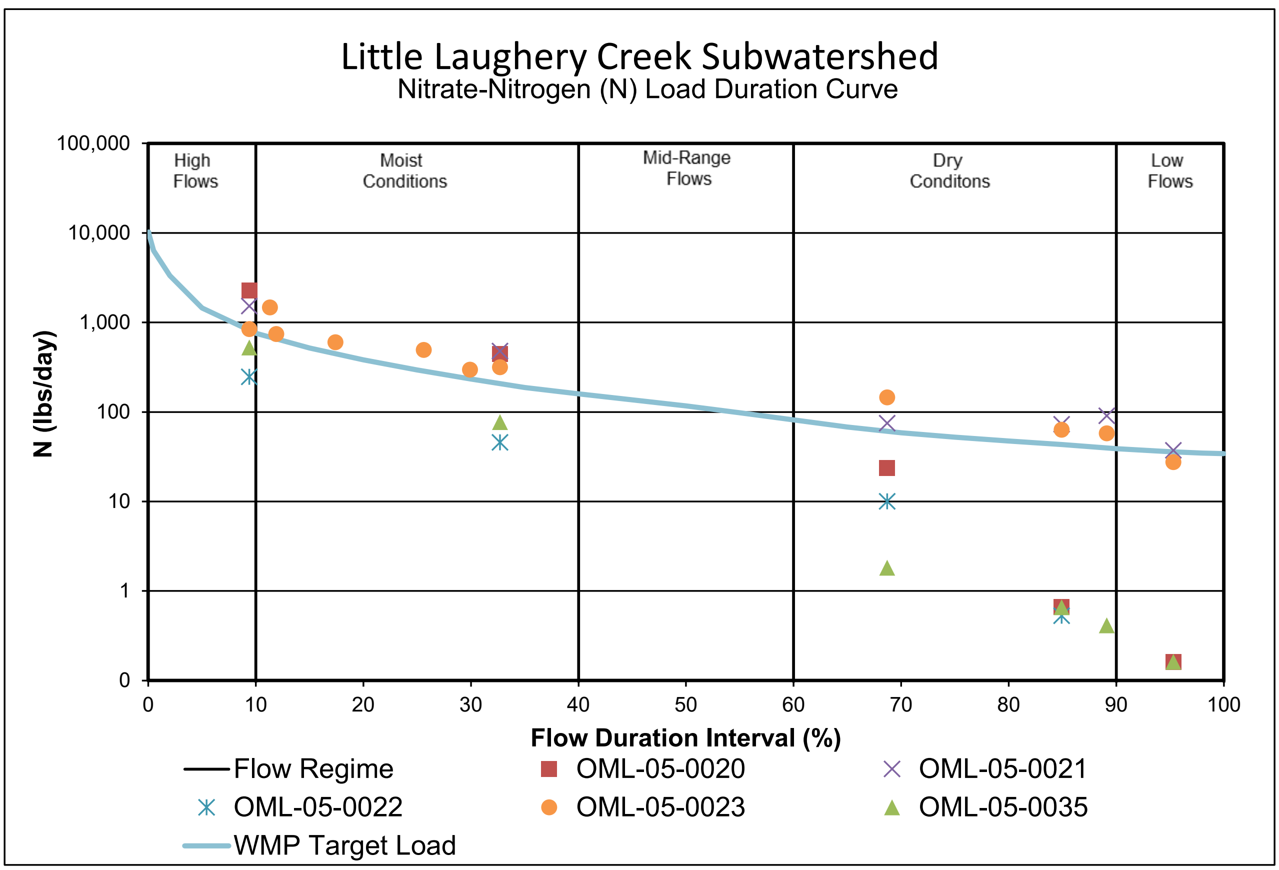


Figure 39: Little Laughery Creek Nitrate Nitrogen Load Duration Curve

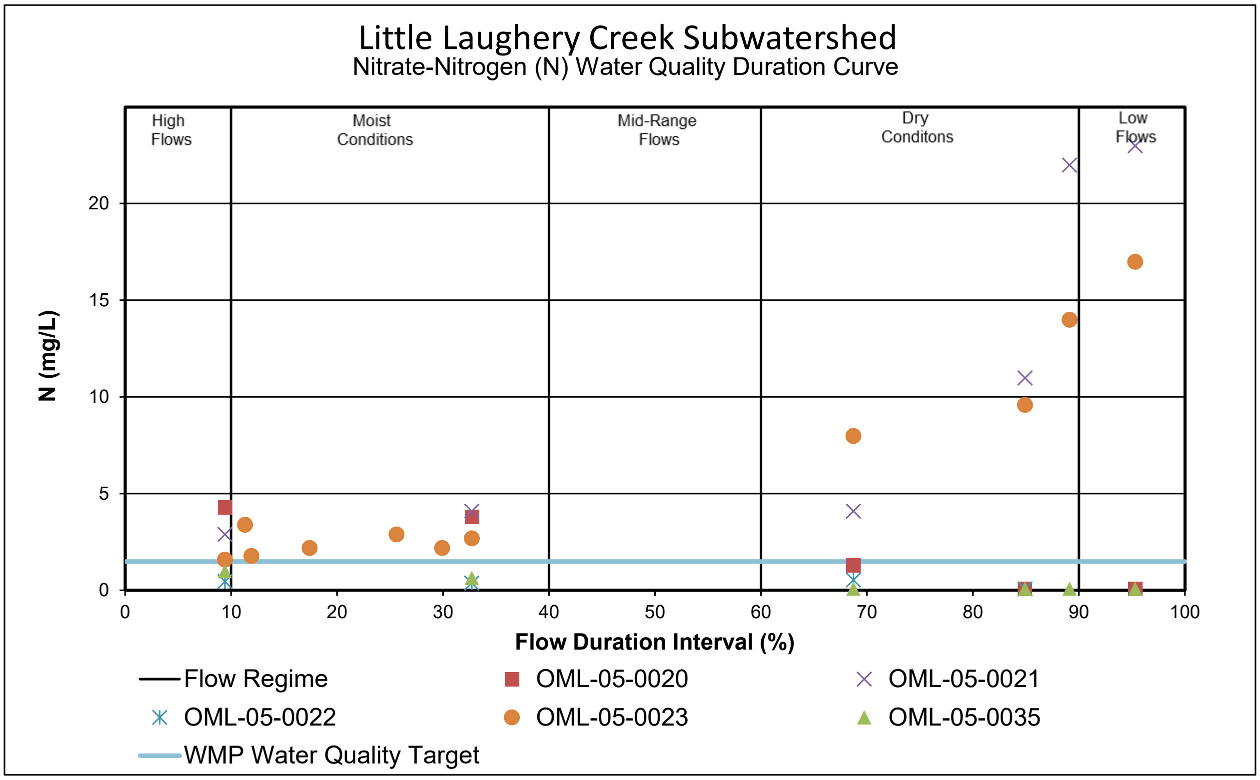


Figure 40: Little Laughery Creek Nitrate Nitrogen Water Quality Duration Curve

Table 34: Summary of Little Laughery Creek Subwatershed Characteristics

Little Laughery Creek (050902030502)					
Drainage Area	27.28 square miles				
Surface Area	27.28 square miles				
TMDL Sample Site	OML-05-0020, OML-05-0021, OML-05-0022, OML-05-0023, OML-05-0035				
Listed Segments	INV0352_01, INV0352_02, INV0352_03, INV0352_T1001, INV0352_T1008				
Listed Impairments [TMDL(s)]	*E. coli* [*E. coli*], Impaired Biotic Communities [TSS], Dissolved Oxygen [TSS], Nutrients [N/A]				
Land Use	Agricultural Land: 34% Forested Land: 30% Developed Land: 16% Open Water: 2% Pasture/Hay: 17% Grassland/Shrubs: 0% Wetland: 0%				
NPDES Facilities	City of Batesville WWTP (IN0039268), Hillenbrand, Inc. (IN0057118), Batesville Water & Gas Utility (IN0004642), Batesville Manufacturing Inc. Assembly (INRM00412), Batesville Tool & Die Inc. (INRM00618), Batesville Manufacturing Inc. Stamping Plant (INRM00921), Batesville Logistics Inc. (INRM01156), Hill-Rom, Inc. (Ritter Plant) (IN0061484)				
CAFOs	NA				
CFOs	Siebert Farms Inc. (Farm ID: 3829)				
TMDL *E. coli* Allocations (MPN/day)					
Allocation Category **Duration Interval (%)**	**High Flows 5%**	**Moist Conditions 25%**	**Mid-Range Flows 50%**	**Dry Conditions 75%**	**Low Flows 95%**
LA	8.549E+11	1.550E+11	4.719E+10	8.086E+09	*
WLA (Total)	2.348E+10	2.348E+10	2.348E+10	2.348E+10	*
MOS (10%)	1.033E+11	2.099E+10	8.314E+09	3.714E+09	2.559E+09
Future Growth (5%)	5.167E+10	1.050E+10	4.157E+09	1.857E+09	1.279E+09

TMDL = LA+WLA+MOS	1.033E+12	2.099E+11	8.314E+10	3.714E+10	2.559E+10
WLA (Individual)					
City of Batesville WWTP	2.35E+10	2.35E+10	2.35E+10	2.35E+10	*

TMDL Total Suspended Solids Allocations (lbs/day)					
Allocation Category Duration Interval (%)	**High Flows 5%**	**Moist Conditions 25%**	**Mid-Range Flows 50%**	**Dry Conditions 75%**	**Low Flows 95%**
LA	23,967.60	4,442.74	1,449.21	348.76	72.52
WLA (Total)	751.21	578.83	539.60	539.60	539.60
MOS (10%)	2,908.10	590.77	233.98	104.51	72.01
Future Growth (5%)	1,454.05	295.39	116.99	52.26	36.01
TMDL = LA+WLA+MOS	**29,080.96**	**5,907.72**	**2,339.78**	**1,045.13**	**720.14**
WLA (Individual)					
City of Batesville WWTP	528.65	528.65	528.65	528.65	528.65
Hillenbrand Inc.	0.94	0.94	0.94	0.94	0.94
Batesville Water & Gas Utility	10.01	10.01	10.01	10.01	10.01
Construction stormwater	71.18	13.19	0.00	0.00	0.00
Industrial stormwater	140.43	26.03	0.00	0.00	0.00

*Note – WWTP design flow exceeds low flow; Allocation = (flow contribution from source) x (235 MPN/100 mL); see Section 5.1 in TMDL

Little Laughery Creek Subwatershed Windshield Survey Results (48 sites)	
Finding	**# Present**
Contaminated Runoff into Streams from livestock	3
Livestock Access to Streams	9
Excess Nutrients Entering Stream from livestock	0
Streambank Erosion	2
Gully Erosion	1
Sediment Entering Stream	3
Overgrazed Pasture	14
Conventional Tillage being used	18
Flooding	0
Lack of Riparian Buffers	15
Total	**65**

Table 35: Windshield Survey Results of Little Laughery Creek Subwatershed

The Little Laughery Windshield Survey completed in April 2021 shows non point source pollution issues affecting this subwatershed include use of conventional tillage in cropland acres and lack of riparian buffers. There are also 9 sites where livestock have access to streams, along with the issue of overgrazing on many sites.

Headwaters Ripley Creek 050902030503

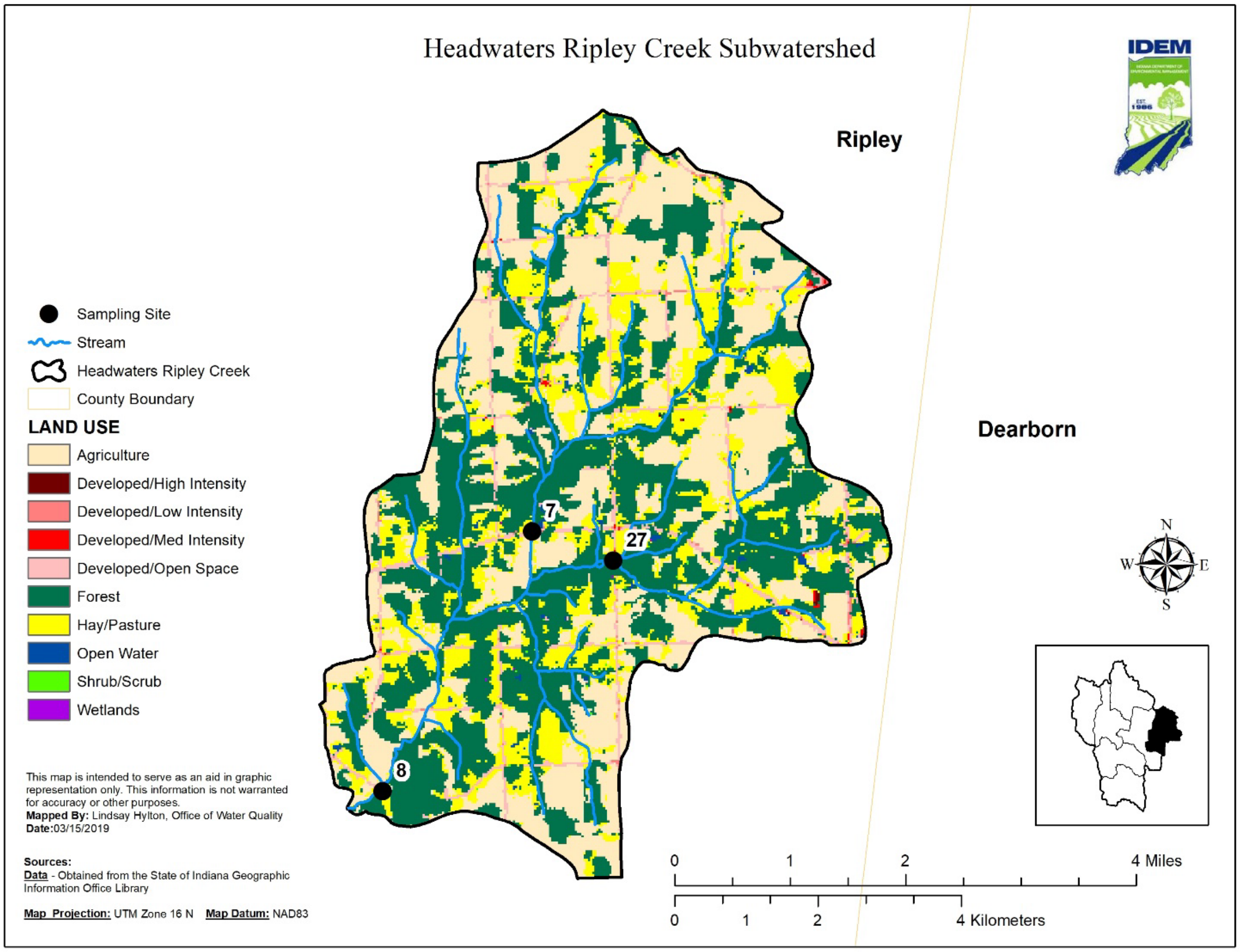


Figure 41: Sampling Stations and landuse in the Headwaters Ripley Creek Subwatershed

The Headwaters Ripley Creek subwatershed drains approximately 19 square miles. The land use is primarily forest (39%) and agriculture (36%), followed by hay/pasture land (19%). There is one NPDES permitted facility in the subwatershed, the Town of Sunman WWTP (IN0021679). The majority of the subwatershed is rural, indicating many homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire Laughery Creek watershed is very limited. Maintenance and inspections of septic systems in the area are important to ensure proper function and capacity. While the landscape in the area is relatively hilly, 36% of the subwatershed has been converted to agricultural production and use. In parts of the subwatershed there are little to no remaining riparian buffers left along the banks, due to agricultural practices. The subwatershed does contain significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes.

Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential areas for wetland restoration or high functioning two-stage ditch implementation. With a land use of 19% pasture land, a low to moderate presence of pasture animals is expected. There are no permitted CFOs in the watershed.

There are three sites located in this subwatershed, OML-05-0025 (7) and OML-05-0026 (8) on Ripley Creek and OML-05-0040 (27) on a tributary of Ripley Creek. In 2018-2019 this watershed was sampled 32 times between the three sites, resulting in all three failing the WQS for *E.coli*. These stream reaches will be placed on the 2022 303(d) List of Impaired Waters. The *E. coli* geomean for site 7 was 434.58 MPN with 6/9 samples in exceedance of the single sample max, site 8 had a geomean of 398.14 with 7/9 samples in exceedance of the single sample max, and site 27 had a geomean of 1382.54 with 7/9 samples in exceedance of the single sample max. The geomeans from sites 7, 8, and 27 were taken on the same day for five consecutive weeks. High *E. coli* levels are reflective of high animal concentration, land application of waste, wildlife, leaking and failing septic systems, and run-off from urban areas.

The fish community IBI score for site 7 was 38 (fair) and the QHEI was 53 (good). The macro community mIBI score was 40 (fair) and the QHEI was 44 (poor). The fish community IBI score for site 8 was 42 (fair) and the QHEI was 56 (good). The macro community mIBI score was 42 (fair) and the QHEI was 57 (good). The fish community IBI score for site 27 was 34 (poor) and the QHEI was 53 (good). The macro community mIBI score was 42 (fair) and the QHEI was 49 (poor). Therefore, Site 27 will be impaired for IBC.

TSS concentrations ranged from 2 mg/L to 40 mg/L across 23 sampling events within the watershed, and exceeded the target value two times, at site 7 and at site 8. Total phosphorus concentrations ranged from 0.04 mg/L to 1.10mg/L across 23 sampling events within the watershed, and exceeded the target value two times, both at site 7. Site 7 was determined to be impaired for nutrients, with total phosphorus being over the target value for two consecutive sampling events. Additionally, dissolved oxygen was found below water quality standards on numerous occasions on Ripley Creek (site 7). Given that targets for total phosphorus and TSS were sporadically violated throughout the watershed, TMDLs were developed to address the biological communities and dissolved oxygen impairments within the watershed. Additionally, high total phosphorus values are also believed to be a primary linkage to the nutrients impairments within the watershed. Therefore, a TMDL for total phosphorus will also serve to address nutrients impairments in this subwatershed.

There are approximately 37 miles of stream in the subwatershed. Based on IDEM data collected in 2018- 2019, there will be 21 stream miles impaired for *E. coli*, 9 miles impaired for biological communities, 7 miles impaired for dissolved oxygen, and 7 miles impaired for nutrients listed on the 2022 303(d) List of Impaired Waters. Therefore, *E. coli* TMDLs were developed to address all *E. coli* impairments, TSS TMDLs were developed to address all impaired biotic communities, and TP TMDLs were developed to address all nutrient impairments. Additionally, both TP and TSS TMDLs will be used to address all dissolved oxygen impairments in the subwatershed.

Load duration and water quality duration curves were developed for the subwatershed and are summarized in the graphs below. Evaluating these graphs, with consideration of the watershed characteristics, allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli,* TSS, and TP concentrations. Elevated levels of pollutants during rain events can indicate contributions due to run-off. The load duration curves for these sites shows the streams are susceptible to high loads of *E. coli* and TSS from run-off events, while total phosphorus exceedances occur in the stream during lower flow conditions. However, the streams are also consistently in violation of water quality standards/targets for *E. coli* during drier conditions on the chart.

Based on these graphs, it can be concluded that the majority of sources of *E. coli* and TSS in this watershed are nonpoint sources that could include small animal operations, wildlife, animals with direct access to streams, illegal straight-pipes, leaking and failing septic systems, streambank erosion, and agricultural practices.

Total phosphorus loadings from the Town of Sunman WWTP at low flows were based on the average flow for the facility. The loadings were then calculated based on the average concentration value determined from comparing similar facilities where available water quality monitoring data was available. Based upon an analysis of the monitoring data for facilities with and without phosphorus treatment, IDEM determined that similar facilities on average showed a 90% reduction in total phosphorus loadings following issuance and compliance with a 1.0 mg/L permit limit. Therefore, IDEM believes it is reasonable to expect compliance with a 1.0 mg/L permit limit will result in necessary reductions for meeting water quality targets. This recommended allocation may be adjusted appropriately as more water quality monitoring data is obtained for this facility.

HEADWATERS RIPLEY CREEK WATERSHED			
Pollutant	**Range**	**Average**	**Samples Exceeding WMP Target**
E.Coli	90.8 cfu - 2419.6 cfu	705.9 cfu	20 of 27 Samples (74%)
Phosphorus	.04mg/L - 1.10mg/L	0.148 mg/L	9 of 23 Samples (39%)
TSS	2.0 mg/L - 40 mg/L	12.34 mg/L	3 of 23 Samples (13%)
Nitrogen	0.052 mg/L - 2.0 mg/L	0.88 mg/L	2 of 23 Samples (9%)

Table 36:Summary of Headwaters Ripley Creek Water Quality Testing Data

As shown in the table above, E. Coli and Phosphorus are a non point source issue in this subwatershed. There is one NPDES permitted facility in the subwatershed, the Town of Sunman WWTP (IN0021679). The majority of the subwatershed is rural, indicating many homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire Laughery Creek watershed is very limited. Approximately 19% of this watershed is used for hayland and pasture with many sites allowing livestock access to the stream, and contaminated runoff from feeding areas to enter into the streams.

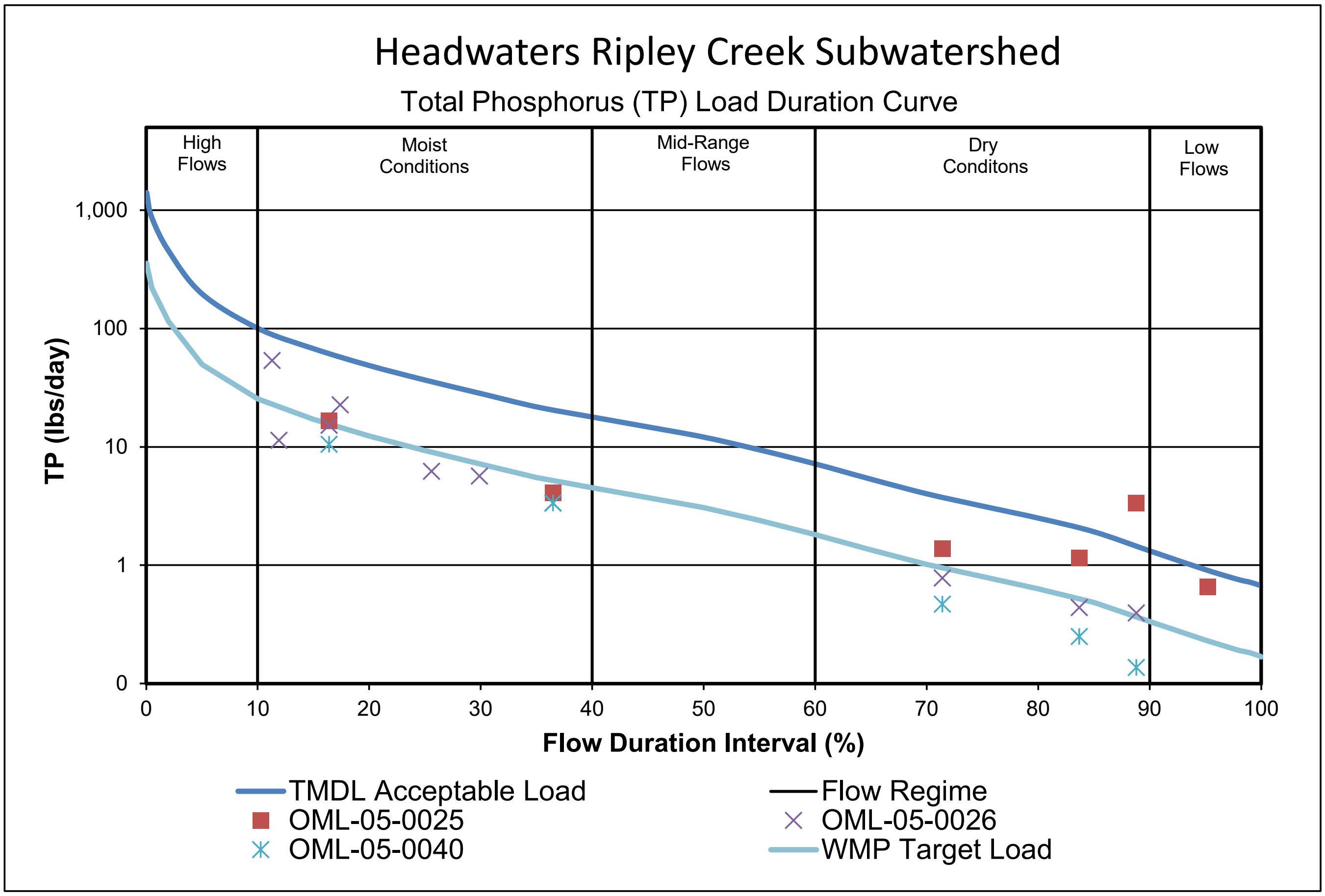


Figure 42: Headwaters Ripley Creek Total Phosphorus Load Duration Curve

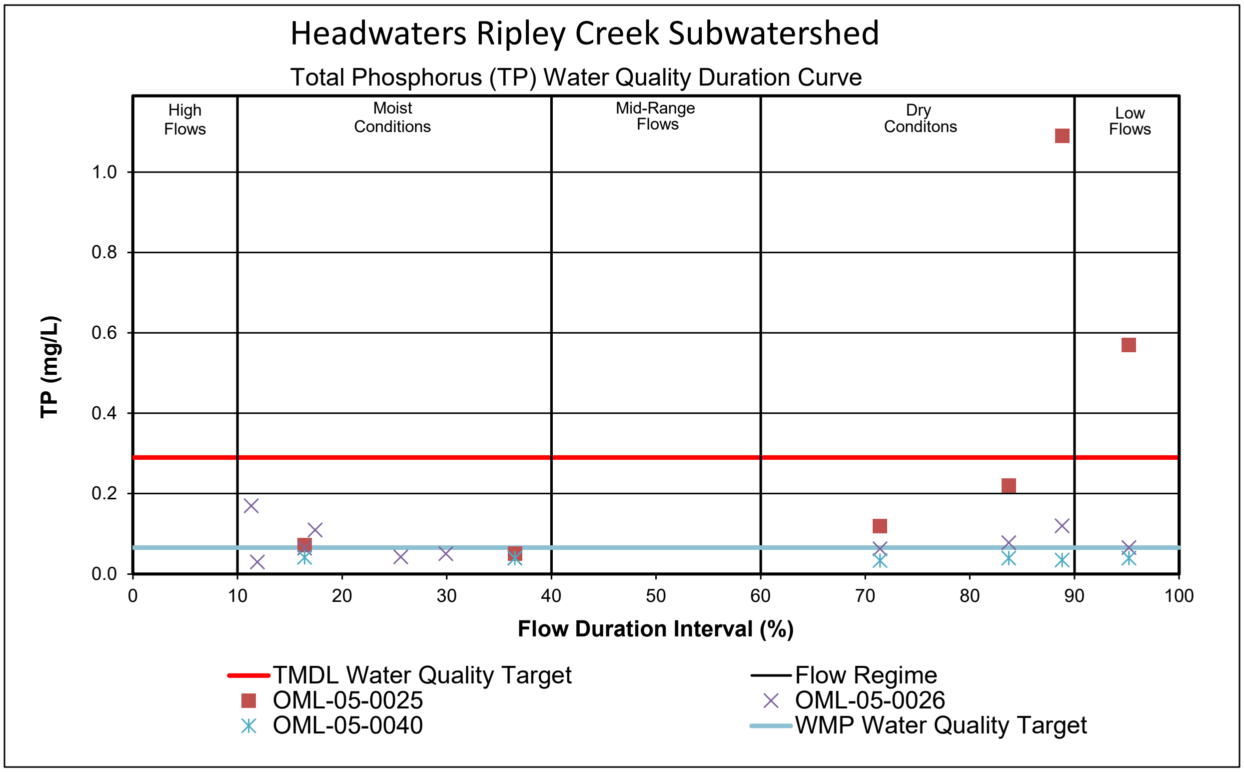


Figure 43: Headwaters Ripley Creek Total Phosphorus Water Quality Duration Curve

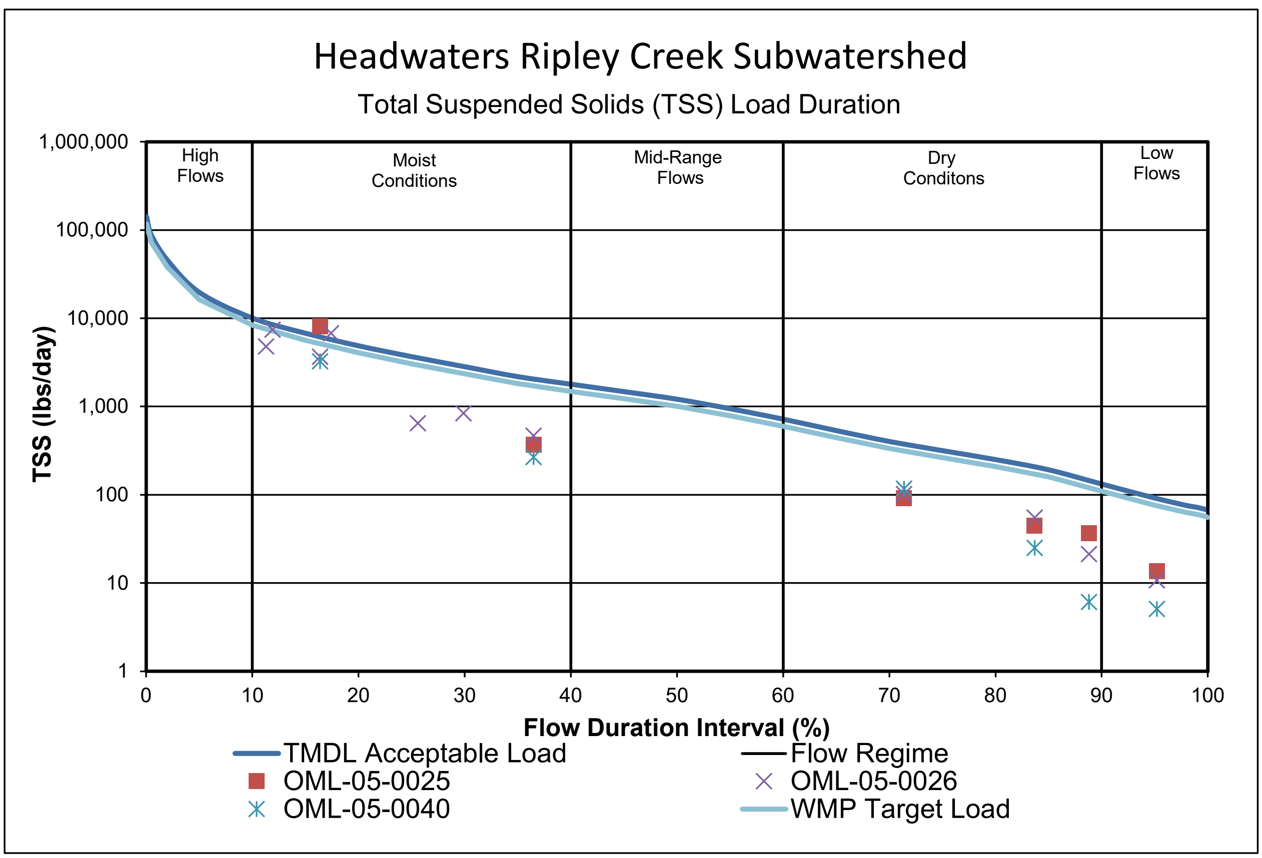


Figure 44: Headwaters Ripley Creek TSS Load Duration Curve

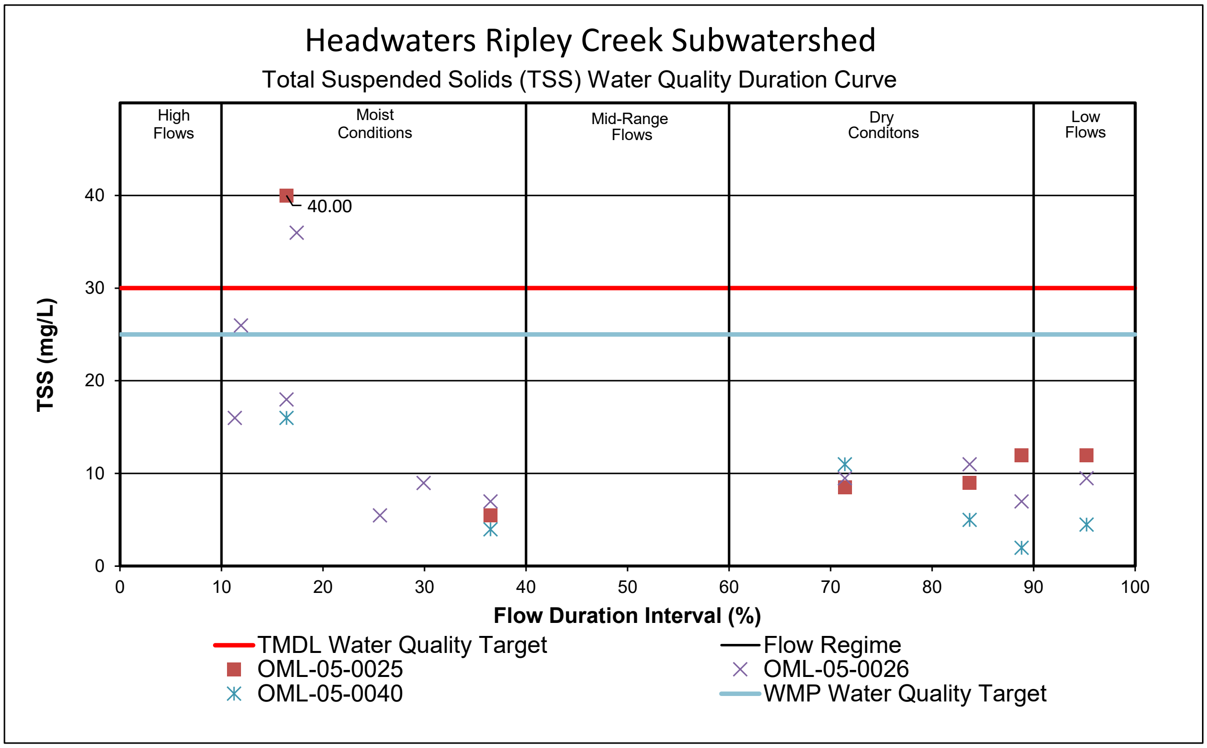


Figure 45: Headwaters Ripley Creek TSS Water Quality Duration Curve

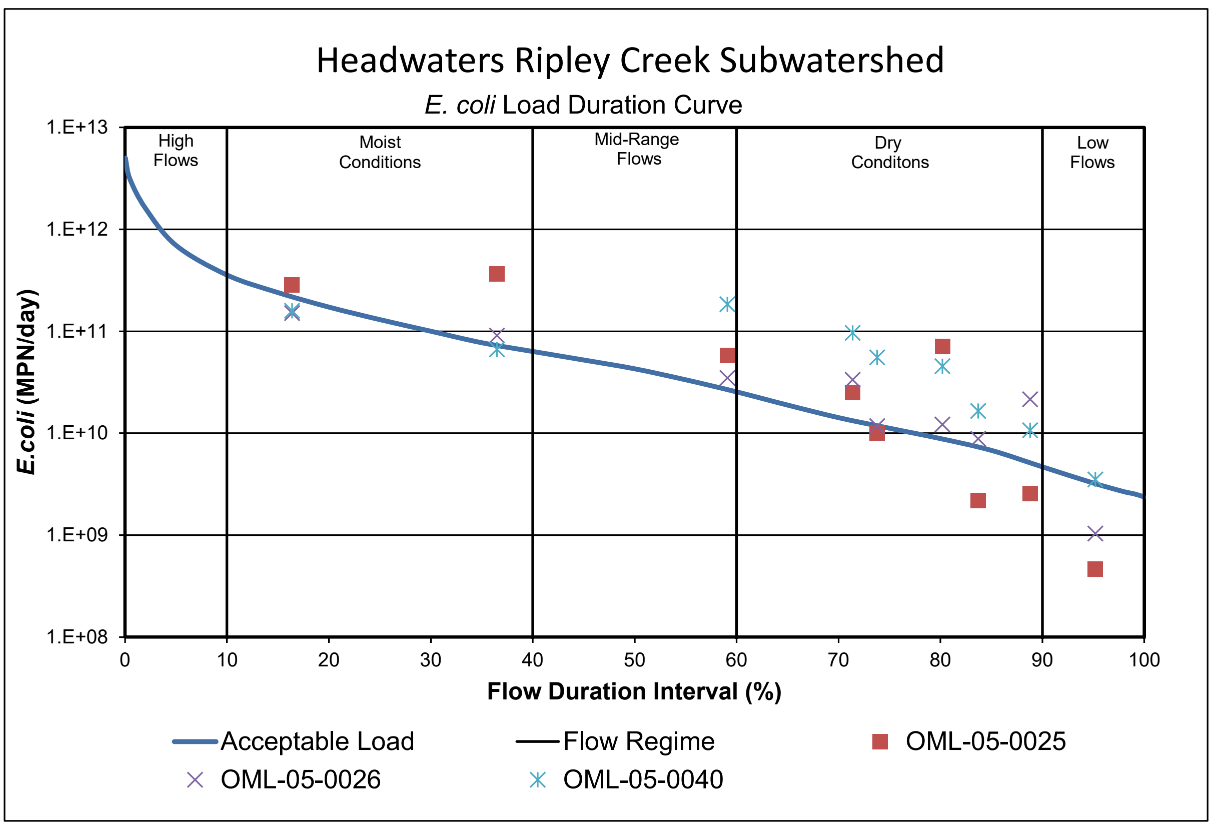


Figure 46: Headwaters Ripley Creek E. coli Load Duration Curve

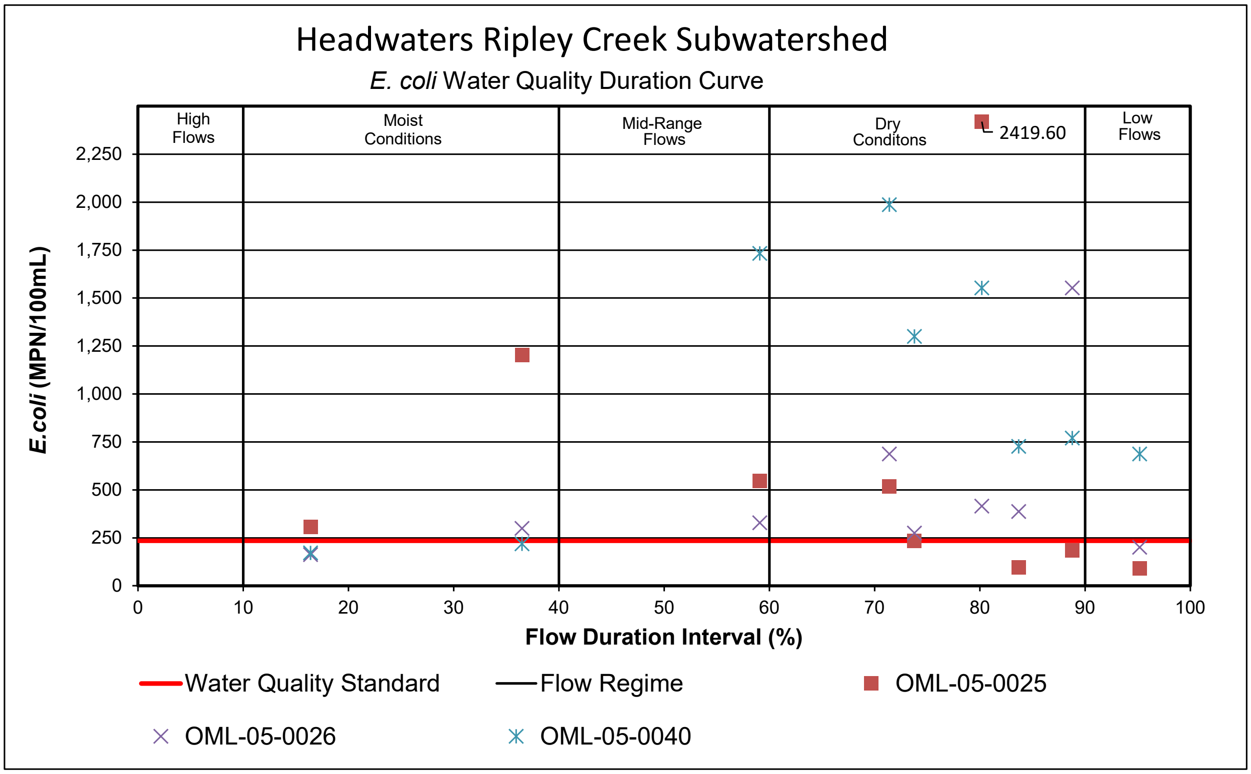


Figure 47: Headwaters Ripley Creek E. coli Water Quality Duration Curve

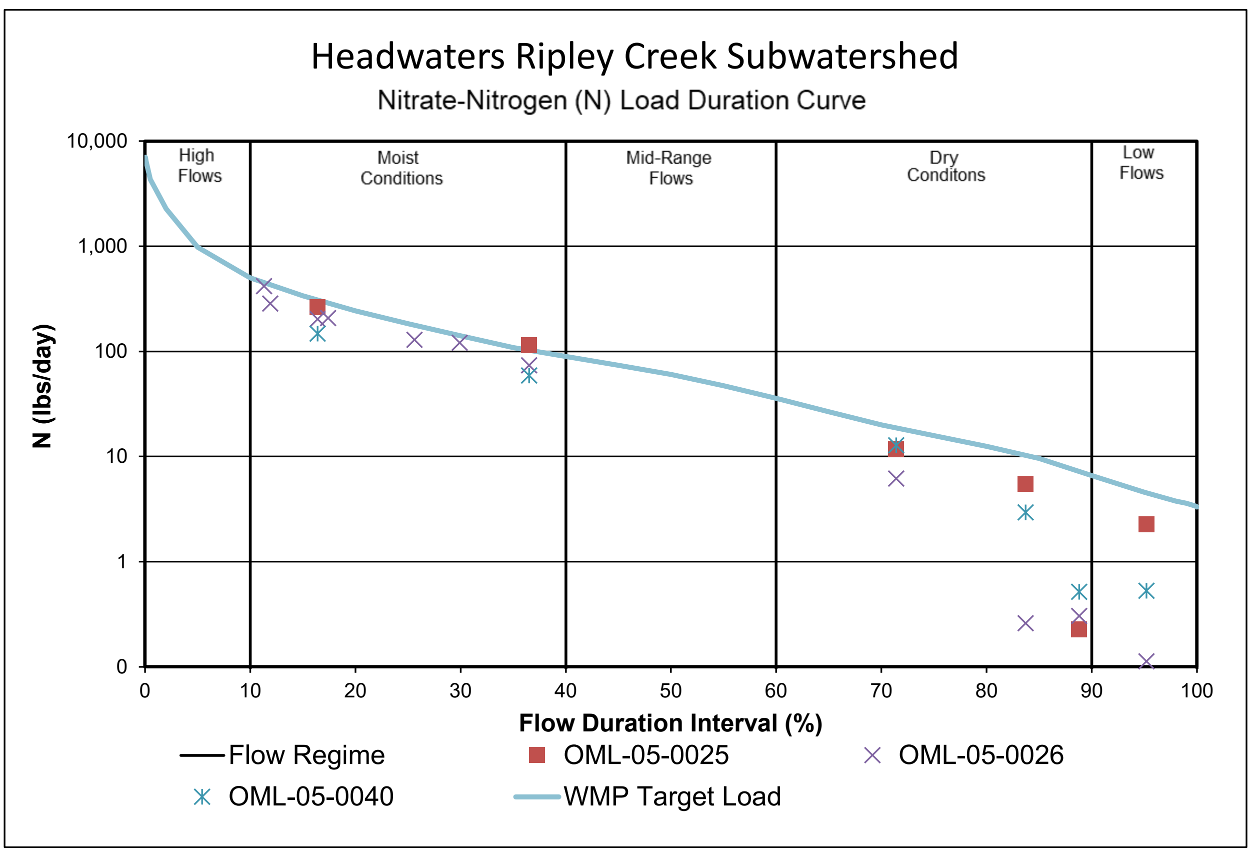


Figure 48: Headwaters Ripley Creek Nitrate Nitrogen Load Duration Curve

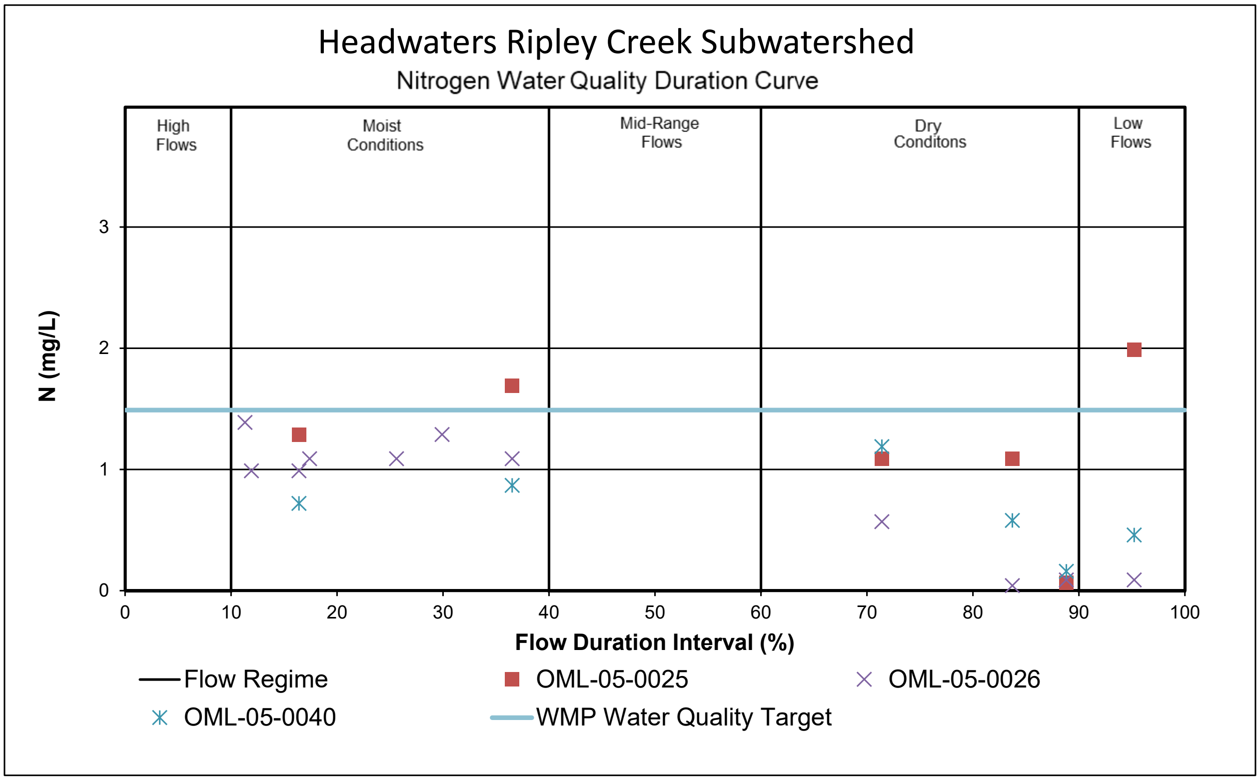


Figure 49: Headwaters Ripley Creek Nitrogen Water Quality Duration Curve

Table 37: Summary of Headwaters Ripley Creek Subwatershed Characteristics

NPDES Facilities	Town of Sunman WWTP (IN0021679)				
CAFOs	NA				
CFOs	NA				
TMDL *E. Coli* Allocations (MPN/day)					
Allocation Category **Duration Interval (%)**	**High Flows** **5%**	**Moist Conditions** **25%**	**Mid-Range Flows** **50%**	**Dry Conditions** **75%**	**Low Flows** **95%**
LA	5.91E+11	1.09E+11	3.45E+10	7.53E+09	7.65E+08
WLA (Total)	2.00E+09	2.00E+09	2.00E+09	2.00E+09	2.00E+09
MOS (10%)	6.98E+10	1.30E+10	4.29E+09	1.12E+09	3.25E+08
Future Growth (5%)	3.49E+10	6.51E+09	2.15E+09	5.61E+08	1.63E+08
TMDL = LA+WLA+MOS	**6.98E+11**	**1.30E+11**	**4.29E+10**	**1.12E+10**	**3.25E+09**
WLA (Individual)					
Town of Sunman WWTP	2.00E+09	2.00E+09	2.00E+09	2.00E+09	2.00E+09
TMDL Total Suspended Solids Allocations (Lbs/day)					
Allocation Category **Duration Interval (%)**	**High Flows** **5%**	**Moist Conditions** **25%**	**Mid-Range Flows** **50%**	**Dry Conditions** **75%**	**Low Flows** **95%**
LA	16,634.06	3,060.20	970.29	211.91	21.54
WLA	56.91	56.43	56.32	56.32	56.32
MOS (10%)	1,963.64	366.66	120.78	31.56	9.16
Future Growth (5%)	981.82	183.33	60.39	15.78	4.58
TMDL = LA+WLA+MOS	**19,636.45**	**3,666.62**	**1,207.77**	**315.57**	**91.60**
WLA (Individual)					
Town of Sunman WWTP	56.32	56.32	56.32	56.32	56.32
Construction stormwater	0.59	0.11	0.00	0.00	0.00
TMDL Total Phosphorus Allocations (Lbs/day)					
Allocation Category **Duration Interval (%)**	**High Flows** **5%**	**Moist Conditions** **25%**	**Mid-Range Flows** **50%**	**Dry Conditions** **75%**	**Low Flows** **95%**
LA	165.03	29.29	8.39	0.81	0.03
WLA	1.88	1.88	1.88	1.88	*0.51
MOS (10%)	19.64	3.67	1.21	0.32	0.06
Future Growth (5%)	9.82	1.83	0.60	0.16	0.03
TMDL = LA+WLA+MOS	**196.36**	**36.67**	**12.08**	**3.16**	**0.63**
WLA (Individual)					
Town of Sunman WWTP	1.88	1.88	1.88	1.88	*0.51

*Note- Allocation is based upon an analysis of reported discharges from similar facilities with phosphorus treatment and using the average reported flow of 0.11 MGD for the Town of Sunman

Headwaters Ripley Creek Subwatershed Windshield Survey Results (57 sites)	
Finding	**# Present**
Contaminated Runoff into Streams from livestock	31
Livestock Access to Streams	31
Excess Nutrients Entering Stream from livestock	31
Streambank Erosion	26
Gully Erosion	0
Sediment Entering Stream	15
Overgrazed Pasture	31
Conventional Tillage being used	25
Flooding	0
Lack of Riparian Buffers	0
Total	**190**

Table 38: Windshield Survey Results of Headwaters Ripley Creek Subwatershed

The Headwaters Ripley Creek windshield survey completed in April 2021 show issues affecting this subwatershed include many sites allowing livestock access to the stream, and contaminated runoff from feeding areas to enter into the streams. There was also many areas of overgrazed pasture and conventional tillage which may also add to sediment and nutrient load.

<u>North Branch 050902030504</u>

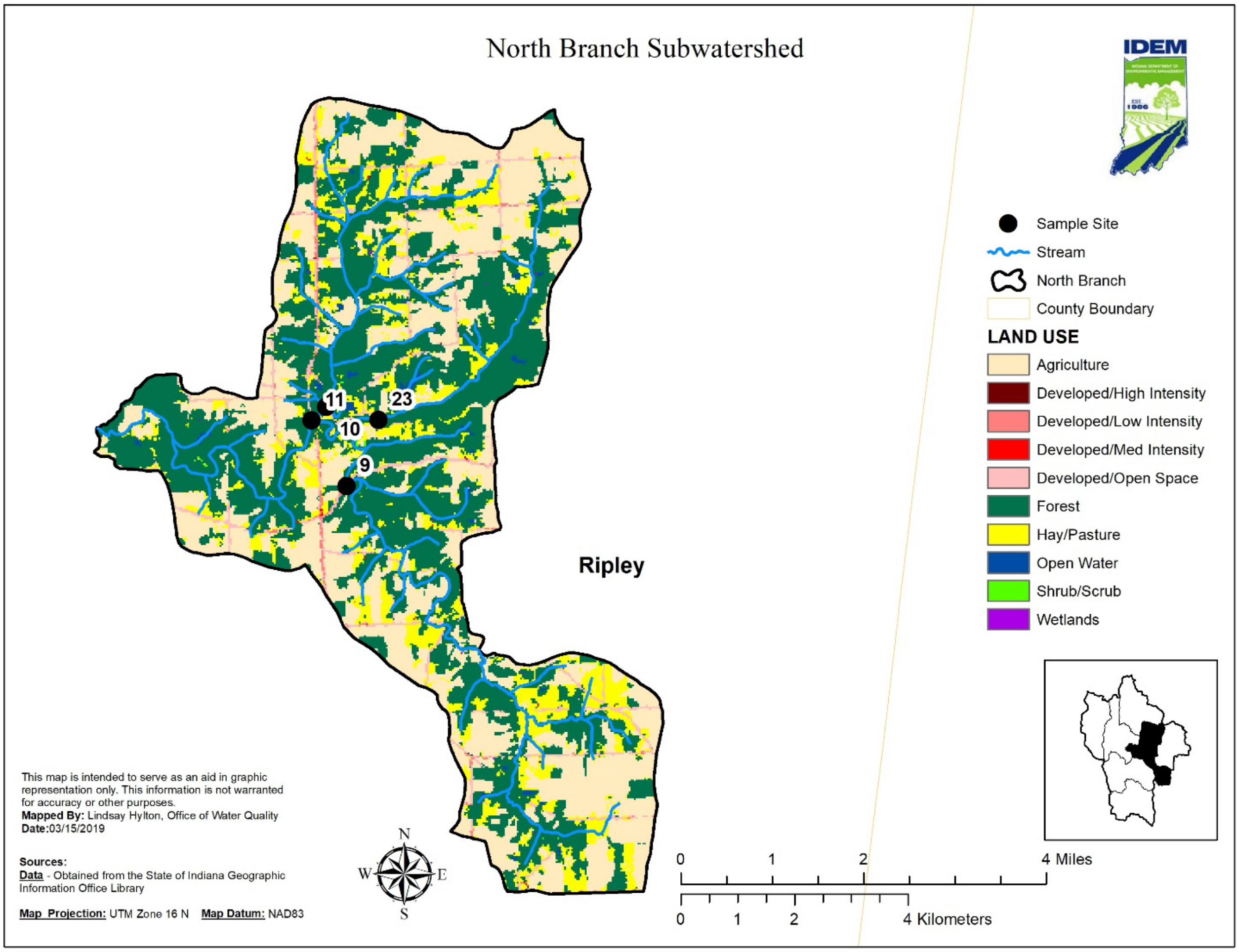


Figure 50: Sampling Stations and landuse in the North Branch Subwatershed

The North Branch subwatershed drains approximately 42 square miles with an actual land area of approximately 23 square miles. The land use is primarily forest (45%) followed by agriculture (36%) and hay/pasture land (14%). There are no NPDES permitted facilities in the subwatershed. The entire subwatershed is rural, indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, the entire Laughery Creek watershed is very limited. Maintenance and inspections of septic systems in the area are important to ensure proper function and capacity. While the landscape in the area is relatively hilly, 36 percent of the subwatershed has been converted to agricultural production and use. In parts of the subwatershed there are little to no remaining riparian buffers left along the banks, due to agricultural practices. The subwatershed does contain significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes.

Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential areas for wetland restoration or high functioning two-stage ditch

implementation. With a land use of 14 percent pasture land, a heavy presence of pasture animals in not expected. There are no permitted CFOs in the watershed.

There are four sites located in this subwatershed, OML-05-0027 (9) on Ripley Creek, OML-05-0028 (10) on North Branch Ripley Creek, OML-05-0029 (11) on Ripley Creek, and OML-05-0036 (23) on a tributary of Ripley Creek. In 2018-2019 this watershed was sampled 35 times between the four sites resulting in all four sites failing the WQS for *E.coli*. These stream reaches will be placed on the 2022 303(d) List of Impaired Waters. The *E. coli* geomean for site 9 was 202.46 MPN with 3/8 samples in exceedance of the single sample max. Site 10 had a geomean of 172.47 with 3/7 samples in exceedance of the single sample max. Site 11 had a geomean of 242.6 with 2/8 samples in exceedance of the single sample max. Site 23 had a geomean of 382.34 with 4/7 samples in exceedance of the single sample max. The geomeans from all four sites were taken on the same day for five consecutive weeks. High *E. coli* levels are reflective of high animal concentration, land application of waste, leaking and failing septic systems, and wildlife.

The fish community IBI score for site 9 was 50 (good) and the QHEI was 75 (good). The macro community mIBI score was 38 (fair) and the QHEI was 71 (good). The fish community IBI score for site 10 was 34 (poor) and the QHEI was 57 (good). The macro community mIBI score and QHEI could not be assessed due to the stream being dry at the time of sampling. The fish community IBI score for site 11 was 48 (fair) and the QHEI was 72 (good). The macro community mIBI score was 38 (fair) and the QHEI was 72 (good). The fish community IBI score for site 23 was 38 (fair) and the QHEI was 49 (poor). The macro community mIBI score and QHEI could not be assessed due to the stream being dry at the time of sampling. Site 10 will be impaired for IBC.

There are approximately 48 miles of stream in the subwatershed. Based on IDEM data collected in 2018-2019 there will be 22 stream miles impaired for *E. coli* listed on the 2022 303(d) List of Impaired Waters. Additionally, there will be 3 miles listed for impaired biotic communities and 5 miles listed for dissolved oxygen impairments. *E. coli* TMDLs were developed to address all *E. coli* impairments. Since there was no apparent pollutant linkage for the IBC or DO impairments, a TMDL was not developed to address these issues. They are likely linked to the low flow conditions in the streams.

Load duration and water quality duration curves were developed for the subwatershed and are summarized in the graphs below. Evaluating these graphs, with consideration of the watershed characteristics, allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations. Elevated levels of pollutants during rain events can indicate contributions due to runoff. The graph for these sites shows the streams are susceptible to high loads of *E. coli* from runoff events. However, the streams are consistently in violation of water quality standards/targets even during drier conditions on the chart. This indicates that sources like pasture animals with direct access to the streams, wildlife, illegal straight-pipes, or leaking and failing septic systems could be causes of the impairment.

NORTH BRANCH WATERSHED			
Pollutant	**Range**	**Average**	**Samples Exceeding WMP Target**
E.Coli	22.6cfu - 2419.6 cfu	331 cfu	12 of 30 Samples (40%)
Phosphorus	.03mg/L - .16mg/L	0.058 mg/L	3 of 23 Samples (13%)
TSS	3.0 mg/L - 23 mg/L	9.69 mg/L	0 of 33 Samples (0%)
Nitrogen	0.077 mg/L - 1.4 mg/L	0.75 mg/L	0 of 23 Samples (0%)

Table 39: Summary of North Branch Water Quality Testing Data

As shown in the chart above the streams in this subwatershed are susceptible to high loads of *E. coli.* The streams are consistently in violation of water quality standards/targets even during drier conditions on the chart. This indicates that sources like pasture animals with direct access to the streams, wildlife, illegal straight-pipes, or leaking and failing septic systems could be causes of the impairment.

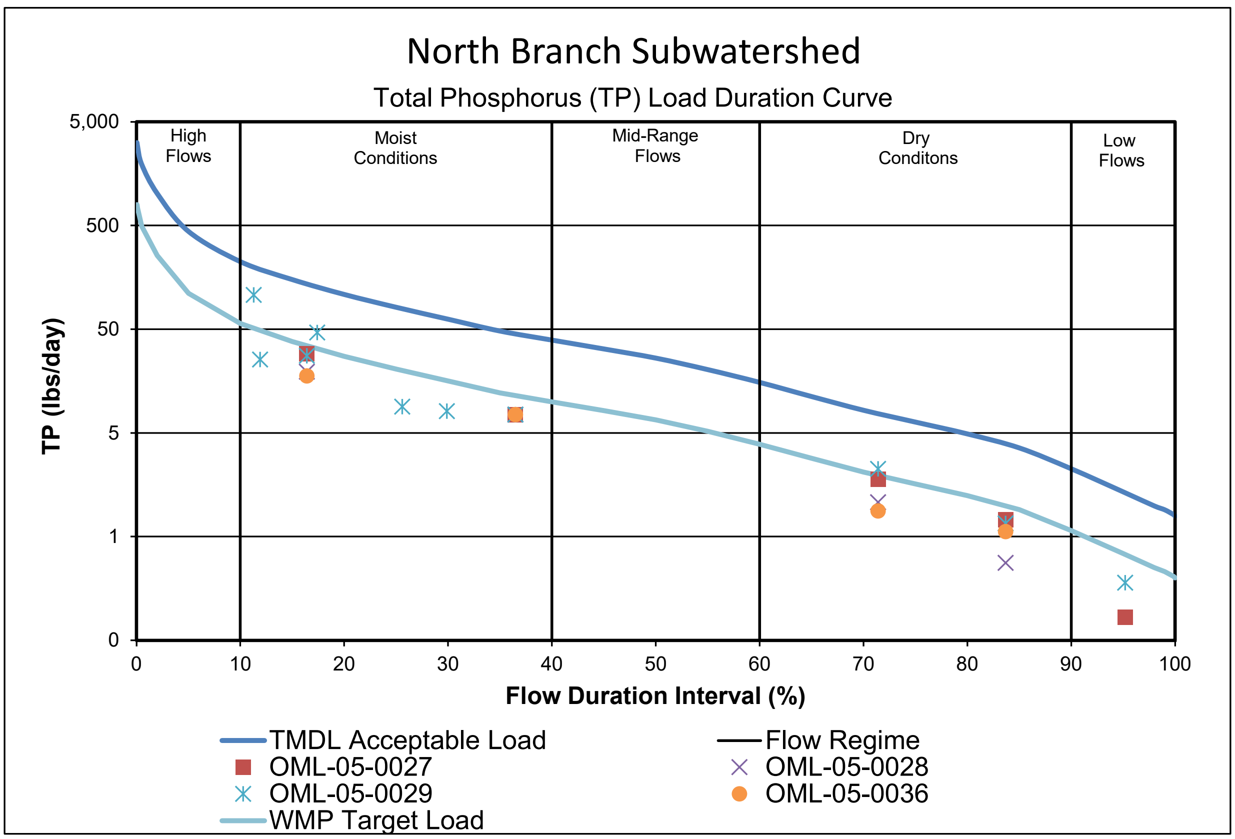


Figure 51: North Branch Total Phosphorus Load Duration Curve

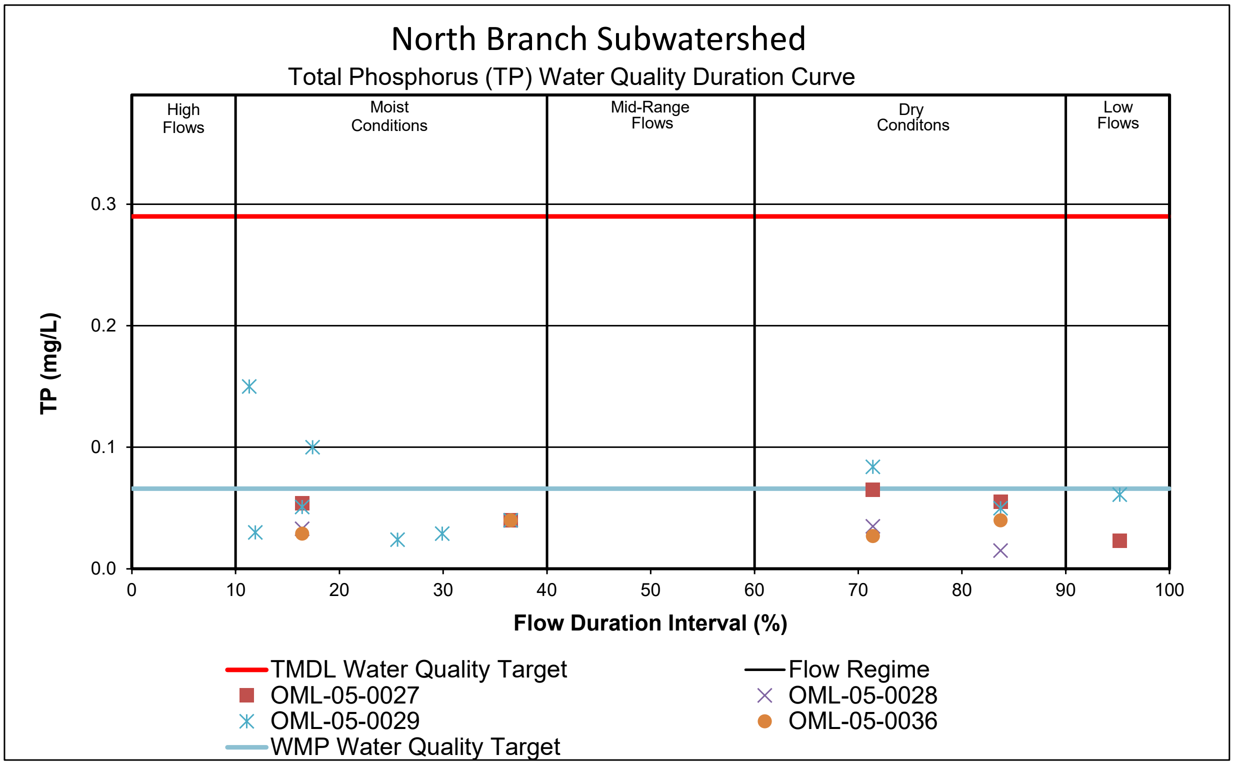


Figure 52: North Branch Total Phosphorus Water Quality Duration curve

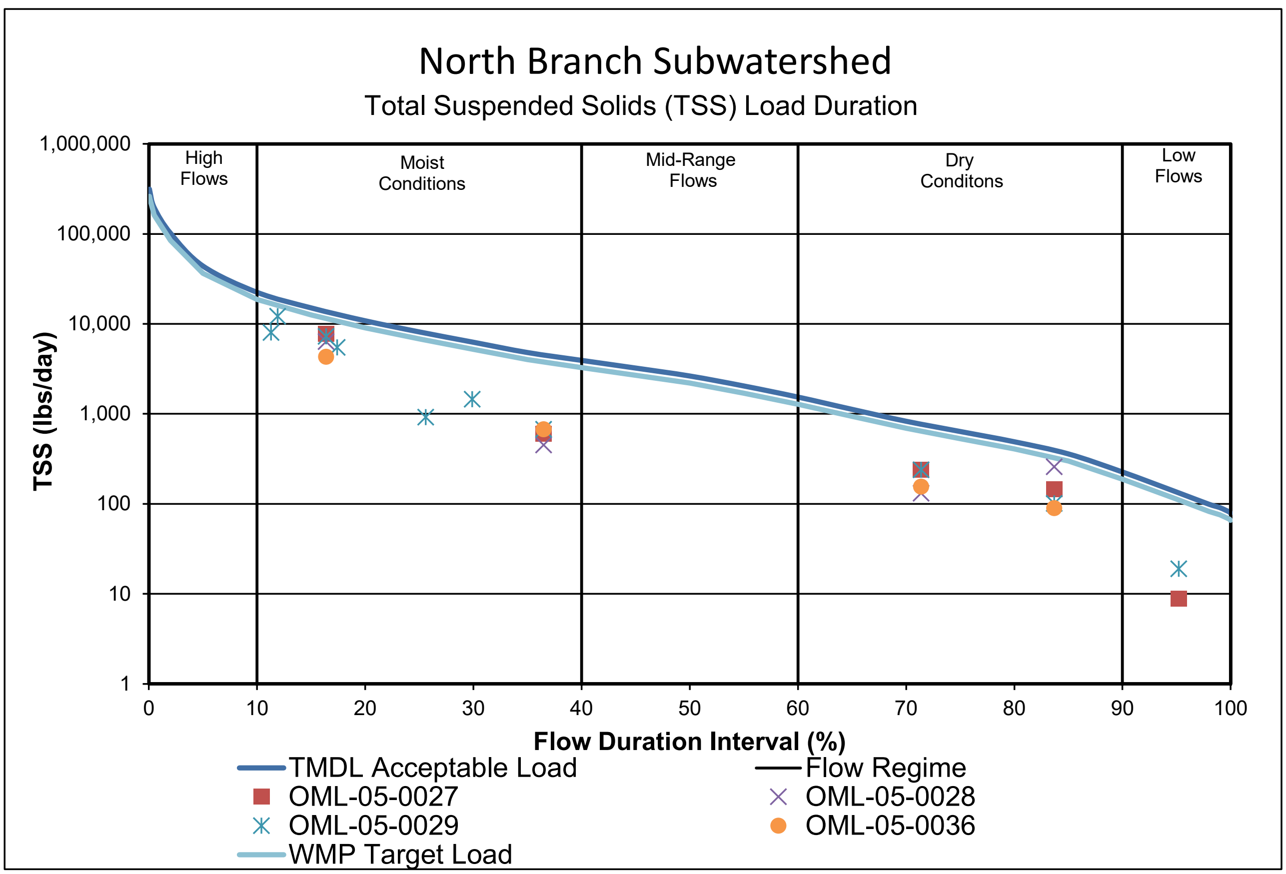


Figure 53: North Branch TSS Load Duration

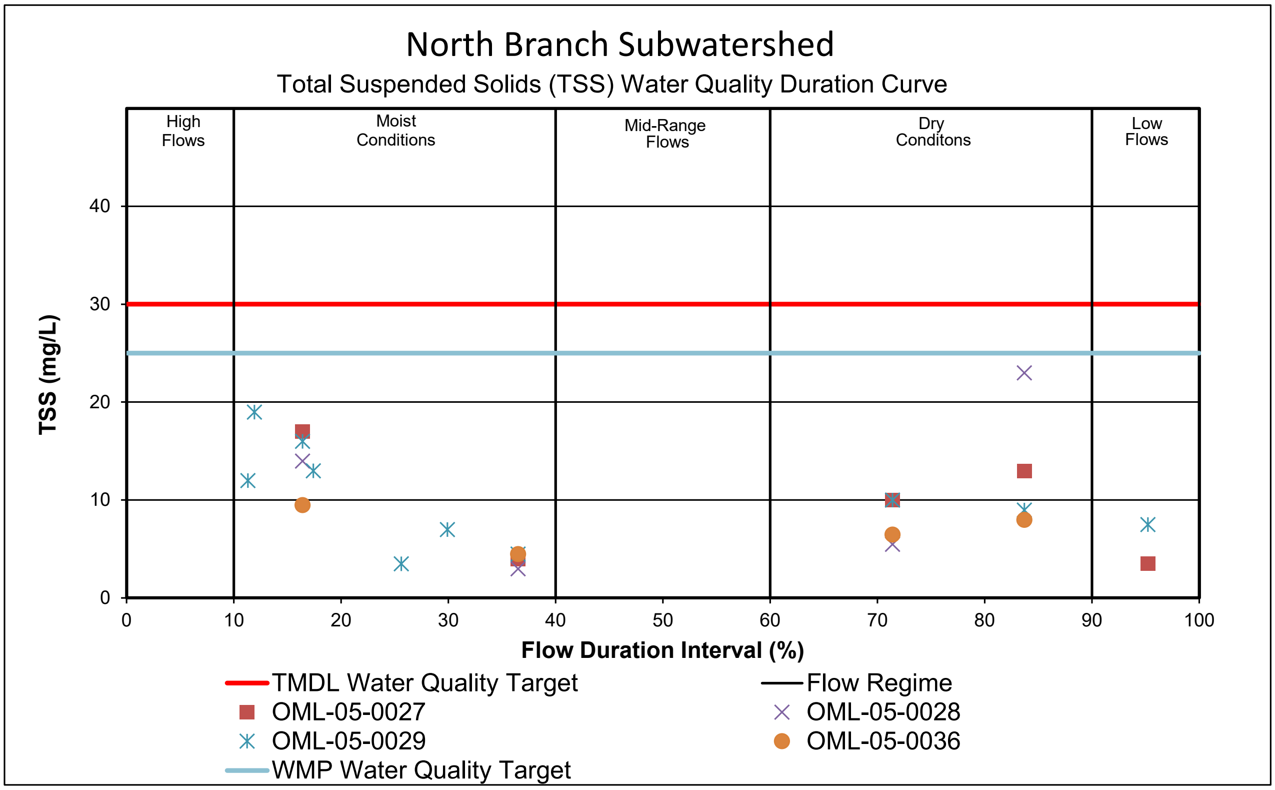


Figure 54: North Branch TSS Water Quality Duration Curve

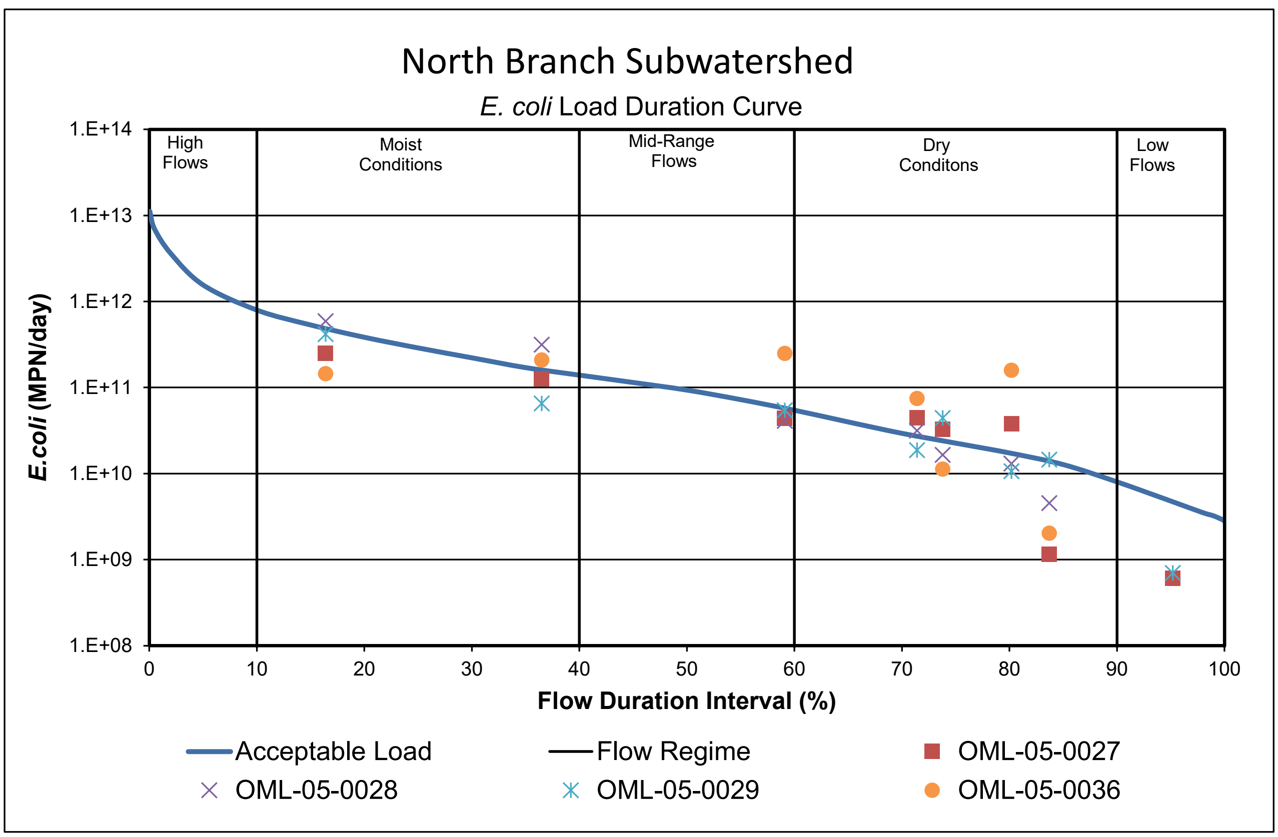


Figure 55: North Branch E. coli Load Duration Curve

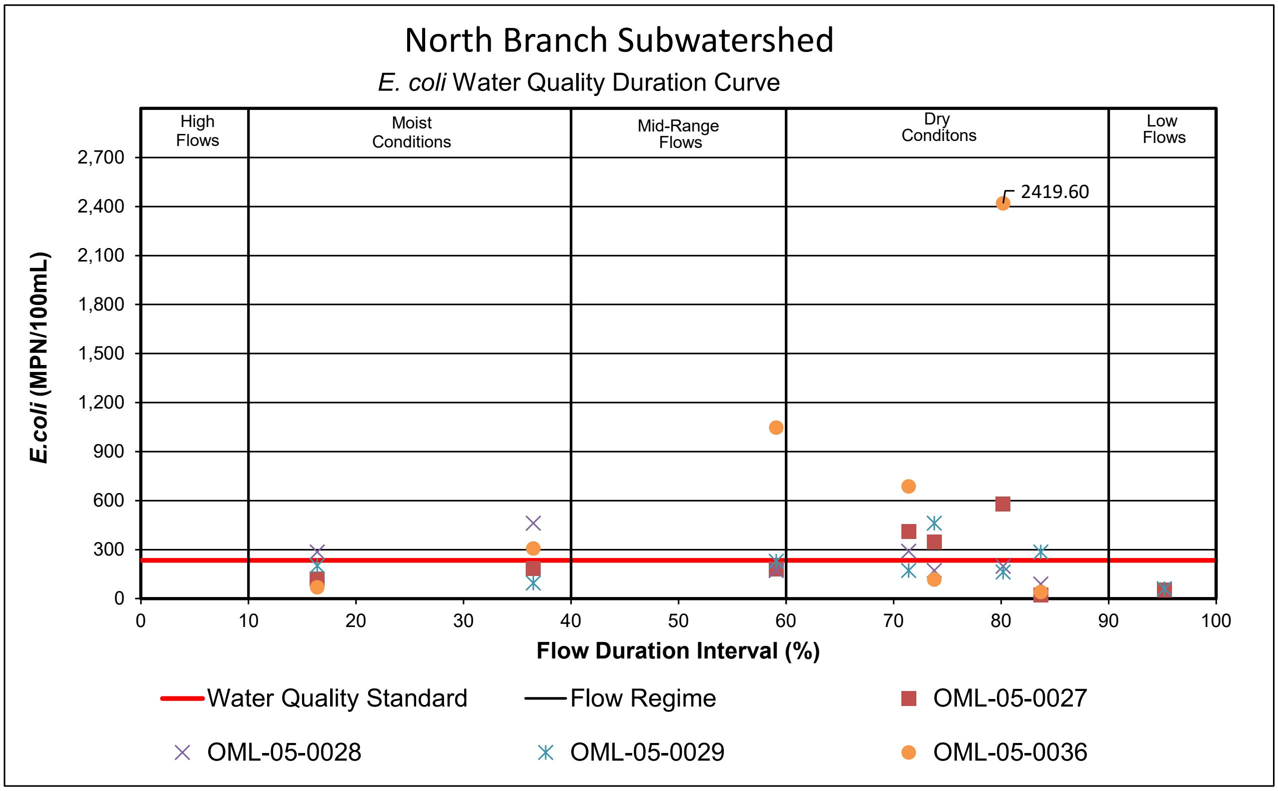


Figure 56: North Branch E. coli Water Qualiy Duration Curve

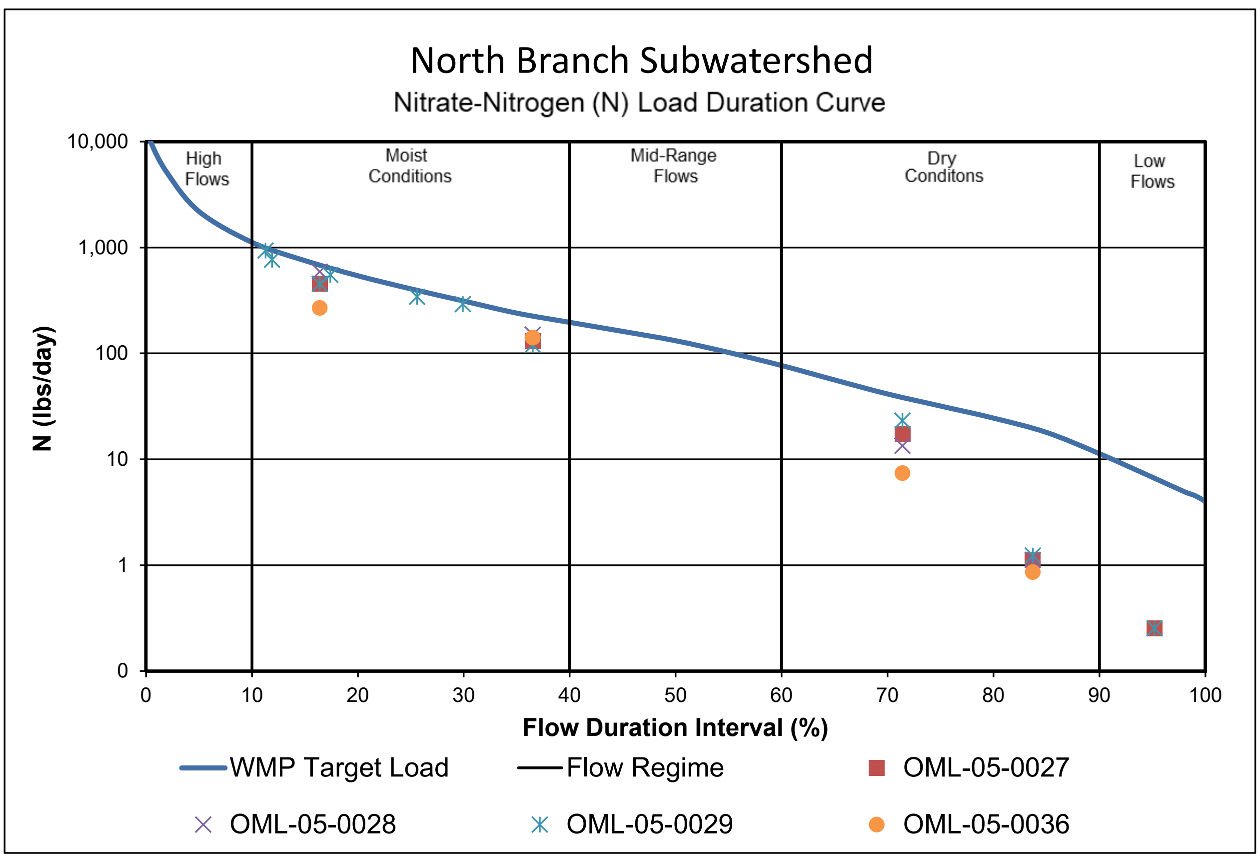


Figure 57: North Branch Nitrate Nitrogen Load Duration Curve

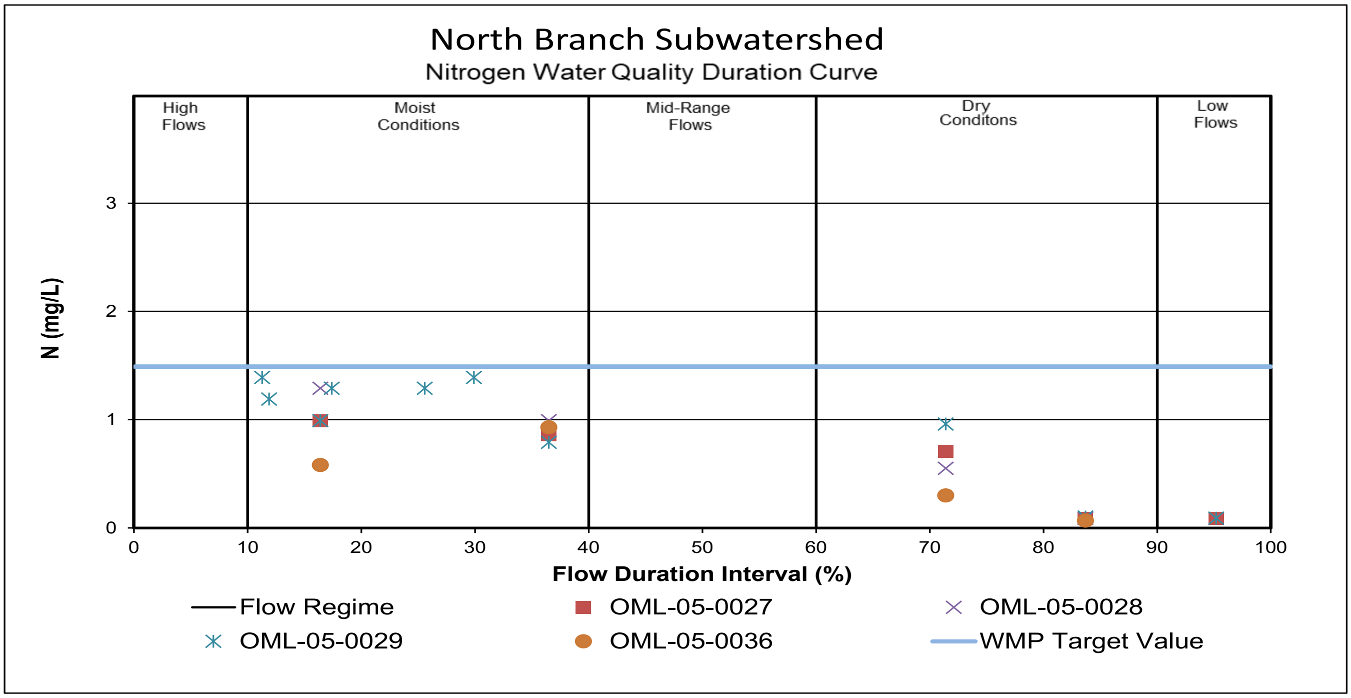


Figure 58: North Branch Nitrogen Water Quality Duration Curve

Table 40: Summary of North Branch Subwatershed Characteristics

North Branch (050902030504)					
Drainage Area	42.11 square miles				
Surface Area	23.31 square miles				
TMDL Sample Site	OML-05-0027, OML-05-0028, OML-05-0029, OML-05-0036				
Listed Segments	INV0354_03, INV0354_04, INV0354_T1002, INV0354_T1013				
Listed Impairments [TMDL(s)]	*E. coli* [*E. coli*], Impaired Biotic Communities [N/A], Dissolved Oxygen [N/A]				
Land Use	Agricultural Land: 36% Forested Land: 45% Developed Land: 4% Open Water: 1% Pasture/Hay: 14% Grassland/Shrubs: 0% Wetland: 0%				
NPDES Facilities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. Coli* Allocations (MPN/day)					
Allocation Category **Duration Interval (%)**	**High Flows 5%**	**Moist Conditions 25%**	**Mid-Range Flows 50%**	**Dry Conditions 75%**	**Low Flows 95%**
LA	7.333E+11	1.352E+11	4.312E+10	9.709E+09	1.321E+09
WLA (Total)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MOS (10%)	8.627E+10	1.591E+10	5.073E+09	1.142E+09	1.554E+08
Future Growth (5%)	4.313E+10	7.953E+09	2.537E+09	5.711E+08	7.772E+07
Upstream Drainage Input (Headwaters Ripley Creek)	**6.978E+11**	**1.303E+11**	**4.292E+10**	**1.121E+10**	**3.255E+09**
TMDL = LA+WLA+MOS	**1.560E+12**	**2.894E+11**	**9.365E+10**	**2.264E+10**	**4.809E+09**

North Branch Subwatershed Windshield Survey Results (69 sites)	
Finding	**# Present**
Contaminated Runoff into Streams from livestock	30
Livestock Access to Streams	30
Excess Nutrients Entering Stream from livestock	30
Streambank Erosion	0
Gully Erosion	0
Sediment Entering Stream	30
Overgrazed Pasture	32
Conventional Tillage being used	37
Flooding	0
Lack of Riparian Buffers	0
Total	**199**

Table 41: Windshield Survey Results of North Branch Subwatershed

The North Branch windshield survey completed in April 2021 show issues affecting this subwatershed include many sites allowing livestock access to the stream, and contaminated runoff from feeding areas to enter into the streams. There were also many areas of overgrazed pasture and conventional tillage which may also add to sediment and nutrient load.

Walnut Creek 050902030505

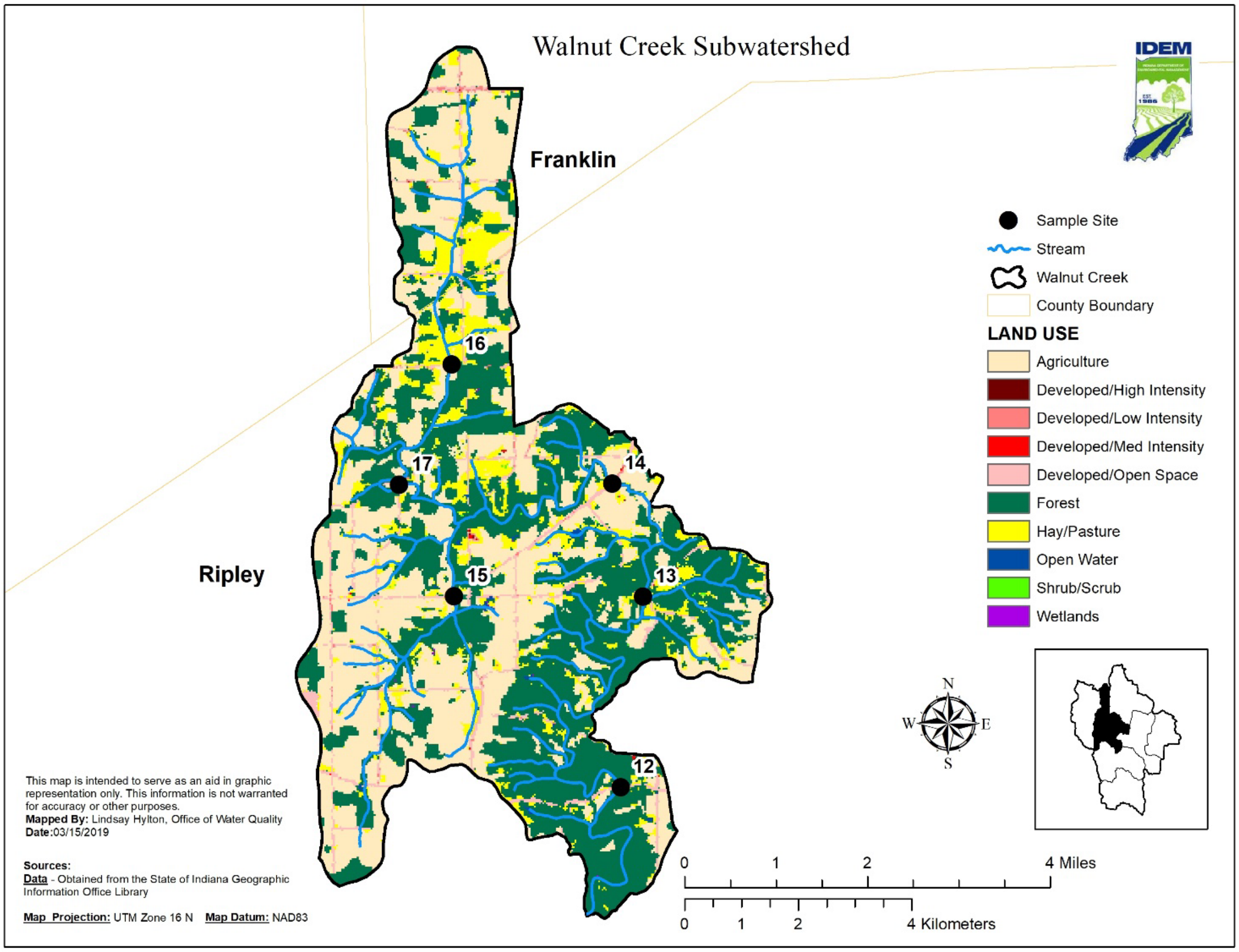


Figure 59: Sampling Stations and landuse in the Walnut Creek Subwatershed

The Walnut Creek subwatershed drains approximately 117 square miles, with an actual land area of approximately 23 square miles. The land use is primarily forest (44%) and agriculture (40%), followed by hay/pasture land (11%). There are no NPDES permitted facilities in the subwatershed. The entire subwatershed is rural, indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, the entire Laughery Creek watershed is very limited. Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. While the landscape in the area is relatively hilly, 40 percent of the subwatershed has been converted to agricultural production and use. In parts of the subwatershed there are little to no remaining riparian buffers left along the banks, due to agricultural practices. The subwatershed does contain significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes.

Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential areas for wetland restoration or high functioning two-stage ditch

implementation. With a land use of 11 percent pasture land, a heavy presence of pasture animals in not expected. There are no permitted CFOs in the watershed.

There are six monitoring sites located in this subwatershed, OML-05-0030 (12) and OML-05-0031 (13) on Laughery Creek, OML-05-0032 (16) on Walnut Fork, OML060-0005 (15) on a tributary of Laughery Creek, and OML060-0006 (17) and OML060-0007 (14) on Laughery Creek. In 2018-2019 this watershed was sampled 57 times between the six sites, resulting in four sites failing the WQS for *E.coli*. These stream reaches will be placed on the 2022 303(d) List of Impaired Waters. The *E. coli* geomean for site 12 was 98.72 MPN with 2/9 samples in exceedance of the single sample max. Site 13 had a geomean of 609.13 with 7/9 samples in exceedance of the single sample max. Site 16 had a geomean of 347.53 with 6/8 samples in exceedance of the single sample max. Site 15 had a geomean of 373.98, with 5/8 samples in exceedance of the single sample max. Site 17 had a geomean of 116.0, with 3/9 samples in exceedance of the single sample max. And site 14 had a geomean of 529.4, with 7/9 samples in exceedance of the single sample max. The geomeans from all six sites were taken on the same day for five consecutive weeks. High *E. coli* levels are reflective of high animal concentration, land application of waste, wildlife, and leaking and failing septic systems.

The fish community IBI score for site 12 was 54 (excellent) and the QHEI was 75 (good). The macro community mIBI score was 38 (fair) and the QHEI was 61 (good). The fish community IBI score for site 13 was 48 (good) and the QHEI was 53 (good). The macro community mIBI score was 32 (poor) and the QHEI was 57 (good). The fish community IBI score for site 16 was 40 (fair) and the QHEI was 55 (good). The macro community mIBI score was 40 (fair) and the QHEI was 32 (poor). The fish community IBI score for site 15 was 40 (fair) and the QHEI was 63 (good). The macro community mIBI score was 40 (fair) and the QHEI was 46 (poor). The fish community IBI score for site 17 was 38 (fair) and the QHEI was 73 (good). The macro community mIBI score was 40 (fair) and the QHEI was 53 (good). The fish community IBI score for site 14 was 50 (good) and the QHEI was 66 (good). The macro community mIBI score was 40 (fair) and the QHEI was 48 (poor). Site 13 will be impaired for IBC.

TSS concentrations ranged from 3.5 mg/L to 34 mg/L across 39 sampling events at all six sites, and exceeded the target value once, at site 12. Additionally, dissolved oxygen was found below water quality standards on two sampling events on Walnut Fork (site 16). The target value for TSS was exceeded once (34 mg/L) during moist conditions in Walnut Creek. Given the characteristics of the stream segments impaired for IBC and DO, it is believed that a combination of TSS inputs and low physical flows in the system are likely contributing to these impairments. A TSS TMDL was developed to address nonpoint source contributions during periods of higher flow for IBC and DO.

There are approximately 57 miles of stream in the subwatershed. Based on IDEM data collected in 2018-2019, impairments include 35 stream miles impaired for *E. coli,* 6.68 miles impaired for biological communities, and 8.71 miles impaired for dissolved oxygen listed on the 2022 303(d) List of Impaired Waters. Therefore, *E. coli* TMDLs were developed to address all *E. coli* impairments and TSS TMDLs were developed to address both the DO and biotic community impairments in the subwatershed.

Load duration and water quality duration curves were developed for the subwatershed and are summarized below in Figure . Evaluating these graphs, with consideration of the watershed characteristics, allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* and TSS concentrations. Elevated levels of pollutants during rain events can indicate contributions due to run-off. The load duration curves for these sites show the streams are susceptible to high loads of *E. coli* and TSS from run-off events. However, the streams are also consistently in violation of water quality standards/targets for *E. coli* during drier conditions on the chart.

Based on these graphs and the lack of permitted facilities, it can be concluded that the majority of sources of *E. coli* and TSS in this watershed are nonpoint sources that could include small animal operations, wildlife, pasture animals with direct access to streams, illegal straight-pipes, leaking and failing septic systems, streambank erosion, and agricultural practices.

WALNUT CREEK WATERSHED			
Pollutant	**Range**	**Average**	**Samples Exceeding WMP Target**
E.Coli	29 cfu - 1120 cfu	362 cfu	30 of 52 Samples (58%)
Phosphorus	.03mg/L - .18mg/L	0.0764 mg/L	14 of 39 Samples (36%)
TSS	3.5 mg/L - 30 mg/L	11.1 mg/L	3 of 39 Samples (7.7%)
Nitrogen	0.10 mg/L - 11 mg/L	2.17 mg/L	23 of 39 Samples (59%)

Table 42: Summary of Walnut Creek Water Quality Testing Data

The table above shows the streams are susceptible to high loads of *E. coli* and high nutrient levels. The majority of sources of *E. coli* in this watershed are nonpoint sources that could include small animal operations, wildlife, pasture animals with direct access to streams, illegal straight-pipes, leaking and failing septic systems, streambank erosion, and agricultural practices. Conventional Tillage on cropland could also be responsible for the elevated levels of nutrients within the streams.

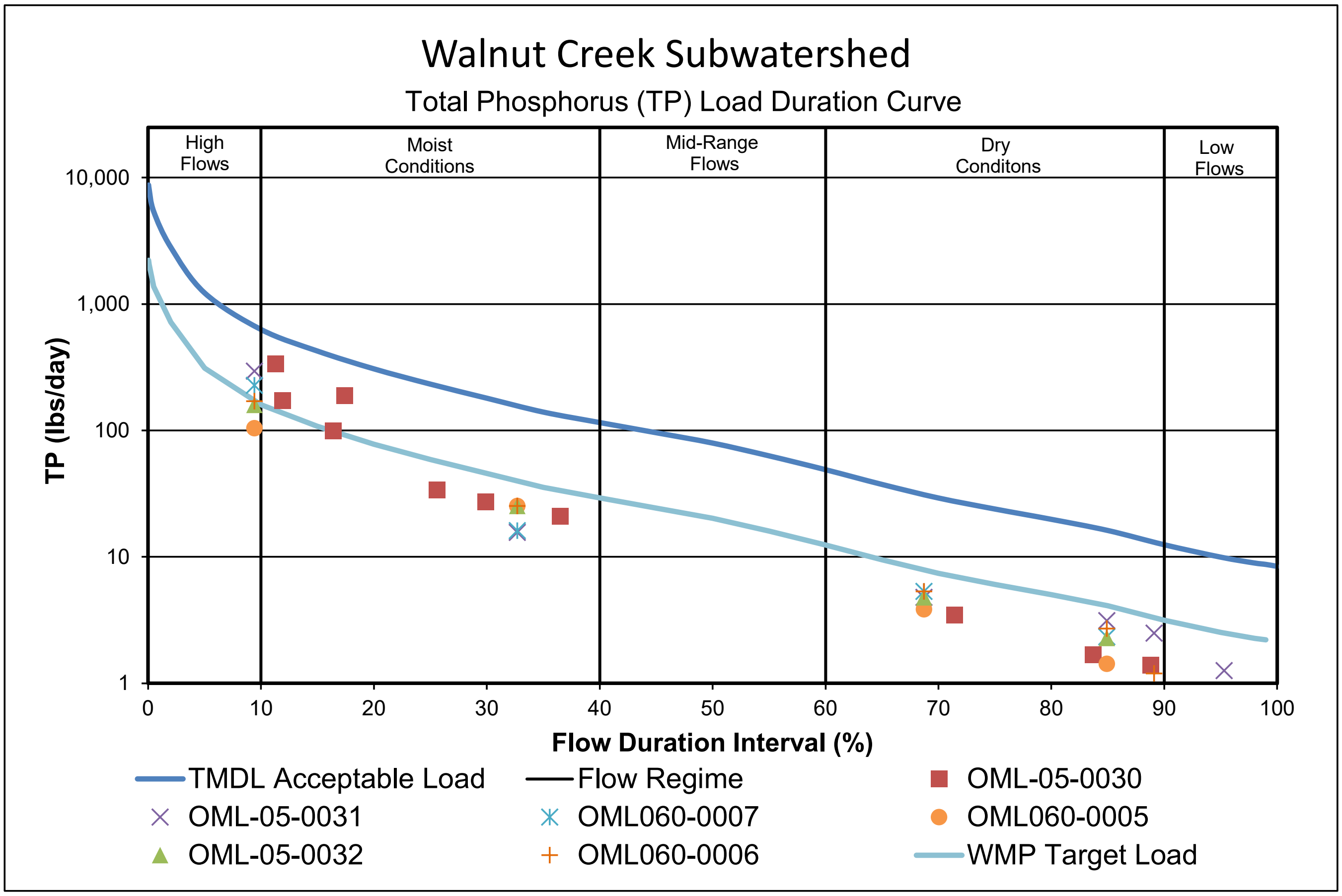


Figure 60: Walnut Creek Total Phosphorus Load Duration Curve

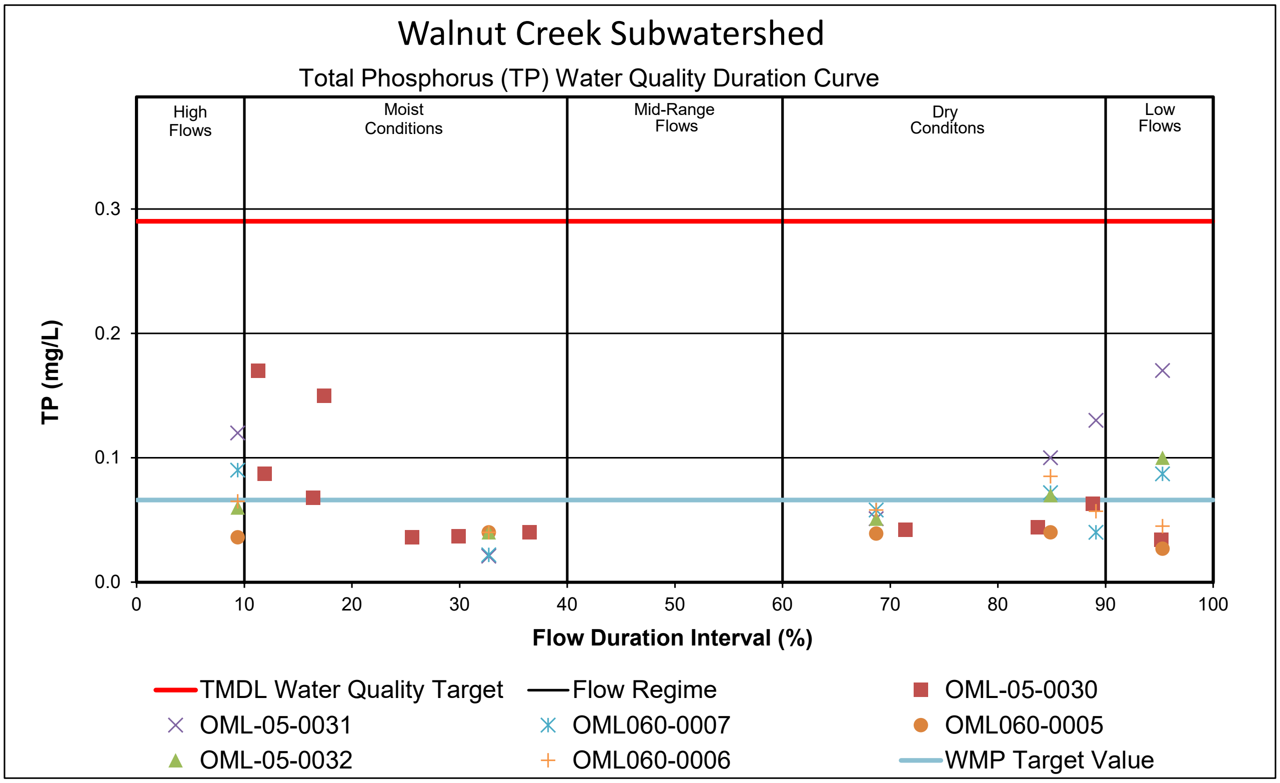


Figure 61: Walnut Creek Total Phosphorus Water Quality Duration Curve

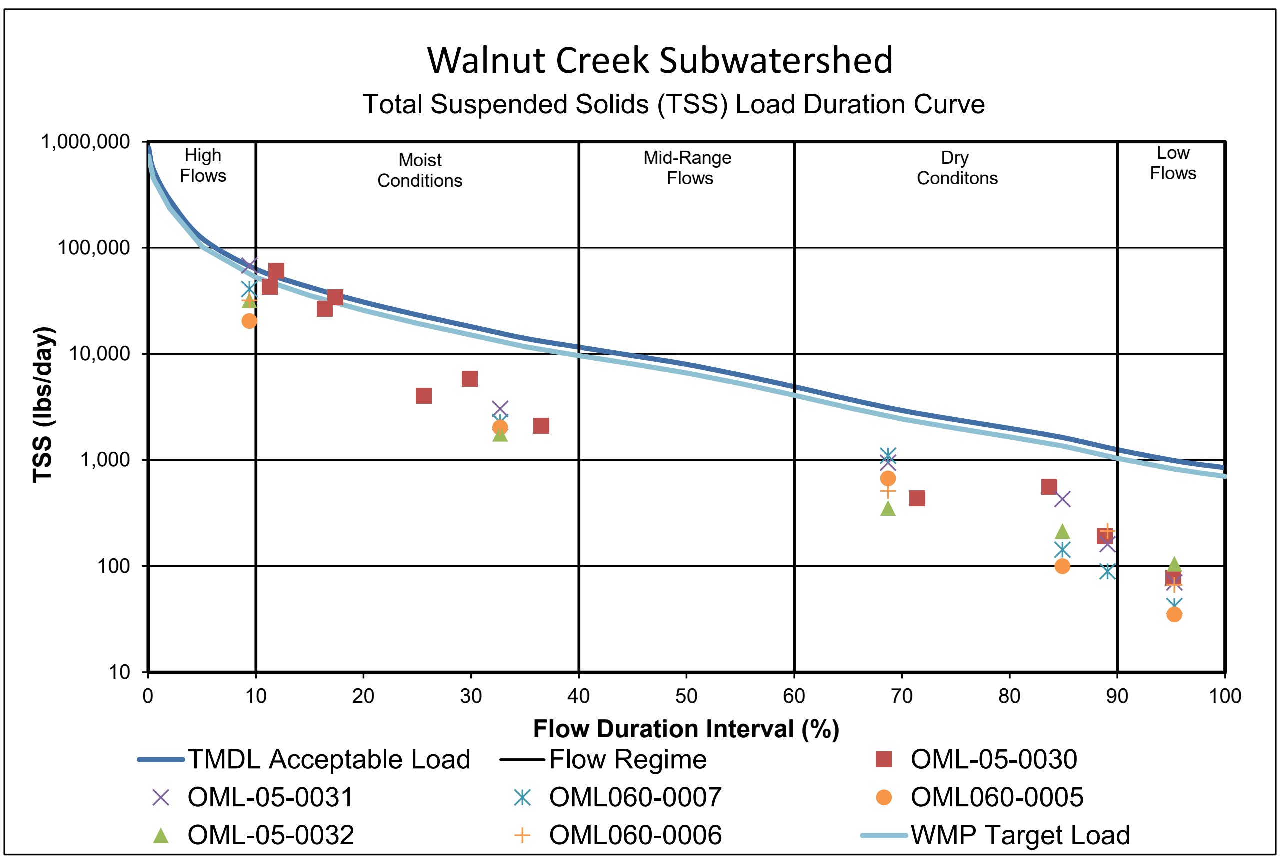


Figure 62: Walnut Creek TSS Load Duration Curve

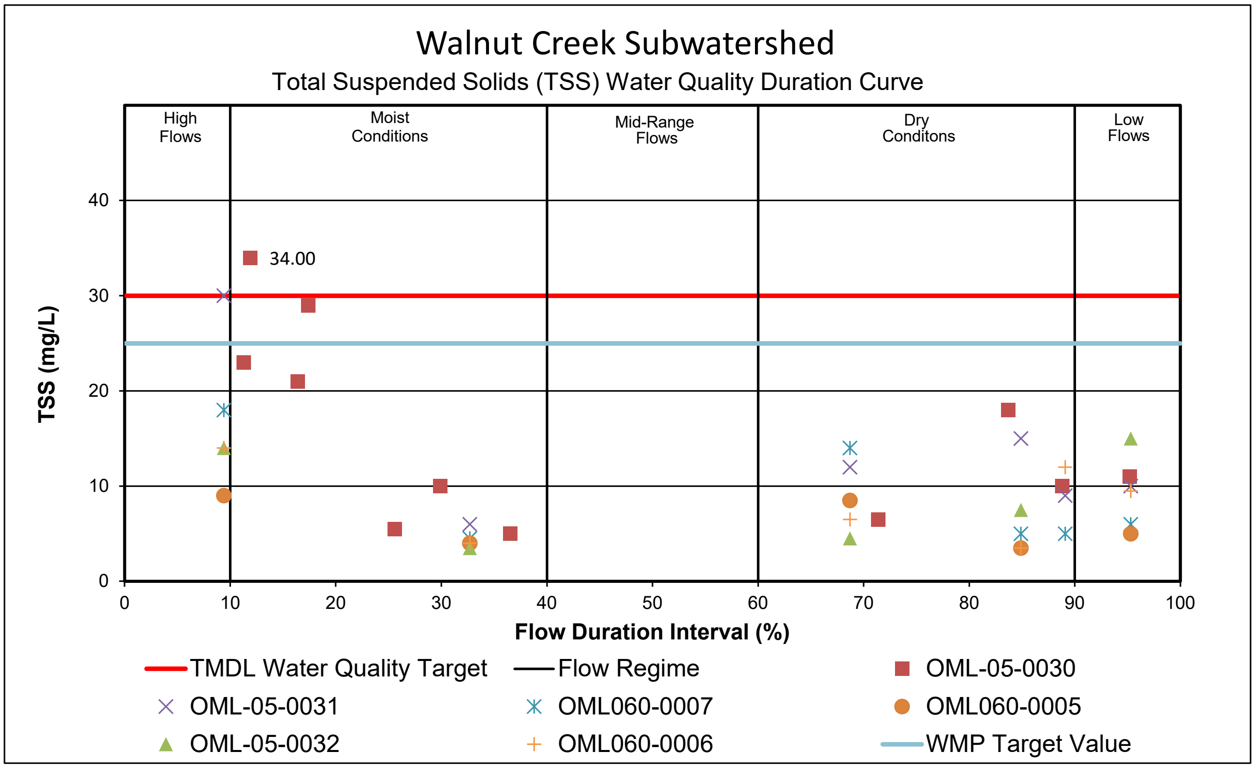


Figure 63: Walnut Creek TSS Water Quality Duration Curve

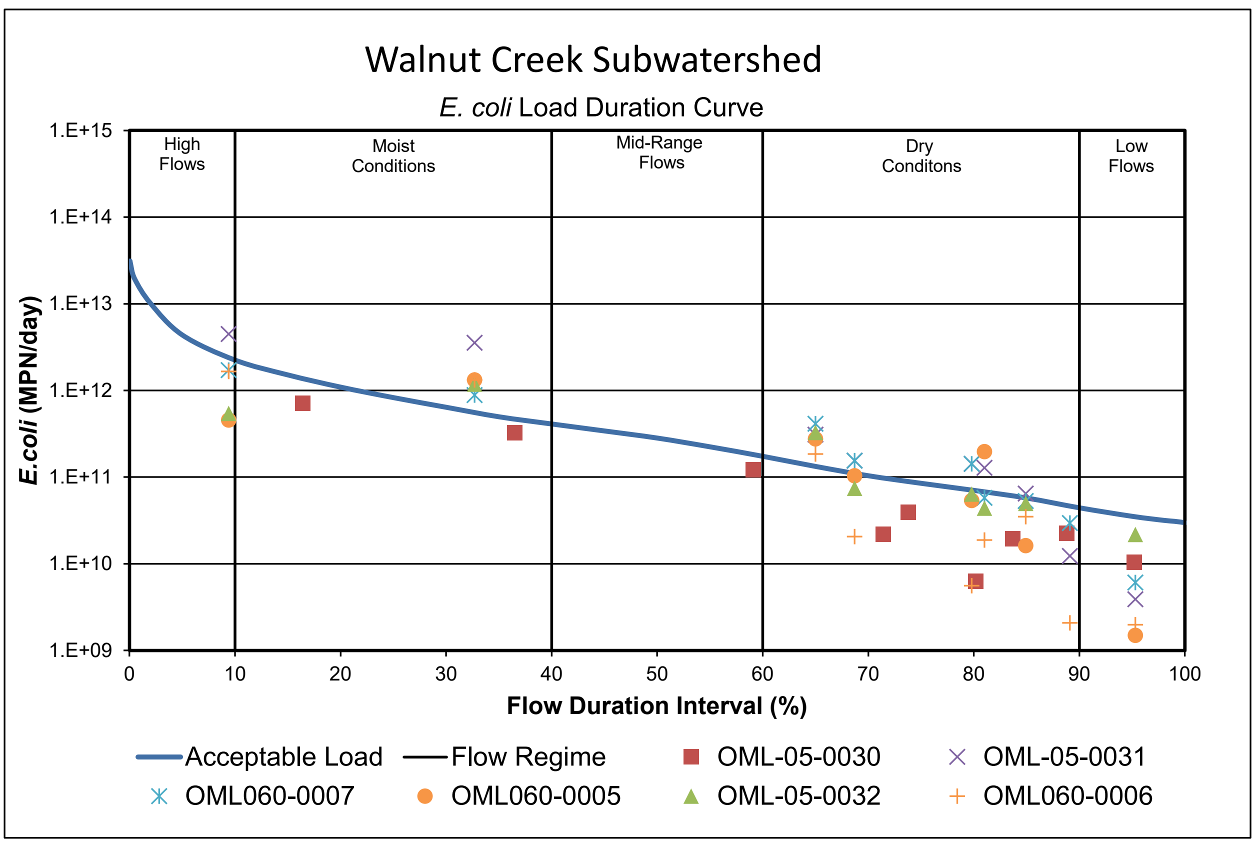


Figure 64: E. coli Load Duration Curve

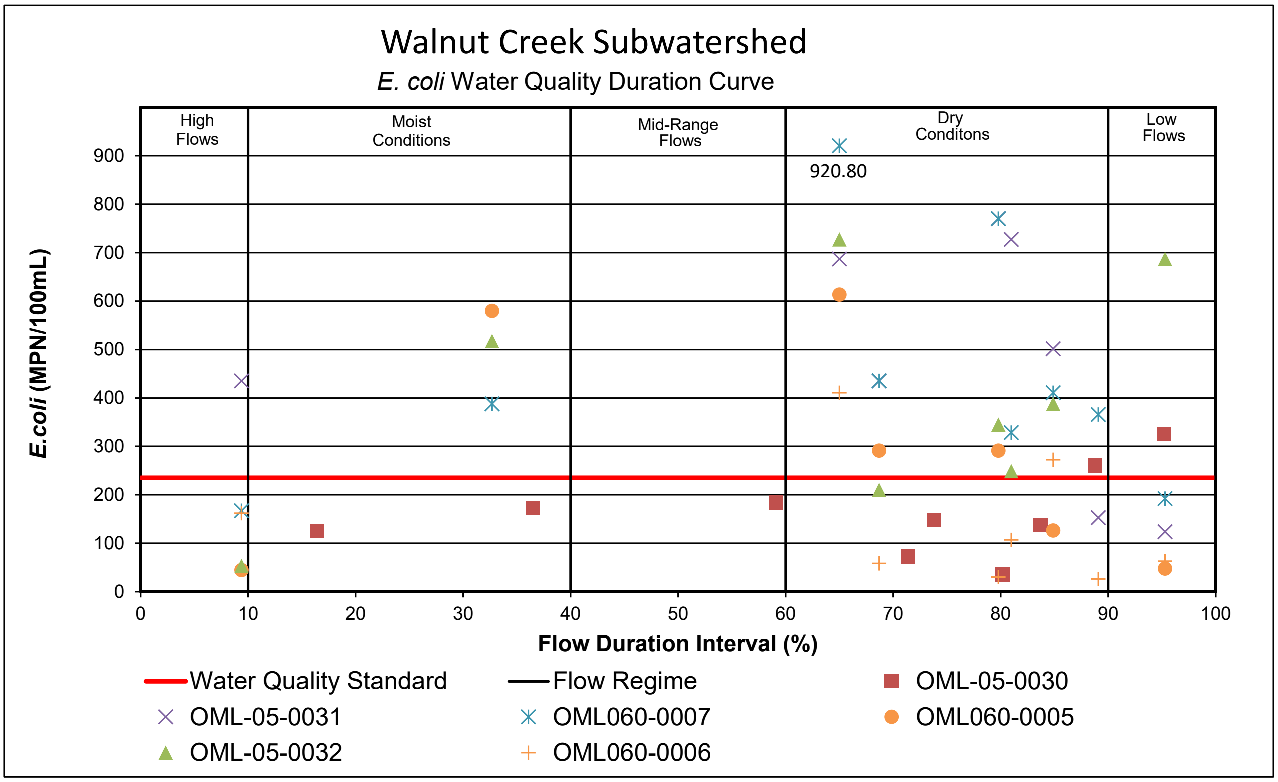


Figure 65: Walnut Creek E. coli Water Quality Duration Curve

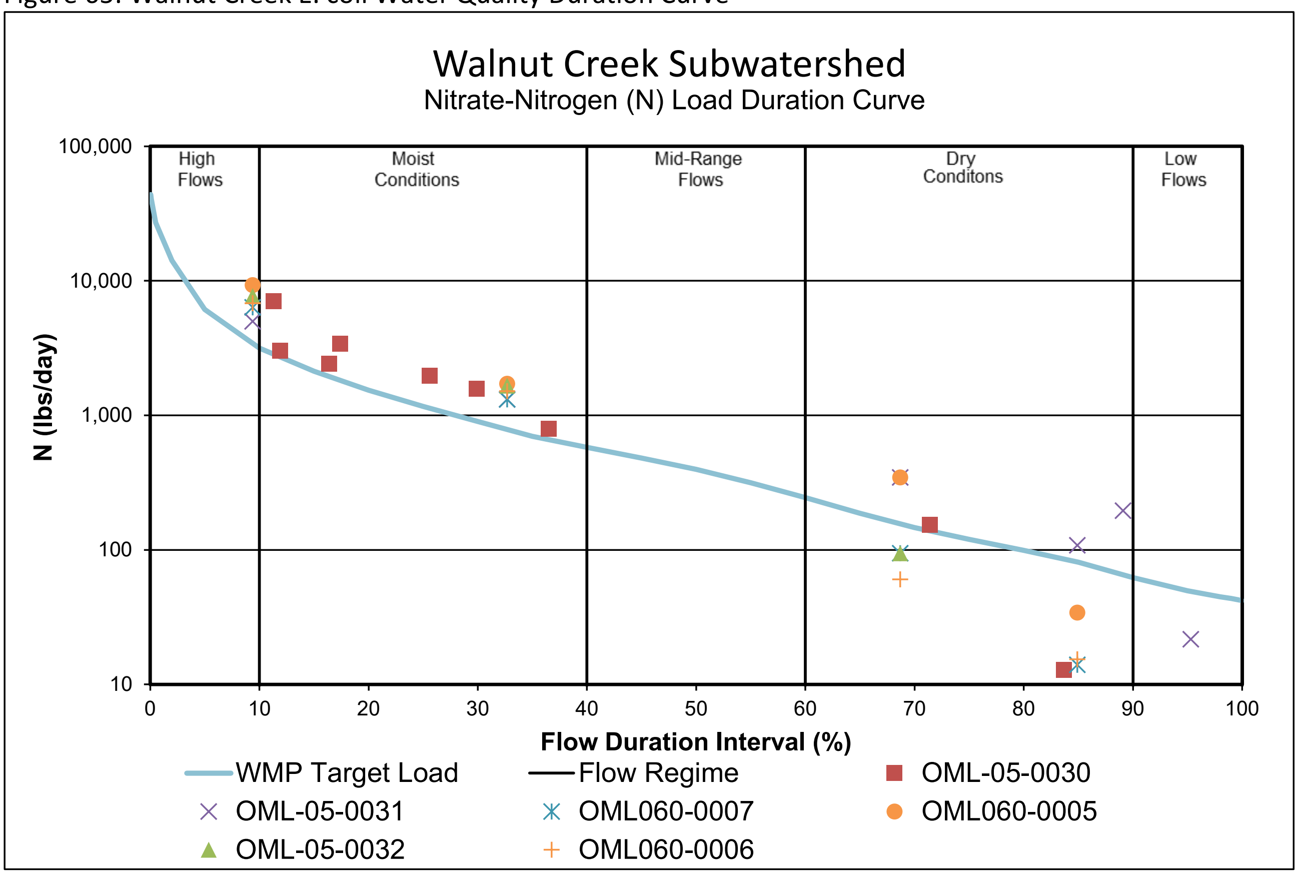


Figure 66: Walnut Creek Nitrate Nitrogen Load Duration Curve

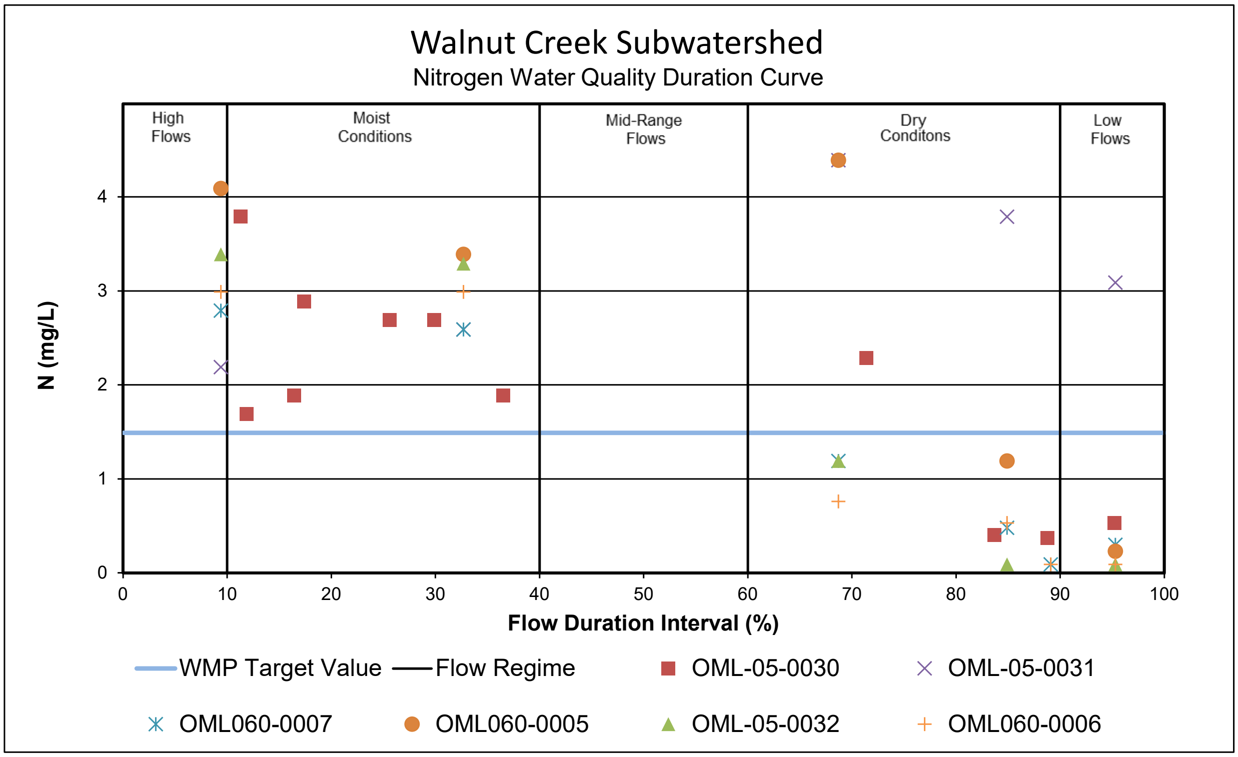


Figure 67: Walnut Creek Nitrogen Water Quality Duration Curve

Table 43: Summary of Walnut Creek Subwatershed Characteristics

Walnut Creek (050902030505)					
Drainage Area	117.21 square miles				
Surface Area	23.18 square miles				
TMDL Sample Site	0ML-05-0030, OML-05-0031, OML-05-0032, OML060-0005, OML060-0006, OML060-0007				
Listed Segments	INV0355_03, INV0355_06, INV0355_T1001, INV0355_T1002				
Listed Impairments [TMDL(s)]	*E. coli* [*E. coli*], Impaired Biotic Communities [TSS], Dissolved Oxygen [TSS]				
Land Use	Agricultural Land: 40% Forested Land: 44% Developed Land: 5% Open Water: 0% Pasture/Hay: 11% Grassland/Shrubs: 0% Wetland: 0%				
NPDES Facilities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. Coli* Allocations (MPN/day)					
Allocation Category Duration Interval (%)	**High Flows** 5%	**Moist Conditions** 25%	**Mid-Range Flows** 50%	**Dry Conditions** 75%	**Low Flows** 95%
LA	6.86E+11	9.12E+10	4.29E+10	9.66E+09	1.31E+09
WLA (Total)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MOS (10%)	8.07E+10	1.07E+10	5.05E+09	1.14E+09	1.55E+08
Future Growth (5%)	4.04E+10	5.37E+09	2.52E+09	5.68E+08	7.73E+07
Upstream Drainage Input (Tub, Little Laughery, North Branch)	**3.56E+12**	**7.20E+11**	**2.32E+11**	**7.36E+10**	**3.38E+10**
TMDL = LA+WLA+MOS	**4.37E+12**	**8.27E+11**	**2.83E+11**	**8.50E+10**	**3.54E+10**

TMDL Total Suspended Solids Allocations (lbs/day)					
Allocation Category Duration Interval (%)	**High Flows** 5%	**Moist Conditions** 25%	**Mid-Range Flows** 50%	**Dry Conditions** 75%	**Low Flows** 95%
LA	19,310.84	2,566.73	1,207.28	271.82	36.99
WLA	0.00	0.00	0.00	0.00	0.00
MOS (10%)	2,271.86	301.97	142.03	31.98	4.35
Future Growth (5%)	1,135.93	150.98	71.02	15.99	2.18
Upstream Drainage Input (Tub, Little Laughery, North Branch)	**100,130.45**	**20,264.34**	**6,533.83**	**2,071.85**	**951.77**
TMDL = LA+WLA+MOS	**122,849.08**	**23,284.02**	**7,954.16**	**2,391.64**	**995.29**

Walnut Creek Subwatershed Windshield Survey Results (76 sites)	
Finding	**# Present**
Contaminated Runoff into Streams from livestock	18
Livestock Access to Streams	18
Excess Nutrients Entering Stream from livestock	18
Streambank Erosion	1
Gully Erosion	1
Sediment Entering Stream	1
Overgrazed Pasture	25
Conventional Tillage being used	47
Flooding	1
Lack of Riparian Buffers	13
Total	**133**

Table 44: Windshield Survey Results of Walnut Creek Subwatershed

The Walnut Creek windshield survey completed in April 2021 show issues affecting this subwatershed include many sites allowing livestock access to the stream, and contaminated runoff from feeding areas to enter into the streams. There was also many areas of overgrazed pasture and conventional tillage which may also add to sediment and nutrient load.

Jericho Creek 050902030506

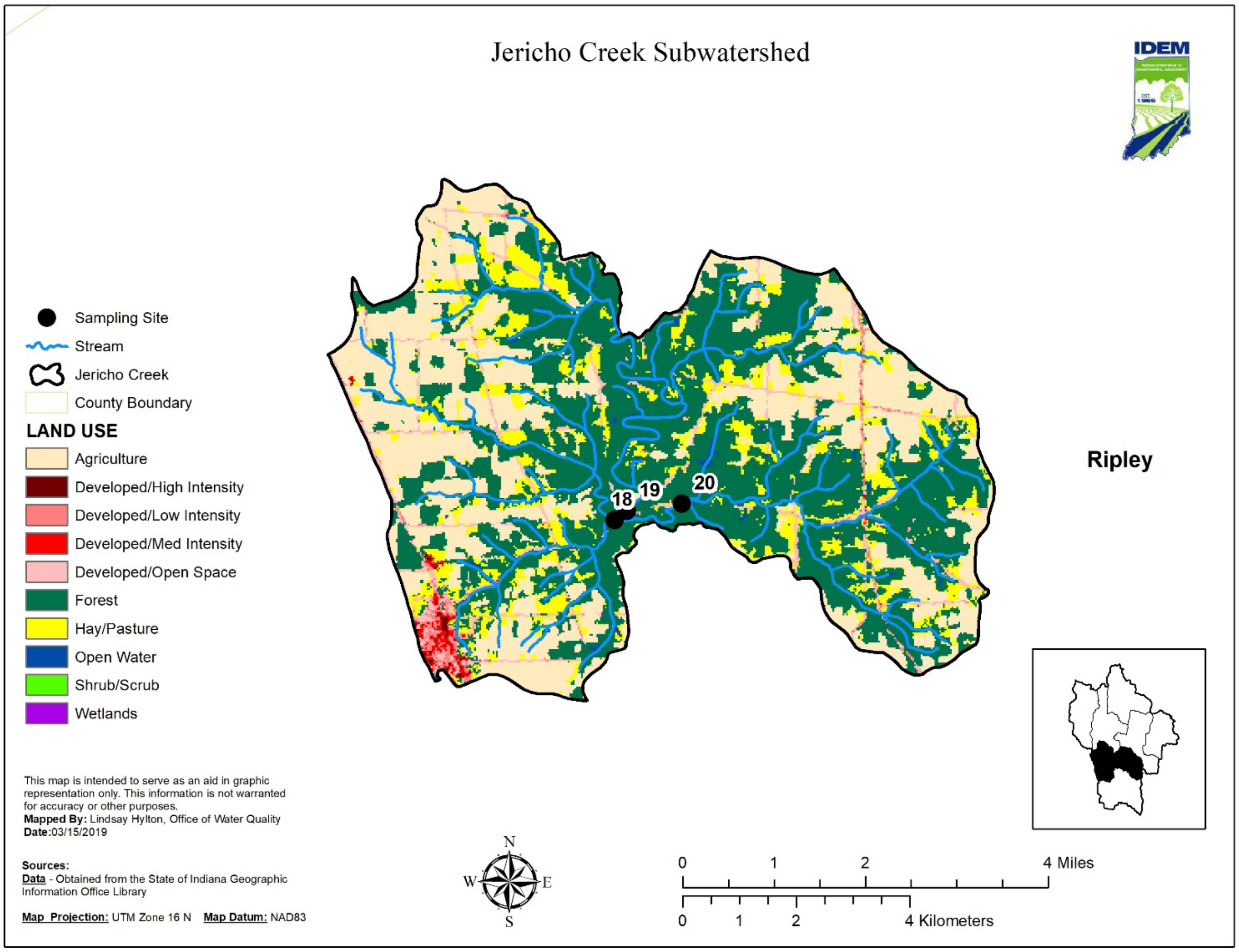


Figure 68: Sampling Stations and land use in the Jericho Creek Subwatershed

The Jericho Creek subwatershed drains approximately 142 square miles with a land area covering approximately 25 square miles. The land use is primarily forest (49%) followed by agriculture (33%) and hay/pasture land (12%). There is one NPDES permitted facility located within the subwatershed, the Town of Osgood WWTP (IN0021695). Over half of the subwatershed is rural indicating a portion of homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire Laughery Creek watershed is very limited. Maintenance and inspections of septic systems in the area are important to ensure proper function and capacity. While the landscape in the area is relatively hilly, 33 percent of the subwatershed has been converted to agricultural production and use. In parts of the subwatershed there are little to no remaining riparian buffers left along the banks, due to agricultural practices. The subwatershed does contain significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes.

Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential areas for wetland restoration or high functioning two-stage ditch

implementation. With a land use of less than 15 percent pasture land, a heavy presence of pasture animals in not expected. There are no permitted CFOs in the subwatershed.

There are three monitoring sites located in this subwatershed, OML-05-0033 (18) on Plum Creek, OML-05-0034 (20) on Castators Creek, and OML-05-0042 (19) on Laughery Creek. In 2018-2019 this watershed was sampled 31 times between the three sites, resulting in two of the sites failing the WQS for *E.coli*. These stream reaches will be placed on the 2022 303(d) List of Impaired Waters. The *E. coli* geomean for site 18 was 407.87 MPN with 4/9 samples in exceedance of the single sample max. Site 20 had a geomean of 187.77 with 2/9 samples in exceedance of the single sample max. Site 19 had a geomean of 26.66, the lowest of any site, with no sites exceeding the single sample max. The geomeans from all three sites were taken on the same day for five consecutive weeks. High *E. coli* levels are reflective of high animal concentration, land application of waste, leaking and failing septic systems, and wildlife.

The fish community IBI score for site 18 was 46 (good) and the QHEI was 67 (good). The macro community mIBI score was 36 (fair) and the QHEI was 70 (good). The fish community IBI score for site 20 was 42 (fair) and the QHEI was 64 (good). The macro community mIBI score was 36 (fair) and the QHEI was 59 (good). The fish community IBI score for site 19 was 54 (excellent) and the QHEI was 64 (good). The macro community mIBI score was 36 (fair) and the QHEI was 54 (good). Therefore, no sites failed for IBC.

TSS concentrations ranged from 2 mg/L to 37 mg/L across 22 sampling events within the watershed and exceeded the target value only once. Given that the target for TSS was violated in the subwatershed, a TSS TMDL was developed to address the existing biological communities impairment within the watershed.

There are approximately 61 miles of stream in the subwatershed. Based on IDEM data collected in 2018-2019, impairments include 5 stream miles impaired for *E. coli* and 6 miles impaired for biological communities listed on the 2022 303(d) List of Impaired Waters. Therefore, *E. coli* TMDLs were developed to address all *E. coli* impairments and TSS TMDLs were developed to address the biotic community impairments in the subwatershed.

Load duration and water quality duration curves were developed for the subwatershed and are summarized in the graphs below. Data from IDEM's fixed station site on Laughery Creek (OML060-0004) is included on the load duration and water quality duration curves, as well as in the subwatershed water quality summary in Table 45. Evaluating these graphs, with consideration of the watershed characteristics, allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* and TSS concentrations. Elevated levels of pollutants during rain events can indicate contributions due to run-off. The load duration curves for these sites show the streams are susceptible to higher loads of TSS from run-off events. However, the streams are more consistently in violation of water quality standards/targets for *E. coli* during drier conditions on the chart.

Based on these graphs, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that are not rainfall-dependent, including small animal operations, wildlife, pasture animals with direct access to streams, illegal straight-pipes, and leaking and failing septic systems. High levels of TSS in this subwatershed are likely due to streambank erosion and agricultural practices, tied to run-off events.

JERICHO CREEK WATERSHED			
Pollutant	**Range**	**Average**	**Samples Exceeding WMP Target**
E.Coli	5.2 cfu - 1119.9 cfu	172 cfu	6 of 26 Samples (23%)
Phosphorus	.03mg/L - .38mg/L	0.095	17 of 33 Samples (52%)
TSS	2.0 mg/L - 223mg/L	20.12	3 of 33 Samples (9%)
Nitrogen	0.10 mg/L - 24 mg/L	3.36	19 of 29 Samples (66%)

Table 45: Summary of Jericho Creek Water Quality Testing Data

As shown in the table above, issues with Jericho Creek Subwatershed include high levels of E. Coli and a high number of samples with excessive nutrient (nitrogen and phosphorus) levels. There is one NPDES permitted facility located within the subwatershed, the Town of Osgood WWTP (IN0021695). Sources of *E. coli* in this watershed may be nonpoint sources that are not rainfall-dependent, including small animal operations, wildlife, pasture animals with direct access to streams, illegal straight-pipes, and leaking and failing septic systems. There is approximately 33% of this watershed used for agricultural use with many cropland acres using conventional tillage, this may contribute to elevated nutrient runoff into streams.

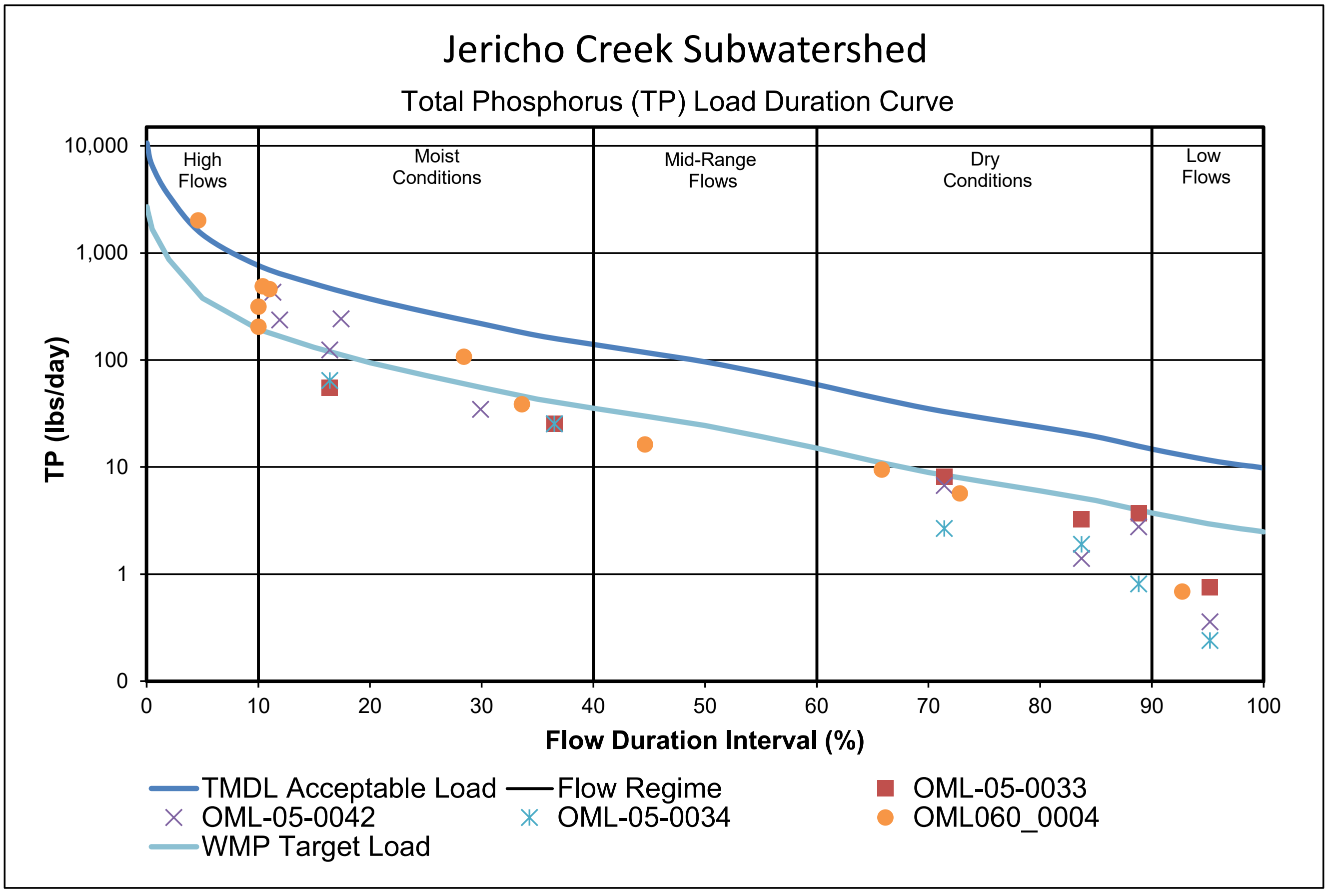


Figure 69: Jericho Creek Total Phosphorus Load Duration Curve

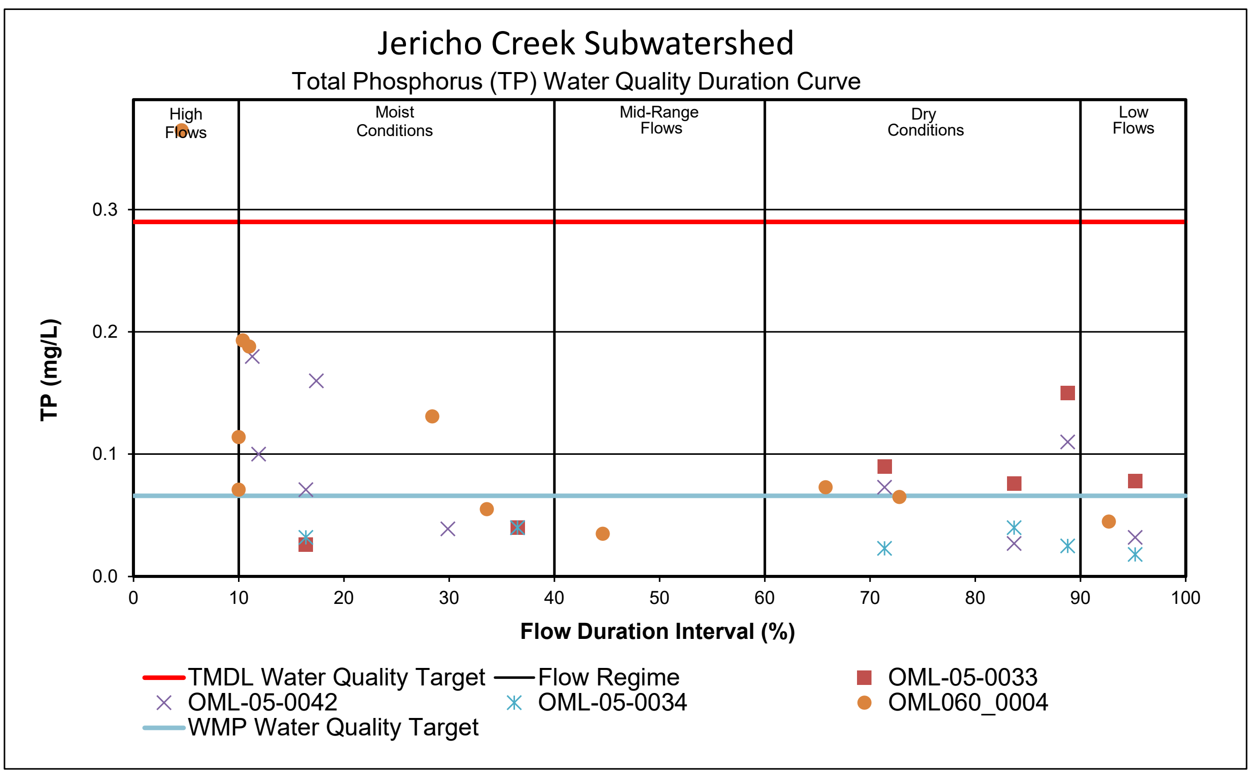


Figure 70: Jericho Creek Total Phosphorus Water Quality Duration Curve

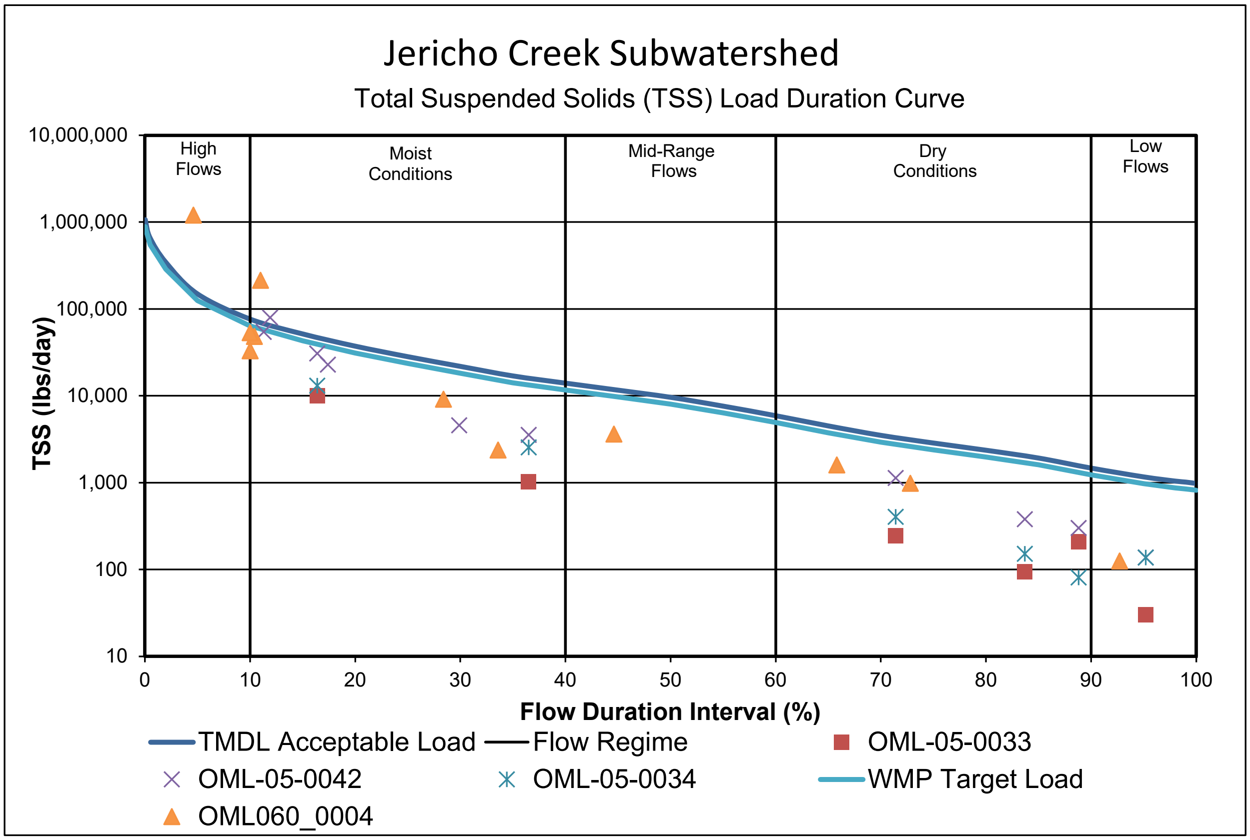


Figure 71: Jericho Creek TSS Load Duration Curve

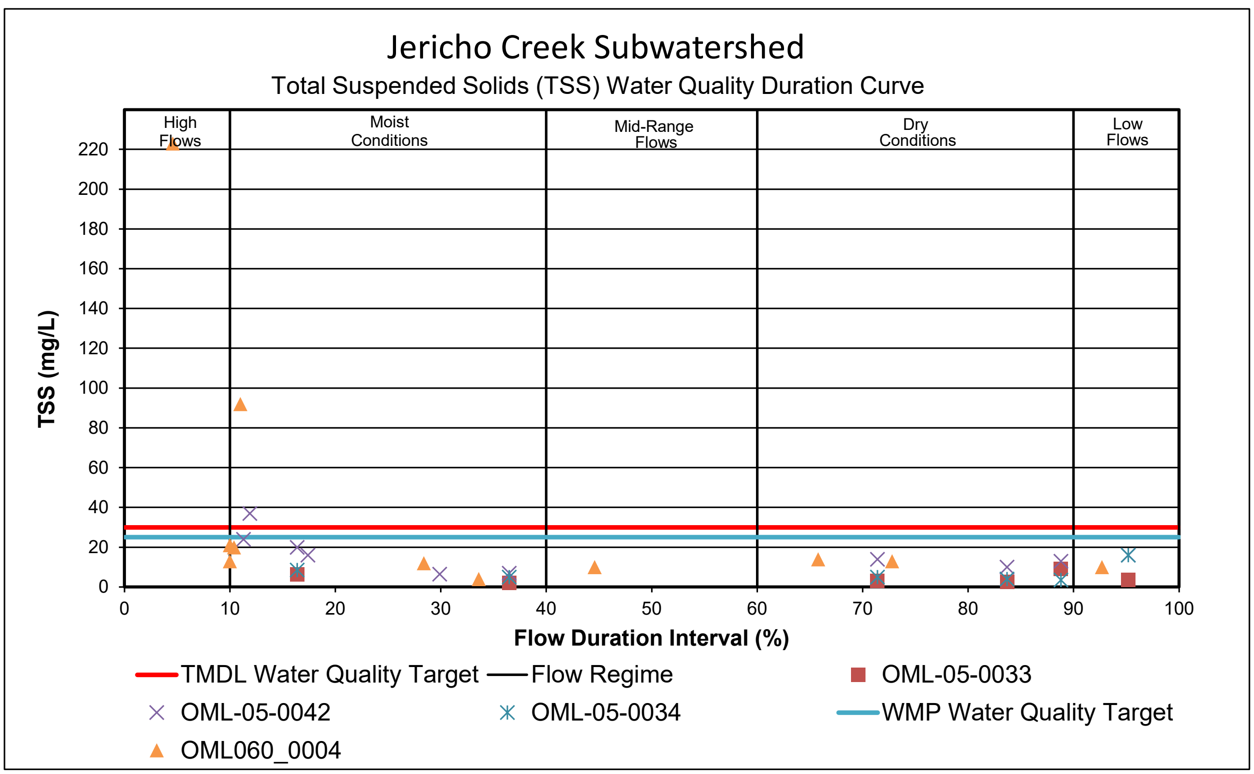


Figure 72: Jericho Creek TSS Water Quality Duration Curve

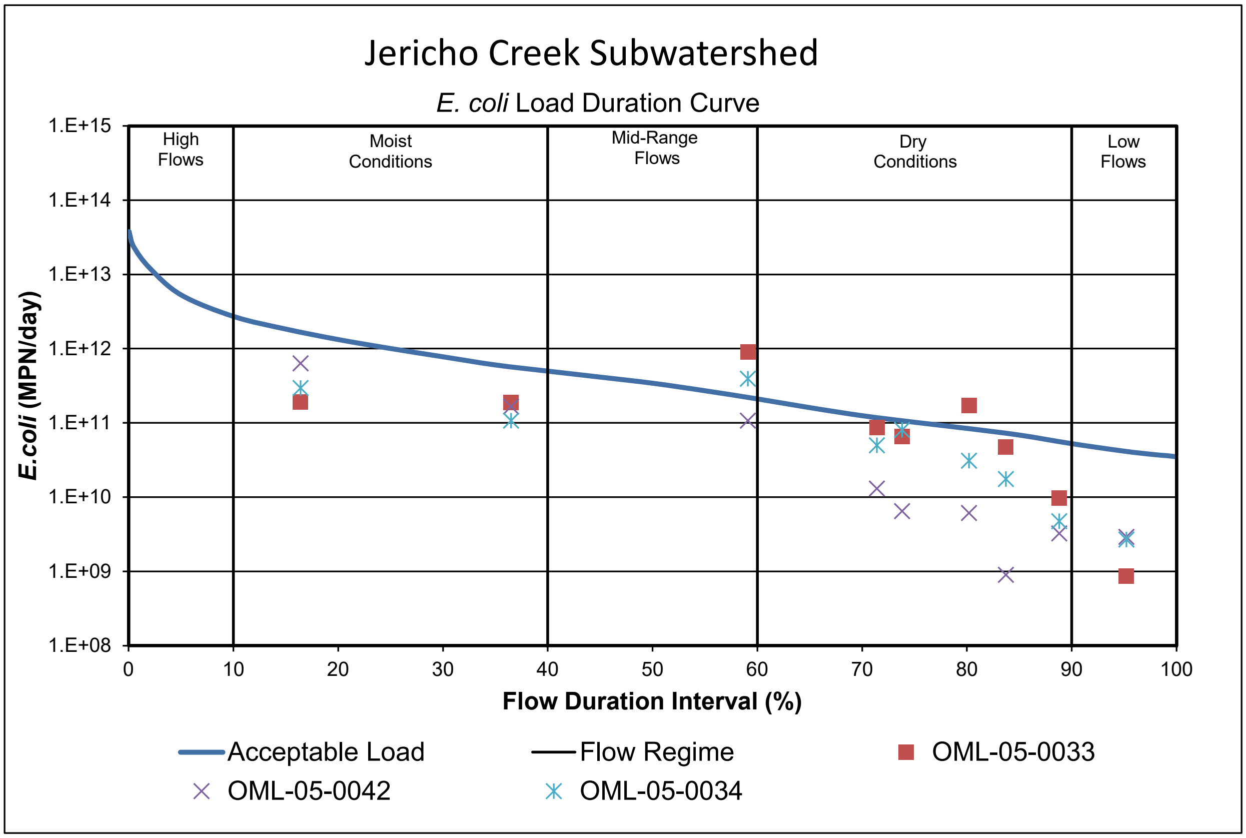


Figure 73: Jericho Creek E. coli Load Duration Curve

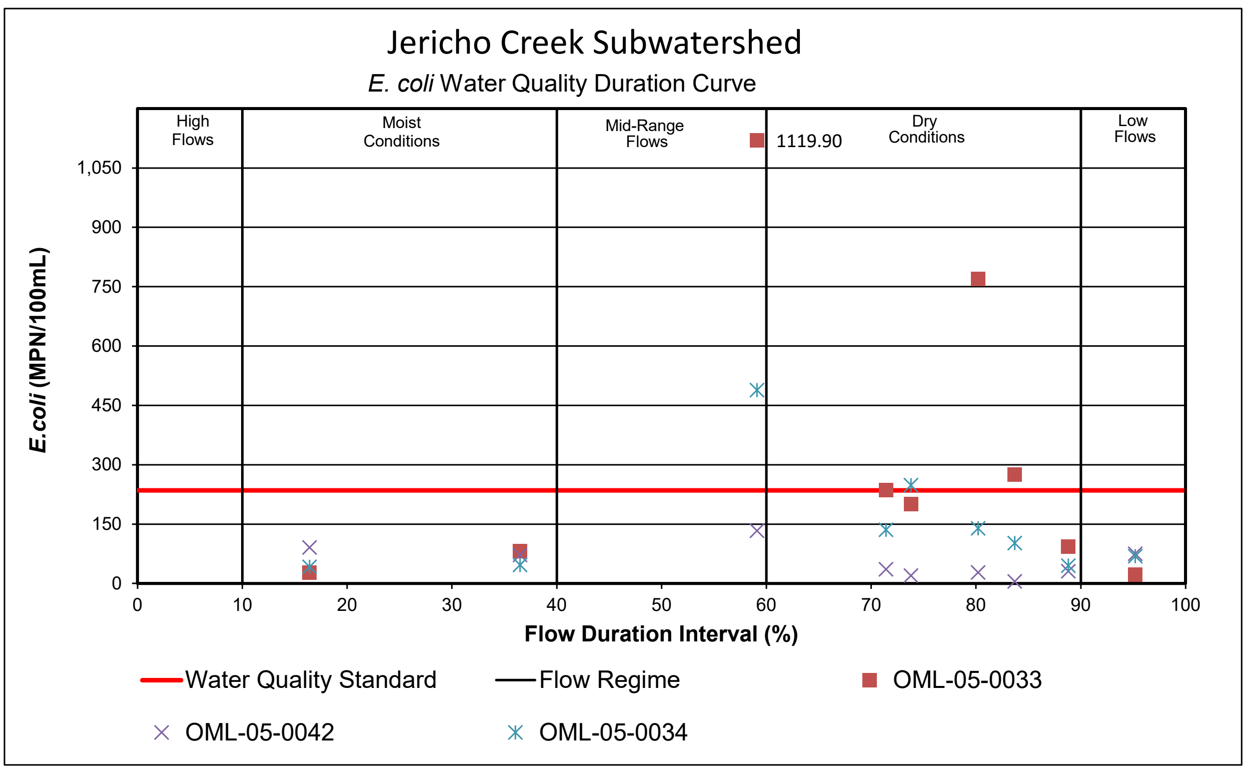


Figure 74: Jericho Creek E. coli Water Quality Duration Curve

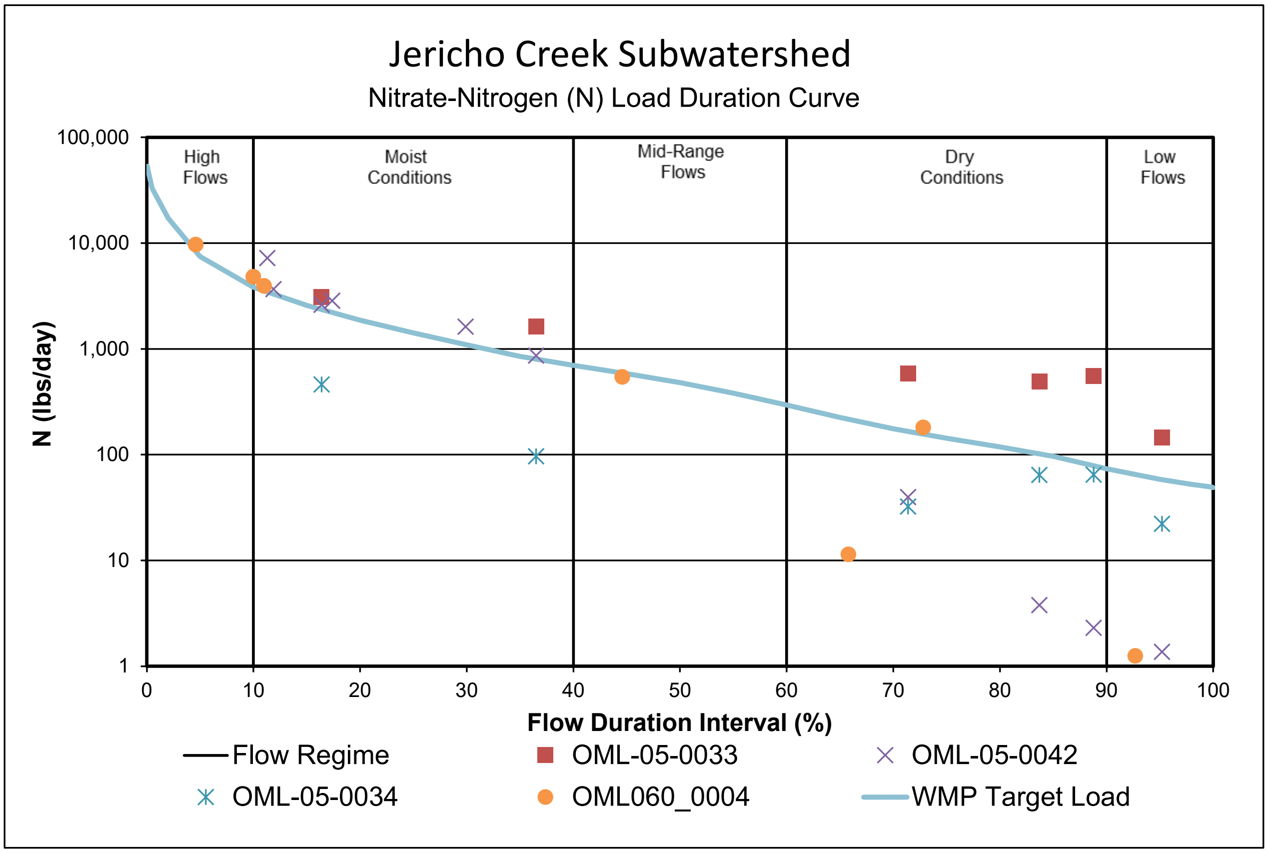


Figure 75: Jericho Creek Nitrate-Nitrogen Load Duration Curve

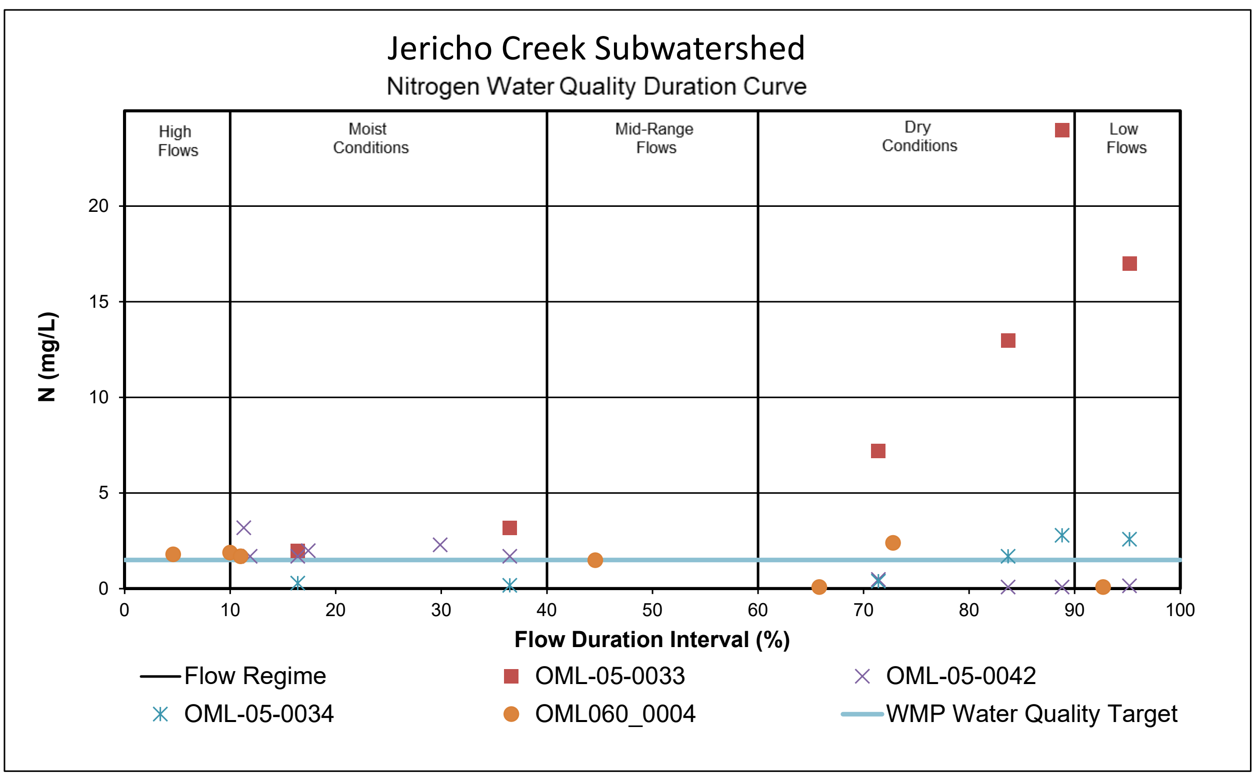


Figure 76: Jericho Creek Nitrogen Water Quality Duration Curve

Jericho Creek (050902030506)					
Drainage Area	142.45 square miles				
Surface Area	25.24 square miles				
TMDL Sample Site	OML-05-0033, OML-05-0034, OML-05-0042				
Listed Segments	INV0356_03, INV0356_05, INV0356_T1006, INV0356_T1013				
Listed Impairments [TMDL(s)]	*E. coli* [*E. coli*], Impaired Biotic Communities [TSS]				
Land Use	Agricultural Land: 33% Forested Land: 49% Developed Land: 5% Open Water: 1% Pasture/Hay: 12% Grassland/Shrubs: 0% Wetland: 0%				
NPDES Facilities	Town of Osgood WWTP (IN0021695)				
CAFOs	NA				
CFOs	NA				
TMDL *E. Coli* Allocations (MPN/day)					
Allocation Category Duration Interval (%)	**High Flows 5%**	**Moist Conditions 25%**	**Mid-Range Flows 50%**	**Dry Conditions 75%**	**Low Flows 95%**
LA	7.933E+11	1.457E+11	4.602E+10	9.846E+09	7.636E+08
WLA (Total)	4.447E+09	4.447E+09	4.447E+09	4.447E+09	4.447E+09
MOS (10%)	9.385E+10	1.767E+10	5.938E+09	1.682E+09	6.130E+08
Future Growth (5%)	4.693E+10	8.834E+09	2.969E+09	8.408E+08	3.065E+08
Upstream Drainage Input (Walnut Creek)	**4.365E+12**	**8.274E+11**	**2.826E+11**	**8.498E+10**	**3.537E+10**
TMDL = LA+WLA+MOS	**5.304E+12**	**1.004E+12**	**3.420E+11**	**1.018E+11**	**4.150E+10**
WLA (Individual)					
Town of Osgood WWTP	4.447E+09	4.447E+09	4.447E+09	4.447E+09	4.447E+09
TMDL Total Suspended Solids Allocations (lbs/day)					
Allocation Category	**High Flows 5%**	**Moist Conditions 25%**	**Mid-Range Flows 50%**	**Dry Conditions 75%**	**Low Flows 95%**
LA	22,325.25	4,101.15	1,295.23	277.08	21.49
WLA	125.39	125.20	125.15	125.15	125.15
MOS (10%)	2,641.25	497.22	167.10	47.32	17.25
Future Growth (5%)	1,320.63	248.61	83.55	23.66	8.63
Upstream Drainage Input (Walnut Creek)	**122,849.08**	**23,284.02**	**7,954.16**	**2,391.64**	**995.29**
TMDL = LA+WLA+MOS	**149,261.59**	**28,256.20**	**9,625.21**	**2,864.85**	**1,167.81**
WLA (Individual)					
Town of Osgood WWTP	125.15	125.15	125.15	125.15	125.15
Construction WLA	0.23	0.04	0.00	0.00	0.00

Table 46: Summary of Jericho Creek Subwatershed Characteristics

Jericho Creek Subwatershed Windshield Survey Results (58 sites)	
Finding	**# Present**
Contaminated Runoff into Streams from livestock	30
Livestock Access to Streams	30
Excess Nutrients Entering Stream from livestock	30
Streambank Erosion	0
Gully Erosion	0
Sediment Entering Stream	1
Overgrazed Pasture	31
Conventional Tillage being used	34
Flooding	0
Lack of Riparian Buffers	2
Total	**158**

Table 47: Windshield Survey Results of Jericho Creek Subwatershed

The Jericho Creek windshield survey completed in April 2021 show issues affecting this subwatershed include many sites allowing livestock access to the stream, and contaminated runoff from feeding areas to enter into the streams. There was also many areas of overgrazed pasture and conventional tillage which may also add to sediment and nutrient load.

Henderson Bend 050902030507

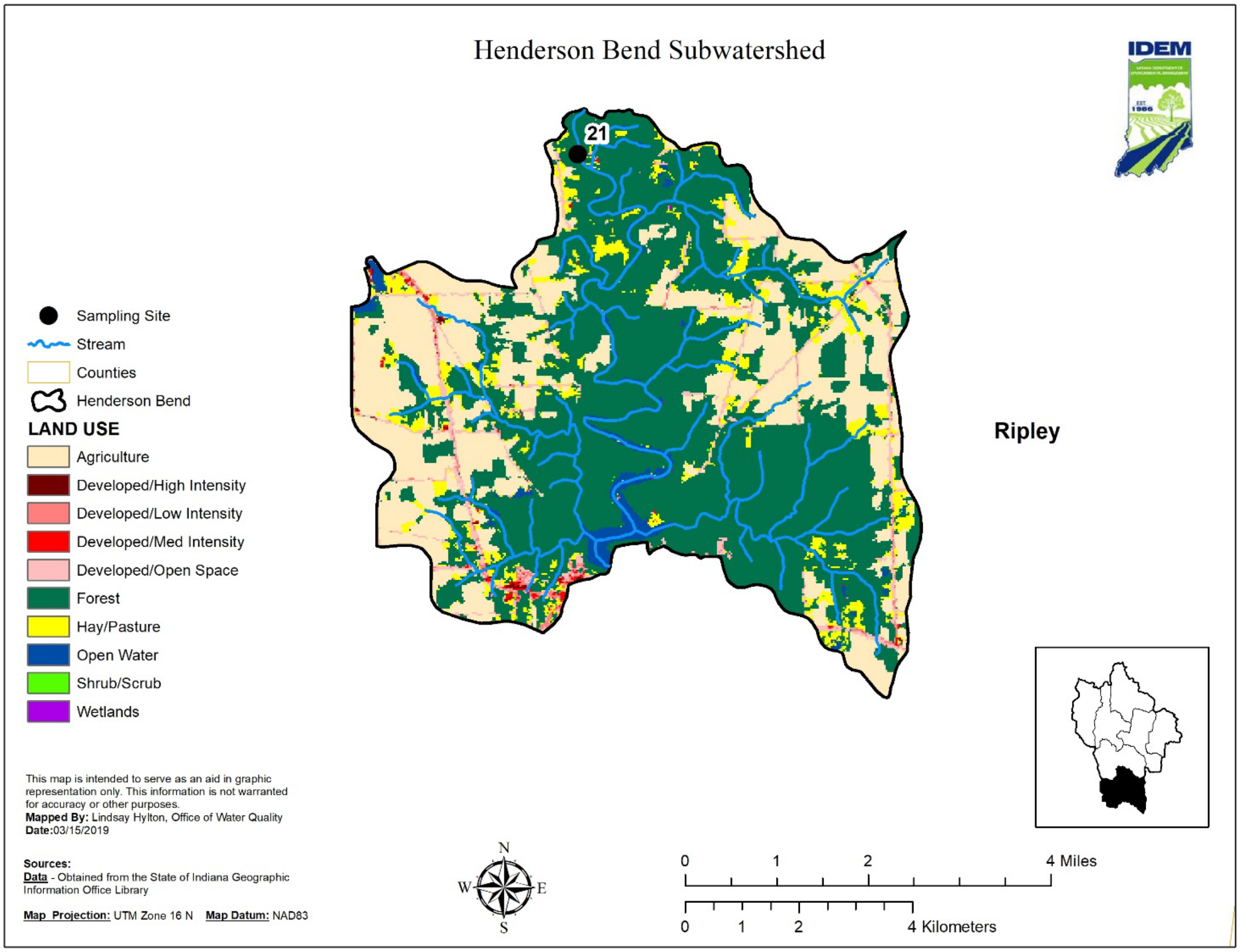


Figure 77: Sampling Stations and landuse in the Henderson Bend Subwatershed

At the pour point of the watershed, the Henderson Bend subwatershed drains approximately 167 square miles, with an actual land area of approximately 25 square miles. The land use is primarily forest (58%), followed by agriculture (28%), and contains Versailles State Park where Laughery Creek becomes Versailles Lake. There is one NPDES facility located within the subwatershed, Ohio Rod Products (INRM01052). The majority of the subwatershed is rural, indicating many homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is very limited. Maintenance and inspections of septic systems in the area are important to ensure proper function and capacity. While the landscape in the area is relatively hilly, 28 percent of the subwatershed has been converted to agricultural production and use. In parts of the subwatershed there are little to no remaining riparian buffers left along the banks, due to agricultural practices. The subwatershed does contain significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes.

Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential locations for wetland restoration or high functioning two-stage ditch implementation. With a land use of only seven percent pasture land, a heavy presence of pasture animals in not expected. There are no permitted CFOs in the watershed.

There is one site located in this subwatershed, OML-05-0012 (21), which is located on Laughery Creek. In 2018-2019 this watershed was sampled at this site 13 times, resulting in it passing the WQS for *E.coli*. The E. *coli* geomean for site 21 was 74.89 MPN with 1/9 samples in exceedance of the single sample max. The geomean from site 21 was taken on the same day for five consecutive weeks. The fish community IBI score for site 21 was 56 (excellent) and the QHEI was 75 (good). The macro community mIBI score was 34 (poor) and the QHEI was 54 (good). Due to the high IBI and QHEI scores, amongst other factors, it was decided based upon best professional judgement (BPJ) that the site would not fail for IBC based upon the mIBI score alone.

There are currently no known impairments within the subwatershed, therefore no segments are listed on the 303(d) List of Impaired Waters requiring the development of a TMDL. As no segments are listed as impaired, no TMDLs were developed for this subwatershed at this time.

HENDERSON WATERSHED			
Pollutant	**Range**	**Average**	**Samples Exceeding WMP Target**
E.Coli	43.1 cfu - 248.9 cfu	109	1 of 9 Samples (11%)
Phosphorus	.03mg/L - 0.21mg/L	0.083	4 of 10 Samples (40%)
TSS	4.5 mg/L - 35 mg/L	14.45	1 of 10 Samples (10%)
Nitrogen	0.63 mg/L - 4.8 mg/L	1.99	7 of 10 Samples (70%)

Table 48: Summary of Henderson Bend Water Quality Testing Data

As shown in the table above, issues with Henderson Subwatershed include a high number of samples with excessive nutrient (nitrogen and phosphorus) levels. There is approximately 28% of this watershed used for agricultural use with many cropland acres using conventional tillage, this may contribute to elevated nutrient runoff into streams.

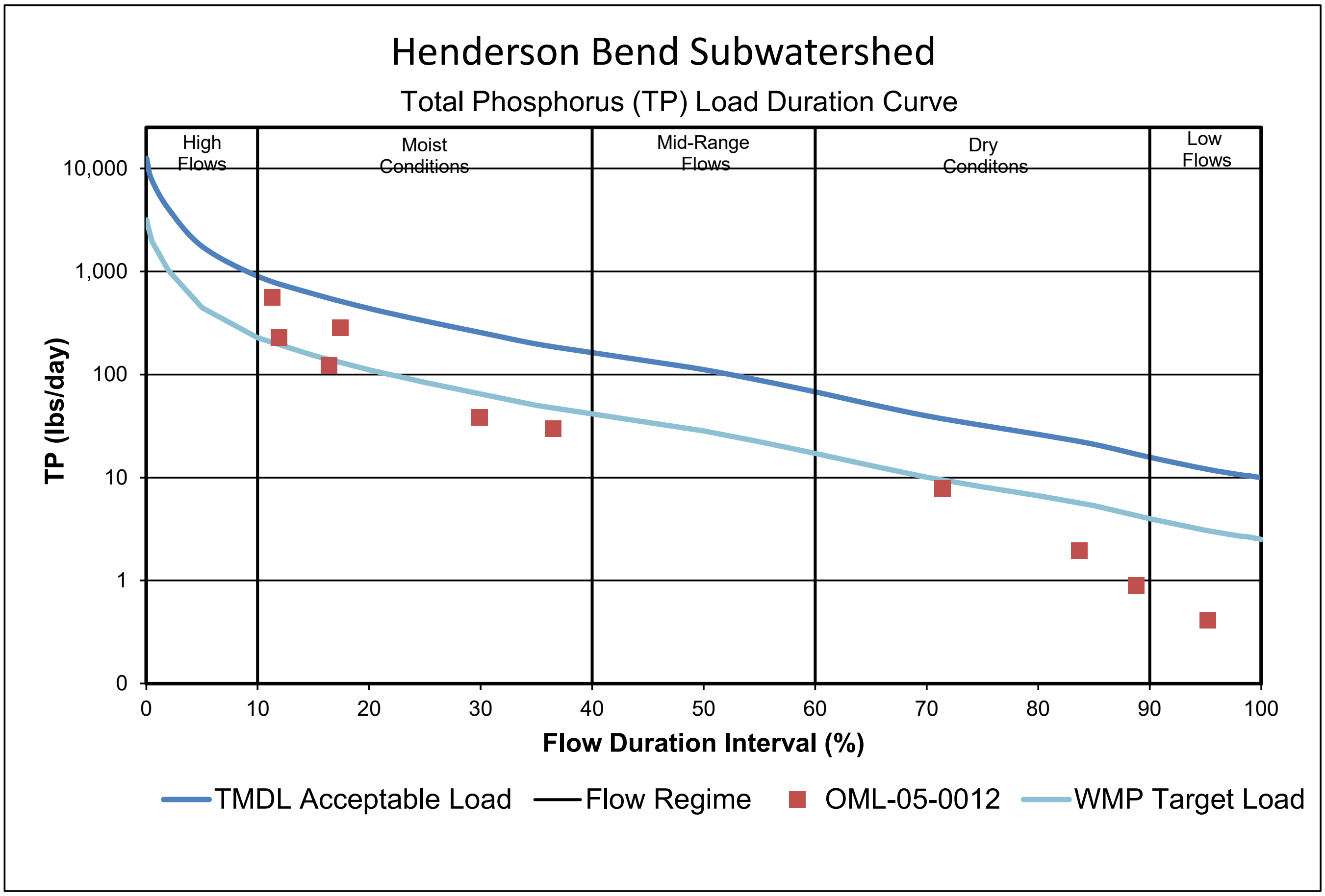


Figure 78: Henderson Bend Total Phosphorus Load Duration Curve

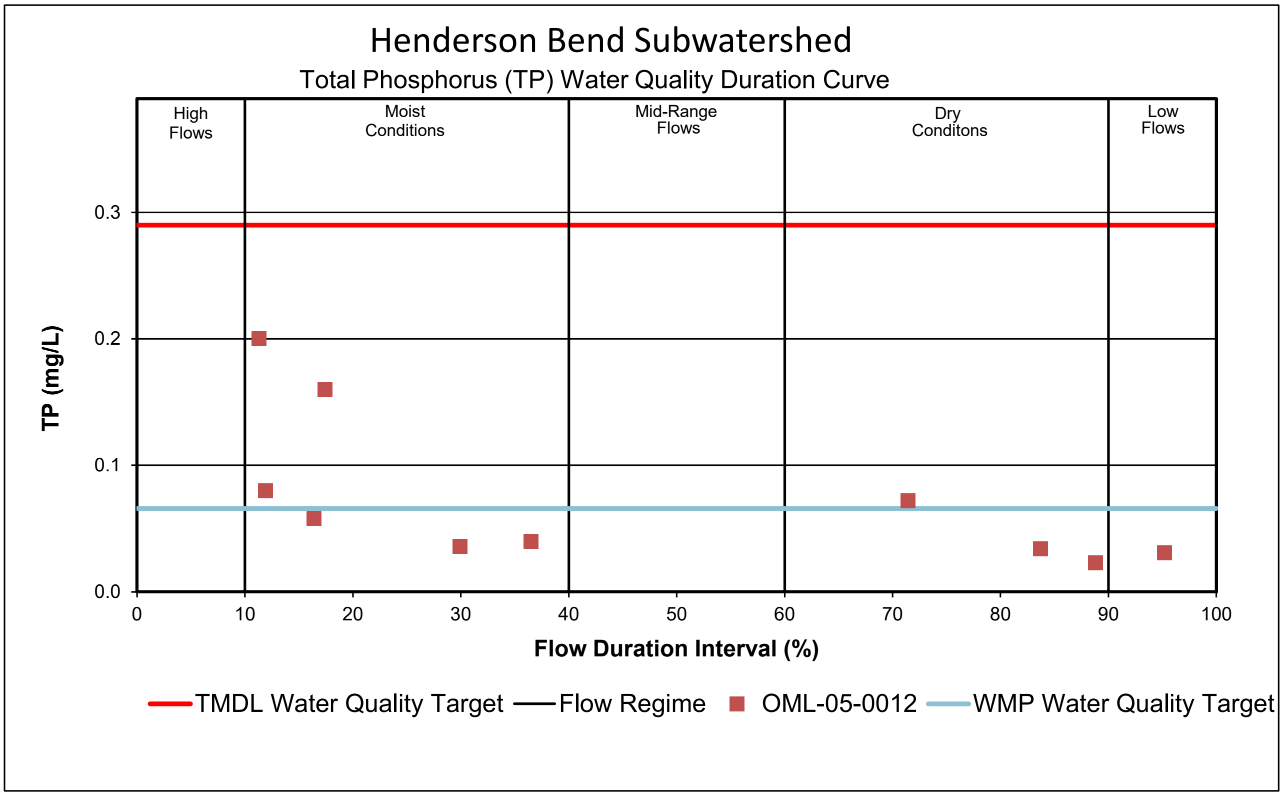


Figure 79: Henderson Bend Total Phosphorus Water Quality Duration Curve

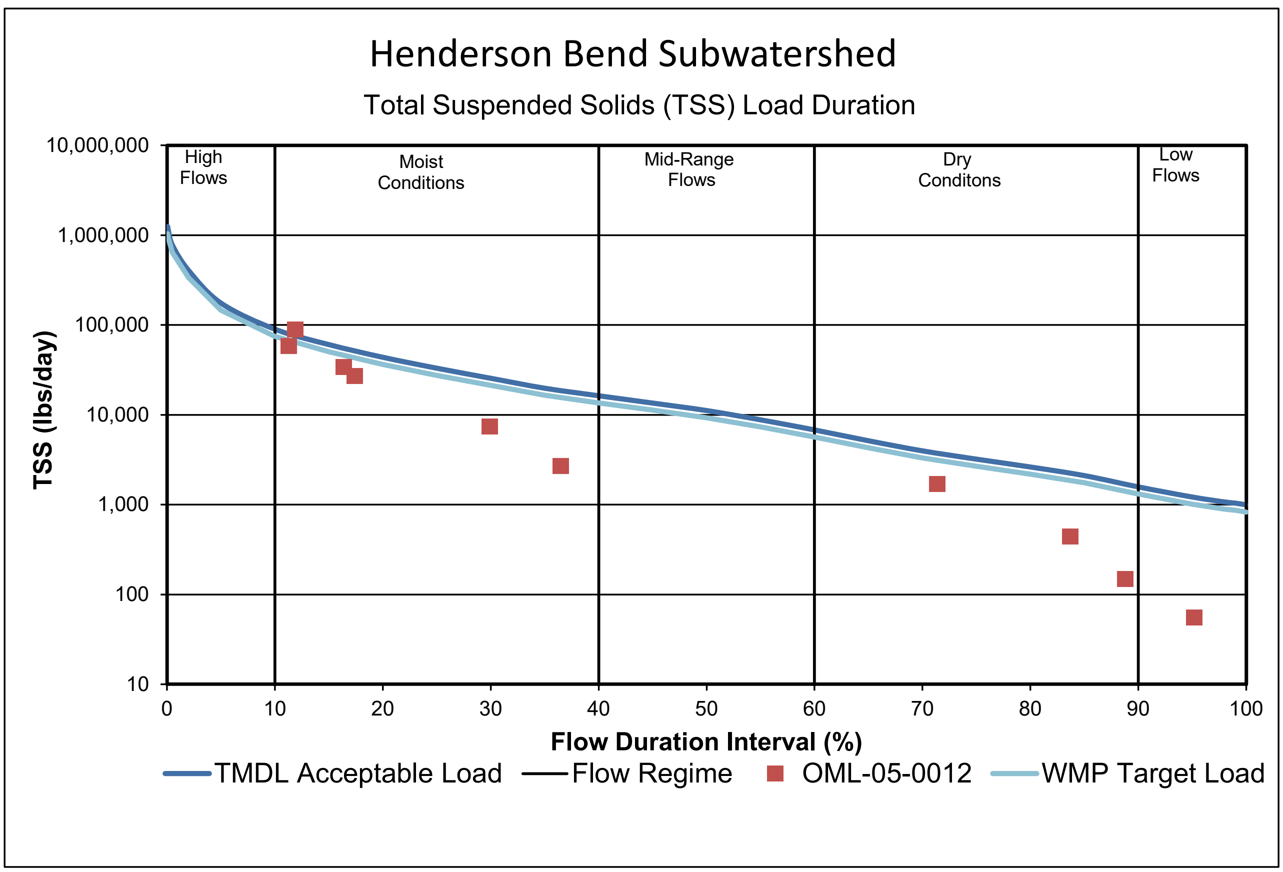


Figure 80: Henderson Bend TSS Load Duration

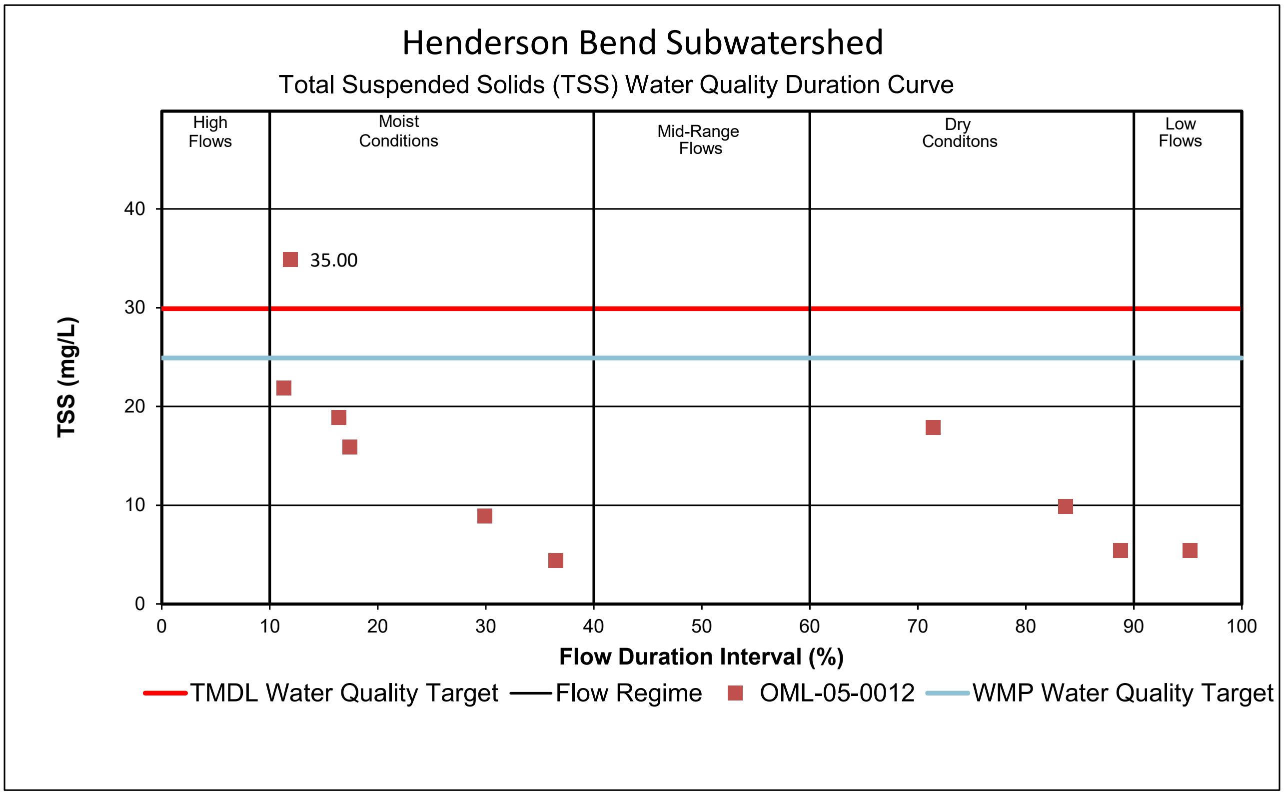


Figure 81: Henderson Bend TSS Water Quality Duration Curve

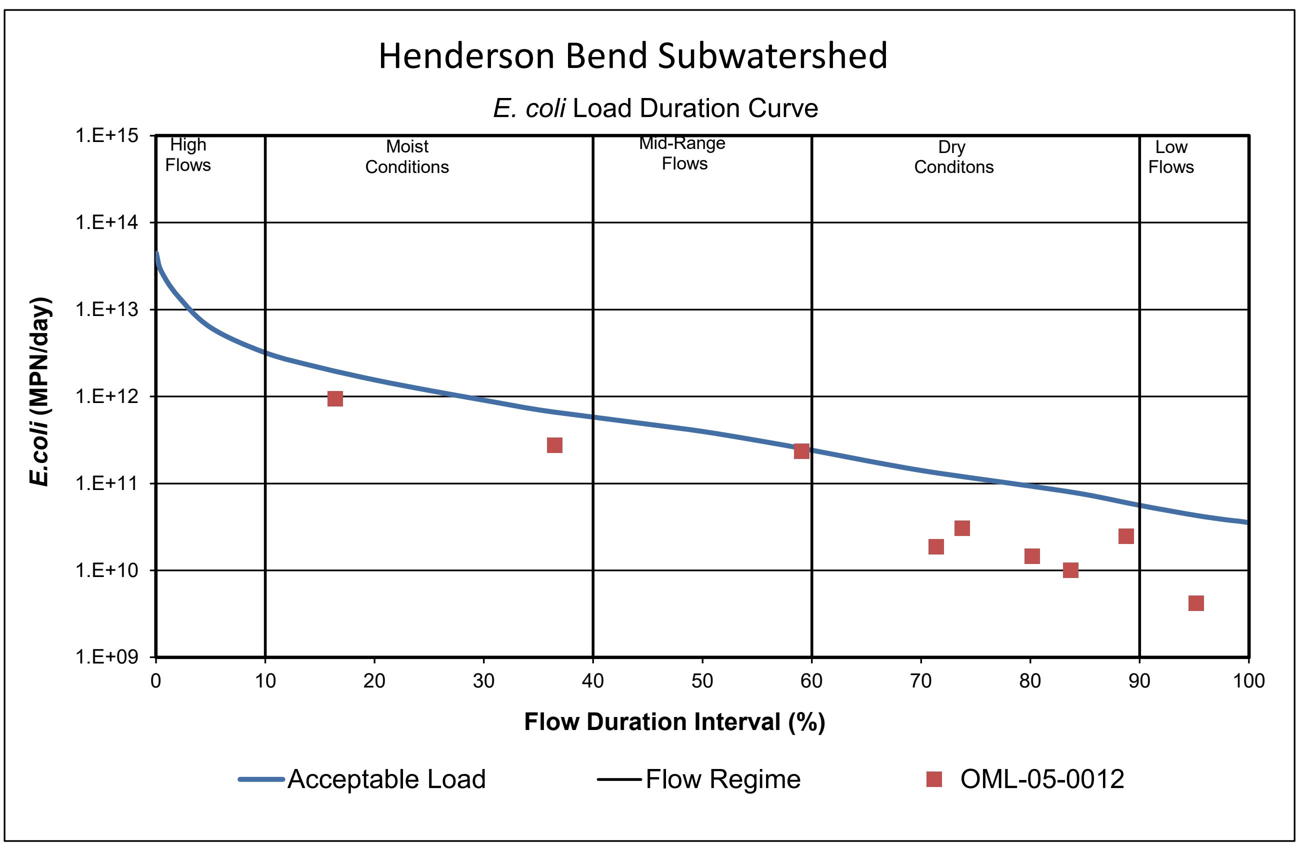


Figure 82: Henderson Bend E. coli Duration Curve

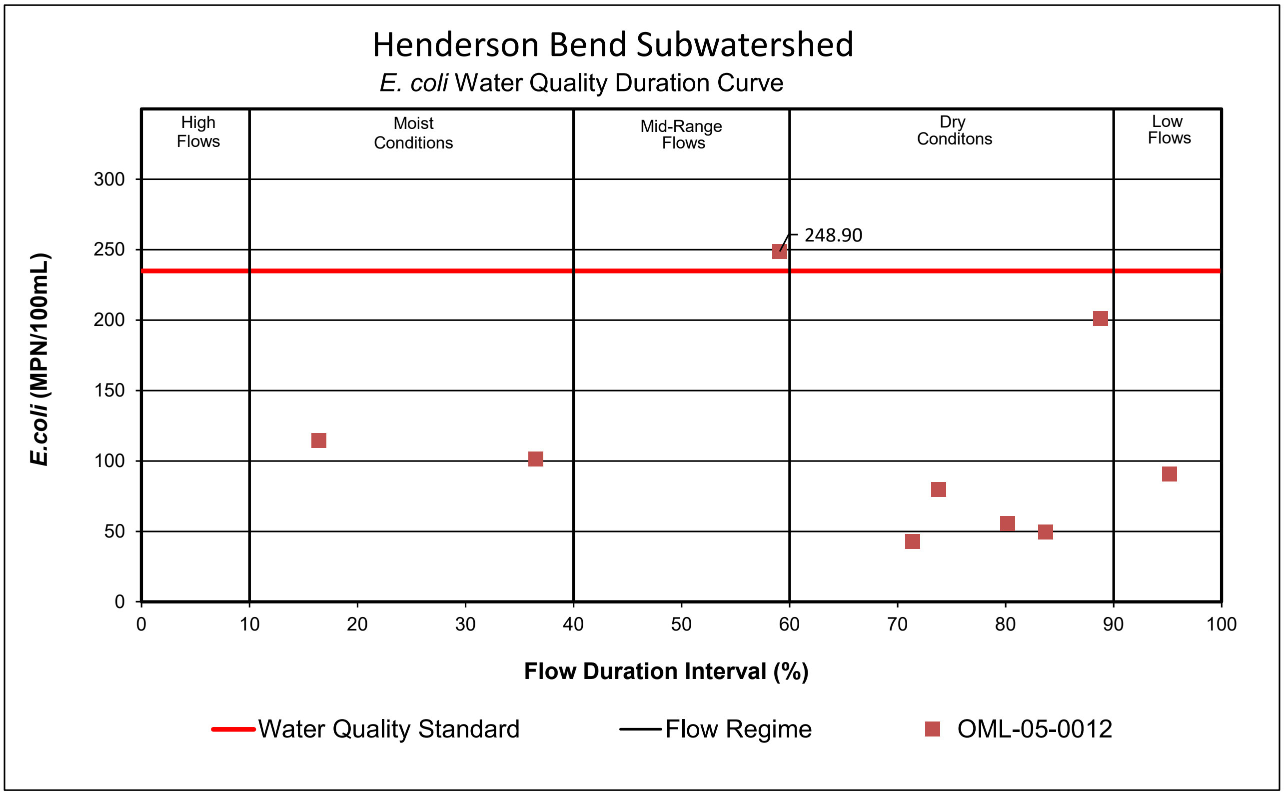


Figure 83: Henderson Bend E. coli Water Quality Duration Curve

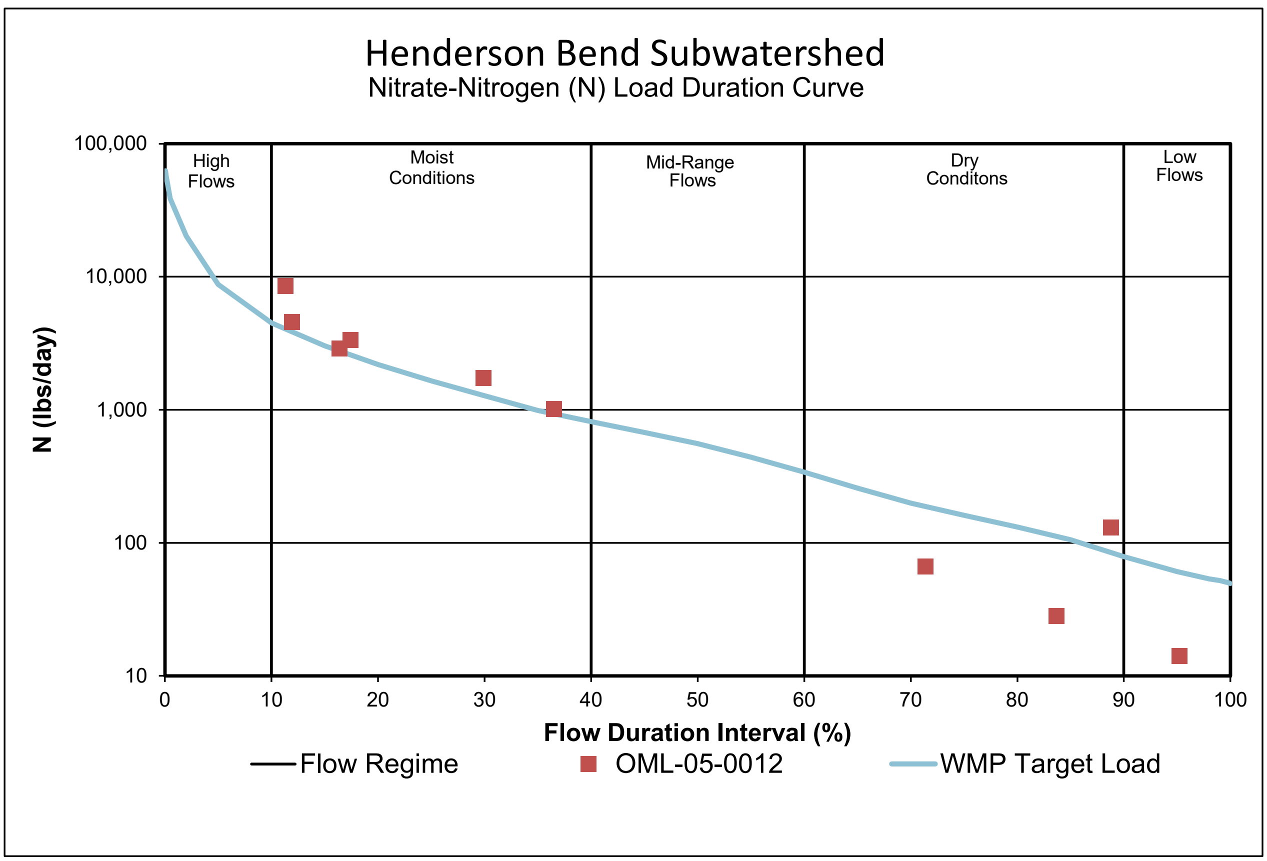


Figure 84: Henderson Bend Nitrate-Nitrogen Load Duration Curve

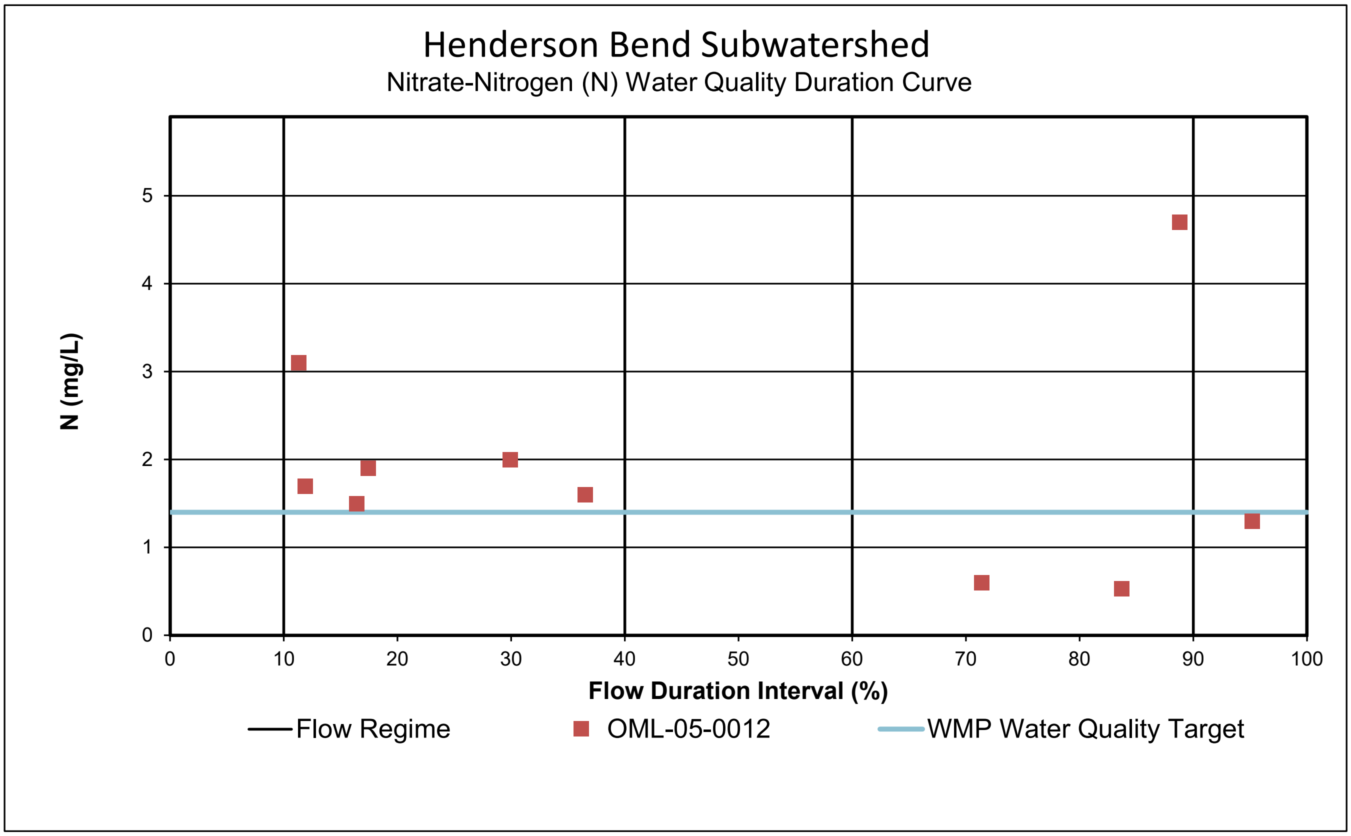


Figure 85: Henderson Bend Nitrate Nitrogen Water Quality Duration Curve

Henderson Bend (050902030507)	
Drainage Area	167.43 square miles
Surface Area	24.97 square miles
TMDL Sample Site	OML-05-0012
Listed Segments	NA
Listed Impairments [TMDL(s)]	NA
Land Use	Agricultural Land: 28% Forested Land: 58% Developed Land: 5% Open Water: 3% Pasture/Hay: 7% Grassland/Shrubs: 0% Wetland: 0%
NPDES Facilities	Ohio Rod Products (INRM01052)
CAFOs	NA
CFOs	NA

Table 49: Summary of Henderson Bend Subwatershed Characteristics

Henderson Bend Subwatershed Windshield Survey Results (25 sites)	
Finding	**# Present**
Contaminated Runoff into Streams from livestock	14
Livestock Access to Streams	14
Excess Nutrients Entering Stream from livestock	14
Streambank Erosion	6
Gully Erosion	0
Sediment Entering Stream	14
Overgrazed Pasture	14
Conventional Tillage being used	11
Flooding	0
Lack of Riparian Buffers	0
Total	**93**

Table 50: Windshield Survey Results of Henderson Bend Subwatershed

The Henderson Bend windshield survey completed in April 2021 show issues affecting this subwatershed include many sites allowing livestock access to the stream, and contaminated runoff from feeding areas to enter into the streams. There was also many areas of overgrazed pasture and conventional tillage which may also add to sediment and nutrient load.

WATERSHED INVENTORY

Data was collected at 24 sample sites from November 2018 to October 2019 by IDEM for the TMDL analysis. The data indicate that 19 of the sample sites violated one or more of the Indiana Water Quality Standards (327 IAC 2).

Potential sources of biotic impairment, *E. coli*, nutrients, and low dissolved oxygen levels in the watershed include both regulated point sources and nonpoint sources. Point sources including wastewater treatment plants (WWTPs) and Public Water Supply (PWS) facilities that discharge wastewater, industrial stormwater, and permitted construction activities are regulated through the National Pollutant Discharge Elimination System (NPDES). Nonpoint sources such as unregulated urban stormwater, agricultural run-off, wildlife, confined feeding operations (CFOs), pasture animals with access to streams, and faulty and failing septic systems are also potential sources.

Determining the specific reasons for high *E. coli* counts in any given waterbody is challenging. There are many potential sources and *E. coli* counts are inherently variable. Within the Laughery Creek watershed, subwatersheds with the greatest areas of hay and pastureland have the highest average *E. coli* counts. It is therefore possible that small unregulated farming operations that allow livestock to have direct access to streams in these subwatersheds are contributing to the elevated *E. coli* levels. However, with even higher amounts of land being forested or in agricultural use throughout all of the subwatersheds, wildlife excrement, or the land application of manure, could also contribute to high *E. coli* levels. Additionally, being a very rural watershed, other factors such as failing septic systems or illegal straight pipes could be affecting subwatersheds that also tend to experience lower flows, and thus have less dilution. Specific sources of *E. coli* to each impaired waterbody should be further evaluated during follow-up implementation activities.

Within the Laughery Creek watershed, certain subwatersheds had high total phosphorus loads and multiple low dissolved oxygen hits. It is possible that field run-off in these subwatersheds is contributing to elevated phosphorus loads, resulting in lower dissolved oxygen. However, other factors could also explain the correlation, such as upstream loading, failing septics, impeded flow, tillage practices, or point source contributions. Low dissolved oxygen levels can also be correlated with elevated levels of total suspended solids by reducing light availability to aquatic plants.

Various subwatersheds in the Laughery Creek watershed have impaired biological communities. Biological communities include fish and aquatic macroinvertebrates, such as insects. These in-stream organisms are indicators of the cumulative effects of activities that affect water quality conditions over time. An IBC listing on Indiana's 303(d) list suggests that one or more of the aquatic biological communities is unhealthy as determined by IDEM's monitoring data. IBC is not a source of impairment but a symptom of other sources. To address these impairments in the Laughery Creek watershed, high total suspended solids (TSS) has been identified as the pollutant for TMDL development.

An important step in the TMDL process is the allocation of the allowable loads to individual point sources, as well as sources that are not directly regulated. The Laughery Creek watershed TMDL includes these allocations, which are presented for each of the 12-digit hydrologic unit code (HUC) subwatersheds containing impairments.

There are surface water intakes in Batesville, Osgood, and Versailles. There are also 14 NPDES permitted facilities located in the Laughery Creek watershed. These facilities include four municipal wastewater treatment plants, three facilities that treat industrial wastewater, including a stone quarry and a public water supply facility, and seven facilities with industrial stormwater permits. Of these facilities, one municipal facility was found to be in violation of its permit limits for *E. coli,* three municipal facilities for TSS, and one municipal facility for dissolved oxygen in the last five years. Although these NPDES facilities were found to be in violation of their permit limits, the majority of the time effluent from permitted facilities meets water quality standards and/or targets.

There are several types of documented and suspected nonpoint sources located in the Laughery Creek watershed, including unregulated livestock operations with direct access to streams, agricultural row crop land use, straight pipes, leaking or failing septic systems, wildlife, and erosion. Of these, agricultural row crop land use, livestock operations, and erosion are found most often in subwatersheds with elevated levels of *E. coli*, TSS, and total phosphorus. Although Indiana does not have a permitting program for nonpoint sources, many nonpoint sources are addressed through voluntary programs intended to reduce pollutant loads, minimize runoff, and improve water quality. As shown in Figure 86 below   (North Laughery Inventory Summary Map) many sites allow livestock access to the stream, and contaminated runoff from feeding areas to enter into the streams. There are many areas of overgrazed pasture and conventional tillage which also may add to sediment and nutrient load within the watershed.

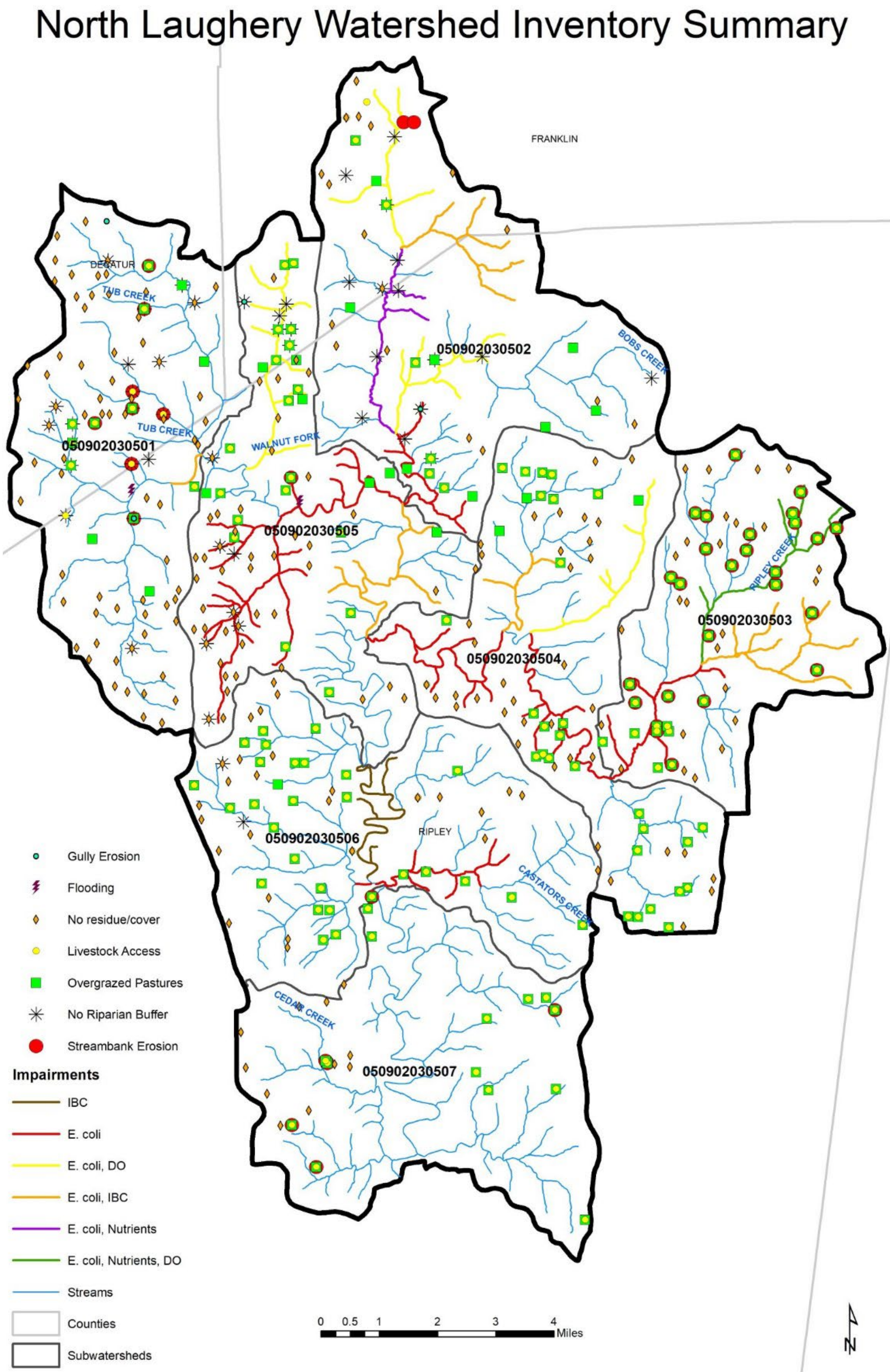


Figure 86: Inventory Summary Map of North Laughery Creek Watershed.

NEEDED POLLUTANT REDUCTIONS

Tables 51 and 52 below provide the foundation necessary to identify subwatersheds that are in need of the most significant pollutant reductions to achieve water quality standards in the Laughery Creek watershed. Using these two tables, along with the sub-watershed land use information, the North Laughery Steering Committee has a better understanding of which subwatersheds require the most pollutant load reductions. This can assist in future efforts to identify critical areas in the Laughery Creek watershed for implementation. The tables below focus on the information and data collected and analyzed through the TMDL development process for percent reduction purposes, whereas critical conditions take into account other factors for consideration (e.g., political, social, economic) to help determine implementation feasibility that will affect progress toward pollutant load reductions and, ultimately, attainment of water quality standards. This information can be key to the North Laughery Watershed Steering Committee in the process of identifying and selecting critical areas and implementation activities for the purposes of developing this watershed management plan. The percent reductions were taken into consideration when selecting critical areas for purposes of watershed management planning. By also taking into account different flow regimes, the North Laughery Steering Committee was able to prioritize practices that give them the most efficient load reductions for each critical area that is chosen.

	Duration Curve Zone				
Contributing Source Area	**High (0%-10%)**	**Moist (10%-40%)**	**Mid-Range (40%-60%)**	**Dry (60%-90%)**	**Low (90%-100%)**
Wastewater treatment plants (point source)			L	M	H
Livestock direct access to streams			L	M	H
Wildlife direct access to streams			L	M	H
Pasture Management	H	H	M		
On-site wastewater systems/Unsewered Areas	L	M	H	H	H
Riparian Buffer areas	H	H	M	M	
Stormwater: Impervious	H	H	H		
Stormwater: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M	L	
Bank erosion	H	M	L		

Note: Potential relative importance of source area to contribute loads under given hydrologic condition (H: High; M: Medium; L: Low)
(Modified from EPA, 2007 *An Approach for Using Load Duration Curves in the Development of TMDLs)*

Table 51: Relationship Between Load Duration Curve Zones and Contributing Sources

Table 52: Critical Conditions for TMDL Parameters

Parameter	Subwatershed (HUC)	Critical Condition				
		High	Moist	Mid-Range	Dry	Low
E. coli (MPN/day)	Tub Creek (050902030501)	0%	85%	--	60%	43%
	Little Laughery Creek (050902030502)	89%	95%	--	95%	61%
	Headwaters Ripley Creek (050902030503)	--	83%	92%	93%	79%
	North Branch (050902030504)	--	65%	84%	80%	0%
	Walnut Creek (050902030505)	62%	87%	32%	84%	75%
	Jericho Creek (050902030506)	--	0%	87%	53%	0%
Total Phosphorus (mg/L)	Headwaters Ripley Creek (050902030503)	--	0%	--	26%	37%
Total Suspended Solids (mg/L)	Tub Creek (050902030501)	0%	12%	--	0%	0%
	Little Laughery Creek (050902030502)	30%	15%	--	0%	0%
	Headwaters Ripley Creek (050902030503)	--	17%	--	0%	0%
	Walnut Creek (050902030505)	0%	0%	--	0%	0%
	Jericho Creek (050902030506)	84%	9%	0%	0%	0%

Note: -- represents no data collected in the flow regime

ANALYSIS OF STAKEHOLDER CONCERNS

The North Laughery steering committee developed a list of stakeholders' concerns during the early phase of the North Laughery Creek WMP 319 grant. These concerns were voiced by several local stakeholders, producers, county officials, contractors and conservation-minded citizens. Many of these concerns were identified by landowners possessing an extensive knowledge of the historical and recent land uses, while other concerns were based on individual landowners' experiences in their own area.

These concerns were looked at individually to determine whether each concern was supported by data, quantifiable, and whether the concern was outside the project's scope. If there was data to support that concern, the evidence was indicated. The group then decided whether they wanted to focus on the concern. Table 53 shows the results on that discussion.

Table 53: Analysis of Stakeholder Concerns

ANALYSIS OF STAKEHOLDER CONCERNS					
STAKEHOLDER CONCERN	**EVIDENCE**	**SUPPORTED BY DATA**	**INSIDE PROJECT SCOPE**	**QUANTIFIABLE**	**FOCUS PRIORITY**
Water Quality throughout the Watershed	Windshield survey & Monitoring data	YES	YES	YES	HIGH
Contaminated Runoff entering Streams from livestock	Windshield survey	YES	YES	YES	HIGH
Livestock Access to Streams/Sensitive Areas	Windshield survey	YES	YES	YES	HIGH
Septic System Failures	E. coli data	YES	NO	NO	MEDIUM (thru education)
Excessive Nutrients entering Streams from livestock	Windshield survey, & monitoring data	YES	YES	YES	HIGH
Streambank Erosion	Windshield survey, TSS loads	YES	YES	YES	MEDIUM
Gully Erosion	Windshield survey	YES	YES	YES	MEDIUM
Sediment entering Streams	Tillage Transects, Windshield survey &TSS data	YES	YES	YES	HIGH
Overgrazed Pastures	Windshield survey	YES	YES	YES	HIGH

No Residue/Cover on Fields	Tillage & windshield survey	YES	YES	YES	HIGH
STAKEHOLDER CONCERN	**EVIDENCE**	**SUPPORTED BY DATA**	**INSIDE PROJECT SCOPE**	**QUANTIFIABLE**	**FOCUS PRIORITY**
Invasive Species invading Areas	NO	NO	NO	NO	NO
Trash/Dumping Sites	NO	NO	NO	NO	NO
Flooding	Flooding observed during windshield survey	YES	NO	YES	NO
Pulling Stone from Creek	NO	NO	NO	NO	NO
Lack of Riparian Buffers	Windshield survey	YES	YES	YES	MEDIUM
Regional Wastewater/ New Septic technologies	NO	NO	NO	NO	NO

Flooding was a concern of the North Laughery Steering Committee and was observed during the windshield survey, but it was determined to be outside the scope of the project.

Water Quality Concerns and Problems Analysis

The steering committee broke down the concerns into the problems they cause for the watershed. They grouped together nitrogen and phosphorus problems as high nutrient levels. Many of the concerns result in the same problems for the watershed area, as shown in the table below.

Table 54: Watershed Concerns and Problems

Concerns of the Watershed	Problems
Water Quality throughout the Watershed	High Nutrient Levels Sedimentation High E.coli Levels Degraded Habitat & Biodiversity
Contaminated Runoff entering Streams	High Nutrient Levels Sedimentation High E.coli Levels Degraded Habitat & Biodiversity
Livestock Access to Streams/Sensitive Areas	High Nutrient Levels Sedimentation High E.coli Levels Degraded Habitat & Biodiversity
Septic System Failures	High E.coli Levels High Nutrient Levels
Excessive Nutrients entering Streams	High Nutrient Levels
Streambank Erosion	Sedimentation High Nutrient Levels Degraded Habitat & Biodiversity
Gully Erosion	Sedimentation High Nutrient Levels
Sediment entering Streams	Sedimentation High Nutrient Levels Degraded Habitat & Biodiversity
Overgrazed Pastures	Sedimentation High Nutrient Levels High E.coli Levels
No Residue/Cover on Fields	Sedimentation High Nutrient Levels
Inadequate Riparian Buffers	Sedimentation High Nutrient Levels High E.coli Levels Degraded Habitat & Biodiversity

WATER QUALITY PROBLEMS AND CAUSES

The steering committee analyzed the problems and came up with potential causes and sources for each of the problems, as well as the magnitude of each. Magnitude of the problem relied heavily on observations made during the windshield survey. See below for the results of the analysis.

Table 55: Water Quality Concerns, Sources, and Magnitude

Problem	Potential Causes	Potential Sources	Magnitude
Sedimentation	Sedimentation Total Suspended Solids (TSS) Levels Exceed Target	Erosion	594 occurrences of Erosion (all subwatersheds) • Livestock Access to Streams – 146 (HUC 501 – 14, 502 – 9, 503 - 31, 504 – 30, 505 – 18, 506 – 30, 507 – 14) • Streambank Erosion – 43 (HUC 501 – 8, 502 – 2, 503 - 26, 505 – 1, 507 – 6) • Gully Erosion – 4 (HUC 501 – 2, 502 – 1, 505 – 1) • Overgrazed Pasture – 160 (HUC 501 – 13, 502 – 14, 503 – 31, 504 – 32, 505 – 25, 506 – 31, 507 – 14) • Conventional Tillage – 241 (HUC 501 – 69, 502 – 18, 503 – 25, 504 – 37, 505 – 47, 506 – 34, 507 – 11)
		Inadequate Buffers	49 Survey Sites showed lack of buffer (HUC 501 –19, 502 –15, 505 –13, 506 –2)
High Nutrient Levels	Nutrient Levels Exceed Target	Erosion	594 occurrences of Erosion (all subwatersheds) • Livestock Access to Streams – 146 (HUC 501 – 14, 502 – 9, 503 - 31, 504 – 30, 505 – 18, 506 – 30, 507 – 14) • Streambank Erosion – 43 (HUC 501 – 8, 502 – 2, 503 - 26, 505 – 1, 507 – 6) • Gully Erosion – 4 (HUC 501 – 2, 502 – 1, 505 – 1) • Overgrazed Pasture – 160 (HUC 501 – 13, 502 – 14, 503 – 31, 504 – 32, 505 – 25, 506 – 31, 507 – 14) • Conventional Tillage – 241 (HUC 501 – 69, 502 – 18, 503 – 25, 504 – 37, 505 – 47, 506 – 34, 507 – 11)
		Animal Access to Sensitive Areas	146 Survey Sites showed Animal Access to Streams (HUC 501 – 14, 502 – 9, 503 - 31, 504 – 30, 505 – 18, 506 – 30, 507 – 14)
		Failing Septic Systems	Majority of the Watershed has very limited soils for septic systems
			Failing septic systems in many of the older homes within the Watershed
		Improper Fertilizer/Manure Applications	No current data available but the potential problem does exist with the amount of cropland and livestock present
High E.coli Levels	E.coli Levels Exceed Target	Animal Access to Sensitive Areas	146 Survey Sites showed Animal Access to Streams (HUC 501 – 14, 502 – 9, 503 - 31, 504 – 30, 505 – 18, 506 – 30, 507 – 14)
		Failing Septic Systems	Majority of the Watershed has very limited soils for septic systems
			Failing septic systems in many of the older homes within the Watershed

Problem	Potential Causes	Potential Sources	Magnitude
		Improper Manure Applications	No current data available but the potential problem does exist with the amount of livestock present
		Pet & Wildlife Waste	TMDL – All subwatersheds
Degraded Habitat & Biodiversity	Sedimentation	Erosion	594 occurrences of Erosion (all subwatersheds) • Livestock Access to Streams – 146 (HUC 501 – 14, 502 – 9, 503 - 31, 504 – 30, 505 – 18, 506 – 30, 507 – 14) • Streambank Erosion – 43 (HUC 501 – 8, 502 – 2, 503 - 26, 505 – 1, 507 – 6) • Gully Erosion – 4 (HUC 501 -2, 502 – 1, 505 -1) • Overgrazed Pasture – 160 (HUC 501 – 13, 502 – 14, 503 – 31, 504 – 32, 505 – 25, 506 – 31, 507 – 14) • Conventional Tillage – 241 (HUC 501 – 69, 502 – 18, 503 – 25, 504 – 37, 505 – 47, 506 – 34, 507 – 11)
		Animal Access to Sensitive Areas	146 Survey Sites showed Animal Access to Streams (HUC 501 – 14, 502 – 9, 503 - 31, 504 – 30, 505 – 18, 506 – 30, 507 – 14)
	Nutrients Levels Exceed Target	Failing Septic Systems	Majority of the Watershed has very limited soils for septic systems
			Failing septic systems in many of the older homes within the Watershed
		Improper Fertilizer/Manure Applications	No current data available but the potential problem does exist with the amount of cropland and livestock present
		Inadequate Buffers	49 Survey Sites showed lack of buffer (HUC 501 –19, 502 –15, 505 –13, 506 –2)

Watershed Pollutant Load Reductions

Water quality data from each subwatershed and flow data from the USGS gage on Vernon Fork Muscatatuck River were used to estimate existing pollutant loads in the watershed. Estimated current loads were derived from the 90th percentile concentration for each flow regime (90% of the observed values are lower than the value listed, 10% are higher). After the 90th percentile loads were calculated for each flow regime, the highest load value for each subwatershed was selected to represent the existing loads. Target loads were calculated using the WMP targets and the corresponding flow data for the flow regime. Target loads were then subtracted from the existing loads to get the load reductions needed (Table 56). See appendix C to see how these numbers were derived. Loads from the Jericho Creek subwatershed were selected to develop goal statements, as it includes a sampling site close to the furthermost sampling site in Henderson Bend and includes an IDEM fixed station site. Having data from the IDEM fixed station site will be a useful tool in tracking progress on the WMP goals.

– Subwatershed Loads and Reductions Needed

WATERSHED NAME	P (lbs./yr.)	N (lbs./yr.)	TSS (lbs./yr.)	E. coli (cfu/yr)
Little Laughery				
Current Load	51,657	1,323,281	15,072,661	1.84E + 15
Target Load	26,890	530,727	8,845,458	3.77E + 14
Reduction Needed	24,767	792,553	6,227,203	1.47E + 15
Percent Reduction	47.9	60	41.3	80
Walnut Creek				
Current Load	176,370	5,709,616	8,045,406	1.25E + 15
Target Load	113,594	2,241,996	7,082,223	3.02E + 14
Reduction Needed	62,776	3,467,620	963,182	9.43E + 14
Percent Reduction	35.6	61	12	76
Jericho Creek				
Current Load	589,842	3,432,270	331,604,534	5.28E + 14
Target Load	138,017	2,724,024	45,400,402	1.25E + 14
Reduction Needed	451,825	708,246	286,204,132	4.03E + 14
Percent Reduction	76.6	21	86.3	11
Tub Creek				
Current Load	18,668	1,028,813	1,988,933	2.19E + 14
Target Load	4,420	469,063	1,453,899	6.20E + 13
Reduction Needed	14,248	559,749	535,035	1.57E + 14
Percent Reduction	76.3	54	27	72
Headwaters Ripley Creek				
Current Load	5,353	1,888	1,605,980	1.53E + 14
Target Load	3,390	1,672	1,115,264	4.76 E + 13
Reduction Needed	1,963	216	490,716	1.05E + 14
Percent Reduction	36.7	11	30.6	69
North Branch				
Current Load	9,987	136,721	11,692	1.16E + 14
Target Load	7,530	148,610	41,167	3.42E + 13
Reduction Needed	2,457	0	0	8.23E + 13
Percent Reduction	24.6	0	0	71
Henderson Bend				
Current Load	76,408	1,065,693	11,461,228	1.53E + 14
Target Load	30,563	603,223	10,053,709	1.45E + 14
Reduction Needed	45,845	462,471	1,407,519	8.56E + 12
Percent Reduction	60	43	12.3	6

Table 56: North Laughery Watershed Pollutant Load Reductions

Table 57 for pathogens, 24 sites in the Laughery Creek were sampled. Below provides a summary of pathogen data for all of the subwatersheds in the Laughery Creek watershed, and percent reduction for E.coli. The pathogen reduction goal was developed using the percent reductions based on the geometric mean from the North Laughery TMDL. Pathogen load estimates provided in Table 56 are based on the single sample maximum and is provided for informational purposes.

Table 57: Summary of Pathogen Data for Subwatersheds in Laughery Creek Watershed

Subwatershed	Station #	AUID	Period of Record	Total Number of Samples	Percent of Samples Exceeding *E. coli* WQS (#/100 mL) 125	235	Geomean (#/ 100 mL)	Single Sample Maximum (#/ 100 mL)	Percent Reduction Based on Geomean (125/ 100mL)
Tub Creek	OML-05-0009	INV0351_05	4/1/19-9/9/19	8	75	50	181.55	866.4	31.15
	OML-05-0024	INV0351_T1003	4/1/19-9/9/19	8	25	25	101.58	488.4	0
Little Laughery Creek	OML-05-0020	INV0352_01	4/1/19-9/9/19	8	87.5	87.5	1474.33	>2419.6	91.52
	OML-05-0021	INV0352_02	4/1/19-10/7/19	9	100	88.89	1136.92	2419.6	89.01
	OML-05-0022	INV0352_T1008	4/1/19-8/5/19	7	100	85.71	934.49	>2419.6	86.62
	OML-05-0023	INV0352_03	4/1/19-10/7/19	9	100	77.78	420.58	2419.6	70.28
	OML-05-0035	INV0352_T1001	4/1/19-10/7/19	9	55.56	44.44	195.34	1986.3	36.01
Headwaters Ripley Creek	OML-05-0025	INV0353_01	4/2/19-10/8/19	9	77.78	66.66	434.58	2419.6	71.24
	OML-05-0026	INV0353_02	4/2/19-10/8/19	9	100	77.78	398.14	1553.1	68.60
	OML-05-0040	INV0353_T1003	4/2/19-10/8/19	9	100	77.78	1382.54	1986.3	90.96
North Branch	OML-05-0027	INV0354_03	4/2/19-9/10/19	8	62.5	37.5	202.46	579.4	38.26
	OML-05-0028	INV0354_T1002	4/2/19-8/6/19	7	85.71	42.86	172.47	461.1	27.52
	OML-05-0029	INV0354_04	4/2/19-9/10/19	8	75	25	242.6	461.1	48.47
	OML-05-0036	INV0354_T1013	4/2/19-8/6/19	7	57.14	57.14	382.34	2419.6	67.31
Walnut Creek	OML-05-0030	INV0355_07	4/2/19-10/8/19	9	66.67	22.22	98.72	325.5	0
	OML-05-0031	INV0355_06	4/1/19-10/7/19	9	88.89	77.78	609.13	1553.1	79.48
	OML060-0007	INV0355_03	4/1/19-10/7/19	9	100	77.78	529.41	920.8	76.39
	OML060-0005	INV0355_T1002	4/1/19-9/9/19	8	75	62.5	373.98	1119.9	66.58
	OML-05-0032	INV0355_T1001	4/1/19-9/9/19	8	87.5	75	347.53	727	64.03
	OML060-0006	INV0355_02	4/1/19-10/7/19	9	44.44	33.33	116.00	579.4	0
Jericho Creek	OML-05-0033	INV0356_T1006	4/2/19-10/8/19	9	55.56	44.44	407.87	1119.9	69.35
	OML-05-0042	INV0356_04	4/2/19-10/8/19	9	11.11	0	26.66	133.4	0

Subwatershed	Station #	AUID	Period of Record	Total Number of Samples	Percent of Samples Exceeding *E. coli* WQS (#/100 mL)		Geomean (#/ 100 mL)	Single Sample Maximum (#/ 100 mL)	Percent Reduction Based on Geomean (125/ 100mL)
					125	235			
	OML-05-0034	INV0356_T1 013	4/2/19-10/8/19	9	44.44	22.22	187.77	488.4	33.43
Henderson Bend	OML-05-0012	INV0357_02	4/2/19-10/8/19	9	22.22	11.11	74.89	248.9	0

North Laughery Watershed Goals and Objectives

Many individuals on the North Laughery Steering Committee has years of combined experience gained through planning and implementation of best management practices with other watershed projects. This experience was an invaluable resource in developing goals and objectives for the North Laughery Watershed.

The Steering Committee used the reductions needed to come up with goal statements for nitrogen, phosphorous, sediment, and E. coli. The committee decided to set goals in 3 to 5 year increments to easily keep track of progress. Different practices and strategies can be used to improve water quality in a watershed and are often referred to as best management practices (BMPs). BMPs are effective, practical, structural or nonstructural methods which prevent or reduce the movement of sediment, nutrients, bacteria, and other pollutants from the land to surface or ground water, or which otherwise protect water quality from potential adverse effects of various land use activities.

Goal #1 – Nitrogen needs to be reduced within the watershed. The load reduction needed to meet the <1.5 mg/L target is 708,246 lbs/yr. Below are the reductions needed to meet the goals for nitrogen:

Decrease the nitrogen load by 5% in 3 years (35,412 lbs)

Decrease the nitrogen load by 10% in 6 years (70,825 lbs)

Decrease the nitrogen load by 20% in 9 years (141,649 lbs)

Decrease the nitrogen load by 30% in 12 years (212,474 lbs)

Decrease the nitrogen load by 40% in 15 years (283,289 lbs)

Goal # 2 – Phosphorous needs to be reduced within the watershed. The load reduction needed to meet the <0.076 mg/L target for TP is 451,825 lbs/yr. Below are the reductions needed to meet the goals for phosphorous:

Decrease the load of phosphorous by 10% in 3 years (45,182 lbs)

Decrease the load of phosphorous by 20% in 6 years (90,365 lbs)

Decrease the load of phosphorous by 30% in 9 years (135,547lbs)

Decrease the load of phosphorous by 40% in 12 years (180,730 lbs)

Decrease the load of phosphorous by 50% in 15 years (225,912 lbs)

Goal #3 – Reduce soil erosion and amount of sedimentation entering the streams. The load reduction needed to meet the <25 mg/L target is 143,102 tons/yr. Below are the reductions needed to meet the goals for sediment:

Decrease the load of sediment by 20% in 3 years (28,620 tons)

Decrease the load of sediment by 40% in 6 years (57,241 tons)

Decrease the load of sediment by 60% in 9 years (85,861 tons)

Decrease the load of sediment by 80% in 12 years (114,482 tons)

Decrease the load of sediment by 100% in 15 years (143,102 tons)

Goal #4 – Reduce E. coli concentrations throughout the watershed.

Reduce E. coli concentrations throughout the watershed not only to meet water quality target but to have the impaired stream segments delisted (97.99 miles). E. coli reductions needed based on the geometric mean value range from 0% to 92%. We would like to see a decrease in the reductions needed to 55% within 15 years. Water quality monitoring by IDEM will serve as an indicator to determine progress towards E. coli target value. To help achieve this goal, we would like to implement the following:

Exclude 150 head of livestock from the stream/sensitive areas in 3 years

Exclude 300 head of livestock from the stream/sensitive areas in 6 years

Exclude 450 head of livestock from the stream/sensitive areas in 9 years

Exclude 600 head of livestock from the stream/sensitive areas in 12 years

Exclude 750 head of livestock from the stream/sensitive areas in 15 years

Provide education through 3 workshops or publications every 3 years for the next 15 years – Topics covered may include septic system maintenance, proper septic system installation, importance of livestock restriction to sensitive areas, importance of maintaining adequate grazing heights in pasture to reduce the amount of runoff, and best management grazing practices that could help.

Goal #5 – Improve the water quality and habitat of the streams in the watershed: increase biodiversity of both macroinvertebrates and fish in 15 years.

Strive to achieve nutrient, sediment, and E. coli goals listed above

Delist the streams from IDEM's 303(d) list for impaired biotic communities

Install practices to protect or restore stream habitats

Increase macroinvertebrate and fish population and diversity so mIBI and IBI scores are passing (>35)

Improve stream habitat so QHEI scores are passing (>51)

Goal #6 – Increase public awareness and education: Education and activities about how individual choices impact the watershed

Encourage partnerships and project involvement. Use signage to create public awareness of designation.

Educate and promote best management practices (BMPs) to landowners, operators, and public.

Goal #7 – Partner with government agencies and landowners on decreasing streambank erosion

Educate partners and landowners on the importance of buffers, increasing infiltration, and streambank stabilization

Seek out programs and funds to assist with efforts

Publications (newsletters, articles, etc.) will be distributed by individual mailings using a contact list developed for North Laughery Watershed. In addition these materials will be available at workshops and events, and also at local offices of partners of the watershed. Materials will also be available through numerous partner websites and a specific website for North Laughery Creek Watershed. Information about meetings and events will be publicized through local media outlets, and electronic media (websites, facebook, etc.)

Goal Objectives and Indicators

The following page is set of objectives and indicators were set for each of the watershed goals.

Goal #1 – Nitrogen needs to be reduced within the watershed. The load reduction needed to meet the <1.5 mg/L target is 708,246 lbs/yr. Decrease the nitrogen load by 5% for the first 3 years, then by 10% every 3 years thereafter for a period of 15 years (283,289 lbs).

Goal # 2 – Phosphorous needs to be reduced within the watershed. The load reduction needed to meet the <0.076 mg/L target for TP is 451,825 lbs/yr. Decrease the load of phosphorous by 10% every 3 years for a period of 15 years (225,912 lbs)

Table 58: Nutrients Goal Objectives & Indicators

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
Cropland					
Educate landowners and operators on proper nutrient management and application	Education through publications and workshops	Landowners and Operators	Watershed, SWCD, and Partner Staff	2022-2036	# of publications distributed # of people attending workshops # of nutrient management plans developed lbs. of phosphorus and nitrogen from the calculated load reductions from BMPs installed Water quality improvement based on monitoring for P and N parameters
Promote the use of cover crops on all cropland acres	Education through publications and field days Provide financial assistance to plant cover crops	Landowners and Operators	Watershed, SWCD, and Partner Staff	2022-2036	# of publications distributed # of people attending workshops # of acres planted to cover crops lbs. of phosphorus and nitrogen from the calculated load reductions from BMPs installed Water quality improvement based on monitoring for P and N parameters
Livestock					
Promote proper manure application	Education through publications and workshops	Livestock Owners	Watershed, SWCD, and Partner Staff	2022-2036	# of publications distributed

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
	Promote and educate landowners in the development and implementation of nutrient management plans Promote and provide financial assistance in design and implementation of HUAP's and roof runoff systems				# of people attending workshops # of nutrient management plans developed # of nutrient management plans implemented lbs. of phosphorus and nitrogen from the calculated load reductions from BMPs installed Water quality improvement based on monitoring for P and N parameters
Promote good pasture management by maintaining adequate grazing heights	Educate livestock owners on pasture management through publications and field days Provide financial assistance to implement improved pasture management systems	Livestock Owners	Watershed, SWCD, and Partner Staff	2022-2034	# of publications # of people attending field days # of cost-share participants implementing an improved pasture management plan lbs. of phosphorus and nitrogen from the calculated load reductions from BMPs installed Water quality improvement based on monitoring for P and N parameters # of prescribed grazing plans implemented
Urban					

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
Promote proper nutrient management	Education through publications and workshops	General public	Watershed, SWCD, and Partner Staff	2022-2036	# of publications # of people attending workshops # of people in the watershed that pledge to do various activities on the Clear Choices, Clean Water website – covering fertilizer, septic maintenance, and several other items.

Goal #3 – Reduce soil erosion and amount of sedimentation entering the streams. The load reduction needed to meet the <25 mg/L target is 143,102 tons/yr. Decrease the load of sediment by 20% every 3 years for 15 years (143,102tons)

Table 59: Sedimentation Goal Objectives & Indicators

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
			Cropland		
Plant cover crops on HEL fields	Education through field days/workshops Education through publications Provide financial assistance to plant cover crop	Agricultural landowners and operators	Watershed, SWCD, and Partner Staff	2022 - 2036	# of people attending workshops # of publications distributed # of acres planted Tons of sediment calculated from the load reductions of BMPs installed Water quality improvement based on monitoring for turbidity and TSS parameters

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
Increase the number of acres being no-tilled	Education through workshops and field days Education through publications Provide education and financial assistance to landowners who convert from tillage to no-till in high residue crops such as corn (not soybeans)	Agricultural landowners and operators	Watershed, SWCD, and Partner Staff	2022 - 2036	# of people attending workshops # of publications distributed # of acres converted Change in tillage transect data Tons of sediment calculated from the load reductions of BMPs installed Water quality improvement based on monitoring for turbidity and TSS parameters
Establish buffers in sensitive areas	Provide financial assistance to landowners to establish grassed waterways Provide financial assistance to landowners to establish filter strips	Agricultural landowners and operators	Watershed, SWCD, and Partner Staff	2022 - 2036	# of landowners enrolled in cost-share programs for buffers # of feet of buffers installed Tons of sediment calculated from the load reductions of BMPs installed Water quality improvement based on monitoring for turbidity and TSS parameters

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
Pasture/Hay					
Reduce acres of overgrazed pasture	Educate livestock owners on stocking density through publications and field days	Landowners with livestock	Watershed, SWCD, and Partner Staff	2022 - 2036	# of people attending field days # of publications distributed # of prescribed grazing plans implemented Tons of sediment calculated from the load reductions of BMPs installed Water quality improvement based on monitoring for turbidity and TSS parameters
	Educate livestock owners on proper overwintering practices through field days and publications				
	Provide financial assistance for interior fencing to implement rotational grazing				
Reduce livestock access to sensitive areas along streams and woodlands	Education through publications	Landowners with livestock	Watershed, SWCD, and Partner Staff	2022 - 2036	# of publications # of head removed from sensitive areas Tons of sediment calculated from the load reductions of BMPs installed Water quality improvement based on monitoring for turbidity and TSS parameters
	Provide financial assistance for fencing and watering systems				

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
Natural Areas					
Increase riparian buffers along streams	Education through workshops and publications Provide financial assistance to establish riparian buffers	Landowners	Watershed, SWCD, and Partner Staff	2022 - 2036	# of landowners who attended workshops # acres and length of established buffers Tons of sediment calculated from the load reductions of BMPs installed Water quality improvement based on monitoring for turbidity and TSS parameters
Urban					
Promote the use of urban best management practices	Educate urban landowners about best management practices through publications and workshops	Urban Landowners	Watershed, SWCD, and Partner Staff	2022 - 2036	# of publications # of people who attend workshops

Goal #4 – Reduce E. coli concentrations throughout the watershed.

Reduce E.coli concentrations by 55% within 15 years - Water quality monitoring by IDEM will serve as an indicator to determine progress towards E. coli target value. The load reduction is based on reaching the geometric mean of <125 cfu / 100 ml sample.

Table 60: E. coli Goal Objectives & Indicators

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
Livestock					
Fence livestock away from streams and ponds	Educate livestock owners on the importance of access control through publications Provide financial assistance for exclusion and alternative watering systems	Livestock Owners	Watershed, SWCD, and Partner Staff	2022-2036	# of publications # farmers willing to exclude livestock # of head excluded Water quality improvement based on monitoring for E. coli #/amount of exclusion fences installed
Promote good pasture management by maintaining adequate grazing heights	Educate livestock owners on pasture management through publications and field days Provide financial assistance to implement improved pasture management systems	Livestock Owners	Watershed, SWCD, and Partner Staff	2022-2036	# of publications # of people attending field days # of cost-share participants implementing an improved pasture management plan Water quality improvement based on monitoring for E. coli #/amount of improved pasture BMPs implemented
Septic Systems					

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
Educate homeowners and renters about the importance of septic system maintenance and proper working conditions	Develop and distribute publications about septic system maintenance	Homeowners and Renters	Watershed, SWCD, and Partner Staff	2022-2026	# of publications distributed # of people who attend workshops Water quality improvement based on monitoring for E. coli
	Hold Septic System workshops				
Educate septic contractors and developers on appropriate sites feasible for septic system functionality	Hold workshops on proper site selection and installation	Contractors and Developers	Watershed, SWCD, and Partner Staff	2022-2026	# of people attending workshops

Goal #5 – Improve the water quality and habitat of the streams in the watershed : increase biodiversity of both macroinvertebrates and fish in 15 years.

Table 61: Habitat & Biodiversity Goal Objectives & Indicators

Objective	Action - Cost	Target Audience	Performed By	Time Schedule	Indicator
Habitat and Biodiversity					
Improve water quality and habitat to obtain passing mIBI, IBI, and QHEI scores and delist streams currently on IDEM's 303(d) list for IBC	Provide financial assistance to install riparian buffers	General Public, Landowners, Public Officials, and Local Agencies	Watershed, SWCD, IDEM, and Partner Staff	2022-2037	# of stream segments delisted for IBC mIBI scores QHEI scores # of feet of riparian
	Provide financial assistance for BMPs that reduce nutrient and sediment loading				

	Monitor changes in populations and habitat				buffers installed Reduction of sediment and nutrients

Goal #6 – Increase public awareness and education: Education and activities about how individual choices impact the watershed

Table 62: Public Education and Outreach Goal Objectives & Indicators

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
		Outreach			
Encourage partnerships and project involvement. Use signage to create public awareness of designation.	Obtain partners and volunteers	Landowners, Organizations, and General Public	Watershed, SWCD, and Partner Staff	2022-2036	# of partners # of volunteers # of signs distributed
		Education			
Educate and promote best management practices to landowners, operators, and public	Hold educational events/workshops	Landowners, Operators, and General Public	Watershed, SWCD, and Partner Staff	2022-2036	# of events/workshops held # of people attending
	Develop and distribute publications on best management practices				# of publications distributed

Goal #7 – Partner with government agencies and landowners on decreasing streambank erosion

Table 63: Streambank Stabilization Goal Objectives & Indicators

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
		Streambank Stabilization			

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
Educate partners and landowners on the importance of buffers, increasing infiltration, and streambank stabilization.	Hold events/workshops on topics	Landowners, Organizations, and General Public	Watershed, SWCD, and Partner Staff	2022-2036	# of events/workshops held
	Develop and distribute publications on topics				# of publications distributed
Seek out programs and funds to assist with efforts of goal	Find partners and resources and obtain needed funds	Landowners, Organizations, and General Public	Watershed, SWCD, and Partner Staff	2022-2036	# of partners/resources # of funds obtained

Identification of Watershed Critical Areas

One of the most crucial steps in watershed management planning is defining the critical areas in the project. For our purposes, a critical area is an area in the watershed which has the worst water quality, produces high pollutant loads, and where best management practices are needed

The steering committee decided to designate the subwatersheds of Tub Creek (501), Little Laughery Creek (502), Walnut Creek (505), and Headwaters Ripley Creek (503) as high priority critical areas. Their decision was based on a combination of factors such as watershed subunits which are primarily agricultural in nature, have high total nutrient and sediment concentrations, and a high number of stream miles with 303d listed impairments. Also the windshield survey provided information on areas where there was a high amount of conventional tillage happening, and identified subunits where livestock and livestock runoff was entering the streams, along with overgrazing of pastures. All of these factors were discussed by the technical members of the steering committee and used to determine high priority critical areas. The watersheds of Jericho Creek (506), and North Branch (504) are designated as medium priority critical areas. The watershed of Henderson Bend is considered as low priority – non critical. To clarify, a designation of *low priority – non critical* does not mean there is no need for improvement or that there aren't resource concerns to address. EPA's planning guidance states that the entire watershed cannot be considered critical. The project and other organizations could also obtain funding through sources other than Section 319 to implement BMPs in these areas. Table 64 below illustrates the summary of the data used to prioritize the critical areas of the watershed. The subwatershed column is color coded to identify the priority level with red = high, yellow = medium, and green = low priority. The map below also shows the critical areas and their priority level.

Table 64: Sub watershed Critical Area Determination Data Summary

Subwatershed	Landuse %			Impaired Streams Miles on 303(d) list	Number of Sites Not Meeting Target / %					Total Findings on Windshield Survey	Primary Resource Concerns (Windshield Survey)
	Agriculture	Pasture	Forest		Dissolved Oxygen	Qualitative Habitat Evaluation	Total Phosphorus	Total Suspended Solids	E. Coli Geomean		
Tub Creek 501	62	8	21	14.4	0/ 0%	0/ 0%	2/ 100%	2/ 100%	1/ 50%	160	Lack of Crop Residue, Overgrazed Pastures, Livestock Access to Streams, No Riparian Buffers
Walnut Creek 505	40	11	44	34.69	1/ 17%	3/ 50%	5/ 83%	2/ 40%	4/ 67%	133	Overgrazed Pastures, Lack of Crop Residue, Livestock access to Streams, No Riparian Buffers
Jericho Creek 506	33	12	49	11.92	1/ 33%	0/ 0%	2/ 66%	1/ 33%	2/ 66%	158	Overgrazed Pastures, Livestock access to streams, Lack of Crop Residue
North Branch 504	36	14	45	22.23	1/ 25%	0/ 0%	2/ 50%	0/ 0%	3/ 75%	199	Lack of Crop Residue, Overgrazed Pastures, Livestock Access to Streams
Headwaters Ripley Creek 503	36	19	39	21.03	2/ 66%	2/ 66%	2/ 66%	2/ 66%	3/ 100%	190	Overgrazed Pastures, Livestock access to streams, Streambank Erosion, Lack of Crop Residue
Little Laughery Creek 502	34	17	30	28.2	3/ 60%	4/ 80%	5/ 100%	2/ 40%	5/ 100%	65	Lack of Crop Residue, Lack of Riparian Buffers, Overgrazed pastures, Livestock access to streams
Henderson Bend 507	28	7	58	0.0	0/ 0%	0/ 0%	1/ 100%	1/ 100%	0/ 0%	93	Overgrazed Pastures, Livestock access to streams, Lack of crop residue

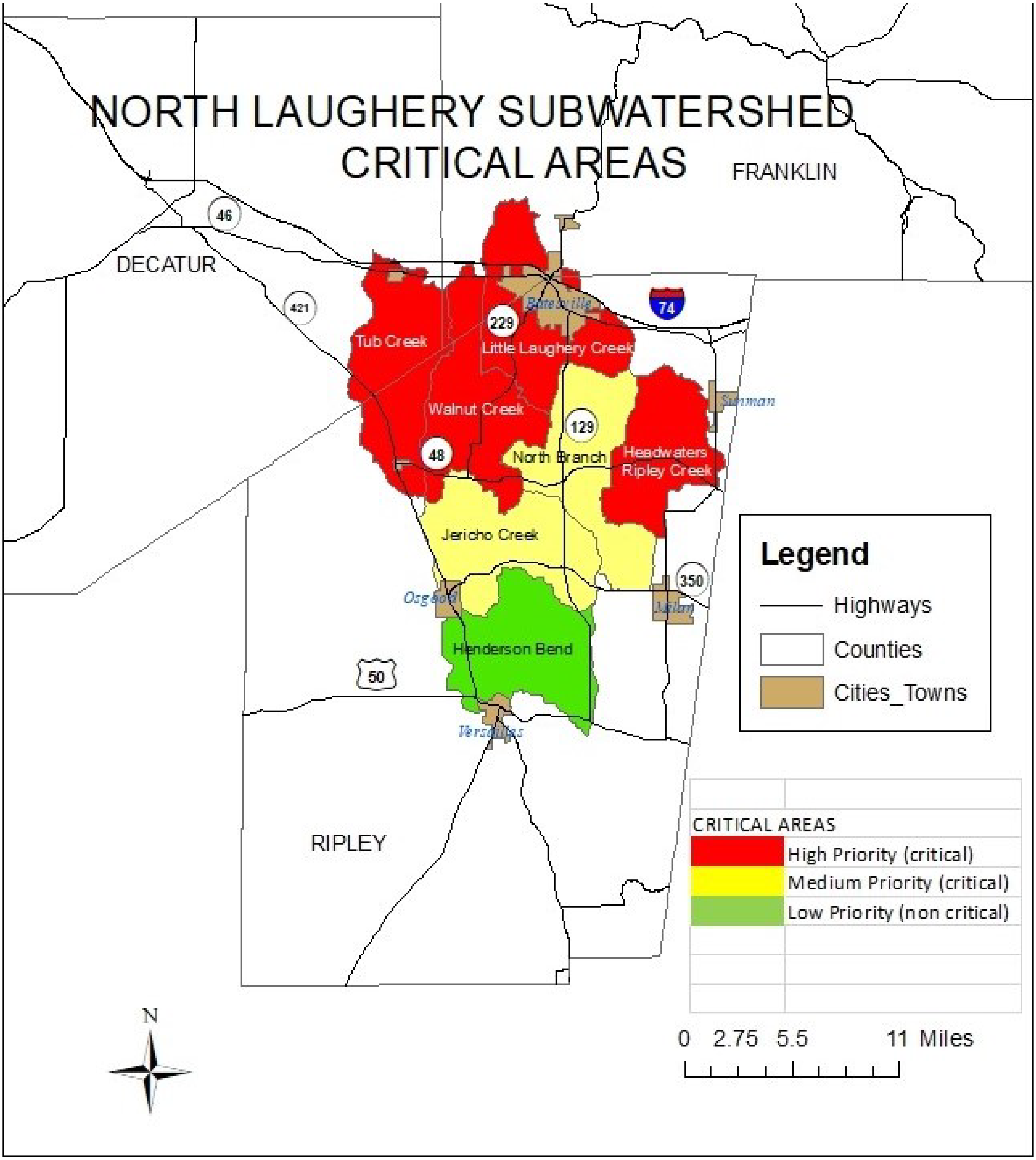


Figure 87: Map of North Laughery Subwatershed Critical Areas

Best Management Practices

Different practices and strategies can be used to improve water quality in a watershed and are often referred to as best management practices. BMPs are effective, practical, structural or nonstructural methods which prevent or reduce the movement of sediment, nutrients, bacteria, and other pollutants from the land to surface or ground water, or which otherwise protect water quality from potential adverse effects of various land use activities. These practices are developed to achieve a balance between water quality protection, conservation, and the land production within natural and economic limitations. Each parcel of land in the watershed is unique and faces its own challenge or challenges. Therefore, there may be more than one applicable BMP for meeting the challenges of that particular area. The right BMPs are ones that are practical and economical while maintaining and improving both water quality and the productivity of the land. The following are BMPs which would be beneficial in improving the water quality of the North Laughery Creek watershed.

Agricultural Best Management Practices

Agricultural best management practices are implemented on agricultural lands, typically row crop agricultural lands and pastures, in order to protect water resources and aquatic habitat while improving land resources and quality. These practices control nonpoint source pollutants, reducing their loading to the North Laughery Creek Watershed by minimizing the volume of available pollutants. Potential agricultural best management practices designed to control and trap agricultural nonpoint sources of pollution include:

- Alternate Watering Systems
- Riparian Buffer Strips (Shrub/Tree)
- Conservation Tillage (No till end goal)
- Cover Crops
- Grassed Waterways
- Filter Strips (grass)
- Hay/Pasture Planting
- Livestock Restriction
- Rotational Grazing
- Roof runoff & collection structures
- Heavy Use Area Protection
- Access Roads

These practices are appropriate for all of the subwatersheds, since the watershed is mostly agricultural. In addition, crop and pasture resource concerns were observed in every subwatershed during the windshield survey. Priority for BMP implementation will be based on the ranking of the critical areas: (High – Tub Creek (501), Little Laughery Creek (502), Walnut Creek (505), Headwaters Ripley Creek (503), Medium – North Branch (504) and Jericho Creek (506) The high priority areas will receive funding over medium priority areas if funding becomes limited. Programs to assist landusers in the implementation of BMP's can be found in Appendix B.

Alternate Watering Systems

Alternative watering systems provide an alternate location for livestock to seek water rather than using a surface water source. This removes the negative impacts of livestock access to streams including direct deposit of manure and bank erosion and destabilization, while improving the health of livestock by providing a clean water source and better footing while drinking. This results in less E. coli, phosphorus, nitrogen, and sediment entering a surface waterbody. Two main types of alternative watering systems are used including gravity systems and pump systems.

Riparian Buffer Strips/Filter Strips

Installing natural buffers or filters along major and minor drainages and sinkholes in the watershed helps reduce the nutrient and sediment loads reaching surface and subsurface waterbodies. Buffers provide many benefits including restoring hydrologic connectivity, reducing nutrient and sediment transport, improving recreational opportunities and aesthetics, and providing wildlife habitat. Sediment, phosphorus, nitrogen, and E. coli are at least partly removed from water passing through a naturally vegetated buffer. The percentage of pollutants removed depends on the pollutant load, the type of vegetation, the amount of runoff, and the character of the buffer area. The most effective buffer width can vary along the length of a channel. Adjacent land uses, topography, runoff velocity, and soil and vegetation types are all factors used to determine the optimum buffer width.

Many researchers have verified the effectiveness of filter strips in removing sediment from runoff with reductions ranging from 56-97% (Arora et al., 1996; Mickelson and Baker, 1993; Schmitt et al., 1999; Lee et al, 2000; Lee et al., 2003). Most of the reduction in sediment load occurs within the first 15 feet of installed buffer. Smaller additional amounts of sediment are retained and infiltration is increased by increasing the width of the strip (Dillaha et al., 1989). Filter strips have been found to reduce sediment-bound nutrients like total phosphorus but to a lesser extent than they reduce sediment load itself. Phosphorus predominately associates with finer particles like silt and clay that remain suspended longer and are more likely to reach the strip's outfall (Hayes et al., 1984). Filter strips are least effective at reducing dissolved nutrients like those of nitrate and phosphorus, and atrazine and alachlor, although reductions of dissolved phosphorus, atrazine, and alachlor of up to 50% have been documented (Conservation Technology Information Center, 2000). Simpkins et al. (2003) demonstrated 20-93% nitrate-nitrogen removal in multispecies riparian buffers. Short groundwater flow paths, long residence times, and contact with fine textured sediments favorably increased nitrate-nitrogen removal rates. Additionally, up to 60% of pathogens contained in runoff may be effectively removed. Computer modeling also indicates that over the long run (30 years), filter strips significantly reduce amounts of pollutants entering waterways.

Both filter strips and buffer strips should be designed as permanent plantings to treat runoff and should not be considered part of the annual rotation of adjacent cropland. Filter strips should receive only sheet flow, and they should be installed on stable banks. A mixture of grasses, forbs, and herbaceous plants should be used. In more permanent plantings, shrubs and trees should be intermingled to form a stable riparian community.

Conservation Tillage

Conservation tillage refers to several different tillage methods or systems that leave at least 30% of the soil covered with crop residue after planting (Holdren et al., 2001). Tillage methods encompassed by conservation tillage include no-till, mulch-till, ridge-till, zero till, slot plant, row till, direct seeding, or strip till. The purpose of conservation tillage is to reduce sheet and rill erosion, maintain or improve soil organic matter content, conserve soil moisture, increase available moisture, reduce plant damage, and provide habitat and cover for wildlife. The remaining crop residue helps reduce soil erosion and runoff volume.

Several researchers have demonstrated the benefits of conservation tillage in reducing pollutant loading to streams and lakes. A comprehensive comparison of tillage systems showed that no-till results in 70% less herbicide runoff, 93% less erosion, and 69% less water runoff volume when compared to conventional tillage (Conservation Technology Information Center, 2000). Reductions in pesticide loading have also been reported (Olem and Flock, 1990).

Cover Crops
Cover crops include legumes, such as clover, hairy vetch, field peas, alfalfa, and soybean, and non-legumes, such as rye, oats, wheat, radishes, turnips, and buckwheat which are planted prior to or following crop harvest. Cover crops are typically grown for one season and are typically grown in non-cropping seasons. Cover crops are used to improve soil quality and future crop harvest by improving soil tilth, reducing wind and water erosion, increasing available nitrogen, suppressing weed cover, and encouraging beneficial insect growth. Cover crops reduce phosphorus transport by reducing soil erosion and runoff. Both wind and water erosion move soil particles that have phosphorus attached. Sediment that reaches water bodies may release phosphorus into the water. The cover crop vegetation recovers plant-available phosphorus in the soil and recycles it through the plant biomass for succeeding crops. Runoff water can wash soluble phosphorus from the surface soil and crop residue and carry it off the field.

Grassed Waterways
Grassed waterways are natural or constructed channels established for transport of concentrated flow at safe velocities using adequate channel dimensions and proper vegetation. They are generally broad and shallow by design to move surface water across farmland without causing soil erosion. Grassed waterways are used as outlets to prevent rill and gully formation. The vegetative cover slows the water flow, minimizing channel surface erosion. When properly constructed, grassed waterways can safely transport large water flows downslope. These waterways can also be used as outlets for water released from contoured and terraced systems and from diverted channels. This BMP can reduce sediment concentrations of nearby waterbodies and pollutants in runoff. The vegetation improves the soil aeration and water quality due to its nutrient removal through plant uptake and absorption by soil. The waterways can also provide wildlife corridors and allows more land to be natural areas.

Hay/Pasture Planting

This practice applies to all lands suitable to the establishment of annual, biennial or perennial species for forage or biomass production. This practice does not apply to the establishment of annually planted and harvested food, fiber, or oilseed crops. This practice has many benefits which includes: improve or maintain livestock nutrition and/or health, provide or increase forage supply during periods of low forage production, reduce soil erosion, improve soil and water quality, and produce feedstock for biofuel or energy production.

Livestock Restriction or Rotational Grazing – (Fencing)
Livestock that have unrestricted access to a stream or wetland have the potential to degrade the waterbody's water quality and biotic integrity. Livestock can deliver nutrients and pathogens directly to a waterbody through defecation. Livestock also degrade stream ecosystems indirectly. Trampling and removal of vegetation through grazing of riparian zones can weaken banks and increase the potential for bank erosion. Trampling can also compact soils in a wetland or riparian zone decreasing the area's ability to infiltrate water runoff. Removal of vegetation in a wetland or riparian zone also limits the area's ability to filter pollutants in runoff. The degradation of a waterbody's water quality and habitat typically results in the impairment of the biota living in the waterbody.

Restoring areas impacted by livestock grazing often involves several steps. First, the livestock in these areas should be restricted from the waterbody or stream to which they currently have access. If necessary, an alternate source of water should be created for the livestock. Second, the wetland or riparian zone where the livestock have grazed should be restored. This may include stabilizing or reconstructing the banks using bioengineering techniques. Minimally, it involves installing filter strips along banks or wetland edge and replanting any denuded areas. Finally, if possible, drainage from the land where the livestock are pastured should be directed to flow through a constructed wetland to reduce pollutant loading, particularly nitrate-nitrogen loading, to the adjacent waterbody. Complete restoration of aquatic areas impacted by livestock will help reduce pollutant loading, particularly nitrate-nitrogen, sediment, and pathogens.

A livestock exclusion system is a system of permanent fencing (board, barbed, etc) installed to exclude livestock from streams and areas, not intended for grazing. This will reduce erosion, sediment, and nutrient loading, and improve the quality of surface water. Education and outreach programs focusing on rotational grazing and exclusionary fencing are important in the success of this BMP.

Roof runoff and collection structures

Runoff from impervious surfaces like roofs can carry a significant amount of nonpoint source pollutants to nearby streams. It is recommended that structures that collect, control, and transport precipitation from roofs be installed to reduce this effect. A container that collects and stores rainwater from rooftops (via gutters and downspouts) for later use for irrigation, livestock watering, or slow release during dry periods is recommended. Rain is a naturally soft water and devoid of minerals, chlorine, fluoride, and other chemicals. Collection structures, like cisterns, help to reduce peak volume and velocity of stormwater runoff to streams.

Heavy Use Area Protection

Heavy Use Area Protection is used to stabilize a ground surface that is frequently and intensively used by people, animals, or vehicles. Natural vegetation cannot withstand intense use so the area becomes unstable and vulnerable to erosion. These intensely used areas are very common in grazing systems around the water tanks and feeding areas, especially during the winter when all vegetation is dormant.

Access Roads

An access road is used to provide a fixed route for vehicular travel for resource activities involving the management of timber, livestock, agriculture, wildlife habitat, and other conservation enterprises. Access roads will be designed to serve the enterprise or planned use with the expected vehicular or equipment traffic. The type of vehicle or equipment, speed, loads, soil, climatic, and other conditions under which vehicles and equipment are expected to operate need to be considered.

Septic System Care and Maintenance

Septic, or on-site waste disposal systems, are the primary means of sanitary flow treatment outside of incorporated areas. Because of the prohibitive cost of providing centralized sewer systems to many areas, septic tank systems will remain the primary means of treatment into the future. Annual maintenance of septic systems is crucial for their operation, particularly the annual removal of accumulated sludge. The cost of replacing failed septic tanks is about $5,000-$15,000 per unit based on industry standards.

Property owners are responsible for their septic systems under the regulation of the County Health Department. When septic systems fail, untreated sanitary flows are discharged into open watercourses that pollute the water and pose a potential public health risk. Septic systems discharging to the ground surface are a risk to public health directly through body contact or contamination of drinking water sources. Additionally, septic systems can contribute significant amounts of nitrogen and phosphorus to the watershed. Therefore, it is imperative for homeowners not to ignore septic failures. If plumbing fixtures back up and/or will not drain then the system is failing.

As conservation practices are implemented throughout the watershed, a continuous pollutant load reduction total can be calculated using the StepL and Region5 load reduction tools. These pollutant loads can be recorded so that progress can be tracked for the purpose of verifying when watershed pollutant load reduction goals are achieved, both short-term and long-term. See Table 65 for expected load reductions for agricultural BMP's.

Table 65: Agricultural BMP Expected Load Reductions

Practices	Amount	Sediment (T/yr)	Phosphorus (lbs./yr)	Nitrogen (lbs./yr)	E.coli Percent reduction efficiency	Target Amount to Install	Targeted Subwatersheds
Alternate Watering Systems	1 acre	3	4	8.5	82% cells/year	20 units – serving 2,000 acres	**High Priority:** Tub Creek (501) Little Laughery Creek (502) Walnut Creek (505) Headwaters Ripley Creek (503) **Medium Priority:** North Branch (504) Jericho Creek (506)
Buffer Strip (Shrub/Tree)	1 acre	9	9	17	-	2.3 acres	
Conservation Tillage/No till	1 acre	11	9	12	-	3,000 acres	
Cover Crop	1 acre	5	5	9	-	10,000 acres	
Filter Strip (grass)	1 acre	9	9	17	71% cells/year	4 acres	
Livestock Restriction or Rotational Grazing (Fencing)	1 acre	3	4	8.5	90% cells/year (rotational grazing) 52% cells/year (exclusion fence)	105,600 ft serving 1,320 acres	
Grassed Waterway	0.1 acre	18	18	36	-	25 acres	
Hay/Pasture Planting	1 acre	17.6	17.9	35.7	-	1,000 acres	
Roof Runoff & Structures	1 unit	NA	454	NA	-	10 units	
Heavy Use Area Protection	1 HUAP	90	67	134	-	25 HUAPs	
Access Road	100'	8.5	6.5	13.5	-	4,000 feet	

Urban Management Practices

The North Laughery Watershed is mostly rural but contains the communities of Batesville, Napoleon, and Osgood. The outskirts of the watershed have the communities of Sunman, Milan, and Versailles with a small portion of each town within the watershed. In these areas, the installation of urban BMPs would be beneficial. The best way to mitigate storm water impacts is to infiltrate, store, and treat storm water onsite before it can run off into the streams in the area. Although there will be no 319 cost share money available to implement urban best management practices, there will be educational activities and materials available to assist the urban sector. Urban BMP's that are available, and designed to complete the actions listed above include:

- Bioretention Practices
- Detention Basins
- Grass Swales
- Phosphorus-free Fertilizers
- Rain Barrels/ Cisterns
- Rain Gardens
- Trash Control and Removal
- These practices would mainly be feasible for the subwatersheds of Little Laughery Creek, Jericho Creek, and Walnut Creek, since they contain the watershed's urban areas.

Bioretention Practices

Bioretention practices use biofiltration or bioinfiltration to filter runoff by storing it in shallow depressions. Bioretention uses plant uptake and soil permeability mechanisms in a variety of manners typically in combination. Potential practices include sand beds, pea gravel, overflow structures, organic mulch layers, plant materials, gravel underdrains, and an overflow system to promote infiltration. Bioinfiltration can also be used to treat runoff from parking lots, roads, driveways and other areas in the urban environment. Bioretention should not be used in highly urbanized areas instead it should be used in areas where onsite storage space is available, and there is no risk of subsurface collapse.

Detention Basins

Detention basins are large, open, un-vegetated basins designed to hold water for short periods following a rain event (dry detention basin) or continuously (wet detention basin). Detention basins are designed to hold water for longer periods with the goal of reducing sediment flow from the basin or provide filtration of stormwater before it enters the basin through the use of urban pond buffers. Additionally, oils, grease, nutrients, and pesticides can also settle in the basin. The nutrients are then used by the plants for growth and development.

Grass Swales

Grass swales are used in urban areas and are often considered landscape features. Swales are graded to be linear with a shallow, open channel of a trapezoidal or parabolic shape. Vegetation that is water tolerant is planted within the channel which promotes the slowing of water flow through the system. Swales reduce sediment and nutrients as water moves through the swale and water infiltrates into the groundwater.

Phosphorus-free Fertilizers

Phosphorus-free fertilizers are those fertilizers that supply nitrogen and minor nutrients without the addition of phosphorus. Phosphorus increases algae and plant growth which can cause negative impacts on water quality within aquatic systems. The Clear Choices, Clean Water (2010) program estimates that a one acre lawn fertilized with traditional fertilizer supplies 7.8 pounds of phosphorus to local waterbodies annually. Established lawns take their nutrients from the soil in which they grow and need little additional nutrients to continue plant growth. Fertilizers are manufactured in a variety of forms including that without phosphorus. Phosphorus-free fertilizer should be considered for use in areas where grass is already established.

Rain Barrel/Cisterns
A rain barrel, or larger cistern, is a container that collects and stores rainwater from your rooftop (via your home's disconnected downspouts) for later use on your lawn, garden, or other outdoor uses. Rainwater stored in rain barrels can be useful for watering landscapes, gardens, lawns, and trees. Rain is a naturally soft water and devoid of minerals, chlorine, fluoride, and other chemicals. In addition, rain barrels help to reduce peak volume and velocity of stormwater runoff to streams and storm sewer systems. Although rain barrels do not specifically reduce nutrient or sediment loading to waterbodies, their presence can reduce the first flush of water reaching storm drains.

Rain Gardens
Rain gardens are small-scale bioretention systems that can be used as landscape features and small-scale stormwater management systems like single-family homes, townhouse units, some small commercial development, and to treat parking lot or building runoff. Rain gardens provide a landscape feature for the site and reduce the need for irrigation, and can be used to provide stormwater depression storage and treatment near the point of generation. These systems can be integrated into the stormwater management system since the components can be optimized to maximize depression storage, pretreatment of the stormwater runoff, promote evapotranspiration, and facilitate groundwater recharge. The combination of these benefits can result in decreased flooding due to a decrease in the peak flow and total volume of runoff generated by a storm event.

Additionally, rain gardens can be designed to provide a significant improvement in the quality of the stormwater runoff. These systems should not be installed in or near sinkholes. Adding additional drainage to these features can cause further dissolution of limestone, which in turn may cause further collapse.

Implementation and Management Strategy Summary

The target amount of BMPs proposed to be installed are not required to be implemented exactly as the quantities suggest. These targets are simply guidelines for achieving the goals. These BMPs were chosen based on landuse and windshield survey concerns identified, in addition to water quality data. The table below lists the total expected load reductions for the target number of BMPs that are proposed to be installed. It also compares the expected load reduction with the load reduction that is required to meet the water quality targets. When the true load reductions are calculated for the practices installed, the goal may still be unmet. The steering committee realizes that the model's calculations are only an estimate, and actual reductions could be beyond the model's estimation. The Region V model does not provide estimated reductions for all suggested BMPs; therefore, those load reductions are not accounted for. BMPs implemented through other funding sources could account for additional load reduction. The steering committee acknowledges that they have set the bar high by establishing ambitious and strenuous water quality targets that will be difficult to obtain. The group is committed to improve water quality the best that they can, even in the event that the original load reduction goals are not met. Additional reductions may be required to meet the water quality targets for sediment, phosphorus, and nitrogen.

Table 66: Load reduction needed to meet 15 year water quality targets

Practices	Target Amount to Install	Sediment (T/yr)	Phosphorus (lbs./yr)	Nitrogen (lbs./yr)
Alternate Watering Systems	20 units serving 2,000 acres	6,000	8,000	17,000
Buffer Strip (Shrub/Tree)	2.3 acres	21	21	39
Conservation Tillage/No till	3,000 acres	33,000	27,000	36,000
Cover Crop	10,000 acres	50,000	50,000	90,000
Filter Strip (grass)	4 acres	36	36	68
Livestock Restriction or Rotational Grazing (Fencing)	1,320 acres	3,960	5,280	11,200
Grassed Waterway	25 acres	4,500	4,500	9,000
Hay/Pasture Planting	1,000 acres	17,600	17,900	35,700
Roof Runoff & Structures	10 units	NA	4,540	NA
Heavy Use Area Protection	25 HUAPs	2,250	1,675	3,350
Access Road	4,000 ft.	340	260	540
Septic System Care and Maintenance	75 systems	NA	488	4,125
Load reduction from target amount of BMPs		117,707	119,700	207,022
Load reduction needed to meet 15 year water quality targets		143,102	225,912	283,289
Load Reduction still needed to meet target		25,395	106,212	76,267

Action Plan for Implementation

An action plan was developed as a guide to move forward and start working to achieve the water quality goals set in the watershed management plan. It includes specific and measurable objectives and strategies the project wishes to implement. In it are objectives, milestones, cost estimates, possible partners, and technical assistance. Some of the objectives and milestones for the different goals list the same or very similar activities. For example, publications and workshop/field days listed can cover many topics and would apply to multiple goals. Many BMPs also can address more than one resource concern, so one BMP can help meet different goals of the watershed management plan. The same workshop/field day, publication, and BMPs may be listed for different goals when it is relevant.

Table 67: Action Plan and Strategies for the North Laughery Watershed

Goal	Objective	Target Audience	Milestones	Estimated Cost Share	Potential Partners (P)/ Technical Assistance(T)
Reduce soil erosion and amount of sedimentation entering the streams. The load reduction needed to meet the <25 mg/L target is 143,102 tons/yr.	Educate and promote installation of BMPs through field days/workshops	Producers, Landowners, Residents, and County Agencies	Hold 1 field day/workshop annually	$499,500.	SWCD P&T NRCS P&T Purdue P&T ISDA P&T US Fish & Wildlife P&T IDEM P&T
	Education through publications		Develop 4 publications annually		
	Provide financial assistance to convert from conventional tillage to no-till systems in high residue crops such as corn (not soybeans)		Convert 600 acres to no-till every 3 years		
	Provide financial assistance to plant cover crops		Plant 2,000 acres every 3 years		
	Provide financial assistance to establish grassed waterways		Establish 5 acres of grassed waterways every 3 years		
	Provide financial assistance to establish filter strips		Establish 1 acre of filter strips every 3 years		
	Provide financial assistance to implement rotational grazing systems		Implement rotational grazing on 264 acres every 3 years		
	Provide financial assistance for fencing and watering systems		Install 3 systems of fence and watering systems every 3 years		
	Provide financial assistance to establish riparian buffers		Establish 400 ft. of riparian buffers every 3 years		
	Provide financial assistance to establish HUAPs and Access Roads		Install 4 HUAPs and 300' of Access Roads every 3 years		
	Promote the use of urban BMPs		Develop 1 publication annually		
Nitrogen needs to be reduced within the watershed. The load reduction needed to meet the <1.5 mg/L target is 708,246 lbs/yr. Phosphorous needs to be reduced within the watershed. The load reduction needed to meet the <0.076 mg/L	Educate and promote installation of BMPs through field days/workshops	Producers, Landowners, Residents, and County Agencies	Hold 1 field day/workshop annually	$350,000	SWCD P&T NRCS P&T Purdue P&T ISDA P&T US Fish & Wildlife P&T IDEM P&T
	Education through publications		Develop 4 publications annually		
	Provide financial assistance to plant cover crops		Plant 2,000 acres every 3 years		
	Provide financial assistance to implement improved pasture management systems		Implement 5 improved pasture management systems annually		

Goal	Objective	Target Audience	Milestones	Estimated Cost Share	Potential Partners (P)/ Technical Assistance(T)
target for TP is 451,825 lbs/yr.	Educate and promote proper nutrient management to the general public		Develop 1 publication annually		
Reduce E. coli concentrations throughout the watershed to meet water the quality target.	Educate livestock owners on the importance of pasture management & access control through field days/workshop	Producers, Landowners, Contractors, Realtors, and Residents	Hold 1 field day/workshop annually	$125,000	SWCD P&T NRCS P&T Purdue P&T ISDA P&T US Fish & Wildlife P&T IDEM P&T Health Departments P&T Consultants T
	Educate livestock owners on the importance of pasture management & access control through publications		Develop 1 publications annually		
	Provide financial assistance to exclude livestock from sensitive areas		Exclude 50 head of cattle annually from sensitive areas		
	Provide financial assistance to implement improved pasture management systems		*Implement 5 improved pasture systems annually		
	Educate and promote proper septic maintenance		Develop 1 publications annually	$10,000	
	Hold workshop for contractors and realtors on proper septic system sites and installation		Hold 1 contractor/realtor workshops every 3 years		
	Hold workshop on proper septic maintenance for landowners in the watershed		Hold 1 landowner workshop every 3 years		
Improve water quality and habitat to obtain passing mIBI, IBI, and QHEI scores and delist streams currently on IDEM's 303(d) list for IBC	Implement 319, CWI and other cost-share programs to implement BMPs that enhance riparian and wetland habitat. Promote CRP, WRP,and other cost-share programs designed to improve riparian and wetland habitat.	Landowners, Stakeholders, Agricultural Producers, General Public, county officials	Implement over 2,000 ft. new filter strips in watershed within 5 – 10 years	$7,500	SWCD P&T NRCS P&T Purdue P&T ISDA P&T US Fish & Wildlife P&T IDEM P&T Health Departments P&T Consultants T

Goal	Objective	Target Audience	Milestones	Estimated Cost Share	Potential Partners (P)/ Technical Assistance(T)
Increase public awareness and provide education on how individual choices and activities impact the watershed	Create a "North Laughery Watershed" signage program	Producers, Landowners, Residents, and County Agencies	Develop signage and criteria by 2023	$25,000	Environmental Groups P&T Residents P Government Agencies P&T
	Educate landowners, operators, and public on BMPs		Hold 1 educational events/workshops annually	$500	
	Educate landowners, operators, and public on BMPs	Landowners, Stakeholders, Agricultural Producers, General Public, county officials	Develop and distribute 4 publications annually		Environmental Groups P&T Residents P Government Agencies P&T IDEM P&T
Partner with government agencies and landowners on decreasing streambank erosion	Educate partners and landowners on the importance of buffers, increasing infiltration, and streambank stabilization.	Producers, Landowners, Residents, Environmental groups, and County Agencies	Hold 1 workshop on streambank stabilization, infiltration, or buffers every 3 years	$6,500	SWCD P&T NRCS P&T Purdue P&T ISDA P&T US Fish & Wildlife P&T IDEM P&T Consultants

Future Activities

In moving forward, the next step for the project is to start implementing this management plan for the North Laughery Watershed. Implementation 319 funds will be available for 18 months following the approval of the North Laughery Watershed Management Plan. These funds will be used to install best management practices (BMPs) and develop an education and outreach program. The Steering Committee will be requesting additional cost share funds from IDEM for 2023 and beyond.

In order to track the project's progress in reaching its goals and improving water quality, information and data will need to be continually collected during implementation. The following strategies will be used for tracking the progress toward its watershed management goals and its education and outreach effectiveness.

Table 68: Strategies for Tracking Goals and Effectiveness of Implementation

Tracking Strategy	Frequency	Total Estimated Cost	Partners	Technical Assistance
BMP Load Reductions	Continuous	NA	SWCDs & NRCS	Staff and Partners
Attendance at Workshop/Field Days	Yearly	NA	NA	NA
Post Workshop Surveys for Effectiveness	Yearly	NA	SWCDs & Purdue Extension	NA
Number of Educational Publications	Yearly	NA	NA	NA
Windshield Survey	Every 5-6 years	NA	NA	Staff and Committee
Number of cost-share participants	Yearly	NA	NA	Staff, Partners, & Committee

The tracking strategies above will be used to document changes and aid in the plan re-evaluation. Work completed towards each goal/objective will be documented in a tracking database, which will include scheduled and completed activities, numbers of individuals attending, or efforts completed toward each objective, as well as load calculations or monitoring results for each goal, objective, and strategy. Overall project progress will be tracked by measurable items such as workshops held, BMPs installed, meetings held, etc. Load reductions will be calculated for each BMP installed. These values and associated project details, including BMP type, location, size, cost, installer, etc. will be tracked over time. Individual landowner contacts and information will be tracked for both identified and installed BMPs. The North Laughery Watershed Educator is responsible for updating and maintaining the tracking database.

Future Water Monitoring Efforts

It is also anticipated that additional water quality monitoring will be completed by IDEM's Watershed Assessment and Planning Branch through their Performance Monitoring program. Performance monitoring is conducted to identify changes in areas where there is reason to believe improvements may have occurred as a result of activities that may have a mitigating effect on water quality impairments identified on the state's 303(d) List of Impaired Waters. There is also a fixed station in Jericho Creek that is sampled monthly and can be used to gauge progress on goals.

The specific parameters to be monitored and the number of sampling sites will vary depending on the type and spatial extent of the original impairment. Additional data could potentially be provided through the Probabilistic Monitoring program. The main objective of the probabilistic monitoring project is to provide a comprehensive, unbiased assessment of the ability of rivers and streams to support aquatic life and recreational uses

Due to the uncertainty of the watershed management planning, an adaptive management strategy will be implemented to improve the project's success. While much thought and expertise has been put into the planning process, not all scenarios can be foreseen. Often times there are changes such as a shift in North Laughery Watershed Management Plan community attitude/behavior, changes in resource concerns, development of new information or accomplishing a goal sooner or later than expected. By implementing an adaptive management strategy, the North Laughery Steering Committee can adjust the watershed management plan to ensure project success. A four step adaptive management strategy has been outlined for the North Laughery Watershed Project and can be found below.

Step 1: Planning- The planning process developed the North Laughery WMP that follows the IDEM's 2009 Watershed Management Checklist. The watershed coordinator, guided by the North Steering Committee, developed the WMP using knowledge of the watershed, inputs from stakeholders, new data from water monitoring and windshield surveys, and historical data. This plan includes goals, action register, and schedule outlining how and when to achieve the defined goals.

Step 2: Implementation- The action register and schedule will then be implemented to achieve the goals of the North Laughery project objectives and goals. Partnering agencies such as NRCS, SWCD, ISDA, and IDEM will carry out the implementation. Implementation will include a cost-share program and education events, both for youth and adults. Practices implemented through the cost-share program will follow the NRCS Field Office Technical Guide (FOTG) Practice Standards and will include, but not limited to, practices such as cover crops, heavy use area protection, pipeline, watering facilities, fencing, filter strips, and grassed waterways. Cost-share funding will be implemented in priority areas, addressing high priority areas before the medium priority area. A ranking system will be used to prioritize applications that will have the greatest impact on water quality improvement.

Step 3: Evaluate & Learn- Evaluations will occur every 3 years to check the progress being made toward the project goals. The steering committee will annually review progress and determine if the project is on track to meet interim and project end goals outlined in the Action Plan and goals. Factors evaluated will include, but are not limited to, numbers of BMPs installed, calculated/estimated load reductions of installed BMPs, number of individuals reached through outreach, etc. The evaluations will be conducted by the North Laughery Steering Committee. The group will then provide recommendations that will improve project success.

Step 4: Alter Strategy- The project's implementation and management strategy will be adjusted to improve the project's success. If progress is not made proportionate to the time into the project, the steering committee will have the opportunity to alter their strategy in order to meet the goals of the project. Adjustments will be based off of recommendations from the Evaluate and Learn step. Once the adjustments are agreed upon by the steering committee, the project will revert back to Implementation (Step 2) to continue with the Adaptive Management strategy (steps 2-4) until all goals have been met or all conservation opportunities have been exhausted. Historic Hoosier Hills is responsible for maintaining records for the project. Historic Hoosier Hills contact information: P.O. Box 407, Versailles, IN 47042   812-689-4107.

Appendix A - AIMS Sample Site Concentration Data

Tub Creek: Values shaded exceed pollutant limits set for the North Laughery management plan.

OML-05-0009				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N)
11/26/2018	#N/A	0.33	35.00	2.60
12/17/2018	#N/A	0.21	16.00	3.40
1/15/2019	#N/A	0.07	8.00	3.50
2/18/2019	#N/A	0.05	7.50	4.30
3/11/2019	#N/A	0.04	27.00	3.70
4/1/2019	108.10	0.08	14.00	3.20
5/13/2019	866.40	0.03	5.00	3.30
7/8/2019	88.60	0.05	4.50	1.50
7/15/2019	307.60	#N/A	#N/A	
7/22/2019	325.50	#N/A	#N/A	
7/29/2019	137.60	#N/A	#N/A	
8/5/2019	161.60	0.09	5.00	0.26
9/9/2019	238.20	0.07	5.00	0.10

Table 69: Tub Creek sample site OML-05-0009

OML-05-0024				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N)
11/26/2018	#N/A	0.34	67.00	1.50
12/17/2018	#N/A	0.12	15.00	5.40
1/15/2019	#N/A	0.03	6.00	3.20
2/18/2019	#N/A	0.04	5.00	4.00
3/11/2019	#N/A	0.24	14.00	3.60
4/1/2019	101.40	0.07	16.00	3.30
5/13/2019	488.40	0.05	3.50	2.90
7/8/2019	62.00	0.04	4.50	1.00
7/15/2019	82.60	#N/A	#N/A	
7/22/2019	285.10	#N/A	#N/A	
7/29/2019	93.30	#N/A	#N/A	
8/5/2019	79.40	0.27	7.50	1.00
9/9/2019	30.50	0.05	6.00	0.47

Table 70: Tub Creek sample site OML-05-0024

Walnut Creek: : Values shaded exceed pollutant limits set for the North Laughery management plan.

OML-05-0030				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N)
11/26/2018	#N/A	0.16	29.00	2.9
12/17/2018	#N/A	0.18	23.00	3.8
1/15/2019	#N/A	0.05	5.50	2.7
2/18/2019	#N/A	0.05	10.00	2.7
3/11/2019	#N/A	0.10	34.00	1.7
4/2/2019	124.60	0.08	21.00	1.9
5/14/2019	172.70	0.05	5.00	1.9
7/9/2019	72.30	0.05	6.50	2.3
7/16/2019	34.50			
7/23/2019	184.20			
7/30/2019	148.30			
8/6/2019	137.60	0.05	18.00	0.41
9/10/2019	325.50	0.04	11.00	0.54
10/8/2019	260.30	0.07	10.00	0.38

Table 71: Walnut Creek sample site OML-05-0030

OML-05-0031				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N)
4/1/2019	435.20	0.13	30.00	2.2
5/13/2019	1553.10	0.03	6.00	2.6
7/8/2019	435.20	0.06	12.00	4.4
7/15/2019	770.10	#N/A	#N/A	
7/22/2019	686.70	#N/A	#N/A	
7/29/2019	727.00	#N/A	#N/A	
8/5/2019	501.20	0.11	15.00	3.8
9/9/2019	123.60	0.18	10.00	3.1
10/7/2019	152.90	0.14	9.00	11

Table 72: Walnut Creek sample site OML-05-0031

OML060-0007				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N)
4/1/2019	167.00	0.10	18.00	2.8
5/13/2019	387.30	0.03	4.50	2.6
7/8/2019	435.20	0.07	14.00	1.2
7/15/2019	770.10	#N/A	#N/A	
7/22/2019	920.80	#N/A	#N/A	
7/29/2019	328.20	#N/A	#N/A	
8/5/2019	410.60	0.08	5.00	0.49
9/9/2019	191.80	0.10	6.00	0.31
10/7/2019	365.40	0.05	5.00	0.1

Table 73: Walnut Creek sample site OML060-0007

OML060-0005				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
4/1/2019	44.30	0.05	9.00	4.1
5/13/2019	579.40	0.05	4.00	3.4
7/8/2019	290.90	0.05	8.50	4.4
7/15/2019	290.90	#N/A	#N/A	
7/22/2019	613.10	#N/A	#N/A	
7/29/2019	1119.90	#N/A	#N/A	
8/5/2019	125.90	0.05	3.50	1.2
9/9/2019	47.30	0.04	5.00	0.24

Table 74: Walnut Creek sample site OML060-0005

OML-05-0032				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
4/1/2019	53.00	0.07	14.00	3.4
5/13/2019	517.20	0.05	3.50	3.3
7/8/2019	209.80	0.06	4.50	1.2
7/15/2019	344.80	#N/A	#N/A	
7/22/2019	727.00	#N/A	#N/A	
7/29/2019	248.90	#N/A	#N/A	
8/5/2019	387.30	0.08	7.50	0.1
9/9/2019	686.70	0.11	15.00	0.1

Table 75: Walnut Creek sample site OML-05-0032

ML060-0006				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
4/1/2019	161.60	0.08	14.00	3
5/13/2019	579.40	0.05	4.00	3
7/8/2019	58.10	0.07	6.50	0.77
7/15/2019	30.30	#N/A	#N/A	
7/22/2019	410.60	#N/A	#N/A	
7/29/2019	106.70	#N/A	#N/A	
8/5/2019	272.30	0.10	3.50	0.54
9/9/2019	62.70	0.06	9.50	0.1
10/7/2019	25.90	0.07	12.00	0.1

Table 76: Walnut Creek sample site OML060-0006

Jericho Creek: Values shaded exceed pollutant limits set for the North Laughery management plan.

OML-05-0033				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
4/2/2019	27.20	0.04	6.50	2
5/14/2019	81.60	0.05	2.00	3.2
7/9/2019	235.90	0.10	3.00	7.2
7/16/2019	770.10	#N/A	#N/A	
7/23/2019	1119.90	#N/A	#N/A	
7/30/2019	201.40	#N/A	#N/A	
8/6/2019	275.50	0.09	2.50	13
9/10/2019	22.30	0.09	3.50	17
10/8/2019	93.30	0.16	9.00	24

Table 77: Jericho Creek sample site OML-05-0033

OML-05-0042				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
11/26/2018	#N/A	0.17	16.00	2
12/17/2018	#N/A	0.19	24.00	3.2
2/18/2019	#N/A	0.05	6.50	2.3
3/11/2019	#N/A	0.11	37.00	1.7
4/2/2019	90.80	0.08	20.00	1.7
5/14/2019	71.70	0.05	7.00	1.7
7/9/2019	35.50	0.08	14.00	0.49
7/16/2019	27.50	#N/A	#N/A	
7/23/2019	133.40	#N/A	#N/A	
7/30/2019	19.90	#N/A	#N/A	
8/6/2019	5.20	0.04	10.00	0.1
9/10/2019	74.80	0.04	16.00	0.16
10/8/2019	30.90	0.12	13.00	0.1

Table 78: Jericho Creek sample site OML-05-0042

OML-05-0034				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
4/2/2019	42.00	0.04	8.50	0.3
5/14/2019	46.50	0.05	5.00	0.19
7/9/2019	135.40	0.03	5.00	0.4
7/16/2019	139.60	#N/A	#N/A	
7/23/2019	488.40	#N/A	#N/A	
7/30/2019	248.10	#N/A	#N/A	
8/6/2019	101.90	0.05	4.00	1.7
9/10/2019	68.90	0.03	16.00	2.6
10/8/2019	45.00	0.04	3.50	2.8

Table 79: Jericho Creek sample site OML-05-0034

OML060_0004				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N)
11/5/2018		0.14	12.00	
12/3/2018		0.20	20.00	
1/10/2019		0.07	4.00	
2/11/2019		0.08	13.00	
3/25/2019		0.38	223.00	1.80
4/10/2019		0.05	10.00	1.50
5/30/2019		0.12	21.00	1.90
6/24/2019		0.20	92.00	1.70
7/25/2019		0.08	13.00	2.40
8/21/2019		0.08	14.00	0.10
9/5/2019		0.06	10.00	0.10

Table 80: Jericho Creek sample site OML-06-0004

North Branch Creek: Values shaded exceed pollutant limits set for the North Laughery management plan.

OML-05-0027				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
4/2/2019	121.10	0.06	17.00	1
5/14/2019	185.00	0.05	4.00	0.87
7/9/2019	410.60	0.08	10.00	0.72
7/16/2019	579.40	#N/A	#N/A	
7/23/2019	183.50	#N/A	#N/A	
7/30/2019	344.80	#N/A	#N/A	
8/6/2019	22.60	0.07	13.00	0.099
9/10/2019	52.70	0.03	3.50	0.1

Table 81: North Branch Creek sample site OML-05-0027

OML-05-0028				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
4/2/2019	285.10	0.04	14.00	1.3
5/14/2019	461.10	0.05	3.00	1
7/9/2019	290.90	0.05	5.50	0.56
7/16/2019	198.90	#N/A	#N/A	
7/23/2019	172.30	#N/A	#N/A	
7/30/2019	172.20	#N/A	#N/A	
8/6/2019	88.90	0.03	23.00	0.1

Table 82: North Branch Creek sample site OML-05-0028

OML-05-0029				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
11/26/2018	#N/A	0.11	13.00	1.3
12/17/2018	#N/A	0.16	12.00	1.4
1/15/2019	#N/A	0.03	3.50	1.3
2/18/2019	#N/A	0.04	7.00	1.4
3/11/2019	#N/A	0.04	19.00	1.2
4/2/2019	201.40	0.06	16.00	1
5/14/2019	95.90	0.05	4.50	0.8
7/9/2019	172.50	0.09	10.00	0.97
7/16/2019	162.40	#N/A	#N/A	
7/23/2019	228.20	#N/A	#N/A	
7/30/2019	461.10	#N/A	#N/A	
8/6/2019	285.10	0.06	9.00	0.11
9/10/2019	60.90	0.07	7.50	0.1

Table 83: North Branch Creek sample site OML-05-0029

OML-05-0036				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
4/2/2019	70.30	0.04	9.50	0.59
5/14/2019	307.60	0.05	4.50	0.94
7/9/2019	686.70	0.04	6.50	0.31
7/16/2019	2419.60	#N/A	#N/A	
7/23/2019	1046.20	#N/A	#N/A	
7/30/2019	117.80	#N/A	#N/A	
8/6/2019	39.90	0.05	8.00	0.077

Table 84: North Branch Creek sample site OML-05-0036

Headwaters Ripley Creek: Values shaded exceed pollutant limits set for the North Laughery management plan.

OML-05-0025				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
4/2/2019	307.60	0.08	40.00	1.3
5/14/2019	1203.30	0.06	5.50	1.7
7/9/2019	517.20	0.13	8.50	1.1
7/16/2019	2419.60	#N/A	#N/A	
7/23/2019	547.50	#N/A	#N/A	
7/30/2019	235.90	#N/A	#N/A	
8/6/2019	95.90	0.23	9.00	1.1
9/10/2019	90.80	0.58	12.00	2
10/8/2019	185.00	1.10	12.00	0.075

Table 85: Headwaters Ripley Creek sample site OML-05-0025

OML-05-0026				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
11/26/2018	#N/A	0.12	36.00	1.1
12/17/2018	#N/A	0.18	16.00	1.4
1/15/2019	#N/A	0.05	5.50	1.1
2/18/2019	#N/A	0.06	9.00	1.3
3/11/2019	#N/A	0.04	26.00	1
4/2/2019	163.10	0.08	18.00	1
5/14/2019	298.70	0.05	7.00	1.1
7/9/2019	686.70	0.07	9.50	0.58
7/16/2019	416.00	#N/A	#N/A	
7/23/2019	328.20	#N/A	#N/A	
7/30/2019	275.50	#N/A	#N/A	
8/6/2019	387.30	0.09	11.00	0.052
9/10/2019	201.40	0.08	9.50	0.1
10/8/2019	1553.10	0.13	7.00	0.1

Table 86: Headwaters Ripley Creek sample site OML-05-0026

OML-05-0040				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
4/2/2019	172.20	0.05	16.00	0.73
5/14/2019	218.70	0.05	4.00	0.88
7/9/2019	1986.30	0.04	11.00	1.2
7/16/2019	1553.10	#N/A	#N/A	
7/23/2019	1732.90	#N/A	#N/A	
7/30/2019	1299.70	#N/A	#N/A	
8/6/2019	727.00	0.05	5.00	0.59
9/10/2019	686.70	0.05	4.50	0.47
10/8/2019	770.10	0.05	2.00	0.17

Table 87: Headwaters Ripley Creek sample site OML-05-0040

Little Laughery Creek: Values shaded exceed pollutant limits set for the North Laughery management plan.

OML-05-0020				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
4/1/2019	1299.70	0.09	17.00	4.3
5/13/2019	2419.60	0.05	5.00	3.8
7/8/2019	1119.90	0.09	11.00	1.3
7/15/2019	2419.60	#N/A	#N/A	
7/22/2019	1732.90	#N/A	#N/A	
7/29/2019	2419.60	#N/A	#N/A	
8/5/2019	613.10	0.05	18.00	0.1
9/9/2019	56.50	0.05	12.00	0.1

Table 88: Little Laughery Creek sample site OML-05-0020

OML-05-0021				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
4/1/2019	866.40	0.10	19.00	2.9
5/13/2019	2419.60	0.10	3.50	4.1
7/8/2019	866.40	0.15	7.50	4.1
7/15/2019	1203.30	#N/A	#N/A	
7/22/2019	2419.60	#N/A	#N/A	
7/29/2019	1299.70	#N/A	#N/A	
8/5/2019	579.40	0.33	4.00	11
9/9/2019	307.60	0.34	4.00	23
10/7/2019	185.00	0.30	4.50	22

Table 89: Little Laughery Creek sample site OML-05-0021

OML-05-0022				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
4/1/2019	275.50	0.15	47.00	0.47
5/13/2019	1119.90	0.06	8.00	0.39
7/8/2019	2419.60	0.06	17.00	0.55
7/15/2019	165.00	#N/A	#N/A	
7/22/2019	2419.60	#N/A	#N/A	
7/29/2019	613.10	#N/A	#N/A	
8/5/2019	1203.30	0.05	6.50	0.08

Table 90: Little Laughery Creek sample site OML-05-0022

OML-05-0023				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
11/26/2018	#N/A	0.36	65.00	2.2
12/17/2018	#N/A	0.15	22.00	3.4
1/15/2019	#N/A	0.06	8.00	2.9
2/18/2019	#N/A	0.07	15.00	2.2
3/11/2019	#N/A	0.10	32.00	1.8
4/1/2019	365.40	0.14	36.00	1.6
5/13/2019	2419.60	0.07	6.50	2.7
7/8/2019	579.40	0.13	19.00	8
7/15/2019	344.80	#N/A	#N/A	
7/22/2019	1732.90	#N/A	#N/A	
7/29/2019	272.30	#N/A	#N/A	
8/5/2019	139.60	0.23	7.50	9.6
9/9/2019	328.20	0.27	9.00	17
10/7/2019	172.20	0.25	6.00	14

Table 91: Little Laughery Creek sample site Table OML-05-0023

OML-05-0035				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
4/1/2019	920.80	0.05	9.00	1
5/13/2019	275.50	0.02	3.00	0.66
7/8/2019	172.60	0.06	10.00	0.1
7/15/2019	98.70	#N/A	#N/A	
7/22/2019	1553.10	#N/A	#N/A	
7/29/2019	125.00	#N/A	#N/A	
8/5/2019	86.00	0.03	3.50	0.1
9/9/2019	32.70	0.05	4.50	0.1
10/7/2019	1986.30	0.58	13.00	0.1

Table 92: Little Laughery Creek sample site OML-05-0035

OML-05-0012				
Date	E. coli	Phosphorus, Total	Solids, Suspended Total, (TSS)	Nitrate-Nitrogen (N
11/26/2018	#N/A	0.17	16.00	2
12/17/2018	#N/A	0.21	22.00	3.2
2/18/2019	#N/A	0.05	9.00	2.1
3/11/2019	#N/A	0.09	35.00	1.8
4/2/2019	114.50	0.07	19.00	1.6
5/14/2019	101.40	0.05	4.50	1.7
7/9/2019	43.10	0.08	18.00	0.7
7/16/2019	55.60	#N/A	#N/A	
7/23/2019	248.90	#N/A	#N/A	
7/30/2019	79.80	#N/A	#N/A	
8/6/2019	49.50	0.04	10.00	0.63
9/10/2019	91.00	0.04	5.50	1.4
10/8/2019	201.40	0.03	5.50	4.8

Henderson Bend: Values shaded exceed pollutant limits set for the North Laughery management plan.

Table 93: Henderson Bend sample site OML-05-0012

APPENDIX B - Programs to Assist with BMP Implementation

There are a number of federal, state, and local programs that either require or can assist with the implementation activities recommended for the Laughery Creek watershed. A description of these programs is provided in this section. The following section discusses how some of these programs relate to the various sources in the Laughery Creek watershed. Many of these programs directly address the stakeholder concerns listed earlier, particularly excessive sediment and nutrients entering Laughery Creek and its tributaries.

Federal Programs

Clean Water Act Section 319(h) Grants

Section 319 of the federal Clean Water Act contains provisions for the control of nonpoint source pollution. The Section 319 program provides for various voluntary projects throughout the state to prevent water pollution and also provides for assessment and management plans related to waterbodies in Indiana impacted by nonpoint source pollution. The Watershed Planning and Restoration Section within the Watershed Assessment and Planning Branch of the IDEM Office of Water Quality administers the Section 319 program for the nonpoint source-related projects.

U.S. EPA offers Clean Water Act Section 319(h) grant monies to the state on an annual basis. These grants must be used to fund projects that address nonpoint source pollution issues. Some projects which the Office of Water Quality has funded with this money in the past include developing and implementing Watershed Management Plans (WMPs), BMP demonstrations, data management, educational programs, modeling, stream restoration, and riparian buffer establishment. Projects are usually two to three years in length. Section 319(h) grants are intended to be used for project start-up, not as a continuous funding source. Units of government, nonprofit groups, and universities in the state that have expertise in nonpoint source pollution problems are invited to submit Section 319(h) proposals to the Office of Water Quality.

Clean Water Action Section 205(j) Grants

Section 205(j) provides for planning activities relating to the improvement of water quality from nonpoint and point sources by making funding available to municipal and county governments, regional planning commissions, and other public organizations. For-profit entities, nonprofit organizations, private associations, universities, and individuals are not eligible for funding through Section 205(j). The CWA states that the grants are to be used for water quality management and planning, including, but not limited to:

- Identifying most cost effective and locally acceptable facility and nonpoint source measures to meet and maintain water quality standards;
- Developing an implementation plan to obtain state and local financial and regulatory commitments to implement measures developed under subparagraph A;
- Determining the nature, extent, and cause of water quality problems in various areas of the state.

The Section 205(j) program provides for projects that gather and map information on nonpoint and point source water pollution, develop recommendations for increasing the involvement of environmental and civic organizations in watershed planning and implementation activities, and develop watershed management plans.

HUD Community Development Block Grant Program (CDBG)

The Community Development Block Grant Program (CDBG) is authorized under Title I of the Housing and Community Development (HCD) Act of 1974, as amended. The main objective of the CDBG program is to develop viable communities by helping to provide decent housing and suitable living environments and expanding economic opportunities principally for persons of low- and moderate- income. The U.S. Department of Housing and Urban Development (HUD) provides federal CDBG funds directly to Indiana annually, through the Office of Community and Rural Affairs (OCRA), which then provides funding to small, incorporated cities and towns with populations less than 50,000 and to non- urban counties.

CDBG regulations define eligible activities and the National Objectives that each activity must meet. OCRA is responsible for ensuring projects that receive funding in Indiana are in accordance with the National Objectives and eligible activities.

OCRA is required to develop a Consolidated Plan that describes needs, resources, priorities, and proposed activities to be undertaken. Indiana's Consolidated Plan includes four goals for prioritizing fund allocations. These goals include: expand and preserve affordable housing opportunities throughout the housing continuum, reduce homelessness and increase housing stability for special needs populations, promote livable communities and community revitalization through addressing unmet community development needs, and promote activities that enhance local economic development efforts. OCRA has funded a variety of projects, including sanitary sewer and water systems.

USDA Conservation Stewardship Program (CSP)

The Conservation Stewardship Program (CSP) helps landowners build on their existing conservation efforts while strengthening their operation. Whether they are looking to improve grazing conditions, increase crop yields, or develop wildlife habitat, NRCS can custom design a CSP plan to help them meet those goals. NRCS can help landowners schedule timely planting of cover crops, develop a grazing plan that will improve the forage base, implement no-till to reduce erosion or manage forested areas in a way that benefits wildlife habitat. If landowners are already taking steps to improve the condition of the land, chances are CSP can help them find new ways to meet their goals.

USDA Conservation Reserve Program (CRP)

NRCS provides technical assistance to landowners interested in participating in the Conservation Reserve Program (CRP) administered by the USDA Farm Service Agency. The Conservation Reserve Program reduces soil erosion, protects the nation's ability to produce food and fiber, reduces sedimentation in streams and lakes, improves water quality, establishes wildlife habitat, and enhances forest and wetland resources. It encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as tame or native grasses, wildlife plantings, trees, filter strips, or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract. Cost- share funding is provided to establish the vegetative cover practices.

USDA Conservation Reserve Enhancement Program (CREP)

NRCS provides technical assistance to landowners interested in participating in the Conservation Reserve Program (CRP) administered by the USDA Farm Service Agency. The Conservation Reserve Enhancement Program (CREP), an offshoot of CRP, targets high-priority conservation concerns identified by a state, and federal funds are supplemented with non-federal funds to address those concerns. In exchange for removing environmentally sensitive land from production and establishing permanent resource conserving plant species, farmers and ranchers are paid an annual rental rate along with other federal and state incentives as applicable per each CREP agreement. Participation is voluntary, and the contract period is typically 10–15 years.

USDA Conservation Technical Assistance (CTA)

The purpose of the CTA program is to assist landusers, communities, units of state and local government, and other Federal agencies in planning and implementing conservation systems. The purpose of the conservation systems is to reduce erosion, improve soil and water quality, improve and conserve wetlands, enhance fish and wildlife habitat, improve air quality, improve pasture and range condition, reduce upstream flooding, and improve woodlands.

One objective of the program is to assist individual landusers, communities, conservation districts, and other units of State and local government and Federal agencies to meet their goals for resource stewardship and assist individuals in complying with State and local requirements. NRCS assistance to individuals is provided through conservation districts in accordance with the Memorandum of Understanding signed by the Secretary of Agriculture, the Governor of the State, and the conservation district. Assistance is provided to landusers voluntarily applying conservation practices and to those who must comply with local or State laws and regulations.

Another objective is to provide assistance to agricultural producers to comply with the highly erodible land (HEL) and wetland (Swampbuster) provisions of the 1985 Food Security Act as amended by the Food, Agriculture, Conservation and Trade Act of 1990 (16 U.S.C. 3801 et. seq.), the Federal Agriculture Improvement and Reform Act of 1996, and wetlands requirements of Section 404 of the Clean Water Act. NRCS makes HEL and wetland determinations and helps landusers develop and implement conservation plans to comply with the law. The program also provides technical assistance to participants in USDA cost-share and conservation incentive programs.

NRCS collects, analyzes, interprets, displays, and disseminates information about the condition and trends of the Nation's soil and other natural resources so that people can make good decisions about resource use and about public policies for resource conservation. They also develop effective science- based technologies for natural resource assessment, management, and conservation.

USDA Environmental Quality Incentives Program (EQIP)

The Environmental Quality Incentives Program provides technical, educational, and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost effective manner. The program provides assistance to farmers and ranchers in complying with federal, state, and tribal environmental laws, and encourages environmental enhancement. The program is funded through the Commodity Credit Corporation. The purposes of the program are achieved through the implementation of a conservation plan, which includes structural, vegetative, and land management practices on eligible land. Five to ten year contracts are made with eligible producers. Cost-share payments may be made to implement one or more eligible structural or vegetative practices, such as animal waste management facilities, terraces, filter strips, tree planting, and permanent wildlife habitat. Incentive payments can be made to implement one or more land management practices, such as nutrient management, pest management, and grazing land management. Fifty percent of the funding available for the program is targeted at natural resource concerns relating to livestock production. The program is carried out primarily in priority areas that may be watersheds, regions, or multi-state areas, and for significant statewide natural resource concerns that are outside of geographic priority areas.

USDA Farmable Wetlands Program (FWP)

NRCS provides technical assistance to landowners interested in participating in the Conservation Reserve Program administered by the USDA Farm Service Agency. The Farmable Wetlands Program (FWP) is designed to restore previously farmed wetlands and wetland buffer to improve both vegetation and water flow. FWP is a voluntary program to restore up to one million acres of farmable wetlands and associated buffers. Participants must agree to restore the wetlands, establish plant cover, and to not use enrolled land for commercial purposes. Plant cover may include plants that are partially submerged or specific types of trees. By restoring farmable wetlands, FWP improves groundwater quality, helps trap and break down pollutants, prevents soil erosion, reduces downstream flood damage, and provides habitat for water birds and other wildlife. Wetlands can also be used to treat sewage and are found to be as effective as “high tech” methods. The Farm Service Agency runs the program through the Conservation Reserve Program (CRP) with assistance from other government agencies and local conservation groups.

USDA Agricultural Conservation Easement Program (ACEP)

The Agricultural Conservation Easement Program (ACEP) provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. Under the Agricultural Land Easements component, NRCS helps American Indian tribes, state and local governments and nongovernmental organizations protect working agricultural lands and limit non-agricultural uses of the land. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect, and enhance enrolled wetlands. Agricultural Land Easements protect the long-term viability of the nation’s food supply by preventing conversion of productive working lands to non-agricultural uses. Land protected by agricultural land easements provides additional public benefits, including environmental quality, historic preservation, wildlife habitat, and protection of open space.

Wetland Reserve Easements provide habitat for fish and wildlife, including threatened and endangered species, improve water quality by filtering sediments and chemicals, reduce flooding, recharge groundwater, protect biological diversity, and provide opportunities for educational, scientific, and limited recreational activities. NRCS provides financial assistance to eligible partners for purchasing Agricultural Land Easements that protect the agricultural use and conservation values of eligible land. In the case of working farms, the program helps farmers and ranchers keep their land in agriculture. The program also protects grazing uses and related conservation values by conserving grassland, including rangeland, pastureland and shrub land. Eligible partners include American Indian tribes, state and local governments and non-governmental organizations that have farmland, rangeland, or grassland protection programs. Under the Agricultural Land component, NRCS may contribute up to 50 percent of the fair market value of the agricultural land easement. Where NRCS determines that grasslands of special environmental significance will be protected, NRCS may contribute up to 75 percent of the fair market value of the agricultural land easement.

<u>USDA Regional Conservation Partnership Program (RCPP)</u>

The Regional Conservation Partnership Program (RCPP) encourages partners to join in efforts with producers to increase the restoration and sustainable use of soil, water, wildlife, and related natural resources on regional or watershed scales. Through the program, NRCS and its partners help producers install and maintain conservation activities in selected project areas. Partners leverage RCPP funding in project areas and report on the benefits achieved.

USDA Healthy Forests Reserve Program (HFRP)

The Healthy Forests Reserve Program (HFRP) helps landowners restore, enhance, and protect forestland resources on private lands through easements and financial assistance. HRFP aids the recovery of endangered and threatened species under the Endangered Species Act, improves plant and animal biodiversity, and enhances carbon sequestration.

HFRP provides landowners with 10-year restoration agreements and 30-year or permanent easements for specific conservation actions. For acreage owned by an Indian tribe, there is an additional enrollment option of a 30-year contract. Some landowners may avoid regulatory restrictions under the Endangered Species Act by restoring or improving habitat on their land for a specified period of time.

USDA Voluntary Public Access and Habitat Incentive Program (VPA-HIP)

The Voluntary Public Access and Habitat Incentive Program (VPA-HIP) is a competitive grants program that helps state and tribal governments increase public access to private lands for wildlife-dependent recreation, such as hunting, fishing, nature watching, or hiking.

State and tribal governments may submit proposals for VPA-HIP block grants from NRCS. These governments provide the funds to participating private landowners to initiate new or expand existing public access programs that enhance public access to areas previously unavailable for wildlife-dependent recreation. Nothing in VPA-HIP preempts liability laws that may apply to activities on any property related to grants made in this programs.

USDA Watershed Surveys and Planning

The Watershed and Flood Prevention Act, P.L. 83-566, August 4, 1954, (16 U.S.C. 1001-1008) authorized this program. Prior to fiscal year 1996, small watershed planning activities and the cooperative river basin surveys and investigations authorized by Section 6 of the Act were operated as separate programs. The 1996 appropriations act combined the activities into a single program entitled the Watershed Surveys and Planning program. Activities under both programs are continuing under this authority.

The purpose of the program is to assist federal, state, and local agencies and tribal governments to protect watersheds from damage caused by erosion, floodwater, and sediment and to conserve and develop water and land resources. Resource concerns addressed by the program include water quality, opportunities for water conservation, wetland and water storage capacity, agricultural drought problems, rural development, municipal and industrial water needs, upstream flood damages, and water needs for fish, wildlife, and forest-based industries. Types of surveys and plans include watershed plans, river basin surveys and studies, flood hazard analyses, and floodplain management assistance. The focus of these plans is to identify solutions that use land treatment and non-structural measures to solve resource problems.

USDA Wildlife Habitat Incentives Program (WHIP)

The Wildlife Habitat Incentives Program (WHIP) provides financial incentives to develop habitat for fish and wildlife on private lands. Participants agree to implement a wildlife habitat development plan and USDA agrees to provide cost-share assistance for the initial implementation of wildlife habitat development practices. USDA and program participants enter into a cost-share agreement for wildlife habitat development. This agreement generally lasts a minimum of 10 years from the date that the contract is signed.

USDA Section 504 Home Repair Program

USDA Rural Development administers the Section 504 Home Repair Program, or Single Family Housing Repair Loans and Grants. The Section 504 Home Repair Program provides loans to very low-income homeowners to repair, improve, or modernize their home and provides grants to elderly very low-income homeowners to remove health and safety hazards. The purpose of this program is to help families stay in their own home and keep their home in good repair. Applicants must live in a rural area below 50 percent of the area median income. Grant applicants must be age 62 or older and unable to repay a repair loan.

Loans may be used to repair, improve, or modernize homes or to remove health and safety hazards. Grants must be used to remove health and safety hazards. For example, repairing a failed septic system may be an applicable health and safety hazard. The maximum loan amount is $20,000, and the maximum grant amount is $7,500.

State Programs

IDEM Point Source Control Program

Point source pollution is regulated by several IDEM Office of Water Quality branches, including the Wastewater Compliance Branch, the Wastewater Permitting Branch, and the Surface Water, Operations, and Enforcement Branch. The Wastewater Permitting Branch issues NPDES and construction permits to sources that discharge wastewater to streams, lakes, and other waterbodies, including municipal wastewater treatment plants and industrial wastewater dischargers. The Stormwater Program, which is managed under the Surface Water, Operations, and Enforcement Branch, issues NPDES permits for stormwater discharges associated with industrial activities, active construction that results in a land disturbance of an acre or more, and municipal separate storm sewer systems (MS4). NPDES permits are issued in accordance with the Clean Water Act, federal laws, and state laws and regulations. The purpose of the NPDES permit is to control the point source discharge of pollutants into the waters of the state such that the quality of the water of the state is maintained in accordance with applicable water quality standards. The Wastewater Compliance Branch and Stormwater Program conduct inspections of facilities and projects with NPDES permits and review and evaluate compliance data to ensure permittees abide by the requirements of their permit. Control of discharges from point sources consistent with WLAs are implemented through the respective NPDES program.

IDEM Nonpoint Source Control Program

The state's Nonpoint Source Program, administered by the IDEM Office of Water Quality's Watershed Planning and Restoration Section, focuses on the assessment and prevention of nonpoint source water pollution. The program also provides for education and outreach to improve the way land is managed. Through the use of federal funding for the installation of BMPs, the development of watershed management plans, and the implementation of watershed restoration pollution prevention activities, the program reaches out to citizens so that land is managed in such a way that less pollution is generated.

Nonpoint source projects funded through the Office of Water Quality are a combination of local, regional, and statewide efforts sponsored by various public and not-for-profit organizations. The emphasis of these projects has been on the local, voluntary implementation of nonpoint source water pollution controls. The Watershed Planning and Restoration Section administers the Section 319 funding for nonpoint source- related projects, as well as Section 205(j) grants.

To award 319 grants, Watershed Planning and Restoration Section staff review proposals for minimum 319(h) eligibility criteria and rank each proposal. In their review, members consider such factors as: technical soundness; likelihood of achieving water quality results; strength of local partnerships; and competence/reliability of contracting agency. They then convene to discuss individual project merits and pool all rankings to arrive at final rankings for the projects. All proposals that rank above the funding target are included in the annual grant application to U.S. EPA, with U.S. EPA reserving the right to make final changes to the list. Actual funding depends on approval from U.S. EPA and yearly congressional appropriations.

Section 205(j) projects are administered through grant agreements that define the tasks, schedule, and budget for the project. IDEM project managers work closely with the project sponsors to help ensure that the project runs smoothly and the tasks of the grant agreement are fulfilled. Site visits are conducted at least quarterly to touch base on the project, provide guidance and technical assistance as needed, and to work with the grantee on any issues that arise to ensure a successful project closeout.

IDEM Hoosier Riverwatch Program

Hoosier Riverwatch (HRW) is a statewide volunteer stream water quality monitoring program administered by the IDEM Office of Water Quality, Watershed Assessment and Planning Branch. The mission of HRW is to involve the citizens of Indiana in becoming active stewards of Indiana's water resources and to increase public awareness of water quality issues and concerns. HRW accomplishes this through watershed education, hands-on training of volunteers, water monitoring, and clean-up activities. HRW collaborates with agencies and volunteers to educate local communities about the relationship between land use and water quality and to provide water quality information to citizens and governmental agencies working to protect Indiana's rivers and streams.

ISDA Division of Soil Conservation

The Indiana State Department of Agriculture (ISDA) Division of Soil Conservation's mission is to ensure the protection, wise use, and enhancement of Indiana's soil and water resources. The Division's employees are part of Indiana's Conservation Partnership, which includes the 92 soil and water conservation districts (SWCDs), the USDA Natural Resources Conservation Service, and the Purdue University Cooperative Extension Service. Working together, the partnership provides technical, educational, and financial assistance to citizens to solve erosion and sediment-related problems occurring on the land or impacting public waters.

ISDA Clean Water Indiana (CWI) Program

The ISDA Division of Soil Conservation administers the Clean Water Indiana (CWI) program under the direction of the State Soil Conservation Board. The CWI program provides financial assistance to landowners and conservation groups to support the implementation of conservation practices which will reduce nonpoint sources of water pollution through education, technical assistance, training, and cost sharing programs. The program is responsible for providing local matching funds, as well as competitive grants for sediment and nutrient reduction projects through Indiana's SWCDs.

ISDA INfield Advantage (INFA) Program

The ISDA Division of Soil Conservation administers Infield Advantage (INFA). INFA is a collaborative opportunity for farmers to collect and understand personalized, on-farm data to optimize their management practices. Participating farmers use precision agricultural tools and technologies, such as aerial imagery and the corn stalk nitrate test, to conduct research on their own farms to determine nitrogen use efficiency in each field that they enroll. Peer to peer group discussions, local aggregated results, and collected data allow participants to make more informed decisions and implement personalized best management practices. INFA is available to farmers as a resource and a conduit to diverse on-farm research, innovative ideas, and technologies. INFA collaborates with local, regional, and national partners to help Indiana farmers improve their bottom line, adopt new management practices, protect natural resources, and benefit their surrounding communities.

IDNR Lake and River Enhancement (LARE) Program

The Lake and River Enhancement program is part of the Aquatic Habitat Unit of the Fisheries Section in the Indiana Department of Natural Resources (IDNR), Division of Fish and Wildlife. The goal of the LARE program is to protect and enhance aquatic habitat for fish and wildlife and to insure the continued viability of Indiana's publicly accessible lakes and streams for multiple uses, including recreational opportunities. This is accomplished through measures that reduce nonpoint source sediment and nutrient pollution of surface waters to a level that meets or surpasses state water quality standards. The LARE program provides technical and financial assistance to local entities for qualifying projects that improve and maintain water quality in public access lakes, rivers, and streams.

IFA State Revolving Fund (SRF) Loan Program

The SRF is a fixed rate, 20-year loan administered by the Indiana Finance Authority (IFA). The SRF provides low-interest loans to Indiana communities for projects that improve wastewater and drinking water infrastructure. The program's mission is to provide eligible entities with the lowest interest rates possible on the financing of such projects while protecting public health and the environment. SRF also funds nonpoint source projects that are tied to a wastewater loan. Any project where there is an existing pollution abatement need is eligible for SRF funding.

Local Programs

Programs taking place at the local level are key to successful TMDL implementation. Partners like Historic Hoosier Hills RC&D are instrumental to bringing grant funding into the Laughery Creek watershed to support local protection and restoration projects. This is a summary of the local programs taking place in the Laughery Creek watershed that help to reduce pollutant loads, as well as provide ancillary benefits to the Laughery Creek watershed.

APPENDIX C – Load Calculations

Tub Creek

90th Percentile Concentrations	High (5%)	Moist (25%)	Mid-range (50%)	Dry (75%)	Low (95%)
E. coli (cfu/100ml)	107.43	828.60		309.39	217.43
TP (mg/L)	0.08	0.32		0.22	0.07
TSS (mg/L))	15.80	34.20		6.75	5.90
Nitrate-Nitrogen (mg/L)	3.29	4.27		1.35	0.43
Flow (cfs)	159	30	10	2	1
Target TP Load (lbs/year)	23,766	4,420	1,441	360	89
TP 90th percentile load (lb/year)	24,516	18,668		1,024	83
TP Reduction (lbs/year)	**751**	**14,248**		**664**	
TP Reduction %	**3.1%**	**76.3%**		**64.8%**	
Target TSS Load (lbs/year)	7,817,725	1,453,899	474,071	118,536	29,286
TSS 90th percentile load (lb/year)	4,940,802	1,988,933		32,005	6,912
TSS Reduction (lbs/year)		**535,035**			
TSS Reduction %		**27%**			
Target N Load (lbs/year)	469,063	87,234	28,444	7,112	1,757
N 90th percentile load (lb/year)	1,028,813	248,326		6,401	507
N Reduction (lbs/year)	**559,749**	**161,092**			
N Reduction %	**54%**	**65%**			
Target E. coli load (cfu/year)	3.33E+14	6.20E+13	2.02E+13	5.05E+12	1.25E+12
E. coli 90th percentile load (cfu/year)	1.52E+14	2.19E+14		6.65E+12	1.16E+12
E. coli Reduction (cfu/year)		**1.57E+14**		**1.60E+12**	
E. coli Reduction %		**72%**		**24%**	

Little Laughery

90th Percentile Concentrations	High (5%)	Moist (25%)	Mid-range (50%)	Dry (75%)	Low (95%)
E. coli (cfu/100ml)	1148.14	2419.60		2419.60	322.02
TP (mg/L)	0.15	0.17		0.32	0.32
TSS (mg/L))	42.60	35.30		17.80	11.10
Nitrate-Nitrogen (mg/L)	3.74	3.83		13.40	21.20
Flow (cfs)	180	37	14	6	4
Target TP Load (lbs/year)	26,890	5,463	2,164	966	666
TP 90th percentile load (lb/year)	51,657	12,291		4,120	2,795
TP Reduction (lbs/year)	**24,767**	**6,828**		**3,154**	**2,129**
TP Reduction %	**47.9%**	**55.6%**		**76.5%**	**76.2%**
Target TSS Load (lbs/year)	8,845,458	1,796,933	711,684	317,895	219,043
TSS 90th percentile load (lb/year)	15,072,661	2,537,269		226,341	97,255
TSS Reduction (lbs/year)	**6,227,203**	**740,336**			
TSS Reduction %	**41.3%**	**29.2%**			

Target N Load (lbs/year)	530,727	107,816	42,701	19,074	13,143
N 90th percentile load (lb/year)	1,323,281	275,290		170,392	185,748
N Reduction (lbs/year)	**792,553**	**167,474**		**151,318**	**172,606**
N Reduction %	**60%**	**61%**		**89%**	**93%**
Target E. coli load (cfu/year)	3.77E+14	7.66E+13	3.03E+13	1.36E+13	9.34E+12
E. coli 90th percentile load (cfu/year)	1.84E+15	7.89E+14		1.40E+14	1.28E+13
E. coli Reduction (cfu/year)	**1.47E+15**	**7.12E+14**		**1.26E+14**	**3.46E+12**
E. coli Reduction %	**80%**	**90%**		**90%**	**27%**

Headwaters Ripley Creek

90th Percentile Concentrations	High (5%)	Moist (25%)	Mid-range (50%)	Dry (75%)	Low (95%)
E. coli (cfu/100ml)		755.45	1495.82	1813.02	589.64
TP (mg/L)		0.12		0.40	0.48
TSS (mg/L))		36.00		11.20	11.50
Nitrate-Nitrogen (mg/L)		1.40		1.12	1.69
Flow (cfs)	121	23	7	2	1
Target TP Load (lbs/year)	18,157	3,390	1,117	292	85
TP 90th percentile load (lb/year)		5,353		1,551	534
TP Reduction (lbs/year)		**1,963**		**1,259**	**449**
TP Reduction %		**36.7%**		**81.2%**	**84.1%**
Target TSS Load (lbs/year)	5,972,752	1,115,264	367,365	95,986	27,862
TSS 90th percentile load (lb/year)		1,605,980		43,002	12,816
TSS Reduction (lbs/year)		**490,716**			
TSS Reduction %		**30.6%**			
Target N Load (lbs/year)	358,365	66,916	22,042	5,759	1,672
N 90th percentile load (lb/year)		62,455		4,300	1,888
N Reduction (lbs/year)					**216**
N Reduction %					**11%**
Target E. coli load (cfu/year)	2.55E+14	4.76E+13	1.57E+13	4.09E+12	1.19E+12
E. coli 90th percentile load (cfu/year)		1.53E+14	9.97E+13	3.16E+13	2.98E+12
E. coli Reduction (cfu/year)		**1.05E+14**	**8.40E+13**	**2.75E+13**	**1.79E+12**
E. coli Reduction %		**69%**	**84%**	**87%**	**60%**

North Branch

90th Percentile Concentrations	High (5%)	Moist (25%)	Mid-range (50%)	Dry (75%)	Low (95%)
E. coli (cfu/100ml)		353.65	800.80	633.05	60.08
TP (mg/L)		0.10		0.08	0.07
TSS (mg/L))		16.80		16.00	7.10
Nitrate-Nitrogen (mg/L)		1.38		0.80	0.10
Flow (cfs)	271	50	16	4	1

Target TP Load (lbs/year)	40,606	7,530	2,437	589	125
TP 90th percentile load (lb/year)		9,987		625	111
TP Reduction (lbs/year)		**2,457**		**36**	
TP Reduction %		**24.6%**		**5.8%**	
Target TSS Load (lbs/year)	13,357,089	2,476,833	801,618	193,758	41,167
TSS 90th percentile load (lb/year)		1,664,431		124,005	11,692
TSS Reduction (lbs/year)					
TSS Reduction %					
Target N Load (lbs/year)	801,425	148,610	48,097	11,625	2,470
N 90th percentile load (lb/year)		136,721		6,162	165
N Reduction (lbs/year)					
N Reduction %					
Target E. coli load (cfu/year)	5.70E+14	1.06E+14	3.42E+13	8.26E+12	1.76E+12
E. coli 90th percentile load (cfu/year)		1.59E+14	1.16E+14	2.23E+13	4.49E+11
E. coli Reduction (cfu/year)		**5.33E+13**	**8.23E+13**	**1.40E+13**	
E. coli Reduction %		**34%**	**71%**	**63%**	

Walnut Creek

90th Percentile Concentrations	High (5%)	Moist (25%)	Mid-range (50%)	Dry (75%)	Low (95%)
E. coli (cfu/100ml)	327.92	968.88	184.20	761.48	506.10
TP (mg/L)	0.12	0.15		0.10	0.15
TSS (mg/L))	25.20	28.40		14.50	13.00
Nitrate-Nitrogen (mg/L)	3.82	3.39		4.40	1.82
Flow (cfs)	759	144	49	15	6
Target TP Load (lbs/year)	113,594	21,530	7,355	2,211	920
TP 90th percentile load (lb/year)	176,370	43,542		2,983	1,756
TP Reduction (lbs/year)	**62,776**	**22,012**		**771**	**836**
TP Reduction %	**35.6%**	**50.6%**		**25.9%**	**47.6%**
Target TSS Load (lbs/year)	37,366,595	7,082,223	2,419,391	727,458	302,734
TSS 90th percentile load (lb/year)	37,665,528	8,045,406		421,926	157,422
TSS Reduction (lbs/year)	**298,933**	**963,182**			
TSS Reduction %	**0.8%**	**12%**			
Target N Load (lbs/year)	2,241,996	424,933	175,660	43,647	18,164
N 90th percentile load (lb/year)	5,709,616	960,349		128,033	22,039
N Reduction (lbs/year)	**3,467,620**	**535,416**		**84,385**	**3,875**
N Reduction %	**61%**	**56%**		**66%**	**18%**
Target E. coli load (cfu/year)	1.59E+15	3.02E+14	1.03E+14	3.10E+13	1.29E+13
E. coli 90th percentile load (cfu/year)	2.22E+15	1.25E+15	8.09E+13	1.01E+14	2.78E+13
E. coli Reduction (cfu/year)	**6.30E+14**	**9.43E+14**		**6.95E+13**	**1.49E+13**
E. coli Reduction %	**28%**	**76%**		**69%**	**54%**

Jericho Creek

90th Percentile Concentrations	High (5%)	Moist (25%)	Mid-range (50%)	Dry (75%)	Low (95%)
E. coli (cfu/100ml)		86.20	993.60	264.54	73.62
TP (mg/L)	0.3248	0.1956	0.045	0.12	0.0781
TSS (mg/L))	182.60	33.10	10	14.00	16.00
Nitrate-Nitrogen (mg/L)	1.89	3.20	1.5	13	12.68
Flow (cfs)	922	175	59	18	7
Target TP Load (lbs/year)	138,017	26,128	8,900	2,649	1,080
TP 90th percentile load (lb/year)	589,842	67,244	5,270	4,183	1,110
TP Reduction (lbs/year)	**451,825**	**41,117**		**1,534**	**30**
TP Reduction %	**76.6%**	**61.1%**		**36.7%**	**2.7%**
Target TSS Load (lbs/year)	45,400,402	8,594,593	2,927,667	871,393	355,209
TSS 90th percentile load (lb/year)	331,604,534	11,379,242	1,171,067	487,980	227,334
TSS Reduction (lbs/year)	**286,204,132**	**2,784,648**			
TSS Reduction %	**86.3%**	**24.5%**			
Target N Load (lbs/year)	2,724,024	515,676	175,660	52,284	21,313
N 90th percentile load (lb/year)	3,432,270	1,100,108	175,660	453,124	180,162
N Reduction (lbs/year)	**708,246**	**584,432**		**400,841**	**158,849**
N Reduction %	**21%**	**53%**		**88%**	**88%**
Target E. coli load (cfu/year)	1.94E+15	3.66E+14	1.25E+14	3.72E+13	1.51E+13
E. coli 90th percentile load (cfu/year)		1.34E+14	5.28E+14	4.18E+13	4.75E+12
E. coli Reduction (cfu/year)			**4.03E+14**	**4.67E+12**	
E. coli Reduction %			**76%**	**11%**	

Henderson Bend

90th Percentile Concentrations	High (5%)	Moist (25%)	Mid-range (50%)	Dry (75%)	Low (95%)
E. coli (cfu/100ml)		113.19	248.90	152.76	91.00
TP (mg/L)		0.19		0.07	0.04
TSS (mg/L))		28.50		16.40	5.50
Nitrate-Nitrogen (mg/L)		2.65		3.98	1.40
Flow (cfs)	1083	204	69	20	8
Target TP Load (lbs/year)	162,074	30,563	10,315	2,968	1,123
TP 90th percentile load (lb/year)		76,408		2,905	606
TP Reduction (lbs/year)		**45,845**			
TP Reduction %		**60.0%**			
Target TSS Load (lbs/year)	53,313,776	10,053,709	3,393,032	976,170	369,468
TSS 90th percentile load (lb/year)		11,461,228		640,367	81,283
TSS Reduction (lbs/year)		**1,407,519**			
TSS Reduction %		**12.3%**			
Target N Load (lbs/year)	3,198,827	603,223	203,582	58,570	22,168
N 90th percentile load (lb/year)		1,065,693		155,406	20,690

N Reduction (lbs/year)		**462,471**		**96,836**	
N Reduction %		**43%**		**62%**	
Target E. coli load (cfu/year)	2.27E+15	4.29E+14	1.45E+14	4.16E+13	1.58E+13
E. coli 90th percentile load (cfu/year)		2.06E+14	1.53E+14	2.71E+13	6.10E+12
E. coli Reduction (cfu/year)			**8.56E+12**		
E. coli Reduction %			**6%**		