Escherichia coli (E. coli)
Total Maximum Daily Load Report for the Otter Creek Watershed

Final

August 22, 2013

Prepared for

U.S. Environmental Protection Agency Region 5

Prepared by

Indiana Department of Environmental Management

Contents

Tables

Figures

1.0 EXECUTIVE SUMMARY

The Otter Creek watershed (HUC# 0512011104) is located near the Indiana-Illinois State Line just northeast of Terre Haute, Indiana, and drains approximately 124 square miles. The Otter Creek watershed originates near northern Clay County, and then flows southwest where it ultimately empties into the Wabash River west of North Terre Haute, totaling approximately 220 stream miles. Land use throughout the watershed is predominantly agricultural.

The Clean Water Act (CWA) and U.S. Environmental Protection Agency (USEPA) regulations require that states develop Total Maximum Daily Loads (TMDLs) for waters on the Section 303(d) impaired waters list. A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. TMDLs are composed of the sum of individual wasteload allocations (WLAs) for regulated sources and load allocations (LAs) for unregulated sources. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this is defined by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

This TMDL has been developed for Escherichia *coli* (*E. coli)* in the Otter Creek watershed.

After the Indiana Department of Environmental Management (IDEM) identifies a waterbody as having impairment and places the waterbody on Indiana's Section 303(d) list of impaired waters, IDEM implements a sampling plan to determine the extent and the magnitude of the impairment. The next task is to reassess each waterbody using new sampling data and to examine the watershed as a whole. The reassessment data helps IDEM identify the area of concern for TMDL development. As a result of the reassessment for the Otter Creek watershed, the pollutants and the impaired segments for which TMDLs were developed differ from the pollutants and impaired segments appearing on the 2012 Section 303(d) list for the following reasons:

- Sampling performed by IDEM in 2009 generated new water quality data that were not available at the time the 2012 Section 303(d) list was developed.

Recent data was used for the TMDL analysis; samples were taken during April 28- May 27, 2009 by IDEM. The data indicate that 17 of the 19 sites violated the geometric mean of 125 MPN/100ml. Reductions needed to achieve water quality standards range from 0%- 84.5%.

Potential sources of *E. coli* in the watershed include regulated point sources such as the Town of Carbon wastewater treatment plant (WWTP), the Town of Staunton WWTP, Seelyville MS4, and Terre Haute MS4. Point sources are regulated through the National Pollutant Discharge Elimination System (NPDES). Unregulated nonpoint sources such as confined feeding operations (CFOs), livestock pastures, failing home septic systems, and row crop agriculture 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 Otter Creek Watershed, subwatersheds with predominantly agricultural land use also have the highest average *E. coli* counts. It is therefore possible that land application of manure in these subwatersheds is contributing to the elevated *E. coli* counts. However, other factors could also explain this correlation, such as failing septic systems, and the fact these subwatersheds tend to experience smaller flows and thus have less dilution. Specific sources of *E. coli* to each impaired waterbody should be further evaluated during follow-up implementation activities.

An important step in the TMDL process is the allocation of the allowable loads to individual point sources as well as unregulated sources. The Otter Creek watershed TMDL includes these allocations, which are presented for each of the 23 Assessment Unit IDs (AUIDs) located in the six 12-digit hydrologic unit code (HUC) subwatersheds.

There are two NPDES permitted facilities located in the Otter Creek watershed. These facilities are both wastewater treatment plants (WWTP), but neither has been found to be in violation of their permit limits for *E. coli*. There are also two MS4 communities that are regulated under a co-permit in the Otter Creek watershed. There are no CSOs, or SSOs in the watershed.

There are several types of nonpoint sources located in the Otter Creek watershed, including failing septics, small livestock operations, and surface runoff. Of these, small livestock operations and failing septics are found most often in six subwatersheds with elevated levels of *E. coli*. 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 flow, and improve water quality.

This TMDL report identifies which locations could most benefit from focus on implementation activities. These areas throughout the Otter Creek watershed are referred to as potential priority implementation areas (PPIAs). It also provides recommendations on the types of implementation activities, including best management practices (BMPs) that key implementation partners in the Otter Creek watershed can consider to achieve the pollutant load reductions calculated for each subwatershed. PPIAs can help watershed stakeholders identify critical areas and select BMPs in the Otter Creek watershed through a watershed management planning process. Table 1 presents the PPIAs and associated BMP recommendations identified having a high likely degree of effectiveness to achieve the *E. coli* load reductions allocated to sources in each subwatershed.

Table 1. PPIAs and Recommended BMPs to Achieve Pollutant Load Reductions by Subwatershed

HUC 12 Subwatershed	PPIA Rank	Implementation Actions	Estimated Pollutant Load Reduction for *E. coli* (billions orgs/ day)
Wastewaters Creek- Otter Creek	1	Outreach, education, and training	3.58E+12
		Manure handling, storage, treatment, and disposal	
		Comprehensive Nutrient Management Plan	
		Storm water planning and management	
		Conservation easements	
Sulphur Creek	2	Outreach, education, and training	2.80E+12
		Manure handling, storage, treatment, and disposal	
		Comprehensive Nutrient Management Plan	
		Storm water planning and management	
		Grazing land management	
North Branch Otter Creek	3	Outreach, education, and training	2.74E+12
		Filter strips	
		Septic System replacement	
		Stream fencing (animal exclusion)	
		Grazing land management	
Gundy Ditch	4	Outreach, education, and training	2.22E+12
		Storm water planning and management	
		Septic System replacement	

HUC 12 Subwatershed	PPIA Rank	Implementation Actions	Estimated Pollutant Load Reduction for *E. coli* (billions orgs/ day)
		Grassed waterways	
		Stream fencing (animal exclusion)	
Little Creek- North Branch Otter Creek	5	Outreach, education, and training	2.05E+12
		Filter strips	
		Septic System replacement	
		Grassed waterways	
		Stream fencing (animal exclusion)	
Headwaters Otter Creek	6	Outreach, education, and training	1.92E+12
		Filter strips	
		Septic System replacement	
		Stream fencing (animal exclusion)	
		Grazing land management	

Public participation is an important and required component of the TMDL development process. The following public meetings and public comment periods have been held to further develop this project:

- A Kickoff Meeting was held at the Vigo County Annex Building on January 17, 2013during which IDEM described the TMDL Program and provided a summary of the available data and the proposed modeling approach.
- A Draft TMDL Meeting was held at the Vigo County Annex Building on June 4, 2013 during which IDEM described the TMDL program and provided an overview of the draft TMDL results.

2.0 INTRODUCTION

This section of the Total Maximum Daily Load (TMDL) provides an overview of the Otter Creek watershed location and the regulatory requirements that have led to the development of this TMDL to address impairments in the Otter Creek watershed.

The Otter Creek watershed (HUC# 0512011104), shown in **Figure** 1, is located near the Indiana-Illinois State Line just northeast of Terre Haute, Indiana, and drains a total of 124 square miles. The Otter Creek watershed originates near northern Clay County, and then flows southwest where it ultimately empties into the Wabash River near North Terre Haute Indiana, totaling approximately 220 stream miles. Land use throughout the watershed is predominantly agricultural.

The Clean Water Act (CWA) and U.S. Environmental Protection Agency (USEPA) regulations require that states develop TMDLs for waters on the Section 303(d) lists. USEPA defines a TMDL as the sum of the individual wasteload allocations (WLA) for point sources and load allocations (LA) for nonpoint sources, seasonal variation in pollutant loading, and a margin of safety (MOS) that addresses the uncertainty in the analysis.

The overall goals and objectives of the TMDL study for the Otter Creek watershed are:

- Assess the water quality of the impaired waterbodies and identify key issues associated with the impairments and potential pollutant sources.
- Determine current loads of pollutants to the impaired waterbodies.
- Use the best available science and data to determine the total maximum daily load the waterbodies can receive and still support the designated uses for which they were impaired.
- If current loads exceed the maximum allowable loads, determine the load reduction that is needed.
- Inform and involve the public throughout the project to ensure that key concerns are addressed and the best available information is used.
- Identify potential priority implementation areas (PPIAs) that watershed stakeholders can use to identify critical areas
- Recommend activities for purposes of TMDL implementation.
- Submit a final TMDL report to the USEPA for review and approval.

Watershed stakeholders and partners can use the final approved TMDL report to craft a watershed management plan (WMP) that meets both USEPA's nine minimum elements under the CWA Section 319 Nonpoint Source Program, as well as the additional requirements under IDEM's WMP Checklist.

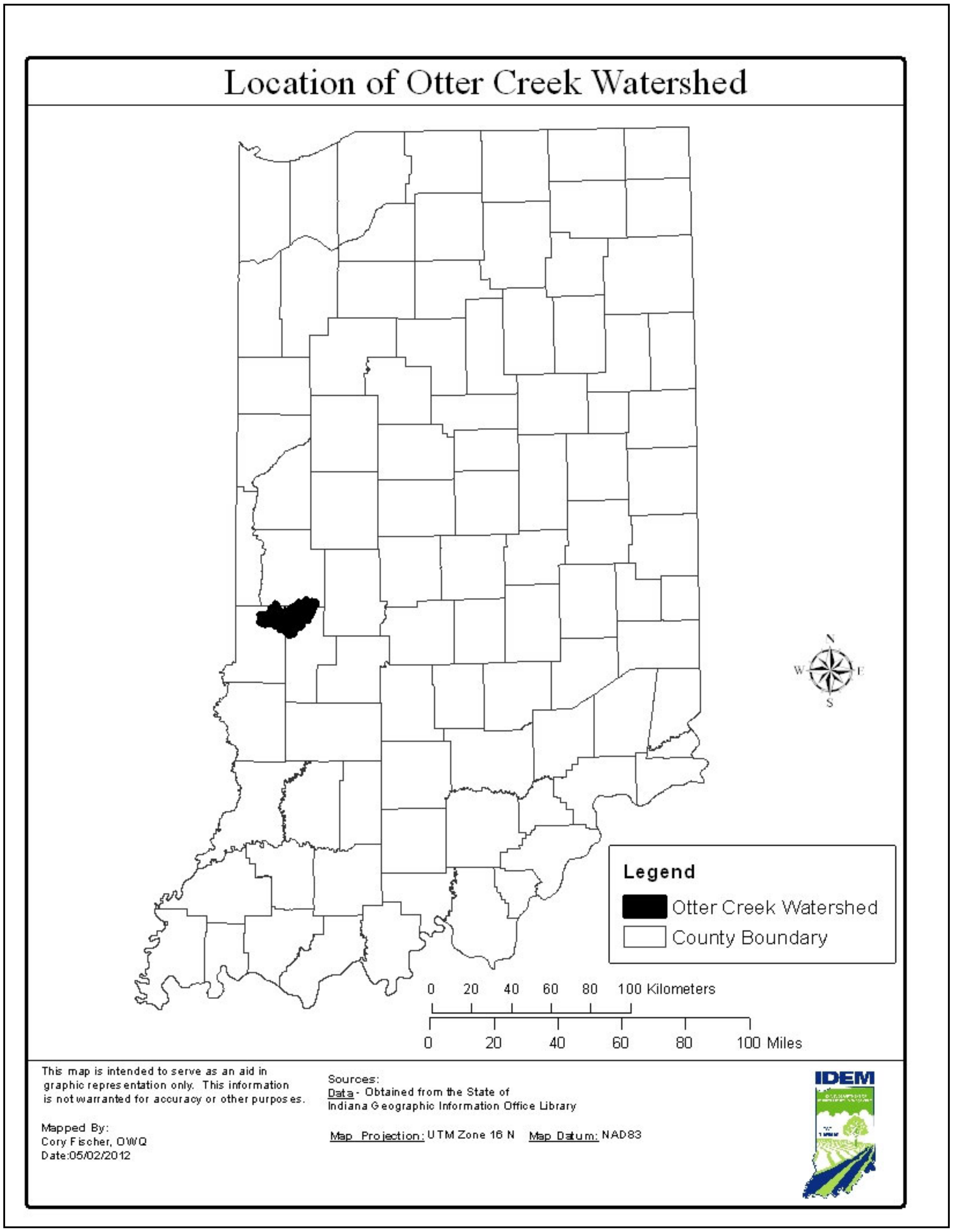


Figure 1. Location of Otter Creek Watershed

2.1 Water Quality Standards

Under the 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 Otter Creek Watershed TMDLs focus on protecting the designated 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* were used as the basis of the Otter Creek Watershed TMDLs.

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).]

2.2 TMDL Target Values

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 Otter Creek Watershed TMDL are presented below.

2.2.1 *E. coli*

The target value used for the Otter Creek Watershed TMDL was based on the 125 counts/100 mL geometric mean component of the standard (i.e., daily loading capacities were calculated by multiplying flows by 125 counts/100 mL). This approach ensures that both components of the standard will be met since a daily loading capacity based on 125 counts/100 mL will, by definition, meet the 235 counts/100 mL component of the standard. The use of the geometric mean component of the standard results in an added MOS (see Section 8.2 for more details).

2.3 Listing Information

There are a number of existing *E. coli* impairments in the Otter Creek watershed from the approved 2008 303(d) List of Impaired Waters (Figure 2). The listings and causes of impairment have been adjusted as a result of reassessment data collected in 2009 at 19 sampling locations in the watershed (Figures 3). Within the Otter Creek watershed a total of 23 assessment unit IDs (AUIDs) are cited as impaired for *E. coli*, (Figure 4). These impaired segments account for approximately 212 stream miles. Table 3 presents listing information for the Otter Creek watershed, including a comparison of the updated listings with the 2008 listings and associated causes of impairments addressed by the TMDLs. The reassessment data used in updating the listings for the Otter Creek watershed are available in Appendix B.

IDEM identifies the Otter 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). (For more information on HUCs, go to http://www.in.gov/idem/nps/2422.htm.) Figure 5 shows the 12-digit HUC subwatersheds located in the Otter Creek watershed.

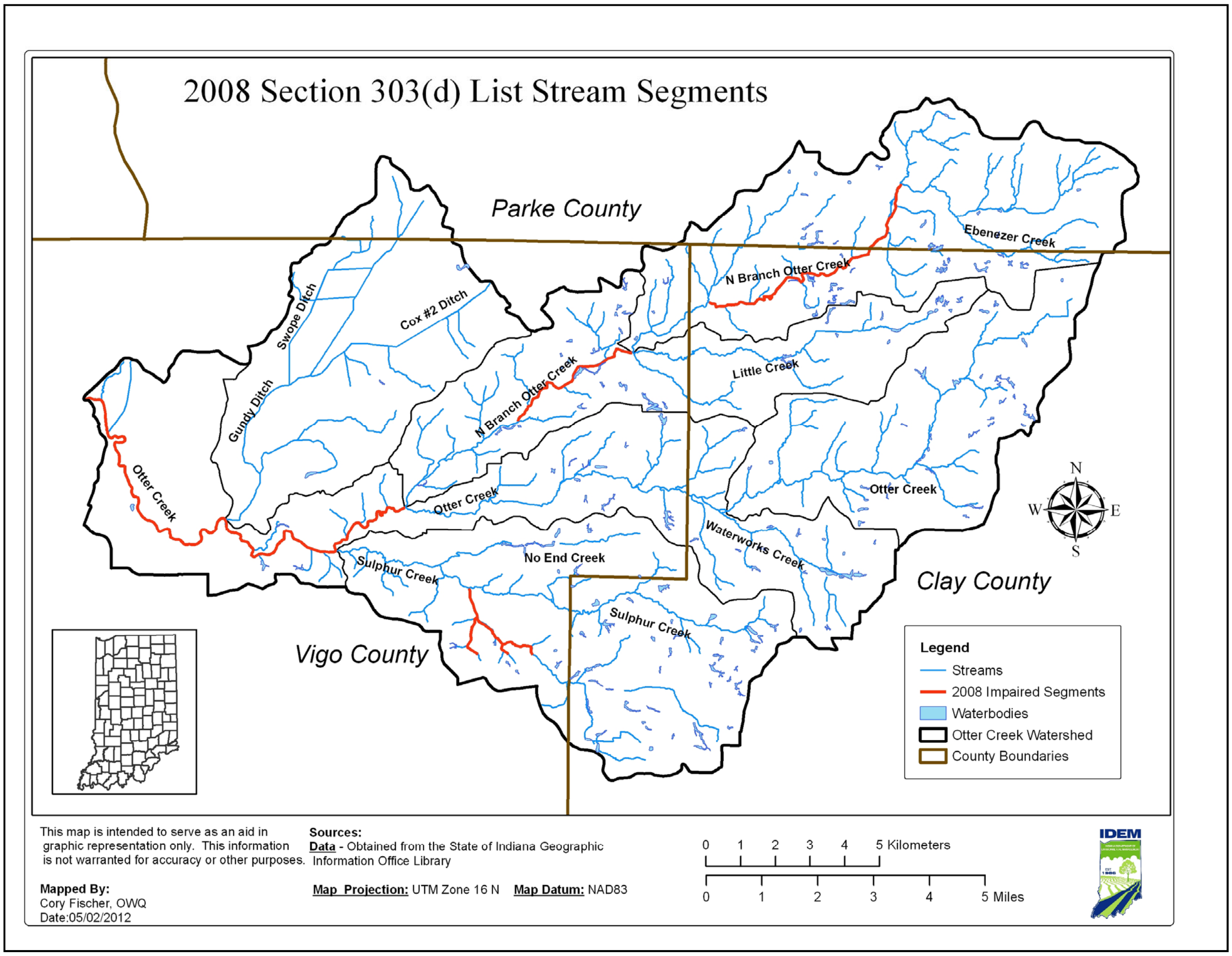


Figure 2. Streams Listed on the 2008 Section 303(d) List in the Otter Creek Watershed

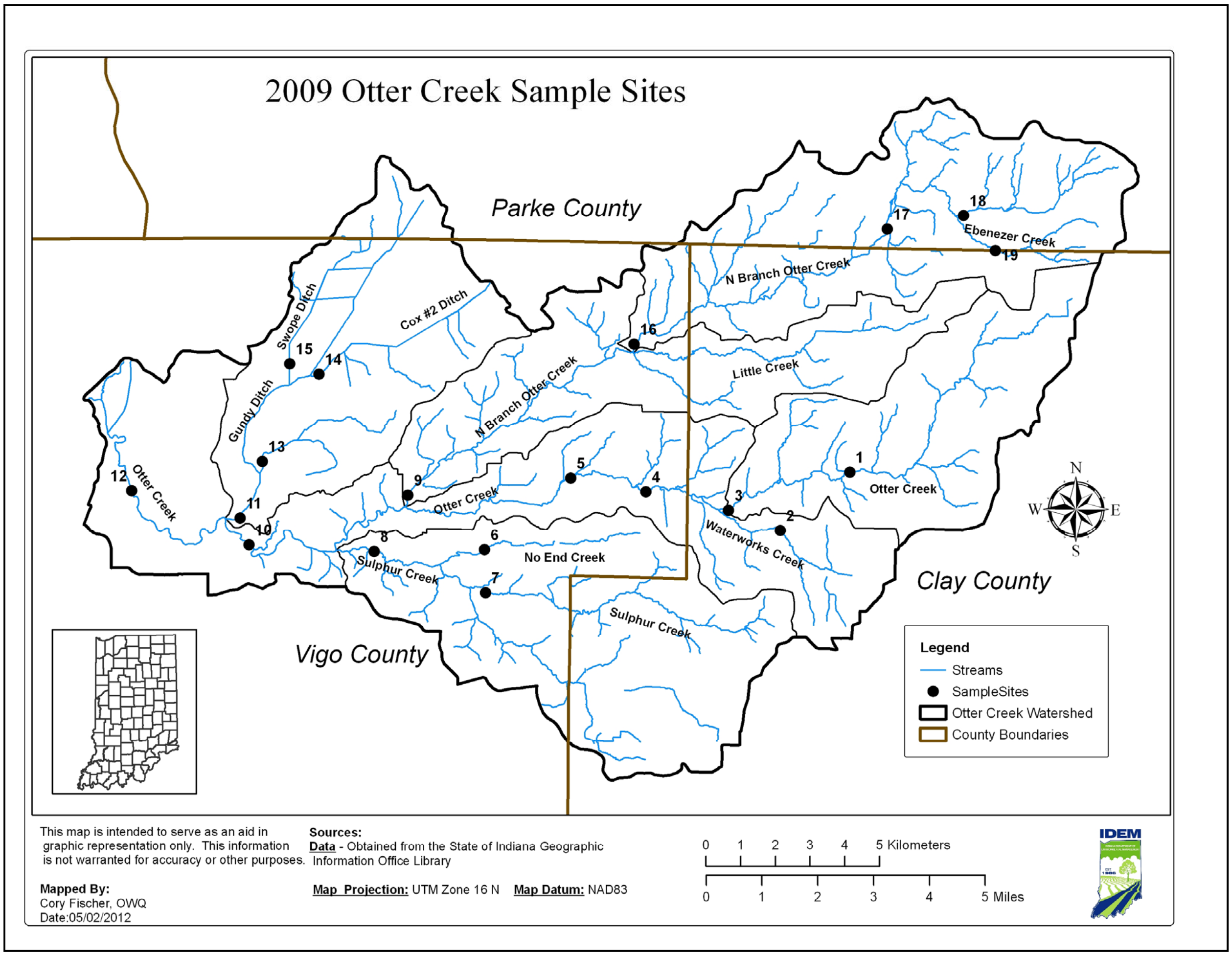


Figure 3. Sampling Locations in 2009 Otter Creek Watershed TMDL

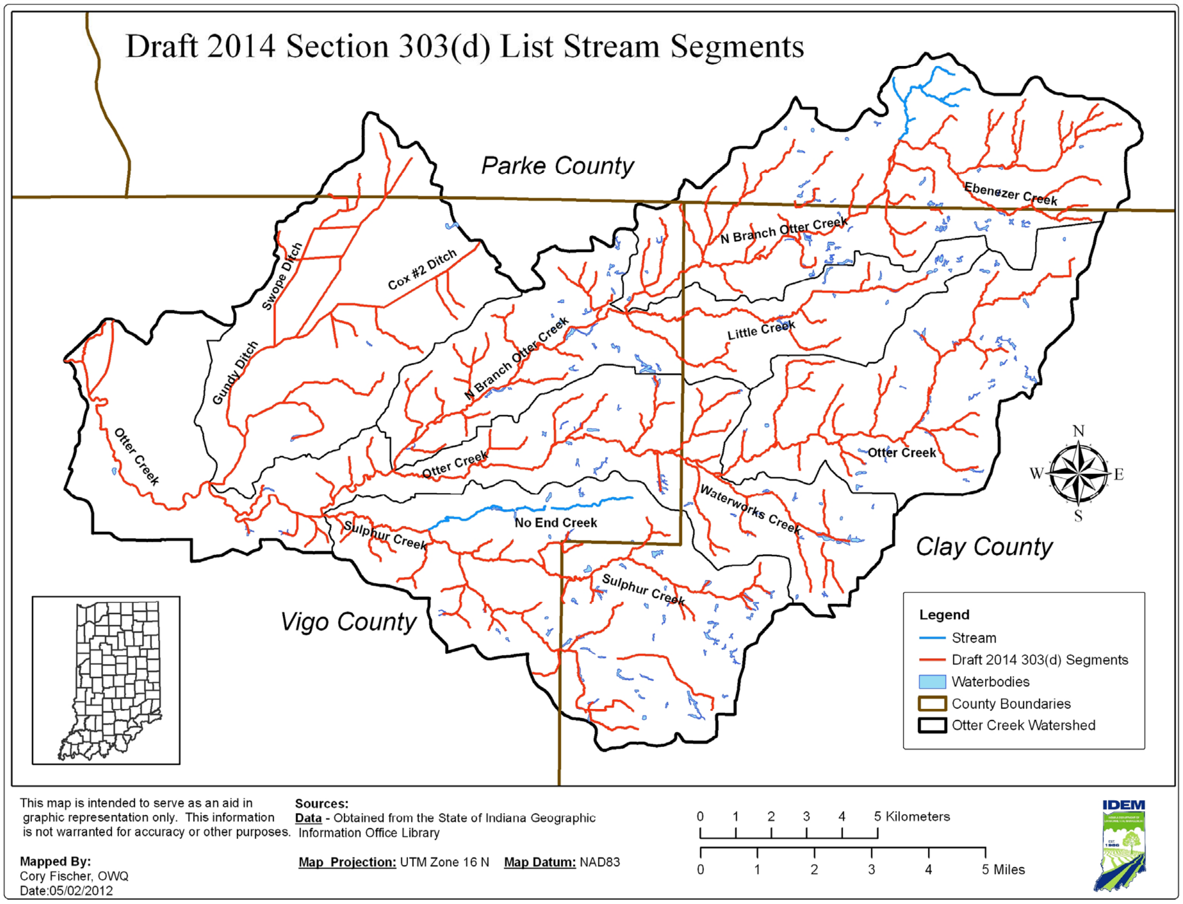


Figure 4. Streams Listed on the Draft 2014 Section 303(d) List in the Otter Creek Watershed

Table 2. Section 303(d) List Information for the Otter Creek Watershed for 2008 and 2014.

Watershed (10-digit HUC)	Subwatershed (12-digit HUC)	Previous AUID 2008	2008 Section 303(d) Listed Impairment	New AUID 2014	Updated Impairments to be Listed 2014
0512011104	Headwaters Otter Creek 051201110401	INB1132_T1021		INB1141_01	*E. coli*
	North Branch Otter Creek 051201110402	INB1134_02 INB1134_T1002 INB1134_T1002 INB1134_02 INB1134_T1006 INB1134_02	 *E. coli* *E. coli*	INB1142_01 INB1142_01A INB1142_01B INB1142_01C INB1142_T1001 INB1142_T1002 INB1142_T1003 INB1142_T1004 INB1142_T1005	*E. coli* *E. coli* *E. coli* *E. coli* *E. coli* *E. coli* *E. coli* *E. coli*
	Little Creek-North Branch Otter Creek 051201110403	INB1135_T1032 INB1135_T1001 INB1135_T1003	*E. coli*	INB1143_01 INB1143_T1001 INB1143_T1001A INB1143_T1002	*E. coli* *E. coli* *E. coli* *E. coli*
	Sulphur Creek 051201110404	INB1136_00 INB1136_T1033 INB1136_00	 *E. coli, S*ulfates	INB1144_01 INB1144_T1001 INB1144_T1001A INB1144_T1002	*E. coli* *E. coli* *E. coli*
	Gundy Ditch 051201110405	INB1137_00 INB1137_00 INB1137_00		INB1145_01 INB1145_T1001 INB1145_T1002	*E. coli* *E. coli* *E. coli*
	Wastewaters Creek-Otter Creek 051201110406	INB1133_T1002 INB1138_T1023 INB1138_T1023	 *E. coli*, pH, Sulfates, TDS	INB1146_01 INB1146_T1001 INB1146_02 INB1146_03	*E. coli* *E. coli* *E. coli* *E. coli*

-Only the *E. coli* impairments are being addressed in this TMDL

Understanding Table** 2**:

- *Column 1: Watershed (10-digit HUC).* Lists the subwatersheds at the 10-digit HUC scale that were part of the initial assessment for the Otter Creek watershed.
- *Column 2: Subwatershed (12-digit HUC).* Shows the name of the subwatershed at the 12-digit HUC scale. The subwatershed found in this second column is the appropriate scale for what the IDEM's WMP Checklist defines as a subwatershed for the purposes of watershed management planning.
- *Column 3: Previous AUID 2008.* Identifies the AUID given to waterbodies within the 12-digit HUC subwatershed for purposes of the 2008 Section 303(d) listing assessment process.
- *Column 4: 2008 Section 303(d) Listed Impairment* . Identifies the cause of impairment associated with the 2008 Section 303(d) listing.
- *Column 5: New AUID 2014.* Provides the updated AUIDs associated with each 12-digit HUC subwatershed. Look for these AUIDs used throughout this report to present detailed analysis of sources, load allocations, and recommended implementation activities in PPIAs.
- *Column 6: Updated Impairment to be Listed 2014.* Provides the updated causes of impairment if new data and information are available.

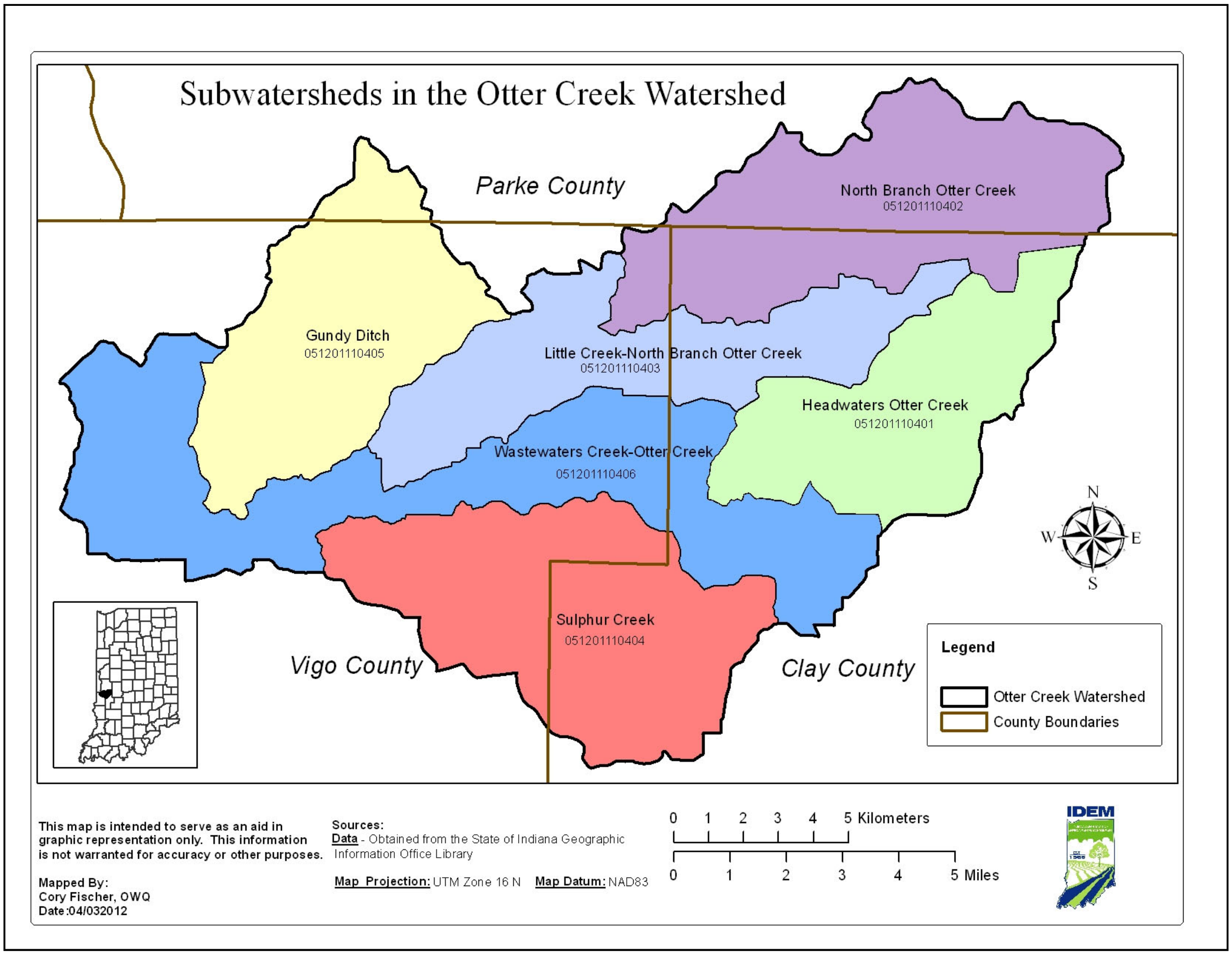


Figure 5. Subwatersheds (12-Digit HUCs) in the Otter Creek Watershed

3.0 DESCRIPTION OF THE WATERSHED

This section of the TMDL report contains a brief characterization of the Otter Creek watershed to provide a better understanding of the historic and current conditions of the watershed that affect water quality and contribute to the *E. coli* impairment. 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.

3.1 Land Use

Land use patterns provide important clues to the potential sources of *E. coli* in a watershed. Land use information for the Otter Creek watershed is available from the Multi-Resolution Land Characteristics Consortium (MRLCC). These data categorize the land use for each 30 meters by 30 meters parcel of land in the watershed based on satellite imagery from circa 2006. Figure 6 displays the spatial distribution of the land uses and the data are summarized in Table 3.

Land use in the Otter Creek watershed is primarily forested and agricultural lands. Each, comprising approximately 42 percent of the Otter Creek watershed and can indicate presents of animals or manure spreading throughout the landscape. The remaining watershed is 8.49 percent developed and can be a source of *E. coli* through Storm water runoff and failing septic. Pasture/hay represents 5.59 percent of the watershed and indicates the presence of animal feedlots that can be significant sources of *E. coli*. The remaining land categories represent less than 3 percent of the total land area.

The Otter Creek watershed has a diverse network of streams. Tributaries include the North Branch Otter Creek, Waterworks Creek, Sulphur Creek, Little Creek, and Gundy Ditch among others. Many of these tributaries are shown in Figure 2. The headwaters of the watershed have good forested buffers with riparian cover, but as one moves from Clay and Parke County into Vigo County, the river system begins to become channelized and urbanized. Agricultural fields in the area are drained using tiles and there are a few legal drains in the Vigo County portion of the Otter Creek Watershed. The legal drains are open channel type totaling 10.35 miles, including Cox Ditch 1, Cox Ditch2, and Swope Ditch. These drains are under the jurisdiction of the Vigo County Surveyor.

Table 3. Land Use of Otter Creek Watershed

Land Use	Watershed		
	Area		Percent
	Acres	Square Miles	
Agriculture	33,072.12	51.68	41.65
Developed, Open Space	5,373.06	8.39	6.77
Developed, Low Intensity	1,085.29	1.69	1.37
Developed, Medium Intensity	208.61	0.33	0.26
Developed, High Intensity	96.96	0.15	0.12
Forested Land	33,359.23	52.12	42.01
Pasture/Hay	4,441.67	6.94	5.59
Shrub/Scrub	1,112.19	1.73	1.40
Wetlands	342.04	0.53	0.43
Open Water	321.58	0.50	0.40
TOTAL	79,412.75	124.06	100

Understanding Table* 3*: The predominant land use types in the Otter Creek watershed can indicate potential sources of *E. coli* 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* 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 *E. coli* to the watershed. Understanding types of land uses will help identify the type of implementation approaches that watershed stakeholders can use to achieve *E. coli* load reductions.

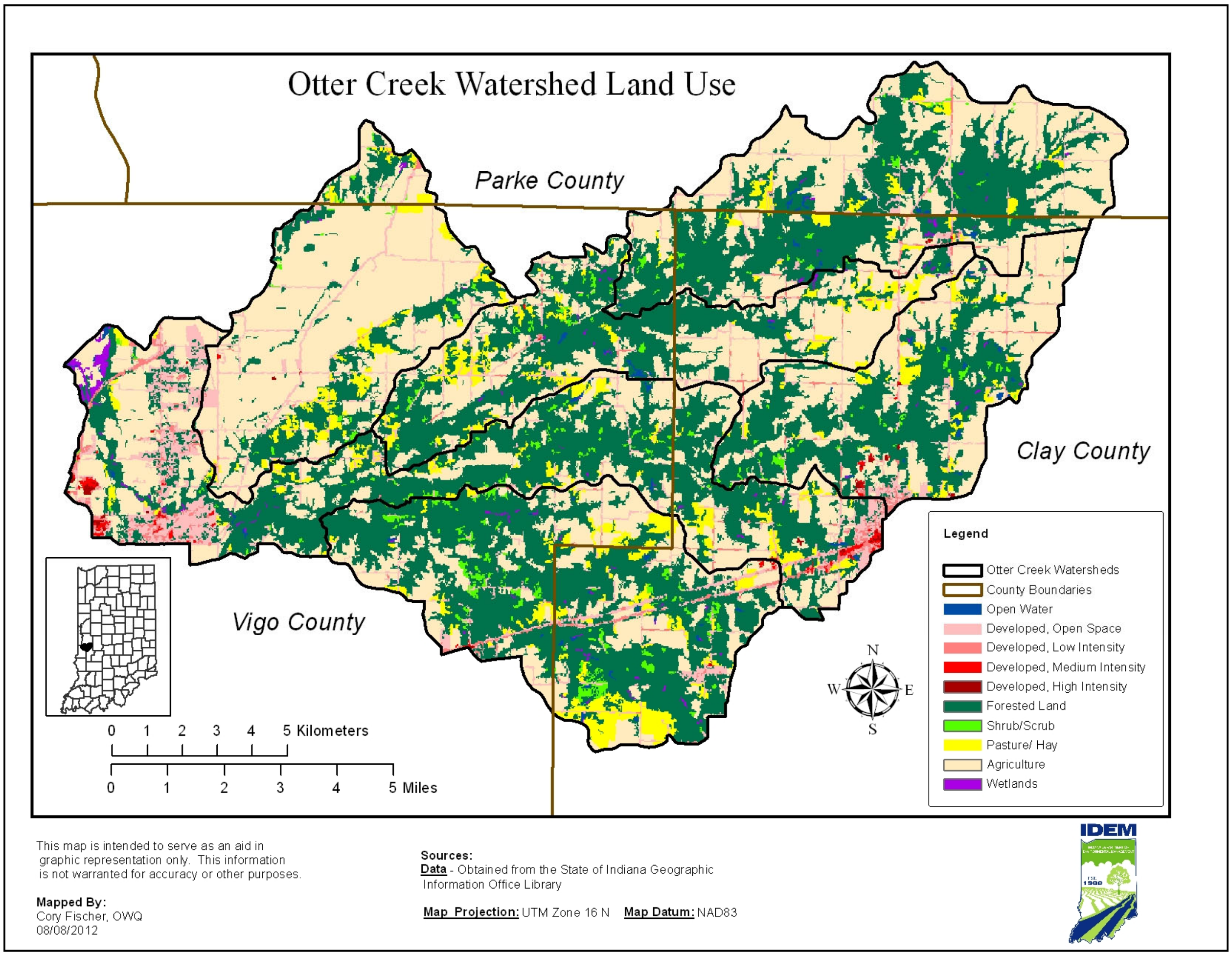


Figure 6. Land Use in the Otter Creek Watershed

3.2 Human Population

Counties with land located in the Otter Creek watershed include Clay, Parke, and Vigo. Major government units with jurisdiction at least partially within the Otter Creek watershed include the towns of Carbon, Seelyville, Rosedale, Staunton, and the cities of Brazil and North Terre Haute. U.S. Census data for each county during the past three decades are provided in Table 4. Municipalities are also are labeled in Figure 7.

Table 4. Population Data for Counties in the Otter Creek Watershed

County	1990	2000	2010
Clay	24,705	26,556	26,890
Parke	15,410	17,241	17,339
Vigo	106,107	105,848	107,848
TOTAL	***146,222***	***149,645***	***152,077***

Source: U.S. Census Bureau.

Understanding Table 4***:*** Water quality is linked to population growth because a growing population often leads to more development, translating into more houses, roads, and infrastructure to support more people. Table 4 provides information that shows how population has changed in each of the counties located in the Otter Creek watershed over time. In addition, understanding population trends can help watershed stakeholders to anticipate where pressures might increase in the future and where action now could help prevent further water quality degradation.

Estimates of population within Otter Creek watershed are based on US Census data (2010) and the percentage of the total county and urban area that is within the watershed (Table 5). Based on this analysis, the estimated population of the watershed is 23,731 with approximately 69 percent of the population classified as rural residents and 31 percent classified as urban residents. Figure 8 indicates population density within the Otter Creek watershed.

Table 5. Estimated Population in the Otter Creek Watershed

County	2010 Population	Total Estimated Watershed Population	Percent of Total Watershed Population	Non-urban Population	Urban Population
Clay	26,890	9,114	38.4	6,127	2,987
Parke	17,339	1,211	5.1	1,211	0
Vigo	107,848	13,406	56.5	9,016	4,390
TOTAL	152,077	23,731	100	16,354 (68.9%)	7,377 (31.1%)

Understanding Table 5***:*** Understanding where the greatest population is concentrated within the Otter Creek watershed will help watershed stakeholders understand 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 impervious surfaces, poor riparian habitat, flashy Storm water flows, and large wastewater inputs. Alternatively, watersheds with a large non-urban population are more likely to suffer problems from failing septic systems, agricultural runoff, and channelized streams. Comparing the information in Table 4 with the information in Table 5 can provide an understanding of how population might change in the Otter Creek watershed and which counties 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 and hydrology. For example, growing populations mean more development, resulting in increased impervious surfaces and hydromodification, such as installing sewer systems, channelizing streams and re-routing storm water flows. . Declining population in areas of the Otter 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).

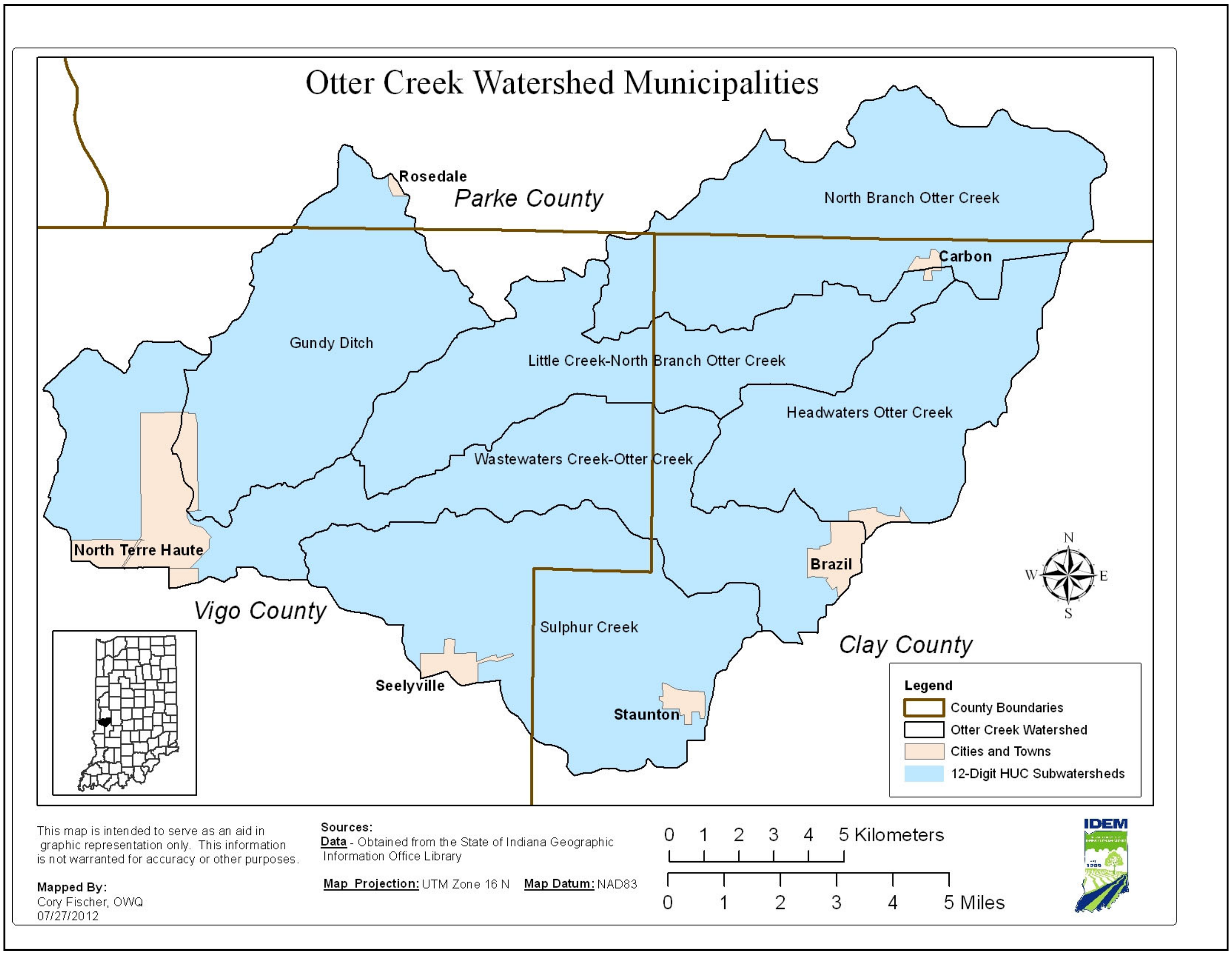


Figure 7. Municipalities in the Otter Creek Watershed

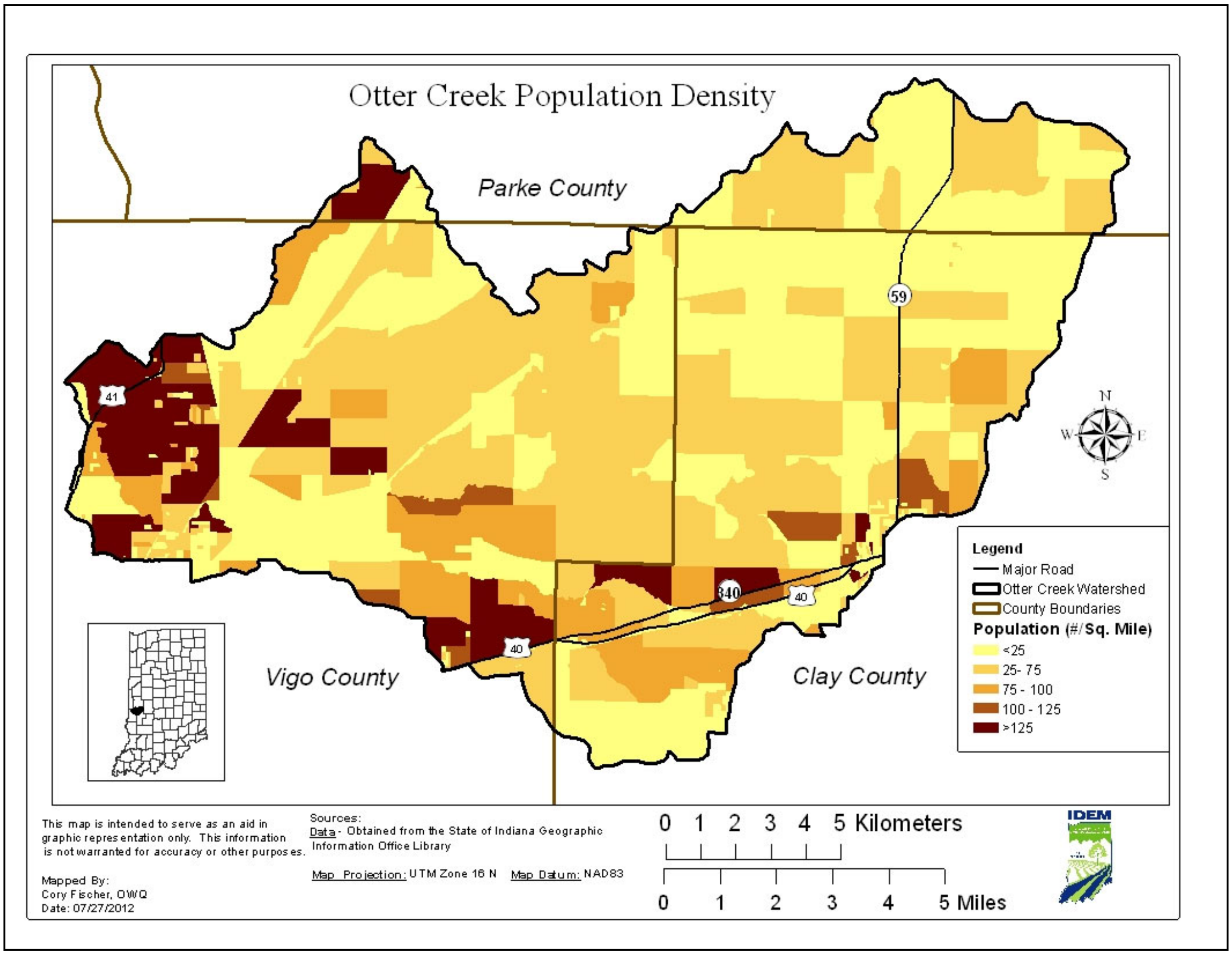


Figure 8. Population Density in the Otter Creek Watershed

3.3 Topography and Geology

Topographic and geologic features of a watershed play a role in defining a watershed's drainage pattern. Information concerning the topography and geology within the Otter Creek watershed is available from the Indiana Geologic Survey (IGS). The Otter Creek watershed originates in Clay County and travels west through Parke and Vigo Counties, eventually discharging to the Wabash River. The Otter Creek watershed is located in the Glaciated Wabash Lowlands physiographic region which is characterized by loamy to sandy soil and having an average elevation of 500 feet. The landscape changes from gently rolling terrain in the northern part of the watershed, to broad lowland tracts in the southern part of the watershed. Figure 9 shows the topography of the Otter Creek watershed. National Elevation Data (NED) is available from the USGS National Map seamless server. (http://seamless.usgs.gov/website/seamless/viewer.htm). This map shows that the elevation is highest northeast of Carbon, Indiana, and gradually decreases in north central Vigo County. Flooding occurs annually in the bottomlands located along the Wabash River. While the topography of the watershed can have an effect on hydrology, it is more likely that soil characteristics and hydromodification play a greater role in affecting hydrologic processes.

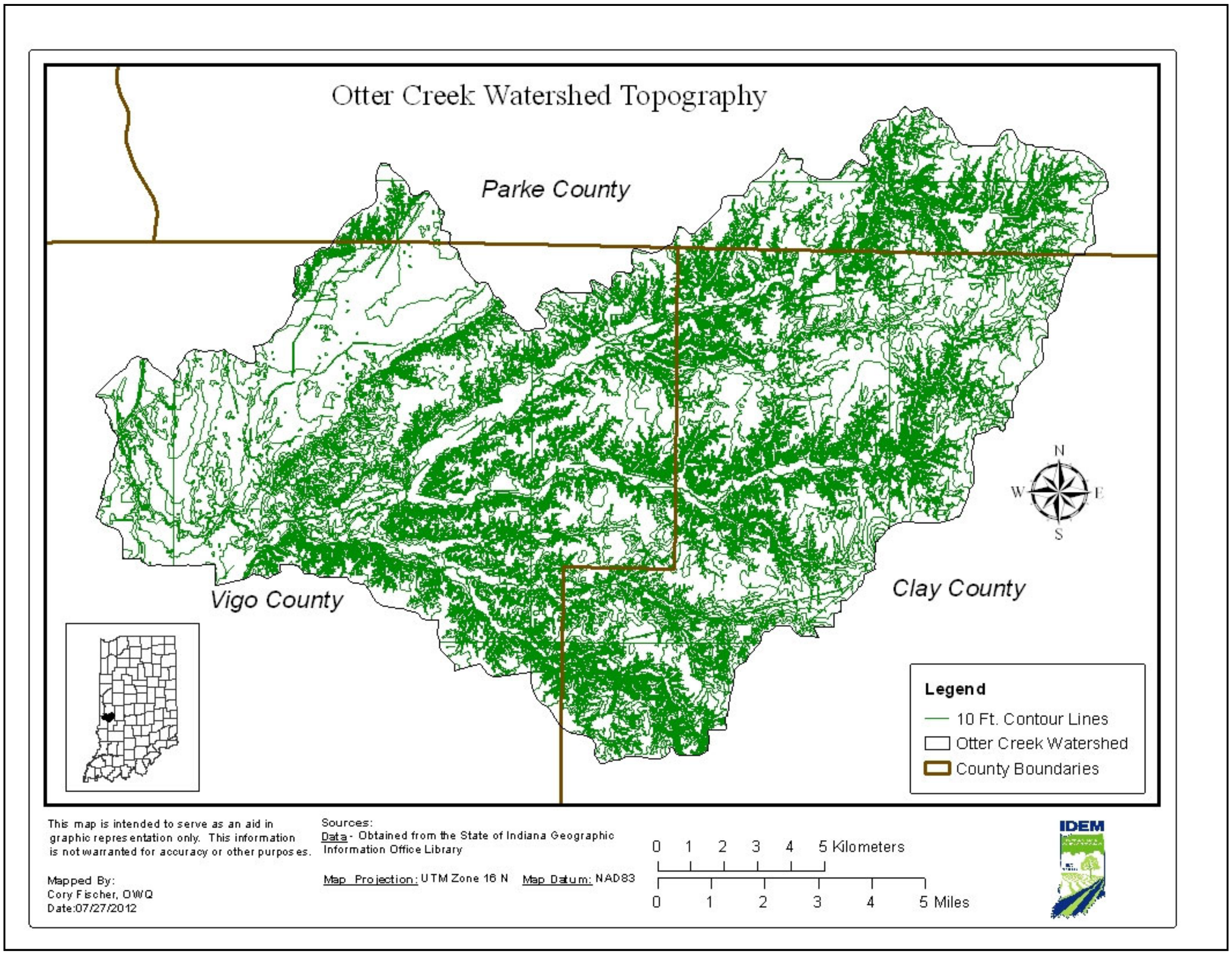


Figure 9. Topography of the Otter Creek Watershed

3.4 Soils

There are different soil characteristics that affect the function of the watershed. These characteristics include soil drainage, septic tank suitability, soil saturation, and soil erodibility.

3.4.1 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 6 (NRCS, 2001). Data for the Otter Creek watershed were obtained from the 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 in Figure 10.

The majority of the watershed is covered by soils with slow infiltration rates (49%), followed by soils with moderate infiltration rates (48%), soils with high infiltration rates (2.8%) and soils with very slow infiltration rates (0.2%).

Table 6. Hydrologic Soil Groups

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.

***Understanding Table** 6:* 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 *E. coli* loading within a watershed. During high flows, areas with low soil infiltration capacity can flood and therefore discharge high *E. coli* loads to nearby waterways. In contrast, soils with high infiltration rates can slow the movement of *E. coli* to streams.

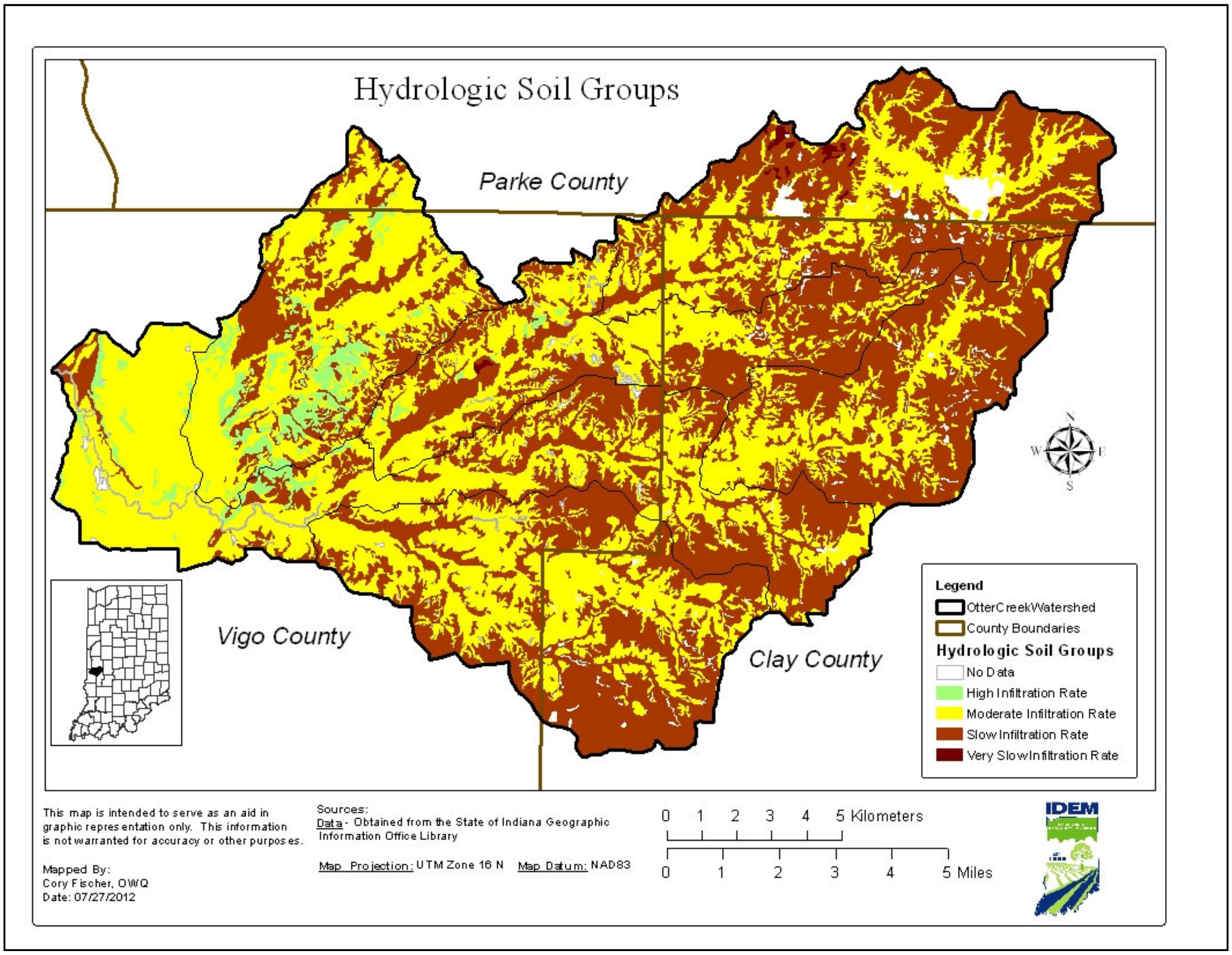


Figure 10. Hydrologic Soil Groups in the Otter Creek Watershed

3.4.2 Septic System Suitability

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 11 shows ratings that indicate the extent to which the soils are suitable for septic systems within the Otter Creek watershed. Only that 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 (ex. Soils with very slow infiltration rates) that is unfavorable for septic systems. Approximately 95 percent of the Otter 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 2 percent of the soils within the Otter 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 3 percent of the soils in the Otter Creek watershed are designated “not limited,” meaning that the soil type is suitable for septic systems. Section 4.0 provides more information on septic systems throughout the Otter Creek watershed.

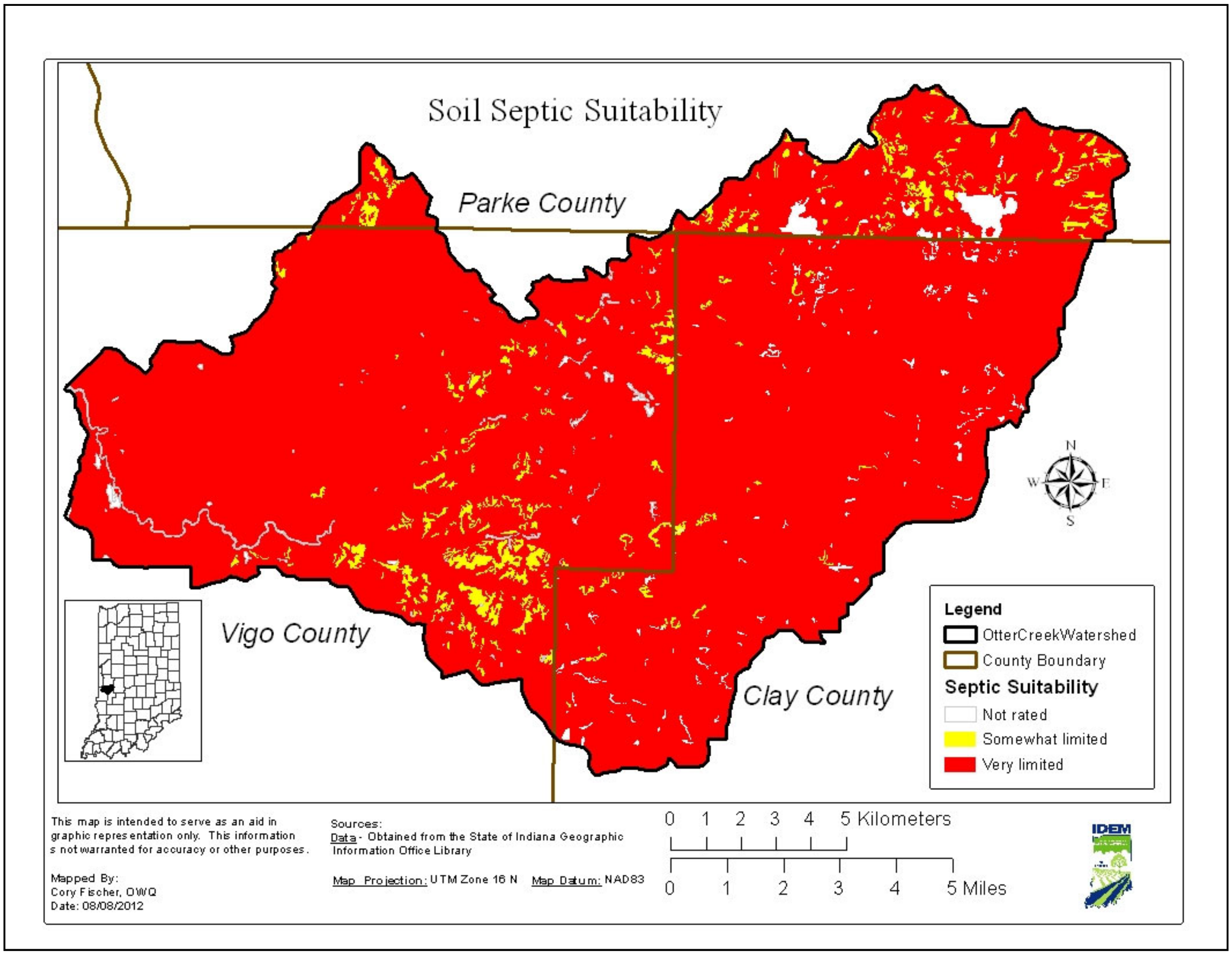


Figure 11. Suitability of Soils for Septic Systems in the Otter Creek Watershed

3.4.3 Soil Saturation

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 Otter Creek watershed and are important in consideration of wetland restoration activities. Approximately 5,171 acres or 6.5 percent of the Otter Creek watershed area contains soils that are considered hydric, as shown in Table 7. However, a large majority of these soils have been drained for either agricultural production or urban development. The location of remaining hydric soils, as shown in Figure 12, 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.

Table 7. Hydric Soils by County in the Otter Creek Watershed

County	Hydric Soil Type	Acres
Clay	Hoosierville Silt Loam	1,423
	Total:	**1,423**
Parke	Ragsdale Silt Loam	150
	Westland Loam, Loamy Substrate	59
	Westland Silt Loam	1.5
	Westland Silty Clay Loam, Loamy Substrate	9.5
	Whitson Silt Loam	141
	Total	**361**
Vigo	Petrolia Silty Clay Loam	259
	Ragsdale Silt Loam	268
	Rensselaer Clay Loam	889
	Rensselaer Loam	1,789
	Vincennes Loam	183
	Washtenaw Silt Loam	38
	Zipp Silty Clay	30
	Total:	**3,446**
	Total:	**5,230**

Understanding Table 7***:*** In the Otter Creek watershed, Vigo County has the most acreage of hydric soils. Areas within these counties might contain opportunities for wetland restoration activities that could help address water quality impairments.

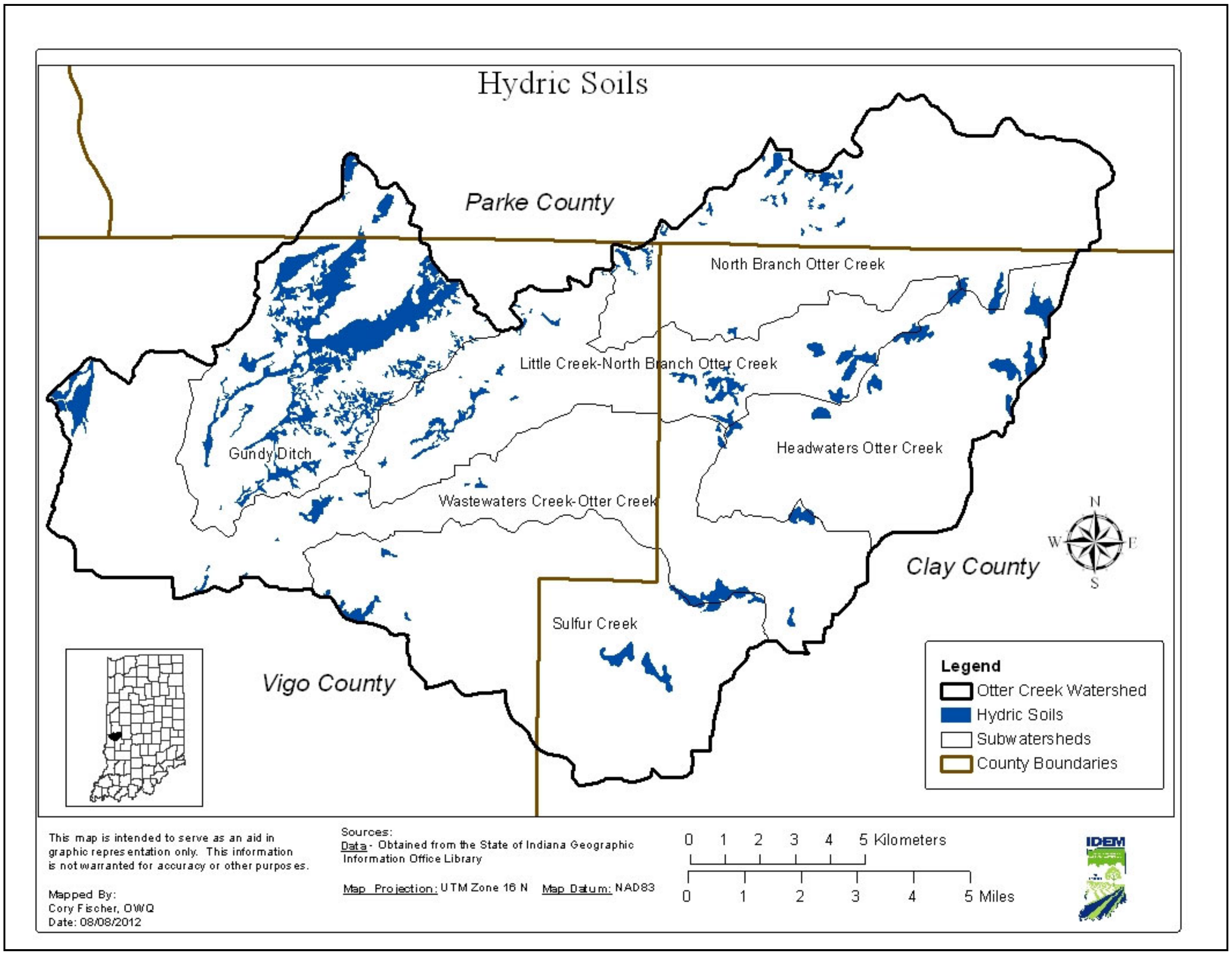


Figure 12. Hydric Soils in the Otter Creek Watershed

Data on hydric soils by county available from NRCS at http://soils.usda.gov/use/hydric/

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. (See http://www.in.gov/dnr/fishwild/files/partner.pdf and http://water.usgs.gov/nwsum/WSP2425/state_highlights_summary.html) Currently, the Otter Creek watershed contains approximately 3,487 acres of wetlands or 0.44percent of the total surface area (USFWS, 2003). Figure 13 shows estimated locations of wetlands as defined by the USFWS's National Wetland Inventory (NWI). Wetland data for Indiana is available from the USFWS NWI at <http://www.fws.gov/wetlands/Data/WebMapServices.html>.

Aerial photograph interpretation techniques were used to compile the NWI. The NWI was not intended to produce maps that show exact wetland boundaries comparable to boundaries derived from ground surveys, and boundaries are generalized in most cases. It should be noted that the estimate of the current extent of wetlands in the Otter Creek watershed from the NWI may not agree with those listed in Section 3.1, which are based upon the MRLCC dataset. Wetland areas act to buffer wide variations in flow conditions that result from storm events. They also allow water to infiltrate slowly thus reducing the risks of contaminated water to be washed-off to waterbodies

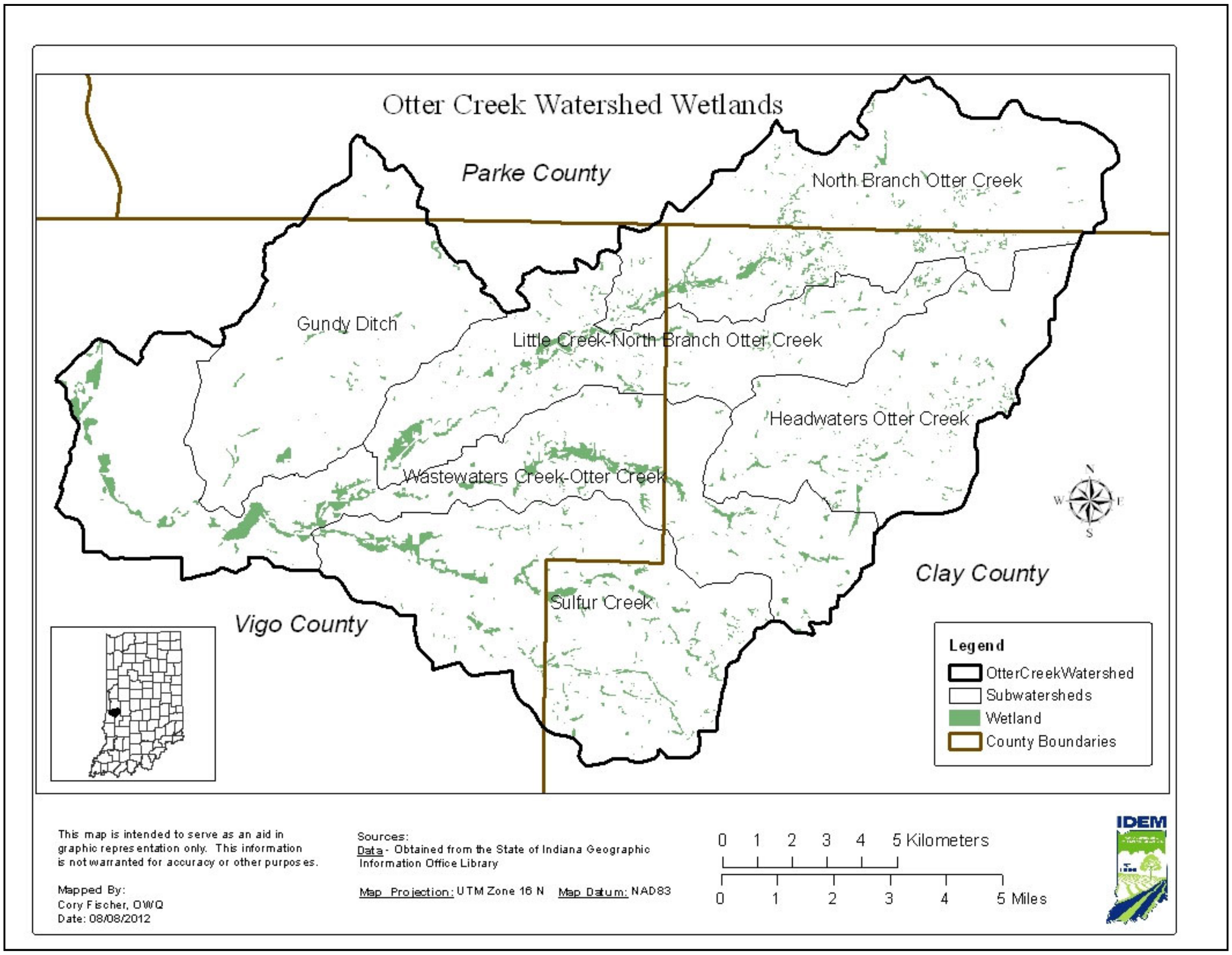


Figure 13. Wetlands in Otter Creek Watershed

Changes to the natural drainage patterns of a watershed are referred to as hydromodifications. Historically, drain tiles have been used throughout Indiana to drain marshes or wetlands and make the land either habitable for humans 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 (http://boonecounty.in.gov/Default.aspx?tabid=167). Records were not kept by private landowners as to the location and quantity of these tiles.

In addition to tile drainage, legal drains and ditches are other forms of hydromodification. In the Otter Creek watershed, there are approximately 6 legal drains and 6 ditches under the jurisdiction of the Vigo County Drainage Board.

3.4.4 Soil Erodibility

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 systems 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. Highly erodible soils 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 highly erodible land 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. The soil types and acreages in the Otter Creek watershed are listed by county in Table 8. Highly erodible lands and potentially highly erodible lands in the Otter Creek watershed are mapped in Figure 14. The data used to create Figure 14 was collected from the NRCS offices of Clay, Parke, and Vigo Counties. A total of 18,993.39 acres or 23.91 percent of the Otter Creek watershed is considered highly erodible or potentially highly erodible. Rainfall within the Otter Creek watershed is moderately heavy with an annual average of 42.40 inches. This rainfall and climate data specific to the watershed is available from the National Climatic Data Center (http://www.ncdc.noaa.gov/oa/ncdc.html). 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.

Table 8. HEL/Potential HEL Total Acres in the Counties in the Otter Creek Watershed

County	HEL/Potential HEL Soil Types	Acres
Clay	Chetwynd Loam	444.26
	Cincinnati silt loam	642.47
	Fairpoint shaly silty clay loam	2,380.15
	Hickory loam	4,501.65
	Hickory silt loam	389.58
	Parke silt loam	183.62
	Total:	**8,541.73**
Parke	Cincinnati-Hickory complex	538.87
	Hennepin-Russell complex	22.38
	Hickory complex	1,614.28
	Negley soils	9.35
	Parke Silt Loam	1.51
	Princeton fine sandy loam	17.54
	Russell silt loam	9.31
	Total:	**2,213.24**
Vigo	Alford silt loam	1,387.37
	Cincinnati silt loam	342.89
	Fox clay loam	17.79
	Hickory loam	4,504.71
	Negley Loam	579.67
	Parke silt loam	143.91
	Princeton fine sandy loam	334.46
	Rodman gravelly loam	88.57
	Strip mines	839.05
	Total:	**8,238.42**

Understanding Table 8***:*** In the Otter Creek watershed, Clay County has the most acreage of HEL/potential HEL soils. Areas within these counties might contribute to water quality impairments associated with excessive erosion, and might contain opportunities for streambank restoration.

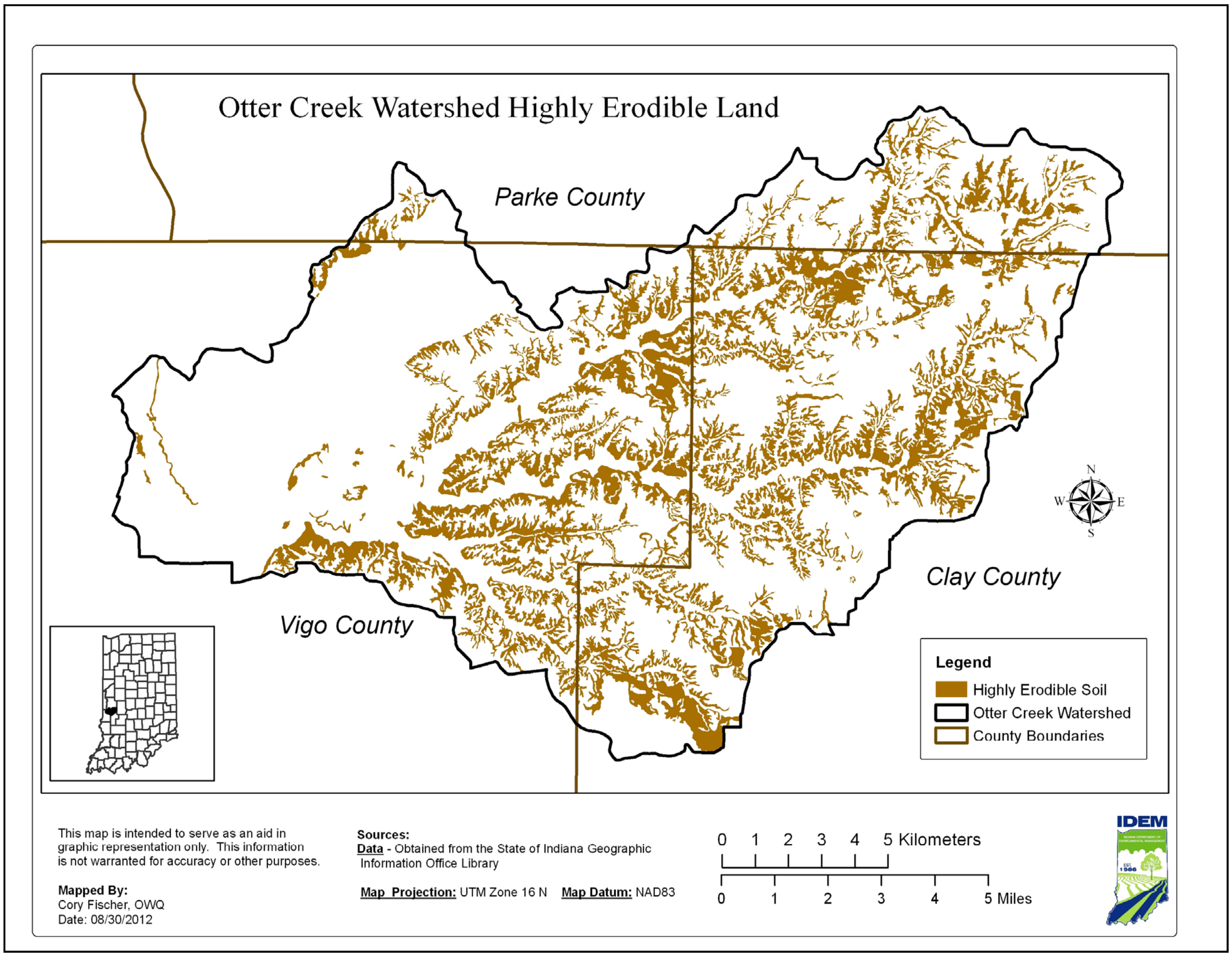


Figure 14. HEL/Potential HEL Soils in the Otter Creek Watershed

The Indiana State Department of Agriculture (ISDA) tracks trends in conservation and cropping practices through annual county tillage transects. Data collected through the tillage transects (county data can be found at http://www.in.gov/isda/2383.htm) can help to determine adoption of conservation practices and estimate the average annual soil loss from Indiana's agricultural lands. The latest figures for the counties in the Otter Creek watershed are shown in Table 9. Tillage practices captured in ISDA's tillage transect include no-till, mulch 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. Conventional tillage is any tillage system leaving less than 30 percent residue cover after planting.

Table 9. Tillage Transect Data for 2011 by County in the Otter Creek Watershed

County	Tillage Practice 2011					
	No Till		Mulch Till		Conventional Till	
	Soybean	Corn	Soybean	Corn	Soybean	Corn
Clay	36,400 acres 52%	16,200 acres 29%	10,500 acres 15%	2,200 acres 4%	11,900 acres 17%	32,500 acres 58%
Parke	45,000 acres 72%	19,200 acres 32%	11,300 acres 18%	4,800 acres 8%	3,800 acres 6%	17,400 acres 29%
Vigo	21,700 acres 36%	1,600 acres 4%	12,600 acres 21%	400 acres 1%	11,400 acres 19%	37,200 acres 92%

***Understanding Table** 9:* According to Table 9, no-till soybeans are predominant in 2 of 3 counties in the Otter Creek watershed. The use of no-till is greatest in Clay and Parke Counties. These counties comprise 52 percent of the entire Otter Creek watershed.

3.5 Climate and Precipitation

Climate varies in Indiana depending on latitude, topography, soil types, and lakes. Information on Indiana's climate is available through sources including the Indiana State Climate Office at Purdue University (http://climate.agry.purdue.edu/climate/narrative.asp).

Climate data from Station 128723 located in Terre Haute, Indiana, were used for climate analysis of the Otter Creek watershed. Monthly data from 1955 - 2012 were available at the time of analysis. In general, the climate of the region is mild with, humid summers and cold winters. From 1955 to 2012, the average winter temperature in Terre Haute was 38.9°F and the average summer temperature was 85.4°F. The average growing season (consecutive days with low temperatures greater than or equal to 32 degrees) is 190 days.

Examination of precipitation patterns is also a key component of watershed characterization because of the impact of runoff on water quality. From 1954 to 2012, the annual average precipitation in Terre Haute at Station 128723 was approximately 43 inches, including approximately 13 inches of snowfall. North Terre Haute represents the mid range of precipitation within the larger river system drainage. More detailed discussions on precipitation data during sampling periods are presented in Section 7.0.

Rainfall intensity and timing affect watershed response to precipitation. This information is important in evaluating the effects of storm water on the Otter Creek watershed. Using data from Station 128723 during 1954 to 2012, 52 percent of the measureable precipitation events were very low intensity (i.e., less than 0.2 inches), while 9 percent of the measurable precipitation events were greater than one inch.

Knowing when precipitation events occur helps in the linkage analysis (Section 7), which correlates flow conditions to pollutant concentrations and loads. Data indicate that the wet weather season in the Otter Creek watershed occurs between the months of April and July.

3.6 Summary

The information presented in Section 3 helps to provide a better understanding of the conditions and characteristics in the Otter Creek watershed that, when coupled with the sources presented in Section 4, affect both water quality and water quantity. In summary, the predominant land uses in the Otter Creek watershed of agricultural and forested serve as indicators of the type of sources that are likely to contribute to water quality impairments in the Otter Creek watershed. Human population, which is greatest in Vigo and Clay in the Otter Creek watershed, 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 Otter Creek watershed. These features interact with land use activities and human population to create pressures on both water quality and quantity in the Otter Creek 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 Storm water on the watershed. Collectively, this information plays an important role in understanding the sources that contribute to water quality impairment during TMDL development and crafting the linkage analysis that connects the observed water quality impairment to what has caused that impairment.

4.0 SOURCE ASSESSMENT

This section presents information concerning IDEM's stream segmentation and water quality assessment process as it applies to the Otter Creek watershed in order to present a source assessment for the watershed as well as summaries of significant sources of *E. coli* for each subwatershed.

4.1 Understanding Subwatersheds and Assessment Units

As briefly discussed in Section 2.3, the Otter Creek watershed contains six 12-digit HUC subwatersheds. Examining subwatersheds enables a closer look at key factors that affect water quality. The subwatersheds include:

- Headwaters Otter Creek (051201110401)
- North Branch Otter Creek (051201110402)
- Little Creek- North Branch Otter Creek (051201110403)
- Sulphur Creek (051201110404)
- Gundy Ditch (051201110405)
- Wastewaters Creek- Otter Creek (051201110406)

Within each 12-digit HUC subwatershed, IDEM has identified several Assessment Units (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 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 10 contains the AUIDs and the associated drainage areas of all AUIDs in the Otter Creek watershed. Subsequent sections of the TMDL report organize information by subwatershed (if applicable) and AUID.

Table 10. Assessment Units in Otter Creek Watershed

Name of Subwatershed	12-digit HUC	Current AUID (2012)	Drainage area (sq. miles)	Percent of Total Drainage area
Headwaters Otter Creek	051201110401	INB1141_01	15.75	12.69
North Branch Otter Creek	051201110402	INB1142_01	22.64	18.24
		INB1142_01A	0.12	0.10
		INB1142_01B	0.05	0.04
		INB1142_01C	0.51	0.41
		INB1142_T1001	3.04	2.45
		INB1142_T1002	1.77	1.43
		INB1142_T1003	1.18	0.95
		INB1142_T1004	3.56	2.87
		INB1142_T1005	0.93	0.75
Little Creek- North Branch Otter Creek	051201110403	INB1143_01	39.30	31.67
		INB1143_T1001	7.49	6.04
		INB1143_T1001A	1.27	1.02
		INB1143_T1002	1.48	1.19
Sulphur Creek	051201110404	INB1144_01	23.09	18.61
		INB1144_T1001	9.27	7.47
		INB1144_T1001A	2.51	2.02
		INB1144_T1002	2.65	2.14
Gundy Ditch	051201110405	INB1145_01	18.29	14.74
		INB1145_T1001	5.10	4.11
		INB1145_T1002	3.35	2.70
Wastewaters Creek- Otter Creek	051201110406	INB1146_01	30.58	24.64
		INB1146_T1001	4.67	3.76
		INB1146_02	97.02	78.19
		INB1146_03	124.09	100

Understanding Table 10: Land area helps IDEM to define the pollutant load reductions needed for each AUID in each 12-digit HUC subwatershed that comprises the Otter Creek watershed. Information in each column is as follows:

- *Column 1: Name of Subwatershed.* Lists the name of the subwatersheds.
- *Column 2: 12-digit HUC.* Identifies the subwatershed's 12-digit HUC.
- *Column 3: Current AUID*. Provides the updated AUIDs associated with each subwatershed.
- *Column 4: Drainage Area.* Quantifies the area the specific AUID drains.
- *Column 5: Percent of Total Drainage Area.* Indicates the percent of the total drainage area, providing a relative understanding of the portion of the AUID in the overall Otter Creek watershed.

IDEM bases percent load reductions on the drainage area for each AUID in the 12-digit HUC subwatersheds. The information contained in this table is the foundation for the calculations found in Sections 5, 6, and 7 of this report. This table will help watershed stakeholders look at the smaller segments within the Otter Creek watershed and understand the smaller areas contributing to the impaired waterbody, helping to quantify the geographic scale that influences source characterization and areas for implementation.

4.2 Source Assessment by Subwatershed

This section summarizes the available information on significant point and nonpoint sources of *E. coli* in the six subwatersheds of the Otter Creek watershed.

The term "point source" refers to any discernible, confined and discrete conveyance, such as a pipe, ditch, channel, tunnel or conduit, by which pollutants are transported to a waterbody. It also includes vessels or other floating craft from which pollutants are or may be discharged. By law, the term "point source" also includes: concentrated animal feeding operations (CAFO) which are places where animals are confined and fed; storm water runoff from Municipal Separate Storm Sewer Systems (MS4s); and illicitly connected "straight pipe" discharges of household waste. Permitted point sources are regulated through the National Pollutant Discharge Elimination System (NPDES) program.

Nonpoint sources include all other categories not classified as point sources. In urban areas, nonpoint sources can include leaking or faulty septic systems, runoff from lawn fertilizer applications, pet waste, storm water runoff (outside of MS4 communities), and other sources. In rural areas, nonpoint sources can include runoff from cropland, pastures and animal feeding operations and inputs from streambank erosion, leaking or failing septic systems, and wildlife.

4.2.1 Subwatershed Summary: Headwaters Otter Creek

This section of the report presents the available information on the sources of *E. coli* in the Headwaters Otter Creek subwatershed.

The Headwaters Otter Creek subwatershed is located in northwestern Clay County, covering nearly 15.75 square miles (Figure 15). The subwaterhsed drains portions of Clay County and includes the northern part of the City of Brazil. Land use in the Headwaters Otter Creek is primarily agricultural and forested as shown in Table 11.

Table 11. Land Use in the Headwaters Otter Creek Subwatershed

Land Use	Watershed		
	Area		Percent
	Acres	Square Miles	
Open Water	58.49	0.09	0.57
Developed, Open Space	495.72	0.77	4.88
Developed, Low Intensity	144.11	0.23	1.46
Developed, Medium Intensity	22.46	0.04	0.25
Developed, High Intensity	28.02	0.04	0.25
Forested Land	4,442.56	6.94	44.01
Shrub/Scrub	120.54	0.19	1.20
Pasture/Hay	416.10	0.65	4.12
Agriculture	4,344.04	6.79	43.06
Wetlands	16.90	0.03	0.19
TOTAL	**10,090.94**	**15.77**	**100**

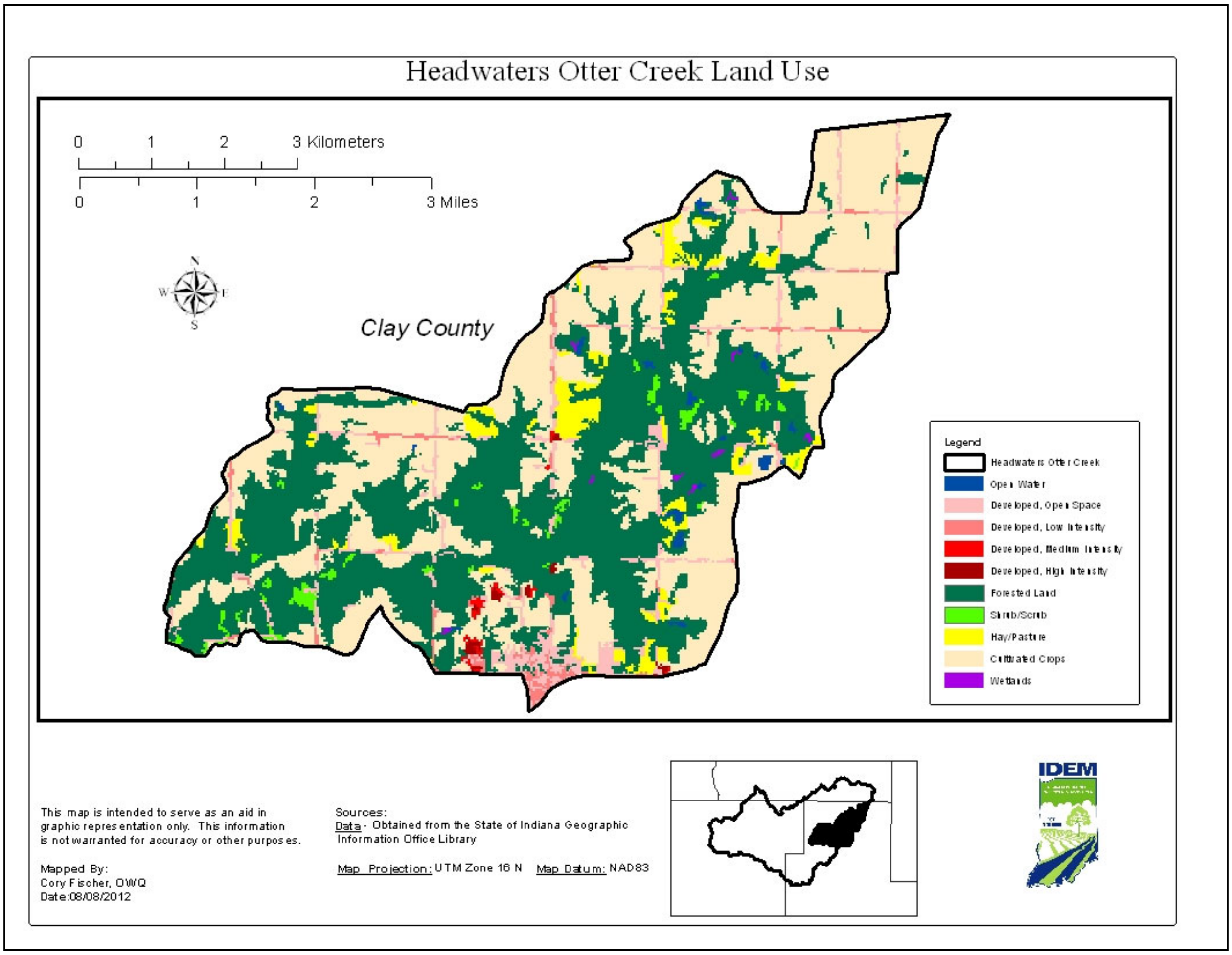


Figure 15. Land Use in the Headwaters Otter Creek Subwatershed

4.2.1.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the Headwaters Otter Creek subwatershed, as regulated through the NPDES Program.

Illicitly Connected "Straight Pipe" Systems

Some household wastes within Indiana and potentially within the Headwaters Otter Creek subwatershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli*, to the stream (these systems are sometimes referred to as "straight pipe" discharges).

4.2.1.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the Headwaters Otter Creek subwatershed that are not regulated through the NPDES Program.

Cropland

Approximately 24 percent of the land in the Headwaters Otter Creek subwatershed is classified as row crops. Croplands can be a source of *E. coli*. Accumulation of *E. coli* on cropland occurs from manure fertilizers, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. (USEPA, 2003).

Watershed specific data are not available for field specific crops. However, county-wide data available from the National Agricultural Statistic Service (NASS) were downloaded and area weighted to estimate crop acreage in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the subwatershed and summed to get an area weighted estimate of cropland with the watershed. The 2012 NASS statistics were used in the analysis, and there is an estimated 60, 497 total acres of cropland in the Headwaters Otter Creek Watershed. Within the total acreage 20, 327 acres are corn, 19,843 acres are soybean, and 1,452 acres are winter wheat.

Pastures and Livestock Operations

In the Headwaters Otter Creek subwatershed, 2.31 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*. 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.

Livestock are potential source of *E. coli*, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the National Agricultural Statistic Service (NASS) were downloaded and area weighted to estimate animal population in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals with the watershed. There are an estimated 523 animal units in the Headwaters Otter Creek subwatershed and the animal unit density is 34 animal units per square mile as shown in Table 12.

Table 12. Animal Unit Density in the Headwaters Otter Creek Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head in Subwatershed	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi^2)
15.77	Hogs and Pigs	451*	2.5	181	34
	Cattle and Calves	271	1	271	
	Sheep and Lambs	8	10	1	
	Horses and Ponies	35	0.5	70	
	TOTAL	765	14	523	

*Vigo County did not disclose Hogs and Pigs data to NASS Survey

Onsite Wastewater Treatment Systems

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 are currently used in Indiana. Local health departments 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.

Clay County has adopted the Residential Onsite Sewage Systems Rule 410 IAC 6-8.2 with no additional county ordinances.

A comprehensive database of septic systems within the Otter 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 population 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 population in the Headwaters Otter Creek subwatershed is shown in Table 13, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Otter Creek watershed.

It should also be noted that hydrologic soil group A and B soils have good infiltration rates and have less risk for failing septic systems due to this factor. Group C soils have slow infiltration rates with finer textures and slow water movement. Headwaters Otter Creek subwatershed has 0 percent of soil group A, 35.79 percent of soil group B and 62.95 percent of soil group C.

Table 13. Rural Population Density in the Headwaters Otter Creek Subwatershed

County	Area of County in Subwatershed (mi^2)	County Population	Urban Population	Rural Population	Rural Population Density (persons/mi^2)
Clay	15.75	2479	1043	1436	91
TOTAL	15.75	2479	1043	1436	

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Typical 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. The percent and distribution of developed land in the Headwaters Otter Creek subwatershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of pet populations and residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the Headwaters Otter Creek subwatershed.

Dog and cat populations were estimated for the Headwaters Otter Creek subwatershed using statistics reported in the *2007 U.S. Pet Ownership & Demographics Sourcebook*[1]. Specifically, the *Sourcebook* reports that on average 37.2 percent of households own dogs and 32.4 percent of households own cats. Typically, the average number of pets per household is 1.7 dogs and 2.2 cats. However, pets are likely only a significant source of *E. coli* in population centers (i.e., cities and towns). The estimated number of domestic pets in cities and towns in the watershed are presented in Table 14 and is based on the average number of pets per household multiplied by the population of the watershed.

Table 14. Estimated Pet Populations in the Cities and Towns in the Headwaters Otter Creek Subwatershed

City/Town	Housholds in 2010	Estimated Number of Cats	Estimated Number of Dogs
Brazil	300	660	510

Wildlife

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*. Population estimates for types of wildlife are generally not available.

In summary, the Headwaters Otter Creek subwatershed is dominated by forested land (44%) and agriculture (43%). Sources of impairment include small feeding operations, Storm water runoff, and failing septics. These characteristics are likely to affect the amount of *E. coli* loading found in the Headwaters Otter Creek subwatershed.

4.2.2 Subwatershed Summary: North Branch Otter Creek

This section of the report presents the available information on the sources of *E. coli* in the North Branch Otter Creek subwatershed.

The North Branch Otter Creek subwatershed is located in southeastern Parke County, northwestern Clay County, and northeastern Vigo County, covering nearly 23 square miles Figure 16. The subwatershed drains portions of Clay, Parke, and Vigo Counties, and includes a portion of the Town of Carbon. Land use in the North Branch Otter Creek is primarily forested and agricultural as shown in Table 15.

Table 15. Land Use in the North Branch Otter Creek Subwatershed

Land Use	Watershed		
	Area		Percent
	Acres	Square Miles	
Open Water	83.40	0.13	0.57
Developed, Open Space	679.42	1.06	4.68
Developed, Low Intensity	90.74	0.14	0.62
Developed, Medium Intensity	2.89	0.005	0.02
Developed, High Intensity	2.67	0.004	0.02
Forested Land	6,760.36	10.56	46.65
Shrub/Scrub	132.10	0.21	0.93
Pasture/Hay	409.87	0.64	2.83
Agriculture	6,295.55	9.84	43.46
Wetlands	32.47	0.05	0.22
TOTAL	**14,489.47**	**22.64**	**100**

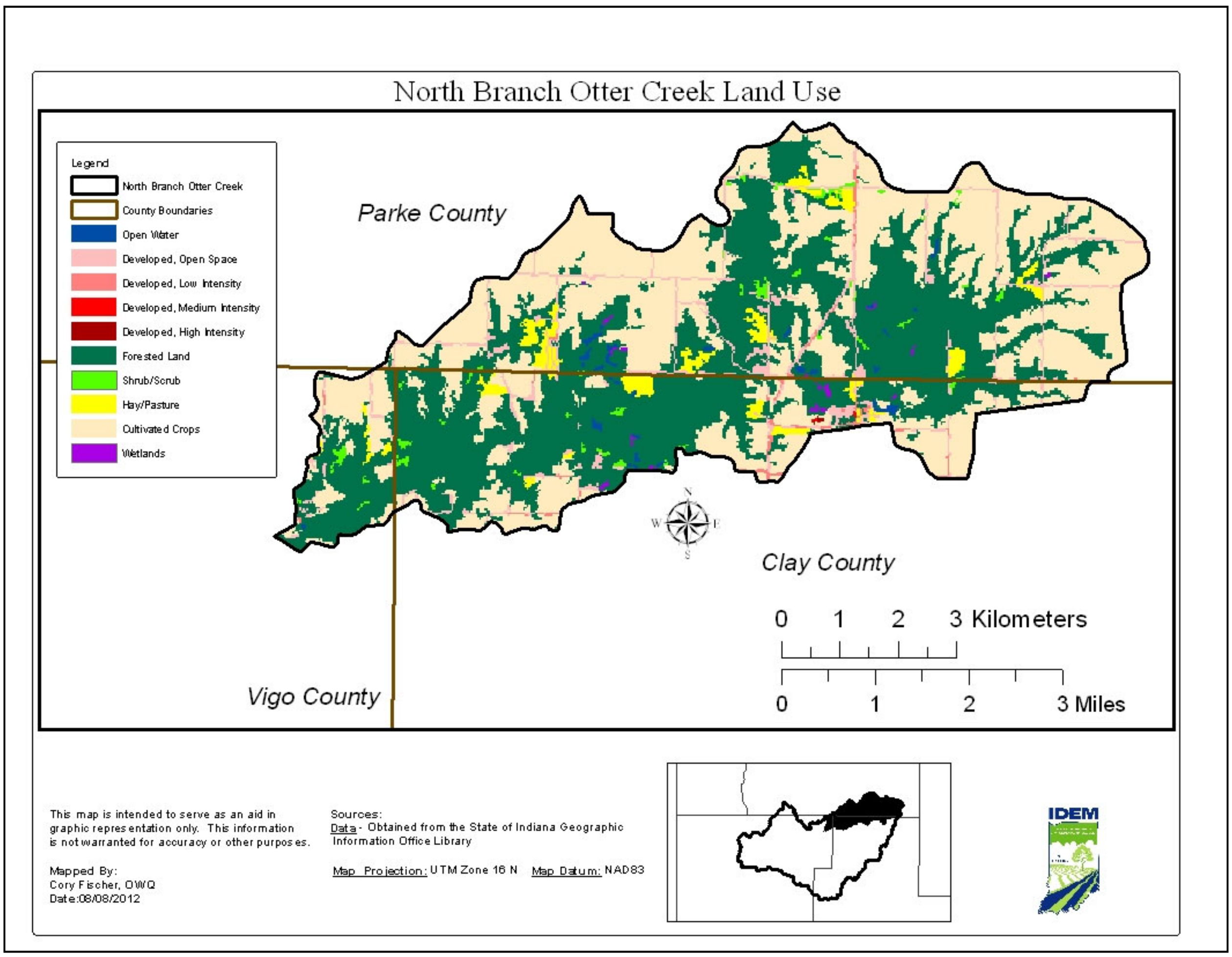


Figure 16. Land Use in the North Branch Otter Creek Subwatershed

4.2.2.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the North Branch Otter Creek subwatershed, as regulated through the NPDES Program.

Wastewater Treatment Plants (WWTPs)

Facilities with NPDES permits to discharge wastewater within the North Branch Otter Creek subwatershed include municipal WWTPs. There is one active WWTP that discharges wastewater containing *E. coli* within the North Branch Otter Creek subwatershed (Table 16 and Figure 17). The facility is the Town of Carbon WWTP. As authorized by the Clean Water Act, the NPDES permit program controls water pollution by regulating WWTPs that discharge pollutants into waters of the United States.

The facility currently operates a Class I-SP, 0.0252 MGD controlled discharge waste stabilization lagoon facility consisting of three waste stabilization lagoon cells totaling three acres in size, an effluent flow meter and a stream gauge. The facility's collection system consists of approximately 160 septic tanks which contribute flow to a lift station for pumping to the treatment lagoons. The septic tanks are pumped on a rotational basis. Two of the lagoons are used for treatment and the other is used for polishing and storage.

Municipal facilities in Indiana are required to disinfect their effluent during the recreational season (April 1 to October 31). IDEM does not require disinfection for waste-stabilization lagoons as long as *E. coli* limits from the permit are met utilizing the lagoon's retention time. Table 16 contains the maximum design flow for the active facility. The Carbon wastewater treatment plant in North Branch Otter Creek subwatershed uses waste stabilization lagoons that have a 90 day detention time. Waste stabilization lagoons discharge at a 10:1 dilution ratio.

Table 16. NPDES Permitted Wastewater Dischargers within the North Branch Otter Creek Subwatershed

Facility Name	Permit Number	AUID	Receiving Stream	Maximum Design Flow (MGD)
Carbon WWTP	IN0039829	INB1142_T1001	Ebenezer Creek	0.0252

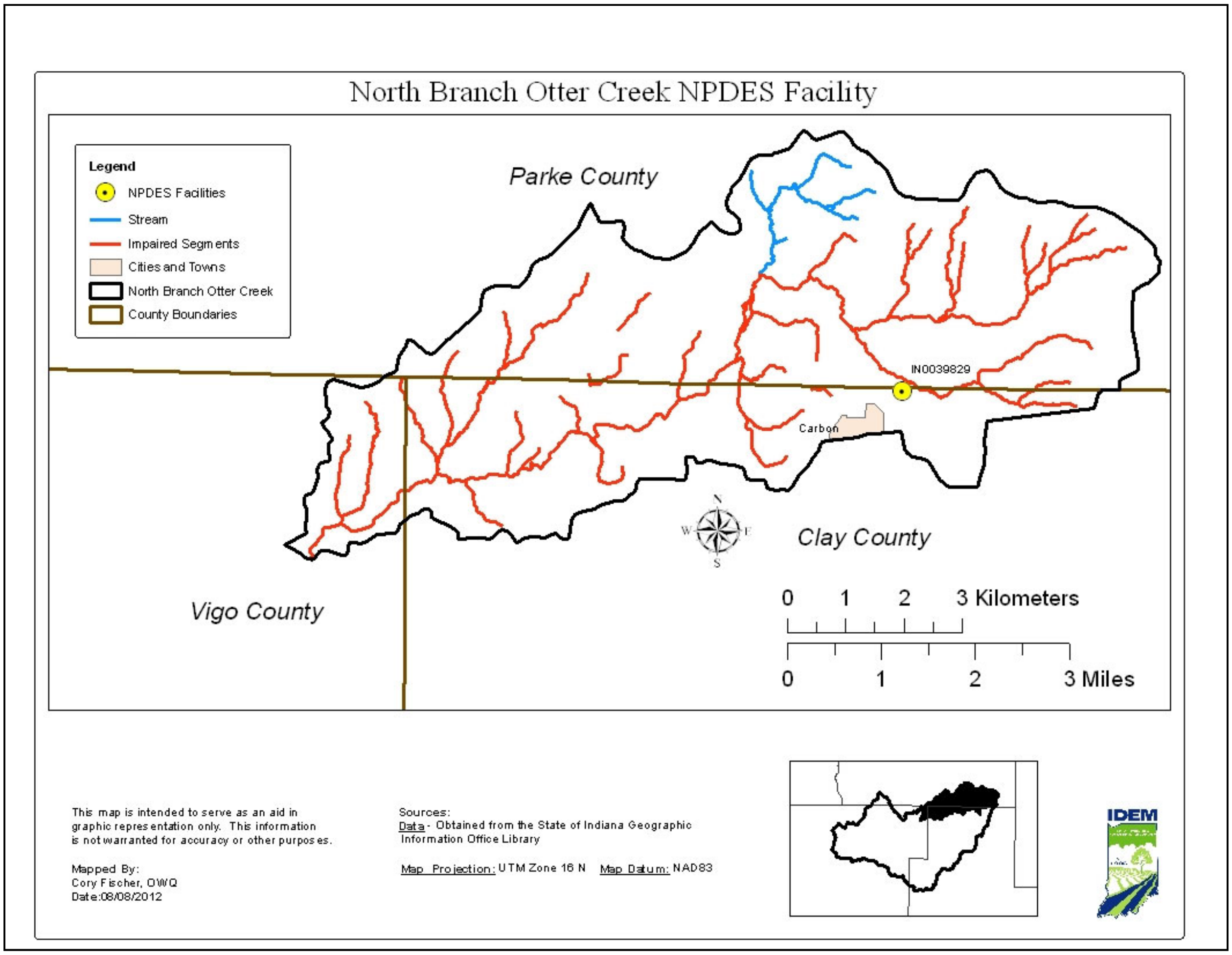


Figure 17. NPDES Facilities in the North Branch Otter Creek Subwatershed

Table 17 presents a summary of permit compliance for all NPDES facilities in the North Branch Otter Creek subwatershed for the five year period between 2007 and 2012. It presents the date of the facility's last inspection and findings from the inspection (i.e., compliance or violation). The table also presents the total number of violations in the five year period for *E. coli* and other parameters. According to table 18, there have been 4 NPDES facility inspections resulting in no violations for *E. coli* in the five year period.

The Carbon WWTP has one open enforcement case with regards to its ammonia limitations. The corrective action plan is to obtain funding for necessary improvements to meet ammonia limits. The improvements must be completed by January 31, 2013. The facility installed a V-notch weir on the effluent discharge allowing discharge at a low rate to stay under the 10% of the creek flow, fixed a broken swing valve that was letting cell one discharge into cell three skipping treatment in cell two, and cleaned the settled sludge away from the discharge pipe of cell three. These changes are believed to have made a significant difference in the facility and allow the lagoon system to stay in compliance without further construction. If Carbon WWTP is able to demonstrate compliance through March 2013, IDEM agrees to close out the Agreed Order. However, if compliance with effluent limits is not achieved through March, 2013, the town will be required to submit an Additional Action Plan within 60 days of becoming aware that any effluent exceedance has occurred.

Table 17. Summary of Inspections and Permit Compliance in the North Branch Otter Creek Subwatershed for the Five Year Period Ending June 2012

Facility Name	Permit Number	AUID	Date of Last Inspection and Findings	Violations from April 2009 through June 2012
Carbon WWTP	IN0039829	INB1142_T1001	09/09/2011: Violation	No *E. coli* violations 1 Quarter with pH violation 6 Quarters with N violations

Illicitly Connected "Straight Pipe" Systems

Some household wastes within Indiana and potentially within the North Branch Otter Creek subwatershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli*, to the stream (these systems are sometimes referred to as "straight pipe" discharges).

4.2.2.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the North Branch Otter Creek subwatershed that are not regulated through the NPDES Program.

Cropland

Approximately 43 percent of the land in the Otter Creek watershed is classified as row crops. Croplands can be a source of *E. coli*. Accumulation of E. *coli* on cropland occurs from manure fertilizers, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities.

Watershed specific data are not available for field specific crops. However, county-wide data available from the National Agricultural Statistic Service (NASS) were downloaded and area weighted to estimate crop acreage in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the subwatershed and summed to get an area weighted estimate of cropland with the watershed. The 2012 NASS statistics were used in the analysis, and there is an estimated 93,335 total acres of cropland in the North Branch Otter Creek subwatershed. Within the total acreage 70,849 acres are corn, 19,899 acres are soybean, and 2,587 acres are winter wheat.

Pastures and Livestock Operations

In the North Branch Otter Creek subwatershed, 2.32 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli* 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.

Livestock are potential source of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the NASS were downloaded and area weighted to estimate animal population in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals with the watershed.

There are an estimated 614 animal units in the North Branch Otter Creek subwatershed and the animal unit density is 27 animal units per square mile as shown in Table 18.

Table 18. Animal Unit Density in the North Branch Otter Creek Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi^2)
22.64	Hogs and Pigs	273*	2.5	109	27
	Cattle and Calves	401	1	401	
	Sheep and Lambs	14	10	1	
	Horses and Ponies	52	0.5	104	
			TOTAL	614	

*Vigo County did not disclose Hogs and Pigs data to NASS Survey

Onsite Wastewater Treatment Systems

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 are currently used in Indiana. Local health departments 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.

Vigo County follows the Indiana Administrative Code (RULE 410 IAC 6-8.2), with regards to septic systems along with local ordinances. Upon a received complaint in Vigo County the Health Inspector will visit and determine if a violation exists and will notify the occupant in writing of the violation. The occupant has 10 days to respond and indicate how the violation will be fixed. Fees can be assessed in the following order: Any person found to be violating any provision of this ordinance shall be punished for the first offense by a fine of two hundred dollars ($200.00); for the second offense by a fine of not more than five hundred dollars ($500.00); and for the third and each subsequent offense by a fine of not more than one thousand dollars ($1,000.00). Each day after the expiration of the time limit for abating unsanitary conditions and completing improvements as ordered by the Vigo County Health Department (VCHD), or by the duly appointed Health Officer of the County, shall constitute a distinct and separate offense.

Parke County follows the Indiana Administrative Code (RULE 410 IAC 6-8.2). The county has some fines set up $100-$1000 for septic violations. The health department staffs have had better success in the past working with landowners to get violations fixed, and explaining to them the benefits of a properly functioning septic system rather than assessing fines right away.

Clay County follows the Indiana Administrative Code (RULE 410 IAC 6-8.2), no additional information was provided.

A comprehensive database of septic systems within the Otter 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 population 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 population in the North Branch Otter Creek subwatershed is shown in Table 19, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Otter Creek watershed.

It should also be noted that hydrologic soil group A and B soils have good infiltration rates and have less risk for failing septic systems due to this factor. North Branch Otter Creek subwatershed has .004 percent of soil group A, 33.68 percent of soil group B, and 57.18 percent of soil group C.

Table 19. Rural Population Density in the North Branch Otter Creek Subwatershed

County	Area of County in Subwatershed (mi^2)	County Population	Urban Population	Rural Population	Rural Population Density (persons/mi^2)
Clay	7.4	961	316	645	89
Parke	13.6	816	0	816	
Vigo	1.6	230	0	230	
TOTAL	22.6	2007	316	1691	

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Typical 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. The percent and distribution of developed land in the North Branch Otter Creek subwatershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of pet populations and residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important sources of E. *coli* in the North Branch Otter Creek subwatershed.

Dog and cat populations were estimated for the North Branch Otter Creek subwatershed using statistics reported in the *2007 U.S. Pet Ownership & Demographics Sourcebook*[1]. Specifically, the *Sourcebook* reports that on average 37.2 percent of households own dogs and 32.4 percent of households own cats. Typically, the average number of pets per household is 1.7 dogs and 2.2 cats. However, pets are likely only a significant source of *E. coli* and nutrients in population centers (i.e., cities and towns). The estimates of domestic pets in cities and towns in the watershed are presented in Table 20 and is based on the average number of pets per household multiplied by the population of the watershed.

Table 20. Estimated Pet Populations in the Cities and Towns in the North Branch Otter Creek Watershed

City/Town	Households in 2010	Estimated Number of Cats	Estimated Number of Dogs
Carbon	105	231	179

Wildlife

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*. Population estimates for types of wildlife are generally not available.

In summary, the North Branch Otter Creek subwatershed is dominated by forested land (47%) and agriculture (43%). Sources of impairment include small animal operations, Storm water runoff, and failing septics. Specifically, North Branch Otter Creek has one permitted facility the Carbon WWTP waste stabilization lagoon. These characteristics are likely to affect the amount of *E. coli* loading found in the North Branch Otter Creek subwatershed.

4.2.3 Subwatershed Summary: Little Creek- North Branch Otter Creek

This section of the report presents the available information on the sources of *E. coli* in the Little Creek-North Branch Otter Creek subwatershed.

The Little Creek- North Branch Otter Creek subwatershed is located in northwestern Clay County and northeastern Vigo County, covering nearly 17 square miles (Figure 18). The subwatershed drains portions of Clay and Vigo Counties, and includes a portion of the Town of Carbon. Land use in the Little Creek-North Branch Otter Creek subwatershed is primarily forested and agricultural as shown in Table 21.

Table 21. Land Use in the Little Creek- North Branch Otter Creek Subwatershed

Land Use	Watershed		
	Area		Percent
	Acres	Square Miles	
Open Water	45.81	0.07	0.43
Developed, Open Space	533.97	0.83	5.01
Developed, Low Intensity	86.07	0.13	0.81
Developed, Medium Intensity	2.89	0.005	0.03
Developed, High Intensity	1.56	0.002	0.01
Forested Land	4,677.41	7.31	43.89
Shrub/Scrub	105.64	0.17	0.99
Pasture/Hay	801.51	1.25	7.52
Agriculture	4,371.39	6.83	41.02
Wetlands	31.36	0.05	0.29
TOTAL	**10,657.61**	**16.65**	**100**

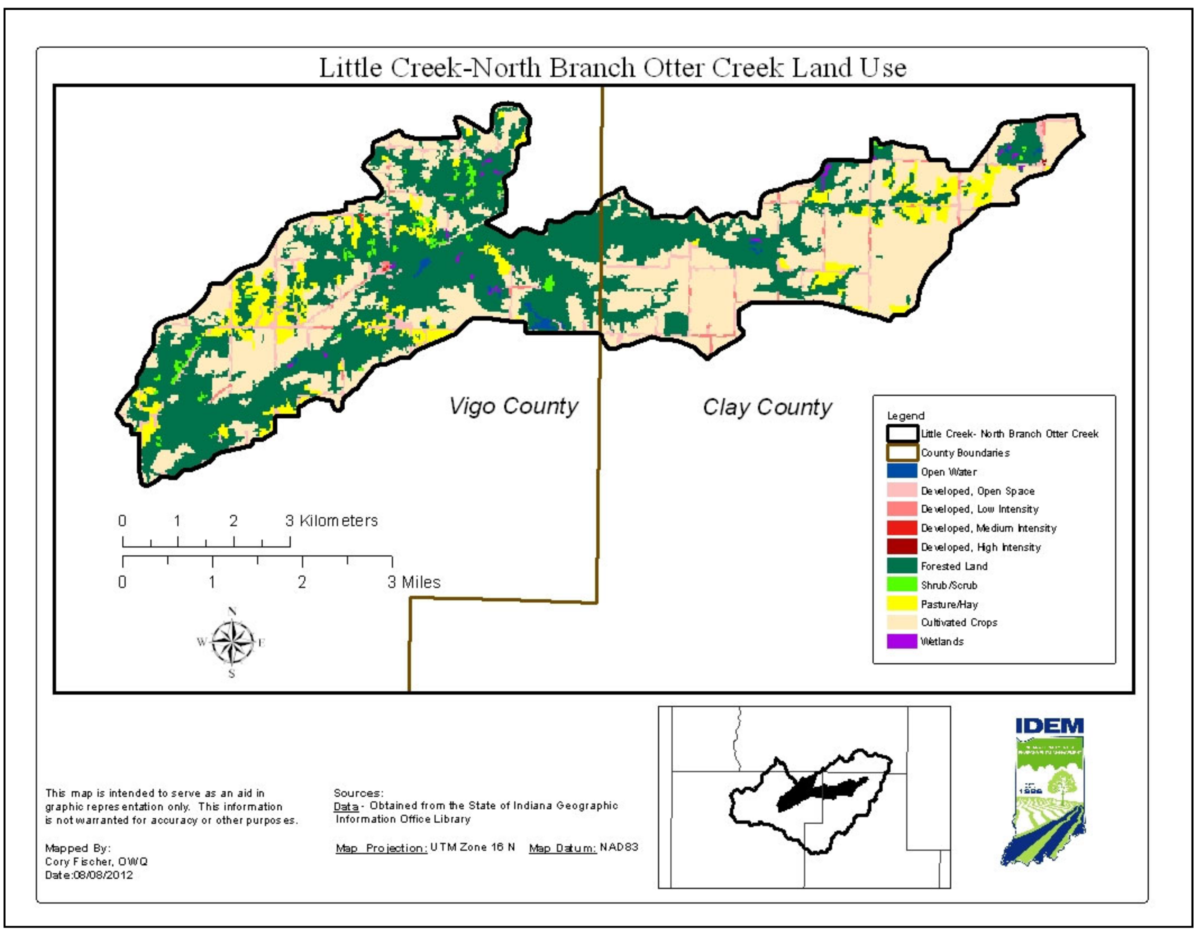


Figure 18. Land Use in the Little Creek- North Branch Otter Creek Subwatershed

4.2.3.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the Little Creek- North Branch Otter Creek subwatershed, as regulated through the NPDES Program.

Illicitly Connected "Straight Pipe" Systems

Some household wastes within Indiana and potentially within the Little Otter Creek-North Branch subwatershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli* to the stream (these systems are sometimes referred to as "straight pipe" discharges).

4.2.3.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the Little Creek- North Branch Otter Creek subwatershed that are not regulated through the NPDES Program.

Cropland

Approximately 41.5 percent of the land in the Little Creek- North Branch Otter Creek subwatershed is classified as row crops. Croplands can be a source of *E. coli*. Accumulation of *E. coli* on cropland occurs from decomposition of residual crop material, manure fertilizers, wildlife excreta, and irrigation water.

Watershed specific data are not available for field specific crops. However, county-wide data available from the National Agricultural Statistic Service (NASS) were downloaded and area weighted to estimate crop acreage in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the subwatershed and summed to get an area weighted estimate of cropland with the watershed. The 2012 NASS statistics were used in the analysis, and there is an estimated 69,163 total acres of cropland in the Little Creek- North Branch Otter Creek subwatershed. Within the total acreage 51,963 acres are corn, 15,234 acres are soybean, and 1,965 acres are winter wheat.

Pastures and Livestock Operations

In the Little Creek- North Branch Otter Creek subwatershed, 4.53 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*. 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.

Livestock are potential source of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the NASS were downloaded and area weighted to estimate animal population in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals with the watershed. There are an estimated 356 animal units in the Little Creek- North Branch Otter Creek subwatershed and the animal unit density is 22 animal units per square mile as shown in Table 22.

Table 22. Animal Unit Density in the Little Creek- North Branch Otter Creek Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head in Subwatershed	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi²)
16.66	Hogs and Pigs	189*	2.5	76	22
	Cattle and Calves	163	1	163	
	Sheep and Lambs	6	10	1	
	Horses and Ponies	58	0.5	116	
	TOTAL	416		**356**	

*Vigo County did not disclose Hogs and Pigs data to NASS Survey

Onsite Wastewater Treatment Systems

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 are currently used in Indiana. Local health departments 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.

Vigo County follows the Indiana Administrative Code (RULE 410 IAC 6-8.2), with regards to septic systems along with local ordinances. Upon a received complaint in Vigo County the Health Inspector will visit and determine if a violation exists and will notify the occupant in writing of the violation. The occupant has 10 days to respond and indicate how the violation will be fixed. Fees can be assessed in the following order: Any person found to be violating any provision of this ordinance shall be punished for the first offense by a fine of two hundred dollars ($200.00); for the second offense by a fine of not more than five hundred dollars ($500.00); and for the third and each subsequent offense by a fine of not more than one thousand dollars ($1,000.00). Each day after the expiration of the time limit for abating unsanitary conditions and completing improvements as ordered by the Vigo County Health Department (VCHD), or by the duly appointed Health Officer of the County, shall constitute a distinct and separate offense.

Clay County follows the Indiana Administrative Code (RULE 410 IAC 6-8.2), no additional information was provided.

A comprehensive database of septic systems within the Otter 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 population 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 population in the Little Creek- North Branch Otter Creek subwatershed is shown in Table 23, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Otter Creek watershed.

It should also be noted that hydrologic soil group A and B soils have good infiltration rates and have less risk for failing septic systems due to this factor. Little Creek- North Branch Otter Creek subwatershed has 1.29 percent of soil group A and 15.63 percent of soil group B.

Table 23. Rural Population Density in the Little Creek- North Branch Otter Creek Subwatershed

County	Area of County in Subwatershed (mi²)	County Population	Urban Population	Rural Population	Rural Population Density (persons/mi²)
Clay	6.72	710	50	660	143
Vigo	9.94	1724	0	1724	
TOTAL	16.66	2432	50	2384	

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Typical 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. The percent and distribution of developed land in the Little Creek- North Branch Otter Creek subwatershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of pet populations and residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the Little Creek- North Branch subwatershed.

Dog and cat populations were estimated for the Little Creek- North Branch Otter Creek watershed using statistics reported in the *2007 U.S. Pet Ownership & Demographics Sourcebook*[1]. Specifically, the *Sourcebook* reports that on average 37.2 percent of households own dogs and 32.4 percent of households own cats. Typically, the average number of pets per household is 1.7 dogs and 2.2 cats. However, pets are likely only a significant source of *E. coli* and nutrients in population centers (i.e., cities and towns). The estimate of domestic pets in cities and towns in the watershed are presented in Table 24 and is based on the average number of pets per household multiplied by the population of the watershed.

Table 24. Estimated Pet Populations in the Cities and Towns in the Little Creek- North Branch Otter Creek Watershed

City/Town	Households in 2010	Estimated Number of Cats	Estimated Number of Dogs
Carbon	20	44	34

Wildlife

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*. Population estimates for types of wildlife are generally not available.

In summary, the Little Creek- North Branch Otter Creek subwatershed is dominated by forested land (44%) and agriculture (41%). Sources of impairment include small feeding operations, Storm water runoff, and failing septics. These characteristics are likely to affect the amount of *E. coli* loading found in the Little Creek- North Branch Otter Creek subwatershed.

4.2.4 Subwatershed Summary: Sulphur Creek

This section of the report presents the available information on the sources of *E. coli* in the Sulphur Creek subwatershed.

The Sulphur Creek subwatershed is located in the southernmost part of the Otter Creek watershed, covering nearly 23 square miles (Figure 19). The subwatershed drains portions of Clay and Vigo Counties, and includes the Town of Staunton and the Town of Seelyville. Land use in the subwatershed is primarily forested as shown in Table 25.

Table 25. Land Use in the Sulphur Creek Subwatershed

	Watershed		
	Area		
Land Use	Acres	Square Miles	Percent
Open Water	60.05	0.09	0.39
Developed, Open Space	861.56	1.35	5.85
Developed, Low Intensity	167.02	0.26	1.13
Developed, Medium Intensity	20.24	0.032	0.14
Developed, High Intensity	4.23	0.007	0.03
Forested Land	7,937.94	12.40	53.73
Shrub/Scrub	474.59	0.74	3.21
Pasture/Hay	1,277.88	2.00	8.67
Agriculture	3,908.14	6.11	26.47
Wetlands	59.82	0.09	0.39
TOTAL	**14,771.47**	**23.08**	**100**

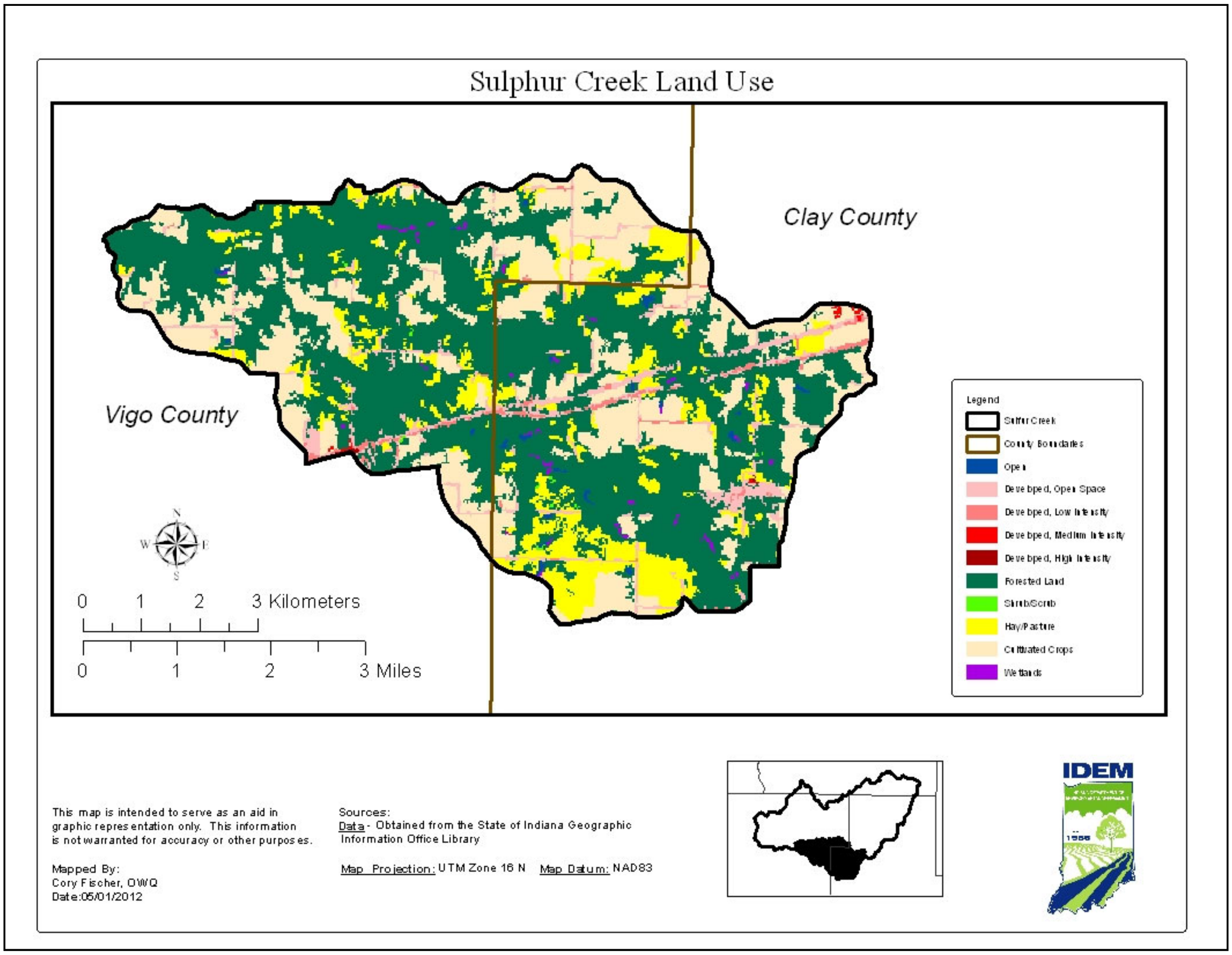


Figure 19. Land Use in the Sulphur Creek Subwatershed

4.2.4.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the Sulphur Creek subwatershed, as regulated through the (NPDES) Program.

Wastewater Treatment Plants (WWTPs)

Facilities with NPDES permits to discharge wastewater within the Otter Creek watershed include municipal WWTPs and industrial facilities. There is one active WWTP that discharges wastewater containing *E. coli* within the Sulphur Creek subwatershed (Table 26 and Figure 20). As authorized by the Clean Water Act, the NPDES permit program controls water pollution by regulating WWTPs that discharge pollutants into waters of the United States. Municipal facilities in Indiana are required to disinfect their effluent during the recreational season (April 1 to October 31).

The Staunton WWTP currently operates a Class I, 0.1 MGD extended aeration treatment facility consisting of a flow meter, a comminutor, a splitter box, two aeration tanks, two clarifiers, a parshall flume, two polishing lagoons, a chlorine contact tank, step aeration, and dechlorination. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass point. The facility discharges to Sulphur Creek via outfall 001. Sulphur Creek has a seven day, ten year low flow ($Q_{7,10}$) of 0.0 cubic feet per second at the outfall location.

Table 26 NPDES Permitted Wastewater Dischargers within the Sulphur Creek Subwatershed

Facility Name	Permit Number	AUID	Receiving Stream	Maximum Design Flow (MGD)
Staunton WWTP	IN0025224	INB1144_T1001	Sulphur Creek	0.1

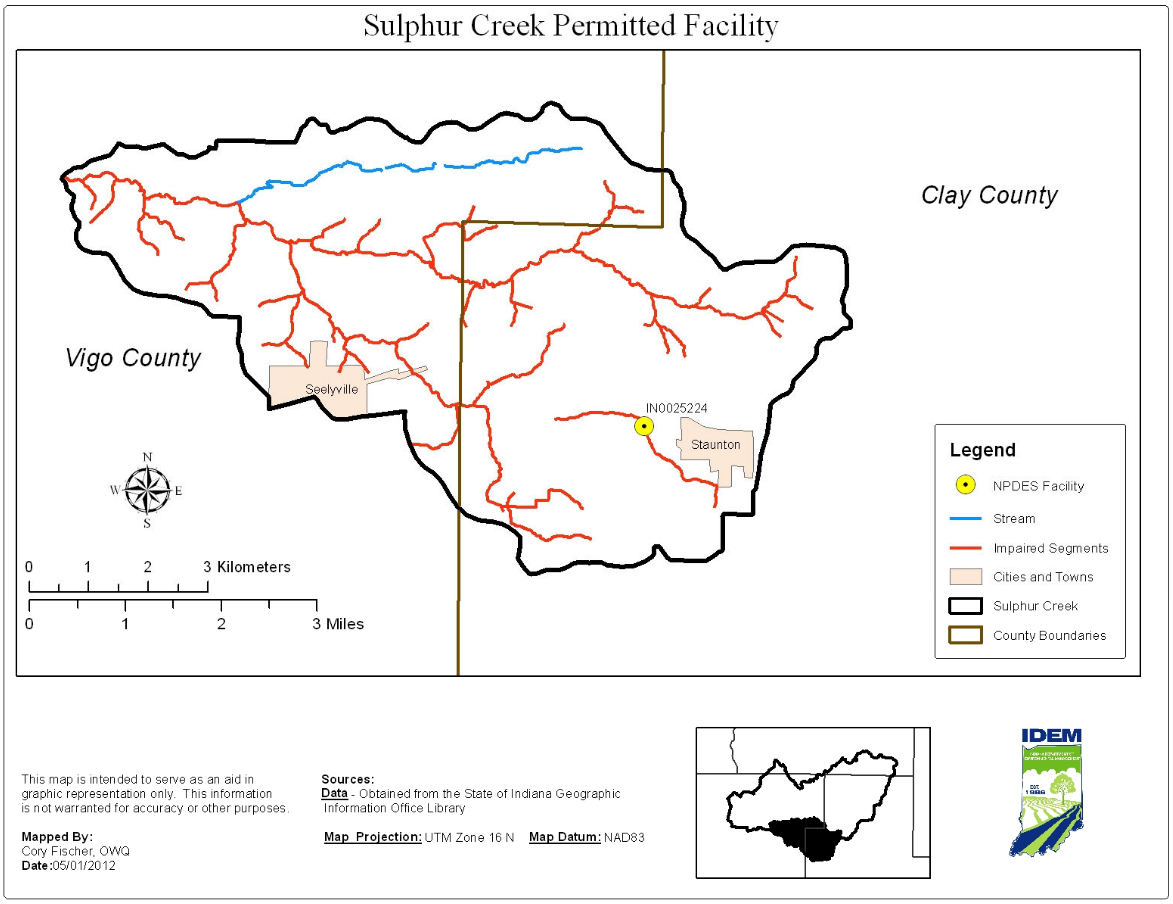


Figure 20. NPDES Facilities in the Sulphur Creek Subwatershed

On May 23, 2000 IDEM imposed a Sewer Connection Ban on the Staunton WWTP. In 2007 the Town of Staunton completed construction of its sewage collection system and wastewater treatment plant which reduced the wet weather flows at the treatment plant. The ban was lifted February 20, 2012 due to actions taken to correct the hydraulic overload that had previously been a problem.

Table 27 presents a summary of permit compliance for all NPDES facilities in the Sulphur Creek subwatershed for the five year period between 2007 and 2012. It presents the date of the facility's last inspection and findings from the inspection (i.e., compliance or violation). The table also presents the total number of violations in the five year period for *E. coli*. Overall, there are a total of 0 permit violations for *E. coli* in the Sulphur Creek subwatershed.

Table 27. Summary of Inspections and Permit Compliance in the Sulphur Creek Subwatershed for the Five Year Period Ending June 2012

Facility Name	Permit Number	AUID	Date of Last Inspection and Findings	Violations from July 2009 through June 2012
Staunton WWTP	IN0025224	INB1144_T1001	10/17/2012: Compliance	0 *E. coli* violations 1 quarter with N violation

Regulated Storm water Sources – Municipal Separate Storm Sewer Systems (MS4s)

MS4s are, in general, public storm sewer systems (including roads with drainage systems and municipal streets) that are owned or operated by a public body and not part of a combined sewer (i.e., storm and sanitary sewers combined). MS4s can be significant sources of *E. coli* because they transport urban runoff that can be affected by pet waste, illicit sewer connections and failing septic systems. Large and medium MS4s serve populations of more than 100,000 people. Regulated small MS4s are identified according to the U.S. Census Bureau definition of urbanized area as established every 10 years in its decennial census. Populations served by these regulated small MS4s range from several hundred to tens of thousands of people, but in most instances these systems serve fewer than about 30,000–50,000 people. Seelyville is the only MS4 community in the Sulphur Creek subwatershed as shown in Figure 21.

Table 28. Sulphur Creek MS4 Community

MS4 Facility Permit ID	MS4 Name	Area (Square Miles)
INR040092	Seelyville	0.53

Municipal boundaries and MS4 boundaries are not always the same, but are often used to delineate the regulated MS4 area if a system map is not readily available. Figure 21 shows the MS4 boundaries in the Sulphur Creek subwatershed. The municipal jurisdictional boundary was used to delineate the Seelyville MS4 boundary.

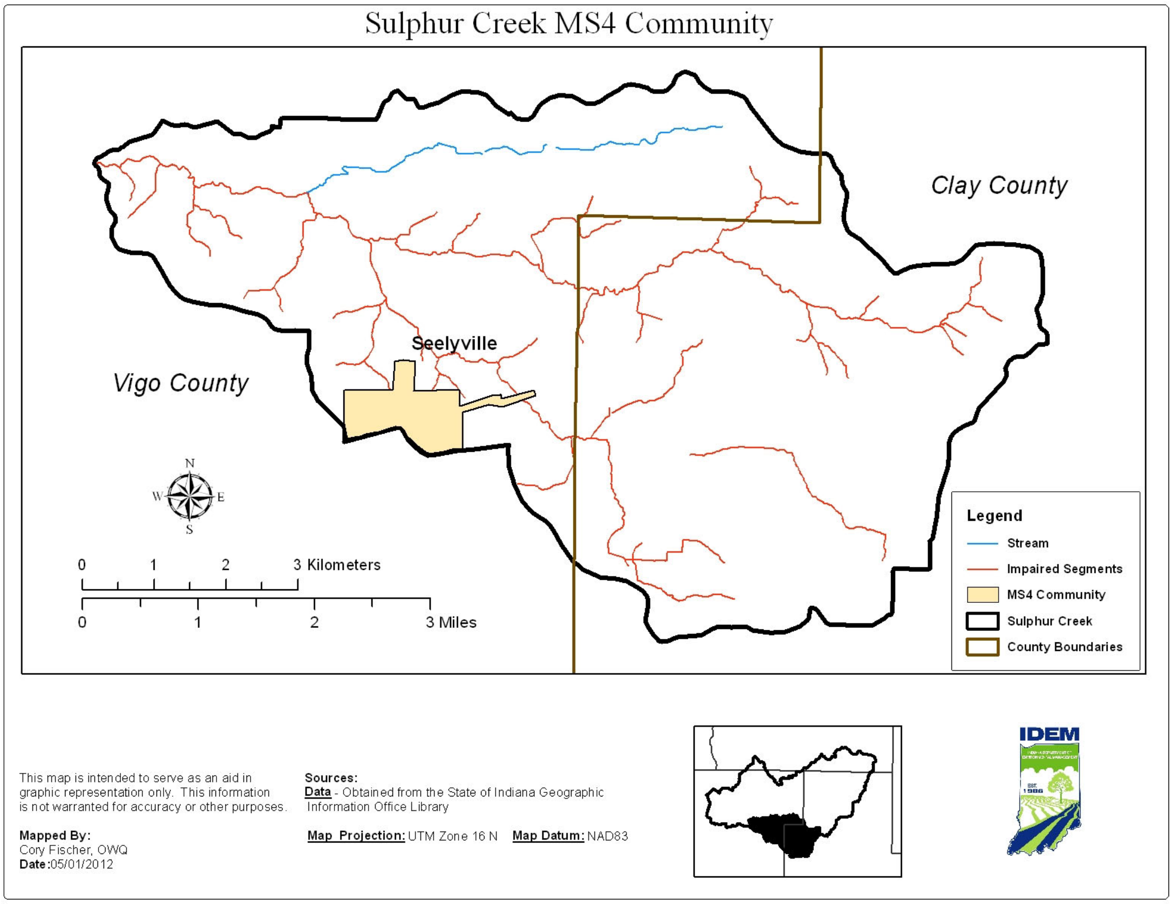


Figure 21. Map of MS4 Boundaries in the Sulphur Creek Subwatershed

Illicitly Connected "Straight Pipe" Systems

Some household wastes within Indiana and potentially within the Sulphur Creek subwatershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli* to the stream (these systems are sometimes referred to as "straight pipe" discharges).

4.2.4.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the Sulphur Creek subwatershed that are not regulated through the (NPDES) Program.

Cropland

Approximately 29 percent of the land in the Sulphur Creek subwatershed is classified as row crops. Croplands can be a source of *E. coli*. Accumulation of *E. coli* on cropland occurs from manure fertilizers, wildlife excreta, and irrigation water.

Watershed specific data are not available for field specific crops. However, county-wide data available from the National Agricultural Statistic Service (NASS) were downloaded and area weighted to estimate crop acreage in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the subwatershed and summed to get an area weighted estimate of cropland with the watershed. The 2012 NASS statistics were used in the analysis, and there is an estimated 51,580 total acres of cropland in the Sulphur Creek subwatershed. Within the total acreage 25,892 acres are corn, 24,240 acres are soybean, and 1,448 acres are winter wheat.

Pastures and Livestock Operations

In the Sulphur Creek subwatershed, approximately 7 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*. 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.

Livestock are potential source of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the National Agricultural Statistic Service (NASS) were downloaded and area weighted to estimate animal population in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals with the watershed. There are an estimated 1,251 animal units in the Sulphur Creek subwatershed and the animal unit density is 55 animal units per square mile as shown in Table 29.

Table 29. Animal Unit Density in the Sulphur Creek Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head in County	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi^2)
23.09	Hogs and Pigs	2,087*	2.5	835	55
	Cattle and Calves	261	1	261	
	Sheep and Lambs	10	10	1	
	Horses and Ponies	77	0.5	154	
	TOTAL	2,435		**1,251**	

Confined Feeding Operations (CFOs) and Animal Feeding Operations (AFOs)

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, and
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
- The number of animal present meets the requirements for the state permitting action.

Confined feeding operations that are not classified as Concentrated Animal Feeding Operations (CAFOs) are known as confined feeding operations (CFOs) in Indiana. Non-CAFO animal feeding operations are considered nonpoint sources by USEPA. CAFOs have federal permits and fall under the jurisdiction of the NPDES Program, as described in Section 4.2.1.1. Indiana's CFOs have state-issued permits but are not under the jurisdiction of the federal NPDES Program and are therefore categorized as nonpoint sources for the purposes of this TMDL. CFO permits are "no discharge" permits. Therefore it is prohibited for these facilities to discharge to any water of the State.

The CFO regulations (327 IAC 16, 327 IAC 15) 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 16, which implement the statute regulating confined feeding operations, were effective on March 10, 2002. The rule at 327 IAC 15-15, which regulates concentrated animal feeding operations and complies with most federal CAFO regulations, became effective on March 24, 2004, with two exceptions. 327 IAC 15-15-11 and 327 IAC 15-15-12 became effective on December 28, 2006. Point Source rules can be found at 327 IAC 5-4-3 (effective 12/28/06) and 327 IAC 5-4-3.1 (effective 3/24/04).

Like CAFOs, 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. CFOs, however, can also be potential sources of *E. coli* due to the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure over application or improper application can adversely impact soil productivity.

There is one CFO in the Sulphur Creek subwatershed as shown in Table 30 and Figure 22.

Table 30. CFO in the Sulphur Creek Subwatershed

Operation Name	Farm ID	AUID
Woll Farm (1,400 Finishers)	600	INB1144_T1001

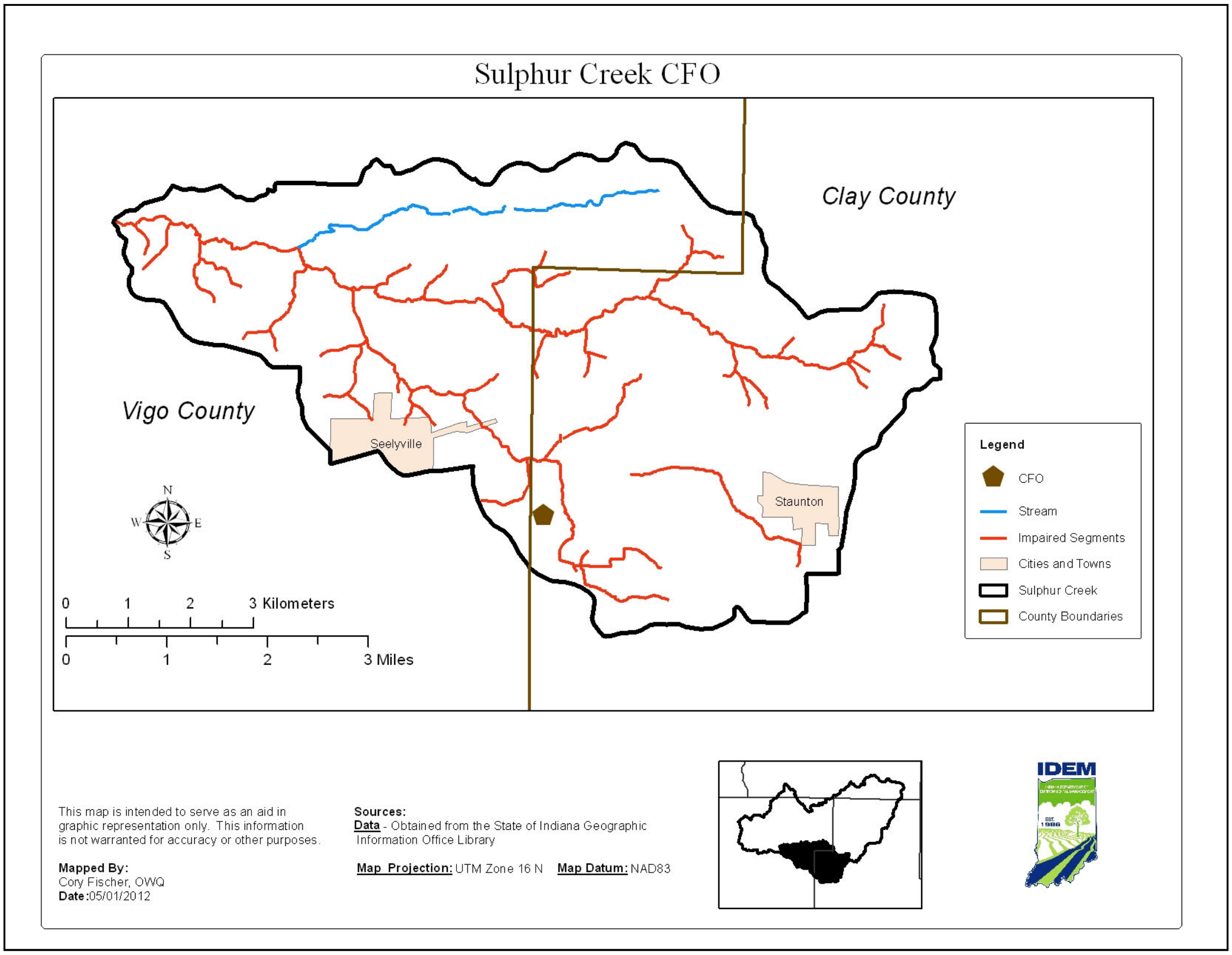


Figure 22: Confined Feeding Operation in Sulphur Creek Subwatershed

Onsite Wastewater Treatment Systems

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 are currently used in Indiana. Local health departments 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.

Vigo County follows the Indiana Administrative Code (RULE 410 IAC 6-8.2), with regards to septic systems along with local ordinances. Upon a received complaint in Vigo County the Health Inspector will visit and determine if a violation exists and will notify the occupant in writing of the violation. The occupant has 10 days to respond and indicate how the violation will be fixed. Fees can be assessed in the following order: Any person found to be violating any provision of this ordinance shall be punished for the first offense by a fine of two hundred dollars ($200.00); for the second offense by a fine of not more than five hundred dollars ($500.00); and for the third and each subsequent offense by a fine of not more than one thousand dollars ($1,000.00). Each day after the expiration of the time limit for abating unsanitary conditions and completing improvements as ordered by the Vigo County Health Department (VCHD), or by the duly appointed Health Officer of the County, shall constitute a distinct and separate offense.
Clay County follows the Indiana Administrative Code (RULE 410 IAC 6-8.2), no additional information was provided.

A comprehensive database of septic systems within the Otter 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 population 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 population in the Sulphur Creek subwatershed is shown in Table 31, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Otter Creek watershed.

It should also be noted that hydrologic soil group A and B soils have good infiltration rates and have less risk for failing septic tanks due to this factor. Sulphur Creek subwatershed 45.41 percent of soil group B, and 53.23 percent of soil group C. This means that Sulphur Creek subwatershed has less] [risk for failing septic tanks.

Table 31. Rural Population Density in the Sulphur Creek Subwatershed

County	Area of County in Subwatershed (mi^2)	County Population	Urban Population	Rural Population	Rural Population Density (persons/mi^2)
Clay	11.58	2,394	7,97	1,597	130
Vigo	11.51	2,535	1,117	1,418	
TOTAL	23.09	4,929	1,914	3,015	

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Typical 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. The percent and distribution of developed land in the Headwaters Otter Creek subwatershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of pet populations and residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the Headwaters Otter Creek subwatershed.

Dog and cat populations were estimated for the Sulphur Creek watershed using statistics reported in the *2007 U.S. Pet Ownership & Demographics Sourcebook*[1]. Specifically, the *Sourcebook* reports that on average 37.2 percent of households own dogs and 32.4 percent of households own cats. Typically, the average number of pets per household is 1.7 dogs and 2.2 cats. However, pets are likely only a significant source of *E. coli* and nutrients in population centers (i.e., cities and towns). The estimates of domestic pets in cities and towns in the watershed are presented in Table 32 and is based on the average number of pets per household multiplied by the population of the watershed.

Table 32. Estimated Pet Populations in the Cities and Towns in the Sulphur Creek Watershed

City/Town	Households in 2010	Estimated Number of Cats	Estimated Number of Dogs
Staunton	198	436	337
Seelyville	294	647	500
Total	492	1,083	837

Wildlife

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*. Population estimates for types of wildlife are generally not available.

In summary, the Sulphur Creek subwatershed is dominated by forested land (54%) and agriculture (27%). Sources of impairment include Staunton WWTP, failing septics, small unregulated feeding operations, a regulated CFO, and Storm water runoff. These characteristics are likely to affect the amount of *E. coli* loading found in the Sulphur Creek subwatershed.

4.2.5 Subwatershed Summary: Gundy Ditch

This section of the report presents the available information on the sources of *E. coli* in the Gundy Ditch subwatershed.

The Gundy Ditch subwatershed is located in the northwestern part of the Otter Creek watershed, covering nearly 18 square miles (Figure 23). The subwatershed drains portions of Parke and Vigo Counties, and includes portions of the Town of Rosedale and the City of NorthTerre Haute. Land use in the subwatershed is primarily agricultural as shown in Table 33.

[1] http://www.avma.org/reference/marketstats/sourcebook.asp

Table 33. Land Use in the Gundy Ditch Subwatershed

Land Use	Watershed		
	Area		Percent
	Acres	Square Miles	
Open Water	0	0	0
Developed, Open Space	774.60	1.21	6.62
Developed, Low Intensity	35.81	0.06	0.31
Developed, Medium Intensity	4.00	0.006	0.03
Developed, High Intensity	2.67	0.004	0.02
Forested Land	2,022.46	3.16	17.28
Shrub/Scrub	85.62	0.13	0.73
Pasture/Hay	690.09	1.08	5.90
Agriculture	8,079.38	12.62	69.02
Wetlands	10.67	0.02	0.09
TOTAL	**11,705.31**	**18.29**	**100**

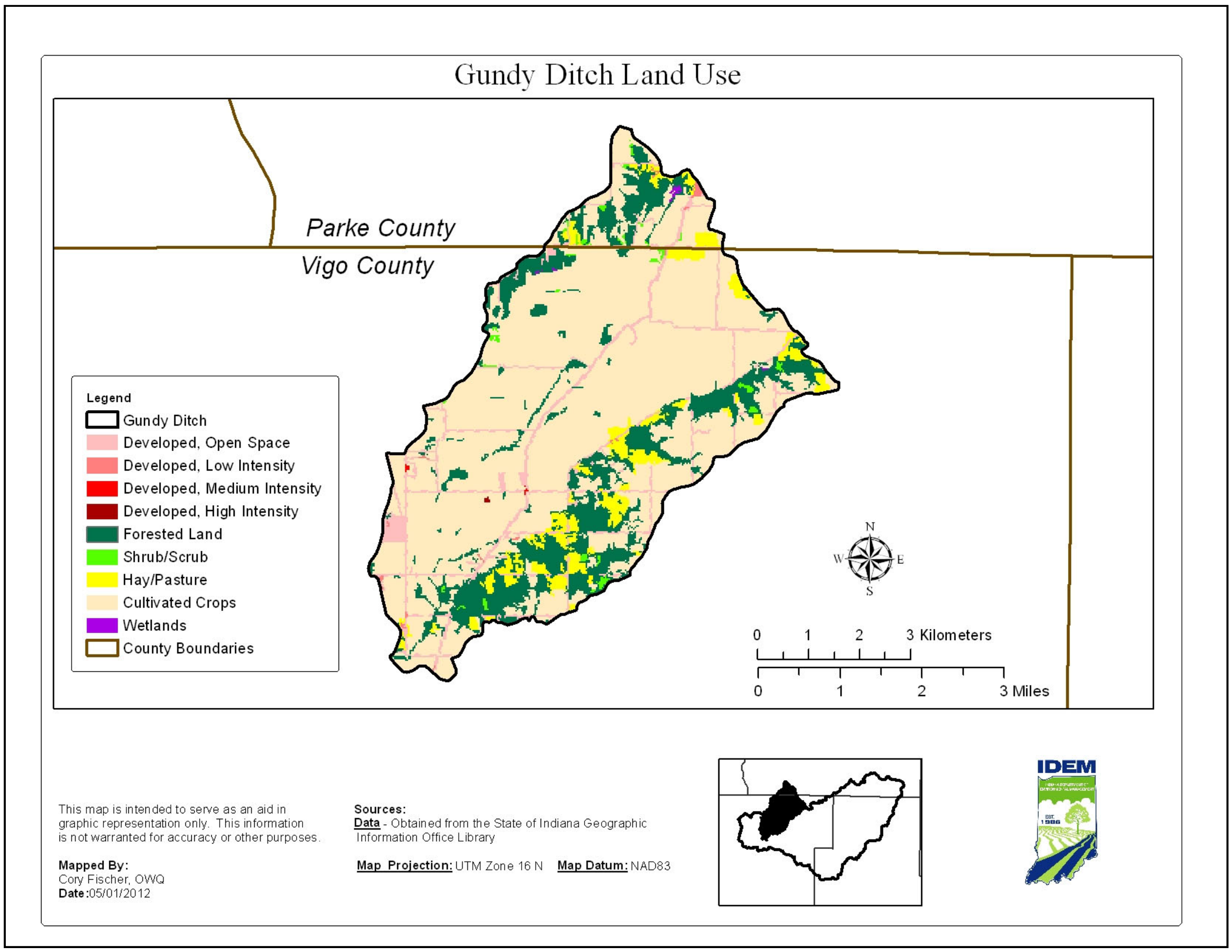


Figure 23. Land Use in the Gundy Ditch Subwatershed

4.2.5.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the Gundy Ditch subwatershed, as regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Regulated Storm water Sources – Municipal Separate Storm Sewer Systems (MS4s)

MS4s are, in general, public storm sewer systems (including roads with drainage systems and municipal streets) that are owned or operated by a public body and not part of a combined sewer (i.e., storm and sanitary sewers combined). MS4s can be significant sources of *E. coli* because they transport urban runoff that can be affected by pet waste, illicit sewer connections, failing septic systems, fertilizer, construction, and streambank erosion from hydrologic modifications. Large and medium MS4s serve populations of more than 100,000 people. Regulated small MS4s are identified according to the U.S. Census Bureau definition of urbanized area as established every 10 years in its decennial census. Populations served by these regulated small MS4s range from several hundred to tens of thousands of people, but in most instances these systems serve fewer than about 30,000–50,000 people. Terre Haute is the only MS4 community in the Gundy Ditch subwatershed as shown in Table 34 and Figure 24.

Table 34. Gundy Ditch MS4 Communities

MS4 Facility Permit ID	MS4 Name	Area (Square Miles)
INR040092	Terre Haute	0.61

Municipal boundaries and MS4 boundaries are not always the same, but are often used to delineate the regulated MS4 area if a system map is not readily available. Figure 24 shows the MS4 boundaries in the Gundy Ditch subwatershed. The MS4 boundary is slightly larger than the municipal boundary. The MS4 boundary extends north with Evans St. being the northern boundary, and extends east to Erickson St.

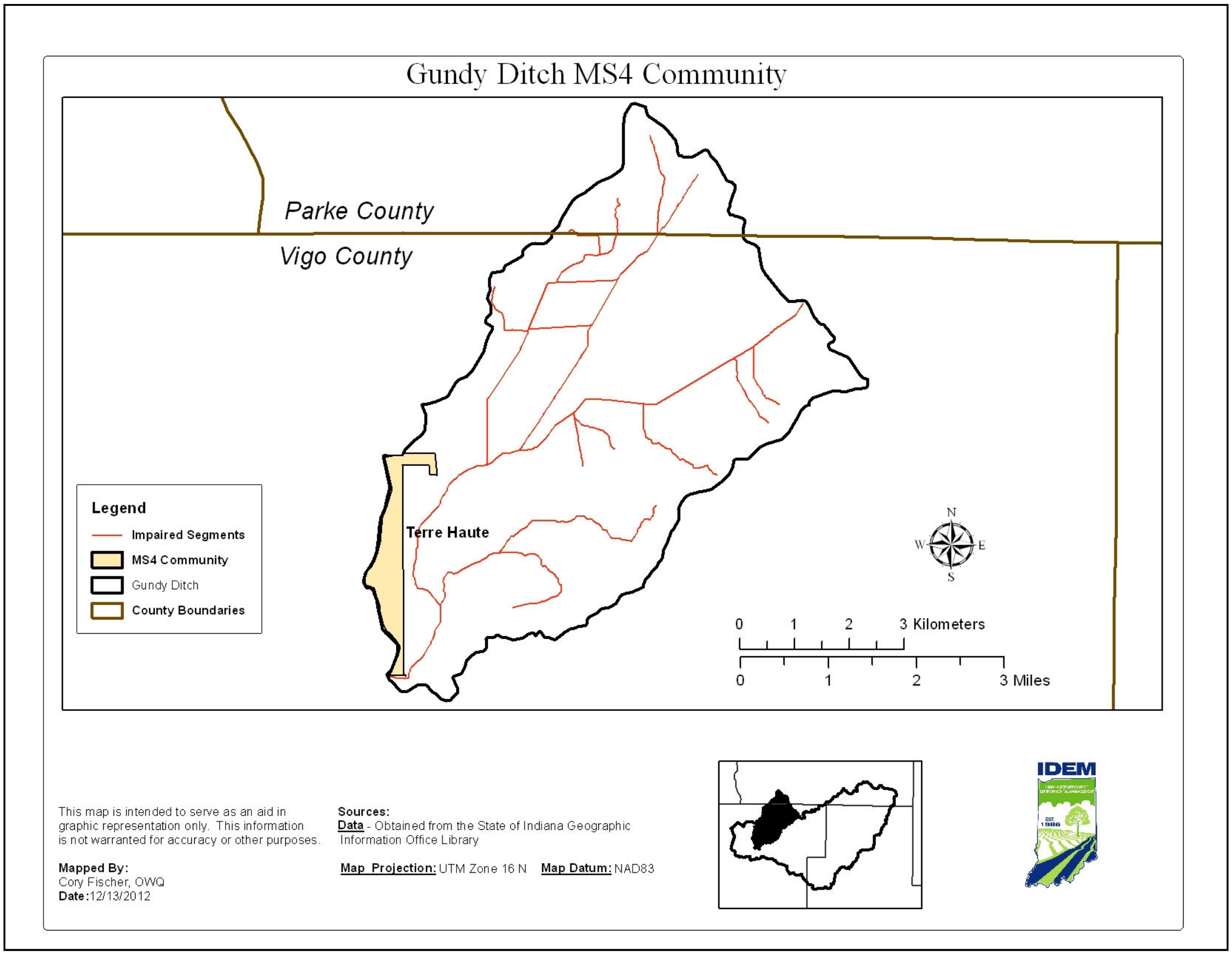


Figure 24. Map of MS4 Boundaries in the Gundy Ditch Subwatershed

Illicitly Connected "Straight Pipe" Systems

Some household wastes within Indiana and potentially within the Gundy Creek subwatershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli* to the stream (these systems are sometimes referred to as "straight pipe" discharges).

4.2.5.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the Gundy Ditch subwatershed that are not regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Cropland

Approximately 70 percent of the land in the Otter Creek watershed is classified as row crops. Croplands can be a source of *E. coli*. Accumulation of *E. coli* on cropland occurs from manure fertilizers, wildlife excreta, and irrigation water.

Watershed specific data are not available for field specific crops. However, county-wide data available from the National Agricultural Statistic Service (NASS) were downloaded and area weighted to estimate crop acreage in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the subwatershed and summed to get an area weighted estimate of cropland with the watershed. The 2012 NASS statistics were used in the analysis, and there is an estimated 39,259 total acres of cropland in the Gundy Ditch subwatershed. Within the total acreage 23,339 acres are corn, 15,131 acres are soybean, and 789 acres are winter wheat.

Pastures and Livestock Operations

In the Gundy Ditch subwatershed, 4 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*, nutrients, and TSS. 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.

Livestock are potential source of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the National Agricultural Statistic Service were downloaded and area weighted to estimate animal population in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals with the watershed. There are an estimated 277 animal units in the Gundy Ditch subwatershed and the animal unit density is 16 animal units per square mile as shown in Table 35.

Table 35. Animal Unit Density in the Gundy Ditch Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head in County	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi^2)
18.29	Hogs and Pigs	9	2.5	4	16
	Cattle and Calves	120	1	120	
	Sheep and Lambs	7	10	1	
	Horses and Ponies	76	0.5	152	
	TOTAL	330		**277**	

Onsite Wastewater Treatment Systems

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 are currently used in Indiana. Local health departments 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.

Vigo County follows the Indiana Administrative Code (RULE 410 IAC 6-8.2), with regards to septic systems along with local ordinances. Upon a received complaint in Vigo County the Health Inspector will visit and determine if a violation exists and will notify the occupant in writing of the violation. The occupant has 10 days to respond and indicate how the violation will be fixed. Fees can be assessed in the following order: Any person found to be violating any provision of this ordinance shall be punished for the first offense by a fine of two hundred dollars ($200.00); for the second offense by a fine of not more than five hundred dollars ($500.00); and for the third and each subsequent offense by a fine of not more than one thousand dollars ($1,000.00). Each day after the expiration of the time limit for abating unsanitary conditions and completing improvements as ordered by the Vigo County Health Department (VCHD), or by the duly appointed Health Officer of the County, shall constitute a distinct and separate offense.

Parke County follows the Indiana Administrative Code (RULE 410 IAC 6-8.2). The county has some fines set up $100-$1000 for septic violations. The health department staffs have had better success in the past working with landowners to get violations fixed, and explaining to them the benefits of a properly functioning septic system rather than assessing fines right away.

A comprehensive database of septic systems within the Otter 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 population 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 population in the Gundy Ditch subwatershed is shown in Table 36, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Otter Creek watershed.

It should also be noted that hydrologic soil group A and B soils have good infiltration rates and have less risk for failing septic tanks due to this factor. Gundy Ditch subwatershed has 12.81 percent of soil group A, 57.14 percent of soil group B, and 29.93 percent of soil group C which are soils with slow infiltration rates, finer textures, and slow water movement. This means that Gundy Ditch subwatershed has less risk for failing septic tanks.

Table 36. Rural Population Density in the Gundy Ditch Subwatershed

County	Area of County in Subwatershed (mi²)	County Population	Urban Population	Rural Population	Rural Population Density (persons/mi²)
Parke	1.8	516	125	391	156
Vigo	16.49	3030	560	2,470	
TOTAL	18.29	3546	685	2,861	

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Typical 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. The percent and distribution of developed land in the Gundy Ditch subwatershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of pet populations and residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the Gundy Ditch subwatershed.

Dog and cat populations were estimated for the Gundy Ditch watershed using statistics reported in the *2007 U.S. Pet Ownership & Demographics Sourcebook*[1]. Specifically, the *Sourcebook* reports that on average 37.2 percent of households own dogs and 32.4 percent of households own cats. Typically, the average number of pets per household is 1.7 dogs and 2.2 cats. However, pets are likely only a significant source of *E. coli* and nutrients in population centers (i.e., cities and towns). The estimates of domestic pets in cities and towns in the watershed are presented in Table 37 and is based on the average number of pets per household multiplied by the population of the watershed.

Table 37. Estimated Pet Populations in the Cities and Towns in the Gundy Ditch Watershed

City/Town	Households in 2010	Estimated Number of Cats	Estimated Number of Dogs
Rosedale	50	110	85
North Terre Haute	180	396	306

Wildlife

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*. Population estimates for types of wildlife are generally not available.

In summary, the Gundy Ditch subwatershed is dominated by agriculture (70%) and forested land (17%). Sources of impairment include small feeding operations, Storm water, and failing septics. These characteristics are likely to affect the amount of *E. coli* loading found in the Gundy Ditch subwatershed.

4.2.6 Subwatershed Summary: Wastewaters Creek- Otter Creek

This section of the report presents the available information on the sources of *E. coli* in the Wastewaters Creek- Otter Creek subwatershed.

[1] http://www.avma.org/reference/marketstats/sourcebook.asp

The Wastewaters Creek- Otter Creek spans the center of the Otter Creek Watershed from east to west, covering nearly 28 square miles (Figure 25). The subwatershed drains portions of Clay and Vigo Counties, and includes portions of both the City of Brazil and the City of NorthTerre Haute. Land use in the Wastewaters Creek- Otter Creek is primarily forested and agricultural as shown in Table 38.

Table 38. Land Use in the Wastewaters Creek- Otter Creek Subwatershed

	Watershed		
	Area		
Land Use	**Acres**	**Square Miles**	**Percent**
Open Water	74.06	0.12	0.42
Developed, Open Space	2,029.35	3.17	11.46
Developed, Low Intensity	555.32	0.87	3.14
Developed, Medium Intensity	151.67	0.237	0.86
Developed, High Intensity	56.71	0.089	0.32
Forested Land	7,487.37	11.70	42.30
Shrub/Scrub	196.60	0.31	1.11
Pasture/Hay	840.87	1.31	4.75
Agriculture	6,112.97	9.55	34.53
Wetlands	194.60	0.30	1.11
TOTAL	**17,699.52**	**27.66**	**100**

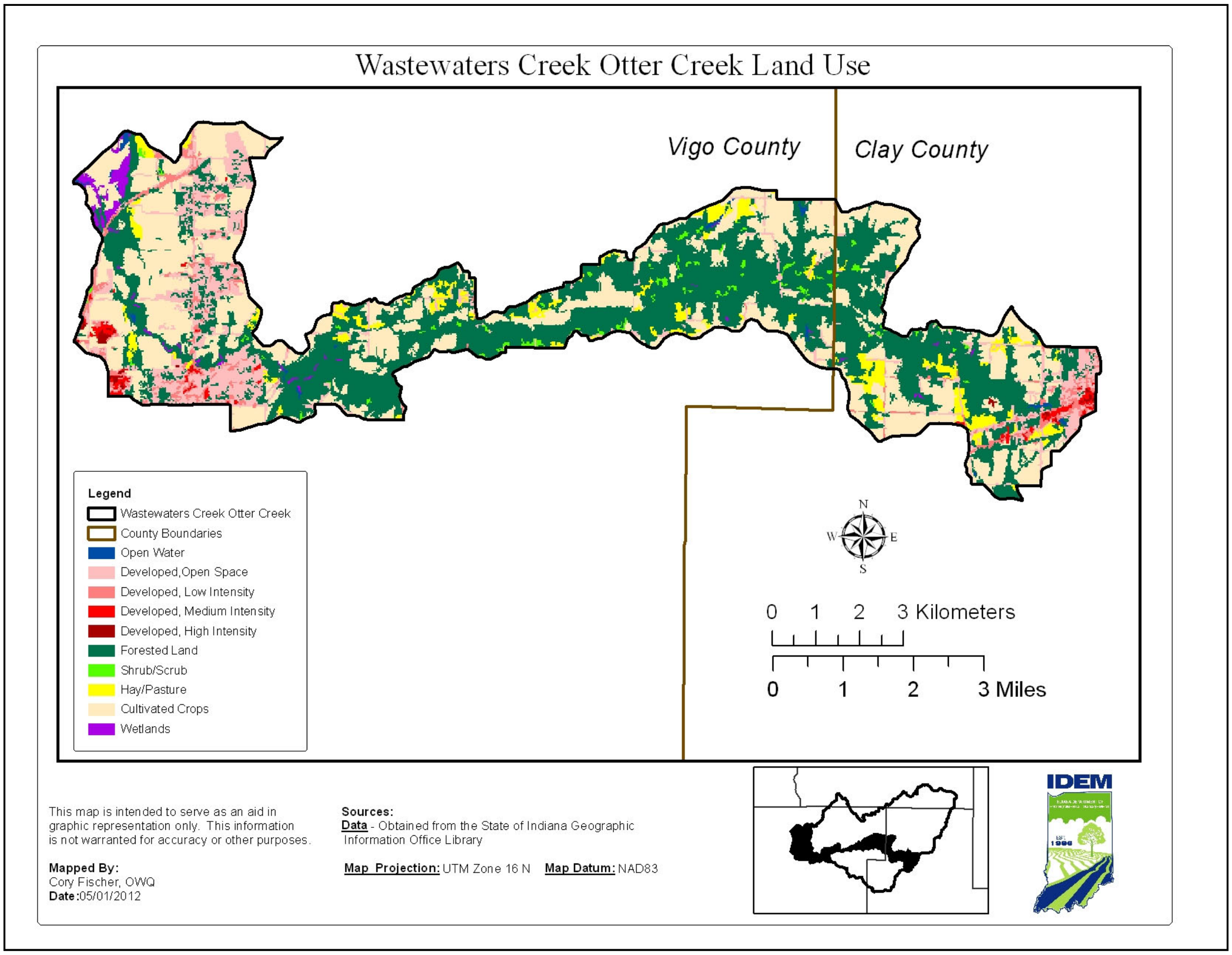


Figure 25. Land Use in the Wastewaters Creek- Otter Creek Subwatershed

4.2.6.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the Wastewaters Creek- Otter Creek subwatershed, as regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Regulated Storm water Sources – Municipal Separate Storm Sewer Systems (MS4s)

MS4s are, in general, public storm sewer systems (including roads with drainage systems and municipal streets) that are owned or operated by a public body and not part of a combined sewer (i.e., storm and sanitary sewers combined). MS4s can be significant sources of *E. coli* because they transport urban runoff that can be affected by pet waste, illicit sewer connections, failing septic systems,. Large and medium MS4s serve populations of more than 100,000 people. Regulated small MS4s are identified according to the U.S. Census Bureau definition of urbanized area as established every 10 years in its decennial census. Populations served by these regulated small MS4s range from several hundred to tens of thousands of people, but in most instances these systems serve fewer than about 30,000–50,000 people. The City of Terre Haute is the only MS4 community in the Wastewaters Creek- Otter Creek subwatershed as shown in Table 39.

Table 39. Wastewaters Creek- Otter Creek MS4 Communities

MS4 Facility Permit ID	MS4 Name	Area (Square Miles)
INR040092	Terre Haute	3.54

Municipal boundaries and MS4 boundaries are not always the same, but are often used to delineate the regulated MS4 area if a system map is not readily available. Figure 26 shows the MS4 boundaries in the Wastewaters Creek- Otter Creek subwatershed. The MS4 boundary is slightly larger than the municipal boundary. The MS4 boundary extends north two blocks with Evans St. being the northern boundary.

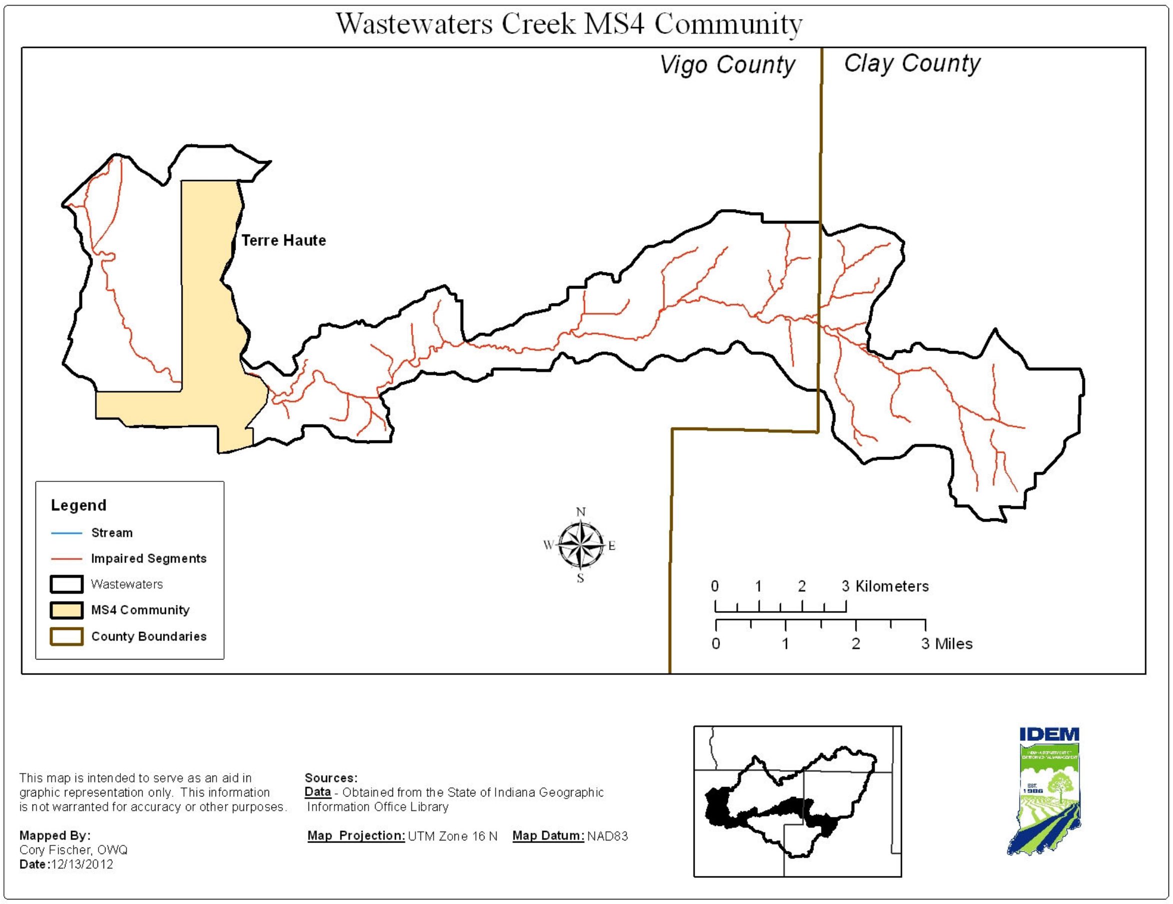


Figure 26. Map of MS4 Boundaries in the Wastewaters Creek- Otter Creek Subwatershed

Illicitly Connected "Straight Pipe" Systems

Some household wastes within Indiana and potentially within the Otter Creek watershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli* to the stream (these systems are sometimes referred to as "straight pipe" discharges).

4.2.6.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the Wastewaters Creek- Otter Creek subwatershed that are not regulated through the NPDES Program.

Cropland

Approximately 34.54 percent of the land in the Wastewaters Creek- Otter Creek subwatershed is classified as row crops. Croplands can be a source of *E. coli*. Accumulation of *E. coli* on cropland occurs from manure fertilizers, wildlife excreta, and irrigation water

Watershed specific data are not available for field specific crops. However, county-wide data available from the National Agricultural Statistic Service (NASS) were downloaded and area weighted to estimate crop acreage in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the subwatershed and summed to get an area weighted estimate of cropland with the watershed. The 2012 NASS statistics were used in the analysis, and there is an estimated 56,663 total acres of cropland in the Wastewaters Creek- Otter Creek subwatershed. Within the total acreage 28,885 acres are corn, 26,408 acres are soybean, and 1,370 acres are winter wheat.

Pastures and Livestock Operations

In the Wastewaters Creek- Otter Creek subwatershed, 4.74 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*. 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.

Livestock are potential source of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the NASS were downloaded and area weighted to estimate animal population in the
watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals with the watershed. There are an estimated 1,745 animal units in the Wastewaters Creek- Otter Creek subwatershed and the animal unit density is 63 animal units per square mile as shown in Table 40.

Table 40. Animal Unit Density in the Wastewaters Creek- Otter Creek Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head in Subwatershed	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi^2)
27.66	Hogs and Pigs	3,257	2.5	1,303	63
	Cattle and Calves	231	1	231	
	Sheep and Lambs	10	10	1	
	Horses and Ponies	106	0.5	210	
			TOTAL	**1,745**	

*Vigo County did not disclose Hogs and Pigs data to NASS Survey

Confined Feeding Operations (CFOs) and Animal Feeding Operations (AFOs)

A confined feeding operation (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, and
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
- The number of animal present meets the requirements for the state permitting action.

Confined feeding operations that are not classified as CAFOs are known as confined feeding operations (CFOs) in Indiana. Non-CAFO animal feeding operations are considered nonpoint sources by USEPA. CAFOs have federal permits and fall under the jurisdiction of the NPDES Program, as described in Section 4.2.1.1. Indiana's CFOs have state-issued permits but are not under the jurisdiction of the federal NPDES Program and are therefore categorized as nonpoint sources for the purposes of this TMDL. CFO permits are "no discharge" permits. Therefore it is prohibited for these facilities to discharge to any water of the State.

The CFO regulations (327 IAC 16, 327 IAC 15) 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 16, which implement the statute regulating confined feeding operations, were effective on March 10, 2002. The rule at 327 IAC 15-15, which regulates concentrated animal feeding operations and complies with most federal CAFO regulations, became effective on March 24, 2004, with two exceptions. 327 IAC 15-15-11 and 327 IAC 15-15-12 became effective on December 28, 2006. Point Source rules can be found at 327 IAC 5-4-3 (effective 12/28/06) and 327 IAC 5-4-3.1 (effective 3/24/04).

Like CAFOs, 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. CFOs, however, can also be potential sources of *E. coli* due to the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure over application or improper application can adversely impact soil productivity.

There is one CFO in the Wastewaters Creek- Otter Creek subwatershed as shown in Table 41 and Figure 27.

Table 41. CFOs in the Wastewaters Creek- Otter Creek Subwatershed

Operation Name	Farm ID	AUID
Lyon Farm (417 Sows,800 Nursery Pigs,1,829 Finishers)	3346	INB1146_T1001

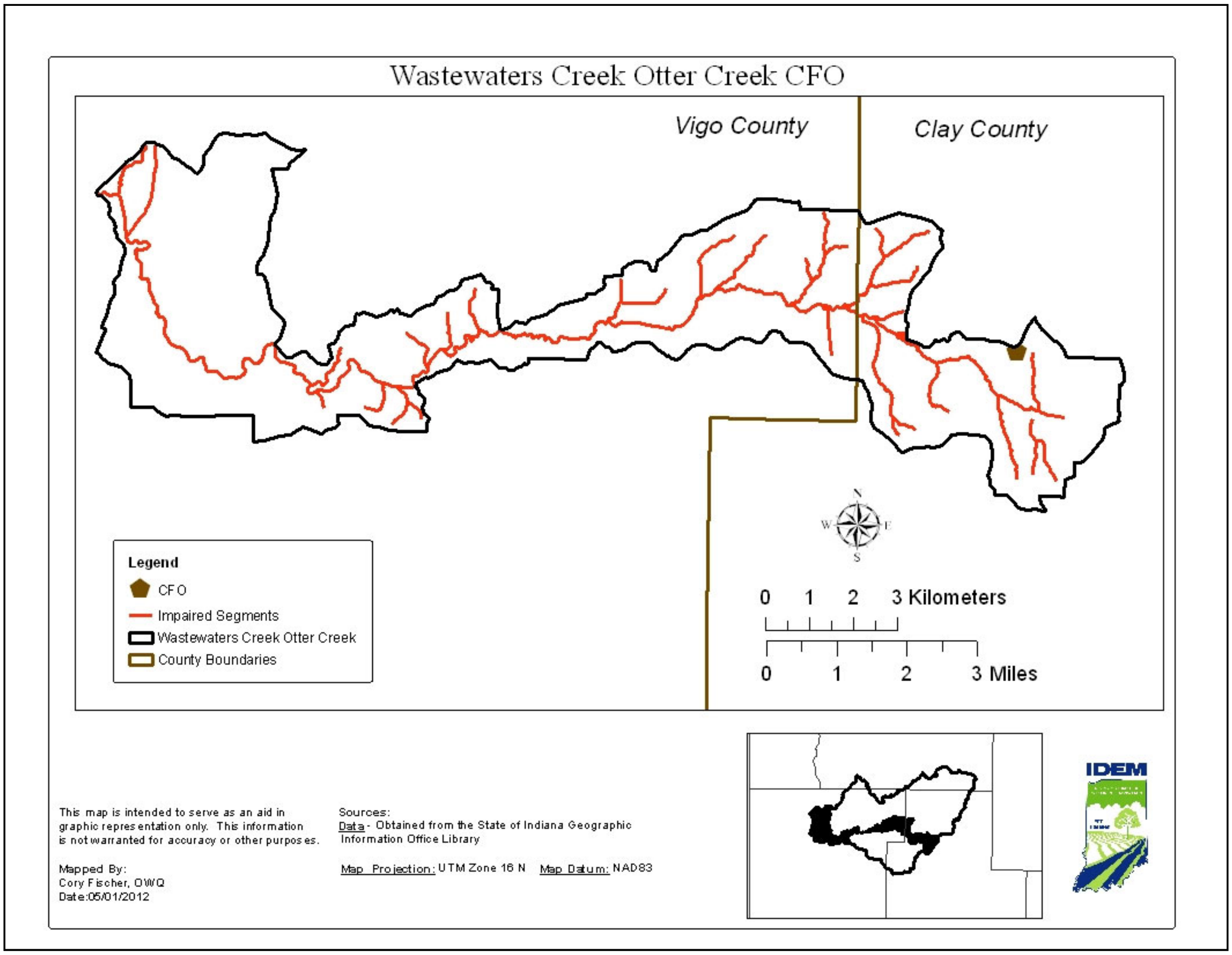


Figure 27: CFO in the Wastewaters Creek- Otter Creek Subwatershed

Onsite Wastewater Treatment Systems

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 are currently used in Indiana. Local health departments 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.

Vigo County follows the Indiana Administrative Code (RULE 410 IAC 6-8.2), with regards to septic systems along with local ordinances. Upon a received complaint in Vigo County the Health Inspector will visit and determine if a violation exists and will notify the occupant in writing of the violation. The occupant has 10 days to respond and indicate how the violation will be fixed. Fees can be assessed in the following order: Any person found to be violating any provision of this ordinance shall be punished for the first offense by a fine of two hundred dollars ($200.00); for the second offense by a fine of not more than five hundred dollars ($500.00); and for the third and each subsequent offense by a fine of not more than one thousand dollars ($1,000.00). Each day after the expiration of the time limit for abating unsanitary conditions and completing improvements as ordered by the Vigo County Health Department (VCHD), or by the duly appointed Health Officer of the County, shall constitute a distinct and separate offense.

Clay County follows the Indiana Administrative Code (RULE 410 IAC 6-8.2), no additional information was provided.

A comprehensive database of septic systems within the Otter 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 population 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 population in the Wastewaters Creek-Otter Creek subwatershed is shown in Table 42, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Otter Creek watershed.

It should also be noted that hydrologic soil group A and B soils have good infiltration rates and have less risk for failing septic systems due to this factor. Group C soils have slow infiltration rates with finer textures and slow water movement. Wastewaters Creek- Otter Creek subwatershed has 3.24 percent of soil group A, 57.14 percent of soil group B, and 35.15 percent of soil group C. This means that Wastewaters Creek- Otter Creek subwatershed has less risk for failing septic systems.

Table 42. Rural Population Density in the Wastewaters Creek- Otter Creek Subwatershed

County	Area of County in Subwatershed (mi^2)	County Population	Urban Population	Rural Population	Rural Population Density (persons/mi^2)
Clay	7.77	3,425	2,642	783	78
Vigo	19.89	6,893	5,500	1,393	
TOTAL	27.66	10,318	8,142	2,176	

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Typical 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. The percent and distribution of developed land in the Wastewaters Creek- Otter Creek subwatershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of pet populations and residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the Wastewaters Creek- Otter Creek subwatershed.

Dog and cat populations were estimated for the Wastewaters Creek- Otter Creek watershed using statistics reported in the *2007 U.S. Pet Ownership & Demographics Sourcebook*[1]. Specifically, the *Sourcebook* reports that on average 37.2 percent of households own dogs and 32.4 percent of households own cats. Typically, the average number of pets per household is 1.7 dogs and 2.2 cats. However, pets are likely only a significant source of *E. coli* and nutrients in population centers (i.e., cities and towns). The estimate of domestic pets in cities and towns in the watershed are presented in Table 43 and is based on the average number of pets per household multiplied by the population of the watershed.

Table 43. Estimated Pet Populations in the Cities and Towns in the Wastewaters Creek- Otter Creek Watershed

City/Town	Households in 2010	Estimated Number of Cats	Estimated Number of Dogs
Brazil	911	2,004	1,549
North Terre Haute	1,500	3,300	2,550

Wildlife

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*. Population estimates for types of wildlife are generally not available.

In summary, the Wastewaters Creek- Otter Creek subwatershed is dominated by Forested Land (42%) and agriculture (35%). Sources of impairment include one CFO, Terre Haute MS4, small feeding operations, unregulated Storm water, and failing septics. These characteristics are likely to affect the amount of *E. coli* loading found in the Wastewaters Creek- Otter Creek subwatershed.

5.0 INVENTORY AND ASSESSMENT OF WATER QUALITY INFORMATION

Below are an inventory and assessment of the available biological and chemical data for the Otter Creek watershed related to *E. coli*. Table 44 reiterates the TMDL target values presented in Section 2.2. These are the target values IDEM uses to assess water quality data collected in the Otter Creek watershed.

Table 44. Target Values Used for Development of the Otter Creek Watershed TMDLs

Parameter	Target Value
E. coli	No value should exceed 125 counts/100 mL (as a geometric mean)

5.1 Water Chemistry Data

Table 45 summarizes the water chemistry data within the Otter Creek watershed by displaying the maximum concentrations (and geometric mean for *E. coli*) at all sampling locations indicating impairments along with the reduction needed to meet the TMDL. Data collected in 2009 by IDEM were used for the TMDL analysis.

The percent reductions were calculated as follows:

$$\%\ \text{Reduction} = \frac{(\text{Observed Value} - \text{Target Value or WQS})}{\text{Observed Value}}$$

$$\%\ \text{Reduction} = \frac{(\text{Observed Geomean} - \text{Target Value or WQS})}{\text{Observed Geomean}}$$

Appendix A shows the individual sample results and summaries of all the water quality data for all 19 monitoring stations.

5.2 *E. coli* Data

For *E. coli*, the 25 AUIDs in the Otter Creek watershed were assessed with data from the 2009 TMDL sampling stations. Table 45 provides a summary of *E. coli* data in the Otter Creek watershed to show which sampling stations correspond to each AUID per subwatershed.

Table 45. Summary of Pathogen Data in Headwaters Otter Creek 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			
Headwaters Otter Creek	WBU030-0084 WBU030-0079	INB1141_01	4/28/2009 – 5/27/2009	10	90	50	339.7	2419.6	63.2
North Branch Otter Creek	WBU030-0081 WBU030-0082 WBU030-0050	INB1142_01	4/28/2009 – 5/27/2009	20	40	20	246.6	2419.6	49.3
		INB1142_01A							
		INB1142_01B							
		INB1142_01C							
	WBU030-0052	INB1142_T1001							
		INB1142_T1002							
		INB1142_T1003							
		INB1142_T1004							
		INB1142_T1005							
Little Creek-North Branch Otter Creek	WBU030-0076	INB1143_01	4/28/2009 – 5/27/2009	5	100	20	262.6	2419.6	52.4
		INB1143_T001							
		INB1143_T001A							
		INB1143_T002							
Sulphur Creek	WBU030-0016 WBU030-0012	INB1144_01	4/28/2009 – 5/27/2009	15	66.67	33.33	381.4	2419.6	67.2
		INB1144_T1001							
		INB1144_T1001A							
	WBU030-0014	INB1144_T1002							

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)
Gundy Ditch	WBU030-0074 WBU030-0011	INB1145_01	4/28/2009 – 5/27/2009	20	70	55	804.6	2419.6	84.4
	WBU030-0075	INB1145_T1001							
	WBU030-0073	INB1145_T1002							
Wastewaters Creek- Otter Creek	WBU030-0078 WBU030-0077	INB1146_01	4/28/2009 – 5/27/2009	25	96	28	304.5	2419.6	58.9
	WBU030-0080	INB1146_T1001							
	WBU030-0001	INB1146_02							
	WBU030-0072	INB1146_03							

Understanding Table 45: *E. coli* data for the Otter Creek Watershed indicates the following:

- Reductions of 63 percent or greater are needed to meet the TMDL target values for *E. coli* in Headwaters Otter Creek.
- Reductions of 49 percent or greater are needed to meet the TMDL target values for *E. coli* in North Branch Otter Creek.
- Reductions of 52 percent or greater are needed to meet the TMDL target values for *E. coli* in Little Creek- North Branch Otter Creek.
- Reductions of 67 percent or greater are needed to meet the TMDL target values for *E. coli* in Sulphur Creek.
- Reductions of 84 percent or greater are needed to meet the TMDL target values for *E. coli* in Gundy Ditch.
- Reductions of 58 percent or greater are needed to meet the TMDL target values for *E. coli* in Wastewaters Creek- Otter Creek.

6.0 TECHNICAL APPROACH

Previous sections of the report have provided a description of the Otter Creek watershed and summarized the applicable water quality standards, water quality data, and identified the potential sources of *E. coli* for assessment units in each subwatershed. This section presents IDEM's technical approach for using water quality sampling data and flow data for each subwatershed as described in Section 4.0 to estimate the current allowable loads of *E. coli* in each subwatershed. This section focuses on describing the methodology and is helpful in understanding subsequent sections of the TMDL report.

6.1.1 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 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., G-org/day for *E. coli* [G-org=1E+09 organisms]) with the following factors used for this TMDL:
- Flow (cfs) x TMDL Concentration Target (#/100mL) x Conversion Factor (0.024463) = Load (G-org/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):

- Very 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 Zone: Flows in this range are related to wet weather conditions. These flows are exceeded 10 – 40 percent of the time.
- Mid-Range Zone: Flows in this range represent median stream flow conditions. These flows are exceeded 40 – 60 percent of the time.
- Dry Zone: Flows in this range are related to dry weather flows. These flows are exceeded 60 -90 percent of the time.
- Very 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 storm water 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 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 46. Relationship between Load Duration Curve Zones and Contributing Sources

	Duration Curve Zone				
Contributing Source Area	**Very High**	**Moist**	**Mid-Range**	**Dry**	**Very Low**
Wastewater treatment plants				M	H
Livestock direct access to streams				M	H
Wildlife direct access to streams				M	H
On-site wastewater systems/Unsewered Areas	M	M-H	H	H	H
Riparian areas		H	H	M	
Abandoned mines	H	H	H	H	H
Storm water: Impervious		H	H	H	
Combined sewer overflows	H	H	H		
Storm water: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M-H	L-M	
Bank erosion	H	M			

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

6.1.2 Stream Flow Estimates

Daily stream flows are necessary to implement the load duration curve approach. Load duration assessment locations in the Otter 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 Otter Creek watershed. Since there are no continuous flow data for the Otter Creek watershed, flow data were estimated for the Otter 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 stream gage on the Big Raccoon Creek near the Town of Fincastle in Putnam County (03340800) is located approximately 30 miles northeast of Otter Creek and was used for the development of the *E. coli* load duration curve analysis for the Otter Creek watershed TMDL. The Big Raccoon Creek watershed was chosen as a “surrogate” due to its proximity to the Otter Creek watershed and its similar hydrologic characteristics. Both watersheds are located in the Middle Wabash and the centers of each watershed are approximately 23 miles from one another. Land use in both watersheds is mostly agricultural and both watersheds consist primarily of Group C soils. The location of the Big Raccoon Creek watershed flow gage is believed to be representative of the trends that would be observed in the Otter Creek watershed. Flows are highest during spring and fall and lowest during the summer months.

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 (03340800) 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 Otter 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.

7.0 LINKAGE ANALYSIS

A linkage analysis connects the observed water quality impairment to what has caused that impairment. An essential component of developing a TMDL is establishing a relationship between the source loadings and the resulting water quality. Potential point and nonpoint sources are inventoried in Section 4.0 and water quality data within the Otter Creek watershed are discussed in Section 5.0. The purpose of this section of the report is to evaluate which of the various potential sources is most likely to be contributing to the observed water quality impairments.

7.1 Linkage Analysis for *E. coli*

Establishing a linkage analysis for *E. coli* is challenging because there are so many potential sources and *E. coli* counts have a high degree of variability. While it is difficult to perform a site-specific assessment of the causes of high *E. coli* for each location in a watershed, it is reasonable to expect that general patterns and trends can be used to provide some perspective on the most significant sources.

Load duration curves were created for the sampling sites in the Otter Creek watershed that were sampled by IDEM in 2009. The load duration curve method considers how stream flow conditions relate to a variety of pollutant loadings and their sources (point and nonpoint). Section 6.1.1 summarizes the load duration curve approach. This section discusses the load duration curves and the linkage between the potential sources in the Otter Creek watershed and the observed water quality impairment.

To further investigate sources, *E. coli*/precipitation graphs have been created. Elevated levels of *E. coli* during rain events indicate *E. coli* contribution due to runoff. The precipitation data was taken from a weather station in Terre Haute and managed by the Indiana State Climate Office at Purdue University.

E. coli sources typically associated with high flow and moist conditions include failing onsite wastewater systems, urban storm water, runoff from agricultural areas, and bacterial re-suspension from the streambed. *E. coli* sources typically associated with low flow conditions include a large number of homes on failing or illicitly connected septic systems that would provide a constant source. Elevated *E. coli* levels at low flow could also result from inadequate disinfection at wastewater treatment plants or animals with direct access to streams.

The following sections discuss the load duration curves, precipitation graphs and linkage of sources to the water quality exceedances for each subwatershed.

7.1.1 Headwaters Otter Creek

Load duration curves and precipitation graphs were created for all the sampling sites (Figure 29 and Figure 30) in the Otter Creek Watershed. Flow data used to develop the load duration curves is summarized in Table 47.

The figures illustrate water quality standards violations during moist flow ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 47 provides a summary of the Headwaters Otter Creek subwatershed, including impaired segment AUID, drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 community, CSO communities, CFOs, and CAFOs, as well as Load Allocations, Wasteload Allocations, and Margin of Safety values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 47. USGS Site Assignments for Development of Load Duration Curve

AUID	Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
INB1141_01	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate

1. Where denoted as “surrogate,” AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 48. Summary of Headwaters Otter Creek Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	15.77 square miles				
TMDL Sample Site	WBU030-0084 (Site # 1), WBU030-0079 (Site # 3)				
Listed Segments	INB1141_01				
Land Use	Agriculture: 44.06% Pasture/Hay: 13.95% Forest: 38.94% Urban: 1.26% Water: 0.31% Wetland: 1.47%				
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL Allocations (billion/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	329.7	87.75	35.64	8.73	2.67
WLA	0.0	0.0	0.0	0.0	0.0
MOS (10%)	36.6	9.75	3.96	.97	.027
TMDL = LA+WLA+MOS	366.3	97.5	39.6	9.7	2.7

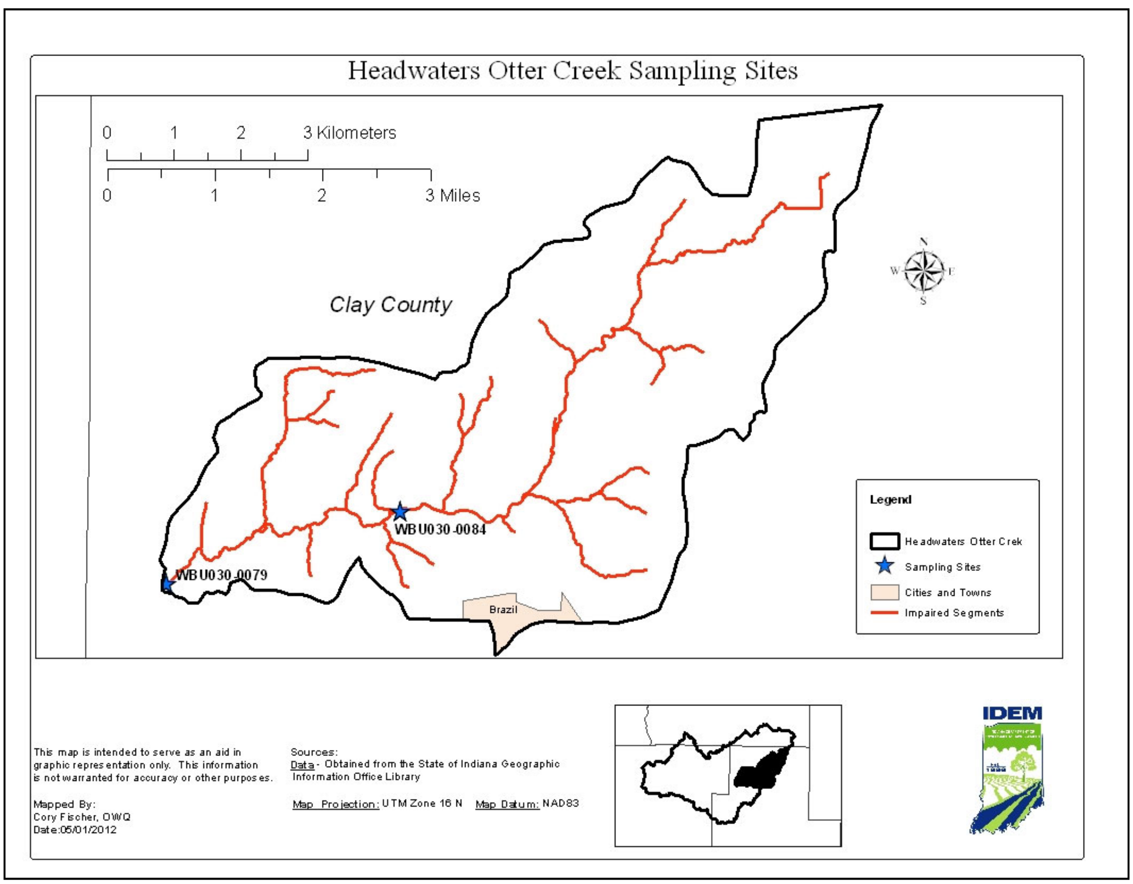


Figure 28. Sampling Stations in Headwaters Otter Creek Watershed

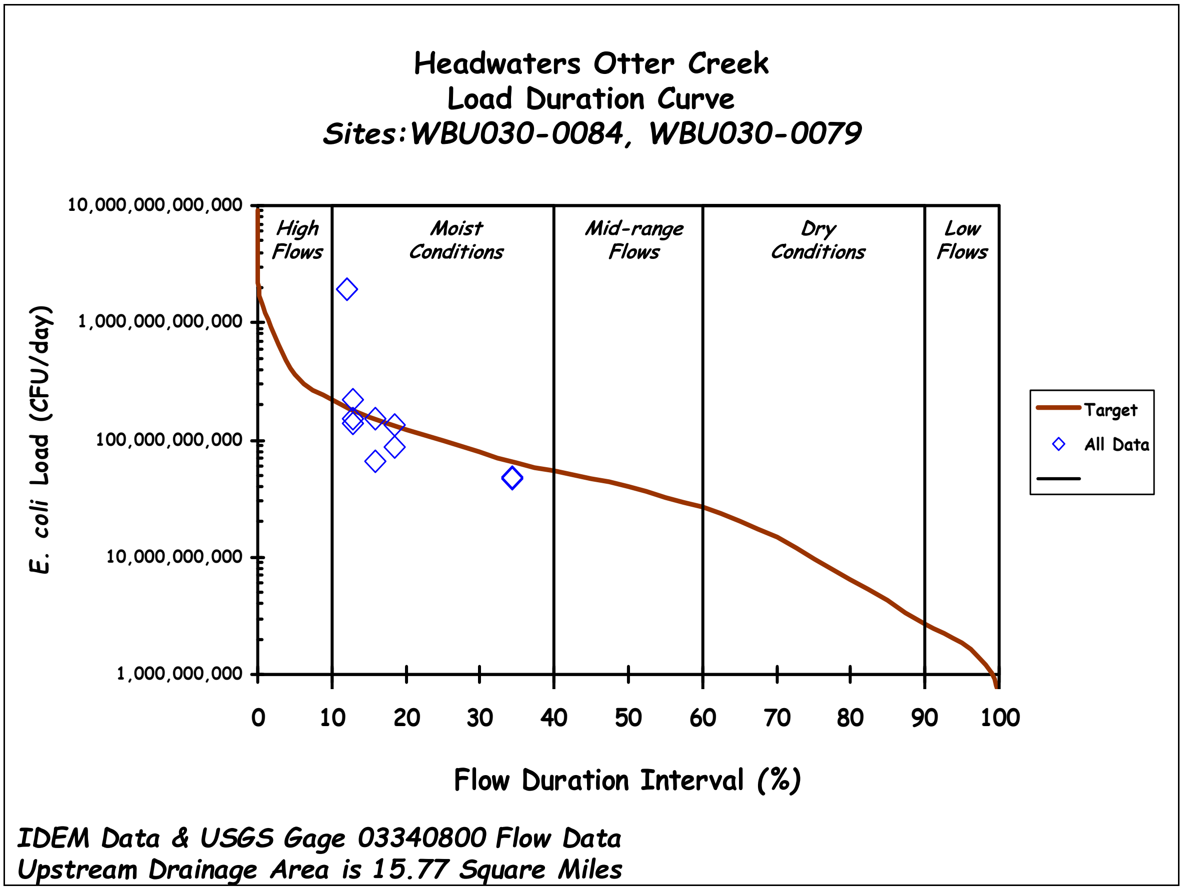


Figure 29. Load Duration Curve for all sites in the Headwaters Otter Creek Subwatershed

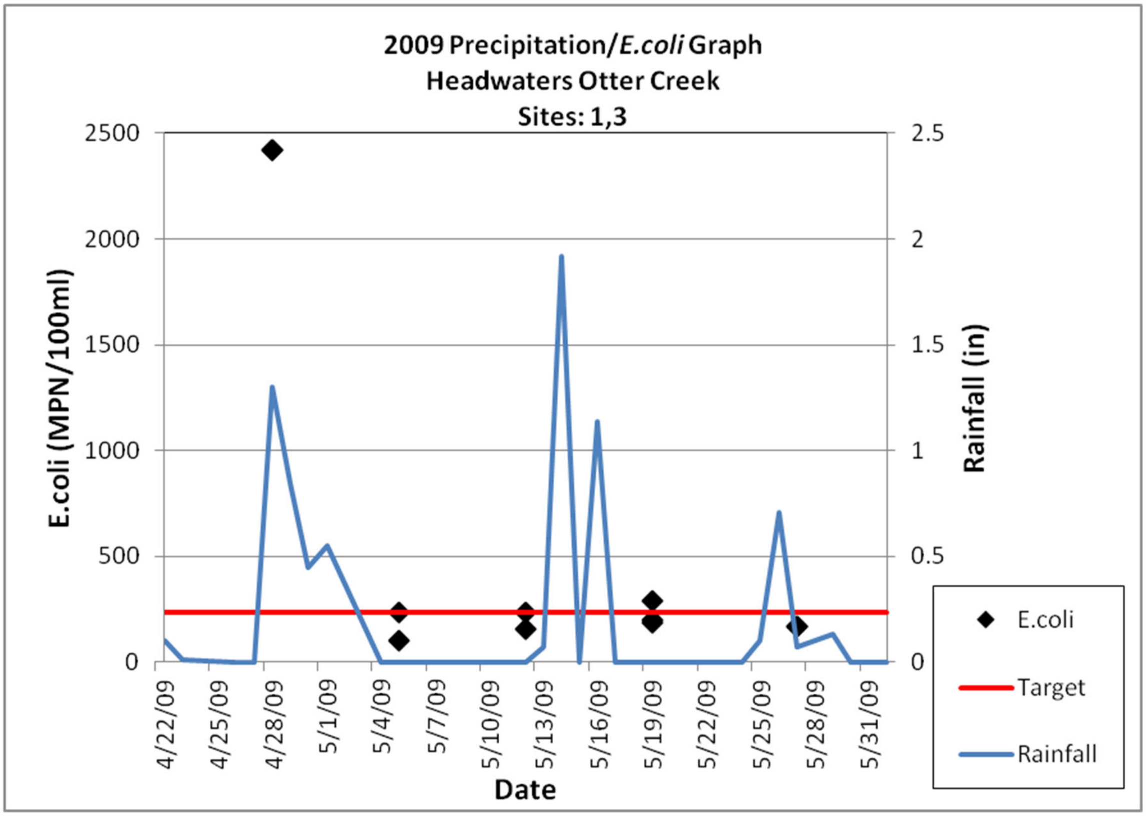


Figure 30. Graph of Precipitation and all E. coli Data in the Headwaters Otter Creek Subwatershed

Site 1 (WBU030-0084) is located at Hendrix Avenue on the main stem of Otter Creek. The geometric mean value for Site 3 is 283.6 MPN/100mL. The load duration curve shows two exceedances of the single sample with three samples below the water quality standard. The precipitation graph shows that the sampling events resulting in impairments were either during a precipitation event or within a few days of a precipitation event. Therefore, the stream is likely susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events nonpoint sources are the most likely source of the higher values seen in a few of the samples.

Site 3 (WBU030-0079) is located at CR 1025 N. The geometric mean value for Site 3 is 339.7 MPN/100mL. The load duration curve shows three exceedances of the single sample with two samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event or within a few days of a precipitation event. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples.

The combined E. coli data for the Headwaters Otter Creek subwatershed have an average single sample maximum violation 45.5% of the time and an average geometric mean violation 100% of the time. There are no NPDES permits with an enforcement case open and there are no CFO or CAFO permit violations. Based on the water quality duration curves, it can be concluded that the majority of sources of E. coli in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

7.1.2 North Branch Otter Creek

Load duration curves and precipitation graphs were created for all the sampling sites (Figure 32 and Figure 33) in the Otter Creek Watershed. Flow data used to develop the load duration curves is summarized in Table 49.

The figures illustrate water quality standards violations during moist flow ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 49 provides a summary of the North Branch Otter Creek subwatershed, including impaired segment AUID, drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 community, CSO communities, CFOs, and CAFOs, as well as Load Allocations, Wasteload Allocations, and Margin of Safety values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 49. USGS Site Assignments for Development of Load Duration Curve

AUID	Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
INB1142_01	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate
INB1142_01A	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate
INB1142_01B	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate
INB1142_01C	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate
INB1142_T1001	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate
INB1142_T1003	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate
INB1142_T1004	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate
INB1142_T1005	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate

1. Where denoted as “surrogate,” AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 50. Summary of North Branch Otter Creek Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	22.64 square miles				
TMDL Sample Site	WBU030-0081 (Site 16), WBU030-0082 (Site 17), WBU030-0050 (Site18), WBU030-0052 (Site 19), WBU030-0076 (Site 9)				
Listed Segments	INB1142_01, INB1142_01A, INB1142_01B, INB1142_01C, INB1142_T1001, INB1142_T1003, INB1142_T1004, INB1142_T1005				
Land Use	Agriculture: 43.32% Pasture/Hay: 10.53% Forest: 42.93% Urban: 0.03% Water: 0.33% Wetland: 2.59%				
NPDES Facilities	Carbon WWTP (IN0039829)				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL Allocations (billion/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	504.06	134.06	54.46	13.32	2.5
WLA	0.09	0.09	0.09	0.09	0.09
MOS (10%)	56.02	14.90	6.06	1.49	0.29
TMDL = LA+WLA+MOS	560.17	149.05	60.61	14.90	2.88

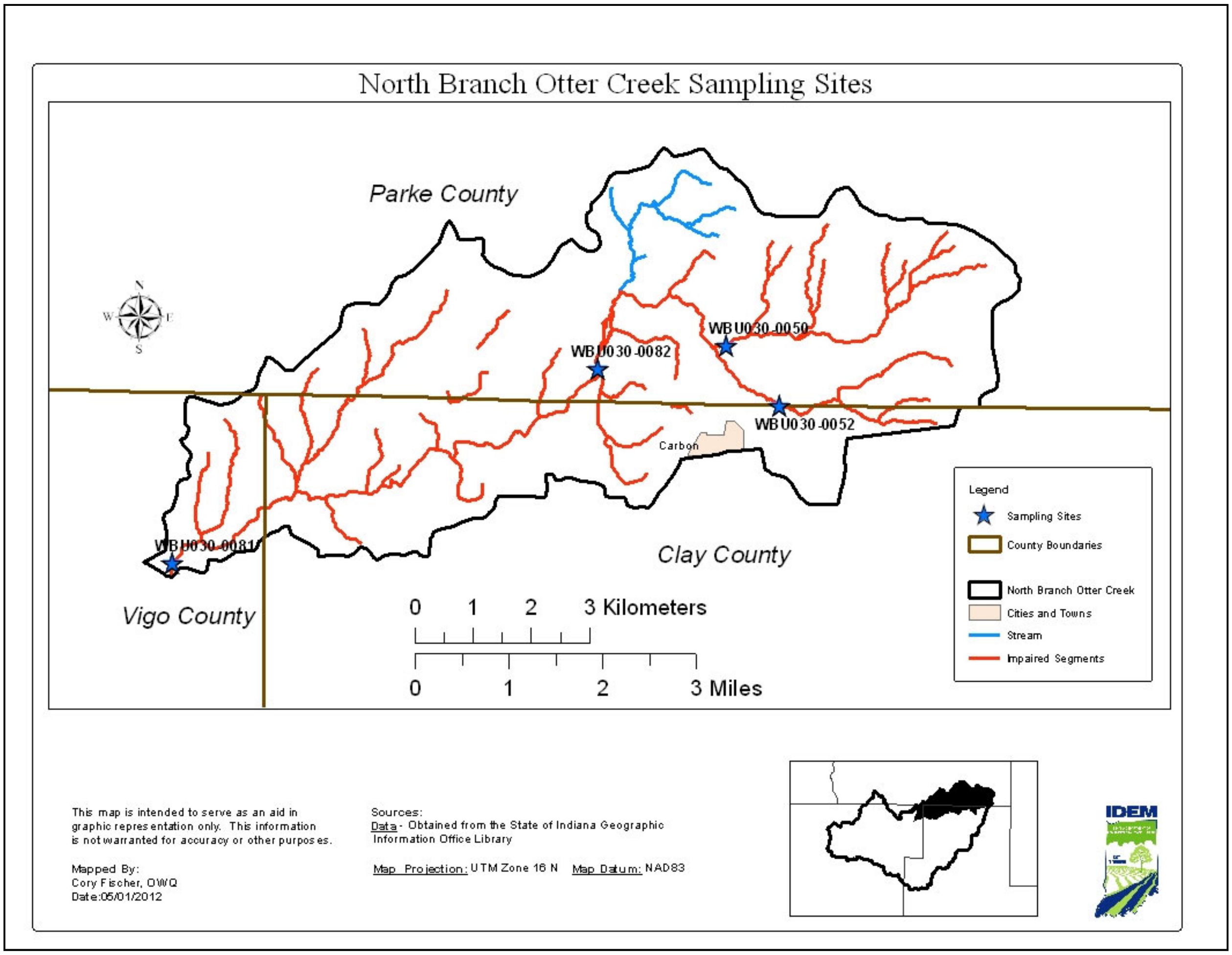


Figure 31. Sampling Stations in North Branch Otter Creek Watershed

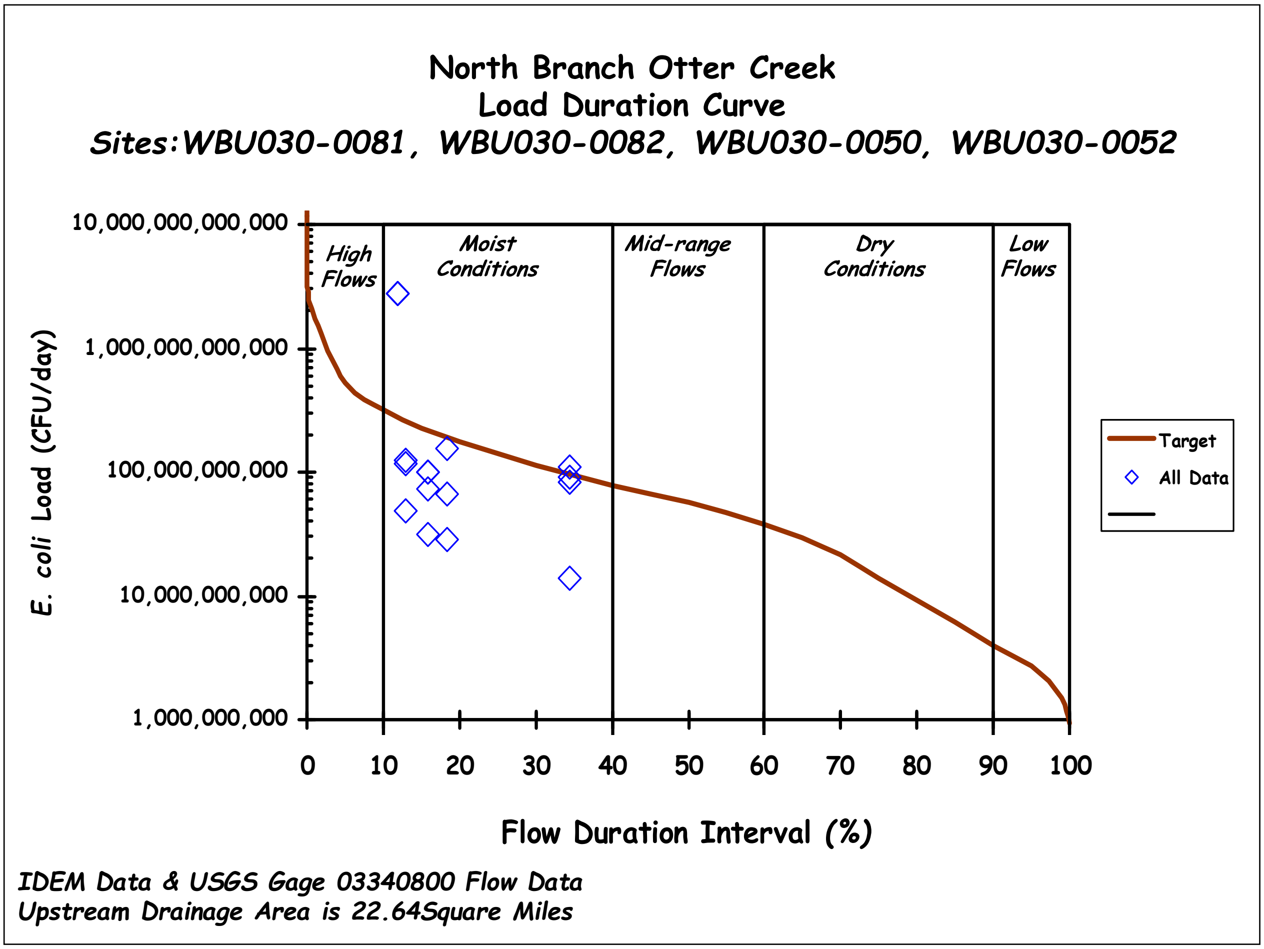


Figure 32. Load Duration Curve for all sites in the North Branch Otter Creek Subwatershed

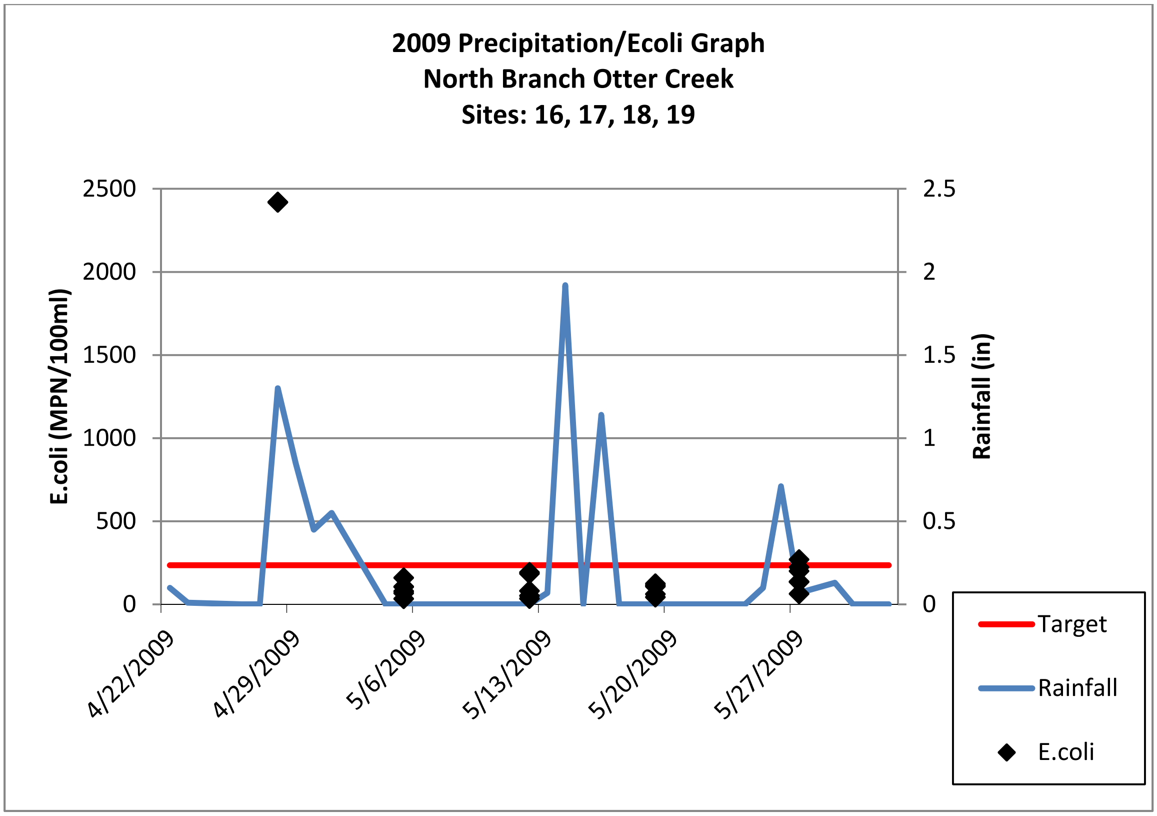


Figure 33. Graph of Precipitation and all E. coli Data in the North Branch Otter Creek Subwatershed

Site 16 (WBU030-0081) is located at Blue Jay Road on the main stem of North Branch Otter Creek. The geometric mean value for Site 16 is 247 MPN/100mL. The load duration curve shows one exceedances of the single sample with five samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event or within a few days of a precipitation event. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples.

Site 17 (WBU030-0082) is located at Rosedale Road on the main stem of North Branch Otter Creek. The geometric mean value for Site 17 is 218 MPN/100mL. The load duration curve shows one exceedances of the single sample with five samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event or within a few days of a precipitation event. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples.

Site 18 (WBU030-50) is located at CR 700 E on the main stem of North Branch Otter Creek. The geometric mean value for Site 18 is 96 MPN/100mL. The load duration curve shows one exceedances of the single sample with four samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event or within a few days of a precipitation event. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples.

Site 19 (WBU030-0052) is located at CR 1500 N on Ebenezer Creek. The geometric mean value for Site 19 is 149 MPN/100mL. The load duration curve shows one exceedances of the single sample with four samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event.. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples. This site is directly downstream of the Carbon WWTP outfall, this facility accounts for approximately 0.3% of the load during normal flow conditions at this site.

The combined *E. coli* data for the subwatershed have an average single sample maximum violation 22.7% of the time and an average geometric mean violation 75.0% of the time. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

7.1.3 Little Creek- North Branch Otter Creek

Load duration curves and precipitation graphs were created for all the sampling sites (Figure 35 and Figure 36) in the Otter Creek Watershed. Flow data used to develop the load duration curves is summarized in Table 51.

The figures illustrate water quality standards violations during all moist ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 51 provides a summary of the Little Creek- North Branch Otter Creek subwatershed, including impaired segment AUID, drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 community, CSO communities, CFOs, and CAFOs, as well as Load Allocations, Wasteload Allocations, and Margin of Safety values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 51. USGS Site Assignments for Development of Load Duration Curve

AUID	Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
INB1143_01	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate
INB1143_T001	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate
INB1143_T001A	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate
INB1143_T002	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate

1. Where denoted as “surrogate,” AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 52. Summary of Little Creek- North Branch Creek Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	16.66 square miles				
TMDL Sample Site	WBU030-0076 (Site 9)				
Listed Segments	INB1143_01, INB1143_T1001, INB1143_T001A, INB1143_T1002				
Land Use	Agriculture: 41.52 Pasture/Hay: 16.48% Forest: 35.73% Urban: 0.98% Water: 0.68% Wetland: 4.6%				
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL Allocations (billion/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	822.7	218.9	89.0	21.9	6.1
WLA	0	0	0	0	0
MOS (10%)	91.4	24.3	9.9	2.4	0.7
TMDL = LA+WLA+MOS	914.1	243.2	98.9	24.3	6.8

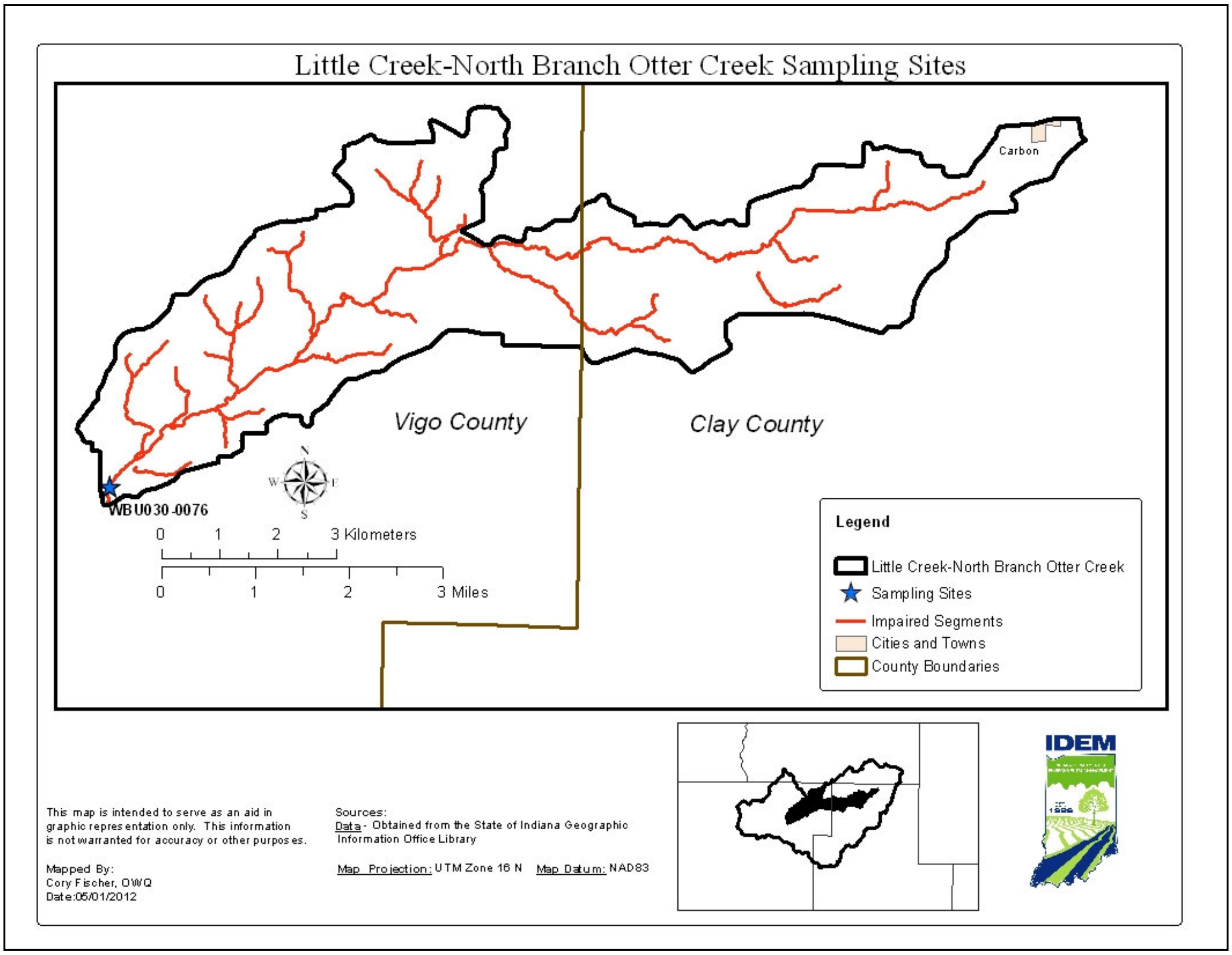


Figure 34. Sampling Stations in Little Creek- North Branch Otter Creek Watershed

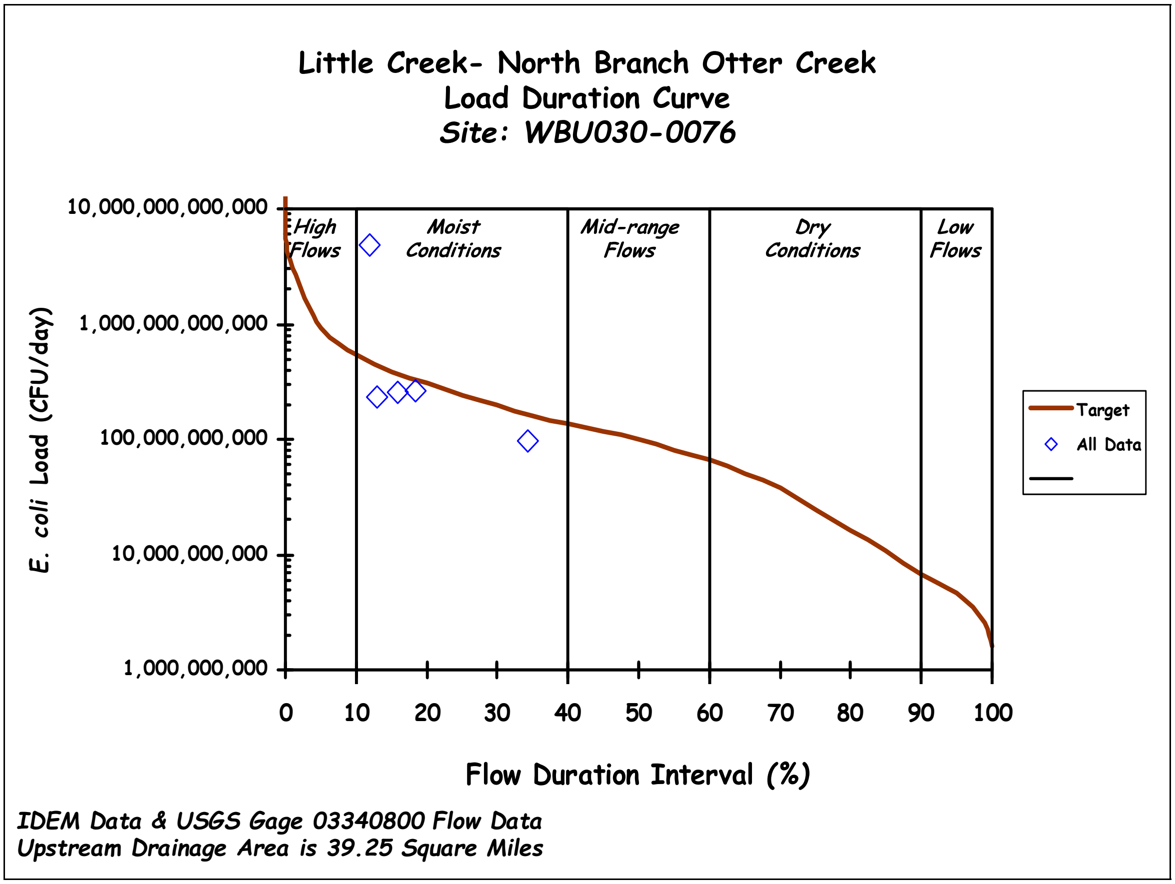


Figure 35. Load Duration Curve for all sites in the Little Creek- North Branch Otter Creek Subwatershed

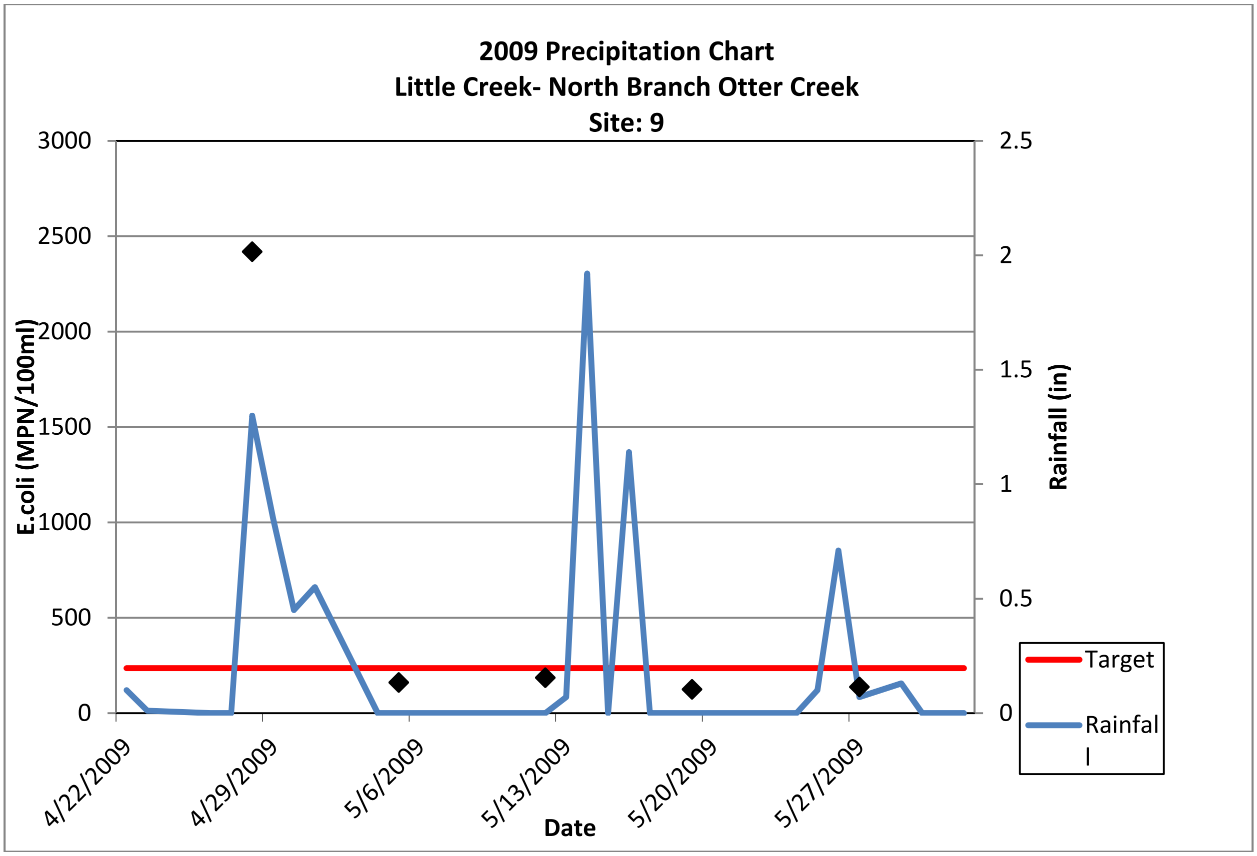


Figure 36. Graph of Precipitation and all E. coli Data in the Little Creek- North Branch Otter Creek Subwatershed

Site 9 (WBU030-0076) is located at Hayne Road on North Branch Otter Creek. The geometric mean value for Site 16 is 263 MPN/100mL. The load duration curve shows one exceedance of the single sample with four samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event or within a few days of a precipitation event. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples.

The combined *E. coli* data for the subwatershed have an average single sample maximum violation 20% of the time and an average geometric mean violation 100% of the time. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

7.1.4 Sulphur Creek

Load duration curves and precipitation graphs were created for all the sampling sites (Figure 38 and Figure 39) in the Sulpur Creek subwatershed. Flow data used to develop the load duration curves is summarized in Table 53.

The figures illustrate water quality standards violations during moist flow ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 53 provides a summary of the Sulphur Creek subwatershed, including impaired segment AUID, drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 community, CSO communities, CFOs, and CAFOs, as well as Load Allocations, Wasteload Allocations, and Margin of Safety values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 53. USGS Site Assignments for Development of Load Duration Curve

AUID	Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
INB1144_01	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate
INB1144_T001	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate
INB1144_T001A	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate

1. Where denoted as “surrogate,” AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 54. Summary of Sulphur Creek Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	23.09 square miles				
TMDL Sample Site	WBU030-0014 (Site 6), WBBU030-0016 (Site 7), WBU030-0012 (Site 8)				
Listed Segments	INB1144_01, INB1144_T001, INB1144_T1001A				
Land Use	Agriculture: 28.64% Pasture/Hay: 20.91% Forest: 42.28% Urban: 2.71% Water: 0.52% Wetland: 4.94%				
NPDES Facilities	Staunton WWTP (IN0025224)				
MS4 Communities	Seelyville MS4 (INR040092) (0.53 sq miles)				
CSO Communities	NA				
CAFOs	NA				
CFOs	Woll Farms Inc.				
TMDL Allocations (billion/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	“Normal” Flows	Lower Flow Conditions	Low Flows
LA	501.87	136.34	55.16	13.21	2.17
WLA Total:	12.20	0.37	0.37	0.37	0.37
Staunton WWTP	0.37	0.37	0.37	0.37	0.37
Seelyville MS4	11.83	0.0	0.0	0.0	0.0
MOS (10%)	57.13	15.20	6.18	1.52	0.29
TMDL = LA+WLA+MOS	571.20	151.91	61.71	15.10	2.83

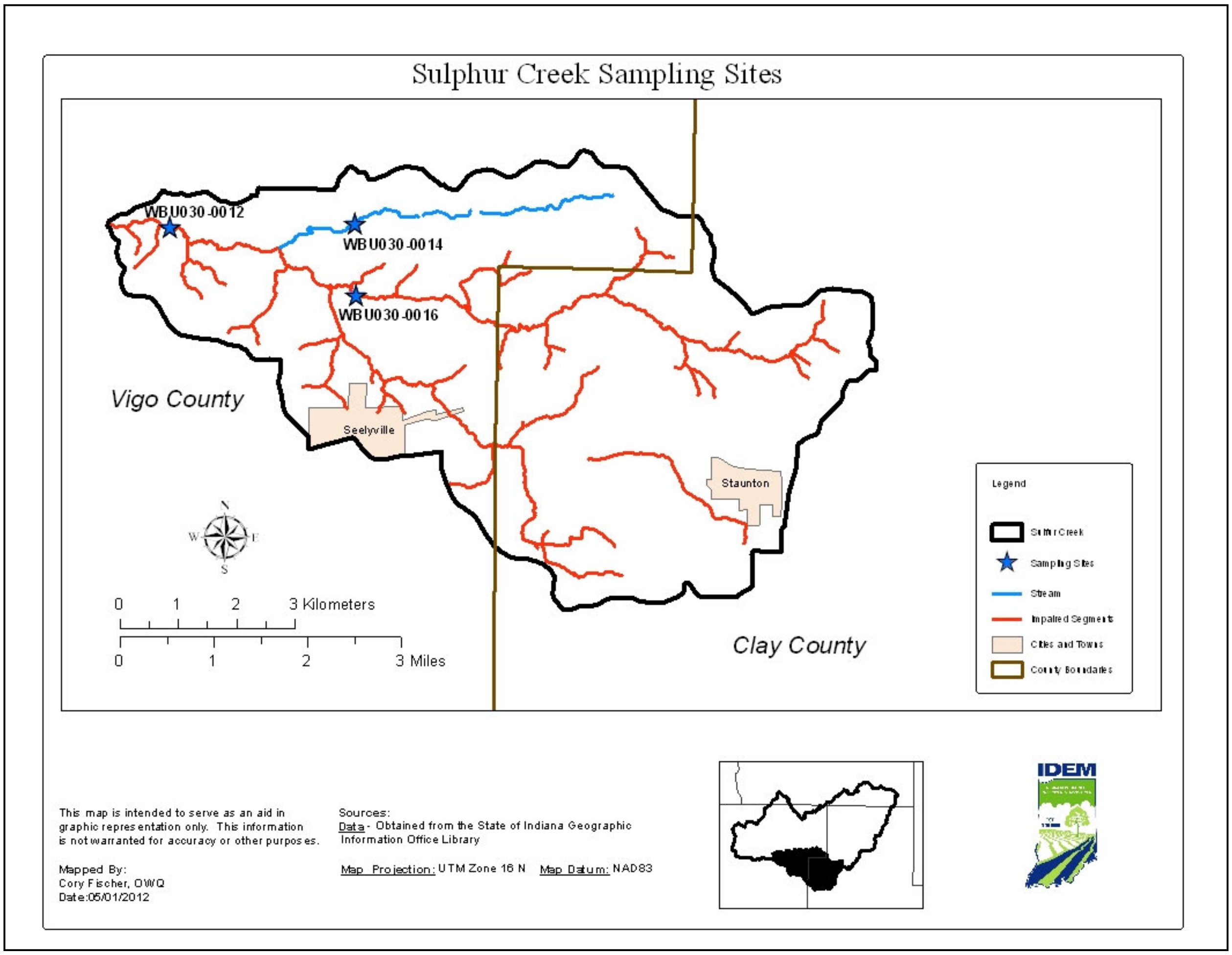


Figure 37. Sampling Stations in Sulphur Creek Watershed

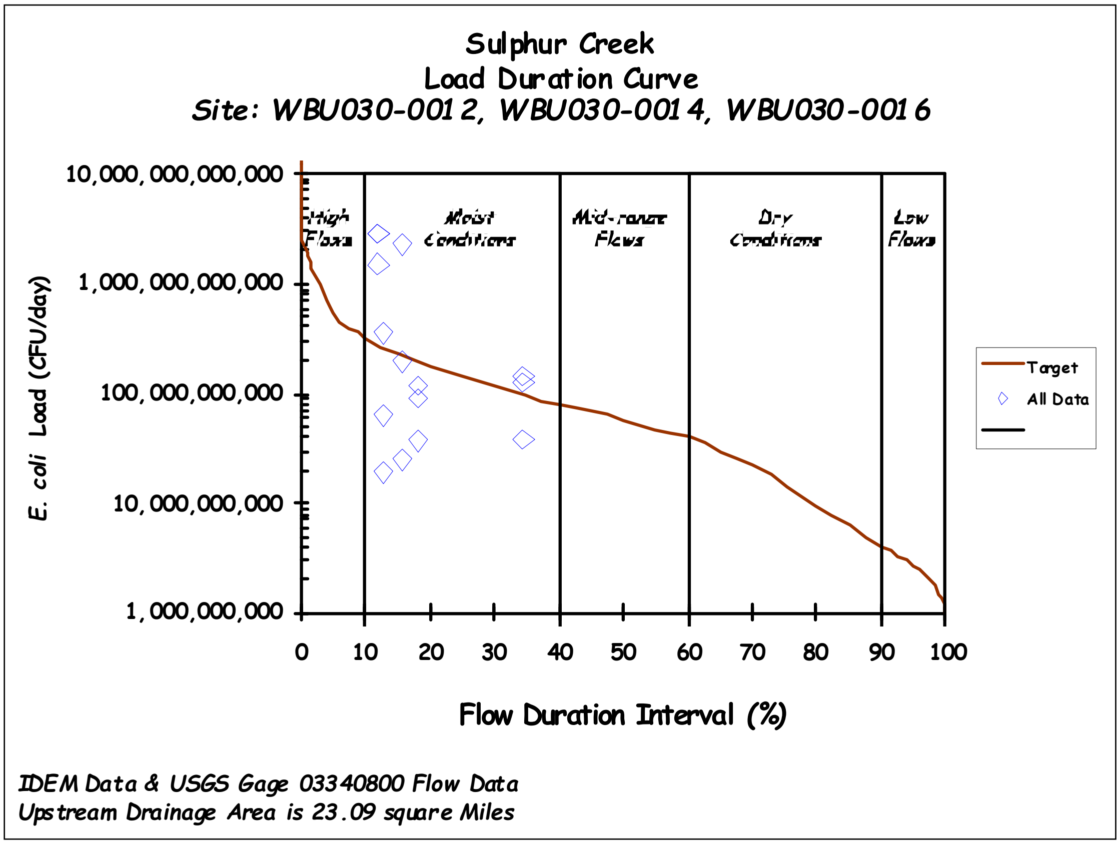


Figure38. Load Duration Curve for all sites in the Sulphur Creek Subwatershed

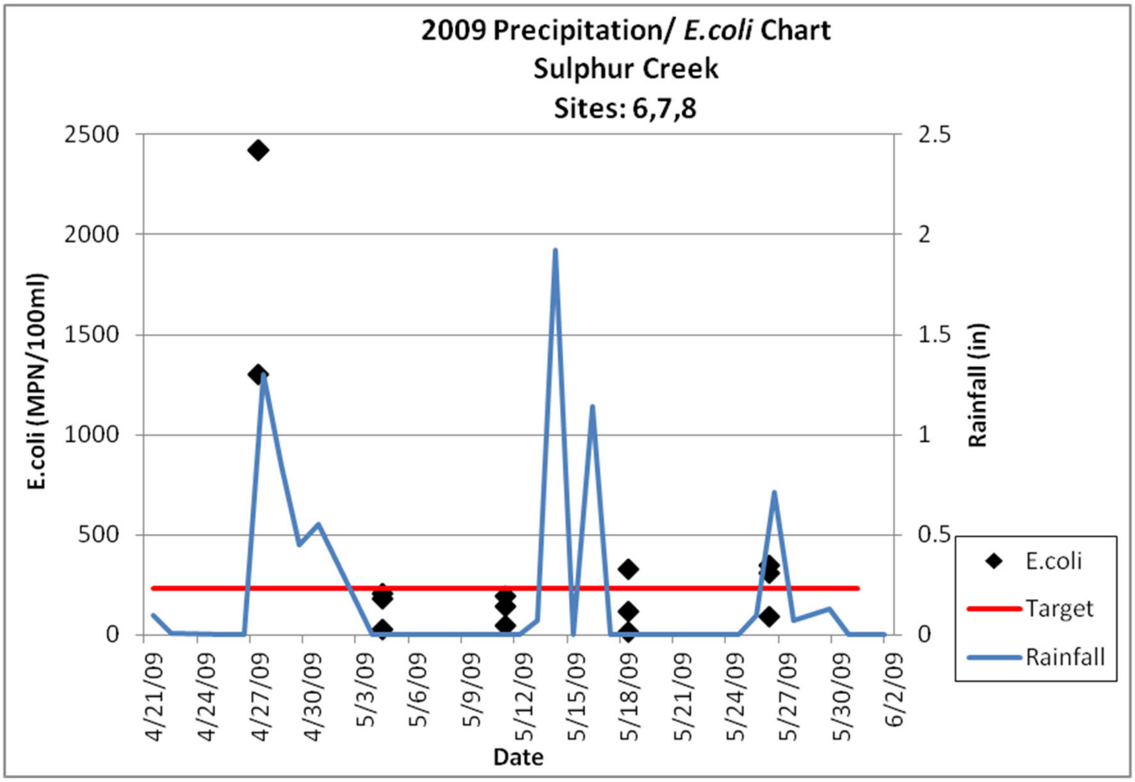


Figure 39. Graph of Precipitation and all E. coli Data in the Sulphur Creek Subwatershed

Site 8 (WBU030-0012) is located at Roberts Road on Sulphur Creek. The geometric mean value for Site 8 is 315 MPN/100mL. The load duration curve shows two exceedances of the single sample with three samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples. This site is the closest downstream site of the Staunton WWTP, this plant accounts for approximately 0.7% of the load during normal flow conditions. This site is also influenced by the Seelyville MS4, Seelyville MS4 is estimated to contribute approximately 2% of the load during very high flows.

Site 6 (WBU030-0014) is located at Grotto Road on No End Creek. The geometric mean value for Site 6 is 75 MPN/100mL. The load duration curve shows one exceedance of the single sample with four samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event or within a few days of a precipitation event. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples.

Site 7 (WBU030-0016) is located at Main Street on Sulphur Creek. The geometric mean value for Site 7 is 382 MPN/100mL. The load duration curve shows three exceedances of the single sample with two samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event or within a few days of a precipitation event. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples.

The combined *E. coli* data for the subwatershed have an average single sample maximum violation 33.3% of the time and an average geometric mean violation 66.7% of the time. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

7.1.5 Gundy Ditch

Load duration curves and precipitation graphs were created for all the sampling sites (Figure 41 and Figure 42) in the Otter Creek Watershed. Flow data used to develop the load duration curves is summarized in Table 55.

The figures illustrate water quality standards violations during moist flow ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 56 provides a summary of the Gundy Ditch subwatershed, including impaired segment AUID, drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 community, CSO communities, CFOs, and CAFOs, as well as Load Allocations, Wasteload Allocations, and Margin of Safety values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 55. USGS Site Assignments for Development of Load Duration Curve

AUID	Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
INB1145_01	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate
INB1145_T1001	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate
INB1145_T1002	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate

1. Where denoted as “surrogate,” AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 56. Summary of Gundy Ditch Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	18.29 square miles				
TMDL Sample Site	WBU030-0011 (Site 11), WBU030-0073 (Site 13), WBU030-0074 (Site 14), WBU030-0075 (Site 15)				
Listed Segments	INB1145_01, INB1145_T1001, INB1145_T1002				
Land Use	Agriculture: 69.54% Pasture/Hay: 15.04% Forest: 13.59% Urban: 0.79% Water: 0% Wetland: 1.04%				
NPDES Facilities	NA				
MS4 Communities	Terre Haute MS4 (INR040092) (0.61 sq miles)				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL Allocations (billion/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	372.2	102.4	41.7	10.3	2.9
WLA: Seelyville MS4	12.8	0.0	0.0	0.0	0.0
MOS (10%)	42.8	11.4	4.6	1.1	0.3
TMDL = LA+WLA+MOS	427.8	113.8	46.3	11.4	3.2

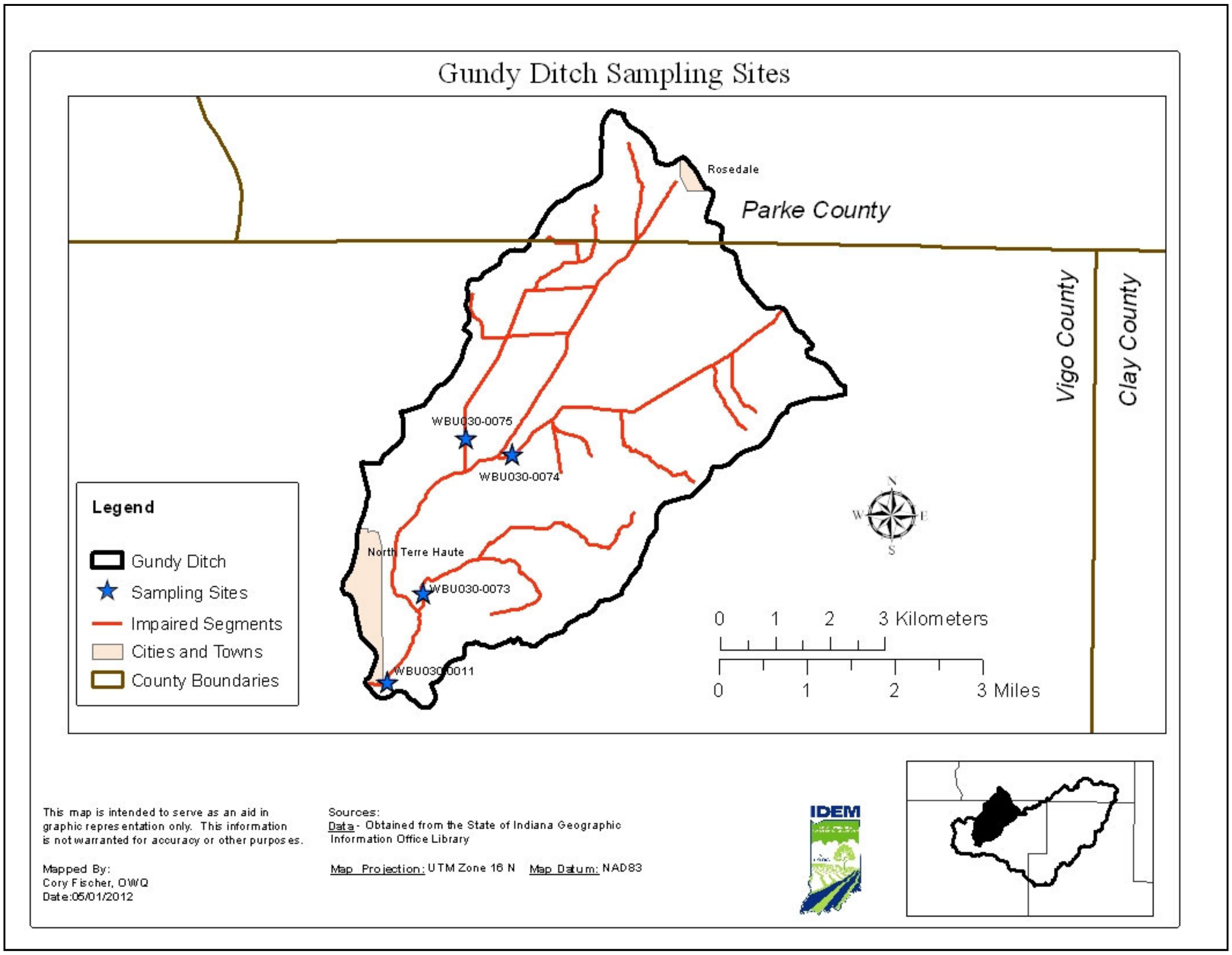


Figure 40. Sampling Stations in Gundy Ditch Watershed

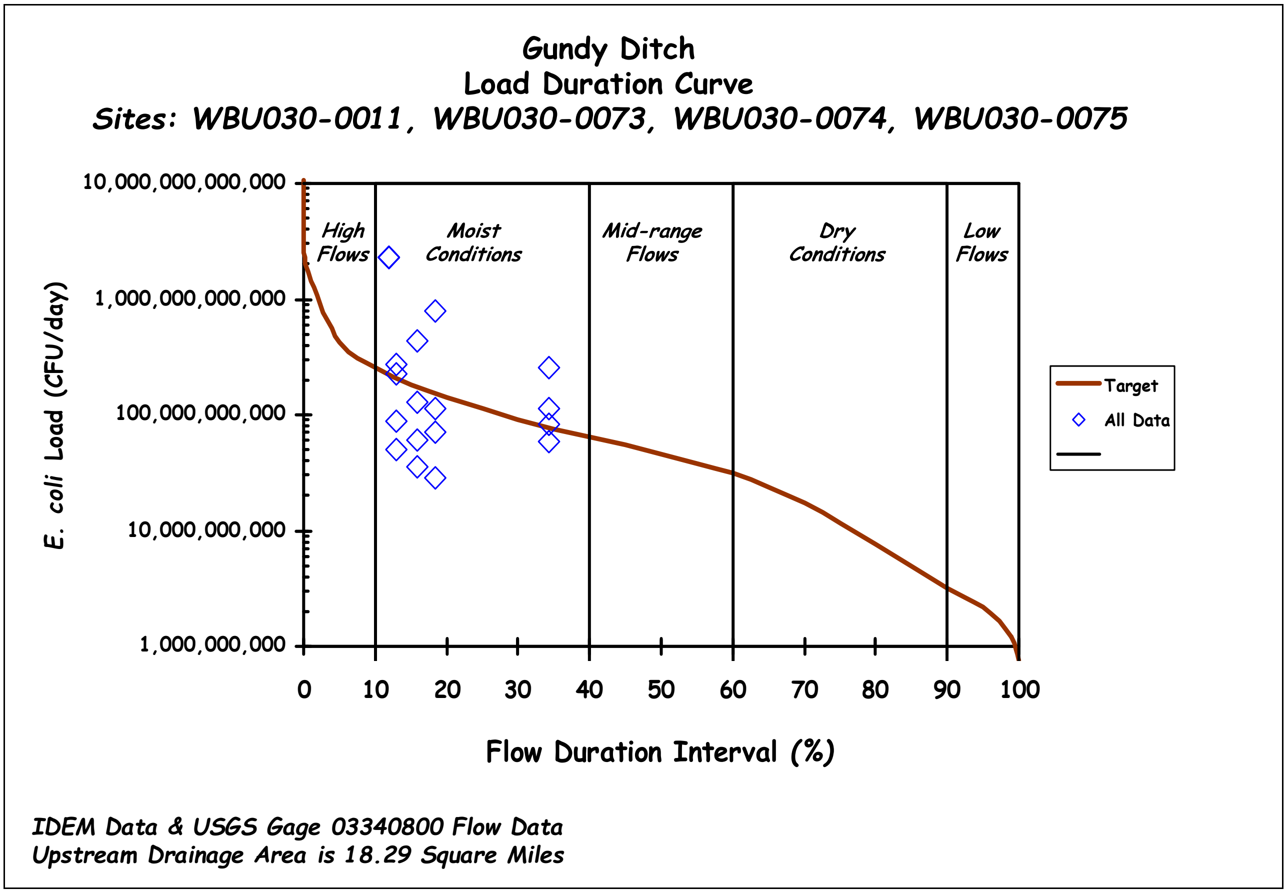


Figure 41. Load Duration Curve for all sites in the Gundy Ditch Subwatershed

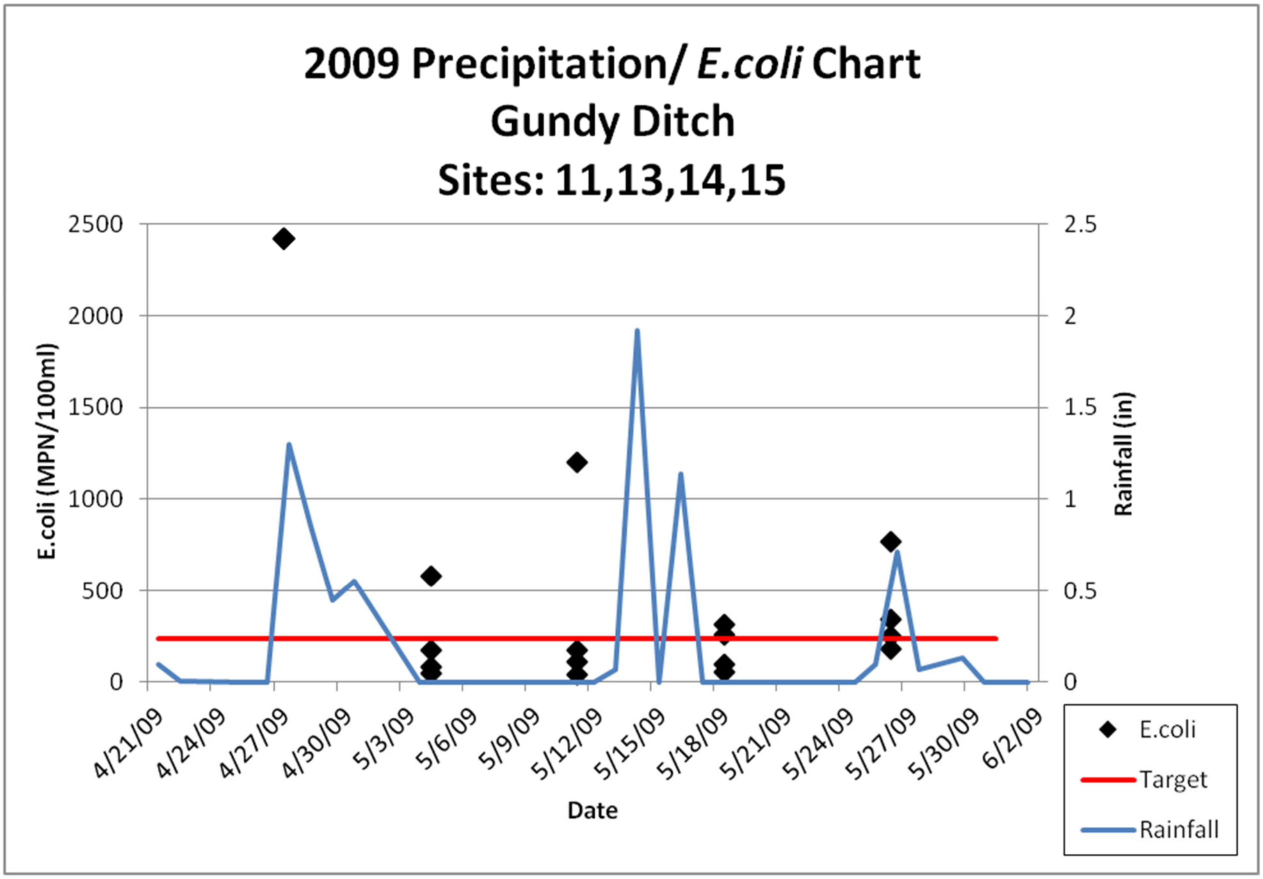


Figure 42. Graph of Precipitation and all E. coli Data in the Gundy Ditch Subwatershed

Site 11(WBU030-0011) is located at CR 21 E on Gundy Ditch. The geometric mean value for Site 11 is 378 MPN/100mL. The load duration curve shows four exceedances of the single sample with two samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event or within a few days of a precipitation event. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples. This site is influenced by Terre Haute MS4, it is estimated that during high flow conditions Terre Haute contributes approximately 3% of the overall load.

Site 13 (WBU030-073) is located at Rosehill Road on an Unnamed Tributary to Gundy Ditch. The geometric mean value for Site 13 is 805 MPN/100mL. The load duration curve shows five exceedances of the single sample with zero samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event or within a few days of a precipitation event. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples.

Site 14 (WBU030-0074) is located at Rosedale Road on Gundy Ditch. The geometric mean value for Site 14 is 197 MPN/100mL. The load duration curve shows two exceedances of the single sample with three samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event or within a few days of a precipitation event. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples.

Site 15 (WBU030-0075) is located at Joppa Road on Swope Ditch. The geometric mean value for Site 15 is 155 MPN/100mL. The load duration curve shows one exceedance of the single sample with four samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event or within a few days of a precipitation event. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples.

The combined *E. coli* data for the subwatershed have an average single sample maximum violation 52.3% of the time and an average geometric mean violation 100% of the time. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

7.1.6 Wastewaters Creek- Otter Creek

Load duration curves and precipitation graphs were created for all the sampling sites (Figure 44 and Figure 45) in the Otter Creek Watershed. Flow data used to develop the load duration curves is summarized in Table 57.

The figures illustrate water quality standards violations during moist flow ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 58 provides a summary of the Wastewaters Creek- Otter Creek subwatershed, including impaired segment AUID, drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 community, CSO communities, CFOs, and CAFOs, as well as Load Allocations, Wasteload Allocations, and Margin of Safety values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 57. USGS Site Assignments for Development of Load Duration Curve

AUID	Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
INB1146_01	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate
INB1146_01_T1001	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate
INB1146_02	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate
INB1146_03	Big Raccoon Creek Near Fincastle IN	03340800	1/1/1990- 5/30/2012	surrogate

1. Where denoted as “surrogate,” AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 58. Summary of Wastewaters Creek- Otter Creek Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	27.66 square miles				
TMDL Sample Site	WBU030-0089 (Site 2), WBU030-0078 (Site 4), WBU030-0077 (Site 5), WBU030-0001 (Site 10), WBU030-0072 (Site 12)				
Listed Segments	INB1146_01, INB1146_01_T1001, INB1146_02, INB1146_03				
Land Use	Agriculture: 37.82% Pasture/Hay: 18.03% Forest: 28.19% Urban: 8.95% Water: 0.55% Wetland: 6.47%				
NPDES Facilities	NA				
MS4 Communities	Terre Haute MS4 (INR040092) (3.54 sq miles)				
CSO Communities	NA				
CAFOs	NA				
CFOs	Lyons Farm				
TMDL Allocations (billion/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	2,500.9	676.8	275.2	67.6	19.0
WLA: Terre Haute MS4	103.3	0.0	0.0	0.0	0.0
MOS (10%)	289.4	75.2	30.6	7.5	2.1
TMDL = LA+WLA+MOS	2,893.6	752.0	305.8	75.1	21.1

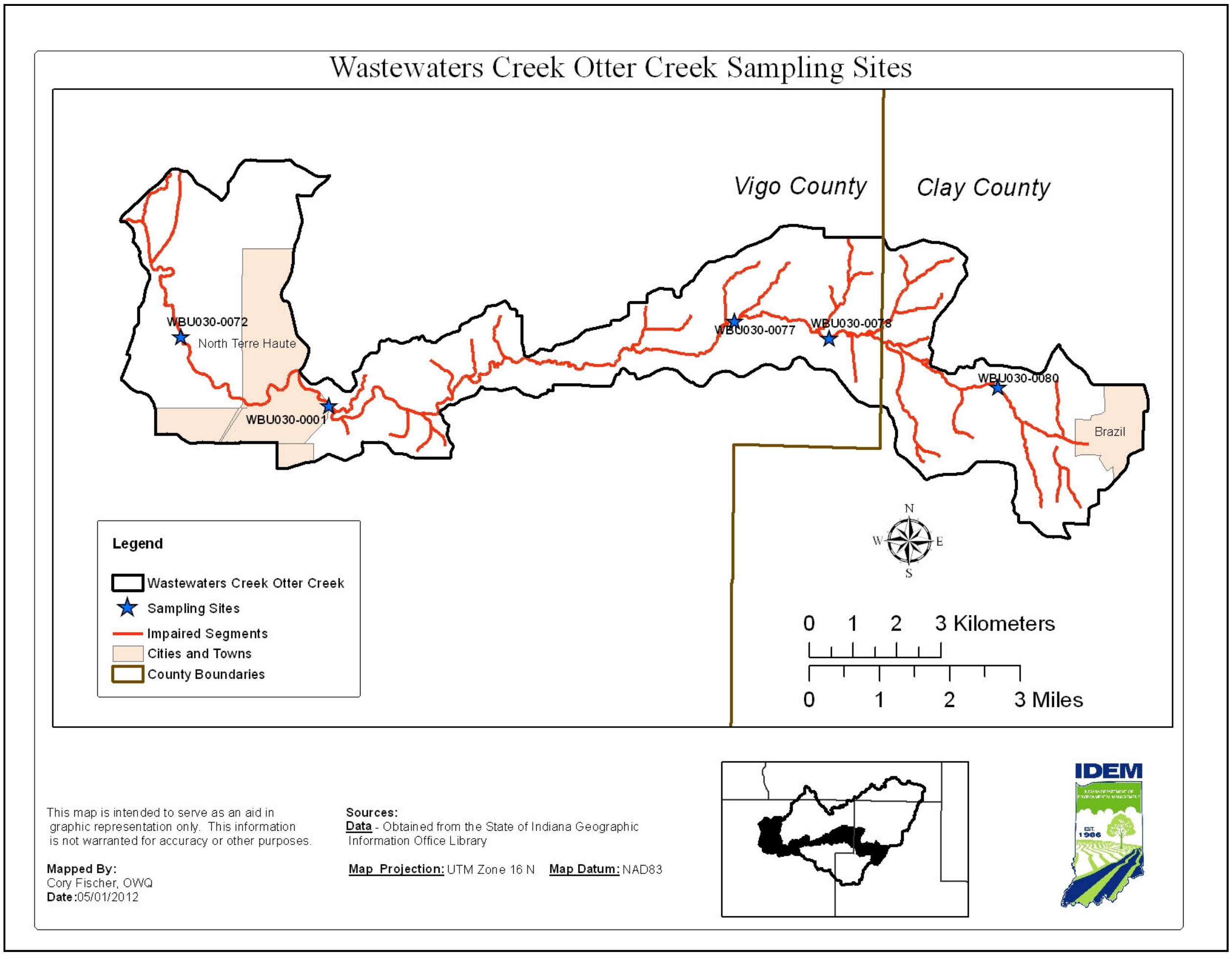


Figure 43. Sampling Stations in Wastewaters Creek- Otter Creek Watershed

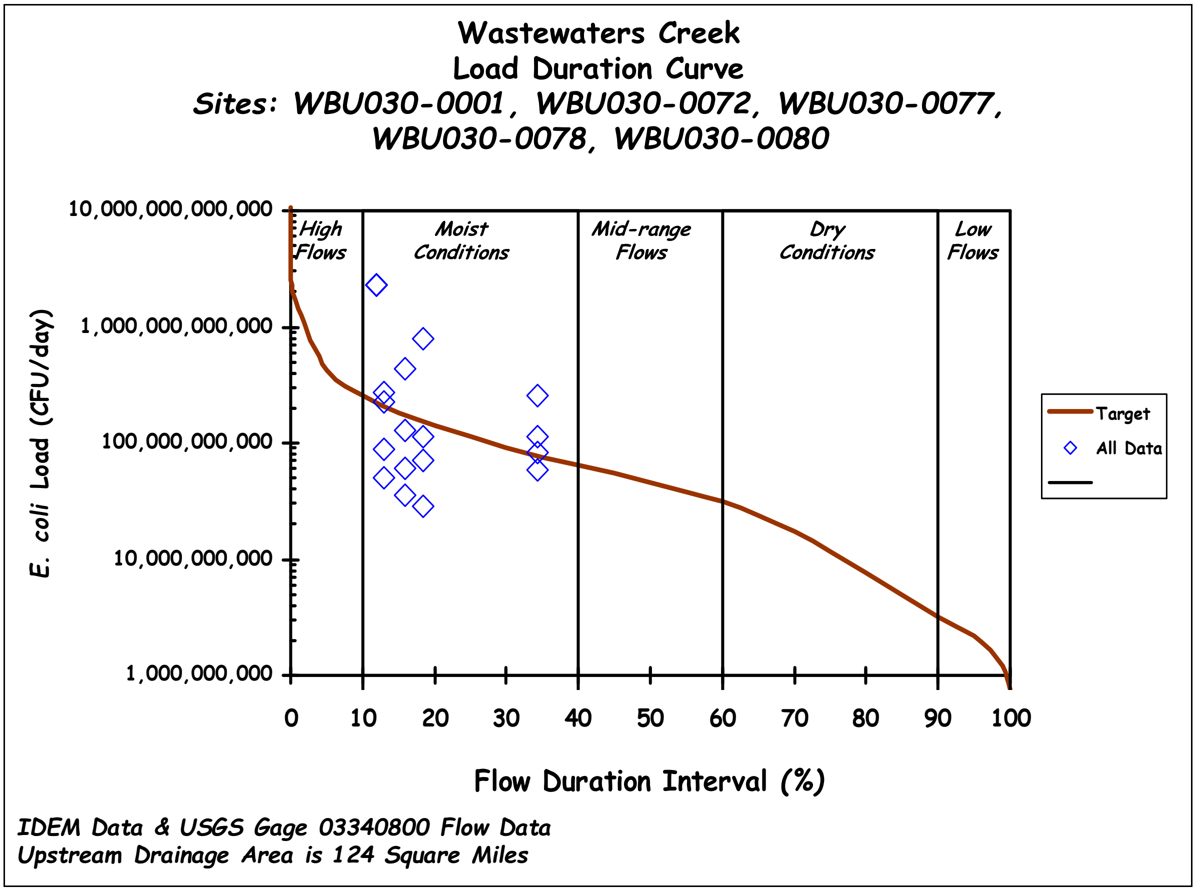


Figure 44. Load Duration Curve for all sites in the Wastewaters Creek- Otter Creek Subwatershed

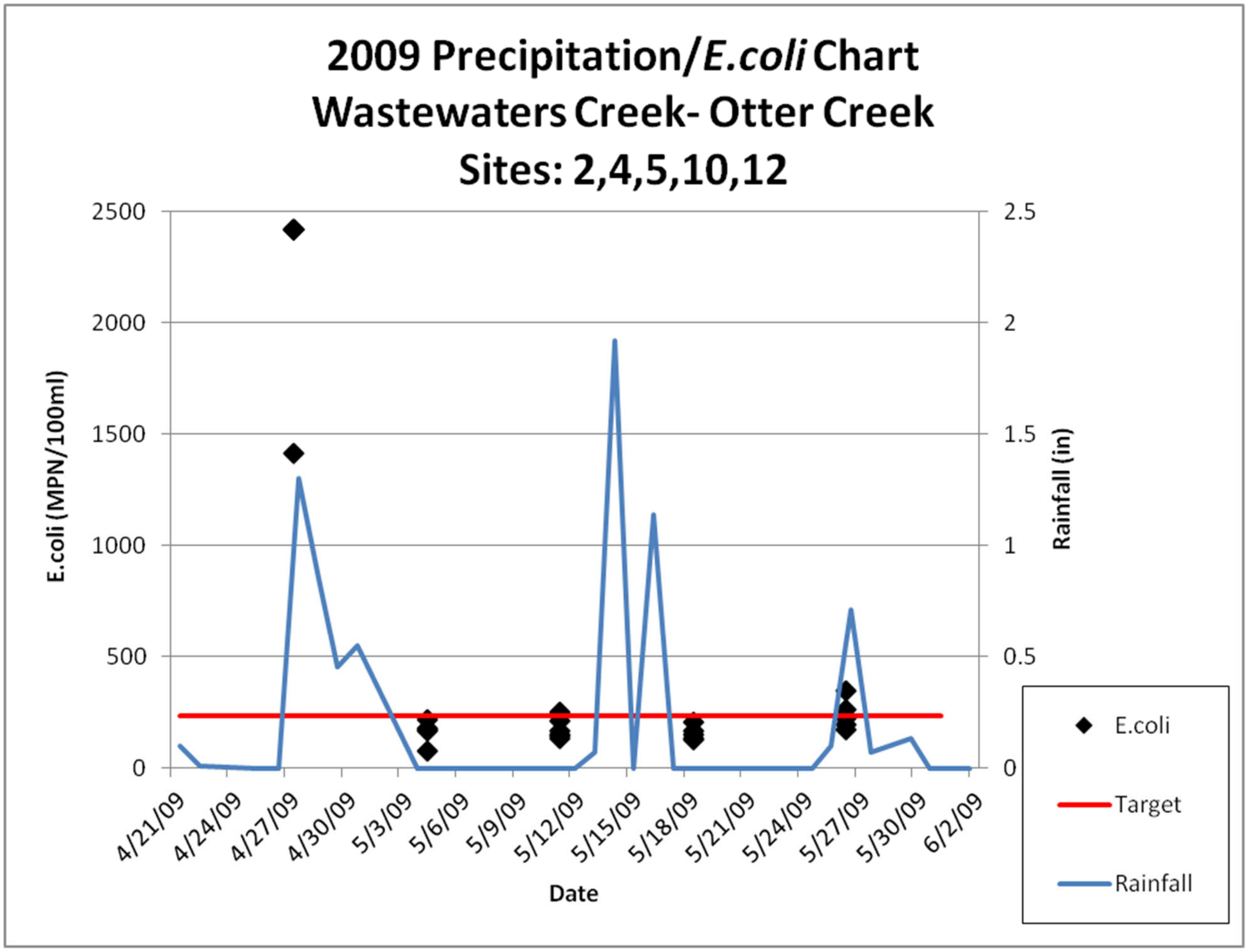


Figure 45. Graph of Precipitation and all E. coli Data in the Wastewaters Creek- Otter Creek Subwatershed

Site 2 (WBU030-0080) is located at Kennedy Crossing on Waterworks Creek. The geometric mean value for Site 2 is 277 MPN/100mL. The load duration curve shows three exceedances of the single sample with two samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event or within a few days of a precipitation event. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples.

Site 4 (WBU030-0078) is located at 35 North Road on Otter Creek. The geometric mean value for Site 4 is 304 MPN/100mL. The load duration curve shows one exceedance of the single sample with four samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event or within a few days of a precipitation event. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples.

Site 5 (WBU030-0077) is located at Miama Gardens St. on Otter Creek. The geometric mean value for Site 5 is 293 MPN/100mL. The load duration curve shows one exceedance of the single sample with four samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event or within a few days of a precipitation event. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples.

Site 10 (WBU030-0001) is located at Rosedale Road on Otter Creek. The geometric mean value for Site 10 is 210 MPN/100mL. The load duration curve shows two exceedances of the single sample with three samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event or within a few days of a precipitation event. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples.

Site 12 (WBU030-0072) is located at Hasselburger Avenue on Otter Creek. The geometric mean value for Site 12 is 291 MPN/100mL. The load duration curve shows three exceedances of the single sample with three samples below the water quality standard. The precipitation graph shows that the impaired sampling events were either during a precipitation event or within a few days of a precipitation event. Therefore, the stream is susceptible to high loads of *E. coli* from run-off. Since the results seem dependent on precipitation events non-point sources are the most likely source of the higher values seen in a few of the samples. This site is influenced by the Terre Haute MS4, it is estimated that during very high flows the Terre Haute MS4 contributes approximately 4% of the load.

The combined *E. coli* data for the subwatershed have an average single sample maximum violation 26.9% of the time and an average geometric mean violation 100% of the time. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

8.0 ALLOCATIONS

A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. TMDLs are composed of the sum of individual WLAs for regulated sources and LAs for unregulated sources. In addition, the TMDL must include a MOS, either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this is defined by the equation:

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

8.1 Results by Assessment Location

The following sections present the allowable *E. coli* loads and associated allocations for each of the subwatersheds and associated assessment units in the Otter Creek watershed. Allocations were calculated for each 12-digit HUC. WLAs were calculated based on the design flow of the facility and the TMDL Target.

Table 59 presents the individual WLAs for NPDES facilities in the Otter Creek watershed by subwatershed.

The Staunton and Carbon WWTPs are estimated to contribute about 0.15 percent of the *E. coli* load during “normal flow” in the Otter Creek watershed. The WWTP WLAs were established based on the design flow multiplied by the TMDL target value of 125/100 mL for *E. coli*. These facilities will continue as normal, and will not have to reduce their loadings into the Otter Creek Watershed.

Table 59. Individual WLAs for NPDES Facilities in the Otter Creek Watershed

Subwatershed	AUID	Facility Name	Permit ID	Design Flow (MGD)	E. coli WLA (Billion/day)
North Branch Otter Creek	INB1142_T1001	Carbon WWTP	IN0039829	0.0252	0.12
Sulphur Creek	INB1144_T1001	Staunton WWTP	IN0025224	0.1	0.37

Table 60 presents the individual WLAs for MS4 communities in the Otter Creek watershed by subwatershed. Different WLAs were established for each MS4 depending on the area of the MS4 upstream of the each assessment location. The jurisdictional areas of townships, municipalities, and urbanized areas were used as surrogates for the regulated area of each MS4. These areas were then used to calculate WLAs based on the proportion of the upstream drainage area located within the MS4 boundaries by multiplying that proportional area by the loading capacity of the assessment location. The MS4 WLAs therefore are equal to the estimated flows from the MS4 multiplied by the TMDL target value of 125/100 mL. Seelyville and Terre Haute are permitted under the same permit number (INR040092), but their WLAs have been broken apart so each community can see their allocation.

Table 60. Individual WLAs for MS4 Communities in the Otter Creek watershed TMDLs

Subwatershed	AUID	MS4 Community	Permit ID	Area in Drainage (sq miles)	*E. coli* WLA [Billion/day]
Sulphur Creek	INB1144_T1001	Seelyville	INR040092	0.53	11.83
Gundy Ditch	INB1145_01	Terre Haute	INR040092	0.61	12.8
Wastewaters Creek Otter Creek	INB1146_03	Terre Haute	INR040092	4.43	103.3

8.2 Margin of Safety (MOS)

Section 303(d) of the Clean Water Act and USEPA regulations at 40 CFR 130.7 require that "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numeric water quality standards with seasonal variations and a MOS which takes into account any lack of knowledge concerning the relationship between limitations and water quality." USEPA guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS). This TMDL uses both an implicit and explicit MOS. An implicit MOS was used by applying a couple of conservative assumptions. A moderate explicit MOS has been applied by reserving ten percent of the allowable load. Ten percent was considered an appropriate MOS based on the following considerations:

- The use of the load duration curve approach minimizes a great deal of uncertainty associated with the development of TMDLs because the calculation of the loading capacity is simply a function of flow multiplied by the target value. Most of the uncertainty is therefore associated with the estimated flows in each assessed segment which were based on extrapolating flows from the nearest downstream USGS gage.
- The *E. coli* TMDLs include an implicit MOS in that they were based on the geometric mean component of the standard rather than the single sample maximum standard. Using the single sample maximum standard would have resulted in larger loading capacities.

- An additional implicit MOS for *E. coli* is included because the load duration analysis does not address die-off of pathogens.

8.3 Critical Conditions

The Clean Water Act requires that TMDLs take into account critical conditions for stream flow, loading, and water quality parameters as part of the analysis of loading capacity. Through the load duration curve approach it has been determined that load reductions for the parameters of concern are needed for specific flow conditions; the critical conditions (the periods when the greatest reductions are required) vary by parameter and location and are summarized in Table 61. The table indicates that critical conditions for most pollutants for most locations occur during higher flow regimes and therefore implementation of controls should be targeted for these conditions.

Table 61. Critical Conditions for TMDL Parameters

Parameter	Station ID (Site #)	Critical Condition				
		Very High	Higher	Normal	Lower	Low
E. coli (counts/mL)	WBU030-0084 (1)		X			
	WBU030-0080 (2)		X			
	WBU030-0079 (3)		X			
	WBU030-0078 (4)		X			
	WBU030-0077 (5)		X			
	WBU030-0014 (6)		X			
	WBU030-0016 (7)		X			
	WBU030-0012 (8)		X			
	WBU030-0076 (9)		X			
	WBU030-0001 (10)		X			
	WBU030-0011 (11)		X			
	WBU030-0072 (12)		X			
	WBU030-0073 (13)		X			
	WBU030-0074 (14)		X			
	WBU030-0075 (15)		X			
	WBU030-0081 (16)		X			
	WBU030-0082 (17)		X			
	WBU030-0050 (18)		X			
	WBU030-0052 (19)		X			

8.4 Future Monitoring

Future *E. coli* monitoring of the Otter Creek watershed will take place during IDEM's nine-year rotating basin schedule. For probabilistic monitoring, the Otter Creek Watershed will be included in the stratified random draw of sites for the Lower Wabash River Basin in 2016; however, this does not guarantee that sites will fall within the Otter Creek watershed. IDEM will monitor at an appropriate frequency to determine whether Indiana's 30-day geometric mean value of 125 E. coli per one hundred milliliters is being met. When results indicate that the waterbody is meeting the *E. coli* WQS, the waterbody will then be removed from Indiana's List of Impaired Waters.

8.5 Potential Priority Implementation Areas (PPIAs)

The information in Section 6 and the allocations presented in this section provide the foundation necessary to identify subwatersheds that are in need of the most significant *E. coli* reductions to achieve water quality standards in the Otter Creek watershed. The areas in need of the most significant *E. coli* reductions under high flow and low flow conditions are considered PPIAs. Using the PPIA rankings, watershed organizations will gain a better understanding of which subwatersheds require the most pollutant load reductions. This can assist in future efforts to identify critical areas in the Otter Creek watershed for implementation. PPIAs differ from critical areas in that PPIAs focus on the information and data collected and analyzed through the TMDL development process for ranking purposes, whereas critical areas take into account other factors into 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.

8.5.1 PPIAs for *E. coli*

Table 62 ranks subwatersheds in the Otter Creek watershed according to *E. coli* load reduction needed to achieve water quality standards, from highest pollutant load reduction to least pollutant load reduction, with the associated flow regime (e.g., very high, higher, normal, lower, low).

Table 62. PPIA Ranking for Subwatersheds in the Otter Creek Watershed

PPIA Ranking	Subwatershed	Percent Load Reduction Needed	*E. coli* Load Reduction Needed	Associated Flow Category
1	Wastewaters Creek- Otter Creek	92.86	3.58E+12	Higher
2	Sulphur Creek	99.32	2.80E+12	Higher
3	North Branch Otter Creek	97.96	2.74E+12	Higher
4	Gundy Ditch	98.33	2.22E+12	Higher
5	Little Creek-North Branch Otter Creek	96.03	2.05E+12	Higher
6	Headwaters Otter Creek	98.33	1.92E+12	Higher

Understanding Table 62***:*** According to this table, Wastewaters Creek- Otter Creek has the highest PPIA ranking under higher flow conditions with a 92.86 percent load reduction needed for *E. coli*. Typically significant pollutant load reductions needed under high flow conditions are indicators of wet weather sources. Typically significant pollutant load reductions needed under low flow conditions are indicators of WWTP and other point sources with more constant discharges. Therefore, implementation activities for the highest ranked PPIAs in Table 62 should likely focus on wet weather sources.

Section 9 identifies recommended implementation activities for each subwatershed and shows the associated PPIA rankings. This information can be key to watershed organizations in the process of identifying and selecting critical areas and implementation activities for the purposes of watershed management plan development. While PPIAs are not intended to dictate those critical areas for watershed organizations; IDEM fully expects that watershed organizations will take the PPIA rankings into consideration when selecting critical areas for purposes of watershed management planning.

9.0 REASONABLE ASSURANCES/IMPLEMENTATION

This section of the Otter Creek watershed TMDL focuses on implementation activities that have the potential to achieve the WLAs and LAs presented in Section 8.1. The focus of this section is to identify and select the most appropriate structural and non-structural best management practices (BMPs) and control technologies to reduce *E. coli* loads from sources throughout the Otter Creek watershed, particularly in the PPIAs identified in Section 8.4. This section also addresses the programs that are available to facilitate implementation of structural and non-structural BMPs to achieve the allocations, as well as current activities in the Otter Creek watershed at the local level that will play a key role in successful TMDL implementation.

To select appropriate BMPs and control technologies, it is important to review the significant sources in the Otter Creek watershed.

<u>Point Sources</u>

- Regulated storm water sources
- Illicitly connected straight pipe systems

<u>Nonpoint Sources</u>

- Cropland
- Pastures and livestock operations
- CFOs and AFOs
- Streambank erosion
- Onsite wastewater treatment systems
- Wildlife/domestic pets
- Urban nonpoint source runoff

9.1 Implementation Activity Options for Sources in the Otter Creek Watershed

Keeping the list of significant sources in the Otter Creek watershed in mind, it is possible to review the types of BMPs that are most appropriate for the *E. coli* and the source type. Table 63 provides a list of implementation activities that are potentially suitable for the Otter Creek watershed based on the *E. coli* and the types of sources. The implementation activities are a combination of structural and non-structural BMPs to achieve the assigned WLAs and LAs. IDEM recognizes that actions taken in any individual subwatershed may depend on a number of factors (including socioeconomic, political and ecological factors). The recommendations in Table 63 are not intended to be prescriptive. Any number or combination of implementation activities might contribute to water quality improvement, whether applied at sites where the actual impairment was noted or other locations where sources contribute indirectly to the water quality impairment.

Table 63. List of Potentially Suitable BMPs for the Otter Creek Watershed

	Pollutant	Point Sources			Nonpoint Sources						
Implementation Activities	**Bacteria**	**WWTPs**	**Regulated Storm water Sources**	**Illicitly Connected "Straight Pipe" Systems**	**Cropland**	**Pastures and Livestock Operations**	**CFOs and AFOs**	**Streambank Erosion**	**Onsite Wastewater Treatment Systems**	**Wildlife/Domestic Pets**	**Urban NPS Runoff**
Disinfection of primary effluent - chlorination	X	X									
Disinfection of primary effluent - ozonation	X	X									
Disinfection of primary effluent – UV disinfection	X	X									
Biological nutrient removal		X									
Inspection and maintenance	X	X	X						X		
Outreach and education and training	X	X	X	X	X	X	X	X	X	X	X
System replacement	X			X					X		
Conservation tillage/residue management	X				X						
Cover crops	X				X			X			
Filter strips	X		X		X	X	X	X			
Grassed waterways	X				X		X	X			
Riparian forested/herbaceous buffers	X				X	X	X	X		X	X
Manure handling, storage, treatment, and disposal	X						X				
Composting	X		X								
Alternative watering systems	X					X	X	X			
Stream fencing (animal exclusion)	X					X		X			
Prescribed grazing	X					X		X			
Conservation easements	X										
Rain barrel			X								
Rain garden			X								
Street rain garden			X								
Block bioretention			X								
Regional bioretention			X								
Porous pavement			X								
Green roof			X								
Storm water planning and management	X	X	X					X	X	X	
Comprehensive Nutrient Management Plan	X				X		X				

	Pollutant	Point Sources			Nonpoint Sources						
Implementation Activities	**Bacteria**	**WWTPs**	**Regulated Storm water Sources**	**Illicitly Connected “Straight Pipe” Systems**	**Cropland**	**Pastures and Livestock Operations**	**CFOs and AFOs**	**Streambank Erosion**	**Onsite Wastewater Treatment Systems**	**Wildlife/Domestic Pets**	**Urban NPS Runoff**
Constructed Wetland	X	X		X	X					X	
Critical Area Planting						X		X			
Drainage Water Management					X						
Heavy Use Area Pad	X					X					
Nutrient Management Plan					X			X			
Terrace					X						
Land Reconstruction of Mined Land								X			
Pasture and Hay Planting	X				X	X	X	X		X	
Streambank Protection					X	X	X	X		X	
Conservation Crop Rotation					X	X	X				
Field Border	X				X	X	X			X	
Waste Treatment Lagoon	X					X	X				
Conservation Crop Rotation	X				X			X			

The information provided in Table 63 assisted in the development of Table 64, which provides a more refined suite of recommended implementation activities targeted to the PPIAs identified in Section 8.5.1.

Watershed stakeholders can use the implementation activities identified in Table 64 for each PPIA and select activities that are most feasible in the Otter Creek watershed. This table can also help watershed stakeholders to identify implementation activities for critical areas that they select through the watershed management planning process. The recommendations in Table 64 are not intended to be prescriptive. Any number or combination of implementation activities might contribute to water quality improvement, whether applied at sites where the actual impairment was noted or other locations where sources contribute indirectly to the water quality impairment.

Table 64. Recommended Implementation Activities by Subwatershed

Subwatershed	PPIA Rank	Potential Implementation Actions
Wastewaters Creek- Otter Creek	1	Outreach, education, and training
		Manure handling, storage, treatment, and disposal

Subwatershed	PPIA Rank	Potential Implementation Actions
		Comprehensive Nutrient Management Plan
		Storm water planning and management
		Conservation easements
Sulphur Creek	2	Outreach, education, and training
		Manure handling, storage, treatment, and disposal
		Comprehensive Nutrient Management Plan
		Storm water planning and management
		Grazing land management
North Branch Otter Creek	3	Outreach, education, and training
		Filter strips
		Septic System replacement
		Stream fencing (animal exclusion)
		Grazing land management
Gundy Ditch	4	Outreach, education, and training
		Storm water planning and management
		Septic System replacement
		Grassed waterways
		Stream fencing (animal exclusion)
Little Creek- North Branch Otter Creek	5	Outreach, education, and training
		Filter strips
		Septic System replacement
		Grassed waterways
		Stream fencing (animal exclusion)
Headwaters Otter Creek	6	Outreach, education, and training
		Filter strips
		Septic System replacement
		Stream fencing (animal exclusion)
		Grazing land management

9.2 Implementation Goals and Indicators

For each *E. coli* TMDL in the Otter Creek watershed, IDEM has identified broad goal statements and indicators. This information is to help watershed stakeholders determine how to track implementation progress over time and also provides the information necessary to complete a watershed management plan.

***E. coli* Goal Statement:** The AUIDs in the Otter Creek watershed should meet the 125 counts/100 mL (geometric mean) TMDL target value.

***E. coli* Indicator:** Water quality monitoring will serve as the environmental indicator to determine progress toward the *E. coli* target value.

9.3 Summary of Programs

There are a number of federal, state, and local programs that either require or can assist with the implementation activities recommended for the Otter Creek watershed in Table 63 and Table 64. 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 Otter Creek watershed.

9.3.1 Federal Programs

9.3.1.1 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 NPS pollution. The Watershed Planning and Restoration Section within the Watershed Assessment and Planning Branch of the Office of Water Quality provides for the administration of the Section 319 funding source for the NPS-related projects.

USEPA offers Clean Water Act Section 319(h) grant moneys 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 BMP demonstrations, watershed water quality improvements, 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.

9.3.1.2 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, non-profit organizations, universities, private associations, and individuals are not eligible for funding through Section 205(j). The act 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 non-point 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.

9.3.1.3 USDA's Conservation of Private Grazing Land Initiative (CPGL)

The Conservation of Private Grazing Land initiative will ensure that technical, educational, and related assistance is provided to those who own private grazing lands. It is not a cost-share program. This technical assistance will offer opportunities for: better grazing land management; protecting soil from erosive wind and water; using more energy efficient ways to produce food and fiber; conserving water; providing habitat for wildlife; sustaining forage and grazing plants; using plants to sequester greenhouse gases and increase soil organic matter; and using grazing lands as a source of biomass energy and raw materials for industrial products.

9.3.1.4 USDA's Conservation Reserve Program (CRP)

NRCS provides technical assistance to landowners interested in participating in the Conservation Reserve Program 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.

9.3.1.5 USDA's 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.

9.3.1.6 USDA's 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.

9.3.1.7 USDA's Small Watershed Program and Flood Prevention Program (WF 08 or FP 03)

The Small Watershed Program works through local government sponsors and helps participants solve natural resource and related economic problems on a watershed basis. Projects include watershed protection, flood prevention, erosion and sediment control, water supply, water quality, fish and wildlife habitat enhancement, wetlands creation and restoration, and public recreation in watersheds of 250,000 or fewer acres. Both technical and financial assistance are available.

9.3.1.8 USDA's 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.

9.3.1.9 USDA's Wetlands Reserve Program (WRP)

The Wetlands Reserve Program is a voluntary program to restore wetlands. Participating landowners can establish conservation easements of either permanent or 30 year duration, or can enter into restoration cost-share agreements where no easement is involved. In exchange for establishing a permanent easement, the landowner receives payment up to the agricultural value of the land and 100 percent of the restoration costs for restoring the wetlands. The 30 year easement payment is 75 percent of what would be provided for a permanent easement on the same site and 75 percent of the restoration cost. The voluntary agreements are for minimum 10 year duration and provide for 75 percent of the cost of restoring the involved wetlands. Easements and restoration cost-share agreements establish wetland protection and restoration as the primary land use for the duration of the easement or agreement. In all instances, landowners continue to control access to their land.

9.3.1.10 USDA's Wildlife Habitat Incentives Program (WHIP)

The Wildlife Habitat Incentives Program 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.

9.3.2 State Programs

9.3.2.1 State Point Source Control Program

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. NPDES permit requirements ensure that the minimum amount of control is imposed upon any new or existing point source through the application of technology-based treatment requirements. Control of discharges from WWTPs, industrial facilities and CSOs consistent with WLAs is implemented through the NPDES program.

MS4s are, in general, public storm sewer systems (including roads with drainage systems and municipal streets) that are owned or operated by a public body and not part of a combined sewer (i.e., storm and sanitary sewers combined). MS4s can be significant sources of *E. coli* because they transport urban runoff that can be affected by pet waste, illicit sewer connections, failing septic systems,. Large and medium MS4s serve populations of more than 100,000 people. Regulated small MS4s are identified according to the U.S. Census Bureau definition of urbanized area as established every 10 years in its decennial census. Populations served by these regulated small MS4s range from several hundred to tens of thousands of people, but in most instances these systems serve fewer than about 30,000–50,000 people.

The Storm water and Sediment Control Program works primarily with developers, contractors, realtors, property holders and others to address erosion and sediment concerns on non-agricultural lands, especially those undergoing development.

9.3.2.2 State 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 USEPA, with USEPA reserving the right to make final changes to the list. Actual funding depends on approval from USEPA 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.

Hoosier Riverwatch, administered by the IDEM Watershed Assessment and Planning Branch, is a water quality monitoring initiative which aims to increase public awareness of water quality issues and concerns through hands-on training of volunteers in-stream monitoring and cleanup activities. Hoosier Riverwatch 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.

9.3.2.3 Indiana State Department of Agriculture Division of Soil Conservation

The 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.

The Division administers the Clean Water Indiana soil conservation and water quality protection program under guidelines established by the State Soil Conservation Board, primarily through the local SWCDs in direct service to landusers. The Division staff includes field-based resource specialists who work closely with landusers, assisting in the selection, design, and installation of practices to reduce soil erosion on agricultural land.

9.3.2.4 Indiana Department of Natural Resources, Division of Fish and Wildlife

The Lake and River Enhancement (LARE) program utilizes a watershed approach to reduce nonpoint source sediment and nutrient pollution of Indiana's and adjacent states' surface waters to a level that meets or surpasses state water quality standards. To accomplish this goal, LARE provides technical and financial assistance to local entities for qualifying projects that improve and maintain water quality in public access lakes, rivers, and streams.

The Healthy River Initiative is the largest land conservation initiative to be undertaken in Indiana. The goal is to permanently protect over 43,000 acres located in the floodplain of the Wabash River and Sugar Creek in west-central Indiana. Projects involve the protection, restoration and enhancement of riparian and aquatic habitats and the species that use them, particularly threatened, endangered, migratory birds and waterfowl. The western edge of the Otter Creek Watershed lies in Wabash Zone three and is eligible for these funds.

9.3.2.5 State Revolving Fund (SRF) Loan Program

The SRF is a fixed rate, 20-year loan administered by the Indiana Finance Authority. 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 non-point source projects that are tied to a wastewater loan. Any project where there is an existing pollution abatement need is eligible for SRF funding.

9.3.3 Local Programs

Programs taking place at the local level are key to successful TMDL implementation. Partners such as Clay, Parke, and Vigo County SWCD offices are instrumental to bringing grant funding into the Otter Creek watershed to support local protection and restoration projects. This section provides a brief summary of the local programs taking place in the Otter Creek watershed that will help to reduce *E. coli* loads, as well as provide ancillary benefits to the Otter Creek watershed.

Clay County:
Clay County received the following funding to improve water quality in 2011:

- Local: $55,745
- Clean Water Indiana: $17,000
- Conservation Reserve Program: $453,256
- Environmental Quality Incentives Program: $189,375
- Wildlife Habitat Incentive Program: $2,127

Clay County SWCD has been doing private drinking well sampling. The houses that return positive for *E. coli* are looked into for problems. This will reduce the amount of failing septic systems throughout the watershed, by making it a known drinking water problem.

Parke County:
Parke County received the following funding to improve water quality in 2011:

- Local: $35,950
- Clean Water Indiana: $15,470
- Conservation Reserve Program: $800,669
- Environmental Quality Incentives Program: $59,338
- Wildlife Habitat Incentive Program: $3,338
- Wetland Reserve Program: $322,775

Vigo County:
Vigo County received the following funding to improve water quality in 2011:

- Local: $101,392
- Clean Water Indiana: $16,250
- Conservation Reserve Program: $145,397
- Environmental Quality Incentives Program: $109,540
- Wildlife Habitat Incentive Program: $13,595
- Wetland Reserve Program: $1,569,907

All Vigo County fifth grade students attend the annual Conservation Field Days at the Vigo County fairgrounds. Two schools Terre Town and Rio Grande Elementary are in the Otter Creek Watershed. Students visiting the Field Day event participate in twenty discussions including erosion and sedimentation, water quality, waste management, watersheds, and many other environmental topics.

9.4 Implementation Programs by Source

Section 9.3 identified a number of federal, state, and local programs that can support implementation of the recommended management or restoration activities for the Otter Creek watershed (Table 65). Table

65 and the following sections identify which programs are relevant to the various sources in the Otter Creek watershed.

Table 65. Summary of Programs Relevant to Sources in the Otter Creek Watershed

Source	State NPDES program	Local agencies/programs	Section 319 program	Section 205(j) program	ISDA Division of Soil Conservation	IDNR Division of Fish and Wildlife	USDA's Conservation of Private Grazing Land Initiative	USDA's Conservation Reserve Program	USDA's Conservation Technical Assistance	USDA's Environmental Quality Incentives Program	USDA's Small Watershed Program and Flood Prevention Program	USDA's Watershed Surveys and Planning	USDA's Wetlands Reserve Program	USDA's Wildlife Habitat Incentives Program
WWTPs and Industrial Facilities	X													
Regulated Storm water Sources	X													
Illicitly Connected "Straight Pipe" Systems	X	X												
Cropland		X	X	X	X	X		X	X	X	X	X	X	
Pastures and Livestock Operations		X	X	X	X	X	X	X	X	X	X	X		
CFOs	X					X								
Streambank Erosion		X	X	X	X	X	X		X	X	X	X		
Onsite Wastewater Treatment Systems		X												
Wildlife/Domestic Pets	X	X	X											
In-stream Habitat	X	X	X											X

9.4.1 Point Source Programs

9.4.1.1 WWTPs

Discharges from WWTPs are regulated under the NPDES program, with permits that authorize the discharge of substances at levels that meet the more stringent of technology- or water quality-based effluent limits. The NPDES program provides IDEM the authority to ensure that recommended effluent limits are applied to the appropriate permit holders within the watershed.

9.4.1.2 Industrial facilities

As with discharges from WWTPs, industrial discharges are regulated under the NPDES program, with permits that authorize the discharge of substances at levels that meet the more stringent of technology- or water quality-based effluent limits. The NPDES program provides IDEM the authority to ensure that recommended effluent limits are applied to the appropriate permit holders within the watershed.

9.4.1.3 Regulated storm water sources

Regulated MS4s are required to obtain permit covered under IDEM's MS4 general permit that requires a storm water management program (SWMP) to address six minimum control measures. There is one county wide MS4 in the Otter Creek watershed that has coverage under IDEM's MS4 general permit. The SWMPs for each of these MS4s describes best management practices implemented to fulfill the six minimum control measure requirements. The MS4 permitted towns of Seelyville and North Terre Haute seek to reduce storm water by implementing many BMPs. These include, construction site storm water runoff control measures, develop and implement a training program for construction plan reviewers, inspectors, and contractors. They also plan to develop a post construction storm water pollution prevention plan (SWPPPs). Other BMPs include public outreach, community cleanup days, street sweeping, storm water system maintenance, outfall scouring remediation, proper material storage, spill prevention and response, proper vehicle maintenance, as well as flood management projects.

9.4.1.4 Illegal straight pipes

Local health departments are responsible for locating and eliminating illicit discharges and illegal connections to the sewer system.

9.4.2 Nonpoint Sources Programs

9.4.2.1 Cropland

Nonpoint source pollution from cropland areas is typically reduced through the voluntary implementation of BMPs by private landowners. Programs available to support implementation of cropland BMPs, whether through cost-share or technical assistance and education, include:

- Clean Water Act Section 319 program
- Indiana Department of Natural Resources Division of Fish and Wildlife (LARE)
- Indiana State Department of Agriculture Division of Soil Conservation/SWCDs
- USDA's Conservation Reserve Program (CRP)
- USDA's Conservation Technical Assistance (CTA)
- USDA's Environmental Quality Incentives Program (EQIP)
- USDA's Small Watershed Program and Flood Prevention Program (WF 08 or FP 03)
- USDA's Watershed Surveys and Planning
- USDA's Wetlands Reserve Program (WRP)
- USDA's Wildlife Habitat Incentives Program (WHIP)

9.4.2.2 Pastures and livestock operations

Nonpoint source pollution from pasture and livestock areas is typically reduced through the voluntary implementation of BMPs by private landowners. Programs available to support implementation of pasture and grazing BMPs, whether through cost-share or technical assistance and education, include:

- Clean Water Act Section 319 program
- Indiana Department of Natural Resources Division of Fish and Wildlife (LARE)
- Indiana State Department of Agriculture Division of Soil Conservation/SWCDs
- USDA's Conservation of Private Grazing Land Initiative (CPGL)
- USDA's Conservation Reserve Program (CRP)

- USDA's Conservation Technical Assistance (CTA)
- USDA's Environmental Quality Incentives Program (EQIP)
- USDA's Small Watershed Program and Flood Prevention Program (WF 08 or FP 03)
- USDA's Watershed Surveys and Planning
- USDA's Wildlife Habitat Incentives Program (WHIP)

9.4.2.3 CFOs

While CAFOs are regulated by federal law, CFOs are not. However, Indiana has CFO regulations 327 IAC 16, 327 IAC 15 that require that operations manage manure, litter, and process wastewater in a manner that "does not cause or contribute to an impairment of surface waters of the state." IDEM regulates CFOs under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 16, which implement the statute regulating CFOs, were effective on March 10, 2002. IDEM's Office of Land Quality administers the regulatory program, which includes permitting, compliance monitoring and enforcement activities.

9.4.2.4 Streambank erosion

Streambank erosion can be the result of changes in the physical structure of the immediate bank from activities such as removal of riparian vegetation or frequent use by livestock, or it can be the result of increased flow volumes and velocities resulting from increased surface runoff throughout the upstream watershed. Therefore, streambank erosion might be addressed through BMPs and restoration targeted to the specific stream reach, and further degradation could be addressed through the use of BMPs implemented to address storm water issues throughout the watershed. Programs available to support implementation of BMPs to address streambank erosion, whether through cost-share or technical assistance and education, include:

- Clean Water Act Section 319 program
- Indiana Department of Natural Resources Division of Soil Conservation
- USDA's Conservation Technical Assistance (CTA)
- USDA's Environmental Quality Incentives Program (EQIP)
- USDA's Small Watershed Program and Flood Prevention Program (WF 08 or FP 03)
- USDA's Watershed Surveys and Planning
- USDA's Wildlife Habitat Incentives Program (WHIP)

9.4.2.5 Onsite wastewater treatment systems

Indiana State Department of Health (ISDH) Rule 410 IAC 6-82 outlines regulations for septic systems, including a series of regulatory constraints on the location and design of current septic systems in an effort to prevent system failures. The rule prohibits failing systems, requiring that:

- No system will contaminate ground water.
- No system will discharge untreated effluent to the surface.

Vigo County follows the Indiana Administrative Code (RULE 410 IAC 6-8.2), with regards to septic systems along with local ordinances. Upon a received complaint in Vigo County the Health Inspector will visit and determine if a violation exists and will notify the occupant in writing of the violation. The occupant has 10 days to respond and indicate how the violation will be fixed. Fees can be assessed in the following order: Any person found to be violating any provision of this ordinance shall be punished for the first offense by a fine of two hundred dollars ($200.00); for the second offense by a fine of not more than five hundred dollars ($500.00); and for the third and each subsequent offense by a fine of not more than one thousand dollars ($1,000.00). Each day after the expiration of the time limit for abating unsanitary conditions and completing improvements as ordered by the Vigo County Health Department (VCHD), or by the duly appointed Health Officer of the County, shall constitute a distinct and separate offense.

Parke County follows the Indiana Administrative Code (RULE 410 IAC 6-8.2). The county has some fines set up $100-$1000 for septic violations. The health department staffs have had better success in the past working with landowners to get violations fixed, and explaining to them the benefits of a properly functioning septic system rather than assessing fines right away.

Clay County follows the Indiana Administrative Code (RULE 410 IAC 6-8.2), no additional information was provided.

9.4.2.6 Wildlife/domestic pets

Addressing pollutant contributions from wildlife and domestic pets is typically done at the local level through education and outreach efforts. For wildlife, educational programs focus on proper maintenance of riparian areas and discouraging the public from feeding wildlife. For domestic pets, education programs focus on responsible pet waste maintenance (e.g., scoop the poop campaigns) coupled with local ordinances.

9.5 Potential Implementation Partners and Technical Assistance Resources

Agencies and organizations at the federal, state, and local levels will play a critical role in implementation to achieve the WLAs and LAs assigned under this TMDL. Table 66 identifies key potential implementation partners and the type of technical assistance they can provide to watershed stakeholders.

Table 66. Potential Implementation Partners in the Otter Creek Watershed

Potential Implementation Partner	Funding and Assistance Type
Federal	
IDEM	Section 319 program grants
IDEM	Section 205(j) program grants
USDA	Conservation of Private Grazing Land Initiative (technical and education assistance only)
USDA	Conservation Reserve Program
USDA	Conservation Technical Assistance (technical assistance only)
USDA	Environmental Quality Incentives Program
USDA	Small Watershed Program and Flood Prevention Program
USDA	Watershed Surveys and Planning
USDA	Wetlands Reserve Program
USDA	Wildlife Habitat Incentives Program
State	
ISDA	Division of Soil Conservation soil and water conservation districts
IDNR	Division of Fish and Wildlife Lake and River Enhancement program

Potential Implementation Partner	Funding and Assistance Type
Local	
Indiana State University	Technical Assistance and Student Volunteers
Rose- Hulman	Technical Assistance and Student Volunteers
The Nature Conservancy	Technical Assistance
Izaac Walton League	Volunteers
County Health Departments	Technical Assistance and Volunteers
Vigo County Conservation Club	Volunteers
West Central Indiana Economic Development District	Technical Assistance and Volunteers
Wabash Valley Audubon	Technical Assistance and Volunteers

IDEM has compiled a matrix of public and private grants and other funding resources available to fund watershed implementation activities. The matrix is available on IDEM's website at http://www.in.gov/idem/nps/3439.htm .

10.0 PUBLIC PARTICIPATION

Public participation is an important and required component of the TMDL development process. The following public meetings were held in the watershed to discuss this project:

- A Kickoff public meeting was held in Terre Haute on January 17, 2013. IDEM explained the TMDL process during these meeting, presented initial information regarding the Otter Creek watershed, and answered questions from the public. Information was also solicited from stakeholders in the area.
- A Draft TMDL public meeting was held in Terre Haute on June 4, 2013. The draft findings of the TMDL will be presented at this meeting and the public will have the opportunity ask questions and provide information to be included in the final TMDL report. A public comment period was from June 4, 2013- July 4, 2013.

Appendix A: *E.coli* data for Otter Creek Watershed

Site #	Project ID	L-Site #	Stream Name	Description	Sample #	Sample Date	E.coli (MPN/100mL)	Geometric Mean
1	2009 Otter Creek TMDL	WBU030-0084	Otter Creek	Hendrix Ave	AA57279	4/28/2009	2419.6	283.6
					AA57300	5/5/2009	103.1	
					AA57321	5/12/2009	238.2	
					AA57342	5/19/2009	185	
					AA57363	5/27/2009	167	
2	2009 Otter Creek TMDL	WBU030-0080	Waterworks Creek	Kennedy Crossing	AA57281	4/28/2009	2419.6	276.7
					AA57302	5/5/2009	77.1	
					AA57323	5/12/2009	151.5	
					AA57324	5/19/2009	248.9	
					AA57365	5/27/2009	344.8	
3	2009 Otter Creek TMDL	WBU030-0079	Otter Creek	CR 1025 N	AA57282	4/28/2009	2419.6	339.7
					AA57303	5/5/2009	238.2	
					AA57325	5/12/2009	156.5	
					AA57346	5/19/2009	290.9	
					AA57366	5/27/2009	172.3	
4	2009 Otter Creek TMDL	WBU030-0078	Otter Creek	35 North Rd	AA57283	4/28/2009	2419.6	304.5
					AA57304	5/5/2009	214.3	
					AA57326	5/12/2009	142.1	
					AA57347	5/19/2009	206.4	
					AA57367	5/27/2009	172.2	
5	2009 Otter Creek TMDL	WBU030-0077	Otter Creek	Miami Gardens St	AA57284	4/28/2009	2419.6	293.3
					AA57305	5/5/2009	172.2	
					AA57327	5/12/2009	131.7	
					AA57348	5/19/2009	151.5	
					AA57368	5/27/2009	261.3	

Appendix A: *E.coli* data for Otter Creek Watershed

Site #	Project ID	L-Site #	Stream Name	Description	Sample #	Sample Date	E.coli (MPN/100mL)	Geometric Mean
6	2009 Otter Creek TMDL	WBU030-0014	No End Creek	Grotto Rd	AA57285	4/28/2009	1299.7	75.4
					AA57306	5/5/2009	25.9	
					AA57328	5/12/2009	45	
					AA57349	5/19/2009	17.3	
					AA57369	5/27/2009	93.3	
7	2009 Otter Creek TMDL	WBU030-0016	Sulphur Creek	Main St	AA57286	4/28/2009	2419.6	381.4
					AA57307	5/5/2009	206.4	
					AA57329	5/12/2009	143.9	
					AA57350	5/19/2009	325.5	
					AA57370	5/27/2009	344.8	
8	2009 Otter Creek TMDL	WBU030-0012	Sulphur Creek	Roberts Rd	AA57287	4/28/2009	2419.6	314.6
					AA57308	5/5/2009	178.5	
					AA57330	5/12/2009	193.5	
					AA57351	5/19/2009	119.8	
					AA57371	5/27/2009	307.6	
9	2009 Otter Creek TMDL	WBU030-0076	North Branch Otter Creek	Hayne Rd	AA57288	4/28/2009	2419.6	262.6
					AA57309	5/5/2009	160.7	
					AA57331	5/12/2009	186	
					AA57352	5/19/2009	125.4	
					AA57372	5/27/2009	137.6	
10	2009 Otter Creek TMDL	WBU030-0001	Otter Creek	Rosedale Rd	AA57289	4/28/2009	2419.6	291.1
					AA57310	5/5/2009	167	
					AA57332	5/12/2009	209.8	
					AA57353	5/19/2009	127.4	
					AA57373	5/27/2009	193.5	

Appendix A: *E.coli* data for Otter Creek Watershed

Site #	Project ID	L-Site #	Stream Name	Description	Sample #	Sample Date	E.coli (MPN/100mL)	Geometric Mean
11	2009 Otter Creek TMDL	WBU030-0011	Gundy Ditch	CR 21 E	AA57290	4/28/2009	2419.6	378.3
					AA57311	5/5/2009	172.3	
					AA57333	5/12/2009	172.2	
					AA57354	5/19/2009	313	
					AA57374	5/27/2009	344.8	
12	2009 Otter Creek TMDL	WBU030-0072	Otter Creek	Hasselburger Ave	AA57292	4/28/2009	1413.6	261.7
					AA57312	5/5/2009	178.5	
					AA57334	5/12/2009	166.4	
					AA57355	5/19/2009	131.4	
					AA57375	5/27/2009	222.4	
13	2009 Otter Creek TMDL	WBU030-0073	Unamed Trib to Gundy Ditch	Rosehill Rd	AA57293	4/28/2009	2419.6	804.6
					AA57313	5/5/2009	579.4	
					AA57335	5/12/2009	1203.3	
					AA57356	5/19/2009	259.5	
					AA57376	5/27/2009	770.1	
14	2009 Otter Creek TMDL	WBU030-0074	Gundy Ditch	Rosedale Rd	AA57294	4/28/2009	2419.6	197.2
					AA57315	5/5/2009	81.6	
					AA57336	5/12/2009	108.1	
					AA57357	5/19/2009	56.3	
					AA57377	5/27/2009	248.1	
15	2009 Otter Creek TMDL	WBU030-0075	Swope Ditch		AA57295	4/28/2009	2419.6	155.0
					AA57316	5/5/2009	48	
					AA57337	5/12/2009	43.5	
					AA57358	5/19/2009	98.7	
					AA57378	5/27/2009	179.3	

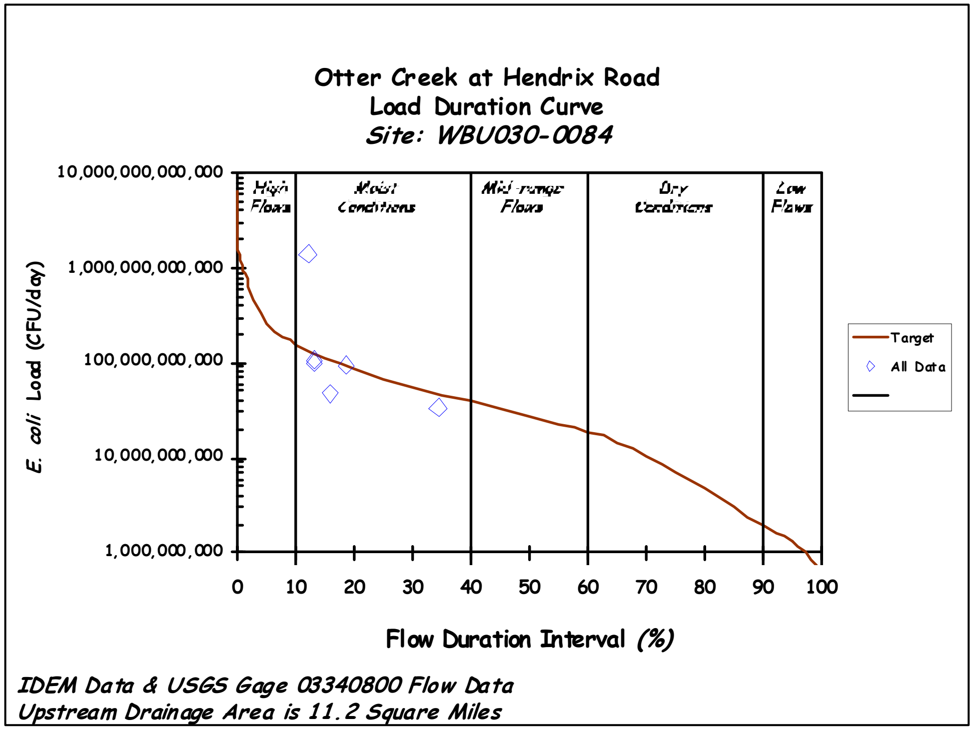
Appendix A: *E.coli* data for Otter Creek Watershed

Site #	Project ID	L-Site #	Stream Name	Description	Sample #	Sample Date	E.coli (MPN/100mL)	Geometric Mean
16	2009 Otter Creek TMDL	WBU030-0081	North Branch Otter Creek	BlueJay Rd	AA57296	4/28/2009	2419.6	246.6
					AA57314	5/5/2009	107.1	
					AA57338	5/12/2009	193.5	
					AA57359	5/19/2009	108.6	
					AA57379	5/27/2009	224.7	
17	2009 Otter Creek TMDL	WBU030-0082	North Branch Otter Creek	Rosedale Rd	AA57297	4/28/2009	2419.6	217.9
					AA57318	5/5/2009	107.1	
					AA57339	5/12/2009	81.6	
					AA57360	5/19/2009	115.3	
					AA57380	5/27/2009	201.4	
18	2009 Otter Creek TMDL	WBU030-0050	North Branch Otter Creek	700 E	AA57298	4/28/2009	2419.6	96.5
					AA57319	5/5/2009	34.1	
					AA57340	5/12/2009	35.5	
					AA57361	5/19/2009	44.3	
					AA57382	5/27/2009	64.4	
19	2009 Otter Creek TMDL	WBU030-0052	Ebenezer Ditch	CR 1500 N	AA57299	4/28/2009	2419.6	149.3
					AA57320	5/5/2009	68.3	
					AA57341	5/12/2009	52.9	
					AA57362	5/19/2009	62.7	
					AA57383	5/27/2009	135.4	

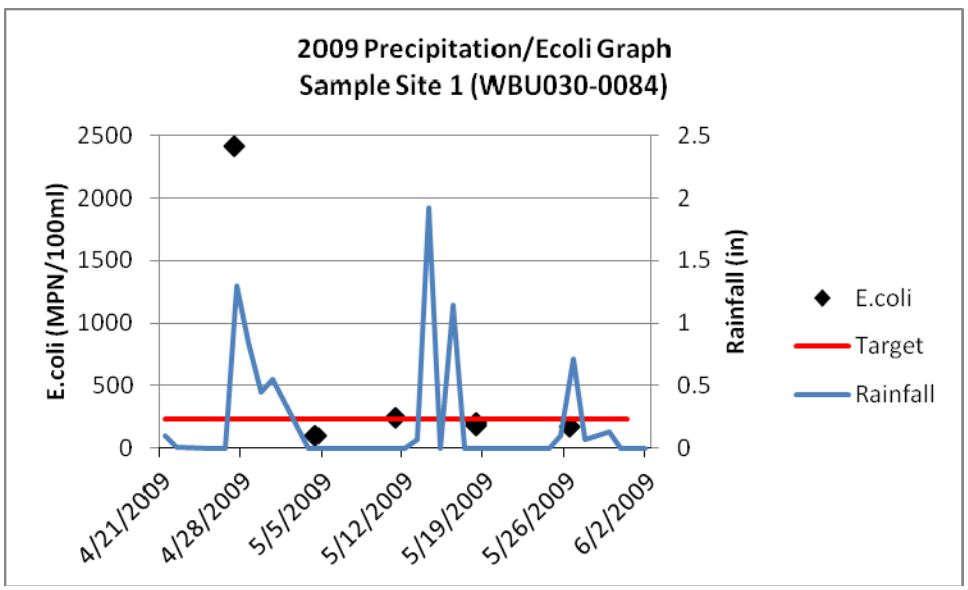
12 HUC	2010 AUID	2012 AUID	Project ID	L-Site #	Stream Name	Description	Sample #	Date	E.coli (MPN/100mL)	GEOMEAN	Notes	Ecoli
51201110401	INB1132_T1021	INB1141_01	2009 Otter Creek TMDL	WBU030-0084	Otter Creek	Hendrix Ave	AA57279	4/28/2009	2419.6	283.64	Landuse is homogeneous, row crop ag, with forested buffers. Potential Sources: Urban runoff from Brazil, CFO application and septic issues are all impacting impairment. WBU030-0079 is also used for this watershed's assessment.	NS
							AA57300	5/5/2009	103.1			
							AA57321	5/12/2009	238.2			
							AA57342	5/19/2009	185			
							AA57343	5/19/2009	201.4			
							AA57363	5/27/2009	167			
			2009 Otter Creek TMDL	WBU030-0079	Otter Creek	CR 1025 N	AA57282	4/28/2009	2419.6	339.66	Landuse is homogeneous, row crop ag with some forested buffers. Potential Sources: Urban runoff from Brazil, CFO manure land application, failing septics may also be contributing. WBU030-0084 is also used for this watershed, impairment increses from upstream	NS
							AA57303	5/5/2009	238.2			
							AA57325	5/12/2009	156.5			
							AA57346	5/19/2009	290.9			
							AA57366	5/27/2009	172.3			
51201110402		INB1142_01	2009 Otter Creek TMDL	WBU030-0081	North Branch Otter Creek	BlueJay Rd	AA57296	4/28/2009	2419.6	246.59	Main stem impairment upstream of this site is increased which suggest inputs of tributaries between the sites . Carbon WWTP may be a source of impairment along with row crop agriculture and failing septics.	NS
							AA57314	5/5/2009	107.1			
							AA57317	5/5/2009	79.8			
							AA57338	5/12/2009	193.5			
							AA57359	5/19/2009	108.6			
							AA57379	5/27/2009	224.7			
			2009 Otter Creek TMDL	WBU030-0082	North Branch Otter Creek	Rosedale Rd	AA57297	4/28/2009	2419.6	217.88	Main stem impairment between this site and WBU030-0050 is doubled which suggest inputs of tributaries between the sites. Carbon WWTP may be a source of impairment along with row crop agriculture and failing septics.	NS
							AA57318	5/5/2009	107.1			
							AA57339	5/12/2009	81.6			
							AA57360	5/19/2009	115.3			
							AA57380	5/27/2009	201.4			
							AA57381	5/27/2009	270			
			2009 Otter Creek TMDL	WBU030-0050	North Branch Otter Creek	700 E	AA57298	4/28/2009	2419.6	96.47	Headwaters are likely not impaired however larger assesmnet unit of downstream data show entire unit is impaired based on impairment.	FS
							AA57319	5/5/2009	34.1			
							AA57340	5/12/2009	35.5			
							AA57361	5/19/2009	44.3			
							AA57382	5/27/2009	64.4			
		INB1142_01A	2009 Otter Creek TMDL		North Branch Otter Creek- Unamed Tributary						Main stem impairment between WBU030-0082 and WBU030-0081 increases which suggest inputs of tributaries between the sites is also impaired. Carbon WWTP may be a source of impairment along with row crop agriculture.	NS
		INB1142_01B	2009 Otter Creek TMDL		North Branch Otter Creek- Unamed Tributary						Main stem impairment between WBU030-0082 and WBU030-0081 increases which suggest inputs of tributaries between the sites is also impaired. Carbon WWTP may be a source of impairment along with row crop agriculture.	NS
		INB1142_01C	2009 Otter Creek TMDL		North Branch Otter Creek- Unamed Tributary						Main stem impairment between WBU030-0082 and WBU030-0081 increases which suggest inputs of tributaries between the sites is also impaired. Carbon WWTP may be a source of impairment along with row crop agriculture.	NS
	INB1134_T1003	INB1142_T1001	2009 Otter Creek TMDL	WBU030-0052		CR 1500 N	AA57299	4/28/2009	2419.6	149.31	Headwaters are likely impaired due to row crop ag as well as Carbon WWTP located on Ebenezer Creek. Potential Sources: Urban runoff from Carbon , CFO manure land application, failing septics may also be contributing.	NS
							AA57320	5/5/2009	68.3			
							AA57341	5/12/2009	52.9			
							AA57362	5/19/2009	62.7			

					Ebenezer Creek		AA57383	5/27/2009	135.4			
	INB1134_T1004	INB1142_T1002	2009 Otter Creek TMDL		Branch Cut Creek						No data	
	INB1134_02	INB1142_T1003	2009 Otter Creek TMDL		Orchard Run						Impaired based on 2012 list	NS
	INB1134_T1006	INB1142_T1004	2009 Otter Creek TMDL		Diamond Creek						Main stem impairment between WBU030-0082 and WBU030-	NS
	INB1134_02	INB1142_T1005	2009 Otter Creek TMDL		Green Brook - Blue Brook						Impaired based on 2012 list	NS
51201110403	INB1135_02	INB1143_01	2009 Otter Creek TMDL	WBU030-0076	North Branch Otter Creek	Hayne Rd	AA57288	4/28/2009	2419.6	262.57	Main stem impairment between WBU030-0081 and WBU030-0076 increases which suggest inputs of tributaries between the sites are also impaired. Small communiteis unsewered may be an input. Fontanet, Barnett. Along with row crop ag.	NS
	INB1135_T1004						AA57309	5/5/2009	160.7			
	INB1135_T1005						AA57331	5/12/2009	186			
	INB1135_T1006						AA57352	5/19/2009	125.4			
							AA57372	5/27/2009	137.6			
	INB1135_T1001	INB1143_T001	2009 Otter Creek TMDL		Little Creek						Previously Impaired will remain impaired	
	INB1135_T1001A	INB1143_T001A	2009 Otter Creek TMDL		Little Creek- Unamed Tributary						0076 increases which suggest inputs of tributaries between the sites are also impaired, will be impaired due to similar landuse in area and septic inputs as well as row crop ag	NS
	INB1135_T1003	INB1143_T1002	2009 Otter Creek TMDL		Little Creek- Unamed Tributary						Main stem impairment between WBU030-0081 and WBU030-0076 increases which suggest inputs of tributaries between the sites are also impaired	NS
51201110404	INB1136_00	INB1144_01	2009 Otter Creek TMDL	WBU030-0016	Sulphur Creek	Main St	AA57286	4/28/2009	2419.6	381.35	Impairment is maintained throughout mainstem. Unsewered small communiteis Septic may be an input. Fontanet, Barnett. Row crop ag may be an input Staunton WWTP, CFO	NS
							AA57307	5/5/2009	206.4			
							AA57329	5/12/2009	143.9			
							AA57350	5/19/2009	325.5			
							AA57370	5/27/2009	344.8			
			2009 Otter Creek TMDL	WBU030-0012	Sulphur Creek	Roberts Rd	AA57287	4/28/2009	2419.6	314.56	Impairment decreases slightly from upstream sampling. This could be attributed to low inputs from no end creek, Unsewered small communiteis Septic may be an input frim Seelyville and Staunton. Row crop ag may be an input from CFO land application	NS
							AA57308	5/5/2009	178.5			
							AA57330	5/12/2009	193.5			
							AA57351	5/19/2009	119.8			
							AA57371	5/27/2009	307.6			
	INB1136_T1033	INB1144_T1001	2009 Otter Creek TMDL								0012 is maintained which suggest inputs of tributaries between	NS
		INB1144_T1001A	2009 Otter Creek TMDL								0076 is maintained which suggest inputs of tributaries between the sites are also impaired. Staunton WWTP	NS
	INB1136_00	INB1144_T1002	2009 Otter Creek TMDL	WBU030-0014	No End Creek	Grotto Rd	AA57285	4/28/2009	1299.7	75.45	Not impaired, could be due to reclaimed mined area strip pits	FS
							AA57306	5/5/2009	25.9			
							AA57328	5/12/2009	45			
							AA57349	5/19/2009	17.3			
							AA57369	5/27/2009	93.3			
51201110405	INB1137_00	INB1145_01	2009 Otter Creek TMDL	WBU030-0074	Gundy Ditch	Rosedale Rd	AA57294	4/28/2009	2419.6	197.19	Headwaters is dominated by row crop ag. This is a regulated ditch by Vigo County draining 2030 acres.	NS
							AA57315	5/5/2009	81.6			
							AA57336	5/12/2009	108.1			
							AA57357	5/19/2009	56.3			
							AA57377	5/27/2009	248.1			
			2009 Otter Creek TMDL	WBU030-0011	Gundy Ditch	CR 21 E- Grant Ave	AA57290	4/28/2009	2419.6	378.30	Headwaters is dominated by row crop ag. The lower reach does include small communities on septics. This is a regulated ditch by Vigo County. The impairment increases in the downstream significantly.	NS
							AA57291	4/28/2009	2419.6			
							AA57311	5/5/2009	172.3			
							AA57333	5/12/2009	172.2			
							AA57354	5/19/2009	313			
							AA57374	5/27/2009	344.8			

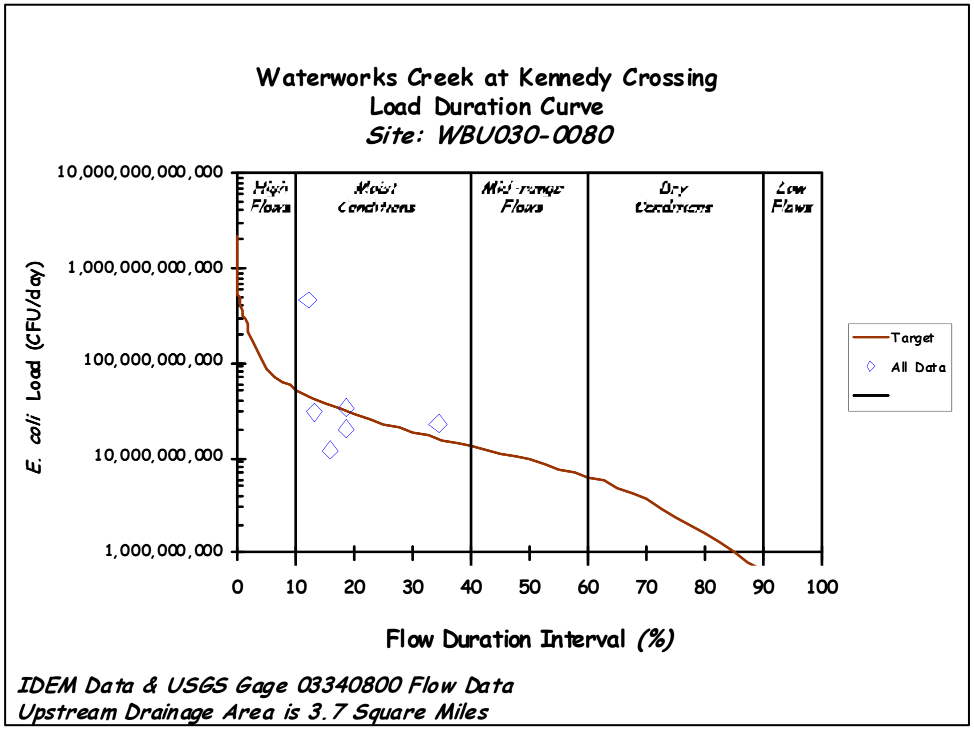
	INB1137_00	INB1145_T1001	2009 Otter Creek TMDL	WBU030-0075	Swope Ditch	Joppa Rd	AA57295	4/28/2009	2419.6	154.98	Headwaters is dominated by row crop ag. This is a regulated ditch by Vigo County draining 2400 acres.	NS
							AA57316	5/5/2009	48			
							AA57337	5/12/2009	43.5			
							AA57358	5/19/2009	98.7			
							AA57378	5/27/2009	179.3			
	INB1137_00	INB1145_T1002	2009 Otter Creek TMDL	WBU030-0073	Unamed Trib to Gundy Ditch	Rosehill Rd	AA57293	4/28/2009	2419.6	804.56	Headwaters is predominetly ag. The lower reaches have small communities with unregulated sewers.	NS
							AA57313	5/5/2009	579.4			
							AA57335	5/12/2009	1203.3			
							AA57356	5/19/2009	259.5			
							AA57376	5/27/2009	770.1			
51201110406		INB1146_01	2009 Otter Creek TMDL	WBU030-0078	Otter Creek	35 North Road	AA57283	4/28/2009	2419.6	304.52	Impairment increases in the downstream. Landuse is ag with forested buffers.	NS
							AA57304	5/5/2009	214.3			
							AA57326	5/12/2009	142.1			
							AA57347	5/19/2009	206.4			
							AA57367	5/27/2009	172.2			
			2009 Otter Creek TMDL	WBU030-0077	Otter Creek	Miama Gardens St	AA57284	4/28/2009	2419.6	293.35	Impairment is maintained from upstream sources. Lanuse is some ag with forested areas	NS
							AA57305	5/5/2009	172.2			
							AA57327	5/12/2009	131.7			
							AA57348	5/19/2009	151.5			
							AA57368	5/27/2009	261.3			
		INB1146_T1001	2009 Otter Creek TMDL	WBU030-0080	Waterworks Creek	Kennedy Crossing	AA57281	4/28/2009	2419.6	276.69	Headwaters is predominetly devloped land, the city of Brazil. CFO application is a possible source.	NS
							AA57302	5/5/2009	77.1			
							AA57323	5/12/2009	151.5			
							AA57324	5/12/2009	248.9			
							AA57345	5/19/2009	166.4			
							AA57365	5/27/2009	344.8			
	INB1138_T1023	INB1146_02	2009 Otter Creek TMDL	WBU030-0001	Otter Creek	Rosedale Rd	AA57289	4/28/2009	2419.6	291.09	Impairment is maintained from upstream sources. Lanuse is some ag with forested areas. Town of North Terre Haute	NS
							AA57310	5/5/2009	167			
							AA57332	5/12/2009	209.8			
							AA57353	5/19/2009	127.4			
							AA57373	5/27/2009	193.5			
	INB1138_T1023	INB1146_03	2009 Otter Creek TMDL	WBU030-0072	Otter Creek	Hasselburger Ave	AA57292	4/28/2009	1413.6	261.68	Impairment is maintained from upstream sources. Lanuse is some ag with forested areas. Town of North Terre Haute	NS
							AA57312	5/5/2009	178.5			
							AA57334	5/12/2009	166.4			
							AA57355	5/19/2009	131.4			
							AA57375	5/27/2009	222.4			



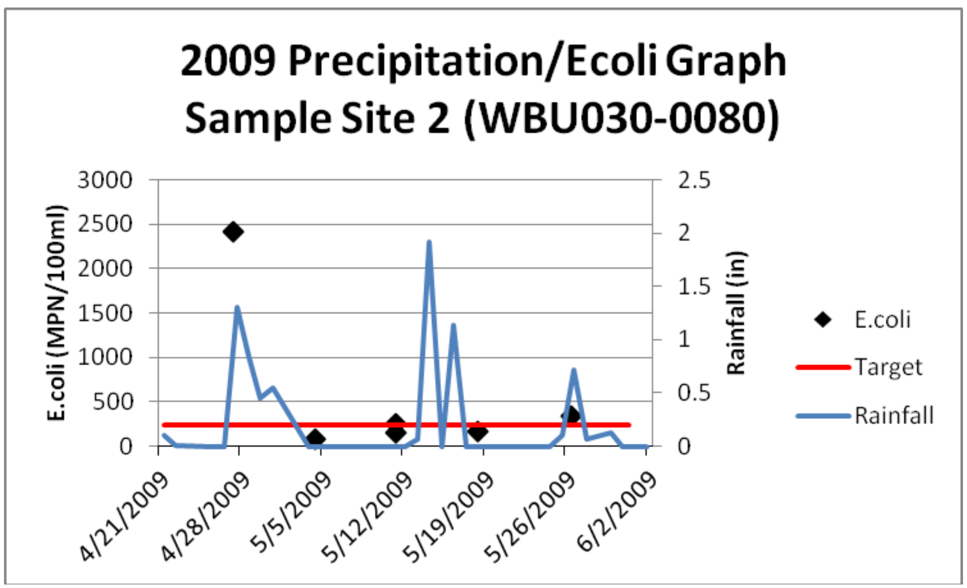
Upstream



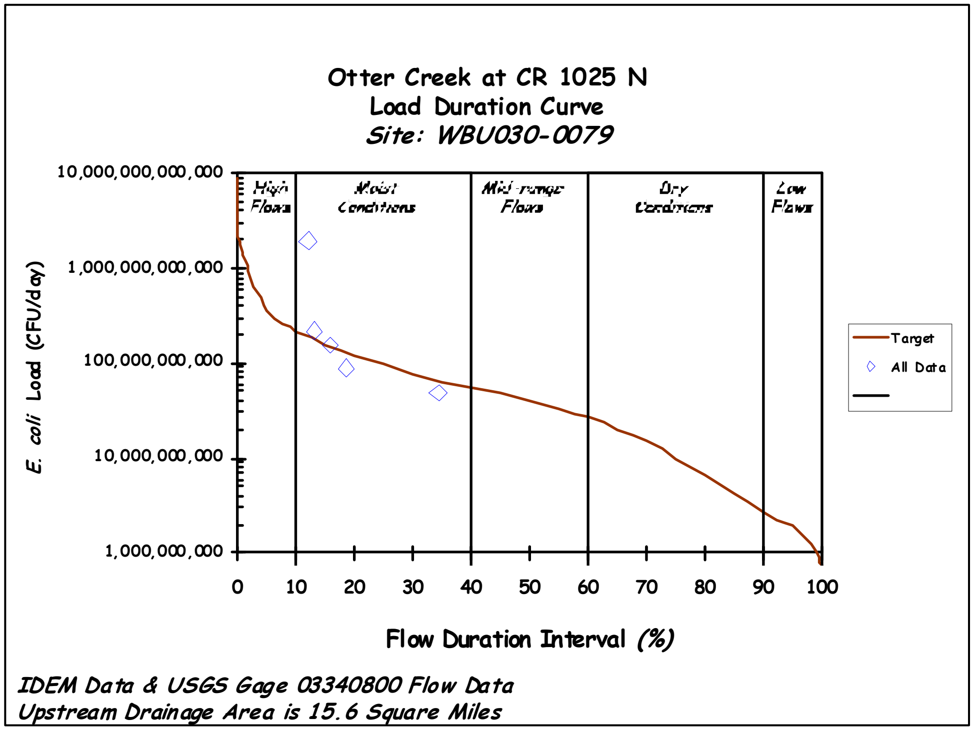
Downstream



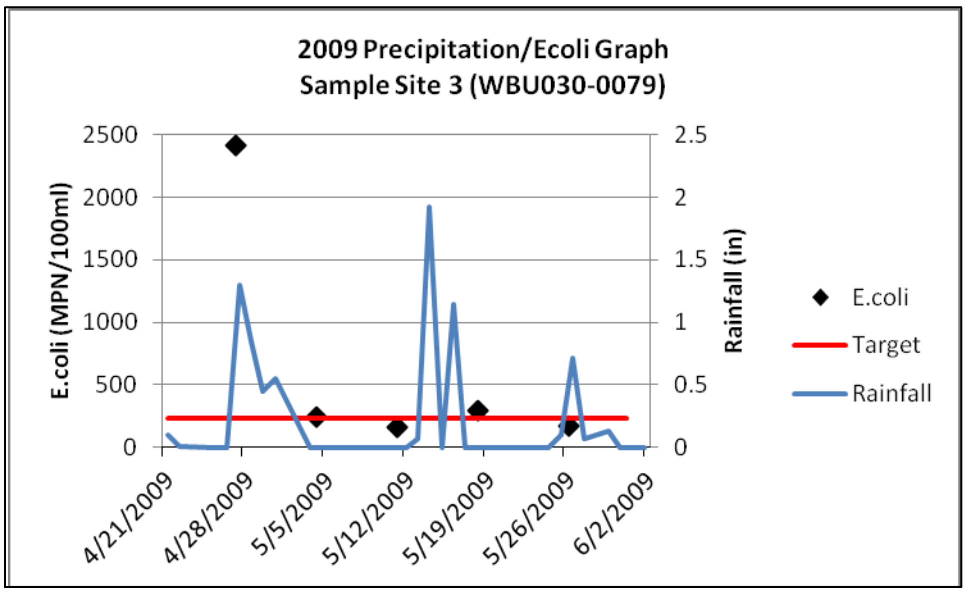
Upstream



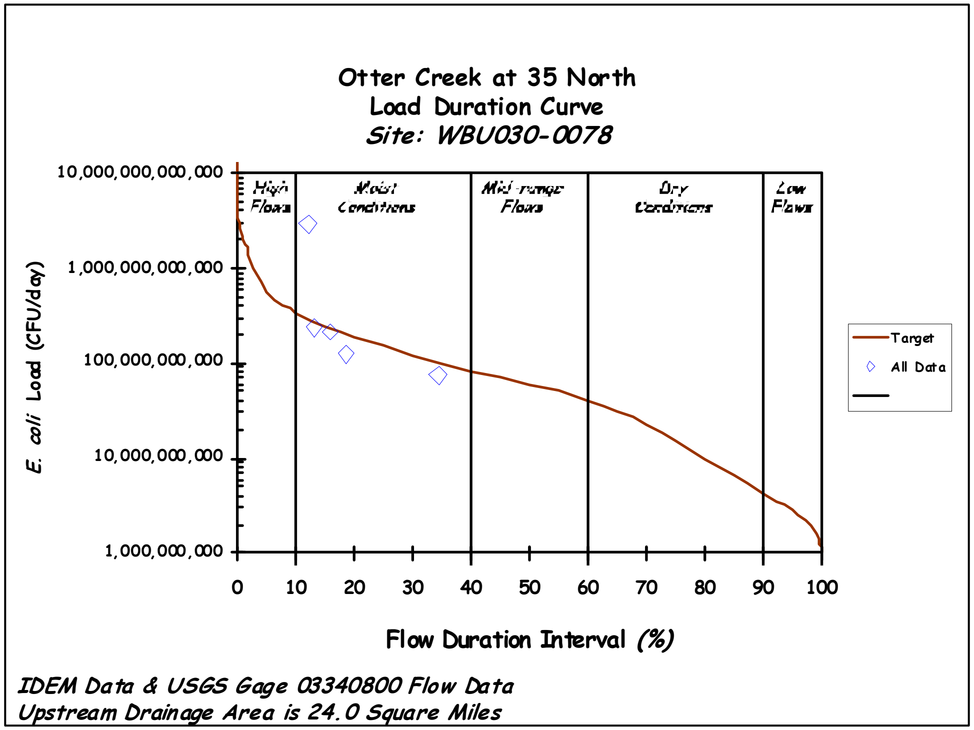
Downstream



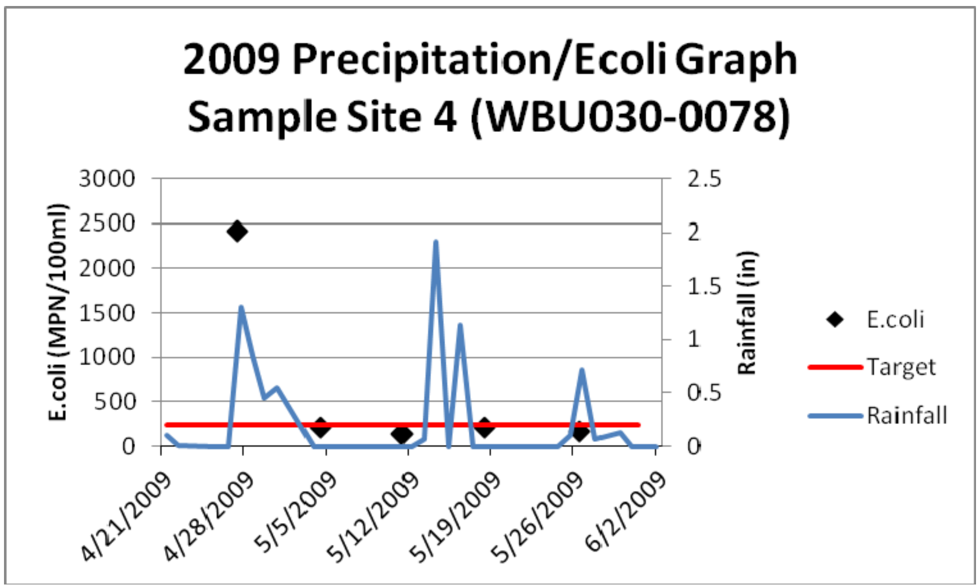
Upstream



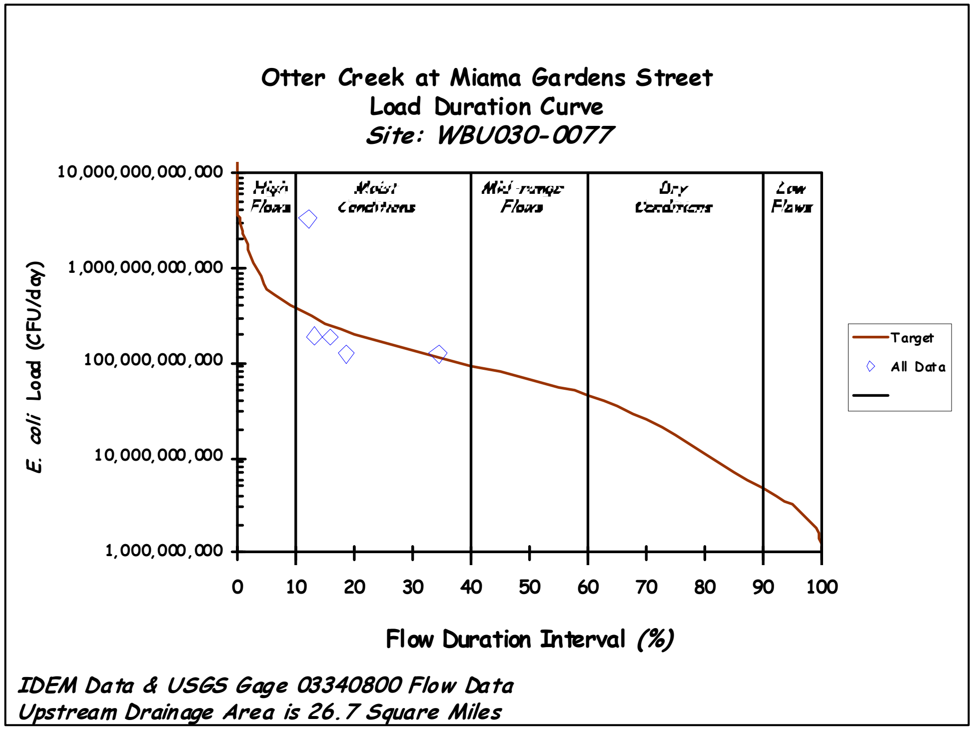
Downstream



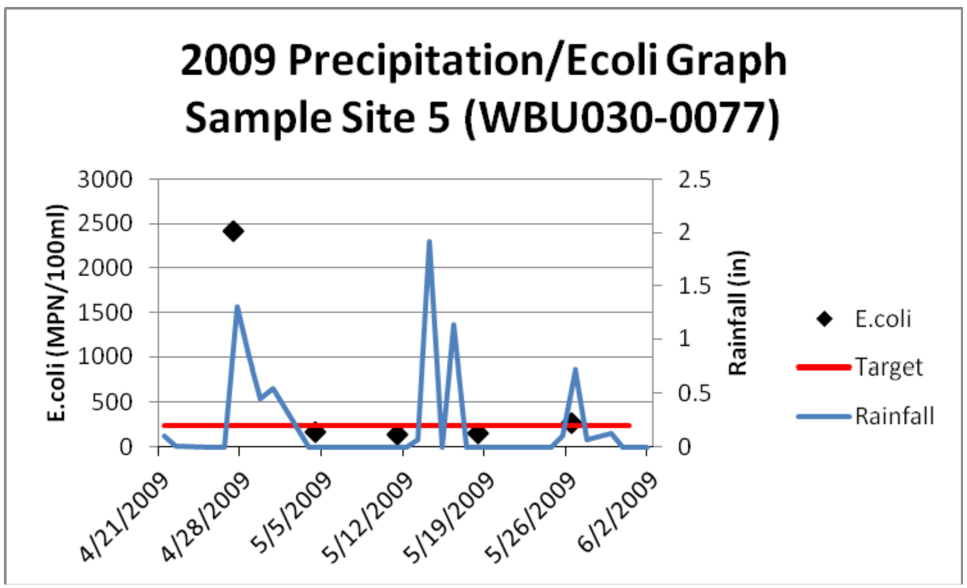
Upstream



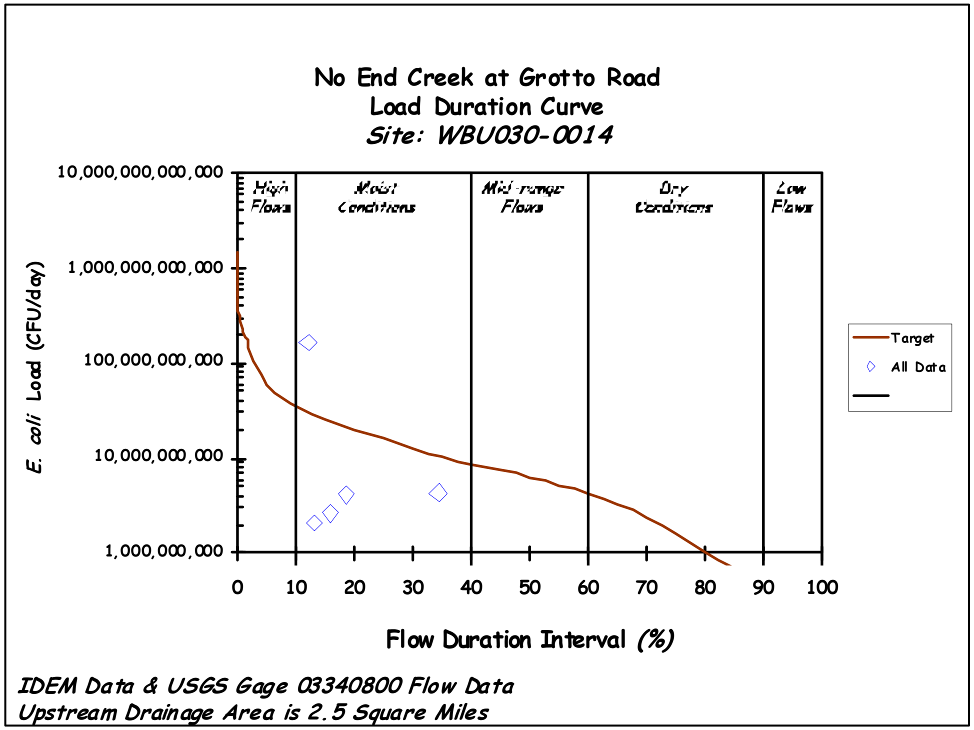
Downstream



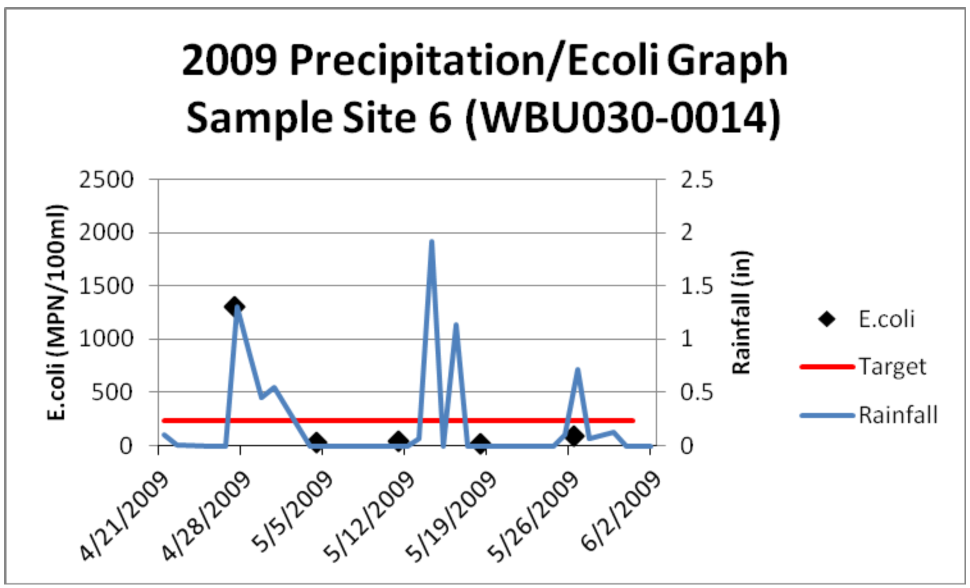
Upstream



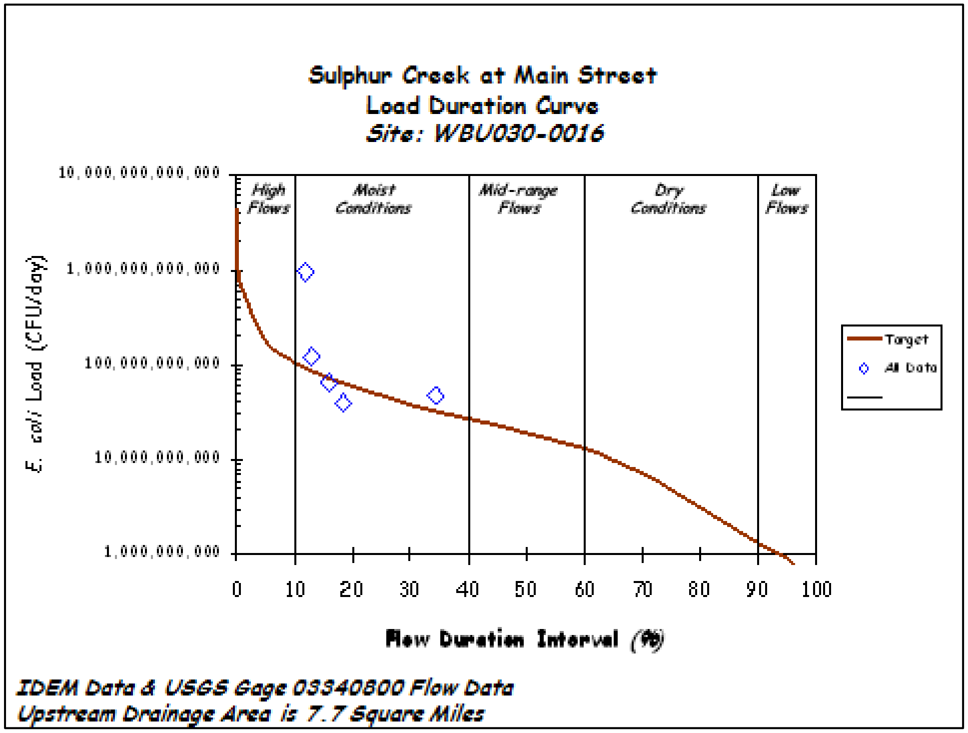
Downstream



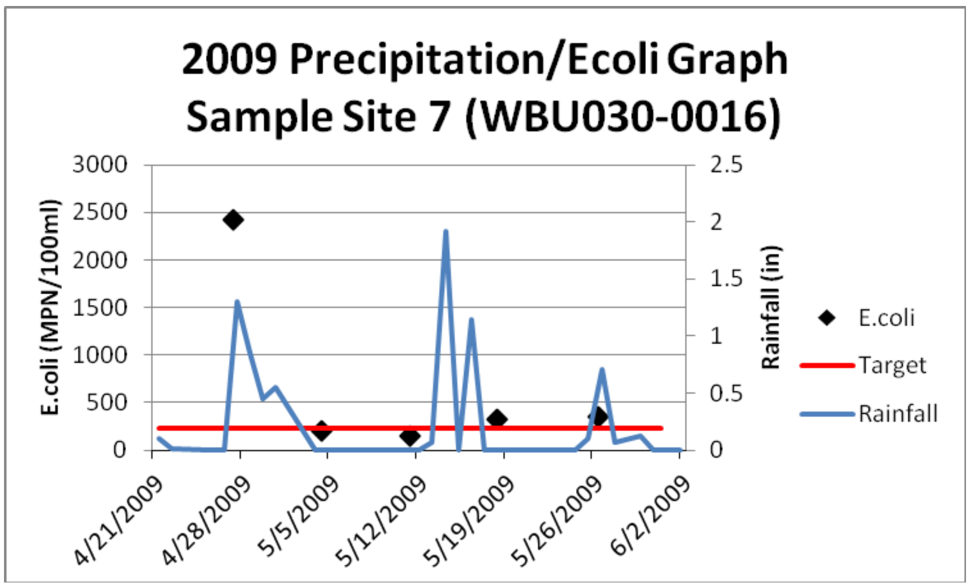
Upstream



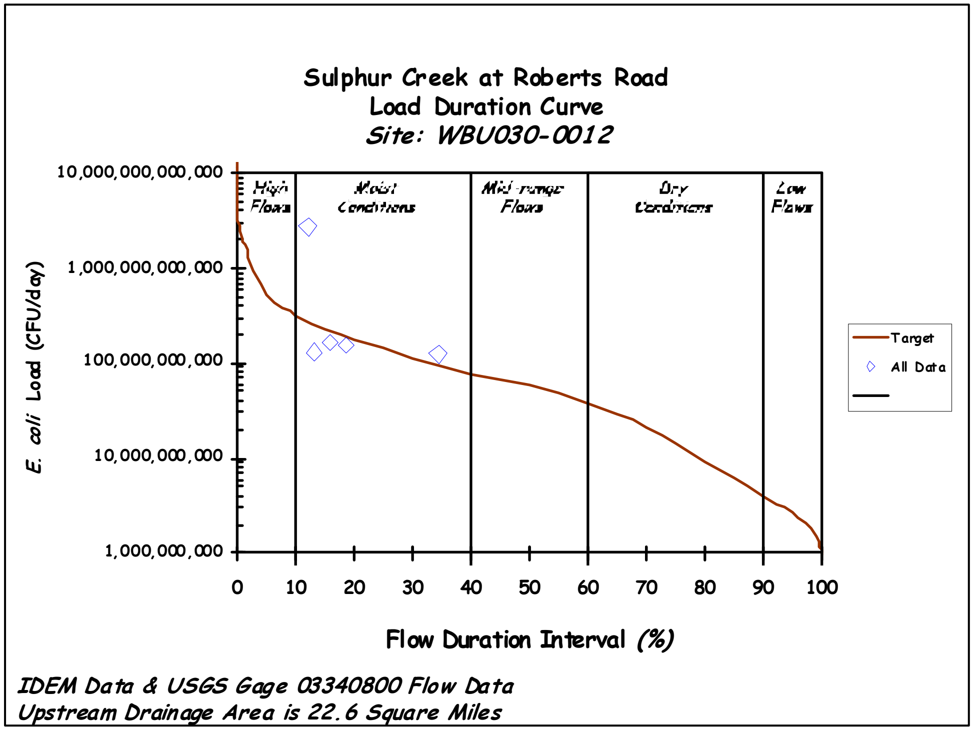
Downstream



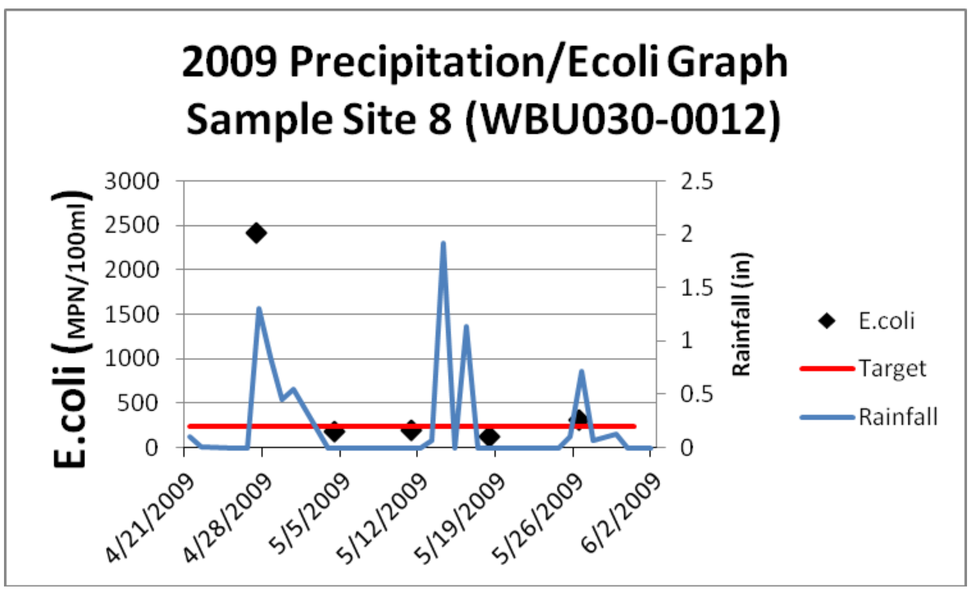
Upstream



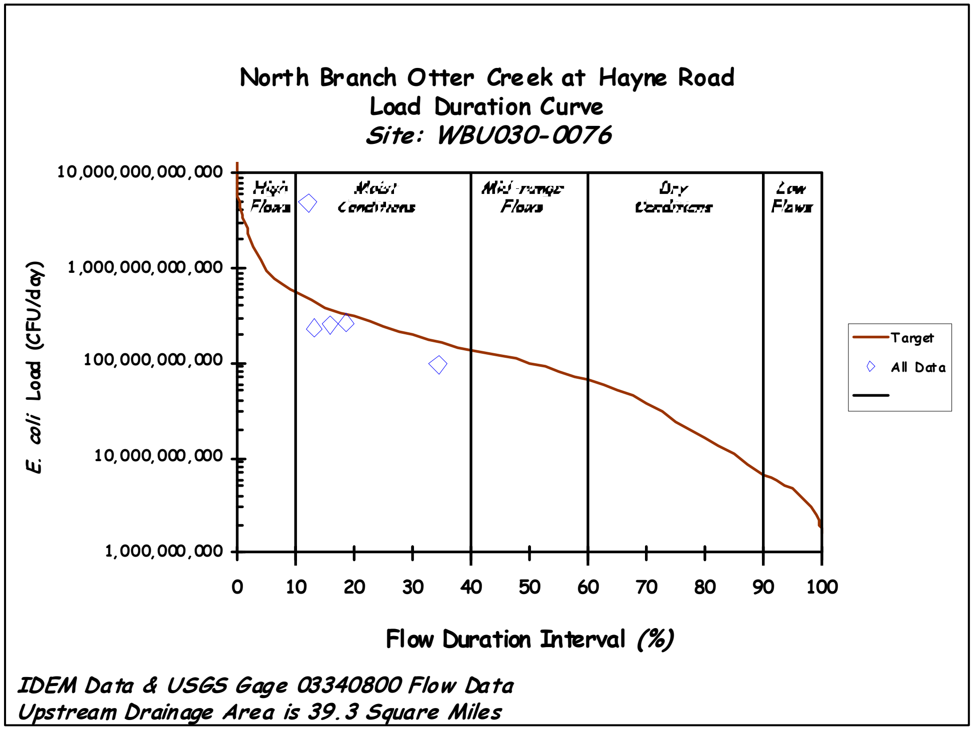
Downstream



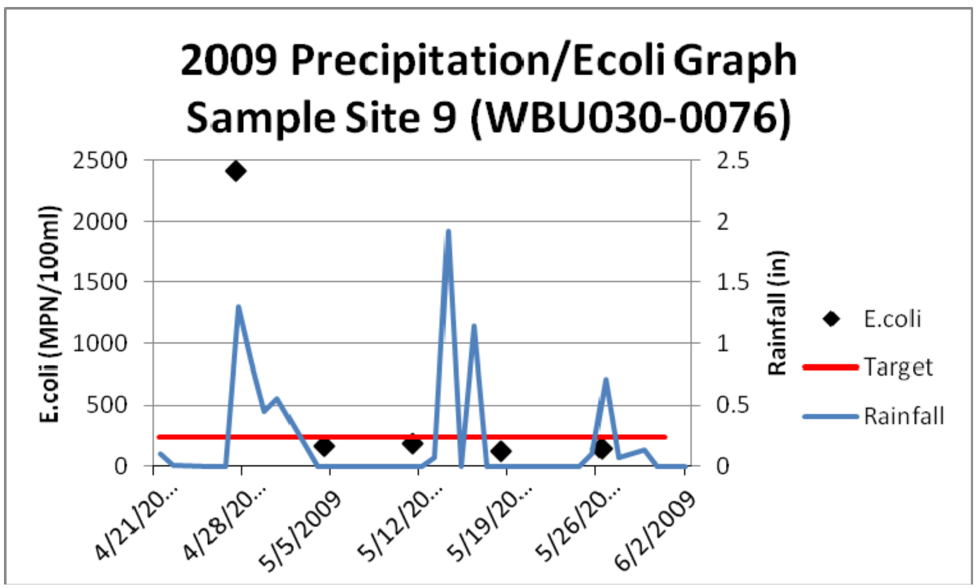
Upstream



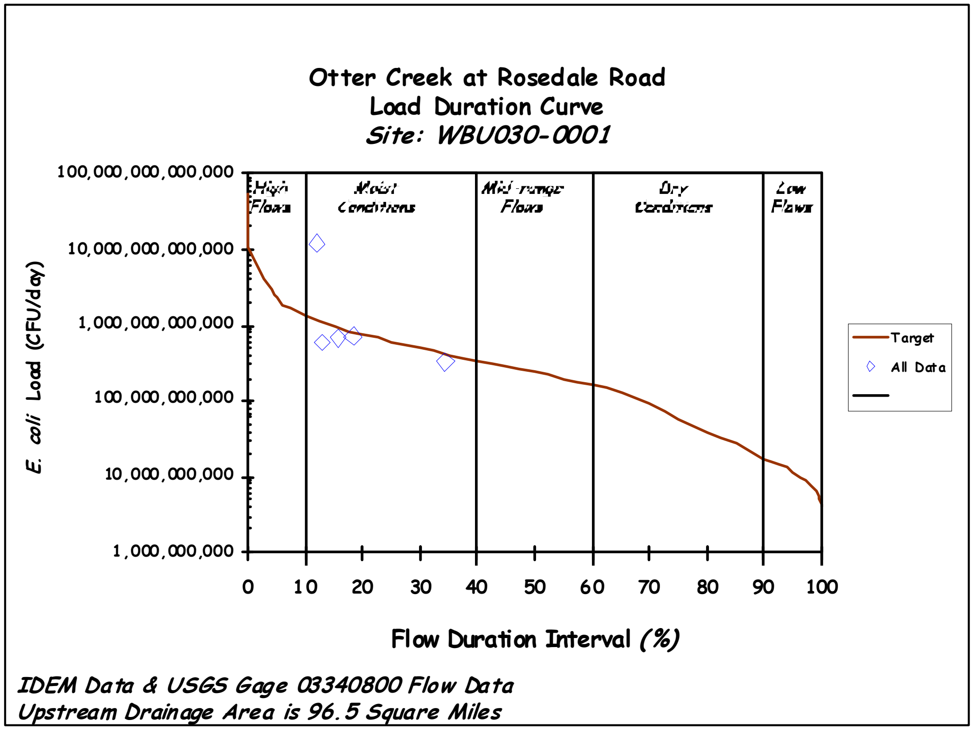
Downstream



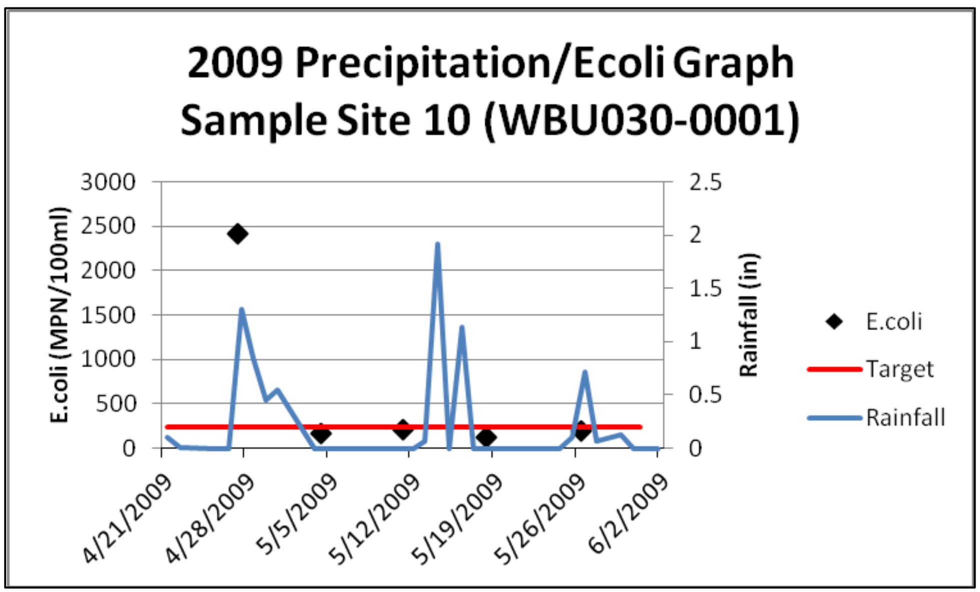
Upstream



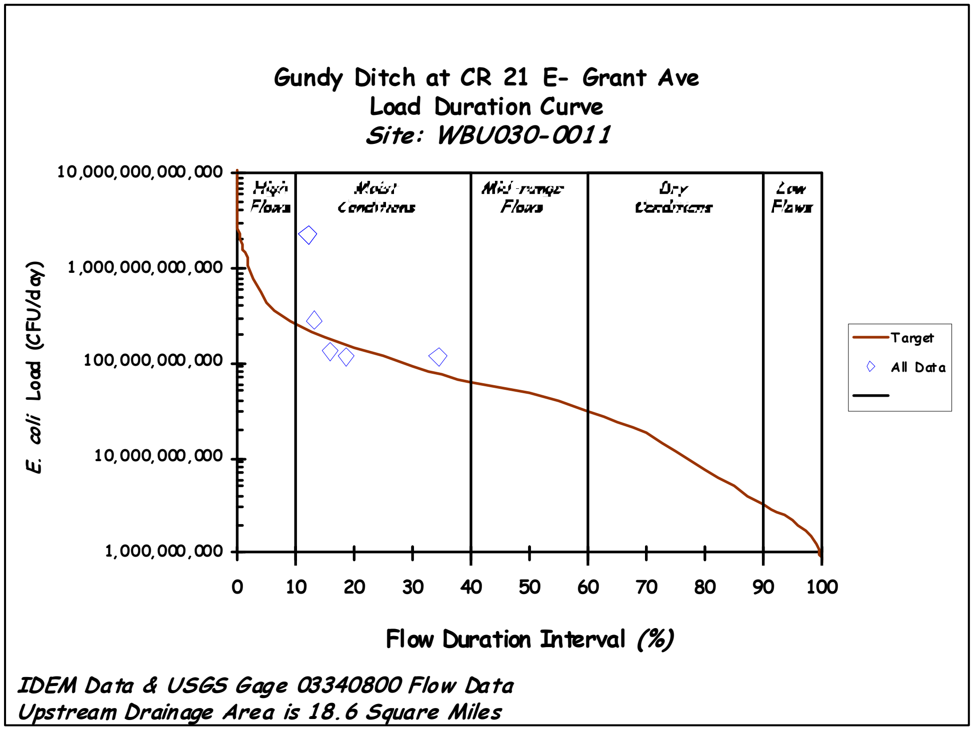
Downstream

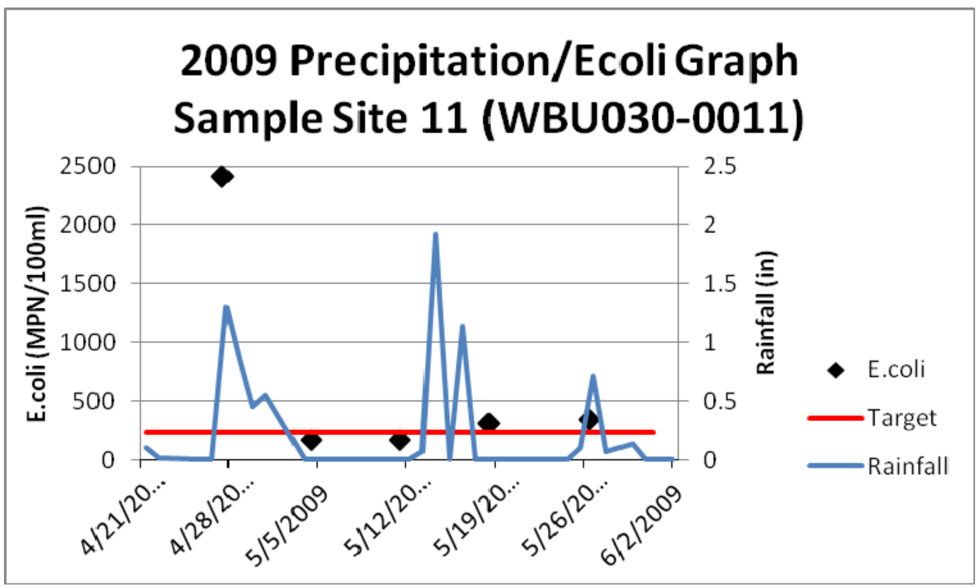


Upstream



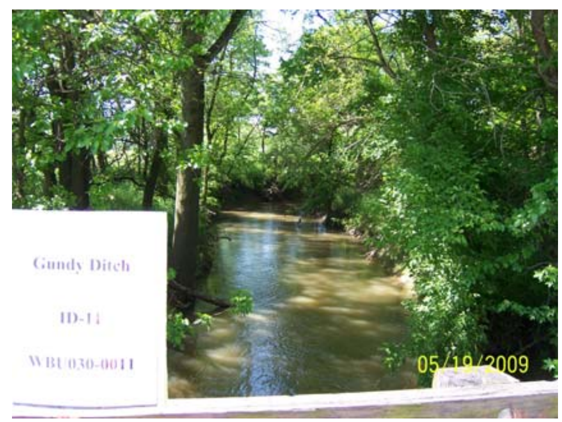
Downstream

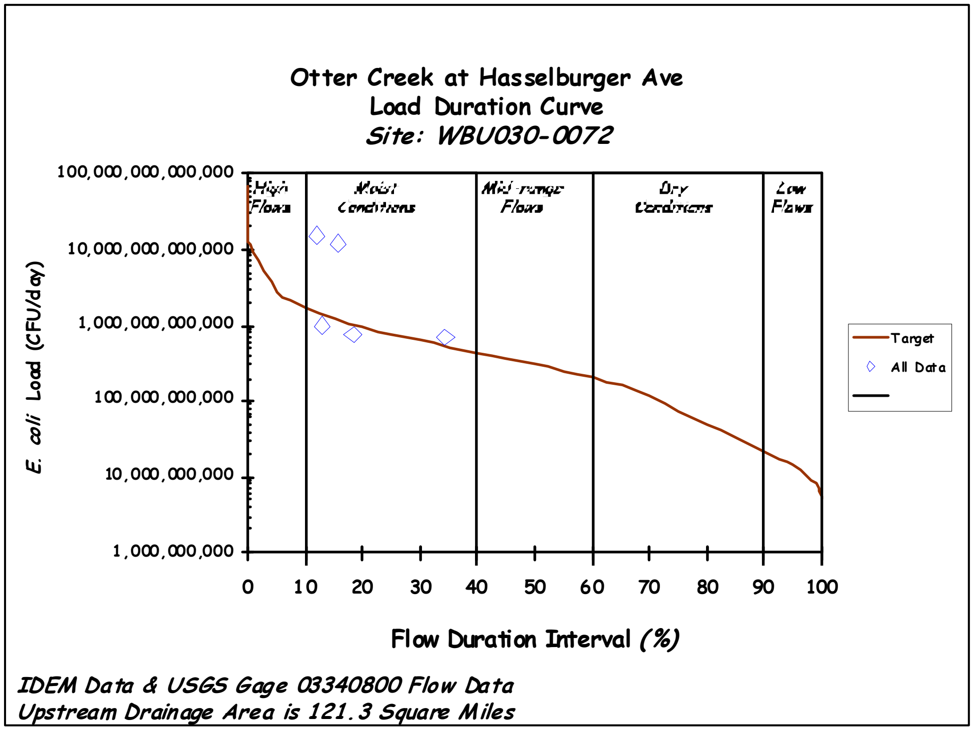




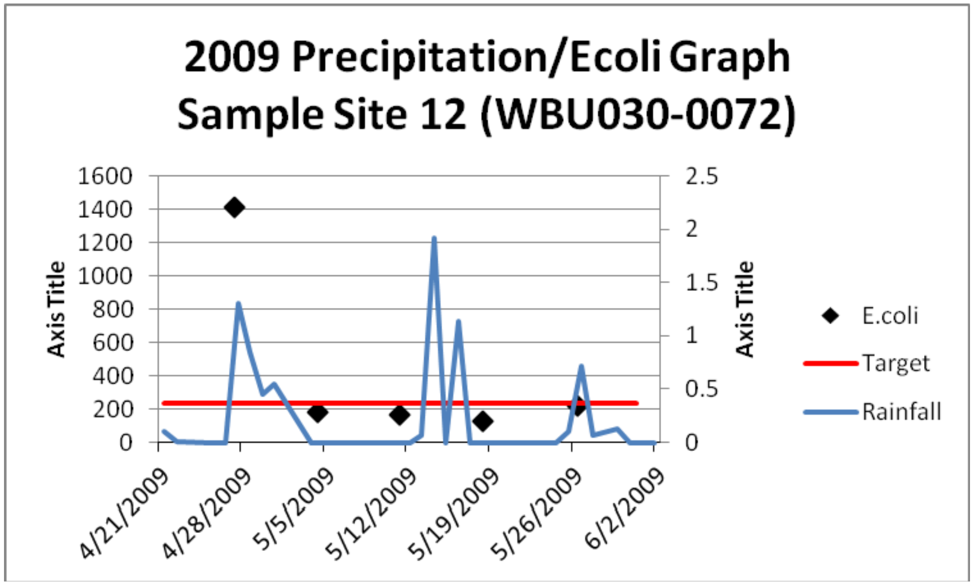
Upstream

Downstream

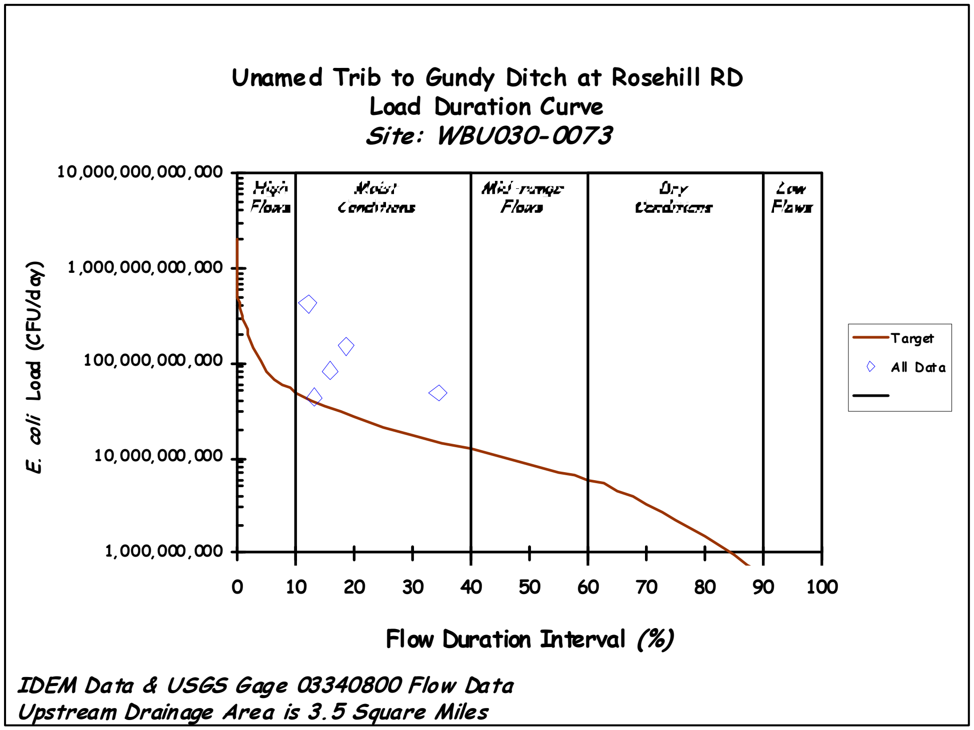


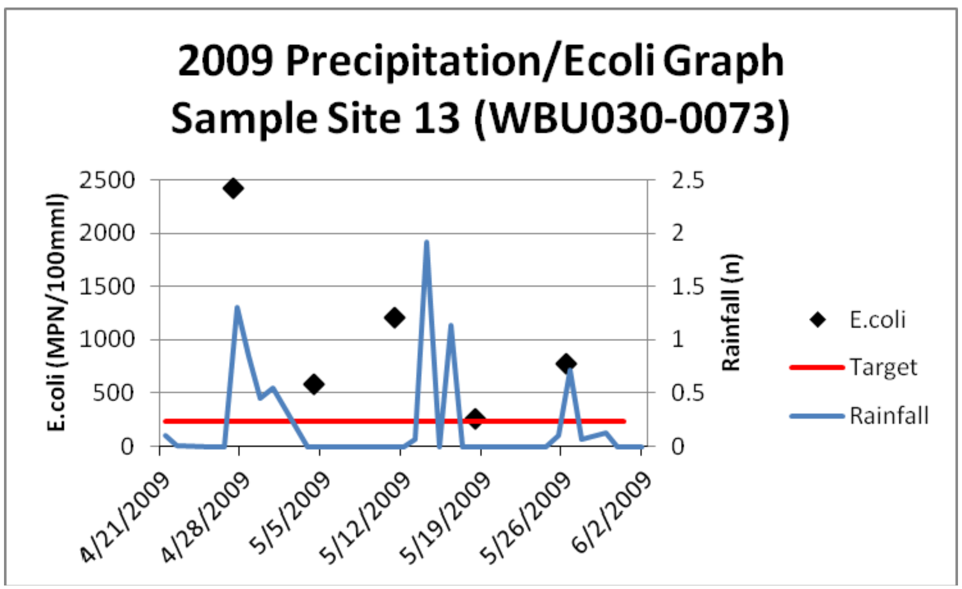


Upstream



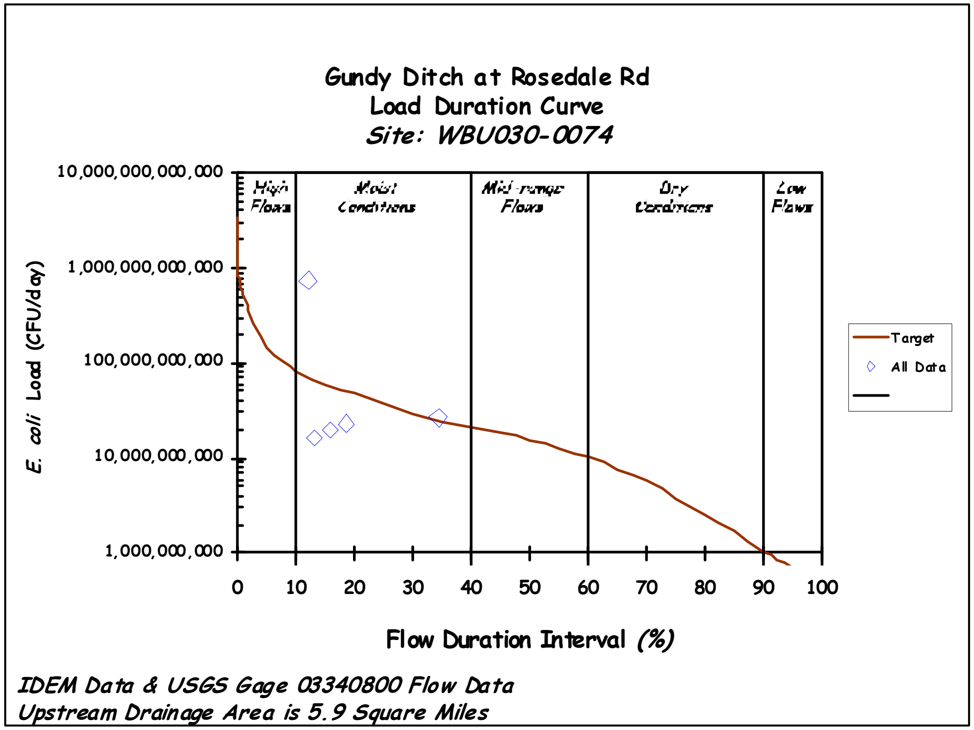
Downstream

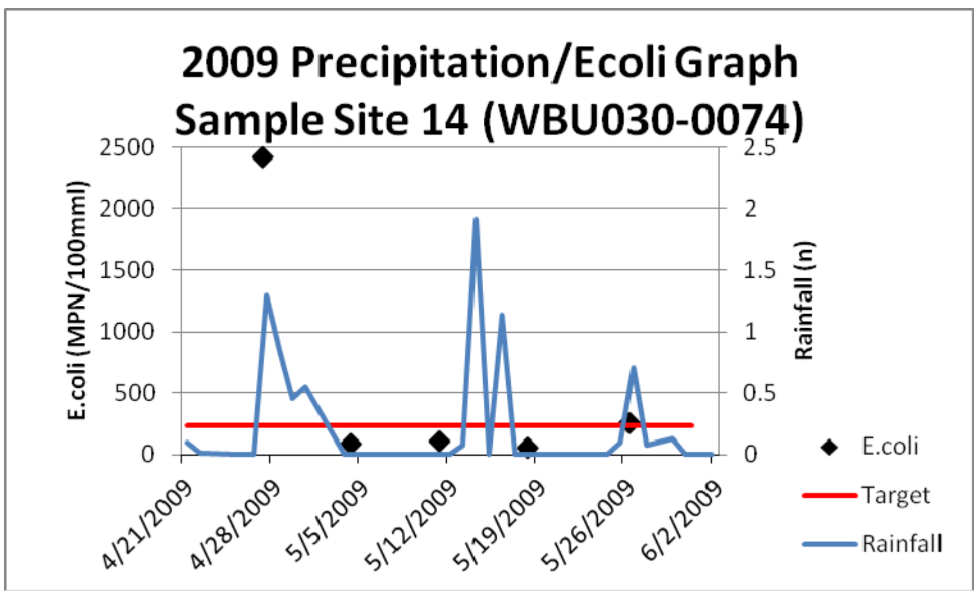




Upstream

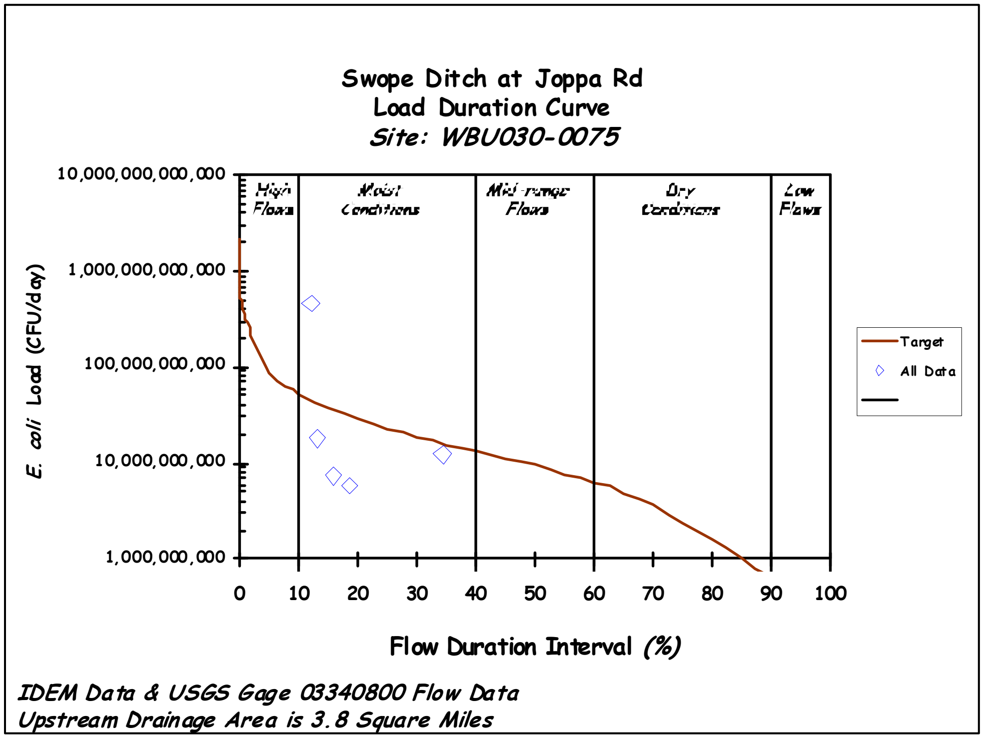
Downstream



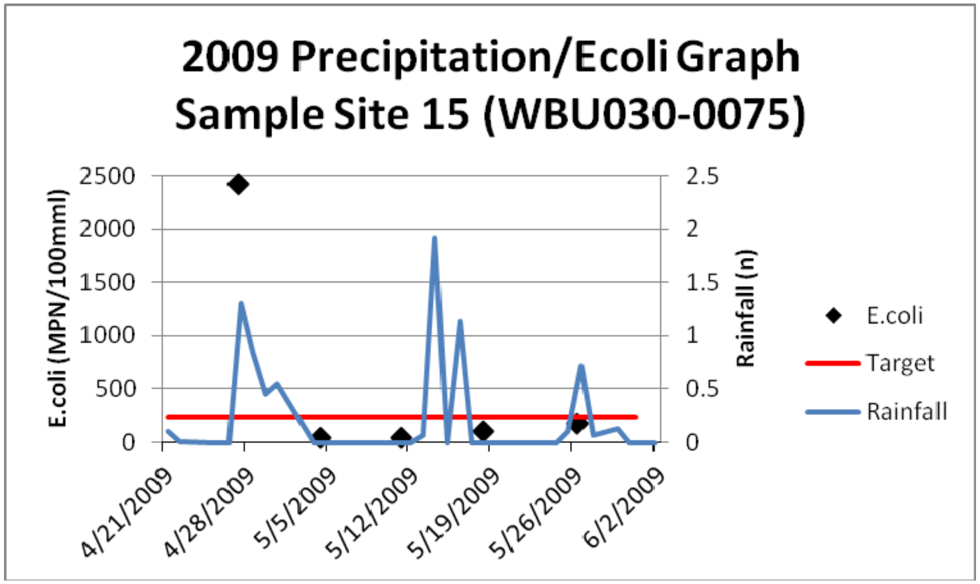


Upstream

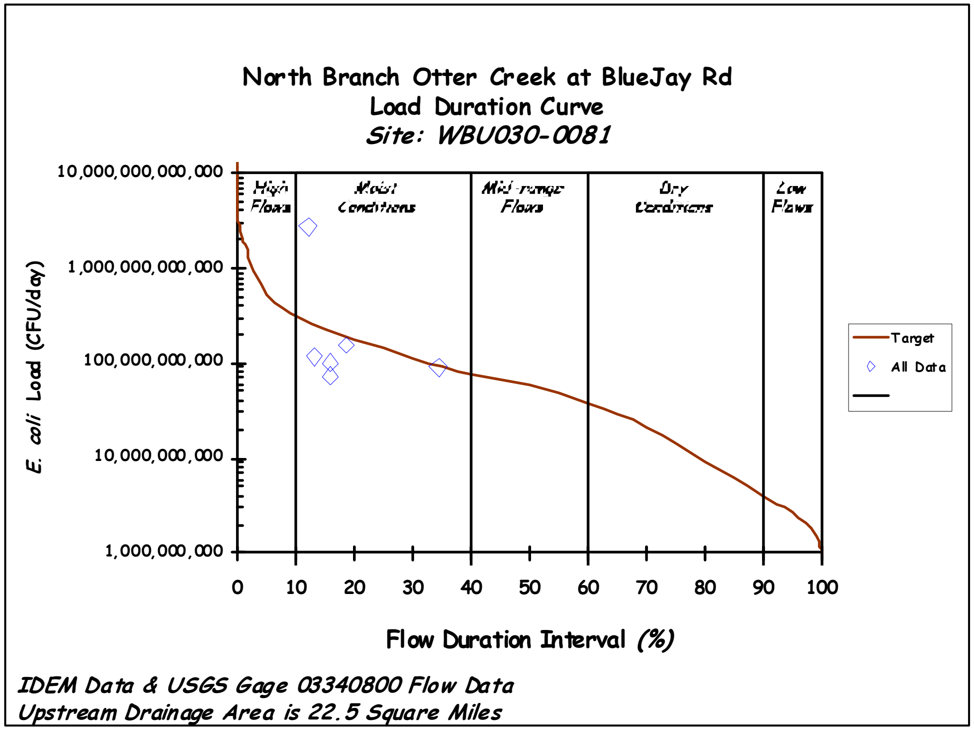
Downstream



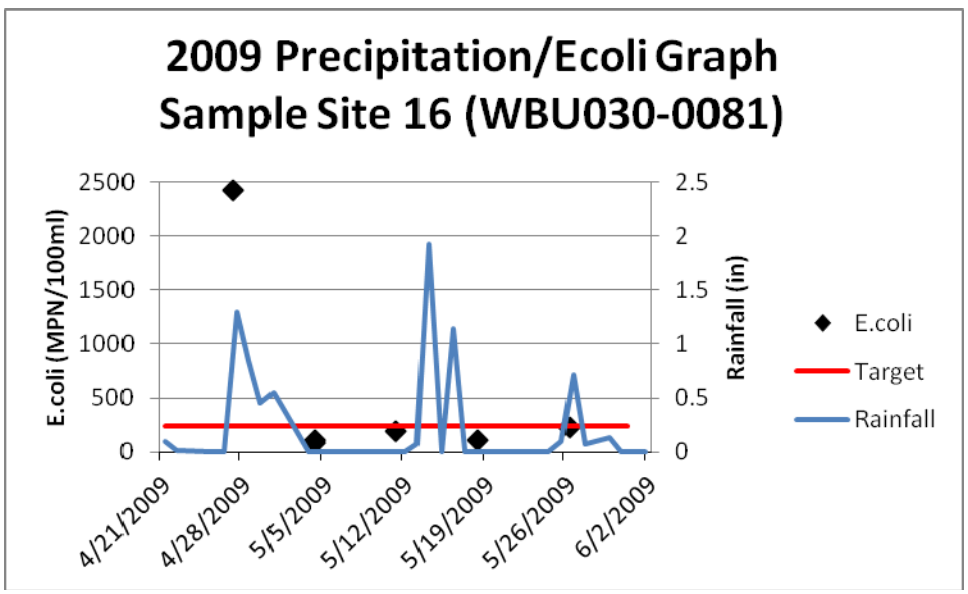
Upstream



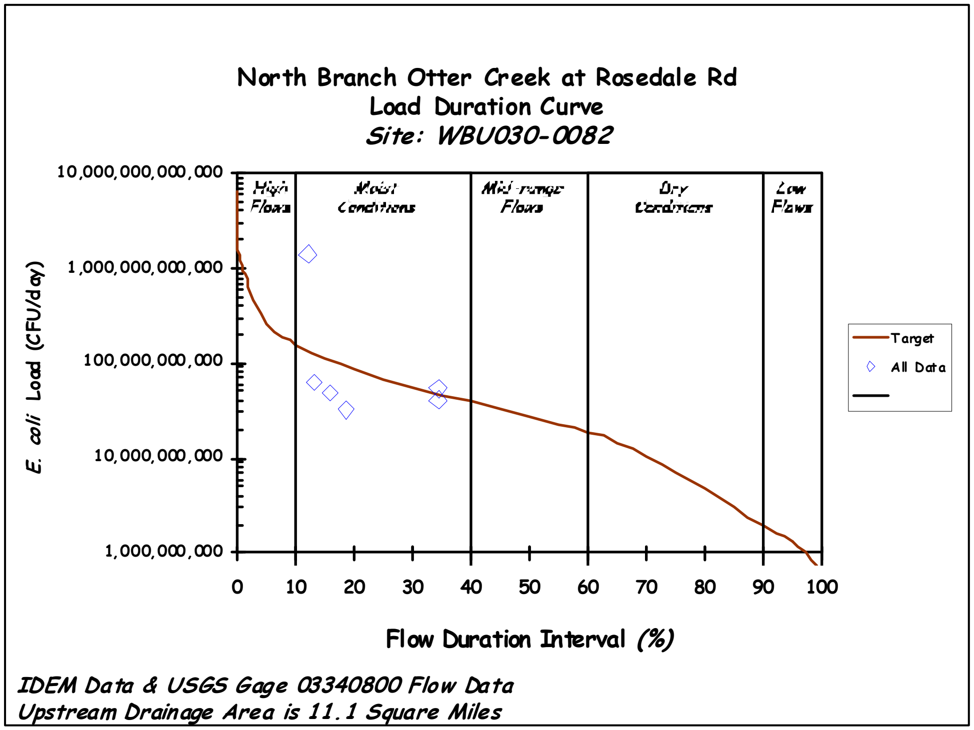
Downstream



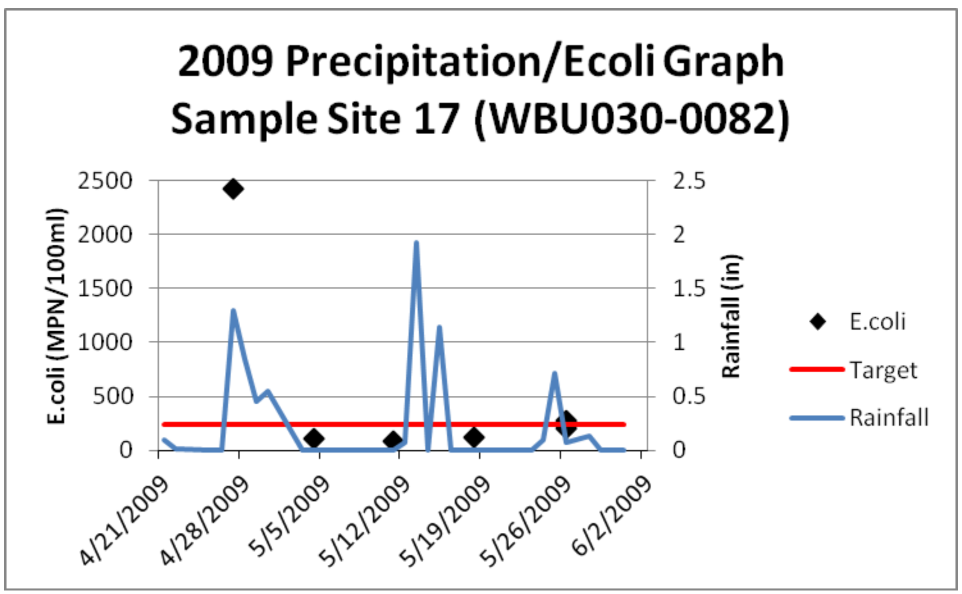
Upstream



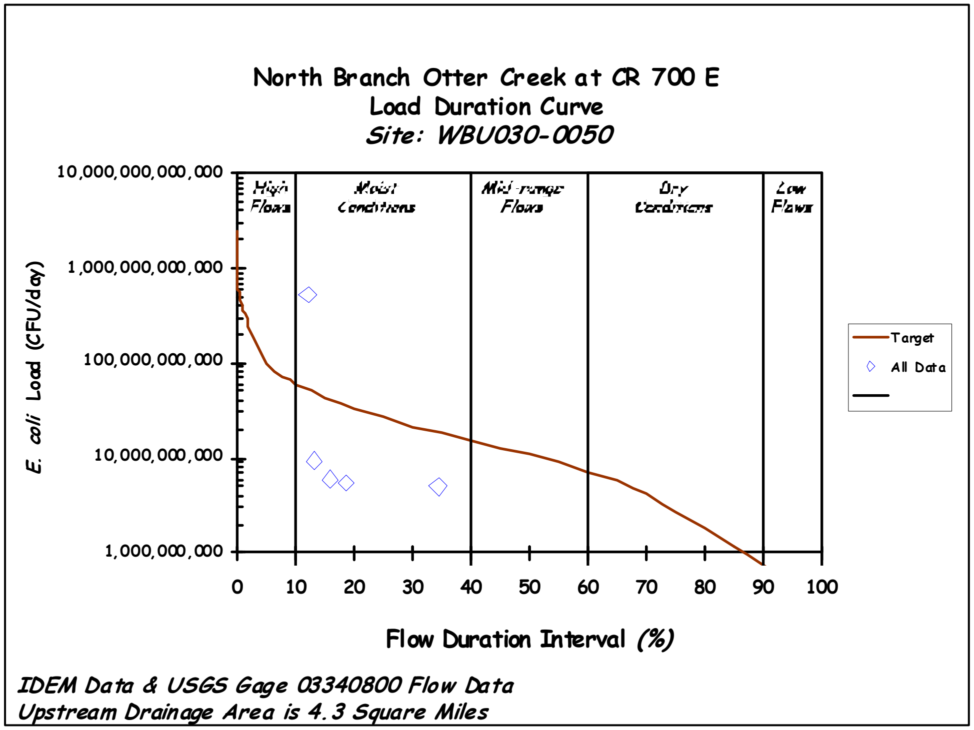
Downstream



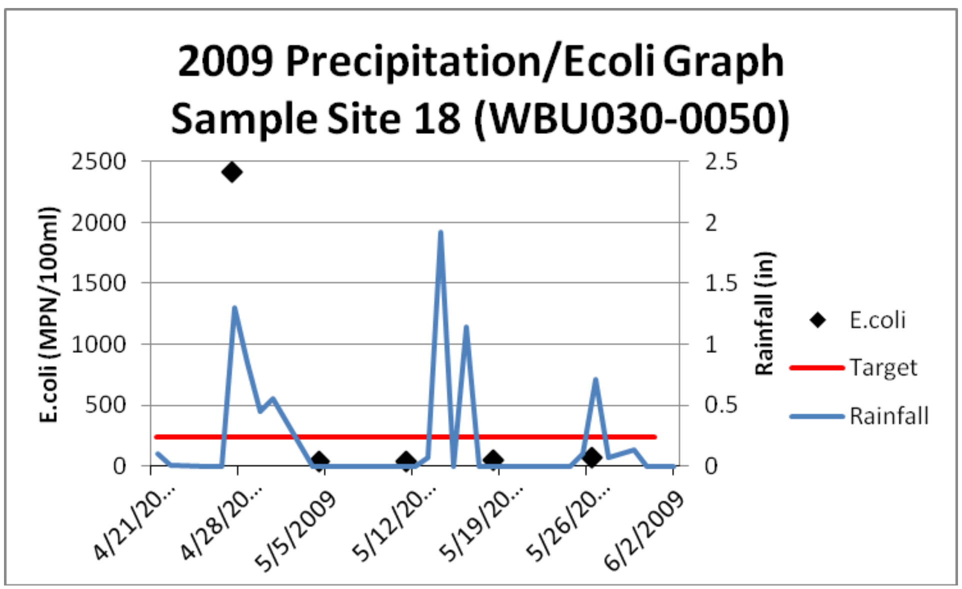
Upstream



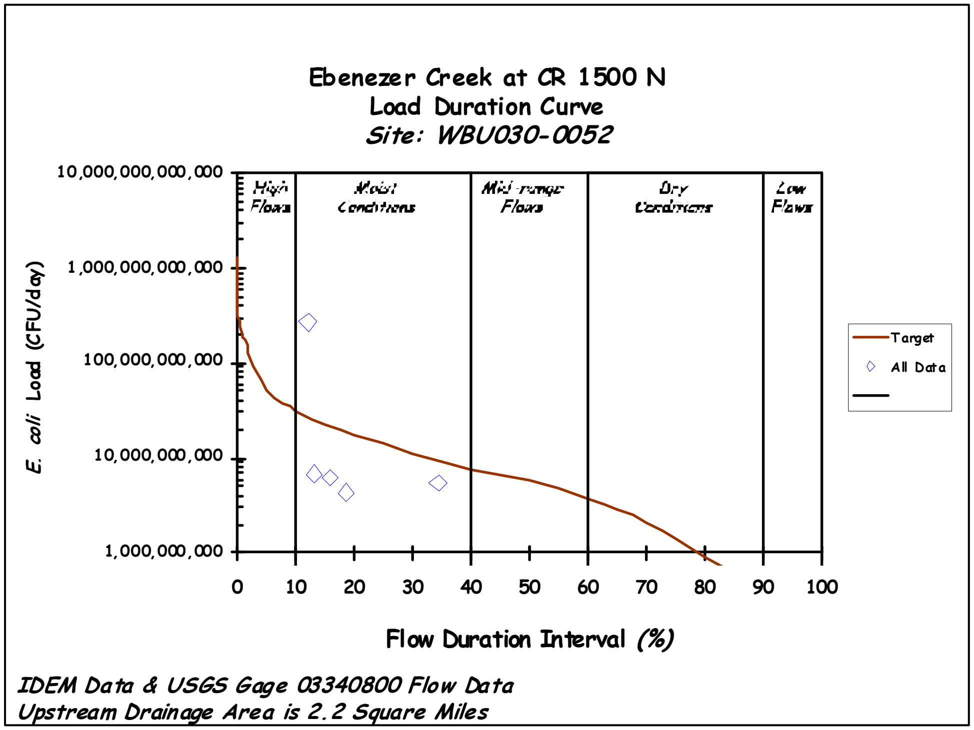
Downstream



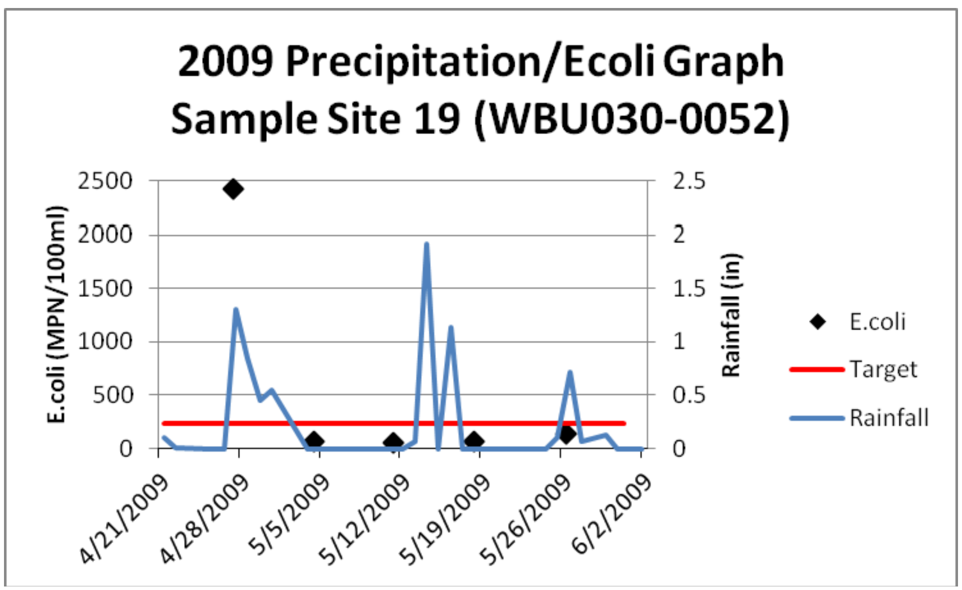
Upstream



Downstream



Upstream



Downstream

Appendix D: *E.coli* Load Reductions for Otter Creek Watershed

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			
Headwaters Otter Creek	WBU030-0084	INB1141_01	4/28/2009-5/27/2009	5	80	40	283.64	2419.6	55.93
	WBU030-0079			5	100	60	339.67	2419.6	63.20
North Branch Otter Creek	WBU030-0081	INB1142_01	4/28/2009-5/27/2009	5	60	20	246.59	2419.6	49.31
	WBU030-0082	INB1142_01		5	40	20	217.88	2419.6	42.63
	WBU030-0050	INB1142_01		5	20	20	96.47	2419.6	0
	WBU030-0052	INB1142_T1001		5	40	20	149.31	2419.6	16.28
Little Creek-North Branch Otter Creek	WBU030-0076	INB1143_01	4/28/2009-5/27/2009	5	100	20	262.56	2419.6	52.39
Sulphur Creek	WBU030-0016	INB1144_01	4/28/2009-5/27/2009	5	100	60	381.35	2419.6	67.22
	WBU030-0012	INB1144_01		5	80	40	314.56	2419.6	60.26
	WBU030-0014	INB1144_T1002		5	20	20	75.45	1299.7	0
Gundy Ditch	WBU030-0074	INB1145_01	4/28/2009-5/27/2009	5	40	40	197.18	2419.6	36.61
	WBU030-0011	INB1145_01		5	100	20	378.29	2419.6	66.96
	WBU030-0075	INB1145_T1001		5	40	20	154.98	2419.6	19.34
	WBU030-0073	INB1145_T1002		5	100	40	804.86	2419.6	84.47
Wastewaters Creek Otter Creek	WBU030-0078	INB1146_01	4/28/2009-5/27/2009	5	100	20	304.52	2419.6	58.95
	WBU030-0077	INB1146_01		5	100	20	293.35	2419.6	57.39
	WBU030-0080	INB1146_T1001		5	80	20	276.68	2419.6	54.82
	WBU030-0001	INB1146_02		5	100	20	291.09	2419.6	57.06
	WBU030-0072	INB1146_03		5	100	20	261.68	1413.6	52.23